MINERAL REPORT 10

Canadian Minerals Yearbook 1963

MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS, OTTAWA

1965

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Foreword

The name *Canadian Minerals Yearbook* is a new designation for the annual volume formerly called *The Canadian Mineral Industry.* Content is essentially the same, covering economic-engineering-resources developments in the Canadian mineral industry during the year concerned. As for the former volumes, the Yearbook consists of a number of individual mineral review chapters issued separately and in advance of the Yearbook itself.

Most of the statistics on Canadian production, trade and consumption are those collected for the Department by the Dominion Bureau of Statistics and are final unless otherwise indicated. 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.

February 1965.

W. Keith Buck,
Chief,
Mineral Resources Division.

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GENERAL REVIEW

A review of the mineral economy*

This summary of the Canadian mineral industry in 1963 has been prepared to introduce and to supplement the mineral industry review series consisting of 58 mineral commodities. The summary is in two parts: the first consisting of descriptive analyses of the year's developments and the other of statistical analyses set out in 59 tables. An introductory section in the first part provides a brief survey of the industry's progress and problems. This is followed by a summary of highlights for each of the principal mineral commodities and by an appraisal of developments in mining technology. Finally, an analysis is made of trends in 11 sectors of the industry, by referring to the statistical tables in the second part. Information is included throughout the summary to relate progress in the mineral industry to the Canadian economy as a whole.

PROGRESS AND PROBLEMS

Production value of the Canadian mineral industry reached $3,052 million in 1963, an all time high. Before reviewing the events of the year, brief reference is made to some historical landmarks in order to give perspective to the industry's current status and progress. Canadian mineral production was first recorded for the year 1886 and in 1900 the value of output reached $64.4 million. As the industry developed, production rose and in 1940 the output value was $529.8 million. There was little change during the war period but a fairly rapid increase in the immediate postwar years to about one billion dollars in 1950. Since then the industry has tripled its output. It is of interest to note that the average annual increase in production value up to 1940 was $10 million. Since the Second

*By the Mineral Resources Division.

World War the average annual gain has been $140 million. This is a measure of the rapid expansion that has taken place in the postwar period.

Behind these production statistics there are many important mineral developments from which today's large diverse industry has been built. To name a few, there were the coal and iron and steel developments in the Maritime provinces prior to 1850, and the discovery of oil in Ontario in 1858. During the 1850's there were widespread gold discoveries in British Columbia. In 1877, the Eastern Township area in Quebec was the scene of major asbestos discoveries that established Canada as the world's leading asbestos producer. In 1883 nickel was discovered in the now world famous Sudbury district. Throughout the 1880's and 1890's there were important gold and base metal discoveries and mine making projects in British Columbia, and exploration moved northward with the discovery of gold in the Yukon in 1898. The next famous landmark in Canadian mining was Cobalt, where a rich silver discovery was made in 1903. This led to the Porcupine and Kirkland Lake gold discoveries, with production commencing in 1912; that same year, natural gas was discovered in the Turner Valley field of Alberta. The Yukon silver-lead deposits at Keno Hill were first developed in 1919. The year 1921 marked the commencement of the Noranda mining operation in northwestern Quebec. Each of these discoveries was a forerunner of many others and, while the degree of activity in exploration and mine developments has varied from decade to decade, there have been many important discoveries in every period of Canadian history.

The postwar period has been the most productive in the history of the Canadian mineral industry. By the early 1950's the oil developments of western Canada and the iron ore developments of Quebec-Labrador were underway. These mineral developments have had a profound effect on the entire Canadian economy. By the mid-1950's Canada was established as one of the world's leading sources or uranium. At this time, there were other important mineral exploration actitities including copper discoveries in Gaspé, northern Quebec and northern Ontario; lead-zinc discoveries in New Brunswick; and asbestos in northern British Columbia. The latter part of the decade was marked by such major accomplishments as the opening of the Thompson nickel mine in northern Manitoba, the commencement of potash development in Saskatchewan and the start of large-scale natural gas production in Alberta and British Columbia. In the 1960's these and many other mineral resource projects have moved ahead. In addition there has been renewed interest in the Athabasca oil sands, and production plans have been completed for such new metal mining projects as the Pine Point lead-zinc operation on the south shore of Great Slave Lake. Thus the industry of today is the product of numerous resource developments, some of which are of first importance in the world mineral economy.

Having reached the status of a major Canadian industry and a leader in the world mineral economy, the mineral industry depends more and more for its growth and prosperity on favourable national and international trends. Progress in resource development, production and in marketing is closely related and responsive to supply and demand forces of national and international origin. Because of its large size and strong degree of export orientation, the industry must be viewed in the final analysis as a part of the international mineral economy. As a consequence of its important international position, the Canadian mineral industry finds its most serious obstacle to future growth in trade restrictions. Trade problems arise not only from normal changes in supply and demand trends but also from resource development and marketing policies based on various forms of restrictive nationalism including tariffs, quotas and subsidies. The close relation between trade progress and the economics of exploration, production, processing and transportation requires examination of all phases of the industry, including related labour, finance and taxation matters, in any assessment of the industry's progress. Consequently this General Review has been designed to provide the basic information for industry assessments as well as a summary of progress for 1963.

Resource Development and Production

An indication of the extent of mineral industry activity in 1963 can be obtained by merely listing some of the principal projects that were underway across the country. In Newfoundland a new asbestos property came into production at Baie Verte, involving a capital expenditure of $25 million. In the Quebec-Labrador iron ore industry the emphasis was on the installation of facilities for pelletizing iron ore to upgrade it prior to shipment. A large increase in capacity resulted from the completion of one plant in Labrador, Newfoundland. Another large increase will occur in 1965 with the completion of a pellet plant at Pointe Noire, Quebec. In New Brunswick a large lead-zinc mine in the Bathurst area was prepared for production commencing in 1964 at a daily output of 3,000 tons, and construction of a lead-zinc smelter complex was started at Balladune Point, on the north shore of the Bay of Chaleur. In Quebec three new zinc-copper mines came into production in the Matagami Lake area of the northwestern section of the province. Associated with these mine developments, a new zinc refinery, the first in eastern Canada, was completed at Valleyfield near Montreal. Exploration for base metals continued at a high level in northwestern Quebec and a number of properties were being prepared for production. The province's first nickel mine operated at capacity during the year. Resource development of molybdenum continued, particularly in the Preissac Township near Cadillac.

In Ontario, plans were made to develop an asbestos occurrence 40 miles southwest of Timmins. A new cold-rolling mill to produce 25,000 tons of aluminum sheet annually was brought into production at Kingston. The high silver price heightened interest in former silver producing properties in the Cobalt-Gowganda area. In Manitoba, exploration and development of mining properties was active in the Snow Lake area, east of Flin Flon. In Saskatchewan, Canada's initial potash operation near Esterhazy operated successfully in its first full year of production and preparations were made for other potash mining operations near Regina and Saskatoon. There was a revival of interest in oil exploration in the southeastern portion of the province. In Alberta oil and gas exploration proceeded actively in the northwestern part of the province while sulphur production, which is derived from natural gas processing operations throughout the western part of the province, increased by 20 per cent. Active development of the Athabasca oil sands continued and approval was given for the construction of a 45,000-barrel-a-day plant to process the oil sands.

In British Columbia active exploration for natural gas continued in the Peace River district. The iron ore industry achieved record production, with output from the province's five mines reaching almost two million tons. As in Ontario, the favourable price of silver served as a spur to exploration for new silver deposits in British Columbia and in Yukon Territory. Appraisals of a large iron ore occurrence in the Snake River area in the Yukon neared completion. In the Northwest Territories good progress was made on the construction of a 432-mile railroad to the large high-grade lead and zinc deposits at Pine Point on the south shore of Great Slave Lake. Mine development continued in preparation for production in 1966 which will provide initially for an output of 215,000 tons of lead and zinc concentrates a year. These and many other developments marked 1963 as one of the most active periods in recent years in mineral recource development.

The production value increase of 7 per cent was not as great as the gain in 1962 but above that of the two previous years. Table 1 shows that metallic mineral production rose only very slightly with the comparatively large increase for iron ore being counterbalanced by declines in the value of nickel and uranium while other metals remained at about their 1962 levels. Industrial minerals, including nonmetals and structural materials, rose almost 10½ per cent. The largest increase was in the fuels sector, with the value of output being up by about 16 per cent.

Markets

The state of the market for minerals and the near-term prospects for growth have a dominant effect on exploration and resource development, and set limits to actual output. Because of its strong export orientation, the Canadian mineral industry is particularly sensitive to changing conditions in export markets. Some minerals and products are marketed in large part outside the country while the industry, as a whole, relies on exports as an outlet for about 60 per cent of its output. The generally buoyant economy throughout the world in 1963 created an increased demand for minerals, and Canada benefited at least in some measure from this favourable state of the international mineral market. Of particular importance to Canada was the condition of rising mineral demand in the United States, Britain and Japan; exports to these markets increased whereas exports to the European Economic Community (EEC) suffered some decline. Buoyant economic conditions in the United States led to a rising demand for durable goods and this, in turn, to increased iron and steel and nonferrous metal requirements. This situation provided an opportunity for increased exports of iron ore and aluminum to the United States but there was a decline in exports of most nonferrous metals because of other factors, related to stockpile disposal and non-tariff restrictions to trade. Improved economic conditions in Britain gave rise to a favourable market situations for steel and nonferrous metals and Canada was able to participate in its expanding mineral markets. The same can be said for Japan, but in the EEC countries there were more losses than gains for Canadian minerals because of increasing competition from other sources and in increasing tariff barrier.

Many other factors affected marketing in 1963. Excess supplies of copper and nickel in 1962 had led to production curtailments throughout the World. Consequently, the buoyant demand in mineral markets did not call for increased production during the first half of 1963 because of surpluses of these and other metals such as aluminum. It was not until the second half of the year that producers' stocks in North American markets were sufficiently drawn down to permit a step-up in production. Increasing economic activity at home and abroad also began to favour increased sales of industrial minerals and construction materials. In this mineral sector, world markets began to open up rapidly for Canada's recently developed sulphur resources and for its new potash industry. A surplus stock situation in sulphur made possible a 70 per cent increase in exports while production was being increased by 20 per cent.

Underlying special marketing conditions which develop from time to time, some very important factors exert a continuing impact on the marketing of Canadian minerals. The proximity of the large United States market and close corporate ties of suppliers and consumers favour the United States as a marketing area of first importance. On the other hand, longer shipping distances to overseas markets, lack of corporate ties between Canadian producers and foreign consumers, and the increasing availability of mineral supplies from developing countries in Africa, South America and southeastern Asia are factors which tend to inhibit Canada's mineral exports to other important markets of the world.

Changes in markets for the major metals and for all minerals as a group for selected years since 1950 are shown in the accompanying table of exports in raw and semiprocessed forms.

World marketing forces cause changes in the relative importance of Canada's mineral marketing areas throughout the world; they also bring about changes in the relative importance of leading mineral exports. In recent years iron ore and the fuels have been contributing an increasing proportion to the total value of mineral exports; uranium rose rapidly in the late 1950's and is now declining; and some of the nonferrous metals have also been accounting for somewhat smaller shares in total exports than a decade ago. The percentages of the leading minerals in total mineral exports in 1963 compared with 1962 were as follows: nickel - 16.1 and 16.7 per cent; fuels (crude oil and natural gas) - 15.9 and 16.3 per cent; aluminum - 15.3 and 14.9 per cent; iron ore - 13.5 and 11.4 per cent; copper 10.3 and 10.5 per cent; asbestos - 6.9 and 7.0 per cent; uranium - 6.8 and 8.6 per cent; and lead and zinc combined - 4.2 and 4.4 per cent. Seven metals, asbestos, and the fuels accounted for 90 per cent of all mineral exports, the same percentage as in 1962.

Competition in international mineral markets remains keen and Canadian mineral producers had to meet a number of problems in 1963 and be prepared to take advantage of market growth opportunities affecting individual mineral commodities. Nickel producers were not able to increase production in line with rising demand in foreign markets because of large stocks and inventory liquidation, particularly in the United States; in fact Falconbridge had to cut back its production in the Sudbury area as International Nickel had done in 1962. Reduced nickel output restricted copper production growth in the Sudbury area which had

Distinations 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	50	60.4
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	29	19.0
Countries of the European Free Trade Area* excluding Britain	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
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
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
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	7	6.0

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

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

a marked effect on Canada's total copper output. Canada lost ground in the United States and EEC copper markets but made compensating gains in Britain and Japan. Although lead and zinc demand improved considerably, exports to the United States were held down by quota restrictions. In mid-1963, the federal government instituted a short-term stockpile program for the uranium industry to lessen the impact of rapidly declining markets. With the near-completion of its United States marketing contracts, the industry will for several years be relying almost solely on its United Kingdom contracts; in 1963 almost one third of its sales were made in Britain. Gold production continued the decline of recent years because of high costs and the fixed price. Rising steel consumption in the United States and Britain in the second half of 1963 enabled the Canadian iron ore industry to make good progress in these markets after very little gain in the first half of the year. Losses in the EEC market have been more than compensated for by gains in shipments to Japan since 1961. Outstanding gains have been made for aluminum in the United States market since 1961, although marketing progress elsewhere has not been pronounced because of increasing competition from other leading producers and trade restrictions. The asbestos industry experienced a sharp decline in EEC countries but more than compensated for this by increased shipments to Britain and a number of smaller markets throughout the world.

As a result of these and other changes in the marketing situation for individual commodities, the $79 million gain in 1963 in the export value of raw and semi-processed mineral commodities was due primarily to gains in the British and Japanese markets. The slight gains in the United States and in other markets throughout the world were cancelled out by losses in the EEC. These changes reversed a trend of declining relative importance for the British market, evident since the mid-1950's, and raised the importance of the Japanese market almost to the level of the EEC market. The progress in the British and Japanese mineral markets was made along a broad front, with gains being evident for almost every mineral commodity. The main difficulties in the United States market related to the sale of uranium and the principal nonferrous metals. Overall results were disappointing in EEC markets and only moderate progress was made in the many other markets throughout the world. The year's export results point to the overwhelming importance of the United States and British markets to the Canadian mineral industry. In the early 1950's, these two markets took over 85 per cent of the country's mineral exports; subsequently the percentage dropped to less than 75 per cent but in 1962 and 1963 it was at the 80 per cent level. The expanding economic activity throughout the world in 1963 encouraged increased mineral exports from Canada. However, because of the existence of world surplus stocks, and of quotas and other restrictions to trade, the growth in exports was not comparable to the expansion in world market demand.

Mineral and Metal Prices

Prices of minerals and metals during 1963 were subjected to two principal forces. Buoyant demand in world markets for most minerals and metals which sulphur production has required large capital outlays in recent years and the expenditure in 1963 of $44 million was second only to the outlay of $77 million in 1961.

The $500 million capital expenditures made in 1963 in construction and for machinery and equipment in metal mines, coal mines, oil and gas fields, natural gas processing plants, and industrial mineral mines and quarries does not include an additional outlay of $140 million for repair expenditures. These expenditures raised the total outlay in what is essentially the mining sector to some $640 million. Exploration expenditures of almost $45 million in metal mining and of $58 million in petroleum added a further $100 million, at least. In the primary metal industries, capital and repair expenditures totalled $343 million in 1963. Expenditures in the petroleum and natural gas sector in transportation, refining and marketing totalled $350 million. Thus total outlays for the mineral industry as a whole aggregated some $1.4 billion. A complete accounting of all expenditures related to the year's activities would also require the addition of amounts expended on roads, railways, dock and power facilities that were established for the purpose of serving mineral industry enterprises.

Employment

Notwithstanding the extensive growth of the mineral industry in recent years and the magnitude of capital investment, total employment has changed very little. Several factors account for the lack of employment growth in this expanding industry. Open-pit operations now account for over one third of the total tonnage mined compared with about one sixth in the early 1950's, and the adoption of this method, particularly in the fast-growing iron ore industry, has resulted in the substitution of machines for manpower. Employment in the declining gold, coal and uranium industries, formerly employers of large numbers of underground workers, has been considerably reduced. Growth in relative importance of the oil industry also has been a factor because it is a capital intensive industry, with a low labour content.

In 1963, employment in the iron ore industry was lower than in the previous year notwithstanding increased labour requirements in Quebec-Labrador. The main reason for the decline was the cutback in operations at Wabana mine in Newfoundland that has lost important markets for its product in Europe. Within the nonferrous mineral sector, increased employment in zinc and copper operations was offset by layoffs late in 1962 and in 1963 in the Sudbury nickel area, with very little overall change in employment. Employment in gold mining was reduced still further because of production declines and the closing of two small mines. With less than 15,000 employees, gold mining now employs only 65 per cent of the 1949 complement. At the end of 1963, the uranium industry employed less than 4,000 compared with 16,000 in 1958. Further declines are expected as three of the remaining six mines are scheduled to close by the end of 1964. Employment has grown by nearly 10 per cent since early 1961 in the nonmetallic mineral sector with the opening of an asbestos mine and processing plant in Newfoundland, expansion of the potash industry in Saskatchewan, and a busy structural materials industry across the country. Employment in oil and gas production was lower than in 1962; in coal mines it remained at about its 1962 level.

General Trends

Progress in the Canadian mineral industry in 1963, measured in terms of exploration activity, new mineral producing operations, production volume and value increases, capital investment, and trade expansion indicates that the industry is maintaining a satisfactory rate of growth. The growth in production and trade was not as great as in 1962, nor were the production and trade percentage increases as great as those in the gross national product and in total merchandise exports. However, the extent of exploration activity and the progress in preparing new mineral properties for production was very favourable and will provide for sizable production increases in the future. Among the new developments that will support higher production levels in the immediate future are the Matagami area zinc-copper mines and the associated zinc refinery at Valleyfield, Quebec; the lead-zinc mine and smelter complex under development in the Bathurst area of New Brunswick; expansion of production capacity in the aluminum industry; completion of mining and beneficiation facilities in the iron ore industry of Labrador; and expansion of the Saskatchewan potash industry. The large number of other projects scheduled for completion within the next five years gives further assurance of higher production capabilities in the future.

The mineral industry continued to exert a strong influence on economic growth in Canada during 1963. Important economic developments included a reduction in the size of the deficit in Canada's international current account to $521 million and an increase in the surplus of the merchandise trade balance to $484 million. The mineral industry has contributed greatly to the improvement in the trade balance since 1959 when there was a deficit of $422 million. In the period 1959-63, the favourable trade balance on raw and semiprocessed mineral products increased by $364 million thus accounting for two fifths of the improvement in the country's over - all merchandise trade balance in that period. The gain in merchandise exports of $700 million in 1963 came about as a result of a $200 million increase in wheat sales along with increases in the exports of manufactured goods, minerals and metals, forest products and other primary products. Although the mineral industry accounted for only 10 per cent of the year's exports gain, compared with 37 per cent in 1962, the prospects are that mineral exports will in the near-term future account for a greater proportion of the merchandise export increase than in 1963.

The leading factors currently affecting mineral industry growth are the same as those which are influencing the country's balance of payments position. These factors include the rising economic activity in North America and in major markets abroad such as Britain, some countries of Western Europe and Japan.

Coupled with an improvement in the competitive position of Canadian industry, expanding markets abroad have given rise to greater demand for Canadian goods. At the same time, there is a growing domestic market that is of particular importance to the strongly export-oriented mineral industry; a greater domestic market will lessen the industry's vulnerability in an increasingly competitive world mineral market. As with the economy as a whole, the mineral industry continues to benefit from the 1962 devaluation of the Canadian dollar. In general, the industry is broadening its resource base, achieving cost reductions through technological research, giving increasing emphasis to market development and, as a result, playing a leading role in the expanding Canadian economy.

MINERAL COMMODITY HIGHLIGHTS OF 1963

Canada's mineral industry continued its long-time pattern of growth and diversification in 1963 with production value reaching an all-time high of $3,051,892,732, 7.0 per cent above the previous record of $2,850,986,179 set in 1962. There has been a gain in total output every year since the end of the Second World War, except in 1958. Three sectors of the mineral industry - metals, industrial minerals and mineral fuels - registered increases to new highs in 1963 with mineral fuels showing the strongest advance. The ten leading minerals in terms of value of output accounted for nearly 80 per cent of total output, essentially the same as in previous years. Production was higher for iron ore, zinc, asbestos, crude petroleum, natural gas and its byproducts, and structural materials. Gains in those mineral commodities more than offset declines for gold, nickel and uranium.

The metals sector includes the precious metals such as gold and silver; the nonferrous metals such as copper, zinc, and lead; iron ore and the additive metals such as chromium, cobalt and manganese; and the minor metals such as antimony, bismuth and magnesium. The industrial minerals or nonmetal sector comprises two groups: nonmetallic minerals such as asbestos, gypsum, salt and sulphur; and structural materials which includes cement, stone, and sand and gravel. The mineral fuels comprise crude petroleum, natural gas and its hydrocarbon byproducts, and coal. Production was reported for 54 mineral commodities in 1963.

Metals

The value of metallic minerals production in 1963 was $1,510,403,586 compared with $1,496,433,950 the previous year. There were no dominant trends in output and neither substantial gains nor losses were apparent. The metals accounted for 57.8 per cent of total mineral production compared with 53 per cent in 1962. The leading metals were nickel, iron ore, copper, gold, uranium and zinc, in that order, contributing 90 per cent of the value of all metals output. Rises in value were registered for iron ore, with an increased output of 10 per cent, and for silver, lead and zinc mainly because of higher prices. Reduced values for nickel, uranium and gold were attributable to lower output. Growth in metals production is largely dependent upon exports and the ability of Canadian producers to meet competition in foreign markets, particularly in the United States and to a smaller degree in Britain, western Europe and Japan.

Aluminum

Primary aluminum output in 1963 increased 4.2 per cent to 719,390 tons or 81.5 per cent of rated smelter capacity. Primary consumption for Canada was 146,796 tons and total consumption at the first processing stage, including primary, secondary and scrap was 166,909 tons. Exports of primary forms totalled 635,187 tons valued at $287 million. The United States continued to be the largest market and exports to that country increased 29.5 per cent to 274,496 tons. Britain took 168,459 tons compared with 167,822 tons in 1962. Shipments to other markets declined 2.1 per cent to 192,232 tons. Exports of semi-fabricated forms were 12,787 tons valued at $7.1 million.

All six Canadian smelters are close to hydro-electric power and tidewater so that outgoing shipments of metal and incoming supplies, mainly alumina and petroleum coke, can be handled efficiently and at low cost.

Canadian British Aluminium Company Limited (CBA) operates a smelter at Baie Comeau, Quebec, and produced 93,800 tons in 1963. The bulk of production is sold under long-term agreements to The British Aluminium Company, Limited and the remainder to Canadian fabricators. The four other Quebec smelters, at Beauharnois, Shawinigan, Arvida and Alma are owned by Aluminum Company of Canada, Limited (ALCAN) as is the Kitimat smelter in British Columbia. Aggregate production from ALCAN smelters was 625,600 tons. At year-end the rate of production had been increased to 90 per cent of the rated 788,000-ton-capacity and a further 20,000 tons of new capacity was almost completed at Kitimat.

The greatly improved marketing position in 1963 resulted only in part from generally improved world demand; it was mainly the result of continued investment in fabricating facilities, both wholly-and partly-owned, coupled with product development in the use of mill forms. Shipments to the United States, for example, increased mainly because of the inauguration of a new rolling mill at Oswego, New York.

Cobalt

Cobalt production in 1963 was 3,024,965 pounds valued at $6,122,169 compared with 3,481,922 pounds valued at $6,345,205 in 1962. The decrease in production is attributable mostly to lower nickel production, particularly in Sudbury, Ontario, during the recovery of which cobalt is obtained as a byproduct.

No cobalt ores have been mined 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. Prior to April 1961, it was also recovered as a byproduct of silver refining at Deloro, Ontario. The International Nickel Company of Canada, Limited (INCO), recovers high purity electrolytic cobalt and cobalt oxide at its Port Colborne, Ontario, refinery and cobalt oxide at its Thompson, Manitoba, refinery. The International Nickel Company (Mond) Limited, a British subsidiary of INCO, at Clydach, Wales, produces cobalt oxides and salt from nickel-oxide sinter shipped to Britain from Ontario. In 1963, INCO reported production of 1,891,442 pounds of cobalt from all operations.

Falconbridge Nickel Mines, Limited, produces electrolytic cobalt at its refinery at Kristiansand, Norway, from the refining of nickel-copper matte produced at Falconbridge, Ontario. Metal deliveries for 1963 were reported to be 1,262,000 pounds.

Cobalt Refinery Limited produced cobalt as a byproduct from its silver smelting and refining of arsenical-silver-cobalt ores of the Cobalt-Gowganda areas of Ontario. The company sells cobalt as cobalt oxide (black 70-71 per cent), mostly to Canadian manufacturers of frit. Production in 1963 was 52,637 pounds.

Sherritt Gordon Mines, Limited, recovers cobalt as a byproduct of its nickel refining operations at Fort Saskatchewan, Alberta; this refinery treats nickel-copper-cobalt ores from the company's Lynn Lake, Manitoba mine and also from purchased cobalt-bearing materials. Sherritt Gordon sells cobalt in three forms: powder, briquettes and strip, and its production in 1963 was 607,511 pounds.

Reports for 1963 indicate that non-communist world production of cobalt was in the order of 13,000 tons, about 300 tons less than the production for 1962. The Republic of the Congo (Leopoldville) is by far the largest producer of cobalt. Its production in 1963 was 8,050 tons, all derived as a byproduct from the copper refining operations of Union Minière du Haut-Katanga. Other major producing countries are Northern Rhodesia and French Morocco.

Copper

Canadian mine production of copper in 1963 was 452,559 tons, 4,826 tons less than in 1962. In common with copper companies in other countries, production curtailments imposed by major producers in 1962 were continued in 1963. A 17-per-cent cut in production instituted in October at the mines of Falconbridge Nickel Mines, Limited in the Sudbury area of Ontario, a prolonged strike at the Solbec mine in Quebec and the shutdown of copper and copper-nickel mining in the Territories, offset production from new mines in Quebec and British Columbia. Production decreased in Ontario, Quebec, Newfoundland and Saskatchewan, and increased in British Columbia, Manitoba and New Brunswick.

Production of refined copper continued the decline that started in 1961 and at 378,911 tons in 1963, was 3,957 tons less than in 1962. Consumption, however, continued to increase and at 169,750 tons was 18,225 tons higher than in 1962. Increased domestic consumption and decreased production of refined copper brought about a decrease in exports of primary refinery shapes in 1963 when 214,987 tons were exported, 8,056 tons less than in the previous year. Exports of copper in ores and matte increased 3,556 tons to 92,930 tons in 1963.

At that end of 1963 reserves of copper ore were 786,150,200 tons averaging 1.36 per cent copper. The reserves at the end of 1962 were estimated at 691,981,000 tons averaging 1.49 per cent copper. These estimates are in terms of measured and indicated ore and include reserves at producing mines, developing mines with announced production plans, and four prospects with large indicated reserves.

Highlights of world copper markets in 1963 were increased production and consumption and the first signs of a break in the price stability that had been maintained for over two years. Consumption outstripped production and Free World stocks of copper declined. The decrease in stocks, coupled with fears of work stoppages at mines and smelters in the United States in mid-1964, caused a rise in copper prices on the London Metal Exchange in December for the first time since January 1962. The London Metal Exchange price remained at 29.25 cents (U.S.) a pound until December when it moved up to within a range of 29.3 and 29.5 cents. The United States producers price remained at 31 cents (U.S.) for the year thus setting a record of 31.5 months of price stability, the longest period, except in wartime, in the history of the industry. The Canadian producers price remained at 31.5 cents (Can.) since May 1962.

There are six copper smelters in Canada operated by five companies. The two smelters of The International Nickel Company of Canada, Limited (INCO) at Copper Cliff and Coniston, both in Ontario, have a combined annual capacity of 4,800,000 tons of feed. The company is followed in order by Noranda Mines, Limited at Noranda, Quebec (1,600,000 tons); Falconbridge Nickel Mines, Limited at Falconbridge, Ontario (650,000 tons); Hudson Bay Mining and Smelting Co., Limited at Flin Flon, Manitoba (575,000 tons) and Gaspé Copper Mines, Limited at Murdochville, Quebec (300,000 tons). Copper refineries are operated by Canadian Copper Refineries Limited at Montreal East, Quebec, which has a rated annual capacity of 270,000 tons, and by INCO's Copper Refining Division at Copper Cliff, Ontario, which has a rated annual capacity of 168,000 tons. Canada's present level of copper production is supplied from 57 mines operated by 36 companies; stable prices and firm demand for copper have stimulated exploration. The rate of discovery and the size of the new deposits assure that Canada will maintain her position as the world's fifth largest copper producer.

Gold

There was a 34-cent-per-ounce rise in the average Mint value for a troy ounce of fine gold in 1963 but gold production, nevertheless, declined by 4.8 per cent to 3,986,044 troy ounces. Lode gold mines accounted for 3,289,185 ounces, base metal mines 638,954 ounces and placer operations 57,905 ounces. Ontario remained the principal producer with 58.7 per cent of the total followed by Quebec with 23 per cent.

Among Free World producers, Canada was second only to the Republic of South Africa. For 1963, the United States Bureau of Mines estimated total world production at 51.7 million troy ounces of which the Republic of South Africa produced 27.4 million ounces, Canada 4.0 million, the United States 1.5 million and Australia 1.0 million. U.S.S.R. production was estimated at 12.5 million troy ounces.

In December 1963 the Emergency Gold Mining Assistance Act (E.G.M.A.A.) was extended to the end of the 1967 calendar year without changing the method of computing the amount of assistance payable. This should assist gold mines to continue operations. Many of the larger gold mines are faced with increased depth of mining, lower grades of ore available to work and higher operating costs. During 1963, there were 50 lode gold mines operating in Canada of which 42 received cost assistance under the E.G.M.A.A. Two small gold mines closed during the year and no new gold mine started production. Canada's second largest gold mine, Hollinger Consolidated Gold Mines, Limited, is expected to cease operations at the end of 1964 and a number of smaller gold mines are also expected to close down. Several potential gold mines were under development in 1963-64 and some of these are expected to start producing in 1964-65. Production from these new mines cannot, however, replace the decline in production from the older mines and a further decline in Canada's gold production can be expected in 1964 and 1965.

Iron Ore

The iron ore mining industry in 1963 experienced its second consecutive record year of shipments which amounted to 26,913,972 long tons, up 10.2 per cent from 1962. All producing provinces shared in the increase. Some individual producers that sell ore on the open market continued to meet strong competition, a result of an increasingly captive international market and the trend towards a demand for higher quality products.

No new mine began production in 1963 but two companies - one near Sudbury, Ontario and one in Labrador - completed pellet plants during the year. Two companies with mines in British Columbia ceased production. The ore reserves of one were depleted while the other was being reorganized and should resume production in 1964.

Two companies with properties near Kirkland Lake, Ontario, and at Wabush in Labrador continued development of orebodies and plant construction for the production of pellets starting late in 1964 or early 1965. Another company, in the Steep Rock Lake area, announced plans to build a plant to screen its direct shipping ore and to pelletize the fines. Annual iron ore production capacity of all operations at the beginning of 1964 was an estimated 38.3 million tons, including 8.2 million tons of high-grade pellets. By early 1966, annual production capacity is expected to reach 45.6 million tons, including 15.1 million tons of pellets.

Producers of medium-grade ore in Newfoundland and Ontario shipped approximately the same tonnages as in 1962. One large producer in Labrador-Quebec, near Schefferville, Quebec, had sharply reduced shipments of direct shipping ore but production from its Labrador City facility that produces high-grade concentrate and pellets expanded sufficiently to make up for the reduced shipments of medium grade ore. This second property started production in 1962. Another large producer of high-grade concentrates in Quebec also had substantially higher shipments in 1963. Production of concentrates or pellets increased at most of the Ontario and British Columbia magnetite mining operations.

Iron and Steel

The Canadian primary iron and steel industry consists of four integrated plants that account for over 94 per cent of pig iron production and over 90 per cent of crude steel production. Three of the four integrated plants are in Ontario, one at Sault Ste. Marie and two at Hamilton, and the fourth is at Sydney, Nova Scotia.

In addition to pig iron production at these four integrated plants, merchant pig iron is made at three other plants. One is a blast furnace works at Port Colborne, Ontario; another is at Tracy, Quebec, where titanium-dioxide slag and pig iron are obtained by electric furnace smelting of ilmenite; and the third, at Kimberley, British Columbia, produces pig iron in electric furnaces by smelting iron ore sinter obtained from iron oxide calcine which is a product of roasting pyrites for sulphuric acid production.

There are more than 36 plants in Canada that make steel in electric furnaces by melting scrap. Of these, seven operate steel rolling mills and the remainder operate steel foundries. There are also four other plants that process purchased steel ingots, semis or rails into primary rolling mill products; these plants do not have steelmaking facilities.

The Canadian steel industry registered its third consecutive yearly record in 1963 when 8.19 million tons of crude steel (ingots and castings) were produced compared with 7.17 million tons in 1962 and 6.49 million tons in 1961. From 3.38 million tons of steel in 1950, output increased 72 per cent to 5.81 million tons in 1960. Steel output is expected to rise further in 1964 to about 9.0 million tons. Investment in new plant and equipment in 1964 is also expected to reach a new high.

Since the early 1950's, the industry has invested large amounts of capital to modernize existing plants and, more important, to diversify its range of products. Whereas the industry could produce only about 65 per cent of the range of primary steel products consumed by Canada in the early 1950's, it can now produce about 90 per cent. Increased industrialization, a greater per capita consumption of steel and increasing exports all contributed to the current high output. The competitiveness of the industry is indicated by stable posted prices since 1957 notwithstanding higher raw material and labour costs; by increased exports; by less dependence on imports even though it operates under a relatively modest level of tariffs; and by high capital outlays, largely from retained earnings, for new plant and equipment. Canadian companies were the first in North America to instal basic oxygen furnaces and continuous casting units, and to adopt supplementary fuel injection practices to blast furnaces. The industry is quick to adopt improved technology for pig iron and steel manufacture and for rolling mill practice. It employs about 40,000 and these employees are among the best paid in any Canadian industry.

Although the most recent blast furnace was completed in 1960, pig iron capacity in Canada has continued to grow substantially through the adoption of such techniques as supplementary fuel injection, higher top pressures, improved physical and chemical properties of changes, and rebuilding. Pig iron capacity was 6.9 million tons a year at the end of 1963; it is expected to exceed 7.4 million tons a year by December 31, 1965.

In recent years capacity increases for crude steel for open-hearth and basic oxygen furnaces have occurred largely because of technological improvements. Since the first basic oxygen furnace (BOF) was installed in 1954 steel from the the BOF process now accounts for about 29 per cent of output. The basic open-hearth furnace process continues to be the major supplier of crude steel. Electric furnace output has declined in relative importance. Annual steelmaking capacity exceeded 9.4 million tons at the end of 1963; by December 31, 1965, it is expected to be 11.1 million tons.

Lead

Based on the lead content of ores and concentrates exported and the lead recovered domestically from ores and concentrates, Canada's production of lead in 1963 was less than her production in 1962 - 201,165 tons compared with 215,329 tons. Slight increases in shipments reported by a number of companies were offset by declines in shipments that resulted in part from prolonged strikes at the Solbec mine in the Eastern Townships of Quebec and the Reeves MacDonald mine in southeastern British Columbia.

Of the 15 principal producers of lead in Canada, The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) and Canadian Exploration, Limited in British Columbia, American Smelting and Refining Company in Newfoundland, and United Keno Hill Mines Limited in Yukon Territory accounted for 87 per cent of the total output. COMINCO's Sullivan mine in southeastern British Columbia, by far the largest single source of lead, produced over 121,000 tons or 59 per cent of the total production. In New Brunswick, construction of a lead-silver smelter complex of Imperial Smelter Corporation design was commenced at Belledune Point, 20 miles northwest of Bathurst. The complex, to be in operation in mid-1966, will initially produce lead and zinc from concentrates produced near

Bathurst by an associated company, Brunswick Mining and Smelting Corporation Limited. Production at one of Brunswick's mine properties, began early in 1964. In the Northwest Territories construction of a townsite at Pine Point, the site of large lead-zinc deposits, was well advanced by the end of 1963 and the 430-mile railroad from Grimshaw, Alberta to Pine Point was about half completed. Pine Point Mines Limited, a COMINCO subsidiary, expects to commence production in 1966 at 5,000 tons of ore daily.

Output of refined lead at Trail, British Columbia, by COMINCO, Canada's only producer of primary lead metal, was 155,000 tons compared with 152,217 tons in 1962. Most of the lead ores and concentrates treated were from mines in British Columbia.

Except for a sharp reduction of 28,504 tons in Canada's shipments of metal to the United States, there was little change in the lead export pattern. Britain and the United States continued to be Canada's largest customers taking almost three quarters of all primary lead exports. Other important buyers of Canadian lead were Belgium, Japan, India and West Germany.

The quotas on United States imports of unmanufactured lead continued throughout 1963. Except for the second quarter, which was 17 tons short, all quarterly allotments pertaining to metal were filled but those pertaining to ores and concentrates were filled only during the first quarter.

The International Lead and Zinc Study Group, which held its seventh session in Geneva from October 28 to November 7, stated that new supplies of lead were expected to exceed demand by a small amount in 1964. The importance of liberalizing trade in lead and zinc was stressed as a means of avoiding distortions inherent in the isolation of sectors of the market.

Magnesium

Dominion Magnesium Limited with mine and smelter in Haley, Ontario, is the only Canadian producer. Shipments in 1963 were at an all-time high of 8,905 short tons, except for 1956.

Exports declined slightly in value from $3.96 million in 1962 to $3.67 million. Britain was the main outlet for exports ($2.1 million). Canada imported magnesium metal and alloys valued at $311,131 and semimanufactured products valued at $603,189 from the United States, according to figures compiled by the U.S. Department of Commerce.

World production in 1963 was estimated at 155,000 tons with the United States, the U.S.S.R., Norway and Canada in that order being the principal producers.

Molybdenum

Production of molybdenum in Canada increased for the fourth consecutive year in 1963 with shipments of molybdenum contained in molybdic oxide (MoO_3)

and molybdenite (MoS_2) concentrates amounting to 833,867 pounds valued at $1,344,004. This quantity was exceeded only by 1944 production but the value of shipments was an all-time high. Domestic consumption of molybdenum contained in various products was 1.31 million pounds, only slightly less than the all-time high of 1.26 million pounds established in 1962.

Canadian molybdenum production in 1963 came from Molybdenite Corporation of Canada Limited and Gaspé Copper Mines, Limited, a wholly-owned subsidiary of Noranda Mines, Limited. Molybdenite Corporation's mine is at Lacorne, Quebec, where the company also operates a roasting plant to convert most of its concentrates to technical-grade MoO_3, the material from which all types of molybdenum salts and compounds are produced. Molybdenite concentrates are recovered as a byproduct by Gaspé Copper Mines at its copper operations at Murdochville, Quebec.

Bethlehem Copper Corporation Ltd., Noranda Mines, Limited and Canadian Exploration, Limited announced production plans for their respective British Columbia properties and Kennco Explorations (Canada), Limited continued exploration on its Alice Arm, B.C. property. Bethlehem Copper Corporation Ltd. plans to commence the recovery of byproduct molybdenite at its copper mining plant at Ashcroft, British Columbia early in 1964. Noranda's property is at Boss Mountain in the Cariboo district of central British Columbia and the company expects to be in production by early 1965. Canadian Exploration, Limited's property is four miles south of Endako in the Omineca Mining Division.

Estimates indicate that world mine production of molybdenum during 1963 was in the order of 91 million pounds, an all-time high. However, an increase in world demand for molybdenum resulted in a shortage and many consumers in Europe and Japan are reported to have paid a premium of about 33 cents a pound above the price established for molybdenum by Climax Molybdenum Company, a division of American Metal Climax, Inc., the world's leading producer.

Nickel

Canadian nickel production during 1963 was 217,030 tons valued at $360,392,658, slightly less than in 1962. The industry operated at about 93 per cent of its rated capacity. Canada is the world's leading supplier of nickel and accounts for about 80 per cent of Free World production. The leading producers - INCO and Falconbridge Nickel Mines, Limited - are the world's largest.

Near Sudbury, Ontario, INCO operated six mines: the Creighton, Frood-Stobie, Garson, Levack, Murray underground mines and the Clarabelle open pit. Expansion of the iron recovery plant from 300,000 to 900,000 tons of pellets a year was completed. Also near Sudbury, Falconbridge operated the Falconbridge and East Mines in the Falconbridge area and the Hardy, Onaping and Fecunis mines in the Onaping area. As a result of a production cut, the East mine was closed and production was reduced at the other four mines. The company completed and opened a one million dollar addition to its research centre at Thornhill, Ontario. The addition includes a new metallurgical laboratory and expanded facilities for the mineral sciences.

The Lynn Lake, Manitoba, mine of Sherritt Gordon Mines, Limited operated at capacity though at slightly lower grade than in 1962. It had a good market for its nickel products sold in briquettes and powder forms. At the Thompson, Manitoba, mine of INCO, a decision was made to sink a second production shaft on the edge of Thompson Lake some 8,000 feet east of No. 1 shaft. The new shaft, No. 3, will be sunk to the 2,400-foot level and will be used only as a service shaft.

Several smaller nickel mining operations made good progress in 1963. The Gordon Lake mine of Metal Mines Limited in northwestern Ontario began production with a mill designed to treat 500 to 700 tons of ore daily. The company experienced difficulties in reaching capacity because of poor ground conditions in the mine. A bulk nickel-copper concentrate is trucked to Lac du Bonnet, Manitoba, and shipped to Copper Cliff, Ontario, for smelting. The company has a five-year smelting contract with International Nickel. Marbridge Mines Limited, with a mine in La Motte township, Quebec, was operating at close to its daily capacity of 400 tons. Bulk nickel-copper flotation concentrates, amounting to about 2,800 tons a month, are trucked to Falconbridge, Ontario, for smelting by Falconbridge Nickel Mines, Limited. Lorraine Mining Company Limited was shaft sinking to 1,000 feet on its property in the Belleterre area of Quebec. Indicated ore reserves to 800 feet are 550,000 tons of 2.1 per cent combined nickel-copper. Giant Mascot Mines, Limited, near Hope, British Columbia, treated about 1,200 tons of ore daily for 23 days each month. Bulk nickel-copper concentrates are exported to Japan. After installation of a new jaw crusher, another ball mill and additional flotation cells, daily mill capacity in 1964 will probably be about 1,500 tons.

There was no price change for nickel during the year. Prices remained at 84 cents per pound for Canada and 79 cents for the United States, both f.o.b. Port Colborne, Ontario. The United States price includes a 1¼ cents-a-pound import duty. The difference in price quotations is based on the discount of the Canadian dollar relative to the United States dollar.

Niobium (Columbium) and Tantalum

St. Lawrence Columbium and Metals Corporation, with mine and concentrator at Oka, Quebec, continued to be the only Canadian producer of columbium concentrates. The company reported that production during 1963 was 1,521,701 pounds of columbium pentoxide (Cb_2O_5) contained in concentrates averaging 51.8 per cent Cb_2O_5 with a value at the mine of $1.6 million; shipments for the year were 1.5 million pounds of concentrates, compared with one million pounds for 1962. The company is the only large-scale world producer of columbium concentrates as a sole product and it also operates the largest single producing mine. A mill-expansion program that began in 1962 was completed early in 1963 and production during 1964 is expected to reach 3.6 million pounds of concentrates.

Estimates for 1963 indicate that production of columbium-and tantalum-bearing concentrates in non-communist countries was 5,330 tons. This was 725 tons greater than in 1962 and was the fifth consecutive year that non-communist production of columbium-tantalum concentrates increased after a decline from a record high of 5,865 tons in 1955 to a low of 2,440 tons in 1958. Nigeria is the world's largest producer, with production for 1963 at 2,270 tons. The United States is the largest importer of columbium-tantalum ores and the largest consumer of columbium and tantalum products.

Platinum Metals

Canadian production of the platinum metals in 1963 amounted to 357,651 ounces valued at $22,585,205. This is a reduction from the previous year and resulting from decreased nickel production; platinum metals are recovered as a byproduct of nickel mining and recovery. World markets for platinum metals were fairly strong. The group consists of platinum, palladium, rhodium, ruthenium, iridium and osmium. All except osmium are produced in Canada.

During 1963, Canada, the Republic of South Africa and the Union of Soviet Socialist Republics continued to supply the bulk of world production. World production in 1963 was 1,543,000 troy ounces of which Canadian production was 357,651 ounces and that of South Africa and the U.S.S.R. was 305,500 and 800,000 ounces.

Platinum metals occur in Canadian nickel ores to the extent of about 0.025 ounce per ton of ore. In the treatment of these ores for nickel, the platinum metals follow nickel and are eventually removed as sludges from the electrolytic tanks in which nickel anodes have been formed. The sludge is purified and sent to precious metal refineries in Britain and the United States for recovery of the platinum metals. All of Canada's platinum metals production results from the treatment of nickel ores of the Sudbury district of Ontario and those of the Thompson mine in Manitoba.

Platinum metals are valuable to industry because of their many special properties, the chief of which are their 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 rhodium plating.

Selenium and Tellurium

Selenium and tellurium are produced at Canada's two copper refineries from the tankhouse slimes resulting from the electrolytic refining of copper anodes. Selenium production from all sources in 1963 decreased to 468,772 pounds valued at $2.27 million from 487,066 pounds valued at $2.8 million in 1962. Most of the 462,400 pounds of refined selenium produced was exported to the United States and Britain. Domestic consumption in the glass, rubber, alloy-steel and electronics industries was 12,424 pounds.

Tellurium production, in all forms, at 76,842 pounds valued at $499,473 was 18,117 pounds and $147,123 higher than in the previous year. Tellurium is also used in electronics and rubber manufactures and some is used in the grey-iron casting and nonferrous alloys industries. Domestic consumption in 1963 was 1,853 pounds.

Silver

Although two new silver mines in the Cobalt area of Ontario began production in 1963, Canada's output of silver at 29,927,723 ounces was only slightly lower than the 30,422,972 ounces produced in 1962.

Base metal ores accounted for 81 per cent of the silver output with the remainder coming from silver-cobalt ores mined in northern Ontario (17 per cent) and from lode-and-placer-gold ores (2 per cent).

The two largest producers were United Keno Hill Mines Limited in Yukon Territory and COMINCO in southeastern British Columbia. Lead-zinc-silver ores mined by these two producers were the source of about 10.1 million ounces or 33 per cent of Canadian production.

Although there are six silver refineries in Canada, most of the refined silver output was produced by three companies: COMINCO at its plant at Trail, British Columbia from lead and zinc concentrates; Canadian Copper Refiners Limited at Montreal East from blister copper; and Cobalt Refinery Limited at Cobalt, Ontario, from silver concentrates.

Canada's silver exports in 1963 remained largely unchanged from those of 1962 with the United States continuing to take over 80 per cent. Imports of refined silver, although considerably lower than those of 1962, remained at a high level because of the continuing large requirements of silver by the Royal Canadian Mint for coinage.

Titanium

The value of titanium-bearing materials shipped during 1963 as ore, heavy aggregate and titanium-bearing slag was $14 million. Nearly all of this was accounted for by the sale of titanium dioxide (TiO_2), which was $2.4 million more than its 1962 value.

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 a heavy aggregate and for the manufacture of ferrotitanium. 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 72 per cent titanium dioxide, a high-quality pig iron, and a complex calcium-magnesium-aluminum silicate used as a slag thinner in smelting. Much of the slag was 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 British Titan Products (Canada) Limited, at Ville-de-Tracy, Quebec.

The installed TiO_2 pigment-producing capacity in Canada is about 47,000 tons a year and consumption of TiO_2 in pigments in Canada in 1963 was an estimated 39,000 tons with the paint industry consuming about 66 per cent. The titanium content of ferrotitanium consumed in Canada was 78 tons compared with 94 tons in 1962.

Quebec Iron and Titanium Corporation (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; there are also very large reserves of inferred ore. QIT operates eight electric-arc smelting furnaces at Sorel with an ore-treating capacity of 1.1 million tons a year.

Preliminary estimates indicate that world production of titanium in 1963, in the form of ilmenite, rutile concentrates and titanium-dioxide slag was 2.6 million tons, an all-time high.

Tungsten

Canada has produced no tungsten commercially since July 1958, when Canadian Exploration, Limited closed its tungsten operation at Salmo, British Columbia. In 1963, Canada Tungsten Mining Corporation Limited 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.

Because of depressed conditions in the tungsten market, which saw the price of tungsten concentrates drop as low as $7.75 a short-ton-unit (20 pounds) of WO_3, Canada Tungsten suspended operations in July at its open-pit mine and 300-ton-a-day concentrator. Though the ore assays 2.47 per cent WO_3 and the deposit is one of the world's highest grade, the low price of concentrates and, to a lesser degree, the relatively high cost of operating a mine in so remote a location made the operation uneconomical.

Preliminary estimates indicate that world mine production of tungsten was about 65 million pounds in 1963, some seven million pounds less than in 1962.

The depressed status of the tungsten market was the subject of three meetings of the United Nations ad hoc Tungsten Committee in 1963. Large tonnage shipments from Communist-bloc countries and the quantity of tungsten in United States stockpiles were factors contributing to the depressed market. Towards the end of 1963, there was a reduction in the availability of concentrates from communist-bloc countries that was reflected in a slight increase in the price for concentrates.

Uranium

Uranium production was slightly lower in 1963 with deliveries totalling 8,352 tons of uranium oxide (U_3O_8) valued at $137 million compared with 8,431 tons valued at $151 million in 1962.

Ontario production was about three quarters of the Canadian total. Four mines were in operation in the Elliot Lake district and two in the Bancroft area of southeastern Ontario. The rest of the production came from the Eldorado Mining and Refining Limited and the Gunnar Mining Limited mines in the Beaverlodge Lake area of northern Saskatchewan. Production under government contracts is scheduled to decline steadily for the next eight years to 933 tons in 1971.

The most significant development in 1963 was the institution of the federal government's short-term stockpile program. Under this plan, announced in June 1963, the government agreed to stockpile limited quantities of uranium that would enable three mines to remain in production until July 1, 1964. 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 of Ontario for a slightly longer period so that alternative measures of assistance for these communities might be studied.

The short-term outlook for Canadian uranium producers is not bright because peacetime markets for uranium have not been developed as rapidly as expected, particularly its use for the generation of nuclear electric power. Stocks for military purposes are sufficient for many years. However, with continued improvement in the design of nuclear power reactors, costs will be lowered and, in time, nuclear-developed energy will account for a large share of energy production. It is expected that demand for uranium for nuclear power reactors will reach significant proportions beginning about 1970.

Despite the present surplus of uranium there is a growing concern in such agencies as Euratom and the United States Atomic Energy Commission about long-term supplies for a market that could reach major proportions by 1980.Recent studies by the Department of Mines and Technical surveys, however, show that Canada's recources of nuclear fuels are sufficient to support very large nuclear power porgrams for many years to come.

Zinc

Mine output of zinc totalled 497,000 short tons, about 5,000 tons less than the record output of the previous year. Production was reduced by prolonged strikes at two mines with a loss of about 15,000 tons, and by reduced ore grades at a number of other mines. Counteracting these influences, two new mines were brought into production in October 1963 in the Matagami district of northwestern Quebec, adding about 18,000 tons to zinc output.

Production in the last quarter of the year rose to 133,000 tons, 12,000 more than the average of earlier quarters. There was a further rise in the first quarter of 1964 to 160,000 tons. Assuming that this rate continues and taking into account the output of new mines scheduled to open during 1963, mine output should rise by about 225,000 tons or to 725,000 tons of contained zinc in 1964.

Production of refined zinc in 1963 totalled 284,000 tons, 4,000 more than in the previous year. Production increased in the last quarter following the opening in late September of a new electrolytic refinery at Valleyfield, Quebec. Output at the electrolytic refineries at Trail, British Columbia and at Flin Flon, Manitoba was at about the same level as in 1962. Primary refining capacity at the end of 1963 was as follows: COMINCO, Trail, B.C. - 208,000 tons, Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Manitoba - 79,000 tons, and Canadian Electrolytic Zinc Limited, Valleyfield, Quebec - 72,000 tons.

Zinc concentrates produced in Manitoba and Saskatchewan were refined at Flin Flon. Most of those produced in British Columbia and Yukon Territory were refined at Trail; the remainder was exported to refineries in northwestern United States. The production of eastern mines was exported to the United States, Europe and Japan, except for the amounts required by the Valleyfield zinc refinery. Some zinc concentrate destined for the United States went first to Canadian roasting plants at Port Maitland, Ontario, and to Arvida, Quebec, for preliminary recovery of sulphur.

Britain and the United States were the principal export markets for refined zinc, accounting for 79 per cent of exports in this form. Zinc concentrates were exported principally to the United States.

Import quotas imposed by the United States government in October 1958 remained in effect, limiting imports to 80 per cent of the annual average during the period 1953-57. The quota on imports of zinc ores from Canada is 33,240 tons of contained zinc per quarter; the zinc metal quota is 18,920 tons per quarter.

Canada was the second-ranking mine producer among Free World countries in 1963, after the United States, and the third-ranking in production of refined zinc, after the United States and Japan.

The International Lead and Zinc Study Group held two meetings in Geneva in 1963. Its main conclusion was that consumption of zinc which had been rising for several years was likely to increase further in 1963 and would probably exceed current supplies. The importance of liberalizing trade in lead and zinc to the greatest extent possible was stressed.

Free World consumption of zinc at 3.21 million tons in 1963 was about eight per cent greater than in 1962. Canadian consumption rose by 11 per cent to 75,591 tons.

Industrial Minerals

In 1963 Canada's production of industrial minerals reached a record high for the fifth consecutive year with value of output at $633,061,059 being 11.04 per cent above that of 1962. Each of the two groups of commodities in this section of the mineral industry registered new highs in value of output: the nonmetallics advanced 11.7 per cent to $254,049,943 and structural materials gained 10.6 per cent to $379,011,116. Continued growth in output value of the industrial minerals sector, which now contributes about 20 per cent of total mineral output, is expected as production of potash and of elemental sulphur, recovered from processing of natural gas, increases substantially and that of structural materials (clay products, cement, lime, sand and gravel, and stone) continued to keep pace with Canada's growing industrial output and construction activity.

New production records were set in 1963 for asbestos, gypsum, potash, sulphur, cement and sodium sulphate. Potash output was valued at $22.5 million in 1963. Among the industrial minerals, asbestos output at $137 million was in first place, followed by sand and gravel ($124 million), cement ($119 million) and stone ($80 million); these four accounted for 72.6 per cent of industrial mineral production. With the exception of asbestos, sulphur, gypsum and titanium dioxide, industrial mineral commodities are not substantial contributors to export trade. They are consumed generally by domestic industries and construction projects.

Asbestos

Shipments of asbestos from Canadian operations set a new record for the fourth consecutive year, as 1,275,530 tons valued at $136,956,180 moved to markets throughout the world. The increase from 1962 shipments of about 5 per cent in quantity and 5.1 per cent in value was shared by Quebec, Newfoundland and British Columbia; shipments from Ontario were down slightly. Newfoundland became a producer for the first time when the mine and plant of Advocate Mines Limited at Baie Verte started operating its 5,000-ton-a-day mill in July.

Canada is by far the western world's leading asbestos producer but is being challenged for first place in world production by the Soviet Union. Notwithstanding higher production by several countries in recent years Canada has maintained a modest increase in world markets and now accounts for about 40 per cent of world production in 1963. Almost all production is exported with about 50 per cent of it in 1963 going to the United States. Domestic requirements of amosite asbestos are imported from the Republic of South Africa and those of crocidolite asbestos come from South Africa and Australia.

What are believed to be the world's largest deposits of asbestos occur in the Eastern Townships of Quebec in a narrow band that extends from east of the Chaudiere River southwest almost to Sherbrooke, about 80 miles east of Montreal. All production in the province comes from this area where diamond drilling to depth has indicated reserves sufficient for many years. Production from Quebec has been continuous since 1878 and constitutes about 90 per cent of current production in Canada.

Gypsum

Shipments of gypsum in 1963 increased to 5,955,266 tons from 5,332,809 tons the previous year. It is produced from both underground and open-pit mines with the latter accounting for by far the largest tonnage. Gypsum is mined in Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba and British Columbia; 82 per cent of 1963 production came from Nova Scotia.

Producers continued expansion of mining and processing facilities for the domestic market. Western Gypsum Products Limited of Winnipeg, Manitoba, began developing a deposit at Silver Plains, about 30 miles south of Winnipeg. A shaft was begun to the high-grade deposit that lies at a depth of about 120 feet. Western Gypsum's new $3.5 million products plant at Clarkson, Ontario, was completed in May. Crude gypsum for the plant is obtained from eastern producers but the company plans to develop and underground gypsum deposit near Drumbo, Ontario.

About 80 per cent of crude gypsum produced is exported to the United States, the remainder being used in domestic processing plants. In 1962, The Flintkote Company of Canada Limited and The Bestwall Gypsum Company (Canada) Ltd. began shipments from deposits in Newfoundland and Nova Scotia to their parent companies' manufacturing plants in eastern United States.

Potash

The beginning of potash mining in Canada experienced serious technical difficulties and presented problems that delayed continuous commercial production of this very important fertilizer ingredient. Potash Company of America produced the first potash from its mine at Patience Lake, Saskatchewan in 1958, but the mine was soon forced to close by heavy flows of water from the porous Blairmore formation. Shaft and mine rehabilitation has been under way since then; production is scheduled to resume late in 1964.

In August 1962, International Minerals & Chemical Corporation (Canada) Limited commenced production of potash from its mine at Esterhazy, Saskatchewan, after successfully penetrating and sending off inflows of water from the Blairmore formation by using a 'freezing and tubing' technique of sinking its shaft through the troublesome horizon. Production was continuous in 1963 and a first stage of expansion to 1.2 million tons of potash a year from the initial 600,000 tons a year was nearly completed at the end of the year. Further large-scale development and expansion will increase production capacity to four million tons a year in 1968. About one million tons of K_2O equivalent was produced in 1963.

Kalium Chemicals Limited in 1963 began construction of a plant at Patience Lake for the solution-mining of potash from sylvite beds that lie at a depth of more than 5,000 feet. The decision to proceed with development of the property that is about 25 miles west of Regina was made after extensive preliminary tests on this new 'solution-mining' of potash had been conducted. Production is scheduled for late in 1964. Alwinsal Potash of Canada Limited, controlled by West European interests, expects to begin shaft-sinking late in 1964 as part of a $50-million program of a potash mining-concentration facility. Several other companies hold potash leases on favourable ground in Saskatchewan and have done considerable work on their holdings.

Trade in potash is world wide. The main producing areas are western Europe, the United States, East Germany and the U.S.S.R. Europe is the main producer and consumer; United States production is nearly in balance with North American consumption. World production of potash is currently about 10 million tons of K_2O (equivalent) a year.

There has been steady growth in production of potash to serve fertilizer needs; most new production is marketed regionally and as demand increases it appears that Canada alone will be in a position to supply potash in large quantities for export. An annual output of Canadian potash approaching six million tons by 1970 does not appear unrealistic. Canadian reserves are large and high grade containing an average of 25 per cent K_2O, much above the estimated grade of reserves in most producing countries.

Salt

Shipments of salt at 3,721,994 tons valued at $22,316,565 were down from the record set in 1962 when shipments were 3,638,778 tons worth $21,927,135. Over the past two decades the growing need for ice control for winter highway traffic has resulted in a large increase in the market for rock salt. Almost one half of the Canadian output is now rock salt, some of which is exported to the United States. The chemical products industry consumes most of the remainder of production with food preparations, meat packing, pulp and paper, and fish processing consuming together about 200,000 tons a year.

Disposal of 'fines' from rock salt production, which is above 8-mesh in particle size, is a problem for mine operators. In 1963, a new two million dollar plant that uses a brining process to dissolve the fines and recover various grades of fine salt by evaporation was completed at Pugwash, Nova Scotia. The products are sold in eastern Canada, the West Indies and Europe. Also at Pugwash, a second 16-foot diameter shaft that will increase mine productive capacity to 3,500 tons a shift was being sunk to 800 feet.

Sulphur

The dramatic development of the western Canadian gas fields as an important source of world sulphur continued in 1963. Output of elemental sulphur rose some 20 per cent from 1962 and the aggressive drive by the western producers to seek wider markets met with outstanding success. Over 1,200,000 tons of western Canada's sulphur were shipped to domestic and foreign markets, an increase of over 80 per cent over 1962.

In the Canadian industry, the most notable event has been the recent development of a world-wide marketing outlook. As well as large exports to northern United States, substantial tonnages were shipped to the USSR, the Republic of South Africa, Australia and Taiwan. During the year, elemental sulphur began moving to Japan. Sales within Canada have increased, thus reducing our imports of Frasch sulphur from the United States.

With a capacity of two million short tons of elemental sulphur a year, Canada ranks second to the United States amongst world elemental sulphur producers. Canadian production of elemental sulphur recovered from the processing of natural gas in 1963 was 1,281,999 long tons.

Elemental sulphur is a byproduct of the preparation of natural gas for the market. It is produced at 15 plants in Alberta and one each in Saskatchewan and British Columbia. No new plant was built during 1963 although two are planned for 1964. Existing plants are adequate to serve current contracts for cleaned natural gas for markets in Canada and the United States. It is expected, however, that by 1967 the demand for western Canadian natural gas will require the construction of additional plants with a capacity of 500,000 tons of elemental sulphur a year.

Sulphur production in all forms amounted to 1,838,540 short tons in 1963 and comprised the sulphur content of pyrites (235,410 tons), sulphur content (353,243 tons) of smelter gases that is used to make sulphuric acid and liquid sulphur dioxide, and shipments of elemental sulphur (1,249,887 tons) derived from natural gas. Minor amounts of elemental sulphur recovered from oil refining gases are not included in production statistics.

Other Nonmetallics

Developments of importance also took place in other commodities that comprise the nonmetallic minerals industry.

Canadian Magnesite Mines Limited continued extensive laboratory investigations, economic studies and market surveys concerning its magnesite deposit in Deloro and Adams townships, Ontario. Limited diamond drilling has outlined a considerable tonnage containing over 50 per cent magnesite. This deposit is of particular interest because of its low calcium oxide content.

Quebec Lithium Corporation continued to expand its lithium-chemicals operation at the mine site, north of Val d'Or, Quebec. Spodumene concentrate is produced and processed to lithium carbonate and lithium hydroxide monohydrate. After some delay, during which the circuit was modified, the first shipments of lithium hydroxide monohydrate were made in November to Canadian oil companies, for use in lubricants. The annual capacity will be 1.5 million pounds. Improvements in the lithium carbonate circuit have increased the capacity for production of this product to 2.5 million pounds a year. Sales of the carbonate, for use in porcelain enamel frits, are increasing and are becoming global in extent.

Imports of phosphate rock, exceeding one million short tons for the first time in 1961, will increase substantially as a result of developments in the domestic phosphate-fertilizer industry. The most noteworthy expansion is that of COMINCO. Construction is nearing completion of a new 85,000-ton-a-year ammonium-phosphate plant at Kimberley, B.C. and an announcement has been made of a planned 83,000-ton-a-year ammonium-phosphate plant near Regina, the first such plant in Saskatchewan. To supply the phosphate rock, COMINCO's mining subsidiary, Montana Phosphate Products Company is developing a new mine near Philipsburg, Montana, and building a concentrator to produce 300,000 tons of flotation concentrate a year.

The value of titanium shipped in 1963 in ore, heavy aggregate and titanium-bearing slag was $14 million which was $2.4 million above that of 1962. Nearly all of this was accounted for by titanium dioxide (TiO_2) slag produced by Quebec Iron and Titanium Corporation at Tracy, Quebec, from Allard Lake, Quebec, ilmenite. At the Tracy plant, a labour strike, which commenced on August 28, 1962, and was not settled until March 16, 1963, kept the value of shipments for both 1962 and 1963 well below the all-time high of $16.7 million attained in 1961.

The production values of shipments of fluorspar ($2 million), quartz ($3.9 million), sodium sulphate ($4.1 million), magnesitic-dolomite and brucite ($3.4 million) and nepheline syenite ($2.7 million) were all higher than in 1962. Barite production ($1.7 million) was slightly lower than in 1962.

Structural Materials

This category is composed of cement, sand and gravel, stone, clay products and lime. In 1963, a continuing high level of activity in home building, industrial construction, and road and rail programs resulted in record output values for four of these structural materials; there was a slight increase in value of lime shipments from $17.6 million to $18.5 million even though output increased from 1,424,459 tons to 1,450,731 tons.

Major engineering projects contributed to the high level of activity in the construction industry. The industrial development of Canada has created an increasing demand for low-cost electrical power. To meet this demand The Quebec Hydro-Electric Commission is currently developing new sources of hydro electric power. North of Baie Comeau, a new power complex that will eventually add six million horsepower to the Quebec system, is being developed at a cost of $2 billion. Construction of five major dams on the Outardes and Manicouagan Rivers will make this one of the world's greatest power generation projects. Engineering projects of this kind, road construction and the building industry required record quantities of crushed and natural aggregate during 1963.

There was also renewed interest in certain phases of the dimensional stone industry. In this industry, limestone, sandstone, granite and marble are all quarried and dressed for use in building construction and ornamental applications. For some years Canadian marble quarrying has been nearly dormant. However, in 1963 interest was renewed, particularly in eastern Ontario where several quarries having stone of a variety of colors were operating or being prepared. It was a year of consolidation for the granite industry as Rock of Ages Corporation of the United States consolidated its position in granite quarries and dressing plants in Quebec by further property acquisitions. It now produces a wide range of accepted colours, and a more favourable export market in the United States for Quebec granites will probably develop. Also a number of companies are producing black granites that are competing strongly in domestic markets with the traditional Swedish black granite.

Production of portland cement in Canada was at a record level of 7,013,662 tons, valued at $118,614,929, during 1963. The increase is a reflection of major engineering projects currently under construction. The Manicouagan power project alone required up to 4,000 barrels of portland cement daily during peak periods.

During the year the cement industry completed a modest expansion program that added more than two million barrels to installed annual capacity, at a cost of some $2 million. Plans were also announced for new plant construction that will add 5.8 million barrels to annual capacity. Canada Cement Company, Limited is planning a new plant at Brookfield, Nova Scotia, to be completed in the first half of 1965 at a cost of $12 million. Annual capacity is expected to be 1.4 million barrels. When this plant starts production Nova Scotia will become the ninth province in Canada to manufacture cement. St. Lawrence Cement Company is expanding its Villeneuve, Quebec, plant at a cost of $5 million.

Mineral Fuels

The production value of the mineral fuels in 1963 was $908,428,087, a 16-per-cent increase from 1962. Their value accounted for 30 per cent of total mineral production value compared with 27 per cent the previous year. Production of natural gas and its byproducts has been growing rapidly and was equivalent to 24 per cent of the fuels value in 1963. The value of crude petroleum has also increased considerably although its share of total fuels value has declined from about four fifths to slightly less than three quarters in recent years. Coal output has been remaining fairly constant but its percentage in fuels output value has been steadily declining and was less than eight per cent in 1963.

Coal

The Canadian coal industry has undergone a long period of declining production during which severe readjustment has been made in an endeavour to meet strong competition from alternative fuels. Since 1959, output of all types of coal has been stabilized between 10 and 11 million tons a year having a value between $69 million and $74 million.

Production in 1963 of 10.6 million tons valued at $71.8 million represented very little change from 1962. For the past several years about 40 per cent of output has been obtained from surface operations (strip mines) and the remainder from underground. Nova Scotia, the largest producing province with about two fifths of Canada's output, obtains all its coal from underground mines. In the western provinces about two thirds is obtained from strip mines. One characteristic of Canadian coal mining is that most of the higher ranking coals are obtained from the relatively high-cost underground mines; the lower rank and lignite coals are generally obtained from strip mines. A little over 85 per cent of the higher ranking bituminous coal is obtained from underground mines; over 90 per cent of lignite and sub-bituminous output is strip-mined.

Of the 22.6 million tons of coal consumed during 1963, 5.7 million tons were carbonized to produce coke which is used mainly in blast furnaces to make pig iron. It is also used in foundries, in smelter for base metal recovery, in chemical processing plants and for domestic heating. The main producers of coke in declining order of capacity are The Algoma Steel Corporation, Limited, The Steel Company of Canada, Limited and Dominion Foundries and Steel, Limited, all in Ontario; Dominion Steel and Coal Corporation, Limited at Sydney, Nova Scotia; Quebec Natural Gas Corporation at Ville La Salle, Quebec, and The Crow's Nest Pass Coal Company, Limited at Fernie, British Columbia. Coke production from bituminous coal was 4.3 million tons in 1963, up slightly from the previous year.

Imports of coal for all purposes were 13.1 million tons, all from the United States. Coal exports were 1,054,367 tons, three quarters went to Japan and the remainder to the United States.

In the industrial market, coal is gaining increased recognition as a source of low-cost energy and the increased number of coal-fired thermal electric plants across Canada is a significant development in recent years. The steelmaking industry, through its reliance on coke in the manufacture of pig iron, is a substantial and growing market for coal. Coke production accounted for over 25 per cent of coal consumption in 1963.

In contrast to the industrial and coke-making fields, the market for coal for heating purposes by industry and homes continued to decline because of inroads made in these markets by oil and natural gas. The transportation market (railways, ships, bunkers, etc.) for coal, presently amounting to less than three per cent of the total, does not offer much hope for future growth either. For a bulk low-cost commodity such as coal, transportation and associated handling charges add very substantially to the market price in consuming areas. The main market areas are in central Canada, far from domestic sources and, as a result, transportation subventions have been required on the movement of coal for many years to provide a selling price comparable with that of imported coal.

Natural Gas

Net new production of natural gas increased 18.0 per cent in 1963, an excellent rate of growth although considerably less than the 44.4-per-cent increase of 1962. Net new production, excluding withdrawals from storage and gas flared and wasted, was 1,117,425 million cubic feet, or 3,061 million cubic feet a day. Alberta produced 84.4 per cent of this output, British Columbia 10.6 per cent, Saskatchewan 3.6 per cent, and Ontario 1.4 per cent. Only minor amounts were produced in New Brunswick and the Northwest Territories.

A total of 443 gas wells were completed, a small increase from the previous year. Important new gas discoveries were made in several areas - near Edson, 125 miles west of Edmonton; Marten Hills, 130 miles north of Edmonton; and in the Fort Nelson region of northeastern British Columbia and the adjacent portion of Alberta.

Sales of natural gas in Canada increased 7.5 per cent to 451,598 million cubic feet with industrial sales accounting for 52.1 per cent, residential sales 32.3 per cent and the remainder going to commercial customers. Ontario, for the first time, became the leading consumer with 37.1 per cent of sales. Alberta sales accounted for 34.7 per cent and Saskatchewan for 9.3 per cent.

Exports totalled 340,953 million cubic feet, 43 per cent of all sales. Most of the 6.7-per-cent increase in exports was accounted for by increased throughput in the Alberta to California gas pipeline that carried 47 per cent of all exported gas. Westcoast Transmission Company Limited exported 28 per cent of the total through Huntingdon, British Columbia, and the Trans-Canada Pipe Lines Limited exported 17 per cent through its lateral line at Emerson, Manitoba. Imports of natural gas at 6,877 million cubic feet formed a very small part of Canada's natural gas supply.

The net increase in natural gas reserves was 1,523,000 million cubic feet, or 4.3 per cent compared to 5.7 per cent in 1962. Year-end reserves were 36,960,000 million cubic feet, sufficient to last 33 years at the 1963 rate of gross new production. Additions to reserves increased British Columbia's share of the total from 13.9 to 15.6 per cent. Alberta's share decreased from 82.3 to 80.9 per cent and Saskatchewan's from 3.0 to 2.7 per cent.

Several small gas-processing plants were completed in 1963 to bring the number of plants in Canada to 84. The total gas processing capacity of these plants at year-end was 3,841 million cubic feet a day. Capital investment in gas-processing facilities was $44 million, slightly more than half of the investment of the peak construction year of 1961, yet it was the second highest on record.

Petroleum

Output of all liquid hydrocarbons (crude oil plus natural gas liquids) was 287,404,946 barrels in 1963, an average of 787,411 barrels a day. Production reached an all-time high, 7.1 per cent higher than in 1962. Crude oil production totalled 257,661,777 barrels. Alberta's share of Canadian production of liquid hydrocarbons amounted to 67.8 per cent. Saskatchewan and British Columbia gained a greater share of production, supplying 25.2 per cent and 5.0 per cent, respectively. The remaining two per cent was produced in Manitoba, Ontario, the Northwest Territories and New Brunswick. Natural gas liquids production is mostly from Alberta and British Columbia.

Drilling in western Canada totalled 14,123,800 feet, a gain of 8.0 per cent. The increase was mainly in development drilling, as exploratory drilling, comprising one third of the total footage, increased only slightly. Although drilling increased in all areas except British Columbia, the increase was most noteworthy in Saskatchewan and Manitoba. No major oil discovery was made but several medium-sized oil pools are being developed as a result of 1963 discoveries - notably the Goose River and House Mountain fields in Alberta.

The net increase in reserves was 8.7 per cent compared with 9.0 per cent in 1962. Year-end recoverable reserves of liquid hydrocarbons amounted to 5,629,237,000 barrels, a 19.6-year supply at the 1963 rate of production. A significant proportion of new recoverable reserves was developed by large-scale pressure maintenance and secondary recovery projects that utilize waterflooding. Ninety-seven per cent of the increase in reserves resulted from revisions of previous estimates and extensions of known oil accumulations. Because of the limited area assigned to each new discovery, only three per cent of the reserves increase was from newly-discovered oil accumulations.

Nearly 1,100 miles of oil pipelines were laid in 1963 but about 700 miles of this was not ready for operation until the first quarter of 1964. More than half the 1963 pipeline construction was accounted for by one project, the 577-mile six-inch natural gas liquids line from the Alberta-Saskatchewan boundary to Winnipeg. Heavy asphaltic crude oil from Lloydminster began moving to eastern Canada by pipeline as a crude-condensate mixture. This involves a small pipeline, from the Interprovincial line to Lloydminster, that transports condensate to Lloydminster where it is mixed with the heavy crude and then the pipeline flow is reversed to take the lower viscosity crude oil back to the Interprovincial pipeline.

Crude oil received at Canadian refineries increased by 23.9 million barrels or 7.7 per cent in 1963. Domestic crude petroleum made up 56.0 per cent of the 332.9 million barrels received, compared with 56.2 per cent in 1962. Refinery consumption decreased slightly in British Columbia but increased in all other provinces. Increase in refinery consumption was greater in Ontario (12.2 per cent) with nearly all of it being Canadian crude. The crude oil refining capacity of Canadian refineries increased to 1,019,000 barrels a day from 988,000 at the beginning of 1963. One new refinery was brought on stream: the 30,500-barrel-a-day plant of Shell Canada Limited at Oakville, Ontario. Two small refineries, at Lloydminster and Wainwright, Alberta, closed down.

Receipts of imported crude oil rose 8.3 per cent to 146.6 million barrels. Sixty-two per cent was imported from Venezuela and 33 per cent from the Middle East. Refineries in Quebec and the Atlantic Provinces continued to use only imported crude. Imports of petroleum products totalled 33.8 million barrels, an increase of 3.7 million barrels. Transfers of petroleum products, derived from foreign crude, into Ontario from Quebec and the Maritimes totalled nearly 29 million barrels, about 10 per cent more than in 1962. Late in 1963, the reversal of flow in a section of the Montreal to Toronto petroleum products pipeline extended the marketing territory available to Canadian petroleum as far east as Brockville.

Exports of crude oil and natural gas liquids to the United States nearly levelled off in 1963 in contrast to sharp increases in the previous two years. Exports of crude totalled 90.9 million barrels, of which 51 per cent went to three refineries in the Puget Sound Region of the west coast and the remainder went to 17 refineries in northern United States between western Montana and Buffalo, New York. Exports of petroleum products to the United States increased 23 per cent to 5.4 million barrels.

MINING TECHNOLOGY

Advances in mining techniques that took place in Canada during 1963 are reviewed in this section. In addition, improvements of an operating nature are continuously being incorporated in many mining plants, but these improvements do not attract the same amount of attention as new changes in technique. All technological changes and improvements are designed to cut costs, improve safety and speed operations. World markets for most minerals are highly competitive and continuous attention to cost reduction and efficiency is therefore necessary if industry is to expand its markets.

Production and Mining Methods

The tonnage of ore mined and rock quarried has risen from 87.7 million tons in 1950 to 229.0 million tons in 1962 and increases are expected to occur in 1963. The ratio of ore production from open pits to that from underground mines continues to rise with increased iron ore production. In metal mining operations in 1962, 33.2 million tons of ore came from open pits and 62.4 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	1955	1960	1961	1962
Metal Mines	45.9	69.2	101.6	99.4	114.3
Non-Metal Mines	17.7	24.7	42.0	47.0	52.2
Stone Quarries *	34.1	38.8	55.8	59.7	62.5
Total (other than coal)	87.7	132.7	199.4	206.1	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 * from Metal Mines, 1950-1962

(millions of short tons)

Year	Underground** tons	Open Pit** tons	Total, tons	Ratio underground to open pit
1950	35.4	5.6	41.0	6.3 : 1.0
1955	68.2	14.9	83.1	4.6 : 1.0
1960	69.2	24.8	94.0	2.8 : 1.0
1961	64.2	29.3	93.5	2.2 : 1.0
1962	62.4	33.2	95.6	1.9 : 1.0

* 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.

** Excludes waste.

The world's first method of potash recovery from drill holes by the solution method was being developed in 1963 by Kalium Chemicals Limited. Potash mining by the room-and-pillar method proceeded on schedule at Esterhazy, Saskatchewan, and plans were underway for other mining operations in the extensive potash beds of central and southern Saskatchewan.

A method of blasthole stoping which utilizes waste for support was instituted by Geco Mines Limited, Manitouwadge, Ontario. Transverse stopes are mined on two sides of a pillar that is simultaneously drilled off. When the transverse stopes are emptied, the large pillar is blasted, almost filling the opening. Waste from a surface quarry is dumped directly into a fill raise leading to the opening and while the opening is kept filled with waste, controlled drawing of ore is continued.

Drilling and Blasting

The use of wagon drills for drilling of uppers in cut-and-fill stopes was extended at Falconbridge Nickel Mines, Limited. The company built its own drill wagon and cable-pneumatic feed for mounting of 2 5/8-inch and 3-inch drills.

A mine in Elliot Lake and another in the Gaspé area have extended the use of long blastholes for pillar removal and production drilling. Another Elliot Lake mining company has made a detailed study of small-diameter hold spacing in stope headings with the result that efficiency, represented by material broken per foot of hole drilled, has increased. In many mines, there was further extension in the use of alloy drill rods that are carburized.

A major advance in jet-piercing occurred with the design of a new burner that enables air-fuel mixtures to replace oxygen-fuel mixtures when penetrating spallable rocks. Known as the JPAM-100, the new drill has been manufactured by Linde Gases Division of Union Carbide Corporation and Gardner-Denver Company. The new drill may be adapted for drilling large diameter open-pit and quarry holes, and for chambering bottoms of small diameter holes drilled in a conventional manner.

In open-pit mining, the last of the churn drills used for production drilling has been replaced by rotary drills. Improvements have also been made in down-the-hole percussion drills. One major iron ore mining company has replaced, in part, 9 7/8-inch tricone bits with 12¼-inch bits to increase the ore yield by 30 per cent. In the soft ores, the increased diameter of the bits has not significantly decreased the penetration rate.

In underground blasting, ammonium nitrate-fuel oil (AN-FO) mixtures have probably reached their maximum application during the year. A non-electric detonating device, the Anodet Delay, has been developed by Canadian Industries Limited to detonate AN-FO successfully without a booster.

The COMINCO has developed a better ammonium nitrate prill that is eminently suited to blasting in small diameter underground holes. The prills are relatively insensitive during transport but sensitive to the detonation of a cap in the drill hole.

In open-pit blasting, further developments occurred in the design of slurry-type blasting agents. Metallic slurries appeared in greater variety.

Support

During 1963 there was a further extension in the use of self-supporting cemented tailings fill. Test work, begun in previous years in some mines, resulted in the adoption of cemented tailings fill into standard mining practices.

The use of small diameter rock bolts was extended in underground mining. One company in the Elliot Lake area has developed a dished plate washer that gives visual indication of bolt tension and permits better anchoring in areas with uneven surfaces.

In the Manitouwadge area mines, rock bolts of 1 1/8-inch and 1 1/4-inch diameter having a 22-foot length have been developed for supporting walls of blasthole stopes. The bolts are anchored during stope development. Tension on the bolts is maintained at 50 to 60 tons while the bolts are grouted into place. The procedure has resulted in less sloughing of hanging walls and improved control of dilution. In the Geco mine, Manitouwadge, pillars are being laced with discarded 1 5/8-inch diameter lock-coil cable and high tension bolts, grouted into place. Tension of 40 tons is applied before grouting.

Loading, Hauling and Handling

Greater attention has been given to large-scale automated haulage systems. At Algoma Ore Properties, Wawa, a Grangesburg bottom-dump train has been installed for a main transfer haul. Initial results have been satisfactory. Comparable bottom-dump rail haulage equipment has been designed in Canada for underground and surface use.

In the Craigmont mine, Granby cars of 256-cubic-foot capacity have been provided for underground haulage. In the same mine, AC current was adopted for underground locomotive haulage.

The trend toward larger haulage equipment is evident from the adoption of 37-ton capacity rubber-tired haulers in an underground salt mine.

The automated railway ore haulage system at the Carol Lake iron ore project continues to attract wide interest. In other open pits, the gradual replacement of haulage units results in increased vehicle size. A 55-ton capacity off-road truck is now being manufactured in Canada for this purpose.

Miscellaneous

A hand-held, 24-oz. magnetometer has passed exhaustive tests on actual exploration programs and has become generally available. The magnetometer is equipped with a hydraulic levelling device and a sensitive detecting system.

There is increasing use of computers for calculation of ore reserves and for operations research. The greatest use of computers has thus far been made by the larger mining companies. Where computers are used, the information available for decision making has been spectacularly increased.

MINERAL INDUSTRY TRENDS

The growth and importance of the mineral industry can be readily appraised by examination of statistical series on production, trade, consumption, prices, costs, employment, exploration, mine output, transportation, taxes and capital investment. The statistical series in the tables that follow this summary include detailed data for 1963 and representative statistics for recent years, and thereby provided a means of assessing mineral industry trends. The following observations, related to the tables, direct attention to the more significant trends and to present conditions in the industry.

Production

Mineral production value reached an all-time high in 1963 and the year's gain was slightly above the average annual increase in the period 1950-63 (Tables 1 and 2). As in recent years, the increase in the production value of the fuels accounted for a major part of the overall increase. Consequently, there has been a considerable change in the percentage composition of total mineral value, as noted in a comparison of 1963 and 1960 percentages: metallic minerals – 49.5 (56.4) per cent, nonmetallic minerals – 20.7 (20.9) per cent, fuels – 29.8 (22.7) per cent.

The extent to which the mineral industry has outpaced the industrial economy as a whole since 1949 is illustrated by a comparison of the indexes of industrial production and of mining. However, in 1963 the mining index did not advance as much as the industrial index. In fact, there was a decline in the metals index, indicating that the slight value increase came about as a result of improvement in metal prices rather than from a rise in production volume. There was only a minor increase in the nonmetals index, and thus the overall advance in the mining index was due to the production gain for the fuels (Table 3). Petroleum, nickel, iron ore, copper, gold, uranium and asbestos have been the leading minerals in terms of production value in recent years and in 1963 iron ore replaced copper in third place. These seven minerals accounted for 65.4 per cent of the total production value of 55 mineral commodities in 1963, slightly lower than in the previous year. Seventeen minerals had a value of one per cent or more of total output, and in the aggregate these minerals accounted for 93.6 per cent of total output value (Table 4).

A regional analysis of mineral production provides interesting locational data (Table 5). The Appalachian, St. Lawrence Lowlands and Cordilleran regions had approximately equal proportions of total output in 1963 and, in the aggregate, accounted for 27.7 per cent of Canada's mineral value, the same as in 1962. The Interior Plains accounted for 29.8 per cent, an increase of 2.9 per cent. The Canadian Shield, which has been the leading producing region since the turn of the century, was the source of 42.5 per cent of the country's mineral output, a decline of 2.9 per cent. On a provincial basis, Alberta continued to widen its lead over Quebec and to gain on Ontario. These three provinces accounted for 68.3 per cent of total output compared with 70.1 per cent in 1962. Only Ontario and the Northwest Territories experienced a decline in mineral production. Ontario's decline has continued since 1960 (Tables 7 and 8). Although output of the leading minerals tends to be concentrated in certain provinces - crude petroleum in Alberta, nickel in Ontario, asbestos in Quebec - there is good provincial distribution of mineral production (Table 9), and further diversification can be expected as the resource base is enlarged. This trend is illustrated by the growing importance of British Columbia as a copper producer, of Saskatchewan as a potash producer, of Manitoba as a nickel producer, and of Quebec as a zinc producer.

The importance of the mining industry in the Canadian economy can be appraised by net values of production. The latest available statistics show that the mining industry has a net value almost as great as that of agriculture (Table 11) whereas in 1950 the industry's net value was only one third of agricultural output. During the period 1950-61, the mining industry percentage of the primary output for all industries, in net value terms, rose from 19.7 to 32.1 per cent. These comparisons relate to mining activity only; the values of primary iron and steel, nonferrous smelting and refining, petroleum refining, and nonmetallic mineral processing are included in the manufacturing total of Table 11.

The importance of the Canadian mineral industry in the world mineral economy can be judged from Table 10. Canada ranks among the first six producing countries for 19 minerals. Although the country has always been a leading world producer, it has increased its prominence since the early 1950's when it was among the first six countries for 14 minerals. In terms of the principal mineral groups, Canada accounts for about 12 per cent of the world's mine output of the nonferrous minerals, 5 per cent of the world's iron ore production and 3 per cent of its oil production. The country's share of world production for other important minerals is as follows: platinum metals, 23 per cent; silver, 12 per cent; sulphur, 15 per cent; cadmium, 9 per cent; cobalt, 12 per cent; gypsum 11 per cent; and magnesium, bismuth, barite and natural gas, 5 to 10 per cent.

Mineral Trade

For the purposes of the following trade analysis, mineral exports and imports are classified as raw material and semiprocessed mineral products (Tables 12 and 13). Canada has a very favourable trade balance for these classes, although the increase in 1963 was not as great as in 1962. During 1963, the value of raw material exports exceeded imports by 74 per cent, compared with 80 per cent in 1962. Semiprocessed exports were eight times greater than imports; nine times greater in the previous year. These declines were caused primarily by the decrease in nonferrous metal exports and by a greater rise in imports than in exports for the nonmetallics and fuels, at the raw material stage. The lack of appreciable progress in semiprocessed exports in all mineral classes and an accompanying increase in semiprocessed imports in the nonferrous class were also factors. The most satisfactory progress in the raw material category was that made for iron ore, with the increase in exports being over four times that of the imports. In total, there was a favourable trade balance of $1,295 million, compared with $1,285 million in 1962 and $1,150 million in 1961.

The mineral industry has a prominent position in Canada's export trade. Since the early 1950's, mineral exports in the raw and semiprocessed categories have risen from about one fifth to almost one third of all industrial product exports. At the same time, mineral imports have remained at about one tenth of all industrial product imports (Tables 20 and 21). Mineral exports in the raw form and in semiprocessed forms were 15.3 and 14.3 per cent of all exports in 1963 (Table 14), with the comparable percentage of imports for these categories being 9.1 and 1.8 per cent (Table 15). The low proportion of imports for the semiprocessed mineral commodities is particularly favourable. It is significant, too, that the raw material imports are not spread widely throughout the mineral economy but rather consist primarily of raw material requirements, not produced in Canada, for the aluminum industry and crude oil for the petroleum refining industry in Quebec and the Atlantic provinces which are beyond the economic reach of oil from western Canada.

The United States was the destination of 60.4 per cent of the value of Canada's exports of raw and semiprocessed mineral materials, and the source of 35.5 per cent of its imports in these categories (Tables 16 and 17). The increase of $79 million over 1962 in total mineral exports resulted largely from an increase to Britain and Japan that more than compensated for the decline in shipments to EEC countries, while exports to all other markets remained close to the previous year's levels (Tables 18 and 19). There is an increasing diversification of export markets for Canada's minerals but the United States remains by far the most important market; during the period 1950-63, the percentage of mineral exports going to that market was in the range of 52 to 65 per cent. Two thirds of the rise in iron ore exports in 1963 was due to increased shipments to the United States, which also took greater amounts of aluminum, primary ferrous metals, fuels and a number of the minor minerals, but lesser amounts of uranium and the nonferrous metals. The largest increase in mineral shipments to Britain occurred for uranium but there were also favourable increases for iron ore and most of the nonferrous metals. There were modest increases in shipments of aluminum, nickel and zinc to EEC countries but declines for most other minerals. An increase was recorded for all mineral exports going to Japan, except for nickel which remained at about the previous year's level.

Domestic Consumption

Canada's degree of mineral self-sufficiency can be measured in terms of consumption expressed as a percentage of production (Table 22). With very few exceptions, Canada's large and diversified mineral production is well in excess of domestic demand. The few exceptions to self-sufficiency in mineral supply include molybdenum, tungsten, chromium, manganese, tin and mica. The deficiencies in molybdenum and tungsten will soon be largely met by new production. The previous deficiency in sulphur has been overcome and potash production is now adequate to meet domestic requirements and provide for growing exports. The gap between crude oil production and consumption is being gradually narrowed. Although Canada's coal resources are very large, continuing reliance must be placed on imports at least equivalent to domestic output because of the high cost of mining and transporting Canadian coal. The consumption percentages in Table 22 illustrate the importance of mineral exports to the industry; as a whole, export markets take about three fifths of total mineral output. Three quarters of the metals are marketed outside of Canada, as well as about one third of the industrial minerals and the fuels.

Of the four major nonferrous metals, aluminum has the smallest percentage of its production marketed in Canada and consequently the aluminum industry must place much reliance on expanding export markets (Table 24). However, the domestic market for aluminum has been assuming increasing importance in the past 10 years whereas for the other principal nonferrous metals it has fluctuated but not changed materially.

Prices

There were mixed trends in world mineral prices in 1963 (Table 25) but at the end of the year the main trend was towards price increases for most minerals. On balance, the price change effects during 1963, including the effect of the

May 1962 devaluation of the Canadian dollar, resulted in a one-per-cent increase in value of output for the metallic minerals, as listed in Table 1, essentially no change for the nonmetallics, and a seven-per-cent increase for the fuels. Thus unit price changes accounted for the over-all value increase for the metals, and for about one half the gain for the fuels.

The price index for nonferrous metals (including gold) increased 2.8 per cent in 1963 compared with 1.9 per cent for the wholesale price index. The index for iron and products declined one per cent while the nonmetallic minerals index remained practically constant (Table 26). During the past decade the price indexes for iron and its products, nonferrous metals including gold, and nonmetallic minerals increased 14.4, 17.1 and 7.1 per cent respectively, while the wholesale price index advanced 10.8 per cent (Table 27).

Principal Statistics of the Mineral Industry*

In the metallics sector (Table 28 and 28A) wages and salaries were four per cent higher in 1962 than in the previous year. The number of establishments fell by 20 per cent although the total number employed in the sector remained almost constant. The cost of fuel and supplies rose, but the gross value of production was considerably higher so that the net value was 5.2 per cent higher in 1962 than in 1961. A similar pattern may be noted in industrial minerals, which showed an eight per cent increase in net value. Fuels showed a 20 per cent increase. The net value of production as a percentage of the gross value for the three groups in the industry was 72 per cent, 78 per cent and 89 per cent respectively. In the previous year these values were 72 per cent, 79 per cent and 90 per cent. The relationship for nonferrous smelting and refining was 38 per cent compared with 36 per cent in the previous year, and net value advanced 13 per cent. Consumption of fuels and electricity by the Canadian mineral industry is given in Tables 30, 30A, 31 and 31A which show that value purchased rose 3¼ per cent from 1961 to 1962. These tables also show no over-all trend toward or away from one specific fuel. For instance the quantity of coal consumed rose in two sectors and fell in two others; the quantity of liquefied petroleum gas used in three sectors was more than double the 1961 quantity but in the fourth sector it was less than half. The tables on principal statistics afford a means of comparing the relative costs of wages, supplies and energy in the several sectors of the mineral economy.

Employment

The total number of employees in the Canadian mining industry was virtually unchanged from 1961 (Tables 33 and 34). There was a rise of 4.8 per cent

* It should be noted in studying the principal industry statistics and employment data of Tables 28 to 34 and Table 36 that a change was made by the Dominion Bureau of Statistics, commencing in 1960, in certain accounting procedures relative to the adoption of the Standard Industrial Classification. As a result, some firms in the industrial minerals classification, particularly those engaged in sand and gravel operations, were reclassified in the construction industry and other categories. Employment, salaries and wages, and other industry statistics for the industrial minerals sector are therefore not directly comparable with similar statistics for previous years.

in the industrial minerals sector and a fall of 7 per cent in the fuels sector. The fall was almost entirely confined to the coal industry (Tables 28 and 28A) where some establishments were no longer classified in the mining industry; there was also a number of mines that closed (Tables 28 and 28A). The largest of the mines that closed was the Dominion No. 16 colliery at New Waterford, Nova Scotia, where about 870 men were laid off. Metal mining and nonferrous smelting and refining employment totals were almost the same as 1961. Annual average wages and salaries rose by four per cent in the year. This is the same growth rate as the past decade.

With the exception of the silver-cobalt group of mines, the average number of tons mined per worker in Canada continued to rise (Table 35). An overall increase in mechanization and efficiency within the industry resulted in fewer man hours per ton mined (Table 36). This trend was most marked in the iron ore sector where the annual output per man reached about 8,000 tons (Table 35); this represents a 48-per-cent increase in 1961. However, this increase was not entirely the result of a productivity increase but was caused in part, at least, by the transition from property development to production especially in Labrador-Newfoundland where the Quebec Cartier Mining Co. more than tripled production to 11.3 million long tons. In addition, initial shipments amounting to 2½ million long tons of ore were made from the Carol Lake project of the Iron Ore Company of Canada.

In the past decade wage costs per ton in metal mines has fallen at the annual rate of 4¼ per cent (column 6, Table 35), while the average annual wage has risen at the rate of 3½ per cent (column 3, Table 35). Basic hourly wage rates in 1962 (Table 37) for underground, surface and mill workers in metal mining showed an increase of about $0.02 per hour compared with 1961. Increases to workers in the iron ore sector amounted to about $0.12 per hour. Wages in gold mines continued to be lower than the remainder of the industry. The average weekly wage paid to metal miners continued to compare favourably with the wage paid in other sectors of the economy (Tables 38 and 39).

Prospecting and Exploration

Distribution of the costs of exploration among different groups of mining companies was similar to previous years, with mining companies classified as copper-gold-silver producers making the greatest expenditures, and nickel-copper mines the next greatest (Tables 41 and 42). Total exploration costs were up $305,000, or 0.7 per cent from 1961, principally because of expenditure declines in the copper-gold-silver category.

The amount of contract diamond drilling carried out for mining companies was up slightly from 1961, but not as high as the peak years of the mid-1950's (Table 43). Contract rotary drilling for oil companies was off 1¼ per cent from 1961 (Table 44).

Ore Mined and Rock Quarried

The total tonnage of metallic ores mined in Canada in 1962 was greater than the amount mined the previous year. Iron ore tonnage was up by 50 per cent and accounted for 44 per cent of the total. The increase in quantity of iron ore more than compensated for the decreases in nickel-copper ore and in gold ore mined (Table 45). The tonnages reported from industrial mineral operations in 1962 were almost the same as those from metal mines (Table 46).

Transportation of Minerals

The importance of minerals in the Canadian economy is well illustrated by the volume of mineral traffic on Canadian railways and the amount of railway construction attributable to mineral development. Crude minerals account for two fifths of all revenue-producing freight moved by Canadian railways. This is essentially the same type of indicator as 'freight car loadings' (Table 47). During the past decade, crude-mineral shipments have constituted an increasingly important part of total railway freight, the proportion having increased from about one third to the present two fifths (Table 48). Iron ore and coal account for over one half of mineral industry freight. The primary products of smelters and refineries constitute only a small percentage of the revenue freight received by Canadian railways (Table 49). Of the 1885 miles of new railway construction completed in Canada since the end of the Second World War, a total of 1442 miles was built for mineral development.

The mineral industry provides about two fifths of the inland-waterways traffic through the principal canals (Table 50). Iron ore and coal account for almost 90 per cent of mineral industry freight on canals.

Petroleum moved in pipelines in 1963 amounted to 63.9 million tons, almost as much as the total mineral tonnage received by railways (Table 51). Ten years ago, petroleum tonnage via pipelines was only two fifths of mineral freight tonnage on railways, an indication of the rapid growth and present importance of pipeline transportation. Natural gas volume in pipelines has also grown rapidly, having doubled since 1959. These statistics point to the fact that pipelines are now a major component of Canada's transportation system.

Taxation

Almost 60 per cent of the taxes paid by the five major divisions of the mineral industry are in the form of federal income taxes; provincial and municipal taxes account for the remainder. Taxes paid by the nickel-copper mining and smelting industry are an indication of this sector's leading position in the mineral economy (Tables 52 and 53). Taxes paid by the mineral industry account for almost one fifth of all federal income taxes (Table 54).

Capital Investment, Ownership and Control

In 1963 there was a 4½ per cent increase in capital investment and repair expenditures in the mineral industry compared with an 8 per cent increase in 1962 and an 11 per cent increase in 1961. In the metals sector investment fell 16 per cent; it rose 4½ per cent in the nonmetals and 23 per cent in the fuels. The increase in the fuels sector was due to petroleum and natural gas increases; there was a decline in the coal sector. Table 55 shows the capital and repair expenditures for the several sectors of the mining industry, but it does not include expenditures in the nonferrous smelting and refining industries, the petroleum refining industry nor the pipeline transport industry. Total expenditures attributable to mineral industry activity are also understated to the extent of mining company expenditures on railways and electric power facilities, as well as expenditures by other businesses dependent on the industry.

In the petroleum and natural gas industries capital investment was up in all sectors except petroleum refining for a total increase of about 21 per cent. This position is the reverse of the previous year when there was a slight decline in total expenditures although there was an increase in petroleum refining investment (Table 56).

The latest available statistics show that 64.0 per cent of the mining sector of Canada's mineral industry is foreign owned; 59.9 per cent of the petroleum industry and 55.4 per cent of the nonferrous smelting industry is foreign owned (Table 57). Foreign-owned capital forms a larger proportion of total capital employed in the mineral industry than in other areas of the economy such as manufacturing or construction (Table 58). Statistics for the past 30 years illustrate the dominant position the United States has maintained among foreign countries investing in the Canadian mineral industry. United States capital has constituted over 85 per cent of the total foreign investment each year in the mining and smelting industries and in the petroleum and natural gas industries (Table 59).

Statistical Tables

Table No.	Title and Page

TABLE 1

Mineral Production of Canada, 1962 and 1963

	Unit of measure	1962		1963	
		Quantity	$ '000	Quantity	$ '000
Metals					
Antimony	'000 lb	1,931	748	11,601	625
Bismuth	'000 lb	425	840	359	704
Cadmium	'000 lb	2,605	4,731	2,475	5,941
Calcium	'000 lb	124	124	99	117
Cobalt	'000 lb	3,482	6,345	3,025	6,122
Columbium (Cb_2O_5)	'000 lb	1,017	1,006	1,393	1,300
Copper	'000 s.t.	457	282,733	453	284,404
Gold	'000 troy oz.	4,178	156,314	3,986	150,473
Indium	'000 oz	..	..	..	..
Iron ore	'000 l.t.	24,428	263,004	26,914	312,141
Iron (remelt)	'000 s.t.	...	9,846	...	11,807
Lead	'000 s.t.	215	42,721	201	44,256
Magnesium	'000 lb	17,631	4,822	17,810	5,358
Molybdenum (Mo content)	'000 lb	818	1,261	834	1,344
Nickel	'000 s.t.	232	383,784	217	360,393
Platinum metals	'000 troy oz.	471	28,849	358	22,585
Selenium	'000 lb	487	2,801	469	2,274
Silver	'000 troy oz.	30,423	35,443	29,928	41,420
Tantalum (Ta_2O_5)	'000 lb	—	—	—	—
Tellurium	'000 lb	59	352	77	499
Thorium	'000 lb	..	..	..	..
Tin	'000 lb	651	443	927	649
Titanium ore	'000 s.t.	—	—	—	—
Tungsten (WO_3)	'000 lb	4	2	..	..
Uranium (U_3O_8)	'000 lb	16,859	158,184	16,703	136,909
Zinc	'000 s.t.	463	112,081	474	121,083
Total, metals			1,496,434		1,510,044
Non metals					
Arsenious oxide	'000 lb	161	7	187	7
Asbestos	'000 s.t.	1,216	130,282	1,276	136,956
Barite	'000 s.t.	227	2,124	174	1,693
Diatomite	s.t.	211	10	798	197
Feldspar	'000 s.t.	10	223	...	1,976
Fluorspar	'000 s.t.	...	1,870	16	16
Gemstones	1000 lb	—	—	—	—
Graphite	s.t.	—	—	—	—
Grindstone	s.t.	10	2	10	2

Table 1 (cont'd)

	Unit of measure	1962		1963	
		Quantity	$ '000	Quantity	$ '000
Gypsum	'000 s.t.	5,333	9,350	5,955	11,238
Helium	Mcf	–	–	..	..
Iron oxide	'000 s.t.	0.8	58	1	75
Lithia	'000 lb	500	559	644	682
Magnesite, dolomite and brucite	'000 ton	...	3,432	...	3,440
Mica	'000 lb	1,204	85	1,183	44
Mineral water	'000 gal	377	207	–	–
Nepheline syenite	'000 s.t.	254	2,605	254	2,699
Nitrogen	Mcf	–	–	..	..
Peat moss	'000 s.t.	238	7,480	243	8,486
Potash (K_2O)	'000 s.t.	..	3,000r	627	22,500
Pozzolana	s. t.	...	5	...	18
Pyrite, pyrrhotite	'000 s.t.	517	1,880	476	1,644
Quartz	'000 s.t.	2,086	3,817	1,889	3,860
Salt	'000 s.t.	3,639	21,927	3,722	22,317
Soapstone, talc, pyrophyllite	'000 s.t.	46	625	54	758
Sodium suphate	'000 s.t.	247	3,954	257	4,121
Sulphur, in smelter gas	'000 s.t.	293	3,090	353	3,488
Sulphur, elemental	'000 s.t.	695	9,287	1,250	13,380
Titanium dioxide, etc.	'000 s.t.	...	11,574	...	14,426
Total, nonmetals			217,453r		254,050
Fuels					
Coal	'000 s.t.	10,285	69,160	10,576	71,756
Natural gas	'000 Mcf	946,703	108,641	1,117,425	150,469
Natural gas byproduct	'0C0 bbl	...	50,778	...	70,998
Petroleum crude	'000 bbl	244,115	552,353	257,662	615,205
Total, fuels			780,932		908,428
Structural Materials					
Clay products	'000 $	...	37,817	...	38,154
Cement	'000 s.t.	6,879	113,234	7,014	118,615
Lime	'000 s.t.	1,424	17,647	1,451	18,504
Sand and Gravel	'000 s.t.	181,246	118,603	189,570	123,854
Stone	'000 s.t.	47,553	68,866r	62,655	79,884
Total, structural materials			356,167r		379,011
Total, all minerals			2,850,986r		3,051,893

Symbols: .. Not available for publication; ... Not applicable; r Revised from previously published figure.

TABLE 2
Value of Mineral Production of Canada And Its Per Capita Value
Selected Years 1925–1963

	Production				Per Capita Value
	Metals ($ millions)	Industrial Minerals ($ millions)	Fuels ($ millions)	Total ($ millions)	($)
1925 ...	117	53	57	227	24.38
1930 ...	143	69	68	280	27.42
1935 ...	222	36	55	313	28.84
1940 ...	382	69	79	530	46.55
1945 ...	317	88	94	499	41.31
1950 ...	617	227	201	1,045	76.24
1955 ...	1,008	373	414	1,795	114.37
1960 ...	1,407	520	566	2,493	139.48
1961 ...	1,387	542	653	2,582	141.59
1962 ...	1,496	574r	781	2,851r	153.53r
1963 ...	1,510	633	909	3,052	161.51

r Revised from previously published figure.

TABLE 3

Indexes of Physical Volume of Industrial and Mineral Production in Canada, 1949–63
Unadjusted (1949=100)

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Total Industrial Production	100.0	109.9	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
Total Mining	100.0	106.9	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
Metals															
All Metals	100.0	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
Gold	100.0	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
Nickel	100.0	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
Lead	100.0	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
Zinc	100.0	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
Copper	100.0	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
Iron Ore	100.0	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
Fuels															
All Fuels	100.0	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
Coal	100.0	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
Natural gas	100.0	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
Petroleum	100.0	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
Nonmetals															
All nonmetals	100.0	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
Asbestos	100.0	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
Other nonmetals	100.0	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
Quarrying and sand pits	100.0	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

TABLE 4

Percentage Contributions of Leading Minerals to Total Value of Mineral Production in Canada, 1954-1963

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Petroleum	16.4	17.0	19.5	20.7	19.0	17.5	17.0	18.9	19.4	20.2
Nickel	12.1	12.0	10.7	11.8	9.2	10.7	11.9	13.6	13.5	11.8
Iron ore	3.3	6.2	7.7	7.6	6.0	8.0	7.0	7.3	9.2	10.2
Copper	11.8	13.4	14.1	9.4	8.3	9.7	10.6	9.9	9.9	9.3
Gold	10.0	8.7	7.2	6.8	7.4	6.2	6.3	6.1	5.5	4.9
Natural gas	0.8	0.8	0.8	1.0	1.5	1.6	2.1	2.6	3.8	4.9
Asbestos	5.8	5.4	4.8	4.8	4.4	4.5	4.9	5.0	4.6	4.5
Uranium (U_3O_8)	1.8	1.4	2.2	6.2	13.3	13.7	10.8	7.6	5.5r	4.5
Sand and gravel	4.0	3.8	3.9	4.1	4.6	4.3	4.6	4.1	4.2	4.1
Zinc	6.1	6.6	6.0	4.6	4.4	4.0	4.4	4.1	3.9	4.0
Cement	4.0	3.7	3.6	4.3	4.6	3.9	3.7	4.0	4.0	3.9
Stone	2.7	2.4	2.3	2.7	2.6	2.5	2.4	2.6	2.4r	2.6
Coal	6.5	5.2	4.6	4.1	3.8	3.1	3.0	2.7	2.4	2.4
Lead	3.9	3.2	2.8	2.3	2.0	1.6	1.8	1.8	1.5	1.5
Silver	1.7	1.4	1.2	1.1	1.3	1.2	1.2	1.1	1.2r	1.4
Clay products	2.2	2.0	1.8	1.6	2.0	1.8	1.5	1.4	1.3	1.3
Platinum metals	1.4	1.3	1.1	1.2	0.7	0.7	1.2	0.9	1.0	0.7
Potash (K_2O)	—	—	—	—	—	—	—	—	0.1	0.7
Salt	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.7
Lime	1.0	0.9	0.8	0.8	0.9	0.9	0.8	0.7	0.6	0.6
Titanium dioxide	0.3	0.3	0.4	0.4	0.3	0.4	0.5	0.6	0.4	0.5
Elemental sulphur	..	..	..	..	0.1	0.1	0.2	0.3	0.3	0.4
Gypsum	0.5	0.4	0.3	0.4	0.2	0.3	0.4	0.3	0.3	0.4
All other minerals	3.1	3.3	3.6	3.5	2.7	2.6	2.9	3.6	4.2	4.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Symbols: r Revised from previously published figure; — Nil; .. Not available.

TABLE 5

Value of Mineral Production in Canada, by Main Geological Regions, 1963

	Metals		Industrial Minerals		Fuels		Total All Minerals	
	$ Millions	% of Total	$ Millions	% of Total	$ Millions	% of Total	$ Millions	% of Total
Canadian Shield ...	1,263.8	83.7	32.5	5.1	—	—	1,296.3	42.5
Appalachian Region	63.6	4.2	165.5	26.1	52.0	5.7	281.1	9.2
St. Lawrence Lowlands	1.3	0.1	280.2	44.3	9.5	1.0	291.0	9.5
Interior Plains	*	*	107.5	17.0	801.5	88.3	909.0	29.8
Cordilleran Region .	181.7	12.0	47.4	7.5	45.4	5.0	274.5	9.0
Total Canada ..	1,510.4	100.0	633.1	100.0	908.4	100.0	3,051.9	100.0

* Less than $5,000.
— Nil.

TABLE 6

Value of Mineral Production in Canada, by Provinces and Mineral Group, 1963

	Metals		Industrial Minerals		Fuels		Total	
	$000	% of Total	$000	% of Total	$000	% of Total	$000	% of Total
Ontario	683,175	45.2	181,144	28.6	9,509	1.0	873,828	28.6
Alberta	5	—	46,489	7.3	622,817	68.6	669,311	21.9
Quebec	293,410	19.4	249,869	39.5	—	—	543,279	17.8
Saskatchewan ..	65,404	4.3	38,770	6.1	168,181	18.5	272,355	8.9
British Columbia .	170,495	11.3	44,743	7.1	45,908	5.1	261,146	8.6
Manitoba	134,982	8.9	25,347	4.0	9,189	1.0	169,518	5.6
Newfoundland ..	123,665	8.2	13,583	2.1	—	—	137,248	4.5
Nova Scotia	1,043	0.1	20,582	3.3	44,693	4.9	66,318	2.2
New Brunswick ..	9,255	0.6	11,736	1.9	7,352	0.8	28,343	0.9
Northwest Territories ...	14,727	1.0	—	—	655	0.1	15,382	0.5
Yukon	14,243	1.0	—	—	124	—	14,367	0.5
Prince Edward Island	—	—	798	0.1	—	—	798	0.03
	1,510,404	100.0	633,061	100.0	908,428	100.0	3,051,893	100.0

— Nil.

TABLE 7

Value of Mineral Production in Canada, by Provinces, 1954–63

($ millions)

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Ontario	497	584	651	749	790	971	983	944	913	874
Alberta	279	326	411	410	346	376	396	473	566	669
Quebec	279	357	423	406	366	441	446	455	519r	543
Saskatchewan ...	68	85	123	173	210	210	212	216	241r	272
British Columbia..	159	189	203	179	151	159	186	188	235	261
Manitoba	35	62	68	64	57	55	59	101	159	170
Newfoundland ...	43	68	84	83	65	72	87	92	102	137
Nova Scotia	73	67	66	68	63	63	66	62	62	66
New Brunswick ..	12	16	18	23	16	18	17	19	22	28
Northwest Territories	26	26	22	21	25	26	27	18	18	16
Yukon	17	15	16	14	12	13	13	13	13	15
Prince Edward ... Island	–	–	–	–	–	5	1	1	0.7	0.8
Canada	1,488	1,795	2,085	2,190	2,101	2,409	2,493	2,582	2,851r	3,052

Symbols: – Nil; r Revised from previously published figure.

TABLE 8

Percentage Contribution of Provinces to Total Value of Mineral Production in Canada, 1954–63

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Ontario	33.4	32.5	31.2	34.2	37.5	40.3	39.4	36.6	32.0r	28.6
Alberta	18.8	18.2	19.7	18.7	16.5	15.6	15.9	18.3	19.9	21.9
Quebec	18.8	19.9	20.2	18.5	17.4	18.3	17.9	17.6	18.2r	17.8
Saskatchewan	4.6	4.7	5.9	7.9	10.0	8.7	8.5	8.4	8.4r	8.9
British Columbia ..	10.7	10.5	9.7	8.2	7.2	6.6	7.5	7.3	8.2r	8.6
Manitoba	2.4	3.5	3.3	2.9	2.7	2.3	2.4	3.9	5.6	5.6
Newfoundland	2.9	3.8	4.0	3.8	3.1	3.0	3.5	3.6	3.6	4.5
Nova Scotia	4.8	3.7	3.2	3.1	3.0	2.6	2.6	2.4	2.2	2.2
New Brunswick ...	0.8	0.9	0.9	1.1	0.8	0.8	0.7	0.7	0.8	0.9
Northwest Territories	1.7	1.5	1.1	1.0	1.2	1.1	1.1	0.7	0.6	0.5
Yukon	1.1	0.8	0.8	0.6	0.6	0.5	0.5	0.5	0.5	0.5
Prince Edward Island	–	–	–	–	–	0.2	0.05	0.02	0.02	0.3
Canada	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

r Revised from previously published figure; – Nil.

TABLE 9

Production of Leading Minerals in Canada, by Provinces, 1963

		Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Petroleum	bbl	–	–	–	7,381	–	1,205,376	3,771,163	71,303,893	168,214,054	12,528,681	631,229	–	257,661,777
	$	–	–	–	10,333	–	3,459,429	9,188,635	160,226,978	416,844,350	24,841,518	633,754	–	615,204,997
Nickel	s.t.	–	–	–	–	2,506	149,089	63,585	–	–	1,850	–	–	217,030
	$	–	–	–	–	4,209,785	246,252,488	106,822,887	–	–	3,107,498	–	–	360,392,658
Iron ore	s.t.	9,683,004	–	–	–	11,650,787	6,749,617	–	–	–	2,060,241	–	–	30,143,649
	$	99,053,621	–	–	–	122,306,806	70,033,690	–	–	–	20,746,424	–	–	312,140,541
Copper	s.t.	14,012	–	237	8,964	141,400	178,960	16,980	29,772	–	62,218	16	–	452,559
	$	8,827,797	–	149,394	5,647,307	89,081,976	112,048,454	10,697,506	18,756,028	–	39,184,967	10,281	–	284,403,710
Gold	oz.	12,318	–	–	1,128	917,229	2,338,854	49,886	64,813	132	159,473	387,000	55,211	3,986,044
	$	465,004	–	–	42,582	34,625,395	88,291,739	1,883,196	2,446,691	4,983	6,020,106	14,609,250	2,084,215	150,473,161
Natural gas	Mcf	–	–	–	103,524	–	15,920,055	–	39,936,193	943,354,973	118,058,994	51,478	–	1,117,425,217
	$	–	–	–	109,520	–	6,049,621	–	2,364,223	129,428,302	12,495,718	21,330	–	150,468,714
Asbestos	s.t.	20,390	–	–	–	1,158,210	33,715	–	–	–	63,215	–	–	1,275,530
	$	3,320,064	–	–	–	116,582,134	5,372,645	–	–	–	11,681,337	–	–	136,956,180
Uranium (U_3O_8)	lb	–	–	–	–	–	12,770,421	–	3,932,645	–	–	–	–	16,703,066
	$	–	–	–	–	–	102,951,146	–	33,957,973	–	–	–	–	136,909,119
Sand and gravel	s.t.	4,640,993	629,475	6,633,581	4,417,611	42,375,911	80,259,750	9,653,471	7,368,017	16,139,744	17,451,950	–	–	189,570,503
	$	4,276,626	573,345	4,086,794	2,720,159	20,186,642	56,338,204	6,947,039	3,980,098	14,894,547	9,850,800	–	–	123,854,254
Zinc	s.t.	34,485	–	–	10,614	75,084	66,470	46,392	33,320	–	201,432	–	5,925	473,722
	$	8,814,473	–	–	2,712,939	19,191,567	16,989,728	11,857,855	8,516,479	–	51,485,905	–	1,514,520	121,083,466
Cement	s.t.	92,460	–	–	161,833	2,330,641	2,552,665	455,325	217,545	727,122	476,071	–	–	7,013,662
	$	1,848,347	–	–	2,658,949	36,938,775	39,551,719	9,684,760	5,672,084	13,713,527	8,546,768	–	–	118,614,929
Stone	s.t.	382,260	225,000	457,525	4,416,799	30,003,825	20,402,614	3,693,144	–	138,894	2,935,268	–	–	62,655,329
	$	827,465	225,000	1,199,580	4,126,713	39,406,180	25,073,707	4,643,636	–	416,426	3,964,712	–	–	79,883,419
Coal	s.t	–	–	4,554,944	886,336	–	–	–	1,873,556	2,289,943	962,684	–	8,231	10,575,694
	$	–	–	44,693,053	7,232,170	–	–	–	3,713,988	9,864,890	6,128,805	–	123,675	71,756,581
Lead	s.t.	23,392	–	1,400	1,783	4,337	1,539	2,737	–	–	157,487	–	8,490	201,165
	$	5,146,264	–	308,053	392,277	954,051	338,560	602,203	–	–	34,647,144	–	1,867,647	44,256,199
Silver	oz.	981,005	–	423,189	332,472	4,441,644	9,601,621	766,434	746,683	12	6,451,158	77,468	6,106,037	29,927,723
	$	1,357,711	–	585,694	460,141	6,147,235	13,288,643	1,060,745	1,033,409	17	8,928,402	107,216	8,450,755	41,419,968
Clay	$	92,120	–	1,337,430	623,166	6,852,660	21,819,687	594,072	1,044,721	3,452,835	2,337,603	–	–	38,154,294
Platinum metals	oz.	–	–	–	–	–	357,649	–	–	–	2	–	–	357,651
	$	–	–	–	–	–	22,585,055	–	–	–	150	–	–	22,585,205
Potash (K_2O)	s.t.	–	–	–	–	–	–	–	626,860	–	–	–	–	626,860
	$	–	–	–	–	–	–	–	22,500,000	–	–	–	–	22,500,000
Salt	s.t.	–	–	356,902	–	–	3,187,491	24,883	56,301	96,417	–	–	–	3,721,994
	$	–	–	4,043,804	–	–	14,793,161	618,533	1,364,490	1,496,577	–	–	–	22,316,565
Lime	s.t.	–	–	–	16,919	358,201	952,945	54,879	–	54,826	12,961	–	–	1,450,731
	$	–	–	–	382,713	4,586,493	11,434,223	908,952	–	970,673	221,166	–	–	18,504,220
Titanium dioxide	s.t.	–	–	–	–	...	–	–	–	–	–	–	–	...
	$	–	–	–	–	14,426,444	–	–	–	–	–	–	–	14,426,444
Elemental sulphur	s.t.	–	–	–	–	–	...	...	...	...	...	–	–	1,249,887
	$	–	–	–	–	–	53,744	14,777	589	–	1,794,594	–	–	13,380,182
Gypsum	s.t.	232,259	–	4,910,536	80,544	–	439,206	131,767	–	11,516,478	160,954	–	–	5,955,266
	$	766,098	–	8,228,893	139,497	–	1,225,301	395,301	–	–	482,862	–	–	11,237,952
Total, leading minerals	$	134,795,590	798,345	64,632,695	27,258,466	515,496,143	857,950,944	165,920,097	265,577,751	602,603,605	246,466,479	15,381,831	14,040,812	2,910,922,758
Grand total, all minerals	$	137,248,341	798,345	66,317,617	28,343,419	543,278,426	873,828,297	169,517,064	272,355,007	669,311,368	261,146,081	15,381,831	14,366,936	3,051,892,732
% of grand total		98.2	100.0	97.5	96.2	94.9	98.2	97.9	97.5	90.0	94.4	100.0	97.7	95.4

Symbols: – Nil; ... Not applicable.

TABLE 10

World Role of Canada as Producer of Certain Important Minerals, 1963

Metal or Nonmetal		World Production	Rank of the Six Countries 1	2	3	4	5	6
		1963	CANADA	U.S.S.R.	New Caledonia	Cuba	U.S.A.	Finland
Nickel (Mine production)	s.t.	373,000	217,030	90,000	32,200	16,200	11,432	3,231
	% of world total		58	24	9	4	3	1
		1963	CANADA	U.S.S.R.	Republic of South Africa	S. Rhodesia	China	U.S.A.
Asbestos	s.t.	3,200,000	1,275,530	1,200,000	205,744	142,254	110,000	66,606
	% of world total		40	38	6	4	3	2
		1963	U.S.S.R.	CANADA	Republic of South Africa	U.S.A.	Colombia	Japan
Platinum group metals	troy ounces	1,543,000	800,000	357,649	305,500	49,750	28,592	3,040
(mine production)	% of world total		52	23	20	3	2	–
		1963	U.S.A.	CANADA	Republic of South Africa	France	Australia	Spain
Uranium (U_3O_3 concentrates).....	s.t.	30,400	14,218	8,352	4,532	2,021	1,200	55
(Free World)....	% of world total		47	27	15	7	4	–
		1963	U.S.A.	CANADA	U.S.S.R.	Australia	Mexico	Japan
Zinc (mine production)	s.t.	3,791,724	526,995	497,180	463,000	298,657	264,351	218,194
	% of world total		14	13	12	8	7	6
		1963	Republic of the Congo	CANADA	S. Morocco	N. Rhodesia	Cuba	Australia
Cobalt (mine production)	s.t.	12,800	8,050	1,512	1,511	778	192	18
(Free world) ...	% of world total		63	12	12	6	2	–
		1963	U.S.A.	CANADA	Norway	Australia	Malaya	Finland
Titanium concentrates	s.t.	2,222,000	888,400	379,321	275,600	224,000	164,656	120,398
(ilmenite)	% of world total		40	17	12	10	7	5
Cadmium (smelter		1963	U.S.A.	U.S.S.R.	CANADA	Japan	Belgium	Poland
production)	'000 lb.	26,300	9,990	4,850	2,475	2,185	2,000	930
	% of world total		38	18	9	8	8	4

		1963	U.S.A.	U.S.S.R.	CANADA	France	Japan	Norway
Aluminum (primary metal)	s.t.	5,994,316	2,312,528	990,000	719,390	328,888	244,791	241,581
	% of world total		39	17	12	6	4	4
		1963	U.S.A.	U.S.S.R.	CANADA	Britain	France	Spain
Gypsum	'000 s.t.	54,000	10,388	8,815	5,955	4,614	4,519	3,307
	% of world total		19	16	11	9	8	6
		1963	Republic of South Africa	U.S.S.R.	CANADA	U.S.A.	Australia	Ghana
Gold (mine production)	troy ounces	51,700,000	27,431,573	12,500,000	3,986,044	1,468,750	1,023,400	921,255
	% of world total		53	24	8	3	2	2
		1963	Mexico	Peru	U.S.A.	CANADA	U.S.S.R.	Australia
Silver (mine production)	troy ounces	248,700,000	42,760,487	36,447,110	35,000,000	29,927,723	27,000,000	18,900,000
	% of world total		17	15	14	12	11	8
		1963	U.S.A.	U.S.S.R.	Norway	CANADA	Italy	Britain
Magnesium	s.t.	155,000	75,845	35,000	18,700	8,905	6,300	4,200
	% of world total		49	23	12	6	4	3
		1963	U.S.A.	West Germany	Mexico	U.S.S.R.	CANADA	Yugoslavia
Barite	s.t.	3,200,000	803,106	460,000	282,847	220,000	173,503	115,176
	% of world total		25	14	9	7	5	4
		1963	Peru	Mexico	Japan	Bolivia	CANADA	S. Korea
Bismuth (mine production)	pounds	6,500,000	1,243,000	948,000	660,000	504,600	359,125	350,000
	% of world total		19	15	10	8	6	5
		1963	U.S.S.R.	Australia	U.S.A.	Mexico	CANADA	Peru
Lead (mine production)	s.t.	2,718,676	440,900	436,027	250,791	209,423	198,988	161,317
	% of world total		16	16	9	8	7	6
		1963	U.S.A.	Chile	N. Rhodesia	U.S.S.R.	CANADA	Republic of the Congo
Copper (mine production)	s.t.	4,935,120	1,208,197	662,126	648,238	600,000	452,559	297,500
	% of world total		24	13	13	12	9	6
		1963	U.S.A.	U.S.S.R.	Chile	China	CANADA	Japan
Molybdenum (Mo content)	s.t.	45,725	32,506	6,250	3,352	1,650	417	366
	% of world total		71	14	7	4	1	1
		1963	U.S.S.R.	U.S.A.	France	China	CANADA	Sweden
Iron ore	'000 l.t.	523,201	136,804	72,310	57,556	49,210	26,914	22,115
	% of world total		26	14	11	9	5	4

TABLE 11

Net Values of Production in Canada of Commodity-Producing Industries, 1959–61

($ millions)

	1959	1960	1961
Primary industries			
Agriculture	1,850	2,043	1,675
Forestry	597	688	667
Fishing	106	100	110
Trapping	10	12	12
Mining	1,438	1,453	1,562
Electric power	748	796	840
Total	4,749	5,092	4,866
Secondary industries			
Manufacturing	10,153	10,380	10,682
Construction	3,710	3,635	3,701
Total	13,863	14,015	14,383
Grand total	18,612	19,107	19,249

TABLE 12

Value of Exports of Minerals and Their Products From Canada, by Main Groups and Degree of Manufacture 1962 and 1963

($ millions)

Minerals and Products	1962	1963	Increase or Decrease	
			$ millions	%
Iron and its products				
Raw material	220.5	270.9	+50.4	+22.9
Semiprocessed	63.9	76.9	+13.0	+20.3
Total	284.4	347.8	+63.4	+22.3
Nonferrous metals and their products				
Raw material	388.3	370.6	−17.7	− 4.6
Semiprocessed	750.3	764.7	+14.4	+ 1.9
Total	1,138.6	1,135.3	− 3.3	− 0.3
Nonmetallic minerals and their products (including fuels)				
Raw material	383.3	401.2	+17.9	+ 4.7
Semiprocessed	129.2	129.8	+ 0.6	+ 0.5
Total	512.5	531.0	+18.5	+ 3.6
Total minerals and their products				
Raw material	992.1	1,042.7	+50.6	+ 5.1
Semiprocessed	943.4	971.4	+28.0	+ 3.0
Total	1,935.5	2,014.1	+78.6	+ 4.1

TABLE 13

Value of Imports of Minerals and Their Products into Canada, by Main Groups and Degree of Manufacture, 1962 and 1963

($ millions)

Minerals and Products	1962	1963	Increase or Decrease	
			$ millions	%
Iron and its products				
Raw material	56.3	67.9	+11.6	+20.6
Semiprocessed	24.1	30.6	+ 6.5	+27.0
Total	80.4	98.5	+18.1	+22.5
Nonferrous metals and their products				
Raw material	73.5	75.7	+ 2.2	+ 3.0
Semiprocessed	58.7	69.9	+11.2	+19.1
Total	132.2	145.6	+13.4	+10.1
Nonmetallic minerals and their products (including fuels)				
Raw material	419.4	456.1	+36.7	+ 8.8
Semiprocessed	19.0	19.4	+ 0.4	+21.1
Total	438.4	475.5	+37.1	+ 8.5
Total minerals and their products				
Raw material	549.2	599.7	+50.5	+ 9.2
Semiprocessed	101.8	119.9	+18.1	+17.8
Total	651.0	719.6	+68.6	+10.5

TABLE 14

Value of Exports of Minerals and their Products from Canada, by Degree of Manufacture and in Relation to Total Export Trade, 1962 and 1963

	1962		1963	
	$ millions	% of total	$ millions	% of total
Raw Materials	992.1	16.0	1,042.7	15.3
Semiprocessed	943.4	15.3	971.4	14.3
Total, minerals and products	1,935.5	31.3	2,014.1	29.6
Total, all products	6,178.6	100.0	6,798.5	100.0

TABLE 15

Value of Imports of Minerals and Their Products into Canada, by Degree of Manufacture and in Relation to Total Import Trade, 1962 and 1963

	1962		1963	
	$ millions	% of total	$ millions	% of total
Raw Material	549.2	8.8	599.7	9.1
Semiprocessed	101.8	1.6	119.9	1.8
Total, minerals and products .	651.0	10.4	719.6	10.9
Total, all products	6,257.8	100.0	6,558.8	100.0

TABLE 16

Value of Exports of Minerals and Their Products from Canada, Raw and Semiprocessed, by Destinations, 1963

($ millions)

	Britain	United States	Other Countries	Total
Iron and its products	38.7	267.3	41.8	347.8
Nonferrous metals and their products	330.2	521.9	283.2	1,135.3
Nonmetallic minerals and their products	13.3	426.8	90.9	531.0
Total, minerals and their products	382.2	1,216.0	415.9	2,014.1
Percentage	19.0	60.4	20.6	100.0

TABLE 17

Value of Imports of Minerals and Their Products into Canada, Raw and Semiprocessed, by Sources, 1963

($ millions)

	Britain	United States	Other Countries	Total
Iron and its products	0.6	87.0	10.9	98.5
Nonferrous metals and their products	17.8	37.4	90.4	145.6
Nonmetallic minerals and their products	2.5	131.2	341.8	475.5
Total, minerals and their products	20.9	255.6	443.1	719.6
Percentage	2.9	35.5	61.6	100.0

TABLE 18

Value of Exports of Raw and Semiprocessed Minerals from Canada, by Commodity and Destination, 1963

($'000)

Minerals	U.S.A.	Britain	Other E.F.T.A. Countries [1]	E.E.C. Countries [2]	Japan	Other Countries	Total
Iron ore	214,531	26,271	–	9,850	20,295	–	270,947
Primary ferrous metals	52,779	12,448	8	4,478	6,653	506	76,872
Aluminum	121,821	81,996	7,989	31,829	10,579	53,122	307,336
Copper	59,916	63,611	20,008	11,444	34,379	18,726	208,084[3]
Lead	10,464	7,494	58	2,936	1,338	942	23,232
Nickel	165,315	90,982	49,414	8,759	3,400	6,733	324,603
Zinc	31,408	16,756	1,210	5,274	871	4,951	60,470
Uranium	96,879	40,509	–	–	130	13	137,531
Asbestos	57,687	9,891	4,452	29,551	8,334	29,532	139,447
Fuels	312,801	4	–	–	7,425	90	320,320
All other minerals	92,418	32,238	1,828	6,981	4,548	7,268	145,281
Total	1,216,019	382,200	84,967	111,102	97,952	121,883	2,014,123

[1] Other European Free Trade Area countries: Norway, Sweden, Denmark, Switzerland, Austria and Portugal. [2] European Economic Community (Common Market) countries: France, West Germany, Italy, Belgium, Luxembourg and the Netherlands. [3] Brass scrap included.

TABLE 19

Value of Exports of Raw and Semiprocessed Minerals from Canada, by Commodity and Destination, 1962

($'000)

Minerals	U.S.A.	Britain	Other E.F.T.A. Countries [1]	E.E.C. Countries [2]	Japan	Other Countries	Total
Iron ore	178,688	14,891	–	12,334	14,610	–	220,523
Primary ferrous metals	43,324	8,069	2	8,434	2,196	1,842	63,867
Aluminum	103,729	81,540	7,327	29,975	5,192	60,380	288,143
Copper	63,262	59,766	20,942	21,274	25,341	11,890	202,475 [3]
Lead	13,708	6,493	–	3,646	773	1,177	25,797
Nickel	173,855	85,669	48,821	6,078	3,421	6,021	323,865
Zinc	33,866	16,816	52	4,134	28	5,662	60,558
Uranium	149,165	16,598	–	206	40	–	166,009
Asbestos	57,449	7,994	5,146	30,771	8,216	26,062	135,638
Fuels	308,227	1	–	–	5,946	57	314,231
All other minerals	85,709	33,337	1,402	8,900	1,708	3,220	134,276
Total	1,210,982	331,174	83,692	125,752	67,471	116,311	1,935,382

[1] Other European Free Trade Area countries: Norway, Sweden, Denmark, Switzerland, Austria, Portugal. [2] European Economic Community (Common Market) countries: France, West Germany, Italy, Belgium, Luxembourg and the Netherlands. [3] Brass scrap included.

TABLE 20

Value of Exports of Raw and Semiprocessed Minerals from Canada in Relation to Total Export Trade, 1954–1963

($ millions)

	Raw	Semi-Processed	Total Minerals	Exports all Products	Mineral Exports as % of Export Trade
1954	241	630	871	3,881	22
1955	353	772	1,125	4,282	26
1956	532	857	1,389	4,790	29
1957	658	854	1,512	4,839	31
1958	679	682	1,361	4,791	28
1959	783	753	1,536	5,022	31
1960	777	906	1,683	5,264	32
1961	823	935	1,758	5,755	31
1962	992	943	1,935	6,179	31
1963	1,043	971	2,014	6,799	30

TABLE 21

Value of Imports of Raw and Semiprocessed Minerals into Canada in Relation to Total Import Trade, 1954–63

($ millions)

	Raw	Semi-Processed	Total Minerals	Imports all Products	Mineral Imports as % of Import Trade
1954	392	53	445	4,093	11
1955	434	73	507	4,712	11
1956	523	115	638	5,705	11
1957	563	90	653	5,623	12
1958	470	62	532	5,192	10
1959	472	82	554	5,509	10
1960	501	83	584	5,483	11
1961	517	86	603	5,769	10
1962	549	102	651	6,258	10
1963	600	120	720	6,559	11

TABLE 22

Reported Consumption of Minerals in Canada and Relation to Production, 1963

Mineral	Unit of Measure	Consumption	Production [1]	Consumption as % of Production
Metals				
Aluminum	s.t.	166,909	719,390	23.2
Antimony	lb	975,627	1,601,253	60.9
Bismuth	lb	47,813	359,125	13.3
Cadmium	lb	208,596	2,475,485	8.4
Chromium (Chromite)	s.t.	56,016	—	—
Cobalt	lb	364,594	3,024,965	12.1
Copper	s.t.	169,750 [2]	452,559	37.5
Lead	s.t.	46,772 [3]	201,165	23.3
Magnesium	s.t.	3,641	8,905	40.9
Manganese ore	s.t.	92,270	—	—
Mercury	lb	147,396	—	—
Molybdenum (Mo content)	lb	1,306,193	833,867	156.6
Nickel	s.t.	5,869	217,030	2.7
Selenium	lb	12,424	468,772	2.7
Silver	oz	17,574,628	29,927,723	58.7
Tellurium	lb	1,853	76,842	2.4
Tin	l.t.	4,942	414	1,193.7
Tungsten (W content)	lb	904,924	..	—
Zinc	s.t.	71,078 [3]	473,722	15.0
Nonmetals				
Feldspar	s.t.	6,009	8,608	69.8
Fluorspar	s.t.	142,840	..	..
Mica	lb	3,432,000	1,183,041	190.1
Barite	s.t.	11,343	173,503	6.5
Talc etc.	s.t.	39,301 [4]	54,250 [5]	72.4
Nepheline Syenite	s.t.	44,678	254,000	17.6
Phosphate rock	s.t.	1,166,573	—	—
Sodium sulphate	s.t.	222,001	256,914	86.4
Sulphur (elemental)	s.t.	525,795	1,249,887	42.1
Potash (muriate of potash)	s.t.	158,963	626,860	25.4
Fuels				
Coal	s.t.	22,610,589	10,575,694	213.8
Natural gas	mcf	451,598,298	1,117,425,217	40.5
Petroleum, crude	bbl	332,744,794	257,661,777	129.1

[1] Production for metals, in most cases, refers to production in all forms. This include 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. [2] Producers' domestic shipments of refined copper. [3] Consumption of primary refined metal only. [4] Ground talc. [5] Includes soapstone and pyrophyllite.

Symbols: .. Not available; — Nil.

TABLE 23

Apparent Consumption of Minerals in Canada and its Relation to Production, 1963

	Unit of Measure	Apparent Consumption*	Production**	Consumption as % of Production
Asbestos	s.t.	69,105	1,275,530	5.4
Quartz (silica)	s.t.	2,640,204	1,888,596	139.8
Gypsum	s.t.	1,326,776	5,955,266	22.3
Salt	s.t.	2,941,140	3,721,994	79.0
Cement	s.t.	6,772,438	7,013,662	96.6
Lime	s.t.	1,396,938	1,450,731	96.3
Iron ore	l.t.	8,384,712	26,913,972	31.2

* Production plus imports less exports. Consumption of the above as reported by consumers is not readily available. ** Producers' shipments.

TABLE 24

Domestic Consumption [1] of Principal Refined Base Metals in Relation to Production [2] in Canada, 1954–1963

	Unit of measure	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Copper											
Domestic consumption [3]	s.t.	102,432	138,559	145,286	118,225	122,893	129,973	117,636	141,807	151,525	169,750
Production	s.t.	253,365	288,997	328,458	323,540	329,239	365,366	417,029	406,359	382,868 r	378,911
% Consumption of production		40.4	47.9	44.2	36.5	37.3	35.6	28.2	34.9	39.6	44.8
Zinc											
Domestic consumption [4]	s.t.	46,735	58,062	61,173	52,713	56,097	64,788	55,803	60,878	65,320	71,078
Production	s.t.	213,775	256,542	255,564	247,316	252,093	255,306	260,968	268,007	280,158	284,021
% Consumption of production		21.9	22.6	23.9	21.3	22.3	25.4	21.4	22.7	23.3	25.0
Lead											
Domestic consumption .	s.t.	67,947	76,351	75,882	71,583	69,769	65,935	72,087	73,418	77,286	77,958
Production	s.t.	166,005	148,811	147,865	142,935	132,987	135,296	158,510	171,833	152,217	155,000
% Consumption of production		40.9	51.3	51.3	50.1	52.5	48.7	45.5	42.7	50.8	50.3
Aluminum											
Domestic consumption [5]	s.t.	80,355	91,522	91,869	77,984	101,886	114,344	120,831	135,575	151,893 r	166,909
Production	s.t.	557,897	612,543	620,321	556,715	634,102	593,630	762,012	663,173	690,297	719,390
% Consumption of production		14.4	14.9	14.8	14.0	16.1	19.3	15.9	20.4	22.0	23.2

[1] Refined metal of primary and secondary origin. [2] Refined metal from all sources, including metal derived from secondary materials at primary refineries. [3] Producers' domestic shipments. [4] Primary refined zinc only. [5] Producers' domestic shipments: primary aluminum to 1958: primary and secondary aluminum for 1959 and thereafter.

r Revised.

TABLE 25

Annual Averages of Prices of Main Minerals*, 1962 and 1963

	Unit of Measure	1962	1963	Increase or Decrease	
				Cents or Dollars	%
Aluminum ingot, 99.5%	cents/lb	23.875	22.623	- 1.252	- 5.2
Antimony, New York, boxed .	cents/lb	36.250	36.250	—	—
Bismuth	$/lb	2.25	2.25	—	—
Cadmium	cents /lb	178.056	231.695	+53.639	+30.1
Calcium	$/lb	2.05	2.05	—	—
Chromium metal, 98.5%					
.05% C..................	$/lb	1.15-1.17	1.15-1.19	+ 0.01	+ 0.9
Cobalt metal, 500 lb lots ...	$/lb	1.50	1.50	—	—
Cobalt ore, 10% Co, free					
market, contained Co	cents/lb	60	60	—	—
Copper, U.S. domestic;					
f.o.b. refinery	cents/lb	30.600	30.600	—	—
Gold, Canadian $	$/troy oz	37.41	37.75	+ 0.34	+ 0.9
Iron ore, 51.5% Fe,					
lower lake ports					
Bessemer					
Mesabi	$/l.t.	10.97	10.80	- 0.17	- 1.5
Old Range	$/l.t.	11.22	11.05	- 0.17	- 1.5
Non-Bessemer					
Mesabi	$/l.t.	10.82	10.65	- 0.17	- 1.6
Old Range	$/l.t.	11.07	10.90	- 0.17	- 1.5
Lead, common, New York ..	cents/lb	9.631	11.137	+ 1.506	+15.6
Magnesium, ingot	cents/lb	35.250	35.250	—	—
Mercury	$/flask (76 lb)	191.208	189.451	- 1.757	- 0.9
Molybdenum metal	$/lb	3.35	3.35	—	—
Molybdenite, 95% MoS_2					
contained Mo ..../	$ lb	1.40	1.40	—	—
Nickel, f.o.b. Port Colborne					
(Duty incl.)	Cents/lb	79.895	79.000	- 0.895	- 1.1
Platinum	$/troy oz	82.000	79.755	- 2.245	- 2.7
Selenium	$/lb	5.75	4.60	- 1.15	-20.0
Silver, New York	cents/troy oz	108.375	127.912	+19.537	+18.0
Sulphur, Mexican export price	$/net ton	23.00	20.17	- 2.83	-12.3
Tin, straits, New York	cents/lb	114.652	116.652	+ 2.000	+ 1.7
Titanium metal, A-1 99.3%					
max. 0.3% Fe	$/lb	1.45	1.32	- 0.13	- 9.0
Titanium ore (ilmenite)					
59.5% TiO_2	$/l.t.	23 to 26	23 to 26	—	—
Tungsten metal	$/lb	2.75	2.75	—	—
Zinc, prime western,					
East St. Louis	cents/lb	11.625	11.997	+ 0.372	+ 3.2

* These prices, except those for gold are in United States currency and are from *E & M J Metal and Mineral Markets.*

— Nil.

TABLE 26

Wholesale Price Indexes of Minerals and Mineral Products, Canada, 1953 and 1961–63

(1935–39=100)

	1953	1961	1962	1963
Iron and products	221.4	258.1	256.2	253.6
Pig iron	261.2	295.3	294.6	289.6
Rolling-mill products	209.4	251.7	251.6	251.6
Pipe and tubing	238.3	269.9	271.5	273.2
Wire	249.2	294.2	292.5	274.0
Scrap iron and steel	298.1	313.4	279.0	243.0
Tinplate and galvanized sheet	223.5	238.3	238.3	238.3
Nonferrous metals and products				
Total (including gold)	168.6	181.6	192.1	197.5
Total (excluding gold)	225.3	246.5	260.8	270.0
Antimony	178.5	191.6	198.8	228.7
Copper and products	283.1	282.9	298.8	303.4
Lead and products	269.3	213.5	208.8	231.2
Silver	216.3	241.6	299.2	356.9
Tin	180.2	229.4	242.8	247.8
Zinc and products	258.9	272.9	262.9	278.3
Solder	201.9	218.6	221.8	226.9
Nonmetallic minerals and products	176.9	185.2	189.1	189.5
Clays and clay products	219.2	245.6	244.6	244.0
Pottery	146.8	196.0	222.1	227.2
Coal	178.3	192.3	197.9	200.2
Coal tar	213.7	235.7	235.7	219.6
Coke	227.3	241.9	257.8	260.6
Window glass	233.8	272.7	276.5	305.8
Plate glass	175.4	218.8	218.8	237.7
Petroleum products	165.2	160.8	162.3	160.6
Crude oil	..	184.4	192.2	194.1
Gasoline	137.9	134.6	132.0	126.8
Coal oil	129.9	134.4	134.4	134.4
Asphalt	183.9	194.5	192.3	192.3
Asphalt shingles	150.4	116.6	109.8	111.5
Sulphur	190.9	211.6	223.5	225.6
Plaster	126.7	141.2	142.6	142.6
Lime	190.7	212.1	213.1	215.7
Cement	158.3	163.8	165.0	169.4
Sand and gravel	143.4	144.5	149.4	143.6
Crushed stone	164.3	171.2	171.1	171.6
Building stone	200.7	185.4	174.3	184.3
Asbestos and products	267.1	302.2	303.0	304.4
General wholesale price index (all products)	220.7	233.3	240.0	244.6

.. Not available.

TABLE 27

General Wholesale Price Index and Main Component Groups, Canada, Selected Years 1942 to 1963

(1935–39=100)

	1942	1949	1953	1955	1957	1959	1961	1963
General wholesale price index	123.0	198.3	220.7	218.9	227.4	230.6	233.3	244.6
Mineral products								
Iron and products ..	116.0	175.5	221.4	221.4	252.7	255.7	258.1	253.6
Nonferrous metals and products (including gold)	107.2	145.2	168.6	187.6	176.0	174.6	181.6	197.5
Nonmetallic minerals and products	114.5	158.3	176.9	175.2	189.3	186.5	185.2	189.5
Other products								
Vegetable	114.9	190.5	199.0	195.1	197.0	199.5	203.1	227.8
Animal	137.1	237.5	241.7	226.0	238.4	254.3	254.7	255.6
Textile	131.2	222.5	239.0	226.2	236.0	228.0	234.5	248.0
Wood products	132.3	241.6	288.6	295.7	299.4	304.0	305.1	323.4
Chemical	127.9	155.2	175.7	177.0	182.3	187.0	188.7	189.3

TABLE 28

Principal Statistics of the Mineral Industry by Sectors, in Canada, 1962*

	Estab-lishments	Employees	Salaries and Wages	Cost of Fuel and Electricity	Cost of Process Supplies [3]	Gross Value of Production	Net Value of Production [1]
	(no.)	(no.)	($'000)	($'000)	($'000)	($'000)	($'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
Fuels							
Coal	101	9,470	34,385	3,818	10,045	68,259	54,397
Petroleum and natural gas [2]	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

[1] Net value equals the gross value of production less the cost of process supplies, fuel and electricity, freight and smelter charges. [2] Includes natural gas processing. [3] Includes also cost of ores, concentrates, raw materials and containers.

* Subject to revision.

TABLE 28A

Principal Statistics of the Mineral Industry by Sectors, in Canada 1961

	Es-tablish-ments	Em-ployees	Salaries and Wages	Cost of Fuel and Electricity	Cost of Process Supplies ores, concentrates, raw materials and containers	Gross Value of Production	Net* value of Production
	(no.)	(no.)	($'000)	($'000)	($'000)	($'000)	($'000)
Metals							
Placer gold	47	243	1,326	108	48	2,466	2,255
Gold Quartz	140	15,876	65,466	7,360	19,396	135,034	106,879
Copper-gold-silver	276	10,901	51,459	5,932	14,709	175,463	109,048
Silver-cobalt	20	560	2,217	296	375	4,516	3,424
Silver-lead-zinc	73	4,352	22,099	2,447	6,629	111,172	61,423
Nickel-copper	50	13,697	74,755	4,636	17,877	134,732	109,350
Iron	55	8,049	47,108	8,332	21,644	186,333	124,589
Other	43	5,919	34,331	5,857	22,992	201,214	170,664
Total	704	59,597	298,761	34,968	103,670	950,930	687,632
Industrial Minerals							
Asbestos	23	6,875	35,093	6,666	14,645	133,407	112,095
Feldspar, quartz and nepheline syenite	23	339	1,313	224	397	4,795	3,820
Gypsum	9	613	2,272	313	1,451	6,597	4,834
Salt	9	912	3,950	1,154	3,024	19,568	15,390
Sand and gravel	493	2,513	9,899	3,110	607	39,438	35,721
Stone	228	3,395	12,623	3,029	4,551	44,709	37,129
Clay products	99	3,547	13,538	5,611	4,734	34,527	24,182
Cement	20	3,123	16,697	16,262	14,359	107,044	76,423
Lime	21	825	3,570	2,239	1,785	12,979	8,955
Other	111	2,543	8,534	2,124	3,863	21,875	15,588
Total	1,036	24,685	107,489	40,732	49,416	424,939	334,137
Fuels							
Coal	113	10,461	35,608	4,063	10,080	72,210	58,068
Petroleum and Natural Gas**	630	4,901	28,125	8,030	47,844	647,587	591,712
Total	743	15,362	63,733	12,093	57,924	719,797	649,780
Total mining industry	2,483	99,644	469,983	87,793	211,010	2,095,666	1,671,549
Non-ferrous smelting and refining	24	29,527	157,475	49,000	891,951	1,471,048	530,097

* Net value equals gross value of production less the cost of process supplies, ores, concentrates, raw material, fuel, electricity, freight and smelter charges. ** Includes natural gas processing.

TABLE 29

Principal Statistics [1] of Mining Industry [2] in Canada, 1953–62

	Establishments	Employees	Salaries and Wages	Cost of Fuel and Electricity	Cost of Process Supplies	Value of Gross	Production Net [3]
1953	20,490	104,923	358,520	58,504	110,257	1,111,401	871,340
1954	21,882	103,397	362,710	60,686	115,483	1,239,726	987,861
1955	24,091	105,030	384,406	66,228	124,844	1,456,825	1,156,309
1956	26,914	111,772	435,908	79,195	139,893	1,672,830	1,326,719
1957	29,430	116,256	476,397	88,886	167,145	1,807,562	1,386,948
1958	29,546	112,581	479,418	91,132	177,944	1,823,432	1,438,748
1959	31,587	112,901	497,283	92,599	188,357	2,051,018	1,631,522
1960	3,871	105,605	488,478	91,565	219,420	2,020,455	1,579,982
1961	2,483	99,644	469,983	87,793	211,110	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 were made by the Dominion Bureau of Statistics. The definition of establishment changed to include only those establishments considered separate accounting units, capable of reporting employment, salaries and wages, etc. on a unit basis. This substantially reduced the number of establishments in comparison with previous years. Also some companies formerly included in the mining industry were transferred to other industries (manufacturing, construction, etc.) if their main revenue, producing activity, was not mining.
[2] Does not include the non-ferrous smelting and refining industries. [3] Net value equals the gross value of production less the cost of process supplies, fuel and electricity, freight and smelter charges.

TABLE 30

Consumption of Fuels and Electricity in Canadian Mineral Industry, 1962

	Unit	Metal Mining	Non-ferrous Smelting and Refining	Total	Production of Industrial Minerals	Production of Crude Mineral Fuels	Total, Mineral Industry
Coal and coke	s.t.	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	11,047,346r	7,378,765r	22,977,388r
	$	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	99,258,016r	2,940,746	223,648,635r
	$	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
Manufactured gas	Mcf.	–	–	–	–	–	–
	$	–	–	–	–	–	–
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	30,685,745	5,970,855	75,211,941
Electricity purchased ...	million 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	million 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.

– Nil.

TABLE 30A

Consumption of Fuels and Electricity in Canadian Mineral Industry, 1961

	Unit	Metal Mining	Non-ferrous Smelting and Refining	Total	Production of Industrial Minerals	Production of Crude Mineral Fuels	Total, Mineral Industry
Coal and coke	s.t.	142,511	1,274,984	1,417,495	885,971	49,836	2,354,302
	$	2,093,638	18,411,372	20,505,010	9,626,408	355,598	30,487,016
Gasoline and kerosene ...	gal.	3,079,138	866,887	3,946,025	9,046,523	6,870,995	19,863,543
	$	1,106,639	244,317	1,350,956	3,082,139	2,662,592	7,095,687
Fuel oil	gal.	52,593,364	61,277,202	113,870,566	73,825,467	3,019,299	190,715,332
	$	8,512,547	5,264,939	13,777,486	8,471,310	593,358	22,842,154
Liquefied petroleum gas ..	gal.	282,512	185,030	467,542	234,574	1,571,914	2,274,030
	$	75,984	43,696	119,680	60,425	131,157	311,262
Manufactured gas	Mcf.	–	–	–	9,000	–	9,000
	$	–	–	–	8,292	–	8,292
Natural gas	Mcf.	1,493,884	10,455,801	11,949,685	23,156,525	11,844,402	46,950,612
	$	302,775	3,171,362	3,474,137	6,831,126	1,289,884	11,595,147
Other fuels	$	727,838	65,936	793,774	265,702	97,612	1,157,088
Total fuels	$	12,819,421	27,201,622	40,021,043	28,345,402	5,130,201	73,496,646
Electricity purchased	million kwh.	3,270	5,389*	8,659	1,457	357	10,473
	$	22,148,435	21,798,700*	43,947,135	12,386,362	6,962,461	63,295,958
Total value, fuels and electricity purchased	$	34,967,856	49,000,322	83,968,178	40,731,764	12,092,662	136,792,604
Electricity generated by industry for own use ...	million kwh.	515	12,851	13,366	29	37	13,432

* Due to change in statistical classification, some electricity formerly reported as purchased is from 1961, reported as generated for own use.

– Nil.

TABLE 31

Cost of Fuel and Electricity Used in Canadian Mining Industry [1], 1953–62

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Fuel [2]										
$ millions	35.2	37.0	39.9	47.0	53.1	53.1	53.1	48.8	46.3	50.4
Electricity purchased										
millions kwh	3,091.7	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	23.3	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	58.5	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	240.3	426.2	486.9	557.7	590.0	526.7	550.9	575.4	581.4	637.5
Electricity generated for sale										
millions kwh	8.5	18.8	47.1	12.0	14.2	15.8	17.0	32.9	29.0	31.5

[1] Excludes non-ferrous smelting and refining. [2] Coal, coke, fuel oil, gasoline, gas, wood, etc.

TABLE 32

Cost of Fuel and Electricity Used in Non-ferrous Smelting and Refining, 1953–62

		1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Fuel [1]	$ millions	23.0	24.8	24.3	29.9	27.3	23.4	26.3	26.9	27.2	24.8
Electricity purchased [2]	million kwh	12,296.9	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	29.6	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	52.6	55.2	56.9	64.9	59.5	63.5	62.3	63.2	49.0	46.7
Electricity generated for own use [2]	million kwh	796.2	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	million kwh	4.3	13.4	9.2	12.2	—	33.2	30.7	33.0	35.7	..

[1] Coal, coke, fuel oil, gasoline, gas, wood, etc. [2] Commencing in 1961 changes in statistical classifications account for decreases in electricity purchased and corresponding increases in electricity generated for own use.

Symbols: .. Not available; — Nil.

TABLE 33

Employment, Salaries and Wages in Canadian Mineral Industry, by Sectors, at Five-Year Intervals, 1942–62

	1942		1947		1952		1957		1962	
	Employees (no.)	Salaries and Wages $ millions)	Employees (no.)	Salaries and Wages $ (millions)	Employees (no.)	Salaries and Wages $ (millions)	Employees (no.)	Salaries and Wages $ (millions)	Employees (no.)	Salaries and Wages $ (millions)
Metal mining	43,023	89.6	39,334	96.8	55,338	197.7	62,554	278.5	59,317	310.2
Non-ferrous smelting and refining	21,162	37.3	17,449	40.8	24,608	88.0	29,613r	134.8r	29,303	159.4
Industrial Minerals	17,741	23.1	22,429	39.6	26,141	79.4	31,312r	114.3r	25,767	115.3
Fuels*	30,117	48.6	25,307	52.4	28,029	87.9	21,985r	82.0r	14,293	63.2
Total	112,043	198.6	104,519	229.6	134,116	453.0	145,464r	609,6r	128,680	648.1
Annual average of salaries and wages		1,773		2,197		3,378		4,191		5,037

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

TABLE 34

Number of Wage Earners – Surface, Underground and Mill – in Canadian Mining Industry [1], by Sectors, 1953–62

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Metals [2]										
Surface	13,959	14,098	15,540	16,706	18,532	16,602	16,697	16,039	15,815	15,197
Underground	27,580	26,821	26,522	27,679	29,382	29,712	31,384	30,774	28,975	27,959
Mill	4,320	4,761	4,664	5,624	6,168	6,541	6,573	6,162	6,047	6,504
Total	45,859	45,680	46,726	50,009	54,082	52,855	54,654	52,975	50,837	49,660
Industrial Minerals										
Surface	11,574	11,826	12,204	12,804	14,347	14,029	13,988	10,321	9,485	9,656
Underground	1,718	1,659	1,632	1,798	1,749	1,458	1,327	1,164	995	951
Mill	10,658	10,825	11,445	12,163	11,573	11,216	11,639	10,741	10,511r	10,770
Total	23,950	24,310	25,281	26,765	27,669	26,703	26,954	22,226	20,991r	21,377
Fuels										
Surface	9,838	9,082	8,886	9,622	8,683	7,887	7,537	6,715	5,786	5,585
Underground	13,587	12,422	11,439	11,065	10,043	9,247	8,022	8,257	7,439	6,678
Total	23,425	21,504	20,325	20,687	18,726	17,134	15,559	14,972	13,225	12,263
Total										
Surface	35,371	35,006	36,630	39,132	41,562	38,518	38,222	33,075	31,086	30,438
Underground	42,885	40,902	39,593	40,542	41,174	40,417	40,733	40,195	37,409	35,588
Mill	14,978	15,586	16,109	17,787	17,741	17,757	18,212	16,903	16,558	17,274
Total	93,234	91,494	92,332	97,461	100,477r	96,692	97,167	90,173	85,053r	83,300

[1] Does not include non-ferrous smelting and refining. [2] Includes placer operations. r Revised.

TABLE 35

Labour Costs in Relation to Tons Mined from Metal Mines [1] in Canada 1942, 1952 and 1962

	Number of Wage Earners	Total Wages ($) millions	Average Annual Wage ($)	Tons Mined ('000 s.t.)	Average Annual/ Tons Mined per Worker (s.t.)	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 [2]	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
1952						
Auriferous quartz	18,554	58.8	3,169	16,496	889	3.56
Copper-gold-silver	6,181	22.3	3,608	7,773	1,258	2.87
Nickel-copper	9,991	37.6	3,763	14,381	1,439	2.61
Silver-cobalt [2]	620	1.9	3,065	181	292	10.50
Silver-lead-zinc	9,001	37.6	4,177	6,759	751	5.56
Miscellaneous metal mines [3]	4,585	16.1	3,511	6,753	1,473	2.38
Total	48,932	174.3	3,562	52,343	1,070	3.33
1942						
Auriferous quartz	23,517	47.4	2,016	17,723	754	2.67
Copper-gold-silver	5,016	9.5	1,894	8,576	1,710	1.11
Nickel-copper	6,779	14.2	2,095	12,082	1,782	1.18
Silver-cobalt [2]	165	0.2	1,212	26	158	7.69
Silver-lead-zinc	1,877	4.0	2,131	2,951	1,572	1.36
Miscellaneous metal mines .	1,161	2.1	1,809	1,120	965	1.88
Total	38,515	77.4	2,010	42,478	1,103	1.82

[1] Excludes placer-mining. [2] In silver-cobalt mining operations considerable tonnages of old tailings were used. These tonnages are not included above. [3] Includes iron ore mines.

TABLE 36

Man-hours Worked and Tons of Ore Mined and Rock Quarried—Metal Mines and Industrial Mineral Operations, 1953–62

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Metal Mines [1]										
Ore mined (millions s.t.)	54.4	59.0	69.2	77.4	84.3	78.8	99.0	101.6	99.4	114.3
Man-hours worked [2] (millions) ..	112.6	111.8	116.6	126.4	135.7	133.6	133.3	130.5	124.9	124.4
Man-hours per ton mined (no.) ...	2.07	1.89	1.68	1.63	1.61	1.70	1.35	1.28	1.26	1.09
Industrial Mineral Operations [3]										
Ore mined and rock quarried (millions s.t.)	39.6	53.6	55.0	62.9	70.0	66.5	78.4	86.0	94.6	100.9
Man-hours worked [2] (millions) ..	29.6	30.0	31.7	32.7	32.2	29.3	29.3	27.4	26.9	27.2
Man-hours per ton mined (no.) ...	0.75	0.56	0.58	0.52	0.46	0.44	0.37	0.32	0.28	0.27

1 Excludes placer mining. 2 Includes man-hours worked by all employees, surface, underground, mill and administration. 3 Excludes salt, cement, clay products, stone for cement manufacture and stone produced for lime manufacture.

TABLE 37
Basic Wage Rates per Hour in Canadian Metal-Mining Industry on October 1, 1962

Occupation	Gold Mining ($)	Iron Mining ($)	Other Metal Mining ($)
Underground Workers			
Cage and skiptender	1.54	..	2.22
Chute blaster	1.49	..	2.29
Deckman	1.46	..	1.99
Hoistman	1.65	..	2.39
Labourer	1.38	2.02	2.07
Miner	1.52	2.67	2.18
Miner's Helper	1.42	2.26	1.82
Motorman	1.48	..	2.12
Mucking machine operator	1.45	..	2.18
Mucker and trammer	1.41	..	2.15
Timberman	1.54	..	2.28
Trackman	1.50	..	2.19
Open-pit Workers			
Blaster	..	2.53	..
Bulldozer operator	..	2.50	..
Driller machine	..	2.48	..
Oiler	..	2.31	..
Shovel operator	..	2.80	..
Surface and Mill Workers			
Carpenter, maintenance	1.67	2.72	2.23
Crusherman	1.48	2.36	2.14
Electrician	1.70	2.78	2.45
Hoistman	..	2.38	..
Labourer	1.34	2.11	1.79
Machinist, maintenance	1.70	2.84	2.44
Mechanic, diesel	..	2.69	..
Mechanic, maintenance	1.62	2.78	2.34
Millman	1.54*	2.78	..
Pipefitter, maintenance	1.57	2.66	2.24
Steel sharpener	1.56	..	2.19
Tradesman's helper	1.45	2.31	2.02
Truck driver, heavy truck	1.57	..	2.02
Truck driver, light truck	1.44	..	1.95
Welder, maintenance	1.66	2.71	2.40
Grinding mill operator	..	2.54	2.11
Blacksmith	..	..	2.30
Filter operator	..	..	2.15
Flotation operator	..	..	2.10
Solution man	..	..	2.29

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

.. Not available.

TABLE 38

Average Weekly Wages and Hours of Hourly-Rated Employees in Canadian Mining, Manufacturing and Construction Industries, 1957–1963

	1957	1958	1959	1960	1961	1962	1963
Mining							
Average hours per week	42.3	41.5	41.5	41.7	41.8	41.7	42.0
Average weekly wage	79.35	81.30	84.80	87.26	89.08	91.22	94.12
Metals							
Average hours per week	42.9	41.8	41.7	41.9	42.2	41.9	41.9
Average weekly wage	83.70	84.77	88.73	90.89	92.83	94.43	96.92
Fuels							
Average hours per week	40.8	40.0	39.9	40.6	40.3	40.7	42.2
Average weekly wage	72.91	75.12	77.11	80.13	80.98	85.63	89.58
Nonmetals							
Average hours per week	42.5	42.3	42.2	42.2	42.3	42.3	42.4
Average weekly wage	71.57	73.73	76.87	79.62	82.60	83.82	87.70
Manufacturing							
Average hours per week	40.4	40.2	40.7	40.4	40.6	40.7	40.8
Average weekly wage	64.96	66.77	70.16	71.96	74.27	76.55	79.40
Construction							
Average hours per week	41.2	40.7	40.2	40.4	40.3	40.3	40.8
Average weekly wage	72.55	72.36	74.20	78.36	79.93	83.16	87.51

TABLE 39
Average Weekly Wages of Hourly-Rated Employees in Canadian Mining Industry in Current and 1949 Dollars. 1957–63

	1957	1958	1959	1960	1961	1962	1963
Current dollars							
All mining	79.35	81.30	84.80	87.26	89.08	91.22	94.12
Metals	83.70	84.77	88.73	90.89	92.83	94.43	96.92
Gold	67.48	68.09	68.95	70.81	73.34	75.76	77.38
Other	90.13	91.59	95.92	98.52	100.22	101.25	103.97
Fuels	72.91	75.12	77.11	80.13	80.98	85.63	89.58
Coal	63.51	67.43	67.00	69.36	70.36	73.82	79.26
Oil and natural gas	90.13	89.20	92.74	96.57	95.66	102.35	105.83
Nonmetallics	71.57	73.73	76.87	79.62	82.60	83.82	87.70
1949 dollars							
All mining	65.09	64.99	67.04	68.17	68.95	69.79	70.77
Metals	68.66	67.76	70.14	71.01	71.85	72.25	72.87
Gold	55.36	54.43	54.51	55.32	56.76	57.96	58.18
Other	73.94	73.21	75.83	76.97	77.57	77.47	78.17
Fuels	59.81	60.05	60.96	62.60	62.68	65.52	67.35
Coal	52.10	53.90	52.96	54.20	54.46	56.48	59.59
Oil and natural gas	73.94	71.30	73.31	75.45	74.04	78.31	79.57
Nonmetallics	58.71	58.94	60.77	62.20	63.93	64.13	65.94

TABLE 40
Industrial Fatalities in Canada per Thousand Paid Workers in Main Industry Groups, 1954–1963

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Agriculture	0.82	0.83	1.03	0.95	1.00	0.92	0.62	0.61	0.57	0.49
Logging (forestry)	2.50	2.00	1.90	1.50	1.70	1.70	1.50	1.32	2.05	1.71
Fishing and trapping	3.10	3.20	1.80	2.30	3.80	7.20	2.70	5.71	1.20	3.40
Mining*	2.00	1.60	2.10	1.50	2.20	2.00	1.92	1.75	1.91	2.15
Manufacturing	0.16	0.16	0.14	0.14	0.11	0.13	0.19	0.12	0.15	0.13
Construction	0.86	0.79	0.89	0.91	0.77	0.79	0.56	0.71	0.57	0.59
Public utilities	0.43	0.67	0.44	0.57	0.39	0.44	0.49	0.47	0.56	0.32
Transportation, storage and communications	0.53	0.56	0.56	0.50	0.40	0.44	0.37	0.38	0.39	0.40
Trade	0.08	0.07	0.08	0.09	0.05	0.06	0.06	0.07	0.07	0.07
Finance	0.01	0.03	0.05	0.01	0.02	0.01	0.09	0.05	0.04	0.04
Service	0.08	0.07	0.06	0.07	0.07	0.06	0.07	0.06	0.08	0.08
All industry	0.32	0.32	0.33	0.30	0.27	0.28	0.21	0.21	0.22	0.22

* Includes quarrying and oil-well drilling.

TABLE 41

Cost of Prospecting by Metal-Mining Industry in Canada, by Provinces and Types of Operations, 1961 and 1962

	Placer Gold Operations	Gold Mines	Copper-Gold-Silver Mines	Silver-Cobalt Mines	Zinc-Lead-Zinc Mines	Nickel-Copper Mines	Miscellaneous Metal Mines*	Total
1961								
Newfoundland	–	7,794	588,297	–	476,305	–	484,443	1,556,839
Nova Scotia	–	12,997	184,268	–	48,404	–	28,119	273,788
New Brunswick	–	55,595	490,739	1,307	125,817	–	261,738	935,196
Quebec	52,134	1,300,112	7,450,734	12,016	5,101,504	1,771,332	3,135,387	18,823,219
Ontario	–	1,164,454	3,002,677	77,743	107,419	2,544,031	800,749	7,697,073
Manitoba	–	615,129	2,611,871	4,886	20,000	3,812,959	44,254	7,109,099
Saskatchewan	–	71,754	859,520	–	8,920	329,047	44,150	1,313,391
Alberta	3,209	–	892	–	10,655	–	10,000	24,756
British Columbia	11,771	263,003	2,666,130	6	696,468	4,650	352,319	3,994,347
Northwest Territories	–	162,483	248,158	–	294,337	365,527	213,601	1,284,106
Yukon Territory	32,370	10,099	263,862	–	161,926	–	5,000	473,257
Total Canada	99,484	3,663,420	18,367,148	95,958	7,051,755	8,827,546	5,379,760	43,485,071
1962								
Newfoundland	–	13,000	499,436	–	535,779	606	136,230	1,185,051
Nova Scotia	–	4,379	77,152	–	86,543	297	124,655	293,026
New Brunswick	28,000	34,125	361,098	–	162,842	–	58,567	644,632
Quebec	32,100	2,158,699	5,055,025	–	6,725,228	1,542,879	1,100,316	16,614,247
Ontario	–	1,800,075	1,694,626	47,553	353,178	3,840,373	1,672,100	9,407,905
Manitoba	–	119,485	1,685,544	–	58,563	3,309,538	201,567	5,374,697
Saskatchewan	–	156,295	209,081	–	68,622	267,005	52,211	753,214
Alberta	1,400	467	–	–	161,000	–	39,000	201,867
British Columbia	3,445	377,016	2,957,805	–	985,502	835,968	1,029,958	6,189,694
Northwest Territories	–	159,979	330,956	–	163,144	603,729	230,395	1,488,203
Yukon Territory	35,890	171,745	482,685	–	206,887	20,000	720,398	1,637,605
Total, Canada	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" in this table.

– Nil.

TABLE 42

Cost of Prospecting by Metal-Mining Industry in Canada, by Types of Operations, 1953–62

($)

	Placer/ Gold/ Operations	Gold Mines	Copper Gold-Silver Mines	Silver-Cobalt Mines	Silver-Lead Zinc Mines	Nickel-Copper Mines	Miscellaneous Metal Mines*	Total
1953	33,007	2,573,466	2,514,501	63,985	3,593,678	6,742,918	2,311,203	17,832,758
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	26,805	5,602,547	9,411,381	5,474,273	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: See the general footnote for Table 41.

TABLE 43

Contract Diamond-Drilling Operations* in Canada, 1953–1962

	Footage Drilled	Income from Drilling ($)	Average Number of Employees	Total of Salaries and Wages ($)
1953	5,258,870	15.8	2,238	7.1
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 44

Contract Drilling* in Canada for Oil and Gas, 1953–62

	Footage Drilled				Gross Income from Drilling ($ millions)	Average Number of Employees	Total Salaries and Wages ($ millions)
	Rotary	Cable	Diamond	Total			
1953 ...	10,139,151	625,891	–	10,765,042	59.7	4,903	19.8
1954 ...	9,609,140	457,580	–	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 45
Ore Mined and Rock Quarried in Canadian Mining Industry, 1960–62
(millions of s.t.)

	1960	1961	1962
Metallic ores			
Gold quartz	14.7	14.4	13.7
Copper-gold-silver	14.0	15.0	17.8
Silver-cobalt	0.2	0.2	0.2
Silver-lead-zinc	5.8	5.9	6.2
Nickel-copper	20.8	21.6	18.0
Iron	33.0	32.7	49.9
Miscellaneous	13.1	9.6	8.5
Total	101.6	99.4	114.3
Nonmetallics			
Asbestos	33.2	38.4	42.2
Feldspar and nepheline syenite	0.3	0.3	0.3
Quartz	1.3	0.9	1.1
Gypsum and anhydrite	5.1	5.1	5.4
Other [1]	2.1	2.3	3.2
Total	42.0	47.0	52.2
Structural materials			
Stone, all kinds [2]	45.3	48.9	50.5
Stone for manufacture of cement	7.8	8.2	9.3
Stone for manufacture of lime	2.7	2.6	2.7
Total	55.8	59.7	62.5
Total, ore mined and rock quarried	199.4	206.1	229.0

[1] Includes talc, salt, barite, fluorspar, mica mining, etc. [2] Exclusive of stone for the manufacture of cement and line.

TABLE 46
Ore Mined and Rock Quarried in Canadian Mining Industry at Five-Year Intervals, 1931–62
(millions of s.t.)

	Metal Mines	Industrial-mineral Operations	Total
1931	15.2	15.0	30.2
1936	22.7	13.0	35.7
1941	43.0	21.6	64.6
1946	28.9	24.8	53.7
1951	48.4	43.9	92.3
1956	77.4	73.0	150.4
1961	99.4	106.7	206.1
1962	114.3	114.7	229.0

TABLE 47

Crude Minerals* Transported by Canadian Railways, 1962 and 1963

(millions of s.t.)

	1962	1963
Coal		
Anthracite	1.0	1.0
Bituminous	10.2	10.0
Petroleum, crude	0.6	0.4
Copper ore and concentrates	0.8	0.9
Iron ore and concentrates	24.2	27.7
Copper-nickel ore and concentrates	2.9	2.1
Aluminum ore and concentrates	1.8	1.9
All other ores and concentrates	3.3	3.8
Sand and gravel	6.3	6.5
Stone and rock	5.3	5.6
Asbestos	1.1	1.1
Gypsum, crude	4.5	4.8
Salt	1.6	1.2
All other crude minerals (chiefly industrial)	2.9	3.1
Total	66.5	70.1
All revenue freight moved by Canadian railways	160.9	171.7
Crude minerals as percentage of revenue–freight total	41.3	40.8

* Both domestic and imported.

TABLE 48

Crude Minerals* Transported by Canadian Railways, 1952–1963

(millions of s.t.)

	Total of Revenue Freight	Total of Crude Minerals	Crude Minerals as % of Revenue Freight
1954	143.1	49.6	34.6
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

* Both domestic and imported.

TABLE 49

Primary Mineral Products* Transported by Canadian Railways, 1962 and 1963
(millions of s.t.)

	1962	1963
Aluminum—bar, ingot, pig and slab	0.46	0.52
Copper—ingot and pig	0.51	0.51
Lead and zinc—bar, ingot and pig	0.47	0.46
Iron—pig	0.19	0.24
Iron and Steel—billets bloom, and ingot	0.32	0.31
Coke	1.36	1.39
Asphalt	0.33	0.35
Total, primary mineral products	3.64	3.78
Total, all revenue freight	160.9	171.7
Primary mineral products as a percentage of all freight transported	2.3	2.2

* Both domestic and imported.

TABLE 50

Crude Minerals* Transported through Canadian Canals **, 1962 and 1963
(millions of cargo tons of 2,000 pounds)

	1962	1963
Coal, bituminous	6.1	6.0
Petroleum, crude	0.2	0.2
Iron ore	16.3	20.8
Metallic ores and concentrates, n.e.s.	0.2	0.2
Clay and bentonite	0.2	0.3
Sand, gravel and crushed stone	1.3	1.2
Salt	0.5	0.6
Sulphur	0.1	0.2
Crude materials, inedible, n.e.s.	0.8	0.8
Total	25.7	30.3
Total freight traffic through Canadian canals	63.6	74.6
Crude minerals as percentage of total freight traffic	40.4	40.6

* Domestic and imported. ** Canals and inland waterways included are St. Lawrence, Welland, Sault Ste. Marie, St. Peters, Canso, Richelieu River, Ottawa River, Rideau, Murray, Trent and St. Andrews.

TABLE 51

Quantities* of Petroleum, Petroleum Products, and Gas (Manufactured and Natural) Transported by Pipeline in Canada, 1952–1963

	Petroleum and Petroleum Products		Gas
	(millions of bbl.)	(millions of s.t.)	('000 Mcf)
1952	107.8	15.9	74,100e
1953	147.3	21.8	84,500e
1954	172.5	25.5	102,500e
1955	224.3	33.2	136,738
1956	274.9	40.7	163,764
1957	290.8	43.1	184,738
1958	274.8	40.7	211,751
1959	308.5	45.7	283,808
1960	316.0	46.8	326,212
1961	353.4	52.4	379,044
1962	387.5	57.2	421,631
1963	431.1	63.9e	452,943

* Both domestic and imports.

e Estimate.

TABLE 52

Taxes* Paid by Five Important Divisions of Canadian Mineral Industry, 1957–62

($ millions)

	1957	1958	1959	1960	1961	1962*
Auriferous-quartz mining	5.9	6.1	7.0	6.5	7.0	6.1
Copper-gold-silver mining	19.2	8.5	13.0	19.7	20.1	15.2
Silver-lead-zinc mining and smelting	12.7	10.8	12.2	15.3	15.7	17.7
Nickel-copper mining, smelting and refining	46.6	22.4	12.1	41.0	38.2	51.6
Asbestos refining	12.1	11.4	12.1	14.2	16.8	18.4
Total	96.5	59.2	56.4	96.7	97.8	109.0

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

TABLE 53

Taxes* Paid to Federal, Provincial and Municipal Governments in Canada by Five Important Divisions of Mineral Industry, 1962

($)

	Federal Income Tax	Provincial Tax	Municipal Tax	Total
Auriferous-quartz mining	2,903,266	2,344,133	841,971	6,089,370
Copper-gold-silver mining	8,285,599	4,963,540	1,973,590	15,222,729
Silver-lead-zinc mining and smelting	10,728,843	5,715,248	1,296,153	17,740,244
Nickel-copper mining, smelting and refining	32,149,991	17,195,307	2,198,886	51,544,184
Asbestos mining	10,890,077	5,763,889	1,720,261	18,374,227
Total	64,957,776	35,982,117	8,030,861	108,970,754

* The above amounts refer only to the payments actually made within the calendar year specified. These tax payments do not necessarily reflect the tax assessments of a calendar year.

TABLE 54

Federal Income Tax Declared by Companies in Mining and Related Industry in Canada, Fiscal Years Ended March 31, 1961 and 1962

($ millions)

	1961	1962
Mining, Quarrying and Oil Wells		
Gold mining	3.6	3.4
Other metal mining	54.5	50.6
Coal mines	0.3	0.6
Oil and natural gas	8.2	11.6
Other nonmetal mines	11.5	12.1
Quarries	1.9	1.3
Prospecting and Contract Drilling	3.7	2.8
Total	83.7	82.4
Metallurgical and Metal Fabricating Industries		
Iron and steel mills	36.5	32.0
Iron foundries	4.9	3.1
Metal smelting and refining	10.1	11.5
Boilers and fabricated structural material	3.0	1.6
Metal stamping, pressing and coating	6.5	8.2
Wire and wire products	4.0	3.8
Miscellaneous metal fabricating	5.9	5.6
Total	70.9	65.8
Nonmetallic mineral products		
Cement, clay and stone products	15.6	17.4
Glass and nonmetallic minerals	7.7	10.3
Fertilizers and industrial chemicals	7.3	13.9
Total	30.6	41.6
Petroleum and products		
Petroleum refineries	46.1	39.7
Coal and petroleum products	9.8	7.1
Total	55.9	46.8
Total mining and related industries	241.1	236.6
Total all industries	1,301.6	1,363.3

TABLE 55
Capital and Repair Expenditures of Canadian Mining Industry
($'000)

	1962			1963p			1964f		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
Metals									
Gold mines	6,770	9,262	16,032	6,020	8,994	15,014	4,735	8,813	13,548
Silver-lead-zinc	14,597	5,317	19,914	29,325	5,489	34,814	19,603	5,516	25,119
Iron mines	147,564	33,080	180,644	96,610	37,855	134,465	149,758	45,185	194,943
Other metal mines*	40,116	30,810	70,926	33,805	28,996	62,801	27,654	27,922	55,576
Total	209,047	78,469	287,516	165,760	81,334	247,094	201,750	87,436	289,186
Nonmetals									
Salt	5,059	1,692	6,751	3,586	1,062	4,648	2,560	1,139	3,699
Asbestos, gypsum and other nonmetals	43,544	19,725	63,269	53,202	21,035	74,237	61,830	21,993	83,823
Quarries and sandpits	11,530	9,509	21,039	6,055	10,481	16,536	8,792	10,049	18,841
Total	60,133	30,926	91,059	62,843	32,578	95,421	73,182	33,181	106,363
Fuels									
Coal	5,990	3,633	9,623	2,673	4,157	6,830	6,082	4,501	10,583
Petroleum and natural gas	182,642	18,425	201,067	227,008	18,471	245,479	222,048	18,912	240,960
Natural gas processing	21,820	3,881	25,701	44,224	3,353	47,577	38,224	3,111	41,335
Total	210,452	25,939	236,391	273,905	25,981	299,886	266,354	26,524	292,878
Total mining industry	479,632	135,334	614,966	502,508	139,893	642,401	541,286	147,141	688,427

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

Symbols: p Preliminary; f Forecast.

TABLE 56

Capital Investment in the Canadian Petroleum and Natural Gas Industries [1]

($ millions)

Year	Exploration	Development and Production	Oil Pipelines	Gas Transmission Pipelines	Gas Processing	Petroleum Refining	Marketing		Capital Investment in Canada	
							Oil [3]	Gas [4]	Petroleum and Natural Gas Industry	All Industries
1947	2	9.5	2.6	–	–	25.7	14.9	2.5	55.2	2,440
1948	2	37.3	4.3	–	–	32.6	9.7	3.8	87.7	3,087
1949	2	45.0	7.7	–	–	31.6	11.3	4.3	89.9	3,539
1950	2	53.9	55.0	–	–	34.1	16.7	6.6	156.3	3,936
1951	2	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	6.3	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	9.4	486.7	6,244
1956	73.7	252.4	43.5	133.6	10.5	79.1	68.5	46.6	707.9	8,034
1957	77.3	237.8	68.0	242.1	34.5	81.5	74.9	69.8	885.9	8,717
1958	62.4	181.5	23.6	214.8	40.1	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 p ...	58.7	227.0	24.4	86.9	44.2	48.6	50.9	81.2	621.9	9,312
1964 f ...	59.3	222.0	16.7	127.9	38.2	25.0	58.2	66.8	614.1	10,084

[1] 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 57 to 59 inclusive apply only to companies whose main revenues are derived from oil and gas activities. [2] Capital investment in exploration prior to 1952 is included in Development and Production column. [3] Capital investment in this item chiefly includes outlets reported by major companies. [4] Capital expenditures in gas marketing are on gas-distribution pipelines.

Symbols: p Preliminary; f Forecast; – Nil.

TABLE 57

Ownership and Control of Canadian Mineral Industry, Year-End, 1961

	1961	
	$ millions	%
Mining [1]		
estimated total investment	2,428	100.0
owned in:		
Canada	875	36.0
United States	1,397	57.6
Britain	85	3.5
Other countries	71	2.9
Petroleum and natural gas [2]		
estimated total investment	6,717	100.0
owned in:		
Canada	2,694	40.1
United States	3,434	51.1
Britain	299	4.5
Other countries	290	4.3
Nonferrous smelting and refining [3]		
estimated total investment	968	100.0
owned in:		
Canada	432	44.6
United States	421	43.5
Britain	62	6.4
Other countries	53	5.5

[1] Excludes petroleum and natural gas. [2] Applies only to companies whose main revenues are derived from oil and gas activities. [3] Native ores only.

TABLE 58

Estimated Book Value, Ownership and Control of Capital Employed in Selected Canadian Industries Year-End, 1959–61

($ billions)

	1959	1960	1961
Total capital employed			
Manufacturing	11.7	12.2	12.7
Petroleum and natural gas*	5.6	6.1	6.7
Other mining and smelting	3.1	3.3	3.4
Railways	5.2	5.3	5.4
Other utilities	8.5	9.2	10.3
Merchandising and construction	9.5	9.4	9.8
Total	43.6	45.6	48.2
Resident-owned capital			
Manufacturing	5.7	5.8	5.9
Petroleum and natural gas*	2.2	2.3	2.7
Other mining and smelting	1.3	1.3	1.3
Railways	3.8	3.9	4.0
Other utilities	7.3	7.9	9.0
Merchandising and construction	8.6	8.5	8.9
Total	28.8	29.9	31.7
Nonresident-owned capital			
Manufacturing	6.0	6.4	6.8
Petroleum and natural gas*	3.5	3.7	4.0
Other mining and smelting	1.8	2.0	2.1
Railways	1.4	1.4	1.4
Other utilities	1.2	1.3	1.3
Merchandising and construction	0.9	0.9	0.9
Total	14.8	15.7	16.5

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

Note: Owing to rounding, figures do not add to totals in all categories.

TABLE 59

Foreign Capital Invested in the Canadian Mineral Industry
Selected Years (end of year) 1956–1961
($ millions)

	1956	1957	1958	1959	1960	1961
Owned by all Nonresidents						
Mining and smelting	1,330	1,570	1,657	1,783	1,977	2,089
Petroleum and natural gas*	2,275	2,849	3,187	3,455	3,727	4,023
Owned by United States residents						
Mining and smelting	1,129	1,307	1,386	1,513	1,701	1,818
Petroleum and natural gas*	2,063	2,570	2,866	3,108	3,184	3,434

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

Abrasives

J.S. Ross*

Canada's output of abrasives is principally of the crude artificial varieties. This country ranks as the world's largest producer of crude silicon carbide and fused alumina. Its output of refined abrasive grains, however, is small and practically all of the natural variety. Canada's requirements for abrasive grains are relatively small and many types are supplied solely by imports.

Almost all minerals, mineral assemblages and 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. They may be generally 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 and commonly have a small particle size and are used for polishing and scouring.

Practically all the natural abrasives produced in Canada are from operations established primarily to supply materials for non-abrasive purposes. Consequently, most natural abrasives result as minority co-products. Although statistics are not available, output of these commodities is valued at about $100,000 a year. It includes silica and beach sand, iron oxide, feldspar, granite and grindstone. In addition, large tonnages of sized ores are used as grinding media in autogenous and pebble grinding. These media eventually become pulverized and are then consumed for other purposes.

*Mineral Processing Division, Mines Branch

TABLE 1

Abrasives – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production*				
Artificial abrasives				
Crude silicon carbide[1]	65,853	10,233,094		
Crude fused alumina[1]	161,849	17,081,260		
Abrasive wheels and segments	na	7,933,738		
Other products[2]	na	9,448,600		
Total		44,696,692		
Imports				
Natural and artificial abrasives				
Artificial-abrasive grains		2,880,156		2,968,607
Diamond dust, bort and carbonado		5,941,353		5,809,537
Emery in bulk[3]		204,872		271,599
Grinding wheels, bonded, with natural or artificial grains		2,263,360		2,263,512
Grinding stones or blocks manufactured by bonding together either natural or artificial abrasives, not otherwise provided for		426,647		459,574
Grindstones, not otherwise provided for		9,178		9,211
Pumice and pumice stone, lava and calcareous tufa, not further manufactured than ground		237,721		195,349
Coated abrasive paper and cloth		1,526,229		1,500,989
Manufactures of abrasives, not otherwise provided for		568,072		599,375
Total		14,057,588		14,077,753
Exports				
Natural and artificial abrasives				
Abrasives, natural, not elsewhere specified	–	–	124	4,029
Fused alumina, crude and grains	164,870	17,972,548	152,461	16,318,688
Silicon carbide, crude and grains	62,766	9,343,177	72,905	9,855,821
Abrasive paper and cloth		714,695		351,271
Abrasive wheels and stones		280,086		145,277
Abrasive basic products not elsewhere specified	281	1,780,064	260	955,244
Total		30,090,570		27,630,330
Re-exports				
Diamonds, industrial, and dust		4,795,455		3,591,228

Table 1 (cont'd)

	1962		1963	
Consumption*(incomplete)[4]	Short Tons	$	Short Tons	$
Abrasives, natural and artificial, in the production of artificial-abrasive products				
Natural-abrasive grains				
Garnet	225	64,908		
Emery	47	10,952		
Quartz or flint	110	7,429		
Other	7	1,112		
Total	389	84,401		
Artificial-abrasive grains for wheels, paper etc,.				
Fused alumina	2,811	887,152		
Silicon carbide	2,435	678,449		
Total	5,246	1,565,601		

Source: Dominion Bureau of Statistics.
*Production and consumption statistics for 1963 are not available.
[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]Includes also corundum and garnet. Separation is not possible. [4]Does not include the consumption of such natural abrasives as diamonds, pumice and calcareous tufa, nor does it include the consumption of natural and artificial grains for use as loose grains.
Symbols: na Not available; — Nil.

The import value of natural abrasives is large and amounted to $6.3 million in 1963. Imports consisted mainly of diamonds valued at $5.8 million, most of which were re-exported. They also included emery, garnet, corundum, pumice, pumicite, calcareous tufa, and quartz. 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 minor, but the re-export of industrial diamonds is substantial. In 1963, these re-exports were down appreciably from 1962 and were valued at $3.6 million, indicating an apparent consumption value of $2.2 million compared with $1.1 million for 1962.

Canada's output of crude artificial abrasives is substantial. In 1962, it amounted to 161,849 tons of fused alumina valued at $17.1 million and 65,853 tons of silicon carbide valued at $10.2 million. The overall output for 1963 is estimated to be slightly higher. The 1962 production represented 89 and 57 per cent of the North America output of fused alumina and silicon carbide, respectively. 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 demand for fused alumina fluctuates greatly from year to year whereas that for silicon carbide is more stable and has been generally increasing since 1939. Metallic abrasives, such as shot and grit, are also produced but are not reported separately in statistics.

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
	Gap de la Madeleine, Que.	Silicon carbide
Simonds Canada Abrasive Company Limited	Arvida, Que.	Fused alumina

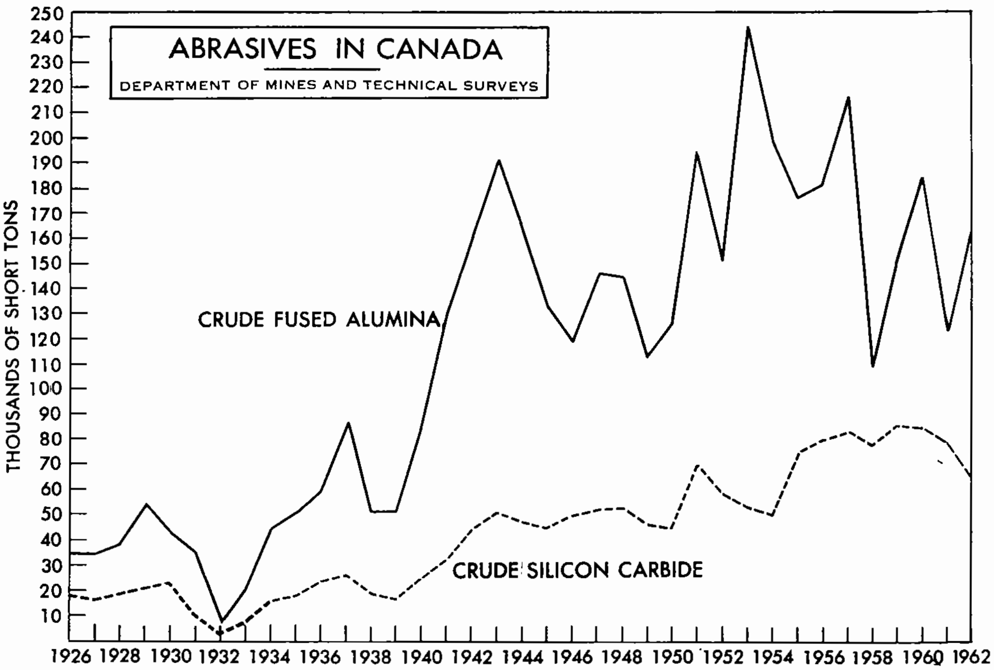
Manufactured abrasive products, other than artificial abrasives, are also made in Canada. In 1962 they consisted of abrasive wheels and segments valued at $7.9 million and other products valued at $9.4 million. The latter category includes abrasive cloth and paper, abrasive tile and artificial pulpstone as well as some nonabrasive materials. Consequently, the total production value of the artificial-abrasives industry was $44.7 million in 1962.

Imports of semi-processed and finished artificial abrasive products amounted to little more than half the total abrasives imports of $14 million in 1963. The largest item was refined artificial-abrasive grains which were used mostly in the manufacture of finished products. Exports were practically all of the artificial type and in 1963 amounted to $27.6 million. Virtually all the crude silicon carbide and fused alumina that Canada produced made up most of the exports and amounted to $26.2 million. Nearly all exports went to the United States. The remaining exports were mostly finished manufactured abrasive products.

PRODUCERS

Production of natural abrasives is insignificant. These commodities come from several operations as co-products of industrial minerals processed principally for other uses. Canada's output included quartzite, sandstone, beach sand, feldspar, granite and iron oxide.

Sand for sandblasting is produced from quartzite by Dominion Industrial Mineral Corporation at Lachine, Quebec, and by Nova Scotia Sand and Gravel Limited near Shubenacadie, Nova Scotia. International Minerals & Chemical



Corporation (Canada) Limited ships feldspar from near Buckingham, Quebec, for use in soaps and cleansers. Finely ground silica is sold for the same purpose by Canadian Silica Corporation Limited, St. Canut, Quebec. At Red Mill, Quebec, The Sherwin-Williams Company of Canada, Limited, processed bog iron oxide partly for use as crocus and jeweller's rouge. H.C. Reid manufactures grindstones from sandstone recovered in the Bathurst district, New Brunswick. A few other companies supply small quantities of natural abrasives.

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 for other purposes. However, they serve a two-fold purpose, initially as grinding media and eventually as a semi-processed ore. In Canada, many ores are subjected to this type of comminution.

Crude artificial abrasives comprise most of Canada's abrasive production. They virtually consist of fused alumina and silicon carbide and are produced by six companies in four plants in Ontario and in four plants in Quebec. The producing plants, listed in Table 2, have experienced little change in recent years. Small quantities of their products are exported to the United Kingdom and the remainder is exported to the United States. The demand for these commodities varies directly with the degree of metal fabrication in consuming countries. This is particularly exemplified by fused alumina.

Canada also produces a significant quantity of coated and bonded abrasives. Most are produced in Southern Ontario, although Quebec and British Columbia supply small amounts.

USES

Abrasives are employed universally and in numerous applications. Although each abrasive product has many possible applications, its versatility is normally 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 serve as natural abrasives. However, only a few are in demand. The use of ores in pebble and autogenous grinding has already been discussed. 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. As loose refined grains, fused alumina is used for grinding, polishing, sandblasting and for providing "nonslip" surfaces for certain concrete and masonry structures. When bonded, it is employed mainly to grind, cut or polish metallic products. In coated abrasives, fused alumina is used in the metalworking, woodworking and leather industries. Because silicon carbide and fused alumina are both high-grade abrasives, they compete with many applications. In the form of loose grains, they have similar applications. Silicon carbide is also bonded into wheels, sticks, rubs, etc., and used to abrade metal, industrial-mineral products, rubber, leather and wood. In coated abrasives it serves industrial applications similar to those served by coated fused alumina.

PRICES

Canada does not produce refined grains for the production of manufactured abrasive products. Consequently, in 1962 the following average prices per short ton at the consuming plants were substantial: fused alumina $316, silicon carbide $279, garnet $288, emery $233 and quartz $675.

Aggregates, Lightweight

H.S. Wilson*

The value of construction in Canada in 1963 reached another new record of $7.7 million, exceeding the 1962 value of $7.3 million by 5.5 per cent. Thus the increase begun in 1961 continued, following decreases in construction during 1959 and 1960.

Table 1 shows the percentage changes in the various types of construction between 1962 and 1963, and the percentage of the total represented by each type.

The production of lightweight aggregates did not follow this upward trend. For the first time since 1954, the value of the lightweight aggregates produced was below that of the previous year—down 2.4 per cent, from $6.4 million to $6.3 million.

The expanded-clay and -shale aggregates were 0.8 per cent lower in volume and 3.2 per cent lower in value than in 1962. This was the first decrease in production since 1958. One new plant went into operation during the year, and two did not operate.

TABLE 1

Types of Construction in Canada, 1963

Type of Construction	Percentage Change 1962–63	Percentage of Total Value	
		1962	1963p
Engineering	+8.8	38	39
Residential	+7.5	29	29
Institutional	+0.4	11	11
Commercial	–0.4	10	9
Industrial	+3.1	7	7
Other building	–3.7	5	5

Source: Dominion Bureau of Statistics.
p Preliminary.

*Mineral Processing Division, Mines Branch

TABLE 2
Production of Lightweight Aggregates, 1962–63

	1962		1963p	
	Cubic Yards	$	Cubic Yards	$
From domestic raw materials				
Expanded clay and shale	441,400	2,447,800	437,824	2,369,410
Expanded slag	305,943	745,839	283,405	678,609
From imported raw materials				
Exfoliated vermiculite	327,822	2,452,468	324,412	2,468,323
Expanded perlite	96,132	731,704	89,594	722,682
Pumice		48,600		31,000
Total		6,426,411		6,270,024

Source: Information supplied directly by the producers.
p Preliminary

Production of expanded slag was down 7.4 per cent in volume and 9.0 per cent in value. This was the first decrease since the lows in 1957 and 1958. One expanding installation which had been operated in previous years was not used in 1963.

Vermiculite production decreased 1.0 per cent in volume, but increased 0.6 per cent in value from the previous year's figures. Production has remained relatively constant since 1960, below the maximum achieved in 1959.

Perlite production, which decreased 6.8 per cent in volume from 1962, was the lowest since 1956. The value decreased 1.2 per cent, the lowest since 1957. Peak production was reached in 1958. One plant did not produce during 1963.

The value of pumice used as lightweight aggregate was down 36.2 per cent from the 1962 figure, the lowest since before 1954.

The production and value of the different types of lightweight aggregates produced in 1962 and 1963 are shown in Table 2. The accompanying graph shows the production of the principal lightweight aggregates during the period 1954–1962.

SOURCES OF RAW MATERIALS AND PRODUCERS

The 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.

Eleven plants were in operation in 1963 as follows: Quebec – Lafleche and Laprairie; Ontario – Cooksville; Manitoba – St. Boniface(2); Saskatchewan – Regina(2); Alberta – Calgary and Edmonton(2); and British Columbia – Saturna Island. The plant at Lafleche, Quebec was put into operation during 1963. The plant at Ottawa, Ontario and one plant at Calgary, Alberta were not in production during 1963.

Expanded blast furnace slag is a byproduct of the iron and steel industry. It was produced in 1963 at Hamilton, Ontario, and at Sydney, Nova Scotia. The plant at Port Colborne, Ontario was shut down in 1962.

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.
Consolidated Concrete Limited[1]	Edmonton, Alta.
Echo–Lite Aggregate Ltd.	St. Boniface, Man.
Edmonton Concrete Block Co. Ltd.	Edmonton, Alta.
Light Aggregate (Sask.) Limited	Regina, Sask.
Expanded Shale	
Aggrite Inc.	Laprairie, Que.
British Columbia Lightweight Aggregates Ltd.	Saturna Island, B.C.
Cell–Rock Inc.	Lafleche, Que.
Consolidated Concrete Limited	Calgary, Alta.
Domtar Construction Materials Ltd.	Cooksville, Ont.
Expanded Slag	
Dominion Iron & Steel Limited	Sydney, N.S.
National Slag Limited	Hamilton, Ont.
Vermiculite	
Grant Industries Ltd.	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.
Vantec Industries Ltd.[2]	Richmond, B.C.
Vermiculite Insulating Limited	Rexdale, Ont.[3]
	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.	Beauport, Que.
	Charlesbourg West, Que.
Perlite Industries Reg'd	Ville St. Pierre, Que.
Perlite Products Ltd.	Winnipeg, Man.
Sherbrooke Perlite Inc.	Lennoxville, Que.
Vantec Industries Ltd.[2]	Richmond, B.C.
Western Gypsum Products Limited	Vancouver, B.C.
Pumice	
Miron Company Ltd.	Montreal, Que.
Ocean Cement Limited[4]	Vancouver, B.C.

Table 3 (continued)

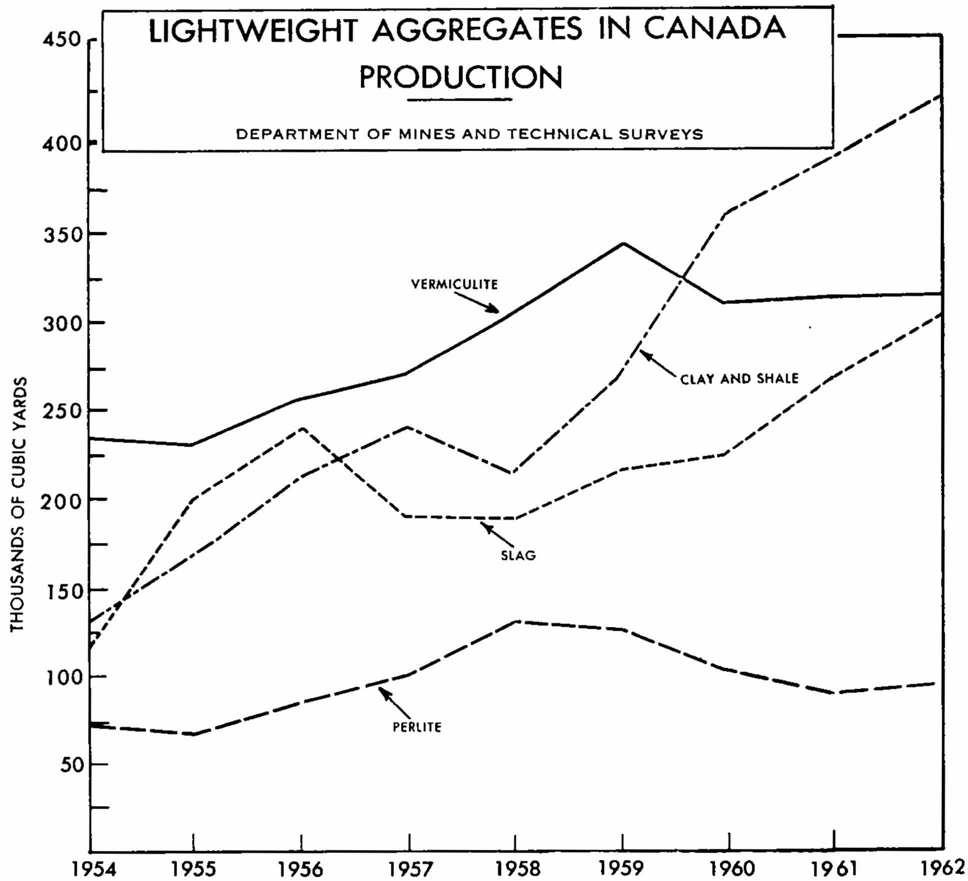
Company	Location
Nonproducing Plants	
Expanded Clay	
Featherock Inc.	St. Francois du Lac, Que.
Expanded Shale	
Hayley–Lite Limited	Ottawa, Ont.
Perlite	
Miron Company Ltd.	Montreal, Que.
Dismantled Plants	
Expanded Shale	
Burtex Industries Limited	Calgary, Alta.
Vermiculite	
Vermiculite Insulating Limited	Rexdale, Ont.
Perlite	
Western Perlite Co. Ltd.	Calgary, Alta.

[1]Formerly Hobbs Concrete Blocks Ltd. [2]Formerly Western Expanded Ores Ltd. [3]Closed October 1963. [4]Formerly Evans, Coleman & Evans, 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. Six companies produce exfoliated vermiculite at 12 locations: British Columbia – Vancouver(2) and Richmond; Alberta – Calgary; Saskatchewan – Regina; Manitoba – Winnipeg and St. Boniface; Ontario – Toronto, Rexdale and St. Thomas; and Quebec – Lachine and Montreal. The plant at Rexdale was dismantled near the end of 1963.

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. Ten plants were in operation during the year: Quebec – Ville St. Pierre, Beauport, Charlesbourg West, and Lennoxville; Ontario – Caledonia and Hagersville; Manitoba – Winnipeg; Alberta – Calgary; British Columbia – Vancouver and Richmond. One plant in Calgary was shut down at the end of 1962.

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 block and precast concrete shapes accounted for 81 and 8 per cent respectively of the 1963 production, consumption changing from 73 and 6 per cent in 1962. Cast-in-place structural concrete used 8 per cent in 1963, compared with 18 per cent the previous year. Minor uses – refractory materials, loose insulation and lightweight brick – accounted for 3 per cent of production; this was unchanged from 1962. Considering that total production was 1 per cent lower in 1963 than in 1962, only the volume used in concrete block was greater in 1963.

Expanded Slag

In 1963, ninety-eight per cent of expanded slag was used as aggregate in concrete block, the same as in 1962. Precast concrete shapes and cast-in-place structural concrete each consumed one per cent. Total production being down by 7 per cent, all product categories consumed less expanded slag than in 1962.

Exfoliated Vermiculite

Loose insulation consumed 80 per cent of production in 1963, compared with 79 per cent in 1962. Plaster accounted for 12 per cent–one per cent less. Five per cent, unchanged from 1962, was used in insulating concrete. Three per cent was used for such purposes as soil and fertilizer conditioners, underground pipe insulation, and for agriculture and horticulture in both 1962 and 1963. Insulation and concrete used slightly more vermiculite in 1963; plaster and the minor uses consumed less than in 1962.

Expanded Perlite

Plaster aggregate accounted for 88 per cent of the 1963 production–2 per cent more than in 1962. Three per cent was used in insulating concrete–6 per cent less than in 1962. Nine per cent was used in insulation, horticulture, acoustics, etc., an increase of 4 per cent. The quantities used in plaster and concrete were less in 1963 than in 1962; the minor uses consumed more.

Pumice

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

PRICES

Expanded-clay and -shale aggregates sold at $3.50 to $6.70 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 40 cents a cubic foot. Vermiculite and perlite are marketed in bags of 3 and 4 cubic feet. All prices are f.o.b. plant. Raw vermiculite was imported at costs ranging from about $25 to $60 a ton and raw perlite at costs ranging from about $20 to $30 a ton.

Aluminum

W.H. Jackson*

Primary aluminum output in 1963 was 719,390 tons, an increase of 4.2 per cent over 1962, representing an average operating rate of 81.5 per cent of smelter capacity.

Canadian consumption of primary aluminum rose 11.3 per cent to 156,786 tons. Consumption at the first processing stage rose 9.9 per cent to 166,963 tons (Table 3).

Exports increased to 635,187 tons from 576,206 tons. According to data compiled by the British Bureau of Non-Ferrous Metal Statistics, Canada supplied 54.6 per cent of British imports, or 162,811 tons out of a total of 298,332 tons. Consumption in Britain was 351,143 tons compared with 315,985 in 1962.

According to the U.S. Department of Commerce, United States imports of crude metal and alloys were 415,668 tons of which Canada supplied 272,884 tons.

DOMESTIC INDUSTRY AND DEVELOPMENTS

All six Canadian smelters (Table 4), are close to hydroelectric power generating stations, seaports and main railway lines so that outgoing shipments of metal and incoming supplies, mainly alumina and petroleum coke, can be handled efficiently and at low cost.

* Mineral Resources Division

TABLE 1
Aluminum – Production and Trade

	1962 Short Tons	1962 $	1963 Short Tons	1963 $
Production				
Ingot	690,297		719,390	
Imports				
Bauxite and alumina for refining				
British Guiana	1,183,095	13,385,482	741,681	12,358,536
Surinam	186,062	1,273,659	551,196	3,412,608
Jamaica	475,843	29,813,206	537,544	33,431,331
Guinea	11,739	895,624	39,603	2,500,986
United States	142,787	10,067,679	136,306	9,431,267
Ghana	13,047	89,605	–	–
Total	2,012,573	55,525,255	2,006,330	61,134,728
Cryolite				
Denmark	3,353	636,111	4,213	685,980
United States	219	59,648	591	145,493
Czechoslovakia	–	–	20	2,848
West Germany	–	–	11	1,615
Italy	1,531	360,376	11	2,946
Britain	7	1,795	11	2,884
Total	5,110	1,057,930	4,857	841,766
Aluminum scrap				
Total	1,312	299,088	1,492	318,527
Aluminum ingots				
Total	3,855	2,269,600	1,954	1,364,959
Aluminum products				
Semimanufactured		13,450,628		21,621,217
Fully manufactured		23,871,855		21,743,091
Total		37,322,483		43,364,308

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Exports				
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars				
United States	211,999	95,043,603	274,496	117,676,471
Britain	167,822	80,452,880	168,459	81,804,007
West Germany	21,790	10,161,517	30,390	14,093,761
Brazil	15,570	7,156,154	18,682	8,178,223
Japan	7,629	3,469,751	17,532	8,252,820
Sweden	11,726	5,522,038	15,658	7,243,569
Republic of South Africa	15,162	7,111,142	13,947	6,304,300
Italy	14,289	6,175,059	13,478	5,856,025
Spain	9,169	4,437,313	11,652	5,255,624
Hong Kong	5,944	2,738,876	6,848	3,159,927
Pakistan	3,777	1,688,844	6,477	2,840,132
India	5,263	2,236,707	5,834	2,431,517
Mexico	9,083	4,245,931	5,388	2,518,593
Australia	22,637	10,784,900	5,000	2,374,501
Other countries	54,346	25,003,710	41,346	19,191,561
Total	576,206	266,228,425	635,187	287,181,031
Bars, rods, plates, sheet, circles, castings and forgings				
India	4,201	1,947,619	2,608	1,241,029
United States	10,921	6,407,472	2,243	1,575,773
Mexico	330	160,322	1,963	884,081
Spain	1,545	726,896	1,741	860,953
New Zealand	194	103,382	824	477,101
Greece	–	–	551	253,196
Republic of South Africa	10	11,718	550	224,278
Italy	508	241,885	519	262,080
France	247	112,738	512	372,348
Other countries	4,687	2,873,430	1,276	1,001,926
Total	22,643	12,585,462	12,787	7,152,765
Foil				
Britain	312	340,756	307	319,154
New Zealand	23	34,276	82	103,851
Brazil	–	–	41	9,873
United States	79	83,753	29	22,862
Venezuela	18	26,038	3	3,961
Other countries	31	46,661	3	3,883
Total	463	531,484	465	463,584

Table 1 (cont'd)

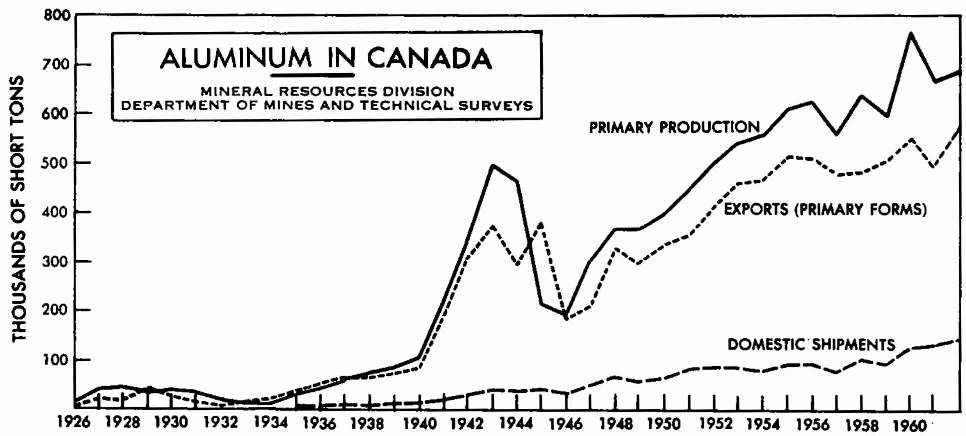
	1962		1963	
	Short Tons	$	Short Tons	$
Fabricated materials, not elsewhere specified				
Mexico	6	12,854	3,853	1,617,991
New Zealand	655	376,868	2,753	1,190,040
Venezuela	426	223,069	919	426,032
Brazil	863	447,313	913	462,744
Pakistan	914	467,826	771	563,063
United States	598	478,831	728	667,750
Malaya	107	71,704	678	365,684
Dominican Republic	31	21,656	612	393,502
Britain	547	621,848	373	423,752
Other countries	3,740	2,486,350	2,703	1,822,205
Total	7,887	5,208,319	14,303	7,932,763
In ores and concentrates (alumina)				
United States	1,933	256,496	2,595	352,863
Britain	235	38,350	22	1,136
West Germany	3	2,869	12	1,688
Australia	—	—	12	1,494
Norway	1,512	86,174	—	—
Other countries	190	13,452	3	390
Total	3,873	397,341	2,644	357,571
Scrap				
Italy	13,425	4,701,049	19,462	6,881,394
United States	10,715	2,022,493	14,313	2,216,331
Japan	4,550	1,722,065	6,368	2,297,275
Australia	32	9,311	2,262	981,897
West Germany	784	205,564	577	104,479
Other countries	739	272,877	564	162,370
Total	30,245	8,933,359	43,546	12,643,746

Source: Dominion Bureau of Statistics.
— Nil.

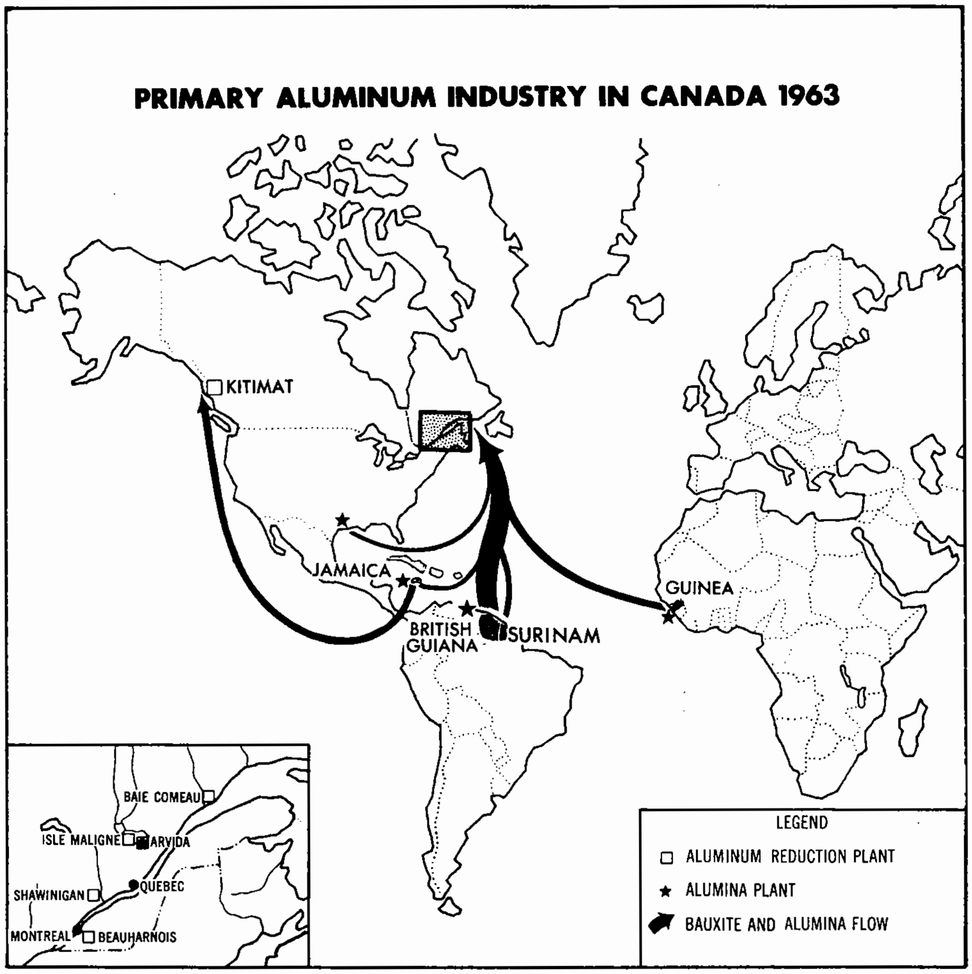
TABLE 2
Aluminum – Production, Trade and Consumption,
1954–63
(short tons)

	Production	Imports	Exports	Consumption*
1954	557,897	115	468,494	80,355
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	135,575r
1962	690,297	3,855	576,206	151,893r
1963	719,390	1,954	635,187	166,909

*Producers' domestic shipments to 1959, consumer reports from 1960.
r Revised from previously published figure.



The five smelters of Aluminum Company of Canada, Limited (ALCAN) produced 625,600 tons compared with 596,200 tons in 1962. The average operating rate was 80 per cent of capacity, reaching 90 per cent at year-end, owing to re-activation of idle capacity in mid-year. New capacity amounting to 20,000 tons was almost completed at Kitimat, B.C., and a further 100,000 tons can be completed in stages as warranted by markets. Renovation of potlines was underway at Beauharnois. Aluminium Limited group companies, of which ALCAN is a subsidiary, produced 214,000 tons outside Canada; internal use of primary by the whole group totalled 426,100 tons, an increase of 40 per cent. Ingot sales to other customers were 435,500 tons compared with 423,400 in 1962.



A new smelting process, under test at Arvida, involves the partial reduction of bauxite with carbon in an electric furnace to form aluminum carbide. Reaction of this crude product with aluminum trichloride vapour at about 1200°C to form aluminum monochloride gas leaves impurities behind. In a condenser, the monochloride reverts to trichloride and aluminum, the latter being removed periodically.

Canadian British Aluminium Company Limited operates a smelter at Baie Comeau, Quebec, and produced 93,800 tons in 1963. The bulk of production is sold under long-term agreements to The British Aluminium Company, Limited; the balance, which amounts to some 30 to 35 thousand tons annually, is sold to fabricators in Canada.

Table 6 lists the main semi-fabricators or users of primary aluminum in Canada and shows the general type of products manufactured.

In June, ALCAN opened a new $12-million, cold-rolling mill at Kingston, Ontario, with a capacity to produce 25,000 tons of sheet annually.

TABLE 3
Canadian Consumption of Aluminum at First Processing Stage
(short tons)

	1960	1961	1962r	1963
Castings				
Sand	1,284	1,183	1,472	1,192
Permanent-mould	2,375	2,348	2,583	3,040
Die	3,662	3,520	4,571	6,806
Other	1,105	593	747	825
Total	8,426	7,644	9,373	11,863
Wrought products				
Extrusions	29,764	30,524	41,229	45,200
Sheet, plate, coil and other (including rod, forgings and slugs)	80,334	94,944	97,792	105,932
Total	110,098	125,468	139,021	151,132
Destructive Uses				
Nonaluminum-base alloys, powder and paste	866	967	1,604	1,559
Deoxidizers	1,441	1,496	1,895	2,355
Total	2,307	2,463	3,499	3,914
Total consumed	120,831	135,575	151,893	166,909
Secondary aluminum produced	9,109	9,644	11,422	14,995
Receipts and inventories at plants:	Metal Entering Plant		On Hand Dec. 31	
	1962r	1963	1962	1963
Primary aluminum ingot and alloys	147,534	155,412	54,971	53,587
Secondary aluminum	6,062	6,913	815	795
Scrap originating outside plant	14,964	20,662	1,385	2,150

Source: Dominion Bureau of Statistics as reported by consumers.
r Revised.

Coil from the 100,000-ton hot-mill of Alroll Inc. of Oswego, New York, is imported for the new plant, which produces sheet in widths from 36 to 72 inches and in thicknesses ranging from .015 to .187 inch. The older mill at Kingston hot rolls sheet to 48-inch width and has a 30,000-ton capacity. Reynolds Aluminum Company of Canada Ltd. announced that it will construct a $3.5-million, cold-mill extension to its present facilities at Cap de la Madeleine, Quebec. As part of its $10-million program, a 64-inch foil mill, annealing furnaces and a roto-gravure press will also be installed. Nesco Aluminum Ltd., a Reynolds group company, is building a $2-million, rod-mill of 25,000-ton-a-year capacity at La Malbaie, Quebec. There are two other rod mills in Canada at Vancouver and Shawinigan; both mills are owned by ALCAN.

TABLE 4
Annual Capacities of Canadian Aluminum Plants,
December 31, 1963

Companies and Plants	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.	192,000
Canadian British Aluminium Company Limited (CBA)	
Baie Comeau, Quebec	100,000
Total	888,000

ORE SUPPLY AND WORLD TRENDS

The only alumina plant in Canada is at Arvida, Quebec, where ALCAN treats beneficiated ore from a subsidiary, the Demerara Bauxite Company (DEMBA), in British Guiana and from N.V. Billiton Company in Surinam. Companies in these countries also produce chemical, abrasive and refractory grades of bauxite which command premium prices. The bauxites were formed by the laterization of pre-existing clays and are low in iron and titania. Crushing and washing are needed to remove clay impurities and to upgrade the ore but the process results in a considerable loss in fines. DEMBA also operates a 245,000-ton alumina plant in British Guiana. Another subsidiary, Alumina Jamaica Limited, operates two alumina plants in Jamaica, one at Kirkvine (540,000 tons) and the other at Ewarton (305,000 tons). Jamaican ores being mined are high in iron but low in silica with particles in the sub-micron range. They cannot be upgraded.

Much of the alumina from the Jamaican plants is smelted in Canada; the remainder is sold to other customers. ALCAN has an interest of 20 per cent in the output of the alumina plant planned for a capacity of 672,000 tons a year to be completed in Queensland, Australia, in 1967. Bauxite from the Republic of Guinea in Africa is no longer available to the Arvida plant as the mines at Kassa were seized when ALCAN, through a subsidiary company, did not proceed with a large new bauxite mine development at Boké. Subsequently, mining rights to the Boké area were granted by the Government of Guinea to Harvey Aluminum Company of the United States and production will start in 1964. Part of the alumina for the Baie Comeau plant comes from the Fria consortium in Guinea but most is supplied by the Corpus Christi, Texas, plant of Reynolds Metals Company.

As bauxite mining and alumina refining are usually carried out by integrated companies or sold under long-term contracts, free market quotations are not available. The value of metal-grade bauxite depends on the specific content of alumina, reactive silica, iron and titania with bonus and penalty clauses. A typical value is $6.50 a short ton, f.o.b. vessels, British Guiana for 60 per cent Al_2O_3, 6 per cent SiO_2, and 1.25 per cent Fe_2O_3. Metal-grade bauxite from Surinam, which is sold under long-term contract, has an average value, according to Canadian trade statistics, of $6.11 a ton. Alumina, f.o.b. Jamaican ports, was valued at $62.57 a ton; that from the United States at $68.00. According to *E & M J Metal and Mineral Markets,* typical prices for a long ton of bauxite, f.o.b. cars, Atlantic ports, were:

Chemical Grade	60% Al_2O_3, 6% Si, 1.25% Fe	– $13.95
Abrasive Grade	87% Al_2O_3, min.	– 25.50
Refractory Grade	88% Al_2O_3, min.	– 34.75

Table 5 shows the relative position, by geographical area, of ore supply and metal production and consumption. The insufficiency of bauxite in continental North America, an area with substantial resources of low-cost power, is met by supplies from the Carribean area where power deficiencies prevent large-scale metal production.

The trend of world industry developments has been greatly influenced by governmental policies. In North America the round of smelter expansion that characterized the 1950's has slowed and the government stockpile and investment incentives that encouraged it have ceased. Expanding markets have enabled excess capacity to be utilized and further expansion will be based on sound business assessment of markets. The European Economic Community (EEC) will have no internal aluminum tariff among its members. For other suppliers the ultimate common external tariff will be 9 per cent. Alumina has an 11-per-cent tariff or 6-per-cent metal equivalent so a competitive advantage accrues to smelters having alumina supplies within the Community. For example, Surinam, Greece, and Cameroon are associate EEC members and could supply tariff-free metal and alumina to the community. In Greece, Aluminum de Grece will process 450,000 tons of bauxite annually to make 200,000 tons of alumina of which 80,000 tons are for export within the Community; the remainder will be smelted in Greece at a new 62,500-ton capacity plant. Cameroon has the only integrated producer in Africa. Bauxite and alumina resources of the Republic of Guinea are being developed. The hydroelectric potential of Ghana is also being developed for aluminum smelting but there is, as yet, no bauxite production. In Surinam, a large alumina plant that will feed a 60,000-ton smelter in that country and another in the Netherlands is being built.

Australia has become the focus of major bauxite and aluminum smelting developments. Commonwealth Aluminium Corporation has been shipping bauxite from Weipa, Queensland, to its Tasmanian smelter that will have a capacity of 52,000 tons in 1964. The first 20,000-ton smelter unit of Alcoa of Australia Limited at Geelong came into operation in 1963 and the alumina plant at Kwinana, Western Australia, was completed. A consortium of companies formed Queensland Alumina Limited at Gladstone, Australia. It will build a $112-million alumina plant with production scheduled for 1967, and for 10 years will obtain all its bauxite from the Weipa deposits of Comalco Industries Proprietary Limited. Aluminium Limited of Montreal, will take about 20 per cent of the 672,000-ton output for sale. Another subsidiary of Aluminium Limited is a major fabricator in Australia. Australia now has an aluminum capacity well in excess of its needs; domestic sources of metal are used in fabrication.

The construction of very small smelter units has been undertaken in a number of countries to save foreign exchange. The tonnage is not too significant but markets for suppliers of ingot thereby become more restricted and price is a secondary factor. Of more significance is the trend toward vertical integration within corporate groups based on national markets for semi-fabricated products.

TABLE 5
World Data on Primary Aluminum, 1963
(thousands of short tons)

Area	Bauxite	Aluminum Production	Smelter Capacity	Aluminum Consumption
North and South America	16,460	3,073	3,640	2,745
Western Europe	5,391	1,192	1,339	1,438
Africa	2,074	58	58	20
Asia	1,779	317	352	295
Australia	369	46	102	63
Free World	26,073	4,686	5,491	4,561
Eastern Bloc	6,823	1,308	1,420	1,265
World total	32,896	5,994	6,911	5,826

Source: American Bureau of Metal Statistics.

CONSUMPTION AND USES

According to Data in Table 3, primary aluminum consumption in Canada, allowing for inventory adjustment, was 156,786 tons. Total consumption at the first processing stage was 166,909 tons.

TABLE 6
Consumers of Primary Aluminum

	General alloying, deoxidizers	Extrusions	Castings	Sheet	Cable	Foil	Rod
The Algoma Steel Corporation, Limited	X						
Alsco Products of Canada 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 Mouldings Limited		X					
Canadian Steel Improvement Limited			X				
Chrysler Canada Ltd.			X				
Custom-Aire Aluminum 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				
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 Wire & Cable Company Ltd.					X		
The Hoover Co., Limited			X				
Industrial Wire & Cable Co., 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, Conduits Limited					X		
Phillips Electrical Company Limited					X		
Precision Castings Limited			X				

TABLE 6 (cont'd)

	General alloying, deoxidizers	Extrusions	Castings	Sheet	Cable	Foil	Rod
Price-Acme of Canada Limited		X					
Reynolds Aluminum Company of Canada Ltd.				X		X	
Reynolds Extrusion Sales Co. Ltd.		X					
Specialty Extruders Limited		X					
The Steel Company of Canada, Limited	X						
Supreme Aluminum Industries Limited				X			
Thompson Products, Limited			X				
Wallaceburg Aluminum Extrusions Limited		X					
Western Wire Products (1963) Ltd.					X		

Castings have varied end-uses; the increase shown in die-castings is mainly in the automotive market. Extrusions are used in conjunction with sheet in curtain wall-systems of building construction, in the manufacture of trucks and trailer bodies, for residential doors and windows, as irrigation pipe and as tubing for lightweight furniture. A considerable quantity of tubing was used in the construction of a hydroelectric dam project to circulate cooling water that controlled the setting of concrete. Aluminum rod goes into the making of electrical wire and cable. There is a substantial domestic and export market. 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

Effective October 2, 1963, the nominal United States and overseas market price of aluminum ingot was raised from 22.5 to 23.0 cents a pound, delivered in the United States or main ports in Europe.

The delivered Canadian base price for primary aluminum in 50-pound ingots, minimum purity 99.5 per cent was 24.0 cents from June 18, 1962 until October 2, 1963; after that date, the price was 24.75 cents a pound.

TARIFFS

	British Preferential	Most Favored 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¢ per lb	5¢ per lb
Bars, rods, plates, sheets, strips, circles, squares, disks and rectangles	free	3¢ per lb	7½¢ per 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%
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%

Tariffs (cont'd)

United States	
Bauxite	50¢ per long ton (duty 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¢ per lb
Other	
Aluminum other than alloys of aluminum	1.25¢ per lb
Alloys of aluminum:	
Aluminum silicon	2.125¢ per lb
Other	1.25¢ per lb
Aluminum waste and scrap	1.5¢ per lb (duty temporarily suspended)
Wrought rods of aluminum	2.5¢ per 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¢ per 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¢ per lb
Clad	
Wholly of aluminum	2.5¢ per lb
Other	24% ad val
Aluminum powders and flakes	
Flakes	5.1¢ per lb
Powders	19% ad val

Tariffs (cont'd)

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

Antimony

J.W. Patterson*

All of Canada's antimony production from domestic ores and concentrates is in the form of antimonial lead from lead-refining. In 1963, the antimony content of the antimonial-lead output was 1.6 million pounds; in 1962 it was 1.9 million pounds. Consumption of antimony metal at 975,627 pounds was somewhat lower than the 1.2 million pounds used in 1962. As in previous years, most antimony consumed went into the production of antimonial lead whose main use was in the manufacture of storage batteries.

All antimony metal used in Canada is imported. In 1963, Communist China was the main source of Canada's imports – 866,090 pounds out of a total of one million pounds. Other important sources were Yugoslavia, the Netherlands and France. A total of 649,000 pounds of antimony oxide were also imported, with Britain supplying almost 80 per cent. A large part of the antimonial lead produced in Canada was exported to the United States.

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. Small amounts of high-purity antimony are produced from imported metal in COMINCO'S electronic-materials plant at Trail.

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 one per cent antimony, which is recovered in anode residues and furnace drosses

* Mineral Resources Division

TABLE 1

Antimony – Production, Trade and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production				
Antimony content of antimonial-lead alloys	1,931,397	748,223	1,601,253	624,489
Imports				
Regulus				
China (Communist)	842,229	135,401	866,090	136,273
Yugoslavia	–	–	66,247	18,819
Netherlands	–	–	57,795	14,683
France	–	–	45,635	13,554
United States	4,122	1,428	468	296
Britain	164,536	35,312	–	–
Czechoslovakia	110,230	23,670	–	–
West Germany	110,000	23,605	–	–
Belgium and Luxembourg	44,800	12,171	–	–
Total	1,275,917	231,587	1,036,235	183,625
Antimony Oxide				
Britain	332,280	94,285	511,840	151,572
United States	128,055	33,868	82,200	21,202
China (Communist)	99,900	17,191	44,092	7,495
Belgium and Luxembourg	67,354	18,301	11,200	3,223
Total	627,589	163,645	649,332	183,492
Antimony Salts				
United States	30,688	19,976	26,281	18,713
Belgium and Luxembourg	2,600	2,105	–	–
Total	33,288	22,081	26,281	18,713
Consumption				
Antimony regulus in production of:				
Antimonial-lead alloys	749,850		648,126	
Babbitt	101,056		91,187	
Solder	14,698		14,691	
Type metal	180,751		180,273	
Other commodities*	164,301		41,350	
Total	1,210,656		975,627	

Source: Dominion Bureau of Statistics
* Includes antimony oxide, foil, bronze, secondary metals, pipe and sheet, lead-base alloys, drop shot and other minor commodities.
–Nil.

from the electrolytic refining of the bullion. These residues and drosses are treated to yield antimonial-lead alloy to which refined lead may be added to produce a marketable product.

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 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 deposits are situated 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.

TABLE 2

Antimony – Production, Imports and Consumption, 1954–63

(pounds)

	Production[1] (all forms)	Imports (regulus)	Consumption[2] (regulus)
1954	1,302,333	2,043,544	1,610,000
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

Source: Dominion Bureau of Statistics.
[1] 1954 to 1957 inclusive includes antimony content of antimonial-lead alloys, flue dust and dore slag; 1958 to 1963 inclusive consists of antimony content of antimonial-lead alloys only. [2] Consumption of antimony regulus as reported by consumers. Does not include antimony in antimonial lead produced by COMINCO.

World production in 1963, as reported by the *U.S. Bureau of Mines* and shown in Table 3, totalled 61,000 tons.

United States, the largest user of antimony, continued to depend on foreign supplies for a large portion of its requirements. Imports of antimony and antimony-bearing materials were about 12 per cent more than in 1962 with the increase being attributable to increased imports of antimony in ores and concentrates, and antimony metal. Imports of antimony oxide and antimony, the latter in the form of antimonial lead, were lower. The ores and concentrates were principally from Mexico and the Republic of South Africa, and most of the antimony metal was from Yugoslavia, Britain and Belgium.

TABLE 3

World Mine Production of Antimony, 1962–63

(short tons)

	1962	1963
China (Communist)	16,500[e]	16,500[e]
Republic of South Africa (exports)	11,697	12,410
Bolivia (exports)	7,331	8,337
U.S.S.R.	6,600[e]	6,700[e]
Mexico	5,257	5,320
Yugoslavia	2,966	2,933
Turkey	1,962	1,981
Czechoslovakia	1,800	1,800
Canada	966	801
Other countries	3,621	4,318
Total	58,700	61,100

Source: United States Bureau of Mines, *Minerals Yearbook 1963*.
[e]Estimate.

USES

Antimony is used both in its metallic form and in the form of antimony compounds, oxides and salts. Only a small amount of antimony is used as a pure metal. Its main use is as an ingredient in many lead alloys, an application based on its hardening and strengthening effects and, to a lesser extent, the expansion-on-solidification effect which it imparts to lead.

Antimonial lead containing from 3 to 12 per cent antimony is used in the manufacture of storage batteries. Various other alloys made up of antimony, lead and, in some cases, other metals are used mainly in the production of type metal, bearing metal, solder and cable sheathing.

In its non-metallic form, antimony has a wide range of industrial applications. Certain compounds of antimony, because of their fire-retardant properties, are used in flame-proof plastics and in solutions that make fabrics fire-resistant by surface application. The pentasulphide of antimony is used as a vulcanizing agent by the rubber industry and as a red pigment. The trioxide is an important ingredient of water and acid-fume resistant paints. Other pigments are used in the manufacture of glass and ceramics.

High-purity antimony is used in increasing amounts by manufacturers of inter-metallic compounds for semiconductor use. An aluminum-antimony alloy is widely used as a semiconductor in transistors and rectifiers. Also used by the electronics industry are alloys of antimony which exhibit thermoelectric properties.

PRICES AND TARIFFS

Throughout 1963 the price of antimony, boxed, New York, as quoted, by *E & M J Metal and Mineral Markets,* was 36.5 cents a pound. The bulk price, f.o.b. shipping point, was 32.5 cents a pound.

Antimony metal and antimony salts enter Canada free of duty. Ad valorem duties of 12½ per cent (most favored nation) and 15 per cent (general) are applied to imports of antimony oxide.

The United States imposes the following duties: antimony regulus, 2 cents a pound; the lead content of antimonial lead, 1-1/16 cents a pound; antimony oxide 0.6 cent a pound; antimony, liquated or needle, ¼ cent a pound; and antimony sulphides and other compounds, ad valorem rates or fixed-amount rates. Antimony ores and concentrates enter the United States duty-free.

Asbestos

H.M. Woodrooffe*

Shipments of asbestos by the Canadian asbestos industry established a new record for the fourth successive year, and amounted to 1.3 million tons valued at $137 million. The increase was shared by Quebec, British Columbia and Newfoundland. In 1963, Newfoundland joined the asbestos-producing provinces with the coming into production in mid-year of Advocate Mines Limited at Baie Verte.

Canada is by far the free world's leading asbestos-producing nation, but is being challenged for first position in total world production by the U.S.S.R. In spite of growing production in several countries, Canada has maintained a modest but steady increase in the asbestos markets for the last five years and accounts for 42 per cent of world production.

Almost all of the Canadian production is exported to world markets. In 1963 about 50 per cent of the asbestos exported was shipped to the United States. All Canadian requirements of amosite are imported from the Republic of South Africa; requirements of crocidolite come from South Africa and from Australia.

Although chrysotile asbestos is not uncommon in northern Ontario, Quebec, Newfoundland, British Columbia and Yukon Territory, most occurences 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 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.

*Mineral Processing Division, Mines Branch

TABLE 1

Asbestos – Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)				
By type				
Crude	205	172,160	217	177,045
Milled fibres	547,447	95,676,720	579,085	100,218,289
Shorts	668,162	34,433,086	696,228	36,560,846
Total	1,215,814	130,281,966*	1,275,530	136,956,180
By province				
Quebec	1,125,131	114,297,886	1,158,210	116,582,134
British Columbia	55,132	10,297,360	63,215	11,681,337
Ontario	35,551	5,686,720	33,715	5,372,645
Newfoundland	–	–	20,390	3,320,064
Total	1,215,814	130,281,966	1,275,530	136,956,180
Exports				
Crude				
West Germany	76	65,290	108	79,764
Japan	54	47,562	44	34,735
United States	18	15,935	35	45,356
East Germany	18	13,756	6	4,125
Other countries	16	12,621	2	1,117
Total	182	155,164	195	165,097
Milled – Group 3 grades				
United States	15,422	6,659,974	14,016	6,026,300
West Germany	2,247	907,551	4,115	1,631,036
France	1,553	620,852	2,044	794,793
Britain	2,319	922,036	1,997	789,772
Japan	1,524	631,143	1,168	487,710
Italy	933	365,071	820	309,959
Spain	429	167,279	694	252,770
India	70	28,275	639	209,120
Belgium and Luxembourg	332	127,995	355	141,687
Mexico	38	13,761	105	39,250
Austria	36	14,759	73	24,139
Netherlands	214	78,716	65	23,978
Brazil	80	30,330	63	25,360
Australia	32	11,101	20	6,831
Other countries	2,595	1,035,301	2,010	863,739
Total	27,824	11,614,144	28,184	11,626,444
Milled – Group 4 and 5 grades				
United States	154,290	26,828,876	163,135	27,692,903
West Germany	41,410	7,586,766	47,616	7,899,213
Britain	30,080	5,248,243	40,831	7,264,591
Japan	29,881	3,984,575	31,160	4,178,819
France	46,967	8,263,022	26,932	4,699,070
Belgium and Luxembourg	27,635	4,869,750	24,922	4,418,229
India	11,734	2,160,026	20,891	3,948,713
Australia	21,148	3,644,894	20,247	3,520,511
Spain	10,223	1,838,599	17,504	3,031,023
Brazil	14,811	2,545,425	15,917	2,769,356
Mexico	9,139	1,616,820	14,582	2,621,371
Netherlands	7,923	1,481,624	13,462	2,334,905
Italy	11,152	2,028,781	12,735	2,270,543

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Columbia	11,110	2,151,945	11,260	2,018,885
Austria	11,115	1,938,199	9,518	1,669,331
Other countries	65,578	11,199,989	56,523	9,743,686
Total	504,196	87,387,534	527,235	90,081,149
Total, milled fibres, groups 3,4 and 5				
United States	169,712	33,488,850	177,151	33,719,203
West Germany	43,657	8,494,317	51,731	9,530,249
Britain	32,399	6,170,279	42,828	8,054,363
Japan	31,405	4,615,718	32,328	4,666,529
France	48,520	8,883,874	28,976	5,493,863
Belgium and Luxembourg	27,967	4,997,745	25,277	4,559,916
India	11,804	2,188,301	21,530	4,157,833
Australia	21,180	3,655,995	20,267	3,527,342
Spain	10,652	2,005,878	18,198	3,283,793
Brazil	14,891	2,575,755	15,980	2,794,716
Mexico	9,177	1,630,581	14,687	2,660,621
Italy	12,085	2,393,852	13,555	2,580,502
Netherlands	8,137	1,560,340	13,527	2,358,883
Colombia	11,110	2,151,945	11,260	2,018,885
Austria	11,151	1,952,958	9,591	1,693,470
Other countries	68,173	12,235,290	58,533	10,607,425
Total	532,020	99,001,678	555,419	101,707,593
Milled – Short-fibre grades				
United States	449,147	23,944,176	445,261	23,923,387
Japan	41,663	3,551,600	43,267	3,632,057
Britain	34,163	1,823,776	35,019	1,836,266
West Germany	28,353	1,498,633	31,333	1,788,778
Belgium and Luxembourg	13,657	1,121,048	15,581	1,188,098
France	12,362	836,885	15,331	1,098,912
Netherlands	11,331	715,376	14,325	668,476
Australia	5,639	385,348	8,318	513,695
Sweden	5,221	350,046	4,760	319,681
Denmark	2,628	208,116	4,539	357,476
Austria	1,727	137,393	4,085	280,192
Brazil	3,689	298,346	4,082	326,979
Other countries	22,888	1,610,061	24,910	1,640,757
Total	632,468	36,480,804	650,811	37,574,754
Grand total, exports of asbestos fibre	1,164,670	135,637,646	1,206,425	139,447,444
Manufactured Products				
Brake linings and clutch				
Lebanon		39,841		50,555
Ecuador		32,067		32,219
United States		43,502		27,510
Iran		8,531		25,421
Greece		16,690		19,775
El Salvador		16,053		18,548
Netherlands		10,372		14,956
Kuwait		6,065		14,342
Iraq		12,975		11,192
Switzerland		4,247		10,189
Syria		28,052		9,176
Other countries		171,041		128,030
Total		389,436		361,913

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Asbestos and asbestos-cement building materials				
United States		320,859		618,901
Australia		–		65,916
Venezuela		–		27,096
Colombia		–		23,000
Jamaica		852		7,009
Other countries		42,415		9,309
Total		364,126		751,231
Other asbestos and asbestos-cement products				
United States		327,254		261,909
Mexico		12,084		30,943
Switzerland		18,608		16,531
Britain		15,667		15,627
Jamaica		13,281		13,461
Finland		4,539		11,743
New Zealand		772		10,024
Australia		1,103		3,945
Venezuela		144		257
Other countries		23,738		10,397
Total		417,190		374,837
Grand Total, exports of manufactured products		1,170,752		1,487,981
Imports				
Packing	217	443,937	267	483,070
Auto brake linings		910,275		1,069,950
Auto clutch facings		249,528		217,471
Other brake linings and clutch facings		285,963		334,037
Other manufactured asbestos		3,050,140		3,182,460
Total		4,939,843		5,286,988

Source: Dominion Bureau of Statistics.
*Does not include the value of the containers which amounted to $4.8 million in 1962.
– Nil.

TECHNOLOGY

A number of minerals have a fibrous- or psuedo-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.

TABLE 2

Asbestos – Production and Exports, 1954–63

(short tons)

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Production*										
Crude	725	724	717	622	605	432	330	163	205	217
Milled	326,653	395,096	392,983	404,016	342,562	404,019	483,183	548,230	547,447	579,085
Shorts	596,738	667,982	620,549	641,448	582,164	645,978	634,943	625,302	668,162	696,228
Total.....	924,116	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
Exports										
Crude	641	586	560	638	483	416	241	176	182	195
Milled	312,844	365,980	377,044	393,311	318,280	401,583	458,053	527,324	532,020	555,419
Shorts	574,243	635,261	586,317	636,611	547,867	611,923	610,199	589,380	632,468	650,811
Total.....	887,728	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

Source:Dominion Bureau of Statistics.
*Producers' shipments

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 five 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 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 more the result of the mineral's physical characteristics 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 in which 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 of 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 the war, 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 began production of fibre in July 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 produced in the southern part of the province, in the counties of Richmond, Arthabaska, Megantic and Beauce. In 1963, there were 13 producing mines in the vicinities of Thetford Mines, Black Lake, East Broughton and Asbestos.

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 the war 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.

Asbestos Corporation Limited has three mills in operation in the Thetford Mines area. Two – the British Canadian, at Black Lake; and the Normandie, in Ireland township – process ore recovered from adjacent open pits. At Thetford Mines, the operations of the Beaver pit and King underground mine have been integrated with a common mill.

Johnson's Company Ltd., the oldest in the industry, has an underground mine at Thetford Mines. Its associate, Johnson's Asbestos Company, produces the mineral from an open pit at Black Lake, where a 4,000-ton mill began operating in 1954.

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. Rémi 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.

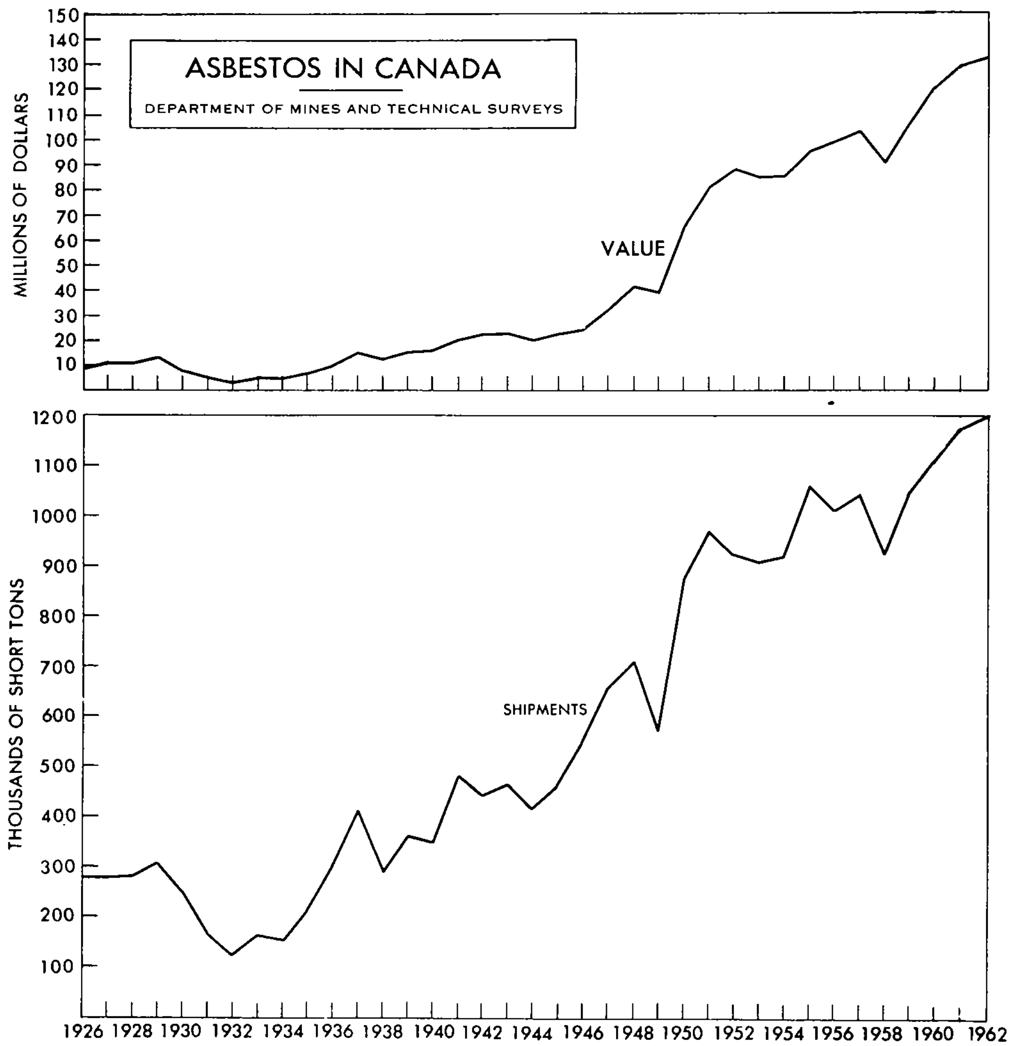
Carey-Canadian Mines Ltd., a subsidiary of The Philip Carey Manufacturing Company, is in production at its property near Tring Junction, Beauce county, east of Thetford Mines.

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 continued an engineering study of the Asbestos Hill project of Murray Mining Corporation Limited. The occurrence is 40 miles southeast of Deception Bay.

Ontario

Canadian Johns-Manville Company, Limited, operates an underground mine at Munro, east of Matheson, in northern Ontario. This is the only producing asbestos mine in the province.



The company announced plans to develop another occurrence in Reeves Township, southwest of Timmins.

British Columbia

Cassiar Asbestos Corporation Limited recovered long- and medium-fibred asbestos from a deposit on Mount McDame, in northern British Columbia. The fibre is shipped by the Alaska Highway to Whitehorse, Yukon Territory, and then by the White Pass & Yukon Route railway to Skagway, Alaska.

WORLD REVIEW

According to preliminary information, world production of asbestos during 1963 was estimated at three million short tons. Canadian production was 40 per cent of the world total.

During the past few years, the U.S.S.R. has markedly increased its production from deposits near Sverdlovsk in the Urals and is approaching Canada in volume of output. Although the U.S.S.R. does not publish statistics on the asbestos industry, its current level of production is estimated to be one million tons a year. It exports about 15 per cent of its production and competes with Canadian asbestos in overseas markets. The U.S.S.R. is reported to be developing a new deposit at Kiembi, Kazakhastan, with a potential annual capacity of 250,000 tons.

TABLE 3

World Production of Asbestos

(short tons)

	1962	1963
Canada	1,215,814	1,275,530
U.S.S.R.	1,100,000	1,200,000
Republic of South Africa	221,302	205,744
Southern Rhodesia	142,195	142,254
China	100,000	110,000
World Total	3,055,000	3,200,000

Source: U.S. Bureau of Mines, *Minerals Yearbook 1963* and fór Canada Dominion Bureau of Statistics.

The southern part of the African continent has become an important producing area. In 1963, the Federation of Rhodesia and Nyasaland reported an output of 142,000 tons of high quality chrysotile from deposits located in Southern Rhodesia. Because of its freedom from magnetic iron, this fibre finds ready acceptance in asbestos products for the electrical trade. In August, Pangani Mines Limited began production from a new mine at Filabusi, Southern Rhodesia.

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 1963, production of all varieties amounted to 205,744 short tons.

USES

Chrysotile, because of its physical characteristics, 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 organic staple fibres. Consequently it may be carded, spun and woven into cloths of different weights, thicknesses and qualities. These cloths are used in the manufacture of heat-resistant friction materials.

The 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 molded 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 1963 were virtually the same as in 1962. Prices, per short ton, f.o.b. mine, Quebec, in Canadian currency, by grades were as follows:

No. 1 crude	$1400	5 K fibre	$142
No. 2 ”	750	5 R ”	120
3 F fibre	565	6 D ”	86
3 K ”	480	7 D ”	75
3 R ”	408	7 F ”	71
3 T ”	370	7 H ”	61
3 Z ”	345	7 K ”	50
4 A ”	320	7 M ”	44
4 D ”	218	7 T ”	41
4 H ”	208	7 RF floats	44
4 K ”	200	7 TF ”	44
4 M ”	200	7 R ”	43
4 T ”	181	8 S ”	29
4 Z ”	181	8 T ”	22
5 D ”	142		

Minimum carload quantity, grades 1 to 5 R inclusive, is 20 tons; grades 6 to 8 inclusive, is 30 tons.

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%
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*

Barite shipments were considerably lower than in 1962 because of decreased export demand for the crude product. As has been the case for many years, production was slightly greater than exports. Shipments were mostly by one producer to plants in the United States which are owned by the parent company of that producer. Thus, Canadian barite output depends mainly on the requirements of the one chief foreign customer and does not necessarily fluctuate proportionately with the over-all demands of the foreign well-drilling industry, the chief market.

Because export demand fell 31 per cent from 1962, Canada's production declined 23 per cent to 173,503 tons valued at $1.7 million. Ninety-one per cent of the output was in the crude form, although about 15 per cent of the total was eventually pulverized in this country.

Although Canada ranked fourth in world barite production in 1962, an estimate for 1963 indicates that Canada was displaced to fifth position by Russia. The leading producers in 1963 were the United States, West Germany and Mexico in decreasing order.

Exports, the main market outlet for the industry, amounted to 92 per cent of production and were mostly in the crude form. Practically all the crude barite exported went to ports in the United States along the Gulf of Mexico. Total United States imports dropped considerably from the record established in 1962, principally because of reduced requirements by the well-drilling industry. Consequently, Canada's share of this market dropped from 213,000 tons in 1962 to 140,000 tons valued at $1.2 million.

As is customary, imports were insignificant in 1963 and practically all were of chemical grade from the United States.

World consumption remained at a low level because of depressed requirements by the well-drilling industry. For the same reason, domestic requirements in 1963 were small. They amounted to 11,343 tons, 74 per cent of which was used by

*Mineral Processing Division, Mines Branch

TABLE 1

Barite – Production, Trade and Consumption

	1962 Short Tons	1962 $	1963 Short Tons	1963 $
Production (mine shipments)				
Crushed and lump	210,456	1,790,590	157,453	1,361,686
Ground	16,144	333,374	16,050	331,433
Total	226,600	2,123,964	173,503	1,693,119
Imports (ground)				
United States	2,209	106,455	3,752	192,887
West Germany	218	8,436	78	3,051
Total	2,427	114,891	3,830	195,938
Exports				
United States	212,535	1,805,915	140,292	1,215,540
Trinidad	18,368	332,260	15,680	290,080
Venezuela	nil	nil	3,920	33,318
Total	230,903	2,138,175	159,892	1,538,938
Consumption*				
Well-drilling	8,873		8,419	
Paints	1,343		1,683	
Glass	628		768	
Rubber goods	322		178	
Miscellaneous chemicals	73		148	
Miscellaneous non-metallic products	10		147	
Total	11,249		11,343	

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

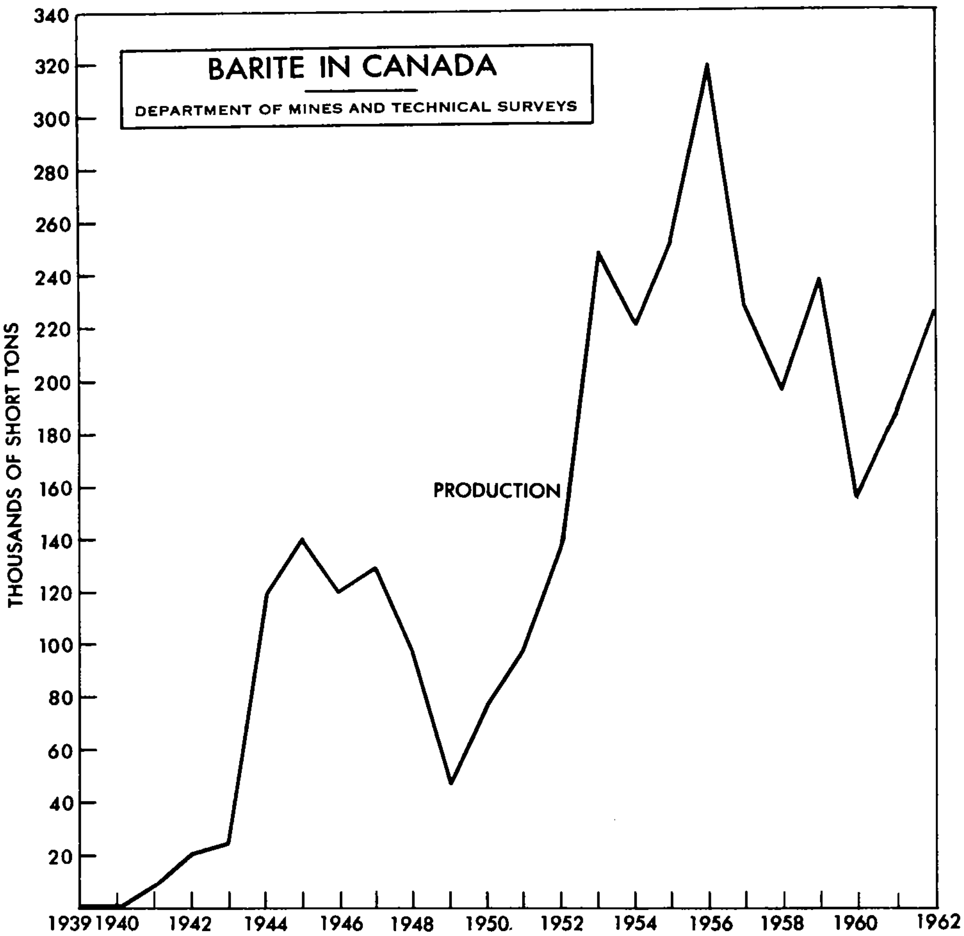
TABLE 2

Barite – Production, Trade and Consumption, 1954-63

(short tons)

	Production[1]	Imports	Exports	Apparent Consumption
1954	221,472	1,236	207,800[2]	14,908
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[3]
1960	154,292	2,021	134,972	25,483[3]
1961	191,404	1,889	171,696	18,723[3]
1962	226,600	2,427	230,903	11,249[3]
1963	173,503	3,830	159,892	11,343[3]

Source: Dominion Bureau of Statistics.
[1]Mine shipments. [2]Based on producers' stated export shipments. [3]Consumption as reported by consumers.



the well-drilling industry. Consequently, the seven barite-producing mines and plants in western Canada, which depend entirely on the domestic market for sales, had little demand for their product.

Small quantities of barium and strontium metal are produced for export by Dominion Magnesium Limited at Haley, Ontario.

PRODUCTION

Canada has relatively abundant barite (natural barium sulphate) resources. Occurrences have been noted in all provinces except Alberta, Saskatchewan and Prince Edward Island. In 1963, it was recovered from five deposits, one in Nova Scotia and four in British Columbia. All production from British Columbia was

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.*

shipped as crude to other provinces for final processing. Practically all of this went to Alberta. Nova Scotia output was mainly as crude barite and all was shipped out of the province, mostly to southeastern United States.

Nova Scotia

By far the largest Canadian barite operation, and the only barite mine east of British Columbia, is managed by Magnet Cove Barium Corporation near Walton. It normally produces about 90 per cent of Canada's output. Except for occasional small shipments to other provinces, this operation is completely dependent on the export market. Its location next to the ocean port of Walton makes its product competitive in eastern Canada and in the world's most important barite-market area – along the east coast of North America, and along the north coast of South America.

The barite is mined by blast-hole stoping and block caving and is concentrated at the beneficiation plant. Concentrates are trucked to Walton from where crushed, lump and occasionally pulverized barite are shipped, mainly by water. Most goes to plants owned by the parent company in the United States as crushed and lump concentrates. It is then processed further, mainly for use in well-drilling in that country.

British Columbia

Mountain Minerals Limited mined barite by open-pit and underground methods from its deposits near Brisco and Parson. The output went to other provinces, mostly to the company's grinding plant at Lethbridge, Alberta, where it was processed principally for the well-drilling industry.

Baroid of Canada, Ltd. recovered barite at its Giant property near Spillimacheen and shipped it to its grinding plant at Onoway, Alberta. Practically all this barite was used in the well-drilling industry.

Sheep Creek Mines Limited recovered barite as a byproduct during the mining of lead-zinc ore at its Mineral King mine near Invermere. The crude barite was shipped to Alberta for processing and most was sold as a heavy medium in well drilling.

Alberta

No barite was mined in Alberta. However, practically all that was mined in British Columbia was ground at the Lethbridge plant of Mountain Minerals, the Rosalind plant of Magnet Cove Barium Corporation Ltd. (formerly Magcobar Mining Company, Limited), or the Onoway operation of Baroid of Canada.

Quebec

Industrial Fillers Limited grinds purchased barite at its Montreal plant as the market demands.

OTHER OCCURRENCES

Many other barite deposits have been found in Canada and a few have been mined on a small scale. The more noteworthy are at the 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 occurring in Canada have not yet been used.

Barite deposits in Quebec and Nova Scotia were explored during the year.

Estimated reserves in deposits now being worked are sufficient to meet normal requirements for more than a decade. Additional barite is available from a number of noteworthy deposits that are being exploited for other minerals.

USES AND SPECIFICATIONS

Most barite is used because of its physical properties, which include a high specific gravity of at least 4.3, inertness under normal conditions and, on occasion, whiteness. There is a small demand for barite in the chemical industry, where it is used as a source of the element barium.

In 1963, 74 per cent of the barite consumed in Canada was used as a heavy medium in oil- and gas-well drilling. Normally about 90 per cent of the North American requirement and most of the world's needs are for that purpose. In well drilling, this commodity assists in controlling pressure and in forcing drill cuttings to the surface. It is the most desirable material for this purpose and is not likely to be replaced to any extent in the near future by other heavy media.

Although new drilling techniques have been adopted in North America in recent years, there has been no noticeable effect on barite consumption. Specifications for this use commonly require a minimum specific gravity of 4.20 to 4.25 and a particle size of at least 90 per cent minus 325 mesh.

Eighteen per cent of domestic requirements involved the use of barite as a conventional type of filler in 1963. Most of this barite was used in paints but some found application in rubber, paper and miscellaneous products. Except for some rubber products, barite for filler purposes should normally have a high reflectivity, a minimum of 94 per cent barium sulphate, and a particle size of minus 200 mesh or smaller.

About seven per cent of Canada's consumption was used in glass manufacture, in which barite acts as a flux, increases the workability of the melt and adds luster to the product. Commonly, specifications 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.

Because the barium-chemicals industry is virtually nonexistent in Canada, this industry's consumption of barite is minor and sporadic. 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 ceramics. Barium oxide, hydrate, titanate, chlorate, nitrate, sulphide and phosphate are also manufactured. Some of these chemicals are used as a source of barium metal. Because barium titanate

TABLE 4
Barium Compounds – Imports and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Imports				
Lithopone (70% $BaSO_4$)	734	120,156	391	59,181
Blanc fixe and satin white	1,156	125,700	1,001	108,457
			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.

has a high dielectric constant and piezoelectric and ferroelectric properties, its use in relatively minor amounts has become widespread. Barite for the manufacture of chemicals must be in lump form and contain a minimum of 94 per cent barium sulphate and a maximum of one per cent ferric oxide.

Import and consumption statistics for some of the barium chemicals consumed in Canada are given in Table 4.

Barite is also used to a minor extent as heavy aggregate in concrete employed as shielding against atomic radiation.

PRICES

Most of the barite shipped is in the crushed, lump and semi-processed form and in 1963 averaged $8.65 a short ton at the mine or mill. The finished ground product averaged $20.65 a ton. Both these prices differ notably from the Canadian prices published below.

According to *E & M J Metal and Mineral Markets* of December 30, 1963, 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
96-97 ½% $BaSO_4$, crushed, bulk	19.00 – 23.50
99 ½% $BaSO_4$ water ground, 325 mesh, bags	45.00 – 49.00

TARIFFS

The Canadian tariff on barite was recently reduced from 25 per cent for the Most Favored Nation category. Tariffs for Canada and the United States are as follows.

	British Preferential	Most Favored Nation	General
Canada			
Crude or ground	free	20%	25%
For drilling-mud use	free	free	free

United States

Ore, per long ton	
Crude or unmanufactured	$2.55
Ground or otherwise manufactured	6.50

Bentonite

J.S. Ross*

Domestic bentonite consumption increased appreciably in 1963. This was the first of a series of major increases which is scheduled to continue at least until 1966. Consumption was 57,237 tons in 1962, 93,512 tons in 1963, and is scheduled to increase to a rate of about 155,000 tons a year before the end of 1965. Practically all this extra demand will result from the requirements for bentonite in pelletizing iron-ore concentrates. A trend has already been established for the use of imported bentonite for this purpose. Consequently, a challenge exists for the establishment of a high-quality Canadian source of bentonite for pelletizing.

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

PRODUCTION AND TRADE

Current production statistics are not available. However, from consumption and trade statistics, it is estimated that domestic operators supplied about 31,000 tons in 1962. Although domestic shipments apparently increased slightly

*Mineral Processing Division, Mines Branch

TABLE 1

Bentonite — Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Imports (incomplete)				
Activated clay[1]				
United States		934,465		1,405,725
Fuller's earth				
United States		165,282		137,122
West Germany		4,346		2,607
Britain		3,187		1,183
Total		172,815		140,912
Clay for use in drilling mud				
United States	14,954	416,800	16,892	458,700
Exports				
Earth or clays artificially activated[2]				
United States	4,029	149,132	2,302	90,422
Consumption[3]				
Well drilling	29,839		33,932	
Iron and steel foundries	13,878		17,642	
Pelletizing iron-ore concentrates	10,091		37,575	
Petroleum refining	1,870		1,790	
Paper	366		296	
Miscellaneous chemicals	378		291	
Miscellaneous nonmetallic products	815		1,986	
Total	57,237		93,512	

Sources: Dominion Bureau of Statistics with exceptions as indicated.
[1]Includes clay catalysts in addition to adsorptive clays. [2]From exports of activated clays to the United States as given by the U.S. Department of Commerce, in its *United States Imports of Merchandise for Consumption* (Report FT 110). Values in United States dollars. [3]Includes fuller's earth; calculated from data provided by the Dominion Bureau of Statistics.

in 1963 because of increased drilling activity, the proportion of the domestic market supplied by Canadian producers decreased considerably. This was because most of the large increase in consumption was satisfied by imports.

Swelling, nonswelling and acid-activated bentonites, the most commonly used types, were produced by three companies. More than two thirds of total output was of the swelling type, all shipped from two plants in Alberta. The other types were produced by one company in Manitoba. Magnet Cove Barium Corporation Ltd. (formerly Magcobar Mining Company, Ltd.) recovers several grades of swelling bentonite from the Upper Cretaceous Edmonton formation near Rosalind, Alberta. The clay is dried, pulverized and sized and most is sold for use in well drilling. 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 uses. Much is shipped to the company's Winnipeg plant for activation and eventual sale as bleaching clay for decolorizing animal, vegetable and mineral oils. Much of the activated product is exported.

In addition, Carol Pellet Company pulverizes imported crude bentonite at Labrador City, Labrador.

Exports of bentonite are usually small and of the nonswelling and activated types. Imports, virtually all from the United States, were significant in value and amounted to an estimated $2 million at the consuming plants in 1963. The volume was an estimated 55,000 tons, of which about 37,575 tons were required for iron-ore pelletizing. More than three quarters of the total was of the swelling type from Wyoming and South Dakota. Official import statistics are incomplete and indicate that 16,892 tons of clay valued at $458,700 were received from the United States for use in drilling mud. Most of this was bentonite. In addition, fuller's earth valued at $140,912 was imported mainly from the United States. Activated clay, which included some bentonite, was received from the United States at a value of $1.4 million.

CANADIAN OCCURRENCES

The more extensive domestic bentonite deposits are in western Canada in formations of Cretaceous and Tertiary age. Those in Alberta have received the most attention. In that province, the better types of swelling bentonite are in the Edmonton and Bearpaw Upper Cretaceous formations. Outcrops of this clay 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, northwest to Swan River.

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.

CONSUMPTION AND USES

Bentonite has numerous uses but usually constitutes a small part of the final product in which it is an ingredient. Most is used as a filler and binder and a small amount is employed as an absorbent and adsorbent.

TABLE 2
Bentonite – Imports and Consumption, 1954–63

	Partial Imports[1] Bentonite ($)	Consumption Fuller's Earth (short tons)	Bentonite (short tons)
1954	835,433	1,732	23,344
1955	1,247,355	1,565	28,821
1956	1,484,124	1,783	30,562
1957	1,536,512	1,654	26,105
1958	980,585	1,595	23,429
1959	1,082,593	1,369	60,258[2]
1960	1,590,441[3]		64,871[2]
1961	1,528,170[3]		63,268[2]
1962	1,524,080[3]		57,237[2]
1963	2,005,337[3]		93,512[2]

Source: Dominion Bureau of Statistics.
[1] Activated clays for oil-refining. They include clay catalysts in addition to adsorptive clays.
[2] Larger totals are due in part to increases in survey coverages, particularly in well-drilling. They include fuller's earth. Calculated from data provided by the Dominion Bureau of Statistics. [3] The larger totals are due in part to an increase in the survey coverage and include fuller's earth and clay used for well-drilling.

In 1963, Canadian consumption was 93,512 tons valued at an estimated $4.8 million at the consuming plants. It was 36,275 tons more than in 1962 principally because of increased demand in pelletizing, well drilling and foundries. Forty per cent was used by pelletizing plants, 36 per cent by the drilling industry and 19 per cent by iron and steel foundries. The swelling variety constituted about 91 per cent of the total and was the only type consumed in well drilling and iron-ore pelletizing.

Owing to the growing pelletizing industry, Canada's requirements will continue to expand rapidly at least until 1966. In addition to the two iron-ore pelletizing plants that were in operation in 1962, the large plant of Carol Pellet Company at Labrador City, Labrador, and the Moose Mountain, Ontario, plant of Lowphos Ore, Limited began operation. A similar plant near Kirkland Lake, Ontario, is scheduled for production in 1964 by Jones & Laughlin Steel Corporation. Announcements have been made for plant construction by Arnaud Pellets and Caland Ore Company Limited respectively at Pointe Noire, Quebec, and at Steep Rock Lake, Ontario. If bentonite remains competitive and is required in current proportions as a pelletizing agent, Canada's total consumption for this use could be 100,000 tons a year by the end of 1965. The total annual consumption would then be 155,000 tons, 97 per cent of which would be of the swelling type.

Swelling bentonite serves as a binder in the foundry and pellitizing industries. In well drilling, it prevents setting of drill cuttings, retains drilling fluids by forming impervious coatings on drill-hole walls and, within limits, controls the viscosity of drilling fluids. This commodity is also used to plasticize abrasive, ceramic and refractory raw mixes; as a filler in paper, rubber, pesticides, cosmetics and medicinal products, soaps and cleansers; in the grouting of underground water-bearing zones; and in sealing such structures as dams and reservoirs. Bentonite slurry is effective in firefighting. In Canada, a new application for bentonite slurry has been in the retainment of excavation walls prior to placement of concrete.

Activated bentonite is used in decolorizing 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 1963, domestic drilling-quality bentonite sold for about $43 a ton at Edmonton. Activated clay commonly sells from $35 to $60 a ton at the producing plants.

At United States mines, car lots of swelling bentonite cost about $14 a ton in bags or about $7 to $8 a ton in bulk.

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

	British Preferential	Most Favored 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	
Whether or not washed, ground or otherwise beneficiated	81¼¢
Clays, artificially activated	1/10¢ a lb plus 12½% ad valorem

Bismuth

J.W. Patterson*

Bismuth production in 1963 at 359,125 pounds was considerably less than the 425,102 pounds in 1962 because of lower production in British Columbia. All but a very small portion of the 1963 output was accounted for by three companies – The Consolidated Mining and Smelting Company of Canada Limited, which operates a refinery at Trail, British Columbia; Molybdenite Corporation of Canada Limited, which recovers bismuth from molybdenite-bismuth ore at its Lacorne mine near Val d'Or, Quebec; and Gaspé Copper Mines, Limited, which recovers bismuth from the treatment of flue dust at Murdochville, also in Quebec.

Based on published data pertaining to 1963, Peru, Mexico, Japan, Bolivia and Canada, in that order, were the Free World's largest producers of bismuth. World output for 1963 was six and a half million pounds. The United States, a major producer of bismuth, does not report production.

DOMESTIC SOURCES

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited, the only producer of bismuth metal in British Columbia, derives most of its production from lead concentrate produced at the Sullivan lead-zinc mine at Kimberley. Other sources include the company's two other mines in southeastern British Columbia – the H.B. mine at Salmo and the Bluebell mine at Riondel. Lead bullion resulting from the smelting of these concentrates and other concentrates from mines most of which are in the province contains about 0.05 per cent bismuth. Bismuth is recovered as 99.99+ per cent pure metal from the electrolytic refining of the lead bullion. For use in research and in the electronics industry, this bismuth is further treated to result in a purity of up to 99.9999 per cent.

* Mineral Resources Division

TABLE 1

Bismuth – Production, Trade and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	196,501	332,418	201,961	355,197
British Columbia	228,601	507,494	157,099	348,760
Ontario	–	–	65	146
Total	425,102	839,912	359,125	704,103
Refined metal[2]	230,000		177,000	
Imports				
Metal and residues				
Bolivia	55,947	35,695	4,276	3,299
United States	1,116	2,799	2,107	5,249
Total	57,063	38,494	6,383	8,548
Salts				
Britain	10,855	27,988	6,243	16,374
United States	320	1,378	550	2,790
Total	11,175	29,366	6,793	19,164
Exports				
Refined and semirefined metal	382,182		399,772	
Consumption				
Refined metal				
Fusible alloys and solders	29,130		31,707	
Other uses[3]	8,120		16,106	
Total	37,250		47,813	
Bismuth salts				
Chemical and allied products industries	11,576		na	

Source: Dominion Bureau of Statistics
[1] Refined metal from Canadian ores plus the bismuth content of bullion and concentrates exported.
[2] Refined bismuth metal from domestic and foreign ores. [3] Includes bismuth used in research and in the manufacture of pharmaceuticals, fine chemicals and malleable iron.
Symbols: – Nil; na Not available.

Quebec

During the 12-month period ending September 30, 1963, Molybdenite Corporation of Canada Limited produced impure ingots of bismuth containing 145,158 pounds of bismuth. It was recovered at the Lacorne molybdenum-bismuth mine and plant, 23 miles northwest of Val d'Or. Three principal steps are involved in the treatment process. A bulk concentrate containing about eight 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 98 per cent bismuth, minor amounts of lead and silver, and traces of copper, iron and antimony.

TABLE 2

Bismuth – Production, Exports and Consumption, 1954–63

(pounds)

	Production		Exports[2]	Consumption[3]
	All Forms[1]	Refined Metal		
1954	258,675	226,000	134,000	74,000
1955	265,896	160,000	56,000	92,000
1956	285,361	156,000	135,000	131,000
1957	319,941	146,000	143,000	55,000
1958	412,792	172,000	352,000	39,800
1959	334,736	182,000	300,000	39,700
1960	423,827	248,000	286,000	44,700
1961	478,118	305,000[r]	389,500	42,600
1962	425,102	230,000	382,182	37,200
1963	359,125	177,000	399,772	47,813

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.
r Revised.

TABLE 3

World Production of Bismuth

(pounds)

	1962	1963
Peru[1]	1,084,227	1,243,000
Mexico[1]	780,000	948,000[e]
Japan (metal)	572,841	650,000[e]
Bolivia[2]	652,300	504,600[e]
Canada[1]	425,102	359,125
South Korea (in ore)	353,000	350,000[e]
Yugoslavia (metal)	199,765	194,657
Other countries	2,632,765	2,240,618
Total	6,700,000[3]	6,500,000[3]

Source: United States Bureau of Mines *Minerals Yearbook 1963*.
[1]Bismuth content of refined metal and bullion plus recoverable content of concentrates exported.
[2]Bismuth content in ore and bullion exported, excluding that in tin concentrates. [3]Includes United States production, which is not available for publication.
e Estimate.

Gaspé Copper Mines, Limited, Quebec's other producer of bismuth, recovered 47,000 pounds of bismuth from the treatment of flue dust from its copper-smelting operations at Murdochville.

Ontario

Base bullion containing some lead and silver, and a small amount of bismuth was shipped to a lead smelter by Cobalt Refinery Limited which operates a silver refinery near Cobalt.

USES AND CONSUMPTION

Manufacturers of low-melting-point alloys, which find application in fire-protection devices, electrical fuses and solders, use large amounts of bismuth. 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. Another important use is in the production of compounds for medical and cosmetic preparations. It is also used to improve the machinability of aluminum alloy, malleable iron and steel forgings.

Increasing use is being made of a thermoelectric bismuth alloy – bismuth telluride – in the development of nonmechanical refrigerating units. In this type of refrigeration, the thermoelectric alloy produces coldness when an electric current flows through it in one direction and heat when the current flows in the opposite direction.

The relative importance of the various uses of bismuth is indicated in Table 4.

TABLE 4

Bismuth – United States Consumption, by Principal Uses

(pounds)

	1962	1963
Fusible alloys	795,588	763,862
Other alloys	442,040	572,543
Pharmaceuticals	645,149	808,383
Experimental uses	5,212	6,433
Other uses	21,559	23,817
Total	1,909,548	2,175,038

Source: United States Bureau of Mines, *Minerals Yearbook 1963*.

PRICES AND TARIFFS

Canadian and United States prices did not change during 1963. The Canadian price, 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 in lots of less than one ton. The United States price, as published by *E & M J Metal and Mineral Markets* and expressed in United States funds, was $2.25 a pound in ton lots.

Bismuth metal enters Canada free of duty. In the United States there is a 1.875 per cent ad valorem duty on bismuth metal and various other duties on bismuth compounds and alloys. The main source of bismuth in the United States is lead ores and concentrates, which are imported in large amounts; no duty is charged on the bismuth content of these imports.

Cadmium

J.W. Patterson*

Production of cadmium in all forms in 1963 was 2.5 million pounds, a drop of 129,488 pounds from 1962. The largest reduction in output, 106,688 pounds, took place in British Columbia and was attributable mainly to Reeves MacDonald Mines Limited, whose mine in the southern part of the province was closed by a strike for about eight months.

Canadian consumption of cadmium metal was not at as high as in 1962—208,596 pounds compared with 231,876 pounds. Tight supplies which resulted in some substitution of cadmium by zinc for plating purposes may have accounted for part of the decline. Exports fell from 2.3 million pounds in 1962 to 1.9 million pounds in 1963. Shipments to Britain and the United States, Canada's two most important markets, declined by about 400,000 pounds.

Zinc ores and, to a lesser extent, lead ores are the principal sources of cadmium. It is present in both types of ores in minor amounts as a sulphide intimately associated with sphalerite (zinc sulphide). In Canada, metal production was from two refineries – one at Trail, British Columbia, operated by The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) and the other at Flin Flon, Manitoba, operated by Hudson Bay Mining and Smelting Co., Limited. A third company, Canadian Electrolytic Zinc Limited, recovered cadmium in sponge form at its new zinc recovery plant at Valleyfield, Quebec. Treatment of zinc concentrates began there in October 1963.

While most of the cadmium recovered by COMINCO and Hudson Bay came from concentrates produced at their own mines, important amounts also came from mines operated by other companies. In addition to the cadmium metal produced in Canada from domestic concentrates, some cadmium, not all of which was reported, was recovered by foreign smelting companies from lead and zinc concentrates produced in Canada.

Scarcity of cadmium was reported in Britain, the United States and a number of other countries. The shortages were due, in part, to the continuing popularity of cadmium as a plating material and to its growing uses especially in the United

*Mineral Resources Division

States, in the manufacture of nickel-cadmium batteries; because cadmium is a byproduct of zinc smelting and refining, its supply is completely dependent on the production of zinc and is not easily adjusted to increased demand. Growing demands for zinc, as reported by a number of countries including Britain, Japan and the United States, should result in increased cadmium production. In Canada, new sources of cadmium are the zinc ores produced at two mines in northwestern Quebec which commenced production in October 1963; a portion of their concentrates are shipped to Valleyfield for treatment.

To alleviate the cadmium shortage in the United States, the government on April 9, 1963, authorized the sale of two million pounds from its national stockpile. By early September 2.1 million pounds had been sold. On June 26, a bill

TABLE 1

Cadmium – Production, Exports and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production				
All forms[1]				
British Columbia	2,086,692	3,839,513	1,980,004	4,752,010
Manitoba	189,272	325,548	183,110	439,464
Yukon	134,493	231,328	135,885	326,124
Saskatchewan	128,223	220,544	132,940	319,056
Quebec	66,293	114,024	43,546	104,510
Total	2,604,973	4,730,957	2,475,485	5,941,164
Refined[2]	2,435,299		2,353,815	
Exports				
Cadmium metal				
Britain	1,467,650	2,274,901	1,306,465	2,957,358
United States	829,664	1,270,233	584,929	1,375,682
India	2,997	4,869	33,390	90,694
Brazil	13,820	25,730	9,036	18,161
Sweden	nil	nil	5,063	14,176
Netherlands	22,400	33,152	nil	nil
Other countries	3,758	6,550	227	1,043
Total	2,340,289	3,615,435	1,939,110	4,457,114
Consumption (cadmium metal)[3]				
Plating	195,694		185,251	
Solders	14,694		19,645	
Other products[4]	21,488		3,700	
Total	231,876		208,596	

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.

was introduced to Congress which, if approved, would authorize the release of an additional five million pounds. Early in 1964, the General Services Administration submitted to Congress a plan to dispose of a like amount.

Consumption of cadmium in the United States, the second largest user of Canadian cadmium was 11.6 million pounds compared with 12.6 (revised) million pounds in 1962. Production at 10.0 million pounds was 1.1 million pounds

TABLE 2
Cadmium – Production, Exports and Consumption, 1954–63
(pounds)

	Production		Exports	Con-
	All Forms[1]	Refined[2]	Cadmium Metal	sumption[3]
1954	1,086,780	1,058,000	776,391	196,000
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

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]Consumption as reported by consumers.

TABLE 3
World Production of Cadmium Metal
('000 pounds)

	1962	1963
United States	11,137	9,990
U.S.S.R.	4,410[e]	4,850[e]
Canada	2,605	2,475
Japan	1,940	2,185[e]
Belgium	1,854	2,000
Poland	880	930
Other countries	4,274	3,870
Total	27,100	26,300

Source: U.S. Bureau of Mines *Minerals Yearbook 1963*, and, for Canada, Dominion Bureau of Statistics.
[e] Estimate

below that of 1962. Imports of cadmium metal and flue dust at 2.4 million pounds were substantially the same as in 1962. Canada was by far the most important foreign source of cadmium metal and supplied 62 per cent of United States imports.

In 1963, world production of cadmium metal was 26 million pounds with over half being accounted by two countries – the United States and the U.S.S.R. which produced 10.0 million and 4.8 million pounds respectively. Canada was the third largest world producer.

DOMESTIC SOURCES

British Columbia

British Columbia's production of cadmium is derived for the most part from lead-zinc ore mined in the Sullivan mine at Kimberley. This mine and two other lead-zinc mines – the Bluebell at Riondel and H.B. Mine at Salmo – are operated by COMINCO. Byproduct cadmium from ores mined in these mines and in several other mines in British Columbia and Yukon Territory was recovered in the company's smelter complex at Trail. Companies, other than COMINCO, whose ores were also the source of cadmium in 1963 are listed in Table 4.

TABLE 4

Company	Location of Mine	Cadmium Production (pounds)
The Anaconda Company (Canada) Ltd.	Britannia	33,940
Canadian Exploration, Limited	Salmo	237,250
Mastodon-Highland Bell Mines Limited	Beaverdell	8,061
Reeves MacDonald Mines Limited	Remac	55,830
Sheep Creek Mine Limited	Toby Creek	59,141

Yukon Territory

All the cadmium credited to Yukon Territory was produced by United Keno Hill Mines Limited which operates lead-zinc-silver mines in the Mayo district, about 220 miles north of Whitehorse. During the 12-month period that ended on September 30, 1963, the company produced 199,708 pounds of cadmium in zinc concentrate obtained from 186,721 tons of ore.

Saskatchewan and Manitoba

Hudson Bay Mining and Smelting Co., Limited, was the only producer of cadmium in Saskatchewan and Manitoba. Concentrates from base-metal ores mined near Flin Flon and near Snow Lake, Manitoba, yielded 316,050 pounds of cadmium, which was recovered in the company's refinery at Flin Flon.

Eastern Canada

Canadian Electrolytic Zinc Limited has installed facilities at its new electrolytic-zinc recovery plant at Valleyfield, Quebec, to recover cadmium in the form of sponge. It is recovered from concentrates shipped to the refinery from mines in northwestern Quebec and northern Ontario. Production of slab zinc commenced in October 1963.

USES

Cadmium is used extensively as a resistant rustproof coating on iron and steel and, to a lesser extent, on copper-base alloys and other metals and 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.

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 increasing. 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.

Cadmium sulphide and cadmium sulphoselenide are used where bright, high-quality yellow or red colors are employed in electroplating solutions. Cadmium bromide and iodide are used in the making of photographic films and in photoengraving and photolithography. Cadmium stearate goes into the making of vinyl plastics.

PRICES AND TARIFFS

The United States price per pound of cadmium in commercial stocks advanced about 30 cents during 1963. According to *E & M J Metal and Mineral Markets*, the price at the beginning of the year was between $1.70 and $1.85 a pound for ton lots and $1.75 and $1.85 a pound for less than ton lots. By September 23, after three changes, the price was established at between $2.50 and $2.65 and $2.55 and $2.70 for the two categories. By December 12, two additional changes brought the price to its year-end level of $3.00 and $3.05 a pound, respectively, for the large and small lots.

COMINCO'S price for cadmium sold in Canada in the form of sticks, bars or balls, 99.98 per cent pure, advanced four times in 1963, from $1.90 a pound for lots of 5,000 pounds and over and $2.10 a pound for lots under 5,000 pounds, to $3.25 and $3.45, respectively. The last price change took place in mid-December.

Cadmium metal in crude form entered Canada duty-free from Commonwealth countries. The most-favored-nation and general duties were respectively 15 and 25 per cent ad valorem.

Cadmium in a processed form of a class or kind produced in Canada is subject to the following tariffs: British Preferential – 15 per cent, Most Favored Nation – 20 per cent and General – 25 per cent.

The United States duty on cadmium metal during 1963 was 3.75 cents a pound. Cadmium flue dust was duty free.

Calcium

W.H. Jackson*

Smelter shipments of 98,673 pounds of calcium metal were mainly consigned to export markets as Canadian demand is only a few hundred pounds a year. Details of production and export statistics are shown in the accompanying tables. The slump in production following 1956-57 was caused by the replacement of calcium by magnesium as a reducing agent in the large-scale production of uranium. Current demand for calcium is low but an increase in consumption is likely as more diversified uses become developed.

Dominion Magnesium Limited is the only Canadian producer of calcium. Smelter output at Haley, Ontario is capable of immediate expansion since 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. Other metals smelted are thorium and small quantities of strontium, barium, zirconium and titanium.

To produce Grade 4 calcium, 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 in subsequent refining operations.

The four grades of calcium metal available from Haley range in purity from the 98 per cent of Grade 4 to the nominal 99.9 per cent of Grade 1. The maximum impurities in Grade 4 are 0.5 to 1.5 per cent magnesium, 1.0 per cent nitrogen

*Mineral Resources Division

TABLE 1

Commercial Calcium Grades and Typical Applications

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

TABLE 2

Production and Exports

	1962		1963	
	Pounds	$	Pounds	$
Production (metal shipments)	123,511	124,412	98,673	117,247
Exports (metal)				
United States	44,700	54,002	26,100	32,969
West Germany	20,000	23,362	19,300	22,700
India	14,900	22,345	16,100	23,667
Belgium and Luxembourg	9,100	5,100	13,300	11,015
Britain	28,000	44,059	9,600	11,663
Italy	2,700	2,318	7,700	8,055
Other countries	4,700	6,036	nil	nil
Total	124,100	157,222	92,100	109,069

Source: Dominion Bureau of Statistics.
Symbols: p Preliminary; na Not Available

TABLE 3

Historical Production and Exports

(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
1963p	98,673	92,100

Source: Dominion Bureau of Statistics.
* Production from 1956 to 1960 inclusive; shipments from 1961 onwards.
e Estimated.

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 minus 4 mesh, extruded rods and bars, cast billets, and five-pound ingots.

Production by country is not available. Dominion Magnesium is an important commercial source of calcium. Other producers are Société Planet in France and Nelco Metals Inc., Div. of Charles Pfizer Company. There is also a small amount of captive production by American Smelting and Refining Company and Union Carbide Metals Company in the United States.

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 non-ferrous 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 eight 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 strength, fatigue-resistance and hardness. Minor amounts are used for deoxidizing, for general alloying mainly in aluminum and magnesium, and in the preparation of catalysts with silver.

Calcium-silicon or calcium-manganese-silicon are usually added to ferrous metals. These low cost alloys are made by reducing a charge of lime and silica in an electric furnace. Higher cost calcium metal is used when impurity control is important. The calcium helps to deoxidize, desulphurize and scavenge the melt, reducing the effect of non-metallic impurities in steel and controlling the size and distribution of graphitic carbon in cast iron.

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 production.

PRICES

The Canadian prices quoted by Dominion Magnesium Limited throughout 1963 ranged from 80 cents a pound for Grade 4 to $3.50 a pound for Grade 1 f.o.b. Haley.

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

TARIFFS

	British Preferential	Most Favored 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	15%		

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

Cement

J.S. Ross*

Canada's cement industry experienced record production and major expansion activity in 1963. Although cement was in eleventh place in the value of mineral production, shipments increased 2.0 per cent over the previous peak year of 1962. Most of the increased output took place in Quebec, owing mainly to dam construction at hydroelectric developments.

The expansion in capacity of cement-clinker output was widespread and remarkable, and involved projects costing about $40 million. These were initiated in Alberta, Manitoba, Ontario and Quebec, as well as in Nova Scotia where that province's first cement plant is being constructed. Of the 19 clinker-producing plants, six increased capacity by improving efficiency, one expanded its production facilities, and three others started plant expansions. In addition, the construction of two new plants was started and servicing facilities for another new plant were installed.

As a result, in 1963, Canada's annual production capacity of cement at clinker-producing plants increased by 4.1 per cent to 54.6 million barrels or 9.6 million short tons. The industry operated at 73 per cent of year-end rated capacity, a moderate rate for a commodity that experiences fluctuating seasonal demands. This rate compares with 75 per cent for 1962.

Construction was started at five plants to provide an additional capacity of 2.6 million barrels in 1964 and another 4.8 million barrels in 1965. An additional capacity of 2.8 million barrels has been indicated for 1965 by the preparation of servicing facilities at one plant and by an announcement made early in 1964 scheduling expansion at another plant. Consequently, the 1965 capacity could be 64.8 million barrels, an increase of 18.7 per cent over that for 1963.

In western Canada, where a noteworthy proportion of cement consumers are some distance from cement-producing plants, the trend continues toward the establishment of additional cement-distribution terminals. One such terminal was completed in Alberta and another partly constructed in Saskatchewan.

*Mineral Processing Division, Mines Branch

TABLE 1
Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production[1]				
By province				
Ontario	2,510,783	38,704,090	2,552,665	39,551,719
Quebec	2,242,591	33,330,630	2,330,621	36,938,775
Alberta	799,030	14,780,423	727,122	13,713,527
British Columbia	397,435	7,112,890	476,071	8,546,768
Manitoba	432,079	8,715,034	455,325	9,684,760
Saskatchewan	230,072	5,830,227	217,545	5,672,084
New Brunswick	169,823	2,774,908	161,833	2,658,949
Newfoundland	96,916	1,985,524	92,460	1,848,347
Total	6,878,729	113,233,726	7,013,662	118,614,929
By type				
Portland	6,609,051	107,393,591	6,818,276	114,786,857
Masonry	181,427	3,475,231	195,369	3,827,804
Other	88,251	2,364,904	17	268
Total	6,878,729	113,233,726	7,013,662	118,614,929
Exports				
Portland cement				
United States	217,721	3,437,627	272,803	4,201,720
Japan	1,400	25,200	–	–
St. Pierre	43	1,384	–	–
Total	219,164	3,464,211	272,803	4,201,720
Cement and concrete products				
United States		1,042,991		280,231
Hydraulic cement clinker imported by United States from Canada[2]	80,759	892,692		
Imports				
Portland cement, normal				
Britain	1,581	23,246	56	1,049
United States	173	5,196	54	1,648
Netherlands	55	1,137	50	1,030
Cuba	1,164	18,804	–	–
Total	2,973	48,383	160	3,727
White cement				
Belgium and Luxembourg	2,289	68,296	5,851	170,952
Britain	5,200	163,395	4,193	131,470
Denmark	2,298	72,584	3,025	94,046
West Germany	1,654	56,569	2,953	101,681
Japan	590	13,600	2,149	50,966

Table 1 (cont'd.)

	1962		1963	
	Short Tons	$	Short Tons	$
White Cement concl.				
France	1,881	53,781	2,046	57,205
United States	830	36,196	586	34,009
Total	14,742	464,421	20,803	640,329
Cement, not otherwise provided for				
Britain	5,962	204,583	7,871	265,555
West Germany	1,184	65,376	1,542	83,792
United States	1,664	126,309	1,192	118,868
Yugoslavia	–	–	11	347
Total	8,810	396,268	10,616	468,562
Total cement imports	26,525	909,072	31,579	1,112,618
White-cement clinker				
United States	1,726	41,886	18,168	469,479
France	–	–	263	7,320
Denmark	14,941	288,069	–	–
Total	16,667	329,955	18,431	476,799

Source: Dominion Bureau of Statistics.
[1] Producers' shipments plus quantities used by producers. [2] U.S. Department of Commerce, United States Imports of Merchandise for Consumption (Report FT 110). Not available separately for 1963.
– Nil.

TABLE 2
Production, Trade and Consumption, 1954–63
(short tons)

	Production[1]	Exports[2]	Imports[2]	Apparent Consumption[3]
1954	3,926,559	21,638	401,135	4,306,056
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

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.

PRODUCTION

Canada produces portland, masonry and oil-well cement as well as white cement from imported clinker. Most of the production is of normal portland cement. Special cements for large projects are produced as required. In 1963, 97.2 per cent of total shipments were of the portland type and 2.8 per cent was of masonry cement.

TABLE 3
Production Capacity*, 1956–63

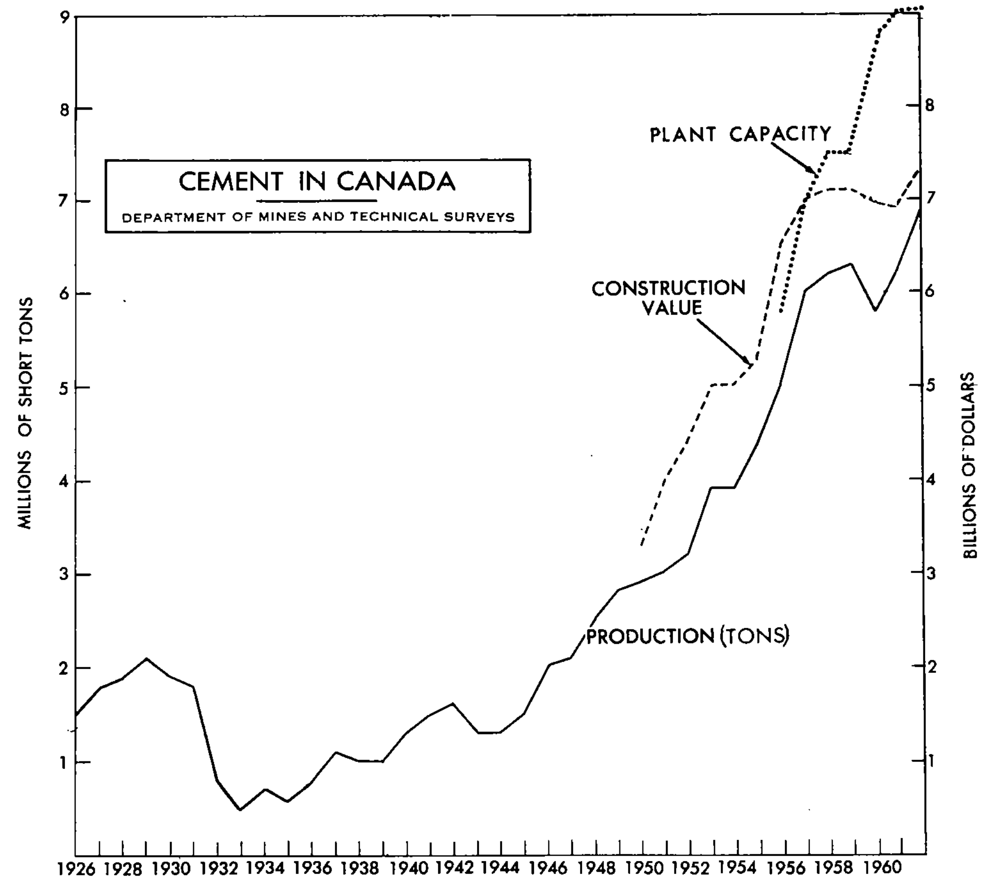
	Approximate Year-End Capacity		Production	Production as
	(barrels/ year)	(short-tons/ year)	(short tons)	% of Year-End Capacity
1956	33,300,000	5,827,500	5,021,683	86
1957	39,200,000	6,860,000	6,049,098	88
1958	42,800,000	7,490,000	6,153,421	82
1959	42,800,000	7,490,000	6,284,486	84
1960	50,000,000	8,750,000	5,787,225	66
1961	51,800,000	9,065,000	6,205,948	68
1962	52,450,000	9,179,000	6,878,729	75
1963	54,600,000	9,556,000	7,013,662	73

*Of clinker-producing plants.

TABLE 4
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*.



Production, at 73 per cent of rated capacity, amounted to a record 7,013,662 tons valued at $118,614,929 in 1963. This represents and increase of 2.0 per cent in quantity and 4.8 per cent in value over 1962. The value of cement shipments was in eleventh place in Canadian mineral production. All provinces except Alberta, Saskatchewan, New Brunswick and Newfoundland registered gains in shipments over 1962. However, the greatest increase was by Quebec which, along with Ontario, accounted for 70 per cent of total production.

Cement was manufactured in all provinces except Nova Scotia and Prince Edward Island. Nineteen plants with a total of 45 kilns produced cement clinker, four of these employing dry processing methods. All plants are listed in Table 5 and their locations are indicated on the accompanying map. The 11 in Ontario and Quebec represented 68 per cent of the total rated capacity. In 1963, cement plants consumed 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.

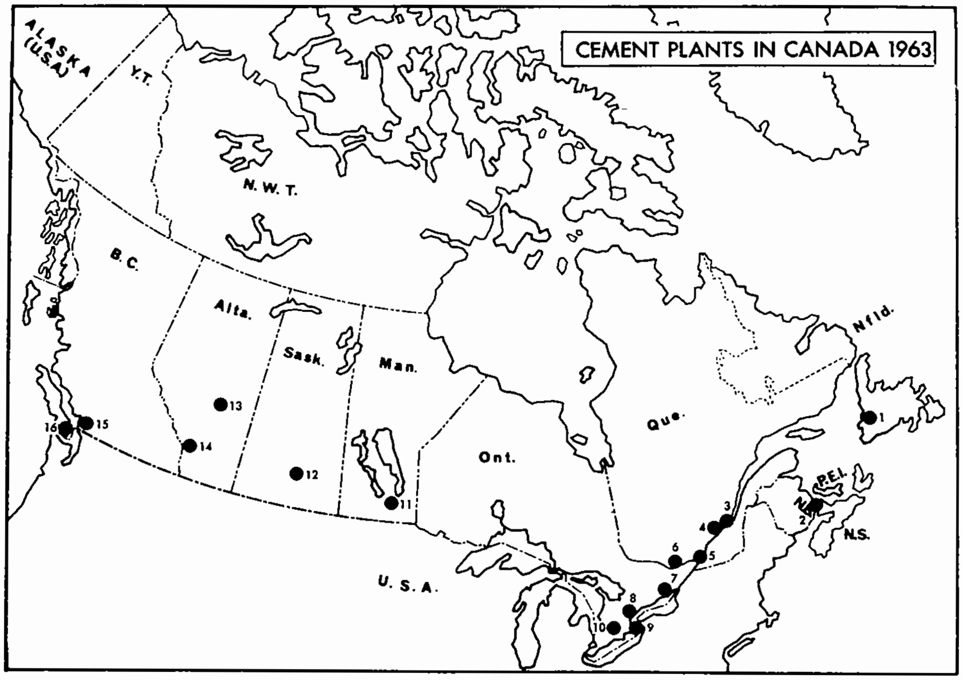
In addition, two separate clinker-grinding plants were in operation. Clinker from the Exshaw, Alberta, plant is ground by Canada Cement Company, Limited,

TABLE 5
Approximate Plant Capacities[1] at End of 1963
(Numbers in parentheses refer to locations on the accompanying map)

Company and Location	Barrels/ Year	Short Tons/ 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 Quebec 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 Portland Cement Company Limited, 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)	3,500,000	613,000
Manitoba		
Canada Cement Company, Limited, Fort Whyte(11)	3,400,000	595,000
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[3], Bamberton(16)	3,300,000	577,000
Total	54,600,000	9,556,000

Source: Company correspondence.
[1]Not including the capacities of the separate grinding plants. [2]Calculated. [3]Previously British Columbia Cement Company Limited.

at Clover Bar, Alberta. Medusa Products Company of Canada, Limited, grinds imported clinker at Paris, Ontario, for the production of white cement.



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

As shown in Table 4, Canada ranked twelfth in world cement production in 1963 and produced less than two per cent of the total. That same year, world output reached a record 414 million short tons with the United States, Russia and Japan the leading producers in that descending order.

TRADE

Cement is produced in large quantities by many countries. Because of this and cement's relatively low unit value, trade is usually small compared with production. In 1962 for instance, cement exports and imports for the world's largest producer, the United States, were respectively 0.1 and 1.7 per cent of production. For Canada, these proportions were 3.9 and 0.4 per cent in 1963. Canada's exports, all to the United States, increased slightly over the previous year to 272,803 tons valued at $4,201,720. Canada supplied about one quarter of the United States imports and most went to New York state. Exports of cement and concrete products, all to the United States, decreased considerably to a value of $280,231.

Imports continued to be low and chiefly consisted of special types, particularly white cement and white cement clinker. Britain and Belgium-Luxembourg were the principal suppliers.

DEVELOPMENTS

Considerable activity in clinker-plant expansion took place in 1963. The projects under construction and planned for the near future are listed in Table 6.

TABLE 6

Plant Expansion

Company and Location	Capacity Increase (million barrels/ year)	Year Started	Year Scheduled for Completion	Approximate Cost (million)
Nova Scotia				
Canada Cement, Brookfield	1.4[1]	1963	1965	$12
Quebec				
St. Lawrence Cement, Villeneuve	2.4[2]	1963	1965	$5
Ciment Quebec, St. Basile	0.7[2]	1962	Completed 1963	$3
Canada Cement, Montreal	0.5[3]		Completed 1963	–
Canada Cement, Hull	0.1[3]		Completed 1963	–
Ontario				
Lake Ontario Portland Cement, Picton	1.8[2]	1964[4]	1965	$6
Canada Cement, Belleville	0.4[3]		Completed 1963	–
Canada Cement, Woodstock	0.15[3]		Completed 1963	–
St. Mary's Cement, St. Mary's	0.75[2]	1963	1964	–
Manitoba				
Canada Cement, Fort Whyte	0.2[3]		Completed 1963	–
	1.87[2]	1963	1964	$4
British-American Construction and Materials Limited, Rosser	1.0[1]	1963	1965	$8
Inland Cement, Tuxedo	1.0[1]	1964[4]	1965	$9
Alberta				
Canada Cement, Exshaw	0.1[3]		Completed 1963	–
Total	12.37			

[1]New Plant, [2]Expansion. [3]Increased efficiency. [4] Scheduled.
– Not available.

In summary, construction started on two of three proposed new plants, four existing plants were being expanded and one was scheduled for expansion, and the capacities of six operations were increased by improving efficiency. Nova Scotia will become the ninth province to produce cement, and plans are to increase Manitoba's rated capacity by 114 per cent before 1966. Consequently, before 1966, Canada's rated capacity is scheduled to increase 18.7 per cent over that for 1963 – by 4.8 per cent in 1964 and 13.3 per cent in 1965.

Each expansion or new plant involved preparation for one new kiln. Thus, in 1963, a kiln was installed by Ciment Quebec and preparation for a kiln installation was made by St. Lawrence Cement at Villeneuve, Canada Cement at Fort Whyte and Brookfield, St. Mary's Cement, and British-American Construction. New kilns have also been proposed for Lake Ontario Portland, and Inland Cement at Tuxedo. In addition, considerable auxiliary equipment and storage capacity were being added. Of the eight kilns installed or scheduled for installation, six will be employed in wet-process operations.

Lake Ontario Portland installed a new secondary crushing system in 1963. The cost of this addition was $0.5 million.

A cement-distribution terminal was completed at Calgary, Alberta, by Inland Cement Company and the construction of a similar type of terminal was started by Canada Cement Company at Floral, Saskatchewan.

British Columbia Cement Company Limited was merged with Evans, Coleman & Evans, Limited under the name of Ocean Cement Limited. Ocean Cement & Supplies Ltd. remains as the parent company.

The only major vertical integration of cement and concrete-products companies took place when St. Mary's Cement acquired control of Schell Industries Limited of Woodstock, Ontario, a company specializing in concrete products.

A major cement-handling project was undertaken involving the transportation of cement from Quebec producers to the construction site of Manicouagan-5 dam northeast of Baie Comeau, Quebec. The construction schedule for the dam called for one million cubic yards of concrete between March 15 and December 1, 1963. This required the delivery of about 197,000 tons of cement. A converted tanker, "Maplebranch", with a capacity of 6,400 tons, transported cement from near the producing plants, down the St. Lawrence River to Baie Comeau. The cement was then pneumatically pumped a distance of 1,500 feet from the vessel to six silos. From there the material was loaded onto 30-ton trucks and transported 135 miles to the batching plant at the dam site.

The Portland Cement Association announced that effective January, 1964, Canadian headquarters will be in Ottawa. At the same time district offices, in addition to the one established at Vancouver in 1920, were established at Edmonton, Toronto, Montreal and Halifax. The purpose of the Association is to improve and extend the uses of portland cement and concrete.

CONSUMPTION AND USES

Cement is used mainly for construction purposes. Consequently, plant shipments and consumption vary directly with construction expenditures. This is indicated by the accompanying graph. In 1963 the preliminary value of construction reached a new record of $7.7 billion. For the same period, cement shipments and apparent consumption also set a record, respectively increasing 1.6 and 0.9 per cent over 1962. The Dominion Bureau of Statistics has estimated that the value of construction planned for 1964 will be a record $8.3 billion, an increase of 8 per cent from 1963. It follows that cement consumption and production should also reach a record for 1964.

The most noteworthy increase in consumption was in Quebec where large-scale construction of the Manicouagan-5 dam took place. This dam is part of a project being carried out for the Quebec Hydro-Electric Commission. The complete project will cost two billion dollars and will be completed about 1974. It is one of the world's largest power-dam projects and involves the erection of three dams on the Manicouagan River and two on the Outardes River. About 850,000 tons of cement, approximately one third of Quebec's 1963 production, will eventually be required for the dams Manicouagan-2 and-5.

British Columbia registered a moderate increase in apparent cement consumption because of 43,750 tons required for the Peace River hydroelectric project. Consumption of this commodity increased in Saskatchewan owing mainly to construction of the South Saskatchewan dam project. This requirement was for 44,400 tons in 1963 and both the Saskatchewan and the Manitoba producer shared the contract.

In 1962, cement was first used on a large scale as a stabilizer in hydraulically placed fill in underground mining. This application has gained in popularity since then, particularly at mines of The International Nickel Company of Canada, Limited. The result has been increased consumption for this purpose. This application was developed at nickel mines near Sudbury, Ontario, and involves the addition of a small percentage of cement to a slurry of fill being diverted underground. This type of fill reduces ore dilution, stoping time and the amount of timber used, and permits mining by the cut-and-fill method to depths greater than was previously possible. The result is a less costly operation.

The use of cement in soil-cement for road bases continues to increase. Alberta is the largest user but its use in the Maritime provinces and Saskatchewan is growing rapidly. Lesser amounts are used in Manitoba and Ontario.

Cement is also used in grouting, in cementing oil and gas wells, in certain paints, and in the manufacture of many asbestos products. In underground mining, as previously mentioned, cement is employed in general construction, concrete stope floors, and hydraulically placed fill.

Complete statistics are not available for consumption by use. However, most cement is used in general construction with more than one third going into ready-mixed concrete and other concrete products such as blocks, bricks, pipe, tile and other shapes. About 31 per cent was used in ready-mixed concrete in 1963. Table 7 indicates a net decrease in the output of concrete brick, block and pipe and tile in 1963. However, the output of ready-mixed concrete again established a record and increased four per cent.

TABLE 7
Production of Concrete Products

	1962	1963
Concrete bricks (number)	102,480,161	97,541,366
Concrete blocks (except chimney blocks)		
Gravel (number)	113,590,083	116,374,946
Cinder (number)	5,087,579	5,428,494
Other (number)	42,100,958	28,522,704
Concrete drain pipe, sewer pipe, water pipe, and culvert tile (tons)	1,039,719	999,157
Concrete, ready-mixed (cubic yards)	9,447,894	9,825,703

Source: Dominion Bureau of Statistics.

SPECIFICATIONS, PRICES AND TARIFFS

Canadian cement conforms to the specifications of the Canadian Standards Association. The types not covered by the Association generally meet the specifications of the American Society for Testing and Materials.

Prices vary, depending on supply and demand, location and the type of cement. The average value of shipments for all types was $16.83 a ton compared with $16.46 in 1962.

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

	British Preferential	Most Favored 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 or 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*

Imports of chromium ore (chromite) in 1963 amounted to 49,654 tons valued at approximately $1.7 million, a decrease of 22,315 tons and $433,839 from 1962. Consumption of chromium ore for 1963 was 56,016 tons which compares with 70,342 tons for 1962; consumption of ferrochromium at 9,662 tons in 1963 was approximately 200 tons more than for 1962

During 1963 there was an increasing demand for chromium alloys in Canada; the largest amount was used in the manufacture of stainless steels. Because of imports of ferroalloys however, this increased demand did not result in an increase in domestic production of chromium steel additives. Prices for ferrochromium throughout the year were low and highly competitive, and at year-end price levels there was little hope for improvement in the volume of Canadian production. Foreign suppliers with new and modern facilities and low-cost labor invaded Canadian markets to dispose of excess capacity, surplus to their home markets. The Canadian producers continued to maintain a small position in the domestic market with sales of high-carbon ferrochromium and ferrochromium-silicon.

Southern Rhodesia and Turkey, traditional suppliers of high-grade metallurgical chromite, were again seriously affected by the sale of high-grade Russian ore at reduced prices. European and Asian ferroalloy producers, who availed themselves of the Russian ore, were able to offer ferrochromium to European and American consumers at lower prices than manufacturers who purchased ore elsewhere. North American ferroalloy producers faced the additional competition of lower-priced ferrochromium from the Republic of South Africa.

*Mineral Resources Division

TABLE 1
Chromium – Trade and Consumption
(short tons)

	1962		1963	
	Short Tons	$	Short Tons	$
Imports (chromite)				
Philippines	19,040	453,301	18,256	664,162
Rhodesia and Nyasaland	14,312	466,471	14,131	446,458
United States	27,402	929,934	13,912	477,866
Turkey	–	–	2,240	80,798
Republic of South Africa	5,219	63,576	1,115	19,284
Cuba	3,196	87,275	–	–
Cyprus	2,800	121,850	–	–
Total	71,969	2,122,407	49,654	1,688,568
Exports (ferrochromium)				
United States	6,437	1,135,641	2,749	483,989
Venezuela	–	–	137	21,730
India	–	–	20	3,515
Belgium & Luxembourg	–	–	2	539
Dominican Republic	–	–	2	89
Britain	165	36,540	–	–
Total	6,602	1,172,181	2,910	509,862
Consumption (chromite)	70,342		56,016	

Source: Dominion Bureau of Statistics.
– Nil

TABLE 2
Chromium – Trade and Consumption, 1954–63
(short tons)

	Imports	Exports	Consumption	
	Chromite	Ferrochromium	Chromite	Ferrochromium
1954	37,517	15,304	64,782	3,500
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[r]
1963	49,654	2,910	56,016	9,662

Source: Dominion Bureau of Statistics.
r Revised

TABLE 3
World Production of Chromium Ore 1962–1963
(short tons)

	1962	1963
U.S.S.R.[e]	1,270,000	1,355,000
Republic of South Africa	1,006,173	873,212
Philippines	585,574	502,884
Turkey	580,964	445,212
Southern Rhodesia	507,685	412,392
Albania[e]	283,000	310,000
Iran	121,254	110,000
Yugoslavia	106,974	103,364
India	64,390	71,419
Cuba[e]	39,000	55,800
Japan	64,024	48,205
Other countries	210,962	187,512
Total	4,840,000	4,475,000

Source: United States Bureau of Mines, *Minerals Yearbook 1963*.
[e]Estimate

The only commercially important ore mineral of chromium (Cr) is chromite ($FeO.Cr_2O_3$) which has a theoretical chromic oxide (Cr_2O_3) of 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; they seldom contain more than 50 per cent Cr_2O_3. The ore from any locality has its own characteristic composition and analysis.

Canada has no known deposit of commercial-grade chromium ore. During the period 1940–50 some chromite was produced in the Province of Quebec; peak production, reached in 1943, amounted to 29,595 tons. The Bird River deposits in the Lac du Bonnet district of southeastern Manitoba are large but low grade, carrying about 26 per cent chromic oxide (Cr_2O_3) and 12 per cent iron with a chromium-to-iron ratio of about 1.4:1.

Chromite is consumed in Canada by Union Carbide Canada Limited, Metals and Carbon Division, at Welland, Ontario, where low- and high-carbon ferrochromium and ferrochromium silicon are produced; by Chromium Mining & Smelting Corporation, Limited, at Beauharnois, Quebec, where high-carbon and charge-grade ferrochromium and ferrochromium silicon are produced, and at Sault Ste. Marie, Ontario, where exothermic chromium alloys are produced; by Canadian Refractories Limited at its refractories plant at Marelan, Quebec, about 50 miles west of Montreal; and by General Refractories Company of Canada Limited, Smithville, Ontario.

WORLD PRODUCTION AND TRADE

According to estimates, world mine production of chromite in 1963 was 4.5 million tons compared with 4.8 million tons* in 1962. In most trade reports, world production of stainless steel for 1963 was shown to be greater than for 1962 and, therefore, it is reasonable to assume that the large inventories of chromite in consumers stockpiles were reducing during the year. Consumers stocks in Canada were reduced by 6,300 tons during the year and in the United States they decreased 118,000 tons.

The United States, which is the largest importer and consumer of chromite, imported 1.4 million tons* in 1963, a decrease of 55,000 tons from 1962. Consumption in the United States for 1963 was 1.2 million tons*, an increase of some 56,000 tons from 1962. The Republic of South Africa, Southern Rhodesia and the Philippines were, in that order, the leading suppliers. Turkey, which at one time was one of the principal suppliers of chromite to the United States, dropped to fifth position in 1963, behind the U.S.S.R., and supplied only 82,334 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 ever increasing extent. In the United States over the last four years the metallurgical industry has accounted for 54 per cent of all chromite consumed, the refractory industry for 32 per cent and the chemical industry for 14 per cent.

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.

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

**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*.

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 two per cent carbon maximum, is used in stainless and heat-resistant steels. High carbon ferrochromium, in which the carbon content varies from four to nine 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-resistance alloys 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.

Chromium plating is extensively used to produce brilliant, nontarnishing and durable finishes. Many articles such as dies, gauges and punches are plated with a relatively thick layer to improve their wear-resisting qualities and performance.

Refractory-grade Chromite

Specifications for refractory-grade chromite are not as rigid as for metallurgical grade. For brick of the best quality, the mineralogical constitution is nevertheless of great importance. Because it is desirable to keep the silica content 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 ten and five 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 refractory materials 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 eight 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.

PRICES

E & M J Metal and Mineral Markets of December 30, 1963, quotes chrome prices in United States currency as follows:

	Dollars
Chrome metal, electrolytic, 99.8% according to size of lot, per lb. delivered	1.15 – 1.19
Chrome ore, dry basis, subject to penalties if guarantee not met, f.o.b. Atlantic ports, per long ton, Rhodesian (term contracts)	
48% Cr_2O_3, 3:1 ratio	35.75 – 36.25 (nominal)
48% Cr_2O_3, 2.8:1 ratio	32.00 – 33.50 (nominal)
48% Cr_2O_3, no ratio	27.00 – 28.00 (nominal)
South African (Transvaal)	
48% Cr_2O_3, no ratio	25.50 – 27.00
44% Cr_2O_3, no ratio	19.75 – 20.50
Turkish (basis 48%, 2:1) lump and concentrates	
48% Cr_2O_3, 3:1 ratio	36.00 – 38.00 (nominal)
46% Cr_2O_3, 3:1 ratio	33.50 – 34.00 (nominal)
Ferrochrome, carload lots, delivered, lump, continental U.S. per lb. contained Cr	
High carbon, all grades C, 67–71% Cr	nominal
Low carbon, 0.025% C, 67–73% Cr	22½¢
Charge chrome, 5.25% C, 61–68% Cr	21½¢
Refined chrome, 4.25% C, 58–65% Cr	21¼¢

Note: The 'quoted' prices for ore are nominal and are the same as those reported on December 31, 1962; however, few sales are completed at these prices and each sale is subject to negotiation between buyer and seller.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
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
Ferrochrome	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%
Ferrochrome	
Less than 3% C	8½%
3% or more C	5/8¢ per lb. on Cr content
Chromic acid	12½%
Chromium carbide; chromium-nickel, -silicon and -vanadium	12½%
Chrome brick	25%
Chrome colors	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 suitable for brick and tile occur in most regions of Canada and are the principal raw material used for these products.

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, flue lining, wall tile, floor tile, electrical porcelain, sanitary ware, dinnerware, and pottery. The foregoing, from fire clay refractories to flue lining, inclusive, have clay as their principal ingredient. The remainder are prepared bodies of the whiteware type and, 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

The value of imported high-quality-type clays continues to increase slightly each year. In 1953 clay imports amounted to about \$3.0 million and at \$6.6 million in 1963, the value has more than doubled. In the same period production of domestic clays for sale as clay (including bentonite) rose from about \$0.52 million to about \$1.05 million in 1963.

*Mineral Processing Division, Mines Branch.

TABLE 1

Clays and Clay Products – Production and Trade

(dollars)

Production (domestic sources)	1962	1963
Clays including bentonite	1,085,107	1,056,674p
Clay products from:		
Common clay	29,026,297	
Stoneware clay	5,417,634	
Fire clay	571,002	
Other	1,716,838	
Total	37,816,878	38,154,294p
Imports		
Clay		
Fire clay, ground	443,161	447,014
China clay, ground	3,166,629	3,649,438
Pipe clay, ground	57,361	79,337
Clays, ground, not otherwise provided for	975,316	1,030,618
Activated clay for refining of oils	934,465	1,405,725
Total	5,576,932	6,612,132
Clay Products		
United States	21,581,980	21,877,120
Britain	14,848,005	14,290,375
Japan	3,956,461	4,736,761
West Germany	1,296,975	1,020,790
Other countries	1,004,015	1,102,613
Total	42,687,436	43,027,659
Exports		
Clays, Ground or Unground*		
West Germany	39,903	22,321
United States	10,049	4,797
Britain	5,054	2,600
Other countries	734	446
Total	55,740	30,164
Clay Products		
United States	3,349,176	3,895,378
Australia	54,737	211,797
Puerto Rico	92,033	183,914
Italy	88,088	129,710
Chile	487,705	109,242
New Zealand	73,330	98,000
Britain	123,719	82,208
Brazil	84,581	67,347
Sweden	73,995	67,159
India	111,418	63,338
Other countries	828,466	667,785
Total	5,367,248	5,575,878

Source: Dominion Bureau of Statistics.
*For 1961 and subsequent years activated clays are excluded.
p Preliminary.

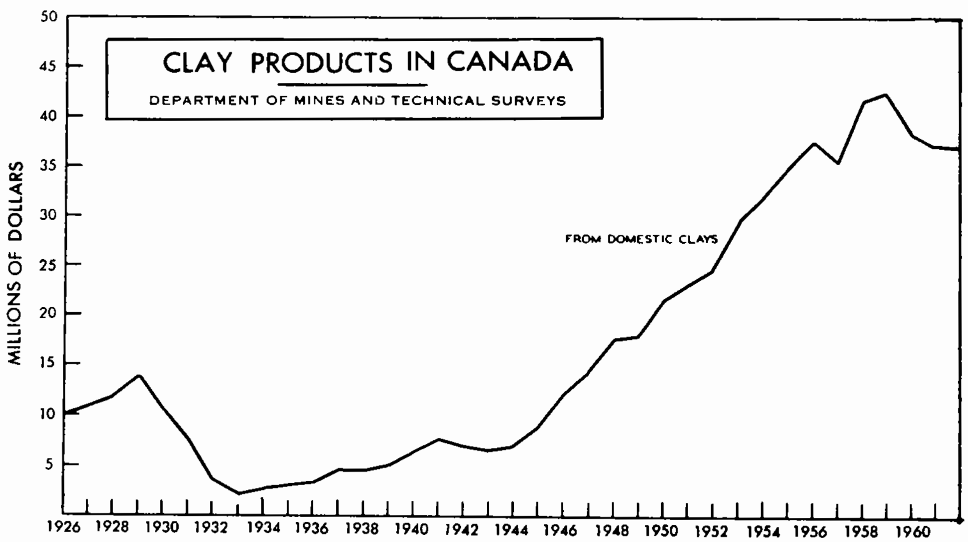
TABLE 2

Clays and Clay Products – Production and Trade, 1954–63

(millions of dollars)

	Production			Imports	Exports
	Domestic Clays	Imported Clays	Total		
1954	32.4	16.0	48.4	35.0	2.2
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	na	na	47.1	5.8
1962	37.8	na	na	48.3	5.4
1963	38.2	na	na	49.6	5.6

Source: Dominion Bureau of Statistics
na Not available.



During the past four years the value of clay products made in Canada from domestic clays has remained at about $37 million. The 1963 value of $37.1 million is below the high of $41.9 million in 1959 by 11.5 per cent. The principal products in this category are common and facing brick, structural tile, drain tile, sewer pipe, flue lining, conduits, fire clay, refractories, flower pots and artware. About two million tons of raw materials are required for these products.

The value of clay products made from imported clays is not available. Judging from past statistics this is likely about $26 million. The principal products made from imported clays are sanitary ware, floor and wall tile, electrical porcelain, dinnerware, refractories and pottery.

During the past four years the value of imported clay products remained the same at about $42 to $43 million. At $43 million, the value for 1963 was about ten per cent less than the previous high of $47.8 million in 1956.

The value of clays exported was negligible and the value of exported clay products at $5.5 million was much the same as in the past few years.

Because the value of clay products manufactured from imported clays is not available, an estimate of the value of clay products consumed during the year is not possible.

Seventy-seven 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.

The use of kaolin in Canada has increased slightly in the past few years. No statistics on consumption of fire clay and ball clays are available.

TABLE 3

Consumption of China Clay, by Industries

(short tons)

	1961	1962	1963
Paper	80,447	84,079	92,625
Rubber and linoleum	11,583	12,247	11,805
Paint	1,707r	2,306r	2,131
Ceramics	10,374r	13,906r	12,515
Other products[1]	4,167	8,762	10,939
Total	108,278	121,300	130,015

Source: Dominion Bureau of Statistics.
[1]Includes chemicals, cosmetics, and other miscellaneous products.

USES, NATURE AND LOCATION OF CLAY AND SHALE DEPOSITS

China Clay (Kaolin)

China clay, frequently referred to as kaolin, is a high-quality material used as a filler and coater in the paper industry, a raw material in ceramic products and a filler for rubber and other products. The properties needed in the paper industry are intense whiteness, freedom from abrasive grit and high coating-retention. In the ceramic industry it is used as a refractory raw material. In prepared whiteware bodies it is used along with such materials as nepheline syenite, silica, feldspar and talc, for the manufacture of such products as wall tile, floor tile, sanitary ware, dinnerware, pottery and electrical porcelain. China clay is used as a source of alumina and silica in the whiteware industries. It also imparts a degree of plasticity to the unfired body and helps to maintain a white fired color.

China clay usually requires beneficiation to separate the clay from undesirable impurities. Purified china clay consists almost entirely of the clay mineral kaolinite. The theoretical composition of pure kaolinite – silica 46.54 per cent, alumina 39.50 per cent and combined water 13.96 per cent – gives a very refractory mixture that is nearly white both as unfired and as fired. Good-quality commercial kaolins have minor amounts of alkalis, alkaline earth material, and iron and titanium compounds, and usually closely approach the theoretical composition of kaolinite.

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

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

A deposit of refractory clay similar to a secondary china clay occurs along the Fraser River near Prince George, British Columbia. The material varies from very plastic to very sandy. The upper beds are considerably iron-stained. Recently a pit was opened in the deposit to provide raw material for production of buff facing brick.

A clay deposit at Arborg, Manitoba, contains colloidal iron, a considerable quantity of quartz and some other impurities in addition to kaolinite. Some investigational work is underway on this material. Kaolin-bearing rock occurs in Quebec at St.Remi d'Amherst, Papineau county; Brebeuf, Terrebonne county;

Lac Labelle, Labelle county; Point Comfort, on Thirtyone Mile Lake, Gatineau county; and Chateau Richer, Montmorency county. The Quebec deposits, in general, contain an excessive amount of quartz and iron minerals. The kaolinite content is variable but is usually less than 50 per cent. The Chateau Richer material is mainly feldspar with about 25 per cent kaolinite. In the past two or three years, various companies have shown considerable interest in Quebec's kaolin-bearing deposits because of their kaolinite content and because of the possible uses of the unbeneficiated material for the facing-brick and other industries.

Some of the china clay in the kaolin deposit at St. Remi d'Amherst is white, but exploration has revealed a considerable amount of a light-brown iron-stained type containing excessive quartz. Kaolinite also occurs in the quartzite of this area. At St. Remi d'Amherst, some development by open-pit and underground mining and by beneficiation through the removal of china clay from quartzite was discontinued in 1948 because of operational difficulties. Many years ago some of this clay was used for manufacturing low-grade refractories.

The Laurentian Art Pottery Inc., St. Jerome, Quebec, stopped using clay from the Brebeuf deposit about 17 years ago, mainly because of beneficiation difficulties and the cost of hauling the crude clay to St. Jerome. When washed, this clay fires from white to a light buff.

Kaolinized deposits occur extensively in northern Ontario. To date certain difficulties with quality and exploration have not been overcome.

Ball Clay

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

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

In Canada, ball clays are known to occur only in the Whitemud formation of southern Saskatchewan. Good-quality deposits are known to exist at Willows, Readlyn, Big Muddy Valley, Blue Hills, Willow Bunch and Flintoft and in other areas. Clay from the Willows area has been used for many years in the potteries at Medicine Hat, Alberta, and in Vancouver, British Columbia; it has been tested in the United States. The lack of proper quality control and the distance from large markets have been the principal disadvantages affecting the use of this material. A processing plant near the Willows deposits at Assiniboia, suspended operations in 1960 because of operational difficulties. Some ball clay from the Flintoft area is being used for white to buff facing brick.

Fire Clay

Canadian fire clays are used principally for the manufacture of medium-duty and high-duty firebrick and refractory specialties. High-duty refractories require 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 of less than 29 but greater than 15 (approximately 1,430°C) may be suitable for low-duty refractories or ladle brick as well as for other clay products. No known Canadian 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 color, and the products generally have dark specks owing to the presence of 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. In the past, exploration work has been done in this area, but adverse terrain and climate have made it difficult. One of the various interested companies did some sampling in the area in 1962 and another company took sampies 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 carried out on their use for the production of ladle brick. Clay from Musquodoboit, Nova Scotia, is being 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 only 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 color. 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 color 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, building 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 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 use by the 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.

The following are typical of U.S. prices of china and ball clay according to the *Oil, Paint and Drug Reporter* of December 30, 1963:

	Dollars
Ball clay	
Domestic, airfloated, bags, car lots, f.o.b. Tennessee, per short ton	18.00 to 22.00
Crushed, moisture repellant, bulk, car lots, f.o.b. Tennessee, per short ton	8.00 to 11.25
China clay	
Domestic, dry-ground, calcined, airfloated, bags, car lots, f.o.b. works, per short ton	43.00 to 68.00
Domestic, dry-ground, uncalcined, airfloated, 99%, 325 mesh, f.o.b. Georgia, bags, car lots per short ton	11.00 to 17.00
Water-ground, washed, bags, car lots, f.o.b. works	21.50 to 50.00

Imported, white, lump, bulk, car lots ex dock Philadelphia, Portland, Me., per long ton	23.00 to 35.00
White, powdered, bags, car lots, ex dock, per net ton	50.00

Coal and Coke

Coal

T.E. Tibbetts*

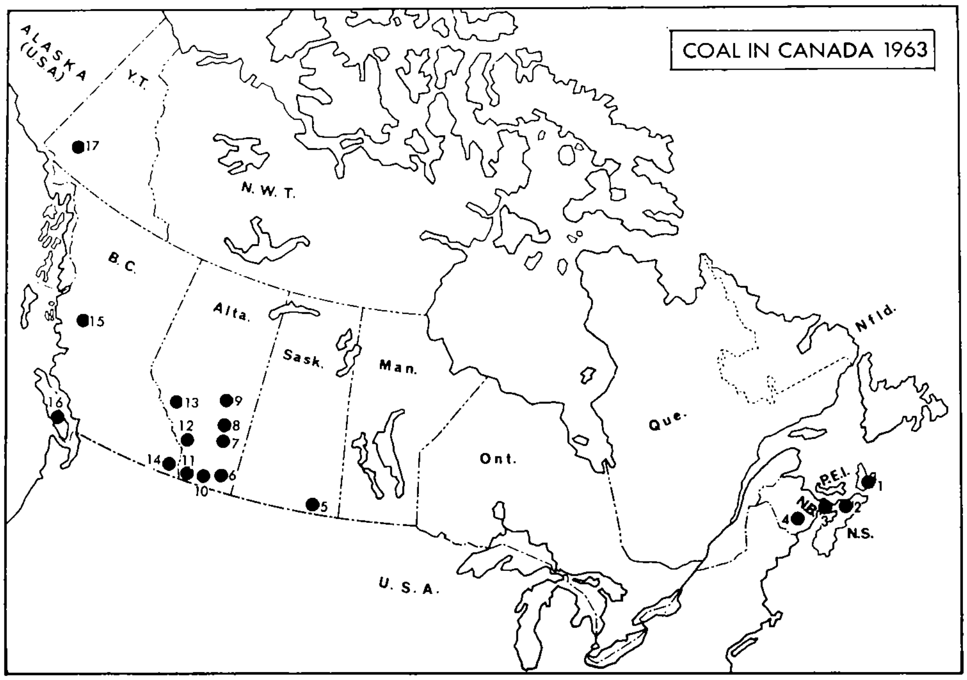
In general the picture for Canada's coal industry brightened in 1963, as significant increases in production, trade and consumption were realized. Production increased in all coal-producing provinces except Saskatchewan where the production of lignite, the province's only coal, decreased 17 per cent. This serious decrease was due mainly to the change to natural gas at a number of industrial heating and processing plants.

On the other hand, increased quantities of subbituminous and bituminous coals were used to generate electricity in Canada. For example, the Hydro-Electric Power Commission of Ontario signed a five-year contract for the delivery of 2.85 million tons of Nova Scotia coal to its thermal generating stations. Under this contract, volumes will increase from 350,000 tons in 1963 to 750,000 tons in 1966 and 1967. A self-unloading, ocean-going coal carrier of 25,000 tons capacity was being built in 1963 particularly for this trade. Exports increased as western Canada coal producers and the railways co-operated in moving coking coals to the Japanese metallurgical markets through the improved and expanded bulk-loading facilities at Port Moody, B.C.

Technological advances in mining and conveying in underground mines 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.

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)	122
Chestico Mining Corporation Limited	26
Dominion Coal Company, Limited	3,272
Dominion Steel and Coal Corporation, Limited, Old Sydney Collieries Division	695
Evans Coal Mines Limited	30
Indian Cove Coal Company, Limited	11
2. *Pictou area* (medium- and high-volatile bituminous)	
Dominion Steel and Coal Corporation, Limited, Acadia Coal Company Division	216
Drummond Coal Company Limited	57
Greenwood Coal Company, Limited	20
Linacy Coal Company Limited	1
3. *Springhill and Joggins areas* (high-volatile bituminous)	
River Hebert Coal Company Limited	56
Springhill Coal Mines Limited	48

New Brunswick

4. *Minto area* (high-volatile bituminous)	
A.W. Wasson, Limited	14
Avon Coal Company, Limited	288
D.W. & R.A. Mills Limited	189
Dufferin Mining Limited	70

New Brunswick (cont'd)

Knox, Harold	11
Michiels Limited	11
Miramichi Lumber Company Limited	170
New Haven Coal Company	20
Newcastle Coal Co. (1963) Ltd.	46
C.H. Nichols Co. Ltd.	30
Norman I. Swift, Ltd.	6
V.C. McMann, Ltd.	53

Saskatchewan

5. *Souris Valley area* (lignite)	
Great West Coal Company, Limited	628
Manitoba and Saskatchewan Coal Company Limited	338
North West Coal Co. Ltd.	42
Utility Coals Ltd.	866

Alberta

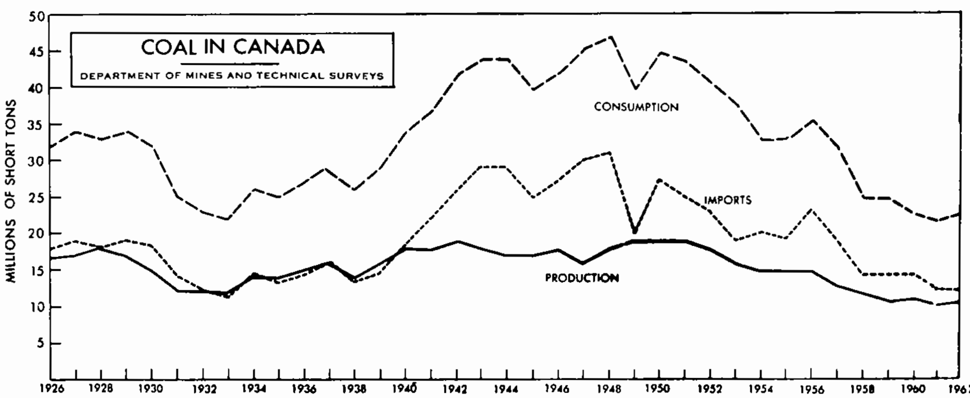
6. *Brooks and Taber areas* (subbituminous)	
Alberta Coal Sales Limited	29
The Kleenbirn Collieries, Limited	6
7. *Drumheller, Sheerness and Carbon areas* (subbituminous)	
Amalgamated Coals Ltd.	134
Century Coals Limited	134
Federated Co-operatives Limited	25
Alfred Fox	2
Fox Coulee Coals Ltd.	
Great West Coal Company, Limited	175
Halbert Coal mine	3
Nottal Brothers	10
Subway Coal Limited	12
8. *Castor, Ardley and Camrose areas* (subbituminous)	
Battle River Coal Company Limited	200
Burnstad Coal Ltd.	6
Camrose Collieries Ltd.	17
Forestburg Collieries Limited	362
John Lynass	11
R.C. Sissons	17
Stettler Coal Company Limited	8
R.R. Straub	10
9. *Edmonton, Tofield and Pembina Areas* (subbituminous)	
Alberta Coal Ltd. (mines Nos. 419 and 1757)	338
Black Gem Coal Company Ltd.	11
Black Nugget Coal Ltd.	6
Egg Lake Coal Company Limited	11
Jet Construction Ltd.	12
Charles Ostertag	8
Slide Hill Coal Co. Ltd.	2
Star-Key Mines Ltd.	44
Warburg Coal Co. Ltd.	12
Whitemud Creek Coal Co. Ltd.	17
10. *Lethbridge area* (high-volatile bituminous)	
Lethbridge Collieries, Limited	55
11. *Crowsnest area* (medium-volatile bituminous)	
Coleman Collieries Limited	355
12. *Cascade area* (low-volatile bituminous and semianthracite)	
The Canmore Mines, Limited	215
13. *Coalspur area* (high-volatile bituminous)	
The MacLeod River Hard Coal Company, Limited	5

British Columbia

14. *East Kootenay (Crowsnest) area* (medium-volatile bituminous)	
The Crow's Nest Pass Coal Company, Limited	883
15. *Northern area* (medium- and high-volatile bituminous)	
Bulkley Valley Collieries, Limited	3
16. *Vancouver Island area* (high-volatile bituminous)	
Comox Mining Company Limited	74

Yukon Territory

17. *Carmacks area* (high-volatile bituminous)	
Yukon Coal Company Limited	8



Source: Dominion Bureau of Statistics

TABLE 1
Coal – Production, Trade and Consumption, 1954–63
(short tons)

	Production	Imports[1]	Exports	Consumption		
				Domestic[2]	Imported[3]	Total
1954	14,913,579	18,579,989	219,346	14,466,212	18,322,056	32,788,268
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	13,111,532	22,616,435

Source: Dominion Bureau of Statistics.
[1]Imported coal referred to by DBS as 'Entered for Consumption' represents amounts cleared from custom's ports, duty paid. Prior to 1962, 'Landed Imports' were shown; this is 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.

PRODUCTION

Production of bituminous coal increased by 7.9 per cent; subbituminous coal mines, located only in Alberta, increased their production by 10.5 per cent; and production of lignite, as previously mentioned, decreased about 17 per cent. Production over-all increased 2.8 per cent to almost 10.6 million tons in 1963.

Provincial production of coal as a percentage of the national output was: Nova Scotia, 43.1 per cent; Saskatchewan, 17.7 per cent (all lignite); Alberta, 21.6 per cent; British Columbia, 9.2 per cent (including small amount produced in the Yukon Territory); New Brunswick, 8.4 per cent. Nova Scotia's production, all bituminous coal, was up by about 8.3 per cent. In Alberta increases in production of bituminous coal of 7.7 per cent and of subbituminous coal of 10.5 per cent resulted in an over-all increase of 9.7 per cent. Production in British Columbia increased 5.4 per cent, and in New Brunswick increased 8.7 per cent.

The average output per man-day for all coal mines in Canada decreased 0.063 tons to 4.728 tons. The most significant decrease was in strip mining, which accounted for 38.1 per cent of the coal production, with an average output of 15.778 tons per man day in 1963 compared to 17,097 tons the previous year. Average output for underground mines was 3.300 tons per man day which is an increase of 0.061 tons from 1962. Productivity had shown a steady increase during the last 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.

TABLE 2

Coal Production, by Types, Provinces and Territories

	1962		1963	
	Short Tons	$	Short Tons	$
Bituminous*				
Nova Scotia	4,204,779	41,713,202	4,554,944	44,693,053
New Brunswick	815,529	6,752,042	886,336	7,232,170
Alberta	590,139	4,285,510	635,650	4,503,825
British Columbia and Yukon Territory	920,845	6,171,461	970,915	6,252,480
Total	6,531,292	58,922,215	7,047,845	62,681,528
Subbituminous* – Alberta	1,497,171	5,684,098	1,654,293	5,361,065
Lignite* – Saskatchewan	2,256,306	4,553,900	1,873,556	3,713,988
Total Canada, all types	10,284,769	69,160,213	10,575,694	71,756,581

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).

More than 82 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 58 per cent from 51.5 per cent in 1962 but in British Columbia it decreased to 10.2 per cent from 11.7 per cent. Nova Scotia has no strip mines.

TABLE 3

Coal Production, by Type of Mining and Average Output Per Man-day, 1963

(short tons)

	Production (with percentage of total)		Average Output Per Man-day	
	Underground	Strips	Underground	Strips
Nova Scotia	4,554,944 (100)		2.909	
New Brunswick	156,142 (17.6)	730,194 (82.4)	1.662	5.369
Saskatchewan	nil	1,873,556 (100)		41.673
Alberta	960,976 (42.0)	1,328,967 (58.0)	4.970	21.356
British Columbia	864,139 (89.8)	98,545 (10.2)	6.001	21.615
Yukon	nil	8,231 (100)	3.372	
Canada	6,539,659 (61.9)	4,028,913 (38.1)	3.300	15.778
Total, all mines ..	10,575,694		4.728	

Source: Dominion Bureau of Statistics.

TABLE 4

Comparison of Average Values of Canadian Coals, 1963

	Average Btu/lb	Average Value Per Short Ton	Average Value Per Million Btu
		$	¢
Nova Scotia, bituminous	13,450	9.81	36.47
New Brunswick, bituminous	11,900	8.16	34.29
Saskatchewan, lignite	7,400	1.98	13.38
Alberta			
Bituminous	12,950	7.09	27.37
Subbituminous	9,000	3.24	18.00
British Columbia, bituminous	13,800	6.37	23.08
Yukon Territory, bituminous	11,450	15.03	65.63
Total			
Bituminous	13,210	8.89	33.65
Subbituminous	9,000	3.24	18.00
Lignite	7,400	1.98	13.38
Average, Canada	11,520	6.79	29.47

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

Coal produced in Canada in 1963 averaged $6.79 a ton and totalled more than $71.7 million. Bituminous coal accounted for 87.1 per cent of the total value, averaging $8.89 a ton – a decrease of about 13 cents a ton from the previous year. Bituminous coals from all provinces decreased in value; the largest decrease, 26 cents a ton, was for British Columbia coals.

The value of lignite decreased four cents a ton following an arbitrary adjustment reported for the previous year. The value of subbituminous coal declined 56 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 13.38 cents per million Btu, is the cheapest source of coal-derived energy in this country.

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 thermoelectric plants) and household and commercial heating. The greatest single use of Nova Scotia coal, however, is 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. In 1963 Nova Scotia shipped more than 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 thermoelectric power generation. A small amount of Nova Scotia coal was exported to the island of St. Pierre. New Brunswick shipped about 9.4 per cent of its output to central Canada and more than 16 per cent to the United States.

TABLE 5

Interprovincial Shipments of Coal, 1963

(short tons)

	Originating Province				
Destination	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia
Newfoundland	77,433	—	—	—	—
Prince Edward Island	31,192	—	—	—	—
Nova Scotia	—	92	—	—	—
New Brunswick	216,544	—	—	—	—
Quebec	1,796,087	78,890	—	—	—
Ontario	656,234	4,320	111,435	29,309	21,456
Manitoba	—	—	551,568	131,471	145,255
Saskatchewan	—	—	—	343,634	279
Alberta	—	—	—	—	589
British Columbia and Yukon	—	—	—	262,433	—
Total	2,777,490	83,302	663,003	766,847	167,579

Source: Dominion Bureau of Statistics, *The Coal Mining Industry.*
Symbol: — Nil.

Saskatchewan

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

About 35 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 about 46 per cent of the total lignite production, provided the fuel for the new Boundary Dam thermoelectric 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; 46 such mines operating in 1963 produced more than 72 per cent of Alberta's coal. These mines are in the following areas, listed in order of decreasing output: Castor, Pembina, Drumheller, Sheerness, Edmonton, Ardley, Taber, Camrose, Westlock, Tofield, Carbon, Brooks, Champion, Wetaskiwin, Redcliff, Gleichen. More than 85 per cent of the total production of subbituminous coal is from seven mines in the Castor, Pembina, Drumheller and Sheerness areas.

TABLE 6

Exports of Coal, 1963

(short tons)

Destination	Shipments from Mines, by Province*						Total Exports**
	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	All	
St. Pierre . . .	4,903	nil	nil	nil	nil	4,903	7,138
United States	nil	143,886	2,361	5,583	1,799	153,629	274,759
Japan	nil	nil	nil	410,558	367,330	777,888	772,470
Total	4,903	143,886	2,361	416,141	369,129	936,420	1,054,367
Value							$9,870,185

Source: Dominion Bureau of Statistics.
*Direct to destination. ** Cleared through Customs as reported by *Trade of Canada*. Differences from the amounts reported as shipped from mines are made up from coal shipped from stock and coal shipped to industrial dealers but ultimately consigned to the Export market. The latter circumstance applied to New Brunswick, Alberta, and British Columbia coals going to the United States.

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

In 1963 a large part of the bituminous coking coals produced in the Crowsnest area was exported to Japan, where they were used to upgrade the Japanese coal blends for metallurgical use. A total of 410,676 tons of Alberta coal went to Japan and more than 5,500 tons to 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.

About 33 per cent of Alberta's coal production was shipped to other provinces, Saskatchewan and British Columbia taking, respectively, 15.0 and 11.5 per cent. About 5.7 per cent went to Manitoba and 1.3 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 almost 92 per cent of the production. More than 369,000 tons of medium-volatile bituminous coking coal from this area were exported, 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 15.1 per cent of the output of the province was shipped to Manitoba, more than 2.2 per cent went to markets in Ontario and small amounts were shipped to Saskatchewan and Alberta.

All coal produced in the Yukon Territory was 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 1963. The amount to which such assistance was applied increased by 409,000 tons; the value of this assistance increased $110,000 to $17.5 million in 1963.

Subvention assistance amounting to about $2.5 million was applied to the export of 762,578 tons of coal from the Crowsnest area of Alberta and British Columbia.

Also in 1963, a special subsidy was allowed to producers in Nova Scotia and New Brunswick for shipment of coal to markets in direct competition with imported residual oil. Under this scheme $746,384 was paid to mine operators in

TABLE 7
Coal Moved Under Subvention
(short tons)

Origin of Coal	1962	1963
Nova Scotia	2,191,938	2,428,819
New Brunswick	114,186	191,766
Saskatchewan	82,511	89,311
Alberta and British Columbia	692,394	780,085
Total	3,081,029	3,489,981
Value of Subvention Assistance	$17,433,355	$17,543,915

Source: Dominion Coal Board

Nova Scotia at the rate of 30 cents a ton and $40,871 to operators in New Brunswick at a ten-cent-a-ton rate.

Payments under the Atlantic Provinces Power Development Act, 1958, totalled $1,471,853.

IMPORTS

There was an increase of 3.9 per cent in coal imports in 1963. Imports of bituminous coal from the United States increased 4.8 per cent whereas imports of anthracite, also mainly from the United States with some from Britain decreased 7.3 per cent. More than 41 per cent of the bituminous coal imported was high-grade coking coal used in the metallurgical industry, mainly in Ontario.

CONSUMPTION

Consumption of coal in Canada increased 3.3 per cent in 1963 to about 22.6 million tons. More than 57 per cent of the coal consumed was imported.

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

TABLE 8

Imports of Coal for Consumption

(short tons)

Country of Origin	Anthracite		Bituminous*		Total	
	1962	1963	1962	1963	1962	1963
United States.	883,765	826,225	11,699,853	12,264,805	12,583,618	13,091,030
Britain	30,571	21,101	nil	nil	30,571	21,101
Total	914,336	847,326	11,699,853	12,264,805	12,614,189	13,112,131
Value $......	10,306,348	10,700,317	63,865,142	67,331,449	74,171,490	78,031,766

Source: Dominion Bureau of Statistics, *Trade of Canada.*

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

The decline in the use of coal in the household and commercial building heating market in the period 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.

Industrial consumption of coal, including that used by thermoelectric generating stations, increased 14.7 per cent in 1963. The proportion of Canadian coal used industrially declined slightly to about 49 per cent, the remainder being mainly bituminous coal from the United States.

TABLE 9
Consumption of Canadian and Imported Coal, 1954–63

	Canadian		Imported		
	Short Tons*	% of Consumption	Short Tons**	% of Consumption	Total Short Tons
1954	14,466,212	44.1	18,322,056	55.9	32,788,268
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

Source: Dominion Bureau of Statistics.
*The sum of coal sold at Canadian mines, 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.

TABLE 10
Consumption of Coal – Major Uses, 1962 and 1963

	1962	1963
Household and Commercial Building Heating		
Canadian		
Bituminous	433,266	429,393
Subbituminous	535,020	442,706
Lignite	350,246	280,923
Total*	1,318,532	1,153,022
Imported		
Anthracite	578,780	483,998
Bituminous	1,396,149	1,252,479
Total	1,974,929	1,736,477
Unspecified	210,145	166,280
Total, all types	3,503,606	3,055,779
Industrial**		
Canadian		
Bituminous	3,766,131	4,019,260
Subbituminous	357,160	743,945
Lignite	1,494,246	1,323,882
Total	5,617,537	6,087,087
Imported		
Anthracite	215,429	220,912
Bituminous	5,003,245	6,125,889
Total	5,218,674	6,346,801
Total, all types	10,836,211	12,433,888

Table 10 (cont'd)

	1962	1963
Coke Making		
Canadian, bituminous	574,869	663,890
Imported, bituminous	4,877,451	5,074,733
Total	5,452,320	5,738,623

Source: Dominion Bureau of Statistics, *The Coal Mining Industry*.
*Excludes 37,009 tons of briquettes in 1962 and 31,998 tons in 1963. ** Does not include firms using less than 500 tons per annum.

There was an increase of about 5.3 per cent to about 5.7 million tons in the use of coal to manufacture coke, the increased consumption being mostly imported coal. Use of Canadian coal for this purpose increased 15.5 per cent to about 11.6 per cent of the total coal used for coke manufacture.

BRIQUETTES

There was an increase in the production of coal briquettes in 1963. The increase in production for both lignite and bituminous coal briquettes was similar. Apparent consumption of briquettes was about 40 per cent more than in 1962.

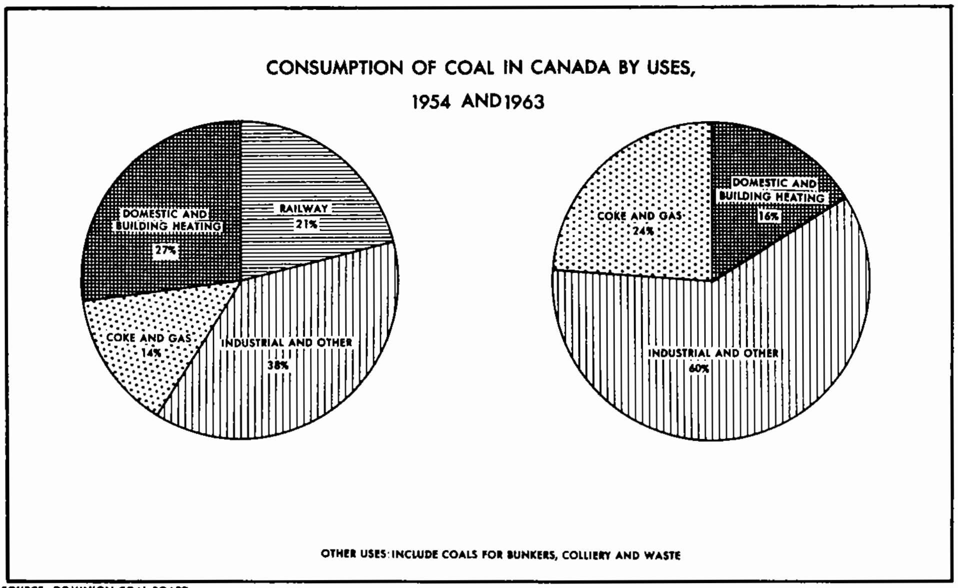
TABLE 11

Briquettes — Production and Consumption

(short tons)

	1962	1963
Production		
Saskatchewan	27,000[e]	35,000[e]
Alberta* and British Columbia	28,631	37,358
Total	55,631	72,358
Consumption — briquettes available for consumption**	54,500	76,224

Source: Dominion Bureau of Statistics.
*Alberta production excludes 11,677 tons of char produced in 1963 (carbonized briquettes previously known as 'char' are now defined as coke.) **Production (including char) plus 'landed' imports less exports.
e Estimate.



SOURCE: DOMINION COAL BOARD

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Coke

J.C. Botham*

Of the 22.6 million tons of coal consumed in Canada in 1963, about 5.7 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 mainly manufactured at five plants in batteries of standard slot-type ovens of some 50 units to a battery, the plants in operation varying in annual coal capacity from 500,000 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 The Crow's Nest Pass Coal Company, Limited, collieries in Michel, B.C. About 95 per cent of the coal used in the production of coke is processed at these six plants.

There is a trend in North America toward a return to the use of nonrecovery ovens of the horizontal-bed internal-combustion type. The Mitchell oven and modifications of this design are the ovens of this type which 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

*Fuels 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	Byproducts 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,	4 batteries of 253 ovens with an annual rated capacity of 2,100,000 tons of coal	Blast furnace use – 3½ × ¾ inch; base metal industry ¾ × 3/8 inch and 3/8 × 3/16 inch; sintering – 3/16 × 0 inch.
	No. 5	Koppers-Becker Underjet	86	1943	solvent naphtha, naphthalene, light oil, gas		
	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,	3 batteries of 191 ovens with an annual rated capacity of 1,470,000 tons of coal	Blast furnace use – plus 7/8 inch; domestic heating – 7/8 × 3/8 inch; sintering – minus 3/8 inch.
	No. 3	Wilputte Underjet	61	1947	benzole, toluene, xylene, solvent naphtha,		
	No. 4	Wilputte Underjet	83	1952	sodium phenolate, gas		
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 rated capacity of 930,000 tons of coal	Blast furnace use – plus ¾ inch; sintering – 1/8 × 0 inch; other uses – ¾ × 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, sulphate of ammonia, nitration benzole, industrial benzole, nitration and industrial toluene, xylene, solvent naphtha, gas	2 batteries of 114 ovens with an annual rated capacity of 900,000 tons of coal.	Blast furnace use – 3½ × 1½ inch, 2½ × 1½ inch domestic heating – 2½ × 1½ inch, 1½ × 7/8 inch, 7/8 × ¼ inch sintering – ¼ × 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, benzole, toluene, xylene, gas.	2 batteries of 74 ovens with an annual rated capacity of 626,300 tons of coal.	Foundry coke, domestic heating, chemical industry, blast furnace, use base metal industry, rockwool producers.
	No. 2	Koppers-Becker	15	1947			

TABLE 2
Other Carbonization Plants in Canada

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 – 25,000 tons; barbecue briquettes – 1,000 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 rated capacity of 243,000 tons of coal.	Base metal industry – 4 × 2 inch; beet sugar industry – 5 × 2 inch; iron reduction in electric furnaces 1½ × ¾ inch, ¼ × 1/8 inch; sintering use – minus ¼ inch; chemical industry – ¼ × 0 inch.
		10	1943	5.5			
		16	1949	7.5			
		16	1952	7.5			

*formerly Dominion Briquettes and Chemicals Ltd.

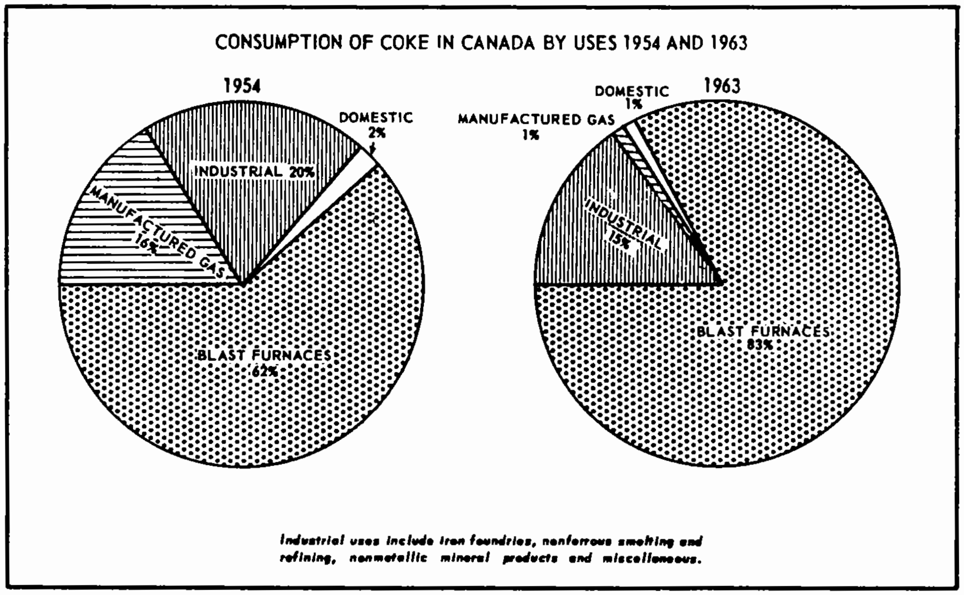


TABLE 3

Coke – Production and Trade

	1962		1963	
	Short Tons	$	Short tons	$
Production				
Coal coke*				
Ontario	3,247,962		3,416,047	
Other provinces	773,812		864,750	
Total	4,021,774		4,280,797	
Pitch coke	1,899	54,038	2,014e	60,420e
Petroleum coke**	201,985	1,870,529	259,167e	2,400,076e
Total	4,225,658		4,541,978	
Imports (all types)				
United States	585,237	10,076,547	603,535	10,525,932
Britain	135	3,876	112	3,818
Total	585,372	10,080,423	603,647	10,529,750
Exports (all types)				
United States	129,551	1,661,566	149,909	1,761,197
Britain	4,576	186,174	2,103	92,725
Other countries	23,755	258,613	2,320	41,450
Total	157,882	2,106,353	154,332	1,895,372

Source: Dominion Bureau of Statistics.
*Values of coal coke production and selling prices 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.
e Estimate

for their use are: lower capital cost, lower labor 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. The intention is to produce a coke product by crushing a carbonized briquette prepared from low-volatile and semianthracite coals; a form-coke could be produced if desired. Pelletized coal is also being considered as a feed material. 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.

Lethbridge Collieries, Limited announced plans to build a rotary-hearth carbonizing unit, construction to begin early in 1964. The product is to be used primarily for iron-ore smelting in electric furnaces.

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 sintered ores in the iron blast furnace and a corresponding increase in the fuel requirements for sintering have 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.

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 such as coke breeze.

Cobalt

V.B. Schneider*

Cobalt production in 1963 was 3.0 million pounds valued at $6.1 million. This compares with 3.5 million pounds valued at $6.3 million in 1962. The decrease is attributable mainly to lower production of nickel, particularly at Sudbury, Ont., 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, Ont.; from Lynn Lake and Thompson Man.; and as a byproduct of silver refined at Cobalt, Ont., by Cobalt Refinery Limited.

PRODUCERS

Ontario

The International Nickel Company of Canada, Limited (INCO) recovers cobalt from its nickel-refining operations at Port Colborne, Ont. High-purity electrolytic cobalt and cobalt oxide are produced at the Port Colborne refinery and cobalt oxides 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 1963, INCO reported production of 1.9 million pounds of cobalt from all operations.

Falconbridge Nickel Mines, Limited, produced electrolytic cobalt at its refinery at Kristiansand, Norway, from the refining of nickel-copper matte produced at Sudbury. Cobalt deliveries for 1963 were reported to be 1.3 million pounds.

Cobalt Refinery Limited produces cobalt as a byproduct from its silver smelting and refining of arsenical-silver-cobalt ores of the Cobalt-Gowganda area of Ontario. The company sells cobalt as cobalt oxide (black 70–71 per cent) mostly to the Canadian manufacturers of frit. Production in 1963 was 53,000 pounds.

*Mineral Resources Division

TABLE 1
Cobalt – Production, Trade and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production[1], all forms, cobalt content	3,481,922	6,345,205	3,024,965	6,122,169
Exports				
Cobalt metal				
United States	455,717	780,305	558,902	921,881
Britain	36,000	55,742	148,289	215,595
France	15,804	26,079	10,950	22,995
West Germany	6,818	11,110	6,920	11,464
India	26	767	5,988	9,461
Argentina	nil	nil	4,400	5,302
Republic of South Africa	nil	nil	3,528	27,872
Japan	nil	nil	250	405
Sweden	28,200	45,080	nil	nil
Total	542,565	919,083	739,227	1,214,975
Cobalt oxides and salts[2]				
Britain	1,606,700	2,285,609	1,088,900	1,496,341
United States	23,200	27,597	9,400	11,987
Total	1,629,900	2,313,206	1,098,300	1,508,328
Imports				
Oxides[2]				
Britain	37,736	43,909	26,295	32,403
United States	3,200	3,861	1,996	2,344
Total	40,936	47,770	28,291	34,747
Consumption[3], cobalt metal and cobalt contained in oxides and salts	383,442		364,594	

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]Gross weight. [3]As reported by consumers.

Manitoba-Alberta

Sherritt Gordon Mines, Limited, produced 608,000 pounds of cobalt during 1963, almost the same quantity as in 1962. 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, Man., mine and from purchased cobalt-bearing materials. Sherritt Gordon's cobalt is produced in three forms – powder, briquettes and strip. Powdered cobalt is chiefly used by the chemical industry as a raw material for salts, catalysts, and driers; a small quantity is used for special alloy production. Cobalt briquettes are used for alloy production, especially in the advanced techniques such as vacuum melting or electron beam melting, where their high purity can be fully utilized. Strip is produced at the company's plant by powder rolling, resulting in a very ductile form of cobalt for many specialized uses.

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

TABLE 2

Cobalt – Production, Trade and Consumption, 1954–63

(pounds)

	Production[1]	Exports				Imports		Consumption[2]
	All Forms	Cobalt in Ores and Concentrates	Metallic Cobalt	Cobalt Alloys[3]	Cobalt Oxide and Salts[3]	Cobalt Ores	Cobalt Oxides[3]	
1954	2,252,965	3,300	1,139,039	4,926	836,205	10,400	6,935	122,000
1955	3,318,637	nil	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	nil	1,024,667	9,712	522,144	nil	16,230	260,000
1959	3,150,027	nil	680,323	3,280	1,100,734	nil	24,716	188,000
1960	3,568,811	nil	844,293	1,938	1,175,206	nil	20,227	182,000
1961	3,182,897	nil	603,931	[4]	1,521,000	nil	28,364	307,000
1962	3,481,922	nil	542,565	[4]	1,629,900	nil	40,936	299,000
1963	3,024,965	nil	739,227	[4]	1,098,300	nil	28,291	270,000

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. [4]Not reported as a separate class after 1960.

WORLD MINE PRODUCTION

World production of cobalt in 1963, excluding the Communist Bloc, was 12,800 tons. This is 3,100 tons less than 1962 production, as reported by the U.S. Bureau of Mines, *Minerals Yearbook 1962*. This reduction was common to all major producing countries.

The Republic of the Congo (Leopoldville) is by far the largest producer of cobalt. Its production in 1963 was 8,050 tons, all derived as a byproduct from the copper refining operations of Union Minière du Haut-Katanga. According to the company's annual report for 1963, production of the company's mine returned to normal in April after cutbacks in production because of internal strife in the Congo. The company was cautious about its probable output in 1964, but expected that production would exceed that of 1963.

Cobalt was produced in Northern Rhodesia by Rhokana Corporation Limited and Chibuluma Mines Limited. According to the U.S. Bureau of Mines, production of cobalt during 1963 amounted to 778 tons. According to the Northern Rhodesia Chamber of Mines Yearbook for 1963, sales of cobalt in 1963 amounted to 815 tons valued at £871,441.

In Morocco cobalt is derived from the cobalt bearing deposits in the Bou Azzer district by the Société Minière du Bou Azzer et du Graaza. Production for 1963 was 1,511 tons. Most of the Morocco cobalt concentrates are refined in France; the remainder is refined 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 *Engineering and Mining Journal* estimates that production for 1963 was about 500 tons. Bethlehem Steel Corporation treats calcined ore from its Cornwall, Penn., mine at a sulphuric-acid leaching plant at Sparrows Point, Md. This leaching operation produces a 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*, 1962 and 1963

(short tons)

	1962	1963
Republic of the Congo	10,674	8,050
Northern Rhodesia	951	778
Canada	1,741	1,512
Morocco	1,583	1,511
Other countries**	951	949
Total	15,900	12,800

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

*Exclusive of Communist Bloc countries.
**Includes United States production.

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 coloring 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, by far the largest consumer of cobalt, used, according to U.S. Bureau of Mines publication *Cobalt* of May 1964, 10.5 million pounds of contained cobalt in all forms in 1963, about one million pounds less than in 1962. According to the Cobalt Information Centre publication, also titled *Cobalt*, of March 1964, there are indications that cobalt consumption in other non-Communist countries was slightly higher than in 1962, so that the overall non-Communist world consumption figure for 1963 will probably be very close to the level of 15,000 tons which has prevailed for the past few years.

TABLE 4

Cobalt Consumed in U.S. by Uses

	1962		1963	
	'000 lb	%	'000 lb	%
Metallic:				
High speed steel	343	3.0	404	3.8
Other tool and alloy steel	610	5.4	835	7.9
Permanent-magnet alloys	2,867	25.5	2,352	22.3
Cutting and wear-resisting materials	316	2.8	275	2.6
High-temperature high-strength materials	3,015	26.8	2,453	23.3
Alloy hard-facing rods and materials	650	5.8	607	5.8
Cemented carbides	610	5.4	409	3.9
Non-ferrous alloys and other metallic uses	710	6.3	584	5.6
Total, metallic	9,121	81.0	7,919	75.2
Non-metallic (exclusive of salts and driers)				
Ground coat frit	533	4.7	580	5.5
Pigments	168	1.5	222	2.1
Other materials	474	4.2	606	5.8
Total, non-metallic	1,175	10.4	1,408	13.4
Salts and driers – lacquers, varnishes, paints, etc.	972	8.6	1,202	11.4
Grand Total	11,268	100.0	10,529	100.0

Source: *Minerals Yearbook 1963.*

TABLE 5

Cobalt Consumption in Canada, 1962 and 1963

(pounds of contained cobalt)

	1962	1963
Cobalt metal	298,624	270,136
Cobalt oxide	48,669	61,565
Cobalt salts	36,149	32,893
Total	383,442	364,594

Source: Dominion Bureau of Statistics.

Table 4 indicates a slight alteration in the general pattern of distribution among the various uses. There was a general overall decline in the consumption of cobalt used by the metallics industry; this has been accompanied by a slight increase in its use in the nonmetallics and chemical applications. Among metallic uses the biggest decline has occurred in its application in permanent-magnet alloys and in high-temperature-strength materials. To a great extent this decline is largely due to technological improvements that allow a more economical and effective use of cobalt and, to a minor extent, by the imports of permanent magnets into the United States from other countries.

Canadian consumers of cobalt include: in Ontario – Deloro Smelting & Refining Company, Limited, Deloro and Belleville; Canadian General Electric Company Limited and Nuodex Products of Canada Limited, both of Toronto ; Dussek Bros. (Canada) Limited, Belleville; The Indiana Steel Products Company of Canada Limited, Kitchener; Ferro Enamels (Canada) Limited, Oakville; Atlas Steels Company, Division of Rio Algom Mines Limited, Welland; in Quebec – Dominion Glass Company, Limited, and Mallinckrodt Chemical Works, Limited, both of Montreal; Canadian General Electric Company Limited, Quebec city; in British Columbia – Macro Division of Kennametal Inc., Port Coquitlam.

PRICES

E & MJ Metal and Mineral Markets of December 30, 1963, quotes cobalt prices in the United States as follows:

Cobalt metal per lb f.o.b. New York		
500–lb lots	$1.50	
100–lb lots	1.52	
Less than 100 lb	1.57	
Fines (95–96% cobalt)		1.50 to 1.65
Powder (99 +% cobalt)		1.82 to 2.32

Cobalt oxide (ceramic grade, 350–lb containers) per lb	
72½–73½ % cobalt	
East of Mississipi	$1.15
West of Mississipi	1.18
70–71 % cobalt	
East of Mississipi	1.12
West of Mississipi	1.15

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

TARIFFS

	British Preferential	Most Favored 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%

Copper

A.F. Killin*

World copper markets were highlighted by increased production and consumption of primary copper and by the first signs of a break in the price stability that had been maintained for over two years. The increase in consumption outstripped the production increase and Free World stocks of refined copper declined. A continuation of the strong consumer demand in December, coupled with fears of work stoppages at mines and smelters in the United States in mid-1964, caused a rise in copper prices on the London Metal Exchange for the first time since January 1962.

The United States producers' price remained at the May 1961 level throughout 1963, the longest period of price stability in the history of the industry except in wartime. The Canadian producers' price has not changed since May 1962.

A general rise in world industrial activity has been mainly responsible for increased copper consumption. Many officials in the major world copper producing companies also attribute the increased consumption to the price stability, which has encouraged fabricators to use copper and its alloys in consumer products, and to new and improved uses for copper and its alloys that have been developed through research.

Mine production in Canada at 452,559 tons was 4,826 tons lower than in 1962 but the consumption of refined copper rose to 169,750 tons, 12 per cent higher than in 1962. Production of refined copper continued to decline and at 378,911 tons was 3,957 tons lower than 1962 production.

Exports of copper in ore and matte continued to increase with increased shipments of concentrates from British Columbia to Japan. A decrease in the amount of copper exported as refinery shapes is attributed to increased domestic consumption and to the decrease in refined production.

Exploration for new properties and development of known deposits continued in all copper-producing provinces and in the territories. Four mines started

* Mineral Resources Division

TABLE 1

Copper – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production[1]				
All forms				
Ontario	188,995	116,347,723	178,960	112,048,454
Quebec	147,431	91,407,164	141,400	89,081,976
British Columbia	54,490	33,766,394	62,218	39,184,967
Saskatchewan	32,017	19,850,465	29,772	18,756,028
Manitoba	12,738	7,897,714	16,980	10,697,506
Newfoundland	17,308	10,731,154	14,012	8,827,797
New Brunswick	3,674	2,277,864	8,964	5,647,307
Nova Scotia	204	126,300	237	149,394
Northwest Territories	314	194,928	16	10,281
Yukon	214	132,990	–	–
Total	457,385	282,732,696	452,559	284,403,710
Refined	382,868[r]		378,911	
Exports				
In ore and matte				
Japan	43,627	20,388,990	57,325	28,275,298
United States	20,653	9,312,399	15,685	7,352,160
Norway	17,213	8,066,346	15,261	7,087,306
Britain	1,818	950,723	1,815	882,640
Belgium and Luxembourg	1,892	572,174	991	238,421
West Germany	1,368	564,881	948	394,654
Portugal	453	208,347	905	400,498
Spain	2,350	1,080,932	–	–
Total	89,374	41,144,792	92,930	44,630,977
Refinery shapes				
Britain	93,693	56,999,248	98,703	61,361,375
United States	76,506	50,692,337	74,098	49,308,036
India	3,440	2,058,837	13,834	8,503,391
West Germany	11,907	7,005,832	7,013	4,348,320
France	13,928	8,541,309	6,112	3,795,267
Poland	4,759	2,923,583	3,807	2,360,550
Sweden	5,376	3,237,668	3,695	2,289,505
Belgium and Luxembourg	4,951	2,940,852	2,255	1,388,714
Italy	2,160	1,320,183	1,829	1,141,577
Portugal	392	251,501	897	600,280
Czechoslovakia	–	–	896	555,367
Pakistan	419	267,520	882	536,008
Other countries	5,512	3,462,257	966	609,710
Total	223,043	139,701,127	214,987	136,798,100

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Exports (cont'd)				
Scrap, slag, skimmings, sludge				
Japan	1,593	871,126	6,356	3,475,310
Spain	2,005	1,086,718	1,753	962,677
United States	2,294	877,577	1,123	379,683
Yugoslavia	466	245,381	971	588,988
India	270	143,415	243	132,233
West Germany	286	139,796	124	57,984
Netherlands	56	31,119	76	39,000
Other countries	1,298	671,316	38	19,737
Total	8,268	4,066,448	10,684	5,655,612
Bars, rods and shapes (sections) not elsewhere specified and plates, sheet, strip and flat products				
Norway	6,605	4,178,004	7,768	4,988,845
Switzerland	5,009	2,931,542	4,723	2,859,163
Pakistan	1,434	881,033	3,508	2,173,343
Denmark	2,863	1,781,531	2,587	1,590,775
United States	1,908	1,594,985	2,294	2,052,448
Britain	2,667	1,804,485	2,025	1,353,338
Venezuela	705	489,357	1,445	1,000,080
Spain	2	1,416	811	505,710
Colombia	220	157,982	497	361,838
New Zealand	400	358,833	383	325,799
Other countries	349	307,667	328	278,991
Total	22,162	14,486,835	26,369	17,490,330
Pipe and tubing				
United States	1,577	1,552,681	2,435	2,120,691
New Zealand	1,213	1,227,207	1,776	1,834,812
Britain	498	538,587	521	575,991
Philippines	211	243,242	433	449,751
Puerto Rico	383	375,973	394	373,811
Venezuela	291	286,708	332	333,945
Colombia	183	168,372	262	248,110
Israel	6	6,100	164	150,396
Spain	95	103,616	160	165,639
Other countries	1,035	1,091,915	1,038	1,091,889
Total	5,492	5,594,401	7,515	7,345,035
Wire and cable, not insulated				
Italy	–	–	119	101,096
United States	317	219,148	49	40,283
Saudi Arabia	1	614	26	19,924
Cuba	–	–	26	28,244

Table 1 (concluded)

	1962		1963	
	Short Tons	$	Short Tons	$
Exports — continued				
Wire and cable, not insulated (cont'd)				
Costa Rica	—	—	26	19,097
Bermuda	24	18,306	26	19,598
New Zealand	—	—	21	19,473
Dominican Republic	7	5,515	20	17,989
Other countries	108	80,965	63	64,915
Total	457	324,548	376	330,619
Wire and cable insulated[2]				
United States	3,983	4,036,404	4,760	4,625,113
Venezuela	224	243,769	247	283,904
Dominican Republic	145	158,453	219	204,344
India	44	29,675	200	132,800
United States Oceania	21	13,819	155	93,647
Pakistan	..	429	136	152,289
Bermuda	106	90,405	125	116,220
Other countries	912	962,925	1,027	1,153,689
Total	5,435	5,535,879	6,869	6,762,006
Imports				
Copper in blocks, pigs, ingots	147	89,737	6,549	3,817,125
Copper scrap	454	262,599	3,254	1,983,494
Copper bars for electric wires	856	688,015	1,062	890,804
Copper in bars or rods, n.o.p.	139	103,391	215	171,205
Copper in strips, sheets, plates	173	241,202	83	144,362
Copper tubing	200	302,872	315	433,346
Copper rollers for wallpaper		197,301		249,920
Copper wire, n.o.p.	20	41,711	22	42,651
Copper wire cloth, woven wire		45,892		na
Copper manufactures, n.o.p.		1,244,833		1,049,151
Oxide of copper	143	123,469	271	224,073
Copper sulphate	437	158,513	366	111,998
Total		3,499,535		9,118,129
Consumption[3]				
Refined	151,525		169,750	

Source: Dominion Bureau of Statistics.

[1] Blister copper plus recoverable copper in matte and concentrates exported. [2] Includes also small quantities of non-copper wire and cable, insulated. [3] Producers' domestic shipments.

Symbols: na Not available; .. Less than one short ton; — Nil; r Revised.

TABLE 2
Copper – Production, Trade and Consumption, 1954-63
(short tons)

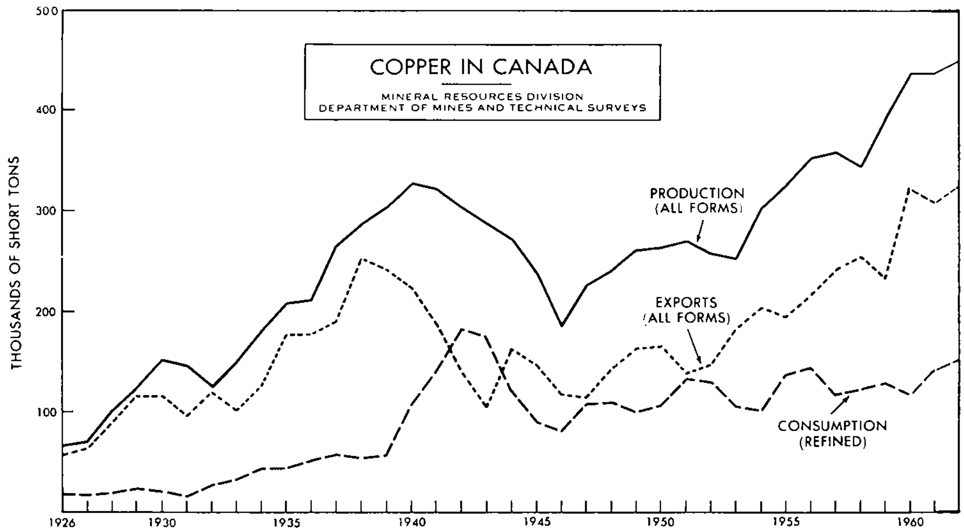
	Production		Exports			Imports	Consumption[2]
	All forms[1]	Refined	In ore and matte	Refined	Total	Refined	Refined
1954	302,732	253,365	47,411	156,130[3]	203,541	1,703	102,432
1955	325,994	288,997	41,565	153,199	194,764	35	138,559
1956	354,860	328,458	40,993	174,844	215,837	2,541	145,286
1957	359,109	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	382,868r	89,374	223,043	312,417	147	151,525
1963	452,559	378,911	92,930	214,987	307,917	6,549	169,750

Source: Dominion Bureau of Statistics.
[1] Blister copper plus recoverable copper in matte and concentrate exported. [2] Producers' domestic shipments, refined copper. [3] Includes blister and anode copper exported for refining: 4,712 short tons.
r Revised

production in 1963 and seven were being developed. Production increased in British Columbia, Manitoba, New Brunswick and Nova Scotia; decreased in Saskatchewan, Ontario, Quebec and Newfoundland. There was no production in the Yukon. The decreased production in Ontario and Quebec resulted from the continuation of production cuts instituted in 1962 at the mines of The International Nickel Company of Canada, Limited at Sudbury, Ontario, and Noranda Mines, Limited at Noranda and Murdochville, Quebec, and a production cut initiated at the end of the third quarter at the Falconbridge, Ontario, mines of Falconbridge Nickel Mines, Limited. Decreased production at the Tilt Cove mine of Maritimes Mining Corporation Limited and the Little Bay mine of Atlantic Coast Copper Corporation Limited accounted for Newfoundland's reduced output. Saskatchewan production was lowered by decreased production from the Coronation mine of Hudson Bay Mining and Smelting Co., Limited and from the company's Flin Flon orebody in Saskatchewan.

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

Newfoundland's copper production decreased to 14,012 tons valued at $8,827,797 in 1963.

Although the milling rate at the Little Bay mine of Atlantic Coast Copper Corporation Limited was increased to 1,031 tons a day from 963 tons a day in 1962, copper production decreased in 1963 because of excessive dilution. Caving in the old stopes forced the company to abandon all the production workings above the 1,000-foot level and lowered the mill heads to 0.84 per cent copper. Shaft sinking to the 1,350-foot level was completed and development of the orebody below the 1,000-foot level was begun. The Buchans Unit of American Smelting and Refining Company in central Newfoundland continued normal operations. Nearly two thirds of the production was obtained from the recently-developed MacLean orebody. Production of copper from the Tilt Cove mine of Maritimes Mining Corporation Limited decreased. Exploration at the Tilt Cove mine has not discovered sufficient ore to maintain ore reserves and the company is planning to move the mining plant and mill to the Gullbridge property when present reserves are depleted in 1965. The Gullbridge mine is four miles west of the Trans-Canada Highway and 20 miles from Badger station on the Canadian National Railways' main line. Exploration to date at the property has outlined 4.3 million tons averaging 1.24 per cent copper. At Baie Verte, Consolidated Rambler Mines Limited continued underground exploration and development of its copper orebody and construction of a 400-ton-a-day mine plant and concentrator. Production is scheduled for May 1964. British Newfoundland Exploration Limited, a subsidiary of British Newfoundland Corporation Limited, completed shaft sinking on its property at Whales Back Pond and started a program of underground development and exploration. Results indicated an orebody containing about three million tons of 1.8 per cent copper ore.

Nova Scotia

The 237 tons of copper produced in Nova Scotia in 1963 were obtained from the lead-zinc ore produced at the Magnet Cove Barium Corporation's mine at Walton.

New Brunswick

Copper production at 8,964 tons in 1963 was the highest recorded in this province, more than doubling the 1962 total. The value of this production at $5,647,307 also set a new record. All production was obtained from two mines. Heath Steele Mines Limited operated 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 at the junction of the Nepisiguit River and Forty-mile Brook. Each mine produced 750 tons of ore a day.

Brunswick Mining and Smelting Corporation Limited continued underground development and plant and mill construction at its No. 12 mine approximately 10 miles southwest of Bathurst. The mill will have capacity to treat 4,500 tons of ore a day. The concentrates produced from 3,000 tons of ore a day will be shipped under contract to Belgium for smelting, and production from the remaining 1,500 tons of ore will be processed in a smelter to be built by East Coast Smelting and Chemical Company Limited, a wholly owned subsidiary of Brunswick, at Belledune Point, 40 miles from the mine.

Quebec

Quebec's copper production in 1963 was 141,400 tons, 6,031 tons less than in 1962. The decrease was caused by the continuation of production curtailments at the mines of Noranda Mines, Limited and Gaspé Copper Mines, Limited, and a prolonged strike at Solbec Copper Mines, Ltd.

The strike at the Solbec mine in the Eastern Townships delayed the development of the mine of Cupra Mines Ltd., a subsidiary company, 2½ miles south of Solbec. Production from Cupra's 860-thousand ton copper-zinc orebody is scheduled to start in 1964. The ore will be trucked to Solbec's mill for concentration.

Three mines started production in the Matagami Lake area. Mattagami Lake Mines Limited completed the initial phase of underground development of its mine and built a townsite, mining plant and a 3,000-ton-a-day mill. Production of copper, zinc and lead concentrates started in October. The copper concentrate was shipped to Noranda for smelting. New Hosco Mines Limited, also in the Matagami area, completed construction of its mining plant and started shipping 900 tons of copper ore a day to the mill of Orchan Mines Limited. Orchan has developed a large zinc-copper orebody near Mattagami Mines and built a 1,900-ton-a-day mill. The company produced and milled 1,000 tons a day of zinc-copper ore from its own mine and milled 900 tons a day of copper ore from New Hosco's mine on a toll basis. Copper concentrates were shipped to Noranda for smelting.

(text continued on page 242)

TABLE 3
Producing Companies, 1963

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1963 (1962) (short tons)	Grade Copper (%)	Grade Zinc (%)	Grade Nickel (%)	Developments
Newfoundland						
American Smelting and Refining Company (Buchans Unit), Buchans.	1,300	376,000 (378,000)	1.15	13.86	—	MacLean orebodies in full production, routine development and exploration.
Atlantic Coast Copper Corporation Limited, Little Bay	1,150	376,403 (367,748)	0.91	—	—	Main shaft deepened from 1,283 to 1,474 feet below the collar. New levels established at 1,150 and 1,350 feet.
Maritimes Mining Corporation Limited, Tilt Cove.	2,350	831,641 (831,835)	1.15	—	—	Routine mining and development of remaining reserves. Preparations underway to move mining and milling plant to Gullbridge mine near Badger Station.
Nova Scotia						
Magnet Cove Barium Corporation, Magnet Cove	125	49,058 (..)	0.77	1.4	—	Routine development and exploration.
New Brunswick						
The Consolidated Mining and Smelting Company of Canada Limited (Wedge Mine), Nepisiguit River, Bathurst-Newcastle.	750 tons of ore a day shipped to Heath Steele mill.	263,000 (223,920)	..	..	—	Routine exploration and development.

Table 3 (cont'd)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1963 (1962) (short tons)	Grade Copper (%)	Grade Zinc (%)	Grade Nickel (%)	Development
New Brunswick (cont'd)						
Heath Steele Mines Limited, Bathurst-Newcastle.	1,500	265,939 (. .)	1.10	5.6	—	Treats 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	833,286 (739,333)	1.95	—	—	Development and stope preparation in the Main and Henderson mines. New development and exploration in the Cedar Bay mine. Ore reserves depleted in the Kokko Creek mine.
Gaspé Copper Mines, Limited, Murdochville.	7,300	2,772,000 (2,694,100)	1.26	—	—	Routine exploration and development. Preparations underway to start production from Copper Mountain orebody.
Manitou-Barvue Mines Limited, Val d'Or.	1,300	293,000 (291,440)	0.93	—	—	Routine exploration and development.
		174,365 (169,140)	—	5.63	—	
Mattagami Lake Mines Limited, Matagami.	3,000	166,725 (—)	0.68	12.30	—	Mine started production in October 1963. Routine development.
Merrill Island Mining Corporation, Ltd., Doré Lake, Chibougamau.	650	143,087 (159,910)	2.51	—	—	Exploration and development of the E ore zone at depth. Company established an outside exploration department and is active in search for new properties.

New Hosco Mines Limited, Matagami	900 tons of ore a day trucked to Orchan mill.	44,000 (–)	1.8	–	–	Company started shipping ore to the Orchan mill in October 1963. Underground development is continuing and exploration of the ore zone at depth is being carried out by diamond drilling.
Noranda Mines, Limited, Noranda.	3,200	1,236,000 (901,500)	1.82	–	–	Level development and diamond drilling on the 7,000- and 8,000-foot levels to explore the ore zone at depth.
Normetal Mining Corporation, Limited, Normetal.	1,000	345,384 (354,751)	2.65	5.32	–	Exploratory drilling below the 6,765-foot level. Company expects to mine higher grade zinc ore in 1964.
Opemiska Copper Mines (Quebec) Limited, Chapais.	2,000	737,543 (544,518)	2.94	–	–	Routine exploration and development of Springer and Perry orebodies. Perry orebodies scheduled for production in 1965.
Orchan Mines Limited, Matagami.	1,900 treats 900 tons of copper ore a day from New Hosco mine.	35,955 (–)	0.89	10.54	–	Mine started production in October, 1963. Routine exploration and development in fourth quarter.
The Patino Mining Corporation, Copper Rand Division, Gouin Peninsula, Chibougamau, (Machin Point, Chibougamau Jaculet, Portage Island and Quebec Chibougamau Gold fields mines)	1,800 treated at central, Machin Point mill.	675,730 (639,711)	2.46	–	–	Routine exploration and development. Production from Jaculet stopped to allow development of four new levels.

Table 3 (cont'd)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1963 (1962) (short tons)	Grade			Development
			Copper (%)	Zinc (%)	Nickel (%)	
Quebec (cont'd)						
Quemont Mining Corporation, Limited, Noranda.	2,300	803,000 (804,600)	1.22	2.21	—	Routine exploration and development.
Solbec Copper Mines, Ltd., Stratford Place.	1,000	188,943 (271,384)	1.96	4.72	—	Production interrupted by five-month strike. Drier installed to remove moisture from concentrates. Routine development of Solbec and Cupra orebodies. Open pit mining will start in 1964 from the Solbec orebody.
Sullico Mines Limited, Val d'Or.	3,000	1,007,046 (991,868)	0.63	0.42	—	Routine exploration and development of small orebodies.
Vauze Mines Limited, Noranda.	350	115,878 (109,242)	3.14	2.42	—	Exploration of ore zone by diamond drilling. Routine development of known ore.
Ontario						
Falconbridge Nickel Mines, Limited (Falconbridge, Hardy, Onaping and Fecunis mines), Sudbury.	3,000 at Falconbridge 1,500 at Hardy 2,400 at Fecunis.	2,065,259 (2,407,520)	0.78	—	1.63	Routine exploration and development at producing mines. Extensive development and underground diamond drilling at Strathcona mine. Exploration for new properties in many parts of Canada.
Geco Mines Limited, Manitouwadge.	3,300	1,281,165 (1,282,414)	1.88	5.72	—	Routine exploration and development of known ore. Sinking of the No. 4 production shaft was started and development headings driven

						to its location from the No. 1 shaft on the 1850- , 2050- , 2250- and 2450-foot levels. The new shaft will allow the development of the ore zone to a depth of 4,000 feet below the surface.
The International Nickel Company of Canada, Limited, (Frood-Stobie, Creighton, Garson, Levack and Murray mines and the Clarabelle open-pit mine), Copper Cliff	30,000 at Copper Cliff, 12,000 at Creighton mine, 6,000 at Levack mine.	11,208,443 (12,407,768)	..	–	..	Routine exploration and development. Iron ore recovery plant expanded to produce over 800,000 tons of iron ore pellets a year from nickeliferous pyrrhotite.
Kam-Kotia Porcupine Mines, Limited, Timmins.	1,600	400,091 (376,533)	2.00	0.85	–	Mill capacity increased from 1,000 tons of ore a day to 1,600 tons a day and a circuit installed to recover a zinc concentrate. No. 1 shaft completed to a depth of 1,036 feet below the surface and five levels established. The open-pit mine will supply all of the mill feed until March, 1964 at which time production from the underground mine will start and will gradually replace production from the open pit.
McIntyre-Porcupine Mines, Limited, Schumacher.	1,000	156,400 (–)	0.94	–	–	Copper ore from development headings milled from January to July. Stope production at 800 tons a day started in August. Daily tonnage will be increased to 1,000 tons in 1964.

Table 3 (cont'd)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1963 (1962) (short tons)	Grade Copper (%)	 Zinc (%)	 Nickel (%)	Development
Ontario (cont'd)						
North Coldstream Mines Limited, Kashabowie.	1,100	367,677 (364,348)	2.01	—	—	Routine exploration and development of known orebodies. Exploration for new orebodies was carried out underground by drifting and diamond drilling in the favorable zone and on the surface by geological mapping and geophysical surveying.
Rio Algom Mines Limited, Pronto Division, Spragge.	750	258,499 (256,325)	1.96	—	—	Routine exploration and development. Diamond drilling at depth. As mining attained greater depth the stoping method was changed from shrinkage to cut and fill.
Temagami Mining Co. Limited, Timagami	200	55,009 (52,970	7.24	—	—	Routine exploration and development. Three new levels developed at 175, 975 and 1,125 feet below the surface. A change was made from diesel-generated electric power to hydro-electric power from the Hydro Electric Power Commission and a 12.5 kv transformer station installed. A new bunkhouse, assay office and a boiler house with a 1,000-hp. boiler, were built.
Willroy Mines Limited, Manitouwadge	1,200	483,800 (495,028)	2.02	3.32	—	Routine exploration and development. Shaft sinking at Lun-Echo property from which production expected in 1964.

Manitoba–Saskatchewan

Hudson Bay Mining and Smelting Co., Limited, (Flin Flon, Coronation, Schist Lake and Chisel Lake mines) Flin Flon.	6,000 treated at central mill at Flin Flon.	1,618,617 (1,702,340)	2.58	5.2	–	Routine development at producing mines. Stall Lake mine will start production in first quarter of 1964. Osborne Lake mine being developed for production.
Sherritt Gordon Mines, Limited, Lynn Lake.	3,500	1,346,192 (1,262,502)	0.58	–	0.96	Routine exploration and development.
Stall Lake Mines Limited, Snow Lake, Manitoba.	100 tons of ore a day shipped to Flin Flon for milling.	.. (–)	..	–	–	Mining of known reserves.

British Columbia

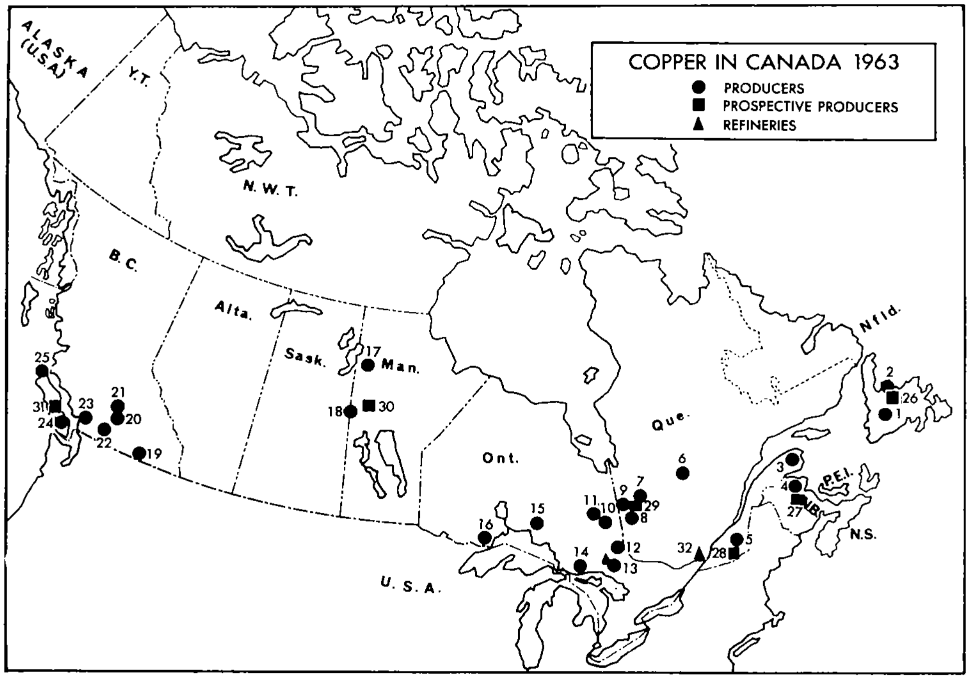
The Anaconda Company (Canada) Ltd., Britannia Beach.	4,000 (operating rate 2,000)	493,700 (501,078)	1.29	0.99	–	Routine mining of known reserves. Extensive exploration program for new orebodies on company-owned claims.
Bethlehem Copper Corporation Ltd., Highland Valley.	3,300	1,203,750 (74,435)	1.06	–	–	Routine open-pit mining in East Jersey zone. Stripping of overburden started in Jersey zone. Mill capacity will be increased to 6,000 tons of ore a day by Dec. 1964. Molybdenum circuit added to mill to recover an estimated one ton of MoS_2 a day.
The Consolidated Mining and Smelting Company of Canada Limited, Coast Copper mine, Benson Lake, V.I.	750	281,347 (66,499)	1.85	–	–	Development and rehabilitation of lower levels in the mine. An extension to the mill to recover 80,000 tons a year of high-grade magnetite has been added.

Table 3 (cont'd)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1963 (1962) (short tons)	Grade			Development
			Copper (%)	Zinc (%)	Nickel (%)	
British Columbia (cont'd)						
Cowichan Copper Co. Ltd., Sunro mine, River Jordan.	1,500	267,675 (144,009)	1.60	—	—	The mine operated normally until December 5 when an abandoned stope broke through to the surface under the Jordan River. Flooding has forced the cessation of development work below the main haulage level.
Craigmont Mines Limited, Merritt.	5,000	1,787,717 (1,797,000)	1.85	—	—	Routine mining of open-pit ore. Development of orebodies underground.
Giant Mascot Mines, Limited, Hope.	1,000	313,836 (311,443)	0.32	—	0.85	Routine exploration and development.
The Granby Mining Company Limited, Phoenix Division, Greenwood.	2,000	645,083 (554,699)	0.69	—	—	Mill capacity increased by the addition of extra flotation cells and classifiers. Mining in the open pit continued.

Source: Company reports.

Symbols: .. Not available; — Nil.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRODUCERS

1. American Smelting and Refining Company (Buchans Unit)
2. Atlantic Coast Copper Corporation Limited
   Maritimes Mining Corporation Limited
3. Gaspé Copper Mines, Limited (smelter)
4. 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)
   The Patino Mining Corporation, Copper Rand Mines Division (4 mines)
   Merrill Island Mining Corporation, Ltd.
   Opemiska Copper Mines (Quebec) Limited
7. Mattagami Lake Mines Limited
   New Hosco Mines Limited
   Orchan Mines Limited
8. 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. McIntyre-Porcupine Mines, Limited
11. Kam-Kotia Porcupine Mines, Limited
12. Temagami Mining Co. Limited
13. Falconbridge Nickel Mines, Limited (4 mines, 1 smelter)

PRODUCERS (cont'd)

13. The International Nickel Company of Canada, Limited (6 mines, 2 smelters, 2 refineries)
14. Rio Algom Mines Limited
15. Geco Mines Limited
    Willroy Mines Limited
16. North Coldstream Mines Limited
17. Sherritt Gordon Mines, Limited
18. Hudson Bay Mining and Smelting Co., Limited (4 mines, 1 smelter)
    Stall Lake Mines Limited
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. Cowichan Copper Co. Ltd. (Sunro mine)
25. The Consolidated Mining and Smelting Company of Canada Limited (Coast Copper mine)

PROSPECTIVE PRODUCERS

26. Consolidated Rambler Mines Limited
27. Brunswick Mining and Smelting Corporation Limited
28. Cupra Mines Ltd.
29. Lake Dufault Mines, Limited
30. Hudson Bay Mining and Smelting Co., Limited (Stall Lake and Osborne Lake mines)
31. Western Mines Limited

REFINERIES

13. The International Nickel Company of Canada, Limited (2 refineries)
32. Canadian Copper Refiners Limited

In the Noranda-Normetal area, Lake Dufault Mines, Limited completed shaft sinking to 1,995 feet below the collar and started lateral development to open up the massive copper orebody for mining. Construction of a 1,300-ton-a-day mill was started and production is scheduled for September 1964. Joutel Copper Mines Limited continued underground lateral development and diamond drilling at its property 60 miles north of Amos. Two mineralized zones have been discovered; the larger contains 1.4 million tons averaging 2.5 per cent copper and the smaller, which hasn't yet been fully delineated, 216,000 tons averaging 10.9 per cent zinc and 0.2 per cent copper. Rio Algom Mines Limited completed shaft sinking to a depth of 1,225 feet below the surface at its copper property adjoining Joutel Copper. Lateral development was started on the 1,000- and 1,150-foot levels. The company plans to explore and delimit the one-million ton orebody by drifting, crosscutting and diamond drilling.

TABLE 4
Prospective Producing Companies*, 1963

Company and Location	Type of Ore	Mill Capacity (tons ore/day)	Production to Start	Destination of Concentrates
Newfoundland				
Consolidated Rambler Mines Limited, Baie Verte.	Cu-Au	750	1964	..
New Brunswick				
Brunswick Mining and Smelting Corporation Limited, Bathurst.	Zn,Pb,Cu	4,500	1964	Belgium and own smelter
Quebec				
Cupra Mines Ltd., Stratford Place.	Zn,Cu	500 tons of ore a day will be trucked to Solbec mill.	1964	Overseas markets
Lake Dufault Mines, Limited, Noranda.	Zn,Cu	1,300	1964	Noranda, Quebec.
British Columbia				
Western Mines Limited, Buttle Lake, V.I.	Zn,Cu	750	1965	Japan

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

Many companies were active in the exploration for new copper orebodies in Quebec. Interest was centered in the Noranda-Val d'Or-Amos area, the Matagami area and the Holton Lake area, all in northwestern Quebec, and also in Ungava.

Ontario

The continuation of production curtailments at the Sudbury area mines of The International Nickel Company of Canada, Limited and a production cut instituted in the third quarter at the mines of Falconbridge Nickel Mines, Limited caused Ontario's production to decline for the second successive year. Copper production in 1963 totalled 178,960 tons, almost 10,035 tons less than in 1962 and 32,687 tons less than in 1961. The value of 1963's output was $112,048,454, down $4,299,269 from 1962.

McIntyre-Porcupine Mines, Limited at Schumacher became Ontario's newest copper producer when it began mining and milling 1,000 tons a day of low-grade copper ore. The concentrates were shipped for treatment to International Nickel Company's smelter at Copper Cliff. Kam-Kotia Porcupine Mines, Limited, near Timmins, enlarged its mill from 900 tons a day to 1,600 tons, completed shaft sinking to 1,036 feet below the collar, established five working levels from the shaft and started lateral development to explore the new orebody discovered in 1962. At Manitouwadge, Geco Mines Limited started a major shaft-sinking program to reach the deeper part of its orebody. Willroy Mines Limited carried out a program of surface diamond drilling on the adjoining property of Lun-Echo Gold Mines Limited and shaft sinking on this ground started in August. Tribag Mining Co., Limited discovered a body of copper ore in the Batchawana area about 50 miles north of Sault Ste Marie. Diamond drilling from the surface established sufficient reserves to justify underground exploration and a shaft was collared; shaft sinking is scheduled for 1964. The discovery has stimulated exploration along the north shore of Lake Superior from Batchawana to Port Arthur.

Manitoba – Saskatchewan

Three companies operating six mines in these provinces produced 46,752 tons of copper in 1963 valued at $29,453,534. Hudson Bay Mining and Smelting Co., Limited operated the Flin Flon mine, a 6,000-ton-a-day concentrator and a smelter at Flin Flon, Manitoba, the Coronation mine in Saskatchewan and the Schist Lake and Chisel Lake mines near Snow Lake, Manitoba. The company was also developing the Stall Lake and Osborne Lake mines in the Snow Lake area. Stall Lake Mines Limited mined 100 tons of copper-zinc ore a day from a property adjacent to Hudson Bay's Stall Lake mine and shipped this ore to Flin Flon for smelting. Sherritt Gordon Mines, Limited at Lynn Lake, Manitoba, continued exploration of its ore zone from the Farley shaft and shipped copper concentrates from its 3,500-ton-a-day nickel-copper mill to Flin Flon for smelting.

British Columbia

Six mines in British Columbia produced a record total of 62,218 tons of copper valued at $39,184,967 in 1963, exceeding the 1962 record by 7,728 tons and $5,418,573.

The Britannia mine on Howe Sound, 20 miles north of Vancouver, was sold by Howe Sound Company to The Anaconda Company (Canada) Ltd. This company continued to mine the known orebodies and to explore for new ore. Western Mines Limited at the south end of Buttle Lake on Vancouver Island was exploring the Lynx and the Paramount orebodies by surface and underground diamond drilling; mill construction is scheduled in 1964. In Highland Valley, Bethlehem Copper Corporation Ltd. increased its mill capacity from 3,500 tons of ore a day to 4,000 tons and expects to reach a capacity of 6,000 tons a day by December 1964. A molybdenite recovery circuit was added to the mill. Stripping of the overburden from the Jersey orebody was started and production is planned from this orebody for the fall of 1964. Craigmont Mines Limited, at Merritt, continued production from its open-pit mine and from underground development of the orebody. The Phoenix Division of the The Granby Mining Company Limited mined low-grade copper ore from its open-pit mine east of Greenwood. Mill capacity was increased to 2,000 tons of ore a day from 1,500 tons. Cowichan Copper Co.

Ltd. continued production from the Sunro mine at River Jordan until December when a stope caved through to the surface and allowed flooding of the mine.

On the Unuk River north of Stewart, Granduc Mines, Limited completed an initial exploration program and started a study of the feasibility of bringing the 32-million ton orebody into production. Kennco Explorations (Western) Limited was drilling a promising copper property on Galore Creek, a tributary of the Stikine River. A study is being made of the feasibility of bringing the Granisle copper deposit at Babine Lake into production. The success of the Bethlehem and Craigmont mines and the discovery of large orebodies at Granduc and Galore Creek have stimulated exploration in many parts of British Columbia.

DOMESTIC CONSUMPTION AND USES

Price stability, abundant supply and a high level of industrial activity have combined to increase copper consumption throughout the world. In addition to its conventional uses in the fields of electric wires and cables, radiators, brasses and bronzes etc., copper has increased its share of the construction market, particularly in the field of drainage- water- and vent-tubing in building construction.

Canada's domestic consumption of refined copper in 1963 totalled 170,709 tons, 14,890 tons more than in 1962.

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 Electrical Company 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, Conduits 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

Although Canada has no tariff on copper entering the country in ores and concentrates, various tariff rates are in effect for the copper content in bars, rods, wire, semifabricated forms and fully processed products. The following table summarizes the Canadian tariff rates on copper and its products. At the beginning of 1962, tariffs were reduced on copper in pigs, blocks, ingots and cathodes and on copper in scrap and these changes are also summarized in the table.

The United States tariff on ores, concentrates and primary shapes is 1.7 cents a pound on copper content; on fabricated materials it is as high as 4.5 cents a pound plus 1.7 cents a pound on copper content.

TABLE 6
Canadian Tariffs*

	British Preferential		Most Favored Nation		General	
	Change		Change		Change	
	from	to	from	to	from	to
Ores and concentrates	free	same	free	same	free	same
Pigs, blocks, ingots and cathodes	1¢ lb	¾¢ lb	1.5¢ lb	¾¢ lb	1.5¢ lb	¾¢ lb
Scrap	1¢ lb	¾¢ lb	1.5¢ lb	¾¢ lb	1.5¢ lb	same
Anodes	5%	same	7.5%	same	10%	same
Oxide	free	same	15%	same	15%	same
Bars or rods, tubing not less than 6 ft. in length, unmanufactured; copper in strips, sheets or plates, not polished, planished or coated	5%	same	10%	same	10%	same
Bars and rods for the manufacture of wire and cable .	free	same	10%	same	10%	same
Tubing not more than ½ in. dia. and not less than 6ft. long	5%	same	10%	same	10%	same
Alloys of copper consisting 50% or more, by weight of copper in sheets, plates, bars, rods and tubes	7.5%	same	15%	same	25%	same

* Changes effective January 1, 1962

SMELTERS AND REFINERIES

Salient statistics on Canada's six copper smelters and two refineries are given in Tables 7 and 8. In 1963 the smelters treated 83 per cent of the domestic ores and concentrates. All the blister and anode copper produced was refined in Canada and some blister copper was imported for refining. Nickel-copper matte from the Falconbridge smelter was shipped to Norway for treatment.

TABLE 7
Canadian Copper and Copper-Nickel Smelters

Operator and Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1963 (short tons)	Blister or Anode Copper Produced, 1963 (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.	347,756	..
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.	285,900 (of which 75,000 were custom concentrates)	48,100
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.	384,189	37,919
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'd)

Operator and Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1963 (short tons)	Blister or Anode Copper Produced, 1963 (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. 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.	278,050	.. .. ..
Noranda Mines, Limited, Noranda, Que.	Copper anodes	1,600,000 (ores, concentrates and scrap)	Roasting furnaces, two hot-charge reverberatory furnaces, one green-charge reverberatory furnace, and five converters. Also smelts custom material.	1,594,773 (of which 613,354 were custom material)	161,461

Source: Company reports.
.. Not available.

TABLE 8
Canadian Copper Refineries

		Rated Annual Capacity (tons)	
Canadian Copper Refiners Limited, Montreal East, Que.	CCR brand electrolytic copper wire bars, ingot bars, ingots, cathodes, cakes and billets.	284,000	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.
The International Nickel Company of Canada, Limited, Copper Refining Division, Copper Cliff, Ont.	ORC brand electrolytic copper, cathodes, wire bars, cakes, billets, ingots and ingot bars	168,000	Refining of blister copper from Copper Cliff smelter. Also custom refining. Precious metals, selenium and tellurium are recovered from anode slimes.

Source: Company reports.

WORLD MINE PRODUCTION

Primary copper production in the Free World, as reported by the American Bureau of Metal Statistics, increased in 1963 to 3,609,236* tons from the 3,600,375 tons produced in 1962, in spite of continued production curtailments and sporadic strikes in all major producing countries.

TABLE 9
World Production of Copper, 1963
(short tons)

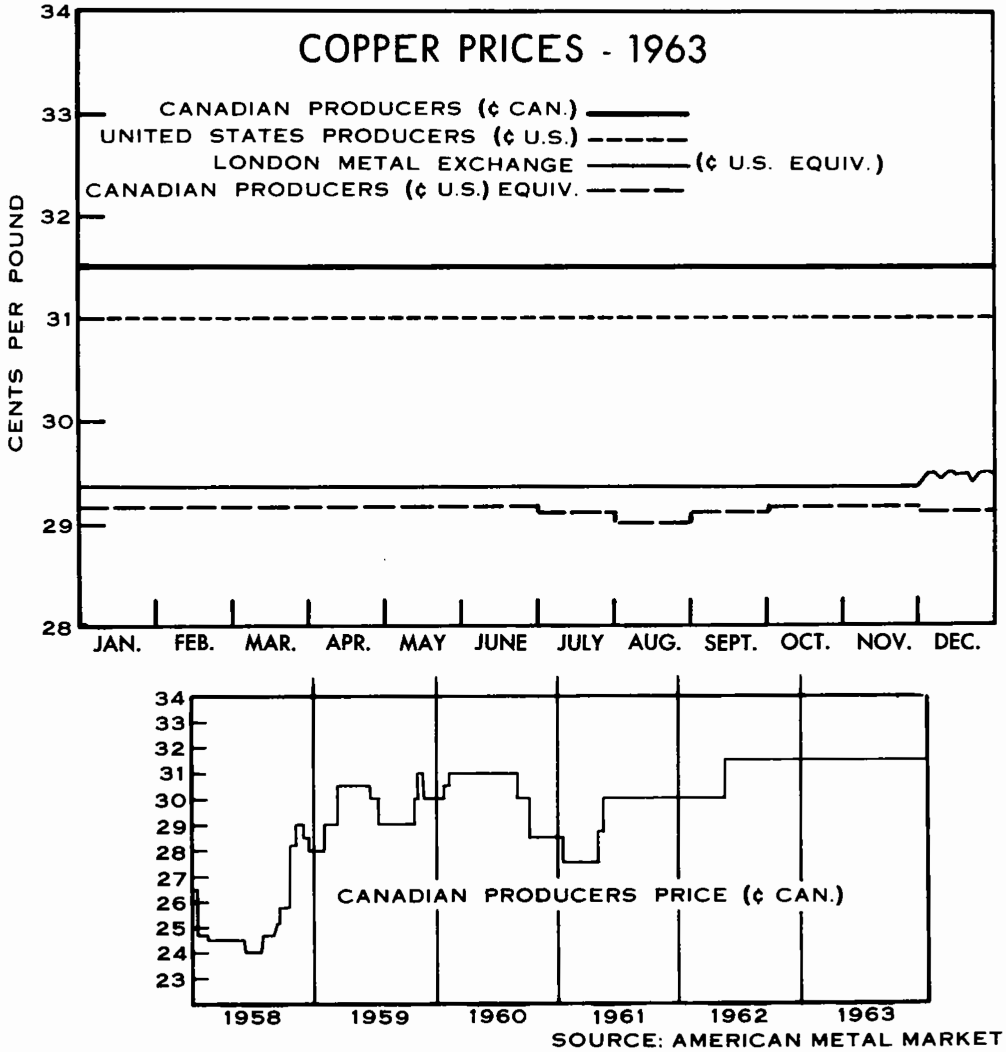
	Mine Production	Smelter Production
United States	1,208,197	1,393,003
Chile	662,126	615,216
Northern Rhodesia	648,238	624,725
Russia	600,000	600,000
Canada	452,559	353,000
West Germany	2,443	333,713
Republic of the Congo	297,500	297,500
Peru	195,519	173,469
Japan	118,021	325,400
Australia	118,832	96,369
Other countries	631,685	543,436
Total	4,935,120	5,355,831

Source: American Bureau of Metal Statistics Yearbook.

PRICES

The price of copper on all world markets was remarkably stable throughout the year. Production adjustments to balance supply and demand and producer support on the London Metal Exchange maintained the price stability that started in May 1961. The London Metal Exchange price was 29.25 cents (U.S.) a pound until December when it moved in a range between 29.3 and 29.5 cents (U.S.). The Canadian producers' price was 31.5 cents (Can.) a pound, delivered Toronto or Montreal, for the year and the United States producers' price was 31 cents (U.S.) delivered Connecticut Valley. The United States custom smelter price was discontinued on July 23 and for the rest of the year the producers' price was quoted. The custom smelter price had been the same as the producer price since January 17, 1961.

* This total is the latest available but does not include production from Russia, Japan, Australia, Yugoslavia, Norway, Sweden, Finland, the Messina mine in the Transvaal and several small countries from which reports are not available.


COPPER PRICES - 1963
CANADIAN PRODUCERS (¢ CAN.)
UNITED STATES PRODUCERS (¢ U.S.)
LONDON METAL EXCHANGE (¢ U.S. EQUIV.)
CANADIAN PRODUCERS (¢ U.S.) EQUIV.
CENTS PER POUND
34
33
32
31
30
29
28
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
34
33
32
31
30
29
28
27
26
25
24
23
CANADIAN PRODUCERS PRICE (¢ CAN.)
1958
1959
1960
1961
1962
1963
SOURCE: AMERICAN METAL MARKET

Feldspar

J.E. Reeves*

Production of Canadian feldspar continued to decline; in 1963, at 14 per cent below production in 1962, it was at the lowest level in more than 30 years. International Minerals & Chemical Corporation (Canada) Limited is the only operator; it produces fine-ground feldspar at Buckingham, Quebec, from hand-cobbed raw material that originates in the Back Mine in nearby Derry township.

Imports increased appreciably to meet the demand in western Canada. Exports were little changed. All trade was with the United States.

HISTORY

Feldspar, produced continuously in Canada since 1894, reached a peak of 54,851 short tons in 1948. Almost all has been mined from very coarse grained granitic pegmatites which are relatively common in southeastern Ontario and southwestern Quebec. The wide and growing acceptance of nepheline syenite as a replacement for feldspar has been the major factor in the latter's decline.

TECHNOLOGY

Feldspar is the term for a group of minerals consisting of aluminum silicates of potassium, sodium and calcium. The potassium and sodium varieties are valued in the ceramic industry as sources of alumina (Al_2O_3), potash (K_2O) and soda (Na_2O), and for their relatively low firing temperature. They are also of value because of their moderate abrasive properties. High-calcium feldspar (commonly the variety labradorite) because of its durability, iridescence and pleasing color, is in some demand for building and decorative purposes. It is not included in Canadian statistics on feldspar and is therefore not referred to further.

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

*Mineral Processing Division, Mines Branch

TABLE 1
Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production, shipments — Quebec	9,994	222,460	8,608	197,031
Imports — United States	1,901	43,846	2,600	59,217
Exports — United States	3,698	87,499	3,282	78,921
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.

TABLE 2
Production and Trade, 1954–63
(short tons)

	Production	Imports	Exports
1954	16,096	398	1,056
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

Source: Dominion Bureau of Statistics.

pegmatites with the feldspar concentrated in zones have been the main commercial sources. Hand cobbing was the common method of further concentration, and grinding and particle-size classification were the only processing required. Canadian feldspar is still prepared for market in this way.

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 noncommercial 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 and alkalis (potash and soda) 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 30, 1963, prices in the United States, f.o.b. point of shipment, North Carolina, in bulk, per short ton, were:

200 mesh	\$17.00 to \$21.00
325 mesh	\$18.00 to \$22.00
40 mesh, glass	\$13.50
20 mesh, semigranular	\$ 7.50

TARIFFS

Canadian and United States feldspar tariffs in effect at the time of writing were:

Canada	British Preferential	Most Favored Nation	General
Crude only	free	free	free
Ground but not further manufactured	”	15%	30%

United States

Crude	12½¢ per long ton
Ground	7½% ad valorem

Fluorspar

C.M. Bartley*

In 1963 Canadian fluorspar production, almost entirely from Newfoundland, increased in value to almost $2 million, the highest since 1956.

PRODUCTION AND TRADE

The Director mine, at St. Lawrence, Newfoundland, produced fluorspar concentrate which when shipped to Arvida, Quebec, was further processed and used in the production of aluminum. Four tons of crystal fluorspar were exported; all of it went to Britain where it was used in the optical industry. This material has a high value but demand is not large.

Imports of fluorspar, mainly from Mexico, were fractionally lower than in 1962 at 66,798 tons valued at $1.9 million. Most was consumed in steel production and in metallurgical and foundry processes.

Consumption of fluorspar in Canada reached an all-time high of more than 123,000 tons in 1962. Over the past several years, production (shipments) plus imports minus exports show an accumulating balance suggesting that consumption may be somewhat higher than official figures indicate. *See* Table 2.

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. Hydrofluoric acid is used to manufacture fluorocarbon aerosols and refrigerants, in gasoline alkylation and uranium metal processing.

Huntington Fluorspar Mines Limited with a new plant at Northbrook, Ont. is now manufacturing a five-pound fluorspar briquette using imported metallurgical-grade fluorspar. The briquettes are marketed exclusively by Foseco Canada Limited, Guelph, Ont. for foundry use.

*Mineral Processing Division, Mines Branch

TABLE 1
Fluorspar – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)				
Newfoundland	na	1,870,184	na	1,976,006
Exports, Britain	4	10,366*	4	7,500*
Imports				
Mexico	52,906	1,609,564	48,548	1,385,851
Republic of South Africa	12,077	310,846	9,583	221,560
United States	2,236	98,979	6,954	250,445
Britain	628	32,667	1,713	88,401
Total	67,847	2,052,056	66,798	1,946,257
Consumption				
Metallurgical flux	40,396		43,663	
Glass	1,297		1,999	
Other (including aluminum production)	82,001		97,178	
Total	123,694		142,840	

Source: Dominion Bureau of Statistics.
*Shipments of clear crystal for optical use.
na Not available.

TABLE 2
Fluorspar – Production, Trade and Consumption, 1954–1963
(short tons)

	Production[1]	Exports[2]	Imports	Consumption
1954	118,969	34,756	16,240	80,610
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[3]	7	30,408	89,933
1959	74,000[3]	3,774	26,588	96,016
1960	77,000[3] r	10,312	59,690	111,835
1961	80,000[3] r	2,048	32,769	111,542
1962	75,000[3] r	4	67,847	123,694
1963	85,000[4]	4	66,798	142,840

Source: Dominion Bureau of Statistics except where otherwise indicated
[1] Producers' shipments. Tonnage statistics after 1957 are not available for publication. [2] Exports to the United States for 1954 as reported in the United States import statistics. Exports after 1954 are as recorded in *Trade of Canada* (DBS). [3] Estimates reported by the U.S. Bureau of Mines. [4] Shipments reported in Aluminium Limited annual report 1963.
r Revised from previously published figure.

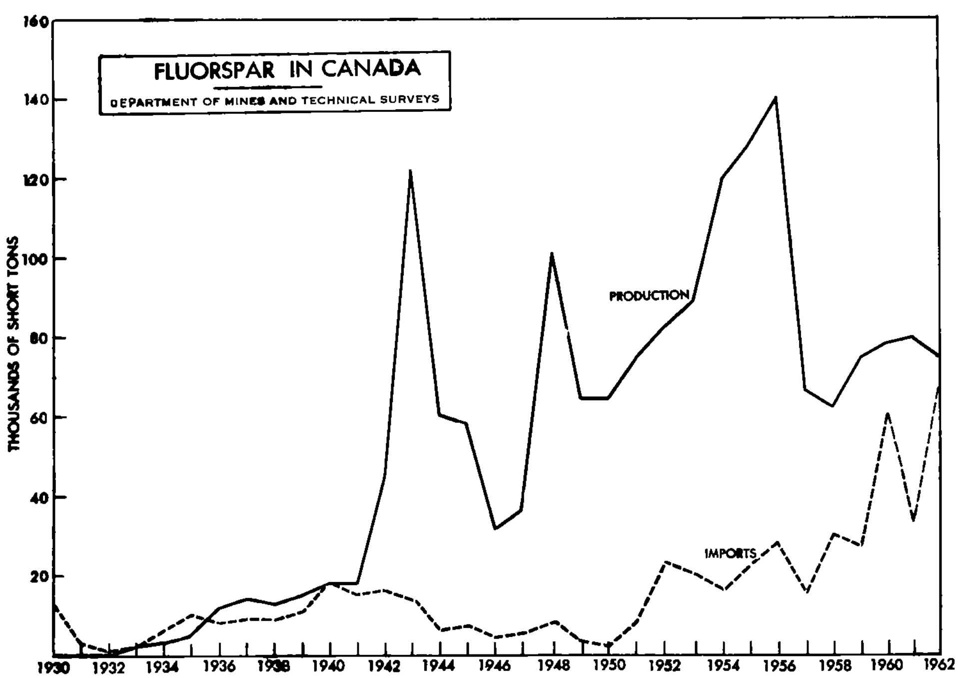
TABLE 3

World Production of Fluorspar

(short tons)

	1962	1963
Mexico	553,642	530,893
France	237,200	248,000
U.S.S.R.	230,000e	235,000e
China	220,000e	220,000e
United States	206,026	199,843
Spain	165,356	168,441
Italy	171,474	137,232
West Germany	116,592	95,942
Canada	75,000	85,000
East Germany	80,000e	80,000e
Britain	79,525	75,121
Republic of South Africa	111,683	57,761
Others	163,502	224,767
Total	2,410,000	2,358,000

Source: U.S. Bureau of Mines, *Minerals Yearbook 1963;* for Canada, 1963 annual report Aluminium Limited.
e Estimate.



Canadian Fluorspar Resources

Fluorspar has been produced from deposits in Newfoundland, Nova Scotia, Ontario and British Columbia. Smaller undeveloped occurrences are known in New Brunswick, Quebec, and the Yukon, and large reserves are available particularly in Newfoundland and British Columbia. At present, however, because of the location and cost of operation these deposits are not competitive with the large output, efficient low cost operation and lower transportation charges of production from Mexico and Europe.

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 1.7 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, because of water problems and insufficient finances, mined to shallow depths only. 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 Ainsley 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 available to justify its re-opening. Shallow flat-lying fluorspar deposits along the Liard River in northern British Columbia have received preliminary investigation and large amounts of ore are indicated. The remote location and high cost of transportation however 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 underway for some time, however, and the company reports encouraging results.

The Mount Pleasant Mines Limited tin-base metal property in New Brunswick contains some fluorspar which may be recoverable as a byproduct in milling.

WORLD REVIEW

Although the world fluorspar situation appears to have changed little during 1963 there are signs that continually rising demand, particularly in North America, is beginning to cause uneasiness about future supplies. Current world production is fully adequate for immediate needs and in both Mexico and Italy overproduction has made producers unhappy with the prices they must accept to compete for markets.

Because world requirements for fluorspar for metallurgical use, including cryolite for the manufacture of aluminum, will increase with the expansion in these industries, the requirements are predictable. The use of fluorine chemicals and derived products has grown strongly because of the popularity of fluorocarbon compounds as used in aerosols, refrigerants and high-performance plastics. The new and unique performance characteristics of these materials and the new chemicals and new applications being developed continually assure that raw material requirements will continue to rise rapidly though at rates which may be difficult to predict.

The potential of the fluorine chemical industry, its expected future demand for fluorspar and the effect that this may have on the availability of future supplies and prices have been carefully studied in the United States. In that country a feature of the hydrofluoric acid industry has been the rapid technological development. As well as this, the expansion of production facilities has resulted in greater competition and lower prices. Another feature has been the concentration of production facilities around the Gulf of Mexico close to Mexican fluorspar supplies. These supplies of high-grade material enter the United States at a low tariff compared with the tariff on low-grade concentrate.

In western Europe and Japan the industrial resurgence and growing prosperity will doubtless result in increased fluorspar consumption. Demands for steel and aluminum may soon exceed that of North America and rising consumer income will open markets for fluorine chemical end products on at least a comparable scale. Because much of the research and development has already been done, the markets may develop faster than they did in North America.

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 the melting of 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. It has been estimated that fluorspar requirements for chemical purposes will continue to increase. For these various uses, the following 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 five 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 ($CaCO_3$), three 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 one per cent SiO_2. Like the ceramic grade it is used in powdered form.

PRICES

Canada

Ceramic grade, 94% CaF_2, coarse, Aluminum Company, Limited, per net ton f.o.b. Arvida, Quebec $61.50

United States

According to *E & M J Metal and Mineral Markets*
December 30, 1963, per short ton f.o.b. Illinois, Kentucky.
Metallurgical grade, 72½-60% CaF_2 $37–$39

Acid Grade,

Dry 97% CaF_2

carloads \$45; less than carloads \$50; bagged, \$3 extra.

Pellets, carloads \$55; less than carloads \$60.

Ceramic grade, calcite and silica variable, Fe_2O_3 maximum 0.14%

88-90% CaF_2 \$41; 93-94% CaF_2 \$42; 95-96% CaF_2 \$43; bagged, \$3 extra.

European

c.i.f. U.S. ports, duty paid, per short ton

Metallurgical 72½% CaF_2 \$30 – \$33

Acid – wet filter cake, 8-10% moisture, sold on dry content \$36 – \$40

Mexican per short ton, f.o.b.

Metallurgical, 72½% CaF_2 border, rail, duty paid \$24.50 – \$26; Brownsville, barge, duty paid \$27 – \$28.50; Tampico, vessel, cargo lots \$17 – \$19; U.S. Atlantic ports, cars, duty paid \$31 – \$34.

TARIFFS ON FLUORSPAR

Canada – free.

United States

Containing over 97% by weight of calcium fluoride – \$2.10 per long ton

Containing not over 97% by weight of calcium fluoride – \$8.40 per long ton

Gold

T.W. Verity*

In 1963 the average Royal Canadian Mint value for a fine troy ounce of gold increased to $37.75 from $37.41. Notwithstanding the higher price, gold production dropped 4.6 per cent to 3,986,044 fine troy ounces. Gold continued to be fifth in value of output in Canada following crude petroleum, nickel, iron ore and copper. Ontario remained the principal producer with 58.6 per cent of the total; Quebec followed with 23 per cent, Northwest Territories had 9.5 per cent and British Columbia 4 per cent.

The United States Bureau of Mines estimated total world gold production in 1962 at 50 million troy ounces. Among Free World producers the Republic of South Africa produced 25.5 million ounces; Canada ranked second with 4.2 million ounces followed by the United States with 1.5 million and Australia with one million ounces. Production in the U.S.S.R., where no information on gold production is published, was estimated at 12.2 million troy ounces.

World output in 1963 increased 3.8 per cent, mainly because of an increase of 1.9 million ounces in the Republic of South Africa. The United States Bureau of Mines has not completed world estimates for 1963 but the First National Bank of New York places Free World production at 38.9 million troy ounces of gold, a three per cent increase over 1962 production. The Republic of South Africa, with a seven and a half per cent increase over its 1962 total, is contributing 70 per cent of Free World production.

In December 1963 the Emergency Gold Mining Assistance Act (E.G.M.A.A.) was extended to the end of the calendar year 1967, without changing the present method of computing the amount of assistance payable. New provisions in the Act required, however, that new lode gold mines commencing production after June 1965 must provide direct support to existing gold mining communities to qualify for cost assistance. At least one half of the persons employed at a new gold mine must reside in one or more such communities. A schedule added to the Act lists existing gold mining communities.

* Mineral Resources Division

TABLE 1
Production of Gold
(Troy Ounces)

	1962	1963
Newfoundland		
Base-metal mines	13,966	12,318
New Brunswick		
Base-metal mines	553	1,128
Nova Scotia		
Auriferous-quartz mines	–	–
Quebec		
Auriferous-quartz mines		
Bourlamaque-Louvicourt	293,480	278,698
Cadillac-Malartic	261,013	234,490
Noranda-Belleterre	26,137	2,253
Miscellaneous	1	17
Total.........................	580,631	515,458
Base-metal mines	412,812	401,771
Placer operations	117	–
Total, Quebec	993,560	917,229
Ontario		
Auriferous-quartz mines		
Porcupine.........................	1,006,700	992,790
Red Lake and Patricia..............	507,791	507,470
Larder Lake.......................	422,263	333,896
Kirkland Lake	249,852	259,952
Thunder Bay (Port Arthur)...........	132,728	150,052
Sudbury...........................	35,735	34,627
Miscellaneous	27	105
Total.........................	2,355,096	2,278,892
Base-metal mines	66,153	59,962
Total, Ontario	2,421,249	2,338,854
Manitoba		
Auriferous-quartz mines	37,194	20,819
Base-metal mines	31,065	29,067
Total.........................	68,259	49,886

Table 1 (cont'd)

	1962	1963
Saskatchewan		
Base-metal mines	66,034	64,813
Alberta		
Placer operations	186	132
British Columbia		
Auriferous-quartz mines	121,608	87,016
Base-metal mines	35,232	68,868
Placer operations	2,652	3,589
Total	159,492	159,473
Northwest Territories		
Auriferous-quartz mines	400,292	387,000
Yukon Territory		
Placer operations	54,805	54,184
Base-metal operations	–	1,027
Total	54,805	55,211
Canada, Total		
Auriferous quartz mines	3,494,821	3,289,185
Base-metal mines	625,815	638,954
Placer operations	57,760	57,905
Total	4,178,396	3,986,044
Total value	156,313,794	150,473,161
Average value per ounce	$37.41	$37.75

Source: Dominion Bureau of Statistics.
– Nil.

TABLE 2
World Gold Production
(Troy Ounces)

	1962	1963
North America		
Canada	4,178,396	3,986,044
United States (including Alaska)	1,556,000	1,468,750
Mexico	236,758	237,948
Nicaragua	221,984	204,769
Other countries	4,862	5,489
Total	6,198,000	5,903,000
South America		
Colombia	396,827	324,514
Peru	122,985	94,369
Brazil	180,000	180,000
Chile	65,009	79,572
Other countries	95,179	214,545
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	500,826	505,357
Total	12,900,000	13,200,000
Asia		
Philippines	423,394	376,036
Japan	286,593	261,868
Korea (including North Korea)	267,880	250,095
India	163,326	138,280
Other countries	103,807	118,721
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	211,615	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	51,700,000

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

TABLE 3
Production of Gold, 1954–63

Year	Auriferous-Quartz Mines troy ounces	%	Placer Operations troy ounces	%	From Base-Metal Ores troy ounces	%	Total Gold Production troy ounces	Total Value in Canadian Dollars	Average Value per Ounce in Canadian Funds	Gold % of All Mineral Production Value
1954	3,738,955	85.7	89,571	2.1	537,914	12.2	4,366,440	148,764,611	34.07	10.0
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	85.9	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	83.6	57,760	1.4	625,815	15.0	4,178,396	156,313,794	37.41	5.5
1963	3,289,185	82.5	57,905	1.5	638,954	16.0	3,986,044	150,473,161	37.75	4.9

Source: Dominion Bureau of Statistics.

The E.G.M.A.A. originally came into force in June 1948 and was designed to assist marginal gold mines that faced rising costs and a pegged gold price, and help maintain communities that existed in the gold mining areas. The gold mines continued to face adverse conditions and the Act was extended, with some amendments, several times. During 1963, 42 of the 50 producing lode gold mines received cost assistance under the Act.

Inspite of sustained cost assistance, many gold mines were having difficulty in continuing to operate. Increased depth of mining and lower grades of ore available for mining increased the cost of recovering gold. In Quebec one small gold mine closed in December 1962 and another closed in May 1963; in Ontario one small gold mine closed in March 1963. No new mines opened but some gold was recovered from clean-up of old gold mines and from development ore from prospective gold producers in various parts of Canada.

OPERATIONS AT PRODUCING MINES

Atlantic Provinces

Gold output came as a byproduct from the lead-zinc ores of the Buchans Unit, American Smelting and Refining Company, in the Red Indian Lake district of Newfoundland, and from copper ores of the Tilt Cove operation of Maritimes Mining Corporation Limited and the Little Bay operation of Atlantic Coast Copper Corporation Limited, both on Newfoundland's northeast coast. In New Brunswick, a small amount of gold was recovered as a byproduct from Heath Steele Mines Limited and the Wedge mine of The Consolidated Mining and Smelting Company of Canada Limited, both in the Bathurst-Newcastle area. No gold production was reported from Nova Scotia or Prince Edward Island.

Quebec

Total gold production declined eight per cent. The proportion coming as a byproduct from base-metal mining increased to 44½ per cent from 41½ per cent in 1962. No production was reported from placer operations. Thirteen lode gold mines operated, one less than in 1962.

Auriferous-quartz Mines

Bourlamaque-Louvicourt District – Five gold mines continued operating until May 1963 when Akasaba Gold Mines Limited closed. Only Bevcon Mines Limited and Sigma Mines (Quebec) Limited had increased gold output.

Cadillac – Malartic District – Seven mines operated, but Malartic Hygrade Gold Mines Limited was carrying out underground development and building a mill during 1963 and had little gold production. Only Marban Gold Mines Limited and Norlartic Mines Limited had increased gold output. East Malartic Mines, Limited, increased mining activity in its new east ore zone but the grade of ore milled was much lower. Tons of ore milled and ounces of gold produced were much lower at Barnat Mines Ltd. Canadian Malartic Gold Mines Limited and Malartic Gold Fields Limited were both on a salvage basis and had lower gold recovery.

Noranda District – Eldrich Mines Limited ceased operating in December 1962 and the company name was changed to Canadian-Australian Exploration Limited in April 1963. Elder-Peel Limited deepened its No. 2 shaft to 2,600 feet and was developing four new levels. Ore shipments to the Noranda smelter were discontinued during this development program and did not resume until December 1963.

Base-metal Mines

Nearly all copper concentrates from base-metal mines in Quebec and from some Ontario mines are smelted by Noranda Mines, Limited, at Noranda. Anode copper from Noranda and blister copper from Flin Flon, Manitoba, are refined at Montreal East by Canadian Copper Refiners Limited, a subsidiary of Noranda Mines, Limited. Over 400,000 troy ounces of gold are recovered by Noranda annually and most of this comes from base-metal operations of northwestern Quebec. Some gold is also recovered at Montreal East from copper anodes produced at the Murdochville smelter of Gaspé Copper Mines, Limited.

Placer Operations

Beauce Placer Mining Co. Ltd. did not operate its electric dredge on the Gilbert River near Beauceville East in 1963.

Ontario

Twenty-eight lode gold mines were operating at year-end; one mine closed in the Red Lake area in March. Gold production was lower by 3.2 per cent. Only Kirkland Lake and the Port Arthur mining division showed increased gold output.

Auriferous-quartz Mines

Porcupine Mining Division – Twelve mines continued operating but gold production decreased by 1.4 per cent. The two largest mines, Hollinger Consolidated Gold Mines, Limited, and McIntyre-Porcupine Mines, Limited, had lower tonnage milled and a decrease in gold recovery. Paymaster Consolidated Mines, Limited, and Preston Mines Limited also had lower gold production while all other mines in the division increased gold output. McIntyre started production from its copper mine in August at approximately 800 tons of copper ore a day. Paymaster commenced sinking its No. 6 internal shaft from the 4,375-foot level in September 1962 and plans to sink to 6,025 feet and open 11 new levels. In June, Dome Mines Limited completed sinking No. 7 internal shaft from the

4,000-foot level to 4,858 feet. Hallnor Mines, Limited completed sinking No. 3 internal shaft from the 3,209-foot level to 4,450 feet in May.

Red Lake and Patricia Mining Division – Seven mines operated until March when H.G. Young Mines Limited ceased production. Total gold production in the two divisions was close to the 1962 total. All mines except H.G. Young and Cochenour Willans Gold Mines, Limited, increased gold output. McKenzie Red Lake Gold Mines Limited increased its mill rate from 230 to 270 tons a day and was shaft sinking to develop four new levels.

Larder Lake Mining Division – Kerr-Addison Gold Mines Limited, Canada's largest gold producer, reduced output by 24 per cent. On November 18, 1963 Kerr-Addison, Anglo-Huronian, Limited, and Bouzan Mines Limited were amalgamated into a new company, Kerr Addison Mines Limited, which acquired assets of Prospectors Airways Company, Limited.

Kirkland Lake District – Five mines continued operating and gold production was four per cent higher. The Teck-Hughes Gold Mines, Limited, and Lamaque Gold Mines Limited were merged with Canadian Devonian Petroleums Limited under the name Teck Corporation Limited. On December 1, 1963 the Teck-Hughes mine was sold to Lamaque Mining Company Limited.

Port Arthur Mining Division – Gold production was 13 per cent higher from the three mines operating. Consolidated Mosher Mines Limited increased shipments to the MacLeod-Cockshutt Gold Mines Limited mill to 1,500 tons per day while MacLeod milled tons dropped to below 400 tons a day.

Sudbury Mining Division – Gold production at Renabie Mines Limited was three per cent lower than in 1962.

Base-metal Mines

Byproduct gold came mainly from nickel-copper mines in the Sudbury area and zinc-copper mines in the Manitouwadge area. Gold recovered was lower by 9.4 per cent.

Manitoba – Saskatchewan

San Antonio Gold Mines Limited at Bissett, Manitoba, leased the adjoining property of Forty-Four Mines, Limited, in October 1962 and all lode gold production in the province in 1963 came from San Antonio. Byproduct gold was recovered from copper-zinc ores of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon and from the nickel-copper ores of Sherritt Gordon Mines, Limited, at Lynn Lake. Production from both lode gold and byproduct gold was lower in 1963.

Gold recovered from the Saskatchewan operations of Hudson Bay Mining and Smelting Co., Limited, declined two per cent.

Alberta

A small amount of placer gold was recovered from gravels of the North Saskatchewan River near Edmonton.

British Columbia

Gold production from lode gold mines declined 28 per cent while gold recovered as a byproduct from base-metal mines increased 95.5 per cent. Placer gold recovery was 35.3 per cent higher. Two large lode gold mines operated: Bralorne Pioneer Mines Limited, Bridge River area, and The Cariboo Gold Quartz Mining Company, Limited, in the Wells area. The increase in gold recovered from base-metal mines came mainly from the new copper mine of Coast Copper Company Limited, on Vancouver Island. Other large producers of byproduct gold were Phoenix Copper Company Limited, The Anaconda Company (Canada) Ltd. (Britannia Mine) and Bethlehem Copper Corporation Ltd., a new copper producer near Ashcroft.

Northwest Territories

All gold came from lode gold mines. Gold production declined 3.3 per cent because of lower outputs from Giant Yellowknife Mines Limited and Consolidated Discovery Yellowknife Mines Limited. Some 14,000 tons of ore from Camlaren Mines, Limited, at Gordon Lake were mined in 1962, trucked over winter roads and treated in the Consolidated Discovery mill during the summer of 1963.

Yukon Territory

Gold recovered from placer operations was one per cent lower; 1,027 ounces were recorded from base-metal mining. The Yukon Consolidated Gold Corporation, Limited, operated six electric dredges in the Dawson City area, one more than in 1962, and also carried out two benching operations. There were some 35 small placer operations in the Yukon Territory during the year.

DEVELOPMENTS AT OTHER PROPERTIES

Quebec

In the Malartic area Kiena Gold Mines Limited commenced sinking a 2,100-foot shaft, Camflo Mattagami Mines Limited started sinking a 950-foot shaft in September and Con-Shawkey Gold Mines Limited drifted on the 700-foot level and trucked some development ore to the custom mill of Malartic Gold Fields Limited. Chimo Gold Mines Limited, near Louvicourt, and Transterre Explorations Limited, near Senneterre, were diamond drilling and had some good ore intersections. Wasamac Mines Limited, west of Noranda, intends to construct a 1,500-ton-a-day mill in 1964. Sturgeon River Mines Limited, at Bachelor Lake, completed shaft sinking to 1,115 feet in August, 1963.

Ontario

Sapawe Gold Mines Limited, near Atikokan, was tuning up a 100-ton-a-day mill in November. Surluga Gold Mines Limited was developing a gold property near Wawa in the Algoma district. Kenilworth Mines Limited was carrying out underground development at the old Naybob and De Santis mines near Timmins, in the Porcupine area, and late in December was tuning-up the former mill of the Coniaurum Mines, Limited, to be used as a custom mill. Stairs Exploration & Mining Company Limited, 45 miles south of Timmins, was preparing for shaft sinking. Lake Beaverhouse Mines Limited, near Larder Lake, was preparing to truck gold ore to the mill at Upper Canada Mines, Limited. In the Red Lake area, underground development continued at Consolidated Marcus Gold Mines Limited, Wilmar Mines Limited and Robin Red Lake Mines Limited. A new company, Annco Mines Limited, was formed to develop five claims acquired from Wilmar Mines Limited.

British Columbia

W.E. McArthur leased a gold property on Vancouver Island from Tofino Mines Limited and shipped a small amount of high grade ore to the Trail smelter of The Consolidated Mining and Smelting Company of Canada Limited. New Hamil Silver-Lead Mines Limited sub-leased the Tofino mine from McArthur, completed construction of a small cyanide mill and was tuning-up this mill in December 1963.

Northwest Territories

Tundra Gold Mines Limited (formerly Taurcanis Mines Limited) at Matthews Lake plans to start operating a 100-ton-a-day mill in March 1964. Many prospecting groups were active during 1963 throughout the Territories and diamond drilling indicated gold occurrences in the Contwoyto Lake and Coronation Gulch areas. In the Yellowknife area, a small amount of gold was recovered in development ore from the N'Kana property of The Consolidated Mining and Smelting Company of Canada Limited.

Yukon Territory

Ormsby Mines Limited drove a new adit into the old La Forma mine, near Carmacks, and was developing several high-grade ore shoots.

USES

Gold has always been prized for its rarity, beauty, lustre, its ability to resist corrosion and because it could 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 resistance in recent times has made it useful 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, goldware, foil, leaf, lace, thread, gilding, gold solutions, inserts, inlays and lettering. The color 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 vapor 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 of electronics include radio tubes, gold-plated printed circuits, gold-film thermometers, x-ray tubes, bolometers, transparent windows and semiconductors. 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, including Telstar, the first privately owned television satellite.

The Committee for Research on the Properties and Uses of Gold, Inc., was formed by the Transvaal and Orange Free State Chamber of Mines, the Chamber of Mines of Western Australia and the Homestake Mining Company of San Francisco, U.S.A. to promote increased industrial uses for gold. The Committee's business and research monitoring agent – Clyde Williams and Company, Columbus, Ohio – published a progress report in November 1963 that was available only to Committee members.

PRICES

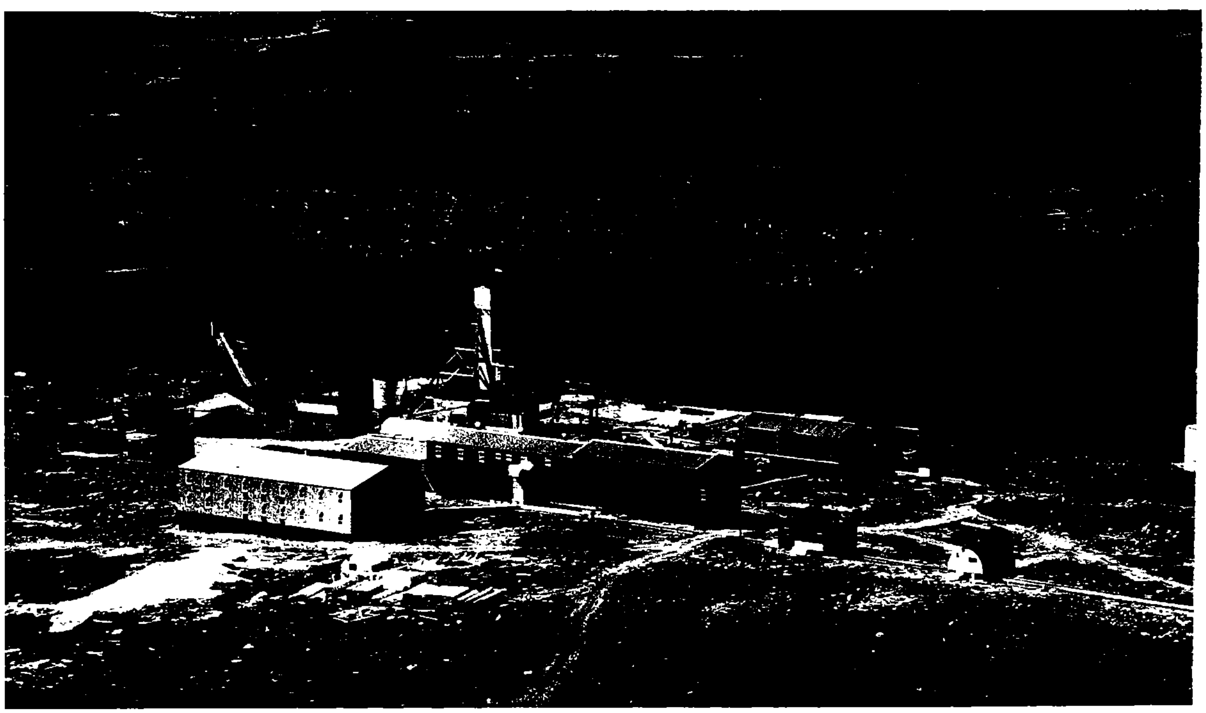
The average Royal Canadian Mint value for a troy ounce of fine gold in Canadian dollars increased to $37.75 from the 1962 average of $37.41.

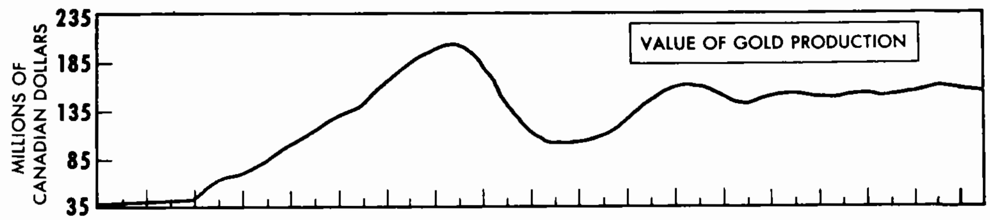
On May 2, 1962, the Canadian Government fixed the value of the Canadian dollar at $0.925 United States dollars: it may be allowed to fluctuate one per cent either side of parity. The Mint buying price in Canadian funds may vary, therefore, between $37.46 and $38.22 a troy ounce; during 1963, it varied only between $37.66 and $37.91 an ounce and was $37.80 at the year-end. The price of an ounce of gold on the international gold market of London, England, fluctuated between the narrow limits of $35.03 and $35.11 (weekly averages) in United States funds.

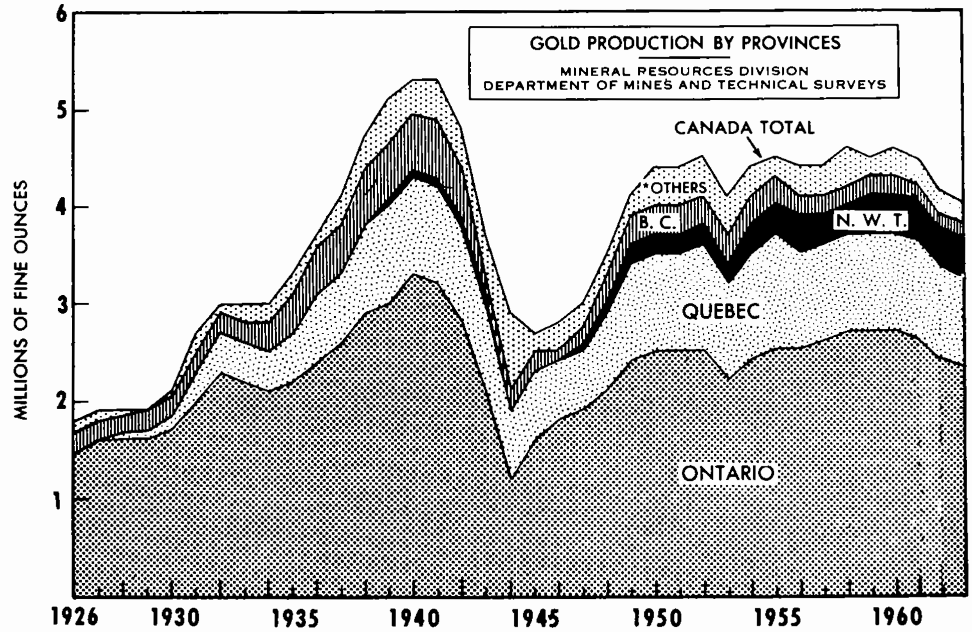
An accompanying graph shows the Royal Canadian Mint price for a fine troy ounce of gold in Canadian funds from 1926 to 1963. The Mint price for gold has been pegged at $35 a fine ounce in United States funds since 1934 and varies because of the relationship between the Canadian and United States dollars. Gold production by provinces and the value of gold production from 1926 to 1963 are shown in a second graph. There has been relatively little change in the value of gold production since 1954: a decline occurred in 1963 and further declines are indicated for 1964 and 1965 as some older operating gold mines exhaust known ore reserves and cease operations.

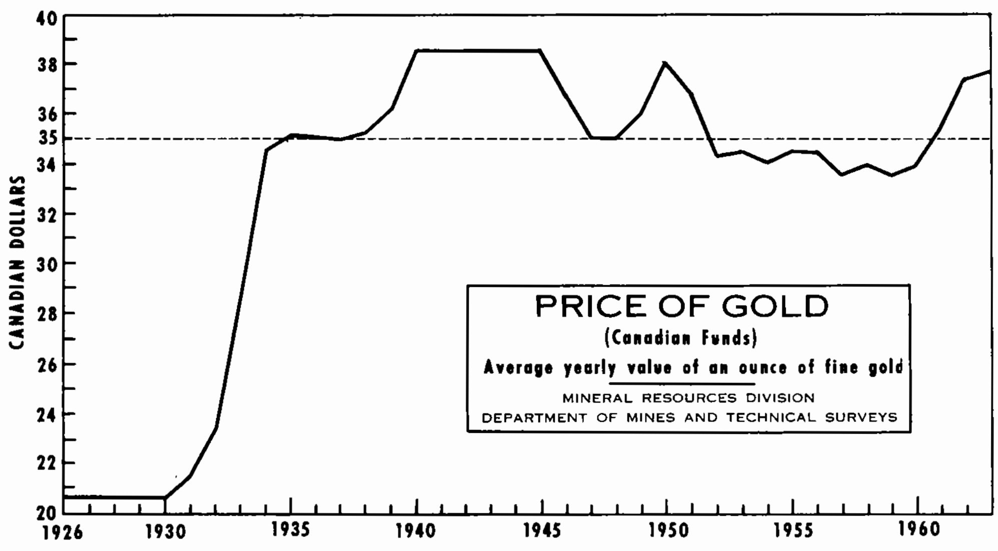
United States gold reserves declined by $465 million to $15.5 billion at the end of 1963. This represented about 37 per cent of the Free World monetary gold. Canadian gold reserves were $817 million with total reserves of gold and U.S. dollars at $2,595 million. International Monetary Fund officials and United States monetary authorities have stated that no increase in the U.S. price of gold is contemplated.

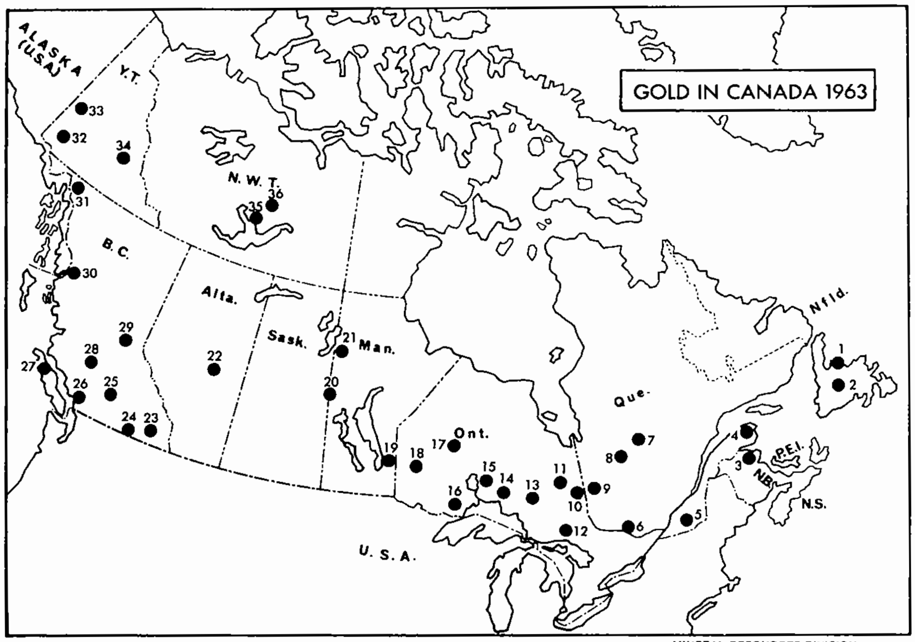
Tundra Gold Mines Limited, on Matthews Lake, is the newest gold producer in the Northwest Territories. Tundra, scheduled to start production in March 1964, will bring the total number of operating mines in N.W.T. to five.




VALUE OF GOLD PRODUCTION
MILLIONS OF CANADIAN DOLLARS
235
185
135
85
35


GOLD PRODUCTION BY PROVINCES
MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
CANADA TOTAL
*OTHERS
B. C.
N. W. T.
QUEBEC
ONTARIO
MILLIONS OF FINE OUNCES
6
5
4
3
2
1
1926
1930
1935
1940
1945
1950
1955
1960


PRICE OF GOLD
(Canadian Funds)
Average yearly value of an ounce of fine gold
MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
CANADIAN DOLLARS
40
38
36
35
34
32
30
28
26
24
22
20
1926
1930
1935
1940
1945
1950
1955
1960



PRODUCERS AND PROSPECTIVE PRODUCERS

Newfoundland

1. Atlantic Coast Copper Corporation Limited(a)
   Maritimes 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. Beauce Placer Mining Co.Ltd.(c)(d)
   Solbec Copper Mines, Ltd.(a)
6. New Calumet Mines Limited(a)
7. *Chibougamau District*
   Campbell Chibougamau Mines Ltd.(a)
   The Patino Mining Corporation (Copper Rand Mines Division)(a)
   Merrill Island Mining Corporation, Ltd.(a)
   Opemiska Copper Mines (Quebec) Limited(a)
8. *Bachelor Lake District*
   The Coniagas Mines, Limited (a)
9. Rouyn - Noranda District
   Elder-Peel Limited (b)
   Noranda Mines, Limited (a)
   Quemont Mining Corporation, Limited(a)
   Vauze Mines Limited
   Cadillac-Malartic District
   Barnat Mines Ltd.(b)
   Canadian Malartic Gold Mines Limited(b)
   East Malartic Mines, Limited (b)
   Malartic Gold Fields Limited (b)
   Malartic Hygrade Gold Mines Limited(b)
   Marban Gold Mines Limited(b)
   Norlartic Mines Limited(b)
   Camflo Mattagami Mines Limited(b)(d)
   Con-Shawkey Gold Mines Limited(b)(d)
   Kiena Gold Mines Limited (b)(d)

Quebec (cont'd)

Bourlamaque-Louvicourt District
Akasaba Gold Mines Limited(b)
Bevcon Mines Limited(b)
Lamaque Mining Company Limited(b)
Sigma Mines (Quebec) Limited(b)
Sullivan Consolidated Mines, Limited(b)
Manitou-Barvue Mines Limited(a)
Sullico Mines Limited(a)

Duparquet District
Normetal Mining Corporation, Limited(a)

Ontario

10. *Larder Lake District*
Kerr Addison Mines Limited(b)
Kirkland Lake District
Lake Shore Mines, Limited(b)
Lamaque Mining Company Limited (Teck-Hughes Mining Division)(b)
Macassa Gold Mines Limited(b)
Upper Canada Mines, Limited(b)
Wright-Hargreaves Mines, Limited(b)
Lake Beaverhouse Mines Limited(b)(d)

11. *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(b)
Hollinger Ross mine(b)
Hugh-Pam Procupine Mines Limited(b)
McIntyre-Porcupine Mines, Limited(a)(b)
Pamour Porcupine Mines, Limited(b)
Paymaster Consolidated Mines, Limited(b)
Preston Mines Limited(b)
Kenilworth Mines Limited(b)(d)
Matachewan District
Stairs Exploration & Mining Company Limited(b)(d)

12. *Sudbury Mining Division*
The International Nickel Company of Canada, Limited(a)
Falconbridge Nickel Mines, Limited(d)

13. Renabie Mines Limited(b)
Port Arthur Mining Division

14. Geco Mines Limited(a)
Surluga Gold Mines Limited(b)(d)
Willroy Mines Limited(a)

15. Consolidated Mosher Mines Limited(b)
Leitch Gold Mines Limited(b)
MacLeod-Cockshutt Gold Mines Limited(b)

16. North Coldstream Mines Limited(a)
Sapawe Gold Mines Limited(b)(d)

17. *Patricia Mining Division*
Pickle Crow Gold Mines, Limited(b)

18. *Red Lake Mining Division*
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)
H.G. Young Mines Limited(b)

Manitoba

19. Forty-Four Mines, Limited(b)
San Antonio Gold Mines Limited(b)

20. Hudson Bay Mining and Smelting Co., Limited(a)

21. Sherritt Gordon Mines, Limited

Alberta

22. Small placer operations on North Saskatchewan River(c)

British Columbia

23. Consolidated Mining and Smelting Company of Canada Limited (Bluebell, H.B., Sullivan mines)(a)

24. Phoenix Copper Company Limited(a)

25. Craigmont Mines Limited(a)
Bethlehem Copper Corporation(a)

British Columbia (Cont'd)

26. The Anaconda Company (Canada) Ltd. (Britannia mine)(a)
27. Coast Copper Company Limited(a)
    Texada Mines Ltd.(a)
28. Bralorne Pioneer Mines Limited, (Bralorne Division)(b)
29. The Cariboo Gold Quartz Mining Company, Limited(b) Small placer operations
30. Silbak Premier Mines, Limited(a)
31. Small placer operations(c)

Yukon Territory

32. The Burwash Mining Company Limited(c) and smaller operations(c)
33. The Yukon Consolidated Gold Corporation, Limited(c)
    Ballarat Mines Limited(c) and smaller operations
34. Ormsby Mines Limited(b)(d)

Northwest Territories

35. The Consolidated Mining and Smelting Company of Canada Limited (Con, Rycon, N'Kana mines)(b)
    Giant Yellowknife Mines Limited(b)
36. Camlaren Mines, Limited(b)
    Consolidated Discovery Yellowknife Mines Limited(b)
    Tundra Gold Mines Limited(b)(d) and other small gold mines(b)(d)

(a) Base metals. (b) Auriferous quartz. (c) Placer. (d) Prospective producer.

Graphite

J.E. Reeves*

Although not officially recorded, two tons of graphite, valued at 35 cents a pound, were shipped in 1963 by O. Clot Graphite Mining Ltd., Labelle, Quebec, to the domestic rubber industry.

Imports of natural graphite in various forms come from several countries. The United States is by far the main source, although the raw material originates elsewhere. The value of imports from most sources was higher than in 1962, in some cases considerably higher. Much of the graphite has been ground or otherwise processed to some degree before being imported. The value of imported graphite crucibles increased slightly.

Artificial graphite is produced by the electric-furnace treatment of petroleum coke 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 is relatively common (although generally not in very high concentration) in many parts of Canada, but particularly in the Precambrian limestones and gneisses of southeastern Ontario and southwestern Quebec, in which it occurs mainly as disseminated fine- to medium-grained flakes. One such deposit, located a few miles southeast of Perth, Ontario, has been under intermittent development for several years. The main source of graphite for the previously mentioned operation at Labelle is a group of coarse-grained graphite veins and stringers in a contact zone between a granitic rock and Precambrian limestone and quartzite.

*Mineral Processing Division, Mines Branch

TABLE 1

Natural Graphite – Production and Imports

	1962		1963	
	Short Tons	$	Short Tons	$
PRODUCTION (shipments)	nil	nil	nil	nil
IMPORTS				
Unmanufactured				
United States		28,706		41,500
Mexico		21,550		22,476
Ceylon		2,777		12,143
Norway		4,622		8,709
French Africa		nil		1,594
France		465		569
Britain		231		nil
Total		58,351		86,991
Ground and manufactured				
United States		998,089		1,659,179
Japan		253,410		615,793
West Germany		42,427		46,850
Britain		68,095		27,285
France		108		2,523
Ceylon		nil		1,618
Austria		363		315
Italy		nil		253
Total		1,362,492		2,353,816
Crucibles and covers				
United States		156,380		164,842
Britain		98,067		118,974
West Germany		nil		390
Total		254,447		284,206

Source: Dominion Bureau of Statistics.

WORLD PRODUCTION

There was a considerable increase in world production of natural graphite in 1963, mainly because of a very large increase in the production of amorphous graphite in the Republic of Korea. Mexico and Austria are also large producers of the amorphous variety; 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.

TABLE 2

Natural Graphite – Production and Trade, 1954–63

	Production* (short tons)	Imports		
		Unmanufactured $	Manufactured $	Crucibles $
1954	2,463	54,385	548,824	156,516
1955	–	64,798	561,394	202,864
1956	–	87,926	815,384	260,000
1957	–	74,089	748,732	237,333
1958	–	53,219	909,226	166,056
1959	–	64,014	976,250	224,204
1960	–	75,714	905,756	236,148
1961	1	47,450	945,258	215,788
1962	–	58,351	1,362,492	254,447
1963	–	86,991	2,353,816	284,206

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

TABLE 3

World Production of Natural Graphite
(short tons)

	1962	1963
Republic of Korea	204,032	334,777
Austria	98,416	109,778
U.S.S.R.	60,000[e]	60,000[e]
North Korea	72,000[e]	77,000[e]
China	45,000[e]	45,000[e]
Mexico	31,992	33,000[e]
Malagasy Republic	19,274	17,319
West Germany	13,134	13,000[e]
Ceylon	9,665	9,280
Norway	7,055	7,000
Italy	3,703	1,884
Hong Kong	902	891
Other countries	24,827	21,071
Total	590,000	730,000

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

TECHNOLOGY

Graphite is the common form of natural crystalline carbon. It occurs as flakes 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 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, is a good conductor of heat and electricity and is highly resistant to the action of heat and chemicals.

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 & M J Metal and Mineral Markets* of December 30, 1963, were:

	Dollars
Crystalline, f.o.b. source, in bags per metric ton (2,205 pounds)	
Malagasy Republic	90–200
Norway	80–140
West Germany	114–672
Ceylon (per long ton – 2,240 pounds)	95–250
Amorphous, f.o.b. source (80–85% C)	
In bulk, per metric ton	
Mexico	17– 20
Korea	15
In bags, per long ton – Hong Kong	21

TARIFFS

Partial information on tariffs in effect at this date is as follows:

	British Preferential	Most Favored 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 temporarily suspended on amorphous graphite valued at $50 or less per long ton.

Gypsum and Anhydrite

R.K. Collings*

GYPSUM

Gypsum, a hydrous calcium sulphate, is an important non-metallic mineral primarily because of its use in the manufacture of plaster and plaster products for the building-construction industry. The total tonnage quarried and mined domestically during any one year is greater than that of any other industrial mineral except sand, gravel and stone. It is produced in Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba and British Columbia. Nova Scotia, the chief producer, annually accounts for over 80 per cent of the total and exports most of its production to plants located along the eastern coast of the United States.

Production rose to a record 6.0 million tons in 1963, an increase of 12 per cent over 1962. Value of production increased 20.2 per cent, to $11.2 million. Quarries in Nova Scotia accounted for most of the increased production although output from Newfoundland was more than 2½ times that for 1962. Exports of crude gypsum, at 4.7 million tons, were 13 per cent greater than the previous year and represented almost 80 per cent of the total production. Imports of crude gypsum amounted to 74,628 tons. Most of this was from Mexico for use in British Columbia.

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 on Cape Breton Island; in the St. George's Bay area in southwestern Newfoundland; and in southeastern New Brunswick near Hillsborough.

* Mineral Processing Division, Mines Branch

No natural gypsum occurrences are known on the mainland of Quebec but extensive deposits outcrop over large areas of the Magdalen Islands in the Gulf of St. Laurence.

In Ontario, gypsum occurs in the Moose River area in the northeast, and in the Grand River area, south and west of Hamilton. The Moose River gypsum is 15 to 20 feet thick and is usually under 10 to 30 feet of cover; the Grand River deposits occur at depths up to 200 feet and are generally thin.

TABLE 1

Gypsum – Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)				
Crude gypsum				
Nova Scotia	4,451,072	7,113,517	4,910,536	8,228,893
Ontario	435,140	1,007,818	439,206	1,225,301
Newfoundland	83,992	284,564	232,259	766,098
British Columbia	147,900	443,700	160,954	482,862
Manitoba	122,870	338,527	131,767	395,301
New Brunswick	91,835	161,649	80,544	139,497
Total	5,332,809	9,349,775	5,955,266	11,237,952
Imports				
Crude gypsum				
Mexico	68,000	266,392	73,300	219,900
United States	1,935	34,128	1,322	24,369
Britain	12	456	6	262
Total	69,947	300,976	74,628	244,531
Plaster of paris, wall plaster				
United States	7,011	307,959	7,820	338,884
Britain	31	630	555	21,270
West Germany	3	129	5	292
France	6	1,245	2	425
Total	7,051	309,963	8,382	360,871
Wallboard and lath				
United States	71	17,211	65	11,556
Total imports	77,069	628,150	83,075	616,958
Exports				
Crude gypsum				
United States	4,162,997	5,630,206	4,703,118	7,674,340

Source: Dominion Bureau of Statistics.

Manitoba and Alberta each have large gypsum deposits. The main occurrences in Manitoba are at Amaranth where 40 feet of gypsum is found 100 feet below the surface, and at Gypsumville where beds 30 feet or more in thickness are exposed. An underground deposit was discovered recently in the vicinity of Silver Plains, 30 miles south of Winnipeg. This deposit of high-quality gypsum is 120 feet below the surface.

TABLE 2

Gypsum Production, Trade and Consumption, 1954–63
(short tons)

	Production[1]	Imports[2]	Exports[2]	Apparent Consumption[2,3]
1954	3,950,422	4,958	2,830,945	1,124,435
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

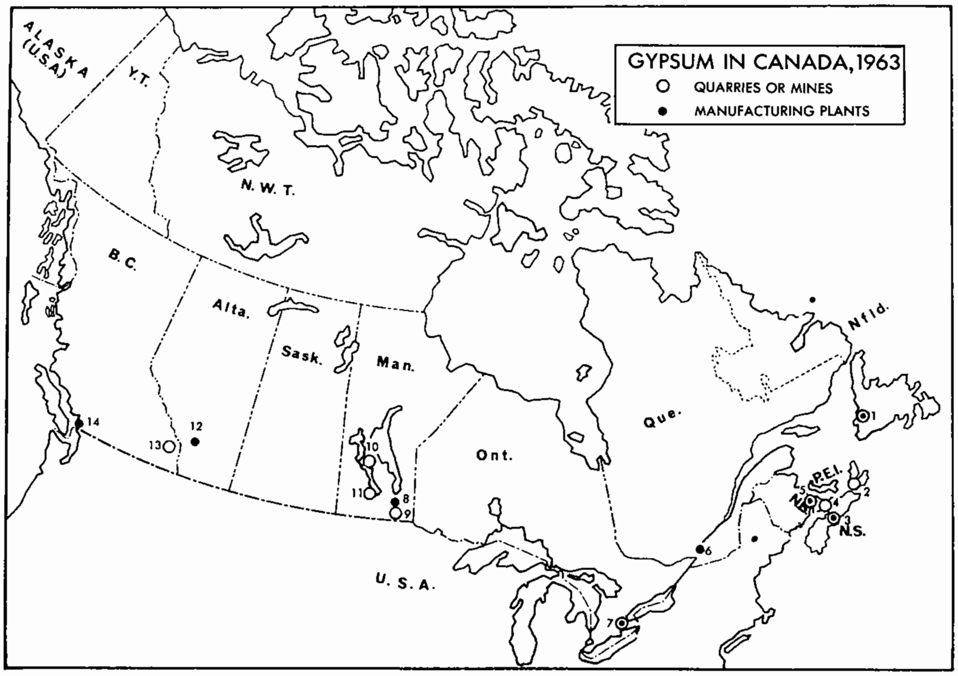
Source: Dominion Bureau of Statistics.
[1] Producers' shipments, crude gypsum. [2] Includes crude and ground but not calcined. [3] Production plus imports minus exports.

TABLE 3

World Production of Gypsum, 1963
('000 short tons)

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.*



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

QUARRIES OR MINES

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, Walton, and Cheverie
   Domtar Construction Materials Ltd., McKay Settlement
4. Domtar Construction Materials Ltd., Nappan
5. Canadian Gypsum Company Limited, Hillsborough
7. Canadian Gypsum Company Limited, Hagersville
   Domtar Construction Materials Ltd., Caledonia
9. Western Gypsum Products Limited, Silver Plains (being developed)
10. Domtar Construction Materials Ltd., Gypsumville
11. Western Gypsum Products Limited, Amaranth
13. Western Gypsum Products Limited, Windermere

MANUFACTURING PLANTS

1. Atlantic Gypsum Limited, Humbermouth
3. Domtar Construction Materials Ltd., Windsor
5. Canadian Gypsum Company Limited, Hillsborough
6. Canadian Gypsum Company Limited, Montreal
   Domtar Construction Materials Ltd., Montreal
7. Canadian Gypsum Company Limited, Hagersville
   Domtar Construction Materials Ltd., Caledonia
   Western Gypsum Products Limited, Clarkson
8. Domtar Construction Materials Ltd., Winnipeg
   Western Gypsum Products Limited, Winnipeg
12. Domtar Construction Materials Ltd., Calgary
    Western Gypsum Products Limited, Calgary
14. Domtar Construction Materials Ltd., Port Mann
    Western Gypsum Products Limited, Vancouver

Gypsum occurs in Alberta in Wood Buffalo Park and is exposed along the banks of the Peace River between Peace Point and Little Rapids. It also 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, and at Falkland near Kamloops. Another deposit, recently discovered near Loos in east-central British Columbia, is under investigation.

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.

CURRENT OPERATIONS

Nova Scotia

There are five companies actively producing gypsum in Nova Scotia. Production totalled 4.9 million tons in 1963, 82 per cent of the Canadian total. Over 90 per cent of the production of this province was exported to the United States in 1963.

Fundy Gypsum Company Limited, a subsidiary of United States Gypsum Company of Chicago, operates quarries for the export of crude gypsum at Wentworth and Miller Creek near Windsor.

National Gypsum (Canada) Ltd., a subsidiary of National Gypsum Company of Buffalo, New York, operates a quarry near Milford, 30 miles north of Halifax. Most of the gypsum from this quarry is for export to company plants in the United States; however, a small amount is shipped to Quebec. Gypsum for export is also obtained from quarries at Walton and Cheverie, 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, obtains gypsum from near Nappan for use in a company-owned gypsum-products plant in Montreal. This company 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 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

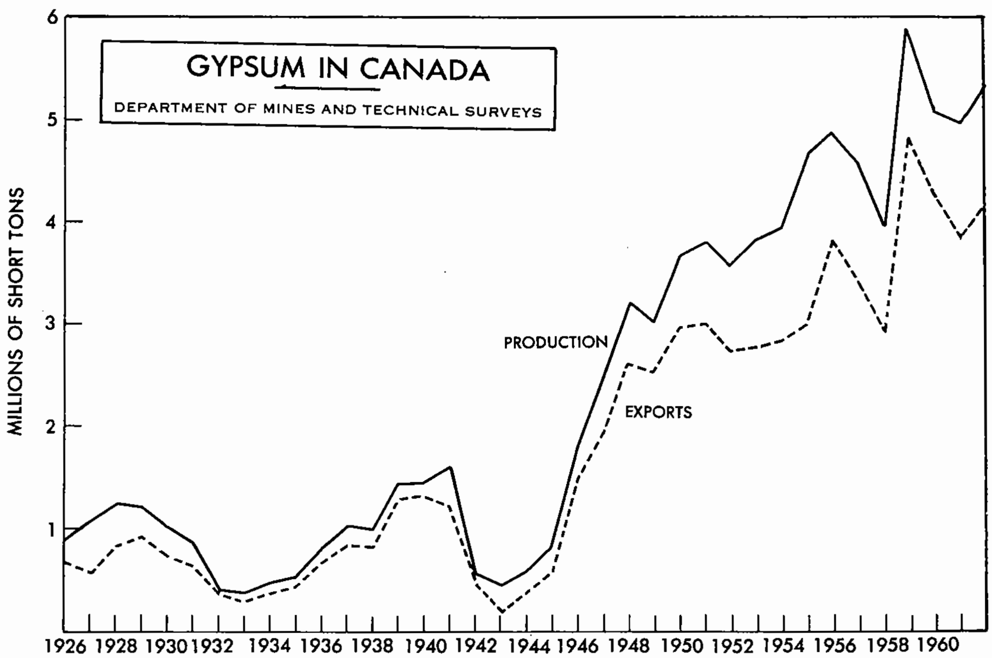
Gypsum is mined at Caledonia, near Hamilton, by Domtar Construction Materials Ltd., and at Hagersville, southwest of Caledonia, by Canadian Gypsum Company Limited. This gypsum is used in the manufacture of plaster and wallboard at company plants located near each of the mines.

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 Flinkote Company of Canada Limited, Toronto, a subsidiary of Flinkote Company of New York. Crude gypsum for its operation is obtained from Flinkote's quarries at Flat Bay Station, 62 miles by rail southwest of Humbermouth. Most of the production from the Flat Bay quarries is transported to St. George's, six miles distant, by aerial conveyor 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 operates a gypsum quarry near Windermere in the southeastern part of the province. Gypsum from this quarry 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 for plaster and wallboard manufacture at a company-owned plant.

Western Gypsum Products Limited obtains gypsum from an underground deposit at Amaranth, 90 miles northwest of Winnipeg, for use in a company-owned gypsum products plant in Winnipeg. This company is developing an underground occurrence of gypsum near Silver Plains, 30 miles south of Winnipeg. The deposit is 120 feet below the surface.

New Brunswick

Gypsum is quarried near Hillsborough by Canadian Gypsum Company Limited for plaster and wallboard manufacture at a company-owned plant at Hillsborough.

Canada Cement Company, Limited, obtains gypsum from Havelock, west of Moncton, for cement manufacture at Havelock.

OTHER PROCESSING PLANTS

Quebec

Domtar Construction Materials Ltd. and Canadian Gypsum Company Limited operate gypsum-products plants in Montreal East. Crude gypsum is obtained from quarries in 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 quarries in 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 quarry.

USES

Calcined gypsum, or plaster of paris, is the main constituent of 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 its sets, producing a firm, strong wallboard. Gypsum board and sheathing 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 a means of restoring impervious, dispersed soil and as a fertilizer for peanuts and other legumes.

TARIFFS

	British Preferential	Most Favored Nation	General
Canada			
Gypsum, crude	free	free	free
Gypsum, ground, not calcined	10%	12½%	15%
Plaster of paris and prepared wall plaster, per 100 lb	free	11¢	12½¢
Gypsum wallboard and lath	15%	20%	35%
United States			
Gypsum, crude		free	
Gypsum, ground or calcined, per long ton		$1.19	
Gypsum wallboard and lath		12½%	

ANHYDRITE[1]

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 1963 was about 222,274[2] 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 by-product cement. The gases are then converted into sulphuric acid.

[1]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. [2]Nova Scotia Department of Mines, Halifax.

Indium

D.B. Fraser*

Indium is found in trace amounts in certain ores of zinc, lead, tin, tungsten and iron. It is usually associated with sphalerite, the common zinc mineral, and becomes concentrated in residues and slags derived from zinc and lead smelting operations. The metal is produced commercially at only a few of the world's lead and zinc smelters.

Statistics on production of indium are not available. The metal is produced regularly in Canada and the United States and is reported to have been produced also in Peru, Belgium, West Germany, Japan and Russia. The single Canadian producer, The Consolidated Mining and Smelting Company of Canada Limited (COMINCO), which has plants at Trail, British Columbia, for the reduction of lead and zinc, is one of the world's largest suppliers of indium.

PRODUCTION

The first extraction of indium at Trail was made in 1941, though the presence of indium in the lead-zinc-silver ores of COMINCO's Sullivan mine at Kimberley, British Columbia, had been known for many years. In the following year, 437 ounces were produced by laboratory methods. There followed several years of intensive research and development, and in 1952 production began on a commercial scale. At present, the potential annual production at Trail is one 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

* Mineral Resources Division

indium again remains in the residue, which is re-treated in the lead smelter. From the lead bullion, indium is removed in the bullion dross. The dross is re-treated for recovery of copper matte and lead, and in this process a slag is recovered which contains lead, tin and copper as the major constituents, together with 2.5 to 3.0 per cent indium.

The dross re-treatment 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 a high-purity grade (approximately 99.999 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 resistance to corrosion and its low coefficient of sliding friction. It is easily scratched with the finger nail and can be made to adhere to other metals merely by hand-rubbing. It has a melting point of 156°C, which is relatively low, and a high boiling point of 2,000°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 bearing alloys, 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 radio-activity is easily induced in indium by neutrons of low energy. Indium compounds added to lubricants have been found to have a beneficial anti-corrosive effect. Indium anodes have been used in lightweight storage-battery cells.

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 United States 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 for the whole of 1963 in *E & M J Metal and Mineral Markets* were as follows:

25-ounce lots	$2.25
Ingot, 100 to 10,000 ounces	$1.50 to $1.80

Iron and Steel

R.B. Elver*

The Canadian iron and steel industry registered its third consecutive annual production record in 1963 at 8.19 million tons compared with 7.17 million tons in 1962 and 6.49 million in 1961. As measured by the index of industrial production, the industry outpaced the generally favorable level of total Canadian economic growth (Table 1).

Since the early 1950's, the industry has invested large amounts of capital to both modernize existing equipment and, more important, to diversify its range of products. Whereas the industry could only produce about 65 per cent of the various primary steel products consumed in Canada in the early 1950's, it can now bid for about 90 per cent. Increased national self-sufficiency combined with growing steel consumption in Canada has contributed to high levels of output. The competitiveness of the industry is indicated by stable posted prices since 1957 despite higher raw material and labor costs; by increased exports, although profit margins were necessarily narrowed in 1963; by decreased dependence on imports under a relatively modest level of tariffs; and by large investments from retained earnings. The application of advanced technology is indicated by the fact that Canadian companies were the first in North America to install basic oxygen furnaces, continuous casting units and supplementary fuel injection to blast furnaces. The industry does not lag either in the use of improved blast-furnace feeds or rolling mills of advanced design. It employs about 40,000 persons and these are among the highest paid in the country.

From 3.38 million tons of steel in 1950, Canadian output increased by 72 per cent to 5.81 million tons in 1960. Since 1960, however, output increased again by 41 per cent to 8.19 million tons in 1963.

Note: This Review previously appeared, in part, in List 1-1, *Metallurgical Works in Canada, Primary Iron and Steel*. For details on equipment and capacity by companies, the List should be consulted.

* Mineral Resources Division

TABLE 1
General Statistics of the Primary Iron and Steel Industry

	1961	1962	1963
Index of industrial production (1949=100)			
Total Industrial Production for Canada	172.9	186.0	195.9
Primary iron and steel industry	174.0	193.0	216.9
Value of Shipments (millions of $)	$789.3	$862.9	$957.3
Value of unfilled orders at year-end	$101.6	$106.2	$109.8
Value of inventory owned at year-end	$180.2	$166.1	$179.8
Value of exports (millions of $)*	$118.1	$130.9	$164.0
Value of imports (millions of $)*	$163.8	$175.6	$207.8
Employees			
Administrative	6,027	6,688	7,023
Hourly rated	28,344	30,574	32,180
Total	34,546	37,262	39,203
Average hours per week by hourly rated	40.2	40.3	40.5
Average earnings per hour by hourly rated	$ 2.54	$ 2.60	$ 2.67
Average wages and salaries per week, all employees	$106.60	$109.53	$114.2
Employment index, all employees (1949=100)	116.6	124.0	131.0
Capital expenditure ($000)			
On construction	$13,043	$20,898	$24,727
On machinery	54,599	91,979	82,552
Total	67,642	112,877	107,279
Repair expenditure ($000)			
On construction	$4,198	$5,126	$5,121
On machinery	67,885	80,359	88,455
Total	72,083	85,485	93,576
Total capital and repair expenditures ($000)	$139,725	$198,362	$200,855

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 Crude Steel Production
(short tons)

1950	3,383,575
1955	4,534,672
1960	5,809,108
1961	6,488,307
1962	7,173,475
1963	8,190,279

TABLE 2
World Production of Steel
(thousands of short tons)

	1961	1962	1963e
North America			
Canada	6,488	7,173	8,190
United States	98,014	98,328	109,261
Total, North America	104,502	105,501	117,451
Latin America	5,883	6,478	7,789
Western Europe			
Belgium, Luxembourg	12,252	12,519	12,740
France	19,375	18,997	19,342
West Germany	36,881	35,894	34,828
Italy	10,059	10,756	11,231
Netherlands	2,172	2,299	2,584
Total ECSC countries	80,739	80,465	80,725
Britain	24,736	22,950	25,222
Other	13,668	13,687	14,493
Total	119,143	117,102	120,440
Eastern Europe			
U.S.S.R.	77,990	84,112	88,404
Poland	7,973	8,469	8,818
Czechoslovakia	7,761	8,420	8,375
Other	9,338	10,251	10,097
Total	103,062	111,252	115,694
Africa	2,833	3,256	3,468
Middle East	250	265	285
Far East			
Japan	31,160	30,364	34,724
China	13,200	8,000	8,300
India	4,517	5,635	6,609
Other	1,120	1,453	1,624
Total	49,997	45,452	51,257
Oceania	4,414	4,750	5,214
World total	390,084	394,056	421,598

Source: *Annual Statistical Report* of the American Iron and Steel Institute 1963.
e Estimate.

WORLD STEEL PRODUCTION

Canada ranks tenth among the world's steel producers in per capita production and total output. World output continues to increase; it was at an all-time high in 1963 (Table 2). The resurgence of United States production was a feature of 1963 after five years with no pronounced growth in tonnage. In the major producing countries of western Europe, production has not kept pace with investment in new capacity. With supply greater than demand, a highly competitive situation on the world steel market has developed and many of these countries are exporting steel at reduced prices and, in turn, being subject to low-priced imports in their respective domestic markets. This has had repercussions in North America as well as western Europe as evidenced by increased United States charges of dumping and the imposition of a higher general tariff level by the European Coal and Steel Community (ECSC).

In most countries of eastern Europe, production continued to increase but at a slower rate than in previous years. In Asia, Japanese output increased to a new high although it was below estimates. It is understood that China encountered increased economic difficulties in recent years which include a decline in steel output.

CANADIAN PRIMARY IRON AND STEEL INDUSTRY

The Canadian primary iron and steel industry, consists of four integrated plants, that account for over 94 per cent of pig-iron production and over 90 per cent of crude-steel production (Table 9). Three of these plants are in Ontario; two at Hamilton and the third at Sault Ste. Marie. The fourth is at Sydney, N.S. With the exception of one Hamilton plant, all were established by the early 1900's.

Besides pig-iron production at the four integrated plants there are three others that produce various grades of merchant pig iron. One is a blast-furnace works at Port Colborne, Ont.; it is operated by one of the four major companies. The other two are electric-furnace shops at Tracy, Que., and Kimberley, B.C.

There are over 36 additional plants throughout the country that produce steel from scrap in electric furnaces. Of these, seven operate rolling mills and the remainder operate steel foundries. There are also four separate rolling-mill plants that process steel ingots or semis into primary-steel products.

Raw Materials

Most raw materials were in good supply in 1963. The upward pressure on prices for imported ore and coal, an important portion of total requirements for Ontario companies, stabilized in 1963. In 1962, the Government had decreased and stabilized the external value of the Canadian dollar at $U.S. 0.925. Scrap iron and steel prices stabilized at a low level after having decreased 22 per cent in 1962.

TABLE 3
Pig-Iron Production, Shipments, Trade and Consumption
(short ton — 2,000 pounds)

	1961	1962	1963
Furnace capacity, Dec. 31	5,528,500	6,115,200	6,905,000
Production			
Basic iron	4,203,578	4,558,571	5,084,882
Foundry iron	386,644	252,052	308,951
Malleable iron	355,799	478,310	521,164
Total	4,946,021	5,288,933	5,914,997
Shipments			
Basic iron	120,253	50,788	66,196
Foundry iron	308,276	352,913	329,237
Malleable iron	354,659	407,934	363,524
Total	783,188	811,635	758,957
Imports	1,663	4,897	4,035
Exports	599,358	459,443	481,936
Consumption of pig iron			
Steel furnaces	4,056,763	4,559,486	5,084,606
Iron foundries	242,280	257,539	299,509
Consumption of iron and steel scrap			
Steel furnaces	3,025,590	3,520,481	4,064,168
Iron foundries	633,000	585,950	667,649

Sources: Dominion Bureau of Statistics and the Canadian steel industry.
Value of trade is shown in Table 8.

Pig Iron

Pig-iron production, exports and consumption increased in 1963 (Table 3). Shipments to nonintegrated steel plants and iron foundries, however, decreased.

Consumption of iron ore in blast furnaces increased.The ratio of beneficiated iron ore to the total consumed was among the highest in the world. Of all iron ore consumed, 38.1 per cent was pellets, 16.9 per cent was sinter produced at mines and 18.3 per cent was sinter produced from fines and concentrates at furnace plants (Tables 9 and 10). The remaining 26.7 per cent was crude and concentrate.

Although the newest blast furnace was completed in 1960, Canadian pig-iron capacity has continued to grow substantially by the use of such techniques as supplementary fuel injection, higher top pressures, improved physical and chemical properties of charges, and rebuilding. Pig-iron capacity, 6.9 million tons a year at year-end 1963, is expected to exceed 7.4 million tons by the same time in 1965.

TABLE 4
Crude Steel Production, Shipments, Trade and Consumption
(short ton – 2,000 pounds)

	1961	1962	1963
Furnace Capacity, Dec. 31			
Steel ingot			
Basic open hearth	5,045,000	5,045,000	5,427,000
Basic oxygen converter	1,870,000	2,100,000	2,550,000
Electric	969,350	931,000	1,008,500
Total	7,884,350	8,076,000	8,985,500
Steel castings	546,400	538,000	493,740
Total	8,430,750	8,614,000	9,479,240
Production			
Steel Ingot			
Basic open hearth	3,886,846	4,237,902	4,983,908
Basic oxygen converter*	1,826,000e	2,159,204	2,338,826
Electric	663,261	653,736	742,138
Total	6,376,107	7,050,842	8,064,872
Steel Castings			
Basic open hearth	2,830	3,913	6,729
Electric	109,370	118,720	118,678
Total	112,200	122,633	125,407
Total production	6,488,307	7,173,475	8,190,279
Alloy steel in total	279,135	347,217	433,195
Shipments from plant			
Steel ingots	265,461	247,704	271,923
Steel castings	104,599	121,415	121,933
Rolled steel products	4,603,965	5,122,341	5,916,903
Total	4,974,024	5,491,460	6,310,759
Exports in equivalent steel ingots	841,236	989,899	1,292,001
Imports in equivalent steel ingots	1,096,168	1,046,082	1,083,843
Indicated consumption**	6,743,239	7,229,728	7,982,121

Source: Dominion Bureau of Statistics; Estimates by Department of Mines and Technical Surveys, Ottawa.
Note: *Contains several thousand tons of electric and open-hearth steel.
**Crude steel production plus imports less exports.
Symbol: e Estimate

Crude Steel

Output of steel ingots and castings surpassed previous records (Table 4) and most companies and regions shared in the increases. Increases in capacity in recent years for open hearths and oxygen converters have been largely due

TABLE 5
Shipments of Rolled Steel Products by Type
(short ton — 2,000 pounds)

	1961	1962	1963
Hot Rolled Products			
Semis	308,228	312,597	307,078
Rails	194,543	230,875	339,113
Wire rod	355,716	352,313	391,616
Structurals			
heavy	236,620	358,435	378,042
light	75,139	81,891	90,523
Bars, concrete reinforcing	404,133	393,811	426,623
Bars, other hot rolled	388,126	465,032	544,071
Tie plate and track material	60,007	76,445	78,669
Plates	660,954	608,505	730,757
Sheets and strips	681,154	821,029	1,005,074
Total	3,364,620	3,700,933	4,291,566
Cold Rolled and Coated Products			
Bars	38,328	47,661	57,740
Strip	47,271	52,460	59,976
Sheets, tin mill black plate and tinplate	816,317	956,608	1,119,609
Galvanized sheets	337,429	364,679	388,015
Total	1,239,345	1,421,408	1,625,340
Total shipments	4,603,965	5,122,341	5,916,906
Alloy steel in Total shipments	121,798	162,993	208,540

Source: Dominion Bureau of Statistics.

to technological advances rather than new furnaces. Since the first unit was installed in 1954, basic oxygen steel now accounts for about 29 per cent of output. Correspondingly, electric furnaces have declined in relative importance. The basic open-hearth furnace continued to be the major process used. At year-end 1963, annual steelmaking capacity exceeded 9.4 million tons; by year-end, 1965 it is expected to be 11.1 million tons.

Rolled Steel Products

Production and shipments of rolled-steel products were also at record levels. (Tables 4, 5 and 6). Increases in shipments were made for all major product groups except semis, and to all major consuming industries except manufacturers of railway cars. Production of rails, bars, and most flat-rolled products increased significantly. Shipments to construction industries, wholesalers, the automotive industry and the pipe and tube industry were particularly buoyant.

TABLE 6

Rolled Steel Products, Shipments to Consuming Industries

(short ton – 2,000 pounds)

	1961	1962	1963
Automotive	249,481	313,493	414,493
Agricultural equipment and manufactures	99,521	129,551	164,695
Building construction	889,046	993,762	1,122,608
Containers	340,180	377,957	395,656
Machinery and tools	213,842	265,496	286,917
Merchant trade products	420,543	406,022	473,629
Mining, lumbering, etc.	71,892	77,554	77,646
Pressing, forming and stamping	226,879	271,943	307,860
Railway operating	211,765	225,694	250,764
Railway cars and locomotives	40,594	60,001	35,083
Shipbuilding	68,614	79,175	94,679
Pipe and tubes	670,167	538,973	643,344
Wholesalers and warehouses	606,246	721,395	803,610
Miscellaneous	41,241	52,537	47,307
Total	4,150,011	4,513,553	5,118,291
Direct exports*	453,954	608,788	798,615
Total	4,603,965	5,122,341	5,916,906

*Does not include exports by nonproducers and does not include ingots and castings exported.
Source: Dominion Bureau of Statistics.

Trade

The value of imports continues to exceed exports but by a decreased margin (Table 1). On a tonnage basis, however, Canada exported more than was imported in 1963. Although flat-rolled products of higher unit value are increasing, ingots and semis still represent a large proportion of exports. Imports are almost entirely of shapes with higher unit value and Canada is still a net importer of these.

There appears to be further opportunities for import displacement by the Canadian steel industry for items such as rod, structurals, bars, plates, sheets and strip, pipes and tubes and wire products. Although absolute self-sufficiency is unlikely and not economically justifiable, more of a few of these items could be produced in Canada. To this end, the Canadian steel industry continues to invest large amounts of capital in increasing capacity and diversifying its product-mix; company details under the section on investments outline the trend.

Prices and Tariffs

Prices of most iron and steel products marketed by the industry were at 1957 levels though exports as well as domestic sales were subject to more intense price competition. Pressure for longer-term credits increased in the export market and competition from western Europe and Japan was particularly noticeable. Tables 11 and 12 contain data on prices and tariffs.

TABLE 7

Trade in Steel Castings, Ingots and Rolled Products

(thousands of short tons)

	Imports			Exports		
	1961	1962	1963	1961	1962	1963
Steel castings	1.6	4.9	4.0	5.9	10.8	11.6
Steel ingots	1.3	2.3	1.7	158.4	163.4	175.3
Rolled products, hot						
Semis	4.5	4.0	1.3	168.1	101.2	202.0
Rails	5.7	3.4	6.9	70.3	85.0	135.2
Wire rod	38.5	69.9	75.7	5.6	2.9	6.1
Structurals	381.1	212.2	233.0	15.0	17.4	28.9
Bars	106.7	143.6	150.0	34.4	26.5	38.3
Track material	3.1	1.7	3.5	11.2	21.6	15.5
Plates	68.4	56.9	98.0	12.5	26.2	23.5
Sheet and strip	57.4	38.6	111.0	62.8	134.0	205.8
Total (rolled prod.)	665.4	530.3	679.4	383.9	414.8	655.3
Rolled products, cold						
Bars	9.3	7.4	4.8	2.7	1.7	1.4
Sheet and strip						
Cold	35.5	24.0	22.0	..	28.0	69.9
Galvanized	5.9	6.8	5.2	..	53.0	42.3
Other	52.2	61.2	72.2	143.6	112.0	114.4
Pipes	121.2	126.0	121.5	37.2	47.5	21.0
Wire and wire products	53.3	61.8	66.4	3.0	4.5	5.4
Total	277.4	287.2	292.1	186.4	246.7	254.4
Total rolled prod.	942.8	817.5	971.5	570.3	661.5	909.7
Total steel	945.7	824.7	977.2	734.6	835.7	1,096.6

Source: Dominion Bureau of Statistics. Symbol: .. Not available separately.
Note: Related values are contained in Table 8.

Employees and Earnings

Hours worked, hourly earnings, average weekly wages and number of employees continued to increase in 1963. Higher production and capacity in recent years was largely due to technological developments and extensive capital investment. Employment opportunities have increased but the industry, like many others, requires increased skills. Labor contracts with three of the four major producers expire in mid-1964.

Investment

Capital expenditures decreased in 1963 but remained at a high level. Repair expenditures continued to increase. Expenditures in 1964 for projects under way in 1963 or planned for 1964 are expected to be $163 million compared with $107 million in 1963. This would be an all-time high. A large part of this investment is for rolling mills that will increase output, improve efficiency and broaden the

TABLE 8

Value of Trade in Pig Iron, Steel Castings, Ingots and Rolled Products

(thousands of dollars)

	Imports			Exports		
	1961	1962	1963	1961	1962	1963
Steel castings	991	2,506	2,192	1,551	3,152	2,904
Steel ingots	414	655	563	10,178	11,552	14,859
Rolled products						
Hot	78,615	73,385	91,363	39,415	45,639	75,130
Cold	83,761	98,225	105,632	37,934	45,563	48,840
Total	162,376	171,610	196,995	77,349	91,202	123,970
Total steel	163,781	174,771	199,750	89,078	105,906	141,733
Pig iron	28	502	787	29,068	24,969	24,321
Total iron and steel	163,809	175,273	200,537	118,146	130,875	166,054

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.

product-mix. Affecting investment costs was the Federal Government's four-per-cent sales tax on construction materials levied in April 1963. This rose to eight per cent in April 1964 and will rise to 11 per cent on April 1, 1965. Company progress and plans for new investment projects are reviewed in the following sections.

COMPANY REVIEW

The Algoma Steel Corporation, Limited, Sault Ste. Marie, Ont.

In 1963, capital expenditures were $31.5 million, a high level although a decrease from the $33.2 million of 1962. For both years $1.6 million of the total was pents on mine development. Expenditures are expected to be $40 million in 1964, of which about $22 million will be for a wide cold strip mill.

Projects Completed in 1963 – A 106-inch-wide hot strip mill, a thermal generating plant, nine ingot soaking pits, a gas-cleaning plant for the steel plant, a fourth line for grinding-ball production, and modernization of one blast furnace were completed. The hot strip mill, one of the widest of its kind, can roll sheet and light plate from 24 to 96 inches wide. The mill commenced production in August. One of the two small blast furnaces was relined and enlarged. Equipment for fuel injection and higher top pressure was added.

Projects Under Way in 1963 – A wide cold strip mill, a third basic oxygen furnace, a large scarfing machine in the 44-inch blooming mill, an electric furnace in the foundry and a calcining plant for burned lime were under way. The 80-inch-wide cold strip mill was being installed in a new building in which existing narrower cold mills will be relocated. It will have an annual capacity of 300,000 tons of sheet and strip of up to 74 inches wide.

TABLE 9

Steel, Iron, Coke and Sinter Capacity and Production at Integrated Plants, 1963*

	ALGOMA		COMINCO	DOFASCO	DOSCO	Q.I.T.	STELCO	Total
	Sault Ste. Marie	Port Colbourne	Kimberley	Hamilton	Sydney	Tracy	Hamilton	
Crude Steel Capacity, Dec. 31								
Open hearth	1,150,000	–	–	–	979,000	–	3,250,000	5,379,000
Basic oxygen	1,050,000	–	–	1,500,000	–	–	–	2,550,000
Electric	–	–	–	50,850	30,000	–	–	80,850
Total	2,200,000	–	–	1,550,850	1,009,000	–	3,250,000	8,009,850
Production	2,091,821	–	–	1,391,091	794,572	–	3,109,903	7,387,387
Pig Iron Capacity, Dec. 31								
Blast furnace	2,000,000	210,000	–	1,550,000	810,000	–	1,935,000	6,505,000
Electric	–	–	40,000	–	–	360,000	–	400,000
Total	2,000,000	210,000	40,000	1,550,000	810,000	360,000	1,935,000	6,905,000
Production	1,923,679	152,991	37,678	1,201,779	549,039	251,943	1,818,088	5,935,197
Coke								
Capacity, Dec. 31	1,458,000	–	–	625,000	612,000	–	1,200,000	3,895,000
Production	1,390,158	–	–	644,770	409,947	–	1,207,759	3,652,634
Sinter								
Capacity, Dec. 31	600,000	–	300,000	–	250,000	–	900,000	2,050,000
Production	..	–	..	–	..	–	..	1,764,478
Number of Furnaces								
Steel								
Open Hearth	6	–	–	–	6	–	14	26
Basic oxygen	2	–	–	3	–	–	–	5
Electric	–	–	–	5	1	–	–	6
Pig iron								
Blast furnace	4	1	–	3	3	–	4	15
Electric	–	–	1	–	–	8	–	9
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 1963.
Symbols: .. Not available separately. – Nil.

TABLE 10
Consumption of Raw Materials at Integrated Plants, 1963*

	Sinter Plants	Pig Iron Plants: Blast Furn.	Pig Iron Plants: Electric	Steel Furnaces
Iron Ore				
Crude and Concentrates	1,381,225	2,486,976	915,360	191,507
Pellets	73,701	3,548,851	nil	217,123
Sinter (from mines)	8,734	1,574,926	nil	nil
Total	1,463,660	7,610,753	915,360	408,630
Sinter (produced at works)	nil	1,690,807	56,488	nil
Total	1,463,660	9,301,560	971,848	408,630
Cinder, scale, slag, flue dust, etc.	410,090	103,921	nil	nil
Total	1,874,569	9,405,481	971,848	408,630
Iron content	1,044,073	5,443,836	na	270,596
Coke				
Own make	72,950	3,418,020	na	1,171
Purchased	13,501	125,648	na	nil
Total	86,451	3,543,668	na	1,171
Pig Iron	nil	nil	nil	5,070,899
Scrap				
Own make	36,222	116,232	na	2,081,616
Purchased	305	65,775	na	1,006,250
Total	36,527	182,007	na	3,087,866
Lime	173	nil	na	214,034
Stone				
Limestone	139,064	742,970	na	156,435
Dolomitic limestone	26,049	18,562	na	nil
Dolomite	94,343	415,730	na	20,670
Total	259,456	1,177,262	na	177,105
Production	1,764,478 (sinter)	5,645,576 (pig iron)	289,621 (pig iron)	7,387,387 (crude steel)

Source: Company data supplied directly to the Mineral Resources Division.
*Raw materials consumed by plants listed in Table 9.
Symbol: na Not available

Projects Planned for 1964 – The company plans relining one of the two large blast furnaces, equipping the second small blast furnace with fuel injection and higher top-pressure equipment, a new blast-furnace blower, the replacing of some equipment at the 44-inch blooming mill, the modernization of rail finishing facilities, the expansion of a reheating furnace and construction of a five-million gallon fuel oil storage tank.

TABLE 11
Posted Base Prices for Canadian Steel
(f.o.b. mill)

Semis, for rerolling	$78,00 per ton
	Cents Per Pound
Wire rods	5.70
Bars and small shapes	5.30
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
Skelp	4.70
Rails, heavy	5.55

Source: *Steel*, January 6, 1964

Atlas Steels Division of Rio Algom Mines Limited, Welland, Ont.

Capital expenditures of Atlas Steels were $5.2 million in 1961 and $18.6 million in 1962. Expenditures in 1963 declined slightly to $15.8 million. Effective January 1, 1963, Rio Algom Mines Limited assumed control of Atlas. The largest project under way was the new plant at Tracy, Que. Construction commenced in November 1961 and the cost is expected to be $48 million. Approximately $16 million was spent in 1962 and another $14.6 million was spent in 1963. The remainder, $17.4 million, will be spent in 1964 and early 1965.

The plant is designed to produce 75,000 tons of stainless steel annually as billets, and as sheet and strip in thicknesses from 0.005 to 0.250 inch and widths up to 48 inches. Plans include a 60-ton electric furnace, a continuous casting machine, a Sendzimir hot planetary mill and cold-rolling facilities. By the end of 1963, the following units were operating: slitting line, level and cut line, cold-rolling mill, annealing line, anneal and pickle line, and electric furnace. All these units will be in full production by mid-1964. Until completion of the planetary mill in early 1965, crude steel will be partially processed on facilities at another location.

At the Welland plant, expenditures of $1.2 million in 1963 were lower than in 1962 but were important to quality control, product development and facility revisions. Improvements were made to cold-drawing equipment for greater efficiency. A similar expenditure is expected in 1964.

The Consolidated Mining and Smelting Company of Canada Limited (COMINCO), Kimberley, B.C.

Installation of a second electric pig-iron furnace will be completed early in 1964 at an estimated cost of $4 million. Annual capacity will increase from 40,000 to 110,000 tons.

TABLE 12
Canadian Customs Tariff On Selected
Iron and Steel Items

	British Preferential	Most Favored 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	$3.00	$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.*

Dominion Brake Shoe Company, Limited, Quebec and Manitoba

Since completion of an expansion and modernization program in 1960 at the company's Joliette Steel Division, in Quebec, expenditures have been made for additional heat treating, machinery and make-up air equipment. Additional quality-control equipment and plant space are planned for 1964. The Manitoba Steel Foundry Division, Selkirk, will add new moulding facilities in 1964.

Dominion Foundries and Steel, Limited, Hamilton, Ontario

Capital expenditures in 1963 totalled $18.1 million, an increase from $12 million and $16.9 million in 1961 and 1962. Expenditures for new facilities are expected to increase to $29 million in 1964. In addition, the company has a 15-

per-cent interest in Wabush Mines' iron-ore project in Labrador and a 16.3-per-cent interest in the pellet plant at Pointe Noire, Quebec. To the end of 1963, about one half of the company's $45-million participation in the project had been spent, about $7.5 million of it spent in 1963. The company purchased Itmann Coal Company in the United States to provide a source of low-volatile coking coal.

Projects Completed in 1963 – Completed were two new ingot soaking pits in the hot mill, additional batch-annealing furnaces in the cold mill, a new 66-inch temper mill, and a 300-foot extension to the railway highline at the blast-furnace site.

Projects Under Way in 1963 or Planned for 1964 – The company had under way a new office building, three additional soaking pits, additional steam-generating capacity, additional charging and pouring capacity in the steel plant, a dust collecting system, number four 56-inch cold mill and additional annealing and shearing units. All these will be completed in 1964. Increases in the amounts and types of silicon steel are anticipated with the completion of a plant in the third quarter of 1964. Research is continuing on coke production, vacuum degassing for specialty steels, methods of casting steel by both continuous and pressure-casting methods, and steel-coating techniques.

Dominion Steel and Coal Corporation, Limited, Montreal, Que.

Capital expenditures on new plants and equipment totalled $9.3 million in 1963, a substantial increase from the $3.5 million and $4.2 million of 1961 and 1962. Projects announced or under way indicate a further increase in capital expenditures in 1964. A large part of the expenditures has been for the works at Sydney, N.S. In 1964, however, emphasis is being placed on the Montreal area.

Projects completed in 1963 – The company completed rebuilding of the rail mill reheating furnace at Sydney, improved rod storage and the wire drawing equipment at Etobicoke in Ontario, increased heating capacity for billets and made mill modifications at Montreal, installed equipment at various plants at the Wabana iron-ore mine in Newfoundland and in company coal mines in Nova Scotia.

Projects Under Way in 1963 – A new $20-million continuous-rod and bar mill is to be completed in the last quarter of 1964. Construction for this started at Contrecoeur, Quebec, at a new site east of Montreal, in 1963. The mill will roll 40-foot billets to squares and rounds of up to 1.5 inches, flats to 4 inches and angles to 2.5 by 2.5 inches.

A continuous casting machine for the production of billets from electric furnace steel at the Montreal plant is scheduled for completion in the fall of 1964.

Projects Planned for 1964 – To improve efficiency of steel production, an oxygen plant was being built at Sydney by Canadian Liquid Air Ltd. from which DOSCO will purchase oxygen for steel furnace injection.

Enamel & Heating Products, Limited, Amherst, N.S.

During 1962, a $1-million modernization and expansion program was initiated that included a 45,000-square-foot warehouse and fabricating department that was completed in 1962. In 1963, work commenced on a new electric-furnace melt shop to provide the rolling mill with ingots which previously had been purchased. The furnace to have an annual capacity of 20,000 tons is expected to be in operation by mid-1964.

Imperial Oil Limited, Toronto, Ont.

The company is proceeding with construction of a $7-million research plant at Dartmouth, N.S, to evaluate various iron ores in a process that will produce metallic iron. Petroleum products are used in the reduction of iron ores in this process. Total expenditures from 1964 to 1966 will exceed $13 million. The plant is scheduled for completion in 1965.

The Indiana Steel Products Company of Canada Limited, Kitchener, Ont.

The first phase of an expansion program begun late in 1962 included: installation of a 2,000-pound induction furnace to permit production of larger castings, a 72-inch shot blast machine to increase casting cleaning capacity, new handling equipment, and a fully automatic shell moulding machine. The second phase of the program was initiated late in 1963 and includes: a 6,000-square-foot addition to the foundry to increase storage facilities, a heat-treating furnace for stainless steel and additional equipment for quality control. Total cost of the program is expected to be $275,000.

Lake Ontario Steel Company Limited, Whitby, Ont.

The company is building a new nonintegrated steel plant. Steel will be produced from scrap melted in an electric furnace shop. Products will consist of concrete reinforcing bars and merchant mill products. A continuous casting machine will be installed. The plant will be completed late in 1964 with an annual capacity of 100,000 tons of steel ingots. Total cost is expected to be $8 million.

Peace River Mining & Smelting Ltd., Edmonton, Alta.

The company is proceeding with construction of a $1.75-million pilot plant at Edmonton to process iron-bearing material from the Peace River area, northwest of Edmonton, into iron powder for rolling into flat-rolled steel products. The purpose of the plant is engineering studies; it will be in operation by mid-1965.

Province of Quebec

The Quebec provincial government in recent years has undertaken and commissioned consultants to study the economic and technical feasibility of establishing a primary iron and steel plant within the province. Such a plant would be in addition to plants that produce pig iron at Tracy, electric-furnace steel at Tracy, Montreal, Sorel, and other centres, and steel rolling-mill products at Montreal and Tracy.

General information released to date tentatively suggests a plant near Becancour on the south shore of the St. Lawrence River between Montreal and Quebec City. The cost would be from $200 million to $270 million for a plant with an annual capacity of 620,000 tons of ingot steel.

Quebec Iron and Titanium Corporation, Tracy, Que.

In 1964, a new 200-ton induction heating furnace will be completed for the production of improved grades of pig iron. This unit is several times larger than any in operation. Construction of a $500,000 research laboratory will commence in 1964.

Slater Steel Industries Limited, Hamilton, Ont.

The company is installing a second electric steel furnace, erecting a new warehouse and effecting a general rearrangement of its plant at Hamilton, Ont. With completion of the program in the third quarter of 1964, annual steel ingot capacity will have been increased from 28,000 tons to about 61,000 tons. Cost of the program is expected to be $2.5 million.

The Steel Company of Canada, Limited (STELCO), Hamilton, Ont.

Capital expenditures totalled $52.2 million in 1963 compared with $38.8 million and $67 million in 1961 and 1962. The company's largest expansion program was initiated in mid-1963; it will require an expenditure of about $152 million to the early part of 1965. Most expenditures are for facilities at Hamilton.

Projects Completed in 1963 – The company completed a new 80-inch four stand cold rolling mill and extensions to related facilities, new hot strip processing and warehouse facilities including a slitting and shearing line, improvements to existing bar mills, one new ingot soaking pit, a continuous hot scarfing machine, smoke control equipment for steel furnaces, enlargement and relining of 'C' blast furnace, a new plant for the Canadian Drawn Steel Division at Hamilton and additional equipment to increase output and improve quality at various fabricating plants.

The company purchased a large parcel of land adjacent to its Parkdale wire mill in Hamilton; the site is suited to future expansion of rod and bar facilities. Another site was purchased at nearby Burlington for a new research centre.

Projects Under Way in 1963 or Planned for 1964 – A new 148-inch-wide plant mill with improved finishing and shipping facilities is to be completed in 1965. The mill will have an annual capacity of several hundred thousand tons and will produce products in sizes not previously produced in Canada. An 80-inch pickling line and an 80-inch temper mill will be built to complement the

80-inch cold mill completed in 1963. Changes and additions to existing plate and hot strip mills will increase output of hot rolled sheet to feed the increased cold rolling capacity.

At the fabricating plants, heavy-duty looms for welded steel fabric, new wire-drawing equipment and machines for fastener products are to be installed. A third electric steel furnace and auxiliary equipment will be completed in 1964 at the Edmonton plant of Premier Steel Mills Ltd., a wholly owned subsidiary.

Raw Materials – The company has a 23.5-per-cent interest in Wabush Mines' iron-ore project in Labrador. Total cost of the project is expected to be $280 million. About $35 million of STELCO's $70-million share had been spent by the end of 1963. The project, to start production late in 1964, is designed to produce about 5.5 million long tons of high-grade concentrate of which 4.9 million tons will be pelletized.

Erie Mining Company, with a pellet operation in Minnesota, is developing a new iron-ore deposit. This ore, when blended with ore from existing pits, should improve the quality and reduce the cost of pellets produced. STELCO has a ten-per-cent interest in the operation.

Western Rolling Mills Ltd., Calgary, Alberta

The company is building a new nonintegrated steel plant to produce concrete reinforcing bars and a variety of merchant mill products. Steel ingots will be produced from scrap in an electric furnace; annual capacity of the plant will be about 25,000 tons. The plant, expected to be completed by mid-1964, will cost $2.5 million.

Iron Ore

G.E. Wittur*

The Canadian iron ore industry in 1963 set its second consecutive record level of shipments, 26.9 million tons**, up 10.2 per cent from 1962 with all provinces sharing in the increase. The consumer demand was for high-grade ore with good physical characteristics; some shippers of medium-grade ore recorded lower sales and prices. In their efforts to meet these demands, many Canadian ore producers are carrying out research programs to develop economical beneficiation processes for their ores.

The Province of Quebec, Canada's largest producer of iron ore, shipped 39 per cent of the 1963 total. Quebec Cartier Mining Company and Hilton Mines, Ltd. shipped record amounts of high-grade concentrates and pellets, respectively. Iron Ore Company of Canada (IOCC), with mines in Quebec and Labrador, had reduced sales of medium-grade direct shipping ore.

Newfoundland, because of the Labrador deposits, ranks second with 32 per cent of Canada's total shipments. Sales of medium-grade ore by Wabana Mines and IOCC were lower than in 1962 but shipments of concentrates and pellets from IOCC's Labrador City mine increased. Wabush Mines continued construction at its project near Wabush Lake where production of high-grade concentrates is scheduled to begin in 1965. A plant is being built at Pointe Noire, Quebec to pelletize part of Wabush Mines' concentrate.

Ontario ranks third among producing provinces with 22 per cent of Canadian shipments. Most producers of medium-grade ore in the province shipped about the same amount or slightly more than in 1962. Marmoraton Mining Company, Ltd. had reduced shipments of pellets. Lowphos Ore, Limited, completed its pellet plant and shipments by the company were well above those in 1962. The International Nickel Company of Canada, Limited completed its plant expansion and sales of INCO pellets were at a record level. Caland Ore Company Limited announced plans to build a plant to pelletize part of its output. Development of a new mine and construction of a plant near Kirkland Lake by Jones & Laughlin Steel Corporation continued. Production of pellets is to begin in 1964.

* Mineral Resources Division

**The long or gross ton (2,240 pounds) is used throughout unless otherwise specified.

TABLE 1
Iron Ore – Production and Trade

	1962		1963	
	Long Tons	$	Long Tons	$
Production (shipments)				
Quebec	9,967,841	112,444,643	10,402,488	122,306,806
Newfoundland	7,131,170	67,753,153	8,645,539	99,053,621
Ontario	5,727,621	64,479,510	6,026,444	70,033,690
British Columbia	1,601,650	18,326,911	1,839,501	20,746,424
Total	24,428,282	263,004,217	26,913,972	312,140,541
Byproduct iron ore in above*	343,428	–	612,285	–
Imports				
United States	4,449,348	54,665,032	4,977,763	63,453,734
Brazil	155,471	1,659,310	344,930	4,404,834
Nigeria	–	–	3,012	13,255
West Germany	–	–	8	947
Total	4,604,819	56,324,342	5,325,713	67,872,770
Exports				
Iron ore, direct shipping				
United States	9,513,573	90,063,625	6,380,037	65,789,693
Britain	1,520,818	13,916,270	572,823	5,228,460
Netherlands	447,053	4,021,174	488,979	4,784,183
West Germany	243,276	2,210,783	263,556	2,644,384
Belgium, Luxembourg	–	–	110,300	853,134
Italy	–	–	18,500	115,625
Total	11,724,720	110,211,852	7,834,195	79,415,479
Iron ore, concentrated				
United States	6,028,240	70,065,698	9,226,914	108,805,931
Japan	1,544,523	14,610,173	1,978,774	20,295,198
Britain	147,979	975,414	1,502,141	15,150,950
Belgium, Luxembourg	261,520	2,455,808	88,160	825,328
Italy	89,146	579,449	49,580	310,103
Netherlands	121,113	904,755	26,440	171,860
West Germany	275,090	1,788,182	12,350	77,090
France	23,190	221,465	–	–
Total	8,490,801	91,600,944	12,884,359	145,636,460
Iron ore, agglomerated				
United States	1,212,033	15,308,527	2,371,376	33,896,710
Britain	–	–	388,763	5,887,728
Total	1,212,033	15,308,527	2,760,139	39,784,438

Table 1 (cont'd)

	1962		1963	
	Long Tons	$	Long Tons	$
Iron ore, not elsewhere specified including by-product iron ore				
United States	190,573	3,248,701	350,378	6,039,407
West Germany	27,631	151,971	24,042	68,500
Britain	—	—	1,860	4,499
Total	218,204	3,400,672	376,280	6,112,406
Total, all classes				
United States	16,944,419	178,686,551	18,328,705	214,531,741
Britain	1,668,797	14,891,684	2,465,587	26,271,637
Japan	1,544,523	14,610,173	1,978,774	20,295,198
Netherlands	568,166	4,925,929	515,419	4,956,043
West Germany	545,997	4,150,936	299,948	2,789,974
Belgium, Luxembourg ...	261,520	2,455,808	198,460	1,678,462
Italy	89,146	579,449	68,080	425,728
France	23,190	221,465	—	—
Total	21,645,758	220,521,995	23,854,973	270,948,783

Source: Dominion Bureau of Statistics.
*Total shipments of byproduct iron ore compiled by Mineral Resources Division from data supplied by individual companies.
— Nil

TABLE 2
Iron Ore — Production, Trade and Consumption, 1954-63
(Long Tons)

	Production (shipments)	Imports	Exports	Consumption* (indicated)
1954	6,572,855	2,709,991	5,470,480	3,812,366
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

Source: Dominion Bureau of Statistics.
* Shipments plus imports less exports with no account taken of changes in stocks at consuming plants.

Five British Columbia companies which export magnetite concentrates to Japan accounted for seven per cent of Canadian iron ore shipments. Sales by three companies increased while those from the other two were down. Two companies ceased production: Zeballos Iron Mines Limited which did not ship ore in 1963, because of financial difficulties and Nimpkish Iron Mines Ltd. because its ore was depleted. A new company, Empire Ventures Limited, will resume production at Zeballos in 1964. Coast Copper Company Limited announced that it plans to recover magnetite concentrates from its copper-iron ores beginning in 1964.

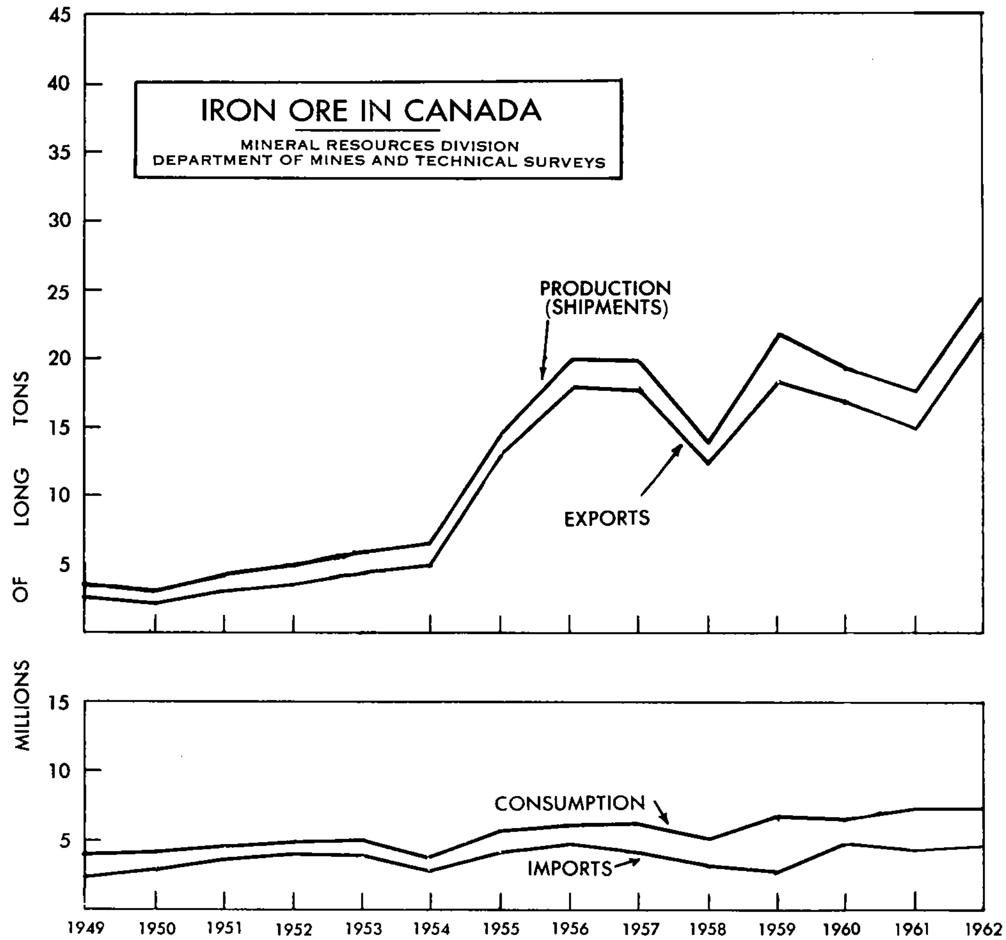
Annual iron-ore shipping capacity of operations in Canada at the beginning of 1964 was an estimated 38.3 million tons. This was comprised of 18.7 million tons of medium-grade, natural or concentrated ore; 11.4 million tons of concentrate, grading above 60 per cent iron; and 8.2 million tons of pellets, grading above 64 per cent iron. Annual capacity in early 1966 is expected to reach 45.6 million tons with most of the increase over 1964 capacity being pellets. Pellet capacity of existing plants and those being built will reach 15.1 million tons a year by the end of 1966. Production capacity of medium-grade ores will decline by about half a million tons.

MARKETS AND TRADE

There are five major market areas for Canadian iron ore: United States, Britain, Japan, western Europe and Canada. In the United States, the principal market, receipts of Canadian iron ore were at a record high in 1963 having increased 3.46 million tons to 17.7 million tons. United States consumption of ore imported from all other countries increased only 525,000 tons to 14.2 million tons. In addition, the United States consumed 69.4 million tons of domestically produced ore.

Canadian iron ore exports to western Europe, consisting mainly of medium-grade ores, declined in the face of continued rigorous price and quality competition from sources of high-grade ore in Africa, South America, and from Sweden. Shipments to Britain increased. For the first time a large part of the shipments to Britain was high-grade concentrated or pelletized ore. Japan continued to be an expanding market for British Columbia ore.

In recent years, industry developments in Canada have enabled the Canadian steel industry to acquire an increasing part of its ore requirements from domestic sources. This general upward trend is expected to continue, particularly after 1965. By then a new project, Wabush Mines, will come into production in Labrador that will annually provide nearly two million tons of captive ore to two Canadian steel companies. Iron ore consumption in Canada increased substantially in 1963 as steel production reached a record 8.2 million net tons, about 14.4 per cent above that of 1962. However, domestic consumption of Canadian iron ore increased only slightly. Imports from United States and Brazil were higher.



WORLD PRODUCTION

World iron ore production estimated at 523 million tons was 3.9 per cent greater than in 1962. Though the countries listed in Table 3 together produced over four per cent more than in 1962 production by some countries of the group changed significantly; output in France and West Germany, for example, fell 12 and 22 per cent, respectively. This decline was the result of the closure of mines by producers of low-grade ores as consumers showed increasing preference for imported high-grade material. Shipments from mines in Venezuela continued the decline that began following a record 19.2 million tons shipped in 1960.

Production continued to increase in the USSR, India and some countries in Africa, South America and Asia. A large mining project in Liberia and several smaller mines in other areas commenced production. Exploration activity continued in northwest Australia, where large amounts of iron ore have recently been discovered. That country promises to become an important exporter of iron ore, particularly to Japan, within the next decade.

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, 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 3

Production of Iron Ore, By Country

('000 Long Tons)

	1960	1961	1962	1963
USSR	104,343	116,137	126,077	136,804
United States	88,784	71,329	71,829	72,310
France	65,907	65,525	65,272	57,556
China	54,100	44,300	34,400	49,210
Canada	19,242	18,178	24,428	26,914
Sweden	20,983	22,766	21,675	22,115
India	10,514	12,076	12,972	14,045
Britain	17,088	16,518	15,277	14,797
West Germany	18,571	18,568	16,380	12,694
Venezuela	19,182	14,335	13,057	11,929
Subtotal	418,714	399,732	401,367	418,374
Other countries	95,103	104,047	102,164	104,827
World total	513,817	503,779	503,531	523,201

Source: American Iron and Steel Institute, *Annual Statistical Report, 1963*.

TABLE 4

Consumption of Iron Ore in Canadian Iron and Steel Plants

(Long Tons)

	1962	1963
In blast furnaces, direct	5,952,476	6,767,441
In steel furnaces, direct	322,083	435,764
In sintering plants before ore is charged to blast or steel furnaces	1,442,582	1,234,895
Miscellaneous	6,180	322
Total	7,723,321	8,438,422

Source: American Iron Ore Association.

TABLE 5

Consumption and Stocks of Iron Ore at Canadian Iron and Steel Plants, 1962 and 1963

(Long Tons)

	1962	1963
Receipts imported	4,684,012	5,424,636
Receipts from domestic sources	2,706,350	3,281,246
Total receipts at iron and steel plants	7,390,362	8,705,882
Consumption of iron ore	7,723,321	8,438,422
Stocks of ore at iron and steel plants		
December 31	3,211,404	3,516,561
Change from previous year	-287,147	+305,157

Source: American Iron Ore Association, compiled from company submissions.

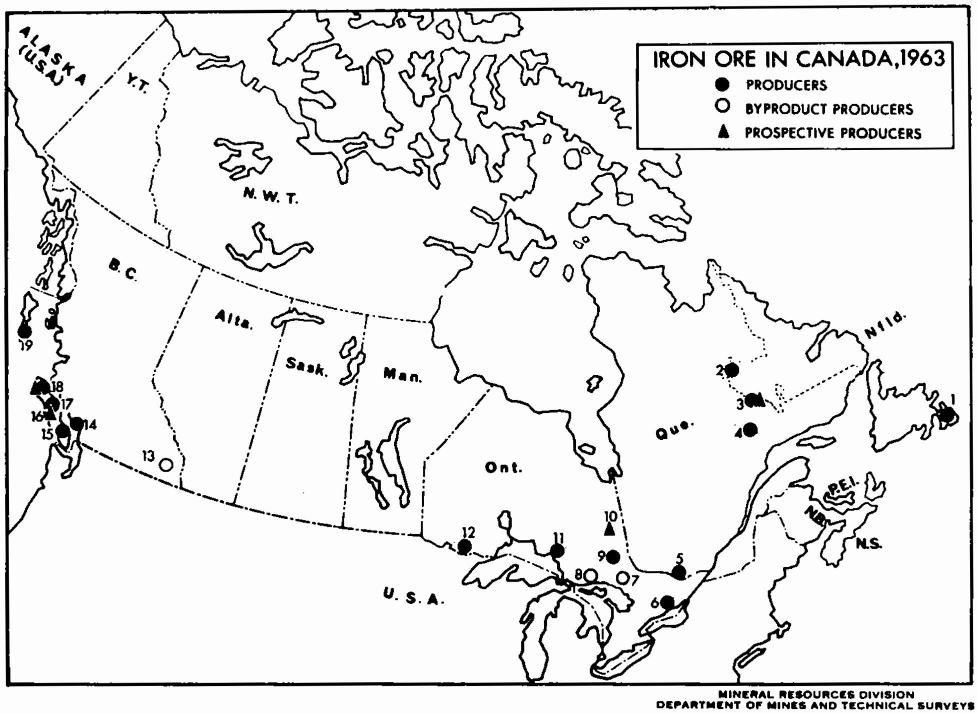
TABLE 6

Production and Capacity of Pig Iron and Crude Steel at Canadian Iron and Steel Plants, 1962 and 1963

(Short Tons)

	1962	1963
Pig iron		
production	5,288,933	5,914,997
capacity* at Dec. 31	6,115,200	6,905,000
Steel ingots and castings		
production	7,173,475	8,190,279
capacity at Dec. 31	8,614,000	9,479,240

Source: Dominion Bureau of Statistics.
*Compiled by Mineral Resources Division.



PRODUCERS

1. Dominion Steel and Coal Corporation, Limited (Wabana Mines Division)
2. Iron Ore Company of Canada (Schefferville)
3. Iron Ore Company of Canada (Labrador City)
4. Quebec Cartier Mining Company
5. Hilton Mines, Ltd.
6. Marmoraton Mining Company, Ltd.
9. Lowphos Ore, Limited
11. The Algoma Steel Corporation, Limited (Algoma Ore Properties Division)
12. Caland Ore Company Limited
    Canadian Charleson, Limited
    Steep Rock Iron Mines Limited
14. Texada Mines Ltd.
15. Brynnor Mines Limited
17. Nimpkish Iron Mines Ltd.
18. Empire Development Company, Limited
19. Jedway Iron Ore Limited

BYPRODUCT PRODUCERS

7. Falconbridge Nickel Mines, Limited (mines and plant)
   The International Nickel Company of Canada, Limited (mines and plant)
8. Cutler Acid Limited (plant moved to Sudbury area in stages in 1962-63)
13. The Consolidated Mining and Smelting Company of Canada Limited (mine and plant)

PROSPECTIVE PRODUCERS

3. Wabush Mines (1965)
10. Jones & Laughlin Steel Corporation (Adams Mine, 1964)
16. Empire Ventures Limited (1964) (formerly Zeballos Iron Mines Limited)
18. Coast Copper Company Limited (1964) (byproduct)

CANADIAN DEVELOPMENTS

Newfoundland

Shipments from Wabana Mines Division of Dominion Steel and Coal Corporation, Limited, declined 8.4 per cent despite increased shipments to the parent company's Sydney, N.S. steel plant and to Britain. Total exports fell by 281,677 tons, with sales to West Germany almost ceasing and to the Netherlands and Italy being reduced by half.

Labrador (Newfoundland)

IOCC's Labrador City mining-concentrating operation approached designed capacity of seven million tons of concentrates a year by late fall after a tune-up period that started in July 1962. The adjacent pelletizing plant of an associated company, Carol Pellet Company, commenced production in May 1963 and is the first producer of pellets in the Labrador-Quebec area. Construction of the $65-million plant began in 1961. It is operated under contract by IOCC and is designed to pelletize up to 5.5 million tons of IOCC concentrate a year. Additional stockpile and boat-loading facilities were completed at the port of Sept-Iles to handle the concentrate and pellets along with direct-shipping ore from the Schefferville area.

Wabush Mines continued development of its iron ore project on the southeast side of Wabush Lake. Initial production of concentrates, expected to grade over 65 per cent iron, will start early in 1965. The concentrator is designed to produce over five million tons of concentrate a year from specular hematite and magnetite crude grading 36 per cent iron. A pellet plant being built at Pointe Noire, Quebec, across the bay from Sept-Iles and expected to commence production later in 1965 will treat up to 4.9 million tons of concentrate; the remainder will be shipped as sinter feed. Major projects in 1963 included stripping of the orebody and construction of the concentrator, administration and maintenance buildings and housing units. At Pointe Noire, ore storage and handling facilities were installed and excavation for the pellet plant was started.

Canadian Javelin Limited continued negotiations with foreign ore consumers for the sale of large amounts of pellets on a long-term basis. A long-term sales contract would be necessary before the company's ore deposits near Wabush Lake, Labrador, and westward in Quebec, could be developed for production.

Quebec – Labrador (Newfoundland)

Shipments from Iron Ore Company of Canada's Schefferville area mines fell by three million tons from 1962 but shipments of concentrate and pellets from the company's Labrador City operation increased. Total shipments from the two operations were slightly higher than in 1962. The company continued its extensive ore-research program in an attempt to develop a process by which its medium-grade natural ore in the Schefferville area could be economically upgraded.

Quebec

Quebec Cartier Mining Company encountered serious operational problems at its concentrator during the winter of 1962 and 1963 mainly because of inability to maintain a steady throughput of ore from the crusher under severe weather conditions. However, design changes permitted rated-capacity operation by the end of 1963. Production from the company's $350-million operation commenced in July 1961. The project includes a large open-pit mine capable of producing 20 million tons of crude a year, sufficient to produce eight million tons of high-grade concentrate; a 193-mile railway; stockpile and boat-loading facilities; and two new towns – Port Cartier and Gagnon. The company is presently mining the Lac Jeannine deposit but owns several other large deposits for future development.

Shipments of pellets from Hilton Mines, Ltd., at 871,000 tons, exceeded the designed annual capacity of 800,000 tons.

Quebec Iron and Titanium Corporation mines ilmenite, a titanium-iron oxide, near Allard Lake, Quebec, and smelts it in electric furnaces at its plant at Sorel, Quebec. Titania slag (TiO_2) and pig iron are produced. The company resumed operations in March after a 6½-month strike. Consumption of ilmenite at Sorel was 817,286 tons from which 338,679 tons of slag and 224,949 tons of iron were produced. Comparable figures for 1962 were 665,851, 269,150 and 184,991 tons respectively. Although pig iron is produced from the Allard Lake material, the ilmenite is not classed as iron ore and is not included in iron ore statistics.

Ontario

Because of increased consumption at the parent company's Sault Ste. Marie steel plant, Algoma Ore Properties Division of The Algoma Steel Corporation, Limited, shipped slightly more sinter than in 1962. Sales to other consumers declined. The company continued exploration of its Goulais River low-grade magnetite property 50 miles northeast of Sault Ste. Marie.

Steep Rock Iron Mines Limited maintained approximately the same production rates as in 1962. Additions – a crushing and screening plant, a stockpile and a conveyor belt – costing $4.5 million for the new Roberts open pit were completed and this pit is now the prime source of ore. Small amounts continued to come from experimental stopes of the Errington underground mine. The company continued its research program on iron-ore beneficiation aimed at further improving ore quality.

Caland Ore Company Limited shipped approximately the same amount from its Steep Rock Lake area mine as in 1962. Of major significance was the company's announcement that it will build a $15-million ore-processing plant to be completed in 1965. It will have an annual capacity of one million tons of high-grade pellets and up to 1.5 million tons of screened, medium-grade lump ore. No concentration steps will be involved prior to pelletizing. However, during pelletizing, chemically bonded water will be driven off thereby raising the iron content of the pellets by more than 10 per cent. This will be one of the first plants in the world to beneficiate medium-grade ore containing 52 to 54 per cent iron to screened lump ore and high-grade pellets.

Canadian Charleson, Limited, did not operate its mine and concentrator in the Steep Rock Lake area but made small shipments from stockpile.

Lowphos Ore, Limited, completed construction of a pelletizing plant at its mine north of Capreol. The plant will treat the full output of concentrate, up to 625,000 tons a year, that in previous years was shipped elsewhere for sintering.

Shipments of pellets by Marmoraton Mining Company, Ltd., declined for the second consecutive year.

The International Nickel Company of Canada, Limited, completed its expansion program whereby annual pellet capacity was tripled to 750,000 tons. The plant can treat up to 1.1 million tons of nickeliferous pyrrhotite concentrate a year to produce iron oxide calcine that is then pelletized. Shipments in 1963 were nearly double those of 1962.

Noranda Mines, Limited, made small shipments of byproduct iron ore from stockpile. This material was made from iron sulphide concentrates at Noranda's Cutler sulphuric acid plant before the plant was sold to Cutler Acid Limited, a subsidiary of Canadian Industries Limited, in 1962. One of the plant's two roasting units was moved to CIL's Copper Cliff plant where it is used to produce sulphuric acid from smelter exhaust fumes. The other unit had been moved in 1962.

Falconbridge Nickel Mines, Limited, operated its new byproduct iron ore plant steadily throughout the year. The plant has a capacity of about 100,000 tons of iron oxide calcine a year produced from iron sulphide concentrates recovered in base-metal operations.

Jones & Laughlin Steel Corporation proceeded on schedule with mine development and plant construction at its $30-million project near Kirkland Lake. The project, with a designed annual capacity of 1.25 million tons of high-grade pellets from magnetite iron formation grading 23 per cent iron, is scheduled for production in the fall of 1964.

Prairie Provinces

No iron ore was produced in the Prairie Provinces; however, because of a possible future need in the region for iron ore by steel producers, exploration has been carried out on a number of prairie iron ore deposits. Peace River Mining & Smelting Ltd. continued to evaluate various means of utilizing iron-bearing material from the Peace River area of northwestern Alberta. The company announced plans to build a pilot plant at Edmonton for the production of iron powder.

British Columbia

Two mines ceased production in British Columbia in 1963. Nimpkish Iron Mines Ltd. closed at year-end when its reserves on northern Vancouver Island were depleted. Zeballos Iron Mines Limited near Zeballos, Vancouver Island, closed early in the year because of financial difficulties. Empire Ventures Limited, controlled by Falconbridge Nickel Mines, Limited, took over the property and sales contract of Zeballos and plans to convert the mine to an underground operation; production is to be resumed late in 1964.

Texada Mines Ltd. on Texada Island and Jedway Iron Ore Limited in the Queen Charlotte Islands continued underground development programs. Jedway was forced to reduce its production rate during the summer because of a shortage of process water. Brynnor Mines Limited, operating an open pit, started sinking a shaft preparatory to underground mining.

Coast Copper Company Limited, a subsidiary of The Consolidated Mining and Smelting Company of Canada Limited, announced plans to begin recovering by-product magnetite concentrate from copper ore early in 1964. A $600,000 - addition to the concentrator was nearing completion at the end of the year. Production is expected to be 250 tons of concentrate a day.

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 near the Yukon-Northwest Territories border.

Baffinland Iron Mines Limited continued exploration of its Baffin Island property, believed to contain large amounts of high-grade hematite. A drilling program is planned for 1964.

PRICES AND TARIFFS

Traditionally, prices received by most iron ore producers in Ontario and Quebec for shipments made to Canadian and United States consumers are a reflection of the Lake Erie price, that is, the price paid per long ton of iron ore delivered at the rail of vessel at Lake Erie ports. The Canadian mine price can be approximated by deducting the appropriate handling charges and transportation charges. The Lake Erie price is based on a natural iron content of 51.5 per cent and various other specifications regarding physical and chemical properties. Despite increasing production costs, which in many cases have not been offset by increased productivity, the Lake Erie price remained stable from 1957 to early 1962. In April 1962, the price for traditional medium-grade ores declined by about seven per cent. This decrease was the result of increased supplies from Canada and overseas countries and the trend toward lower ore prices in

TABLE 7
Lake Erie Base Prices, 1950–64
(Mesabi non-Bessemer grade)

Year	Per Long* Ton ($ US)	Per Long* Ton Unit ($ US)
1950	7.70	0.1495
1951	8.30	0.1612
1952 (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
1963–64	10.55	0.2049

* Basis 51.50% Fe, unscreened, delivered to rail of vessel at Lake Erie ports. Premium for coarse ore of 80¢ a ton; penalty for fine ore of 45¢ a ton.

international markets particularly in western Europe. In August 1963, iron ore freight rates between ports at the head of Lake Superior and Lake Erie ports were reduced by 10 cents a ton, thus lowering the Lake Erie price by that amount. Base prices received by British Columbia mines are negotiated individually between producers and consumers but generally range from $8.30 to $9.70 a ton f.o.b. port for ore grading 58 to 60 per cent iron.

Late in 1963, it was announced that the price of Swedish ores would be reduced by one kronor a ton for the 1964 season. However, freight rates were raised by the same amount so delivered prices remained constant. Swedish prices were reduced by seven per cent in both 1962 and 1963. Swedish ore prices generally set the trend for European prices.

There are no tariffs on iron ore in any country with which Canada trades. In 1959 and 1960 public hearings were held by the United States Tariff Commission to determine whether iron ore imports were injurious to United States domestic producers. Its findings, based on the 1960 hearings, were that imports had not seriously injured the domestic iron mining industry. Since that time, both the Senate and Congress have been requested to initiate some form of protection against imports but to the end of 1963 no legislative action has been taken.

TABLE 8

Canadian Producers of Iron Ore During 1963

Company and Property Location	Participating Companies	Product Mined (average natural grade)	Product Shipped (average natural grade)	Shipments[1] ('000 long tons) 1962	1963
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 (33.32% Fe)	Ore beneficiated by sink-float and sintered (50.86% Fe, 2.84% Mn)	1,561	1,618
Brynnor Mines Ltd.; near Kennedy Lake, Vancouver Island, B.C.	Noranda Mines, Ltd.	Magnetite from open pit mine (54.0% Fe)	Magnetite concentrate (60.3% Fe)	410	671
Caland Ore Co. Ltd.; E. arm of Steep Rock Lake, N. of Atikokan, Ont.	Inland Steel Co.	Hematite and goethite from open pit mines (53.69% Fe)	Direct-shipping ore (53.69% Fe)	2,005	2,003
Canadian Charleson, Ltd.; S. of Steep Rock Lake, near Atikokan, Ont.	Oglebay Norton Co.	Hematite-bearing gravels (12 – 20% Fe)	Jig and spiral concentrate (56.20% Fe)	119	19
Carol Pellet Company; adjacent to IOCC's concentrator, Labrador City, Labrador.	United States participants of IOCC	Company's plant operation by IOCC to process IOCC concentrate into pellets	Pellets (65.0% Fe)	–	1,835
Empire Development Co., Ltd.; Benson R., 25 miles SW. of Port McNeill, Vancouver, B.C.	Loram Ltd.; Quatsino Copper-Gold Mines, Ltd.	Magnetite from open pit and underground mines (35.5% Fe)	Magnetite concentrate (56.9% Fe)	22	86
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 (66.29% Fe)	780	871
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 (54.89% Fe)	Direct-shipping ore (54.89% Fe)	9,797[2]	6,753[2]
Labrador City, Nfld.	Same as above	Specular hematite from open-pit mine (36.1% Fe)	Specular hematite concentrate (approx. 64% Fe)	740	2,217[3]
Jedway Iron Ore Ltd.; Moresby Island, Queen Charlotte Is., B.C.	The Granby Mining Co. Ltd.	Magnetite from open-pit mine (41.5% Fe)	Magnetite concentrate (58% Fe)	48	303

Lowphos Ore, Ltd.; Sudbury area, 20 miles N. of Capreol, Ont.	National Steel Corp.; The Hanna Mining Co.	Magnetite from open-pit mine (31.46% Fe)	Magnetite concentrate (60.15% Fe) and pellets (63.63% Fe)	401 —	315 175
Marmoraton Mining Co., Ltd.; near Marmora, in southern Ont.	Bethlehem Steel Corp.	Magnetite from open-pit mine (43.77% Fe)	Iron oxide pellets (64.82% Fe)	408	387
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 (57.5% Fe)	324	275
Quebec Cartier Mining Co.; Gagnon, Que.	United States Steel Corp.	Specular hematite from open-pit mine (31.3% Fe)	Specular hematite concentrate (64.4% Fe)	4,620	6,353
Steep Rock Iron Mines Ltd.; Steep Rock Lake, N. of Atikokan Ont.	Premium Iron Ores Ltd.; The Cleveland-Cliffs Iron Co., and	Hematite-goethite from open-pit and underground mines (50.93% Fe)	Direct-shipping ores and gravity concentrate (54.0% Fe)	963	963
Texada Mines Ltd.; Texada Island, B.C.	Private company	Magnetite from open-pit and underground mines (39.26% Fe)	Magnetite concentrate (62.58% Fe)	537	451
Dominion Steel and Coal Corp., Ltd., Wabana Mines Division; Bell Island, Conception Bay, E., coast of Nfld.	Wholly owned	Hematite-chamosite from underground and open-pit mines (48.39% Fe)	Heavy-media concentrate (50.54% Fe)	1,275	1,168
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 (65.0% Fe) is further processed into pig iron at the plant.	43[4]	56[4]
Falconbridge Nickel Mines, Ltd.; Sudbury area, Ont.	Wholly owned	Pyrrhotite flotation concentrates treated.	Iron oxide calcine (67% Fe)	na	64
The International Nickel Co. of Canada, Ltd.; mines and plant in Sudbury area, Ont.	Wholly owned	Pyrrhotite flotation concentrates treated.	Iron oxide pellets (68% Fe)	257	458
Noranda Mines, Ltd.; mines at Noranda, Que., 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 (64 – 66 Fe)	37[5]	42
Quebec Iron and Titanium Corp.; mine in Allard Lake area, Que., electric smelter at Sorel, Que.	The Kennecott Copper Corp., New Jersey Zinc Co.	Ilmenite-hematite from open-pit mine (40% Fe, 35% TiO_2)	TiO_2 slag and various grades of desulphurized iron or 'remelt iron'	660[4]	817[4]

Source: Company reports, personal communications and other sources.
Symbols: na Not available; – Nil.
[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 mines ore, included in the total figures, for the account of the two concession companies. Shipments in 1962 were 761,278 tons and 738,721 tons and in 1963 were 854,558 tons and 800,700 tons for the two companies 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]Production.

TABLE 9

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	Expected Annual Production (long tons)
Caland Ore Co. Ltd. (1965)*	E. arm of Steep Rock Lake, N. of Atikokan, Ont.	Inland Steel Co.	Hematite and goethite from open-pit mines (53.76% Fe)	Pellets (+60% Fe) Lump ore (54% Fe)	1,000,000 1,500,000
Coast Copper Co. Ltd. (1964)	Near Benson Lake, northern Vancouver Island, B.C.	COMINCO	Copper ore from underground mine, containing about 25% Fe as magnetite	Magnetite concentrate (plus 60% Fe)	85,000
Jones & Laughlin Steel Corp. (1964)	Boston twp., near Kirkland Lake, Ont.	Wholly owned	Magnetite iron formation from open-pit mine (25% Fe)	Pellets (65 – 66% Fe)	1,000,000
Empire Ventures Ltd. (1964)**	Near Zeballos, Vancouver Is. B.C.	Falconbridge Nickel Mines, Ltd. Empire Development Co. Ltd.	Magnetite from underground mine (about 48% Fe)	Magnetite concentrate (plus 60% Fe)	300,000
Wabush Mines; Pickands Mather & Co., managing agent (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 Iron Corp.; Pittsburgh Steel Co.; Finsider of Italy and Pickands Mather & Co.)	Specular-hematite iron formation from open-pit mine (37% Fe)	Concentrate and pellets (64 – 65% Fe)	4,900,000 pellets, 400,000 concentrate
Byproduct Producers					
The Consolidated Mining and Smelting Co. of Canada Ltd. (1964)	Kimberley, B.C.	Wholly owned	Pyrrhotite flotation concentrates treated	Pig iron	Electric furnace pig iron capacity being increased to 100,000 short tons.

Source: Company reports and personal communications.

* Company presently produces two million tons of natural ore (54% Fe) a year.

** Property formerly open pit operation owned by Zeballos Iron Mines Limited.

Lead

J.W. Patterson*

Based on the lead content of ores and concentrates exported and the lead recovered domestically from ores and concentrates, Canada's production of lead in 1963 was less than her production in 1962 – 201,165 tons compared with 215,329 tons. Slight increases in shipments reported by a number of mines were offset by declines in shipments that resulted in part from prolonged strikes at the Solbec mine in the Eastern Townships of Quebec and the Reeves MacDonald mine in southeastern British Columbia. Refined lead output at the Trail, British Columbia, smelter operated by The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) at 155,000 tons was somewhat higher than the 152,217 tons produced in 1962.

Production calculated by measuring the lead content of ores and concentrates produced, rather than measuring the recoverable content of ores and concentrates exported and the lead content of bullion produced as above, was 198,988 tons. In 1962 and 1961, it was 211,321 and 182,557 tons.

Exports of both ores and concentrates, and metal were less than in 1962. The decline in exports of ores and concentrates – 5,739 tons of contained lead – was largely accounted for by reduced shipments to Belgium and West Germany. The decline in metal exports at 28,658 tons was much higher and was for the most part due to reduced shipments to the United States. The largest increases in exports were those concerning shipments of ores and concentrates to Britain and metal to Japan.

* Mineral Resources Division

TABLE 1

Lead – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production				
All forms[(a)]				
British Columbia	167,641	33,260,028	157,487	34,647,144
Newfoundland	25,330	5,025,529	23,392	5,146,264
Yukon Territory	8,145	1,615,980	8,490	1,867,647
Quebec	4,716	935,656	4,337	954,051
Manitoba	3,792	752,357	2,737	602,203
New Brunswick	1,879	372,865	1,783	392,277
Nova Scotia	2,682	532,047	1,400	308,053
Ontario	1,144	226,879	1,539	338,560
Total	215,329	42,721,341	201,165	44,256,199
Mine output (b)	211,321		198,988	
Refined (c)	152,217		155,000	
Exports				
In ores and concentrates				
United States	29,230	3,991,965	27,103	3,853,694
Belgium and Luxembourg	16,018	1,872,296	12,960	1,596,011
Britain	4,227	508,651	9,389	1,121,557
West Germany	10,020	1,482,333	4,304	635,479
Total	59,495	7,855,245	53,756	7,206,741
In pigs, blocks and shot				
Britain	48,082	5,974,322	44,080	6,367,626
United States	60,194	9,522,669	31,690	6,178,916
Japan	6,014	773,214	9,031	1,338,092
India	7,361	932,225	6,103	768,777
Netherlands	1,764	219,317	3,617	526,430
Italy	392	48,376	718	104,040
Other countries	1,995	256,601	1,905	262,389
Total	125,802	17,726,724	97,144	15,546,270
Lead and lead-alloy scrap				
United States	1,645	192,736	3,355	430,517
Italy	–	–	534	33,428
Belgium and Luxembourg	–	–	62	8,100
West Germany	81	12,405	26	2,774
Britain	54	9,984	12	4,500
Total	1,780	215,125	3,989	479,319

Table 1 (cont'd)

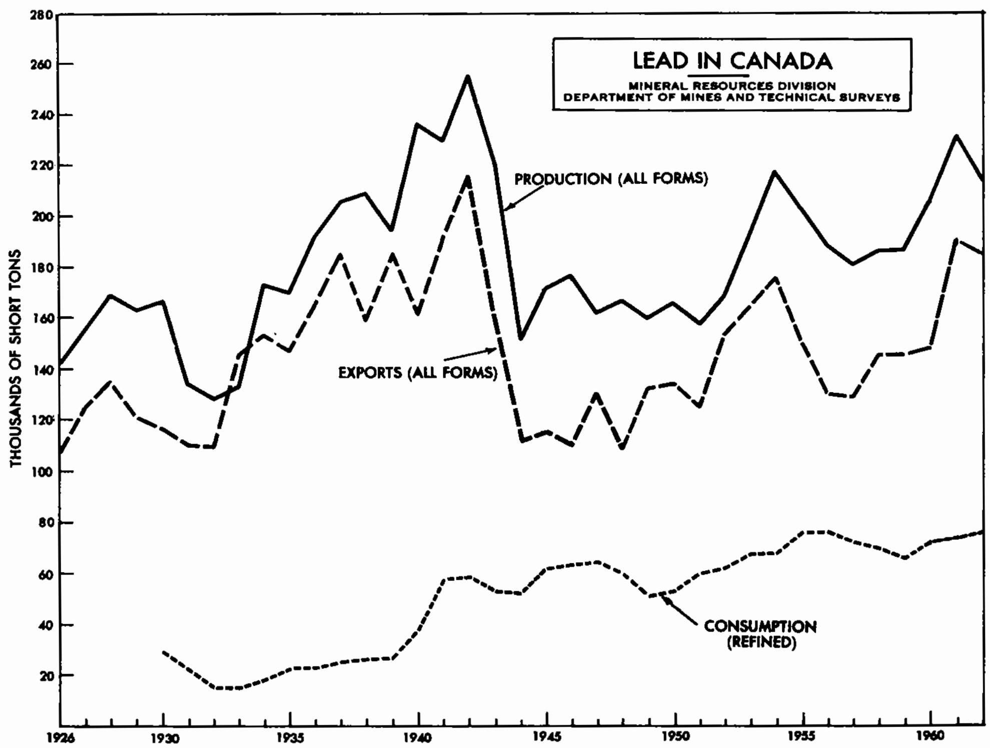
	1962		1963	
	Short Tons	$	Short Tons	$
Lead fabricated materials not elsewhere specified				
United States	2,381	536,654	825	240,583
Bolivia	—	—	22	8,087
Venezuela	6	2,702	5	2,000
Other countries	9	3,304	2	1,281
Total	2,396	542,660	854	251,951
Imports				
Lead in pigs and blocks	578	83,308	1,741	289,734
Lead in bars and sheets	68	23,348	97	33,116
Litharge	772	204,418	1,084	292,386
Lead manufactures		290,597		297,089
Miscellaneous lead products (d)		418,772		355,016
Total		1,020,443		1,267,341
Consumption				
Primary lead				
Antimonial lead	575		1,488	
Batteries and battery oxides	15,568		15,961	
Cable covering	4,026		4,612	
Chemical uses (white lead, red lead, litharge, tetraethyl lead, etc.)	14,215		15,106	
Copper alloys (brass, bronze, etc.)	214		227	
Lead alloys				
Solders	1,575		1,574	
Other (including babbitts, type metal) etc.,	329		604	
Semifinished products (pipe, sheet, traps, bends, block for caulking, ammunition, foil, collapsible tubes, etc.)	8,503		6,276	
Other	972		924	
Total	45,977		46,772	

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Secondary lead				
Antimonial lead	16,760		16,561	
Batteries and battery oxides..	456		619	
Cable covering	2,578		1,470	
Chemical uses (white lead, red lead, litharge, tetraethyl lead, etc.)	1,631		2,557	
Copper alloys (brass, bronze, etc.)	116		123	
Lead alloys				
Solders	2,384		2,717	
Other (including babbitts, type metal, etc.)	2,557		1,827	
Semifinished products (pipe, sheets, traps, bends, block for caulking, ammunition, foil, collapsible tubes, etc.)	3,485		3,695	
Other	1,342		1,617	
Total....................	31,309 (g)		31,186 (g)	
Consumption Summary				
Primary lead	45,976		46,772	
Secondary lead.............	31,309 (g)		31,186 (g)	
Total....................	77,286		77,958	

Source: Dominion Bureau of Statistics.
(a) 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. (b) Lead content of domestic ores and concentrates produced. (c) Primary refined lead from all sources. (d) Includes scrap lead, lead capsules for bottles, orange mineral, red lead, and dry white lead, acetate and nitrate of lead (not ground), arsenate of lead and paste paints, including white lead. (g) Includes all remelt scrap lead and scrap lead used to make antimonial lead.

Canada's consumption pattern was similar to that of 1962. Little change in consumption was reported in any of the main use categories except that pertaining to the manufacture of semi-finished products. In this category, usage of primary lead declined from 8,503 to 6,276 tons. Lead consumption in the United States, where almost one-third of Canada's lead production was exported in 1963, increased to 1.16 million tons from 1.11 million tons in 1962. Most of the increase was attributable to larger amounts being used in tetraethyl lead and storage-battery manufacture. Declines were reported only in three major uses with the largest taking place in red lead and litharge manufacture.



UNITED STATES QUOTAS

The quotas on United States imports of unmanufactured lead continued throughout 1963. Imposed by the United States government on October 1, 1958, the quotas, which are sub-divided into quarterly allotments, restrict annual unmanufactured lead imports from Canada to 26,880 tons of lead in ores and concentrates and 31,840 tons of lead in refined and other metallic forms. Except for the second quarter, which was 17 tons short, all the quarterly allotments pertaining to metal were filled but those pertaining to ores and concentrates were filled only during the first quarter.

As has been done annually for the previous three years, the United States Tariff Commission, in 1963, reviewed trade and related developments in the lead-zinc industry to ascertain if conditions of competition between imported and domestic unmanufactured lead and zinc had changed sufficiently to warrant a further study on the possibility of relaxing the quota restrictions. In its report to the President on October 1, the Commission made no recommendation for such a study.

TABLE 2

Summary – Lead Production, Trade and Consumption, 1954–63

(Short Tons)

	Production		Exports			Imports	
	All Forms(a)	Refined(b)	In Ore and Con-centrates	Refined	Total	Refined(c)	Con-sump-tion(d)
1954	218,495	166,005	59,755	116,409	176,164	148	67,947
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

Source: Dominion Bureau of Statistics.
(a) Lead content in base bullion produced from domestic primary materials (concentrates, slags, residues etc.) plus estimated recoverable lead in domestic ores and concentrates exported. (b) Primary refined lead from all sources. (c) Lead in pigs and blocks. (d) Consumption of lead, both primary and secondary in origin. Prior to 1960, consumption of lead derived from secondary sources was not reported completely.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group, which held its seventh session in Geneva from October 28 to November 7, concluded that the rise in lead and zinc consumption that has been a feature of these metals in recent years would continue throughout 1963 and that record levels for each would be reached in 1964. New supplies of both lead and zinc were expected to fall short of demand by a small amount in 1964. In view of these circumstances, the importance of liberalizing trade in lead and zinc was stressed as a means of avoiding distortions inherent in the isolation of sectors of the market.

On the subject of disposals from its large stockpiles of lead and zinc (1,381,000 tons of lead and 1,581,000 tons of zinc), the United States expressed a willingness to consult the Study Group before any plans were completed for disposals, if arrangements for consultation could be made. In any event, the United States indicated at the Study Group meeting that interested governments would be individually consulted regarding contemplated disposals.

PRODUCING MINES

As has been the case for many years, COMINCO accounted for well over half of Canada's mine production of lead – 137,379 tons. No interruption in production occurred at any of its base-metal mines – the Sullivan, the H.B. and the Bluebell in southeastern British Columbia respectively at Kimberley, Salmo and Riondel, and the Wedge mine in New Brunswick. About 12,650 tons of ore were milled daily with 10,000 tons coming from the Sullivan mine, 1,200 from the H.B. mine, 700 from the Bluebell mine and 750 tons from the Wedge mine.

Major producers besides COMINCO were: American Smelting and Refining Company at Buchans, Newfoundland; United Keno Hill Mines Limited at Elsa, Yukon Territory; and Canadian Exploration, Limited at Salmo, British Columbia. Production of these three companies totalled about 41,000 tons compared with 42,000 tons in 1962. A decline in output at the Jersey mine operated by Canadian Exploration was almost entirely offset by increased production at the Buchans Mine. Little change in output took place at United Keno Hill's operation in the Yukon Territory; most of the ore continued to come from the Elsa and Hector-Calumet mines.

Smaller producers included Reeves MacDonald Mines Limited and Sheep Creek Mines Limited both in southeastern British Columbia, Hudson Bay Mining and Smelting Co., Limited in Manitoba, New Calumet Mines Limited in Quebec, Heath Steele Mines Limited in New Brunswick and Magnet Cove Barium Corporation in Nova Scotia. While no mines of consequence were placed in production during the year, neither were there any closures. Production was curtailed for five months because of strikes at the Solbec mine in the Eastern Townships and for eight months at the Reeves MacDonald mine in British Columbia.

OTHER DEVELOPMENTS

British Columbia

Silbak Premier Mines, Limited and Western Mines Limited announced that they may commence milling in 1964 or 1965; the former, near Stewart, at about 75 tons of lead-zinc-silver ore and the latter, at Buttle Lake on Vancouver Island, at about 750 tons of copper-lead-zinc-silver ore a day. Intermittent shipments of silver-lead-zinc ores and concentrates were made by small companies, partnerships and individuals. Most of these shipments were from properties in the Slocan district but some were from properties in the Hazelton-Smithers area in the central part of the province and from the Stewart area north of Prince Rupert. Owing to the continuing favorable price for silver, it is probable that some of these properties will be placed in production in 1964 on a permanent basis.

TABLE 3

Principal Lead Producers in Canada, 1963

Company	Mine	Location	Mill Capacity (short tons/day)	Grade of Ore Milled in 1963 (principal metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz.ton)	Ore Produced 1962 (short tons)	Ore Produced 1963 (short tons)	Lead Produced 1963 (short tons)
Yukon Territory										
United Keno Hill Mines Limited (a)	Elsa	Mayo District	500	5.44	4.69	na	34.03	184,123	186,721	8,376
	Hector-Calumet	" "								
	Silver King	" "								
British Columbia										
Canadian Exploration, Limited	Jersey	Salmo	1,900	1.5	4.1	*	na	384,894	368,673	5,060
The Consolidated Mining and Smelting Company of Canada Limited	Sullivan	Kimberley	10,000	na	na	na	na	2,583,068	2,595,000	121,653
	Bluebell	Riondel	700	na	na	na	na	237,742	256,000	12,426
	H.B.	Salmo	1,200	na	na	na	na	468,979	474,000	3,300
Mastodon-Highland Bell Mines Limited	Highland-Bell	Beaverdell	75	1.9	2.5	—	40	19,480	21,689	403
Reeves MacDonald Mines Limited(b)	Reeves MacDonald	Remac	1,200	1.28	3.73	*	na	417,448	145,966(b)	1,554
Sheep Creek Mines Limited	Mineral King	Toby Creek	600	2.14	5.09	na	1.01	208,670	203,942	4,011
Manitoba										
Hudson Bay Mining and Smelting Co., Limited	Chisel Lake	Snow Lake	(c)	1.4	12.9	0.49	2.06	338,377	300,065	2,857
Ontario										
Geco Mines Limited	Geco	Manitouwadge	3,300	na	5.72	1.88	2.44	1,282,414	1,281,165	1,570
Quebec										
The Coniagas Mines, Limited	Coniagas	Bachelor Lake	350	1.7	13.7	—	8.0	108,212	111,418	1,433
Manitou-Barvue Mines Limited (d)	Golden Manitou	Val d'Or	1,300	0.73	5.63	—	4.52	169,140(d)	174,365(d)	1,031
New Calumet Mines Limited(a) ...	New Calumet	Grand Calumet Island	750	1.83	6.75	*	3.68	95,623	93,360	1,711
Solbec Copper Mines, Ltd.(e)	Solbec	Northeast of Sherbrooke	1,000	0.65	4.72	1.96	1.54	271,384	188,493	749
New Brunswick										
Heath Steele Mines Limited(f) ...	Heath Steele	Bathurst area	1,500	2.4	5.6	1.1	2.53	na	265,939	4,293
Nova Scotia										
Magnet Cove Barium Corporation	Magnet Cove	Walton	125	3.82	1.4	0.77	12.8	47,416	49,058	1,809
Newfoundland										
American Smelting and Refining Company (Buchans Unit)	Buchans	Buchans	1,250	7.76	13.86	1.15	4.09	378,000	376,000	28,192

(a) Production — fiscal year ending September 30, 1963.

(b) The mine was closed May 6 to December 20 due to a strike of employees.

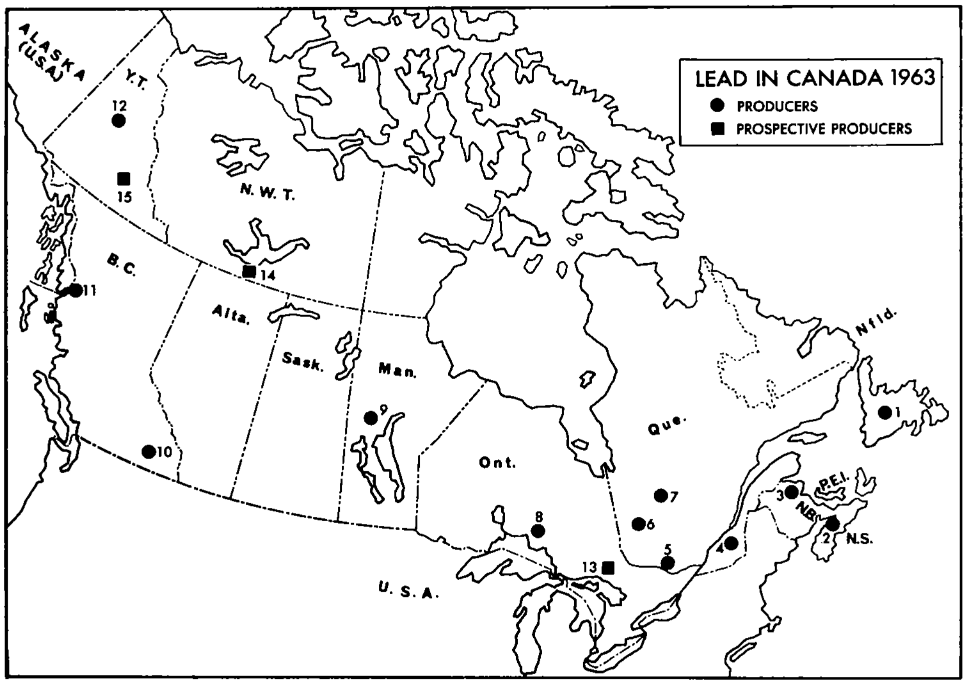
(c) About 1,000 tons of ore are shipped daily to Hudson Bay's 6,000-ton mill at Flin Flon.

(d) Manitou-Barvue also mills copper ore. In 1963, 293,000 tons grading 0.93 per cent copper were treated.

(e) The mine was closed for five months by a strike of employees.

(f) One half of Heath Steele's mill capacity is used to treat copper ore mined by The Consolidated Mining and Smelting Company of Canada Limited at its Wedge mine.

Symbols: na — Not available; * Not recovered, if present; — nil.



PRODUCERS*

1. American Smelting and Refining Company, Buchans Unit
2. Magnet Cove Barium Corporation
3. Heath Steele Mines Limited
4. Solbec Copper Mines, Ltd.
5. New Calumet Mines Limited
6. Manitou-Barvue Mines Limited
7. The Coniagas Mines, Limited
8. Geco 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
    Mastodon-Highland Bell Mines Limited
    Reeves MacDonald Mines Limited
    Sheep Creek Mines Limited
11. Silbak Premier Mines, Limited
12. United Keno Hill Mines Limited

PROSPECTIVE PRODUCING AREAS

13. Sudbury Basin
14. Great Slave Lake
15. Pelly River

* Omitted are several producers, most of which are in British Columbia.

COMINCO, in participation with St. Eugene Mining Corporation, Limited, completed the first phase of an exploration program covering the St. Eugene property at Moyie, near Cranbrook. On the Teddy Glacier silver-lead-zinc property, 20 miles southeast of Revelstoke, Sunshine Lardeau Mines, Limited reported favorable results of that portion of its exploration program completed in 1963. In the same general area, on a base-metal property held by Jordan Mines Limited, Bralorne Pioneer Mines Limited did some surface exploration. New Cronin Babine Mines Limited on its property near Smithers conducted exploration consisting of some underground diamond drilling and the sinking of a 60-foot internal shaft.

New Brunswick

In November, construction of a lead-zinc smelter complex at Belledune Point on the shore of the Bay of Chaleur, 20 miles northwest of Bathurst, was officially commenced by a sod-turning ceremony at which the Honourable Louis Robichaud, Premier of New Brunswick, officiated. The Imperial Smelting Corporation furnace is being built by East Coast Smelting and Chemical Company primarily to treat concentrates produced at mines near Bathurst by Brunswick Mining and Smelting Corporation Limited, which is an associated company. The smelter, to be placed in operation in mid-1966, will initially produce lead and zinc at the annual rate of 30,000 tons of each metal. Production at Brunswick's No. 12 mine is scheduled to start early in 1964, at about 3,000 tons of ore a day. Gradual increases are expected to bring daily production up to 4,500 tons by 1965. To serve Brunswick's mine properties, Canadian National Railways began construction in May of a 15–mile railway spur from Nepisiquit Junction on the Newcastle-Bathurst line.

Northwest Territories

Pine Point Mines Limited constructed over fifty houses, two bunkhouses and several other buildings, installed water and sewage systems, and erected power distribution facilities at Pine Point on the south shore of Great Slave Lake. To obtain more information for open-pit development purposes, about 28,400 feet of diamond drilling was completed. Milling of the lead-zinc ore is scheduled to commence in 1966 at 5,000 tons daily. The concentrates will be shipped by rail to Grimshaw, Alberta on a line which is now being constructed and thence to the Trail, British Columbia smelter complex. The new railway line from Grimshaw, which will serve both the Hay River and Pine Point communities on Great Slave Lake, is about one-half completed.

A contract covering the construction of an 18,000-kilowatt hydro plant at Twin Gorges on the Taltson River was awarded to an Edmonton-based firm. The plant is being constructed primarily to serve Pine Point which is some 150 miles away from the proposed power site.

USES

The main industrial applications of lead in Canada and the tonnages used in each are listed in Table 1.

The most valued properties of lead are its resistance to corrosion, its low melting point, its malleability and its high specific gravity. Because of these, lead is used extensively in the manufacture of corrosive-liquid containers, batteries, cable sheathing, various types of lead-base babbitts, solders and type metals, plumbing equipment such as pipes, drains and bends, caulking materials, ammunition, etc. Lead is also used in large amounts in the manufacture of pigments and tetraethyl lead.

While lead in asbestos pads installed in building foundations has long been used to minimize vibrations, it is only in recent years that this use has become fairly widespread. This is partly due to the greater need for vibration control in large buildings now that it has become common practice to install air-conditioning equipment on the tops of buildings. Also due to shortage of space in many rapidly growing cities, more and more office buildings, hotels and apartments are being erected in areas where vibration-producing equipment such as trains and other heavy haulage vehicles are concentrated.

A promising new use for lead related to vibration control is in the sound insulation field. A number of hotel operators in Ontario have installed lead-lined panels to reduce noise transmission from room to room and aircraft manufacturers are making wider use of lead impregnated plastics as sound absorption material. COMINCO's Montreal offices were partially sound-proofed by the use of sheet lead in partitions.

Lead telluride is used in detection, guidance and control devices installed in satellites and other spacecraft. A ceramic-bonded, solid-film lead monoxide lubricant has been developed for use in rocket propulsion and missile launching. A growing use, still relatively new, is as a radiation shielding material. Nuclear-powered submarines and ships, and nuclear power stations require substantial amounts of lead. In addition, lead is being used in increasing amounts in the manufacture of radioactive-fuel shipping containers.

WORLD PRODUCTION OF LEAD

The countries listed in Table 4 are the Free World's leading producers. Countries of the Soviet bloc in 1963 produced approximately 718,600 tons.

TABLE 4

Mine Production of Lead by Principal Producing Countries

(thousands of short tons)

	1962	1963
Australia	406.4	447.1
United States	246.8	263.9
Canada	211.3	199.0
Mexico	197.0	192.6
Peru	164.1	157.3
Yugoslavia	105.8	111.3
Morocco	98.3	81.2
Republic of South Africa	88.3	90.7
Sweden	72.0	75.7
Spain	77.5	68.0
West Germany	61.1	61.4
Japan	59.0	58.2
Italy	45.5	36.3
Argentina	29.1	29.1
Bolivia	20.5	21.9
Zambia	17.2	20.7
Burma	19.8	19.8
Greece	16.5	15.9
France*	20.6	8.8
Austria	6.3	5.8
Others**	80.9	91.5
Total	2,044.0	2,056.2

Source: International Lead and Zinc Study Group.

* Beginning July 1962, excludes Algeria

** Beginning July 1962, includes Algeria. Bulgaria, mainland China, Czechoslovakia, Eastern Germany, Poland, Rumania, North Korea and the Union of Soviet Socialist Republics are excluded.

PRICES

Changes in prices quoted f.o.b. Montreal and Toronto during 1963 were:

	(cents/pounds)
January 17	10.00 to 10.50
July 3	10.50 to 11.00
August 21	11.00 to 11.50
October 18	11.50 to 12.00
December 9	12.00 to 12.50

TARIFFS

Canadian tariffs on ore and concentrates and certain semifabricated forms were:

	British Preferential	Most Favored Nation	General
Lead ores and concentrates	free	free	free
Pig-lead scrap and blocks...............	½¢ lb	½¢ lb	1¢ lb
Lead bars and sheets...................	10%	10%	25%
Babbitt metal and type metal in blocks, bars, plates and sheet	10%	20%	20%

The United States tariff on the lead content of ores and concentrates remained at 0.75 cents a pound; pig lead, lead bullion, scrap lead and various lead alloys, was unchanged at 1.0625 cents a pound on the lead content. Varying tariffs are applied to imports of lead in other forms.

Lime

J.S. Ross*

The lime industry experienced little change in 1963. Although output rose slightly, it has not varied appreciably since 1961, the year the uranium industry dropped from the largest to the third largest noncaptive market for lime. The lime requirements of this industry will continue to decline in the immediate future. Because of the closing of several mines in 1964 and 1965, consumption for this use could be reduced to 35,000 tons in 1965. It will be difficult for the lime industry to find new markets to absorb the loss.

In addition, there will be a decrease in the use of lime for the production of calcium carbide at the Shawinigan Falls, Quebec, plant of Shawinigan Chemicals Limited. Near the end of 1963, this company began producing acetaldehyde from ethylene, thus reducing its reliance on acetylene produced from calcium carbide.

Shipments amounted to about 1.5 million tons valued at $18.5 million in 1963. This was about half the rated capacity and an increase of 1.0 per cent in amount and 4.9 per cent in value from 1962. As is customary, quicklime made up most of the output—83 per cent of the total. As in 1962, most of the increase in production came from Ontario, the only province that suffered a serious decrease in lime consumption by the uranium industry. Ontario supplied 67 per cent of the total Canadian output. The remaining provinces showed little change from 1962.

Trade – mostly with the United States – is relatively small. As in 1962, exports reached their second consecutive record amounting to 98,000 tons valued at $1.1 million. Imports – mostly of special types – totalled 44,000 tons valued at $714,000.

PRODUCTION

Canada produces quicklime and hydrated lime; most by far is high-calcium quicklime containing at least 90 per cent calcium oxide. Also produced are

*Mineral Processing Division, Mines Branch

TABLE 1
Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production*				
By type				
Quicklime	1,181,058	14,148,347	1,204,824	14,915,096
Hydrated Lime	243,401	3,498,241	245,907	3,589,124
Total	1,424,459	17,646,588	1,450,731	18,504,220
By province				
Ontario	910,930	10,527,910	952,945	11,434,223
Quebec	365,473	4,431,612	358,201	4,586,493
Manitoba	46,348	800,418	54,879	908,952
Alberta	48,138	842,615	54,826	970,673
New Brunswick	17,341	389,876	16,919	382,713
British Columbia	36,229	654,157	12,961	221,166
Total	1,424,459	17,646,588	1,450,731	18,504,220
Imports				
United States	35,909	550,213	44,110	709,207
Britain	206	3,750	163	2,993
France	nil	nil	18	1,357
Total	36,115	553,963	44,291	713,557
Exports				
United States	71,077	1,004,585	95,690	1,114,086
British Guiana	500	4,586	2,310	23,723
Bermuda	nil	nil	80	3,101
Netherlands Antilles	5	290	4	250
St. Pierre	1	58	nil	nil
Total	71,583	1,009,519	98,084	1,141,160

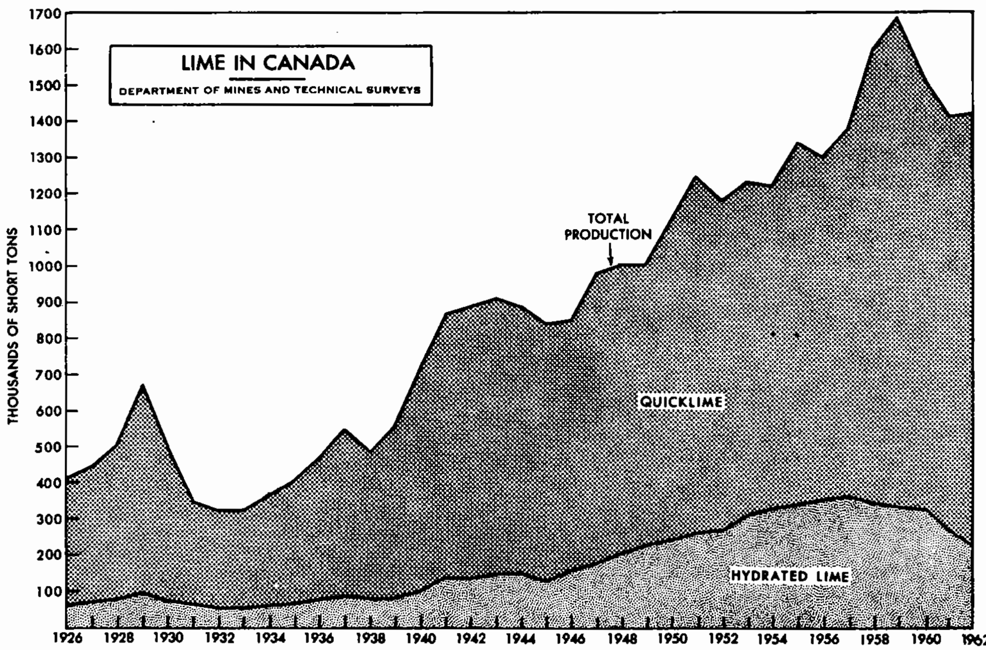
Source: Dominion Bureau of Statistics.

*Producers' shipments of primary lime plus quantities used by producers. In 1963, 887,986 tons of the total were shipped for sale and 562,745 tons were used captively.

TABLE 2
Production Capacity[1], 1958–63

	No. of Plants[2]	No. of Kilns[2]	Approximate Rated Capacity[2] (short tons/day)	Production (short tons)	Production % of Year-End Capacity[3]
1958	38	150	7,400	1,596,422	63
1959	38	155	7,680	1,685,725	64
1960	35	145	8,010	1,529,568	56
1961	35	125	7,825	1,415,290	53
1962	35	125	8,100	1,424,459	52
1963	33	116	7,810	1,450,731	55

[1]Excluding separate hydrating plants. [2]At year end. [3]Assuming 340 operating days a year.



dolomitic quicklime containing 35 to 45 per cent magnesia, small amounts of magnesian quicklime and the hydrated form of each type.

Domestic lime is produced from high-purity limestone; in 1963, 2.7 million tons of limestone were used for that purpose. Limestone suitable for lime production is generally available to most of the more populous areas in all provinces except Saskatchewan and Prince Edward Island.

Primary lime is produced in six provinces: Ontario, Quebec, Manitoba, Alberta, New Brunswick and British Columbia. Ontario is by far the leading supplier and, with Quebec, produced 90 per cent of the 1963 total. All producing provinces supply high-calcium quicklime but only plants in Manitoba, Ontario and New Brunswick market the dolomite type. Although 35 plants with 97 vertical and 28 rotary kilns were in production during 1963, at year-end only 33 plants with 89 vertical and 27 rotary kilns were in operation. Rated capacity at year-end was 7,810 tons a day and production was 55 per cent of this amount. In addition, two separate plants hydrated purchased lime. Thirty-nine per cent of total production was consumed by the companies producing it. It is of interest that, since 1959, the number of lime plants and kilns has decreased 13 and 25 per cent respectively, whereas capacity has risen (Table 2).

A large and unknown amount of secondary lime was recovered from chemical plants, particularly from calcium carbonate sludge at many paper-pulp plants. It is estimated that at least half a million tons of secondary lime are recovered yearly in Canada.

TABLE 3

Producers, 1963

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*
Quebec		
Aluminum Company of Canada, Limited	Wakefield	Magnesian*
Bousquet, Adrien	St. Dominique	High-calcium
Dominion Lime Ltd.	Lime Ridge	” *
Lamothe, N.	Pont Rouge	”
Quebec Sugar Refinery	St. Hilaire	”
Shawinigan Chemicals Limited	Shawinigan	”
Domtar Chemicals Limited	Joliette	” *
	St. Marc des Carrieres	”
Ontario		
Bonnechere Lime Limited	Grattan tp.	High-calcium
Brunner Mond Çanada, 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	”
Indusmin Limited	Coboconk	”
Cyanamid of Canada Limited	Niagara Falls	”
	Ingersoll	”
Dominion Magnesium Limited	Haley	Dolomitic
Domtar Chemicals Limited	Hespeler	” *
	Beachville	High-calcium *
Rockwood Lime Company Limited	Rockwood	Dolomitic*
Manitoba		
Building Products and Coal Co. Ltd.	Inwood	Dolomitic*
The Manitoba Sugar Company, Limited	Fort Garry	High-calcium
The Winnipeg Supply & Fuel Company Limited	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	”
Domtar Chemicals Limited	Blubber Bay	” *
	Granville Island	”

*The hydrated varieties are also produced.

DEVELOPMENTS

The St. Marc des Carrieres, Quebec, lime plant of Domtar Chemicals Limited was closed down in 1963 after many decades of production. The company continued to supply markets from its recently expanded and modernized lime plant at Joliette. The Blubber Bay, British Columbia, lime plant of Domtar Chemicals was also closed in 1963. It first started operation in 1909.

In Quebec, the requirements for lime as a raw material in the production of acetaldehyde will be reduced. This was initiated near the end of 1963 when Shawinigan Chemicals Limited started to use ethylene as a source of acetaldehyde.

CONSUMPTION AND USE

Lime is relatively inexpensive and is desired as an alkali for many purposes; consequently, it is used by most industries. Consumers of lime may be divided into four categories: chemical and metallurgical, construction, agriculture, and other industries as indicated in Table 4.

TABLE 4

Consumption of Lime

(producers' shipments and consumption by usage)

	1961		1962	
	Short Tons	$	Short Tons	$
Chemical and metallurgical, etc.				
Iron and steel plants	185,630	2,174,495	187,344	2,205,413
Pulp mills	185,462	2,382,240	206,857	2,602,043
Uranium mills	127,616	1,594,236	98,304	1,225,405
Nonferrous smelters	91,389	640,117	57,911	470,069
Sugar refineries	31,872	452,153	33,120	463,843
Cyanide and flotation mills	31,678	326,689	42,042	430,549
Glass works	22,085	281,458	11,510	141,073
Fertilizer plants	7,976	41,944	6,564	57,253
Tanneries	5,433	72,817	4,967	67,184
Insecticides, fungicides	1,082	19,852	1,077	20,889
Other	540,305	7,984,308	576,790	6,560,994
Construction				
Finishing lime	75,105	1,675,038	78,372	1,713,431
Mason's lime	47,121	807,174	51,269	820,553
Sand-lime brick	16,077	169,186	17,990	189,897
Agricultural	10,309	116,120	2,682	39,361
Other	36,150	479,544	47,660	638,631
Total	1,415,290	19,217,371	1,424,459	17,646,588

Source: Dominion Bureau of Statistics.

By far most of Canada's lime is used by the chemical and metallurgical industries which consumed 86 per cent of 1962 production. Almost half of this, 550,146 tons, was used captively, mainly in the production of calcium carbide, sodium carbonate and calcium chloride at three plants in Ontario and Quebec. In paper-pulp production, lime is used in the preparation of dissolving fluids for the soda and sulphite processes. It is employed by the iron and steel industry as a flux in smelting and in the neutralization of waste liquors. In the recovery of uranium, lime controls the hydrogen-ion concentration and neutralizes waste sludges. As previously mentioned, the quantity needed for this application is rapidly decreasing. Lime is a flux in nonferrous smelting and is used to regulate 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. It is also used in the production and as an ingredient in some fertilizers, in the tanning of leather and in the manufacture of many materials such as insecticides, fungicides, pigments, glue, acetylene, calcium carbonate, calcium hydroxide, calcium sulphate, magnesia and magnesium metal.

About ten per cent of Canada's lime output was used by the construction industry in 1962. 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.

The application of lime as a soil conditioner diminished to an insignificant level in 1962.

The fourth major consuming group of industries is designated by 'other' in Table 4 and included 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, quicklime and hydrated lime production averaged respectively \$12.38 and \$14.60 a ton at the plant.

Limestone

J.S. Ross*

Shipments of limestone for all uses increased by 9.5 million tons over the previous year. With few exceptions, the yearly output of this commodity has risen steadily since 1946 and is now about nine times the 1945 production and three times that for 1953.

In 1963, shipments again reached a record and amounted to 63.1 million tons, up 18 per cent from 1962. Practically all the increase was in limestone supplied for non-cement and non-lime purposes. Shipments for these other uses amounted to 51.0 million tons valued at $58.1 million, up 22 per cent in quantity and 14 per cent in value from 1962. As is customary, virtually all this limestone was of the sedimentary type, the remainder being recrystallized limestone and marl. Limestone supplied for the production of cement reached a record of 9.4 million tons and that for lime production was up slightly at 2.7 million tons.

About 87 per cent of Canada's output of limestone for non-cement and non-lime purposes comes from Quebec and Ontario with about half the total originating from Quebec. There was no production in Saskatchewan or Prince Edward Island, but over 475 quarries were operated in the eight producing provinces.

In 1963, limestone comprised 81 per cent of the 62.7 million tons (preliminary) of stone produced in Canada for all purposes. The remainder was mainly igneous rock and sandstone as well as some shale and slate. Stone of all types exclusive of that used in the production of cement and lime advanced to 12th place in the value of Canada's mineral production.

Limestone is traded in substantial amounts between Canada and the United States despite its low unit value and the United States tariff on the crushed type. Yet the tonnage involved is small compared with the amount of production. Trade is practically balanced. Exports of crushed limestone nearly all went to the United States and dropped to 634,055 tons valued at $977,060 in 1963. Most was from Ontario although British Columbia and Alberta supplied noteworthy amounts.

* Mineral Processing Division, Mines Branch

TABLE 1

Production, Trade and Consumption

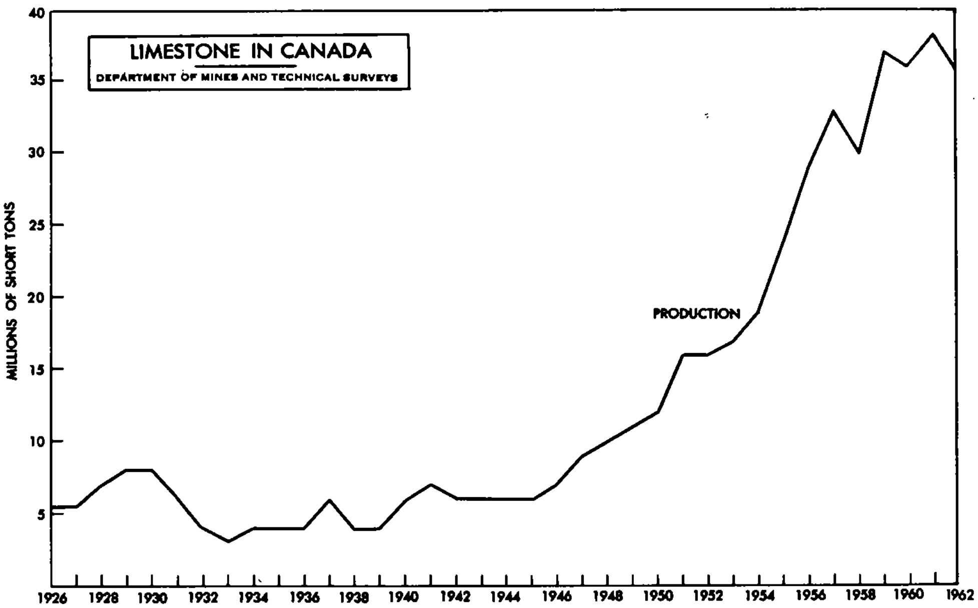
	1962		1963	
	Short Tons	$	Short Tons	$
PRODUCTION[1]				
By province				
Quebec	20,755,048	25,456,560	25,379,221	28,830,411
Ontario	17,314,723	20,180,502	19,205,898	20,544,057
British Columbia	1,385,400	2,181,362	1,500,497	2,305,367
Manitoba	912,702	1,306,682	3,666,644	4,318,636
New Brunswick	867,081	939,619	754,844	828,740
Newfoundland	226,807	442,166	297,607	575,092
Alberta	99,158	345,066	138,577	409,880
Nova Scotia	62,554	170,883	78,108	241,138
Total	41,623,473	51,022,840	51,021,396	58,053,321
	1961		1962	
By type				
General[2]	38,043,151	na	41,465,369	50,073,338
Marl	109,624	na	86,216	241,778
Recrystallized	67,643	775,949	71,888	707,724
Total	38,220,418	47,959,559	41,623,473	51,022,840
By use				
Metallurgical	1,912,640	2,081,473	1,905,407	2,070,943
Pulp and paper	612,355	1,644,575	451,940	1,395,114
Glass making	50,263	160,356	64,816	216,442
Sugar refining	35,624	74,145	42,453	85,214
Other chemical uses	274,752	277,683	518,940	558,981
Pulverized for agricultural use	1,234,038	3,262,240	1,192,105	3,201,782
Pulverized for other uses	262,746	864,266	380,052	1,119,668
Road metal	19,740,454	21,036,857	20,316,924	22,101,509
Concrete aggregate	9,309,635	10,277,302	10,829,627	11,618,168
Rubble and riprap	1,090,777	1,232,520	1,280,693	1,061,562
Railroad ballast	573,386	633,240	971,861	1,009,231
Structural[3]	88,100	2,519,009	60,514	1,969,896
Other uses	3,035,648	3,895,893	3,608,141	4,614,330
Total	38,220,418	47,959,559	41,623,473	51,022,840
EXPORTS	1962		1963	
Crushed limestone and refuse				
United States	788,790	966,152	633,998	975,636
Bermuda	–	–	57	1,424
Total	788,790	966,152	634,055	977,060

Table 1 (continued)

	1962		1963	
	Short Tons	$	Short Tons	$
Crude stone, not elsewhere specified				
United States	98,350	187,341	185,314	306,048
Bermuda	—	—	91	2,320
West Germany	—	—	1	3,928
Belgium and Luxembourg	60	1,590	—	—
Total	98,410	188,931	185,406	312,296
IMPORTS				
Total crushed stone				
United States	730,122	1,257,127	750,310	1,023,434
United Kingdom	1,657	3,067	—	—
Norway	220	3,685	—	—
Total	731,999	1,263,879	750,310	1,023,434
Crushed, ground and broken limestone exported by United States to Canada[4]	575,765	1,349,207	699,783	1,476,157
CONSUMPTION				
In production of cement	9,294,196		9,384,412	
In production of lime	2,668,480		2,720,000[e]	
Miscellaneous	41,623,473		51,021,396	
Total	53,586,149		63,125,808[e]	

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 colored 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 FT 410).
Symbold: e Estimated; — Nil; na Not available.

These two western provinces mainly exported chemical-grade limestone whereas Ontario exported large amounts of limestone for construction as well. In addition, an unknown amount of pulverized and crude limestone was exported. All imports of crushed and ground limestone came from the United States and in 1963 increased to 699,783 tons valued at U.S. $1,476,157. Most went to Ontario for construction purposes. Canada also imported rough and finished marble valued at $1.5 million mostly from Italy and the United States.



Many limestone operations experienced minor expansions during 1963. Several companies improved crushing facilities while others installed equipment to produce smaller sized products with more closely controlled particle size. Two cement companies are planning to open up limestone quarries and to build the necessary crushing and screening plants in conjunction with the construction of new cement plants: Canada Cement Company, Limited is planning to quarry limestone near Brookfield, Nova Scotia, in 1965, and Inland Cement Company Limited is scheduled to start a limestone operation near Steep Rock, Manitoba, in 1965.

In 1963, another new barge was constructed and put into operation on the west coast. It is being used to transport limestone from Texada Island to Portland, Oregon. Exports of limestone from British Columbia to northwestern United States have generally increased in recent years.

DISTRIBUTION OF DEPOSITS

Canada has suitable occurrences of most types of limestone in many of its populated regions, particularly in the southern parts of Ontario and Quebec, where about 87 per cent of the limestone is quarried and consumed. This rock, which is of good quality, is quarried chiefly in or near the cities of these two provinces. Suitable and easily accessible limestone does not occur in central or eastern Alberta, southern Saskatchewan, northwestern Ontario or Prince Edward Island. Chemical-grade dolomitic and high-calcium limestones are shipped from deposits in British Columbia, Manitoba, Ontario, New Brunswick and Nova Scotia. Other producing provinces also supply high-calcium limestone.

The Aguathuna limestone quarry on the Port au Port peninsula on the west coast of Newfoundland is owned and operated by Dominion Steel and Coal Corporation, Limited. This view is from the quarry, looking west towards transfer and boatloading facilities.

Marl, an unconsolidated form of limestone, occurs in practically every province and is recovered in Quebec, British Columbia and Nova Scotia for use as a soil additive. Recrystallized limestone is produced in British Columbia, Ontario, Quebec and New Brunswick.

USES

Owing to its physical properties, abundance and low value, limestone is generally the preferred type of stone for most uses. Distance to markets is usually the greatest factor in determining the extent of use of a particular limestone. Other criteria include chemical composition, accessibility, texture, hardness and color, 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 are in construction, cement and lime production, chemical manufacture 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, mainly high-calcium limestone is desired, although the dolomitic type is used to an appreciable extent. Most goes into the production of lime for chemical purposes. High-calcium limestone serves as a flux in smelting ferrous and non-ferrous ores and in the preparation of bisulphite liquor and lime for processing paper pulp. It is also a raw material in the production of glass and other ceramic products and serves as 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 by Aluminum Company of Canada, Limited near Wakefield, Quebec. The 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 limestone may be valued at more than $90 a ton. Most limestone in the crushed form sells for about $1.10 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.

Canada has no import tariff on crushed limestone from countries in the British preferential or most favored nation categories. For countries in the general category there is a 25 per cent ad valorem tariff.

Import tariffs on limestone entering the United States are:

Crude, broken or crushed when imported for use in manufacture of fertilizers	free
Not suitable for use as monumental or building stone	20¢ per short ton
Suitable as monumental or building stone	
Dressed	21% ad valorem
Unmanufactured, rough	2¢ per cu ft.

Two of these tariffs have been reduced since 1961. For the crude or crushed, but not pulverized limestone, the 1961 rate was 1¼ cents per 100 pounds; in 1962 it decreased to 1⅛ cents per 100 pounds, and in August 1963 the rate was set at 20 cents per short ton. For the last-mentioned category, where the 1961 rate was 7½ cents per cubic foot, in 1962 it was 4½ cents and now is 2 cents per cubic foot.

Interestingly, despite the lower tariff, imports of crushed limestone from Canada into the United States were decidedly lower in 1963 than during the previous two years. The full effect of the lower tariff will not be noticed until 1964. For many years there has been no tariff on crushed limestone entering Canada from the United States. The United States tariff may appear to be excessive for a commodity that is plentiful in each country and that is normally transported to foreign consumers at a cost exceeding its low unit value.

Lithium Minerals

J.E. Reeves*

In 1963, Quebec Lithium Corporation continued to increase its participation in the lithium chemicals industry. Lithium carbonate was being sold at a growing rate and the first shipments of lithium hydroxide monohydrate were made in November.

PRODUCTION AND TRADE

During the year, Quebec Lithium Corporation shipped the initial quantities of lithium hydroxide monohydrate and about one third more lithium carbonate than in 1962. The company's chemical plant is capable of producing three million pounds of lithium carbonate and about 1.5 million pounds of lithium hydroxide monohydrate a year. To supply this plant the company mines, concentrates and decrepitates spodumene periodically at a fairly high rate. All operations are at the mine site north of Val d'Or, Quebec.

More than three quarters of the lithium carbonate is exported; it is marketed in several European countries but mainly in the United States. Sales to Britain have been discontinued because of an antidumping duty. The initial sales of lithium hydroxide monohydrate were domestic.

Available information on imports of lithium chemicals in 1962 – the most recent data – indicates appreciable amounts of lithium hydroxide monohydrate and lithium bromide, but as expected a sharp decrease in lithium carbonate.

OCCURRENCES IN CANADA

Quebec

Quebec Lithium Corporation's property in Lacorne township, north of Val d'Or, contains one of the largest spodumene deposits in the world. It consists of an extensive family of parallel pegmatite dikes containing indicated reserves of more than 20 million tons with an average of 1.15 per cent lithia (Li_2O).

*Mineral Processing Division, Mines Branch

Lithium-bearing pegmatites occur in other parts of Lacorne township and in the neighboring 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 flat 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 nine million tons containing more than two per cent Li_2O.

Other Occurrences

Many occurrences of spodumene-bearing pegmatites, most notably in the Beardmore area, near Lake Nipigon, have been discovered in several areas of northwestern Ontario. 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 RESOURCES AND PRODUCTION

The United States is the dominant producer and consumer of lithium minerals, chemicals and metal. Its domestic sources of raw material are the large spodumene-bearing pegmatites in North Carolina and the vast brine deposits of Searles Lake, California, from which byproduct dilithium sodium phosphate is obtained. The reserves in both areas are very large. Production of raw material in 1963 was estimated to be higher than in 1962.

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 ceramic 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 constituent of the earth's crust, but it generally occurs, in commercial concentrations, only in granitic pegmatites in certain areas. The accompanying table includes most of the lithium minerals, the first four being the principal economic members.

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 becoming increasingly 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.

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 lightweight structural metals.

PRICES

During the latter half of 1963, producers in the United States announced an increase in the price of lithium carbonate and lithium hydroxide monohydrate, to be effective January 1. Within a few weeks of the new year, however, prices reverted to 1963 levels.

According to *Oil, Paint and Drug Reporter* of May 18, 1964, prices of the principal lithium chemicals, per pound, were:

Lithium carbonate	$0.58
Lithium hydroxide monohydrate	0.54 to 0.58
Lithium chloride	1.23 ½
Lithium fluoride	1.55 to 1.65
Lithium stearate	0.47 ½ to 0.53 ½

Magnesite and Brucite

J.S. Ross*

Although Canada's magnesia industry is relatively small, it experienced new activity in the fields of raw materials, processing, product development and end use during 1963. Canadian Magnesite Mines Limited continued intensive research on magnesite from its property in Deloro and Adams townships, Ontario. At Kilmar, Quebec, Canadian Refractories Limited completed construction of crushing and grinding facilities for processing magnesite concentrates. Active magnesium hydroxide was produced commercially in Canada for the first time. This was accomplished at the Wakefield, Quebec, plant of Aluminum Company of Canada, Limited. Meanwhile, a new market was being created for magnesium compounds by developments in pulp processing at a few paper-pulp plants.

Canada's production value of dead-burned and calcined magnesia increased slightly from the record of 1962 to $3,439,890 in 1963. All the output was from Quebec and consisted of dead-burned magnesia from a magnesite-dolomite deposit and of calcined magnesia and magnesium hydroxide from brucitic limestone.

Because most magnesia is used in refractories, world production closely follows the demands of the metallurgical industry. In 1963, world production of "crude magnesite" amounted to 9.1 million tons according to the United States Bureau of Mines *Minerals Yearbook 1963*. More than half of this was supplied by Russia, Austria and China in that descending order. In addition, considerable magnesia is produced from brine and sea water but the quantity is not known. For example, about three-quarters of the United States output is derived from these sources.

Magnesia and its products command prices that allow them to be traded widely. However, there are no separate Canadian export statistics for these products. Available Canadian statistics indicate that in 1963 Canada exported to the United States, 774,395 tons of crude refractory materials valued at

*Mineral Processing Division, Mines Branch

$1,577,821. However, only a small amount of that was magnesia. United States trade statistics indicate that for the same year Canada exported to that country 82 tons of dead-burned magnesia, 6,404 tons of magnesia-lime refractory material, and 16,308 tons of magnesia brick and shapes, at a total value of $3,002,506.

As in recent years, Canada's imports of magnesium compounds in 1963 were substantial in value. They amounted to approximately $3 million, down from 1962, and came mostly from the United States. Almost half this value was for dead-burned magnesia and the remainder was for magnesium salts, magnesia firebrick, magnesium carbonate and sulphate, caustic calcined magnesia and magnesia pipe covering.

TABLE 1

Magnesite and Brucite—Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production[1] (Quebec)				
Dolomitic magnesite and brucite		3,431,873		3,439,890
Imports				
Magnesia, dead-burned and sintered				
United States	16,961	1,395,563	11,447	869,927
Yugoslavia	2,230	132,182	2,205	129,000
Greece	nil	nil	1,323	93,311
Austria	1,984	141,374	992	72,762
Britain	3,629	241,264	345	32,853
Republic of South Africa	16	3,252	36	9,479
West Germany	33	2,478	nil	nil
Total	24,853	1,916,113	16,348	1,207,332
Magnesia, caustic calcined				
United States	2,581	204,059	2,192	186,758
Netherlands	108	6,559	60	3,725
India	2	392	24	4,347
Britain	nil	nil	18	2,638
Austria	22	1,324	nil	nil
Total	2,713	212,334	2,294	197,468
Magnesian firebrick				
United States		233,320		99,434
Britain		99,869		88,833
France		nil		16,261
West Germany		125,844		10,681
Total		459,033		215,209

Table 1 (cont'd.)

	1962		1963	
	Short Tons	$	Short Tons	$
Magnesium carbonate and magnesium oxide				
United States	663	88,467	608	172,173
Britain	211	38,848	155	30,956
Total	874	127,315	763	203,129
Magnesium salts				
United States	1,878	439,946	11,626	1,025,923
Britain	152	62,381	106	58,712
West Germany	83	7,019	99	4,133
Netherlands	nil	nil	17	649
Austria	3	3,681	2	3,925
Spain	nil	nil	nil	9,036
Total	2,116	513,027	11,850	1,102,378
Magnesium sulphate, or Epsom salts				
West Germany	2,065	45,845	2,716	56,949
United States	712	33,294	622	28,518
Britain	29	2,250	23	2,881
Total	2,806	81,389	3,361	88,348
Magnesia pipe covering				
United States		8,217		3,018
Exports				
Crude refractory materials[2]				
United States	1,242,970	2,348,213	774,395	1,577,821
Britain	90	2,640	nil	nil
Total	1,243,060	2,350,853	774,395	1,577,821
Imported by United States[3]				
Magnesia, dead-burned	nil	nil	82	19,052
Refractory material of magnesia and lime	4,439	237,360	6,404	350,057
Magnesia brick and shapes	14,982	2,416,702	16,308	2,633,397

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. In 1963 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* (Report Ft110). Values are in United States dollars. These materials are also exported from Canada to other countries, but the quantities and values are not available.

TABLE 2
Magnesite and Brucite – Production* 1954–63

	$
1954	1,909,163
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

*Brucitic magnesia shipped and dead-burned magnesia and a small quantity of serpentine used or shipped. In 1963 some magnesium hydroxide was shipped.

PRODUCTION

Canada's magnesia production originates from two operations in western Quebec. One produces 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, beneficiated in a heavy-media separation plant and dead-burned, and the product is crushed and sized. Most is consumed in the manufacture of basic refractories at the company's Marelan plant nearby. A small amount is exported for refractory use, mainly to the United States.

Except for test shipments, no magnesite has been produced from other deposits that occur in British Columbia, the Northwest Territories, Saskatchewan, Ontario, Quebec, Nova Scotia and Newfoundland.

Near Wakefield, Quebec, Aluminum Company of Canada, Limited produces calcined magnesia and magnesium hydroxide. The company quarries brucitic limestone as its raw material. The rock is crushed, sized and calcined, and the product is hydrated and separated into magnesia and hydrated lime. After being classified into various grades, the magnesia is sold for use in refractories, fertilizers and chemical processing, and for minor industrial applications.

Brucitic limestone has been produced near Rutherglen, Ontario, but was shipped in crude form as a direct source of magnesia rather than for the production of the compound, magnesia. Brucite deposits have been noted in other areas of Quebec and Ontario as well as in British Columbia and Nova Scotia.

Refractory products high in magnesia are produced and marketed from four plants in Canada. Some of these plants are wholly dependent upon imported magnesia. 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.

DEVELOPMENTS

Canadian Magnesite Mines Limited continued intensive research on the beneficiation of magnesite from its northern Ontario property. As the year progressed, laboratory milling tests resulted in products successively higher in magnesia content. Because of this laboratory work, it was announced early in 1964 that a pilot plant would be constructed to produce trial shipments of magnesite and to allow testing on a larger scale, in anticipation of commercial production.

Canadian Refractories Limited completed construction of a new plant for the preparation of magnesite concentrate prior to kiln treatment. This new plant includes a hammer mill, rotary drier, storage bins, ball mill, and air separator, as well as two blending silos built in 1960.

During the year, Aluminum Company of Canada, Limited started the commercial production of active magnesium hydroxide. This material is suitable for use in the Magnefite process which is scheduled to be in use in Canada for the first time in 1964 at pulp and paper plants. This process will open up a new market for magnesium compounds and has assisted a Canadian producer in developing an additional product. The Magnefite process involves magnesium-base bisulphite pulping and allows for recovery of magnesia and sulphur, thus reducing pollution by plant effluent. This process will be used by the new plant being completed by Spruce Falls Power and Paper Company Limited near Kapuskasing, Ontario. The Fort William plant of Great Lakes Paper Company Limited is being converted to the process and reportedly the Kenora, Ontario, mill of Minnesota and Ontario Paper Company will be likewise converted. The application of this process to other existing mills is also under consideration. However, the size of this market depends on the number of plants that have recovery units.

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 the two semi-processed products 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.

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

Although official consumption statistics for magnesia in Canada are unavailable, it is estimated that about 70,000 tons of the dead-burned and calcined types are consumed annually: about 62,000 tons in refractories and about 8,000 tons for other purposes. More than one-third of total consumption is imported. In 1964, consumption could be 5,000 tons higher owing to the requirements for 8,300 tons of magnesium hydroxide at two of the pulp and paper plants scheduled to use the Magnefite process.

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 in metallurgical processing.

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 however have lost popular appeal. 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.

The current trend toward increased application indicates a promising future for magnesia and its products.

PRICES AND TARIFFS

Prices vary depending on quality and demand. The December 30, 1963, issue of *Oil, Paint and Drug Reporter* quotes the following United States prices per short ton.

Magnesia, dead-burned, standard grade,
bulk, car lots, Chewela, Washington $46.00

Magnesia, calcined, technical, heavy,
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 and United States tariffs on many of the magnesium compounds are as follows:

Canada	British Preferential	Most Favored Nation	General
Magnesite, crude rock	free	free	free
Magnesia, dead-burned or sintered; magnesia, caustic calcined; plastic magnesia	15%	15%	30%
Magnesium carbonate, basic or otherwise, except crude rock, not otherwise provided for	20%	20%	30%
Magnesium carbonate, imported for use in the compounding or manufacture of rubber products	free	20%	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 volorem
Magnesia bricks	0.38¢ per lb plus 5% ad valorem
Magnesium compounds	
Carbonate	
Not precipitated	8.5%
Precipitated	0.35¢ per lb

Magnesium

W.H. Jackson*

Dominion Magnesium Limited is the only Canadian producer of magnesium, calcium, thorium and zirconium. The amount of each metal produced depends on their respective markets. Magnesium shipments were 9,565 tons in 1963. Although there was increased production by competitors and low prices in export markets, the level of shipments compared well with previous years when 9,458 tons were shipped in 1962, 7,802 tons in 1961, and 7,426 tons in 1960.

The value of metal exports at $3.68 million declined slightly in 1963; tonnages are not available for 1963. In the highly competitive market of western Europe, production from France, Italy, and Germany is consumed domestically, the main consumer being Volkswagen in West Germany. Norway and the United States are the main overseas suppliers to the continent; because of the preferential tariff, Canada supplies most of the British magnesium imports. Shipments to the favorably situated United States market – mainly defence sharing arrangements – are nominal because of U.S. tariffs. United States suppliers fulfil nearly all Canadian import needs for alloys and semifabricated forms.

Magnesium ingot consumed in Canada, including imports, was 3,641 tons in 1963 of which 2,569 tons were used for alloying with aluminum.

CANADIAN DEVELOPMENTS

Dominion Magnesium Limited, with mine and plant at Haley, Ont., is the only Canadian producer. Smelter capacity, rated in terms of magnesium, was increased from 8,000 to 10,000 tons in 1962.

*Mineral Resources Division

TABLE 1
Magnesium – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production, metal	8,816	4,821,823	8,905	5,357,816
Imports, alloys				
United States		176,099		181,738
Britain		2,658		–
Total		178,757		181,738
Exports, metal*				
Britain	4,907	2,796,590		2,118,500
West Germany	950	573,332		493,710
France	141	130,939		258,852
United States	212	253,260		243,991
Belgium and Luxembourg	70	39,382		189,608
Mexico	nil	nil		93,304
Yugoslavia	nil	nil		85,844
Japan	nil	nil		57,916
Australia	23	13,454		43,059
Taiwan	9	4,892		28,816
Other countries	259	156,083		63,125
Total	6,571	3,967,932		3,676,725
Consumption, metal				
Castings	252		314	
Extrusions (structural shapes, tubing)	556		355	
Aluminum alloys	2,175		2,569	
All other products**	631		403	
Total	3,614		3,641	

Source: Dominion Bureau of Statistics.
*Quantities not available commencing 1963.
**Including other alloys and magnesium used for cathodic protection and as a reducing agent.

Dolomite of exceptional purity, averaging 21 per cent magnesium oxide, is quarried nearby. In the mill, whose capacity is 280 tons a day, the ore is ground, sized and calcined. Magnesium is obtained by the thermal reduction of a pellet mixture, consisting of calcined dolomite and ferrosilicon, in retorts evacuated to low pressure. In 1963, improvements were made by additions to the melt plant and integration of a drying, screening, and bagging unit with the crushing plant. Improvements were also made in ingot handling, shipping and the quality of kiln feed.

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, five-pound, and one-kilogram

TABLE 2

Magnesium – Summary of Production, Trade and Consumption, 1954–63

	Production (short tons)	Imports[2] $	Exports $	Consumption[4] (short tons)
1954	[1]	99,944	[3]	1,308
1955	[1]	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

Source: Dominion Bureau of Statistics.
[1]Production statistics for 1954 to 1955 inclusive are not available for publication. [2]Magnesium alloys. [3]Statistics for 1954 are not available separately. [4]Increased consumer coverage for 1959 and the years following.

TABLE 3

World Production of Magnesium

(short tons)

	1961	1962	1963
United States	40,475	68,955	75,845
U.S.S.R.	34,000[e]	35,000[e]	35,000[e]
Norway	16,018	16,400	18,700[e]
Canada	7,635	8,816	8,905
Italy	6,192	6,228	6,300[e]
Britain*	5,600	4,200[e]	4,200[e]
France	2,282	2,392	1,970
Japan	2,477	2,301	2,500[e]
China	1,000	1,000	1,000
West Germany	440[e]	500[e]	550[e]
Other countries	11	58	30
Total	116,400	145,900	155,000

Source: U.S. Bureau of Mines, *Minerals Yearbook 1963*. Canada, Dominion Bureau of Statistics.
*Includes remelt.

ingots, as billets from four to 20 inches in diameter, and as granules in minus four- 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 powder, 99.5-per-cent. In 1963, shipments were 7,099 pounds. Titanium and zirconium were produced in the company's research centre as sintered pellets. Barium and strontium of 99.0-per-cent purity are available as extruded sticks.

TABLE 4
Magnesium Imports from the United States into Canada*

	1962		1963	
	Short Tons	$	Short Tons	$
Magnesium metal and alloys in crude form and scrap	1,508	870,436	597	311,131
Magnesium semifabricated forms	158	417,422	207	603,189
Total	1,666	1,287,858	804	914,320

*As reported in *United States Exports Report 410 PT II.*
Imports of magnesium as reported in *Trade of Canada* refer only to magnesium alloys. Unwrought magnesium and magnesium semifabricated forms are not reported in separate identifiable classes.

Production of aluminum and magnesium castings will continue at the Crown-owned plant at Haley, Ont. The plant was built in 1951 to manufacture magnesium castings for the Orenda aircraft engine. It was operated until October 1962 by Light Alloys Limited, a Dominion Magnesium subsidiary, and since December 1963 by the Department of Defence Production. Heroux Machine Parts Limited took over the plant in February 1964 on a one-year lease with a lease-purchase option.

WORLD DEVELOPMENTS

Plants based on the electrolysis of magnesium chloride as in Norway, the United States and the USSR supply most of world's magnesium. For this type of plant, the use of lithium chloride as an electrolyte component will permit improved cell design and efficiency. All other plants use the ferrosilicon process for which there is considerable variation in plant design and the economics of production. From a few thousand pounds in 1951, Norwegian electrolytic capacity has expanded to 20,000 tons. In 1964, when another potline is completed, capacity will be 25,000 tons with further rapid expansion possible if warranted by markets. The amount of magnesium produced in the USSR is not known. Production is estimated at 35,000 tons annually of which 90 per cent is thought to be electrolytic. Demand in Japan was about 3,500 tons in 1963 and is increasing. Furukawa Magnesium Company Limited, using dolomite grading 18 per cent magnesium oxide (MgO) and a thermal reduction process, meets demand for primary magnesium. Successful pilot-plant tests have been carried out in France on the reduction of calcined dolomite by ferrosilicon using the slag as an electric resistor. Investment costs are said to be lower than with the electrolytic or thermic methods. West German consumption of 35,000 tons a year is met by imports. Knapack Griesheim Aktiengesellschaft is continuing development of the recovery of magnesium chloride from wastes of the potash industry to make suitable feed for electrolytic reduction. The British market uses about 9,000 tons of magnesium annually. A 5,000-ton smelter, using the ferrosilicon process, came into operation in June but startup problems were encountered. Vacuum distillation using ferrosilicon as a reductant is also the basis of the 7,000-ton smelter at Bolzano, Italy.

In the United States, Pidgeon Process plants are used by the 5,000-ton Nelco division of Charles Pfizer Company and the 6,250-ton plant of Alamet division of Calumet and Hecla Inc. The Freeport and Velasco, Texas, plants of the Dow Chemical Company are electrolytic plants where sea water is used as a source of magnesia. They have a total capacity of 91,750 tons a year and in 1963 operated at about 70 per cent of capacity. Another plant is the Titanium Metals Corporation of America plant at Henderson, Nevada, which operated at about 50 per cent of its 12,000-ton capacity. It recycles metal internally for the production of titanium. Standard Magnesium and Chemical Corporation plans to build an 11,500-ton plant using byproduct magnesium chloride from its Utah plant. Another planned project is a 20,000-ton smelter (Harvey Aluminum Company) near Port Angeles, Washington. Even in the highly protected United States market – the tariff is 40 per cent of value – a new producer would encounter difficulties in marketing against strong competition. Estimated United States production of primary was 75,000 tons in 1963 and primary consumption, 55,000 tons. The slight increase in consumption does not appear to justify reactivation of unused capacity until it is certain the upward consumption trend on the United States domestic and overseas markets will continue. In 1963, the General Services Administration sold 3,000 tons from stockpile. The new stockpile objective is 145,000 tons; the stockpile is already 30,829 tons above the objective.

USES

The uses of magnesium vary from country to country. In Germany, the largest use is castings for automobile engines; in the United States its use in aluminum alloys and as a reducing agent takes precedence. Canadian ingot consumption, 3,641 tons for 1963, was composed of: castings, 314 tons; extrusions, 355 tons; aluminum alloys, 2,569 tons. The remaining 403 tons were used mainly for cathodic protection, other alloys and as a reducing agent. All sheet requirements are imported and are not included in the statistics for ingot consumption.

Further penetration of structural markets for castings, extrusions and sheet involves competition with aluminum and zinc. Except for military aircraft and aerospace uses, there are few structural applications sufficiently demanding in properties to command a premium price. Price, design and performance of consumer products in which magnesium is used must be competitive with other materials.

PRICES

In 1963, the price of magnesium f.o.b. Haley was 31 cents a pound. Magnesium prices have been more stable than those of most metals. It is not generally realized that the price quoted to Canadian manufacturers is lower than the price at which the metal is available in most other countries. Comparative prices in £ per long ton are: Britain 252, Canada 227, U.S.A. 288, France 418, Italy

302. A Norwegian producer has indicated that a price of about 1.1 times (approximately £203 a ton in 1963) that of aluminum is desirable if markets are to be expanded. In any event, there is a good supply of magnesium and a price increase is unlikely.

TARIFFS

Canada	Preferential	Most Favored Nation	General
Alloys of magnesium, ingots, pigs, sheets, plates, strips, bars, rods tubes	5%	10%	25%
Magnesium scrap	free	free	free
Sheet or plate, of magnesium or alloys of magnesium, plain, corrugated, pebbled, or with a raised surface pattern, for use in Canadian manufacture	free	free	25%

United States

Magnesium, unwrought and wrought; magnesium waste and scrap

Unwrought, other than alloys; and waste and scrap (duty on waste and scrap suspended to June 30, 1965) – 40% ad val

Unwrought, alloys – 16¢ per lb on magnesium content + 8% ad val

Wrought – 13.5¢ per lb on magnesium content + 7% ad val

Manganese

V.B. Schneider*

In 1963, Canadian imports of manganese ore increased for the fourth consecutive year; they amounted to approximately 107,000 tons valued at $3.8 million. Although the amount increased by some 16,000 tons the value decreased by $0.2 million, because of a decrease in value from $44.50 a ton to $35.75 a ton, f.o.b. point of shipment in country of export. Imports of ferro- and silico-manganese, valued at $3.7 million, were at an all-time high and continued to harass the domestic producers. Consumption of manganese ore for ferroalloy manufacture at 92,270 tons was about 7,000 tons greater than in 1962 and was the highest since 1957, the last year in which exports of ferromanganese were significant.

The Canadian market for ferromanganese was expanded by approximately 13.5 per cent because of the record tonnage of steel produced during 1963. The principal manganese alloys produced in Canada were standard ferromanganese, medium- and low-carbon ferromanganese and silicomanganese.

No manganese ore is mined in Canada. In past years, small amounts of manganese ore were mined commercially from occurrences in New Brunswick, Nova Scotia and British Columbia. These were from low-grade replacement or bog deposits. Large low-grade deposits in New Brunswick and Newfoundland may, in time, through technological advances, become economically important. The most notable is near Woodstock, New Brunswick. It has been estimated to contain from 50 to 200 million tons of 13 to 14 per cent iron and from 9 to 11 per cent manganese.

Strategic Materials Corporation, through its subsidiary, Stratmat Ltd., owns the Woodstock deposit and Strategic-Udy Metallurgy Limited, controlled by Stratmat, has conducted research in an attempt to find a method of processing the ore economically. However, because of the depressed conditions prevailing in the ferroalloy industry in North America the project has been suspended.

*Mineral Resources Division

TABLE 1
Manganese – Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Imports				
Manganese ore				
Ghana	49,632	1,918,664	45,439	1,480,564
Congo	–	–	23,972	586,487
Brazil	10,746	460,316	20,634	583,551
United States	28,013	1,539,797	16,535	1,107,971
Japan	61	24,175	189	51,169
Mexico	–	–	82	7,073
Britain	65	27,765	29	3,575
France	7	617	11	1,582
Greece	1,308	41,251	–	–
India	893	25,087	–	–
Total	90,725	4,037,672	106,891	3,821,972
Ferromanganese under 1% silicon				
Republic of South Africa	12,051	1,699,327	18,686	2,393,446
Japan	1,386	378,147	2,618	679,982
France	1,048	299,595	721	204,137
United States	484	99,314	575	99,680
Britain	17	7,952	39	18,767
Total	14,986	2,484,335	22,639	3,396,012
Silicomanganese over 1% silicon				
United States	1,090	166,573	1,563	204,524
Japan	692	106,438	408	49,606
Norway	213	32,316	244	41,780
Mexico	160	32,548	60	11,916
U.S.S.R.	–	–	55	7,018
Yugoslavia	346	50,040	25	3,723
West Germany	113	29,232	–	–
France	112	29,917	–	–
Total	2,726	447,064	2,355	318,567
Exports				
Ferromanganese				
Colombia	13	2,575	9	1,768
Dominican Republic	–	–	1	55
United States	123	17,975	–	–
Total	136	20,550	10	1,823
Consumption				
Manganese ore				
Metallurgical grade	83,490		90,364	
Battery and chemical grade	1,920		1,904	
Total	85,410		92,268	

Source: Dominion Bureau of Statistics.
– Nil

There are some 125 manganese minerals but only a few are of economic importance. Most manganese is obtained from the 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* reports that world mine production was 16.1 million tons in 1963. This is about 308,000 tons more than was produced in 1962. Russia is the largest producer of manganese followed by the Republic of South Africa, Brazil, India and China.

World reserves other than in Russia are reported by Elyutin** to be about 1,700 million tons and he further states: "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 Cheatura 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 both India and Gabon have been estimated to exceed 100 million tons; Brazil, 150 million; and the Republic of South Africa, more than 50 million tons.

The United States is the leading importer and consumer of manganese ores. According to the U.S. Bureau of Mines* , it imported 2.1 million tons and consumed 2.4 million tons in 1963. Imports were received from some 20 countries with Brazil supplying approximately 900,000 tons; Republic of the Congo 250,000 tons; Gabon 225,000 tons and the Republic of South Africa 125,000 tons. Again according to the Bureau, ferromanganese consumption in the United States was some 900,000 tons (gross weight) the highest since 1957 and an increase of 80,000 tons (gross weight) over that of 1962. Imports of ferromanganese into the U.S. in 1963 were 150,000 tons (gross weight) valued at $16.7 million, a 17 per cent increase over 1962, reflecting the continuing competition of foreign-produced ferroalloys in the U.S. market.

Preliminary reports show that in 1963 exports from the Republic of South Africa were one million tons and from India, 825,000 tons. Exports from Brazil were probably close to a million tons. *Russian Foreign Trade Statistics,* for 1962*, shows manganese ore exports of 900,000 metric tons in 1961 and approximately one million metric tons in 1962; trade reports indicate that the trend continued in 1963.

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

**Elyutin, V.P. et al. *Production of Ferroalloys Electrometallurgy.* The State Scientific and Technical Publishing House for Literature on Ferrous and Non Ferrous Metallurgy, Morean 1957, Translated from Russian and published for the National Science Foundation, Washington, D.C.

Although official statistics are lacking, trade reports indicate that ferromanganese and electrolytic manganese producers in the Republic of South Africa continued to increase their share of world ferroalloy markets.

USES AND SPECIFICATIONS

About 95 per cent of the world's output of manganese ore is used by the steel industry. The dry-battery industry accounts for three per cent and the chemical industry for the remaining two per cent.

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. In the proportion of one to two per cent, it increases strength and toughness in steel. In proportions of 12 to 14 per cent, it greatly increases toughness and resistance to wear and abrasion.

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.

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.

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 increases 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 seven per cent iron, eight per cent silica, 0.15 per cent phosphorus, six per cent alumina and one 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.

**Metal Bulletin*, October 23, 1963.

TABLE 2

Manganese – Trade and Consumption, 1954–63

(short tons of 2,000 pounds)

	Imports			Exports	Consumption	
	Manganese Ore	Addition Agents Under 1% Silicon	Addition Agents Over 1% Silicon	Ferro-manganese	Ore	Ferro-manganese
1954	48,962	8,527	19	3,639	66,052	24,312
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	92,268	

Source: Dominion Bureau of Statistics.

TABLE 3

World Production of Manganese Ore, 1962–63

(short tons of 2,000 pounds)

	1962	1963
U.S.S.R.	7,057,000	7,385,000e
Republic of South Africa*	1,614,599	1,441,503
Brazil	1,290,461	1,320,000e
India	1,306,914	1,184,983
China	880,000	1,100,000e
Republic of Gabon	224,038	701,716
Ghana	513,622	434,410
Morocco	517,377	369,283
Republic of the Congo	329,568	348,547
Japan	340,162	305,506
Other countries	1,708,259	1,499,052
Total	15,782,000	16,090,000

Source: U.S. Bureau of Mines *Minerals Yearbook 1963*.
*Owing to a change in classification in 1963 these figures are not directly comparable.
e Estimated

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.

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, Welland, Ontario.

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.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Manganese ore	free	free	free
Ferromanganese (on Mn content)	free	1¢ per lb.	1¼¢ per lb.
Silicomanganese (on Mn content)	free	1½¢ per lb.	1¾¢ per lb.

United States	
Manganese ore	¼¢ per lb. on Mn content (under temporary suspension)
Manganese metal	1 7/8¢ per lb. on Mn content and 15% ad valorem
Ferromanganese*	
Not over 1% C	0.6¢ per lb. on Mn content and 4.5% ad valorem
Over 1% C but under 4% C	15/16¢ per lb. on Mn content
4% or more C	5/8¢ per lb. on Mn content
Spiegeleisen	75¢ per long ton

*These classes must contain 30 per cent or more Mn.

PRICES

Prices of manganese in the United States, according to *E & M J Metal and Mineral Markets* of December 30, 1963, were as follows:

Manganese ore	
Per long-ton unit, 46–48% Mn, c.i.f. U.S. ports, import duty extra	
Indian (max. Al + Si 13%)	80.00¢ to 85.00¢ (nominal)
South African (max. Al + Si 13% Fe 9%, P.O.05%)	80.00¢ to 85.00¢ (nominal)
Manganese metal	
Per lb. 99.9%, electrolytic, f.o.b. shipping point, freight allowed east of Mississippi, carload	31.25¢ to 33.75¢
Premium per lb for hydrogen removed	00.75¢
Ferromanganese	
Per lb. contained Mn, carload lots, lump	
Standard (74–76% Mn), f.o.b. shipping point	8½¢ (nominal)
Medium-carbon (80–85% Mn, 1¼ – 1½% C), f.o.b. shipping point	20½¢ (nominal)
Low-carbon (85–90% Mn, max. 0.07% C), basis as for medium-carbon	nominal
Silicomanganese	
Per lb., carload lots, lump, f.o.b. shipping point	
1.5% max., 18½ – 21% Si	7.8¢
2% C max., 16 – 18% Si	7.5¢
3% C max., 12½ – 16% Si	7.3¢
Spiegeleisen	
Per gross ton, carload lots, lumps, f.o.b. Palmerton, Pa.	
3% Max. Si, 16 – 19% Mn	$82.00
3% Max. Si, 19 – 21% Mn	$84.00
3% Max. Si, 21 – 23% Mn	$86.50

Mica

J.E. Reeves*

Production of mica in Canada in 1963—all phlogopite—declined slightly.

Imports of unmanufactured mica — all muscovite — declined to 1.7 million pounds from the all-time high of 2.3 million pounds in 1962, but the value increased appreciably. Imports originate mainly in India, although most reach Canada via the United States and Britain.

The value of imported manufactured and ground mica rose significantly. The United States is the principal source.

During the year, some small-sized electrical phlogopite was exported to Japan and some scrap phlogopite was shipped to the United States. Statistics on exports of mica, however, are no longer available.

PRODUCERS

Phlogopite originated from several sources in southwestern Quebec and southeastern Ontario, generally on an intermittent basis. Blackburn Brothers, Limited dry-ground scrap phlogopite in a plant near Cantley, Quebec, a few miles from Ottawa. No muscovite was produced.

WORLD PRODUCTION

Canada makes only a minor contribution to total world production, which was 400 million pounds in 1963. The United States produced more than half of this, mostly in the form of scrap or flake muscovite for grinding. India is the prominent source of high-quality electrical muscovite. Much world trade results from the demands of highly industrialized countries that lack sufficient resources or low-cost experienced labor.

*Mineral Processing Division, Mines Branch

TABLE 1
Production, Trade and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production (shipments)				
Trimmed	33,437	33,906		
Sold for mechanical splittings	26,400	7,695	4,235	2,606
Rough, mine-run or rifted	72,187	4,596	12,021	1,390
Ground or powdered	609,968	29,366	813,935	36,759
Scrap and unclassified	462,042	9,035	352,850	3,529
Total	1,204,034	84,598	1,183,041	44,284
Imports				
Unmanufactured				
United States	2,051,400	207,411	1,552,200	269,168
India	158,100	59,533	157,100	54,759
Britain	78,400	3,509	22,400	1,004
Brazil	18,400	15,594	5,900	8,527
Total	2,306,300	286,047	1,737,600	333,458
Manufactured and ground				
United States		425,473		625,061
Britain		12,298		16,064
Belgium and Luxembourg		–		737
Mexico		1,298		525
Netherlands		–		308
Total		439,069		642,695
Exports*				
Rough and scrap				
Japan	74,400	29,040		
United States	23,500	1,315		
Total	97,900	30,355		
Trimmed and ground				
United States	47,400	2,914		
Japan	44,700	54,348		
Brazil	10,200	7,201		
Total	102,300	64,463		

Consumption (available data)	1962 pounds	1963 pounds
Paints and wall-joint sealers	1,780,000	1,730,000
Rubber	576,000	646,000
Asphalt products	42,000	36,000
Paper	266,000	272,000
Electrical apparatus	252,000	428,000
Other products	38,000	320,000
Total	2,954,000	3,432,000

Source: Dominion Bureau of Statistics.
– Nil.
*Not available as a separate class after 1962.

TABLE 2

Production, Trade and Consumption, 1954–63
(pounds)

	Production*	Imports**	Exports**	Consumption
1954	1,706,770	232,700	771,200	3,429,848
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	na	3,432,000

Source: Dominion Bureau of Statistics.
*Producers' shipments.
**Unmanufactured mica.
na 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*.

TECHNOLOGY

Mica is important because of its unusual physical characteristics. It has consistent and relatively high dielectrical 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 colorless, 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 considerably 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 relatively to its composition, and it may range from almost colorless 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 increasing demand.

Mica splittings are used in the manufacture of built-up sheet, tape and cloth. To make built-up sheet, the splittings are bonded with a suitable resin into sheets of required size and the product is baked and pressed. Built-up sheet is used in place of natural sheet, within the limits of its dielectric characteristics, and may be cut or moulded into washers, tubes and other forms. More than 90 per cent of the splittings used are muscovite.

In recent years mica paper and mica board have been developed as substitutes for built-up sheet; essentially, their production follows paper-making techniques, frequently with an inorganic binder.

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.

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 (in inches), the following sizes being in common use: 1 x 1, 1 x 2, 1 x 3, 2 x 3, 2 x 4, 3 x 5, 4 x 6, 5 x 8, and larger.

No formal quality-grading for phlogopite has been established, but the softer, lighter-colored 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.

BUYERS

Canadian producers can sell, depending on demand, small quantities of block and sheet mica to Mica Company of Canada Ltd., 4 Lois Street, Hull, Quebec; and scrap phlogopite to Blackburn Brothers, Limited, 85 Sparks Street, Ottawa, Ontario.

PRICES

Prices for mica in the United States, according to *E & M J Metal and Mineral Markets* of December 30, 1963, included:

	Dollars
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*

Natural mineral pigments have been largely replaced by synthetic and artificial pigments. Consequently, iron oxides are the only true mineral pigments produced in Canada, although some industrial minerals are marketed for their combined filler and whiteness qualities. Synthetic pigments are derived by the chemical and metallurgical processing of metals and minerals. The quantity of mineral pigments consumed is relatively small but they are used widely to impart color and opacity to materials.

Mineral fillers are also used widely but in larger quantities than pigments, which are basically a type of filler. Fillers are industrial minerals which impart desirable physical properties and take the place of more expensive materials in industrial products while remaining relatively chemically inert. 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 color and, on a smaller scale, serve as pigments but are rarely used solely as pigments because of their low hiding power and limited color 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.

IRON OXIDE

Statistics for 1963 indicate the first increase since 1956 in the production of natural iron-oxide pigment. Although this gain was small, output was greater than for any year after 1959. However, this industry continues to be in a depres-

* Mineral Processing Division, Mines Branch

TABLE 1

Iron Oxides – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)				
Natural (crude and calcined)	771	58,363	978	74,505
Exports				
Natural and synthetic iron oxides				
United States	1,442	257,336	1,813	336,719
France	95	16,817	127	22,590
Netherlands	93	16,268	88	15,485
Britain	23	34,160	86	35,890
Australia	75	17,151	69	15,341
Other countries	137	23,850	35	6,133
Total	1,865	365,582	2,218	432,158
Imports*				
Iron oxide pigments, dry, synthetic and natural				
United States	1,987	455,367	2,047	480,864
	1960		1961	
Consumption by the paint industry				
Calcined and synthetic iron oxide	1,858	440,614	1,755	434,206
Ochres, siennas, umbers	150	48,241	130	45,481

Source: Dominion Bureau of Statistics.
*Not available from Trade of Canada. Exports to Canada as reported by the United States Department of Commerce, *United States Exports of Domestic and Foreign Merchandise* (Report FT 410).

sed state owing to a limited demand for its products. Output has decreased markedly from a high of 13,696 tons in 1950. In 1963 it was 978 tons valued at $74,505. Canada's output of this commodity is now dependent upon the demands of the pigment and abrasives industries. Prior to 1960 the producer-gas industry was the main market but it no longer uses appreciable amounts of iron oxide. In addition, synthetic iron-oxide pigments of excellent quality and with a large range of colors are competing with the natural material for use in pigments. Production statistics for the synthetic material are not available.

Exports of both natural and synthetic iron oxides amounted to 2,218 tons valued at $432,158 in 1963, up from 1,865 tons in 1962. About 82 per cent of this went to the United States and most of the remainder went to Europe. Imports of both natural and synthetic pigments compare in quantity and value with exports and were up slightly from 1962 to 2,047 tons valued at $480,864.

TABLE 2
Iron Oxides – Production, Trade and Consumption, 1954–63
(short tons)

	Production	Imports		Exports	Consumption*		
						Paint Industry	
	Natural	Ochres Siennas Umbers	Oxides Fillers Colors etc.	Natural and Synthetic	Coke and Gas Industries	Natural and Synthetic	Ochres Siennas Umbers
1954	5,798	1,052	4,443	3,111	9,167	2,190	212
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	na	1,858	150
1961	808	649	4,903	2,208	na	1,755	130
1962	771	na	na	1,865	na	na	na
1963	978	na	na	2,218	na	na	na

Source: Dominion Bureau of Statistics.
*Partial.
na Not available.

OCCURRENCES AND PRODUCTION

Canada's production of natural pigment-grade iron oxide comes from the Red Mill, Quebec, plant of The Sherwin-Williams Company of Canada, Limited. The raw material 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 Ontario.

USES AND SPECIFICATIONS

Canada's output of bog-iron oxide is used mainly as an abrasive in the United States and as a paint pigment in Canada.

As an abrasive, the commodity is used for metal and glass polishing.

As a pigment, the natural commodity must compete with the synthetic variety. The latter has become more popular because it can be produced more uniformly in numerous pigmentary shades. Both types are used extensively 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 colors from yellow through brown to black. They are used because of their permanence of color and ability to inhibit the oxidation of metal surfaces. The pigment should either compare with a standard color 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 standard. A high degree of opacity and hiding power is required.

PRICES

In 1963, the average price of refined natural iron oxide produced in Canada was $76.18 a ton at the plant.

For various types of iron oxides, *Oil, Paint and Drug Reporter* of December 30, 1963 quotes 6 to 16 cents a pound.

WHITING

True whiting is ground chalk and precipitated whiting is a synthetic chemical precipitate of calcium carbonate. Whiting substitute is white or near-white pulverized limestone that is usually composed mainly of calcium carbonate.

Whiting substitute is the only variety produced in Canada and, in 1963, practically all was derived from limestone from Missisquoi County, Quebec. As usual, production was relatively small; 16,195 tons of rock valued at $231,492 were processed for this purpose. In addition, a much larger amount of off-white pulverized limestone was produced in British Columbia, Manitoba, Ontario and Quebec. This latter material is not normally classified as whiting substitute but it does compete for a few of the lower-quality applications of whiting.

TABLE 3

Whiting – Production, Imports and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production				
Stone processed for whiting	13,356	162,410	16,195	231,492
Imports[1]				
Whiting				
United States	4,242	208,901	5,861	292,605
Britain	2,265	39,668	2,354	49,639
France	1,635	10,689	1,568	17,247
West Germany	nil	nil	6	579
Total	8,142	259,258	9,789	360,070

TABLE 3 (Continued)

Consumption[2]	1962 Short Tons	1962 $	1963 Short Tons	1963 $
Ground chalk, whiting and whiting substitute				
Pharmaceuticals	180		158	
Paints and varnishes	18,378		20,219	
Soaps and toilet preparations	200		180	
Ceramics	1,664		611	
Linoleum, oilcloth and floor tile[3]	12,516		14,790	
Rubber goods[3]	11,025		10,366	
Tanneries	20		255	
Gypsum products[3]	5,451		8,268	
Adhesives	525		923	
Paper	2,255		2,373	
Miscellaneous chemicals	303		573	
Starch and glucose	6		7	
Miscellaneous	1,233		6,359	
Total[3]	53,756		65,082	

Source: Dominion Bureau of Statistics.
[1]Statistics refer to true and precipitated whiting. Those for whiting substitute are not available.
[2]These quantities are calculated from information provided by the Dominion Bureau of Statistics.
[3]Includes ground, off-white limestone.

TABLE 4

Whiting – Production, Imports and Consumption, 1954–63

(short tons)

	Production[1]	Imports[2]	Consumption[3]
1954	15,460	10,824	28,370
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[4]
1960	10,319	8,835	52,226[4]
1961	14,301	8,408	62,442[4]
1962	13,356	8,142	53,756[4]
1963	16,195	9,789	65,082

Source: Dominion Bureau of Statistics.
[1]Rock for whiting substitute only. [2]Whiting only. [3]Whiting and whiting substitute; includes some ground, off-white limestone. [4]Calculated from information provided by the Dominion Bureau of Statistics.

On occasion, small amounts of whiting substitute are exported but these are not shown separately in the statistics. However, Canada imports all three types of whiting, most of which is of the precipitated type and comes mainly from the United States; some is also imported from Britain and France. In 1963, 9,789 tons of true and precipitated whiting, valued at $360,070, were imported. Whiting substitute is imported mainly from the United States, but statistics are unavailable.

USES

In general, whiting is used as a filler to improve physical properties or to replace more expensive materials in industrial products. The less expensive true whiting and whiting substitute are used for most whiting applications but in particular for replacing more expensive materials. On the other hand, the precipitated type is used mainly because of its whiteness. However, the opacity of whiting is low in comparison with synthetic pigments such as titanium dioxide and zinc oxide. Consequently, whiting is used as a white filler. Off-white limestone is produced in larger quantities and serves as a filler where color is unimportant or where dark colors are involved.

In Canada, by far most of the whiting is used in paints where its color, 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. Considerable quantities of off-white limestone go into the production of linoleum, oilcloth, vinyl and asphalt floor tile, rubber goods and gypsum products.

Oil, Paint and Drug Reporter of December 30, 1963, quotes these prices, bagged, in carlots, per ton, at works:

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 produces various other synthetic pigments, some of which will be reviewed briefly. On the other hand, pigments valued at $6.6 million in 1963 were imported: these included iron oxide, chromium oxide, lithopone, litharge, red lead, white lead, zinc oxide, blanc fixe, satin white, copper oxide, cobalt oxide and tin oxide.

Northern Pigment Company, Limited at New Toronto, Ontario, is a leading producer of synthetic iron oxide. This company exports part of its output to many countries.

Synthetically produced titanium dioxide is widely used as a white pigment. However, Canada's output of the commodity, produced by two companies in Quebec, is relatively small compared with that of the United States, the leading world producer.

TABLE 5

Titanium Dioxide – Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Imports				
Titanium dioxide, pure				
Britain	11,779	5,263,425	1,895	811,924
United States	819	464,677	1,472	794,221
Japan	22	7,184	–	–
Netherlands	*	275	–	–
Total	12,620	5,735,561	3,367	1,606,145
Titanium dioxide extended				
United States	12,323	2,354,541	9,319	1,785,904
	1961			
Consumption				
Refined titanium dioxide				
Industrial chemicals	23			
Other chemicals	345			
Linoleum and coated products	1,912			
Paint and varnish	17,291			
Paper	2,444			
Rubber	935			
Synthetic textiles	32			
Toilet preparations	24			
Other non-metallic products	572			
Total	23,578			
Extended titanium dioxide pigments				
Paints	13,104			
Estimated TiO_2 content	3,879			

Source: Dominion Bureau of Statistics.
*Less than one ton.
– Nil.

Canadian Titanium Pigments Limited, with a rated capacity of 25,000 tons a year, produces refined titanium dioxide at Varennes. British Titan Products (Canada) Limited, similarly recovers 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 titania slag and iron. In 1963, the company produced 338,679 tons of slag valued at $14 million, most of which was marketed for use in pigments, mainly in the United States.

The value of titanium dioxide output was about $14.4 million in 1963. Owing to the establishment of the two producers, imports of the pure and extended types have been reduced at a remarkable rate from a peak of 37,872 tons in 1956 to 24,943 tons in 1962 and to 12,686 tons valued at $3.4 million in 1963. Most of the reduction in 1963 was of the pure type from Britain.

In 1961, Canada consumed 23,578 tons of pure titanium dioxide and 13,104 tons of the extended variety. All of the latter and 73 per cent of the former were used in paints. The remaining refined dioxide was used in paper, linoleum and coated products, rubber goods, textiles, toilet preparations, chemicals and other products.

The *Oil, Paint and Drug Reporter* of December 30, 1963 quoted the following United States prices per pound, in bags and in 20-ton carlots:

Anatase	25 1/2¢
Rutile	27 1/2¢
30% TiO_2-calcium pigment	9 3/8¢
50% TiO_2-calcium pigment	14 1/8¢

Molybdenum

V.B. Schneider*

Production of molybdenum in Canada increased for the fourth consecutive year. Shipments of molybdenum contained in molybdic oxide (MoO_3) and molybdenite (MoS_2) concentrates totalled 833,867 pounds valued at $1.3 million; the value was an all-time high. This was 16,162 pounds and $82,553 more than in 1962. Domestic consumption of 1.31 million pounds was slightly more than the previous high of 1.26 million pounds established in 1962.

World mine production for 1963 was estimated by the United States Bureau of Mines** at 91.4 million pounds; an all-time high bettering the previous record production of 88.2 million pounds in 1961. United States production***, 65.0 million pounds, was the third highest in history exceeded only by that of 1960 and 1961. Climax Molybdenum Company, a division of American Metal Climax, Inc., establishes world prices for most molybdenum products and during the year it maintained the prices established June 1, 1961, for molybdenum concentrates. However, an increase in world demand for molybdenum resulted in a shortage and many consumers in Europe and Japan are reported to have paid a premium of about 33¢ pound of molybdenum content for concentrates and oxides from sources other than Climax.

PRODUCTION

Canadian production in 1963 came from Molybdenite Corporation of Canada Limited and Gaspé Copper Mines, Limited, a wholly owned subsidiary of Noranda Mines, Limited. The Molybdenite Corporation's mine is at Lacorne, Quebec, where the company also operates a roasting plant to convert most of its concentrates to technical-grade MoO_3, the material from which all types of molybdenum salts

* Mineral Resources Division
** U.S. Bureau of Mines, *Minerals and Metals Commodity Data Summaries*, February 1964.
***U.S. Bureau of Mines, *Molybdenum Monthly*, April 8, 1964.

and compounds are produced. Molybdenite concentrates are recovered as a byproduct by Gaspé Copper Mines at its copper operations at Murdochville, Quebec. So far the company has marketed its molybdenum as concentrates, mostly to Europe.

Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada Limited holds a substantial interest, continued to prepare its property for production which is expected to start in July 1964. The mine is in Preissac

TABLE 1

Molybdenum – Production, Imports and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production(shipments)[1]	817,705	1,261,451	833,867	1,344,004
Imports				
Molybdic oxide,[2] United States	328,424	302,881	258,765	245,553
Calcium molybdate (grouped with vanadium oxide and tungsten oxide for the manufacture of steel)				
United States	100,298	177,922	148,402	198,076
France	2,976	1,680	nil	nil
Total	103,274	179,602	148,402	198,076
Ferromolybdenum, United States[3]	131,358	234,066	125,869	215,964
Consumption (Mo content)				
By type				
Molybdic oxide	713,074		831,973	
Ferromolybdenum	468,726		414,260	
Molybdenum metal	9,414		10,104	
Molybdenum wire	6,985		6,531	
Other forms[4]	63,181		43,325	
Total	1,261,380		1,306,193	
By end-use				
Ferrous and nonferrous alloys	1,186,033		1,256,306	
Lubricants and pigments	64,049		43,325	
Electrical and electronic products	7,004		6,562	
Unspecified	4,294		nil	
Total	1,261,380		1,306,193	

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.

TABLE 2

Molybdenum – Production, Trade and Consumption, 1954–63

(pounds)

	Production[1]	Exports[2]	Imports: Calcium Molybdate[3]	Imports: Molybdic Oxide[4]	Imports: Ferro-molybdenum[5]	Consumption[6]
1954	451,450	na	121,339	423,344	79,856	374,118
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	na	236,936	656,062	230,600	1,042,077
1961	771,358	na	46,648	266,399	211,779	1,135,610
1962	817,705	na	103,274	328,424	131,358	1,261,380
1963	833,867	na	148,402	258,765	125,869	1,306,193

Source: Dominion Bureau of Statistics. [1]From 1954 to 1956 inclusive 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, exports of 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.
na Not available.

township, about five miles north of Cadillac, Quebec. During World War II the Preissac mine was operated by Indian Molybdenum Limited and produced about 419,000 pounds of molybdenite concentrate. However, a new orebody is being developed from new workings and all indications are that it is larger and of higher grade than the wartime operation.

Anglo-American Molybdenite Mining Corporation continued exploration and development work on its property, also in Preissac township. The necessary financing to bring the mine into production at the rate of 1,000 tons a day by mid-1965 was almost completed by the year-end.

Copperstream-Frontenac Mines Limited continued exploration on its property in Grayhurst and Dorset townships, 48 miles southeast of Thetford Mines, Quebec. The company reports that exploration and development work completed to date has indicated 701,000 tons assaying 0.558 per cent MoS_2 and inferred reserves of two million tons of mineable-grade ore. Molybdenum Corporation of America allowed its option on the property to expire in December.

In Ontario, Pax International Mines Limited carried out exploration and development work at its mine at Ryan Lake, Powell township, about four miles from Matachewan. The mine has not been worked extensively in the past because the ore has proved difficult to concentrate. Geo-Met Reactors Limited, Ottawa, worked on the concentration problem and Pax International made an agreement with Metal Traders Inc., of New York to supply 600,000 pounds of concentrates a year. Geo-Met continued research work on beneficiating and up-grading molybdenite concentrates and manufactured trial lots of ferromolybdenum by means of silicothermic reduction. The shortage of available MoO_3 prevented Geo-Met from launching full-scale production of ferromolybdenum in 1963.

Bethlehem Copper Corporation Ltd., Noranda Mines, Limited, and Canadian Exploration, Limited, announced production plans for their British Columbia properties and Kennco Explorations (Canada), Limited, continued exploration on its Alice Arm, B.C. property.

Bethlehem Copper Corporation Ltd. will commence the recovery of byproduct molybdenite at its copper mining plant near Ashcroft in February 1964. When the byproduct plant reaches capacity it is expected to recover 400,000 pounds of molybdenum a year. Noranda's property is at Boss Mountain in the Cariboo district of central British Columbia; the company expects to be in production at the rate of 1,000 tons a day by early 1965. Grade and ore reserve figures have not been released.

Canadian Exploration, Limited's property, Endako Mines Ltd., is four miles south of Endako in the Omineca Mining Division. The nucleus of the property was once known as the Stella mine. The company plans to begin operations in 1965 and when at full production, will mill 10,000 tons a day. The company has not announced the grade of the ore it intends to mill but even at marginal grades, this rate of milling would produce several millions of pounds of molybdenum a year. Kennco Explorations (Canada), Limited, a wholly owned subsidiary of Kennecott Copper Corporation, continued to investigate its property on Lime

Creek, in the Alice Arm area. Southwest Potash Corporation, a wholly owned subsidiary of American Metal Climax, Inc., continued an exploration program on its property near Smithers, B.C.

United States

The United States is the largest producer and consumer of molybdenum and molybdenum products. In 1963, production and shipments amounted to 65.0 million and 65.8 million pounds of contained molybdenum in concentrates. These were well above the 1962 amounts of 51.2 million and 50.5 million pounds. Exports of molybdenum contained in concentrates and in molybdic oxide, at 26.5 million pounds, were about nine million pounds below the all-time high of 35.7 million pounds of 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. Production at the Climax mine in 1963 was about 47 million pounds, an increase of 14 million pounds over that of 1962 when production was limited by a labor strike.

Climax announced the construction of a plant to recover oxidized molybdenum by a new hydrometallurgical process. The new process is the result of a research program conducted to discover an economical means of extracting molybdenum from oxide ores that could not be processed. Previously it had been possible to extract molybdenum only from sulfide ores. The hydrometallurgical process is reported to have been proven in eight months of continuous pilot plant operation and it is expected that close to three million pounds of molybdenum will be produced by the new process, starting in 1966. The company also exercised an option to purchase the Urad mine on Red Mountain, Clear Creek county, Colorado, from Vanadium Corporation of America.

Among the major producers of byproduct molybdenum from copper operations are Kennecott Copper Corporation, Bagdad Copper Corporation, Phelps Dodge Corporation, San Manuel Copper Corporation, Union Carbide Nuclear Company, American Smelting and Refining Company and Duval Corporation. Kennecott, the world's second largest molybdenum producer of concentrates, reported production of 22.1 million pounds in 1963.

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 very large part of its molybdenum concentrates from Kennecott. An exploration and development program was carried on by the company at its former producing mine at Questa, New Mexico, to determine whether the low-grade orebody contained sufficient ore to justify the construction of a new mill capable of handling from 4,000 to 7,500 tons of ore a day. The company would expect the operation to produce at least eight million pounds of molybdenum a year.

The United States stockpile of molybdenum in ores and concentrates on June 30, 1963 was 79.82 million pounds, about 135 per cent of the maximum objective.

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 Chuquicamata copper property. The copper ore of Anaconda's El Salvador mine also contains considerable molybdenum. Most of Chile's output of molybdenite concentrate was exported to western Europe. Japan, Norway and Yugoslavia are minor producers. China, North Korea and the U.S.S.R. also produce molybdenum but data on their output are not available. Recent reports indicate that three large molybdenum deposits have been discovered 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 U.S.S.R. totalled 12 million pounds in 1963. This places Russia second to the United States, with an annual output of almost double that of Chile.

TABLE 3

World Production of Molybdenum in Ores and Concentrates, 1962 and 1963

(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
Japan	413	366
Canada	409	417
Norway	288	275e
Other countries	290	909
Total	37,550	45,725

Source: Dominion Bureau of Statistics; U.S. Bureau of Mines *Minerals Yearbook 1963*.
e Estimate.

CONSUMPTION AND USES

About 67 per cent of the molybdenum consumed is in the form of molybdic oxide, which is followed (in order of quantity) by ferromolybdenum and molybdenum-metal powder. Molybdenum is used in lesser amounts in calcium, sodium and ammonium molybdate, in molybdenum disulphide and in molybdenite concentrate added directly to 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; but 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 use of molybdenum chemicals has 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, though still small, is becoming increasingly important as a soil conditioner.

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 high-speed steels.

TABLE 4
United States Consumption of Molybdenum, by Use
('000 pounds of contained molybdenum)

	1961	1962	1963
Steel			
High-speed	1,740	2,273	2,089
Other alloys	21,202	21,042	22,869
Miscellaneous*	592	718	931
Gray and Malleable castings	2,578	3,248	3,287
Rolls (steel mills)	953	1,564	1,907
Welding rods	245	239	238
High-temperature alloys	1,398	1,314	1,396
Molybdenum metal wire, rod and sheet	1,476	2,250	1,548
Chemicals			
Catalysts	370	690	688
Pigments and other color compounds	831	859	908
Miscellaneous**	1,236	1,476	1,617
Total	32,621	35,674	37,478

Source: U.S. Bureau of Mines, *Minerals Yearbook 1961, 1962 and 1963.*
*Includes castings as well as hot-work and tool steels. **Includes special alloys, lubricants, refractories, magnets and corrosion- and heat-resistant castings.

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 & M J Metal and Mineral Markets of December 30, 1963 quotes molybdenum prices in the United States as follows:

Molybdenum powder, per lb, carbon-reduced, f.o.b. shipping point $3.35

Molybdenum ore, per lb contained Mo, 95% MoS_2, f.o.b. shipping point Climax, cost of containers extra $1.40

Molybdic trioxide, per lb Mo, f.o.b. shipping point, bags $1.59, cans $1.60

Ferromolybdenum, per lb contained Mo, packed, f.o.b. shipping point, 58 – 64% Mo, powdered, lots 5,000 lb or more $1.95, other sizes $1.89

Calcium molybdate, per lb Mo, lumps, packed $1.63

TARIFFS

	British Preferential	Most Favored Nation	General
Canada			
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

Molybdenum ores and concentrates per lb contained Mo: 24¢

Calcium molybdate, ferromolybdenum, and other compounds of molybdenum, per lb contained Mo: 20¢ plus 6%

Molybdenum metal, per pound of contained Mo unwrought: 20¢ plus 6%; wrought: 25.5%; waste and scrap: 21%.

(duty on scrap suspended June 30, 1965).

Natural Gas

D.W. Rutledge*

Output of natural gas reached an all-time high in 1963 although the rate of increase was much smaller than in the previous year. Because no major new marketing territory was penetrated by Canadian natural gas, growth in production and sales was slower. The increase in demand was mainly in regions already served, particularly Ontario and the United States Pacific northwest. Capital investment in nearly all sectors of the industry was greater than in 1962. Construction of gas-transmission and distribution pipelines was well above 1962 levels. The increase in estimated gas reserves was comparatively small but it is probable that substantial additions to reserves will be made following development in areas of recent gas discoveries.

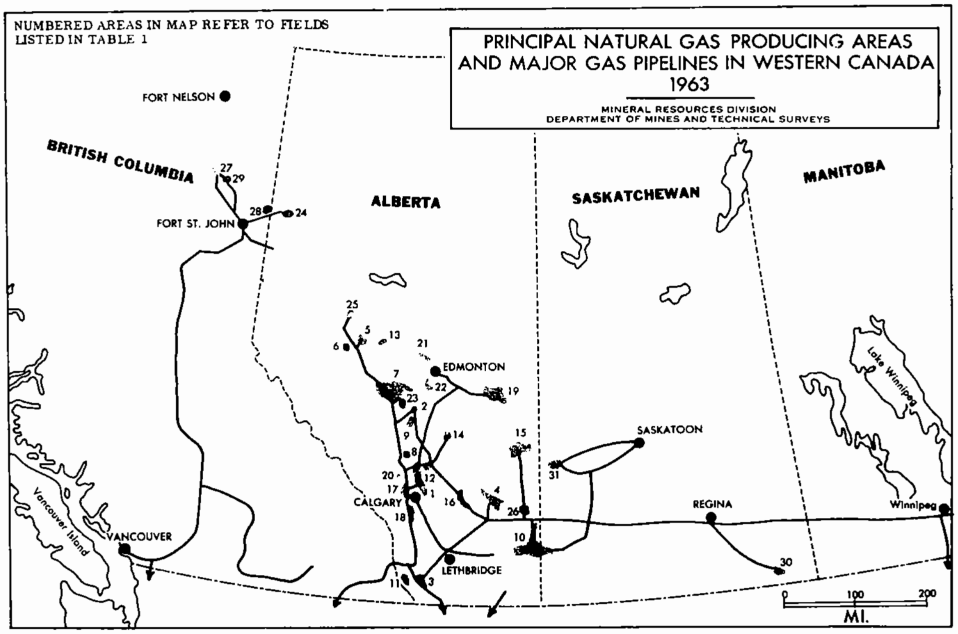
PRODUCTION

In 1963, net new production of natural gas, exclusive of withdrawals from storage and gas flared and wasted, amounted to 1,117,425 million cubic feet, or 3,061 million cubic feet a day. Although the production increase was large, 18.0 per cent, it was considerably less than the 1962 increase of 44.4 per cent.

Table 1 lists the main gas-producing fields in Canada. It is noteworthy that gas from some of the fields with the largest production increases, Carson Creek and Harmattan-Elkton, was not marketed. These are cycling operations—primarily conservation schemes wherein maximum recovery of hydrocarbon liquids from underground is assured by re-injecting the processed gas to maintain reservoir pressure. The re-injected gas will eventually be reproduced for marketing. Gas from the Pine Creek field was injected into the Windfall field to replace gas extracted from the latter. Table 2 shows fields where gas was injected into reservoirs for storage or pressure maintenance.

*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



EXPLORATION AND DEVELOPMENT

British Columbia

Fifty-eight per cent of the 898,720 feet drilled in British Columbia in 1963 was exploratory. Despite a 42-per-cent decrease in total drilling, the decrease in exploratory drilling was slight. The 92 exploratory wells drilled resulted in 27 gas discoveries. Almost all drilling in British Columbia was in the north-eastern corner, east of the mountains. Two main regions were explored for natural gas: the area within a 100-mile radius of Fort St. John where Triassic sand-stones and dolomites were the main exploratory targets; and the Fort Nelson region, where Middle Devonian Slave Point carbonate reefs were the drilling targets. Several important gas discoveries were made north of Fort St. John in the vicinity of the Peejay and Milligan Creek fields. In the Fort Nelson region, two new gas accumulations in Slave Point reef were discovered northeast of Fort Nelson. One of the discovery wells, SOBC Helmet b-49-G, extended the known productive area eastward, and the other, Western Natural Cabin b-40-A, located a significant gas pool midway between the Kotcho Lake and Petitot River fields.

TABLE 1

Natural Gas Fields Producing 10 Million mcf or More

(Mcf)*

The numbers following field names refer to map locations

	1962	1963
Alberta		
Crossfield 1	67,284,940	73,297,707
Westerose South 2	54,340,303	55,302,613
Pincher Creek 3	48,822,471	48,516,912
Cessford 4	46,184,976	48,510,110
Windfall 5	32,532,163	49,825,062
Pine Creek 6	14,620,969	43,545,929
Pembina 7	33,812,055	37,983,029
Harmattan-Elkton 8	25,479,460	36,358,851
Homeglen-Rimbey 9	30,692,212	35,999,139
Medicine Hat 10	28,684,789	34,311,118
Waterton 11	23,259,937	31,755,383
Carstairs 12	25,256,473	31,407,118
Carson Creek 13	546,572	26,087,649
Nevis 14	21,264,592	24,798,738
Provost 15	22,178,351	24,089,738
Hussar 16	19,491,987	22,640,040
Jumping Pound 17	21,695,325	21,976,123
Turner Valley 18	24,110,415	21,378,145
Viking-Kinsella 19	16,836,304	20,674,453
Wildcat Hills 20	15,777,404	16,148,593
Alexander 21	15,128,608	15,637,570
Leduc-Woodbend 22	15,182,955	15,113,286
Minnehik-Buck Lake 23	13,117,906	14,285,826
Worsley 24	2,182,083	13,781,072
Gilby 9	9,788,050	13,577,274
Kaybob 25	9,462,060	13,245,527
Bindloss 26	8,209,079	11,689,549
British Columbia		
Jedney 27	15,498,649	17,128,154
Boundary Lake 28	8,165,964	13,025,613
Laprise Creek 27	13,061,361	12,089,044
Nig Creek 29	8,387,264	11,412,777
Beg 27	10,331,146	10,035,869
Saskatchewan		
Steelman 30	18,906,690	15,106,962
Coleville-Smiley 31	15,321,919	14,630,100

Source: Provincial government reports: gross reservoir withdrawals.
*at 14.65 psia

TABLE 2
Natural Gas Storage and Injection Operations
(Mcf)

	1962		1963	
	Input	Reproduction	Input	Reproduction
Alberta fields*				
Bonnie Glen	–	–	–	–
Bow Island	1,718,511	1,387,703	1,649,552	1,461,570
Campbell-Namao	–	–	–	–
Carson Creek	–	–	22,993,240	–
Duhamel	89,053	–	148,010	–
Garrington	–	–	2,285	–
Golden Spike	2,950,635	–	2,146,538	–
Harmattan East	1,753,000	–	2,097,000	–
Harmattan-Elkton	22,379,367	–	33,995,781	19,332
Jumping Pound	1,985,157	1,585,374	2,459,786	2,526,368
Leduc-Woodbend	6,089,501	–	6,000,921	–
Lookout Butte	–	–	3,009,692	–
Pembina	7,191,328	–	12,035,201	–
Pincher Creek	165,139	3,399,230	–	1,614,452
Sundre	752,897	–	616,769	–
Taber	–	–	–	–
Turner Valley	526,509	602,773	871,186	102,136
Viking-Kinsella	311,533	311,533	–	–
Westerose	1,306,047	–	1,162,413	–
Windfall	14,678,758**	–	46,052,173**	–
Total (14.65 psia)	61,897,435	7,286,613	135,240,547	5,723,858
Volume adjusted to 14.73 psia	61,563,188	7,247,265	134,510,248	5,692,949
Ontario fields*	22,455,876	24,058,628	26,210,562	24,387,443
Saskatchewan*	2,185,682	465,900	3,959,532	937,787
Total, Canada	86,204,746	31,771,793	164,680,342	31,018,179

*Source: Provincial government reports.
**Mainly from Pine Creek field, for pressure maintenance.
Symbol: – Nil.

A step-out well five miles to the south of Imperial Oil's large 1962 Junior gas discovery was successful. At least three important Slave Point gas wells were completed between Kotcho Lake and the Clarke Lake gas field, and gas was discovered 10 miles southwest of the Clarke Lake field. During the past several years, an exceptionally high proportion of wells drilled in the sparsely explored Fort Nelson region have found significant accumulations of natural gas. Seismic surveys and stratigraphic analysis are used as a guide to drilling in the search for the favorable dolomitized barrier reefs.

TABLE 3
Production of Natural Gas[1]

	1962		1963	
	Mcf	$	Mcf	$
Gross new production[2]				
New Brunswick	95,750		103,524	
Ontario	15,648,294		15,920,055	
Saskatchewan	61,993,601		60,742,380	
Alberta	836,530,208		1,001,004,991	
British Columbia	128,833,842		133,748,722	
Northwest Territories	56,707		51,478	
Total, Canada	1,043,158,402		1,211,571,150	
Waste and Flared				
Saskatchewan	23,147,869		20,806,187	
Alberta	65,567,086		57,650,018	
British Columbia	7,740,720		15,689,728	
Total, Canada	96,455,675		94,145,933	
Net New Production[3]				
New Brunswick	95,750	134,476	103,524	109,520
Ontario	15,648,294	5,802,387	15,920,055	6,049,621
Saskatchewan	38,845,732	2,295,783	39,936,193	2,364,223
Alberta	770,963,122	88,660,759	943,354,973	129,428,302
British Columbia	121,093,122	11,724,236	118,058,994	12,495,718
Northwest Territories ...	56,707	23,518	51,478	21,330
Total, Canada	946,702,727	108,641,159	1,117,425,217	150,468,714

Source: Dominion Bureau of Statistics.
[1]Volume measured at 14.65 psia except in Ontario and New Brunswick where the pressure base 14.73 psia is used. [2]Excludes withdrawals from storage. [3]Gross new production less waste and flared.

TABLE 4
Comparison of 1962 and 1963 Production

	1963 Net New Production Increase or Decrease	Share of Production	
		1962	1963
	%	%	
Alberta	+22.4	81.4	84.4
British Columbia	− 2.5	12.8	10.6
Saskatchewan	+ 2.8	4.1	3.5
Ontario	+ 1.7	1.7	1.4
New Brunswick	+ 8.1	negligible	negligible
Northwest Territories	− 9.2	negligible	negligible

Most of the development drilling in British Columbia gas fields was done in the Triassic fields. Extensive development was carried out in the Jedney, Rigel, Buick Creek East and Beg fields which have pipeline connections to markets. There was little development in the Devonian reef fields because

TABLE 5

Value of Gas Produced 1962 and 1963

	1962		1963	
	Total Value ($)	Average Value (¢ per Mcf)	Total Value ($)	Average Value (¢ per Mcf)
Alberta	88,660,759	11.5	129,428,302	13.7
British Columbia	11,724,236	9.7	12,495,718	10.6
Saskatchewan	2,295,783	5.9	2,364,223	5.9
Northwest Territories	23,518	41.5	21,330	41.4
Ontario	5,802,387	37.1	6,049,621	38.0
New Brunswick	134,476	140.4	109,520	105.8
Total, Canada	108,641,159	11.5	150,468,714	13.5

Source: Dominion Bureau of Statistics

TABLE 6

Production, Trade and Total Sales[r], 1954–63

(Mcf)

	Production	Imports	Exports	Sales in Canada[r]
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	1,117,425,217	6,877,438	340,953,146	451,598,298

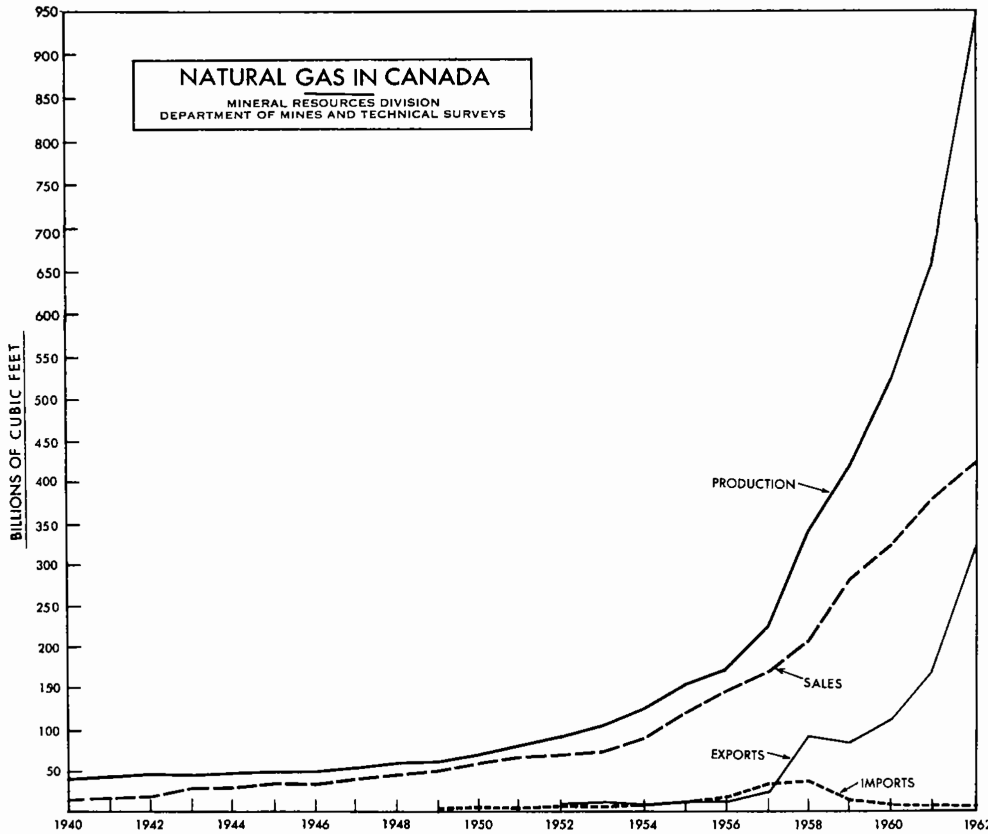
Sources: Dominion Bureau of Statistics. Production and total sales, from *The Crude Petroleum and Natural Gas Industry.* Imports, from *Trade of Canada.* Exports: 1954–1956, from *Gas Utilities.* 1957–62, from *Trade of Canada.*
r Revised.

gathering pipelines do not extend that far north. The number of gas wells in the province capable of production at the end of 1963 was 464, an increase of 66 wells since 1962.

Alberta

In Alberta, 275 gas wells were completed compared with 272 in 1962. Two thirds were development wells and the remainder were exploratory.

A 1962 Mississippian Elkton gas discovery near Edson, 125 miles west of Edmonton, has proved to be one of the largest gas reservoirs found in Alberta in several years. During 1963, a productive area 23 miles long and up to nine miles wide was indicated by more than a dozen wells; the gas-bearing tract has not yet been delimited. In the southern Foothills, a well drilled just south of the Waterton



field, Shell 20 Waterton 5-23-3-1-W5, made an important wet-gas discovery which produced as much as 1,800 barrels of condensate a day. Production came from the Devonian Wabamun formation; the pool is separate from the adjacent Waterton Mississippian reservoir. Another notable discovery in the southern Foothills was Shell-CPOG Unit Jumping Pound West 11-36-24-6-W5 which intersected what is apparently an eight-mile southward extension of the Jumping Pound West gas pool. Twenty-five miles north-northwest along the same trend, TGS Shell Hunter Valley 11-35-29-9-W5 extended the productive ground 1½ miles northwest of the 1962 Mississippian gas discovery. In west-central Alberta, Fina et al. NW Pine Creek 4-26-58-20W5 located a new Devonian D-3 gas pool, with 100 feet of net pay zone, four miles northwest of the Pine Creek D-3 gas field. A large gas field was being outlined at Bigstone, eighteen miles northwest of the NW Pine discovery where Pan Am. E-1 Grizzly 2-25-60-22-W5 intersected over 200 feet of pay zone in Devonian D-3 reef. Five earlier wells in this area had found smaller gas sections in D-3 and Cretaceous strata. The search for oil and gas in Devonian reefs brought forth a conspicuous land play at Cutbank River, 25 miles south of Grande Prairie, and very high prices were paid by oil companies for drilling reservations following geophysical reconnaissance and geological interpretations. The drilling of several wells was proceeding in that area early in 1964. In the northwest corner of Alberta, two large gas discoveries were made early in 1963 in Devonian Slave Point formations – CDR Union Zama Lake 10-8-111-9-W6 and BA North Bistcho 6-13-123-10-W6. In eastern Alberta, areas of significant gas concentration were outlined in Lower Cretaceous and Upper Devonian strata by a series of widely spaced wells in the Marten Hills, northeast of Lesser Slave Lake.

Development of gas fields increased the number of gas wells capable of production from 1,257 to 1,437. At the end of 1963, 85 per cent of these 'capable' wells were in production. In addition, there were 1,466 capped gas wells, many of them beyond the reach of existing pipeline systems. In southeastern Alberta, significant numbers of new wells were drilled in the Medicine Hat, Hussar and Cessford fields. In western Alberta, a notable amount of development was carried out in the Sylvan Lake field and Gilby Rundle pool.

Saskatchewan and Manitoba

Much of the natural gas produced in Saskatchewan is solution gas from oil wells. However, in 1963, the number of gas wells completed was markedly greater than in previous years. Forty-one gas wells were completed compared to 11 in 1962. Most of the wells were drilled near the Alberta boundary, in the Hatton and Hoosier areas. Solution mining continued on the Melville underground gas-storage cavern. By the end of November, 185 million cubic feet of gas was in storage. Near Regina, drilling was completed in preparation for the solution mining of two gas-storage caverns. In Manitoba, no gas wells were drilled and no commercial production of natural gas was started.

Yukon and Northwest Territories

Six wells, all exploratory, were completed during the year. Footage drilled increased by 19 per cent over 1962. In September, two wells were started in the Arctic Islands. The comparatively shallow one drilled on Cornwallis Island was abandoned in December after failing to find any significant amounts of gas or oil. The deep well on adjacent Bathurst Island, completed in February 1964, was also dry. In the southeastern corner of the Yukon Territory, drilling on the Pam et al Kotaneelee A-1 exploratory well was suspended following failure to find any important extension of the gas reservoir encountered in the prolific Beaver River discovery of 1961. Another well to test the same structure, Canada Southern et al. N Beaver River YTI-27, was still being drilled early in 1964. It had encountered natural gas in the target horizon, although technical difficulties made decisive measurements impossible.

Eastern Canada

In Ontario, 392,753 feet (excluding service wells) were drilled and despite the nine-per-cent footage increase, there was a slight decrease in the number of wells completed—from 205 to 202. The average depth of well was 1,944 feet compared to 1,759 feet per well in 1962. This trend toward deeper drilling was largely the result of more emphasis on the search for oil in the comparatively deep Cambrian strata. Gas production, however, continues to come mainly from Silurian formations; the 57 gas wells completed in 1963 were all Silurian. Seventeen of the gas wells were in Lake Erie where drilling disclosed significant new gas reserves near Long Point. However, more drilling is necessary to evaluate the size of the new discoveries.

In Quebec, 13 exploratory wells were drilled. Two of the wells, presently suspended, were drilled on a gravity anomaly 10 miles southwest of Trois-Rivières. Although moderately large gas flows were produced from the Cambrian Potsdam sandstone during short tests, it has not been determined whether gas is present in commercial volumes. Three exploratory wells were completed on Anticosti Island: two were dry and one had 'shows' of oil and gas. Although there were no commercial discoveries, geological conditions were encouraging and more drilling is expected. Three dry development wells delimited the southern limits of the shallow Pointe-du-Lac gas pool near Trois-Rivières.

In New Brunswick, the first drilling since 1960 was unsuccessful. The only well drilled was at a location four miles south of Stony Creek field; its depth was 3,500 feet. Two oil companies acquired substantial acreage off the Nova Scotia coast near Sable Island. Seismic surveying of some of this acreage is planned for 1964 by Shell Canada Limited.

TABLE 7

Footage Drilled in Canada, by Provinces, 1962 and 1963

	Exploratory		Development		All Wells	
	1962	1963	1962	1963	1962	1963
Alberta	3,161,657	3,121,629	5,945,022	6,685,162	9,106,679	9,806,791
Saskatchewan*	731,383	997,375	1,566,505	2,215,745	2,297,888	3,213,120
British Columbia	561,327	522,422	993,081	376,298	1,554,408	898,720
Manitoba	7,580	31,789	52,634	110,774	60,214	142,563
Northwest Territories	52,701	62,643	nil	nil	52,701	62,643
Total, western Canada	4,514,648	4,735,858	8,557,242	9,387,979	13,071,890	14,123,837
Ontario	167,367	217,600	203,308	187,782	370,675	405,382
Quebec	4,445	20,121	1,607	794	6,052	20,915
Maritimes	nil	3,507	nil	nil	nil	3,507
Total, eastern Canada	171,812	241,228	204,915	188,576	376,727	429,804
Total, Canada	4,686,460	4,977,086	8,762,157	9,576,555	13,448,617	14,553,641

Sources: Provincial government departments and agencies and Department of Northern Affairs and National Resources, except for Quebec and Maritimes; Geological Survey of Canada for Quebec and Maritimes.
*Excludes 54,604 feet in service wells in 1962 and 238,861 feet in 1963.

TABLE 8

Drilling Results, 1962 and 1963*

	Gas Wells		Oil Wells		Dry and Abandoned Holes		Total	
	1962	1963	1962	1963	1962	1963	1962	1963
Alberta	272	275	688	869	584	560	1,544	1,704
Saskatchewan ...	11	41	397	572	212	338	620	951
Manitoba	—	—	14	29	10	15	24	44
British Columbia .	65	70	159	31	96	82	320	183
Northwest Territories and Yukon	—	—	—	—	8	6	8	6
Total, western Canada	348	386	1,258	1,501	910	1,001	2,516	2,888
Ontario	70	57	30	31	105	114	205	202
Quebec	7	—	—	—	2	14	9	14
Maritimes	—	—	—	—	—	1	—	1
Total, eastern Canada	77	57	30	31	107	129	214	217
Total, Canada ...	425	443	1,288	1,532	1,017	1,130	2,730	3,105

Source: Provincial government reports and Department of Northern Affairs and National Resources.
*Service wells excluded.
Symbol: — Nil.

RESERVES

The Canadian Petroleum Association's compilation shows that, after allowance for the year's production, Canada's reserves of natural gas increased in 1963 by 1,523,000 million cubic feet to a year-end recoverable total of 36,960,000 million cubic feet. The net increase was 4.3 per cent compared to 5.7 per cent in 1962. Despite the smaller increase in 1963, drilling disclosed large areas of probable accumulations that may provide substantial additional reserves in future estimates. These areas include: Edson, Marten Hills, Jumping Pound West and Bigstone in Alberta and the Fort Nelson region in British Columbia. The main regions where new proven reserves were added in 1963 were: Edson, Jumping Pound West, Kaybob South, Marten Hills, and Fort Nelson. The Alberta Oil and Gas Conservation Boards's estimate of established reserves in the province (including proved reserves and a judgment portion of probable reserves) was 32,901 million cubic feet. Fifty-two per cent of Canada's gross increase in proved reserves was the result of new discoveries; the remaining 48 per cent was the result of revisions of estimates and extensions of known gas pools. At the 1963 rate of gross new production, reserves are sufficient to last 33 years. Additions to reserves increased British Columbia's share of the total from 13.9 to 15.6 per cent. Alberta's share decreased from 82.3 to 80.9 per cent and Saskatchewan's decreased from 3.0 to 2.7 per cent.

TABLE 9

Estimated Year-end Recoverable Reserves of Natural Gas

(Mcf)

	1962	1963
Alberta	29,177,363	29,916,388
British Columbia	4,932,600	5,765,790
Saskatchewan	1,062,201	1,008,955
Eastern Canada	201,771	210,907
Northwest Territories	61,897	56,114
Manitoba	1,060	1,869
Total	35,436,892	36,960,023

Source: Canadian Petroleum Association.

TABLE 10

Gas Pipeline Mileage in Canada, 1960–63

	1960	1961	1962	1963p
Gathering*				
New Brunswick	6	6	6	6
Ontario	910	1,314	1,314	1,345
Saskatchewan	285	275	298	299
Alberta	2,075	2,439	2,540	2,627
British Columbia	410	429	409	448
Total	3,686	4,463	4,567	4,725
Transmission*				
New Brunswick	15	13	13	13
Quebec	25	25	25	25
Ontario	3,565	3,135	3,141	3,928
Manitoba	445	457	496	593
Saskatchewan	2,100	2,274	2,566	2,558
Alberta	3,460	4,088	4,293	4,449
British Columbia	1,105	1,225	1,311	1,350
Total	10,715	11,217	11,845	12,916
Distribution				
New Brunswick	30	32	32	32
Quebec	1,115	1,123	1,144	1,370
Ontario	9,530	10,184	10,865	11,088
Manitoba	835	854	947	1,117
Saskatchewan	1,205	1,273	1,425	1,552
Alberta	2,560	2,896	3,100	3,200
British Columbia	3,135	3,183	3,427	3,725
Total	18,410	19,545	20,940	22,084
Total, Canada	32,811	35,225	37,352	39,725

Source: Dominion Bureau of Statistics.
*Some lines in Ontario and Saskatchewan were reclassified or discontinued in 1961; some in New Brunswick were discontinued.
p Preliminary

TRANSPORTATION

Additions to gas-pipeline systems during the year brought the total of all transmission, distribution and gathering lines to nearly 40,000 miles. Construction increased appreciably over 1962; more than 1,000 miles of gas transmission lines and 1,100 miles of distribution lines were laid. The largest gas-pipeline construction project was the laying of 205 miles of 34-inch loops by Trans-Canada Pipe Lines Limited along its system in Manitoba and Saskatchewan. The Alberta Gas Trunk Line Company laid 26 miles of 34-inch loop along the main line between Princess and Empress and added a total of 43 miles of lateral lines in the Medicine Hat, Wimborne, Provost and Hussar areas. Northwestern Utilities, Limited, completed a 118-mile 12-inch line from the Swan Hills gas plant to Edmonton. Canadian Industrial Gas Limited established a new source of supply, the Westlock gas field, by building a 36-mile extension from the company's existing system near Morinville. Mid-Western Industrial Gas Limited extended its Wabamun pipeline 23 miles to tie in additional gas sources in the Legal and Westlock areas. Saskatchewan Power Corporation added a total of 143 miles of transmission pipeline and 117 miles of distribution line in widely separated areas of Saskatchewan. In Ontario, Union Gas Company of Canada, Limited, provided services to a new region by laying more than 200 miles of transmission and distribution pipeline to communities between Waterloo and Owen Sound. The Consumers' Gas Company extended its transmission system from Brampton to Orangeville and laid a new 30-inch major supply line from Malton to Toronto.

NATURAL GAS PROCESSING

A large proportion of Canadian natural gas is processed at plants near the wellhead in order to meet pipeline and consumer specifications or conservation requirements. In Alberta, in 1963, 83.5 per cent of the marketable gas came from gas-processing plants; the remaining 16.5 per cent was nonprocessed dry gas. At the end of 1963, Canadian plants had a total daily raw-gas capacity of 3,841 million cubic feet, or more than enough to process the average daily gross new production of 3,300 million cubic feet. Because of market limitations, average gas input per plant was well below rated capacity.

Because gas-plant construction was on a comparatively small scale in 1963, the increase in capacity was the smallest in several years. The largest plant to go on stream was a 50-million-cubic-foot-a-day installation at the Judy Creek field in Alberta. This plant processes casinghead gas derived from oil production in the Swan Hills region. A gas-cycling plant was completed at Lookout Butte near Waterton Park, Alberta. Two small gas plants were brought on stream in the Gilby field. At the year-end, a total of 84 gas plants were operative in Canada, of which 74 were in Alberta.

TABLE 11

Natural Gas Processing Plants in Operation – end of 1962

(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	150	125
Carbon	67	65
Carson Creek	75	re-inj.
Carstairs, Crossfield	225	202
Cessford (5 plants)	194	187
Chigwell (2 plants)	12	10
Countess	22	21
Enchant	5	5
Gilby (4 plants)	61	58
Golden Spike	26	22
Harmattan-Elkton	108	re-inj.
Homeglen-Rimbey, Westerose South	326	280
Hussar (2 plants)	90	90
Innisfail	15	10
Judy Creek, Swan Hills, Virginia Hills	50	36
Jumping Pound, Sarcee	110	90
Kaybob	41	40
Kessler	5	5
Leduc-Woodbend	35	31
Lookout Butte	35	re-inj.
Minnehik-Buck Lake	57	51
Morinville, St. Albert-Big Lake, Campbell-Namao	25	25
Nevis	56	48
Nevis, Stettler, Fenn-Big Valley	35	24
Okotoks	30	13
Oyen	3	3
Pembina (9 plants)	96	77
Alberta (cont'd)		
Pembina (Cynthia)	10	9
Pembina (Lobstick)	25	22
Parkland	6	5
Pincher Creek	204	145
Prevo	5	4
Princess (3 plants)	19	19
Provost (2 plants)	93	69
Redwater	11	8
Samson	3	3
Savanna Creek	75	59
Sedalia	5	5
Sibbald	6	5
Three Hills	5	5
Turner Valley	100	85
Waterton	180	121
Wayne-Rosedale (2 plants)	17	15
Wildcat Hills	96	83
Windfall	204	110
Wood River	5	5
Worsley	55	52
Pipeline at Edmonton	70	66
Saskatchewan		
Alida, Nottingham, Carnduff	9	6
Coleville	60	59
Smiley	4	3
Steelman, West Kingsford	38	30
Cantuar	25	24
British Columbia		
Fields in Fort St. John area	395	300
Boundary Lake	10	9
Ontario		
Fields in southwestern Ontario (3 plants)	21	21

Source: (Operators List 7), January 1964, Department of Mines and Technical Surveys, *Natural Gas Processing Plants in Canada.*

USES OF NATURAL GAS

Methane (CH_4) is the main chemical constituent of marketed natural gas, but small amounts of other combustible hydrocarbons such as ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) may be included. Methane is nonpoisonous and odorless but a characteristic odor is usually introduced into marketed natural gas as a safety measure. Heating value of natural gas averages about 1,000 British thermal units per cubic foot of gas.

The most important use of natural gas is as a fuel. Table 15 shows the amount of natural gas used in Canada for residential, industrial and commercial purposes. An important use in each of these categories is 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. In industrial areas such as southwestern Ontario, natural gas has been a boon to such industries as automotive plants, steel producers, metal-working firms, glass factories and food-processing industries. 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 derived 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.

TABLE 12

Liquids and Sulphur Production from Canadian Natural Gas, 1954–63

	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	4,610,478	3,425,811	21,759,526	1,281,999

Source: Dominion Bureau of Statistics and provincial government reports.

TABLE 13
Sales of Natural Gas in Canada, 1963

	Mcf	$	Average $/Mcf	Number of Customers Dec. 31, 1963
New Brunswick	80,574	219,585	2.73	2,636
Quebec	27,160,953	26,405,935	0.97	241,706
Ontario	167,618,964	145,715,290	0.87	596,138
Manitoba	22,696,050	15,489,112	0.68	71,085
Saskatchewan	41,849,992	19,167,230	0.46	92,606
Alberta	156,705,713	48,206,935	0.31	235,607
British Columbia	35,486,052	32,380,090	0.91	157,360
Total, Canada	451,598,298	287,584,177	0.64	1,397,138
Previous totals				
1959	278,226,823	159,781,809	0.57	1,062,976
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

Source: Dominion Bureau of Statistics.

TABLE 14
Sales of Natural Gas in Canada, on Percentage Basis

	1962	1963
Ontario	35.57	37.11
Alberta	36.57	34.70
Saskatchewan	8.41	9.27
British Columbia	8.75	7.86
Quebec	5.21	6.01
Manitoba	5.47	5.03
New Brunswick	0.02	0.02
Total	100.00	100.00

Source: Dominion Bureau of Statistics.

MARKETS AND TRADE

In 1963, Canadian natural gas penetrated no major new market areas; consequently the 8.3 per cent increase in demand was accounted for mainly by market growth in regions already served. While the demand increase compared favorably with that of most other mineral commodities, it was significantly less than in previous years when Canadian gas was entering new regions such as that of eastern Canada and the Pacific northwest and mid-west of the United States.

TABLE 15

Natural Gas – Supply and Demand

(MMcf)

	1962		1963	
Supply				
Gross new production*	1,038,152		1,017,115	
Field waste and flared gas	-96,508		-94,364	
Net new production		941,644		1,111,479
Removed from storage	31,771		31,049	
Placed in storage	- 86,205		- 165,423	
Net withdrawals from storage		- 54,434		-134,374
Net supply of domestic gas		887,210		977,105
Imports		5,575		6,877
Total supply		892,785		983,982
Demand				
Exports		319,566		340,953
Residential sales	134,919		145,856	
Industrial sales	213,468		235,379	
Commercial sales	63,675		70,363	
Total domestic sales		412,062		451,598
Consumption and losses in production		122,496		144,841
Pipeline consumption, losses and metering differences		22,095		33,048
Line pack changes		156		404
Gas unaccounted for		16,410		13,138
Total demand		892,785		983,982
Total domestic consumption**		573,219		643,029
Average daily domestic consumption		1,570		1,761

Sources: Dominion Bureau of Statistics, and provincial government reports.
*Excludes gas reproduced from storage.
**Total demand minus exports.

In Canada, sales of natural gas increased by 9.6 per cent compared with 11.2 per cent in 1962 and 15.6 per cent in 1961. Sales in Ontario increased appreciably and those in Alberta decreased slightly. Consequently, Ontario for the first time surpassed Alberta as the leading consumer. Table 13 lists sales by province and Table 14 shows provincial sales on a percentage basis.

Exports constituted 43 per cent of total sales in 1963, about the same as in 1962. Most of the 6.7 per cent increase in exports was via the Alberta to California gas pipeline through which 47 per cent of all exported gas moved. Twenty-eight per cent of exports was piped through the line of Westcoast Transmission Company Limited at Huntingdon, B.C. and 17 per cent was exported through the lateral of Trans-Canada Pipe Lines Limited at Emerson, Man. Canadian gas reached its most-easterly export market in September 1962, when deliveries began to the Massena-Ogdensburg area of New York state. However, sales to that area remain comparatively small comprising less than one per cent of exports in 1963.

Gas imported from the United States increased by more than 23 per cent but, despite this growth, imports continue to form a very small part of Canada's natural-gas supply. Nearly all the imported gas entered directly into Ontario; a very small part was imported into Alberta.

Nepheline Syenite

J.E. Reeves*

There was a minor decrease in the volume of nepheline syenite shipped in 1963. The value, however, increased 3.6 per cent. Exports, which exceeded 200,000 tons for the first time, were nearly 5 per cent greater than in 1962. Increases were recorded to most countries, including several in Europe. The United States takes most of the exports and more than 70 per cent of total production.

PRODUCERS

The only deposit of nepheline syenite being exploited in Canada is in Methuen township, northeast of Peterborough, Ontario. Its large size, relatively uniform mineralogy and amenability to beneficiation sets it apart from most other known Canadian deposits.

Indusmin Limited, which controls most of the deposit, operates a 600-ton-a-day processing plant near the southwestern end, and two quarries. Glass-grade nepheline syenite is the principal product, but three fine-ground grades and several lower-quality, by-product grades are also produced. At the northeastern end, International Minerals & Chemical Corporation (Canada) Limited operates a quarry and a plant of similar size to produce mainly glass-grade nepheline syenite.

OTHER CANADIAN OCCURRENCES

Nepheline-bearing rocks occur in many parts of Canada, but for the most part are not comparable to the Blue Mountain nepheline syenite as a source of a feldspathic raw material for the ceramic industry.

*Mineral Processing Division, Mines Branch

TABLE 1
Production, Exports and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)	254,418	2,605,421	254,000	2,699,202
Exports				
United States	179,105	2,023,852	184,522	1,995,980
Britain	11,263	130,090	11,535	111,719
Netherlands	286	5,865	3,037	35,390
Puerto Rico	1,000	12,305	1,300	14,110
Belgium and Luxembourg	560	12,040	896	19,264
Australia	239	6,597	722	15,257
Dominican Republic	595	7,259	500	6,724
Italy	nil	nil	341	7,346
Peru	140	2,936	100	2,048
West Germany	250	5,160	55	1,184
Other countries	220	4,730	254	4,920
Total	193,658	2,210,834	203,262	2,213,942
Consumption*				
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.

TABLE 2
Production and Exports, 1954–63
(short tons)

	Production	Exports
1954	123,669	83,952
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

Source: Dominion Bureau of Statistics.

In the Bancroft and Gooderham areas of southeastern Ontario there are numerous small deposits of nepheline gneiss. In places the nepheline content is relatively high, but generally more erratic than at Blue Mountain. Prior to 1942 small quantities were mined. Elsewhere in Ontario there are relatively large deposits–in Bigwood township northeast of Georgian Bay, and adjacent to the north shore of Lake Superior near Port Coldwell–but they appear to be unlikely sources of raw material for low-iron products.

Nepheline syenite occurs in several places in southern British Columbia, notably in national parkland in the Ice River area near Field and in the vicinity of the Big Bend of the Columbia River.

In several places in northern Ontario and southern Quebec, nepheline is common in alkaline rock complexes.

FOREIGN PRODUCTION

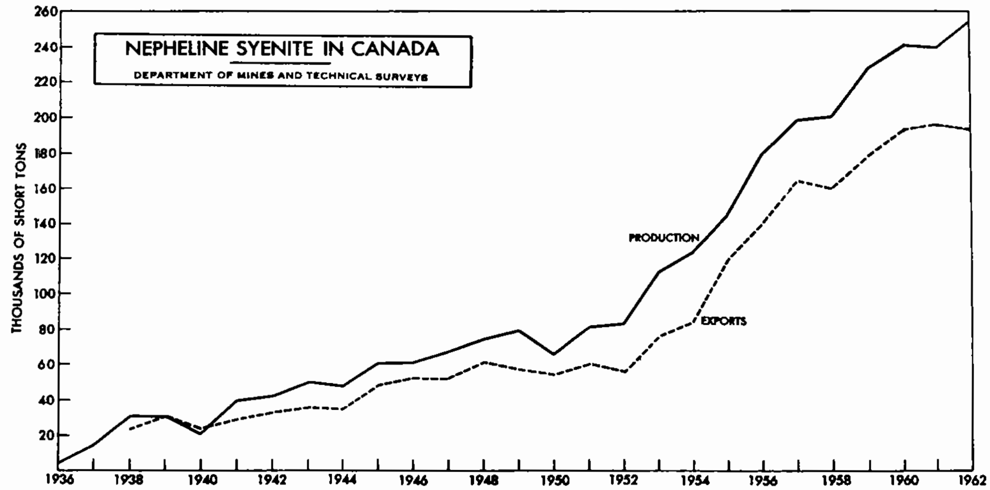
Only two other countries, the U.S.S.R. and Norway, produce nepheline-bearing ceramic raw materials.

In late 1960, mining and dry processing of nepheline syenite began from a large deposit on Stjernöy, an island off the northern coast of Norway. A high-quality glass grade and a high-quality minus 200 mesh ceramic grade 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 Russia has produced a by-product nepheline concentrate from the large quantity of apatite-nepheline rock that is mined annually from the famous and unusual Khibiny deposits in the Kola Peninsula. The nepheline 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 has also become important as an aluminum ore, and has focussed attention on nepheline-bearing rocks elsewhere in the U.S.S.R. as sources of aluminum.

TECHNOLOGY

Nepheline syenite is a quartz-free rock consisting principally of the minerals nepheline (a sodium aluminum silicate) and feldspar (sodium and potassium aluminum silicates). The Blue Mountain deposit consists of 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 variation mineralogically. This consistency and the relative ease with which high-intensity dry magnetic separators remove nearly all of the iron-bearing minerals help make possible the production of uniform, high-quality products.



Ground and beneficiated nepheline syenite is industrially valuable because of its comparatively high alumina and alkali content, and its relatively low melting temperature. Typically, products from the Blue Mountain deposit contain more than 23 per cent Al_2O_3, about 15 per cent total alkali (with a soda-potash ratio of 2:1) and about 0.08 per cent or less Fe_2O_3.

USES AND SPECIFICATIONS

In glass manufacturing nepheline syenite is important primarily as a source of alumina and alkalis. In the Canadian glass industry it has replaced feldspar; in the northeastern United States it has been extensively substituted for feldspar in the glass industry. The specification for particle size is minus 30 plus 200 mesh, U.S. Standard. In general, the iron content, expressed as Fe_2O_3, must be less than 0.1 per cent.

In smaller quantities, nepheline syenite is used 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. Particle size specifications require that the nepheline syenite be mainly minus 325 mesh, the proportion of this size depending on the end use. An Fe_2O_3 content of less than 0.1 per cent is also necessary.

Because of its relatively low fusion temperature, fine-ground nepheline syenite is used as a frit ingredient for porcelain enamels. Specifications are similar to those for whitewares. Small but increasing quantities of fine-ground material are finding acceptance as a filler in paints.

Cheaper, lower-grade by-products are used to some extent in ground-coat enamels, structural-clay products and glass fibre and in the body and glaze of sewer pipe; in all of these the higher iron content is of no importance. Some crude is used in the manufacture of mineral wool.

PRICES

Near the end of the year, an increase in the price of glass-grade nepheline syenite to $10 a ton, f.o.b. plant, was announced. This is in marked contrast to the periodic decreases that have taken place in the last few years.

Canadian Chemical Processing of October 1963 quoted prices as follows: in bags, car lots, f.o.b. works, $11.50 to $28.50 per short ton.

Nickel

C. C. Allen*

Canadian nickel production during 1963 was 217,030 tons valued at $360.4 million, slightly less than the 232,242 tons valued at $383.8 million produced in 1962. There was no price change so the decrease was strictly one of lower output. This combined with withdrawals from producers' stocks met consumer demand. The industry operated at about 93 per cent of its rated production capacity. Falconbridge Nickel Mines, Limited, reduced production 17 per cent in October and The International Nickel Company of Canada, Limited (INCO) cut production of electrolytic nickel at Port Colborne, Ontario.

Increased demand, mainly by the ferrous industry and in particular by producers of stainless steel, resulted in an estimated increase in Free World consumption of 52 million pounds to 525 million pounds in 1963.

With nickel readily available, marketing of standard forms was highly competitive. Free World production capacity remained at about 315,000 short tons of contained nickel and no major changes occurred within the industry. There is sufficient nickel capacity available to keep pace with normal market growth for at least three years without major expansion.

Canada, traditionally the world's leading supplier of nickel, accounts for about 80 per cent of Free World production. The leading producers, INCO and Falconbridge, are the world's largest.

CANADIAN DEVELOPMENTS

Ontario

At Sudbury, INCO operated six mines: the Creighton, Frood-Stobie, Garson, Levack, and Murray underground mines, and the Clarabelle open pit. Ore mined in Ontario and at Thompson, Manitoba, totalled 13.6 million tons compared with

*Mineral Resources Division

TABLE 1
Nickel – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
Ontario	166,582	274,219,955	149,089	246,252,488
Manitoba	61,482	102,586,082	63,585	106,822,887
Quebec	1,540	2,571,898	2,506	4,209,785
British Columbia	1,738	2,902,850	1,850	3,107,498
Northwest Territories	900	1,503,837	nil	nil
Total	232,242	383,784,622	217,030	360,392,658
Exports				
In ores, concentrates, matte or speiss				
Britain	41,861	67,830,193	46,821	76,318,361
Norway[2]	33,396	47,204,005	33,548	47,185,528
Japan	1,673	1,643,801	2,560	2,585,515
United States	479	677,388	463	643,924
Belgium and Luxembourg	1	1,000	nil	nil
Total	77,410	117,356,387	83,392	126,733,328
In oxide sinter				
United States	6,503	9,344,301	9,429	13,858,524
Britain	2,744	2,244,011	2,306	2,771,449
Italy	409	657,726	1,386	2,181,576
Australia	609	856,553	555	784,616
Belgium and Luxembourg	187	298,534	507	800,105
Sweden	295	475,743	403	630,782
France	323	520,609	299	472,590
West Germany	nil	nil	193	303,336
Austria	50	80,402	130	204,142
Other countries	..	279	..	1,129
Total	11,120	14,478,158	15,208	22,008,249
Nickel and nickel-alloy scrap				
United States	785	430,971	760	414,391
West Germany	77	22,995	79	39,825
Japan	nil	nil	75	4,738
Britain	9	6,662	20	20,261
Netherlands	83	4,391	9	6,778
Other countries	15	8,814	14	8,345
Total	969	473,833	957	494,338

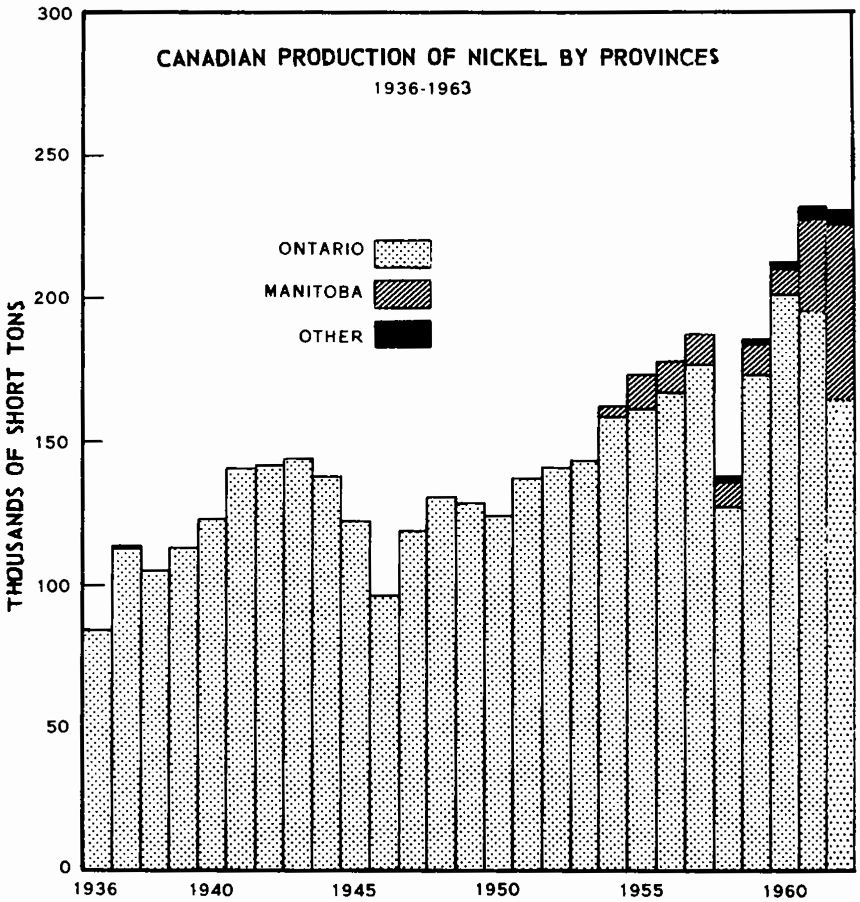
Table 1 (continued)

	1962		1963	
	Short Tons	$	Short Tons	$
Anodes, cathodes, ingots, rod and shot				
United States	104,577	158,315,562	94,064	145,092,288
Britain	9,921	15,157,513	7,476	11,533,995
West Germany	2,000	3,223,209	2,574	4,160,842
India	423	714,599	1,088	1,834,419
Australia	689	1,271,467	837	1,486,058
Austria	308	490,113	573	908,466
Japan	1,052	1,775,188	473	790,819
Italy	727	1,168,421	398	646,959
Brazil	808	1,368,246	368	619,858
Spain	216	360,088	300	474,305
Sweden	284	466,192	295	482,412
Other countries	707	1,207,069	710	1,206,504
Total	121,712	185,517,667	109,156	169,236,925
Nickel and nickel-alloy fabricated materials, not elsewhere specified				
United States	3,182	5,087,157	3,725	5,306,821
Britain	104	429,504	85	338,672
India	42	70,513	55	100,485
Italy	10	40,439	25	99,752
New Zealand	33	150,236	21	96,926
Other countries	140	260,942	101	188,780
Total	3,511	6,038,791	4,012	6,131,436
Imports				
Primary and Semi-fabricated[3]				
Norway	5,595	9,671,199	8,912	15,953,811
United States	1,873	5,004,815	2,018	5,069,008
Britain	18	64,490	12	37,013
West Germany	5	10,770	29	100,099
Sweden	3	12,522	2	6,898
Total	7,494	14,763,796	10,973	21,166,829
Manufactures				
United States		870,712		434,877
Britain		97,650		104,192
West Germany		82,345		59,254
Japan		34,750		26,233
Other countries		44,805		40,270
Total		1,130,262		664,826
Total imports		15,894,058		21,831,655

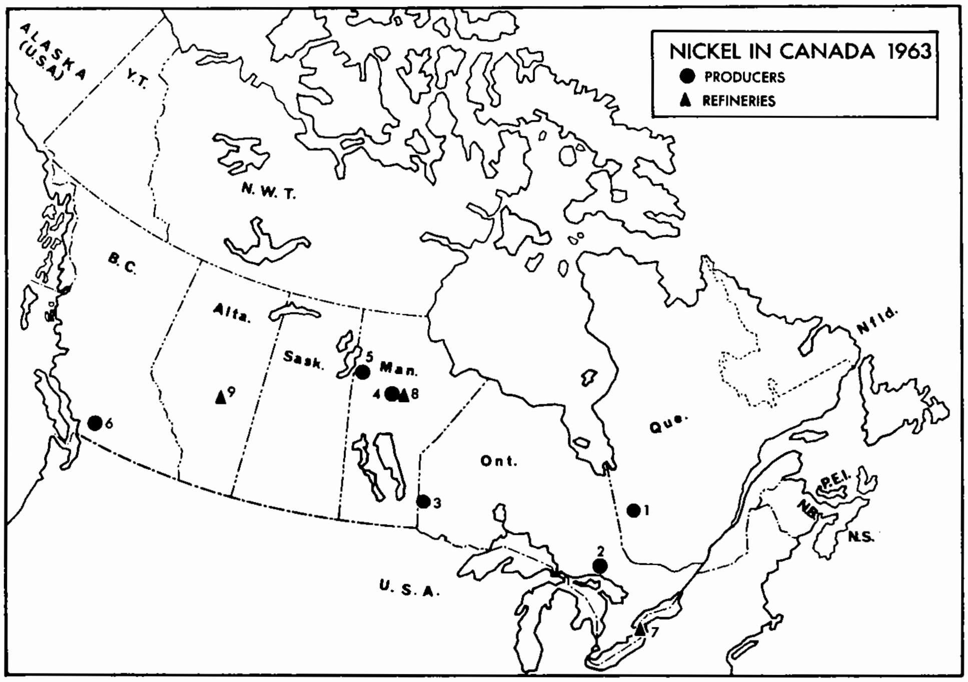
Table 1 (continued)

	1962		1963	
	Short Tons	$	Short Tons	$
Consumption[4]				
All forms	5,322			5,869

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]Nickel in bars, rods, strips, sheets and wire; nickel and nickel-silver in ingots; nickel-chromium in bars. [4]Consumption of nickel, all forms (refined metal, oxide and salts), as reported by consumers.
.. Less than one short ton.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS



PRODUCERS

1. Marbridge Mines Limited
2. Sudbury area
   The International Nickel Company of Canada, Limited (6 mines, 2 smelters) Falconbridge Nickel Mines, Limited (5mines, 1 smelter)
3. Nickel Mining and Smelting Corporation (Metal Mines Limited)
4. The International Nickel Company of Canada, Limited (Thompson mine and smelter)
5. Sherritt Gordon Mines, Limited
6. Giant Mascot Mines, Limited

REFINERIES

7. The International Nickel Company of Canada, Limited (Port Colborne)
8. The International Nickel Company of Canada, Limited (Thompson)
9. Sherritt Gordon Mines, Limited (Fort Saskatchewan)

TABLE 2
Nickel – Production, Trade and Consumption, 1954–63
(short tons)

	Production[1]	Exports				Imports[2]	Consumption[3]
	All forms	In matte etc.	In Oxide Sinter	Refined Metal	Total		
1954	161,279	65,823	1,486	91,410	158,719	1,584	2,595
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	4,059r
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	5,322r
1963	217,030	83,392	15,208	109,156	207,756	10,973	5,869

Source: Dominion Bureau of Statistics
[1]Refined metal and nickel in oxide and salts produced plus recoverable nickel in matte and concentrates exported. [2]Nickel in bars, rods, strips, sheets and wire; nickel and nickel-silver in ingots; nickel-chromium in bars. [3]To 1959, producers' domestic shipments of refined metal; after 1959, consumption of nickel, all forms (refined metal, oxide and salts) as reported by consumers.
r Revised.

13.8 million tons in 1962. Rotary drilling replaced churn drilling at the Clarabelle. Shaft sinking to 4,134 feet was completed at the Copper Cliff North mine and level development proceeded. The wider application of cemented sand fill in cut-and-fill stopes resulted in greater flexibility, increased ore recovery and less dilution. Deliveries of nickel in all forms by INCO totalled 350.7 million pounds. Proven ore reserves at year-end at Sudbury and Thompson amounted to 301.6 million short tons containing nine million short tons of nickel and copper compared with 299.4 million tons containing correspondingly less nickel and copper than a year earlier. The major expansion to the iron pellet recovery plant at Copper Cliff was completed and in production by mid-year. In February 1964, because of greater demand for nickel about 1,850 employees at Sudbury and Port Colborne were rehired and production increased.

Falconbridge operated five underground mines in the Sudbury area: the Falconbridge and East mines in the Falconbridge district and the Hardy, Onaping and Fecunis mines in the Onaping district. Because of the production cut, the East mine was closed and production was reduced at the other four mines. The three concentrators operated on a five–day week. Development work at the Strathcona mine was continued by company crews rather than by contract.

At Thornhill the company completed and opened a $1-million addition to its research centre which includes a new metallurgical laboratory and expanded facilities for the mineral sciences. Nickel deliveries in 1963 amounted to 53.2 million pounds. Ore delivered to treatment plants from company mines totalled 2.1 million tons. Ore reserves at year-end were 51.3 million tons averaging 1.42 per cent nickel and 0.79 per cent copper, an increase of about three million tons above December 1962.

In northwestern Ontario, the Gordon Lake Mine of Metal Mines Limited (formerly Nickel Mining & Smelting Corporation) began production in 1962 with a mill designed to treat 500 to 700 tons of ore daily. The company experienced difficulties in reaching capacity because of poor ground conditions in the mine. Two shrinkage stopes were in operation in 1963 and preparations were being made to mine two others by blast–hole methods. A bulk, nickel–copper concentrate is trucked to Lac du Bonnet, Manitoba, and shipped to Copper Cliff for smelting. Metal Mines Limited has a five-year smelting contract with INCO.

Manitoba

The only major change at the Thompson project of INCO was the decision to sink No. 3 shaft on the edge of Thompson Lake, 8,000 feet east of No. 1 shaft. This service shaft will initially extend to the 2,400–foot level. Pebble grinding is being experimented with in place of ball mill grinding.

At the Lynn Lake mine of Sherritt Gordon Mines Limited, 1.3 million tons of ore were milled. Ore reserves at the year-end totalled 11.9 million tons grading 0.96 per cent nickel and 0.58 per cent copper compared with reserves of 14 million tons grading 0.94 per cent nickel and 0.55 per cent copper a year earlier. At the company's refinery in Fort Saskatchewan, Alberta, the powder–rolling facilities were expanded for both the coinage–strip circuit and for experimental work. A decision was made to produce and market phosphate fertilizers along with urea, anhydrous ammonia and ammonium sulphate. Nickel production in 1963 was 20.9 million pounds. A long–term contract for refinery feed was negotiated in order to ensure capacity operations.

Consolidated Marbenor Mines Limited has a property in northern Manitoba that is under option to Falconbridge. Encouraging drill results late in the year were reported when one hole graded approximately one per cent nickel over 57½ feet.

Quebec

Marbridge Mines Limited, with mine in La Motte township operated at close to its daily capacity of 400 tons. Bulk, nickel–copper flotation concentrates, amounting to about 2,800 tons a month, were trucked to Falconbridge, Ontario, for smelting by Falconbridge Nickel Mines, Limited. Year–end ore reserves amounted to 143,000 tons averaging 2.28 per cent nickel above the 900–foot level. Development of the, 1050– and, 1200–foot levels was underway.

Lorraine Mining Company Limited was shaft sinking to 1,000 feet on its property in the Belleterre area. Indicated ore reserves to 800 feet are 550,000 tons of 2.1 per cent combined nickel–copper. A 400–ton mill is planned for 1964.

Raglan Nickel Mines Limited, with property south of Ungava Bay in northern Quebec, at year–end had an indicated ore reserve of 10 million tons of 1.53 per cent nickel and 0.78 per cent copper or 7.8 million tons 1.70 per cent nickel and 0.87 per cent copper. Additional drilling is planned for 1964.

British Columbia

Giant Mascot Mines, Limited, near Hope, B.C., treated about 1,200 tons of ore daily for 23 days each month. Bulk, nickel–copper concentrates were exported to Japan. After installation of a new jaw crusher, another ball mill and additional flotation cells in 1964, daily mill capacity will probably be 1,500 tons.

WORLD DEVELOPMENTS

The Shimura Kako Company, one of Japan's major nickel refiners, has contracted for an annual minimum of 3,000 tons of contained nickel in matte from Société Le Nickel, New Caledonia. A new jointly owned smelter is planned for New Caledonia.

The Sulawesi Nickel Development Co-operation Company of Japan and the Indonesian government have signed a contract for the development of the Celebes nickel–bearing laterite deposits. The company will provide U.S. $1.35 million for the importation of necessary Japanese machinery. Indonesia will export 120,000 tons of nickel ore a year the first shipments to commence in April 1964.

Falconbridge Nickel Mines, Limited, appointed Mitsubishi International Corporation as exclusive agent for marketing Falconbridge nickel products in Japan.

INCO was granted prospecting right to a 325–square–mile area in Australian New Guinea where large low–grade nickel–bearing laterite deposits occur.

The new nickel refinery at Sered, Czechoslovakia was in partial operation. Annual capacity is 2,000 tons of refined nickel. The refinery operates mostly on imported Albanian ore, the continued supply of which is becoming a problem.

The Philippine government has again sent out invitations for bids on development of the nickel laterites in the Surigao area.

Société Minière et Métallurgique Larco was formed on March 23, 1963, with the Greek Chemical & Fertilizer Co. subscribing $5.5 million for a 68.57-per-cent interest and Société Le Nickel $1.5 million for a 21.43-per-cent interest. Larco will exploit the Larymna iron-nickel deposits in Greece where four new kilns will be installed. Ore treatment includes selective kiln reduction, electric furnace smelting, converter enrichment of nickel products, and electrolysis. Pig iron will be made from the high–iron slag. Capacity nickel production will be about 4,400 tons of electrolytic nickel a year. Production is expected to begin about mid–1964; Le Nickel will market the nickel cathodes.

After three years of nationalization, Cuban nickel production is becoming more significant. Nicaro production in 1962 was estimated to be 16,000 tons and Moa Bay was reported to be operating at about two thirds of its original 25,000–tons–a–year capacity.

TABLE 3

World Production of Nickel, 1963

(short tons)

Canada	217,030
Russia	90,000
New Caledonia	32,200
Cuba	16,200
United States	11,432
Republic of South Africa	2,700
Finland	3,231
Other countries	207
Total	373,000

Source: American Bureau of Metal Statistics, and, for Canada, Dominion Bureau of Statistics.

TABLE 4

Free World * Nickel Production Capacity, 1963

(short tons)

International Nickel (including Thompson) over	200,000
Falconbridge	35,000
Sherritt Gordon	15,000
Total, Canada	250,000
New Caledonia (French and Japanese)	47,500
Hanna Nickel Smelting Company (U.S.A.)	11,750
Finland	2,500
South Africa	3,000
Brazil	1,100
Total, Free World	315,850

Source: Company reports.
*Cuba excluded.

TABLE 5
Free World Nickel Consumption 1959–63, by Products

	1959	1960	1961	1962	1963
	%	%	%	%	%
Stainless steels	29	32	33	30	31
High–nickel alloys	16	15	15	16	17
Electroplating	15	16	15	16	14
Nickel–alloy steels	15	13	14	13	13
Foundry products	12	12	11	12	12
Copper–nickel alloys	4	4	4	4	4
All other products	9	8	8	9	9

Source: INCO

CONSUMPTION AND USES

Stainless steel gained in relative importance as a use for nickel and continued as the largest single outlet for nickel. In almost every use, in utensils, electrical appliances, transportation equipment, or structures, nickel's suitability as an alloy is its chief attraction.

Among the newer developments, INCO marketed a sulphur–containing electrolytic nickel known in North America as "SD" nickel and in Europe as "S" nickel. Its introduction was well received in the electroplating industry. A new high–purity carbonyl nickel powder was marketed by the Mond Division for use in powder metallurgy. Also announced was a 'new electrolytic strip' nickel for use in coinage. Sherritt Gordon marketed a new ultra high–purity nickel powder (grade E 99.9 + per cent nickel), which is expected to be used as sintered powder in nickel–cadmium batteries.

Nickel, by itself, has qualities of strength, hardness, toughness, ductility and corrosion resistance both at low and high temperatures. When alloyed with iron, it imparts many of these qualities to the alloy. As an additive to carbon steel, nickel steels have greater strength and toughness and better quality for heat treatment. Today, approximately 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.

Nickel literally has hundreds of important and varied uses in the ferrous and nonferrous fields. The high nickel–chromium alloys constitute an important group of nonferrous alloys because of their electrical and chemical properties. It is an important ingredient in the high–temperature nickel and cobalt–based alloys. Alloyed with copper in varying proportions, the products have a wide range of uses in the food and food–processing industries. The nickel–chromium–iron series of alloys are highly resistant to oxidation at high temperatures and are used in the papermaking, petroleum, dairy, fruit juice and fatty acid industries. Nickel is used for electroplating for decorative and protective purposes.

Nickel in steels of various compositions improves the strength and resistance to shock, wear and fatigue of these steels. Super alloys used in turbines where corrosion resistance and strength are required under extreme conditions of oxidation at high temperatures, are modifications of nickel–chromium alloys.

Copper–nickel alloys containing under 50 per cent nickel are used extensively for coinage, for condenser tubes in marine service and for heat exchange tubes in petroleum refineries.

As a catalyst, nickel is used in the hydrogenation of oils and in the production of chemical and petroleum products. It is an important constituent in permanent magnet alloys (Alnico type) and in high-permeability alloys (nickel–iron) used in communications and control equipment.

PRICES

The Canadian price of electrolytic nickel, f.o.b. Port Colborne, Ontario, was 84 cents a pound throughout 1963.

The United States price, including the 1¼-cents-a-pound import duty, was 79 cents a pound throughout 1963.

Tariffs

	British Preferential	Most Favored Nation	General
Canada			
Nickel, and alloys consisting of 60% or more of nickel by weight, not otherwise provided for, viz: ingots, blocks and shots; 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 of 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%
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	
Plates and sheets, clad	24% ad valorem
Other	
Not cold worked	10% ad valorem
Cold worked	14% ad valorem
Rods, angles, shapes, and sections, all the foregoing wrought, of nickel; nickel wire	
Rods and wire	
Not cold worked	10% ad valorem
Cold worked	14% ad valorem
Angles, shapes, and sections	18% ad valorem

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 therefor	
Not cold worked	6.25% ad valorem
Cold worked	8.75% ad valorem
Pipe and tube fittings	18% ad valorem
Electro-plating anodes, wrought and cast, of nickel	10% ad valorem

Niobium (Columbium) and Tantalum

V.B. Schneider*

St. Lawrence Columbium and Metals Corporation continued to be the only Canadian producer of columbium concentrates. Mine production during 1963 was 1.4 million pounds of columbium pentoxide (Cb_2O_5) contained in concentrates averaging 51.76 per cent Cb_2O_5. Shipments totalled 1.5 million pounds of Cb_2O_5 in concentrates compared with one million pounds in 1962. The company is the only direct producer of columbium concentrates as a primary product in the world and is also the world's largest single producer. In most columbium operations the concentrate is recovered as a byproduct of tin recovery. A mill-expansion program by St. Lawrence Columbium that began in 1962 was completed early in 1963; production in 1964 is expected to reach 3.6 million pounds of concentrates.

The United States Bureau of Mines estimates that, excluding Communist Bloc countries, world mine production of columbium-tantalum concentrates during 1963 amounted to 10.7 million pounds. According to its estimate, Nigeria was the largest producer with a production of approximately 4.5 million pounds of concentrates and Canada ranked second.

Geo-Met Reactors Limited, Ottawa, 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. Generally, Geo-Met manufactures steel additives on a custom basis to meet particular metallurgical requirements.

*Mineral Resources Division

TABLE 1
Niobium (Columbium) and Tantalum –
Production, Trade and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production (shipments)				
Columbium pentoxide (Cb_2O_5)........	1,016,514	1,006,349	1,393,444	1,300,009
Imports* from United States				
Columbium metal and alloys semifabricated	1,404	16,043	nil	nil
Tantalum metal and alloys, crude and scrap..................	231	23,290	5,456	47,853
Tantalum metal, semifabricated	125	19,598	235	19,090
Exports** to United States				
Columbium ore and concentrates	1,509,928	720,878	1,881,704	868,300
Consumption by steel industry				
Ferrocolumbium and ferrotantalum-columbium (Cb and Ta-Cb content)...	26,000	na	34,000	na

Source: Dominion Bureau of Statistics.
*From United States Bureau of Commerce *Exports of Domestic and Foreign Merchandise* (Report FT410). **From United States Bureau of Commerce *Imports of Merchandise for Consumption* (Report FT 110). Values for trade data from United States sources are in United States dollars.
na Not available.

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, (name changed March 1963 to Q.M.I. Minerals Ltd.) processed gravity concentrates from these deposits to produce high-purity columbium oxide, columbium alloys and columbium sponge. The project was discontinued, however, as uneconomical.

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.

TABLE 2
Production of Columbium Concentrates by
St. Lawrence Columbium and Metals Corporation,
1961–1963
(pounds)

	1961	1962	1963
Concentrates	253,885	1,839,319	2,941,303
Contained Cb_2O_5	134,006	971,624	1,521,701
Shipments of concentrates	119,261	1,909,433	2,692,935
Avg.% Cb_2O_5 in concentrates	53	52.82	51.76

Source: Company report.

TABLE 3
Non-Communist World Production of
Columbium – Tantalum Concentrates, 1962 and 1963
(short tons – 2,000 lb)

	1962	1963
Nigeria	2,552	2,270
Canada	955	1,346
Norway	328	173
Brazil	180	980*
Republic of the Congo and Ruanda-Urundi	142	155
Federation of Malaya	123	99
Mozambique	116	94
Other countries	209	213
Total	4,605	5,330*

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

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 1963 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.

Multi-Minerals Limited has outlined two pyrochlore-bearing deposits on its Nemegos property about 14 miles southeast of Chapleau. In 1962 the company arranged for Chemical Research Associates, of New Jersey, to conduct beneficiation tests on its material, which contains apatite, magnetite and columbium. It is hoped that columbium may be recovered as a byproduct.

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 daily milling rates in 1963 ranging between 850 tons and 1,060 tons, depending on the grade and type ore being treated. The company markets three types of concentrates. In 1963 the average grade of the ore was maintained at 0.41 per cent Cb_2O_5. The company sells 70 per cent of its production of the United States, 27 per cent in Europe, and three per cent in domestic markets. Table 2 shows the company's production and shipments since it commenced operation in 1962.

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.

WORLD MINE PRODUCTION

Preliminary estimates for 1963 indicate that production in the non-Communist countries was 5,330 tons. This is 725 tons greater than in 1962 and was the fifth consecutive year that Free World production of columbium- and tantalum-bearing concentrates increased after a decline from a record high of 5,865 tons in 1955 to a low of 2,440 tons in 1958.

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, tantalum and columbium replacing 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 $(NaCa)_2Cb_2O_6\ F + ThO_2$ 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 Minas Gerais, Brazil, is the largest and highest-grade deposit so far discovered and is believed to contain 7,500 short tons of columbium in ore averaging more than three per cent Cb_2O_5. It is owned by Wah Chang Corporation, Molybdenum Corporation of America and Brazilian interests. Production from the Araxa deposit continued to be held up because of the lack of an export licence.

Nigeria is the perennial leader in the production of columbium concentrates (columbite); in 1963 Mozambique was the principal source of tantalum concentrate (tantalite) with the Republic of the Congo (Leopoldville) slipping from its second position in 1962 to third in 1963.

The Sove Mine, in the Fen area, near Ulefoss, which is 72 miles south-west of Oslo, Norway, produces a 50-per-cent Cb_2O_5 concentrate. This concentrate, with a columbium-tantalum ratio 100:1, is shipped to the European market.

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 February 1964 estimated that 1963 imports of columbium-tantalum concentrates totalled 2,500 short tons, with Canada and Nigeria each supplying one third. The metal content of industrial consumption in 1962 was 1,895 tons, up 612 tons from 1961.

The Bureau of Mines in the same publication also reported that metals and alloys are produced in the United States from columbium-tantalum concentrates by 12 companies. Ferrotantalum-columbium are consumed by more than 50 firms. Columbium consumption is proportioned roughly 86 per cent in steelmaking and 14 per cent in nonferrous alloys and other uses; tantalum consumption is proportioned roughly 60 per cent to electronics applications, 34 per cent in nonferrous alloys and six per cent in carbides.

In October 1963, Kawecki Chemical Company began operation of what is reported to be the largest columbium ore processing plant in the world at Boyertown, Penna. The plant is capable of processing almost any columbium-bearing ore or concentrate into ultra-high-purity columbium compounds, metals and alloys. Initial production will be derived from a supply of tin slags containing tantalum and columbium that the company has on hand.

In Canada, the need is for ferrocolumbium and ferrotantalum-columbium. In 1963, about 17 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 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. 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; and Metallurg (Canada) Ltd. are the principal Canadian suppliers of ferrocolumbium.

The more important Canadian consumers of columbium and tantalum are: Atlas Steels Company, Welland; Black Clawson-Kennedy Ltd., Owen sound; Dominion Foundries and Steel, Limited, Hamilton; Canadian Westinghouse Company Limited, Hamilton, all in Ontario; and Shawinigan Chemicals Limited, Shawinigan, Quebec.

PRICES

The following quotations are from *E & M J Metal and Mineral Markets* of December 31, 1963.

	Dollars
Columbium metal, 99½%, 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

PRICES (cont'd)

	Dollars
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 and Ta_2O_5 f.o.b. shipping point, per lb	
Ratio 10 to 1	0.90 – 1.00
Ratio 8½ to 1	0.85 – 0.90

TARIFFS

Canada	British Preferential	Most Favored Nation	General
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%	25%
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%

*Duty on scrap suspended to June 30, 1964.

Petroleum

D.W. Rutledge*

Most phases of the Canadian petroleum industry, from field production through transportation and marketing, had a good year in 1963, particularly in terms of growth. Although the rate of increase in output of crude oil was not as great as in 1962, production was nevertheless substantially above all previous levels. Output of crude oil and natural gas liquids reached the objective suggested by the federal government in 1961 and production in all provinces except Alberta was near capacity. Despite the absence of major oil discoveries, recoverable reserves of petroleum in Alberta and Saskatchewan were increased by widespread implementation of pressure maintenance and secondary recovery projects.

Cities Service Athabasca, Inc. and Shell Canada Limited proposed projects for production of crude oil from Athabasca bituminous sands were deferred by the Alberta Oil and Gas Conservation Board on the grounds that such large-volume production would disrupt the conventional oil industry. Great Canadian Oil Sands Limited, which had received a permit in 1962 to produce crude oil from the Athabasca sands at a rate of 31,500 barrels a day, re-applied to the Conservation Board, with the backing of Sun Oil Company Limited, to produce at a revised rate of 45,000 barrels a day. This application was approved by the Board and the Alberta government early in 1964. Another important problem is under consideration by the Conservation Board: how to revise, if at all, the present Alberta proration system that allocates market demand among the many oil wells in the province. Oil company submissions on the prorationing problem vary from requests that the present system, using an economic allowable for each well, be essentially retained, to the concept of basing well-production on oil reserves in the pool.

PRODUCTION

Production of all liquid hydrocarbons – crude oil plus natural gas liquids – amounted to 287.5 million barrels for the year, an average of 787 thousand barrels a day. Output reached an all-time high, 7.1 per cent higher than in 1962,

*Mineral Resources Division

TABLE 1

Production of Crude Oil by Province and Field

(Numbers in parentheses give locations of fields on the accompanying map)

	1962 Barrels	1963 Barrels
Alberta		
Pembina (1)	38,041,625	39,720,059
Redwater (3)	17,668,512	16,415,660
Swan Hills (4)	11,549,961	13,213,766
Leduc–Woodbend (2)	12,635,305	11,911,158
Bonnie Glen (2)	8,714,836	7,605,760
Judy Creek (4)	5,488,439	6,411,309
Fenn–Big Valley (8)	6,000,469	5,632,103
Wizard Lake (2)	4,594,689	4,248,397
Joffre (5)	4,340,171	3,912,709
Golden Spike (2)	4,222,917	3,702,036
Joarcam (7)	2,836,722	2,979,331
Sturgeon Lake South (9)	2,683,289	2,956,533
Innisfail (6)	2,843,732	2,723,940
Virginia Hills (4)	2,673,103	2,883,745
Kaybob (10)	2,482,893	2,672,011
Harmattan East (6)	2,273,505	2,499,937
Acheson (2)	2,541,976	2,428,617
Harmattan–Elkton (6)	2,292,967	2,226,952
Crossfield (6)	2,022,772	1,965,516
Willesden Green (1)	2,204,980	1,907,131
Gilby (5)	1,537,429	1,758,551
Westerose (2)	1,947,638	1,727,816
Stettler (8)	1,559,554	1,522,706
Carson Creek North (4)	1,424,652	1,394,240
Turner Valley (11)	1,151,406	1,187,920
West Drumheller (8)	1,040,236	1,006,664
Other fields and pools	18,351,189	21,599,487
Total	165,124,967	168,214,054
Total Value	$379,830,363	$416,844,350
Saskatchewan		
Weyburn (13)	13,180,600	14,166,583
Steelman (14)	8,817,125	10,205,972
Midale (13)	5,689,236	5,781,660
Dollard (18)	4,580,944	4,740,241
Fosterton (19)	2,754,444	3,206,509
Nottingham (15)	2,985,880	2,881,793
Instow (18)	2,365,138	2,776,452
Success (19)	1,797,899	2,095,391
Coleville–Smiley (17)	1,837,846	1,828,464
Hastings (15)	1,777,752	1,674,957
Parkman (16)	1,887,446	1,534,751
Dodsland (17)	1,334,920	1,507,232
Carnduff (12)	1,631,694	1,491,187
Workman (12)	1,129,893	1,328,122

Table 1 (cont'd)

	1962 Barrels	1963 Barrels
Battrum (19)	1,035,224	1,311,215
Queensdale (15)	1,302,618	1,190,314
Alida (15)	1,137,407	969,375
Other fields and pools	9,186,345	12,613,675
Total	64,432,411	71,303,893
Total Value	$141,783,520	$160,226,978
Manitoba		
Virden–Roselea (20)	1,152,610	1,022,102
North Virden–Scallion (20)	1,343,361	1,347,590
Other fields and pools	1,430,712	1,401,471
Total	3,926,683	3,771,163
Total Value	$ 9,435,819	$ 9,188,635
Ontario	1,134,534	1,205,376
Total Value	$ 3,661,174	$ 3,459,429
British Columbia		
Boundary Lake (21)	6,250,313	7,726,776
Blueberry (22)	602,998	1,279,318
Other fields and pools	2,060,909	3,522,587
Total	8,914,220	12,528,681
Total Value	$ 16,872,122	$ 24,841,518
Northwest Territories	572,004*	631,229*
Total Value	$ 755,045	$ 633,754
New Brunswick	10,333	7,381
Total Value	$ 14,466	$ 10,333
Total, Canada	244,115,152	257,661,777
Total Value	$552,352,509	$615,204,997

Sources: Dominion Bureau of Statistics and provincial government reports.
*Excludes base stock reinjected into the reservoir.

and 22.5 per cent greater than 1961. Crude oil production alone in 1963 totalled 257.7 million barrels. Output of natural gas liquids, comprised of condensate, pentanes plus, propane and butanes, totalled over 29 million barrels.

Total liquid hydrocarbon output increased in Alberta by 4.4 per cent; in Saskatchewan 10.7 per cent; British Columbia 39.3 per cent; Ontario 6.2 per cent; and Northwest Territories 10.4 per cent. Production continued to decline in both Manitoba and New Brunswick.

TABLE 2
Production of Natural Gas Liquids by Province
(barrels)

	1962	1963
Alberta		
Propane	2,954,395	3,551,726
Butane	2,069,861	2,528,330
Pentanes plus	16,676,581	20,630,863
Total	21,700,837	26,710,919
Saskatchewan		
Propane	517,015	596,983
Butane	290,859	336,208
Pentanes plus	266,576	273,252
Total	1,074,450	1,206,443
British Columbia		
Propane	200,273	461,769
Butane	383,324	561,273
Pentanes plus	845,885	855,411
Total	1,429,482	1,878,453
Total, Canada	24,204,769	29,795,815

Source: Dominion Bureau of Statistics and provincial government reports.

Although Alberta's share of production declined, it remained the leading producer of crude oil and natural gas liquids, supplying 67.8 per cent of Canadian output. Both Saskatchewan and British Columbia gained a greater share of production, supplying 25.2 and 5 per cent of production respectively. Manitoba production accounted for 1.3 per cent of the total and the remaining 0.7 per cent came from Ontario, the Northwest Territories and New Brunswick.

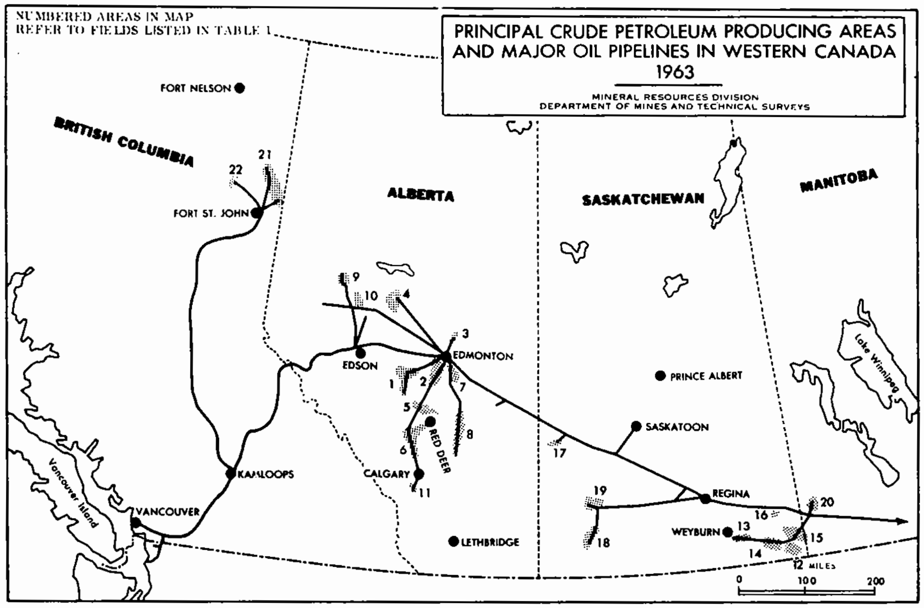
RESERVES

At the end of 1963 Canada's recoverable reserves of liquid hydrocarbons – crude oil and natural gas liquids – amounted to 5.6 billion barrels, according to

TABLE 3
Value of Shipments of Natural Gas Liquids by Province
(dollars)

	1962	1963
Alberta	46,190,893	66,679,857
Saskatchewan	1,878,643	1,875,948
British Columbia	2,708,970	2,441,990
Total, Canada	50,778,506	70,997,795

Sources: Dominion Bureau of Statistics *Final Statistics of Mineral Production of Canada, by Provinces, 1962, 1963.*



estimates compiled by the Canadian Petroleum Association. The net increase in reserves was 8.7 per cent compared to 9.0 per cent in 1962. The 1963 gross increase (net increase plus production), in barrels, was the second largest in history, exceeded only in 1961. About four per cent of the gross increase was from newly discovered oil accumulations but as only a limited area is assigned to each new discovery, larger reserves will eventually be developed from most of the 1963 discoveries. Ninety-six per cent of the estimated gross increase resulted from revisions of previous estimates and extensions of known oil accumulations. Important additions to reserves were made in several of the fields discovered in the 1960-62 period, especially Snipe Lake, Kaybob South, Cyn-Pem, Sylvan Lake and Medicine River, all in Alberta. A significant proportion of new recoverable reserves were developed by large-scale pressure maintenance and secondary recovery projects, particularly in the Swan Hills region and in the Pembina and Weyburn fields.

The Alberta Oil and Gas Conservation Board estimated Alberta's recoverable reserves of crude oil and natural gas liquids at 4.7 billion barrels, nearly the same as in the accompanying table by the Canadian Petroleum Association (CPA). Recoverable reserves of crude oil in Saskatchewan, as published by the Saskatchewan government, exceed 0.9 billion barrels, or considerably more than is shown in the CPA tabulation. The difference is partly accountable to the exclusion from the CPA estimate of petroleum that will eventually be recovered in secondary recovery projects not yet fully developed.

TABLE 4

Crude Oil – Production, Trade and Consumption, 1954–63

(barrels)

	Production[1]	Imports[2]	Exports[2]	Consumption[3] Domestic	Consumption[3] Imported[4]	Consumption[3] 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

Source: Domonion 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).* [4] Imported includes some partly processed crude.

TABLE 5
Reserves of Crude Oil

Province or Region	At End of 1963 ('000 barrels)	Per Cent of Total		Net Change Since 1962 ('000 barrels)
		1962	1963	
Alberta	4,140,847	85.0	84.8	+ 333,838
Saskatchewan	523,457	10.3	10.7	+ 61,085
British Columbia	136,427	3.1	2.8	- 150
Northwest Territories	49,799	1.1	1.0	- 613
Manitoba	23,797	0.3	0.5	+ 8,869
Eastern Canada	7,165	0.2	0.2	- 2,239
Total	4,881,492	100.0	100.0	+ 400,790

Source: Canadian Petroleum Association.

TABLE 6
Reserves of Liquid Hydrocarbons at End of 1963

	Natural gas Liquids (N.G.L.) ('000 barrels)	Crude Oil Plus N.G.L. ('000 barrels)	Per Cent of Total
Alberta	706,067	4,846,914	86.1
Saskatchewan	8,190	531,647	9.5
British Columbia	33,488	169,915	3.0
Other areas	nil	80,761	1.4
Total	747,745	5,629,237	100.0

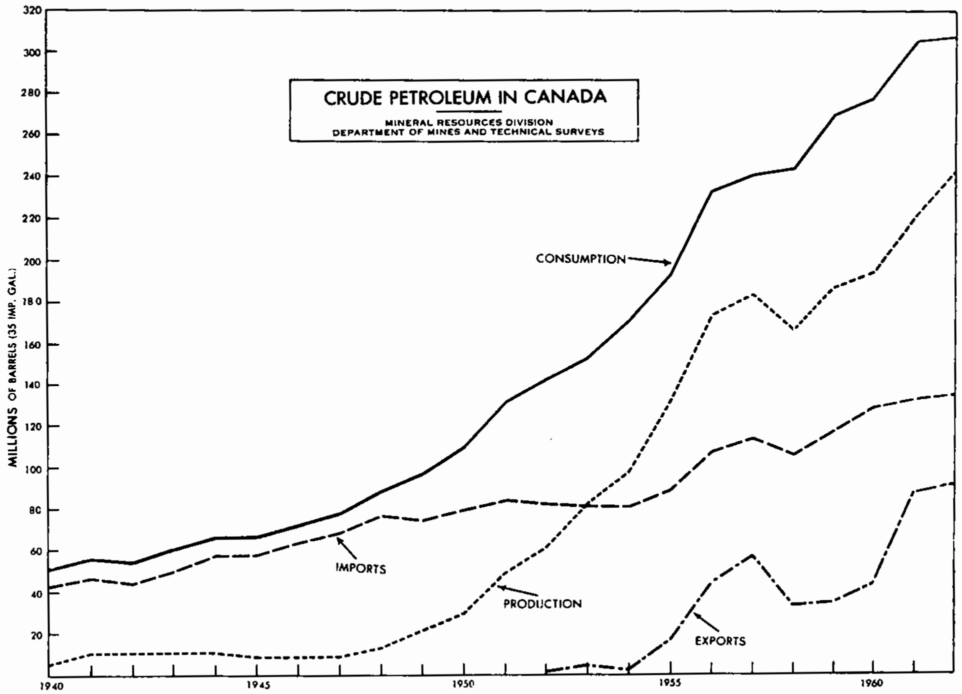
Source: Canadian Petroleum Association

EXPLORATION AND DEVELOPMENT

General

Drilling in western Canada increased from 13.1 million feet in 1962 to 14.1 million in 1963, a gain of eight per cent. This increase was mainly in development drilling; exploratory drilling increased only slightly. Two thirds of the total footage was to develop known oil and gas pools while the remainder was of an exploratory nature. A greater ratio of successful oil wells was attained: that is, 52 per cent of all wells compared to 50 per cent in 1962. Although drilling increased in all areas except British Columbia, the increase was most apparent in Saskatchewan and Manitoba. In Ontario, drilling totalled 405,382 feet compared to 370,675 feet in 1962.

Geophysical activity in western Canada, based on a month-by-month comparison of the number of crews working, was slightly less in 1963 than in 1962.



The decline in geophysical activity has been evident since 1953 except for a levelling-off in the 1961-62 period. There were fewer seasonal fluctuations in seismic surveying in 1963, with fewer crews working in the peak winter period and more crews at work during the summer than in the corresponding periods of 1962. Seismic work decreased in Alberta and British Columbia and increased in Saskatchewan and the Yukon and Northwest Territories. Seismic surveying in the western provinces, given in terms of crew months, was as follows: Alberta, 389; British Columbia, 110; Saskatchewan, 68; Manitoba, 1; Yukon Territory and Northwest Territories, 49. The gravity survey remained a comparatively minor geophysical method in western Canada.

Alberta

Drilling in Alberta totalled 9.8 million feet, 7.7 per cent more than in 1962. Exploratory footage, comprising 31.8 per cent of the total, declined slightly. Development drilling increased significantly, despite the continuing trend toward wider spacing of wells in oil fields. Whereas 40-acre spacing was dominant a decade ago, 160-acre spacing has become common in the past several years.

Several of the main exploration-development regions were the result of 1962 discoveries, particularly Snipe Lake, Kaybob South, Ante Creek and Cyn-Pem, all of which received field status in 1963. The limits of the Snipe Lake field were

TABLE 7
Wells Drilled to Completion* – Western Canada

	Oil Wells		Gas Wells		Dry Holes		Total	
	1962	1963	1962	1963	1962	1963	1962	1963
Alberta	688	869	272	275	584	560	1,544	1,704
Saskatchewan	397	572	11	41	212	338	620	951
Manitoba	14	29	–	–	10	15	24	44
British Columbia	159	31	65	70	96	82	320	183
Northwest Territories & Yukon	–	–	–	–	8	6	8	6
Total	1,258	1,501	348	386	910	1,001	2,516	2,888

Sources: Provincial government reports and Department of Northern Affairs and National Resources.
*Service wells are excluded.
– Nil

TABLE 8
Oil Wells in Western Canada at End of Year

	Producing Wells		Wells Capable of Production	
	1962	1963	1962	1963
Alberta	9,183	9,217	10,809	11,437
Saskatchewan	4,248	4,653	4,935	5,291
Manitoba	730	683	852	839
British Columbia	330	350	356	389
Northwest Territories	31	31	60	60
Total	14,522	14,934	17,012	18,016

Sources: Provincial government reports and Department of Northern Affairs and National Resources.

defined and the field had 55 oil wells by the end of 1963. Drilling in the Kaybob South field, Alberta's first important Triassic oil reservoir, progressed rapidly and by the end of December, the field had 47 oil wells. The Ante Creek field, which, like Snipe Lake, is situated near the western productive limits of the Beaverhill Lake reef complex, was developed at a comparatively slow rate. Similarly, the Freeman pool, a Beaverhill Lake reservoir near the northeast side of the Virginia Hills field, has not been developed appreciably since its discovery in 1962, although considerable possibility for expansion remains. A new "Cardium alley", extending from the northwest corner of the Pembina field to Edson, received considerable attention during the year. A series of five pools had been found along this trend: the Cyn-Pem field, the Carrot Creek pool, and three pools near Edson.

Several medium-sized oil pools are at present being developed as the result of 1963 discoveries. One of the largest of the new pools, now known as the Goose River field, was discovered in September when BA Goose River 10-4-67-18-W5 intersected 60 feet of net oil pay in Beaverhill Lake reef 10 miles north of the Kaybob field. Another Beaverhill Lake oil reservoir, House Mountain, is being rapidly outlined just north of the Swan Hills field. Although this pool was discovered early in 1962, little activity followed until after a westward extension of the pool was intersected in April 1963 by the well SOBC House Mountain 12-23-70-11-W5. The discovery of oil in the Granite Wash sand at Utikuma Lake, 35 miles north of Lesser Slave Lake, gave renewed impetus of oil exploration in north-central Alberta. The first well, Atlantic IOE Utikuma 10-27-81-9-W5 was drilled in February 1963, and was followed by nearly a dozen more oil wells by early 1964.

Some interesting oil discoveries were made in 1963 but at year-end they had not been developed to any appreciable degree. These finds include a well east of the Swan Hills field, Pan Am et al. B-1 Archie 2-34-65-8-W5 and a Mississippian Elkton oil discovery north of Calgary by Triad et al. Crossfield 8-11-27-2-W5. Just south of the Waterton gas field, a wet gas well, Shell 20 Waterton 5-23-3-1-W5, gave a particularly high output of condensate from the Devonian of over 1,800 barrels a day. A discovery of heavy Mississippian oil was made in southern Alberta by Supertest Altana McGregor 10-23-15-21-W4. Several pools of heavy and medium gravity oil in southern Alberta were developed to the extent that they were designated as fields. These include Taber South, Taber Southeast, Bantry South, Alderson, MacBeth, and Chin Coulee. Improved market outlook for these asphaltic crudes promoted more than the usual amount of drilling in eastern Alberta's heavy oil areas of Lloydminster, Cold Lake and Wabasca. A new pipelining technique, that of mixing crude with condensate, now makes it possible for some Lloydminster crude to reach Ontario markets. There remain problems of technology, however, in the production, transportation and refining of the abundant heavy-oil deposits situated between Lloydminster and the Athabasca bituminous sands.

Renewed expansion in the Swan Hills field, particularly on the eastern and northern perimeters, contributed appreciably to the increased development drilling in Alberta. The completion of 102 oil wells in the Swan Hills field raised the field total to 542. The separation between this field and the neighbouring Deer Mountain field, where 26 new oil wells were completed, has become negligible. The vast Pembina field continued to expand, with a net addition of 97 oil wells, despite the conversion of numerous wells to water injection. There were 3,057 oil wells and 966 water-injection wells in the Pembina field at year-end. The Sylvan Lake field was also one of the main development areas with the addition of 42 wells. Continuing abandonment of depleted wells in the the Joffre Viking pool reduced the number of wells by 40.

During 1963, full-scale waterflood recovery was initiated in the Beaverhill Lake reef fields of Swan Hills, Judy Creek and Virginia Hills, and similar programs are planned for the Kaybob, Deer Mountain and Carson Creek North fields. In each of these projects it is anticipated that total recovery will be increased from 15-17 per cent to 40 per cent. Water-injection projects were initiated in the Joarcam, Westward Ho and Sundre fields, and were enlarged in the Willesden Green, Pembina and Wainwright fields.

Saskatchewan

The trend of declining drilling was reversed sharply in 1963 and both exploratory and development drilling increased substantially. A total of some 3.2 million feet was drilled, 40 per cent more than in 1962. Thirty-one per cent of the footage drilled was exploratory. Although 42 of the exploratory wells were oil wells, none could be classed as a major discovery, and most were near established oil fields. A new area of production was opened up early in 1963 when a Mississippian discovery was made 25 miles northeast of the Midale field by Imperial BA Husky-Lost Horse Hills 9-4-10-8-W2. A small oil field, designated as Lost Horse Hills, was subsequently developed at the site. In June, a small but geologically significant oil discovery, Central Del Rio et al. Lake Alma 1-14-1-17-W2, was made in 10,000-foot deep Ordovician strata two miles from the United States boundary. No successful follow-up wells have been completed in the Lake Alma area.

Under the impetus of unprecedented demand for Saskatchewan crude, development drilling increased 42 per cent. The number of oil wells capable of production was increased by 367 to a total of 5,200. Main areas of development were the Dodsland, Weyburn, Pinto, Willmar, Workman and Lost Horse Hills fields. In the heavy oil area of Lloydminster, there was a marked increase in development drilling in the Aberfeldy and Lone Rock fields. A satisfactory secondary recovery method is being sought to increase recovery to the viscous heavy gravity crudes above the present five to ten per cent recovery factor. At Lloydminster a pilot waterflood is undergoing tests but other recovery techniques are also under serious study.

A water-injection secondary recovery project was started in the Weyburn field in the second half of 1963. This is the largest such project ever initiated in Saskatchewan, and it will more than double the field's recoverable reserves. A similar, although smaller, project was started in the neighbouring Midale field late in 1962.

British Columbia

Intense development of British Columbia oil fields in 1961 and 1962 to supply the new oil pipeline serving northeastern British Columbia resulted in a particularly large amount of drilling in those years. By the beginning of 1963, virtual completion of this accelerated phase of oil field development caused a sharp decrease in drilling. Only 898,720 feet of drilling was completed, a 42 per cent decrease from 1962. Whereas development drilling comprised 64 per cent of all drilling in 1962, it made up only 42 per cent in 1963. Thus there has been a return to the pre-1961 emphasis on exploratory drilling in this province. No significant oil discoveries were made in 1963 although important natural gas finds were made in the Fort Nelson region. During the year, the number of oil wells capable of production was increased by 33, 12 of which were in the Boundary Lake field 5 in the Blueberry field and 4 in the Wildmint field; other oil fields had only minor expansion. In the Beatton River field, a waterflood program was started and is being expanded to full-scale in 1964.

Manitoba

An aggregate footage of 142,563 feet was drilled, more than double the 1962 total. Forty-four wells were completed, 27 of them being oil wells. An oil discovery late in 1962 near Hartney provided some incentive for increased drilling in 1963, but no important oil discoveries were made. Despite the greater amount of drilling, the number of oil wells capable of production decreased from 852 to 839 because of unfavourably high water production from some older wells.

Yukon and Northwest Territories

Six wells, all exploratory, were completed during the year. The total footage of 62,643 feet represented a 19-per-cent increase. In September, two wells were started in the Arctic Islands. The well on Cornwallis Island, a comparatively shallow one, was abandoned in December after failing to find any significant amounts of oil or gas. Similarly, the deep well on adjacent Bathurst Island, completed in February 1964, was dry. In the southeastern corner of the Yukon Territory, the Pan Am et al. Kotaneelee A-1 exploratory well was suspended following failure to find any significant extension of the gas reservoir encountered in the prolific Beaver River discovery of 1961. Another well to test the same structure is in progress and has encountered some natural gas in the target horizon.

Eastern Canada

In Ontario, a total of 392,753 feet (excluding service wells) was drilled, and despite this nine-per-cent increase, there was a slight decrease in the number of wells completed. The average depth of well was 1,944 feet compared to 1,759 feet per well in 1962. The trend toward deeper drilling is largely the result of discovery of oil in recent years in formations of Cambrian age, such as the Gobles and Clearville fields, discovered in 1960 and 1962 respectively. Important oil discoveries in 1963 in Cambrian strata in the State of Ohio has provided further incentive for Cambrian exploration in Ontario.

In Quebec, 13 exploratory wells were drilled. Two of these wells, drilled on a gravity anomaly ten miles southwest of Trois Rivières, yielded significant quantities of natural gas from the Cambrian Potsdam sandstone but there is no indication that these will become commercial producers in the near future. Three exploratory wells were completed on Anticosti Island and despite minor showings of oil and gas, the wells have been abandoned. Three development wells were drilled in the shallow gas field in Pleistocene drift at Pointe du Lac near Trois Rivières.

In New Brunswick, the first drilling since 1960 was unsuccessful in finding oil or gas. One well, 3,500 feet deep, was completed, four miles south of the Stony Creek field. Waterflood secondary recovery was started in the Stony Creek field. Two oil companies acquired substantial off-shore acreage off the Nova Scotia coast near Sable Island and seismic surveying is planned for 1964.

TRANSPORTATION

At the end of 1963, approximately 10,607 miles of oil pipelines, predominantly crude oil lines, were in operation. Although nearly 1,100 miles of oil pipelines were laid in 1963, about 700 miles of this was not ready for operation until the first quarter of 1964. More than half of the 1963 pipeline construction was accounted for by one project, the 577-mile six-inch natural gas liquids pipeline from the Alberta-Saskatchewan boundary to Winnipeg. This line, undergoing tests in January 1964, is owned by Pacific Petroleums, Ltd. The line is parallel to the Trans-Canada gas pipeline and is the longest pipeline ever built in Canada solely for transporting natural gas liquids (NGL). The NGL – propane, butane and natural gasoline – are to be extracted from the Trans-Canada pipeline stream at a new gas reprocessing plant near Empress, Alberta.

In Manitoba, Interprovincial Pipe Line Company continued its looping program, adding four sections of 34-inch pipe totalling 41 miles. The company's wholly-owned subsidiary in the United States, Lakehead Pipe Line Company, Inc., added 126 miles of 34-inch loop between the Manitoba boundary and Superior, Wisconsin. Capacity increases were effected in four of the seven sections of the Interprovincial-Lakehead system, with the maximum-capacity section, between Cromer and Gretna, Manitoba, increased to 494,000 barrels a day. First deliveries of crude through the new lateral to Buffalo, New York, were made in May 1963. However, deliveries of Canadian crude to the United States by Interprovincial increased only three per cent. For the first time on a year-round basis, Interprovincial delivered North Dakota crude from the Portal pipeline at Clearbrook, Minnesota, to refineries in Minnesota and Wisconsin, and, in fact, 55 per cent of Interprovincial's increase in deliveries consisted of North Dakota crude.

In Alberta, Peace River Oil Pipe Line Co. Ltd. laid a 25-mile eight-inch line to the Snipe Lake field from the company's existing system south of Sturgeon Lake. Late in the year a six-inch extension of the new line was commenced from Snipe Lake to the Red Earth field, a distance of 120 miles. The extension, the most northerly crude oil pipeline in the province, was essentially complete by February 1964. Imperial Oil Limited completed a six-inch natural gas liquids pipeline, 116 miles long, from the Swan Hills casinghead gas plant to the gas conservation plant at Devon, south of Edmonton. Hudson's Bay Oil and Gas Company Limited laid a short NGL pipeline from the Lookout Butte gas cycling plant in southwestern Alberta to connect with the NGL pipeline to Montana. An important step towards much greater utilization of heavy asphaltic crude oil from the Lloydminster area was achieved in 1963 by the successful application of a new pipelining method that renders viscous Lloydminster crude amenable to pipeline transportation. The procedure employs the new 72-mile six-inch pipeline of Husky Pipeline Ltd. to move condensate from the Interprovincial pipeline at Hardisty northward to Lloydminster where the condensate is mixed with heavy asphaltic crude (77½% crude, 22½% condensate) and the blend is returned by the same pipeline to the Interprovincial system. In the Pembina area, Pembina Pipe Line Ltd. added 30 miles to its system, including a five-mile extension to serve the Cyn-Pem field. Federated Pipe Lines Ltd. extended its gathering facilities in the Swan Hills area because of continued growth of the Swan Hills and Deer Mountain fields and the Freeman pool.

TABLE 9

Mileage in Canada of Pipelines for Crude Oil, Natural Gas Liquids and Products

Year—end	Miles	Year—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

Source: Dominion Bureau of Statistics.

TABLE 10

Deliveries of Crude Oil

(millions of barrels)

Company	Destination	1962	1963
Interprovincial Pipe Line	Western Canada	32.7	32.2
	United States	39.0	41.8
	Superior (for tankers)	nil	nil
	Ontario	86.1	97.8
	Total	157.8	171.8
Trans Mountain Oil Pipe Line	British Columbia	26.2	23.6
	State of Washington	46.2	46.4
	Total	72.4	70.0

Source: Annual reports of Companies.

In Saskatchewan, Producers Pipelines Ltd. completed 14 miles of loops in the Steelman and Pinto fields and 76 miles of gathering lines, including 50 miles in the new areas of Lost Horse Hills, Fletewode, Storthoaks and South Hastings.

In British Columbia, there was no major pipeline construction. Deliveries by Trans Mountain Oil Pipe Line Company decreased slightly (Table 10) and deliveries by the company to the Kamloops refinery ceased. That refinery was supplied solely with British Columbia crude from the pipeline of Western Pacific Products & Crude Oil Pipelines Ltd. Deliveries by Western Pacific to Trans Mountain at Kamloops increased from 20,517 barrels a day in 1962 to 28,739 in 1963.

In Ontario, the flow of the Toronto to Brockville section of the Trans-Northern Pipe Line Company's petroleum products pipeline was reversed to a west-to-east direction in November 1963.

PETROLEUM REFINING

By the end of 1963, Canada's refining capacity, on a calendar day basis, slightly surpassed one million barrels a day. One new refinery was brought on stream, the 30,500 barrel-a-day plant of Shell Canada Limited at Oakville, Ontario. That company's refinery at St. Boniface, Manitoba, was increased in capacity by 3,000 barrels a day. The 3,290 barrel-a-day plant at Wainwright, Alberta, and the 3,500-barrel plant at Lloydminster, Alberta, were closed down. Three more small refineries closed during the first quarter of 1964: at Grande Prairie, Alberta; at Fort William, Ontario; and at Weldon, New Brunswick. The loss of refinery capacity due to the shutdown of these five small plants was approximately balanced by the start-up early in 1964, of Texaco Canada Limited's new 13,500 barrel-a-day refinery near Dartmouth, Nova Scotia. Husky Oil Canada Ltd. began modification of its Lloydminster refinery to allow the processing of heavy crude from the Wainwright field in order to free more of the heavier, asphaltic Lloydminster crude for eastern markets.

TABLE 11

Crude Oil Refining Capacity By Regions

	1962		1963	
	bbl/day	%	bbl/day	%
Atlantic Provinces	103,800	10.5	103,800	10.2
Quebec	304,500	30.8	305,000	29.9
Ontario	279,170	28.2	311,470	30.6
Prairies & Northwest Territories	203,200	20.6	201,130	19.7
British Columbia	97,800	9.9	97,300	9.6
Total	988,470	100.0	1,018,700	100.0

Source: Department of Mines and Technical Surveys, *Petroleum Refineries in Canada (Operators List 5)* January 1964.

At the end of 1963, Imperial Oil Enterprises Ltd. owned 33 per cent of Canada's operative refining capacity. Shell Canada Limited was the second-largest refiner with 18 per cent. Third and fourth largest refiners were The British American Oil Company Limited and Texaco Canada Limited, respectively controlling 16 and 11 per cent of the total refining capacity.

MARKETING AND TRADE

Receipts of crude oil at Canadian refineries totalled 332.7 million barrels in 1963, 23.8 million barrels or 7.7 per cent more than in 1962. Refinery receipts of domestic crude increased 7.2 per cent and the proportion of domestic crude used was about the same as in 1962 – 56 per cent of total crude. Refinery consumption decreased slightly in British Columbia but increased in all other provinces. The increase in refinery consumption was greatest in Ontario – 12.2 per cent, nearly all of which was Canadian crude.

TABLE 12

Crude Oil Received at Canadian Refineries, 1963

(barrels)

Location of Refineries	Country of Origin: Canada	Middle East	Trinidad	Venezuela	Total Received
Atlantic Provinces	8,058	13,350,741	–	22,285,788	35,644,587
Quebec	–	34,717,212	7,721,859	67,781,929	110,221,000
Ontario	94,943,838	–	–	729,435	95,673,273
Prairies Northwest Territories	64,763,865	–	–	–	64,763,865
British Columbia & Yukon	26,442,069	–	–	–	26,442,069
Total	186,157,830	48,067,953	7,721,859	90,797,152	332,744,794

Source: Dominion Bureau of Statistics, *Refined Petroleum Products* monthly reports 1963.
– Nil.

TABLE 13

Regional Consumption of Petroleum Products – Net Sales, 1963

('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	1,319	973	1,189	1,298	2,191
Maritimes	6,991	2,591	2,341	5,779	7,856
Quebec	25,646	6,131	6,281	22,501	23,836
Ontario	43,252	3,875	5,632	32,027	17,682
Manitoba	6,436	683	2,064	2,493	1,411
Saskatchewan	8,753	1,172	2,872	1,659	873
Alberta & Northwest Territories	12,076	393	4,720	1,149	479
British Columbia & Yukon Territory	10,652	1,980	4,459	4,228	6,296
Total	115,125	17,798	29,558	71,134	60,624

Source: Dominion Bureau of Statistics, *Refined Petroleum Products 1963.*

Refinery receipts of imported crude increased by 11.2 million barrels – 8.3 per cent – to 146.6 million barrels. Sixty-two per cent of the imported crude came from Venezuela and 33 per cent from the Middle East, mainly Iran, Saudi Arabia, Kuwait and Qatar. Refineries in Quebec and the Atlantic Provinces continued to use only imported crude, with the exception of a minor amount of crude from the small New Brunswick oil field.

Imports of petroleum products totalled 33.8 million barrels, an increase of 3.5 million barrels. The main sources of imported products were the Netherlands Antilles, Venezuela and the United States. Heavy fuel oil comprised 44 per cent of products imports. Argentina has become an important supplier of heavy fuel oil in the past two years, although the aforementioned nations remain the largest suppliers. Transfers of petroleum products derived from foreign crude into Ontario from Quebec and the Maritimes totalled approximately 28.5 million barrels or 9.2 per cent more than in 1962. In the fall of 1963, flow reversal was effected from Toronto to Brockville in the Trans-Northern products pipeline, concurrent with the opening of the new Shell Canada Limited refinery at Oakville. The availability of this new marketing territory to Canadian petroleum could result in as much as a 10-million-barrel-a-year increase in consumption of indigenous crude in 1964, and a corresponding "backing out" from Ontario of petroleum products manufactured from imported crudes.

TABLE 14

Imports of Refined Petroleum Products

(millions of barrels)

	1962	1963
Heavy fuel oil	13.50	14.74
Light fuel oil	5.62	6.55
Stove oil	2.20	2.16
Motor gasoline	0.79	2.12
Aviation gasoline	0.68	0.35
Diesel fuel	2.73	2.80
Lubricating oil	1.08	1.12
Petroleum coke	1.62	1.77

Source: Dominion Bureau of Statistics, *Refined Petroleum Products.*

Exports to the United States of crude oil and equivalent totalled 90.9 million barrels. Thus exports had virtually levelled off in 1963, in marked contrast to the sharp increases in 1961 and 1962. Therefore, the domestic market consumed most of the production increase of Canadian crude oil in 1963. Fifty-one per cent of crude-oil exports went to three refineries in the Puget Sound region of the west coast, and the remainder went to 17 refineries in northern United States

TABLE 15

Supply and Demand – All Oils
(barrels)

	1962	1963
Supply		
Production		
Crude oil (excluding condensate)	244,115,152	257,661,777
Natural gas liquids (including condensate)	24,204,769	29,795,815
Total, Canada	268,319,921	287,457,592
Total, Canada, barrels per day	735,123	787,555
Imports		
Crude oil	135,364,821	147,720,870
Refined–petroleum products	30,055,174	33,844,235
Total	165,419,995	181,565,105
Change in stock		
Crude oil	– 210,845	+ 192,516
Refined–petroleum products	+ 528,295	– 2,397,787
Net changes in stock	+ 317,450	– 2,205,271
Oils not accounted for	+ 3,783,505	– 3,551,914
Total Supply	437,840,871	463,265,512
Demand		
Exports		
Crude oil	91,580,232	90,875,816
Products	4,358,776	5,509,013
Total	95,939,008	96,384,829
Domestic sales		
Motor gasoline	108,392,668	115,124,229
Middle distillates	119,128,090	126,126,594
Heavy fuel oil	56,378,083	60,624,404
Other products	31,272,347	36,814,819
Total	315,171,188	338,690,046
Uses and losses		
Refinery	23,990,757	25,144,503
Field and pipeline	2,739,918	3,046,134
Total	26,730,675	28,190,637
Total demand	437,840,871	463,265,512

Source: Dominion Bureau of Statistics and provincial government reports.

between western Montana and Buffalo, New York. Exports of petroleum products, all to the United States, consisting largely of heavy and light fuel oil, butane and motor gasoline, increased 26 per cent to 5.5 million barrels.

Phosphate

J.E. Reeves*

Canada has not produced any phosphatic raw material in many years but continues to consume increasing amounts. In 1963, imports were recorded at nearly 1.3 million short tons, worth a little more than $12 million, an increase of more than 11 per cent.

Phosphate rock for use in the manufacture of phosphate fertilizers and phosphorus, valued at about $7 to $8 a short ton, made up about 95 per cent of these imports. Montana and Florida were the main sources, the former supplying the larger proportion. Much of the remainder was much higher priced, low-fluorine materials (defluorinated phosphate rock and dicalcium phosphate) from the United States, Belgium and Japan. Imports from the Netherlands Antilles were naturally low-fluorine phosphate rock from the island of Curacao.

Canada imports much more phosphate rock than is necessary to meet domestic requirements for phosphate fertilizers and phosphorous chemicals. The result is the export of large quantities of phosphatic products—particularly ammonium phosphate from western Canada and triple superphosphate from eastern Canada.

DEVELOPMENTS

The last 18 months have been marked by considerable new activity. The Consolidated Mining and Smelting Company of Canada Limited is in the forefront with several phases of expansion. Coupled with the 83,000 ton-a-year extension of its ammonium phosphate facilities at Kimberley, British Columbia, which was begun in 1962, was the underground development of the Douglas Mine and the construction of a flotation concentrator with a capacity of 300,000 tons a year of beneficiated phosphate rock, near Phillipsburg, Montana. The Kimberley extension was partly in operation before the end of 1963 and was officially opened in March 1964. The Douglas Mine was scheduled to begin operating in the spring of 1964.

* Mineral Processing Division, Mines Branch

In addition, the company announced plans for construction of an 83,000 ton-a-year ammonium phosphate plant at Regina, Saskatchewan, its first such plant outside of British Columbia. To provide this plant with phosphoric acid, a further expansion will take place at Kimberley, where a plant with a capacity of 75,000 tons a year of 54 per cent phosphoric acid will be added. The Regina plant and the additional Kimberley plant will be in production in 1965. Total cost of all these phases of expansion will exceed $25 million.

Electric Reduction Company of Canada, Ltd. stated in early 1964 that it will expand its complex at Port Maitland, Ontario, by building a plant for granulating triple superphosphate.

In the latter half of 1963, Dow Chemical of Canada, Limited announced plans for the construction of a pilot plant at Sarnia, Ontario, for the production of phosphoric acid, using hydrochloric rather than sulphuric acid to react with phosphate rock. Construction is scheduled to start in 1964 and be complete in 1965.

An ammonium phosphate plant with a capacity of 65,000 tons of product a year is planned for production in 1964 at Transcona, Manitoba. It is being built by Border Fertilizer Limited, an affiliate of Border Chemical Limited, which operates a sulphuric acid plant at Transcona.

Early in 1964, Sherritt Gordon Mines, Limited stated that it will build a plant for the production of 120,000 tons a year of ammonium phosphate, at Fort Saskatchewan, Alberta. The plant is scheduled to commence production in late 1965.

Announcements in late 1963 and early 1964 indicate the possibility of the first production of phosphate in Canada in recent time. Multi-Minerals Limited will build a small plant in southern Ontario for the production of phosphoric acid using apatite from its property near Nemegos, in northern Ontario. The process is a new one capable of yielding a high-purity, wet-process acid.

In mid-1963, an agreement was reached between Minerales Industriales del Peru, S.A., a subsidiary of Midepsa Industries Limited of Montreal, and Texada Mines Ltd. for the development of the vast phosphate deposits in the Sechura desert of Peru. A new company, Minera Bayovar, S.A., 60 per cent owned by Texada, was formed to carry out the development.

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 1890's. 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 southeastern Ontario. Typically the deposits also contain phlogopite mica and pink calcite and are found in association with pyroxenite.

TABLE 1
Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Imports				
Phosphate rock[1]				
United States	1,134,905	10,336,232	1,266,043	11,432,139
Morocco	13,230	164,712	22,815	320,349
Netherlands Antilles	3,819	121,825	4,290	206,183
Belgium and Luxembourg	3,351	169,120	3,397	177,544
Japan	661	50,620	882	67,513
Total	1,155,966	10,842,509	1,297,427	12,203,728
Phosphate fertilizers				
Triple superphosphate				
United States	55,494	2,768,599	41,946	2,068,325
Superphosphate, not otherwise provided for				
United States	104,084	1,954,852	83,938	1,596,744
Venezuela	5,724	71,589	nil	nil
Total	109,808	2,026,441	83,938	1,596,744
Phosphate fertilizer, not otherwise provided for				
United States	21,540	1,843,805	37,017	3,288,770
Total, phosphate fertilizers	186,842	6,638,845	162,901	6,953,839
Phosphoric acid and phosphorous compounds	7,965	1,774,775	28,523	2,640,186

	1961	1962
Consumption of phosphate rock (available data)		
Fertilizers[2]	826,192	957,195
Chemicals[3]	150,447	159,412
Total	976,639	1,116,607

Source: Dominion Bureau of Statistics.
[1]Includes some defluorinated phosphate rock and dicalcium phosphate for use as animal-feed supplements. [2]Includes small amount used for animal-feed supplements. [3]Includes small amount used in production of pig iron.

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 by-product of the niobium-mineral production.

TABLE 2

Phosphate Rock – Imports and Consumption, 1954–63

(short tons)

	Imports	Consumption
1954	644,860	628,061
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

Source: Dominion Bureau of Statistics.

Some of the ilmenite-magnetite deposits associated with anorthosite in eastern Quebec contain sufficient apatite to make them potential sources of byproduct 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 production of phosphate was apparently little changed from the more than 53.1 (revised) million short tons produced in 1962. As shown in Table 3, the United States is the largest producer, although it apparently marketed slightly less in

TABLE 3

World Production of Phosphate, 1963

('000 short tons)

United States	22,215
U.S.S.R.	12,230[e]
Morocco	9,423
Tunisia	2,610
Nauru Island	1,733
North Viet Nam	885[e]
China	784[e]
Christmas Island (Indian Ocean)	729
Egypt	674
Senegal	656
Togo	647
Other countries	3,862
Total	56,448

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

1963 than in 1962. Most producing countries supply sedimentary phosphate rock, which constitutes more than 85 per cent of total production. The U.S.S.R., North Viet Nam and Brazil also produce apatite concentrate, which makes up most of the other 15 per cent. India and Chile produce small quantities of apatite. Peru and Chile recover guano as a source of phosphate—about 236,000 short tons in 1963. The Netherlands Antiles markets a naturally low-fluorine phosphate rock for use as an additive to stock and poultry feeds.

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 available to 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.

Monoammonium and diammonium phosphate are manufactured by reacting ammonia with phosphoric acid, and provide relatively high contents of nitrogen and phosphorus. In Canada, wet-process acid, produced by acidulating phosphate rock with sulphuric acid, is used.

Much attention is being paid to the improvement of processing methods and products, and the development of new fertilizers, a wider choice of fertilizers and fertilizers with a higher content of plant food.

Almost all phosphate rock contains about three to four 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

A large part of the phosphate rock used in Canada goes into the manufacture of fertilizers (a minor amount is fine-ground and applied directly to the soil).

Smaller amounts 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 fertilizers, phosphate rock should contain about 74 to 75 per cent B.P.L. For electric-furnace use, a lower B.P.L. content is acceptable, but the rock must have no excess calcium and a maximum of three per cent Fe_2O_3 plus Al_2O_3, and be mostly coarser than five mesh.

PRICES

According to *Oil Paint and Drug Reporter* of December 30, 1963, the following prices apply:

Phosphate rock, Florida land pebble, run of mine, washed, dried, unground, bulk carload, f.o.b. mines, per short ton

66 to 68% B.P.L.	$5.38
68 " 70" "	$6.24
70 " 72" "	$6.82
74 " 75" "	$7.72
76 " 77" "	$8.61

Phosphate rock, Curacao, bulk, f.o.b. Atlantic and Gulf ports, per ton $46.75

Defluorinated phosphate, feed grade, various U.S. sources, 14 to 19% P, $52.00 to $70.35 per ton.

Phosphate rock enters Canada duty free.

Platinum Metals

C.C. Allen*

Canadian production of the platinum metals in 1963 amounted to 357,649 ounces valued at $22.6 million. This is a reduction from the previous year and resulted from decreased 1963 nickel production in association with which platinum metals are recovered as a byproduct. World markets for platinum metals were fairly strong. The metals consist of platinum, palladium, rhodium, ruthenium, iridium and osmium. All except osmium are produced in Canada.

Platinum metals are used widely in industry, and consumption responded to higher industrial output. In spite of this, prices weakened in April when platinum was cut from $80–$85 a fine ounce to $77–$80 and palladium from $24–$26 an ounce to $22–$24. The reductions resulted chiefly from a previous lowering of the Russian price and were the first changes since 1960 when there had been a price advance. Prices recovered later in the year with platinum increasing on August 8 to $79–$82 an ounce and on November 6 to $82–$85 and palladium increasing on August 7 to $24–$26 an ounce.

The price increases for platinum metals were the result of lower Russian offerings and tighter supply which gave rise to speculation of lower Russian output and the possibility of a further increase in the platinum price. Later offerings by Russia were both small and intermittent leaving the filling of demand basically to Johnson Matthey and Company, Limited and Engelhard Industries, Inc. Johnson Matthey markets platinum metals mainly of South African origin; Engelhard, those of Canadian origin. The expansion of Russian chemical and fertilizer industries and decreased platinum output from Ural placer deposits may account for the markedly lower Russian sales to the Free World.

*Mineral Resources Division

TABLE 1

Platinum Metals – Production and Trade

	1962		1963	
	Troy Ounces	$	Troy Ounces	$
Production				
Platinum, palladium, rhodium, ruthenium, iridium	470,787	28,848,637	357,649	22,585,055
Exports				
Domestic origin				
Platinum metals in ores and concentrates				
Britain	517,737	21,676,156	479,838	20,536,696
Norway	16,540	805,474	19,444	937,395
United States	8,708	227,008	7,500	133,856
Total	542,985	22,708,638	506,782	21,607,947
Platinum metals				
Japan	1,926	182,832	31,499	2,159,037
United States	24,248	1,246,091	9,424	638,854
Britain	2,013	195,392	1,137	108,805
Cuba	–	–	729	34,150
Jamaica	75	7,222	56	7,023
Total	28,262	1,631,537	42,845	2,947,869
Foreign Origin*				
Platinum metals refined and semiprocessed	390,018	8,644,781	386,941	10,144,484
Imports				
Platinum metals, semiprocessed and manufactured				
Britain**		12,456,562		13,093,491
United States		468,904		497,084
Total		12,925,466		13,590,575
Platinum crucibles				
United States		1,890,880		1,731,558
Britain		87,514		34,874
Total		1,978,394		1,766,432
Catalysts for refining petroleum				
United States		1,889,170		2,693,309
Britain		12,385		62,212
West Germany		–		8,983
Total		1,901,555		2,764,504

Source: Dominion Bureau of Statistics
*Exports from Canada to the United States of platinum metals in a refined or semiprocessed state. Re-exports of imports from Britain (see following note). **Derived from Canadian concentrates refined and processed in Britain.
– Nil

TABLE 2

World Production

(troy ounces)

	1963
Canada	357,649
U.S.S.R.	800,000e
Republic of South Africa	305,500e
United States	49,750
Colombia	28,592
Other countries	1,509
Total	1,543,000

Sources: U.S. Bureau of Mines, *Minerals Yearbook 1963;* for Canada, Dominion Bureau of Statistics.
e Estimate

TABLE 3

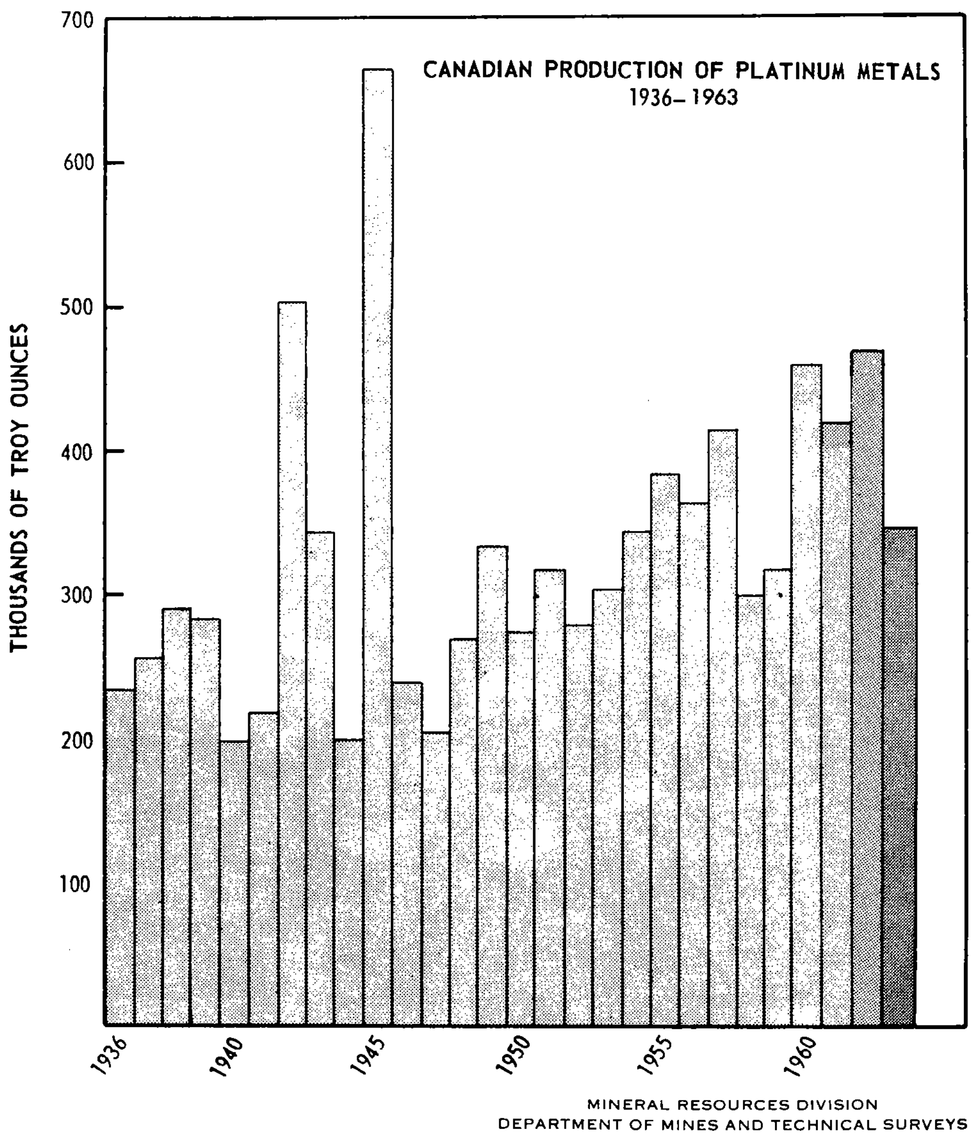
Platinum Metals – Production and Trade, 1954–63

	Production[1]			Exports			Imports[4]
	Platinum (troy oz.)	Other Platinum Metals (troy oz.)	Total (troy oz.)	Domestic[2] ($)	Foreign[3] ($)	Total ($)	($)
1954	154,356	189,350	343,706	16,693,716	10,936,039	27,629,755	17,784,372
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	na	na	483,604	16,068,728	8,404,563	24,473,291	12,951,420
1961	na	na	418,278	26,331,101	9,820,374	36,151,475	11,242,328
1962	na	na	470,787	24,340,175	8,644,781	32,984,956	12,925,466
1963	na	na	357,649	24,555,816	10,144,484	34,700,300	13,590,575

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 for treatment.
na Not available for publication.

During 1963, Canada, the Republic of South Africa and the U.S.S.R. continued to supply the bulk of the world's production of the platinum metals. Estimated world production in 1963 was 1.5 million troy ounces of which Canadian production was 358,000 ounces and that of the Republic of South Africa and the U.S.S.R. respectively 306,000 and 800,000 ounces. The latter figures are estimates as neither country releases production data.

Because of the strong market demand for the platinum metals, Rustenburg Platinum Mines, Limited is undertaking a 25 per cent expansion of production capacity, the first half of which is to be completed early in 1965 and the remainder by the year-end. A second expansion plan in South Africa is that of the Central Mining-Rand Mines group and Anglo American Corporation of South Africa, Limited; and General Mining and Finance Corporation Limited is to open up the Brakspruit property, adjacent to Rustenburg platinum. Among the preliminary considerations are the possibilities of mining through the Rustenburg mine of Rustenburg Platinum and of having Engelhard Industries rather than Johnson Matthey do the refining and marketing.



PRODUCTION

Platinum metals occur in Canadian nickel ores to the extent of about 0.025 ounce per ton of ore. In the treatment of these ores for nickel, the platinum metals follow nickel and are eventually removed as sludges from the electrolytic tanks in which nickel cathodes have been formed.

All of Canada's platinum metals production results from the treatment of nickel ores of the Sudbury district of Ontario and those of Thompson, Manitoba. In the Sudbury area, The International Nickel Company of Canada, Limited and Falconbridge Nickel Mines, Limited each operate nickel smelters. Nickel ore for International Nickel's smelters comes from its five underground mines – Creighton, Frood-Stobie, Garson, Levack and Murray; and the Clarabelle open pit. Proven ore reserves of International Nickel at Sudbury and Thompson, Manitoba totalled 302 million short tons containing 9.1 million tons of nickel and copper. Total ore production during the year amounted to 13.6 million short tons. Platinum group metals and gold deliveries during the year amounted to 439,000 troy ounces compared to 411,000 ounces during 1962.

Falconbridge operated the Falconbridge, East, Fecunis, Hardy and Onaping mines. Its year-end ore reserves in the Sudbury district totalled 51.3 million tons averaging 1.42 per cent nickel and 0.79 per cent copper. Nickel-copper concentrates were also supplied in 1963 to International Nickel by Nickel Mining & Smelting Corporation's Gordon Lake mine and to Falconbridge by Marbridge Mines Limited, La Motte township, Quebec.

A potential producer in 1964 is Lorraine Mining Company Limited, Belleterre area, Quebec. Production plans include construction of a 400-ton-a-day mill for the treatment of nickel-copper ores.

Platinum metal concentrates from International Nickel's Copper Cliff plant are sent to the refinery of The International Nickel Company (Mond) Limited, at Acton, England. The platinum metals in Falconbridge ore are in matte shipped to the refinery at Kristiansand, Norway. The latter platinum-metal slimes from the electrolytic cells are refined by Engelhard Industries at Newark, New Jersey. Engelhard markets platinum metals for both companies.

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 in the fiberglass industries. Platinum metals are used in dental alloys and in jewellery where their ease of working, strength and hardness are valuable properties.

Engelhard Industries, Inc. plans the construction at Newark, N.J., of two new buildings costing in excess of $1 million. One will provide additional space for refining and research by the precious metals refining division; the other will be used for manufacturing, research and general office use by Engelhard's Hanovia Liquid Gold Division. The high catalytic activity of some platinum group metals, together with their anticorrosive properties, have led to the application of these metals in fuel cells. Among the newer developments in this field is an undertaking by Engelhard to supply a precious metal reformer for the Allis-Chalmers fuel cell. The cell is designed to produce 28 volts of direct current through the chemical action of hydrogen and oxygen.

PRICES

E & M J Metal and Mineral Markets of December 30, 1963, gives the United States prices of platinum metals per troy ounce as follows:

Platinum	$ 82 to $ 85
Palladium	24 to 26
Osmium	60 to 70
Iridium	70 to 75
Rhodium	137 to 140
Ruthenium	55 to 60

TARIFFS

Canada	British Preferential	Most Favored 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

TARIFFS – Concluded

	British Preferential	Most Favored Nation	General
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 colors . .	free	10%	10%

United States

Platinum (including gold or silver plated platinum but not rolled platinum) unwrought or semi-manufactured

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

Semi-manufactured

Bars, plates, and sheets, all the foregoing not under 0.125 inch in thickness wholly of metals of the platinum group separately, wholly, of native combinations of metals of the platinum group, or wholly of artificial combinations thereof containing by weight not less than 90 per cent of the metal platinum – free

Other, including alloys of platinum – 40%

Potash

C.M. Bartley*

In September 1963 the first full year of potash production was completed in Canada and by December 31 more than one million tons of muriate of potash had been produced. International Minerals & Chemical Corporation (Canada) Limited (IMC), the single producer in Canada during 1963, reached the capacity of its Esterhazy, Sask., facilities and announced plans for expansion of the present plant and the start of a new shaft to triple productive capacity by 1968. Two other companies, Potash Company of America and Kalium Chemicals Limited, were completing facilities at year-end and planned to start potash production during 1964.

These and other companies in earlier stages of development are expected to raise Canada's potash productive capacity from about ten per cent of the world total in 1964 to 15 per cent by 1966 and to 20 per cent or more by 1970.

In spite of development problems requiring heavy capital investment and several years of difficult construction, the vast bodies of high-quality potash available in Saskatchewan have attracted aggressive companies. Large-scale production from modern facilities operating at low unit cost will inevitably make Canada a major factor in world potash production and trade.

PRODUCTION AND TRADE

The IMC mine and refinery was brought to production in August 1962. By the end of 1963 more than 50 miles of underground workings had been opened and more than two million tons of ore had been mined. In 1963 more than one million tons of potash product valued at $22.5 million were produced.

*Mineral Processing Division, Mines Branch

TABLE 1
Potash – Production and Imports

	1962		1963	
	Short Tons	$	Short Tons	$
Production, K_2O content	na	3,000,000r	na	22,500,000
Imports				
Potash fertilizers				
Muriate of potash				
United States	88,295	2,455,578	37,572	1,002,474
France	22,080	709,648	14,009	388,623
U.S.S.R.	12,589	426,565	12,899	404,734
West Germany	25,009	775,568	9,593	300,588
Total	147,973	4,367,359	74,073	2,096,419
Sulphate of potash				
United States	15,130	623,208	13,808	567,396
France	8,341	312,296	5,106	190,893
West Germany	510	21,682	nil	nil
Total	23,981	957,186	18,914	758,289
Sulphate of potash magnesia				
United States	4,967	87,232	4,748	83,332
West Germany	775	22,681	nil	nil
Total	5,742	109,913	4,748	83,332
Total, potash fertilizers	177,696	5,434,458	97,735	2,938,040
Potash chemicals and compounds	9,262	2,031,767	8,304	1,985,359

Source: Dominion Bureau of Statistics.
Symbols: na Not available; r Revised from previously published figure.

Shipments were exported to the United States, Japan, Britain, Brazil and other overseas countries. Because only one company is in production detailed sales figures were not released, but it is estimated that 85 per cent of production is exported, mainly to the United States.

Imports of potash for fertilizer declined 80,000 tons to 98,000 tons in 1963. In 1962 consumption of potash in Canada, mainly as fertilizers, increased some 20,000 tons to reach a new high of 160,000 tons.

TABLE 2
Potash Consumption
(short tons)

	1961	1962
Muriate of potash		
Fertilizers and chemicals	135,606	158,608
Other	243	947
Total	135,849	159,555

TABLE 3
World Potash Production and Consumption, 1961–62

	Output %	Consumption %
Europe	61.2	53.8
U.S.S.R.	11.0	8.2
North and Central America	26.6	25.9
South America	0.2	1.4
Asia	1.0	8.2
Africa	nil	1.2
Oceania	nil	1.4
	100.0	100.0

Source: *Fertilizer 1962,* United Nations, F.A.O.

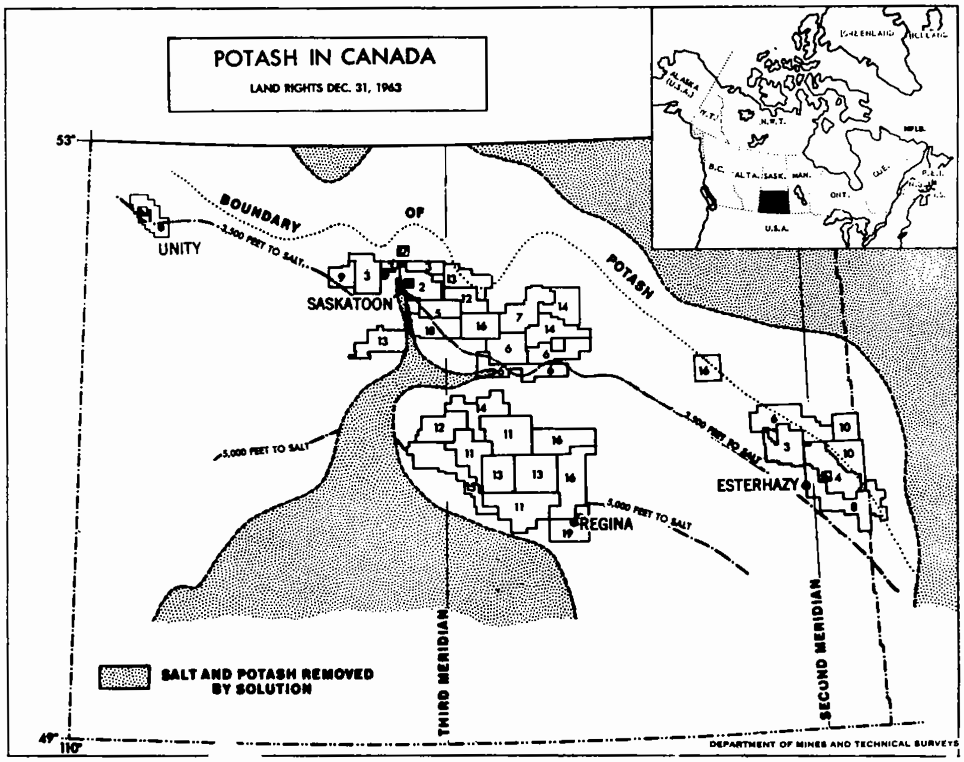
POTASH MINERALS AND THEIR SOURCES

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.

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	$KCl.MgCl_2.6H_2O$	17.0	14
Langbeinite	$K_2SO_4 2MgSO_4$	22.0	19
Kainite	$KCl.MgSO_4 3H_2O$	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.



Companies holding Potash Land Rights, December 31, 1963*

1. Continental Potash Corporation Limited, 1951
2. Potash Company of America, 1952 P.C.A.
3. Duval Corporation, 1954
4. International Minerals & Chemical Corporation (Canada) Limited, 1955 I.M.C.
5. United States Borax & Chemical Corporation, 1955 U.S.B.C.
6. Southwest Potash Corporation, 1956
7. Alwinsal Potash of Canada Limited, 1958
8. Tombill Mines Limited, 1957
9. National Potash Company, 1957
10. Canberra Oil Company Ltd., 1959
11. Kalium Chemicals Limited, 1960 K.C.L.
12. Consolidated Morrison Explorations Limited, 1960
13. Imperial Oil Limited, 1961
14. Kerr-McGee Oil Industries, Inc., 1961
15. Domtar Chemicals Limited, Sifto Salt Division, 1961
16. Shell Canada Limited, 1962
17. Great Plains Development Company of Canada, Ltd., 1963
18. Placid Oil Company, 1963
19. Scurry-Rainbow Oil Limited, 1963

* This map shows the location of potash rights held in Saskatchewan by various companies. The approximate date of the first acquisition of land rights is given although company names and property locations may have changed since that time.

Potash is recovered from 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 and by Midepsa Industries Limited, a Canadian company, from brine occurrences in Peru.

SASKATCHEWAN DEPOSITS

In Saskatchewan, potash was first noted in the early 1940's in cores from oil-well drilling. Additional 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 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,

TABLE 4

Summary of Potash Projects in Saskatchewan

Company and Location	Approx. Capital Cost ($ million)	Date	Type of Mining	Present Status
Western Potash Corporation Limited (WPC), Unity	na	1951	Solution	Test abondoned
WPC (name changed 1955 to Continental Potash Corporation Limited) Unity	3	1953	Shaft	Shaft 1,800 ft. inactive
Potash Company of America, Saskatoon	30	1952	Shaft	Shaft and mill rehabilitated, production 1964.
International Minerals & Chemicals, Esterhazy	40	1957	Shaft	Production Aug. 1962
Gerald	10	1963	No. 2 Shaft	Construction 1964, production 1968.
Kalium Chemicals Limited, Moose Jaw	40	1960	Solution	Construction 1963, production 1964.
Duval Corporation, Saskatoon	1	1962	Solution	Test 1962 and 1963
Imperial Oil Limited, Findlater	1	1962	Solution	Test 1962 and 1963
Alwinsal Potash of Canada Limited, Lanigan	50	1963	Shaft	Construction 1964, production 1968.
Southwest Potash Corporation, Boulder Lake	1	1963	Solution	Test 1963

na Not available

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 ACTIVITY

Starting in 1951 five companies have made six attempts to produce potash by shaft or solution mining. One plant is in full-scale operation and the company will start sinking a second shaft in 1964. Two other plants will be in operation before the end of 1964. Several other companies are actively studying the potash situation and making plans to start construction. These projects together with the drilling of some 200 potash holes and technical and marketing studies, have resulted in the expenditure of more than $200 million to the end of 1963. The accompanying map shows the location of potash property holdings; they total 3,499,352 acres at the end of 1963. Table 4 summarizes potash development projects in Saskatchewan.

International Minerals & Chemical Corporation (Canada) Limited – The mine and refinery reached capacity rate of operation in 1963 and it was announced that additional equipment would be installed early in 1964 to bring output to 1.2 million tons of product a year. A second shaft, near Gerald some six miles southeast of the Yarbo plant, will be started early in 1964. The Gerald shaft will be similar to the first but will have a capacity equivalent to 2.5 million tons of end product, bringing total capacity to four million tons when both shafts and additional refining facilities are in operation.

Potash Company of America – During 1963 the plant near Saskatoon was being re-equipped and restaffed for commercial operation late in 1964. A new friction hoist and new milling equipment will be installed. Capacity of the plant is 600,000 tons of muriate of potash (360,000 K_2O) per year. This orebody has a mining thickness of about 12 feet and has been estimated to grade about 27 per cent K_2O. In the United States the company is a merchant producer of potash and does not manufacture fertilizer.

Kalium Chemicals Limited – This company, owned jointly by Armour and Company and Pittsburg Plate Glass Company, holds potash rights near Belle Plaine 25 miles west of Regina. After Several years of investigation and two years of pilot-plant operation the company early in 1963 announced the immediate commencement of construction of a $50-million solution-mining plant. Capacity has been estimated at 600,000 tons of product a year and production is expected to begin late in 1964.

Water or brine will be injected into the potash zone through holes drilled from the surface and, after dissolving potash and salt from the bed, will be pumped to surface. Evaporation and crystallization in the plant will separate the salt and potash from the solution which, after temperature and salinity adjustment, will again be recirculated through the underground deposit. Potash crystallized from the solution must be dried before storage and shipment.

Alwinsal Potash of Canada Limited—A 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 shaft would be started in early 1964 and that a refinery would be built for production by 1968. Total cost has been estimated at about $50 million and capacity at one million tons of product annually.

Continental Potash Corporation Limited, located near Unity in the western part of Saskatchewan has sunk a shaft partway through the Blairmore formation. In 1961 the shaft was flooded by a break-through of Blairmore sand and water. The shaft was repaired in 1962 and the company is negotiating for finances to complete the project.

Other Companies — Many other companies hold potash rights in Saskatchewan and are engaged in exploration and development work. United States Borax & Chemical Corporation has tested the potash deposit on its property southeast of Saskatoon and at the end of 1963 was considering plans for bringing it to production by shaft mining. Tombill Mines Limited, with a property straddling the Saskatchewan-Manitoba boundary, south of Esterhazy, was negotiating with various companies to obtain financial assistance in bringing a shaft mine project to production. Consolidated Morrison Explorations Limited, with potash holdings both east and south of Saskatoon, was considering methods of financing a shaft operation.

During 1963, solution-mining tests were being conducted by three companies, in addition to Kalium Chemicals Limited. Duval Corporation has a test plant on its property just west of Saskatoon. Since September 1962, tests have been conducted, under various operating conditions, to obtain information needed for an appraisal of the feasibility and economics of solution mining.

Imperial Oil Limited operated a solution-mining test-project at Findlater, 50 miles north of Regina, throughout 1963. An intensive program was carried out to test the practicability of solution mining.

Southwest Potash Corporation, after preliminary tests in 1962, built a solution-mining test-plant southeast of Waterous and started a comprehensive series of tests to establish operating techniques for the solution mining of potash.

Sifto Salt Division of Domtar Chemicals Limited has potash holdings northwest of Moose Jaw. A research program oriented toward solution mining was carried on during 1963 at the Senneville, Quebec, research centre.

OUTLOOK

Because of the small size of the domestic market, in contrast with other producing countries, the development of the Canadian potash industry depends on its ability to export in competition with other sources throughout the world.

The vast reserves of high-grade material in Saskatchewan make this area an attractive source of potash despite the high development cost. In attempting, therefore, to assess the position of Canada in the world potash industry, consideration must be given to the volume and quality of Canadian potash, the cost of production, transportation and marketing, and also the rate at which world-wide potash demand is increasing. The last factor, future potash demand, is of critical importance to those companies now considering the development of new potash projects,especially those in western Canada.

It is widely acknowledged that the reserves in western Canada, with their high-quality potash, are the most attractive of all known world deposits, and it is probable that modern plants based on these deposits will have unit costs lower than any in the world. These factors explain the aggressive development in Saskatchewan. In addition, Canadian potash will have some competitive advantage in the large nearby market south of the Great Lakes, and in the expanding markets in Japan and other Pacific basin countries. Other markets in the United States and throughout the world appear to be attainable in spite of more serious competition from established producers.

Because of the landlocked location of Canadian potash, high freight costs are unavoidable and are generally open to only minor reductions.However, as production increases in western Canada, significant savings may be possible by the adoption of bulk or train-load rates for large export quantities. Such rates have been applied to other commodities under similar conditions. The possible movement of potash and other western Canadian bulk commodities by specialized pipelines has been studied and may offer substantial freight cost reduction when assured markets are sufficient to justify the cost of pipelines.

Potash consumption increased during 1963 and although producers throughout the world expanded production, they had to draw on stocks to satisfy consumer demands. Three inquiries to the United States from eastern European countries for potash early in 1964 found no supplies available for export. Israel is reported to have contracted both 1964 and 1965 production. In mid-1963 it appeared that construction of new potash productive capacity would fully satisfy demand in the near future; at the end of 1963 it was apparent that there was no surplus of potash and, in fact, that shortages might appear before some of the new projects reached production. The current surge in potash consumption can be identified as demand in North America, western Europe and other traditional markets. The possibility of new markets in Communist Bloc countries suggested by crop deficiencies and massive grain purchases should not be ignored.

The present near balance in potash demand and supply and indications of increasing future demand have encouraged efforts to bring new mines to production in western Canada. The cost and physical problems of these projects can now be estimated with some confidence and the number, size and timing of new projects appears now to depend on accurate assessment of the rate at which potash demand will increase. During 1963 several companies were conducting such studies as a basis for decision on major potash projects in western Canada.

Since the start of construction of the Kalium Chemicals Limited solution mining plant in early 1963 there has been much discussion of the relative merits of this method compared to shaft mining for potash. Generally, companies familiar with shaft mining doubt that solution mining can compete economically with their large high-grade mines. Advocates of solution mining state that, where favorable conditions such as substantial thicknesses of good grade ore are available together with plentiful supplies of energy for evaporation and crystallization, solution mined potash will be fully competitive with shaft mining. The unusual size and quality of the Saskatchewan deposits and the fact that several years were spent in developing a solution-mining method specifically for these deposits may explain why the present attempt at producing potash by this method appears to have more chance of success. It has been suggested that, since the character of the deposits and the use of a specifically designed process alone permits successful operation, the solution mining of potash deposits elsewhere in the world may not be economically attractive. Successful solution mining would enormously increase the reserves of potash in western Canada both by recovering material below the reach of shaft mines and by recovering the potash from a much thicker zone.

The world-wide demand for fertilizers is considered promising. Expected strong growth in potash demand will be of particular benefit to Canada as new projects in Saskatchewan are brought to production. The industrialized nations of the world, particularly in western Europe and North America, have clearly demonstrated that mechanized farming, using modern methods of irrigation, cultivation and fertilization, can produce vast quantities of high-quality food. With some technical and financial assistance there is little doubt that food supplies could be increased substantially in the less-developed countries.

WORLD REVIEW

Although world attention was focussed mainly on potash developments in Saskatchewan in 1963, expansion of capacity and exploration of new sources of supply was taking place throughout the world. In spite of production at near-capacity rates in Europe and North America, surpluses have not accumulated and the appreciable rise in demand has set new consumption peaks. Deliveries in North America are reported to be 11 per cent higher than in 1962 and world consumption has been estimated to be five or six per cent greater. Crop failures in Communist Bloc countries have probably had both direct and indirect effects by consuming food surpluses in western countries, thereby increasing the domestic market for fertilizer, and by the reduction of potash exports from Communist Bloc countries because of domestic needs, thereby enlarging the world market for potash.

In the United States potash-capacity expansion was in hand in the Carlsbad, New Mexico, area by Kermac Potash Company, Duval Corporation and National Potash Company. Texas Gulf Sulphur Company expects to start production at its

Moab, Utah, potash property in mid-1964. Operation at this plant was delayed by an underground gas explosion in the fall of 1963. Other companies have potash rights in the Moab area. Bonneville Ltd. expanded capacity and investigations were in progress on bedded potash occurrences in Arizona and on the possible recovery of potash from geothermal saline wells in California. Productive capacity in the United States is estimated at 2.72 million metric tons K_2O (three million short tons) and current expansion will increase this to about four million tons.

Western Europe

The potash industries in western Europe operated at high rates during 1963 and some expansion took place. West Germany and France set production records and inventories were reduced to meet domestic and export demands. Production increased in Italy and capacity expansions were underway at three of the five producers in Spain. Western European potash productive capacity is estimated at 4.2 million metric tons K_2O (4.13 short tons).

Armour Chemical Industries Limited, the United States controlled company investigating the deep Yorkshire, England, deposits for a possible solution mining operation, obtained land options in the area but no announcement regarding development had been made at year-end.

Large amounts of potash-bearing shales found in northern Scotland are under investigation as possible source of potash fertilizer for local and nearby markets.

Communist Bloc

Potash is produced in the U.S.S.R. and East Germany. Capacities are estimated to be 1.65 million metric tons (1.62 short tons) in East Germany and 1.4 million metric tons (1.38 short tons) in U.S.S.R. Expansion of East German production to two million metric tons a year by 1965 is planned and even larger expansions are believed to be underway in the U.S.S.R. to serve both domestic requirements and commitments to Poland and other Communist countries.

In the past, East Germany has been a major exporter of potash but recently the amounts sent to western countries have been reduced. It has been suggested that East German potash may now serve the needs of the Communist Bloc while potash exports from the U.S.S.R. will be used to purchase equipment for the expansion of domestic production. U.S.S.R. and other Communistic inquiries regarding potash supplies from western countries have been reported recently. The discovery of a new rich potash deposit in Uzbekistan, U.S.S.R., has been announced.

Potash production in Poland is apparently low and an agreement has been made to obtain supplies from U.S.S.R. in return for mining equipment.

Asia

At present potash production in Asia is confined to Israel and a small output from India. Israeli operations are based on evaporation of Dead Sea brines. Capacity of about 180,000 metric tons K_2O is being expanded to 350,000 tons by 1965 and possibly to more than 700,000 tons by 1970. Early in 1964 it was reported that almost all Israeli potash production for 1964 and 1965 has already been sold, much of it to eastern European countries.

In Jordan a potash productive capacity of 250,000 tons per year from Dead Sea brines was planned by 1965, although construction had not been started at the end of 1963.

Africa

Shallow bedded potash deposits in the Danakil Depression of Ethiopia are under development by the Ralph M. Parsons Company of Los Angeles and production at the rate of 300,000 tons per year is expected in 1965.

TABLE 5
World Potash Resources

Country	Estimated Reserves in Millions of Metric tons	Estimated Grade in Per cent K_2O	Estimated Production 1963 Millions of Metric Tons K_2O
United States,			
New Mexico	400	18	2.524
Utah		25	under construction
West Germany	2-20,000	12	1.948
East Germany	9,000	20	na
France	300-400	18	1.697
U.S.S.R.	17,600-20,300	10	na
Spain	270-500	16	.272
Italy	155	12	na
Canada	50,000	25	.630
Israel } in Dead Sea	2,000	3	.186
Jordon } brines			under construction
Poland	165	8	na
Ethiopia	50	25	under construction
Gabon	40	na	under construction
Britain			
England	350	16	under investigation
Scotland (shales)	100	10	under investigation
Chile (KNO_3)	na	1	na
Peru (in brines)	na	na	under investigation
Morocco	na	12	under investigation
Libya	9	na	under investigation
Total	103,000	15	na

Sources: U.S. Bureau of Mines, *Phosphorus and Potassium* and others.
Note: 1000 kilograms = 1 metric ton = 1.1023 short tons.
Symbol: na Not available.

It has been reported that potash interests from France, Germany and Israel will join in the development of potash mines near Brazzaville, Republic of Congo. Production of 350,000 metric tons per year is expected before 1970.

French interests have also investigated potash occurrences in Morocco and it has been reported that a United States company is investigating the potash occurrences in the Marada area of Libya.

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

Canadian Prices

IMC on June 7, 1963 issued the following schedule of Canadian potash prices on materials contracted for prior to July 1, 1963. Contracts subsequent to June 30, 1963 are five per cent higher.

Potash prices, July and August 1963 in Canadian funds f.o.b. mine:

	Bulk ¢ per unit	Bagged $ per net ton
Standard muriate, min. 60% K_2O	37.5	28.35
Coarse muriate, min. 60% K_2O	38.5	29.00
Granular muriate, min. 60% K_2O	39.6	29.65
Sulphate of potash, min. 50% K_2O	71.7	43.70
Sul-Po-Mag, 22% K_2O, 18% MgO	$16.75 (per net ton)	23.55

United States

The *Oil, Paint and Drug Reporter* of December 30, 1963, quotes the following U.S. prices:

Potassium muriate

Standard

Bulk, car lots, works, unit-ton – $0.37

Bagged, 60% min. K_2O, same basis, ton – $27.70

Granular

Bulk, car lots, works, unit-ton – $0.40

Bagged, 60% min. K_2O, same basis, ton – $29.50

Potassium sulphate, 50% min. K_2O agricultural, bulk, car lots, works, unit-ton – $0.73

Note: Add 2¢ per unit-ton for material contracted-for after July 1, 1963.

TARIFFS

Canada

German potash salts, muriate and sulphate of potash, crude, saltpetre or potash nitrate – free

United States

Crude potash salts, muriate of potash, and potassium sulphate – free

Roofing Granules

F.E. Hanes*

The value of the 1963 consumption of roofing granules was $3.4 million, a decrease of 2.4 per cent from 1962 and 75.2 per cent of the record $4.5 million achieved in 1958. The volume of granules consumed in 1963 increased by less than half of one per cent compared with 1962.

Granule consumption has been steadily increasing from a low reported in 1960. The consumption of 126,000 short tons in 1963 is slightly greater than the 1962 volume of 125,500 short tons. The 1963 volume was 85.1 per cent of the record volume of 1955 which amounted to 148,000 short tons.

Table 1 shows the consumption of roofing granules by kind and color; it also shows the imports by kind. Table 2 shows the industry's granule consumption during the past ten years, giving the annual figures for total volume and total value of production with an average price per ton for each year.

An increase in the consumption of Canadian-made, artificially colored granules, a decrease in the volume of imported artificially colored granules, and the difference in average price between these two types of granules, account for most of the slight difference in value and volume in 1962 and 1963.

The Canadian producer of black slag granules is supplying an ever greater part of the Canadian demand at a lower price per ton.

PRICES

The average price for all types of granules in 1963, $26.94 per short ton, was the fourth lowest during the 1955–63 period. This average granule price is 77 cents lower than the 1962 price and is considerably lower than the price of $33.51 obtained in 1958.

*Mineral Processing Division, Mines Branch

TABLE 1

Roofing Granules – Consumption and Imports*

	1962		1963	
	Short Tons	$	Short Tons	$
Consumption				
By kind				
Natural colored	52,115	1,091,070	50,115	1,015,112
Artificially colored	73,348	2,385,805	75,794	2,377,242
Total	125,463	3,476,875	125,909	3,392,354
By color				
Black and grey black	46,045	1,046,433	40,032	899,564
Green	21,835	674,838	19,069	610,861
Red	7,457	215,113	7,694	218,181
Blue	4,070	165,424	3,713	151,696
White	19,631	743,918	19,817	736,940
Grey	19,158	374,102	28,147	534,933
Buff	799	29,526	716	25,526
Brown and tan	4,674	156,192	5,112	147,961
Coral, cream and yellow ...	1,073	42,711	893	33,321
Turquoise	438	20,976	716	33,371
Not classified	283	7,642		
Total	125,463	3,476,875	125,909	3,392,354
Imports				
United States				
Natural colored	22,074	509,841	11,367	263,190
Artificially colored	28,779	1,133,110	27,910	1,066,901
Total	50,853	1,642,951	39,277	1,330,091

*Compiled from figures supplied to the Mines Branch by consumers.

TABLE 2

Consumption of Granules – 1954–63

	Total Tons	Total Dollars	Price per Ton
1963	125,909	3,392,354	26.94
1962	125,463	3,476,875	27.71
1961	123,486	3,286,670	26.62
1960	113,826	2,962,363	26.03
1959	138,758	4,182,615	30.14
1958	134,565	4,509,638*	33.51
1957	110,543	3,405,655	30.81
1956	133,691	3,884,961	29.06
1955	147,877*	4,087,668	27.64
1954	133,917	3,563,578	26.61

*Record years.

The average price of imported, natural-colored rock and slag granules in 1963 was $23.15, an eight per cent increase over the 1962 price. The price of the Canadian products increased from $19.26 to $19.95 (average) per ton – a gain of 69 cents. The value of these two groups of granules, which in 1962, were nearly the same, shows the greatest imbalance compared with the other groups in 1963. The value for this class of domestic granule in 1963 rose from $523,542 to $572,934, while the value of the imported granule consumption decreased from $508,566 to $263,190. This marks the first year in which these Canadian-made products have been used in greater amount than imported products.

The volume of the Canadian products in this category increased by 5.5 per cent compared with the 1962 consumption, while the volume of imported granules decreased by 48.5 per cent. Slate, the other natural-colored granule, remains essentially a Canadian supplied material.

The total volume of black-slag granules consumed in 1963 was 26,765 short tons, a decrease of 11.7 per cent compared with 1962. Total value of this commodity, amounting to $611,174, also decreased – by 12.7 per cent. However, the consumption of the Canadian-made, black-slag granules increased in both volume and value in 1963 by more than 42 per cent and 38.4 per cent, respectively, compared with 1962. The price of the Canadian-made, black-slag granule averaged about $2.25 per ton less than the imported slag granule.

The average price per ton for imported, artificially colored granules changed from $39.37 in 1962 to $38.23 in 1963, a decrease of 2.9 per cent. The same decreasing trend was shown for the Canadian-made, artificially colored granule which dropped from $28.11 to $27.36 per ton (average), a decrease of 2.7 per cent.

The total volume and value of imported, artificially colored granules in 1963 compared with 1962 decreased by 3.0 and 5.8 per cent, respectively, while the volume and value of Canadian-made, artificially colored granules increased by 7.4 and 4.6 per cent, respectively.

Except for a large decrease in the consumption of natural-colored, imported granules and a large increase in the consumption of Canadian-made slate granules, the industry remained practically unchanged in total volume and value for granules consumed during 1963.

The Canadian demand for granules is being supplied by Canadian producers in increasing amounts each year. The three types of granules showing this trend are the black slag, the natural-colored slate granules, and the artificially colored granules.

Colors most commonly used in 1963 by manufacturers of roofing shingles and siding were, in order of descending popularity: black, grey, white, green and red, followed by brown and tan, blue, the coral, cream and yellow group, and finally, buff and turquoise. By comparison with 1962, preference remained for black granules followed by green, white and grey. The only difference in the order was the reversal in popularity of the grey and green granules.

CANADIAN PRODUCERS

Manufacturers of granules in Canada are located at Havelock, Ont.; Montreal, Que.; and Vancouver, B.C.

Minnesota Minerals Limited at Havelock crushes a trap rock for granules and operates a coloring plant which produces a wide range of artificially colored 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 obtain their raw materials, 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.

TABLE 3
Average Prices of Artificially Colored Granules
($ per short ton)

Granule Color	Imported		Canadian	
	1962	1963	1962	1963
Red	35.70	43.14	24.72	24.90
Green	37.91	37.33	28.82	29.06
Black	31.95	30.87	20.72	20.57
Blue	45.23	46.43	37.86	37.79
White	41.23	41.09	34.25	32.69
Grey	30.68	28.89	25.51	26.08
Buff	41.01	37.68	35.28	34.38
Brown and Tan	46.99	36.21	24.66	25.82
Coral, cream, yellow	45.53	45.53	27.89	28.31
Turquoise	49.68	49.86	41.15	39.22
Not differentiated	nil	nil	26.08	nil
Average	39.37	38.23	28.11	27.36

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 eight 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
The Barrett Company, Limited	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.

DEVELOPMENT IN THE INDUSTRY

The consumption of roofing granules varies with fluctuations in house construction.

Canada's 1963 $7.7 billion construction program increased 5.5 per cent over 1962. Although the number of completed residential units constructed in 1963 was practically the same as in the previous year, residences under construction and building starts were both higher in number. See Table 4.

TABLE 4
Construction Statistics for Residential Units

Period of Const'n	Building Starts	Under Construction	Units Completed
As of Dec. 31, 1963	120,950	79,233	101,528
As of Dec. 31, 1962	104,279	60,541	100,447
Jan. to April 1964	28,193	58,540	48,536
Jan. to April 1963	22,379	55,260	27,450

TABLE 5
Value of Building Permits in Canada
(category value × $',000)

	1962	1963
New Residential	1,144,364	1,389,923
Total construction	2,516,578	2,823,226
New construction as percentage of total.............	45.5	49.2

The January to April period in 1964 is compared with 1963 to show the increase in housing starts and units under construction. Notable is the very prominent increase in house completions in the first few months of 1964 compared with 1963. The Federal Government's Winter Works Program and the House Bonus Program, are both likely reasons for the early indication of residential construction growth.

The value of Canadian building construction has increased in all but two categories. The categories in which increases are shown are New Residential, Repair, and Industrial. The two categories, Commercial and Institutional-Government, are slightly lower in 1963. The value of new residential construction in 1963 compared with 1962 is shown in Table 5.

The continuing growth in the shingle and siding industry is indicated by the values shown in Table 5 and by the optimistic prediction that the 5.5 per cent increase in the value of over-all construction for 1963 will continue during 1964.

Salt

R.K. Collings*

Canada's salt production in 1963, at 3.7 million tons, was at a record level for the second successive year. The last nine years have been ones of spectacular growth for the domestic salt industry. For several years prior to 1955, annual production hovered just under one million tons; it rose well over that amount in 1955 with the establishment of a rock salt operation at Ojibway, Ontario. The two-million-ton mark was exceeded in 1958, largely as a result of the initiation of brine exports from southern Ontario to the United States. The three-million-ton mark was exceeded in 1959, when two more rock salt mines, one at Goderich, Ontario, the other at Pugwash, Nova Scotia, were brought into production.

Domestic salt production in 1963 was 2.3 per cent greater than in the previous year. Approximately 48 per cent of the production was rock salt, 39 per cent was salt in brine form or salt recovered in chemical operations, and 13 per cent was fine evaporator salt. Value of production was $22.3 million or $6.00 per ton.

Imports, mostly from Mexico, the United States and Spain, amounted to 332,581 tons valued at $1,581,906. British Columbia was the chief importing province.

Exports, valued at $3.7 million, consisted mostly of rock salt and salt in brine form shipped to the United States from producers in southwestern Ontario. Exports to the United States represented 95 per cent of the total value of exports in 1963.

*Mineral Processing Division, Mines Branch

TABLE 1
Production and Trade

	1962 Short Tons	1962 $	1963 Short Tons	1963 $
Production (shipments)				
By type				
Fine vacuum salt	463,093	9,651,016	486,940	10,166,591
Mined rock salt	1,845,393	10,391,050	1,771,242	10,074,331
Salt recovered in chemical operations	25,926	118,606	25,192	122,295
Salt content of brines used and shipped	1,304,366	1,766,463	1,438,620	1,953,348
Total	3,638,778	21,927,135	3,721,994	22,316,565
By province				
Ontario	3,155,589	15,387,911	3,187,491	14,793,161
Nova Scotia	312,519	3,112,753	356,902	4,043,804
Alberta	90,729	1,454,462	96,417	1,496,577
Saskatchewan	54,931	1,337,471	56,301	1,364,490
Manitoba	25,010	634,538	24,883	618,533
Total	3,638,778	21,927,135	3,721,994	22,316,565
Imports				
By type				
Table salt*				
United States	1,178	97,590	..	..
Britain	10	175	..	..
Total	1,188	97,765		
Fishery salt				
Spain	36,376	132,264	39,970	143,800
Bahamas	3,920	20,580	18,985	128,136
Jamaica	4,521	15,346	5,578	22,090
Netherlands	40	760	90	1,817
United States	2,793	11,221	2,212	8,411
Britain	22	798	nil	nil
Total	47,672	180,969	66,835	304,254
Other, in bulk				
Mexico	100,091	123,042	99,263	119,621
United States	85,870	485,030	155,335	891,872
Total	185,961	608,072	254,598	1,011,493
Other, in bags, barrels and other covering				
United States	10,677	226,698	10,812	258,944
Britain	338	7,126	336	7,215
Total	11,015	233,824	11,148	266,159
Total imported	245,836	1,120,630	332,581	1,581,906

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
By province				
Newfoundland	32,715	121,193		
Nova Scotia	13,608	70,465		
New Brunswick	507	3,023		
Quebec	10,897	87,465		
Ontario	58,230	502,450		
Manitoba	1,379	25,915		
Saskatchewan	1,631	32,554		
Alberta	242	3,449		
British Columbia	126,627	274,116		
Total	245,836	1,120,630		
Exports				
United States		3,919,662		3,510,854
New Zealand		22,461		55,121
Trinidad		986		39,311
Jamaica		11,409		37,811
British Guiana		387		21,206
Leeward and Windward isl..		6,612		10,889
British Honduras		3,052		7,066
Bermuda		5,773		5,693
Other countries		17,326		13,405
Total		3,987,668		3,701,356

Source: Dominion Bureau of Statistics.
*Table salt not available as a separate class after 1962.
.. Not available

Undercutting the salt face before drilling and blasting at the Pugwash, Nova Scotia, mine of Canadian Rock Salt Company Limited.

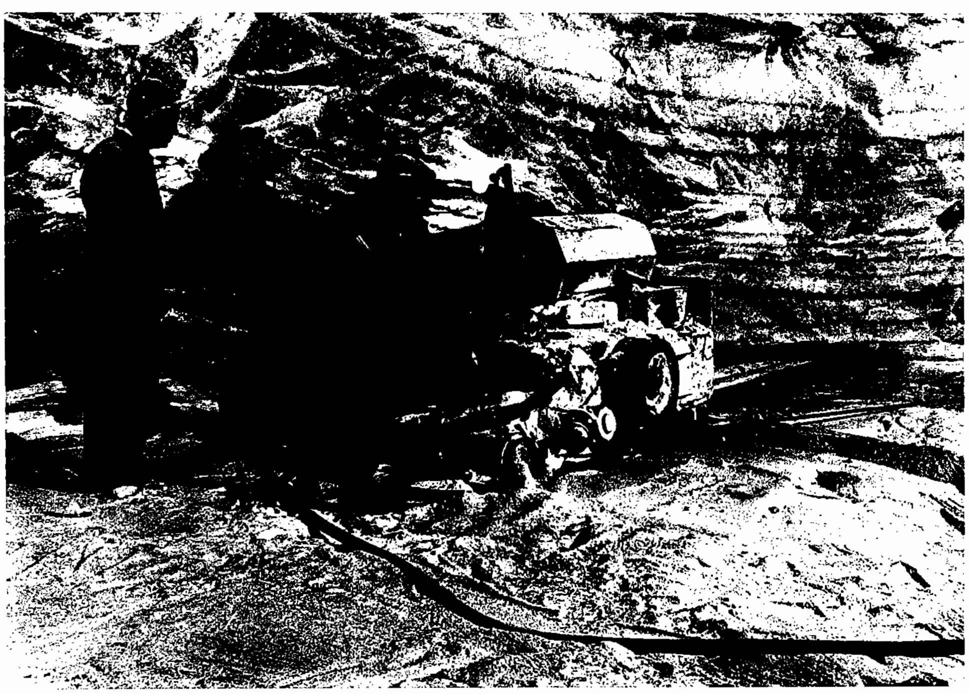


TABLE 2
Production and Trade, 1954–1963
(short tons)

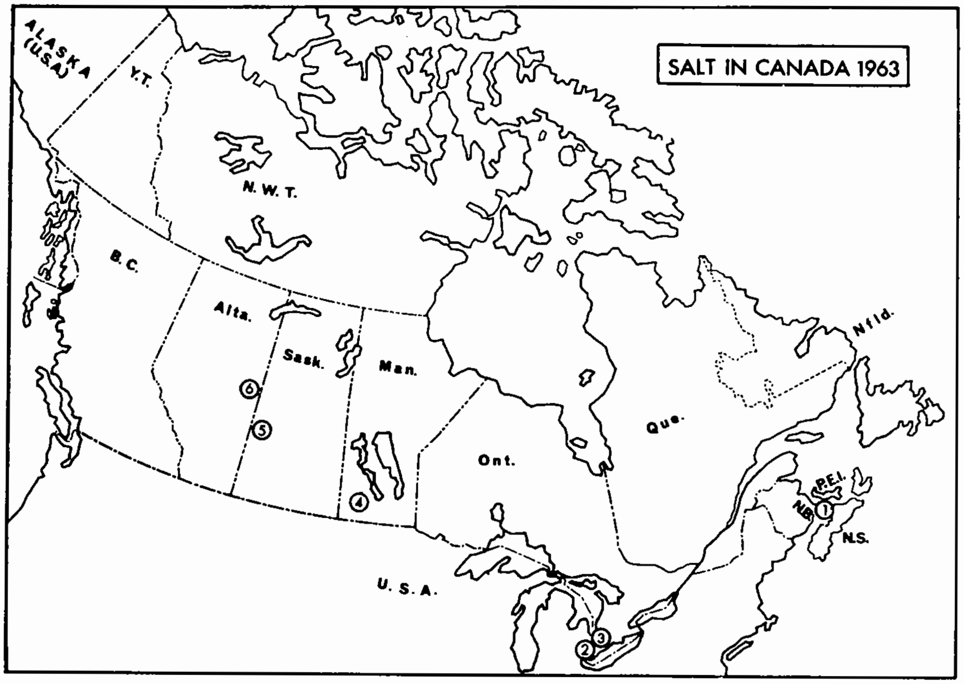
	Production[1]	Imports	Exports[3]	
				$
1954	969,887	370,412	1,199	
1955	1,244,761	365,255	146,472	
1956	1,590,804	319,124	333,935	
1957	1,771,559	367,483	457,888	
1958	2,375,192	340,887	906,707[2]	
1959	3,289,976	369,967	1,274,077	4,639,522
1960	3,314,920	191,940	..	3,461,366
1961	3,246,527	199,365	..	2,829,138
1962	3,638,778	245,836	..	3,987,668
1963	3,721,994	332,581	..	3,701,356

Source: Dominion Bureau of Statistics. 1. Producers' shipments. 2. This has been adjusted to include the salt content of brine, estimated at 500,000 tons, exported to the United States during 1958. 3. Export tonnage not available for years following 1959.
.. Not available.

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 countries	26,415
Total	104,900

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



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

EVAPORATOR PLANTS

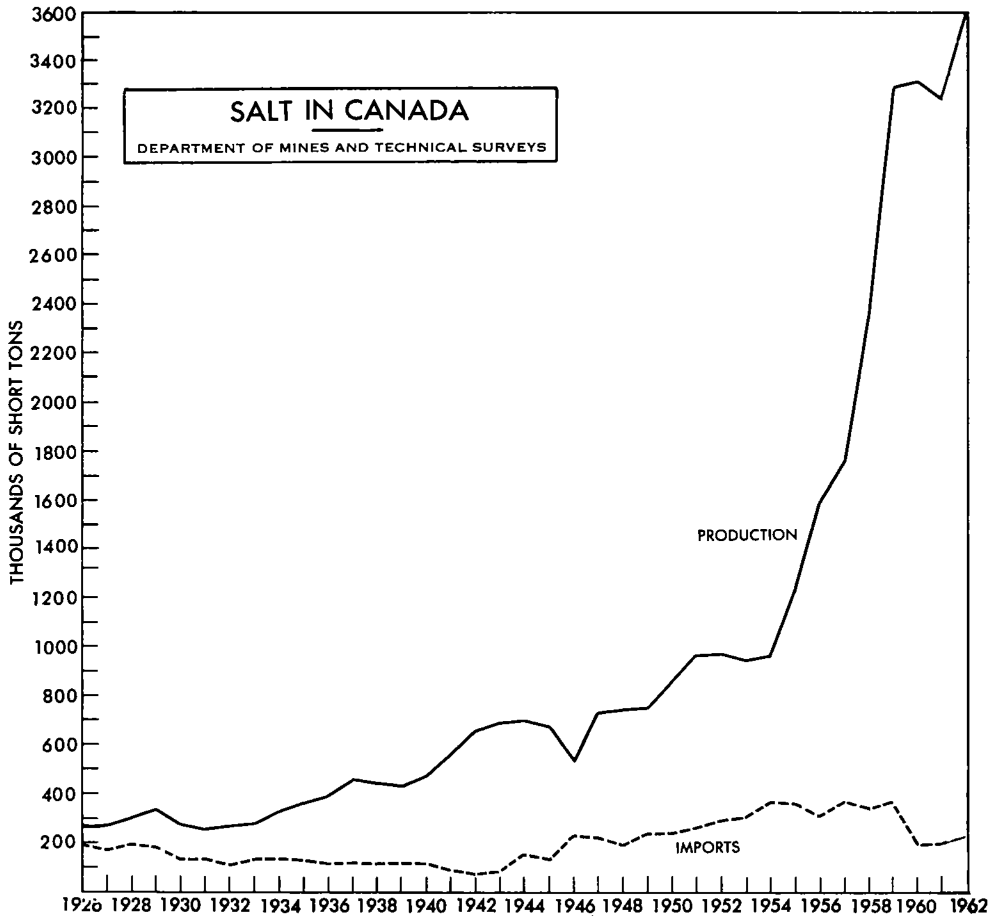
1. Domtar Chemicals Limited, Sifto Salt Division, Nappan, N.S.
1. The Canadian Rock Salt Company Limited, Pugwash, N.S.
2. The Canadian Salt Company Limited, Sandwich, Ont.
2. Brunner Mond Canada, Limited, Amherstburg, Ont.
3. Domtar Chemicals Limited, Sifto Salt Division, Sarnia, Ont.
3. Domtar Chemicals 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 is the chief salt producing province and, in 1963, accounted for over 86 per cent of the total Canadian production. This salt is obtained from huge 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 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 wells at Sarnia is used by Dow Chemical of Canada, Limited for caustic soda and chlorine manufacture. Domtar Chemicals Limited also operates brine wells at Sarnia as well as at Goderich for the production of fine evaporated salt.

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. Here 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.

Fine evaporator salt is produced at Nappan by Domtar Chemicals Limited; brine is obtained from salt beds occurring at depths of 1,100 and 1,800 feet.

Prairie Provinces

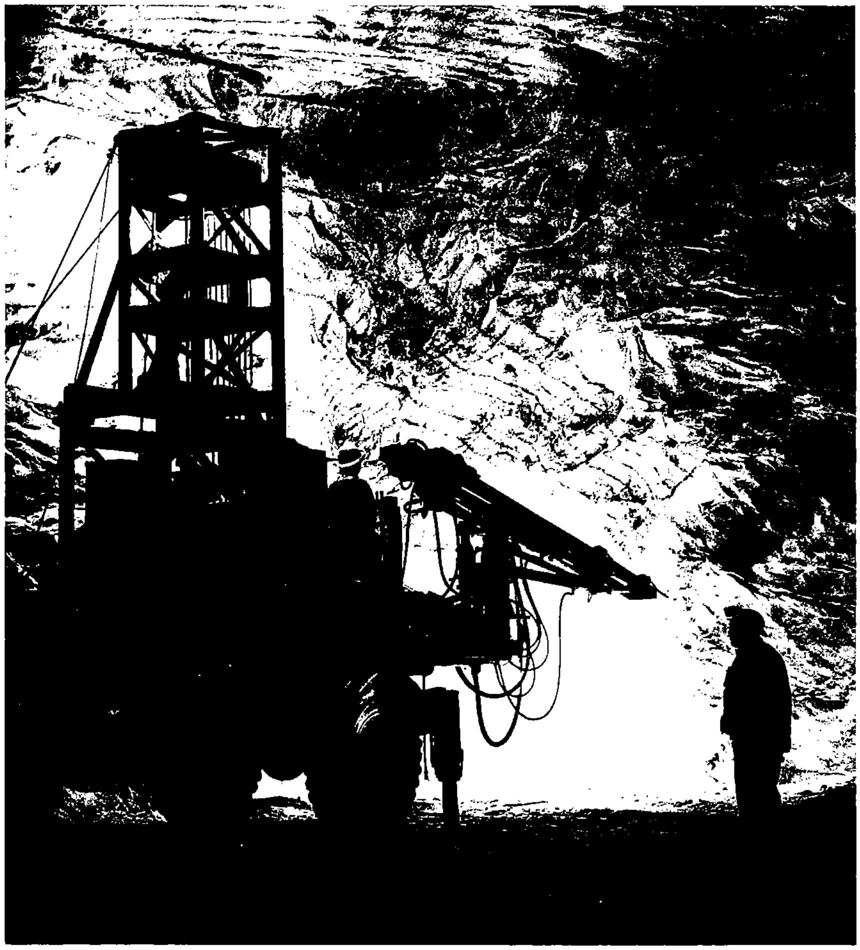
The Canadian Salt Company Limited produces fine salt at Neepawa, Manitoba, using natural brine that occurs at a depth of 1,400 feet, and at Lindbergh, Alberta, using artificial brine from salt beds that are 3,600 feet below the surface. Domtar Chemicals Limited produces fine salt at Unity, Saskatchewan, 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 are known to 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.



Drill jumbos are used to drill off the salt face.

A gathering-arm loader delivers salt to a shuttle car.

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 a host of 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.

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 prior to 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 reduced 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 non-metallic mineral field. Electronic scanners are capable of differentiating between the translucent, light-coloured salt grains and the opaque, darker mineral impurities, as well as between minerals 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 infra-red 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, 1961*

(short tons)

Chemical products (dry salt and salt content of brine)	1,228,757
Snow and ice control	550,000**
Food preparation	41,270
Slaughtering and meat-packing	60,535
Pulp and paper mills	48,494
Fish-processing	17,609
Leather tanneries	7,582
Soap and cleaning preparations	2,474
Dyeing and finishing textiles	714
Breweries	772

Source: Dominion Bureau of Statistics. *The latest year for which all data are available. **Estimate by Domtar Chemicals Limited.

TARIFFS

	British Preferential	Most Favored 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	

Sand, Gravel and Crushed Stone

F.E. Hanes*

The estimated** production of sand, gravel and crushed stone in 1963 was 221 million short tons valued at $172,500,000. Compared with the 1962 production of 213,523,435 short tons valued at $163,901,222 a substantial increase in both volume and value has been approximated at 3.5 and 5.2 per cent respectively.

Final values established for the 1962 production could be used to approximate the distribution by type or province for each category in 1963. Table 1 shows the estimated total volume and value of production allocated for the 1963 production.

The total value of construction in Canada in 1963, amounting to $7,696 million, establishes an all time record. The principal construction categories accounting for this record increase are engineering, residential and industrial. Table 2 shows the increases in each of these categories comparing 1963 with 1962 values, amounting to 8.8, 7.5 and 3.1 per cent respectively.

Engineering and residential construction continued strong upward trends following depressed values reported in 1959 and 1960. Increased activity and gains in related and dependent divisions of the industry are sharing in the current period of growth. Increased growth means increased demand for aggregates.

Construction of roads, highways and aerodromes has increased by nine per cent over 1962; construction of hard surface roads makes up most of the gain in this group. Dam and reservoir construction has expanded considerably in 1963. A slight gain is reported for irrigation construction.

Increases of put-in-place construction by regions in 1963 compared with 1962 amounted to one per cent for the Atlantic region, three per cent for Quebec, six per cent for Ontario, and eight per cent for the Western region.

Construction programs initiated by the Federal Government giving winter house-building incentives to contractors were in part responsible for greater residential construction during 1963. Increased residential construction was

* Mineral Processing Division, Mines Branch

** Total figures for 1963 production of sand, gravel and crushed stone are estimates based on 1962 preliminary figures and averages of previous years. (Further breakdown is unwarranted).

TABLE 1

Production of Sand, Gravel and Crushed Stone

	1962		1963	
	Short Tons	$	Short Tons	$
By Province				
Sand and gravel				
Newfoundland	4,081,055	3,397,728		
Prince Edward Island ..	531,196	452,906		
Nova Scotia	4,341,178	2,721,040		
New Brunswick	4,993,236	2,709,344		
Quebec	42,541,600	22,539,179		
Ontario	68,359,885	47,916,531		
Manitoba	8,834,519	6,318,523		
Saskatchewan	5,092,681	3,191,343		
Alberta	12,639,249	11,982,195		
British Columbia	16,488,580	10,255,017		
Total	167,903,179	111,483,806	171,500,000[e]	117,500,000[e]
Crushed stone				
Newfoundland	900	2,925		
Prince Edward Island ..	225,000	225,000		
Nova Scotia	447,190	697,772		
New Brunswick	2,857,416	2,627,553		
Quebec	22,816,011	26,159,520		
Ontario	16,674,107	19,944,518		
Manitoba	587,319	532,375		
Saskatchewan	—	—		
Alberta	6,508	21,236		
British Columbia	2,005,805	2,206,517		
Total	45,620,256	52,417,416	49,500,000[e]	55,000,000[e]
By Type				
Sand and Gravel				
For roads (roadbed surface).....	105,836,053	60,480,976		
Concrete aggregate	18,134,570	18,379,376		
Asphalt aggregate	3,645,178	2,822,132		
Railroad ballast	4,878,571	2,201,709		
Mortar sand	1,495,744	1,310,354		
Total	133,990,116	85,194,547		

(Cont'd.)

Table 1 (Cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Crushed Gravel				
For roads (roadbed surface)	23,928,131	16,603,857		
Concrete aggregate	4,880,272	5,455,503		
Asphalt aggregate	1,253,204	1,204,897		
Railroad ballast	2,509,387	1,957,527		
Other uses	1,342,069	1,067,475		
Total	33,913,063	26,289,259		
Total sand, gravel and crushed gravel	167,903,179	111,483,806	171,500,000e	117,500,000e
Crushed stone				
Concrete aggregate	12,510,637	14,949,279		
Railway ballast	1,962,887	2,334,935		
Road metal	24,664,635	27,035,202		
Rubble and riprap	2,262,179	2,438,626		
Terrazzo, stucco and artificial stone	58,572	646,473		
Other uses	4,161,346	5,012,901		
Total	45,620,256	52,417,416	49,500,000e	55,000,000e
Total sand and gravel and crushed stone ...	213,523,435	163,901,222	221,000,000e	172,500,000e

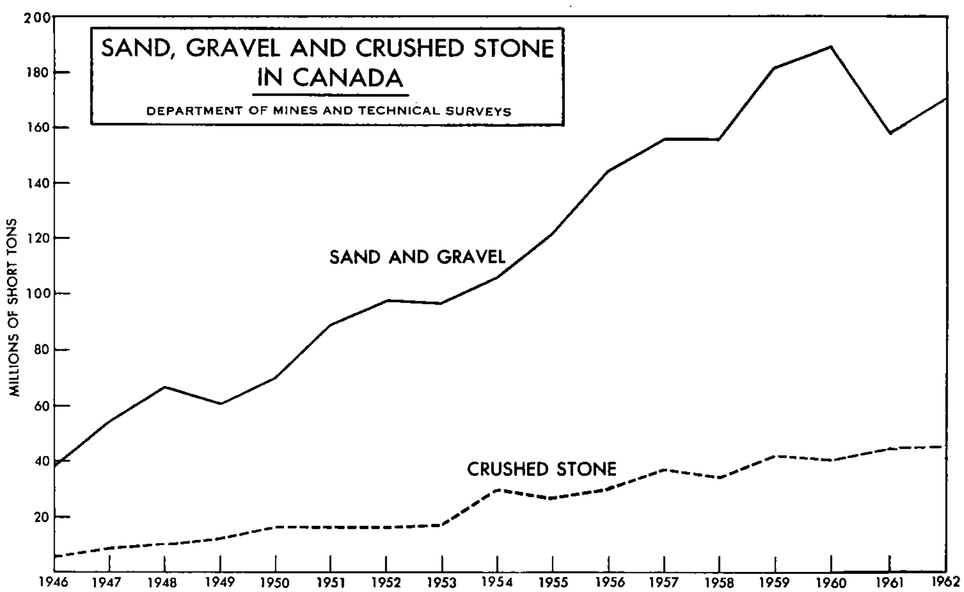
Source: Dominion Bureau of Statistics
e Estimated total only. Insufficient information to estimate detail breakdowns.

TABLE 2

Types of Construction in Canada, 1963

Type of Construction	Per cent change 1962—1963	Per cent of Total Value	
		1962	1963
Engineering	+ 8.8	38	39
Residential	+ 7.5	29	29
Institutional	+ 0.4	11	11
Commercial	− 0.4	10	9
Industrial	+ 3.1	7	7
Other building	− 3.7	5	5

Source: Dominion Bureau of Statistics



also necessary to meet the demand for additional dwellings caused by the growth in the engineering and industrial categories. This was evident by the increase in the number of units under construction and the number of units started during the year which amounted to 14 and 27 per cent respectively.

SAND AND GRAVEL

Deposits of natural sand and gravel are found widely dispersed across Canada. Some areas are abundantly supplied while others have little of these natural materials. The composition of aggregates in a natural sand and gravel deposit varies with the composition of the source beds from which the gravels and sand originate. They are also affected differentially with variable atmospheric conditions while location of the deposit is an important factor.

The principal factor seriously affecting quality of natural aggregates is the source material from which deposits are derived. It is often difficult to classify single deposits because of changes both laterally and vertically as the material is quarried. Changes in quality for each natural sand and gravel pit, as it is used, often results in uneconomic handling of material. Methods required for processing and stockpiling can become cumbersome. Lack of standardization in specification requirements can make economic handling of natural aggregate products more difficult.

Deposits that can be operated most efficiently are those located near suitable markets. The ideal deposit would further be enhanced if the composition and grading of the aggregate were suitable for the specified use to which it would be put with only minor screening and beneficiation processes.

CRUSHED STONE

Ledge rock and massive igneous rock deposits make suitable materials for quarrying, crushing and preparation of coarse and fine aggregates. Because beds of rock from which aggregate products can be produced are usually present over large areas, suitable locations for quarrying and crushing can be most advantageously selected.

Another advantage in using crushed stone aggregate compared with the natural gravel product is that quality can be controlled to a greater degree. The selection of a quarry location can be based on greater knowledge of the subsurface conditions than can be ascertained for naturally occurring sand and gravel deposits. Where adequate information of the ledge-rock formation is available, recovery can be practically guaranteed. Both coarse and fine manufactured aggregates can usually be produced in graded fractions by proper selection of crushing, screening and beneficiation equipment. A flexible flow sheet helps when adjustments are required to meet various specification demands.

Crushing stone for aggregate from bed-rock formations allows greater control for optimum particle shape and size distribution, two factors important in concrete mixes. The cost of production is greater and the variety of production equipment is also more involved than that used for quarrying and processing sand and gravel aggregates. However, an increased value per ton is realised for the crushed stone product. The difference is indicated in the following 'average-value' figures that were obtained from the 1962 statistics. Average values obtained for sand/gravel and crushed stone were 58 and 69 cents for road construction aggregates, \$1.02 and \$1.12 for concrete aggregates, and 45 and 58 cents for railroad ballast, respectively. The total average value of the sand and gravel product in 1963 was 63 cents while the crushed stone product, for the same period, amounted to 78 cents.

The use of crushed stone products for exposed aggregate applications such as precast slabs and panels and cast-in-place units, is gaining more importance each year. A greater variety of colourful exposed aggregates is being used successfully with very interesting results. New types of rock suitable for developing new colour and texture combinations are always being sought.

Delicately coloured types of crushed rock, when specified for exposed use, command good values. These aggregates are often valued at \$60.00 to \$80.00 per ton. The average value placed on all aggregates that were used for terrazzo, stucco, artificial stone manufacture, and exposed aggregate used in other applications in 1963 was approximately \$11.00 per short ton.

IMPORTS AND EXPORTS

Imports of sand and gravel declined from a volume of 1,570,893 short tons valued at \$1,820,752 in 1962 to 1,312,275 short tons valued at \$1,564,275 in 1963. This is a decrease of 16.5 and 14.1 per cent respectively. Materials imported consisted of 43 per cent sand and gravel and 57 per cent crushed stone.

Exports amounting to 990,179 short tons valued at $1,431,265 was almost 14 per cent lower in volume than in 1962, but because of better values received for crushed limestone and refuse, a small increase of $17,300 (1.2 per cent) was realized. The three principal commodities exported were sand, gravel, and crushed limestone and refuse. They made up 34.5, 1.5 and 64.0 per cent respectively of the total amount.

Table 3 compares the import and export values between 1962 and 1963.

TABLE 3
Canadian Imports and Exports of Sand, Gravel and Crushed Stone

	1962		1963p	
	Short Tons	$	Short Tons	$
Imports				
Sand and Gravel	838,894	556,873	561,965	540,841
Crushed stone	731,999	1,263,879	750,310	1,023,434
Total	1,570,893	1,820,752	1,312,275	1,564,275
Exports				
Sand	305,404	401,777	342,211	441,267
Gravel	48,703	46,031	13,913	12,938
Crushed limestone and refuse	788,790	966,152	634,055	977,060
Total	1,142,897	1,413,960	990,179	1,431,265

Source: Dominion Bureau of Statistics
p Preliminary

Selenium and Tellurium

A. F. Killin*

SELENIUM

Selenium is a greyish semimetal with a semimetallic lustre and electrical properties characteristic of the semiconductor group of metalloid elements. It is recovered as a byproduct of copper from the treatment of tank muds produced in the electrolytic refining of copper. Canada's two copper refineries each operated selenium recovery plants in 1963 and produced a combined total of 468,772 pounds of selenium valued at $2.3 million. This was 18,294 pounds and $527,085 less than the production and value in 1962.

The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario, operates a selenium recovery plant on slimes from its Copper Cliff electrolytic copper refinery and Port Colborne, Ontario, nickel refinery. The plant has the capacity to produce 240,000 pounds of minus 200 mesh, 99.7 per cent selenium powder a year.

At Montreal East, Quebec, Canadian Copper Refiners Limited operates Canada's largest selenium recovery plant. The Montreal East refinery treats copper anodes from the Noranda, Quebec, refinery of Noranda Mines, Limited, and the Murdochville, Quebec, smelter of Gaspé Copper Mines, Limited, and blister copper from the smelter of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba. The selenium plant has an annual capacity of 450,000 pounds of selenium metal and salts. In addition to commercial-grade selenium metal (99.5% Se) and high-purity selenium metal (99.9% Se) the refinery can produce a great variety of metallic and organic selenium compounds.

*Mineral Resources Division

TABLE 1

Selenium—Production, Exports and Consumption

(pounds of contained selenium)

	1962		1963	
	Pounds	$	Pounds	$
Production,				
All forms[1]				
Quebec	276,409	1,589,352	286,042	1,387,304
Ontario	142,915	821,761	95,100	461,235
Saskatchewan	56,265	323,524	72,194	350,141
Manitoba	11,477	65,993	15,436	74,865
Total	487,066	2,800,630	468,772	2,273,545
Refined[2]	466,629		462,400	
Exports, metals and salts				
United States	142,300	889,740	230,200	1,216,210
Britain	161,100	1,009,056	189,900	1,063,058
France	3,200	23,420	7,100	47,497
Colombia	700	3,969	3,800	18,682
Brazil	5,200	30,924	3,600	16,831
Republic of South Africa	nil	nil	2,900	17,048
Argentina	3,100	16,949	2,100	11,325
Spain	1,700	11,294	1,700	9,649
Venezuela	1,200	8,012	1,400	6,423
New Zealand	1,100	5,943	1,200	5,722
Other countries	6,000	34,671	1,800	9,293
Total	325,600	2,033,978	445,700	2,421,738
Consumption[3]	12,587		12,424	

Source: Dominion Bureau of Statistics.
[1]Recoverable selenium content of the blister copper treated at domestic refineries, plus refined selenium from stock-piled sludge. [2]Includes production from scrap. [3]As reported by consumers.

CONSUMPTION AND USES

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.

Selenium is used in glassmaking both as a decolorizer and as a coloring agent. Small quantities of selenium added to the glass batch help to neutralize the green color 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

TABLE 2

Selenium—Production, Exports and Consumption, 1954–63
(pounds of contained selenium)

	Production		Exports	Consumption[3]
	All forms[1]	Refined[2]	Metals and Salts	
1954	323,529	297,479	344,292	21,141
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

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 and selenium salts; for 1959 and the years following, consumption as reported by consumers.

selenium to the glass batch. The ceramics and paint industries use selenium as a pigment to obtain orange to dark maroon colors and in the coloring of inks for printing on glass containers.

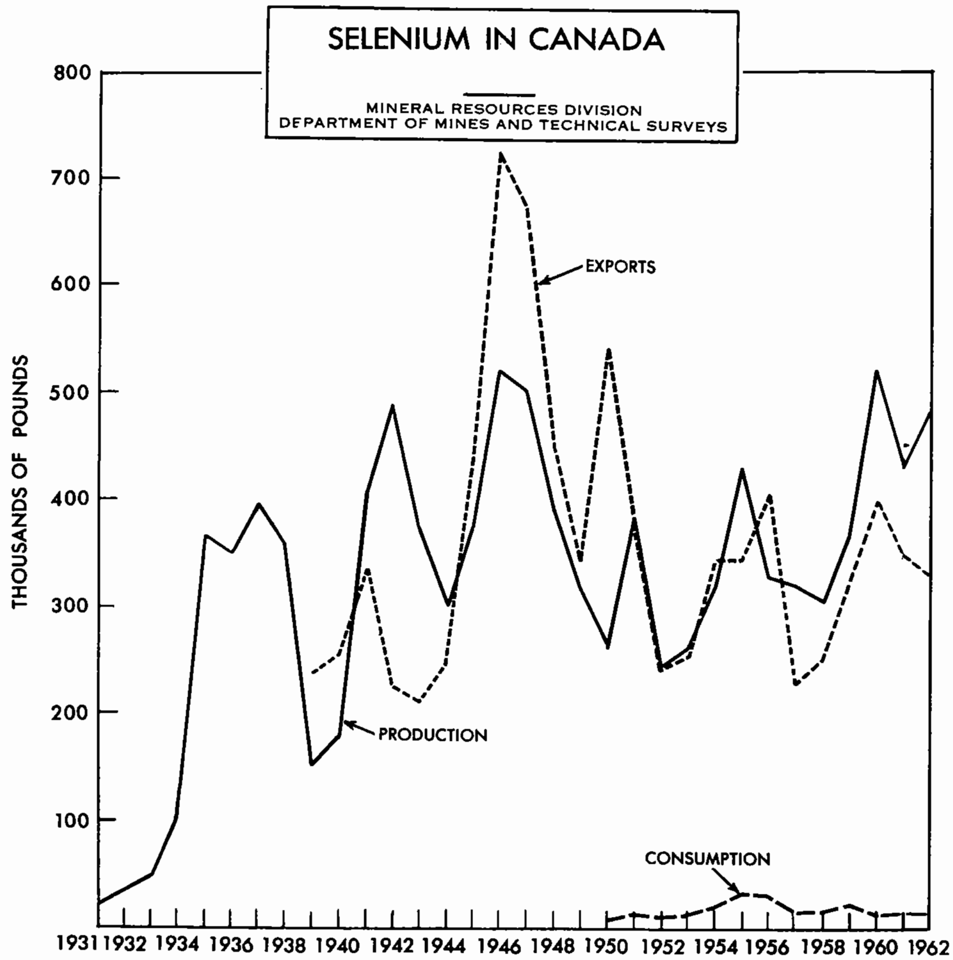
The chemical industry uses selenium as a catalyst in the manufacture of cortisone and nicotinic acid. Selenium and selenium compounds are used in the preparation of various proprietary medicines for the control of dermatitis in humans and animals and for the correction of dietary deficiencies in animals.

TABLE 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.



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 – 57% Se) is added to stainless and lead recarburized steels to improve their machinability and other properties.

TABLE 4

Canadian Industrial Use of Selenium, 1961, 1962 and 1963
(pounds of contained selenium)

	1961	1962	1963
By end-use			
Electronics	1,465	[3]	[3]
Glass	6,643	5,347	6,189
Other[1]	5,052	7,240	6,235
Total	13,160	12,587	12,424
By type			
Ferroselenium	3,518	3,519	3,689
High purity	1,465	1,619	888
Metal powder	6,187	4,562	5,358
Other[2]	1,990	2,887	2,489
Total	13,160	12,587	12,424

Source: Consumers reports to Dominion Bureau of Statistics.
[1]Rubber, steel, pharmaceuticals. [2]Selenium dioxide, sodium selenite and selenium sulphide.
[3]Reported in other.

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
Iroquois Glass Limited, Candiac
Frigistors Ltd., Montreal
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

PRICES

In 1963, *E & M J Metal and Mineral Markets* quoted United States prices for a pound of selenium as follows:

Period	Commercial Grade Powder	High-purity Selenium
Jan. 1 to Jan. 21	5.75	6.75
Jan. 22 to Feb. 17	5.25	6.25
Feb. 19 to Feb. 25	5.00	6.00
Feb. 25 to Dec. 31	4.50	6.00

TARIFFS

Canada	British Preferential	Most Favored Nation	General
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, with selenium, from the refining of tankhouse slimes at Canada's two electrolytic copper refineries. Not all of the tellurium-bearing slimes are processed, as production tends to be on a batch basis governed by market demands. Unprocessed slimes are stockpiled at the refineries. Production in 1963 totalled 76,842 pounds valued at $499,473. Production in 1962 was 58,725 pounds worth $352,350.

The tellurium refinery of The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario, processes slimes from the company's copper refinery at Copper Cliff and nickel refinery at Port Colborne, both in Ontario. Canadian Copper Refiners Limited at Montreal East, Quebec, treats slimes produced by the electrolysis of copper anodes from the Noranda and Murdochville smelters in Quebec and from blister copper of Hudson Bay Mining and Smelting Co., Limited's Flin Flon, Manitoba, smelter.

TABLE 6

Tellurium – Production and Consumption
(pounds of contained tellurium)

	1962		1963	
	Pounds	$	Pounds	$
Production, All forms[1]				
Quebec	45,724	274,344	64,590	419,835
Saskatchewan	4,982	29,892	3,751	24,382
Ontario	7,011	42,066	7,705	50,082
Manitoba	1,008	6,048	796	5,174
Total	58,725	352,350	76,842	499,473
Refined[2]	57,630		79,570	
Consumption refined[3]	4,306		1,853	

Source: Dominion Bureau of Statistics.
[1]Includes the recoverable tellurium content of the blister copper treated, plus refined tellurium from stockpiled sludge. [2]Refinery output from all sources. [3]As reported by consumers.

TABLE 7

Production of Tellurium 1954–63
(pounds)

	All Forms*	Refined**
1954	8,171	7,990
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

Source: Dominion Bureau of Statistics.
*Includes the recoverable tellurium content of blister copper, which was not necessarily recovered in the year designated. Also includes some refinery output from stockpiled sludge. **Refinery production from all sources.

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.

CONSUMPTION AND USES

Tellurium is nontoxic, but when absorbed into the body by direct contact or inhalation it imparts a strong ordor of garlic to the breath and perspiration. Because of this adverse physiological effect, industry has used tellurium less than selenium.

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 the 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 its aging and mechanical properties. The diethyldithiocarbamate compound also helps to reduce the porosity of thick rubber sections and, in combinations with mercaptobenzothiazol, is one of the fastest known accelerators for butyl rubber.

Tellurium powder is added to molten iron to control the depth of chill in grey-iron castings. A 99.5-per-cent copper and 0.5-per-cent tellurium alloy is used in the manufacture of welding tips and in radio and communications equipment because it can be extensively cold-worked, has good hot-working properties and high thermal and electric conductivity. Up to 0.1 per cent tellurium in lead forms a corrosion-resistant alloy used to sheath marine cables and to line tanks subject to chemical corrosion.

TABLE 9

Refined Tellurium Used in Canada, 1961, 1962 and 1963

(pounds of contained tellurium)

	1961	1962	1963
By end-use			
Metal alloys	1,875	1,563	811
Other*	2,968	2,743	1,042
Total	4,843	4,306	1,853
By type			
Metal pellets	1,259	986	—
Other**	3,584	3,320	1,853
Total	4,843	4,306	1,853

Source: Consumers' reports to Dominion Bureau of Statistics.
*Rubber, electronics. **Lump, powder and compounds.

PRICES

The United States price of tellurium in 100-pound lots for 1963 as quoted by *E & M J Metal and Mineral Markets* was $6 for both powder and slab.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
In lumps, powder, ingots, etc.*	free	15%	25%
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, or silicon dioxide (SiO_2), occurs in nature chiefly as quartz. It is found in many forms, commonly as sand, sandstone, quartzite and vein quartz. Although deposits are widespread, only those of high silica content are of interest commercially. Most of the Canadian production of silica is lump quartzite, sandstone and natural sand for use as metallurgical flux. Flux accounted for over 70 per cent of the total domestic production in 1962; the remainder was lump silica for ferrosilicon manufacture and sand for glass and silicon carbide production and for use by the foundry industry.

Although production of high-purity sand increased slightly in 1963, the over-all production of silica was only 1.9 million tons, about 9 per cent below that of 1962. Value of production increased about 1.0 per cent, to $3.9 million.

Imports showed moderate increases in all categories. Imports of high-purity sand rose 2.8 per cent to 787,000 tons in 1963, while total import, excluding silica brick, rose 3.3 per cent, to 801,000 tons. Value of imports, including silica brick, was $4.8 million.

Exports of silica declined sharply, from 156,200 tons in 1962 to 47,437 tons; most of this decline is attributed to reduced export from Ontario of quartzite for ferrosilicon manufacture.

PRINCIPAL PRODUCERS

Nova Scotia

Dominion Steel and Coal Company, Limited, obtains quartzite from Chegoggin Point, Yarmouth County, for use in the manufacture of silica brick at Sydney.

*Mineral Processing Division, Mines Branch

TABLE 1

Silica – Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production, quartz and silica sand*				
By province				
Ontario	1,352,613	1,077,784	952,166	644,287
Quebec	392,395	2,037,944	453,047	2,438,274
Manitoba	120,541	322,806	279,641	468,867
Saskatchewan	172,219	137,775	160,398	86,615
British Columbia	45,350	196,100	40,483	178,937
Nova Scotia	2,502	45,036	2,861	43,000
Total	2,085,620	3,817,445	1,888,596	3,859,980
By use				
Flux	1,534,572	1,186,866		
Ferrosilicon	210,185	785,404		
Silicon carbide	53,877	326,479		
Glass	75,038	468,571		
Foundry	17,115	60,472		
Other uses	194,833	989,653		
Total	2,085,620	3,817,445	1,888,596	3,859,980
Imports				
Silica sand for glass and carborundum manufacture and for use in steel foundries, filtration plants and sandblasting				
United States	761,890	2,883,401	783,593	3,004,691
Norway	2,899	36,391	3,268	31,787
Australia	67	1,547	296	8,600
Belgium and Luxembourg	575	41,287	nil	nil
Total	765,431	2,962,626	787,157	3,045,078
Silex, or crystallized quartz, ground or unground**	8,960	175,509	11,882	204,696
Piezoelectric quartz	5	222,169	6	286,018
Total	8,965	397,678	11,888	490,714
Flint and ground flint stones				
United States	1,003	23,843	1,552	27,256
France	nil	nil	132	6,229
Denmark	190	5,853	128	4,625
Total	1,193	29,696	1,812	38,110

Table 1 (cont'd)

	1962		1963	
	Short Tons	$	Short Tons	$
Firebrick containing not less than 90% silica				
United States		1,168,823		1,268,866
West Germany		34,427		12,441
Britain		62		547
Total		1,203,312		1,281,854
Exports, quartzite				
United States	156,205	489,999	47,437	216,489

Source: Dominion Bureau of Statistics.
*Producers' shipments, including crude and crushed quartz, crushed sandstone and quartzite, and natural silica sands. **Mostly from the United States.

TABLE 2
Available Statistics on Consumption of Silica
By specified Industries, 1962

Industry	Short Tons
Smelter flux*	1,534,572
Glass manufacturing (including fibre glass)	339,310
Foundry sand	169,156
Artificial abrasives	105,605
Ferrosilicon	94,616
Fertilizer, stock and poultry feed	21,296
Silica brick	8,139
Chemicals	14,913
Ceramic	12,426
Asbestos products	3,104
Paints	1,627
Soaps	432
Other	11,120
Total	2,316,316

Source: Dominion Bureau of Statistics.
*Includes low-grade sand and gravel as well as crushed quartz.

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.

TABLE 3

Silica – Production and Trade, 1954–63

(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
1954	1,716,151	3,578	655,863	28,412	1,219	590	162,374
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	1,888,596		787,157	11,888	1,812		47,437

Source: Dominion Bureau of Statistics.
*Not available after 1959. Beginning in 1960, silica used to make silica brick included in the production of quartz and silica. **Included with miscellaneous stone imports from January 1, 1958.

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.

Dominion Industrial Mineral Corporation obtains quartzite at St. Donat de Montcalm for use in the manufacture of silica sand and flour at Lachine. Production from Lachine is used in glass and silicon carbide manufacture and for other products requiring high-quality silica. This company is currently relocating its milling plant at St. Donat.

Canadian Silica Corporation 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.

Ontario

Canadian Silica Corporation Limited and Union Carbide Exploration Ltd. operate quarries in the Lorraine quartzite formation that extends along the northwest end of Georgian Bay. Canadian Silica has quarries at Sheguiandah on Manitoulin Island; Union Carbide's quarry is near Killarney on the mainland. Most of the production is exported to the United States; the remainder is used domestically for ferrosilicon manufacture. Part of the Sheguiandah production is used for silica flour manufacture at Whitby, Ontario.

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

Silica for metallurgical flux is obtained near Noranda, Buckingham and Howick, in Quebec; Sudbury, Ontario; Thompson, Manitoba; west of Flin Flon in Saskatchewan; and near Trail, British Columbia.

SPECIFICATIONS AND USES

Lump Silica

Silica Flux. Quartz and quartzite, as well as 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 one 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. The silica used is generally minus six, plus one inch in size.

Silica Brick. Quartz and quartzite, crushed to minus eight mesh, are used in the manufacture of silica brick for high-temperature refractory furnace linings. The iron and alumina should be less than one 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 non-metallic 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 is usually 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 closely sized sand are used in water-treatment plants as filtering media. Silica is also used as an ingredient in the manufacture of portland cement.

Silica Flour

Silica Flour, formed by grinding quartz, quartzite, sandstone or sand to a very fine powder, 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 two inches in length and one 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 six tons valued at $286,000 were imported. Quartz Crystals Mines Limited, Toronto, produced a small amount for test purposes from its mine near Lyndhurst, Ontario.

PRICES

The price of silica varies greatly depending upon the location of deposits, the purity of the product and the 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

Silver

J.W. Patterson*

Although two new mines in the Cobalt area of Ontario were placed in production in 1963, Canada's output of silver, 29.9 million ounces, was slightly less than the 30.4 million ounces produced in 1962. Production in Ontario, due to the opening of these two mines and to increased output of the copper-zinc mine of Geco Mines Limited, rose by about 218,000 ounces. Output in Yukon Territory was about 376,000 ounces less than in 1962, due to the lower grade of ore mined by United Keno Hill Mines Limited. Production in British Columbia rose by 264,000 ounces to 6,451,000 ounces.

Lead-zinc and silver-lead-zinc ores were the sources of 52 per cent of Canada's silver output. Most of these ores, about 76 per cent, were mined in British Columbia and Yukon Territory. Other important sources were copper, copper-nickel and copper-zinc ores most of which were mined in Ontario and Quebec. The remainder of the silver came from silver-cobalt ores mined in northern Ontario (17 per cent) and from lode and placer gold ores (two per cent).

The principal producers are listed in Table 3 and their approximate locations are shown on the accompanying map. The two largest producers in 1963 were United Keno Hill Mines Limited in Yukon Territory, and, The Consolidated Mining and Smelting Company of Canada Limited (COMINCO), in southeastern British Columbia. Lead-zinc-silver ores mined by these two producers were the source of about 34 per cent of Canada's total production. The output of the five largest producers of silver-cobalt ores in the Cobalt and Gowganda areas of Ontario and of a number of intermittent producers of these ores totalled approximately 5.1 million ounces.

* Mineral Resources Division

TABLE 1
Silver – Production, Trade and Consumption

	1962		1963	
	Troy Ounces	$	Troy Ounces	$
Production				
By provinces and territories				
Ontario	9,383,445	10,931,713	9,601,621	13,288,643
British Columbia	6,186,937	7,207,782	6,451,158	8,928,402
Yukon	6,482,244	7,551,814	6,106,037	8,450,755
Quebec	4,603,019	5,362,517	4,441,644	6,147,235
Newfoundland	1,181,648	1,376,620	981,005	1,357,711
Manitoba and Saskatchewan	1,610,094	1,875,759	1,513,117	2,094,154
Nova Scotia	724,245	843,745	423,189	585,694
New Brunswick	178,521	207,977	332,472	460,141
Northwest Territories	72,802	84,814	77,468	107,216
Alberta	17	20	12	17
Total	30,422,972	35,442,761	29,927,723	41,419,968
By sources				
Base-metal ores	25,046,109		24,302,110	
Gold ores	657,274		560,480	
Silver-cobalt and silver ores	4,707,590		5,053,534	
Placer gold ores	11,999		11,599	
Total	30,422,972		29,927,723	
Exports				
In ores and concentrates				
United States	6,751,273	7,299,218	6,792,965	7,966,982
West Germany	975,465	891,183	529,943	629,419
Belgium and Luxembourg	821,112	696,611	424,927	434,346
Britain	270,594	240,074	281,253	309,082
Japan	43,414	42,702	239,040	281,627
Brazil	–	–	11,844	15,733
Portugal	–	–	6,784	6,196
Total	8,861,858	9,169,788	8,286,756	9,643,385
Silver, refined metal				
United States	9,343,030	10,818,849	10,767,909	14,686,424
Brazil	97,296	115,110	61,138	85,689
Venezuela	4,342	5,374	2,878	4,385
Britain	202	838	2,154	3,873
Other countries	224	1,355	550	2,229
Total	9,445,094	10,941,526	10,834,629	14,782,600

Table 1 (cont'd)

	1962		1963	
	Troy Ounces	$	Troy Ounces	$
Imports				
Unmanufactured				
United States	8,054,180	9,540,562	7,348,541	10,013,103
Mexico	1,707,583	2,066,626	534,814	718,941
Nicaragua	—	—	48,353	62,588
Bahamas	16,934	18,767	15,528	21,460
Britain	3,306,537	3,722,924	3,736	5,010
Netherlands	2,097,102	2,309,190	—	—
Total	15,182,336	17,658,069	7,950,972	10,821,102
Manufactured articles of silver, including toilet articles of sterling silver				
Britain		313,280		269,301
United States		326,357		235,686
West Germany		117,069		146,175
Italy		6,657		35,688
Denmark		27,525		20,478
Other countries		31,578		23,189
Total		822,466		730,517
Consumption, refined				
By use				
Coinage	10,882,071r		13,012,204	
Silverware	1,499,891		1,256,044	
Photography	1,618,650		1,668,784	
Wire and rod	18,536		13,353	
Silver alloys	275,844		331,350	
Miscellaneous*	1,124,350r		1,292,893	
Total	15,419,342r		17,574,628	

Source: Dominion Bureau of Statistics

*Includes sheet, anodes for electroplating, and silver used in the manufacture of electrical equipment and jewelry.

Symbols: r Revised; — Nil.

TABLE 2

Silver – Production, Trade and Consumption 154–63

(Troy Ounces)

	Production	Exports			Imports	Consump-tion**
	All Forms*	In Ore and Concentrate	In Bullion	Total	Unmanu-factured	
1954............	31,117,949	8,672,340	14,467,015	23,139,355	60,165	5,996,563
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 r
1963	29,927,723	8,286,756	10,834,629	19,121,385	7,949,829	17,574,628

Source: Dominion Bureau of Statistics

* Recoverable silver in ores, concentrates and matte shipped for export; in crude gold bullion produced; in blister and anode copper made at Caandian smelters; in base bullion made by COMINCO at Trail, B.C.; bullion produced from the treatment of cobalt-silver ores.

** Includes consumption for coinage.

r Revised.

Approximately two thirds of Canada's mine output of silver was treated in domestic refineries. Production by COMINCO at its Trail, B.C. refinery was 6,848,000 ounces. The output of this refinery was mainly derived from lead and zinc concentrates produced at mines in British Columbia, the most important one being COMINCO's Sullivan mine at Kimberley. The remainder of the Canadian output of refined silver was produced from blister copper by Canadian Copper Refiners Limited in Montreal East, and by The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario; from gold precipitates by Hollinger Consolidated Gold Mines, Limited, at Timmins, Ontario; from gold bullion by the Royal Canadian Mint at Ottawa; and from arsenical-silver-cobalt concentrates by Cobalt Refinery Limited at Cobalt, Ontario. The concentrates treated by the latter company, from mines in the Cobalt and Gowganda areas, were the source of 2,047,503 ounces of silver.

Canada's silver exports in 1963 remained largely unchanged from those of 1962. A small decline in exports of silver in ores and concentrates to Belgium and West Germany was more than compensated for by an increase in exports of refined silver to the United States. Imports of refined silver, although considerably lower than those of 1962, remained at a high level because of the continuing large requirements of silver by the Royal Canadian Mint for coinage. The United States was again the most important source, accounting for 92 per cent of the imports.

Consumption of refined silver by the Royal Canadian Mint was at the record level of over 13 million ounces while industrial consumption at 4,562,424 ounces was only slightly above the 4,537,271 ounces used in 1962.

DEVELOPMENTS

Yukon Territory

Exploration was centred in an area surrounding the mines of United Keno Hill Mines Limited in the Mayo district. This company explored several properties on Galena Hill and Keno Hill and although no new orebodies were discovered, considerable progress was made toward improving the techniques of exploration through permafrost. Preparations to place its Keno Mine in production at between 125 and 150 tons a day were continued.

On properties adjacent to or within a short distance of those owned by United Keno Hill, extensive soil sampling carried out by Silver Titan Mines Limited revealed a number of geochemical anomalies. In addition, some trenching and prospect-adit work was done with encouraging results. The company also explored an area further north between McQuesten Lake and North McQuesten River. Exploration, mainly geochemical surveys followed by trenching, was done by Peso Silver Mines Limited on its property between Haggart and Secret creeks, 15 miles from Elsa. Promising results were obtained from this work and work done in previous years. A major underground program was started in January 1964.

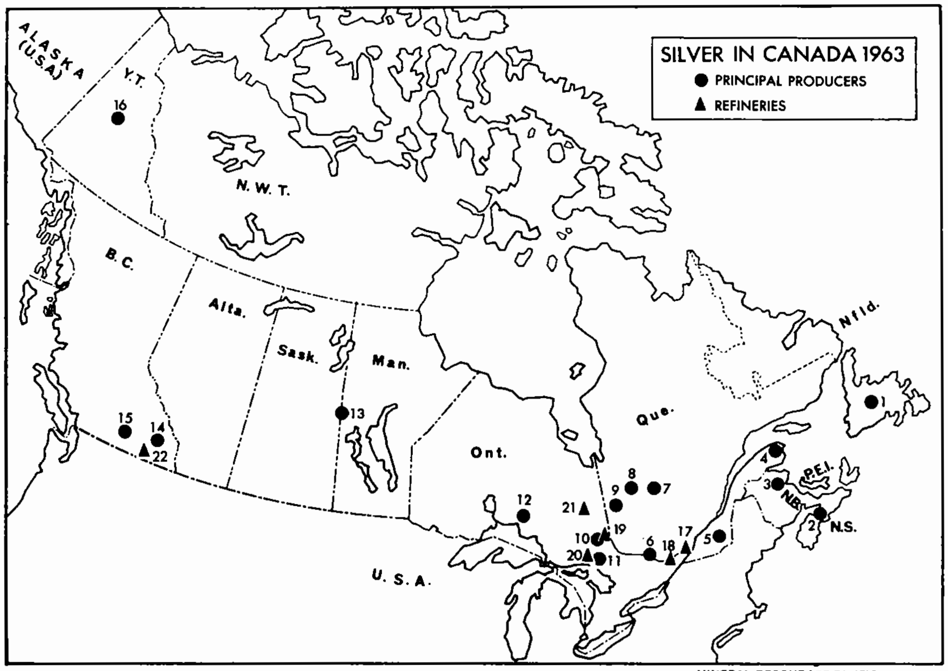
TABLE 3
Principal Silver Producers in Canada, 1963

Company	Mine	Location	Mill Capacity (short tons/day)	Type of Ore Milled	Silver Content 1963 (oz/ton)	Ore Produced 1962 (short tons)	Ore Produced 1963 (short tons)	Silver Produced 1963 (troy ounces)
Yukon Territory								
United Keno Hill Mines Limited[1]	Elsa	Mayo district	500	Ag,Pb,Zn	34.03	184,123	186,721	5,978,075
	Hector-Calumet	" "						
	Silver King	" "						
British Columbia								
The Consolidated Mining and Smelting	Sullivan	Kimberley	10,000	Pb,Zn,Ag	na	2,583,068	2,595,000	3,867,000[2]
Company of Canada Limited	Bluebell	Riondel	700	Pb,Zn,Ag	na	237,742	256,000	na[2]
Mastodon-Highland Bell Mines Limited.	Highland-Bell	Beaverdell	75	Ag,Pb,Zn	40	19,480	21,689	877,861
Manitoba and Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited	Flin Flon	Flin Flon dist.	6,000 (all four mines)	Cu,Zn	1.05	925,030	924,616	1,428,886 (all four mines)
	Coronation	" " "		Cu	0.21	347,731	292,650	
	Schist Lake	" " "		Cu,Zn	1.40	88,316	81,150	
	Chisel Lake	Snow Lake, Man.		Zn,Pb,Cu,Ag	2.06	338,377	300,065	
Ontario								
Geco Mines Limited	Geco	Manitouwadge	3,300	Cu,Zn,Pb,Ag	2.44	1,282,414	1,281,165	2,437,039
Willroy Mines Limited	Willroy	"	1,200	Cu,Zn,Pb,Ag	1.14	495,028	483,800	424,327
The International Nickel Company of Canada, Limited	[3]	Sudbury dist.	[3]	Ni,Cu	na	13,794,000[4]	13,566,000[4]	1,403,000[5]
Agnico Mines Limited	Christopher	Cobalt district	400 (both mines)	Ag,Co	na	66,216	76,752	710,772
	Nipissing-O'Brien	" "		Ag,Co				
Keeley-Frontier Mines Limited[6]	Keeley-Frontier	" "	200	Ag,Co	na	[6]	na	137,557[7]
Deer Horn Mines Limited	Cross-Lake-O'Brien	" "	100	Ag,Co	na	na	na	749,838
Glen Lake Silver Mines Limited	Boiley	" "	100	Ag,Co	na	na	na	942,673[7]
Langis Silver & Cobalt Mining Company Limited	Langis	" "	175	Ag,Co	na	37,750	36,748	376,098[7]
Silver Summit Mines Limited[6]	Savage	" "	200	Ag,Co	na	[6]	na	143,950[7]
McIntyre-Porcupine Mines, Limited, Castle Division	Castle	Gowganda dist.	125	Ag,Co	na	20,759	na	190,780[7]
Siscoe Metals of Ontario Limited	Miller-Lake O'Brien	" "	275	Ag,Co	na	68,665	na	1,404,027

Quebec								
The Coniagas Mines, Limited	Coniagas	Bachelor Lake	350	Zn,Pb,Ag	8.0	108,212	111,418	632,385
Gaspé Copper Mines, Limited	Gaspé	Murdochville	7,000	Cu	na	2,694,100	2,676,300	516,000
Manitou-Barvue Mines Limited	Golden Manitou	Val d'Or	1,300	Cu,Zn,Ag,Pb	4.52	169,140[8]	174,365[8]	657,815
Mattagami Lake Mines Limited[6]	Mattagami Lake	Matagami	3,000	Zn,Cu,Ag	1.31	[6]	166,725	na
New Calumet Mines Limited[1]	New Calumet	Grand Calumet Island	750	Pb,Zn,Ag	3.68	95,623	93,360	289,403
Noranda Mines, Limited	Horne	Noranda	3,200	Cu	na	901,500	819,700	na
Normetal Mining Corporation, Limited .	Normetal	Normetal	1,000	Cu,Zn,Ag	1.83	354,751	345,384	483,598
Quemont Mining Corporation, Limited..	Quemont	Noranda	2,300	Cu,Zn	0.79	804,600	803,003	425,048
Solbec Copper Mines, Ltd.	Solbec	Northeast of Sherbrooke	1,000	Cu,Zn,Pb,Ag	1.54	271,384	188,493	147,809
New Brunswick								
Heath Steele Mines Limited	Heath Steele	Bathurst dist.	1,500[9]	Cu,Zn,Pb,Ag	2.53	na	265,939	395,168
Nova Scotia								
Magnet Cove Barium Corporation	Magnet Cove	Walton	125	Ag,Pb,Zn,Cu	12.8	47,416	49,058	545,035
Newfoundland								
American Smelting and Refining Company (Buchans Unit)	Buchans	Buchans	1,250	Zn,Pb,Cu,Ag	4.09	378,000	376,000	1,379,783

(1) Production for the fiscal year ending September 30, 1963.
(2) COMINCO's total silver production, including that from purchased ores and concentrates was 6,847,606 ounces.
(3) INCO operates six nickel-copper mines in the Sudbury district and the Thompson nickel-copper mine in northern Manitoba. The ores from the Sudbury district mines are treated in three mills having a combined daily capacity of 48,000 tons. The Thompson mill has a daily capacity of 6,000 tons.
(4) Ore production includes the output of the Thompson, Manitoba, mine.
(5) Silver delivered to markets.
(6) Production commenced in 1963.
(7) Shipments via the Temiskaming Testing Laboratory.
(8) Production does not include copper ore milled in a separate circuit. In 1963, 293,000 tons were milled.
(9) One half of Heath Steele's mill capacity is used to treat copper ore from The Wedge mine operated by The Consolidated Mining and Smelting Company of Canada Limited.

Symbol: na Not available.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRODUCERS*

1. American Smelting and Refining Company (Buchans Unit)
2. Magnet Cove Barium Corporation
3. Heath Steele Mines Limited
4. Gaspé Copper Mines, Limited
5. Solbec Copper Mines, Ltd
6. New Calumet Mines Limited
7. The Coniagas Mines, Limited
8. Mattagami Lake Mines Limited
   Orchan Mines Limited
9. Manitou-Barvue Mines Limited
   Noranda Mines, Limited
   Normetal Mining Corporation, Limited
   Sullico Mines Limited
   Quemont Mining Corporation, Limited
10. Agnico Mines Limited
    Deer Horn Mines Limited
    Glen Lake Silver Mines Limited
    Langis Silver & Cobalt Mining Company Limited
    Keely-Frontier Mines Limited
    McIntyre-Porcupine Mines, Limited, Castle Division
    Silver Summit Mines Limited
    Siscoe Metals of Ontario Limited
11. The International Nickel Company of Canada, Limited
12. Geco Mines Limited
    Willroy Mines Limited
13. Hudson Bay Mining and Smelting Co., Limited
14. The Consolidated Mining and Smelting Company of Canada Limited
    Bluebell mine
    Sullivan mine
15. Mastodon-Highland Bell Mines Limited
16. United Keno Hill Mines Limited

*Some small producers are omitted.

REFINERIES

17. Canadian Copper Refiners Limited
18. Royal Canadian Mint
19. Cobalt Refinery Limited
20. The International Nickel Company of Canada, Limited
21. Hollinger Consolidated Gold Mines, Limited
22. The Consolidated Mining and Smelting Company of Canada Limited

British Columbia

Heightened activity was reported in various sections of the province. Dolly Varden Mines Ltd. reported continuing favorable results from exploration on properties in the Alice Arm area, 70 miles north of Prince Rupert. In the Stewart area, also north of Prince Rupert (about 110 miles), Silbak Premier Mines, Limited, made preparations to erect a small mill. On Vancouver Island, at its Buttle Lake property Western Mines Limited has outlined base-metal silver-bearing reserves by both surface and underground exploration. Consideration was given to the erection of a 750-ton mill on the property and to starting production before the end of 1964. Several companies were active in the Slocan district, some of which are planning to commence production. Near Slocan City, Ottawa Silver Mines Ltd., which during the year made fairly regular ore shipments to Trail, commenced milling early in 1964 at about 25 tons a day.

Ontario

Exploration and development activity was at a high level in the Cobalt and Gowganda areas. In addition to the producing companies, at least eighteen companies were active in the area. Several of these companies had intermittent shipments of ore treated on a custom basis at established mills. In July, Silver Summit Mines Limited commenced continuous production of a silver concentrate in its 200-ton mill and another new producer, Keeley-Frontier Mines Limited, was in continuous production from January to about mid-December when milling was suspended to permit resumption of underground exploration. While the silver refinery at Cobalt did not operate continuously, its output, nevertheless, was much greater than in 1962 – 2,047,503 ounces compared with 848,654 ounces. Shipments of high-grade concentrates and metallics via Temiskaming Testing Laboratories totalled 4,253,534 ounces compared with 3,728,585 ounces in 1962. They would have been higher had not the Castle mine of McIntyre-Porcupine Mines, Limited, been closed due to a strike of employees.

Quebec

Mining of zinc-copper and copper ores by Mattagami Lake Mines Limited, Orchan Mines Limited and New Hosco Mines Limited, all in the Matagami Lake area 100 miles north of Amos in the northwestern section of the province, began in the last quarter of 1963. The ores, which contain about 1.25 ounces of silver a ton, were concentrated in two mills having a combined daily capacity of 4,900 tons. The base-metal mine in the Eastern Townships, operated by Solbec Copper Mines, Ltd., one of Quebec's large producers of byproduct silver, was closed by strike action for five months.

New Brunswick

Production of base-metal ore, containing over 2.5 ounces of silver a ton, from the Number 12 property of Brunswick Mining and Smelting Corporation Limited was scheduled to commence in March 1964 at approximately 3,000 tons daily. Within the following six months, production was to be increased to 4,500 tons a day. The Number 12 property is one of a number of base-metal properties in the Bathurst area which hold promise of becoming substantial producers of silver within the next few years.

Nova Scotia

A number of companies including New Jersey Zinc Exploration Company (Canada) Ltd. and Talisman Mines Limited did some exploration along a geological zone in the Walton area in which base-metal mineralization has been known for some time. The Magnet Cove Barium Corporation barite and lead-zinc-silver mine in this zone has been an important source of silver since October 1961.

USES

Of silver's many uses, the manufacture of coinage continues to be the most important by a wide margin. According to Handy and Harman*, Free World consumption of silver for coinage totalled 172.2 million ounces or 41 per cent of the total consumption. Silver's wide popularity as a coinage metal is due to its resistance to corrosion, its relative scarcity and its attractiveness. Large amounts of silver are consumed by the photographic industry which makes use of the light sensitivity and ease of reduction of certain silver compounds, all of which are made from silver nitrate. Jewelry, silverware and silverplate also account for a large portion of the silver consumed. Silverplate, however, is meeting severe competition from stainless steel which in recent years has become quite popular in Canadian homes.

Since World War II, growing use has been made of silver's special properties. Of all metals, silver is the best conductor of electricity and heat. Also, it imparts desirable properties to solders, making them usable with nearly all metals and many alloys. Silver solders are used in refrigeration and air conditioning, and in automotive, electrical appliance and less-common industries, such as those concerned with the manufacture of jets and rockets in assemblies required to withstand high temperature. Silver-zinc and silver-cadmium batteries are finding increasing application in portable equipment where long life and rechargeability are required. These batteries are used in jet aircraft, missiles, satellites and space capsules where dependability is of prime importance.

* *The Silver Market in 1963* compiled by Handy and Harman, a large United States silver consumer.

PRICES

During the first half of the year, the Canadian price gradually increased from $1.3087 an ounce to $1.3960 by July 2. For the remainder of the year the price fluctuated around $1.40 reaching its highest level of $1.4050 on September 9. At year end it was $1.4030.

TARIFFS

	British Preferential	Most Favored 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

Consumption and Prices

Estimated Free World consumption of silver for industrial purposes in 1963 at 252.2 million ounces showed little change from the 247.8 million ounces consumed in 1962. In the United States the larger amounts of silver consumed in certain applications, such as for electrical and electronic purposes, were offset by the lesser amounts of silver used in the manufacture of silverplate and sterling silverware, and it is thought this trend was similar in other Free World countries as well. Consumption of silver for photographic uses remained almost static because of the increasing interest in color photography which requires less silver than black and white photography. Owing to the high price of silver, users are looking for substitutes with the result that growth in silver usage for industrial purposes may tend to level off in the future. Usage of silver for coinage was considerably higher than in 1962. This increase was largely attributable to increases in Canada (13.0 million compared with 10.9 million ounces) and in the United States (111.5 million compared with 77.4 million ounces).

In the United States a bill was passed in June which freed silver from government controls, repealed the Silver Purchase Acts, removed the transfer tax on silver bullion, and authorized the replacement of small denomination silver certificates with Federal Reserve notes. This authorization had the effect of making available at the statutory price of $1.2929 an ounce the reserve of 1.7 billion ounces of silver bullion held by the United States as backing for silver certificates. Because silver has been in short supply for some time, prices soon reached this level and by early September the Treasury Department made its first exchange of silver bullion for silver-backed certificates which are withdrawn from circulation as the silver is accepted for nonmonetary uses. By the end of 1963, withdrawals from the Treasury Department for non coinage purposes were being made at an annual rate of 60 to 65 million ounces and the silver withdrawn for coinage amounted to 111.5 million ounces. As long as these withdrawals can be made and as long as silver can be freely exported from the United States, the Free World price of silver will tend to remain close to $1.29 an ounce. The United States price, and the prices in Britain and Canada, expressed in United States funds, have been close to this level since early in July.

Production

On a mine-production basis, Mexico, as has been the case for many years, led the world in 1963 with an estimated output of 42.8 million ounces. Peru, with a production estimated at 36.4 million ounces, was the next largest producer followed by United States and Canada. Free World production in 1963, as estimated by Handy and Harman was 213.1 million ounces, some 7.4 million ounces higher than the 205.7 million ounces reported in 1962.

TABLE 4

World Production of Silver, 1963

(Troy Ounces)

Mexico	42,800,800
United States	35,000,000*
Peru	36,400,000
Canada	30,700,000p
Russia	27,000,000e
Australia	18,900,000
Japan	8,800,000
Other countries	49,900,000
Total	249,500,000

Source: U.S. Bureau of Mines, *Minerals Yearbook 1963.*
* Refinery production from domestic ores and concentrates; mine production was 35,243,000 ounces.
Symbols: e Estimated; p Preliminary.

Sodium Sulphate

C.M. Bartley*

Production and consumption of sodium sulphate in Canada reached all-time highs in 1963. Imports were down slightly from 1962 and although exports were also lower, industrial activity at year-end indicated a continuing expansion in 1964. Plants based on evaporite crystal beds in Saskatchewan lakes are the main sources of Canadian sodium sulphate. One plant, at Cornwall, Ontario, produces byproduct salt cake.

About 95 per cent of the sodium sulphate consumed in Canada is used by the pulp and paper industry. Expansion in the kraft pulp portion of this industry indicates increasing needs for sodium sulphate, particularly in British Columbia. For this reason the future of the sodium sulphate industry in Canada appears promising.

PRODUCTION AND TRADE

Production (shipments) of sodium sulphate at five plants in Saskatchewan totalled 257,000 tons valued at four million dollars in 1963. Imports dropped about 40 per cent – from 31,000 to 19,000 tons, and exports were down about 12 per cent at 65,000 tons.

The high rate of activity in the Canadian pulp and paper industry during 1963 accounted for increased shipments. In the United States the paper industry also operated at high rates. However, similar high production rates in the industries which produce byproduct sodium sulphate in the southern States made it difficult for Canadian producers to compete with reduced prices from this source of salt cake. In addition, imports of European salt cake on the east coast of the United States reduced the market available to Canadian producers in that area.

Current and planned construction of kraft pulp production capacity in Canada suggests an expansion of about 80 per cent by 1968. This would require substantial additional amounts of sodium sulphate.

*Mineral Processing Division, Mines Branch

TABLE 1
Sodium Sulphate – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)	246,672	3,954,273	256,914	4,121,114
Imports				
Crude sodium sulphate, or salt cake				
United States	22,272	398,948	12,931	255,851
Britain	9,075	210,010	6,054	129,690
West Germany	nil	nil	17	496
Total	31,347	608,958	19,002	386,037
Glauber's salt				
West Germany	129	4,791	324	11,284
United States	294	17,155	167	16,205
Britain	3	633	4	691
Total	426	22,579	495	28,180
Exports				
Crude sodium sulphate				
United States	74,049	1,210,958	65,348	1,076,969
	1962		1963	
Consumption				
Pulp and paper	203,000[e]		204,787	
Glass, including glass wool	2,308		2,866	
Soaps	4,168		4,172	
Other products	1,215		10,176	
Total	210,691		222,001	

Source: Dominion Bureau of Statistics.
e Estimated.

Over the past ten years Canadian consumption of salt cake has varied from 80 to 100 per cent of production and exports have ranged from 23 to 43 per cent of production. The United States is the single export market at present.

DEPOSITS

Sodium sulphate is found in many lakes and ponds of southern Saskatchewan in the form of brines and intermittent or permanent crystal beds. Sulphates in the soil are dissolved by the water from rains and snowfalls and the solutions collect in closed drainage basins. In the summer evaporation reduces the water content of the brine; the crystals are then precipitated as the weather cools in the fall. The seasonal repetition of this cycle over a long period has accumulated thick beds of sodium sulphate crystal in numerous lakes.

Sodium sulphate occurs in nature as Glauber's salt, or mirabilite ($Na_2SO_4 \cdot 10H_2O$), and to a lesser degree as anhydrous sodium sulphate, or thenardite (Na_2SO_4). Both minerals are soluble in water and the solubility increases as the temperature rises. The variable solubility with temperature is used advantageously in Saskatchewan to recover a relatively pure product from the natural occurrences.

Reserves in Saskatchewan have been estimated at more than 200 million tons. Fifteen of the larger deposits have been estimated to contain at least one million tons each. Similar though smaller reserves occur in Alberta and British Columbia.

RECOVERY AND PROCESSING

The first production of sodium sulphate from Saskatchewan was obtained by harvesting raw crystal from dried and frozen lake beds in the winter. This method is still in use but most of the production is now obtained by pumping concentrated lake brines to prepared reservoirs in the summer months, 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 possible concentration and the remaining liquid, which contains some undesirable elements, is returned to the lake before crystallization in the reservoir is complete. The crystal bed is later removed to the plant 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.

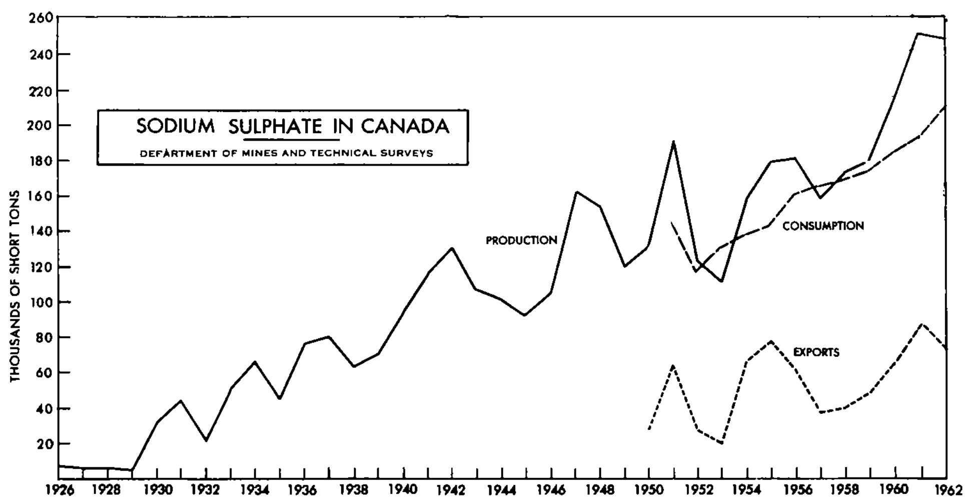


TABLE 2

Sodium Sulphate – Production, Trade and Consumption, 1954-63

	Production[1]	Imports		Exports[2]	Consumption
		Salt Cake	Glauber's Salt		
1954	158,417	30,235	5,134	66,049	138,275
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[3]	200,096r
1962	246,672	31,347	426	74,049	210,691
1963	256,914	19,002	495	65,348	222,001

Source: Dominion Bureau of Statistics except where otherwise indicated.
[1]Producers' shipments of crude sodium sulphate. [2]Exports to the United States for 1954 as reported by the U.S. Department of Commerce, Bureau of the Census, in *United States Imports of Merchandise for Consumption (Report FT 110)*. For 1955 and the years following as reported in *Trade of Canada* (DBS). [3]Revised to exclude 84 tons valued at $10,500 to Malaya appearing in *Trade of Canada*. The material was not sodium sulphate.
r Revised.

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 availability of natural gas in Saskatchewan has helped to increase production and improve efficiency in several plants, mainly as savings on storage, maintenance and corrosion costs that were appreciable when fuels such as low-grade coal or heavy oils were used. The end product from the processing plants is usually marketed as a bulk product grading about 97 per cent Na_2SO_4.

TABLE 3

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

PRODUCING COMPANIES

Table 3 lists four 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 byproduct salt cake annually.

Saskatchewan Minerals, Sodium Sulphate Division, operated plants at Chaplin and at Bishopric, alternately, with one crew. This arrangement provides full-time employment for the operating staff while allowing time for evaporation to increase the concentration of sodium sulphate in the lake brine before it is pumped into the reservoirs.

Midwest Chemicals Limited and Ormiston Mining and Smelting Co. Ltd. report plant and process improvements and sales at satisfactory levels.

INDUSTRY ACTIVITIES AND OUTLOOK

Various methods of processing sodium sulphate from several deposits in Saskatchewan have been investigated by the Research Council of Saskatchewan. The characteristics of the individual deposits determine which process is most efficient. In addition, attention has been directed to the possibility of combining sodium sulphate or natural sodium sulphate lake brines, and potassium chloride from the new potash operations, to produce potassium sulphate fertilizers. Several possible processes have been considered.

In Alberta, Western Chemicals Ltd. have done some work on a sodium sulphate deposit in that province.

Domtar Chemicals Limited conducted diamond drilling and technical studies on the Weldon, New Brunswick glauberite ($Na_2SO_4.CaSO_4$) deposits over a two-year period. This work was directed to the recovery of commercial sodium sulphate from the glauberite ore. As a result of these studies the company decided to abandon its mineral rights late in 1963.

Because the kraft pulp industry consumes most of the sodium sulphate produced, future expansion of sodium sulphate depends on activity in the pulp and paper industry. New kraft pulp capacity is under construction, and additional plants are planned throughout Canada. Most of the increase will be in British Columbia but other additions are being made from Newfoundland to Northern Ontario.

With large reserves, efficient recovery and processing methods, rising consumption in the chief market (kraft paper) and an improvement in rail freight rates and delivery schedules, the Canadian sodium sulphate industry appears to be well established and in a position to experience further growth.

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 1963 was $16.50 a ton.

United States

According to the *Oil, Paint and Drug Reporter* of December 30, 1963, United States prices of sodium sulphate were:

Anhydrous, technical-grade, bags, car lots, per short ton	$56.00
Detergent, rayon-grade, car lots, per short ton – bags, f.o.b. works	$38.00
bulk	$34.00
Crude (salt cake), 100% Na_2SO_4, domestic, bulk, f.o.b. works, per short ton	$28.00

TARIFFS

	British Preferential	Most Favored Nation	General
Canada			
Crude, or 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	

Stone, Building and Ornamental

F.E. Hanes*

The estimated value** of stone produced in Canada in 1963 was $6,302,000, an increase of almost four per cent over the 1962 value***. Estimated increases in the production of sandstone and limestone during 1963 are the principal reasons for the overall increase in total value compared with 1962.

The value of the 1963 sandstone product increased 38.7 per cent; limestone increased 4.2 per cent. Decreases in the value of marble and granite production amounted to 27.2 per cent and 3.4 per cent, respectively.

The estimated volume** of stone produced in 1963, 171,000 short tons, was an increase of 8.9 per cent over the 1962 volume. Increases in sandstone and limestone production of 29 and 4.9 per cent, respectively, during 1963 offset decreases in volume for marble and granite production of 372 and 1,458 short tons, or 15.7 per cent and 2.8 per cent, respectively.

Quebec produces approximately 80 to 85 per cent of the total granite quarried in Canada. On this basis, Quebec's granite production alone amounts to approximately 40 per cent of the value of Canadian building and ornamental stone production. The total value of Quebec production is almost 63 per cent of the total Canadian production value. Ontario with 69,000 short tons production, or 40.4 per cent of the total Canadian production of 171,000 short tons, leads all other provinces. Quebec with 38 per cent was second and the remaining 21.6 per cent was produced in equal amounts by the Western Provinces and the Maritime Provinces.

*Mineral Processing Division, Mines Branch
**Estimated from preliminary data based on past trends.
***The 1962 final figures show a large variation from previous estimates.

TABLE 1

Canadian Production of Building and Ornamental Stone 1962 and 1963

	1962		1963e	
	Short Tons	$	Short Tons	$
Granite	51,458	3,305,856	50,000	3,195,000
Limestone	58,142	1,851,157	61,000	1,928,500
Marble	2,372	118,739	2,000	86,500
Sandstone	44,991	787,254	58,000	1,092,000
Total.............	156,963	6,063,006	171,000	6,302,000

e Estimated

TABLE 2

Canadian Production of Building and Ornamental Stone, by Areas – 1962 and 1963

	1962		1963e	
	Short Tons	$	Short Tons	$
Atlantic Provinces ...	17,052	474,595	19,000	493,000
Quebec	59,866	3,810,641	65,000	3,961,000
Ontario	63,390	1,009,263	69,000	1,049,000
Western Provinces ...	16,655	768,507	18,000	799,000
Total.............	156,963	6,063,006	171,000	6,302,000

e Estimated

IMPORTS AND EXPORTS

The value of Canadian imports of building and ornamental stone, $3.3 million, decreased by 7.8 per cent in 1963 compared with 1962.

Sawn granite and manufactured products imported into Canada dropped in value from $623,000 to $436,000, but imported rough granite blocks increased in value from $453,000 to $522,000. These variations in value which on the surface, appear to favor the Canadian quarrying industry, are misleading. Both the sawn block and the manufactured product represent a much higher dollar value per ton of rock than the rough block. In reality the increased value of imported rough block indicates that a much larger volume of rock is involved compared with the volume of imported sawn and manufactured granite products. The volume of the rough granite import is directly competitive with our domestic product. However, a decrease in domestic tonnage of rough block is not necessarily indicated by the statistics shown.

TABLE 3

Production of Building and Ornamental Stone, 1962

	Granite		Limestone		Marble		Sandstone		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
By Type										
Building										
Rough	11,861	293,572	21,320	214,776	447	9,630	22,697	459,883	56,325	977,861
Dressed	16,719	1,933,176	30,700	1,593,101	1,925	109,109	14,679	241,729	64,023	3,877,115
Total	28,580	2,226,748	52,020	1,807,877	2,372	118,739	37,376	701,612	120,348	4,854,976
Monumental										
Rough	12,721	424,996	84	299	—	—	—	—	12,805	425,295
Dressed	6,781	599,453	—	—	—	—	—	—	6,781	599,453
Total	19,502	1,024,449	84	299	—	—	—	—	19,586	1,024,748
Flagstone	1,999	23,864	6,008	42,648	—	—	7,517	83,993	15,524	150,505
Curbstone	1,352	29,595	30	333	—	—	98	1,649	1,480	31,577
Paving	25	1,200	—	—	—	—	—	—	25	1,200
Total	3,376	54,659	6,038	42,981	—	—	7,615	85,642	17,029	183,282
Grand Total	51,458	3,305,856	58,142	1,851,157	2,372	118,739	44,991	787,254	156,963	6,063,006
By Areas										
Atlantic Provinces	1,357	222,522	768	3,349	—	—	14,927	248,724	17,052	474,595
Quebec	37,648	2,767,824	19,208	920,427	2,097	113,239	913	9,151	59,866	3,810,641
Ontario	3,507	44,118	30,583	432,658	275	5,500	29,025	526,987	63,390	1,009,263
Western Provinces	8,946	271,392	7,583	494,723	—	—	126	2,392	16,655	768,507
Total, Canada	51,458	3,305,856	58,142	1,851,157	2,372	118,739	44,991	787,254	156,963	6,063,006

Symbol: — Nil

The value of marble imports was down by approximately 10 per cent in 1963. A 51.6-per-cent decrease in the value of imported rough marble block is an indication of the curb on foreign marble buying. The popularity of numerous recently exploited Canadian marbles is probably an influencing factor. Estimates shown in Table 1 for domestic marble production are not directly comparable with dollar values for imported materials since estimates are based on previous values of low domestic production.

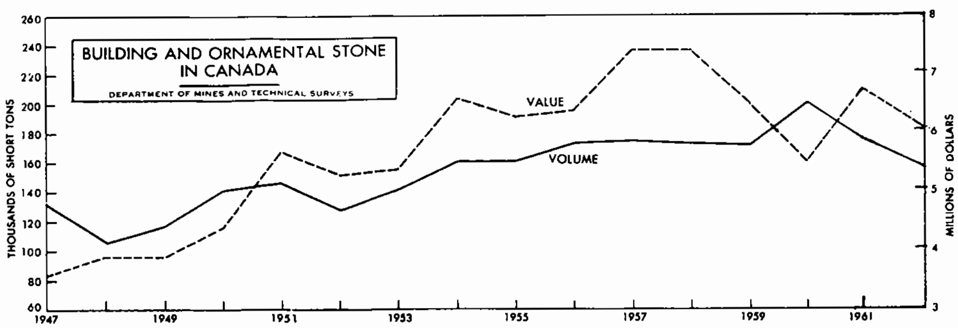
Imports of slate manufactures increased $87,000 to $252,000. No slate industry exists in Canada. Local quarrying is sporadic and the product is usually of low quality.

Imports of limestone and possibly some sandstone decreased in value by $77,500 to $580,000, or 11.8 per cent. The volume of this commodity for the same period decreased by 5,279 short tons, or 22.1 per cent.

The value of exports of Canadian building and natural stone basic products, increased in value to $870,000 in 1963, 147 per cent, compared with the 1962 value of $352,000.

The value of rough building stone exported from Canada increased 94.4 per cent to $502,000. The volume increased by 9,300 tons, 64.6 per cent, to 23,722 tons.

Additional exports of stone classed as natural stone basic products, increased in value in 1963 to $368,000 – almost four times their 1962 value.



Dimension Stone

Dimension stone is the name given to stone from deposits of igneous, sedimentary and metamorphic rocks which can be quarried in large blocks, is amenable to sawing and shaping and is for building and ornamental use. Such stone must be sufficiently durable to ensure sound quality products.

TABLE 4

Building and Ornamental Stone, Imports and Exports

	1962		1963	
	Quantity	$	Quantity	$
Imports				
Granite				
Rough		452,860		521,853
Sawn		195,563		135,768
Manufactures		427,056		300,159
Total		1,075,479		957,780
Marble				
Rough		160,517		77,669
Sawn		1,091,774		1,019,945
Marble for tombstones		42,660		47,607
Ornamental for churches		124,723		174,446
Other manufactures		260,755		189,019
Total		1,680,429		1,508,686
Slate				
Roofing (squares)	871	26,861	475	14,530
Manufactures		138,524		237,392
Total		165,385		251,922
Building stone, other than marble or granite (short tons)	23,898	657,913	18,619	580,438
Total building and ornamental stone		3,579,206		3,298,826
Exports				
Building stone, rough* (short tons)....................	14,415	258,521	23,722	502,432
Natural stone, basic products**		93,423		367,707
Total		351,944		870,139

*Includes building stone, unwrought, and granite and marble, unwrought.
**Includes all kinds of building stone.

CANADIAN DEPOSITS OF BUILDING AND ORNAMENTAL STONE

Building and monumental stone is quarried from igneous, sedimentary and metamorphic rocks. Table 5 gives the sources of building and ornamental stone.

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 produced 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-colored, medium-grained granite in the Antinouri Lake district is a potential producer. 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 quarried sporadically in 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 – Chicoutimi area; blue-grey, rose-grey, deeper pink-grey, green and black, and white gneissic granites come from the Riviere a Pierre district; pink, fine-grained granite is quarried at Guenette, near Mt. Laurier. St. Alban supplies a pink-red granite and St. Raymond has a banded gneiss. Brown-red to green-brown granites are quarried in the Grenville district. An augen-type, coarse-grained, rose-pink granite is obtained south of Mont Tremblant. A mauve-red granite is produced in the Ville Marie 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-colored 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.

Manitoba – A durable, red granite of good quality is being quarried in the Lac du Bonnet area, 70 miles northeast of Winnipeg. A potential grey-granite deposit is also being investigated for production.

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 at several quarries in the vicinity of St. Marc des Carrieres. The stone, besides being used in rough and sawn finishes, takes a high 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 can be quarried at scattered points in the province.

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 several quarries in the Garson area. It is effectively used in rough and sawn finishes and can take a high 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 being produced from an old quarry in Sackville.

Ontario – From thin-bedded sandstone deposits, numerous quarries along the scarp face of the Caledon Hills, between Georgetown and Orangeville, produce a fine-grained, sometimes mottled or speckled building stone that is vari-colored in light buff, brown and deep brown-red. Medium-grained, buff- to cream-colored stone near Bells Corners is now limited in its output. A highly colored, 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.

Sulphur

C.M. Bartley*

The unexpected surge in sulphur demand during 1963 resulted in a marked change in the supply-demand balance, a sharp rise in production and trade and, at the end of 1963, firming prices and brightening hopes of a rise in prices. Against this background Canadian production of sulphur increased substantially, but of particular significance in Canada was the 80 per cent increase in elemental sulphur sales. Instead of the expected surplus Canadian elemental sulphur producers, although nearly doubling output, added only about 150,000 tons to stockpiles. Sales from western Canada in 1963 very nearly equalled the stockpile accumulated over the past five years. At the end of 1963 it was apparent that world production had not kept pace with the rise in consumption and that shortages, rather than surpluses, might be a cause for concern in the future.

Some additions to sulphur productive capacity in Alberta were planned for 1964 but no large increase in output is expected until demand for natural gas expands to the point that new cleaning plants are required. For various reasons several plants in western Canada have not been operated at full capacity, and with demand for sulphur rising, it appears possible that some additional production might be obtained by operating these plants at capacity, or by drawing on gas of higher H_2S content without increasing sales gas production.

Sour gas sulphur reserves are considered to be adequate for any near term demand and vastly larger reserves are available in the Athabasca oil-sand deposits. One oil-sands project now under constrution will produce about 150,000 tons of sulphur per year when operations begin in 1967.

Estimated world production of sulphur from all sources in 1963, listed in Table 8, was in near balance with demand. In the Free World countries consumption of sulphur in all forms increased about 6 per cent and total demand for Free

*Mineral Processing Division, Mines Branch

TABLE 1

Sulphur – Production and Trade

	1962		1963	
	Short Tons	$	Short Tons	$
Production				
Pyrite and pyrrhotite [1]				
Gross weight	517,308		476,438	
Sulphur content	257,084	1,879,584	235,410	1,643,629
Sulphur in smelter gases[2]	292,728	3,089,537	353,243	3,488,181
Elemental sulphur [3]	695,098	9,286,999	1,249,887	13,380,182
Total sulphur content	1,244,910	14,256,120	1,838,540	18,511,992
Imports (elemental sulphur)				
United States	194,989	4,629,132	150,579	3,499,830
France	100	8,456	58	5,565
Total	195,089	4,637,588	150,637	3,505,395
Exports				
Sulphur in ores (pyrite)				
United States	na	890,055	na	881,506
Taiwan	–	–	na	56,377
Total		890,055		937,883
Sulphur, crude and refined				
United States	327,548	5,373,949	534,258	7,101,242
U.S.S.R.	–	–	59,211	947,376
Britain	15,315	297,300	55,414	915,267
Australia	24,010	435,011	42,287	730,978
India	6,131	84,840	36,777	582,786
Republic of South Africa	–	–	31,978	509,348
Britain	11,199	218,168	18,788	280,008
Japan	–	–	18,545	520,458
New Zealand	–	–	14,342	229,472
Philippines	1,099	19,144	2,522	41,795
Chile	–	–	2,240	36,000
Indonesia	2,041	37,565	2,078	37,011
Pakistan	1,659	22,469	1,375	19,160
Colombia	–	–	1,114	21,445
Belgium and Luxembourg	5,689	61,581	–	–
Korea	4,342	78,310	–	–
Malaya	993	21,606	–	–
Total	400,026	6,649,943	820,929	11,972,346

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: – Nil; na Not available.

World sulphur, including Communist Bloc purchases, rose 12 per cent above that of 1962. With consumption and demand rising abruptly, and only minor additions to production on a world scale, world stocks of sulphur increased only fractionally. At the end of 1963 it was apparent that a continued high rate of consumption in 1964 might seriously reduce current stocks in some areas.

Because current expansions may not be capable of supplying increasing demands, efforts will probably be made to increase productive capacity. In the

TABLE 2

Sulphur – Production, Trade and Consumption, 1954–63

(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]
1954	311,159	221,247	22,320	554,726	310,127	188,608	3,339	358,953
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

Source: Dominion Bureau of Statistics.
[1]Sulphur content of pyrite and pyrrhotite shipped by producers. Not necessarily all recovered. For 1954–55, 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. Refers to production for the period 1954–56 and, from 1957 on, to sales. 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; the value is shown instead. [5]Exports of sulphur produced from natural gas and other sources. [6]Consumption of elemental sulphur by industries. Coverage is incomplete.

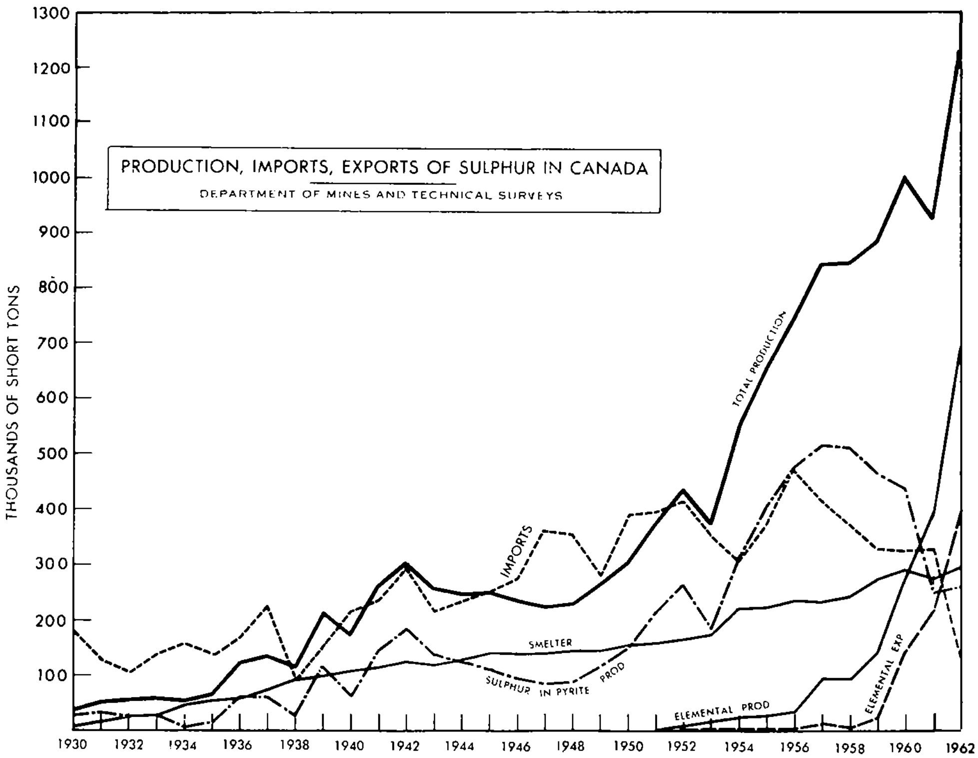


TABLE 3

Consumption of Elemental Sulphur in Canada, 1963

(short tons)

Pulp and paper	299,895
Heavy chemicals, fertilizer	218,354
Rubber goods	3,125
Medicinals	9
Adhesives	50
Starch	335
Sugar refining	88
Petroleum refining	131
Iron and steel	1,375
Asbestos products	30
Miscellaneous nonmetallic products	173
Miscellaneous chemicals	2,230
Total	525,795

Source: Dominion Bureau of Statistics.

meantime it appears likely that several unexpected developments will occur in 1964. Sulphur prices will rise, sulphur from pyrites will become more attractive, aggressive efforts will be made to expand world production and, over the short term, the Frasch sulphur producers in the United States and Mexico will again become the strongest sectors in marketing of sulphur.

The changed sulphur situation at the end of 1963 can only result in benefit to Canada because, although no large increase in production appears possible, income from sulphur will increase as prices rise.

PRODUCTION AND TRADE

Canadian production of sulphur from all sources was about 2 million tons in 1963. Total elemental sulphur was about 1.4 million tons, smelter gas sulphur about 0.35 million tons and the sulphur equivalent of pyrites provided most of the balance.

Sulphur imports fell from 195,000 tons in 1962 to 150,000 tons in 1963 as domestic producers expanded their markets in Canada.

Exports of Canadian sulphur increased 105 per cent, from 400,000 tons in 1962 to 820,000 tons in 1963. The United States purchased 534,000 tons, 192,000 tons went to countries bordering the Pacific Ocean and 72,000 tons went to South Africa and several Asian countries. A contract for 300,000 tons or more over the next three years has been obtained in Australia and it is expected that shipments to several other countries will be increased in 1964. Sulphur exports have a double effect on Canadian trade and foreign exchange figures: they earn foreign funds and at the same time reduce foreign expenditures as sulphur imports become smaller.

Sulphur consumption in 1963 was about 3,000 tons above that of 1962. The considerable expansion of sulphur consuming industries now taking place in Canada (notably fertilizer) indicates that consumption will continue to increase, perhaps more steeply than in the past.

Since the first recovery of 8,931 tons of sulphur from natural gas in Canada in 1952 output has risen to more than one million tons. Production will continue to increase as requirements for natural gas expand and, possibly, directly in response to sulphur demand. The recovery of sulphur from natural gas, together with the simultaneous production of condensate, propane, butane and other hydrocarbons means that the production costs chargeable to sulphur, or any other single fraction recovered, are relatively low. This, in addition to the large reserves of sulphur available in known gas reserves, provides a base for a strong industry that is relatively secure from the hazards of fluctuating sulphur prices. Furthermore, the availability of reliable supplies of low-cost sulphur in western Canada will encourage the development of sulphur consuming industries, such as fertilizer and chemical, with all the resulting benefits in employment, domestic and foreign trade earnings and secondary industry which will follow.

TABLE 4

Producers of Pyrite and Pyrrhotite Concentrates

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

*These companies sell pyrite concentrate to consumers.

Pyrites – Pyrite, Pyrrhotite and other Sulphides

Pyrites, the traditional source of sulphur in Canada, have lost some markets to lower cost elemental sulphur, but the current pyrites operations appear to be stable. The world-wide increase in demand for sulphur in 1963 is expected to make pyrites sources of sulphur more attractive in some parts of the world if sulphur shortages appear or prices increase. For various reasons Europe and Asia are areas where this may occur. It is doubtful that the use of pyrites will increase appreciably in North America, because the production and transportation of sulphur is adequate, but Canadian pyrites exports may increase. Pyrites cannot compete with sulphur for all markets but under conditions where sulphur dioxide gas, iron oxide residues, and possibly some recoverable amounts of other elements are of value, pyrites may be attractive. The determining factor is usually the availability of reliable supplies of byproduct pyrite concentrate, in close proximity to large-scale processing plants. The fact that pyrites often move the long distances to consumers in Europe, Japan and the United States is a reflection of their value for several ingredients rather than for sulphur alone.

Canadian sources of pyrites are listed in Table 4, and production and trade are shown in Table 1. Canadian consumers using pyrites to produce sulphuric acid are: The Consolidated Mining and Smelting Company of Canada Limited (COMINCO), at Kimberley, B.C. ; The Nichols Chemical Company, Limited, at Barnat, B.C., Sulphide, Ontario, and Valleyfield , Quebec; Canadian Industries Limited at Cutler and Copper Cliff, Ontario; Sherbrooke Metallurgical Company Limited at Port Maitland, Ontario, and Aluminum Company of Canada, Limited at Arvida, Quebec. Several other companies could recover large amounts of pyrites concentrate but, because of their location, have no markets for it.

Smelter Gas

As shown in Table 2 the utilized sulphur content of smelter gases has increased steadily since 1954 to reach a high of 353,000 tons in 1963. It is expected that sulphur production from this source will increase as the consuming industries (largely fertilizer) integrated with smelters expand.

Sulphur dioxide gas recovered from smelter gases is cleaned and the concentrates are used to produce sulphuric acid and liquid sulphur dioxide. The main operations of this type are the smelters of COMINCO at Trail, B.C. and The International Nickel Company of Canada, Limited, (INCO) at Copper Cliff, Ontario. Similar recovery would be made at other smelting plants if markets for sulphuric acid were available.

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 recovered from pyrite by Noranda Mines, Limited, at Port Robinson, Ontario, from 1954 – 59, and from pyrrhotite by COMINCO at Kimberley from 1936 – 43.

Other Sulphur

The sulphur in nickel sulphide ore is converted into a 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 about 32,000 tons of sulphur are used in this process annually.

Sulphur from Oil Refineries

Many crude oils contain sulphur compounds which may be released as hydrogen sulphide gas during refining and recovered by the same processes that are 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. Production from these two plants is estimated at 35,000 tons a year.

Because North American crude oils normally contain only small amounts of sulphur, recovery from this source is not expected to be large in Canada.

The Shell Canada Limited refinery at Trafalgar, Ontario, now includes a unit with a capacity to recover 47 tons of sulphur a day.

Imperial Oil Limited is building a sulphur recovery plant with a capacity of 25 tons a day at its Sarnia, Ontario, refinery and The British American Oil Company Limited is building one to recover 40 tons a day at its Clarkson, Ontario, refinery. Both plants will be operating in 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 were large enough that sweet gas reserves were mainly committed, and large amounts of sour gas were required to fulfil the demands.

Before sour gas can be used as a fuel the hydrogen sulphide and other sulphur compounds in it 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. Hydrogen sulphide is removed by passing the sour gas through a solution (usually monoethanolamine) which has an affinity for hydrogen sulphide. Concentrated hydrogen sulphide is stripped from the solution by distillation, the hydrogen sulphide going to the sulphur furnace and the regenerated solution being recirculated. The hydrogen sulphide 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: firstly, the removal of hydrogen sulphide (H_2S) is obligatory if the gas is to be used as fuel; secondly, 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. As a low H_2S content in raw gas may be considered waste, sulphur derived from this material would be very low in cost because the raw material is free.

Reserves of sulphur in sour natural gas in western Canada at the end of 1962 are estimated to total more than 92 million short tons, and experienced engineers have suggested that three times this amount may eventually be found.

During 1963 seventeen gas-processing and sulphur-producing plants operated in western Canada. Several other plants will probably be built to process gas from fields not yet producing but the building date of these future plants is uncertain. Existing plants have excess capacity at present.

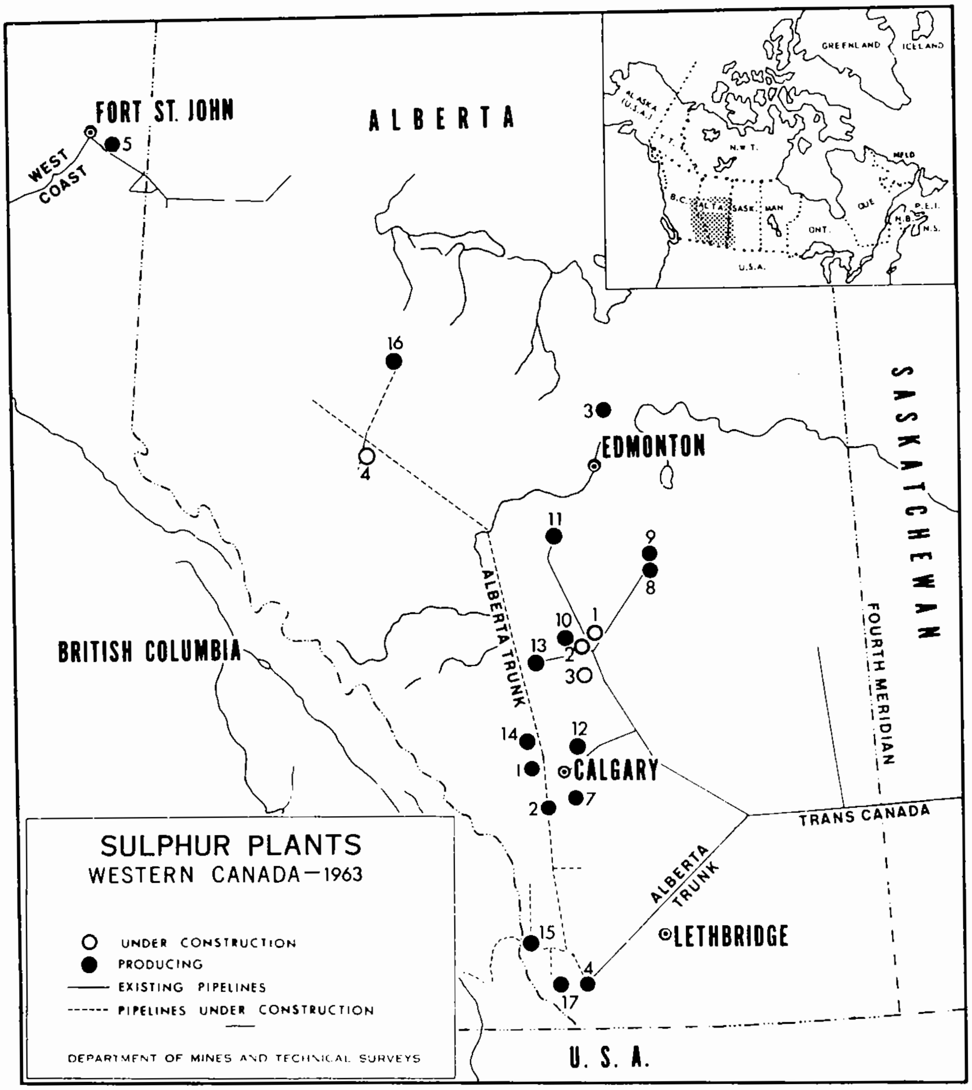
The accompanying map shows the location of the various sulphur producers and Table 5 lists operator, H_2S content of source gas and nominal capacity of the plant.

TABLE 5
Sulphur Plants, Western Canada, 1963

Operating Company	Source field	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.	4	110	38,000
2 Royalite Oil Company, Limited	Turner Valley, Alta.	4	33	11,500
3 Imperial Oil Limited	Redwater, Alta.	3	10	3,500
4 The British American Oil Company Limited	Pincher Creek, Alta.	10	755	264,000
5 Jefferson Lake Petrochemicals of Canada Ltd.	Taylor Flats, B.C.	3	330	115,000
6 Steelman Gas Ltd.	Steelman, Sask. (not shown on map)	1	7	2,400
7 Texas Gulf Sulphur Company	Okotoks, Alta.	35	415	145,000
8 The British American Oil Company Limited	Nevis, Alta.	4-6	85	30,000
9 The California Standard Company	Nevis, Alta.	6	130	45,000
10 Shell Canada Limited	Innisfail, Alta.	14	110	38,000
11 The British American Oil Company Limited	Rimbey, Alta.	2	280	98,000
12 Petrogas Processing Ltd.	East Calgary, Alta.	16	965	337,700
13 Home Oil Company Limited	Carstairs, Alta.	1	56	19,600
14 Canadian Fina Oil Limited	Wildcat Hills, Alta.	4	117	41,000
15 Jefferson Lake Petrochemicals of Canada Ltd.	Coleman, Alta.	14	420	147,000
16 Pan American Petroleum Corporation**	Windfall, Alta.	15-20	730	255,000
17 Shell Canada Limited	Waterton, Alta.	22-27	1,550	542,000
Totals			6,103	2,133,700
Plants under construction in 1963 (numbered on map and indicated by ⊙)				
1 Socony Mobil Oil of Canada, Ltd.	Wimborne and Three Hills Creek	16	368	128,000
2 Olds Gas Limited	Olds	7	122	42,700
3 Pan American Petroleum Corporation	Crossfield East	will recover sulphur in 1975		
4 Hudson's Bay Oil and Gas Company Limited	Edson	2	100	35,000
Totals			590	206,500
Grand Total			6,693	2,340,200

In addition, other plants of which details and location are not yet available, will be constructed in 1964 and 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.

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 to 1,200 tons a day in 1964 and to 1,800 tons a day later.



Athabasca Oil Sand Sulphur

The occurrence of oil-bearing sand 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 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.

TABLE 6

Sulphuric Acid – Production, Trade and Apparent Consumption, 1954–63

(short tons of 100% acid)

	Production	Imports	Exports	Apparent Consumption
1954	923,800	110	21,930	901,980
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	1,719,000	7,162	34,960	1,691,202
1963p	1,902,000	5,634	37,316	1,870,318

Source: Dominion Bureau of Statistics.
p Preliminary.

TABLE 7

Available Data on Consumption of Sulphuric Acid, By Industries, 1961 and 1962

(net tons of 100% acid)

	1963	1962
Iron and steel mills	55,106	58,604
Other iron and steel	13,200	15,000
Electrical products	4,872	4,500
Vegetable-oil mills	100	105
Sugar refineries	218	243
Leather tanneries	2,246	2,025
Textile dyeing and finishing plants	22	48
Pulp and paper mills	36,101	42,900
Processing of uranium ore	283,300	239,699
Manufacture of mixed fertilizers	161,512	237,497
Manufacture of plastics and synthetic resins	20,925	22,425
Manufacture of soaps and cleaning compounds	15,660	17,514
Other chemical industries	11,472	10,680
Manufacture of industrial chemicals[1]	833,405	884,000
Petroleum refining	13,777	12,843
Mining[2]	52,000	46,400
Miscellaneous[3]	96,300	65,369
Total accounted for	1,600,216	1,659,852

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, explosives ammunition and other petroleum and coal products.

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 increased to 1.9 million short tons in 1963. In spite of continued reduction in the amount of acid required for the treatment of uranium ores, production for other purposes has now reached a new peak.

The Cutler, Ontario acid plant, built by Noranda Mines, Limited, was sold to Canadian Industries Limited. Part of the plant was moved to Copper Cliff to expand production there and the other part continued to operate at Cutler.

TABLE 8

Estimated World Production of Sulphur in All Forms[1]

('000 short tons)

	1963					1962[4]
Country	Frasch	Other Solid Sulphur	In Pyrite	In Other Forms[2]	Total	Total
United States	5,467	1,061	385	528	7,411	7,567
U.S.S.R.	–	1,064	1,874	300	3,686	3,385
Japan	–	244	1,764	690	2,698	2,806
Canada	–	1,392[3]	244	336	1,972[3]	1,725[3]
France	–	1,563	119	98	1,780	1,715
Mexico	1,631	81	–	–	1,712	1,585
Spain	–	31	1,061	41	1,133	1,228
Italy	–	48	703	117	868	975
China	–	269	595	?	864	874
West Germany	–	95	188	241	524	536
Cyprus	–	–	388	?	388	438
Norway	–	–	314	19	333	427
Poland	–	339	92	60	491	372
East Germany	–	132	46	148	326	317
Finland	–	56	278	77	411	–
	7,098	6,375	8,051	2,555	24,597	
Other countries	–	7,791	1,245	1,405	2,826	4,340
Totals	7,098	14,167	9,296	3,960	27,423	25,622

[1]Compiled from various sources (mainly U.S. Bureau of Mines and British Sulphur Corp. Ltd.). Because of rounding of figures and unavailable information the data do not add exactly to totals shown. [2]Sulphur in smelter gas, anhydrite-gypsum, spent oxide, hydrogen sulphide (other than elemental) and some smaller sources. Data is mainly 1962 production. [3]Total output rather than shipments. [4]From *Sulphur*, 1962, Dept. of Mines and Technical Surveys.
– Nil.

WORLD REVIEW AND OUTLOOK FOR CANADIAN SULPHUR

World production of sulphur in all forms in 1963 is estimated by *Sulphur* (February 1964) at 28.45 million short tons. Western world production increased only about two per cent to 22.29 million tons and Communist countries are estimated to have produced 6.16 million tons.

World consumption of sulphur in 1963 is estimated at 28.11 million tons including 22.06 million tons in the western world and 6.05 million tons in Communist countries. The narrow margin between production and consumption reflects the abrupt rise in consumption during 1963. The near-balance becomes more significant when it is noted that in addition to substantial rises in all the usual markets, new demands for western world sulphur were made by Japan and some Communist countries, and additional amounts will be required by Italy in 1964. High rates of sulphur consumption throughout the world are attributed mainly to rapidly rising production of fertilizers but also to increased activity in many chemical and processing industries.

The world sulphur industry expects that consumption will increase during 1964 and since only minor increases in production appear possible in Canada and no increase can be foreseen from France, it assumes that any additions to production must come largely from Frasch operations in the United States and Mexico. It is widely assumed that the Frasch industry is capable of rapid expansion and could produce much larger amounts of sulphur to meet any extra needs in 1964. The fact that in 1963 United States consumption of sulphur was greater than production for the first time since 1916, suggests that production has not responded immediately to increasing demand. In the first quarter of 1964, sales exceeded Frasch production. Both reserves and productive capacity of Frasch sulphur are large and constitute the largest single source of supply in the world at the present time but as the sulphur shortage of 1950 showed, when demand exceeds installed Frasch capacity, new production facilities do not appear on short notice. The possibility that rising demand cannot be completely met by installed Frasch capacity suggests the need for a closer look at the possible expansion of sulphur production in Canada.

Careful study of the various sources of sulphur in Canada indicates that all could produce additional sulphur in 1964. Pyrite sulphur should become more attractive in some areas as the price of elemental sulphur rises, particularly if there is no surplus of sulphur. Smelter gas sulphur production has increased steadily over the past ten years and continued expansion is expected. Both pyrites and smelter gas sulphur have restricted markets but their expansion releases a like quantity of elemental sulphur to serve more diversified needs. An appreciable expansion of production from natural gas sources in western Canada is possible by adjustments in the volume and sulphur content of the raw gas fed to processing plants. The stimulus of an increase in the price of sulphur and the desire to maintain and enlarge recently won markets now offers an incentive to Canadian producers to expand rather than restrict production. Finally, additional capacity under construction to recover elemental sulphur from eastern Canadian oil refinery gas could increase annual capacity from this source to 70,000 tons. In total, production of elemental sulphur in Canada might increase by as much as 350,000 tons and sulphur from all sources by as much as 500,000 tons.

The current high rates of sulphur consumption and the relatively minor increases in production focusses attention on sulphur stockpiles. Adequate stocks are available in North America for all short term needs, mainly as Frasch supplies in the United States (5,331,000 tons) and also in Mexico (578,000 tons). In addition, stocks in Canada (1,233,000 tons) and France (780,000 tons) are available for immediate needs. World stocks are thus estimated at about 7.9 million tons, sufficient as a reserve as long as consumption does not outstrip production.

At 1.2 million tons Canadian stocks are less than expected sales in 1964. In spite of worries about surplus sulphur a few years ago this inventory is adequate but not excessive. Four different groups are selling from it and rather than being a problem such a stockpile offers prospective large scale, long term purchasers some assurance of supply. For example one of the United States Frasch sulphur producers has a sulphur inventory of more than three million tons .

Although total sulphur production increased moderately in 1963 only minor additions to capacity have been reported and no major enlargements are expected in 1964. Additional production is expected from the Frasch sulphur industry in the United States and in Mexico, where capacity is being expanded, and in Poland where production of 330,000 tons is expected in 1964 and more than 400,000 tons in 1965. The increases in Poland are not expected to have more than a minor effect on western world sulphur trade because it is doubtful that these amounts can satisfy rising demands in nearby Communist countries.

The trend towards handling and transporting of sulphur in liquid rather than solid form continued in 1963. In the United States it is estimated that 90 per cent of sulphur deliveries were in molten form. United States producers, through their sales agent, Sulphur Export Corporation (Sulexco), are constructing a molten sulphur terminal in Europe and ocean-going molten sulphur tankers to supply it. Similar terminals and tankers are being built or are planned by the major Mexican producer, Pan American Sulphur Company (Pasco), and by the French producer, Société Nationale des Pétroles d'Aquitaine (S.N.P.A.).

The activities of the Sulphur Institute, in sponsoring and reporting research on new uses and applications of sulphur, and the formation of a somewhat similar organization, Alberta Sulphur Research Ltd., by Canadian producers in Alberta will broaden and increase sulphur uses. These efforts, together with new methods of handling and transporting sulphur, and the possibility of more stable prices at levels which will encourage the use of sulphur in developing countries, offer a promising future for sulphur.

The history of sulphur has been one of steadily increasing demand for industrial needs highlighted by occasional surpluses and shortages, price fluctuations, new production techniques such as the Frasch process, and the rise and fall of whole industries, such as that of the Sicilian sulphur operation. Sulphur is still in turmoil but demand is still growing and Canada now appears to be in a position to benefit.

PRICES

In the last quarter of 1963, 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, export, 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, and spent oxide of iron containing more than 25% sulphur	free
Sulphur dioxide	12.5% ad val.
Sulphur compounds	10.5% ad val.

Talc and Soapstone; Pyrophyllite

J.E. Reeves*

In 1963, production of talc and soapstone in Canada declined slightly although the value of total shipments was reportedly higher. Most of the talc and soapstone is consumed domestically. Pyrophyllite production – all exported – rose 39 per cent.

Imports of ground talc rose about 14 per cent. Canada imports comparatively high-quality paint and ceramic grades of talc from the United States in increasing amounts. Especially high-quality talc is imported from Italy and France for cosmetic and pharmaceutical use.

PRODUCERS

Quebec

Baker Talc Limited obtains talc and soapstone from its underground mine near South Bolton, in southern Quebec. From this talc it produces lower-priced grades of ground talc at a mill near Highwater about 10 miles south of the mine. Rough and sawn soapstone blocks are sold for sculpturing.

Broughton Soapstone & Quarry Company, Limited, quarries 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

	1962		1963	
	Short Tons	$	Short Tons	$
Production (shipments)				
Talc and soapstone				
Quebec*	15,285	154,086	15,564	173,147
Ontario**	8,082	127,912	6,903	107,986
Total	23,367	281,998	22,467	281,113
Pyrophyllite: Newfoundland	22,794	343,210	31,783	476,745
Imports, talc				
United States	22,238	1,010,344	26,339	1,204,275
Italy	1,902	109,004	1,194	84,136
France	8	571	6	433
Total	24,148	1,119,919	27,539	1,288,844
Consumption, ground talc (available data)				
Ceramic products	9,732		11,382	
Paints and wall-joint sealers	8,711		7,910	
Roofing	7,641		6,358	
Paper	3,643		3,639	
Insecticides	2,116		1,380	
Toilet preparations	1,560		1,206	
Rubber	1,532		1,994	
Gypsum products	831		844	
Asphalt products	811		655	
Cleaning compounds	649		726	
Pharmaceutical preparations	238		470	
Leather products	17		26	
Other products	496		2,711	
Total	37,977		39,301	

Source: Dominion Bureau of Statistics.
*Ground talc, soapstone blocks and crayons. **Ground talc.

Ontario

Canada Talc Industries Limited mines talc from two underground mines and produces several lower-quality grades of ground talc at Madoc in southeastern Ontario.

Newfoundland

Newfoundland Minerals Limited mines high-quality pyrophyllite from lenses near Manuels and ships it for processing and use to American Encaustic Tiling Company Inc., at Lansdale, Pennsylvania.

TECHNOLOGY

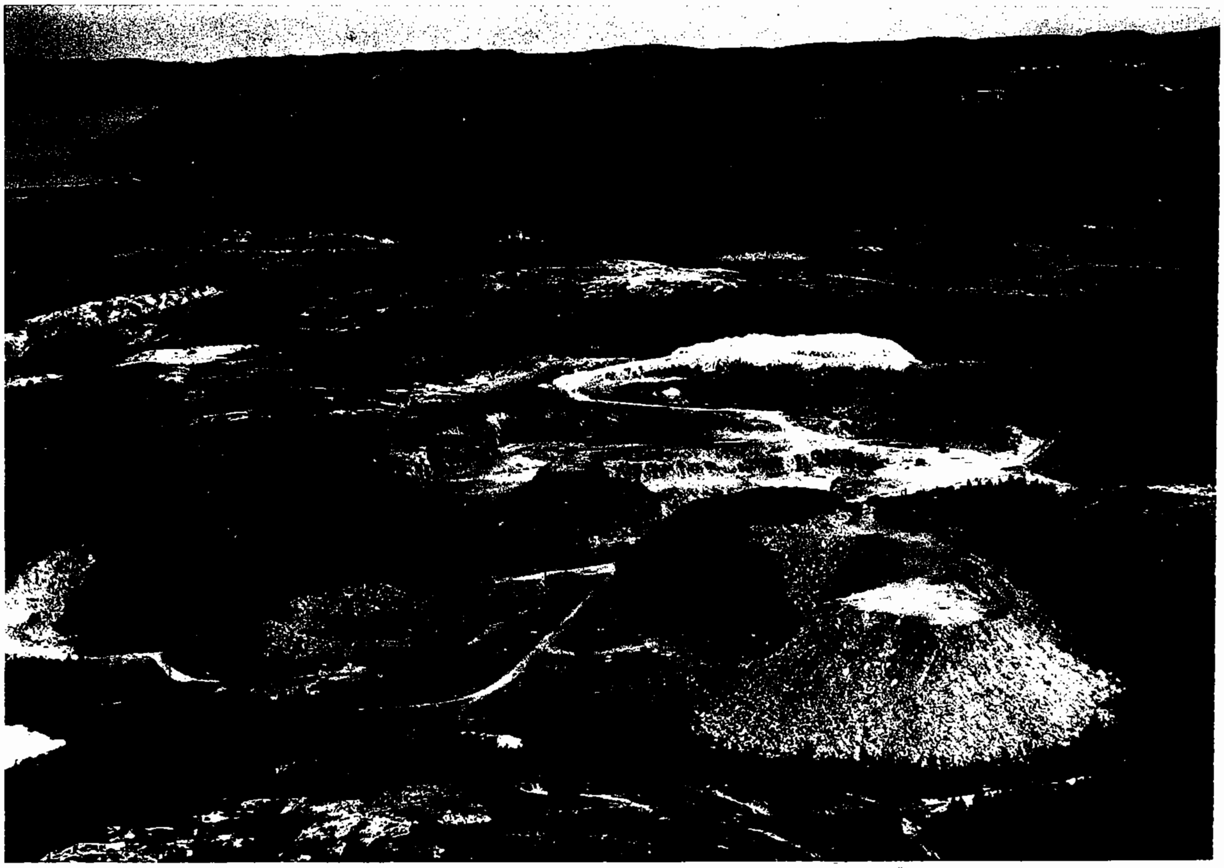
Talc is a hydrous magnesium silicate. It is soft, has a greasy feel or 'slip', is flaky and grinds to a white powder. It is relatively inert chemically, has a high fusion point and low electrical and thermal conductivity.

Many commercial talcs 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–unaltered serpentine, magnesite and iron-bearing minerals such as chlorite. These impurities cause the ground products to be somewhat off-white. Such products can be used where color specifications are not exacting; higher-quality products can be obtained by removing much of the impurity by some process of beneficiation. The Madoc deposits are altered white dolomite consisting principally of talc, tremolite and dolomite in various proportions. Ground products are 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 talcs.

TABLE 2
Production and Trade, 1954–63
(short tons)

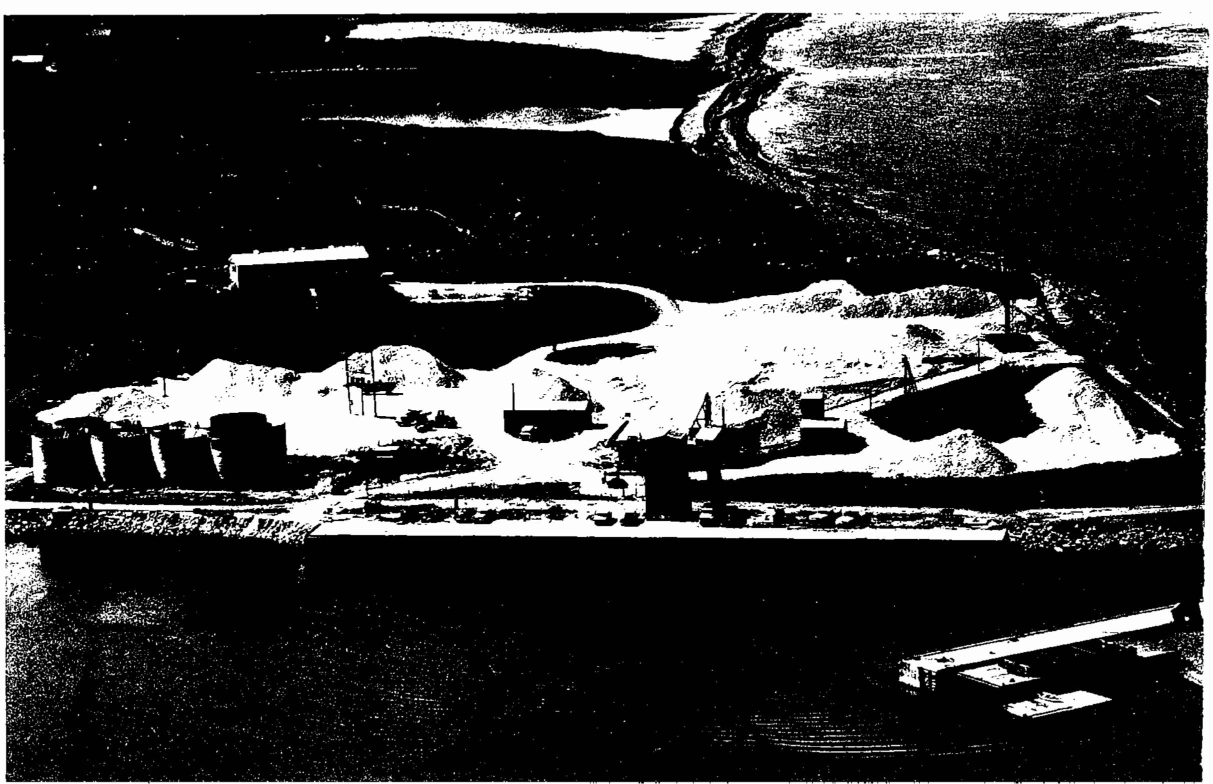
	Production*		Imports	Exports
	Talc and Soapstone	Pyrophyllite	Talc	Talc and Soapstone
1954	28,134	9	12,392	3,609
1955	27,153	7	11,382	4,428
1956	27,947	1,379	16,268	2,613
1957	29,039	5,686	14,949	2,353
1958	27,951	7,454	16,593	1,931
1959	24,733	14,443	18,501	2,053
1960	21,411	20,225	19,153	1,660
1961	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**

Source: Dominion Bureau of Statistics.
*Producers' shipments. **Estimated, not available as a separate trade class after 1960;



Pyrophyllite is mined by Newfoundland Minerals Limited near Manuels, Newfoundland from high-grade zones in altered rhyolite. The ore is crushed to -4" and trucked to stockpiles about three miles from the minesite.

From the stockpiles at Manuels, Newfoundland, the pyrophyllite is shipped in bulk to Lansdale, Pennsylvania, for processing and use in the manufacture of ceramic tile.



The processing of talc in Canada is relatively simple, the important step being grinding and the classification of particles according to size. Some beneficiation is achieved during grinding but the application of electromagnetic separation or flotation would result in a higher-quality product.

Soapstone is essentially an impure talcose rock from which blocks and crayons can be readily sawn. The soapstone in southeastern Quebec was altered from serpentine rock; its grey color results from impurities.

Pyrophyllite is physically very similar to talc but is a hydrous aluminum silicate. It is an alteration product of siliceous rocks and is often accompanied by sericite and quartz. The color–near white–is generally acceptable to industry but the impurities must not be excessive.

USES AND SPECIFICATIONS

Commercial talc is a versatile raw material with numerous applications in industry, mostly as an industrial filler. Most of the talc used in Canada is consumed by about 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 ceramic industry. Specifications for a talc pigment, as established in ASTM Designation D605–53T, relate to chemical limits, color, 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 color, 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 discolor 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; color 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, plastic products, foundry facings, adhesives, linoleum, textiles and oil-absorbent preparation.

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 metal-workers 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 Favored Nation	General
Canada			
Talc or soapstone	10%	15%	25%
Pyrophyllite	free	free	25%
Micronized talc	"	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	12%
Other, not specially provided for	24%

Thorium

J.W. Griffith*

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 company's Elliot Lake plant. However, sales of thorium to Britain have recently improved and marketing arrangements indicate continued production.

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.

In 1958, both Faraday Uranium Mines Limited and Bicroft Uranium Mines Limited conducted experiments in the production of thorium from the uranium residues obtained at their plants near Bancroft, Ontario. For four months of the same year, the latter company operated a small-scale solvent-extraction pilot plant. The experiments were successful but market conditions did not warrant full-scale production.

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.

*Mineral Resources Division

**Rio Tinto Dow was formed by the Rio Tinto Mining Company of Canada Limited and Dow Chemical of Canada, Limited.

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 1963 totalled 7,099 pounds.

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.

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 are now 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 are not being 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 100,000 tons of thorium. At the 1961 rate of uranium production in these camps it would be possible to recover 4,000 tons of thorium oxide a year as a byproduct.

OCCURRENCES IN CANADA

Pegmatitic and granitic occurrences containing uranothorite, monazite, thorite, allanite, and other radioactive minerals are found in many parts of Canada: some of which are the uranium-bearing pegmatites in the Haliburton-Bancroft area of southeastern Ontario; the pegmatites in the Pontiac-Gatineau region in Quebec; occurrences at Nisikkatch Lake, Gatzke Lake, Orbit Bay, Viking Lake, Laird Island on Tazin Lake, Charlot Lake, Grease Bay area, all in the Lake Athabasca region of northern Saskatchewan; Lac la Ronge occurrences in north-central Saskatchewan; Point du Bois area of Manitoba; and on Edgell Island off the southeast coast of Baffin Island.

Vein-type occurrences containing mostly monazite are found near Viking Lake, Gatzke Lake, Fond du Lac, Orbit Bay and on Laird Island (Tazin Lake), all in the Lake Athabasca region. They also occur in the Beaulieu River area, about 46 miles east of Yellowknife, Northwest Territories, and at Whitney Inlet, 35 miles northeast of Chesterfield Inlet on Hudson Bay. Vein-type occurrences containing monazite were also reported in central British Columbia, the Fort Chipewyan area of Alberta and in the Seal Lake area of Labrador.

Low-grade, thorium-bearing placer occurrences have been found at several locations: on the southwest shore of Yamba Lake, 200 miles northeast of Yellowknife, and in the McQuesten River monazite-bearing placers, in the Mayo District, Yukon Territory; in the Bugaboo Creek placers of the Purcell Mountains, B.C.; in the monazite-bearing placers of the Nation River, Omineca Mining District, B.C.; on Quesnel River, eight miles above the Fraser River junction, also in B.C.; and in placers containing monazite in Munro township, Ontario.

A fairly large, low-grade thorium-uranium deposit occurs in dolomite at McLean Bay, Stark Lake, near the east arm of Great Slave Lake, N.W.T. Fine-grained monazite and uraninite are dispersed fairly extensively throughout the dolomite. The thorium content was estimated at 0.025 per cent ThO_2.

Thorium is also found in metasomatic type of deposits at Atlin (Husselbee occurrence), B.C.; near the head of Moose Creek, just southeast of Yoho National Park, B.C.; in Baskatong and Huddersfield (Yates property) townships in Quebec; and in the niobium-bearing deposits at Oka, Quebec, which contain small amounts of uranium and thorium.

Other quartz-pebble conglomerate type of occurrences are found in the Agnew Lake area of Ontario, midway between Sudbury and Blind River. The largest deposit is in Hyman Township. Reserves there are estimated at 750,000 tons ranging from 0.30 to 0.35 per cent ThO_2 and 0.095 per cent U_3O_8*.

EXTRACTION PROCESS

The Rio Tinto Dow thorium-recovery plant, near Elliot Lake, was constructed at a cost of one million dollars. 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 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 of the uranium circuits by solvent extraction, then stripping the thorium from the organic solvent

*Thomson, Jas. E.: *Uranium and Thorium Deposits at the Base of the Huronian System in the District of Sudbury;* Ont. Dept. of Mines, Geological Report No. 1, 1960.

**Foreign plants use the sulphuric-acid process or that of caustic attack on monazite. Thorium products are then separated from the accompanying rare earths.

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 20 per cent ThO_2.

About 30 per cent 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 one pound to every three or four 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. A number of technical obstacles, however, must be overcome if such a reactor is to become more attractive than the uranium-fuelled type.

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.

A large company in the United States recently introduced a new nickel product in which pure nickel is dispersion-hardened by the addition of from two to ten per cent ThO_2. This alloy is said to be more heat-resistant than the super-alloys and not to lose its strength after exposure to extreme heat as they do. It is also said to be highly resistant to oxidation and corrosion and to have excellent thermal and electrical conductivity.

MARKETS, PRICES AND COSTS

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 J. G. Parker of the U.S. Bureau of Mines in *Engineering and Mining Journal*, February 1963, as follows:

	Per Cent ThO_2	Approximate Price per Pound (dollars)
Compounds (10–49 lb lots)		
Carbonate	80	8.70 – 9.35
Chloride	50	7.70
Fluoride	79–80	6.60
Nitrate (mantle grade)	47	3.60
Oxide	98–99.9+	6.90 – 16.00
Other forms		
Metal (nuclear grade)		19.55
Thorium hardener (for alloying)	20–40	12.50 – 15.00
Concentrates	20–30	1.75 – 2.25
Metal		
Ingot		
Less than 10 lb		54
100 to 500 lb		38
Over 2,000 lb		24
Powder or pellets		
Less than 10 lb		45–50
100 to 500 lb		34
Over 2,000 lb		20–22

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 *United States Import Duties (1962)*, a publication of the United States Tariff Commission.

Canada	British Preferential	Most Favored Nation	General
Thorium ores	free	free	free
Thorium isotopes	free	free	25%
Thorium dioxide	15%	20%	25%
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

Tin

W.H. Jackson*

Production of tin-in-concentrate and the tin content of a primary lead-tin alloy from smelting amounted to 414 tons** in 1963 compared with 291 tons in 1962. Consumption of primary tin totalled 4,942 tons, an increase of 9.6 per cent from 1962, the main increase being in the production of the solders and, to a lesser extent, tinplate. New metal supply consisted of: imports – 4,193 tons, disposals from the Canadian stockpile – 467 tons, and stock drawdown of 121 tons. Tin stocks held by Canadian consumers totalled 753 tons on December 31, 1963.

In May 1961 sales commenced from the Canadian tin stockpile held by the Department of Defence Production. Disposals, made entirely within Canada, amounted to 403 tons in 1961, 1,847 tons in 1962 and 467 tons to April 1963 when stocks were exhausted.

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 12 - 4-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.

The company also produces small amounts of a lead-tin alloy from the treatment of lead bullion dross in the indium circuit of the Trail smelter.

The only serious exploration for tin in Canada during the year was by Mount Pleasant Mines Limited. Its property is in Charlotte County, New Brunswick. The company has done surface trenching and extensive diamond drilling from surface and from an adit to establish the pattern and grade of mineralization.

*Mineral Resources Division
**Long tons, 2240 pounds, used throughout.

TABLE 1

Tin – Production, Imports and Consumption, 1962 and 1963

	1962		1963	
	Long Tons	$	Long Tons	$
Production				
Tin content of tin concentrates and lead-tin alloy	291	442,640	414	648,943
Imports				
Blocks, pigs, bars				
Malaysia	1,491	4,029,800	3,095	8,668,763
Britain	185	522,218	550	1,516,814
United States	167	467,977	267	737,783
Belgium and Luxembourg	381	1,041,455	220	584,412
Nigeria	nil	nil	56	164,256
Bolivia	50	142,258	5	13,025
Total	2,274	6,203,708	4,193	11,685,053
Tinplate				
Britain	1,913	447,761	1.942	500,917
United States	1,799	310,330	1,784	302,505
Total	3,712	758,091	3,726	803,422
	Pounds		Pounds	
Tinfoil, United States	13,633	18,567	12,628	19,342
Babbitt Metal				
United States	38,600	35,495	19,300	19,901
Britain	11,200	1,186	1,100	1,190
Total	49,800	36,681	20,400	21,091
	Long Tons		Long Tons	
Consumption				
Tinplate and tinning	2,461		2,581	
Solder	1,139		1,366	
Babbitt	191		223	
Bronze	207		197	
Galvanizing	7		5	
Other uses (including collapsible containers, foil, etc.)	502		570	
Total	4,507		4,942	

Source: Dominion Bureau of Statistics.

Fine-grained cassiterite (SnO_2) is the main ore mineral in variable association with sphalerite, minor chalcopyrite and galena. The locus of mineralization appears to be the altered and highly fractured contact zone of a series of acid volcanics and sediments with an intrusive plug of feldspar porphyry and related volcanic pipe breccias. Low-grade mineralization related to the fracturing is

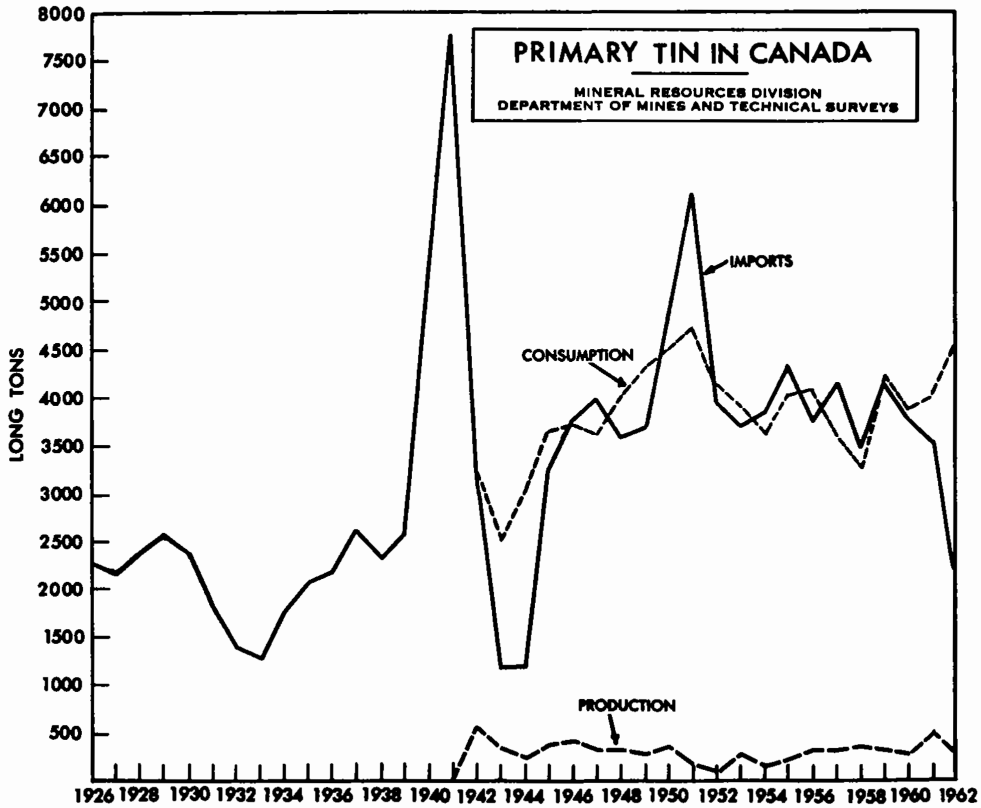


TABLE 2

Tin – Production, Imports and Consumption, 1954–63

(long tons)

	Production[1]	Imports[2]				Consumption[3]
		Blocks Pigs, Bars	Tinfoil	Babbitt Metal	Tinplate	
1954	149	3,836	13	12	9,116	3,604
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	3,293
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

Source: Dominion Bureau of Statistics.
[1]Tin content. [2]Gross weight. [3]Virgin tin.

TABLE 3

Estimated Free World Tin Position, 1961–63

(long tons)

	1961	1962	1963
Ore supply			
Production of tin in concentrates	136,500	141,600	141,000
Stocks at year-end	24,600	23,000	19,200
Primary metal supply			
Smelter production of tin metal	136,500	144,700	143,600
Net trade with Communist-bloc countries	5,268+	643+	259–
Government stockpile sales			
Canada	404	1,847	467
Italy	660	660	660
United States	3,233	2,100	9,325
Buffer stock, sales+, purchases–	10,030+	3,270–	3,270+
Commercial stocks at year-end	56,400	50,300	45,800
Commercial stock drawdown	6,700	6,100	4,500
Primary metal consumption	157,900	158,300	161,500

TABLE 4

Estimated World Production of Tin-In-Concentrates, 1962 and 1963

(long tons)

	1962	1963
Malaysia	58,603	59,947
China	24,000	24,000
Bolivia	21,800	22,246
Indonesia	17,310	12,947
Thailand	14,679	15,585
Republic of the Congo and Ruanda	8,637	8,303
Federation of Nigeria	8,210	8,729
Other countries*	14,761	13,977
Total	168,000	165,734

Source: International Tin Council Statistical Bulletin.
*U.S.S.R. not included.

TABLE 5

Estimated World Production of Primary Tin Metal, 1962 and 1963

	1962	1963
Malaysia	82,073	84,001
China	24,000	24,000
Britain	18,749	17,444
Belgium	8,607	7,044
Federation of Nigeria	8,024	9,051
United States	5,500	1,500
Netherlands	4,282	5,762
Australia	2,704	2,626
Bolivia	2,023	2,462
Other countries	12,679	13,185
Total	168,641	167,075

widespread but higher-grade lodes have been indicated by drilling. Since possible mining layouts would be based on assay boundaries, firm calculations of grade and tonnage in relation to economics await the results of pilot-plant mill-tests. Three hundred tons of representative material were mined and shipped to Britain for this purpose late in 1963.

WORLD DEVELOPMENTS

There are international commodity agreements negotiated under United Nations auspices between producers and consumers for wheat, rubber, sugar and tin, tin being the only metal so covered. The accompanying graph, 'Permissible Price Ranges International Tin Agreement,' shows price movements from July 1, 1956 to June 30, 1961, the period when the First International Tin Agreement was in force, and part of the Second International Tin Agreement which went into effect July 1, 1961 for a five-year period. Both agreements are similar in that producers must contribute cash or tin to a buffer stock. The International Tin Council determines the price ranges within which the buffer stock manager may operate to modify price fluctuations on the major metal exchanges and under certain conditions of oversupply, the Council may declare controls on production and exports. During the first agreement the main problem was oversupply. This situation resulted from the interaction of a number of forces which included the recovery of producing countries from World War II, high industrial demand and stockpile accumulations of the early 1950's which, together with high prices, encouraged more production than normal demand required, and unexpected exports from the U.S.S.R. and China. Sharply curtailed production eventually corrected the oversupply problem by 1959. Then came unsettled conditions in the Congo and a continuing decline in production from Indonesia. Other producers, such as Bolivia, required long-term assistance in mine development and rehabilitation; consequently, prices rose. Stockpile releases by the United States have helped prevent a physical shortage of metal. The supply-demand position is summarized in Table 3.

USES

Some economy in the use of tin has been taking place but, because of the growth in consumer products that require its use, demand has not been affected. Aluminum, plastic and foil-plastic laminate containers have entered certain markets to compete with containers made from tinplate. Thinner tinplate, in which less steel is used but not less tin, has been put on the market to partially meet this competition. Copper conductor wire can now be coated with plastic so the wiping of the copper with tin to inhibit the breakdown of rubber insulation is not needed. Bronze bushings with babbitt liners must compete with roller bearings.

In Canada most tin is used for tinplate and tinning, as shown in Table 1. Straits brand, or equivalent grade, is favored. 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.

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 three to 15 per cent tin. There are two main groups – the phosphor bronzes for machine parts, gears and bearings and the tin bronzes containing one to six 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, three to seven per cent antimony and one to two per cent copper. Britannia metal, which can be cast into intricate designs, contains 90 to 94 per cent tin. Type metal for linotype contains three to five 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 for pattern-making.

Babbitt alloys are used for bearings. The high-tin babbitts are 83 to 91 per cent tin, four to eight per cent copper and four to eight per cent antimony. Lead-base babbitts containing up to 12 per cent tin are not so widely used.

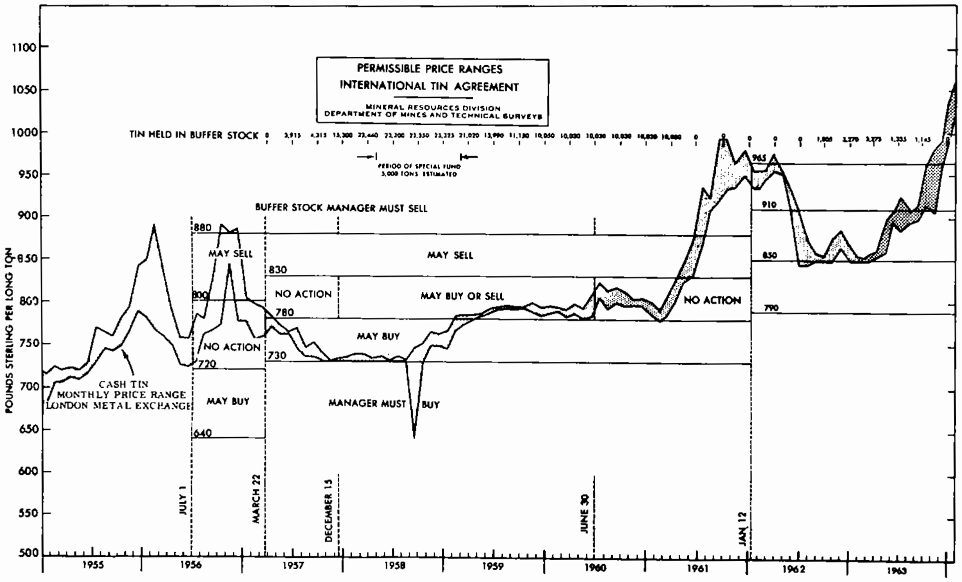
Tin is used as a minor constituent in dental amalgams and in titanium, zirconium and other alloys. In research on the production of powerful magnets, most of the superconductors of electricity now in use are alloys of colombium or zirconium with tin. One major automobile manufacturer is alloying tin with cast iron for use in engine blocks, a possible major use.

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 1963 was: Straits-ex-works, Malaysia, 111.58; Cash, London, England, 113.72; Prompt, New York, U.S.A., 116.64. Allowing for differences such as hedging, each of these markets affects prices in the others and the difference is nominally one of transportation. The general relationship is that the London price is two cents higher than Malaysia and New York is four cents higher. In



summer, a delivered price to Montreal is equivalent to the New York price, allowing for currency exchange. In winter when the Montreal port is closed, a freight differential from Halifax or New York affects the Montreal price. To other destinations in Canada, freight would be extra. Small consumers purchasing from merchants who finance and hold stocks in inventory would pay more.

The Canadian price of Straits tin f.o.b. Montreal, was 124.21 cents a pound at the beginning of 1963. The high for the year was 147.15 cents, on December 24; the low was 124.08 cents on January 23. The year-end price was 146.96 cents a pound.

TARIFFS

	British Preferential	Most Favored 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 in tin and phosphor bronze in blocks, bars, plates, sheets and wire ...	5%	7½%	10%
Oxide of tin	free	15%	15%
Bichloride of tin and tin crystals	free	10%	10%

Canada (cont'd)

Sheet or strip of iron or steel, corrugated or not, and whether or not rolled with surface pattern, 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% of lead – 1.0625¢ per lb on lead content
 Other – free
Tin waste and scrap – free
Tin plates, sheets, and strips, all the foregoing which are wrought of tin, whether or not cut, pressed, or stamped to nonrectangular shapes:
 Not clad – 12% ad val
 Clad – 24% ad val
Tin wire
 Not coated or plated with metal – 12.5% ad val
 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% ad val
Tin pipes and tubes and blanks, therefor, pipe and tube fittings – 12% ad val
Tin foil – 35% ad val
Tin compounds and salts – 12.5% ad val

Titanium

V.B. Schneider*

The value of titanium-bearing material shipped during 1963 as ore, heavy aggregate and titanium-bearing slag was over $14 million. Nearly all of this was accounted for by titanium dioxide (TiO_2), which was worth $2.8 million more than the 1962 shipments. A labor strike that closed the smelter of Quebec Iron and Titanium Corporation (QIT) at Sorel, Quebec, from August 28, 1962 to March 16, 1963 seriously affected production for both years. However, the plant is expected to operate at capacity throughout 1964.

World mine production of titanium ores for 1963, has been estimated by the U.S. Bureau of Mines** at 2.2 million tons of ilmenite concentrate and 220,100 tons of rutile concentrate. Compared with 1962 these estimates show an increase of 2.5 per cent for ilmenite production and 46.7 per cent for rutile.

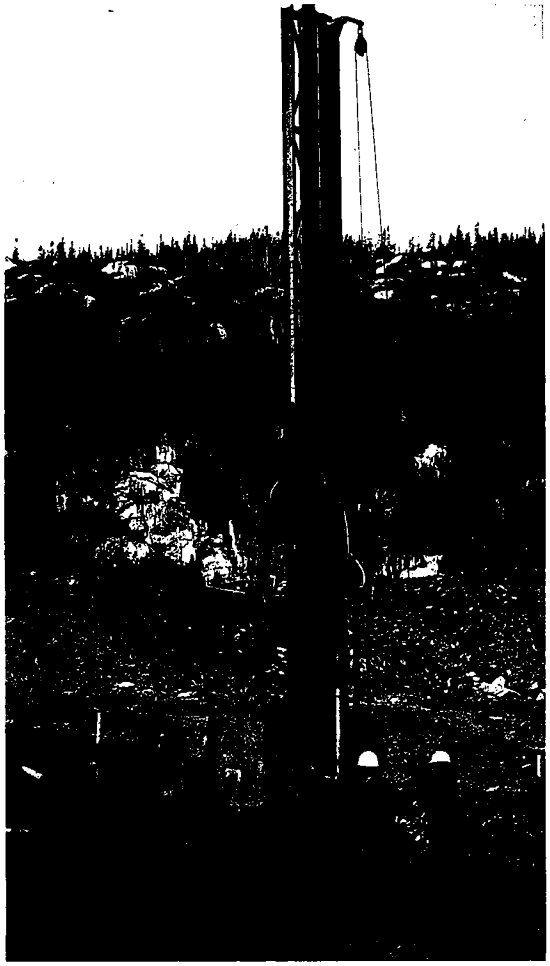
Ilmenite ($FeTiO_3$), rutile (TiO_2), and sphene ($CaTiSiO_5$), which is also called titanite, are the most abundant of the titanium minerals. Sphene, which contains 41 per cent TiO_2, is mined in the Kola Peninsula, U.S.S.R. Generally, only ilmenite and rutile are considered commercially important outside Russia. The maximum titanium-dioxide content of ilmenite is theoretically 53 per cent; that of rutile is theoretically 100 per cent.

PRODUCTION

Canada

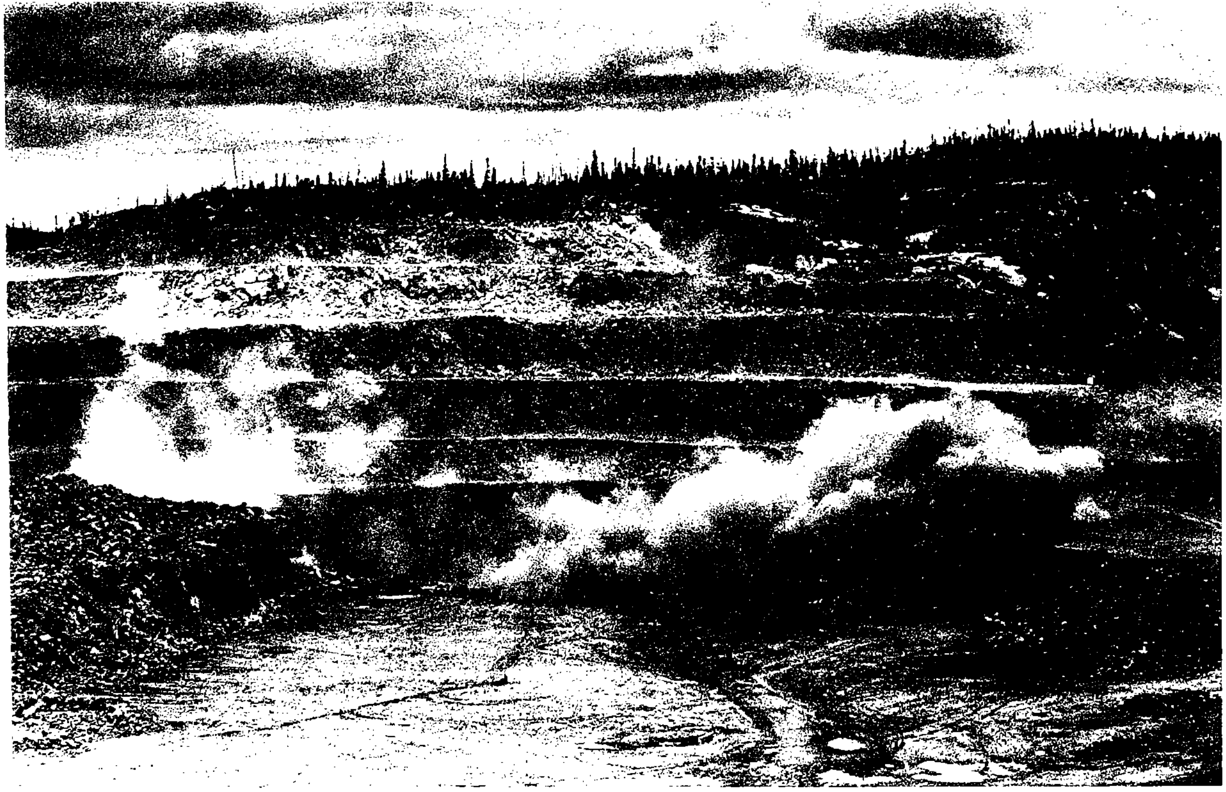
The Canadian titanium industry is based mainly on the mining of ilmenite for the production of titanium-dioxide slag. To a minor degree ilmenite is also used as heavy aggregate and for the manufacture of ferrotitanium. It is mined in the Allard Lake and St. Urbain areas of Quebec. Most of the Allard Lake ilmenite is smelted at Sorel, Quebec, to produce slag containing 72 per cent titanium dioxide (TiO_2), a high-quality pig iron, and a complex calcium-magnesium-aluminum silicate used as a slag thinner in smelting. Much of the slag is exported,

*Mineral Resources Division
**U.S. Bureau of Mines, *Minerals Yearbook 1963.*



With the high density and highly abrasive qualifites of ilmenite ore, percussion drilling is used on both development and production rigs. For development work, three-inch boreholes are used on a 6' x 8' pattern, establishing 35-foot benches. For production drilling, six-inch boreholes on a 15' x 17' pattern are used. All compressed air is supplied by portable diesel driven compressors.

The ilmenite open pit at Allard Lake on the North Shore, 22 miles north of Havre St. Pierre. Ultimate pit layouts were developed to include mining the ore block from 820 feet down to a 400-foot level. The present stage of mining has reached the 610-foot elevation in the centre pit, and perimeter benching is being advanced on the high west and east slopes.



Blasts in the open pit produce from 15,000 to 80,000 tons of broken ore.

Slurry type blasting agents are used for both sizes of boreholes - plain slurry as full-column load on the three-inch holes, metallized slurries for the toe load on the six-inch holes with plain slurry for the balance of the columns. All holes are vertical.

TABLE 1
Canadian Imports of Titanium Dioxide, 1962 and 1963

	1962		1963	
	Short Tons	$	Short Tons	$
TiO_2(Pure)				
Britain	11,779	5,263,425	1,895	811,924
United States	819	464,677	1,472	794,221
Japan	22	7,184	–	–
Netherlands	*	275	–	–
Total	12,620	5,735,561	3,367	1,606,145
TiO_2(Extended)				
United States	12,323	2,354,541	9,319	1,785,904

Source: Dominion Bureau of Statistics.
*Less than one ton
– *Nil.*

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 British Titan Products (Canada) Limited, at Ville-de-Tracy, Quebec.

With a combined annual capacity of 94 million pounds of titanium-base pigments, the two Canadian pigment producers will be able to meet domestic requirements; furthermore, each plant is capable of ready expansion to meet any unexpected increase in domestic needs or export requirements. Both companies manufacture many grades of anatase and rutile types of titanium dioxide pigment, and many improved grades have been introduced to the trade as they are developed.

Canadian imports of titanium-base pigments have been in the range of 25,000 to 30,000 tons a year with the United States and Britain being the major suppliers, in the ratio of 3 to 2. In 1963 imports dropped sharply to 12,686 tons as domestic production increased. The market growth in Canada for titanium dioxide pigments continued to expand and additional development of Canada's secondary industry will lead to even greater growth.

Quebec Iron and Titanium Corporation (QIT)

This company, formed in 1948 with Kennecott Copper Corporation holding two-thirds interest and The New Jersey Zinc Company the remainder, operates eight electric-arc smelting furnaces, with an annual feed capacity of 1.1 million tons, at Sorel, Quebec.

Prior to treatment in the electric furnaces, the ilmenite from Allard Lake is fed to the beneficiation plant 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 eight Dutch State Mine cyclones and 72 Humphrey spirals. The combined concentrates, containing about 37 per cent TiO_2 and 42 per cent Fe, are calcined in rotary kilns to lower the sulphur content. Electic

TABLE 2
QIT Production
(long tons of 2,240 pounds)

	1962	1963
Ore treated	665,851	817,286
Titanium slag produced	269,150	338,679
Iron produced	184,991	224,949

Source: Kennecott Copper Corporation's *Annual Report for 1963.*

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. The company announced plans to build a $500,000 research laboratory at Sorel on which work is expected to commence early in 1964.

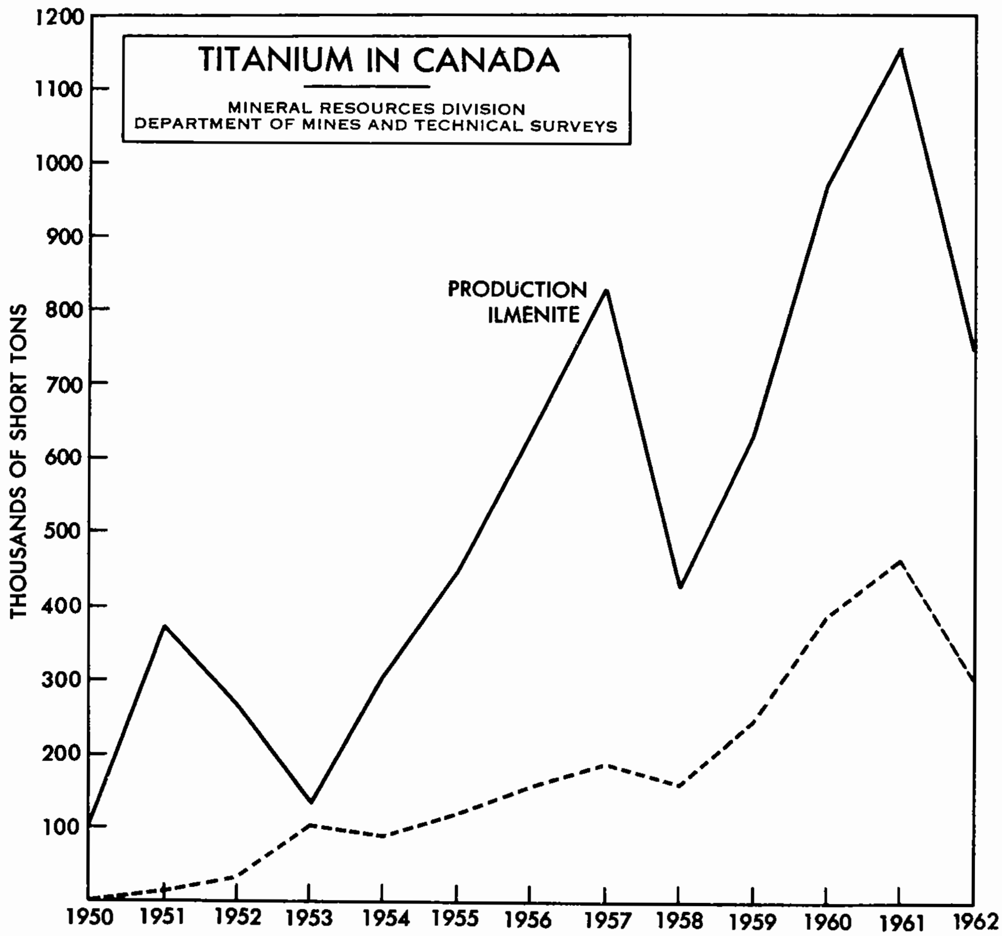


TABLE 3
Canadian Production
Ilmenite and Titanium-Dioxide Slag, and Imports of
Titanium Oxide and Pigments, 1954–63
(short tons)

	Production		Imports
	Ilmenite[1]	Titanium-dioxide Slag	Titanium Oxide and Pigments[3]
1954	304,550	88,408[2]	32,106
1955	445,635	117,042[2]	35,799
1956	630,197	157,374[2]	37,872
1957	824,432	186,422[2]	34,234
1958	420,932	161,312[4]	29,439
1959	626,310	234,670[4]	30,598
1960	967,373	386,639[4]	26,896
1961	1,155,977	463,316[4]	26,621
1962	745,753	301,448[4]	24,943
1963	941,786	379,320[4]	12,686

Sources: Dominion Bureau of Statistics for production from 1954 to 1957 inclusive and for imports from 1954 to 1963; company annual reports for production from 1958 to 1963 inclusive.
[1]Ilmenite shipped from Allard Lake to Sorel and from the St. Urbain area to customers. [2]Titanium-dioxide content of titanium slag produced at Sorel from Allard Lake ilmenite. [3]Containing not less than 14 per cent TiO_2. [4]Slag containing 70–72 per cent TiO_2.

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 dikes, irregular lenses or sill-like bodies, lying within an anorthosite mass covering 134 acres. The largest orebody at Lac Tio contains estimated reserves in excess 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 eight 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 eight 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.

TABLE 4
Production of Ilmenite Concentrates
(short tons)

	1962	1963
United States	807,725	888,400
Norway	276,790	275,600[e]
Canada[1]	301,449	379,321
Australia	204,000	224,000
India	152,241	28,619
Republic of South Africa	87,096	31,039
Other countries [2]	338,699	395,021
Totals	2,168,000[r]	2,222,000

Sources: Dominion Bureau of Statistics. U.S. Bureau of Mines, *Minerals Yearbook 1963.*
[1]Slag containing 72 per cent TiO_2. [2]Exclusive of Soviet Bloc countries.
Symbols: e Estimate; r Revised.

TABLE 5
Production of Rutile Concentrates
(short tons)

	1962	1963
Australia	133,497	203,800
United States	9,981	11,915
Republic of South Africa	3,575	1,385
Other countries*	2,947	3,000
Total	150,000[r]	220,100

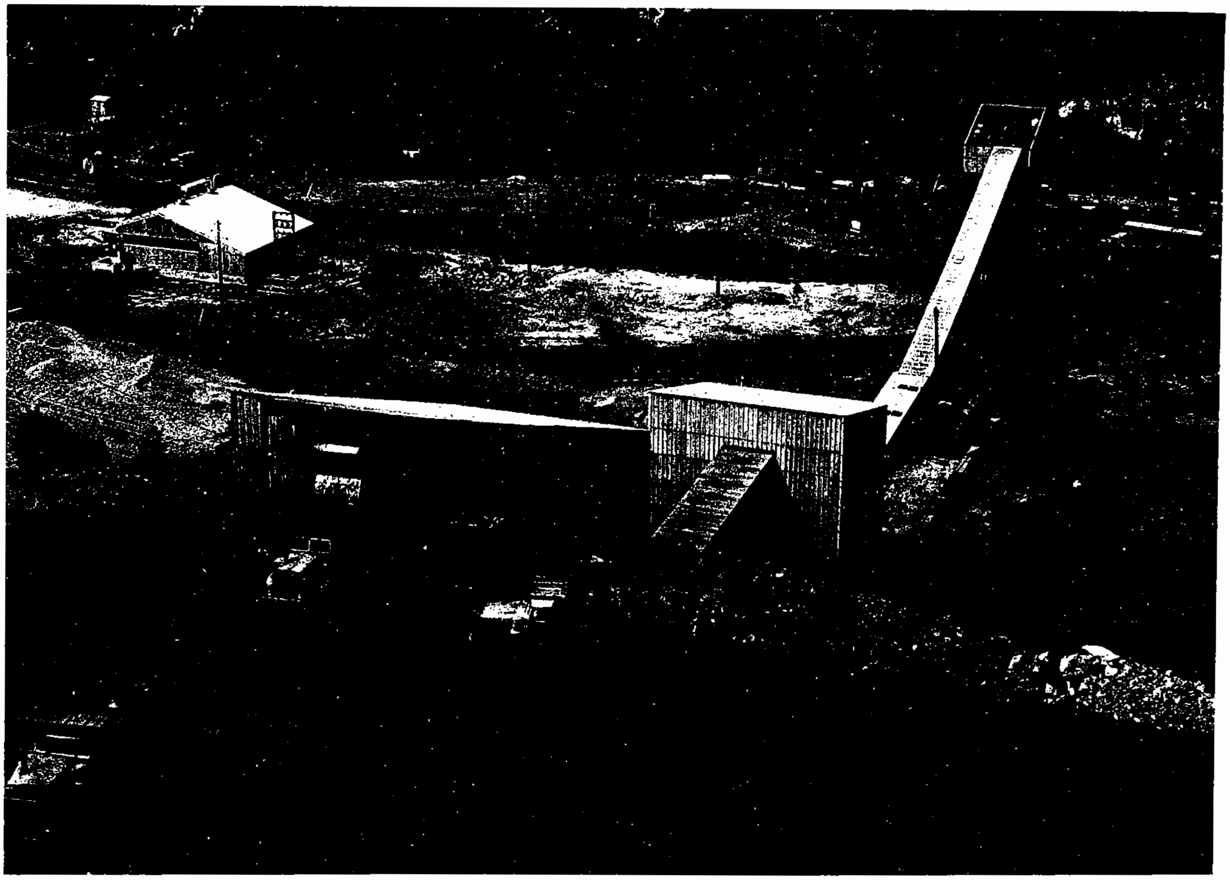
Sources: U.S. Bureau of Mines, *Minerals Yearbook 1963.*
*Exclusive of Soviet Bloc countries.
r Revised.

In 1961, the company stopped the construction of an industrial pilot plant that was to have had the capacity to produce five tons of TiO_2 a day. The company announced in 1963 that negotiations were proceeding for financing a titanium-pigment plant with the capacity to produce 24 tons of pigment a day.

The company's 1963 sales of ilmenite for heavy aggregate and other uses amounted to 26,500 tons valued at $248,000, of which 19,400 tons were shipped to the United States and 7,000 tons were supplied to the domestic market.

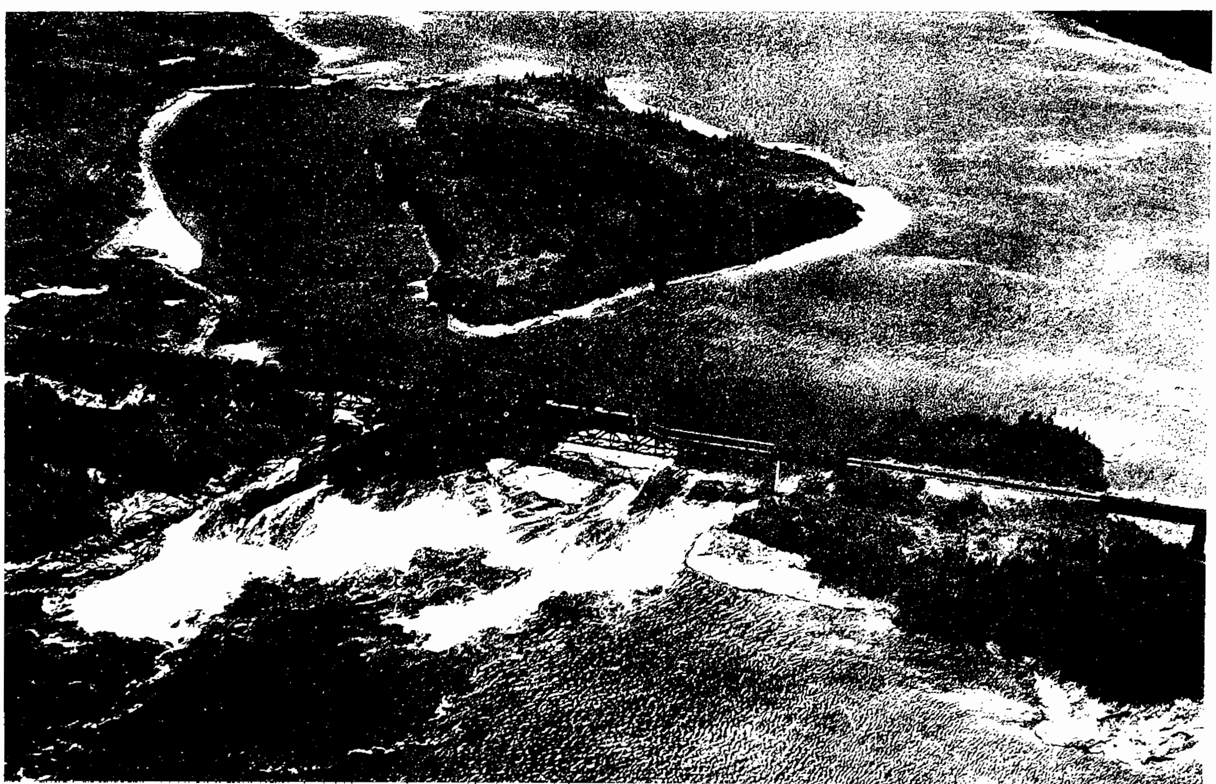
Canadian Titanium Pigments Limited

This company, a wholly-owned subsidiary of National Lead Company, New York, continued operations throughout 1962 of its titanium-dioxide pigment plant at Varennes, Quebec. It manufactures anatase and rutile-type titanium-dioxide



Broken ore is delivered to a surge bin at the primary crusher. Here the material is reduced to nine-inch size by a 48" x 72" jaw crusher. It is then conveyed by belt to the secondary crusher where it is reduced to -3" in a 7-foot cone crusher. Quality check is made on belt samples from the -3" material.

Ore train, crossing the Romaine River. Every two hours, an ore train with 25 to 35 cars leaves the pit for the terminal at Havre St. Pierre. Northbound trains with empty cars leave the terminal on a similar schedule meeting the southbound at Mile 14. Running time is 1¼ hours.



pigments. As in previous years, titanium-bearing slag from the QIT operation at Sorel, and molten sulphur, recovered by Laurentide Chemicals & Sulphur Ltd. from waste oil-refinery gases at Montreal East, continued to be the two main raw materials. The liquid sulphur is used in the company's acid plant to produce sulphuric acid, which is used to digest the titania slag.

British Titan Products (Canada) Limited (BTP(C) Ltd.)

This wholly-owned subsidiary of British Titan Products Company Limited began the construction of a titanium-pigment manufacturing plant at Ville-de-Tracy, Quebec, in the latter half of 1960. It was completed and commissioned two years later, reaching its rated capacity of 22,000 tons a year early in 1963. The plant is so designed that its capacity can be expanded without interruption of established manufacturing facilities. The company has set up elaborate and modern laboratory facilities, whose services to improve established products, evaluate new materials or manufacturing techniques, testing of materials and facilities for accelerated outdoor weathering tests of paint are offered to the industry.

Other Countries

According to the U.S. Bureau of Mines *Minerals Yearbook 1962*, world production of titanium in 1962, in the form of ilmenite, rutile concentrates and titanium slag, amounted to about 2.32 million tons. Production in 1963 was 2.4 million tons.

United States production of ilmenite in 1963 was estimated to be 888,400 tons, and 11,915 tons* of rutile; the combined tonnage is an all-time high. The United States is the largest consumer of ilmenite and rutile. It is also the largest producer of ilmenite but ranks far behind Australia in the production of rutile.

Australian production in 1962 of TiO_2 contained in rutile and ilmenite amounted to 216,000 long tons, and for January – June, 1963 was 120,000 long tons.** It is estimated that 60,000 long tons of rutile were shipped to United States pigment producers in 1963 and that shipments will increase to 120,000 long tons in 1964 and 130,000 long tons in 1965.***

In 1961, E.I. du Pont de Nemours became the first company in the United States to produce TiO_2 pigment from rutile using a chloride process. In 1962, Godfrey Cabot Corporation and American Potash and Chemical Corporation announced that they intended to produce TiO_2 pigment using rutile as the source material.

In 1963, du Pont announced plans to increase the capacity of its chloride – type facilities at Edge Moor, Delaware, by 40 per cent. American Potash and Chemical Corporation (Ampot) announced that it intends to build a 25,000 ton-a-year

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

***The Australian Mineral Industry*, Vol. 16, No. 2, December 1963.

***Ward, J: Prospects for Australian Rutile, *The Australian Mineral Industry*, Vol. 16, No. 2, p. 40.

plant at Aberdeen, Mississippi, to produce TiO_2 pigments; originally the plant was to have been built at Mojave, California. The plant will use a chloride process developed jointly by Ampot and Laporte Industries Limited of Britain.

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.

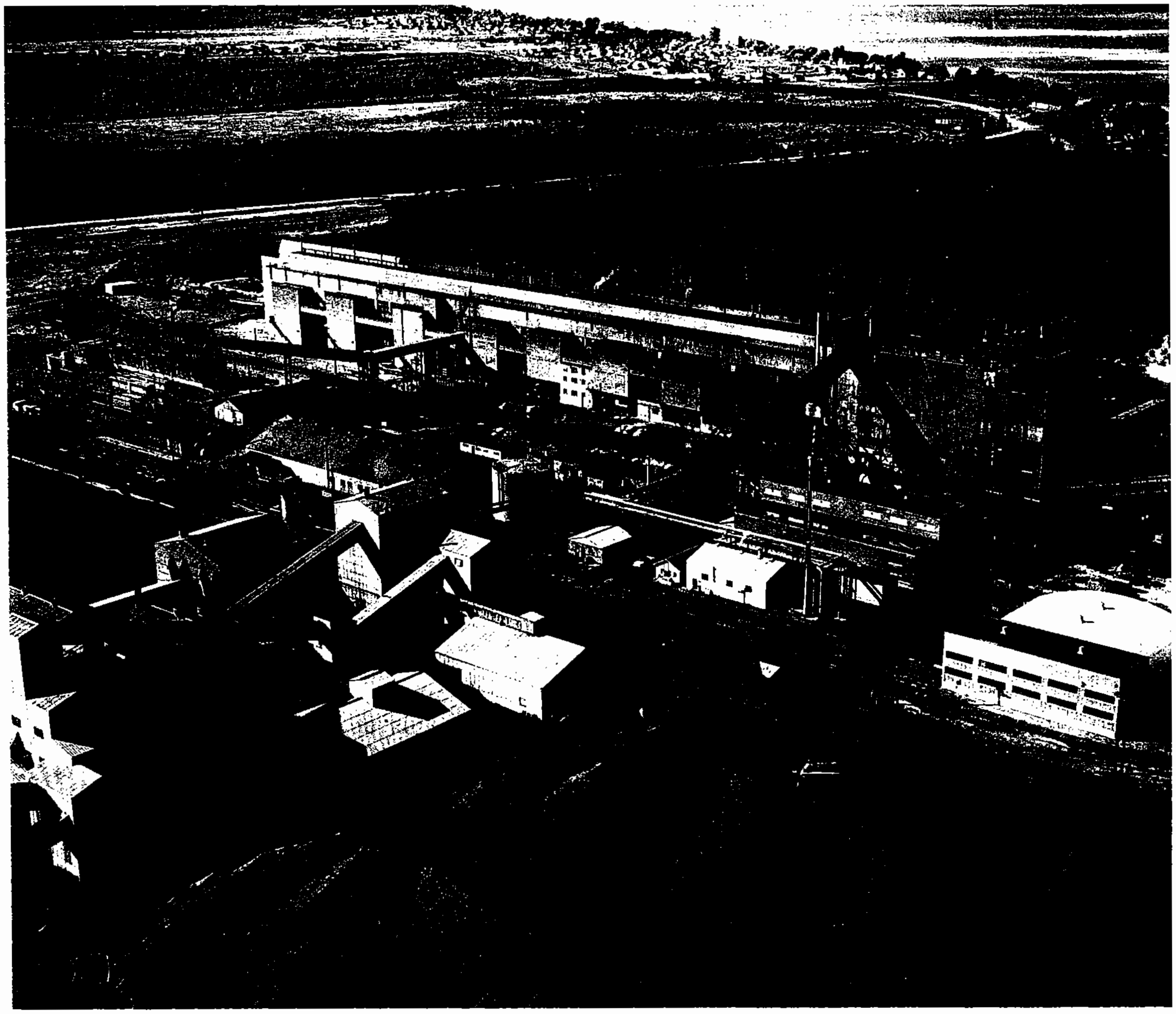
Titanium dioxide owes its value as a pigment to its high refractive index. To take full advantage of this property the TiO_2 must be in powder form of extremely small, uniform-sized particles. It is the high refractive index of TiO_2 pigment that accounts for its opacity. The amount of pigment required 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.

The installed TiO_2 pigment-producing capacity in Canada is about 47,000 tons a year and that of the United States about 690,000 tons. Consumption of TiO_2 pigments in Canada was in the order of 39,000 tons; the use, by industries 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%

The titanium content of ferrotitanium consumed in Canada in 1963 was 78 tons compared with 94 tons in 1962.



Destination of the ilmenite ore is Q.I.T.'s treatment plant at Sorel, Quebec, 200 miles upstream from Havre St. Pierre.

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 five to seven grams each. The principal application for these pellets is for special fuses which are sold almost entirely in Britain. Shipments in 1963 amounted to 9,000 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 also made significant strides forward in the technology and marketing of its specialty line of titanium baskets for use in electrolytic plating, notably nickel plating. The company entered the United States market in 1963 with this line of 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 multi-carbides; the raw material for the process is rutile.

Commercial manufacturers of titanium sponge were reduced to two in the United States when E.I. du Pont de Nemours and Co., Inc., closed its titanium sponge facility at Newport, Delaware. Titanium Metals Corporation of America, at Henderson, Nevada; and U.S. Industrial Chemicals Company, Division of National Distillers and Chemical Corporation, Metals Reduction Plant at Ashtabula, Ohio, are the only manufacturers of titanium sponge. The principal producers of titanium mill products in the United States are Reactive Metals Inc., owned jointly by National Distillers and U.S. Steel Corporation; 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 Nippan Soda Co., Ltd., Tokyo.

In 1963, sponge-metal and ingot production in the United States at 7,900 and 10,900 tons, increased for the fifth consecutive year. According to the U.S. Bureau of Mines, sponge production in Japan, Britain and the United States was 9,900 tons in 1963, the highest since 1957 when the all-time high of 22,300 tons was achieved.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Titanium ore	free	free	free
Titanium oxide, and white pigments containing not less than 14% TiO_2 by weight	free	12½%	15%
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%

United States

Titanium ore, crude	free
Titanium metal	20%
Ferrotitanium	10%
Titanium potassium oxalate and all compounds and mixtures containing titanium	15%

PRICES

The quotations which follow are from *E & M J Metal and Mineral Markets,* December 31, 1963.

	$
Ilmenite, per gross ton, f.o.b. cars, Atlantic ports	
59½% TiO_2	23.00 – 26.00
54% TiO_2	21.00 – 21.50
Rutile, per short ton, delivered within 12 months,	
94% TiO_2	104.00
Titanium metal, 500 lb. lots, 120 Brinell, 99.3% max.	
per lb. f.o.b. shipping point	1.32
Ferrotitanium	
Per lb. contained Ti, lots of ton or more, lump (½") packed, delivered northeastern U.S.	
25-40% Ti max., 0.1% C max.	1.35
Per net ton, carload lots, lump, packed, delivered northeastern U.S.	
17-21% Ti, 3-5% C	375.00
15-19% Ti, 6-8% C	310.00

Tungsten

V.B. Schneider*

Canada has not produced tungsten commercially since July 1958 when Canadian Exploration, Limited closed its tungsten operations at Salmo, British Columbia. The operations were terminated on completion of a sales contract with United States General Services Administration. The company still holds a stockpile containing approximately 37,000 short-ton units (20 lb.) of tungsten trioxide (WO_3). In 1963, Canada Tungsten Mining Corporation Limited 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.

Because of depressed conditions in tungsten markets, which saw the price of tungsten concentrates drop as low as $7.75 a short-ton unit of WO_3, Canada Tungsten suspended development and research operations in July at its open-pit mine and 300-ton-a-day concentrator. Although the ore assays 2.47 per cent WO_3, which makes the deposit one of the highest grade known, the low price of concentrates and, to a lesser degree, the relatively high cost of operating a mine in so remote a location made the operation uneconomical.

The depressed status of world tungsten markets was the subject of three meetings of the United Nations ad hoc Tungsten Committee in 1963. Factors contributing to these depressed markets were large tonnage shipments from Russia and Red China and the quantity of tungsten held in United States stockpiles, which on June 30, 1963 amounted to 204 million pounds, or 322 per cent of the stockpile's maximum objective. Towards the end of 1963, there was a reduction in the availability of concentrates from the Communist Bloc countries and this was reflected in a slight increase in the price offered for concentrates.

Imports of tungsten ore in 1963 were 645,500 pounds, much below the 2.9 million pounds reported in 1962. However, as the tungsten content of ore import has never been reported, a comparison of tungsten ore imports is of little significance. It is known that a very large portion of the 1962 imports was low grade. Domestic consumption at slightly less than a million pounds of contained tungsten was slightly less than in 1962.

*Mineral Resources Division

TABLE 1

Tungsten – Production, Imports and Consumption

	1962		1963	
	Pounds	$	Pounds	$
Production, WO_3	3,580	1,611	na	na
Imports				
Scheelite*				
Korea	80,000	31,239	443,400	129,814
Argentina	2,316,600	613,874	200,000	63,159
United States	60,000	37,315	2,100	1,604
Bolivia	191,900	75,432	–	–
Peru	132,800	60,403	–	–
China (Communist)	51,000	31,050	–	–
Portugal	22,000	9,084	–	–
Total	2,854,300	858,397	645,500	194,577
Ferrotungsten**				
Britain	235,100	108,893	516,200	160,731
Sweden	–	–	75,000	52,159
United States	26,000	36,237	17,500	22,218
Austria	–	–	12,300	7,820
France	18,500	13,825	3,100	1,671
Belgium and Luxembourg	6,000	6,894	–	–
Total	285,600	165,849	624,100	244,599
Consumption (W content)				
Scheelite	802,781r		565,369	
Tungsten metal and metal powder	18,908		147,576	
Tungsten wire	11,694		10,026	
Ferrotungsten	85,617		6,666	
Tungsten-carbide powder				
Sodium tungstate and tungstic oxide..............	120,628		175,287	
Total	1,039,628r		904,924	

Source: Dominion Bureau of Statistics.
*As reported in *Trade of Canada;* WO_3 content is not given. ** As reported in *Trade of Canada;* W content is not given.
Symbols: – Nil; na Not available for publication; r Revised.

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 the 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.

TABLE 2

Tungsten – Production, Trade and Consumption, 1954–63

(pounds)

	Production[1]	Imports[2]		Exports[3] Scheelite	Consumption[4]
	(WO_3 Content)	Tungsten Ore	Ferrotungsten	(W Content)	(W Content)
1954	2,170,633	7,200	85,900	1,239,187	170,980
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	–	1,039,628r
1963	na	645,500	624,100	–	904,924

Source: Dominion Bureau of Statistics.
[1]Producers' shipments of scheelite. [2]As reported in *Trade of Canada*. Tungsten content is not available. [3]Export shipments as reported by producers. [4]Scheelite, ferrotungsten and other tungsten products reported by consumers. From 1959, on, surveys covered a larger number of consumers.
Symbols: na Not available; – Nil; r Revised.

WORLD PRODUCTION AND TRADE

According to the United States Bureau of Mines* world mine production of tungsten (W) in 1963, was 64,700 tons. This was 8,600 tons less than the 1962 production. Production cutbacks were announced in all the major producing countries except mainland China. A reported drop in offerings from China into major importing areas may indicate a reduction in output from that source.

Increasing imports of concentrates in consumer countries from communist sources in 1962 and early 1963 resulted in marked changes in the world supply pattern, which seriously affected producers in non-communist countries, with prices dropping as low as $7.75 a short-ton unit on July 1 on the New York market. But in the last quarter of 1963, for reasons that are unclear, offerings of tungsten concentrates from communist countries declined and the price on the New York market moved up to $12.75.

The United States is the leading consumer of tungsten and until recent years was the predominant importer of concentrates. According to the United States Bureau of Mines*, mine production in the United States decreased 16 per cent compared with 1962 and consumption of concentrates decreased from 13.7 million pounds of contained tungsten in 1962 to 11.1 million pounds in 1963. The Bureau estimates** that the production of tungsten in concentrates in 1963 for the U.S.A. was 11.3 million pounds. American Metal Climax, Inc. reported byproduct tungsten production at Climax of one million pounds*** in 1963. Consumption of tungsten

*U.S. Bureau of Mines, *Minerals Yearbook 1963*.
**U.S. Bureau of Mines, *Minerals and Metals Commodity Data Summaries*, February, 1964.
***Company Annual Report, March 19, 1964.

TABLE 3
World Production of Tungsten in Concentrates, 1962–63
(short tons, 60 per cent WO_3 basis)

	1962	1963
China[e]	24,900	24,900
U.S.S.R.[e]	11,600	12,100
United States (shipments)	8,429	5,657
Republic of Korea	8,219	6,724
North Korea[e]	4,400	4,400
Bolivia (exports)	2,798	2,513
Portugal	2,754	1,635
Australia	1,946	1,771
Argentina	635	129
Other countries[e]	7,619	4,871
Total[e]	73,300	64,700

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

products decreased almost 12 per cent for the same period. Tungsten imports also decreased. Imports for consumption during 1963 were 922,000 pounds or 25 per cent less than those reported for 1962. United States production in 1963 came almost entirely from two mines: the Pine Creek mine of Union Carbide Nuclear Company, near Bishop, California and the Climax mine of the Climax Molybdenum Company, a division of American Metal Climax, Inc., near Climax, Colorado.

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 five 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 one 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 armor-piercing shells.

TABLE 4

Consumption of Tungsten in Canada by Use, In 1963
(lbs. of contained W)

Carbides	591,143
Electric and Electronics	11,284
Nonferrous alloys	10,915
Iron and Steel	278,084
Pigments	13,498
Ceramics	–
Total	904,925

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 among the leading consumers of tungsten:

Ontario

Atlas Steel 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 high-purity tungsten tri-oxide 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 powders for diamond bits and diamond tools, and Kenspray, a composition of tungsten carbide particles bonded with a suitable matrix powder, ready for application by conventional thermo spraying techniques. As raw material the company uses wolframite, and scheelite concentrates. Other consumers start with partially processed and semifabricated tungsten products.

PRICES

According to *E & M J Metal and Minerals Markets* of December 20, 1963, 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	12.75 to 13.75
Wolfram	12.75 to 13.25
Scheelite	12.75 to 13.25
U.S. scheelite, f.o.b. mine or mill	16.00 to 18.00
Tungsten metal, per lb.	
98.8% min., 1,000-lb. lots	2.75
Hydrogen reduced 99.99%	2.45 to 3.20
Ferrotungsten, per lb. contained W, 70-80%, lots 5,000 lbs. or more, lump ¼ in. packed	
domestic	1.75 (nominal)
Imported	1.40 (nominal)
Tungstic acid, per lb., 1,000-lb. lots in drums (according to *Oil, Paint and Drug Reporter*, Dec. 30, 1963)	2.23

TARIFFS

	British Preferential	Most Favored 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%

Canada (cont'd)

	British Preferential	Most Favored Nation	General
Tungsten carbide, in metal tubes for use in Canadian manufacturing	free	free	free
Ferrotungsten	"	5%	5%
Tungsten rod and tungsten when used in Canadian manufacture	"	free	25%
Tungsten metal, in lumps, powder, ingots, blocks, or bars, and scrap of alloy metal containing tungsten, for use for alloying purposes	"	"	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%
Wrought	25.5%

Uranium

J.W. Griffith*

In 1963, deliveries of Canadian uranium oxide (U_3O_8) to the United States, Britain and the Canadian government stockpile totalled 8,352 tons valued at $137 million. Despite the general decline in the uranium mining industry over the past four years, production in 1963 was only slightly lower than that of the previous year (8,430 tons) but substantially lower than the peak production year of 1959 (15,892 tons).

One of the significant events of 1963 was the institution of the federal government's short-term stockpile program. Under this plan, announced in June 1963, 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, Faraday Uranium Mines Limited and the Milliken mine of Rio Algom Mines Limited. 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 of Ontario for a slightly longer period so that alternative measures of assistance for these communities might be studied. The plan was accepted by all three mines. Five other mines were in operation during 1963 but by year-end two of these had closed.

The short-term outlook for the uranium industry in the Free World is one of diminishing production and a gradual shutdown of mines but the long-range picture appears much brighter. Under present firm contracts some production in Canada will continue to October 1971 when only one mine is expected to be in operation. At the end of 1963 there were only six mines (Table 1) in operation compared with the all-time high of 25 in 1958. Two mines closed during 1963: Bicroft mine (owned by Macassa Gold Mines Limited) in the Bancroft area, closed in June, and the Gunnar mine (owned by Gunnar Mining Limited) on the north shore of Lake Athabasca (Beaverlodge area), Saskatchewan, concluded mining operations in October while mill clean-up continued into 1964. Gunnar was unable to complete its contract because of ore depletion. The undelivered quantity, estimated at 1.2 million pounds of U_3O_8 will be offered to the remaining producers at the Gunnar contract price. The company will not receive any credit for this undelivered uranium, nor will it suffer any penalty for not completing its contract.

*Mineral Resources Division

TABLE 1

Canadian Uranium Producers' Statistics for 1963

Company and Location	Production (tons U_3O_8)	Amount of Ore Treated (millions of tons)	Average Mill Rate (tons ore/day)	Mill Capacity (tons ore/day)	Millhead Grade (lb U_3O_8/ton)	Mill Recovery %	Remarks
Elliot Lake District, Ont.							
Denison Mines Limited	2,539	1.59	4,444	6,000	3.34	94.72	
Rio Algom Mines Limited*	2,395	2.00	5,480**	6,400	2.51	95.01	
Stanrock Uranium Mines Limited	923	1.03	2,740**	3,000	1.889	na	
Bancroft Area, Ont.							
Macassa Gold Mines Limited (Bicroft)	..	..	..	1,400	..	..	Closed in June 1963
Metal Mines Limited (Faraday)	390	0.36	1,241	1,500	2.32	94.50	Formerly Faraday Uranium Mines Ltd.
Beaverlodge Area, Sask.							
Eldorado Mining and Refining Limited	928	0.54	1,490**	2,000	4.00	85.25	
Gunnar Mining Limited	952	0.77	2,100	2,100	na	na	Closed in February 1964

Source of Information: Company annual reports unless stated otherwise.
*Operated two mines — Milliken and Nordic. **Estimate. Based on total tons ore treated during 365 days.
Symbols: na Not available for publication. .. Not available at time of writing.

TABLE

Uranium – Production and Exports

	1962		1963	
	Short Tons	$	Short Tons	$
Production (U_3O_8) (shipments)				
Ontario	6,403	118,283,081	6,385	102,951,146
Saskatchewan	2,027	39,900,588	1,967	33,957,973
Total	8,430	158,183,669	8,352	136,909,119
Exports (U_3O_8)				
United States		149,165,248		96,879,093
Britain		16,597,910		40,509,263
Japan		39,689		130,000
Brazil		nil		13,025
West Germany		206,032		nil
Total		166,008,879		137,531,381

Source: Dominion Bureau of Statistics

Output from mines in the Elliot Lake district of Ontario operated by Denison Mines Limited, Stanrock Uranium Mines Limited and Rio Algom Mines Limited was 72 per cent of the total domestic output in 1963. Rio Algom operated two mines in the Elliot Lake district, the Nordic and Milliken mines. Production from the Bancroft camp in southeastern Ontario was about four per cent of Canada's total with most of it coming from Faraday Uranium Mines Limited*. The remaining production came from two mines, one operated by Eldorado Mining and Refining Limited and the other by Gunnar Mining Limited in the Beaverlodge Lake area of northern Saskatchewan.

Rio Algom had planned to close its Milliken mine at the end of July but with the announcement of the government stockpile plan on June 26, the company kept this mine, with 550 employees, in operation. Denison began deliveries under the stockpile plan late in the year and Faraday commenced deliveries early in 1964.

As of March 1, 1964 Eldorado was the only producer in the Beaverlodge area of northern Saskatchewan. Production at this mine is expected to continue until early 1967. Eldorado's refinery at Port Hope, Ontario, operated at reduced capacity and about 50 of its 200 employees were laid off in June because of this contraction. The cutback was necessary to stretch the orange oxide refining contract to the end of 1966.

*In June 1963, the net assets of Faraday Uranium Mines Limited were purchased by Metal Mines Limited – a subsidiary company.

Scheduled deliveries of Canadian uranium under contracts with the United States Atomic Energy Commission (USAEC), the United Kingdom Atomic Energy Authority (UKAEA) and the Canadian government (stockpile) are shown in Table 3.

ORE RESERVES

Canadian ore reserves of uranium and thorium as of January 1, 1964, were estimated by the Department of Mines and Technical Surveys at 225 million 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 $8 a pound for U_3O_8. A recent study by the Geological Survey of Canada and the Mineral Resources Division, Department of Mines and Technical Surveys, showed that Canada's resources of nuclear fuels are sufficient to support very large nuclear power programs for many years to come. This survey included a prognostication of geologically probable discoveries of uranium and thorium as well as an estimate of reserves potentially mineable at higher uranium prices.

Despite the present surplus of uranium there is a growing concern about long-term supplies for a market that some authorities believe will 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 stations is becoming competitive with the cost of power from conventionally-fuelled thermal electric plants and it is expected that by 1975, or earlier, nuclear power will show economic advantages in comparison with conventional thermal power in many countries. The Consultative Committee of the Euratom Supply Agency has estimated that uranium requirements between 1970 and 1980 for nuclear power plants alone will amount to 190,000 metric tons of U which is equivalent to 246,000 short tons of U_3O_8.

Because of the favorable outlook for nuclear-generated electric power there is concern about reserves of nuclear fuels because many producers have recently revised their ore reserve estimates downwards. The revision by the USAEC was from 230,000 tons of U_3O_8 in late 1960 to 167,000 tons in February 1963. French reserve estimates have been reduced from 60,000 tons of U_3O_8 in 1960 to 34,000 tons in 1962. South African Reserves were re-assessed from 370,000 tons of U_3O_8 in 1958 to 150,000 tons in 1963. Reserves in Argentina, Australia, Brazil, India and Spain are considered to be low and Republic of the Congo (Leopoldville) has depleted its reserves. This leaves only Canada with substantial reserves , although these have also been revised downward from 387,000 tons of U_3O_8 in 1958 to 207,000 tons in December 1963.

Canada also has large reserves of thorium, the principal sources of which are the uranium ores of the Elliot Lake district and the uranium-thorium deposits in the Bancroft area. Estimated reserves of uranium and thorium in countries of the Free World are shown in Table 4. These are exploitable reserves from which concentrates can be produced at $10 a pound, or less, for either U_3O_8 or ThO_2. They do not include reserves of lower grade material, which, in some countries, are considerably larger than the reserves listed.

TABLE 3
Scheduled Uranium Deliveries, 1963-71
(short tons of U_3O_8)

	To USAEC	To UKAEA	To Canadian Gov't Stockpile (estimated)	Total
1963	4,521	3,069	800	8,390
1964	1,801	4,292	1,950	8,043
1965	611	2,288	—	2,899
1966	459	1,641	—	2,100
1967	—	1,226	—	1,226
1968	—	1,200	—	1,200
1969	—	1,200	—	1,200
1970	—	1,200	—	1,200
1971	—	933	—	933
	7,392	17,049	2,750	27,191

Source: Eldorado Mining and Refining Limited and Mineral Resources Division.
— Nil, contract deliveries completed.

TABLE 4
Estimated Reserves of Uranium and Thorium in the Free World
(as of Jan. 1, 1964)

Country	Tons of U_3O_8	Tons of ThO_2
Argentina	1,100	nil
Australia	12,000	50,000
Canada	207,000	82,000
France	34,000	11,400
India	16,500	200,000
South Africa	147,000	15,000
Spain	10,000	nil
United States	160,000	120,000
Others	10,000	47,000
Totals	597,600	525,400

Source: Various publications.

PRICES

The prices paid to the Canadian producers for the sale of uranium concentrates (yellowcake), under government contract, varied with each company; they were originally calculated to provide a profit after allowances for amortization of the major estimated capital costs and the estimated operating costs. Under most contracts whereby Eldorado, the Canadian Crown agency, supplied U_3O_8 to the USAEC and the UKAEA, the maximum price paid to a producer was $10.50 a pound of contained U_3O_8. The prices to be paid under the 1962 contract with the UKAEA range from $4.10 to about $7.10 a pound of U_3O_8, the weighted average being $5.03.

Open-market prices for small quantities of uranium (U_3O_8) have been in the range of $3 to $4 a pound. Although the quantities sold privately come under government regulations, it is doubtful if any large sales could be made under the present market situation and it is even more doubtful if they would be made by mining companies at those low prices.

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 to countries that do not hold agreements with Canada for co-operation in the peaceful uses of atomic energy are permitted, but the maximum amount any such country may receive from Canada is 2,500 pounds.

NUCLEAR POWER

Canada's nuclear power demonstration plant (NPD) at Rolphton, Ontario, about 140 miles northwest of Ottawa, continued to operate satisfactorily during 1963. This station, Canada's first nuclear power plant, went into operation in April 1962 and has a net electrical output of 20,000 kilowatts. Atomic Energy of Canada Limited (a Crown corporation), Ontario Hydro Electric Power Commission and Canadian General Electric Company Limited co-operated in the building of NPD; it is the prototype for larger plants such as the 200,000 kilowatt CANDU nuclear power station now under construction at Douglas Point on the east shore of Lake Huron, midway between Kincardine and Port Elgin, Ontario. CANDU is scheduled for completion in 1965. The initial fuel charge in this reactor will consist of about 66 tons of natural uranium in the form of sintered UO_2 pellets, sheathed in zircaloy tubes. Once CANDU is in operation, annual refuelling requirements are not expected to exceed 25 tons of UO_2 (equivalent to 28 tons of U_3O_8).

Since NPD first began operation, the technical feasibility, reliability and safety of the heavy-water moderated type of reactor have been fully confirmed. Recent endurance runs have achieved a capacity factor of over 88 per cent and capacities of over 90 per cent are confidently expected. There have been no fuel rod failures and on-power refuelling is a routine operation.

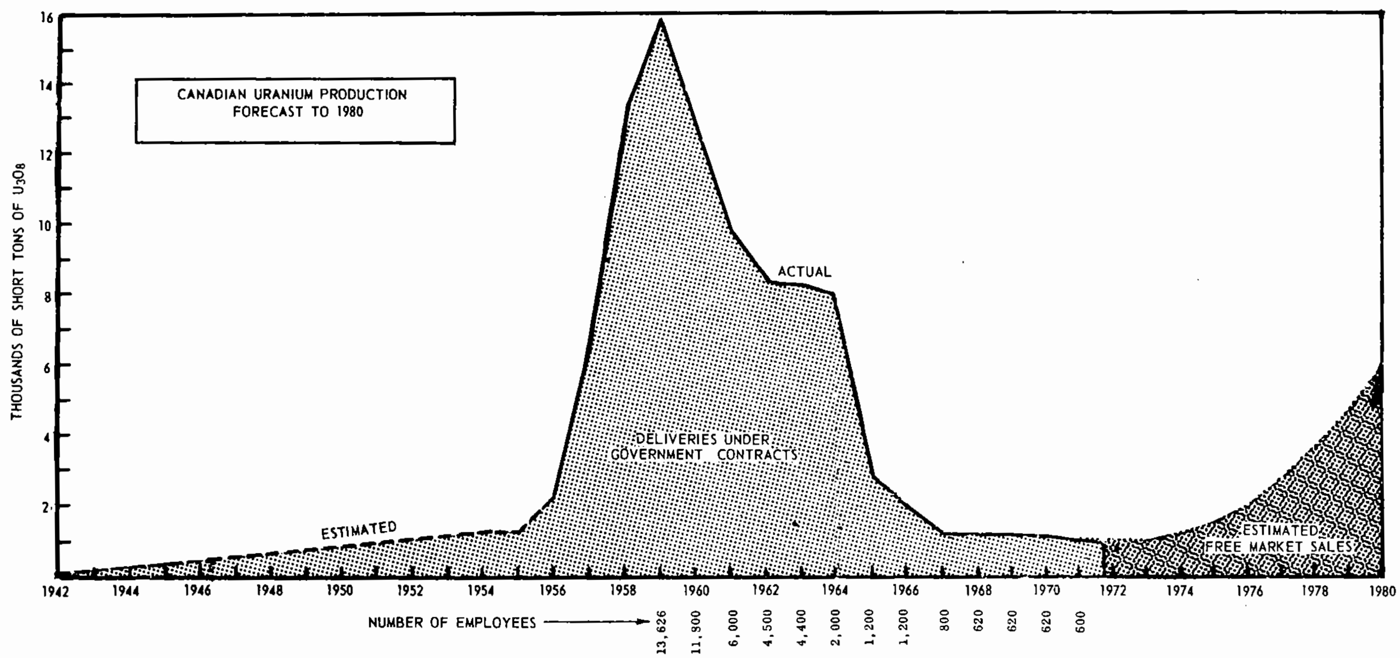
International acceptance of the Canadian type of natural uranium, heavy-water moderated reactor concept continues to grow. India, Britain, Finland, West Germany, Pakistan, Japan, Spain, Sweden, Austria and Italy have shown interest in the Canadian type of plant. During 1963, Canada and India signed an agreement to co-operate in the construction of a nuclear power station of the CANDU type with a net electrical output of 200,000 kilowatts. Canada will provide the reactor design and one half the initial charge of uranium fuel which at current prices would be worth $2.1 million. Canada will also supply such additional fuel for the station as may be required provided that Canadian fuel is not more expensive than fuel from other sources. The Canadian government will provide credit facilities for services and equipment from Canada at an estimated cost of $35 million; the total cost of the project will be about $70 million.

HEAVY WATER PLANT

Heavy water is an expensive commodity used as a moderator in Canada's natural-uranium type of nuclear power reactor. In December, the federal government accepted the bid by Deuterium of Canada Limited to build a heavy water plant in Canada. During the first five years of production the company will supply not less than 200 tons of heavy water a year to Atomic Energy of Canada Limited at $20.50 a pound. The heavy water plant, to be built at Glace Bay, Nova Scotia, is expected to provide an annual market for about 100,000 tons of Nova Scotia coal. The coal will be used in a nearby power plant owned by Seaboard Power Corporation Limited, a subsidiary of Dominion Steel and Coal Corporation, Limited. The generating plant will be enlarged to meet the increased demand for power and heat.

OUTLOOK FOR URANIUM

The development of nuclear power for peaceful uses has not been achieved without some serious problems but experience in operating nuclear-electric generating stations has indicated that these plants have firmly established themselves as being practical, reliable and safe. No nuclear power station has produced power yet at a cost that would be competitive with that produced by a


CANADIAN URANIUM PRODUCTION
FORECAST TO 1980
THOUSANDS OF SHORT TONS OF U_3O_8
16
14
12
10
8
6
4
2
1942
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
ACTUAL
ESTIMATED
DELIVERIES UNDER
GOVERNMENT CONTRACTS
ESTIMATED
FREE MARKET SALES
NUMBER OF EMPLOYEES
13,626
11,900
6,000
4,500
4,400
2,000
1,200
1,200
800
620
620
620
600

conventional thermal power plant but many nuclear experts and economists believe that some areas in the United States and other countries will have economic atomic power before the end of this decade. As of November 1963, there were 73 power stations (96 reactors) in operation, under construction or definitely planned in 17 countries. These stations do not include the experimental, testing, research and ship reactors which number at least 400.

The 73 nuclear power stations, all expected to be in operation before 1970, will have a total net electrical output of about 14,000 megawatts. Equating this amount of electrical energy to tons of uranium fuel, the initial fuel loading requirement will total about 10,000 tons of U_3O_8 equivalent, and annual refuelling needs will be from 5,000 to 6,000 tons of U_3O_8 equivalent. Canada's share in this market is expected to be from 1,000 to 2,000 tons of U_3O_8 annually by 1971 (see Graph). By 1980 however, the yearly demand in this market is expected to reach a minimum of 6,000 tons of U_3O_8 from Canadian uranium producers.

Zinc

D.B. Fraser*

In 1963, mine output totalled 497,180 short tons of zinc contained in concentrates, about 5,000 tons less than in the previous year. Production was reduced by prolonged strikes at two mines causing a loss of output of 15,000 tons, and by lower ore grades at several other mines. Counteracting these influences was the opening in October 1963 of new zinc-copper mines in the Matagami district of northwestern Quebec which added approximately 18,000 tons to the total output of zinc in concentrates.

With the settlement of strikes and the addition of the production of new mines, output of zinc rose in the last quarter of 1963 to 132,926 tons, 12,000 tons more than the average of earlier quarters. There was a further rise in the first quarter of 1964 to 159,800 tons. Assuming that this rate continues, and taking into account the output of new mines scheduled to open during 1964, mine output should rise in 1964 to approximately 725,000 short tons of contained zinc.

Production of refined zinc in 1963 totalled 284,021 tons, 3,863 tons more than in the previous year. Production rose moderately in the last quarter of the year immediately following the start of operations at a new electrolytic refinery at Valleyfield, Quebec. Output at the electrolytic refineries at Trail, B.C. operated by The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) and at Flin Flon, Man. operated by Hudson Bay Mining and Smelting Co., Limited, was at about the same level as in 1962. Primary refining capacity at the end of 1963 was:

	Annual Capacity (short tons)
COMINCO, Trail	208,000
Hudson Bay Mining and Smelting Co., Ltd., Flin Flon	79,000
Canadian Electrolytic Zinc Limited, Valleyfield	72,000

* Mineral Resources Division

The zinc concentrates produced in Manitoba and Saskatchewan were refined at Flin Flon. Most of those produced in British Columbia and Yukon Territory were refined at Trail; the rest was exported to refineries in the northwestern United States. The production of eastern mines, except for the amounts required by the Valleyfield zinc refinery, was exported for treatment to the United States, Europe and Japan.

Some of the zinc concentrates destined for the United States went first to Canadian roasting plants at Port Maitland, Ont. and to Arvida, Que., for preliminary recovery of sulphur.

TABLE 1

Zinc – Production, Trade and Consumption

	1962		1963	
	Short Tons	$	Short Tons	$
Production				
All Forms[1]				
British Columbia	206,716	50,025,192	201,432	51,485,905
Quebec	70,737	17,113,299	75,084	19,191,567
Ontario	63,132	15,278,027	66,470	16,989,728
Manitoba	49,920	12,080,667	46,392	11,857,855
Newfoundland	32,541	7,874,869	34,485	8,814,473
Saskatchewan	30,900	7,477,708	33,320	8,516,479
New Brunswick	2,498	604,575	10,614	2,712,939
Yukon	5,944	1,438,554	5,925	1,514,520
Nova Scotia	757	183,090	nil	nil
Total	463,145	112,080,981	473,722	121,083,466
Mine output[2]	501,937		497,180	
Refined[3]	280,158		284,021	
Exports				
Zinc blocks, pigs and slabs				
Britain	92,338	16,274,265	82,857	15,779,816
United States	74,733	17,381,615	74,251	17,852,987
India	20,266	3,181,999	21,535	3,835,231
Netherlands	4,438	815,864	8,122	1,752,531
West Germany	2,602	449,720	4,564	848,616
Japan	95	13,003	1,874	356,196
Korea	110	18,197	1,423	260,738
Colombia	788	133,461	625	119,524
Belgium and Luxembourg	2,186	405,043	616	144,428
Pakistan	2,568	396,340	600	103,351
Other countries	10,599	1,706,064	3,535	611,094
Total	210,723	40,775,571	200,002	41,664,512

Table 1 (Continued)

	1962		1963	
	Short Tons	$	Short Tons	$
Zinc contained in ores and concentrates				
United States	194,743	16,078,821	156,964	13,093,348
Belgium and Luxembourg	24,066	1,587,548	14,379	1,296,013
Norway	nil	nil	13,035	1,210,460
Britain	5,905	526,111	10,616	959,968
West Germany	3,047	220,434	7,466	801,627
Japan	nil	nil	6,836	514,700
France	8,748	428,082	1,963	189,963
Poland	4,032	280,000	1,785	128,000
Netherlands	1,752	82,503	nil	nil
India	164	25,229	nil	nil
Total	242,457	19,228,728	213,044	18,194,079
Zinc fabricated materials, not elsewhere specified				
United States	183	89,203	556	202,203
Britain	229	653,971	504	321,030
United States Oceania	nil	nil	157	40,638
Trinidad	53	20,525	91	38,188
Other countries	3	2,025	10	9,632
Total	468	765,724	1,318	611,691
Zinc and zinc-alloy scrap, dross and ashes				
United States	2,757	405,577	3,012	461,601
Belgium and Luxembourg	2,111	97,640	2,135	112,364
Netherlands	330	19,515	318	21,034
Britain	200	15,634	257	15,623
Japan	94	14,786	nil	nil
Total	5,492	553,152	5,722	610,622
Imports				
Zinc				
in pigs, slabs, blocks, anodes	710	187,341	639	167,347
bars, rods, plates, sheet	765	426,222	788	465,688
dross and zinc scrap	345	24,889	234	17,956
dust and granules	889	263,866	1,171	353,148
slugs, discs, shells		199,241		138,547
manufactures, not otherwise provided for		3,319,067		3,798,285
chloride	218	46,012	207	43,936
sulphate	1,501	147,984	1,682	178,216
white oxide	2,736	576,795	2,232	458,191
Lithopone	734	120,156	391	59,181
Total		5,311,573		5,680,495

Table 1 (Concluded)

	1962			1963		
	Primary	Secondary	Total	Primary	Secondary	Total
	(short tons)					
Consumption						
Zinc used for or in the manufacture of:						
Copper alloys (brass, bronze, etc.)	6,516	100	6,616	7,296	95	7,391
Galvanizing:						
Electro	695	60	755	770	43	813
Hot-dip	35,898	402	36,300	37,070	326	37,396
Zinc die-cast alloy ...	10,534	nil	10,534	12,344	2,575	14,919
Other products (including rolled and ribbon zinc, zinc oxide)	11,677	2,192	13,869	13,598	1,474	15,072
Total	65,320	2,754	68,074	71,078	4,513	75,591
Stocks on hand at end of year	6,614	734	7,348	7,806	830	8,636

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.

TABLE 2
Zinc – Production, Exports and Consumption, 1954–63
(short tons)

	Production		Exports			Consumption[3]
	All Forms[1]	Refined[2]	In ore and concentrates	Refined	Total	
1954	376,491	213,775	180,172	206,038	386,210	46,735
1955	433,357	256,542	190,585	213,837	404,422	58, 062
1956	422,633	255,564	199,313	183,738	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	71,078

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 virgin zinc only.

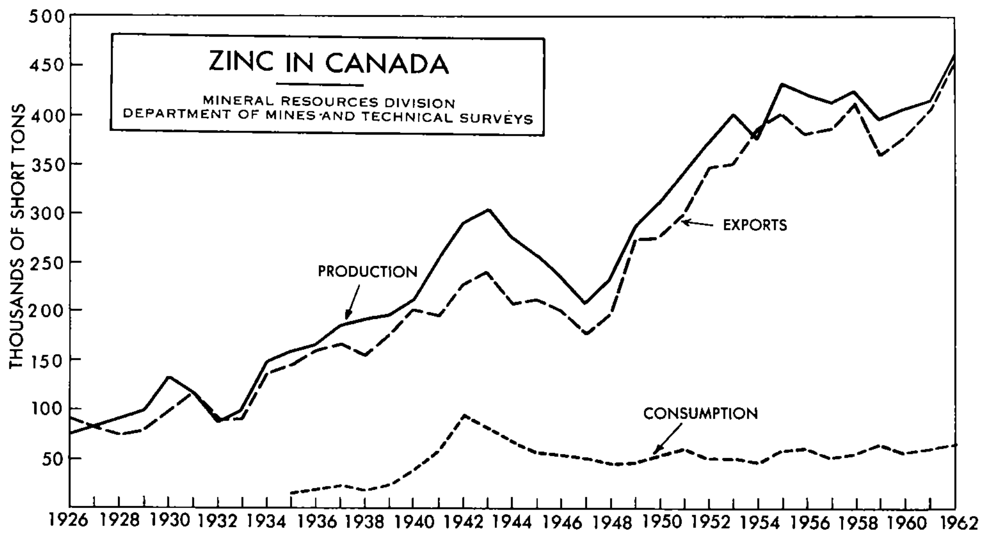


TABLE 3

Free World Production of Zinc, 1963

(short tons)

	Mine Production	Refined Production
United States	582,000	953,000
Canada	497,000	284,000
Australia	354,000	201,000
Peru	272,000e	65,000e
Mexico	260,000	63,000
Japan	215,000	311,000
Spain	125,000	72,000
Italy	118,000	88,000
West Germany	117,000	183,000
France	18,000	185,000
Belgium	nil	227,000
Britain	nil	111,000
Other	597,000	284,000
Total, Free World	3,155,000	3,027,000

Source: International Lead and Zinc Study Group.
e Estimate.

Britain, followed closely by the United States, continued to be the principal export market for refined zinc. The two accounted for 79 per cent of total exports in this form. The principal market for zinc concentrates was the United States (74 per cent of the total); 22 per cent went to western Europe, and small quantities went to Japan and Poland.

Domestic consumption of zinc in die-cast alloy rose by about 40 per cent in 1963 compared with the previous year. This, combined with smaller increases in the other major applications, resulted in an over-all rise in consumption to 75,600 tons, 11 per cent greater than in 1962.

Canada was the second-ranking zinc ore producer among Free World countries in 1963 and the third in production of refined zinc.

Free world consumption of slab zinc was eight per cent or 227,000 tons greater than in 1962. Consumption in the United States rose to 1.1 million tons, the second highest amount on record. Other significant increases were reported in Japan and Australia; consumption in the United Kingdom and Europe, though not substantially higher than in the previous year, was maintained. As a result of the high level of demand, world production was absorbed and producers' stocks, particularly in the United States, reduced. Zinc prices rose during the year by 40 per cent on the London Metal Exchange and by 13 per cent in the United States.

United States Quotas

The import quotas on unmanufactured lead and zinc imposed by the United States in October 1958, continued in effect throughout 1963, limiting commercial imports to 80 per cent of their annual average for the period from 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 ore exports to the United States during 1963 was filled in the first few days of each quarter. The metal quota was filled in all quarters, the last entries being made in the final days of each quarter.

The United States Tariff Commission in its annual report to the President on developments in the United States lead and zinc industry made no recommendation, as in earlier reports, for a change in quota restrictions. In March 1964, the Commission was instructed to investigate further the probable economic effects of such a change.

International Lead and Zinc Study Group

The International Lead and Zinc Study Group, which has met regularly since 1959, held two meetings in Geneva during 1963. The first, in March, was a meeting of the Special Working Group convened to examine the views which had been submitted by member countries a few months earlier, on the principles, objectives and possible forms of international agreements or arrangements. The second, held at the end of October, was a meeting of the full Study Group.

The statistical analysis and forecast made during the second meeting indicated that consumption of zinc, which had been rising for several years, was likely to increase further in 1964 and would probably exceed new supplies. Stress was placed on the importance of liberalizing trade in lead and zinc.

Developments at Producing Mines and Refineries

Canada's leading lead-zinc producer, COMINCO, operated three zinc-producing mines in British Columbia: the Sullivan, the H.B. and Bluebell. Zinc and lead concentrates from these mines provided 87 per cent of the zinc and lead produced at the company's metallurgical works at Trail. The remainder came from purchased ores and concentrates (9 per cent) and from lead blast-furnace slag (4 per cent). Total output of zinc metal was 194,159 tons, 5,234 tons less than in 1962. To replace in part the metal previously recovered from residue and slag stockpiles at Trail, and, while awaiting the start of production at Pine Point, N.W.T., the mining program at the Sullivan mine was temporarily modified to increase production of zinc and other metals.

Hudson Bay Mining and Smelting Co., Limited, produced 79,596 tons of slab zinc from the treatment of zinc concentrates from copper-zinc ores of the Flin Flon and Snow Lake districts. Production the previous year was 1,170 tons larger.

Canadian Electrolytic Zinc Limited, under the management of Noranda Mines, Limited, completed construction of an electrolytic zinc reduction plant at Valleyfield, 30 miles west of Montreal, and from late September to the end of the year produced 10,300 tons of refined zinc. Rated capacity of the new plant, 200 tons a day, was to be reached by March 1964.

Two new zinc-copper mines in the Matagami district of northwestern Quebec were opened during 1963. Mattagami Lake Mines Limited and Orchan Mines Limited began production in October, the first operation a 3,000-ton mill, the latter a 1,900-ton mill of which 900 tons was used to treat copper ore from a third new Matagami-district producer, New Hosco Mines Limited. The two zinc-producing companies of the district, together with Geco Mines Limited, Quemont Mining Corporation, Limited, and Normetal Mining Corporation, Limited, supply zinc concentrate for the refinery at Valleyfield.

The mine production of principal zinc producers is shown in Table 4.

Other Developments

Northwest Territories

Construction of facilities for the production of lead and zinc concentrates at Pine Point on the south shore of Great Slave Lake began during 1963. Work was done on housing construction, on clearing and stripping of one orebody, and on clearing and excavation of the site of the 5,000-ton concentrator. COMINCO, which is managing the work for its subsidiary Pine Point Mines Limited, announced that in order to provide for treatment of Pine Point concentrates the zinc plant at Trail would be expanded to bring the capacity to 235,000 tons a year.

Work on the 430-mile Canadian National Railways line to Hay River and Pine Point proceeded during the year. The scheduled date for its completion was moved ahead to before the end of 1965 from the end of 1966. The Northern Canada Power Commission began construction of an 18,000-kilowatt hydro-electric plant on the Talston River to supply power for Pine Point.

TABLE 4

Principal Zinc Mines in Canada, 1963

Company	Mine and Location	Mill Capacity (short tons/day)	Grade of Ore (principal metals): Lead (%)	Zinc (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1963(1962) (short tons)		Contained Zinc Produced 1963(1962) (short tons)	
British Columbia										
The Anaconda Company (Canada) Ltd.	Britannia, Howe Sound	4,000	nil	0.99	1.29	0.17	493,700	(501,078)	4,233	(3,855)
Canadian Exploration, Limited	Jersey, Salmo	1,900	1.5	4.1	nil	n.a	368,673	(384,894)	14,091	(15,754)
The Consolidated Mining and Smelting Company of Canada Limited	Sullivan, Kimberley	10,000	na	na	nil	na	2,595,000	(2,583,068)	130,966	(131,359)
	Bluebell, Riondel	700	na	na	nil	na	256,000	(237,742)	14,463	(14,029)
	H.B., Salmo	1,200	na	na	nil	na	474,000	(468,979)	20,655	(20,293)
Mastodon-Highland Bell Mines Limited	Highland-Bell, Beaverdell	75	1.9	2.5	nil	40	21,689	(19,480)	532	(396)
Reeves MacDonald Mines Limited	Reeves, MacDonald, Remac	1,200	1.3	3.7	nil	na	145,966	(417,448)	4,822	(14,601)
Sheep Creek Mines Limited	Mineral King, Toby Creek, SW of Invermere	600	2.14	5.9	nil	1.01	203,942	(208,670)	9,352	(10,161)
Yukon Territory										
United Keno Hill Mines Limited[1]	Hector-Calumet, Mayo district Elsa, Mayo district	500	5.44	4.69	nil	34.03	186,721	(184,123)	7,380	(6,943)
Manitoba and Saskatchewan										
Hudson Bay Mining and Smelting Co., Limited	Flin Flon, Flin Flon district	6,000	0.2	4.0	2.41	1.05	924,616	(925,030)	77,774	(85,248)
	Coronation, " "		nil	0.2	4.29	0.21	292,650	(347,731)		
	Schist Lake, " "		nil	8.8	5.45	1.40	81,150	(88,316)		
	Chisel Lake, Snow Lake, Man.		1.4	12.9	0.49	2.06	300,065	(338,377)		
Ontario										
Geco Mines Limited	Geco, Manitouwadge	3,300	na	5.72	1.88	2.44	1,281,165	(1,282,414)	59,529	(49,357)
Kam-Kotia Porcupine Mines, Limited[2]	Kam-Kotia, Timmins	1,600	nil	0.85	2.0	na	400,091	(376,533)	23	(nil)
Willroy Mines Ltd	Willroy, Manitouwadge	1,200	0.10	3.32	2.02	1.14	483,800	(495,028)	11,702	(21,272)

Quebec										
The Coniagas Mines, Limited	Coniagas, Bachelor Lake	350	1.7	13.7	nil	8.0	111,418	(108,212)	13,882	(12,574)
Manitou-Barvue Mines Limited	Golden Manitou, Val d'Or	1,300	0.73	5.63	nil	4.52	174,365	(169,140)	8,826	(9,442)
			nil	nil	0.93	0.16	293,000	(291,440)	nil	(nil)
Mattagami Lake Mines Limited[3]	Mattagami, Matagami	3,000	nil	12.3	0.68	1.31	166,725	(nil)	16,550	(nil)
New Calumet Mines Limited(a)	New Calumet, Calumet Island	750	1.83	6.75	nil	3.68	93,360	(95,623)	6,134	(6,457)
Normetal Mining Corporation, Ltd	Normetal, Normetal	1,000	nil	5.32	2.65	1.83	345,384	(354,751)	14,744	(14,802)
Orchan Mines Ltd[3,4]	Orchan, Matagami	1,000	nil	10.54	0.89	na	35,956	(nil)	1,483	(nil)
		900	nil	nil	1.96	na	42,076	(nil)	nil	(nil)
Quemont Mining Corporation, Ltd	Quemont, Noranda	2,300	nil	2.21	1.22	0.79	803,000	(804,629)	12,999	(15,765)
Solbec Copper Mines, Ltd.	Solbec, Stratford Centre	1,000	0.65	4.72	1.96	1.54	188,493	(271,384)	7,212	(12,178)
Sullico Mines Ltd	East Sullivan, Val d'Or	3,000	nil	0.42	0.63	0.16	1,007,046	(991,868)	1,042	(4,725)
Vauze Mines Limited	Vauze, Noranda	350	nil	na	na	na	115,878	(109,242)	1,741	(1,728)
New Brunswick										
Heath Steele Mines Ltd	Heath Steele, Newcastle	1,500	2.4	5.6	1.1	2.53	265,939	(na)	11,113	(2,500e)
Nova Scotia										
Magnet Cove Barium Corporation	Magnet Cove, Walton	125	3.82	1.4	0.77	12.8	49,058	(47,416)	639	(581)
Newfoundland										
American Smelting and Refining Company (Buchans Unit)	Buchans, Buchans	1,250	7.76	13.86	1.15	4.09	376,000	(378,000)	47,900	(42,442)

[1]Data are for the fiscal year ending September 30, 1963. [2]Recovery of zinc began in last quarter of 1963.
[3]Production started October 1, 1963. [4]900 tons of copper ore daily are custom-milled for New Hosco Mines Limited.
Symbols: na Not available; e Estimate.

British Columbia

Western Mines Limited continued to explore its properties at Myra Falls, Vancouver Island and began sinking an internal shaft at one of these, the Lynx property. Indicated ore grades were 11.1 per cent zinc, 1.3 per cent lead, 2.5 per cent copper, and 3.1 ounces of silver per ton; the indicated tonnage was not reported. Plans for production, based on milling 750 tons of ore daily, were under study.

Manitoba – Saskatchewan

Hudson Bay Mining and Smelting Co., Limited, continued development of copper-zinc orebodies at Stall Lake and Osborne Lake, in the Snow Lake district, 90 miles east of Flin Flon, and began development of the Flexar property, eight miles southwest of Flin Flon. Production at Stall Lake began in February 1964. A small copper-zinc deposit was discovered about eight miles southeast of Flin Flon.

Ontario

Kam-Kotia Porcupine Mines, Limited, installed a zinc circuit in its copper concentrator, 12 miles west of Timmins, and in November began to recover zinc concentrate.

Quebec

Lake Dufault Mines, Limited, carried out exploration and underground development and sunk a shaft to 1,996 feet at its copper-zinc orebody about eight miles northwest of Noranda. Ore reserves in the massive sulphide body were 1.2 million tons grading 11.66 per cent zinc, 5.06 per cent copper and 3.09 ounces of silver per ton. The upper part of a disseminated copper body was found to contain 410,100 tons grading 3.41 per cent copper and 0.17 per cent zinc; exploration of the lower part was still to be completed. Construction of a mill began in September 1963 and it was estimated that production would begin in October 1964 at a rate of 1,300 tons of ore daily.

New Brunswick

Brunswick Mining and Smelting Corporation Limited, which in 1962 began construction of a 3,000-ton concentrator at its property near Bathurst, announced that the concentrator capacity would be increased to 4,500 tons daily and that its associate, East Coast Smelting and Chemical Company Limited, would install a zinc-lead smelter and refinery and a sulphuric acid plant at Belledune, 20 miles northwest of Bathurst. An amended agreement for 12 years was concluded with the Belgian firm, Société Générale des Minerais, for the sale of all concentrates over and above those to be retained for the new smelter. Milling of ores from the No. 12 mine commenced in March 1964 and was to reach a daily rate of 4,500 tons of ore by the end of 1964. The smelter was scheduled to come into operation by mid-1966.

Newfoundland

A syndicate of Leitch Gold Mines Limited, Mastodon-Highland Bell Mines Limited and American Metal Climax, Inc. located zinc mineralization on the west side of the Great Northern Peninsula near Daniel's Harbour. Some 6,400 feet of diamond drilling, distributed among 38 holes, was completed.

USES

The largest use of zinc is in galvanizing in which it is applied as a corrosion preventative coating on iron and steel products. Galvanized products are widely used in the construction industry and in installations such as transmission-line towers and highway equipment where resistance to weathering over long periods is required. A more recent and growing application is the galvanizing of underbodies of automobiles, as a protection against the corrosive attack of road-salt solutions during winter months. The Steel Company of Canada, Limited, and Dominion Foundries and Steel, Limited, both of Hamilton, are the main consumers of zinc for galvanizing.

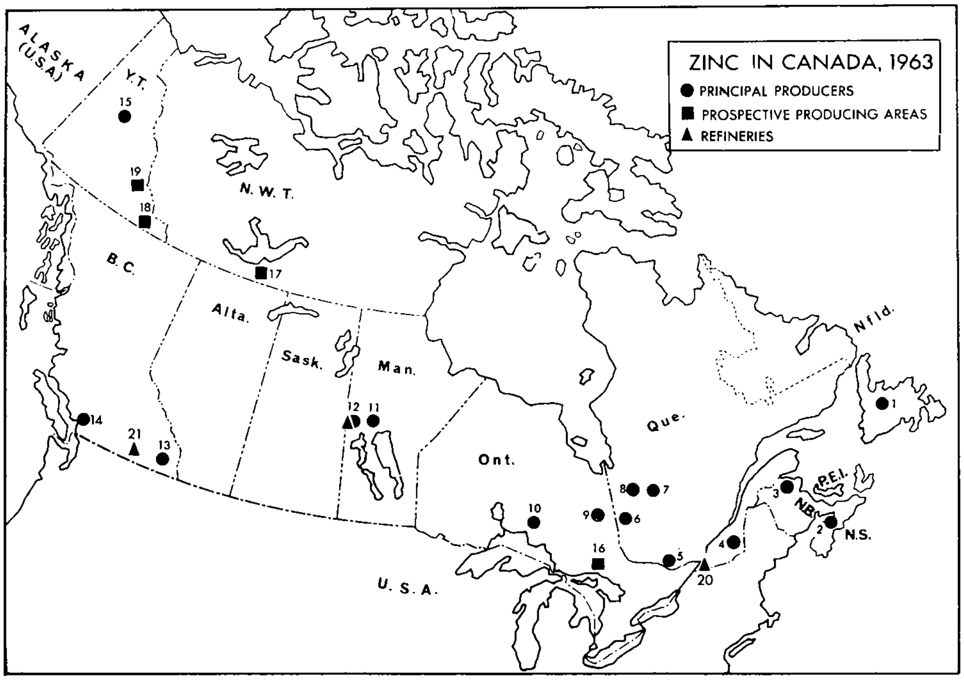
Die castings of zinc-base alloys are used for many automotive, household-appliance and machine parts. The alloys most commonly used for die casting are made of high-purity zinc to which is added about four per cent aluminum, 0.04 per cent magnesium and from zero to one per cent copper. Barber Die Casting Co. Limited, Hamilton; Dominion Die Casting Limited, Wallaceburg; National Hardware Specialties Limited, Dresden; and Schultz Die Casting Company of Canada, Limited, Lindsay, all in Ontario, are among the leading users of zinc for die casting.

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. The principal fabricators of brass mill products are Anaconda American Brass Limited, New Toronto, and Noranda Copper Mills Ltd., Montreal East and New Westminster.

Zinc oxide is used in compounding rubber and in making paint, rayon yarn, ceramic materials, inks, matches and many other commodities. The principal producers in Canada are Zinc Oxide Company of Canada, Limited, and Durham Industries (Canada) Ltd., both in Montreal, and the Pigment and Chemical Company Limited, Milton, Ontario.

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. Burgess Battery Company Limited, Niagara Falls, is the only producer, most of its output being used to make dry-cell battery cups.

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



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Principal Producers

1. American Smelting and Refining Company (Buchans Unit)
2. Magnet Cove Barium Corporation
3. Heath Steele Mines Limited
4. Sólbec Copper Mines, Ltd.
5. New Calumet Mines Limited
6. Manitou-Barvue Mines Limited; Normetal Mining Corporation, Limited; Quemont Mining Corporation, Limited; Sullico Mines Limited; Vauze Mines Limited
7. The Coniagas Mines, Limited
8. Mattagami Lake Mines Limited; Orchan Mines Limited
9. Kam-Kotia Porcupine Mines, Limited
10. Geco Mines Limited; Willroy Mines Limited
11. Hudson Bay Mining and Smelting Co., Limited – 2 mines; Chisel Lake, Stall Lake
12. Hudson Bay Mining and Smelting Co., Limited – 3 mines; Flin Flon, Coronation, Schist Lake.
13. Canadian Exploration, Limited; COMINCO – 3 mines: Sullivan, H.B., Bluebell; Mastodon-Highland Bell Mines Limited; Reeves MacDonald Mines Limited; Sheep Creek Mines Limited
14. The Anaconda Company (Canada) Ltd.
15. United Keno Hill Mines Limited

Prospective Producing Areas

16. Sudbury
17. Great Slave Lake
18. Watson Lake
19. Pelly River

Refineries

20. Canadian Electrolytic Zinc Limited, Valleyfield.
12. Hudson Bay Mining and Smelting Co., Limited, Flin Flon.
21. COMINCO, Trail

and lithopone, a mixture of barium sulphate and zinc sulphide used for making paint.

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

Zinc research activity at the Mines Branch, Department of Mines and Technical Surveys, in 1963 was devoted to continuation of projects previously initiated under the sponsorship of the Canadian Zinc and Lead Research Committee (formerly, Canadian Zinc Research and Development Committee) and the International Lead Zinc Research Organization (formerly, American Zinc Institute Expanded Research Program).

The results of two major programs on the hot-dip galvanizing process, one of which dealt with the effect of bath alloying and the other on the effect of the steel base material, have been reported in two papers submitted for presentation at the Seventh International Galvanizing Conference being held in France in June 1964. Significant features of these prior investigations were combined in a subsequent phase of the project designed to study the galvanizing characteristics of low-alloy high-strength steel materials. It has been established that the characteristic aggressive attack by zinc on certain grades of these steels can be significantly reduced by alloying of the bath. Beneficial modifications of coating microstructure and surface appearance have been found which appear to be of

TABLE 5

United States Consumption, by End Use, 1962 and 1963

(short tons)

	1962	1963
Galvanizing	388,570	420,287
Brass products	129,805	128,237
Zinc-base alloy	423,608	468,619
Rolled zinc	42,233	42,166
Zinc oxide	18,517	16,037
Other uses	29,088	29,767
Estimated undistributed consumption	nil	nil
Total	1,031,821	1,105,113

Source: U.S. Bureau of Mines

commercial importance. Further laboratory experiments on other steel grades are planned in conjunction with pilot scale tests in a commercial galvanizing plant.

In an investigation concerned with the elevated temperature behaviour of galvanized coatings, it was confirmed that the performance of a galvannealed coating (zinc coating completely converted to iron-zinc alloys) was as good and, under certain conditions, better than that of conventional continuous strip coatings. Its superiority at temperatures exceeding 300°C was found to be related to the characteristic absence of a discrete outer zinc layer and to the fully alloyed "single-phase" nature of the coating. Some additional experiments with a series of conventional strip coatings produced by different manufacturers are currently under way.

Fundamental research activity was continued on the determination of viscosity, density and surface tension of molten zinc and some of its alloys. This project is nearing completion and the results are being prepared for publication.

PRICES AND TARIFFS

The Canadian price of Prime Western zinc on the basis of deliveries at Toronto and Montreal was 11.50 cents a pound during all of 1962 and up to April 4, 1963 when it increased to 12.00 cents. On July 3 the price increased to 12.50 cents and on October 29 to 13.00 cents where it remained for the remainder of the year.

The United States price was 11.50 cents a pound from April 1, 1962 to July 1, 1963 when it rose to 12.00 cents. On July 29 it rose to 12.50 cents and on December 2 to 13.00 cents where it remained for the remainder of the year.

At the beginning of 1963 the current bid price of zinc on the London Metal Exchange was £65 7/8 per long ton (2240 pounds), the equivalent of 8.9 cents a pound (Canadian). By the end of the year the price had risen to £94 3/8, or about 12.8 cents a pound.

Zinc ores and concentrates entered Canada duty free. Slab zinc was subject to a ½-cent-a-pound British preferential duty, a ½-cent-a-pound most favored nation duty and a two-cent-a-pound general duty. Varying schedules were applied to imports of zinc in semifabricated forms.

The United States tariff on zinc ores and concentrates, under the new tariff schedules which went into effect on August 31, 1963, was changed from 0.6 cents to 0.67 cents a pound on the zinc content. Because deductions for processing losses were allowed for the first time under the new schedules, the increase in the tariff rate did not effectively change the total duty assessed. The tariff on slab zinc remained unchanged at 0.7 cent a pound. Varying tariffs were applied to imports of zinc in other forms.

Index to Companies