MINERAL REPORT 8

The Canadian Mineral Industry, 1961

Mineral Resources Division
Department of Mines and Technical Surveys, Ottawa

1963

66076-1—1½

Roger Duhamel, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1963

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Foreword

The Canadian Mineral Industry 1961 covers developments in the mineral industry of Canada in 1961. The General Review is a detailed economic-statistical study of over-all developments in the industry. Following the General Review, in revised form, are fifty-seven mineral reviews originally issued as separates during 1962. The reviews deal with exploration and development, production, consumption, trade and technical matters in regard to specific minerals of current or potential importance in the Canadian economy. The text is supported by maps, graphs and tables and is supplemented by a company index and a section of documentary photographs. The report is the continuation of a series of annual reports dating back to 1886.

Commencing with the 1962 volume, the title of the series will be changed to *Canadian Minerals Yearbook*.

Unless otherwise indicated, statistics on Canadian production, trade and consumption are final and were collected by the Dominion Bureau of Statistics. Specific company figures were supplied directly by company officials or were obtained from company 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 mineral industry.

W. Keith Buck,
Chief,
Mineral Resources Division

January 1963

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General Review

*A review of the mineral economy**

This summary of the progress made in the Canadian mineral industry in 1961 is designed to introduce and supplement the industry review series consisting of individual reviews of 57 mineral commodities. It consists of descriptive analyses of the year's developments followed by statistical analyses set out in 58 tables. After an introductory outline of the year's progress and general trends it briefly surveys each of the principal mineral commodities and appraises developments in mining technology. It then calls attention to trends in each of the eleven sectors of the industry as shown in the statistical tables. The summary also relates progress in the mineral industry to the Canadian economy as a whole.

INTRODUCTION

Increased resource development and a changing emphasis in marketing direction characterized Canada's mineral economy in 1961. Interest in exploration and property development was renewed, with the result that actual and planned capital investment increased. This expansion of the resource base took place despite rising competition in foreign markets but with prospects of market growth in the United States. The comparative gains in the United States reversed the 1960 trend toward larger European markets. Market prospects in Japan continued favorable.

The initiation or expansion of important mineral-resource projects took place in several parts of Canada. In the Maritime Provinces, definite plans were completed to get the Bathurst lead-zinc area into production. Large capital expenditures continued to be made in Quebec-Labrador on iron-ore property development and on treatment facilities for the upgrading of iron ore to meet the rapidly changing technological requirements of the steel industry's blast-furnace operators. The completion of plans for an electrolytic zinc refinery at Valleyfield, Quebec, and the start of its construction further stimulated zinc-ore development in the vicinity of Mattagami Lake. Operations got under way at an important iron-ore-resource development in Ontario's Kirkland Lake area. In Manitoba, the Thompson nickel project began its first year of operation. Production from Saskatchewan's vast potash deposits was brought a step closer as major mining problems were solved. In Alberta and northeastern British Columbia, oil and gas exploration and development activity were increased in response to market growth. British Columbia mining was intensified through large-scale property development at the Craigmont copper mine and at other new base-metal and iron-ore properties in the southern part of the province and on Vancouver Island. A major move affecting the Northwest Territories was the industry's decision, made after the federal government's offer of support in the form of railway- and road-building programs, to open the huge Pine Point zinc-lead deposit.

While these and other resource developments were going on across Canada, there was a mixed but generally upward trend in mineral output. Production registered a 3.6-per-cent increase, its value advancing from the 1960 total of

*By the Mineral Resources Division.

$2,492.5 million to $2,574.7 million. The gain was comparable to the 3.5-per-cent increase of 1960 but considerably below the 14.6-per-cent advance of 1959. Table 1 shows that the output of metallic minerals declined slightly and accounted for 53.7 per cent of the value of all mineral production. The output of industrial minerals, comprising nonmetals and structural materials, was slightly above the 1960 level and accounted for 21.0 per cent. Fuels accounted for 25.2 per cent, or 13.8 per cent more than in the previous year.

Since mineral exports have for a number of years amounted to about three fifths of the industry's output, progress in mineral-resource development in Canada depends greatly on conditions in export markets and the corresponding demand for Canadian mineral products. In 1961 the economy levelled off in Europe but recovered substantially in North America and continued its advance in Japan. The market for Canadian minerals accordingly gained in the United States and Japan but slackened in Europe, although in Britain the marketing position of all minerals except iron ore was well maintained. The trend that had lowered the relative importance of the United States as an importer of Canadian minerals from 64.6 per cent in 1950 to 52.3 per cent in 1960 was reversed in 1961 when mineral exports to that country accounted for 53.8 per cent of Canada's mineral-export total. The gains made in the United States did more, in fact, than compensate for the losses suffered in Europe. The changes in the market destinations of the major metals and of all minerals as a group, in their raw and semiprocessed forms, are shown in the accompanying table.

MARKET DESIGNATIONS OF MAJOR METALS AND ALL MINERALS

(as percentages of export total of each)

		Iron Ore	Aluminum	Copper	Nickel	Lead and Zinc	All Mineral Exports
United States	1960	56	20	37	34	48	52.3
	1961	60	26	25	45	48	53.8
Britain	1960	22	30	33	26	32	21.3
	1961	12	30	36	30	27	20.6
Other countries of the European Free Trade Area[1]	1960	1	2	6	21	1	4.8
	1961	0	2	11	15	1	4.7
European Economic Community[2]	1960	13	20	14	13	8	11.0
	1961	13	12	15	5	13	9.0
Japan	1960	6	3	5	0	5	3.4
	1961	13	6	6	1	4	4.7
All other countries	1960	2	25	5	6	6	7.2
	1961	2	24	7	4	7	7.2

[1] Norway, Sweden, Denmark, Austria, Switzerland, Portugal.
[2] France, Germany, Italy, Belgium, The Netherlands, Luxembourg.

Canadian mineral exports have varied in recent years in response to economic changes in major world markets. The relative importance of aluminum, lead, zinc and iron has recently declined slightly while that of nickel, crude oil and natural gas has increased. In 1961, nickel constituted 19.5 per cent of the value of all mineral exports; aluminum, 14.0 per cent; iron, 12.9 per cent; fuels, 11.7 per cent; copper and uranium, 11.0 per cent each; asbestos, 7.5 per cent; lead and zinc, 4.9 per cent; and all other mineral commodities 7.5 per cent.

Notwithstanding the improvement that occurred in United States mineral markets in 1961 and the year-end signs of resumption of market growth in Europe, the over-all capacity of primary-mineral producers in the Free World continued to exceed consumption by a considerable margin. Rising investment foretold further growth in overcapacity. This world situation and the related industrial and government policies in the United States caused that country's rising mineral demand to have a mixed effect on various sectors of the Canadian industry. The declining uranium industry did not benefit, since the decision made by United States authorities in 1960 not to take up their option on the purchase of additional supplies of uranium remained the dominant market determinant. Only part of the decline in copper exports to the United States was taken up by an export increase to western Europe. The nickel and aluminum industries benefited considerably from an increase in American demand. Lead showed modest improvement, although the United States quota system on lead and zinc still posed major marketing problems and resulted in a slight decline for zinc. After the announcement of a Canadian national oil policy early in 1961, oil exports to the United States began to rise. A large gain in natural-gas exports resulted from the completion of an export pipeline across the Manitoba boundary late in 1960 and of an Alberta-to-California pipeline at the close of 1961. The gain in exports of crude oil and natural gas to the United States did more than compensate for the loss in the uranium market. During the first half of the year, the iron-ore industry suffered from the existence of large American stocks, but for the year as a whole Canadian exports to the United States rose slightly. The Canadian iron-ore industry fared better than other foreign suppliers.

Accompanying the continuance of overcapacity in the Free World was the tendency, particularly in Europe and Japan, to import ores and concentrates rather than semi-processed or refined metals. These two factors are serious obstacles to the export of Canada's metals, although some progress has been made with semiprocessed materials.

A weakening of the Canadian dollar and a trend toward lower metal prices affected the value of exports and were factors in mineral investment. The decline that lowered the dollar to 95 cents in United States funds by the end of the year was an advantage in export markets and provided an incentive for investment in the development of Canada's mineral resources. Metal prices were mixed in their trends and effects. In London during the latter part of the year prices declined for copper, lead and zinc as they did for most other mineral commodities. A marked exception was the price of nickel, which rose 10 per cent in July. In the United States, there were also downward price adjustments as the year drew to a close. World metal prices were generally lower than in 1960.

Capital and repair expenditures on metal and industrial mineral mines increased slightly but, as a result of the year's exploration and development activity, a one-quarter increase has been forecast for 1962. Such expenditures on oil and gas wells and gas-processing plants rose by 20 per cent in 1961 but are expected to fall slightly in 1962. The 1961 rise was due primarily to an increase in spending for gas-processing plants. In the mining industry as a whole, capital expenditures went up 9.5 per cent. Investment in smelting and refineries dropped by one fifth in 1961.

Property development and related capital expenditures in the nonferrous and industrial-minerals sectors provided an increase in employment that almost compensated for the decline in the number of those engaged in the mining of iron ore, gold and uranium. The employment decline in uranium-mining was lessening, and employment in mining as a whole had apparently been stabilized. In fuels, the decline continued, largely owing to lay-offs in the coal industry, but it was less severe than previously.

On balance, 1961 was a year of accomplishment in the mineral industry and gave hope that the almost static production record of the three preceding years would improve. Resource development in nonferrous minerals, iron ore, potash and sulphur has prepared the way for a considerable increase in output. Dollar devaluation encouraged exporters and foreign investors. Developments in the European Economic Community held promise that large new markets would open, particularly if Britain's pending membership did not seriously disrupt existing British markets for Canadian minerals. The industry was faced, on the other hand, with the prospect of stronger competition in world markets that have access to many regions of surplus production capacity. The year's events also showed that the industry is still greatly dependent on the United States market. Since its resource base is expanding, the Canadian mineral economy must now be directed toward ever greater production efficiency so that its output may be increased and diversified for the highly competitive mineral markets of the world.

If resource development and marketing progress continue, Canada should not only retain but improve its present position as one of the world's principal producers of minerals. Canada is first in the production of nickel, asbestos and platinum; second in uranium, silver and gypsum; and third in aluminum, zinc, gold, cobalt, cadmium, bismuth and barite. It also ranks high in a number of other mineral commodities. With its prominence in mineral production and its extensive potential in mineral resources, Canada has a leading role to play in meeting the world's future mineral requirements. The progress made in 1961 added much to the accomplishments of the last decade and gave favorable indication of continuing growth and diversification in the 1960's.

MINERAL-COMMODITY HIGHLIGHTS OF 1961

Metals

Metal production declined in value from the 1960 total of $1,406 million to $1,387 million, mainly because of the continuing recession in uranium. The uranium loss was largely counterbalanced, however, by an increase in the value of nickel production.

Aluminum

Canada produced 663,173 tons of aluminum, 12.97 per cent less than in 1960. Operating rates of the six Canadian smelters, five of which are owned by the Aluminum Company of Canada Limited, varied according to the general marketing position of the company concerned or the economics of smelter operation within a corporate group. Production represented 76 per cent of nominal rated capacity, which totalled 872,000 tons. Although no smelter construction took place during the year, Canadian British Aluminium Company Limited announced that construction will start in 1963 on a 45,000-ton addition to the Baie Comeau smelter. This will raise its capacity to 135,000 tons by 1965.

The rapid expansion of world smelting capacity has created difficult marketing conditions in recent years, as witnessed by the surplus capacity in Canada. An increasingly large part of the world aluminum industry is fully integrated from metal to finished product; the rest of the market is competitive. Because expansion and integration are continuing, government policies that affect access to markets are important determinants in future market demand and in decisions regarding the location of new smelters and fabricating plants throughout the world.

In 1961, Canadian exports of primary forms totalled 487,034 tons in comparison with 552,155 tons exported in 1960. Primary exports to the six countries of the European Common Market totalled 60,548 tons, or 45.47 per cent less, while those sent to Britain dropped by 12.83 per cent to 156,575 tons. Although fabricating activity in Europe slackened, an increase in the requirements of independent fabricators in the United States raised Canadian export shipments by 17 per cent to 117,760 tons.

Cobalt

In 1961, cobalt production amounted to 3,183,000 pounds valued at $4,751,000. This was 386,000 pounds less than in 1960 and was partly attributable to the fact that the cobalt content of the silver ores from the Cobalt and Gowganda areas of Ontario was not recovered in 1961. Reported sales totalled 4.6 million pounds in 1961 and 3.8 million pounds in 1960. No cobalt ores have been produced in Canada since 1957 but cobalt has been obtained as a by-product from the smelting and refining of nickel-copper ores from Sudbury, Ontario, and Lynn Lake and Thompson, Manitoba. Production from these areas enabled Canada to continue as the world's fourth-ranking producer of cobalt.

The International Nickel Company of Canada, Limited (Inco), recovered cobalt from its nickel-refining operations at Port Colborne, Ontario, and Clydach, Wales. High-purity electrolytic cobalt is produced at the Port Colborne refinery; cobalt oxides and salts are produced by The International Nickel Company (Mond) Limited, a British subsidiary, at Clydach. In 1961, International Nickel reported production of 2,103,437 pounds of cobalt, including the production at the Clydach refinery.

Falconbridge Nickel Mines, Limited, produced electrolytic cobalt in the refining of nickel-copper matte exported to its refinery at Kristiansand, Norway. Metal deliveries reported for 1961 amounted to 1,462,461 pounds, or 635,744 pounds more than in 1960.

Sherritt Gordon Mines Limited produced 191,043 pounds of cobalt, or 119,367 pounds less than in 1960. This decrease was caused by the use of cobalt circuit for a custom-pilot plant project during the latter half of the year. Sherritt Gordon recovers cobalt as a by-product at its nickel refinery at Fort Saskatchewan, Alberta, from its Lynn Lake, Manitoba, nickel-copper ores. It markets its cobalt in the form of briquettes, powder and cobalt strip, and is developing processes for the production of cobalt rod and wire.

Deloro Smelting & Refining Company, Limited, ceased all smelting and refining operations at its plant at Deloro, Ontario, on April 21, 1961. Production for the year amounted to 27,754 pounds of cobalt in metal, oxides and salts from concentrates received in October 1960 and from the clean-up of low-grade residues accumulated over the years. The Deloro smelter began to produce cobalt on a commercial scale in 1914 and remained the leading producer until 1925, when Belgian refineries began to produce cobalt from the copper-cobalt deposits of Katanga, Belgian Congo. During the lifetime of the plant's operations, 28,227,832 pounds of cobalt were produced as metal and in oxides and salts.

Copper

Canada maintained her position in 1961 as the world's fifth-ranking copper producer with an output of 439,000 tons valued at $255,158,000. This was the same tonnage as in 1960 when a record was set.

World supply and demand were in reasonable balance for the year, production overrunning consumption by 100,000 tons. World production rose in 1961 in spite of strikes at producing plants in Chile, Australia and the United States and political unrest in Katanga province of the Republic of the Congo. The consumption of refined copper increased in the United States but levelled off in western Europe. Total Canadian copper exports in all forms were valued at $193.7 million. Prices were very stable in 1961, especially after mid-year, when the United States price remained at 31 cents a pound (U.S.) and the Canadian price at 30 cents a pound (Canadian). The Canadian price fluctuated between a low of 27.5 cents and a high of 30.25 cents and averaged 29.16 cents a pound for the year.

Activity increased in all segments of Canada's copper industry and in particular in the exploration and development of new properties. The consumption (producers' domestic shipments) of refined copper increased to 141,807 tons, 24,171 tons more than in 1960. Canada's six smelters operated at capacity during the year, treating most of the ores and concentrates produced in the central and eastern provinces. Blister copper from the smelters was treated in the two domestic copper refineries, which together produced 406,438 tons of refined copper.

During the year, five mines were brought into production, 13 mines were under development and new discoveries were reported in many parts of Canada from Fort McKenzie in New Quebec to the Nahanni River valley near the Yukon border. Atlantic Coast Copper Corporation Limited started production in May from its mine at Little Bay, Newfoundland; and Consolidated Rambler Mines Limited, at Baie Verte, Newfoundland, started a program of underground exploration and development. The Consolidated Mining and Smelting Company of Canada Limited commenced production from the Wedge mine, 36 miles southwest of Bathurst, New Brunswick. Vauze Mines Limited, north of the Waite Amulet mine, became Quebec's newest producer when milling started in October. In Ontario, Kam-Kotia Porcupine Mines, Limited, started production in April from its open-pit mine near Timmins. Craigmont Mines Limited, near Merritt, British Columbia, began open-pit mining in September.

Production will start in 1962 or 1963 at the following mines: in New Brunswick, at the mines of Heath Steele Mines Limited and Brunswick Mining and Smelting Corporation Limited; in Quebec, at the mines of Solbec Copper Mines, Ltd., Mattagami Lake Mines Limited, New Hosco Mines Limited and Orchan Mines Limited; in Ontario, at the Strathcona mine of Falconbridge Nickel Mines, Limited; in Manitoba, at the Stall Lake mine, of Hudson Bay Mining and Smelting Co., Limited; and in British Columbia, at the mines of Bethlehem Copper Corporation Ltd., Cowichan Copper Co. Ltd. (Sunro mine), and The Consolidated Mining and Smelting Company of Canada Limited (Benson Lake mine).

Gold

Although there was an increase of nearly $1.50 an ounce in the average price of gold in 1961, production decreased to 4,474,000 troy ounces valued at $158,637,000 from the final 1960 total of 4,629,000 troy ounces valued at $157,152,000. Quebec, Manitoba and Newfoundland were the only provinces recording increases in output. Ontario remained the principal producer, with 59 per cent of the total, followed by Quebec with 24 per cent, the Northwest Territories with 9 per cent and British Columbia with 4 per cent. Canada was the world's third-ranking gold producer, after the Republic of South Africa and the Union of Soviet Socialist Republics.

Nearly 85 per cent of Canada's gold production comes from the operation of auriferous-quartz (lode-gold) mines. High-cost gold mines receive cost assistance under the Emergency Gold Mining Assistance Act, which went into effect in 1948 and has been extended to the end of the calendar year 1963. During 1961, there were 53 producing lode-gold mines, of which 40 received cost assistance under the Act. The producers of about 53 per cent of Canada's gold production were eligible for cost assistance. Most of the remaining gold was available for sale in the open market.

The average Royal Canadian Mint value for a troy ounce of fine gold in Canadian dollars increased to $35.44 from the 1960 average of $33.95. The Hon. D. M. Fleming, Minister of Finance, announced in Parliament during his budget speech on June 20, 1961, that the federal government would reduce the value of the Canadian dollar in relation to the United States dollar. In consequence of this policy, the Mint value of gold increased to more than $36 an ounce and during the week of December 11 - 16 reached a high of $36.51 an ounce, the highest Mint value for gold since November 1951.

The higher Mint price for gold was of great assistance to the gold-mining industry, but production costs continued to rise and at many mines the ore reserves were declining. Three gold mines closed during the year—two in Ontario and one in British Columbia. One small mine started production in Quebec.

The price of gold on the London Gold Market varied only within narrow limits. There was no recurrence of the sharp gold-price increase of October 1960. The flow of gold from United States reserves to European countries continued during 1961. International Monetary Fund figures show a decrease of $5,900 million in four years, with a reduction of $900 million in 1961. President Kennedy, in a message to Congress on February 6, 1961, firmly declared that the United States dollar would not be devalued and outlined measures to be taken to improve the balance-of-payments position.

Iron Ore

Declining for the second consecutive year, iron-ore shipments dropped in 1961 to 18.2 million long tons from the 1960 total of 19.2 million long tons. They reached their all-time high, 21.8 million long tons, in 1959. The value of the 1961 output, $188 million, placed Canada sixth among the world's iron-ore producers. In addition to a continuing decline in exports to the United States, Canada's principal market, the year brought a weakening in the European market. Shipments to the domestic market increased, and exports to Japan from British Columbia were at a record level. Sales prices in North America and Japan remained constant while in western Europe some declined.

Because of the low level of shipments, the weakening in world markets and growing competition from countries in Africa and South America, the Canadian iron-ore industry put greater effort in 1961 into product research and the installation of new ore-beneficiation facilities. In addition, six new projects had been announced or were under development for production by 1965. All will produce beneficiated iron ore and will increase Canada's annual production capacity to more than 40 million long-tons. Besides the 13 companies (12 in 1960) engaged in the mining of iron ore, three companies (two in 1960) are producing and one is planning to produce by-product iron ore from the treatment of iron sulphides derived from the concentration of base-metal ores. One company is producing ilmenite, which is smelted for pig iron and titania slag.

International trade has been and continues to be affected by the improvement in the quality and the increase in the quantity of the iron ore available. From 1950 to 1959, world trade in this commodity increased from 43.7 million to 130.5 million tons a year, and the trend is still upward. In 1950 the main exporters of ore were Sweden and France, but by 1959 Canada, Venezuela and the U.S.S.R. had also become important. Significant exports are now coming from several countries in Africa and Asia as well as from other countries in South America, and projects in various parts of the world are being developed for production by 1965. Quality ore will be abundantly available in the 1960's and, as in the past, no country will have a monopoly.

Lead

In 1961, the recoverable lead content of ores and concentrates exported and the metal produced from domestic ores together totalled 230,000 tons. Slightly more than half of this came from three mines in southeastern British Columbia operated by The Consolidated Mining and Smelting Company of Canada Limited, of which the Sullivan mine at Kimberley is by far the largest producer. All the refined lead produced in Canada, which amounted to 171,832 tons, came from the smelter and refinery operated by this company at Trail.

The United States quotas, imposed in 1958 on imports of unmanufactured lead for consumption, remained in effect throughout 1961, but certain Canadian exports of pig lead to the United States were exempt, being shipped under an agricultural barter arrangement. Canada's exports to the United States were consequently much greater than the annual quota. Other countries that imported large amounts of unmanufactured lead from Canada were, in order of importance, Britain, Belgium and Luxembourg, West Germany, and Japan. Canada's exports totalled 188,604 tons—70,967 tons in ores and concentrates and 117,637 tons in pigs, blocks and shot—and their value was $27.6 million.

The International Lead and Zinc Study Group held two meetings, the first in Mexico City in March and the second in Geneva in October. After the Mexico City meeting, arrangements were made by the United States government to barter surplus agricultural products for part of the lead stocks held outside the United States, and a special working group of 11 countries was set up to make a preliminary examination of the problems facing the lead and zinc industries.

Brunswick Mining and Smelting Corporation Limited announced in July that one of its copper-lead-zinc properties in the Bathurst area would be brought into production in 1963 at 3,000 tons of ore a day. The location survey for a 438-mile railway to serve northern Alberta and the Northwest Territories, and particularly the large lead-zinc deposits at Pine Point, on Great Slave Lake, was completed in November. Tenders for right-of-way clearance were called for in December.

Magnesium

Dominion Magnesium Limited is the only Canadian producer of magnesium, thorium and calcium metals. The capacity of the Haley smelter for the production of magnesium was being expanded from 8,000 to 10,000 short tons and the plant operation was being converted from electricity to natural gas. Magnesium shipments increased to 7,802 tons for the year from the 1960 total of 7,428 tons. Canadian consumption was 2,776 tons, of which 1,604 tons were required for alloying with aluminum.

Molybdenum

Shipments of molybdenum contained in molybdic oxide (MoO_3) and molybdenite (MoS_2) concentrates amounted in 1961 to 771,000 pounds valued at $1,092,000. The value increased by $77,000 despite an increase of only 3,000 pounds in shipments, thus reflecting a 10-per-cent price increase that became effective on June 1. Domestic consumption amounted to 1,135,610 pounds of molybdenum; this is an all-time high.

Molybdenite Corporation of Canada Limited was the only Canadian producer of molybdenite concentrates in 1961. The company's property is at the junction of La Motte, Lacorne, Vassan and Malartic townships, 23 miles north of Val d'Or, Quebec. Also at Lacorne the company operates a roasting plant to convert molybdenite to technical-grade molybdic oxide, the material from which all types of molybdenum salts and compounds are produced.

Nickel

Nickel production in Canada reached an all-time high of 233,000 tons, which was 8 per cent above the record of 215,000 tons, made in 1960. The 1961 value, $351.3 million, enabled nickel to continue as the second most valuable mineral (after crude petroleum) produced in Canada. Sales were good and supply was adequate to demand. The year was marked by the start of production at International Nickel's Thompson project in northern Manitoba and a 10-per-cent increase in the price of nickel that became effective on July 1.

Little change occurred in world supply. Canada and New Caledonia continued to provide the bulk of the nickel used by the Free World, while Russia and Cuba supplied the bulk of the Soviet-bloc requirements. Canadian nickel-producing companies operated at their rated mill capacity and filled more than 75 per cent of the Free World's nickel needs. The outlook for nickel markets remained encouraging as markets in the United States, Britain, western Europe and Japan were firm and growing. Nickel-oxide sinter from Nicaro, Cuba, was being marketed in Europe by Czechoslovakia and competed for markets with nickel from Canada and France.

Most of Canada's nickel output came, as usual, from Ontario's Sudbury area. International Nickel operated its five mines—the Frood-Stobie, Creighton, Garson, Levack and Murray throughout the year. It stopped production at the Frood open pit but began to produce at the new Clarabelle open pit and the smaller Ellen mine. Underground development work continued at the Crean Hill property. The ore mined in the Sudbury area during the year by International Nickel exceeded 16 million tons. The company's project at Thompson, Manitoba, was officially opened on March 25 and by mid-year was up to its rated annual capacity of 75 million pounds of nickel. The ore mined during the year at Thompson amounted to more than a million tons.

Falconbridge Nickel Mines Limited, also near Sudbury had its Falconbridge, East, Hardy and Fecunis mines in continuous operation. The company closed the Longvack and McKim mines and started production at the Boundary and Onaping mines. Development continued at the large Strathcona deposit in preparation for mining. Ore delivered to the treatment plants totalled 2,449,838 tons.

Sherritt Gordon Mines Limited, at Lynn Lake, Manitoba, milled 1,219,157 tons during the year. North Rankin Nickel Mines Limited operated its mine on Rankin Inlet, on the west coast of Hudson Bay, throughout the year. It shipped nickel-copper concentrates to Sherritt Gordon's Fort Saskatchewan refinery. Giant Nickel Mines Limited, in British Columbia, signed a contract on March 1 with Sumitomo Metal Mining Co., Ltd., of Japan, for Giant's entire output of nickel-copper concentrate for a further three-year period. The company's daily mill capacity was increased from 900 tons to 1,200 tons, but during the construction period, from mid-November until the end of the year, the mill was closed. The year's mine production totalled 267,767 tons of ore.

Canada's nickel-producing capacity assures an ample and continuing supply for growing Free World needs.

Niobium (Columbium) and Tantalum

Canada's production of columbium concentrates amounted in 1961 to 62,000 pounds of contained columbium pentoxide (Cb_2O_5) valued at $66,000. The pentoxide was contained in pyrochlore mined by St. Lawrence Columbium and Metals Corporation from its property at Oka, Quebec, about 20 miles northwest of Montreal. This was the first Canadian production of Cb_2O_5 concentrates since 1955, when small quantities were produced from a lithium-tantalum-columbium property 70 miles east of Yellowknife, Northwest Territories. St. Lawrence Columbium and Metals Corporation completed its mill at Oka by mid-1961 and started commercial production in September.

Geo-Met Reactors Limited, Ottawa, Ontario, began to produce two grades of ferrocolumbium and columbium additive, which is a mixture of pyrochlore and a reductive such as aluminum or ferrosilicon.

Selenium and Tellurium

Selenium is produced at Canada's two copper refineries, where it is recovered from the tankhouse slimes resulting from the electrolytic refining of copper anodes. Production in 1961 decreased to 431,000 pounds valued at $2,799,000 from the 522,000 pounds valued at $3,651,000 produced in 1960. Domestic consumption also decreased in 1961, amounting to 13,160 pounds, or 1,301 pounds less than in 1960. Exports totalled 345,800 pounds in 1961, or 58,610 pounds less. Selenium is used in the glass, rubber, alloy-steel and electronics industries.

Tellurium, like selenium, is obtained as a by-product of the electrolytic refining of copper. Production has increased very rapidly in the last two years because of the use of tellurium in thermoelectric modules, which are used for refrigeration and the direct conversion of heat into electricity. Tellurium is also used in the rubber, alloy-iron and nonferrous-alloy industries. Production in all forms in 1961 totalled 78,000 pounds valued at $376,000 or 33,000 pounds and $220,000 more than in 1960. The price of commercial-grade tellurium powder rose from $4 a pound in January to $5.25 a pound in May.

Silver

Silver production was still at a high level although it had fallen from the 1960 record of 34,017,000 ounces to 31,382,000 ounces for 1961. Virtually the whole decline was attributable to a drop in Ontario's output, much of which was due to a decrease in production at mines in the Cobalt area. Canada remains, however, the world's second-ranking producer of silver, following Mexico.

Lead-zinc and silver-lead-zinc ores, most of which were mined in British Columbia, were the source of 56 per cent of Canada's production. Copper and copper-zinc and nickel-copper ores accounted for 26 per cent, silver-cobalt ores for 16 per cent, and lode- and placer-gold ores for 2 per cent. The leading silver producer was United Keno Hill Mines Limited, which mines silver-lead-zinc ores from several mines at Keno Hill, in Yukon Territory's Mayo district.

Much of the silver produced at lead and zinc mines is recovered at Trail, British Columbia, by The Consolidated Mining and Smelting Company of Canada Limited. Other refining centres are in Montreal East and the Sudbury area. Before the closure of the silver and cobalt refinery at Deloro, Ontario, which took place in March, most of the silver from ores of the Cobalt and Gowganda areas was recovered there. After closure, a larger share of the high-grade silver concentrates from these ores were shipped to the United States for treatment.

Canada's most important market for both the sale and the purchase of silver was the United States. Other major importers of Canadian silver were Belgium and Luxembourg and West Germany. The Canadian price of an ounce of silver fluctuated between 90.62 and 95.88 cents until November 29, when, affected by President Kennedy's decision to suspend Treasury Department sales of silver to commercial buyers and the use of free silver for coinage, it climbed to $1.0575. As the year ended, the price was $1.1000.

Titanium

The value of the titanium shipped in 1961 in titanium-bearing slag and Sorel flux was $16,723,743. The previous all-time high in Canadian production was $12,963,265, recorded for 1960. It included a small tonnage of titanium-ore shipments.

Canada's titanium industry is based mainly on the mining of ilmenite for the production of titanium-dioxide slag used in making pigments. To a minor degree ilmenite is also used as heavy aggregate and for the manufacture of ferrotitanium. Ilmenite is mined in the Allard Lake and St. Urbain areas of Quebec. Most of the Allard Lake ore 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. Most of the slag is exported, mainly to the United States, for use as raw material in the manufacture of titanium-base pigments. Some is shipped to Canadian Titanium Pigments Limited, at Varennes, Quebec. In recent years, most of the ore from St. Urbain area has been used as heavy aggregate. In 1961, Atlas Titanium Limited started to produce ferrotitanium in its plant at Welland, Ontario.

Canadian Titanium Pigments Limited increased the capacity of its pigment plant from 16,000 tons a year to 25,000 tons. British Titan Products (Canada) Limited, a wholly owned subsidiary of British Titan Products Company Limited, continued building its titanium-pigment-manufacturing plant at Ville-de-Tracy, Quebec. The plant will have an initial rated capacity of 22,000 tons of pigment a year.

Quebec Iron and Titanium Corporation (QIT), the sole producer of titanium-dioxide slag, operates eight electric-arc smelting furnaces at Sorel, Quebec. An expansion program, begun in 1960 and completed early in 1961, increased the plant's ore-treating capacity from 864,000 tons to 1,100,000 tons a year. QIT owns one of the world's largest known reserves of ilmenite, in the Allard Lake area of Quebec, about 22 miles north of Havre St. Pierre, which is about 500 miles downriver from Sorel.

Tungsten

Canada has produced no tungsten since July 1958, when Canadian Exploration, Limited, closed its tungsten operations at Salmo, British Columbia. The company still holds a stockpile containing approximately 37,000 short-ton units of tungsten trioxide (WO_3).

Canada Tungsten Mining Corporation Limited continued exploration and development work on its property, which is just east of the Yukon-Northwest Territories boundary and 135 miles north of Watson Lake. Diamond-drilling indicated a tungsten deposit of 1.65 million tons grading 2.4 per cent tungsten trioxide, and beneficiation tests have proven that a commercially acceptable scheelite ($CaWO_4$) concentrate can be obtained from the ore. In 1961, some 400 feet of drifting, which was in the form of an adit and some 5,000 feet of underground and surface diamond-drilling were completed.

A 130-mile road-building program consisting of two operations continued throughout the year and will be completed in 1962. The cost of 80 miles of the road is being borne by the federal government under its program for the development of the Northwest Territories. The federal authorities will also pay two thirds of the cost of the remaining 50-mile access road to the property, and the company will pay one third. During the winter of 1961-62, some 3,500 tons of freight were shipped over a winter road to the minesite. These supplies, together with materials flown in earlier and during the winter, have made it possible for the company to complete its building program and be ready to ship concentrate late in 1962.

Uranium

Uranium production continued to decline in 1961 as the industry made further adjustments to meet the new conditions of delivery under the stretch-out plan. Three more mines closed in 1961 and by the end of the year only eight were in production. These mines are expected to complete delivery of their contracts at different times over the next five years.

On December 31, 1961, the amount of uranium (U_3O_8) still to be delivered under the stretch-out plan ending in November 1966 was about 21,000 tons. This does not include 12,000 tons of unallocated uranium scheduled for delivery, under letters-of-intent, to the United Kingdom Atomic Energy Authority between March 31, 1963, and December 31, 1966. When negotiations are completed and a purchase contract is signed, the life of each producer should be extended by at least one year. Many uranium producers of the past and present are diversifying their interests and hope to become less dependent on uranium as a source of revenue.

The number of employees in Canadian uranium mines declined from about 6,000 at the beginning of 1961 to about 4,650 at the end of the year. The all-time high, 13,626, was reached in mid-1959. Canada's uranium-ore reserves are estimated at 300 million tons grading 0.125 per U_3O_8, which at present prices is equivalent to more than 300,000 tons of recoverable U_3O_8 and is sufficient, on the basis of the 1961 production rate, to last at least 30 years. The reserves in Ontario's Elliot Lake district constitute about 98 per cent of the total.

Despite the unfavorable prospects facing the uranium industry for the next six to eight years, an analysis of the requirements forecast for a longer term shows uranium once again in demand from about 1970, primarily for nuclear-electric power plants, and thereafter an ever increasing need for uranium for peaceful uses. The uranium industry is thus confronted with a struggle for survival during the critical period from 1966 to 1970. The sharp drop in demand that has occurred over the past two years has raised important issues: the future role of government in the industry; the improvement of the future competitive position of Canada's mines in world markets; the finding of new uses for uranium; the alleviation of the social problems that have arisen in mining camps as a result of sudden mine closures.

The development of markets for uranium for peaceful purposes still depends greatly on technological improvements and the lowering of costs, particularly in the generation of nuclear-electric power. Improvements are being made, and a brighter long-term future is foreseen.

Zinc

Zinc production continued to increase in 1961, totalling 416,000 tons or 9,000 more than in the previous year. Refined output from the electrolytic zinc plant of The Consolidated Mining and Smelting Company of Canada Limited, at Trail, British Columbia, and from that of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba, was at a record total of 268,000 tons.

Canada in 1961 was the second-ranking Free World producer of zinc ores, following the United States, and the third-ranking producer of refined zinc, following the United States and Belgium.

Exports of zinc in ores and concentrates increased in 1961 by 17 per cent. Those to the United States, under import-quota restrictions, fell by 4 per cent. Those to western Europe and Britain were approximately double their 1960 total.

Exports of refined zinc to the United States, under import-quota restrictions, were moderately lower in 1961. There was a moderate decline in exports of refined zinc to Britain while shipments to India, Japan and western Europe were considerably higher. The total of refined-zinc exports was substantially the same as in 1960.

A group of five Quebec and Ontario mining companies announced plans to build an electrolytic zinc-reduction plant at Valleyfield, near Montreal. Construction began in the spring of 1962, and production at a rate of 73,000 tons a year was scheduled for the end of 1963. Two new mines will be developed during 1962 and 1963 in the Mattagami Lake district of western Quebec to supply the main requirements of the zinc plant. Smaller amounts will be supplied from mines in the Manitouwadge district of Ontario and the Noranda district of Quebec.

In September the federal government approved Bill C-126, which provides for the construction of a 440-mile railway from Grimshaw, in northwestern Alberta, to Great Slave Lake. Construction of the line began in February 1962. Pine Point Mines Limited, in an agreement with the federal government, undertook to bring its lead-zinc property on the south shore of Great Slave Lake into production when the railway is completed. The date of completion is expected to be about the end of 1966.

Brunswick Mining and Smelting Corporation Limited announced that development of its zinc-lead-copper properties near Bathurst, New Brunswick, would be resumed in 1962 and that production at a rate of 3,000 tons a day would begin in the following year.

Two new Quebec mines, The Coniagas Mines, Limited, and Vauze Mines Limited, were brought into production in 1961, and a third, Solbec Copper Mines, Ltd., was opened early in 1962. In Nova Scotia, lead-zinc production began late in 1961 from a deposit associated with the barite mine of Magnet Cove Barium Corporation.

Industrial Minerals

Canada's continuing industrial growth is reflected in year-to-year increases in the output of industrial minerals, which embrace nommetallic minerals and structural materials. Shipments of these minerals in 1961 reached a third successive output record, their value being $541.8 million, or $21.7 million more than in the previous year. New records were established for asbestos, elemental sulphur, sodium sulphate and titania (TiO_2). The output of nonmetallic minerals was worth $210.4 million; structural materials were valued at $331.3 million.

Industrial minerals contribute about 20 per cent to the value of Canada's mineral output. Most of the commodities in the group are basic materials used in domestic processing plants and in construction of all kinds. They generally do not enter into export trade but reflect Canada's rising industrial growth. Some of the minerals, however, are important export items, the chief of which is asbestos. Of lesser value are the exports of elemental sulphur, gypsum and titania.

Asbestos

For the second successive year the asbestos industry set a record, its shipments totalling 1,174,000 tons valued at $129.0 million, or $7.6 million more than in 1960. In spite of rapid growth that has occurred over the past few years in Russian asbestos output, Canada maintained its position as the leading supplier of Free World markets. The Canadian product is sold throughout the world, about 50 per cent of the amount exported going to the United States.

About 94 per cent of Canada's production comes from Quebec's Eastern Townships. The rest is about equally divided between a mine at Matheson, Ontario, and one at Cassiar, in northern British Columbia.

The European Economic Community (EEC) imports half its asbestos requirements from Canada. This amounts to 15 per cent of Canada's output. It is in the EEC that fibre from Russia competes most noticeably, since 25 per cent of the trading bloc's fibre imports come from that country. In most markets Canada also encounters competition from Southern Rhodesia, the world's fourth-ranking asbestos producer.

Newfoundland will join the asbestos-producing provinces by mid-1963, when Advocate Mines Limited is to bring its property into production. The company's large deposit at Baie Verte is being developed by Canadian Johns-Manville Co. Ltd. in association with Patino of Canada Limited and two western European firms. The European partners will provide an assured market for some of the fibre obtained from the 5,000-ton-a-day operation.

In far northern Quebec, Murray Mining Corporation Limited continued exploration of its deposit near Deception Bay, to the west of Ungava Bay. Core-drilling has indicated 20 million tons of ore with a high percentage of the fibre in the readily saleable Group 4 category. Early in 1962 the property was being examined under option by Asbestos Corporation Limited.

Development of apparently large deposits of short-fibre chrysotile asbestos in California is of interest in that any production from there would compete directly with Canadian asbestos.

Gypsum

Because of lower exports to the United States, gypsum shipments declined to 4.94 million tons in 1961, from the 5.2 million tons shipped the previous year. Canada is the world's second-ranking producer, being surpassed only by the United States. About 90 per cent of the Canadian output comes from quarries in Nova Scotia, and nearly all of it is exported to gypsum-processing plants on the United States eastern seaboard.

Consumption increased when changes made late in 1960 in the National Housing Act resulted in an increase in the demand for gypsum products for use in house-building. A significant gain in wallboard output reflected a growing trend toward dry-wall construction in housing projects.

Western Gypsum Products Limited, of Winnipeg, was building a $3-million plant at Clarkson, Ontario, scheduled for completion in 1963, for the manufacture of wallboard lath and plaster. This will be the third plant of its kind in the province.

Bestwall Gypsum Company, of Ardmore, Pennsylvania, was developing a deposit on Cape Breton Island to provide its plants in the United States with crude gypsum. About $3 million will be spent on the 5,500-ton-a-day project, from which first production is scheduled for late in 1962. Flintkote Company of Canada Limited was developing gypsum deposits in the Flat Bay area of Newfoundland, and production was scheduled to start late in 1962. Gypsum from this operation will be used in plants at Humbermouth, Newfoundland and in Quebec and also in the company's plants in the United States. Reserves in the area are large and have been estimated to contain perhaps 200 million tons of minable gypsum.

Potash

Canada is destined to become a major producer of potash. Production of this necessary fertilizer ingredient from the large high-grade deposits lying from 2,600 to 3,400 feet beneath an extensive area of southern Saskatchewan was first obtained in 1958. Water inflow from the 200-foot-thick Blairmore formation caused considerable trouble, and production was suspended until the water-bearing strata could be sealed off. Production was to be resumed in 1962.

International Minerals & Chemical Corporation (Canada) Limited and Potash Company of America, Ltd., sealed off the porous formation in their mine shafts at Esterhazy and near Saskatoon by different methods. Further difficulties were experienced in these shafts early in 1962, and production is not expected to begin until late 1962 or early 1963.

International Minerals was increasing the rated capacity of its concentrator from 420,000 tons a year to 1,200,000 tons, which will make it the largest-capacity potash unit in North America. Potash Company of America's plant is designed to process 4,000 tons a day. As 1961 ended, 15 companies held potash leases in Saskatchewan. Several of these, in addition to the companies just mentioned, are expected to go into production.

Potash markets will grow with the demand for fertilizers for the crops needed to feed a rapidly expanding world population. World consumption is rising some 6 per cent annually, and 600,000 additional tons of potash are required every year. Many sources are being quickly depleted and fresh ones must be obtained. New deposits are being developed in other countries, notably in the United States (Utah and New Mexico), Sicily and Israel, but none are comparable in grade or tonnage to the vast Saskatchewan resources. Potash is one of the three indispensable ingredients in fertilizer, and the world looks to Canada for a large part of its requirements.

Salt

Canada's salt output, at 3.2 million tons, was slightly below the record of the previous year. Salt is marketed as brine, crushed rock salt and evaporated salt. There has been a considerable increase in recent years in the production of brine for use by the chemical industry. It is pumped directly to consuming plants.

The construction of new plants and the expansion of existing facilities are among the main factors in the growth of the industry. A $5-million caustic-soda and chlorine plant to be built in New Brunswick by Canadian Industries Limited will be supplied with salt from Pugwash, Nova Scotia. At its Pugwash mine The Canadian Salt Company Limited was building a $2-million refining plant that will process rock salt from its subsidiary, The Canadian Rock Salt Company Limited, which now produces only rock salt. Sifto Salt (1960) Limited began a second 1,800-foot shaft at its rock-salt mine at Goderich, Ontario, which will increase the production capacity of its mine by about 50 per cent. To provide for the growing needs of the pulp-and-paper industry, facilities for the manufacture of caustic soda and chlorine are continually being expanded, and the consequent demand for chemical salt is increasing. Dryden Chemical Limited will bring a $4-million plant into production in 1962 at Dryden, Ontario, to serve that industry.

Sulphur

Output of elemental sulphur in western Canada from sour natural gas reached 393,454 tons valued at $7.3 million, thus rising 44 per cent above the 1960 total quantity and setting a new record. The 11 sulphur-recovery plants in operation at the beginning of 1961 had a combined annual capacity of 900,000 tons. During the year, six new plants were being built and plans for others were being studied. In 1962, when the six are completed, the recovery capacity will total 2.2 million tons a year.

With the development of large gas reserves in its western provinces, Canada has become one of the principal sulphur-producing countries of the world. The sulphur recoverable from these reserves has been variously estimated at 150 million to 300 million tons. Canada, before beginning to produce this commodity from the cleaning of natural gas, was a great net importer of sulphur. Imports still exceed exports, but a major obstacle to change in this relationship is that at the pulp-and-paper plants of Ontario and Quebec the cost of imported sulphur is less than the cost of sulphur moved by rail from western Canada. Thus the stockpiles that are being built at the processing plants are intended primarily for export markets, which are highly competitive. The industry benefited in 1961 when the railways granted a reduction of 10 to 35 cents a hundredweight in the rates charged for the shipment of sulphur from the Prairies to the west coast.

Sulphur production in all forms amounted to some 927,194 tons in 1961. It consisted of the sulphur content of pyrites, the sulphur recovered from smelter gases used to make sulphuric acid and liquid sulphur dioxide, and elemental sulphur. The consumption of elemental sulphur has been about 500,000 tons a year, upwards of 300,000 tons being supplied from imports.

Other Nonmetallics

Other important nonmetallic minerals produced include: barite ($1.8 million in 1961); fluorspar ($2.0 million); brucite and magnesitic dolomite ($3.1 million); nepheline syenite ($2.6 million); sodium sulphate ($4.0 million); and quartz and silica sand ($3.1 million).

Structural Materials

The output of these materials for 1961 was valued at $331.3 million and comprised cement ($103.9 million), sand and gravel ($104.7 million), stone

($66.6 million), clay products ($37 million) and lime ($19.2 million). It depends mainly on the requirements of all types of construction throughout the country and enters only slightly into the export trade.

Cement ranked tenth in Canada's mineral industry in value of output and is third among the industrial minerals. The growth of the cement industry has been rapid and its capacity at the end of 1961 was considerably greater than production. For many years after World War II Canada imported cement to supplement domestic output. In each of the last seven years, however, it has exported from 3 to 5 per cent of its output. The rated annual capacity of 19 plants, operated by 11 companies, at the end of 1961 was 9,065,000 tons (51.8 million barrels). The trend toward the integration of cement, concrete-products and crushed-stone industries, which became noticeable a few years ago, continued in 1961. Plants producing ready-mix and other concrete products serve a large and growing market. Through purchase and amalgamation, integrated manufacturing and processing concerns have grown and come to dominate the cement and construction industries. There is a trend in construction, especially in the great metropolitan areas, toward an increase in the use of pre-stressed, reinforced and lightweight concrete.

The production of lightweight aggregate, which includes expanded clay and shale, slag, vermiculite and perlite, was valued at $5.8 million in 1960. It is geared primarily to home and industrial construction, while that of sand and gravel and of stone is geared to the construction of railroads, dams, highways and large industrial plants.

Fuels

Fuels again made a major contribution to the value of the mineral output. In 1961 their total value reached the record of $653.3 million, made up of $514.8 million from crude oil and natural-gas liquids ($487.6 million from crude oil), $68.4 million from natural gas and $70.1 million from coal. All fuels except coal increased their output.

Coal

The coal situation in Canada has grown more and more difficult in the past 10 years as competition from other fuels has intensified. Production in 1961 amounted to some 10.4 million tons—the smallest total since 1906. A steady decline that started about 1949 has reduced production by nearly 50 per cent. Since 1948, when the daily average of employees was 24,319, employment in the industry has steadily decreased to its present 11,000.

The coal industry is in difficulty because of the importation of fuel oils, the domestic manufacture of fuel oils from crude petroleum, the growing use of natural gas and the high cost of coal production in eastern Canada. Shipment costs arising from the geographical location of some mines with respect to markets, have been partially offset by subsidies in the form of transportation subventions.

Output was some 613,000 tons less than in 1960. The decrease was kept to this level by the continuance of federal and provincial financial assistance. The Government of Canada has seen fit to maintain this aid to prevent the rapid market decline from causing an abrupt collapse of the industry, particularly in the Cape Breton coalfields. Despite the subvention subsidy and other special aids, mines continued to close. The greatest impact was felt in Cape Breton, where in 1961 these closures affected 1,200 miners.

Imports of United States coal dropped from 13.2 million tons in 1960 to 12 million in 1961. Exports to Japan have been increasing each year since 1958. They come mostly from the Cascade area near Banff, Alberta, and the Crowsnest Pass area of Alberta and British Columbia and are shipped with the aid of freight subventions to Port Moody, British Columbia, the port of exit. At one time about 3.5 million tons of coal were produced in the Crowsnest Pass area, but production has now dwindled to some 1.3 million tons.

For the past 12 months the demand for coal for thermoelectric generating stations in certain parts of Canada has grown significantly, and requirements for this purpose are expected to increase.

Natural Gas

Net new production of natural gas reached an all-time high of 655,738 million cubic feet (exclusive of gas flared and wasted), 25.4 per cent more than in 1960. Alberta produced 76.4 per cent, British Columbia 15.7 per cent, Saskatchewan 5.7 per cent and Ontario 2.2 per cent. Very small quantities were produced in New Brunswick and the Northwest Territories.

Exploratory drilling for gas was more successful than for oil. Throughout Canada, 157 gas discoveries were made, 113 of them in Alberta. One or two of the 26 British Columbia discoveries hold promise of large fields. Development drilling of known gas fields increased considerably, almost two thirds of the new wells being in Alberta.

The completion of the Alberta-California gas pipeline was the year's most significant event in natural-gas transportation. Deliveries through the system to the United States started in December. The 1,367-mile transmission line extends from Whitecourt, in northwestern Alberta, to San Francisco. Permits issued by the National Energy Board allow a maximum of 610.75 million cubic feet to be exported daily via this line, not only for the California market but for the Pacific northwest region. By the end of the year, this quota was being about half filled. The export pipeline of Trans-Canada Pipe Lines Limited, completed in mid-1960, had its first full year of operation in 1961.

The construction in 1961 of nine new plants for the processing of natural gas brought the number of such plants to 68. Several large plants for processing wet, sour gas were built to serve the new Alberta-California pipeline. The raw-gas throughput capacity of Canadian plants was increased 24 per cent to 2,804 million cubic feet a day.

Domestic sales of natural gas totalled 377,065 million cubic feet, or 16 per cent more than in 1960. Alberta continued as the leading regional customer, accounting for 38.7 per cent of these sales. It was followed by Ontario, which consumed 33.2 per cent.

Exports of natural gas totalled 168,180 million cubic feet. The rise in exports was particularly large (49.5 per cent) mainly because of the first full year's operation of the Trans-Canada export pipeline, which enters the United States at Emerson, Manitoba.

Exports through the Alberta-California pipeline, which commenced in December, averaged 285 million cubic feet a day for the month.

Petroleum

The efforts of the petroleum industry to reach production targets of the national oil policy resulted in a 16.5-per-cent increase over 1960's record output. The crude-oil output, which totalled 220.8 million barrels, had a well-head value of $487.6 million. The output of crude oil plus natural-gas liquids was 234.7 million barrels, or 642,980 barrels a day.

Crude-oil production increased in Alberta, Saskatchewan, British Columbia, Ontario and the Northwest Territories, and decreased in Manitoba and New Brunswick. Alberta accounted for 71.5 per cent of the output; Saskatchewan for 25.3 per cent; Manitoba for 2.0 per cent; and Ontario, British Columbia, the Northwest Territories and New Brunswick for the remaining 1.2 per cent.

In western Canada, there were 16,481 oil wells capable of production at the end of 1961, of which 13,722 were producing. Sixty-five per cent of the producing wells were in Alberta. Including outpost and service wells, 865 exploratory and 1,988 development wells were completed in Canada during

1961. The total of 2,853 wells completed was slightly less than the 1960 total, the decrease being the result of the drilling of fewer wells in Alberta, Manitoba and the Northwest Territories. Seventy-six exploratory and 1,345 development wells were oil wells.

More than 1,000 miles of new oil pipelines were laid in 1961, of which the most important was the 504-mile line from Taylor, in northeastern British Columbia, to Kamloops. At Kamloops, it joins the pipeline of Trans Mountain Oil Pipe Line Company, thereby making possible large-volume deliveries of British Columbia crude to Vancouver refineries. By the end of the year, there were more than 9,500 miles of oil pipelines in Canada.

The closing of two small refineries, the opening of a new one, and expansion of existing facilities resulted in a net gain of 11,500 barrels a day in refinery capacity and brought the year-end refinery capacity to 961,700 barrels a day. The two refineries that ceased operation were at Hartell, Alberta, and Dawson Creek, British Columbia. The new refinery, Newfoundland's first, is a 8,500-barrel-a-day plant near St. John's.

Crude oil delivered to Canadian refineries increased 5.2 per cent to 290.4 million barrels. The receipts of Canadian crude remained at 54.1 per cent of this total. Deliveries of imported crude increased 5 per cent, although by the end of the year Ontario refineries had stopped taking foreign crude. Thirty-six per cent of the imported crude came from the Middle East and 64 per cent from the Caribbean region, mainly from Venezuela. Imports of petroleum products decreased by 17.7 per cent to 29.7 million barrels.

The most marked change in petroleum-marketing was in crude-petroleum exports. The amount of Canadian crude exported to the United States increased by 54 per cent to 65.2 million barrels, about half of which went to the Puget Sound area and the remainder to the Great Lakes region. A comparatively small amount of refined-petroleum products was exported—2.3 million barrels, or 28.6 per cent less than in 1960.

MINING TECHNOLOGY

New Mining Procedures

Further advances in open-pit and underground mining methods were achieved in 1961. Largely because of new developments in the iron-ore industry, there was a growing trend toward the use of open-pit methods in ore-mining. This trend is illustrated in the accompanying table.

UNDERGROUND AND OPEN-PIT PRODUCTION[1] IN METAL MINES

Year	Underground[2] (tons)	Open Pit[2] (tons)	Ratio Underground to Open Pit
1950	35,437,000	5,636,000	6.3
1955	68,247,000	14,855,000	4.6
1960	69,182,000	24,788,000	2.8

[1] Compiled from company reports of tons shipped or milled. Owing to differences in the method of compilation, the data presented here may not correspond with those from the Dominion Bureau of Statistics. Where exact data were lacking, estimates were made.

[2] Excludes waste.

In 1960, some 70,000 tons of asbestos ore were mined daily, 50,000 tons of this being from open-pit mines. Statistics for 1961 will show that conversion to open pits at the Jeffrey mine of Canadian Johns-Manville Company, Limited, at Asbestos, Quebec, has materially altered the proportional relationship between the underground and the open-pit mining of ores.

A major advance in underground mining techniques was made by The International Nickel Company of Canada, Limited, at Sudbury, Ontario, when the recently developed undercut-and-fill method of pillar recovery was applied to greater widths and under an increased variety of conditions. As expected, the original technique is being further refined as experience is gained.

The use of cemented floors in cut-and-fill stopes has been extended by Falconbridge Nickel Mines, Limited, which operates near Sudbury, where the method originated and was developed. In the Chibougamau district, where the method is also used, filling practice involves hydraulic placement of tailings fill to within 4 inches of the desired elevation. A final pour of one part cement to four parts tailings provides a firm scraping floor that aids materially in the recovery of fines. Faster cycles result from the elimination of the handling that was necessary under the former method when timber floors were laid before scraping was started.

The Henderson Division of Campbell Chibougamau Mines Ltd. reported details of the successful application of large mobile equipment in cut-and-fill mining. Over-all performance of about 23 tons per manshift was obtained on stope preparation and about 25 tons per manshift on stoping.

Drilling and Blasting

The purpose of the angle-drilling used for many years on open-pit benches in the asbestos mines of Quebec was chiefly to reduce scaling and promote safe working conditions. At Asbestos, Canadian Johns-Manville Company, Limited, has for some time been methodically investigating the use of angle-drilled holes and claims to have had exceptionally favorable results. At Marmora, Ontario, Marmoraton Mining Company, Ltd., drills slightly inclined holes to help reduce the scaling required and break out the toe.

At Iron Ore Company of Canada's Carol Lake project, production drilling will be done by four jet-piercing rigs that were purchased after exhaustive tests of various types of equipment. Apart from some small quarries equipped for jet-piercing that produce siliceous material, the Carol Lake project is the first known to apply jet-piercing to the large-scale mining of metals in Canada.

Further progress was made in the use of ammonium nitrate-fuel oil (AN-FO) for blasting in open pits and underground. At drill-hole collars there is a trend away from crude mixing methods toward the use of bagged, pre-mixed AN-FO of uniform quality. One large company that mines iron ore is still successfully operating a licensed mixing plant from which a uniformly mixed product is transported to drill holes on a truck equipped with screw-and-gravity feed. The use of slurries for wet holes is still practical. Plastic hole liners are sometimes applied successfully when AN-FO is used in wet holes.

A striking advance is the use of AN-FO in underground blasting. Most mining companies have considered this, and provincial bodies are investigating safety factors before incorporating appropriate regulations in provincial mining acts. Safety and efficiency are promoted by the use of good pneumatic loaders available from the explosives companies. A senior explosives-company official has estimated that AN-FO mixtures will reach their maximum use within a year and will then amount to 75 per cent of all explosives used underground.

The International Nickel Company of Canada, Limited, has reported an interesting application of AN-FO to secondary blasting. After considerable testing, limp bombs of AN-FO tied in 30-inch squares of burlap have been developed for easy placement and economical secondary breaking in scraper drifts. For less accessible oversize in hung-up drawpoints, AN-FO is placed pneumatically through a hose manipulated from a safe location.

Loading, Haulage and Handling

In open pits, old equipment is being replaced by larger loading and haulage units. As 15- and 22-ton trucks are retired, 35- and 40-ton trucks are becoming more common. The shovels purchased, formerly of 4- to 6-cubic-yard capacity, are now of 6- to 8-cubic yard size. The Carol Lake project will be supplied with nominally 13-cubic-yard shovels specially modified for Labrador conditions and fitted with 10-cubic-yard buckets. Haulage units serving the shovels at this project will be standard 40-ton Euclid tractors towing 50-cubic-yard, side-dump trailers.

Interest in skip hoisting for open pits has grown. At the Jeffrey mine of Canadian Johns-Manville Company, Limited, 35-ton skips have been installed to hoist truckloads of ore in balance on a 38-degree incline. A similar skipway of a type that gives highly satisfactory performance in ore-hoisting when fitted for drive-over dumping, is under construction for the hoisting of waste. Skip hoisting and other improvements in loading and handling have enabled the company to eliminate a mile-long road haul out of the pit and thus use the trucks for open-pit mining exclusively.

For several years, successful skip hoisting has been practised by Marmoraton Mining Company, Ltd., and part-time skip hoisting by Steep Rock Iron Mines Limited. The Canadian Johns-Manville installation and a similar but smaller installation at Flintkote Mines Limited, Thetford Mines, Quebec, will give the industry greater experience in the use of hoisting as opposed to road haulage. In Quebec's Thetford Mines and Asbestos areas and in Ontario's Marmora area, the saving in stripping costs has been impressive.

The cable-belt conveyor at Craigmont Mines Limited, Merritt, British Columbia, is the first operated in a North American metal mine. A 30-inch cable belt more than 5,700 feet long lowers ore 1,100 feet from a crushing plant to the mill. Electrical power generated by the conveyor system operates the crushing plant.

Steep Rock Iron Mines Limited is achieving continued success and high performance underground with chain conveyors. Two asbestos-mining companies at Thetford Mines are using similar equipment in selected areas.

The use of bottom-dump cars and continuous loading of trains are proving successful at the Henderson Division of Campbell Chibougamau Mines Ltd.

Research

Considerable interest is being shown in the rock mechanics of underground mining operations. Several companies are experimenting with load cells installed in boreholes to measure loads on pillars and development openings. Others are using photoelastic methods to assess the magnitude and direction of stresses.

Greater interest is evident in questions of slope stability in open-pit mines. Studies are under way in the Quebec-Labrador and Ontario iron-ore areas to eliminate methods of trial and error from pit-slope selection.

'Research in the Mineral Industry,' the theme of the 1962 Annual General Meeting of the Canadian Institute of Mining and Metallurgy, was an expression of the continuing forward outlook of the mining industry.

TRENDS IN THE MINERAL INDUSTRY

The status of the mineral industry as a whole can be appraised in terms of a series of statistics on production, trade, consumption, prices, costs, employment, exploration, mine output, transportation, taxes, and capital investment. Such statistics are contained in the tables of this General Review and provide a basis for the following observations on trends and conditions prevailing in the industry during 1961 and on the industry's importance in the Canadian economy.

Production

The value of mineral production reached an all-time high in 1961, but the year's increase was representative of the small gains made since 1957, rather than of the large-scale annual increases of the period 1947-57 (Tables 1 and 2). Thus the total output value remained essentially on the plateau reached in 1957, the 1961 value being only 18 per cent higher, whereas the 1957 value was more than three times that of 1947. The marked gain made by fuels in 1961 resulted in a change from the 1960 percentage composition (shown in parentheses) of the mineral-output value, as follows: metallic minerals, 53.7 (56.4) per cent; nonmetallic minerals, 21.0 (20.9) per cent; fuels, 25.3 (22.7) per cent.

A series on the index of the physical volume of production illustrates the extent to which the mineral industry has been outpacing the industrial economy as a whole since 1947 (Table 4). The relative importance of individual minerals changes from year to year but petroleum, nickel, copper and uranium continued, as in 1960, to hold the four leading positions in terms of output value. Petroleum and nickel increased in relative importance and together accounted for one third of the value of Canada's mineral value. These two minerals plus copper, uranium, iron ore, gold and asbestos accounted for 68 per cent of total value (Table 5).

An analysis of the regional distribution of mineral production shows that the Canadian Shield accounts for 45 per cent of the total value and that in 1961 a small increase occurred in the Interior Plains' share. These two regions thus accounted for 70 per cent of the country's output (Table 3). On a provincial basis, Alberta surpassed Quebec in 1961, and Ontario's commanding lead was slightly decreased (Table 6). Although these three provinces accounted for 72.6 per cent of the total output value, production is well distributed throughout Canada. Manitoba had a significant increase as the new Thompson nickel project went into operation. Growth in the industry during the past decade has been geographically diversified (Tables 7 and 8). Today the mineral output of most provinces is diversified (Table 9), and as the mineral economy grows, the diversity can be expected to increase. Mineral-property development in the Maritime Provinces gave promise in 1961 of a broader mineral economy for that region.

The net value of production affords an interesting criterion for measuring the importance of the mineral economy. The record shows that by the end of the 1950's (Table 10) mineral production was accounting for about 30 per cent of the net value of all commodity-producing industries instead of 25 per cent as in the early years of the decade.

Canada has maintained its leading position as a world producer (Table 11) for some years. It now ranks among the first six producing countries for 18 minerals whereas in the early 1950's it was among the first six producing countries for 14 minerals.

Mineral Trade

Canada has a very favorable trade balance in raw and semiprocessed minerals and their products (Tables 12 and 13). During 1961, raw-material exports exceeded imports by almost 60 per cent and semiprocessed exports were almost 11 times imports. Exports of unprocessed nonmetallic minerals, including fuels, increased greatly and constituted one third of the exports of raw materials. The same group made up more than three quarters of the raw materials imported but declined relatively. This decline, together with the improvement in exports, pointed to greater self-sufficiency. The gain was due largely to an increase in crude-oil and natural-gas exports and a weakening of reliance on crude-oil imports. Slight increases took place in all types of semiprocessed mineral exports, and nonferrous metals accounted for more than three quarters of the group's total. Imports of semiprocessed minerals were small, less than one tenth of their exports. In all, there was a favorable trade balance of about $1,150 million in raw and semiprocessed minerals and their products.

The mineral industry's generally unfavorable trade position is due to the large imports of fully manufactured products. In 1961, minerals of this group constituted 81 per cent of all mineral imports and were 5.5 times greater than the exports in this class. With a value of $2.6 billion, fully manufactured mineral imports were 17 per cent greater than the exports of all minerals and their products. In spite of the favorable export balance at the raw and semiprocessed levels, the imports of the raw, semiprocessed and fully manufactured minerals combined exceeded the corresponding exports by almost $1,000 million. The great trade deficit in fully manufactured products arises from the large imports of iron and its products. Fully manufactured iron products make up three quarters of the imports of minerals in the manufactured class. Consequently, as Canada's manufactures of iron and steel increase, the attainment of a better general trade balance becomes more likely. Good progress has already been made in steel production, and Canada now produces more than four fifths of its own steel requirements.

Since 1957, exports of minerals at the raw and semiprocessed stages have accounted for almost one third of all industrial-product exports while mineral imports of the same type have been about one tenth of industrial-product imports (Tables 20 and 21). With fully manufactured exported products included, the proportion contributed to exports in 1961 was close to two fifths (Table 14). With fully manufactured imported products included, the 1961 mineral contribution to imports was well over half, although proportionally a little smaller than in the previous year (Table 15). The high proportion of minerals and mineral-based materials in commodity imports is further evidence of the extent of Canada's reliance on fully manufactured iron and steel products from other countries.

In 1961 the United States took more than half of Canada's exports of minerals and mineral products and was the source of more than two thirds of its mineral imports (Tables 16 and 17). The slight increase in the export total was due largely to an increase in shipments to the United States. A slight increase in the exports of raw and semiprocessed minerals to the United States reversed a trend prevalent in recent years toward less reliance on this market. During the period 1950-60, Canada's exports to that market declined in relative importance from 64.6 to 52.3 per cent, but in 1961 the proportion rose to 53.8 per cent (Tables 18 and 19). Exports to countries of the European Economic Community, declined, mainly owing to a slackening in the exports of aluminum and nickel and despite a sizeable increase in those of asbestos. The Japanese market grew significantly with rises in the exports of iron ore, aluminum, nickel, asbestos and coal. An increase in shipments to Japan offset the European declines.

Domestic Consumption

The size and diversification of the Canadian mineral industry can be well illustrated by comparing consumption and production (Tables 22 and 23). For all but a few commodities, production is well in excess of demand. The export market is therefore of great importance in the growth of the industry. Such minerals as molybdenum, tin and mica continue strongly dependent on imports. The considerable dependence on foreign sources for sulphur and crude oil is expected to decline in the next few years. Exports of raw and semiprocessed minerals have declined only slightly in relation to the sales of all minerals and are still equivalent to three fifths of the total output. Four fifths of the metals produced, about one third of the industrial minerals and almost one quarter of the fuels are marketed outside Canada. In terms of the principal refined metals, particularly of aluminum, nickel and copper, Table 24 indicates the industry's ability to keep pace with domestic requirements and at the same time expand in the export market.

Prices

United States prices, which Canadian metal prices closely follow, underwent several distinct changes in 1961 in a trend that was generally downward (Table 25). There were declines in the prices of aluminum, copper, lead and zinc but increases in those of nickel and silver. Copper, lead and zinc prices also declined in London and other world markets. The general decrease affected the value of Canadian exports as did the weakening of the Canadian dollar, which by the end of 1961 had fallen to 95 cents in United States currency. The effect of price changes can be seen in Table 1, which shows that the gain in the output of copper, lead and zinc was not paralleled by a comparable increase in value, while a favorable increase did occur for nickel. The increase caused in the unit value of gold by devaluation of the Canadian dollar was offset by a decrease in its output. Although the volume of some other minerals increased, the general price declines restricted the increase in the total value of mineral production. Substantial volume and value increases for nickel and petroleum were the most buoyant factors in the year's production record.

The price indexes for iron products and nonferrous metals and their products increased in 1961 to about the same extent as the general wholesale price index, but the nonmetallic-mineral index showed no significant change. During the past decade, the iron-products index has outpaced the general wholesale index (Tables 26 and 27).

Principal Industry Statistics*

Census-of-industry statistics (Tables 28 and 29) afford a means of examining the relationship between employment, the cost of energy and the cost of process supplies on the one hand and the gross and net values of production on the other. In 1960 the net value of the metallic-mineral output was 70 per cent of its gross value, while the net production values of industrial minerals and of fuels were respectively 80 and 90 per cent of their gross values. The ratio for nonferrous smelting and refining was 34 per cent. Cheap fuel and electricity are essential to a low-cost mineral economy, particularly as regards industrial minerals, in which energy costs are about 10 per cent of the gross value of output. The relative importance of fuels and electricity in the mineral industry is shown in Table 30; the increasing reliance on electricity in Table 31.

Employment

Employment in mining and metallurgy declined in 1961, largely because of the cutback in uranium production, the continuation of the depression in the coal industry and moderate declines in gold and iron ore mining activity. Employment, however, improved in nonferrous metals and industrial minerals, and it rose slightly in the oil industry. Consequently, after allowance for changes in the Dominion Bureau of Statistics employment statistics series, the employment decline experienced for the industry as a whole in 1960 (Table 32) tended to lessen during the latter part of 1961. The only serious long-term decline in employment has been in the fuels sector and has been due to the marked decline in coal mining (Table 33).

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*It should be noted in studying the industry's employment data and principal statistics (Tables 28 to 33 and Table 35) that in connection with the adoption of the Standard Industrial Classification the Dominion Bureau of Statistics made a change, effective in 1960, in certain accounting procedures. In consequence, some firms classified under industrial minerals, particularly those engaged in sand and gravel operations, were reclassified to the construction industry or other categories. Employment, salaries and wages and other statistics on industrial minerals are therefore not directly comparable with similarly designated statistics for previous years.

The employment gains made in metal-mining during the last decade have compensated for the coal industry's employment losses. These gains were accompanied by sizeable wage increases. Productivity increases fortunately resulted in a slight decline in the wage cost per ton mined (Table 34). The productivity increases are shown in Table 35, the wage increases in Table 38. Wages are higher in the various sectors of the mining industry than in the manufacturing and the construction industries. In terms of constant dollars, the wages paid in such depressed sectors as coal and gold have lagged considerably behind those paid in the more buoyant sectors, but all have shown, an absolute increase since the mid-1950's (Table 39).

Prospecting and Exploration

Statistics on the cost of prospecting in 1959 and 1960 indicate that companies engaged in silver-lead-zinc mining and nickel-copper mining expanded their exploration work and that there was a slight decline for the copper-gold-silver mining companies (Table 40). Quebec continues to lead all provinces in the amount spent on exploration by metal-mining companies. The level of exploration activity for the whole of Canada reached in 1959 was maintained in 1960 (Table 41).

The amount of contract diamond-drilling carried out for mining companies has not varied significantly from year to year during the past decade (Table 42), but rotary drilling for the oil industry has increased fourfold (Table 43). Compared in terms of the gross income of drilling companies, contract drilling for the oil industry has involved more than four times the capital expenditures made in the development of metalliferous deposits.

Ore Mined and Rock Quarried

Half the tonnage mined and quarried in the Canadian mining industry is made up of metallic ores, and iron ore accounts for one third of the metallic-ore tonnage. In the nonmetals group, asbestos accounts for four fifths of the tonnage, and stone constitutes a similar proportion for structural materials (Table 44). In the material mined, the approximately equal division that has prevailed during the past decade between metallic ores and industrial-mineral materials continues (Table 45).

Transportation of Minerals

Crude minerals accounted for almost two fifths of the tonnage moved by Canadian railways in 1961 (Table 46). The proportion was slightly less than in the previous two years but well above the average of the early 1950's (Table 47). The primary products of smelters and refineries constitute only a small percentage of the revenue freight carried by Canadian railways; iron ore and concentrates, coal, industrial-mineral materials, and nonferrous ores and concentrates provide much larger tonnages (Tables 46 and 48). Most of the 1,343 miles of new railway construction completed in Canada since the end of World War II have been the direct result of mineral development in northern areas. The mineral industry has thereby played the leading role in providing means of access to Canada's hinterland.

The mineral industry provides more than half the inland-waterways freight (Table 49). As with railway traffic, the iron-ore and coal industries are the main mineral-commodity shippers. In water transport, they account for more than 70 per cent of the mineral tonnage and in railway transport for almost half.

Since 1947 the petroleum industry has built up a major system of transportation by pipeline. Table 50 shows the year-by-year increase in the pipeline transportation of petroleum and its products and of gas. The petroleum moved by pipeline in 1961 amounted to 52.4 million tons, almost as much as all mineral shipments sent by rail and more than those routed by inland waterways. In recent years, pipeline transportation has become a major component of the Canadian transportation network.

Taxation

Almost two thirds of the taxes paid by five major divisions of the mineral industry are federal income taxes; provincial and municipal taxes account for the remainder (Tables 51 and 52). Complete information on the taxes paid by the entire industry is not available, but the mineral industry accounts for about one fifth of all federal income taxes derived from industry (Table 53).

Capital Investment, Ownership and Control

In 1961, capital investment and repair expenditures in the mineral industry increased by one tenth to an estimated $561.5 million, more than half of which was in the petroleum and natural-gas sectors. The total included amounts spent on new capital construction, new machinery and equipment, and the repair of structures, machinery and equipment. Table 54 sets out these capital and repair expenditures, but the amounts shown do not include expenditures in nonferrous smelting and refining, petroleum-refining or pipeline transportation. The expenditures attributable to mineral-industry activity are also understated to the extent of mining-company expenditures on railways, port facilities, power plants and townsites.

Among the metals, iron ore predominates, accounting for about half the expenditures in this sector. Among the nonmetals, asbestos continues to absorb the largest amount of capital. Expenditures in all parts of the petroleum and natural gas economy, including transportation, processing and marketing, amounted in 1961 to more than 8 per cent of all the capital invested in Canada. Investment in oil and gas pipelines and in plants for the processing of natural gas increased in 1961 (Table 55). The forecast for 1962 is that capital expenditures in the mineral industry as a whole will be about the same as in 1961, declines in the fuels sector being offset by gains in the metals and non-metals sectors. The principal increases are expected to occur in the iron-ore and asbestos industries.

The latest available statistics show that 60 per cent of the mining sector of Canada's mineral industry is foreign-owned. In petroleum and natural gas foreign ownership amounts to 63 per cent, and in nonferrous smelting to 56 per cent (Table 56). In a number of other industries taken in aggregate, foreign ownership amounts to about one third (Table 57). Foreign ownership is thus greater in the mineral industry than in many other parts of the Canadian economy. Statistics for the past 30 years show the dominant position the United States has maintained among foreign countries investing in Canada's minerals (Table 58).

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Statistical Tables

List of Abbreviations and Symbols

s.t.	short ton (2,000 lb)	l.t.	long ton (2,240 lb)
bbl	barrel (35 imperial gal)	kwh	kilowatt hour
M	unit of 1,000	f.o.b.	free on board
Mcf	1,000 cubic feet	p	preliminary
f	forecast	billion	1,000 million
(e)	estimated	...	not available for publication
..	not available	-	zero

Sources

Recognized statistical sources have been used throughout: Canada - Dominion Bureau of Statistics, Department of Labour, and Department of National Revenue; United States - United States Bureau of Mines, American Bureau of Metal Statistics, and Engineering and Mining Journal's "Metal and Mineral Markets."

TABLE 1
MINERAL PRODUCTION OF CANADA, 1960 AND 1961

	Unit of Measure	1961 Quantity	1961 $'000	1960 Quantity	1960 $'000
Metals					
Antimony	'000 lb	1,331	470	1,652	539
Bismuth	'000 lb	478	958	424	762
Cadmium	'000 lb	1,358	2,173	2,357	3,348
Calcium	'000 lb	99	101	135	159
Cobalt	'000 lb	3,183	4,751	3,569	6,763
Columbium (Cb_2O_5)	'000 lb	62	66	-	-
Copper	'000 s.t.	439	255,158	439	264,847
Gold	'000 troy oz	4,474	158,637	4,629	157,152
Indium	'000 oz	...	...	...	...
Iron ore	'000 l.t.	18,177	187,950	19,242	175,083
Iron (remelt)	'000 s.t.	...	14,720	...	10,973
Lead	'000 s.t.	230	47,055	206	43,927
Magnesium	'000 lb	15,271	4,307	14,577	4,314
Molybdenum (Mo content)	'000 lb	771	1,092	768	1,015
Nickel	'000 s.t.	233	351,262	215	295,640
Platinum metals	'000 troy oz	418	24,534	484	28,874
Selenium	'000 lb	431	2,799	522	3,651
Silver	'000 troy oz	31,382	29,581	34,017	30,244
Tantalum (Ta_2O_5)	'000 lb	-	-	-	-
Tellurium	'000 lb	78	376	45	156
Thorium	'000 lb	...	...	...	...
Tin	'000 lb	1,119	727	622	522
Titanium ore	'000 s.t.	-	-	3	16
Tungsten (WO_3)	'000 lb	-	-	-	-
Uranium (U_3O_8)	'000 lb	19,281	195,692	25,495	269,938
Zinc	'000 s.t.	416	104,750	407	108,635
Total, metals			1,387,159		1,406,558
Non metals					
Arsenious oxide	'000 lb	419	17	1,724	70
Asbestos	'000 s.t.	1,174	128,956	1,118	121,400
Barite	'000 s.t.	191	1,799	154	1,462
Diatomite	s.t.	214	9	44	1
Feldspar	'000 s.t.	11	230	14	239
Fluorspar	'000 s.t.	...	1.990	...	1,922
Garnet	s.t.	80	3	32	5
Graphite	s.t.	1	0.1	-	-
Grindstone	s.t.	10	2	10	2
Gypsum	'000 s.t.	4,940	7,751	5,206	9,499
Iron Oxide	'000 s.t.	0.8	68	0.9	77
Lithia	'000 lb	536	393	205	84

TABLE 1 (Cont'd)

MINERAL PRODUCTION OF CANADA, 1960 AND 1961 (cont'd)

	Unit of Measure	1961 Quantity	1961 $'000	1960 Quantity	1960 $'000
Magnesite, dolomite and brucite	'000 ton	...	3,064	...	3,279
Mica	'000 lb	1,816	125	1,703	94
Mineral water	'000 gal	365	209	375	202
Nepheline syenite	'000 s.t.	240	2,572	241	2,891
Peat moss	'000 s.t.	224	7,295	186	6,088
Potash K O	'000 s.t.	-	-	...	179
Pozzolana		...	2	-	-
Pyrite, pyrrhotite	'000 s.t.	517	1,830	1,032	3,316
Quartz and silica sand	'000 s.t.	2,194	3,153	2,261	3,267
Salt	'000 s.t.	3,247	19,552	3,315	19,356
Soapstone, talc	'000 s.t.	48	691	42	523
Sodium sulphate	'000 s.t.	251	4,037	214	3,449
Sulphur in smelter gas	'000 s.t.	277	2,708	290	2,855
Sulphur, elemental	'000 s.t.	395	7,288	274	4,299
Titanium-dioxide slag etc.	'000 s.t.	...	16,724	...	12,947
Total, nonmetal			210,468		197,506
Fuels					
Coal	'000 s.t.	10,398	70,053	11,011	74,676
Natural gas	'000 Mcf	655,738	68,422	522,972	52,197
Natural-gas by-products	'000 bbl	...	27,293	...	16,052
Petroleum crude	'000 bbl	220,848	487,560	189,534	422,927
Total, fuels			653,328		565,852
Structural materials					
Clay products	$	...	36,983	..	38,226
Cement	'000 s.t.	6,206	103,923	5,787	93,261
Lime	'000 s.t.	1,415	19,217	1,530	19,302
Sand and gravel	'000 s.t.	170,751	104,654	192,074	111,164
Stone	'000 s.t.	48,939	66,568	45,359	60,641
Total, structural materials			331,345		322,594
Total, all minerals			2,582,300		2,492,510

TABLE 2

VALUE OF MINERAL PRODUCTION OF CANADA AND ITS PER CAPITA VALUE, SELECTED YEARS, 1923-61

	Production				Per Capita Value
	Metals ($ millions)	Industrial Minerals ($ millions)	Fuels ($ millions)	Total ($ millions)	($)
1923	84	52	78	214	23.76
1928	132	69	74	275	27.96
1933	147	27	48	222	20.85
1938	324	54	65	443	39.71
1943	357	81	92	530	44.94
1948	488	172	160	820	63.97
1953	710	312	314	1,336	90.02
1958	1,130	460	511	2,101	122.99
1959	1,371	503	535	2,409	137.79
1960	1,407	520	566	2,493	139.48
1961	1,387	542	653	2,582	141.59

TABLE 3

VALUE OF MINERAL PRODUCTION IN CANADA BY MAIN GEOLOGICAL REGIONS, 1961

	Canadian Shield	Appalachian Region	St. Lawrence Lowlands	Interior Plains	Cordilleran Region	Total Canada
Metals						
$ millions	1,170.7	59.1	0.1	*	157.3	1,387.2
Percentage	84.4	4.3	-	-	11.3	100.0
Industrial minerals						
$ millions	31.7	157.2	246.1	66.1	40.8	541.8
Percentage	5.8	29.0	45.4	12.2	7.6	100.0
Fuels						
$ millions	-	49.4	9.2	569.7	25.0	653.3
Percentage	-	7.6	1.4	87.2	3.8	100.0
Total, all minerals						
$ millions	1,202.3	265.7	255.4	635.8	223.1	2,582.3
Percentage	46.6	10.3	9.9	24.6	8.6	100.0

*Less than $10,000.

TABLE 4

INDEXES OF PHYSICAL VOLUME OF INDUSTRIAL AND MINERAL PRODUCTION IN CANADA, 1947-61, UNADJUSTED (1949=100)

	Total Industrial Production	Total Mining	Metals							Nonmetals				Fuels			
			Total	Gold	Nickel	Lead	Zinc	Copper	Iron Ore	Total	Asbestos	Other Nonmetals	Quarrying and Sand Pits	Total	Coal	Natural Gas	Petroleum
1947	91.5	78.5	79.6	75.7	92.1	101.3	72.1	85.7	50.7	109.2	114.9	95.8	85.6	66.0	82.1	91.5	36.0
1948	96.4	90.0	88.4	86.3	102.4	104.7	81.2	91.4	40.0	118.8	124.5	105.3	101.9	83.2	97.2	100.9	57.6
1949	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1950	106.9	109.5	103.5	107.9	96.2	103.7	108.6	100.4	96.0	139.1	151.8	109.0	119.3	112.1	98.5	107.3	135.5
1951	116.6	123.4	107.9	103.9	107.1	99.0	118.4	102.5	115.9	156.3	170.7	122.0	142.9	143.5	95.6	120.5	226.9
1952	120.9	131.0	110.3	106.9	109.2	105.5	128.9	98.0	126.5	155.5	171.5	117.2	153.5	163.9	90.5	128.9	291.8
1953	129.1	142.1	115.7	97.9	111.7	121.4	139.5	96.1	170.6	152.9	162.3	130.5	154.3	192.7	81.5	147.8	385.5
1954	128.5	158.7	129.0	104.5	125.3	136.8	130.5	114.8	185.4	161.4	167.8	146.3	189.6	215.6	75.2	169.6	457.8
1955	142.3	185.2	142.7	107.7	135.9	126.9	150.3	123.7	316.5	180.2	191.9	152.4	204.3	273.2	74.1	204.5	616.8
1956	154.9	212.3	151.0	107.9	139.0	118.2	145.5	135.2	410.6	187.6	188.4	184.3	237.7	344.7	74.6	235.0	812.7
1957	155.4	227.8	170.0	106.7	146.8	113.9	142.0	137.1	462.6	179.0	184.3	158.2	264.2	358.2	65.4	295.1	859.5
1958	154.4	227.0	180.3	109.7	110.2	116.0	147.2	131.8	321.5	170.9	178.3	142.1	308.2	329.5	56.7	401.6	782.6
1959	166.1	251.1	201.3	108.4	144.8	113.7	137.4	151.6	448.9	191.4	193.5	183.3	317.7	363.1	51.9	503.9	873.7
1960	167.4	253.3	197.9	111.2	166.9	128.3	142.1	168.7	406.3	192.6	201.4	157.7	301.2	380.2	53.3	589.2	909.9
1961	172.9	266.9	191.7	107.1	183.8	139.3	145.0	170.4	504.7	211.7	223.4	166.1	337.1	430.7	49.9	712.0	1,043.7

TABLE 5

PERCENTAGE CONTRIBUTIONS OF LEADING MINERALS
TO TOTAL VALUE OF MINERAL PRODUCTION IN CANADA, 1951-61

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Petroleum	9.4	11.1	15.0	16.4	17.0	19.5	20.7	19.0	17.5	17.0	18.9
Nickel	12.1	11.8	12.0	12.1	12.0	10.7	11.8	9.2	10.7	11.9	13.6
Copper	12.0	11.4	11.3	11.8	13.4	14.1	9.4	8.3	9.7	10.6	9.9
Uranium	...	...	...	1.8	1.4	2.2	6.2	13.3	13.7	10.8	7.6
Iron oxide	2.5	2.6	3.3	3.3	6.2	7.7	7.6	6.0	8.0	7.0	7.3
Gold	13.0	11.9	10.4	10.0	8.7	7.2	6.8	7.4	6.2	6.3	6.1
Asbestos	6.5	6.9	6.4	5.8	5.4	4.8	4.8	4.4	4.5	4.9	5.0
Sand and gravel	3.6	4.0	4.0	4.0	3.8	3.9	4.1	4.6	4.3	4.6	4.1
Zinc	10.9	10.1	7.2	6.1	6.6	6.0	4.6	4.4	4.0	4.4	4.1
Cement	3.2	3.7	4.4	4.0	3.7	3.6	4.3	4.6	3.9	3.7	4.0
Coal	8.8	8.6	7.7	6.5	5.2	4.6	4.1	3.8	3.1	3.0	2.7
Stone	2.3	2.4	2.3	2.7	2.4	2.3	2.7	2.6	2.5	2.4	2.6
Natural gas	0.6	0.7	0.8	0.8	0.8	0.8	1.0	1.5	1.6	2.1	2.6
Lead	4.7	4.3	3.7	3.9	3.2	2.8	2.3	2.0	1.6	1.8	1.8
Clay products	1.9	1.9	2.2	2.2	2.0	1.8	1.6	2.0	1.8	1.5	1.4
Silver	1.8	1.6	1.8	1.7	1.4	1.2	1.1	1.3	1.2	1.2	1.1
Platinum metals	1.8	1.4	1.5	1.4	1.3	1.1	1.2	0.7	0.7	1.2	0.9
Salt	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.8
Lime	1.1	1.1	1.1	1.0	0.9	0.8	0.8	0.9	0.9	0.8	0.7
Titanium dioxide	0.06	0.1	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.5	0.6
Gypsum	0.5	0.5	0.6	0.5	0.4	0.3	0.4	0.2	0.3	0.4	0.3
Other minerals	2.6	3.3	3.5	3.1	3.3	3.6	3.5	2.8	2.7	3.1	3.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 6
VALUE OF MINERAL PRODUCTION IN CANADA,
BY PROVINCES AND MINERAL GROUPS, 1961

	Metals		Industrial Minerals		Fuels		Totals	
	$'000	% of Total	$'000	% of Total	$'000	% of Total	$'000	% of Total
Ontario	780,784	56.3	153,724	28.4	9,162	1.4	943,670	36.6
Quebec	214,236	15.4	241,287	44.5	-	-	455,523	17.6
Alberta	6	-	35,529	6.6	437,946	67.0	473,481	18.3
Saskatchewan	75,144	5.4	15,817	2.9	125,016	19.1	215,977	8.4
British Columbia	129,853	9.4	37,905	7.0	20,784	3.2	188,542	7.3
Newfoundland	83,884	6.0	7,735	1.4	-	-	91,619	3.6
Nova Scotia	-	-	19,977	3.7	41,716	6.4	61,693	2.4
Manitoba	73,218	5.3	18,116	3.3	10,156	1.6	101,490	3.9
Northwest Territories	17,398	1.3	-	-	747	0.1	18,145	0.7
New Brunswick	-	-	11,117	2.1	7,687	1.2	18,804	0.7
Yukon Territory	12,636	0.9	-	-	114	-	12,750	0.5
Prince Edward Island	-	-	606	0.1	-	-	606	-
Canada	1,387,159	100.0	541,813	100.0	653,328	100.0	2,582,300	100.0

TABLE 7

VALUE OF MINERAL PRODUCTION IN CANADA, BY PROVINCES, 1951-61
($ millions)

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Ontario	445	445	466	497	584	651	749	790	971	983	944
Quebec	255	270	252	279	357	423	406	366	441	446	455
Alberta	168	197	249	279	326	411	410	346	376	396	473
Saskatchewan	51	49	48	68	85	123	173	210	210	212	216
British Columbia	176	170	158	159	189	203	179	151	159	186	188
Newfoundland	32	33	34	43	68	84	83	65	72	87	92
Nova Scotia	60	65	67	73	67	66	68	63	63	66	62
Manitoba	30	25	25	35	62	68	64	57	55	59	101
Northwest Territories	8	9	10	26	26	22	21	25	26	27	18
New Brunswick	10	11	12	12	16	18	23	16	18	17	19
Yukon Territory	10	11	15	17	15	16	14	12	13	13	13
Prince Edward Island	-	-	-	-	-	-	-	-	5	1	1
Canada	1,245	1,285	1,336	1,488	1,795	2,085	2,190	2,101	2,409	2,493	2,582

TABLE 8

PERCENTAGE CONTRIBUTION OF PROVINCES

TO TOTAL VALUE OF MINERAL PRODUCTION IN CANADA, 1951-61

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Ontario	35.7	34.6	34.9	33.4	32.5	31.2	34.2	37.5	40.3	39.4	36.6
Quebec	20.6	21.0	18.9	18.8	19.9	20.2	18.5	17.4	18.3	17.9	17.6
Alberta	13.5	15.3	18.6	18.8	18.2	19.7	18.7	16.5	15.6	15.9	18.3
Saskatchewan	4.1	3.8	3.6	4.6	4.7	5.9	7.9	10.0	8.7	8.5	8.4
British Columbia	14.1	13.2	11.8	10.7	10.5	9.7	8.2	7.2	6.6	7.5	7.3
Newfoundland	2.6	2.6	2.5	2.9	3.8	4.0	3.8	3.1	3.0	3.5	3.6
Nova Scotia	4.8	5.1	5.0	4.8	3.7	3.2	3.1	3.0	2.6	2.6	2.4
Manitoba	2.4	1.9	1.9	2.4	3.5	3.3	2.9	2.7	2.3	2.4	3.9
Northwest Territories	0.6	0.7	0.8	1.7	1.5	1.1	1.0	1.2	1.1	1.1	0.7
New Brunswick	0.8	0.9	0.9	0.8	0.9	0.9	1.1	0.8	0.8	0.7	0.7
Yukon Territory	0.8	0.9	1.1	1.1	0.8	0.8	0.6	0.6	0.5	0.5	0.5
Prince Edward Island	-	-	-	-	-	-	-	-	0.2	-	-
Canada	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 9

PRODUCTION OF LEADING MINERALS IN CANADA, BY PROVINCES, 1961

		Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Petroleum	bbl	-	-	-	12,024	-	1,149,087	4,480,348	55,860,104	157,811,712	1,017,826	516,979	-	220,848,080
	$	-	-	-	16,833	-	3,546,740	10,156,000	115,719,791	355,530,845	1,859,873	730,160		487,560,242
Nickel	s.t.	-	-	-	-	-	196,218	32,978	-	-	2,090	1,705	-	232,991
	$	-	-	-	-	-	295,423,149	50,039,745	-	-	3,194,037	2,604,789	-	351,261,720
Copper	s.t.	15,752	-	-	-	149,007	211,647	12,454	33,479	-	15,845	463	441	439,088
	$	9,195,817	-	-	-	86,990,202	122,421,860	7,271,252	19,545,019	-	9,205,938	270,440	257,098	255,157,626
Uranium (U_3O_8)	lb	-	-	-	-	-	14,970,594	-	4,310,871	-	-	-	-	19,281,465
	$	-	-	-	-	-	151,060,610	-	44,631,014	-	-	-	-	195,691,624
Iron ore	s.t.	7,611,340	-	-	-	5,639,931	5,772,664	-	-	-	1,335,068	-	-	20,359,003
	$	59,889,125	-	-	-	53,627,608	62,350,773	-	-	-	12,082,541	-	-	187,950,047
Gold	oz	114,429	-	-	-	1,054,029	2,637,720	57,747	70,784	171	164,467	407,474	66,878	4,473,699
	$	511,652	-	-	-	37,375,868	93,533,551	2,047,709	2,510,000	6,064	5,832,000	14,449,028	2,371,494	158,637,366
Asbestos	s.t.	-	-	-	-	1,103,545	25,047	-	-	-	45,103	-	-	1,173,695
	$	-	-	-	-	115,944,729	4,362,668	-	-	-	8,648,503	-	-	128,955,900
Sand and gravel	s.t.	3,383,724	544,497	5,574,377	5,014,234	44,126,199	70,208,199	7,402,385	7,626,197	12,591,944	14,279,191	-	-	170,750,947
	$	2,777,393	381,644	6,513,612	2,776,139	21,793,232	40,344,071	5,817,415	4,235,777	10,927,057	9,087,792	-	-	104,654,132
Zinc	s.t.	34,638	-	-	-	54,005	51,937	46,509	28,360	-	194,486	-	6,069	416,004
	$	8,722,020	-	-	-	13,598,467	13,077,755	11,710,925	7,141,004	-	48,971,608	-	1,528,100	104,749,879
Cement	s.t.	86,549	-	-	170,953	2,029,159	2,226,923	395,134	201,950	677,914	417,366	-	-	6,205,948
	$	1,789,980	-	-	2,754,052	31,412,617	35,671,569	7,768,334	4,985,021	12,420,025	7,122,046	-	-	103,923,644
Coal	s.t.	-	-	4,300,758	887,903	-	-	-	2,208,851	2,027,826	964,663	-	7,703	10,397,704
	$	-	-	41,716,107	7,526,647	-	-	-	3,769,357	10,472,978	6,453,373	-	114,221	70,052,683
Natural gas	Mcf	-	-	-	96,318	-	14,544,165	-	37,192,595	500,843,900	103,018,988	41,678	-	655,737,644
	$	-	-	-	143,215	-	5,614,048	-	4,050,274	48,882,365	9,714,690	17,326	-	68,421,918
Stone	s.t.	322,820	225,000	1,021,880	2,957,886	22,648,010	18,361,843	594,921	-	96,753	2,709,691	-	-	48,938,804
	$	633,963	225,000	1,657,690	3,155,844	32,525,279	23,493,092	1,005,707	-	337,150	3,533,943	-	-	66,567,668
Lead	s.t.	21,969	-	-	-	3,392	835	3,054	-	-	192,800	-	8,385	230,435
	$	4,485,938	-	-	-	692,694	170,562	623,558	-	-	39,369,815	-	1,712,198	47,054,765
Clay products	$	75,890	-	1,582,153	744,293	8,195,790	19,036,556	623,966	1,115,474	3,517,473	2,091,353	-	-	36,982,948
Silver	oz	1,145,105	-	-	-	4,315,844	8,870,402	767,543	876,450	17	8,391,640	77,890	6,937,086	31,381,977
	$	1,079,376	-	-	-	4,068,115	8,361,240	723,486	826,142	16	7,909,960	73,419	6,538,897	29,580,651
Platinum metals	oz	-	-	-	-	-	418,278	-	-	-	-	-	-	418,278
	$	-	-	-	-	-	24,534,349	-	-	-	-	-	-	24,534,349
Salt	s.t.	-	-	225,875	-	-	2,861,705	23,103	51,964	83,880	-	-	-	3,246,527
	$	-	-	2,659,119	-	-	13,586,373	629,129	1,322,311	1,355,074	-	-	-	19,552,006
Lime	s.t.	-	-	-	13,820	407,427	865,130	48,791	-	47,506	32,616	-	-	1,415,290
	$	-	-	-	308,027	5,086,976	11,548,132	833,238	-	838,365	602,633	-	-	19,217,371
Titanium dioxide	s.t.	-	-	-	-	...	-	-	-	-	-	-	-	...
	$	-	-	-	-	16,723,743	-	-	-	-	-	-	-	16,723,743
Total, leading mineral	$	89,161,154	606,644	54,128,681	17,425,000	428,035,320	928,137,098	99,250,464	209,851,184	444,287,412	175,680,105	18,145,162	12,522,008	2,477,230,282
Grand total	$	91,618,709	606,644	61,693,156	18,804,385	455,522,933	943,669,456	101,489,787	215,977,233	473,480,540	188,542,078	18,145,162	12,750,304	2,582,300,387
% of grand total		97.3	100.0	87.7	92.7	94.0	98.4	97.8	97.2	93.8	93.2	100.0	98.2	95.9

TABLE 10
NET VALUES OF PRODUCTION IN CANADA
BY COMMODITY-PRODUCING INDUSTRIES
1955-59
($ millions)

	1956	1957	1958	1959	1960
Primary Industries					
Agriculture	2,143	1,676	1,925	1,850	2,001
Forestry	761	663	515	597	688
Fisheries	106	94	117	106	101
Trapping	12	11	11	10	12
Mining	1,124	1,308	1,311	1,497	1,470
Electric power	587	632	683	748	796
Total	4,833	4,384	4,562	4,808	5,068
Secondary industries					
Manufacturing	9,605	9,822	9,792	10,321	10,517
Construction	3,344	3,714	3,720	3,710	3,635
Total	12,949	13,536	13,512	14,031	14,152
Grand Total	17,782	17,920	18,074	18,839	19,220

TABLE 11

WORLD ROLE OF CANADA AS PRODUCER OF CERTAIN IMPORTANT MINERALS - 1961

Metal or Nonmetal		World Production	Rank of the Six Leading Countries 1	2	3	4	5	6
Nickel			Canada	U.S.S.R.	New Caledonia	U.S.A.	Cuba	Republic of S. Africa
	s.t.	394,400	232,991	83,000	53,823	11,176	8,000	2,900
	% of world total		59	21	13	3	2	1
Asbestos			Canada	U.S.S.R.	Union of S. Africa	S. Rhodesia	China	Italy
	s.t.	2,773,000	1,173,695	880,000	194,834	161,610	88,000	56,654
	% of world total		42	32	7	6	3	2
Platinum and platinum metals			Canada	Union of S. Africa	U.S.S.R.	U.S.A.	Colombia	Japan
	troy oz	1,203,000	418,278	357,000	350,000	43,248	28,227	3,701
	% of world total		34	30	29	4	2	0.3
Uranium (Free World)			U.S.A.	Canada	Union of S. Africa	France	Australia	Spain
	s.t.	35,670	17,399	9,641	5,468	1,637	1,400	60
	% of world total		49	27	15	5	4	0.2
Cadmium			U.S.A.	Canada	Japan	U.S.S.R.	W. Germany	Italy
	'000 lb	19,100	9,943	1,358	1,350	1,100	946	765
	% of world total		52	7	7	6	5	4
Titanium concentrates (ilmenite)			U.S.A.	Canada	Norway	Australia	India	Malaya
	s.t.	2,313,300	782,412	463,362	342,820	193,312	191,800	119,812
	% of world total		34	20	15	8	8	5
Aluminum			U.S.A.	U.S.S.R.	Canada	France	W. Germany	Norway
	s.t.	4,943,509	1,904,038	800,000	663,173	307,762	190,211	189,511
	% of world total		39	16	13	6	4	5
Gypsum			U.S.A.	U.S.S.R.	Canada	France	U.K.	Spain
	'000 s.t.	42,960	9,500	5,000	4,940	4,245	4,102	2,360
			22	12	11	10	10	5
Zinc			U.S.A.	U.S.S.R.	Canada	Mexico	Australia	Peru
	s.t.	3,371,701	466,576	445,000	416,004	296,489	271,139	194,306
	% of world total		14	13	12	9	8	6

			Republic of S. Africa	U.S.S.R.	Canada	U.S.A.	Australia	Ghana
Gold	troy oz	47,732,000	22,941,561	12,000,000	4,473,699	1,566,800	1,070,000	970,135
	% of world total		48	25	9	3	2	2
			Congo	N. Rhodesia	Canada	Fr. Morocco	Australia	
Cobalt	s.t.	16,100	9,259	1,701	1,591	1,422	21	
	% of world total		58	11	10	9	–	
			Peru	Mexico	Canada	Bolivia	S. Korea	Japan
Bismuth	s.t.	2,750	522	300	239	233	162	144
	% of world total		19	11	9	8	6	5
			Mexico	U.S.A.	Peru	Canada	U.S.S.R.	Australia
Silver	troy oz	232,014,000	40,342,397	34,900,000	33,581,997	31,381,977	25,000,000	13,000,000
	% of world total		17	15	14	14	11	6
			U.S.A.	U.S.S.R.	Norway	Canada	Italy	U.K.
Magnesium	s.t.	115,300	40,745	34,000	16,038	7,635	6,192	4,200
	% of world total		35	29	14	7	5	4
			U.S.A.	W. Germany	Mexico	Canada	Italy	U.S.S.R.
Barite	s.t.	3,013,000	731,381	535,000	277,046	191,404	140,308	140,000
	% of world total		24	18	9	6	5	5
			U.S.S.R.	Australia	U.S.A.	Canada	Mexico	Peru
Lead	s.t.	2,555,356	390,000	282,811	260,348	230,435	199,876	147,628
	% of world total		15	11	10	9	8	6
			U.S.A.	N. Rhodesia	Chile	U.S.S.R.	Canada	State of Katanga
Copper	s.t.	4,672,026	1,159,556	633,534	603,629	550,000	439,088	324,422
	% of world total		25	14	13	12	9	7
			U.S.A.	U.S.S.R.	Chile	China	Japan	Canada
Molybdenum	s.t.	43,950	33,282	5,950	1,850	1,650	414	386
	% of world total		76	14	4	4	1	1

TABLE 12

VALUE OF EXPORTS OF MINERALS AND THEIR PRODUCTS FROM CANADA, BY MAIN GROUPS AND DEGREE OF MANUFACTURE, 1960 AND 1961

($ millions)

	1961	1960	Increase or Decrease $ Millions	Increase or Decrease %
Iron and its products				
Raw material	142.6	155.5	-12.9	- 8.3
Semiprocessed	84.1	73.2	+10.9	+14.9
Fully manufactured	368.5	376.5	- 8.0	- 2.1
Total	595.2	605.2	-10.0	- 1.7
Nonferrous metals and their products				
Raw material	405.0	428.0	-23.0	- 5.4
Semiprocessed	724.7	715.3	+ 9.4	+ 1.3
Fully manufactured	79.8	79.2	+ 0.6	+ 7.6
Total	1,209.5	1,222.5	-13.0	- 1.1
Nonmetallic minerals and their products (including fuels)				
Raw material	272.1	190.4	+81.7	+42.9
Semiprocessed	126.7	117.6	+ 9.1	+ 7.7
Fully manufactured	31.7	31.5	+ 0.2	- 0.6
Total	430.5	339.5	+91.0	+26.8
All minerals and their products				
Raw material	819.7	773.9	+45.8	+ 5.9
Semiprocessed	935.5	906.1	+29.4	+ 3.2
Fully manufactured	480.0	487.2	- 7.2	- 1.5
Total	2,235.2	2,167.2	+68.0	+ 3.1

TABLE 13

VALUE OF IMPORTS OF MINERALS AND THEIR PRODUCTS INTO CANADA, BY MAIN GROUPS AND DEGREE OF MANUFACTURE, 1960 AND 1961

($ millions)

	1961	1960	Increase or Decrease $ Millions	Increase or Decrease %
Iron and its products				
Raw material	47.4	48.4	- 1.0	- 2.1
Semiprocessed	21.5	32.0	-10.5	-32.8
Fully manufactured	1,956.5	1,965.9	- 9.4	- 0.5
Total	2,025.4	2,046.3	-20.9	- 1.0
Nonferrous metals and their products				
Raw material	69.3	55.4	+13.9	+25.1
Semiprocessed	47.3	34.9	+12.4	+35.5
Fully manufactured	392.8	380.8	+12.0	+ 3.1
Total	509.4	471.1	+38.3	+ 8.1
Nonmetallic minerals and their products (including fuels)				
Raw material	399.6	396.1	+ 3.5	+ 0.9
Semiprocessed	17.7	16.0	+ 1.7	+10.6
Fully manufactured	267.2	260.1	+ 7.1	+ 2.7
Total	684.5	672.2	+12.3	+ 1.8
All minerals and their products				
Raw material	516.3	499.9	+16.4	+ 3.3
Semiprocessed	86.5	82.9	+ 3.6	+ 4.3
Fully manufactured	2,616.5	2,606.8	+ 9.7	+ 0.4
Total	3,219.3	3,189.6	+29.7	+ 0.9

TABLE 14

VALUE OF EXPORTS OF MINERALS AND THEIR PRODUCTS FROM CANADA, BY DEGREE OF MANUFACTURE AND IN RELATION TO TOTAL EXPORT TRADE, 1960 AND 1961

	1961		1960	
	$ Millions	% of Total	$ Millions	% of Total
Raw material	819.7	14.2	773.9	14.7
Semiprocessed	935.5	16.3	906.1	17.2
Fully manufactured	480.0	8.3	487.2	9.3
Total, minerals and products	2,235.2	38.8	2,167.2	41.2
Total, all products	5,755.5	100.0	5,266.4	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, 1960 AND 1961

	1961		1960	
	$ Millions	% of Total	$ Millions	% of Total
Raw material	516.3	9.0	499.9	9.1
Semiprocessed	86.5	1.5	82.9	1.5
Fully manufactured	2,616.5	45.3	2,606.8	47.5
Total, minerals and products	3,219.3	55.8	3,189.6	58.1
Total, all products	5,771.0	100.0	5,492.3	100.0

TABLE 16

VALUE OF EXPORTS OF MINERALS AND THEIR PRODUCTS FROM CANADA, BY MAIN GROUPS AND DESTINATIONS, 1961

($millions)

	Britain	United States	Other Countries	Total
Iron and its products	50.4	322.9	221.9	595.2
Nonferrous metals and their products	321.5	551.0	337.0	1,209.5
Nonmetallic minerals and their products	14.2	322.5	93.8	430.5
Total, minerals and their products	386.1	1,196.4	652.7	2,235.2
Percentage	17.3	53.5	29.2	100.0

TABLE 17

VALUE OF IMPORTS OF MINERALS AND THEIR PRODUCTS INTO CANADA, BY MAIN GROUPS AND SOURCES, 1961

($ millions)

	Britain	United States	Other Countries	Total
Iron and its products	257.7	1,592.7	175.0	2,025.4
Nonferrous metals and their products	66.9	324.9	117.6	509.4
Nonmetallic minerals and their products	32.1	266.4	386.0	684.5
Total, minerals and their products	356.7	2,184.0	678.6	3,219.3
Percentage	11.1	67.8	21.1	100.0

TABLE 18
VALUE OF EXPORTS OF RAW AND SEMIPROCESSED MINERALS
FROM CANADA, BY COMMODITY AND DESTINATION, 1961
($'000)

Minerals	U.S.A.	Britain	Other E.F.T.A.[1] Countries	E.E.C.[2] Countries	Japan	Other Countries	Total
Iron ore	96,710	20,227	-	15,468	10,152	9	142,566
Primary ferrous metals	39,267	7,820	265	13,468	18,837	4,479	84,136
Aluminum	64,029	72,586	4,668	30,712	14,838	59,217	246,050
Copper	48,177	69,494	20,726	28,339	12,200	14,763	193,699[3]
Lead	14,598	5,838	50	5,072	1,033	1,003	27,594
Nickel	155,443	103,768	49,932	16,339	2,267	15,278	343,027
Zinc	26,463	17,550	614	6,491	2,508	5,117	58,743
Uranium	173,914	18,256	-	512	40	-	192,722
Asbestos	50,562	9,450	4,736	31,424	11,321	23,848	131,341
Fuels	198,632	1	-	-	6,212	90	204,935
All other minerals[4]	79,089	36,698	1,288	10,925	2,761	2,473	133,234
Total	946,884	361,688	82,279	158,750	82,169	126,277	1,758,047

[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.
[4]Includes salt, which is under 'fully manufactured' in Tables 12, 13, 14 and 15.

TABLE 19

VALUE OF EXPORTS OF RAW AND SEMIPROCESSED MINERALS FROM CANADA, BY COMMODITY AND DESTINATION, 1960

($'000)

Minerals	U.S.A.	Britain	Other E.F.T.A.[1] Countries	E.E.C.[2] Countries	Japan	Other Countries	Total
Iron	101,903	27,722	-	16,423	9,424	-	155,472
Primary ferrous metals	29,107	21,602	1,143	13,539	5,345	2,451	73,187
Aluminum	53,742	79,676	6,895	53,287	8,481	66,073	268,154
Copper	75,400	68,697	12,611	27,759	11,684	10,533	206,684[3]
Lead	11,188	8,521	4	4,160	1,761	409	26,043
Nickel	88,597	67,896	-53,542	32,683	-	15,613	258,331
Zinc	31,837	20,456	997	3,134	2,242	4,869	63,535
Uranium	236,594	25,905	29	295	147	571	263,541
Asbestos	53,903	9,386	3,581	25,498	8,499	19,247	120,114
Fuels	114,743	-	-	-	4,464	83	119,290
All other minerals[4]	82,971	28,437	1,634	8,317	5,353	2,353	129,065
Total	879,985	358,298	80,436	185,095	57,400	122,202	1,683,416

[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.

[4]Includes salt, which is under 'fully manufactured' in Tables 12, 13, 14 and 15.

TABLE 20
VALUE OF EXPORTS OF RAW AND SEMIPROCESSED MINERALS FROM CANADA IN RELATION TO TOTAL EXPORT TRADE, 1951-61

($ millions)

	Raw	Semi-processed	Total Minerals	Exports, All Products	Mineral Exports as % of Export Trade
1951	177	532	709	3,914	18
1952	205	609	814	4,301	19
1953	235	613	848	4,117	21
1954	241	630	871	3,881	22
1955	352	772	1,124	4,282	26
1956	530	857	1,387	4,790	29
1957	655	854	1,509	4,839	31
1958	676	685	1,361	4,826	28
1959	778	753	1,531	5,061	30
1960	774	906	1,680	5,266	32
1961	820	935	1,755	5,756	30

TABLE 21
VALUE OF IMPORTS OF RAW AND SEMIPROCESSED MINERALS INTO CANADA IN RELATION TO TOTAL IMPORT TRADE 1951-61

($ millions)

	Raw	Semi-processed	Total Minerals	Imports, All Products	Mineral Imports as % of Import Trade
1951	492	78	570	4,085	14
1952	459	82	541	4,030	13
1953	435	63	498	4,383	11
1954	390	53	443	4,093	11
1955	432	73	505	4,712	11
1956	521	115	636	5,705	11
1957	561	90	651	5,623	12
1958	468	62	530	5,192	10
1959	470	82	552	5,654	10
1960	500	83	583	5,492	11
1961	516	86	602	5,771	10

TABLE 22

REPORTED[1] CONSUMPTION OF MINERALS IN CANADA
AND RELATIONSHIP TO PRODUCTION, 1960

Mineral	Unit	Consumption	Production[2]	Consumption as % of Production
Metals				
Aluminum	s.t.	120,831	762,012	15.9
Antimony	lb	951,716	1,651,786	57.6
Bismuth	lb	44,709	423,827	10.5
Cadmium	lb	190,416	2,357,497	8.1
Chromium (chromite)	s.t.	54,331	-	
Cobalt	lb	252,050	3,568,811	7.1
Copper	s.t.	121,505	439,262	27.7
Iron ore[3]	l.t.	6,624,000	19,241,813	34.4
Lead	s.t.	40,235[4]	205,650	19.6
Magnesium	s.t.	2,199	7,289	30.2
Manganese ore	s.t.	73,019	-	
Mercury	lb	139,627	-	
Molybdenum (Mo content)	lb	1,042,077	767,621	135.8
Nickel	s.t.	4,861	214,506	2.3
Selenium	lb	14,461	521,638	2.8
Silver	oz	11,742,064	34,016,829	34.5
Tellurium	lb	4,238	44,682	9.5
Tin	l.t.	3,880	278	1,395.7
Tungsten (W content)	lb	947,222	-	
Zinc	s.t.	55,803[4]	406,873	13.7
Nonmetals				
Feldspar	s.t.	7,175	13,862	51.8
Fluorspar	s.t.	111,835	...	...
Mica	lb	3,448,000	1,702,605	202.5
Quartz (silica)	s.t.	2,709,669	2,260,766	119.9
Talc, etc.	s.t.	30,456[5]	41,636[6]	73.1
Sodium sulphate	s.t.	183,062	214,208	85.4
Sulphur, elemental	s.t.	463,465	274,359	168.9
Fuels				
Coal	s.t.	23,249,907	11,011,138	211.1
Natural gas	Mcf	325,609,411	522,972,327	62 3
Petroleum, crude	bbl	276,083,953	189,534,221	145.7

[1]Reported by companies to the Dominion Bureau of Statistics.
[2]'Production', so far as it applies to metals, in most instances refers to production in all forms. This includes the recoverable metal content of ore, concentrates, matte, etc. exported and the metal content of primary products that are recoverable at domestic smelters and refineries. Production of nonmetal means producers' shipments.
[3]Includes by-product sinter, pellets, etc.
[4]Consumption of primary refined metal only.
[5]Ground talc.
[6]Includes soapstone and pyrophyllite.

TABLE 23

APPARENT CONSUMPTION OF MINERALS IN CANADA
AND ITS RELATIONSHIP TO PRODUCTION, 1960

(short tons)

	Apparent Consumption[1]	Production[2]	Consumption as % of Production
Asbestos	49,963	1,118,456	4.5
Barite	21,341	154,292	13.8
Gypsum	992,074	5,205,731	19.1
Nepheline syenite	47,338	240,636	19.7
Salt	2,500,000[e]	3,314,920	75.4
Cement	5,628,586	5,787,225	97.3
Lime	1,541,720	1,529,568	100.8

[1]Production plus imports less exports.
[2]Producers' shipments.
[e]Estimated.

TABLE 24

DOMESTIC CONSUMPTION OF PRINCIPAL REFINED BASE METALS(1) IN RELATION TO THEIR PRODUCTION(2) IN CANADA, 1951-61

	Unit	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Copper												
Domestic consumption[3]	s.t.	134,174	130,347	105,482	102,432	138,559	145,286	118,225	122,893	129,973	121,505	142,922
Production	s.t.	245,466	196,320	236,966	253,365	288,997	328,458	323,540	329,239	365,366	417,029	406,438
% consumption of production		54.7	66.4	44.5	40.4	47.9	44.2	36.5	37.3	35.6	29.1	35.2
Nickel												
Domestic consumption	s.t.	2,744	2,223	2,275	2,595	5,020	5,545	4,532	4,099	4,003r	4,789r	4,852r
Production	s.t.	78,132	76,825	82,684	92,702	108,712	109,453	123,718	75,707	111,711	122,443	135,484
% consumption of production		3.5	2.9	2.8	2.8	4.6	5.1	3.7	5.4	3.6	3.9	3.6
Zinc												
Domestic consumption[4]	s.t.	61,023	51,581	50,717	46,735	58,062	61,173	52,713	56,097	64,788	55,803	60,878
Production	s.t.	218,578	222,200	250,961	213,775	256,542	255,564	247,316	252,093	255,306	260,968	268,006
% consumption of production		27.9	23.2	20.2	21.9	22.6	23.9	21.3	22.3	25.4	21.4	22.7
Lead												
Domestic consumption	s.t.	60,348	62,466	67,718	67,947	76,351	75,882	71,583	69,769	65,935	72,087	73,418
Production	s.t.	162,000	182,943	165,752	166,005	148,811	147,865	142,935	132,987	135,296	158,510	171,832
% consumption of production		37.3	34.1	40.9	40.9	51.3	51.3	50.1	52.5	48.7	45.5	42.7
Aluminum												
Domestic consumption[5]	s.t.	86,241	90,287	88,548	80,355	91,522	91,869	77,984	101,886	89,000	120,831	134,840
Production	s.t.	447,095	499,758	548,445	557,897	612,543	620,321	556,715	634,102	593,630	762,012	663,173
% consumption of production		19.3	18.1	16.1	14.4	14.9	14.8	14.0	16.1	15.0	15.9	20.3

[1]Both primary and secondary refined metal.
[2]Refined metal from all sources including metal derived from secondary materials at primary refineries.
[3]Producers' domestic shipments to 1959. From 1960, consumption reported by consumers.
[4]Virgin slat zinc only. Complete data on secondary-zinc consumption are not available for the years prior to 1963.
[5]Producers' domestic shipments of aluminum ingot to 1959. From 1960, consumers' reported consumption.
rRevised from previously published figure.

TABLE 25

ANNUAL AVERAGE PRICES OF MAIN MINERALS*, 1960 and 1961

	1961	1960	Increase or Decrease Cents or Dollars	Percentage
Aluminum ingot, cents per lb	25.458	27.225	- 1.767	- 6.5
Antimony, N.Y., boxed, cents per lb	35.335	32.590	+ 2.745	+ 8.4
Bismuth, dollars per lb	2.25	2.25	-	-
Cadmium, cents per lb	157.500	152.494	+ 5.006	+ 3.3
Calcium, dollars per lb	2.05	2.05	-	-
Chromium metal, dollars per lb	1.17	1.17	-	-
Cobalt metal, dollars per lb	1.50	1.56	- 0.06	- 3.8
Cobalt ore 10% Co, free market, f.o.b. shipping point, cents per lb Co contained	60.00	60.00	-	-
Copper, U.S. domestic, cents per lb	29.921	32.053	- 2.132	- 6.7
Gold, Canadian dollars per troy oz	35.46	33.95	+ 1.51	+ 4.4
Iron ore 51.5% Fe, dollars per l.t. Lower Lakes ports				
Messabi, non-Bessemer	11.45	11.45	-	-
Mesabi, Bessemer	11.60	11.60	-	-
Old Range, non-Bessemer	11.70	11.70	-	-
Old Range, Bessemer	11.85	11.85	-	-
Lead, Common, N.Y., cents per lb	10.871	11.948	- 1.077	- 9.0
Magnesium ingot, cents per lb	35.250	35.250	-	-
Mercury, dollars per flask (76 lb)	197.605	210.760	-13.155	- 6.2
Molybdenum metal, dollars per lb	3.35	3.35	-	-
Molybdenite 95% MoS_2, dollars per lb Mo contained	1.34	1.25	+ 0.09	+ 7.2
Nickel, f.o.b. Port Colborne (duty included) cents per lb	77.653	74.000	+ 3.653	+ 4.9
Platinum, dollars per troy oz	82.000	81.729	+ 0.271	+ 0.3
Selenium, dollars per lb	6.500	7.000	- 0.500	- 7.1
Silver, N.Y., cents per troy oz	92.449	91.375	+ 1.074	+ 1.2
Sulphur, dollars per l.t.	21.65	23.00	- 1.35	- 5.9
Tin, Straits, N.Y., cents per lb	113.311	101.438	+11.873	+11.7
Titanium metal, dollars per lb	1.50	1.52	- 0.02	- 1.3
Titanium ore (ilmenite) 59.5% TiO_2, f.o.b., Atlantic ports, dollars per l.t.	23 to 26	23 to 26	-	-
Tungsten metal, dollars per lb	2.93	2.85	+ 0.08	+ 2.8
Zinc, Prime Western, East St. Louis, cents per lb.	11.542	12.946	- 1.404	-10.8

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

TABLE 26

WHOLESALE PRICE INDEXES OF MINERALS AND MINERAL PRODUCTS AND THE GENERAL WHOLESALE PRICE INDEX OF ALL COMMODITIES, CANADA, 1951 and 1959-61

(1935-39 = 100)

	1951	1959	1960	1961
Iron and its products	208.7	255.7	256.2	258.1
Pig iron	245.2	295.3	295.3	295.3
Rolling-mill products	192.3	249.2	251.8	251.7
Pipe and tubing	236.4	265.0	268.3	269.9
Wire	227.4	293.7	294.2	294.2
Scrap iron and steel	304.2	307.4	288.5	313.4
Tinplate and galvanized sheet	205.7	240.7	238.4	238.3
Nonferrous metals and their products				
Total (including gold)	180.6	174.6	177.8	181.6
Total (excluding gold)	..	238.0	242.9	246.5
Antimony	401.3	163.9	167.5	191.6
Copper and its products	261.6	285.0	291.4	282.9
Lead and its products	381.5	222.6	224.0	213.5
Silver	243.0	225.8	228.9	241.6
Tin	270.9	196.0	196.8	229.4
Zinc and its products	429.6	266.0	291.1	272.9
Solder	293.8	199.3	200.6	218.6
Nonmetallic minerals and their products	169.8	186.5	185.6	185.2
Clays and clay products	190.1	253.2	255.8	245.6
Pottery	146.8	185.8	185.8	196.0
Coal	172.4	193.0	191.9	192.3
Coal tar	207.1	242.8	214.5	235.7
Coke	222.2	241.3	241.6	241.9
Window glass	194.0	272.1	272.7	272.7
Plate glass	162.5	218.4	218.8	218.8
Petroleum products	164.6	164.2	162.2	160.8
Crude oil	..	190.1	187.1	184.4
Gasoline	140.2	138.0	135.8	134.6
Coal oil	125.0	134.4	134.4	134.4
Asphalt	178.8	203.7	199.5	194.5
Asphalt shingles	..	127.2	116.3	116.6
Sulphur	179.9	199.6	201.8	211.6
Plaster	124.7	137.5	138.1	141.2
Lime	182.0	211.2	212.0	212.1
Cement	141.7	160.6	162.6	163.8
Sand and gravel	137.6	145.4	145.2	144.5
Crushed stone	150.6	171.4	171.4	171.2
Building stone	185.9	208.8	208.8	185.4
Asbestos and products	234.0	304.3	302.2	302.2
General wholesale price index (products of all industries)	240.2	230.6	230.9	233.3

TABLE 27
GENERAL WHOLESALE PRICE INDEX AND INDEXES OF COMPONENT PRODUCTS FOR SELECTED YEARS, CANADA, 1940-61

(1935-39 = 100)

	1940	1947	1951	1953	1955	1957	1959	1961
General wholesale price index	108.0	163.3	240.2	220.7	218.9	227.4	230.6	233.3
Mineral products								
Iron products	108.7	140.7	208.7	221.4	221.4	252.7	255.7	258.1
Nonferrous-metal products	106.9	130.2	180.6	168.6	187.6	176.0	174.6	181.6
Nonmetallic-mineral products	106.7	129.1	169.8	176.9	175.2	189.3	186.5	185.2
Other products								
Vegetable	98.1	157.3	218.6	199.0	195.1	197.0	199.5	203.1
Animal	106.1	183.0	297.7	241.7	226.0	238.4	254.3	254.7
Textile	118.1	179.5	295.9	239.0	226.2	236.0	228.0	234.5
Wood products	119.0	208.8	295.5	288.6	295.7	299.4	304.0	305.1
Chemical	108.5	136.7	187.3	175.7	177.0	182.3	187.0	188.7

TABLE 28

PRINCIPAL STATISTICS[1] OF CANADA'S MINERAL INDUSTRY BY SECTORS, 1960

	Establishments	Employees	Salaries and Wages ($'000)	Cost of Fuel and Electricity ($'000)	Cost of Process Supplies ($'000)	Value of Production Gross ($'000)	Value of Production Net[2] ($'000)
Metals							
Placer gold	32	213	1,225	77	344	2,758	2,285
Gold quartz	146	16,542	66,553	7,216	22,686	135,349	103,749
Copper-gold-silver	277	10,549	48,951	6,547	17,989	172,254	103,755
Silver-cobalt	7	520	2,078	253	297	5,643	4,527
Silver-lead-zinc	47	4,215	21,304	2,246	8,518	111,987	61,377
Nickel-copper	39	12,709	67,504	6,335	18,747	127,212	99,162
Iron	62	7,754	45,985	7,916	20,813	175,083	106,722
Other	68	9,380	54,453	7,571	40,060	273,410	224,482
Total	678	61,882	308,053	38,161	129,454	1,003,696	706,059
Industrial minerals							
Asbestos	24	6,688	33,058	6,134	14,888	125,237	104,215
Feldspar, quartz, nepheline syenite	34	450	1,816	345	615	6,520	5,397
Gypsum	14	791	2,916	475	585	9,499	8,439
Salt	14	892	3,873	1,124	3,298	21,394	16,972
Sand and gravel	1,769	3,281	12,532	3,684	788	52,543	48,071
Stone	265	3,575	13,275	2,987	4,966	44,379	36,426
Clay products	113	3,778	14,168	5,679	1,284	38,034	31,944
Cement	20	3,306	16,463	15,965	11,294	96,770	69,616
Lime	25	950	3,944	2,875	1,010	11,874	8,015
Other[3]	119	2,385	7,883	2,179	2,936	19,372	13,949
Total	2,397	26,096	109,928	41,447	41,664	425,622	343,044
Fuels							
Coal	129	11,587	38,735	4,314	11,720	74,676	58,642
Petroleum and natural gas[4]	667	6,040	31,772	7,643	36,582	516,461	472,237
Total	796	17,627	70,507	11,957	48,302	591,137	530,879
Total, mining industry	3,871	105,605	488,488	91,565	219,420	2,020,455	1,579,982
Nonferrous smelting and refining	23	29,708	153,682	63,268	924,379	1,495,178	507,530

[1]Certain changes, effective in 1960, were made by the Dominion Bureau of Statistics in the industrial classification. The definition of establishment was altered to include only those establishments considered separate accounting units capable of reporting employment, salaries and wages, etc. on a unit basis. In certain sectors, particularly in petroleum and natural gas and in sand and gravel, this substantially reduced the number of establishments below the level of previous years. [2]Net value equals the gross value of production less the cost of process supplies, fuel and electricity, and transportation. [3]Includes talc and soapstone, mica, peat moss, iron oxides, etc. [4]Includes plants for the processing of natural gas.

TABLE 29

PRINCIPAL STATISTICS[1] OF MINING INDUSTRY[2] IN CANADA, 1950-60

	Establish-ments	Employees	Salaries and Wages	Cost of Fuel and Electricity	Cost of Process Supplies	Value of Production Gross	Value of Production Net[3]
			($'000)	($'000)	($'000)	($'000)	($'000)
1950	17,078	100,525	274,696	44,619	84,698	903,818	712,249
1951	18,140	106,057	321,687	49,360	99,959	1,049,806	832,116
1952	19,939	109,508	365,012	54,418	110,027	1,085,831	845,733
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	488,488	91,565	219,420	2,020,455	1,579,982

[1]Certain changes, effective in 1960, were made by the Dominion Bureau of Statistics in the industrial classification. The definition of establishment was altered 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 below the level of previous years.

[2]Does not include the nonferrous-smelting and -refining industries.

TABLE 30

CONSUMPTION OF FUELS AND ELECTRICITY IN CANADIAN MINERAL INDUSTRY, 1960

	Unit	Metal-mining	Nonferrous Smelting and Refining	Total	Production of Industrial Minerals	Production of Crude Mineral Fuels	Total, Mineral Industry
Coal and coke	s.t.	206,263	1,335,788	1,542,051	1,144,217	80,040	2,766,308
	$	2,685,909	19,003,873	21,689,782	11,850,056	576,455	34,116,293
Gasoline and kerosene	gal	3,406,879	837,999	4,244,878	10,624,825	6,555,254	21,424,957
	$	1,292,480	263,818	1,556,298	3,664,502	2,470,528	7,691,328
Fuel oil	gal	56,041,398	61,484,136	117,525,534	66,459,306	4,236,283	188,221,123
	$	10,054,111	4,956,716	15,010,827	8,154,963	882,514	24,048,304
Liquefied petroleum gas	gal	392,737	55,181	447,918	210,933	1,104,609	1,763,460
	$	106,004	15,648	121,652	68,865	117,081	307,598
Manufactured gas	Mcf	4,900	2,490	7,390	51,296	-	58,686
	$	1,980	1,366	3,346	1,813	-	5,159
Natural gas	Mcf	205,584	9,180,884	9,386,468	17,269,589	10,826,885	37,482,942
	$	110,514	2,607,395	2,717,909	5,108,564	959,639	8,786,112
Other fuels	$	302,143	84,079	386,222	337,521	6,670	730,413
Total, fuels	$	14,553,141	26,932,895	41,486,036	29,186,284	5,012,887	75,685,207
Electricity purchased	million kwh	3,388	18,225	21,613	1,430	376	23,419
	$	23,608,256	36,335,163	59,943,419	12,260,736	6,943,676	79,147,831
Total value, fuels and electricity purchased	$	38,161,397	63,268,058	101,429,455	41,447,020	11,956,563	154,833,038
Electricity generated by industry for own use	million kwh	532	1,147	1,679	30	13	1,722

TABLE 31

COST OF FUEL AND ELECTRICITY IN CANADIAN MINING INDUSTRY[1], 1950-60

	Fuel[2]	Electricity Purchased		Total Cost of Fuel and Electricity	Electricity Generated for Own Use	Electricity Generated for Sale
	$ Millions	Millions kwh	$ Millions	$ Millions	Millions kwh	Millions kwh
1950	27.8	2,624.5	16.8	44.6	280.9	32.6
1951	30.3	2,990.3	19.0	49.3	228.9	26.7
1952	33.1	3,026.4	21.3	54.4	248.8	21.0
1953	35.2	3,091.7	23.3	58.5	240.3	9.7
1954	37.0	3,243.3	23.7	60.7	426.2	18.8
1955	39.9	3,540.2	26.5	66.4	486.9	47.1
1956	47.0	4,213.5	32.2	79.2	557.7	12.0
1957	53.1	4,585.9	35.8	88.9	590.0	14.2
1958	53.1	6,292.9	38.1	91.2	526.7	15.8
1959	53.1	5,163.7	39.5	92.6	550.9	17.0
1960	48.8	5,193.9	42.8	91.6	575.4	32.9

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

TABLE 31A

COST OF FUEL AND ELECTRICITY USED IN NONFERROUS SMELTING AND REFINING, 1950-60

	Fuel*	Electricity Purchased		Total Cost of Fuel and Electricity	Electricity Generated for Own Use	Electricity Generated for Sale
	$ Millions	Millions kwh	$ Millions	$ Millions	Millions kwh	Millions kwh
1950	19.0	9,044.6	19.5	38.5	700.0	9.1
1951	21.4	9,993.9	23.3	44.7	624.5	7.2
1952	23.9	11,176.8	26.7	50.6	639.5	7.3
1953	23.0	12,296.9	29.6	52.6	796.2	4.3
1954	24.8	12,690.2	30.4	55.2	753.9	13.4
1955	24.3	13,803.7	32.6	56.9	1,131.9	9.2
1956	29.9	13,981.4	35.0	64.9	1,121.4	12.2
1957	27.3	13,668.2	32.2	59.5	1,036.6	-
1958	23.4	15,081.2	40.1	63.5	1,038.5	33.2
1959	26.3	14,574.6	36.0	62.3	1,060.0	30.7
1960	26.9	18,224.7	36.3	63.2	1,146.5	33.0

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

TABLE 32

EMPLOYMENT, SALARIES AND WAGES IN CANADIAN MINERAL INDUSTRY, BY SECTORS, AT FIVE-YEAR INTERVALS, 1940-60[1]

	1940		1945		1950		1955		1960	
	Employees	$ Millions	Employees	$ Millions	Employees	$ Millions	Employees	$ Millions	Employees	$ Millions
Metal-mining	46,885	83.8	32,913	68.8	47,697	142.0	53,364	211.3	61,882	308.1
Nonferrous smelting and refining	13,466	21.8	16,771	33.9	19,863	58.7	28,606	118.2	29,708	153.7
Industrial minerals	18,171	19.3	17,407	26.3	24,375	58.2	28,208	96.8	26,096	109.9
Fuels[2]	30,364	39.6	29,159	56.3	28,453	74.5	23,458	76.3	17,627	70.5
Total	108,886	164.5	96,250	185.3	120,388	333.4	133,636	502.6	135,313	642.2
Annual average of salaries and wages		$1,511		$1,925		$2,769		$3,761		$4,746

[1]Certain changes, effective in 1960, were made by the Dominion Bureau of Statistics in the industrial classification. The definition of establishment was altered to include only those establishments considered separate accounting units capable of reporting employment, salaries and wages, etc. on a unit basis. In certain sectors, particularly in petroleum and natural gas and in sand and gravel, this substantially reduced the number of establishments below the level of previous years. These changes also affect Tables 33, 34 and 35.

[2]Coal, crude petroleum and natural gas.

TABLE 33

NUMBERS OF WAGE EARNERS - SURFACE, UNDERGROUND AND MILL IN CANADIAN MINING INDUSTRY[1] BY SECTORS, 1950-60

	Metals[2]				Industrial Minerals				Fuels				Total			
	Surface	Under-ground	Mill	Total	Surface	Under-ground	Mill	Total	Surface	Under-ground	Mill	Total	Surface	Under-ground	Mill	Total
1950	12,622	26,168	4,154	42,944	11,283	1,486	9,545	22,314	9,420	16,089	-	25,509	33,325	43,743	13,699	90,767
1951	13,862	27,869	4,365	46,096	11,484	1,680	9,925	23,089	9,985	15,482	-	25,467	35,331	45,031	14,290	94,652
1952	15,689	28,941	4,643	49,273	11,882	1,794	10,079	23,755	9,990	14,897	-	24,887	37,561	45,632	14,722	97,915
1953	13,959	27,580	4,320	45,859	11,574	1,718	10,658	23,950	9,838	13,587	-	23,425	35,371	42,885	14,978	93,234[3]
1954	14,098	26,821	4,761	45,680	11,826	1,659	10,825	24,310	9,082	12,422	-	21,504	35,006	40,902	15,586	91,494
1955	15,540	26,522	4,664	46,726	12,204	1,632	11,445	25,281	8,886	11,439	-	20,325	36,630	39,593	16,109	92,332
1956	16,706	27,679	5,624	50,009	12,804	1,798	12,163	26,765	9,622	11,065	-	20,687	39,132	40,542	17,787	97,461
1957	18,532	29,382	6,168	54,082	14,347	1,749	11,573	27,669	8,683	10,043	-	18,726	41,562	41,174	17,741	100,477
1958	16,602	29,712	6,541	52,855	14,029	1,458	11,216	26,703	7,887	9,247	-	17,134	38,518	40,417	17,757	96,692
1959	16,697	31,384	6,573	54,654	13,988	1,327	11,639	26,954	7,537	8,022	-	15,559	38,222	40,733	18,212	97,167
1960	16,039	30,774	6,162	52,975	10,321	1,164	10,741	22,226	6,715	8,257	-	14,972	33,075	40,195	16,903	90,173

[1]Does not include nonferrous smelting and refining.

[2]Includes placer operations.

See also footnote 1, Table 32.

TABLE 34

LABOR COSTS IN RELATION TO TONS MINED, METAL MINES[1] IN CANADA, 1940, 1950 and 1960

Types of Mines	Number of Wage Earners	Total of Wages	Average Annual Wage	Tonnage Mined	Average Annual Tonnage per Worker	Wage Cost per Ton Mined
(1960)		($ millions)	($)	('000 s. t.)	(s.t.)	($)
Auriferous-quartz	14,736	56.6	3,841	14,725	999	3.84
Copper-gold-silver	9,017	40.4	4,480	13,974	1,550	2.89
Nickel-copper	11,317	57.7	5,099	20,835	1,841	2.77
Silver-cobalt[2]	453	1.7	3,753	221	488	7.69
Silver-lead-zinc	3,528	17.1	4,847	5,832	1,653	2.93
Iron ore	6,084	35.0	5,753	32,957	5,417	1.07
Miscellaneous metal mines	7,641	44.7	5,850	13,037	1,706	3.43
Total	52,776	253.2	4,798	101,581	1,925	2.49
(1950)						
Auriferous-quartz	20,265	56.0	2,763	16,985	838	3.30
Copper-gold-silver	6,649	20.0	3,008	8,759	1,317	2.28
Nickel-copper	7,129	22.5	3,156	10,778	1,512	2.09
Silver-cobalt[2]	317	0.8	2,524	69	218	11.59
Silver-lead-zinc	5,234	14.9	2,847	4,827	922	3.09
Miscellaneous metal mines[3]	2,951	7.6	2,575	4,498	1,524	1.69
Total	42,545	121.8	2,863	45,916	1,079	2.65
(1940)						
Auriferous-quartz	28,747	48.4	1,684	18,986	660	2.55
Copper-gold-silver	5,623	9.5	1,689	8,931	1,588	1.06
Nickel-copper	6,071	11.4	1,878	8,362	1,377	1.36
Silver-cobalt[2]	105	0.1	952	43	410	2.33
Silver-lead-zinc	1,341	2.5	1,864	2,641	1,969	0.95
Miscellaneous metal mines[3]	374	0.5	1,337	306	818	1.63
Total	42,261	72.4	1,713	39,269	929	1.84

[1]Excludes placer-mining operations

[2]In silver-cobalt-mining operations considerable tonnages of old tailings were used. These tonnages are not included in this table.

[3]Includes iron-ore mines.

See also footnote 1, Table 32.

TABLE 35

MAN-HOURS WORKED AND TONNAGES MINED IN METAL MINES AND INDUSTRIAL-MINERAL OPERATIONS IN CANADA, 1953-60

	Metal Mines			Industrial-Mineral Operations		
	Tonnages of Ore Mined	Man-hours Worked	Man-hours Worked per Ton Mined	Tonnages of Ore Mined and Rock Quarried	Man-hours Worked	Man-hours Worked per Ton Mined
	(millions s.t.)	(millions)		(millions s.t.)	(millions)	
1953	54.4	113.5	2.09	47.2	61.7	1.31
1954	59.0	112.6	1.91	61.5	62.5	1.02
1955	69.2	117.4	1.70	63.5	66.8	1.05
1956	77.3	127.1	1.64	73.1	68.5	0.94
1957	84.3	136.4	1.62	82.1	70.1	0.85
1958	78.8	134.3	1.70	78.5	66.3	0.84
1959	99.1	134.0	1.35	90.7	66.7	0.74
1960	101.6	131.1	1.29	97.8	56.9	0.58

See also footnote 1, Table 32.

TABLE 36

INDUSTRIAL FATALITIES IN CANADA PER THOUSAND PAID WORKERS IN MAIN INDUSTRY GROUPS, 1951-61

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Agriculture	0.97	0.94	1.00	0.82	0.83	1.03	0.95	1.00	0.92	0.62	0.61
Logging (forestry)	2.10	2.40	2.70	2.50	2.00	1.90	1.50	1.70	1.70	1.50	1.31
Fishing and trapping	2.00	2.10	3.30	3.10	3.20	1.80	2.30	3.80	7.20	2.70	5.42
Mining*	2.40	2.30	2.00	2.00	1.60	2.10	1.50	2.20	2.00	1.92	1.59
Manufacturing	0.17	0.18	0.18	0.16	0.16	0.14	0.14	0.11	0.13	0.19	0.12
Construction	0.76	0.90	0.77	0.86	0.79	0.89	0.91	0.77	0.79	0.56	0.66
Public utilities	0.60	0.72	0.60	0.43	0.67	0.44	0.57	0.39	0.44	0.49	0.45
Transportation, storage and communications	0.66	0.62	0.46	0.53	0.56	0.56	0.50	0.40	0.44	0.37	0.38
Trade	0.08	0.07	0.09	0.08	0.07	0.08	0.09	0.05	0.06	0.06	0.06
Finance	0.02	0.06	0.02	0.01	0.03	0.05	0.01	0.02	0.01	0.09	0.05
Service	0.16	0.12	0.09	0.08	0.07	0.06	0.07	0.07	0.06	0.07	0.06
Total	0.36	0.36	0.33	0.32	0.32	0.33	0.30	0.27	0.28	0.21	0.21

*Includes quarrying and oil-well-drilling.

TABLE 37

BASIC WAGE RATES PER HOUR IN CANADIAN METAL MINING
AS AT OCTOBER 1, 1960

Occupation	Gold-mining	Iron-mining	Other Metal-mining
	($)	($)	($)
Underground workers			
Cage and skip tenders	1.48	..	2.16
Chute blaster	1.43	..	2.21
Deckman	1.42	..	1.98
Hoistman	1.59	2.21	2.29
Laborer	1.37	..	2.00
Miner	1.46	2.63	2.12
Miner's helper	1.37	..	1.80
Motorman (motor operator)	1.43	2.22	2.10
Mucking-machine operator	1.40	2.07	2.14
Mucker and trammer (shoveller)	1.35	..	2.09
Timberman (shaft timberman)	1.48	..	2.21
Trackman	1.44	..	2.13
Pipe fitter	..	..	2.23
Open-pit workers			
Blaster	..	2.31	..
Bulldozer operator	..	2.38	..
Driller, machine	..	2.38	..
Oiler	..	2.14	..
Shovel operator (power shovel)	..	2.78	..
Truck driver (heavy truck)	..	2.43	..
Surface and mill workers			
Carpenter, maintenance	1.57	2.50	2.20
Crusher operator (crusherman)	1.43	2.30	2.07
Electrician, maintenance	1.64	2.64	2.41
Laborer	1.29	1.83	1.74
Machinist, maintenance	1.61	2.54	2.38
Mechanic, maintenance	1.58	2.51	2.31
Millman*	1.46	..	..
Pipe fitter, maintenance	1.50	2.39	..
Steel sharpener	1.47	..	2.15
Tradesman's helper	1.39	2.19	1.94
Truck driver, (heavy truck)	1.45	..	2.03
Truck driver, (light truck)	1.37	..	1.83
Millwright	..	2.61	
Welder, maintenance	..	2.51	2.36
Blacksmith	..	..	2.27
Filter operator	..	..	2.14
Flotation operator	..	..	2.00
Grinding-mill operator	..	..	2.09
Solution man	..	..	2.15
Stockkeeper	..	..	2.04

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

TABLE 38

AVERAGE OF WEEKLY WAGES AND HOURS OF HOURLY-RATED EMPLOYEES IN THE CANADIAN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1955-61

	1955	1956	1957	1958	1959	1960	1961
Mining							
Average hours per week	43.2	42.8	42.3	41.5	41.5	41.7	41.8
Average weekly wage	$69.68	$73.92	$79.35	$81.30	$84.80	$87.26	$89.08
Metals							
Average hours per week	44.1	43.0	42.9	41.8	41.7	41.9	42.2
Average weekly wage	$73.07	$77.27	$83.70	$84.77	$88.73	$90.89	$92.83
Fuels							
Average hours per week	41.0	42.0	40.8	40.0	39.9	40.6	40.3
Average weekly wage	$64.00	$69.01	$72.91	$75.12	$77.11	$80.13	$80.98
Nonmetals							
Average hours per week	43.3	43.1	42.5	42.3	42.2	42.2	42.3
Average weekly wage	$66.16	$68.79	$71.57	$73.73	$76.87	$79.62	$82.60
Manufacturing							
Average hours per week	41.0	41.0	40.4	40.2	40.7	40.4	40.6
Average weekly wage	$59.45	$62.40	$64.96	$66.77	$70.16	$71.96	$74.27
Construction							
Average hours per week	39.9	41.1	41.2	40.7	40.2	40.4	40.3
Average weekly wage	$60.49	$67.77	$72.55	$72.36	$74.20	$78.36	$79.93

TABLE 39

AVERAGE OF WEEKLY WAGES OF HOURLY-RATED EMPLOYEES
IN CANADIAN MINING INDUSTRY IN CURRENT AND 1949 DOLLARS,
1955-61

	1955	1956	1957	1958	1959	1960	1961
Current dollars							
All mining	69.68	73.92	79.35	81.30	84.80	87.26	89.08
Metals	73.07	77.27	83.70	84.77	88.73	90.89	92.83
Gold	64.17	65.77	67.48	68.09	68.95	70.81	73.34
Other	77.89	82.26	90.13	91.59	95.92	98.52	100.22
Fuels	64.00	69.01	72.91	75.12	77.11	80.13	80.98
Coal	58.88	61.04	63.51	67.43	67.00	69.37	70.36
Oil and natural gas	77.34	85.11	90.13	89.20	92.74	96.58	95.66
Nonmetals	66.16	68.79	71.57	73.73	76.87	79.62	82.60
1949 dollars							
All mining	59.86	62.59	65.09	64.99	67.04	68.17	68.95
Metals	62.77	65.43	68.66	67.76	70.14	71.01	71.85
Gold	55.13	55.69	55.36	54.43	54.51	55.32	56.76
Other	66.92	69.65	73.94	73.21	75.83	76.97	77.57
Fuels	54.98	58.43	59.81	60.05	60.96	62.60	62.68
Coal	50.58	51.69	52.10	53.90	52.96	54.20	54.46
Oil and natural gas	66.44	72.07	73.94	71.30	73.31	75.45	74.04
Nonmetals	56.84	58.25	58.71	58.94	60.77	62.20	63.93

TABLE 40

COST OF PROSPECTING BY METAL-MINING INDUSTRY IN CANADA, BY PROVINCES AND TYPES OF MINES, 1959 AND 1960

($)

	Placer Gold	Gold Quartz	Copper-Gold-Silver	Silver-Cobalt	Silver-Lead-Zinc	Nickel-Copper	Miscellaneous Metal Mines*	Total
1959								
Newfoundland	-	49,646	33,117	-	251,038	-	568,805	902,606
Nova Scotia	468	54,283	90,232	-	2,007	-	8,680	155,670
New Brunswick	17,577	275,593	310,385	-	73,112	-	9,513	686,180
Quebec	-	1,707,344	13,966,818	42,202	205,736	626,542	4,077,469	20,626,111
Ontario	-	1,203,466	3,184,028	45,281	75,738	2,146,916	1,096,012	7,751,441
Manitoba	-	126,883	2,395,300	400	8,442	5,264,027	31,445	7,826,497
Saskatchewan	-	28,211	468,794	-	17,724	188,509	143,202	846,440
Alberta	32,500	-	2,605	-	44,348	-	-	79,453
British Columbia	3,413	76,945	1,436,069	-	737,916	1,043	280,293	2,535,679
Northwest Territories	-	112,491	172,440	-	66,458	285,227	698,730	1,335,346
Yukon Territory	11,181	14,424	167,145	-	77,094	-	2,368	272,212
Canada	65,139	3,649,286	22,226,933	87,883	1,559,613	8,512,264	6,916,517	43,017,635
1960								
Newfoundland	-	28,092	385,623	-	354,094	-	686,499	1,454,308
Nova Scotia	16,686	91,703	186,350	-	17,057	-	2,587	314,383
New Brunswick	-	286,612	809,925	-	669,595	-	9,327	1,775,459
Quebec	-	1,525,247	7,696,468	-	3,068,141	590,134	2,103,458	14,983,448
Ontario	42,440	914,549	3,763,158	26,805	99,036	2,832,077	1,705,987	9,384,052
Manitoba	-	248,231	2,649,070	-	11,691	5,171,145	27,655	8,107,792
Saskatchewan	-	2,364	575,099	-	20,323	462,622	18,061	1,078,469
Alberta	31,865	-	904	-	64,643	-	630	98,042
British Columbia	5,319	228,824	2,508,003	-	845,280	2,465	230,801	3,820,692
Northwest Territories	-	481,939	226,046	-	371,537	352,938	657,680	2,090,140
Yukon Territory	22,495	6,980	304,612	-	81,150	-	31,588	446,825
Canada	118.805	3,814,541	19,105,258	26,805	5,602,547	9,411,381	5,474,273	43,553,610

*Includes iron, uranium and molybdenum, 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 Quartz' in this table.

TABLE 41

COST OF PROSPECTING BY METAL-MINING INDUSTRY IN CANADA, BY TYPES OF OPERATIONS, 1950-60

($)

	Placers Gold Operations	Gold Mines	Copper-Gold-Silver Mines	Silver-Cobalt Mines	Silver-Lead-Zinc Mines	Nickel-Copper Mines	Miscellaneous Metal Mines*	Total
1950	60,550	2,758,669	801,388	86,010	575,322	614,377	456,951	5,353,267
1951	21,106	2,414,004	1,194,546	36,119	968,244	3,123,263	1,419,157	9,176,439
1952	11,805	2,566,981	- 1,740,207	105,902	2,268,355	5,124,466	1,760,458	13,578,174
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

*Includes the mining of iron, uranium, molybdenum, etc.

Note: See the general footnote for Table 40.

TABLE 42

CONTRACT DIAMOND-DRILLING OPERATIONS* IN CANADA, 1950-60

	Footage Drilled	Income from Drilling	Average Number of Employees	Total of Salaries and Wages
		($ millions)		($ millions)
1950	6,006,747	9.5	1,862	4.5
1951	5,091,514	12.4	2,431	6.0
1952	5,180,783	14.7	2,345	7.1
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

*Drilling operations conducted by contractors who employed diamond drills only, and which were used chiefly in testing metalliferous deposits.

TABLE 43

CONTRACT DRILLING* IN CANADA FOR OIL AND GAS, 1950-60

	Footage Drilled				Income from Drilling	Average Number of Employees	Total of Salaries and Wages
	Rotary	Cable	Diamond	Total	($ millions)		($ millions)
1950	3,480,315	308,008	2,132	3,790,455	23.4	2,254	7.3
1951	5,318,736	918,048	446	6,237,230	43.0	3,620	13.1
1952	8,102,599	351,670	-	8,454,269	61.2	4,679	18.1
1953	10,139,151	625,891	-	10,765,042	59.7	4,903	19.8
1954	9,609,140	457,480	-	10,066,620	58.8	4,559	18.1
1955	12,711,953	354,053	-	13,066,006	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

*Drilling done by contract-drilling companies only. Drilling by oil companies with their own equipment is not included.

TABLE 44

TONNAGES OF ORE MINED AND ROCK QUARRIED
IN CANADIAN MINING INDUSTRY, 1958-60

(millions of s.t.)

	1958	1959	1960
Metals			
Gold-quartz	14.8	14.3	14.7
Copper-gold-silver	11.5	12.4	14.0
Silver-cobalt	0.2	0.2	0.2
Silver-lead-zinc	5.9	5.7	5.8
Nickel-copper	12.9	19.0	20.8
Iron	20.3	32.4	33.0
Miscellaneous	13.2	15.1	13.1
Total, metallic ores	78.8	99.1	101.6
Nonmetals			
Asbestos	22.4	23.1	33.2
Feldspar and nepheline syenite	0.3	0.4	0.3
Quartz	0.7	1.0	1.3
Gypsum and anhydrite	4.0	6.0	5.1
Other	1.6	2.7	2.1
Total, nonmetals	29.0	33.2	42.0
Structural materials			
Stone, all kinds*	38.2	46.4	45.3
Stone for manufacture of cement	8.5	8.0	7.8
Stone for manufacture of lime	2.8	3.1	2.7
Total, structural materials	49.5	57.5	55.8
Total, ore mined and rock quarried	157.3	189.8	199.4

*Exclusive of stone for the manufacture of cement and lime.

TABLE 45

TONNAGES OF ORE MINED AND ROCK QUARRIED
IN CANADIAN MINING INDUSTRY, AT FIVE-YEAR INTERVALS,
1929-60

(millions of s.t.)

	Metal Mines	Industrial-mineral Operations	Total
1929	13.9	21.6	35.5
1934	18.8	8.8	27.6
1939	35.9	16.5	52.4
1944	35.3	19.5	54.8
1949	43.3	33.7	77.0
1954	59.0	61.5	120.5
1959	99.1	89.7	189.8
1960	101.6	97.8	199.4

TABLE 46

CRUDE MINERALS* TRANSPORTED BY CANADIAN RAILWAYS, 1960 and 1961
(millions of s.t.)

	1961	1960
Coal		
Anthracite	1.1	1.4
Bituminous	10.5	11.0
Petroleum, crude	0.5	0.6
Copper ore and concentrates	0.7	0.6
Iron ore and concentrates	16.9	18.8
Copper-nickel ore and concentrates	3.9	3.0
Aluminum ore and concentrates	2.2	2.9
All other ores and concentrates	3.2	3.6
Sand and gravel	5.8	5.8
Stone and rock	5.5	6.3
Asbestos	1.1	1.1
Gypsum, crude	4.0	3.4
Salt	1.3	1.2
All other crude minerals (chiefly industrial)	2.9	3.2
Total	59.6	62.9
All revenue freight moved by Canadian railways	153.1	157.4
Crude minerals as percentage of revenue-freight total	38.9	39.9

*Both domestic and imported.

TABLE 47

CRUDE MINERALS* TRANSPORTED BY CANADIAN RAILWAYS, 1951-61

(millions of s.t.)

	Total of Revenue Freight	Total of Crude Minerals	Crude Minerals as % of Revenue Freight
1951	161.3	52.5	32.5
1952	162.1	50.6	31.2
1953	156.2	49.3	31.5
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

*Both domestic and imported

TABLE 48

PRIMARY MINERAL PRODUCTS* TRANSPORTED BY CANADIAN RAILWAYS, 1960 and 1961

(millions of s.t.)

	1961	1960
Aluminum - bar, ingot, pig, and slab	0.37	0.39
Copper - ingot and pig	0.53	0.55
Lead and zinc - bar, ingot, and pig	0.44	0.43
Iron - pig	0.16	0.19
Iron and steel - billet, bloom, and ingot	0.26	0.44
Coke	1.57	1.59
Asphalt	0.33	0.38
Total, primary mineral products	3.66	3.97
Total, all revenue freight	153.1	157.4
Primary mineral products as a percentage of all freight transported	2.4	2.5

*Both domestic and imported.

TABLE 49

CRUDE MINERALS* TRANSPORTED ON INLAND WATERWAYS IN CANADA, 1959 and 1960

(millions of s.t.)

	1960	1959
Coal		
Anthracite	0.13	0.19
Bituminous	11.07	11.44
Petroleum, crude	3.00	2.02
Copper ore and concentrates	0.06	0.07
Iron ore and concentrates	21.50	24.25
Aluminum ore and concentrates	2.51	1.99
Lead and zinc ore	0.03	0.03
All other metallic ores and concentrates	1.12	0.79
Sand, gravel and crushed stone	1.72	2.14
Stone and rock	2.44	1.73
Asbestos	0.28	0.28
Gypsum, crude	0.26	0.33
Salt	0.63	0.66
Sulphur	0.28	0.34
All other crude minerals (chiefly industrial)	1.36	0.43
Total	46.39	46.69
Shipments of all types of commodities	81.16	82.56
Crude minerals as a percentage of all commodities moved on inland waterways	57.1	56.5

*Both domestic and imported.

TABLE 50

QUANTITIES* OF PETROLEUM, PETROLEUM PRODUCTS AND GAS (NATURAL AND MANUFACTURED) TRANSPORTED BY PIPELINE IN CANADA, 1951-61

	Petroleum and Petroleum Products		Gas
	Millions of bbl	Millions of s.t.	'000 Mcf
1951	88.4	13.1	65,200e
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	316.0r	46.8r	326,212
1961	353.4	52.4	379,044

*Both domestic and imported.
rRevised from previously published figure.

TABLE 51

TAXES* PAID BY FIVE IMPORTANT DIVISIONS
OF CANADIAN MINERAL INDUSTRY, 1955-60

($ millions)

	1955	1956	1957	1958	1959	1960
Auriferous-quartz-mining	6.2	6.2	5.9	6.1	7.0	6.5
Copper-gold-silver mining	18.1	26.1	19.2	8.5	13.0	19.7
Silver-lead-zinc mining and smelting	23.0	20.8	12.7	10.8	12.2	15.3
Nickel-copper mining, smelting, and refining	24.6	48.9	46.6	22.4	12.1	41.0
Asbestos-mining	9.2	11.7	12.1	11.4	12.1	14.2
Total	81.1	113.7	96.5	59.2	56.4	96.7

*As the amounts reported pertain 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. Taxes on nonoperating revenue are included.

TABLE 52

TAXES* PAID TO FEDERAL, PROVINCIAL AND MUNICIPAL GOVERNMENTS
IN CANADA BY FIVE IMPORTANT DIVISIONS OF MINERAL INDUSTRY, 1960
($)

	Federal Income Tax	Provincial Tax	Municipal Tax	Total
Auriferous-quartz-mining	3,401,410	2,377,463	745,360	6,524,233
Copper-gold-silver mining	11,953,865	5,764,686	1,945,961	19,664,512
Silver-lead-zinc mining and smelting	11,315,107	2,795,896	1,148,260	15,259,263
Nickel-copper mining, smelting, and refining	26,287,815	12,812,195	1,930,472	41,030,482
Asbestos mining	9,246,299	3,505,954	1,454,821	14,207,074
Total	62,204,496	27.256.194	7,224,874	96,685,564

*As the amounts reported pertain 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. Taxes on nonoperating revenue are included.

TABLE 53

FEDERAL INCOME TAX DECLARED BY COMPANIES IN MINING AND RELATED INDUSTRIES IN CANADA, FISCAL YEARS ENDED MARCH 31, 1959

($ millions)

	1959
Mining, quarrying and oil wells	
Gold-mining	3.3
Other metal-mining	43.1
Coal-mining	0.4
Oil and natural gas	4.3
Nonmetal-mining	8.6
Quarries	2.4
Mineral and oil prospecting	0.3
Total	62.4
Metallurgical and metal-fabricating industries	
Iron castings	8.0
Primary iron and steel	53.4
Agricultural implements	6.6
Boilers and fabricated structural steel	4.7
Hardware and tools	5.0
House, office and store machinery	14.0
Machine-shop products	0.7
Machine tools	0.5
Miscellaneous machinery	11.5
Sheet-metal products	11.8
Wire and wire products	3.6
Miscellaneous iron and steel products	4.3
Aluminum products	1.8
Other nonferrous metal products	8.1
Total	134.0
Nonmetallic mineral products	
Abrasives, asbestos, cement and clay products	13.3
Miscellaneous nonmetallic mineral products	8.1
Fertilizers and industrial minerals	4.9
Total	26.3
Petroleum and products	
Petroleum-refining and products	35.0
Miscellaneous petroleum and coal products	2.0
Fuel, gasoline and other petroleum products	9.7
Total	46.7
Total, mining and related industries	269.4
Total, all industries	1,300.1

TABLE 54

CAPITAL AND REPAIR EXPENDITURES OF CANADIAN MINING INDUSTRY, 1960-62

($'000)

	1962f			1961p			1960		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
Metals									
Gold	7,488	8,403	15,891	6,516	8,867	15,383	9,192	8,788	17,980
Silver-lead-zinc	12,291	4,126	16,417	16,939	4,309	21,248	5,391	4,433	9,824
Uranium	1,824	2,495	4,319	2,870	2,595	5,465	6,362	3,574	9 936
Iron ore	127,771	25,950	153,721	84,126	23,918	108,044	79,345	21,067	100,412
Copper-gold-silver, nickel-copper and silver-cobalt	31,201	24,056	55,257	32,103	23,556	55,659	35,129	24,499	59,628
Total, metals	180,575	65,030	245,605	142,554	63,245	205,799	135,419	62,361	197,780
Nonmetals									
Asbestos, gypsum, salt and other nonmetals	39,588	19,409	58,997	20,792	18,009	38,801	20,400	17,607	38,007
Quarries and sand pits	7,428	8,168	15,596	6,860	8,506	15,366	10,708	11,992	22,700
Total, nonmetals	47,016	27,577	74,593	27,652	26,515	54,167	31,108	29,599	60,707
Fuels									
Coal	4,793	3,532	8,325	2,678	3,955	6,633	5,153	4,138	9,291
Petroleum and natural gas	200,692	14,340	215,032	200,318	14,212	214,530	209,286	14,418	223,704
Natural gas processing plants	19,850	2,477	22,327	78,243	2,098	80,341	19,255	1,883	21,138
Total, fuels	225,335	20,349	245,684	281,239	20,265	301,504	233,694	20,439	254,133
Total, mining industry	452,926	112,956	565,882	451,445	110,025	561,470	400,221	112,399	512,620

TABLE 55

ANNUAL CAPITAL INVESTMENT IN CANADIAN PETROLEUM AND NATURAL-GAS INDUSTRIES[1], 1947-62

($ millions)

Year	Exploration	Development and Production	Oil Pipelines	Pipelines for Gas Transmission	Rail and Water Transport	Processing of Gas	Refining of Petroleum	Marketing Oil[3]	Marketing Gas[4]	Capital Investment in Canada: Petroleum and Natural-Gas Industries	Capital Investment in Canada: All Industries
1947	[2]	9.5	-	-	2.6	-	25.7	14.9	2.5	56.7	2,440
1948	[2]	37.3	-	-	4.3	-	32.6	9.7	3.8	89.5	3,087
1949	[2]	45.0	7.0	-	0.7	-	21.6	11.3	4.3	92.0	3,539
1950	[2]	53.9	53.8	-	1.2	-	24.1	16.7	6.6	160.7	3,936
1951	[2]	72.1	9.8	-	0.9	-	50.9	18.1	6.8	161.8	4,739
1952	59.8	101.6	76.0	2.7	15.9	1.3	60.5	25.0	6.3	352.2	5,491
1953	59.1	107.2	71.7	3.8	4.0	0.7	66.1	36.7	11.2	363.1	5,976
1954	55.1	126.8	61.0	1.6	2.5	8.5	83.9	46.3	9.7	401.5	5,721
1955	67.4	201.6	28.5	17.5	-	2.9	102.9	56.5	9.4	497.0	6,244
1956	73.7	252.4	42.5	133.6	1.0	10.5	79.1	68.5	46.6	707.9	8,034
1957	77.3	237.8	65.8	242.1	2.2	34.5	81.5	74.9	69.8	885.9	8,717
1958	62.4	181.5	21.8	214.8	1.8	40.1	94.9	63.6	79.4	760.3	8,364
1959	51.0	191.9	10.1	48.5	0.6	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(p)	51.9	200.3	47.3	126.8	0.8	78.2	34.6	57.6	59.4	656.9	8,109
1962(f)	46.6	200.7	11.3	57.1	3.1	19.9	65.9	64.2	63.2	532.0	8,596

[1]The petroleum and natural-gas industries in this tabulation 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 56 to 58 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'.
[3]Capital investment in this item chiefly includes outlets reported by major companies.
[4]Capital expenses in the marketing of gas are on gas-distribution pipelines.

TABLE 56

OWNERSHIP AND CONTROL OF CANADIAN MINERAL INDUSTRY
AT END OF YEAR, 1956-49

	1956		1957		1958		1959	
	$ millions	%	$ millions	%	$ millions	%	$ millions	%
Mining[1]								
Estimated total investment	1,609	100.0	1,934	100.0	2,066	100.0	2,121	100.0
Owned in:								
Canada	693	43.1	846	43.7	892	43.2	851	40.1
United States	808	50.2	957	49.5	1,027	49.7	1,127	53.1
Britain	75	4.7	92	4.8	103	5.0	93	4.4
Other countries	33	2.0	39	2.0	44	2.1	50	2.4
Petroleum and natural gas[2]								
Estimated total investment	3,500	100.0	4,483	100.0	4,980	100.0	5,453	100.0
Owned in:								
Canada	1,225	35.0	1,634	36.5	1,793	36.0	1,998	36.6
United States	2,063	58.9	2,570	57.3	2,866	57.6	3,108	57.0
Britain	72	2.1	108	2.4	134	2.7	162	3.0
Other countries	140	4.0	171	3.8	187	3.7	185	3.4
Nonferrous smelting and refining[3]								
Estimated total investment	844	100.0	893	100.0	880	100.0	922	100.0
Owned in:								
Canada	358	42.4	411	46.0	397	45.1	409	44.3
United States	347	41.1	350	39.2	359	40.8	386	41.9
Britain	81	9.6	70	7.9	68	7.7	67	7.3
Other countries	58	6.9	62	6.9	56	6.4	60	6.5

[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 57

ESTIMATED BOOK VALUE, OWNERSHIP AND CONTROL
OF CAPITAL EMPLOYED IN SELECTED CANADIAN INDUSTRIES,
AT END OF YEAR, 1955-59
($ billions)

	1955	1956	1957	1958	1959
Total capital employed					
Manufacturing	8.9	10.0	10.7	11.0	11.7
Petroleum and natural gas*	3.0	3.5	4.5	5.0	5.5
Other mining and smelting	2.1	2.5	2.8	2.9	3.0
Railways	4.2	4.4	4.6	4.9	5.2
Other utilities	5.8	6.4	7.4	8.2	8.8
Merchandising and construction	6.6	7.3	7.8	8.5	9.5
Total	30.5	34.1	37.6	40.5	43.7
Resident-owned capital					
Manufacturing	4.7	5.2	5.4	5.4	5.7
Petroleum and natural gas*	1.1	1.3	1.6	1.8	2.0
Other mining and smelting	1.0	1.1	1.3	1.3	1.3
Railways	2.8	2.9	3.2	3.5	3.8
Other utilities	5.0	5.5	6.3	7.0	7.5
Merchandising and construction	6.0	6.6	7.0	7.7	8.6
Total	20.6	22.7	24.8	26.7	28.9
Nonresident-owned capital					
Manufacturing	4.2	4.8	5.3	5.6	6.0
Petroleum and natural gas*	1.9	2.3	2.8	3.2	3.5
Other mining and smelting	1.1	1.3	1.6	1.7	1.8
Railways	1.4	1.4	1.4	1.4	1.4
Other utilities	0.7	0.9	1.0	1.1	1.3
Merchandising and construction	0.6	0.7	0.7	0.8	0.9
Total	9.9	11.4	12.9	13.8	14.8

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

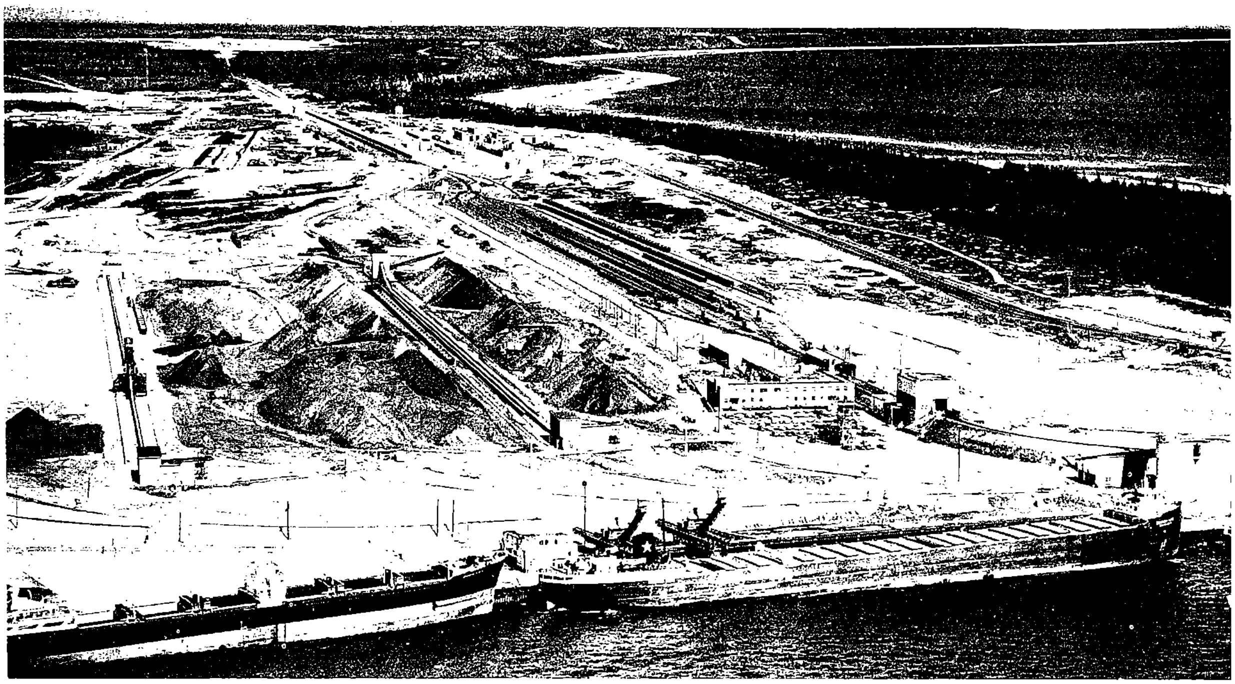
Note: Owing to rounding, figures do not add to totals in all cases.

TABLE 58

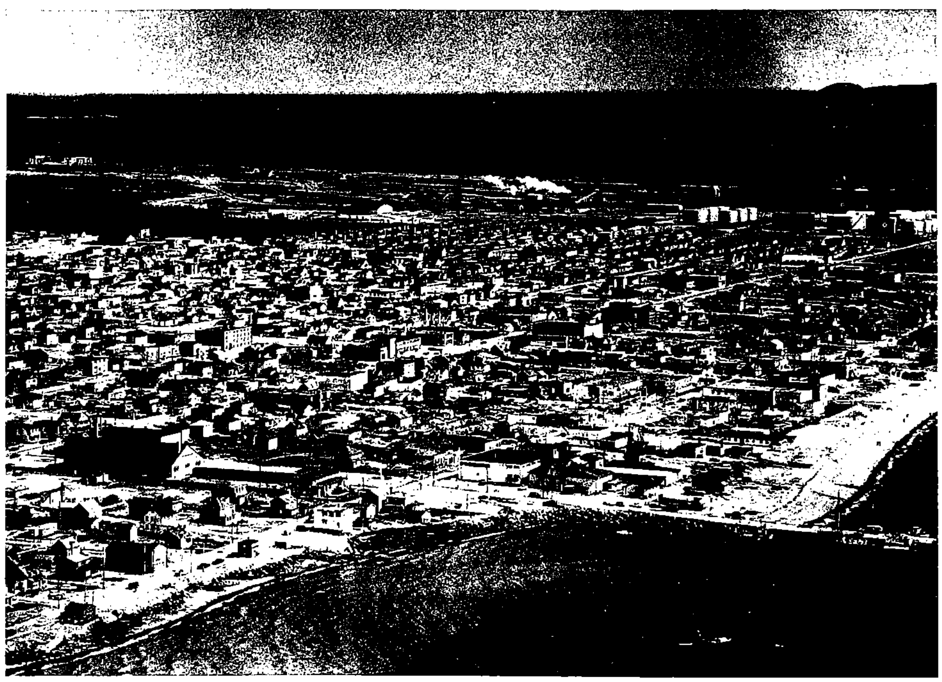
FOREIGN CAPITAL INVESTED IN CANADIAN MINERAL INDUSTRY, SELECTED YEARS, 1930-59 (END OF YEAR)
($ millions)

	Owned by All Nonresidents		Owned by United States Residents	
	Mining and Smelting	Petroleum and Natural Gas*	Mining and Smelting	Petroleum and Natural Gas*
1930	311	150	234	147
1945	359	157	280	149
1955	1,121	1,854	975	1,716
1956	1,330	2,275	1,129	2,063
1957	1,570	2,849	1,307	2,570
1958	1,657	3,187	1,386	2,866
1959	1,783	3,455	1,513	3,108

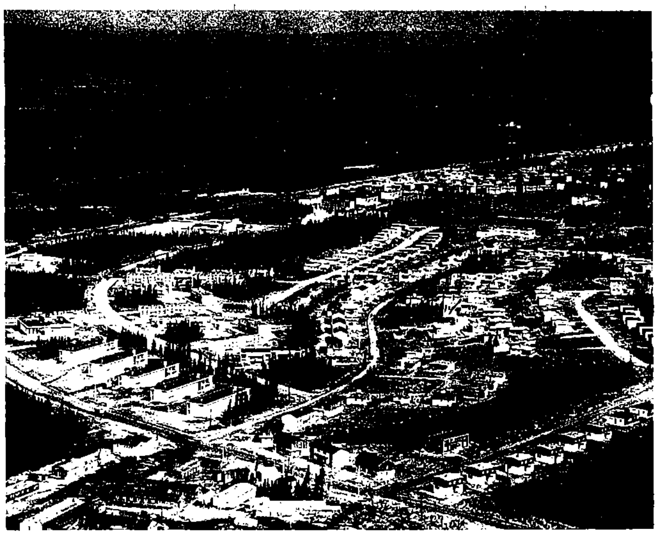
*Data apply only to companies whose main revenues are derived from oil and gas activities.

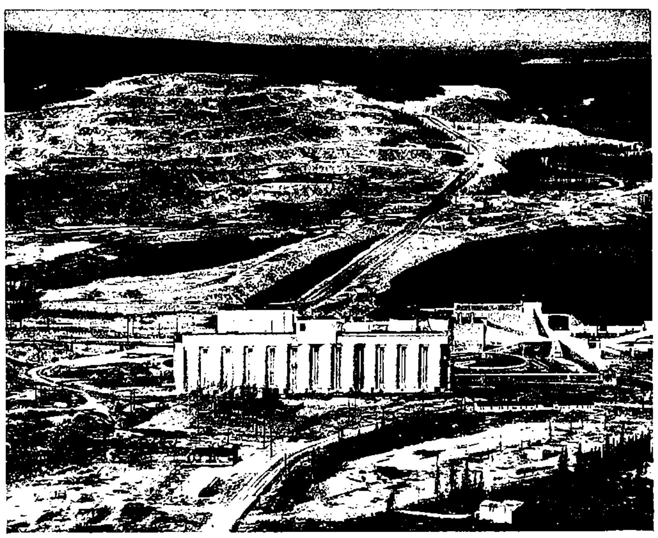


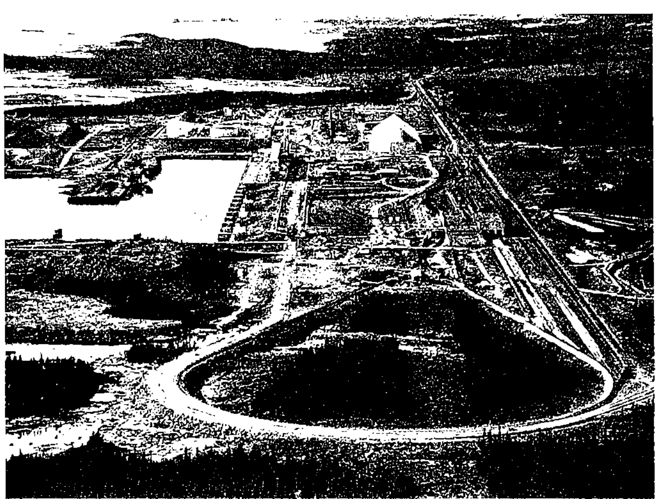
From the port of Sept-Iles, on the north shore of the Gulf of St. Lawrence, nearly 7½ million tons of iron ore were shipped by Iron Ore Company of Canada in the 7-month working season of 1961. The aerial photograph of the harbor facilities shows: the terminal yards of the railway that brings ore from Schefferville 360 miles to the north, the stockpiles of ores arranged for blending, the ship-loading machinery, the new stacker for stockpiling on the left, and the airstrip in the background.



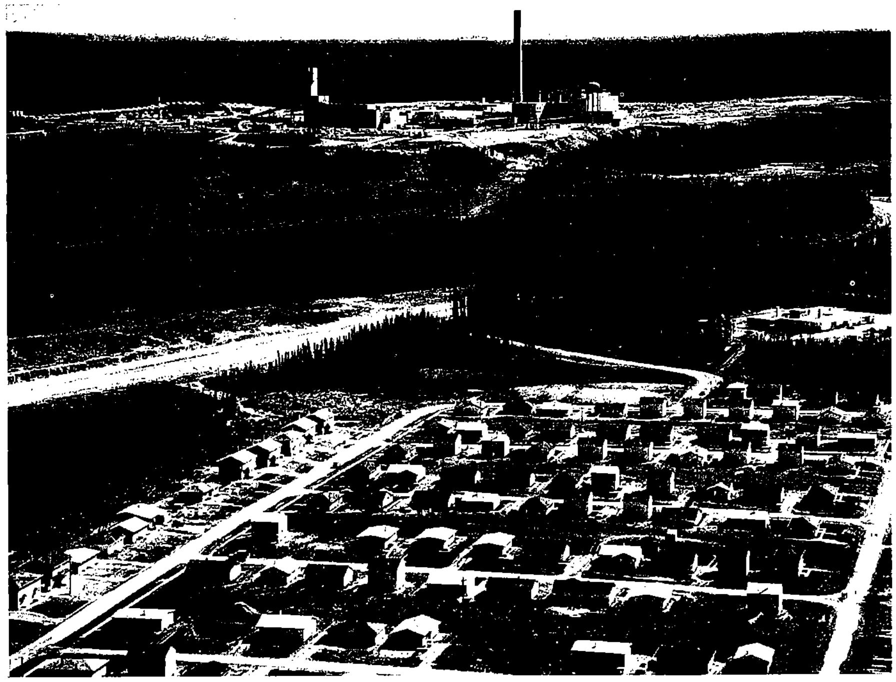
Looking southeast over the town of Sept-Iles one can see the new ore-drying plant (centre background) that can handle about 1¼ million tons of ore a season. The drying plant is needed to remove excess water in the ore mined from an open pit that has permafrost problems.



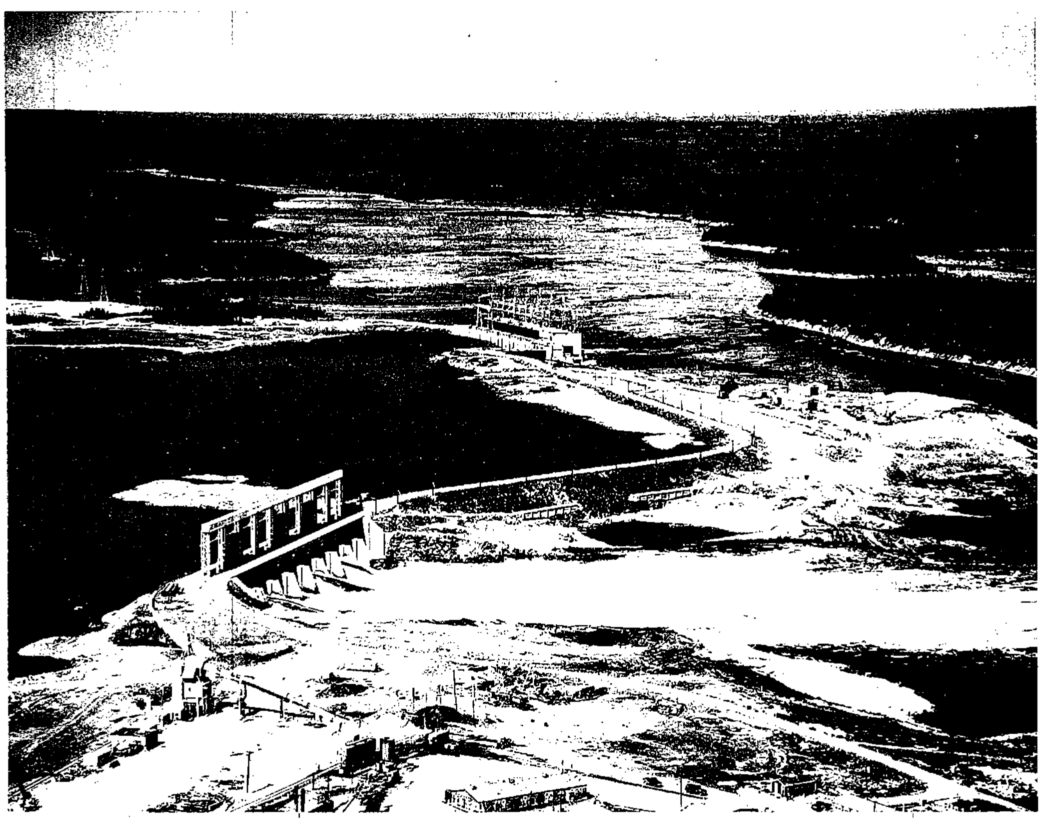


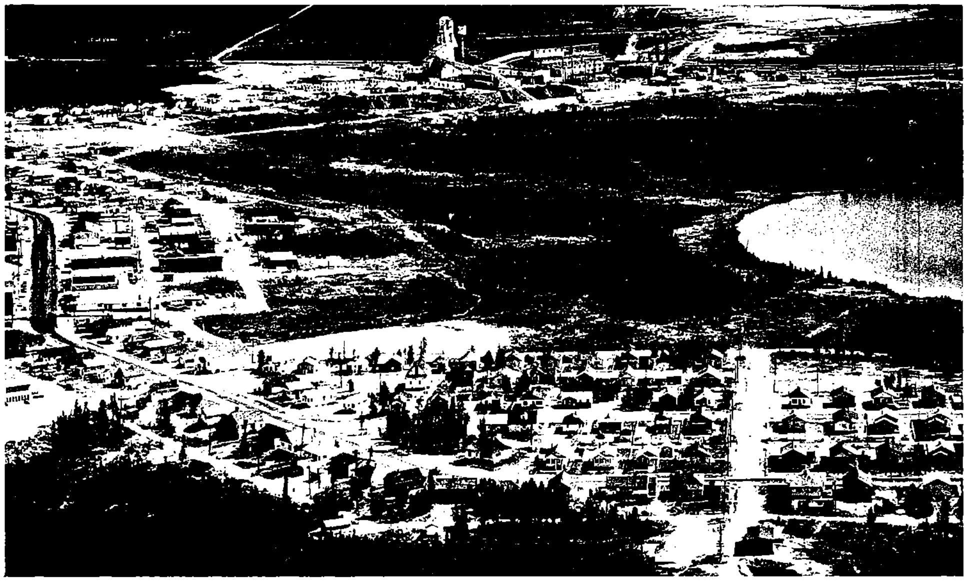


In the heart of New Quebec, 130 miles northwest of Sept-Iles, Quebec Cartier Mining Company completed a construction and mine-development program that cost $250 million in 2½ years. This program included: two new towns—Gagnon (top photograph) and Port Cartier (extreme background, bottom photograph); a 300-million-ton iron deposit developed for open-pit mining (centre photograph) for an ultimate production rate of 20 million tons of ore a year (32% iron); the world's largest iron ore concentrator (centre photograph) capable of upgrading 60,000 tons of ore a day to 65% iron; the excavation of a deep-sea harbor from solid rock and the establishment of complete harbor facilities (lower, bottom photograph). Other major items in the program were the building of a 193-mile railway from Port Cartier to Gagnon and the construction of a 60,000 hp hydroelectric power plant on the Hart-Jaune River. First shipments were made in July 1961.



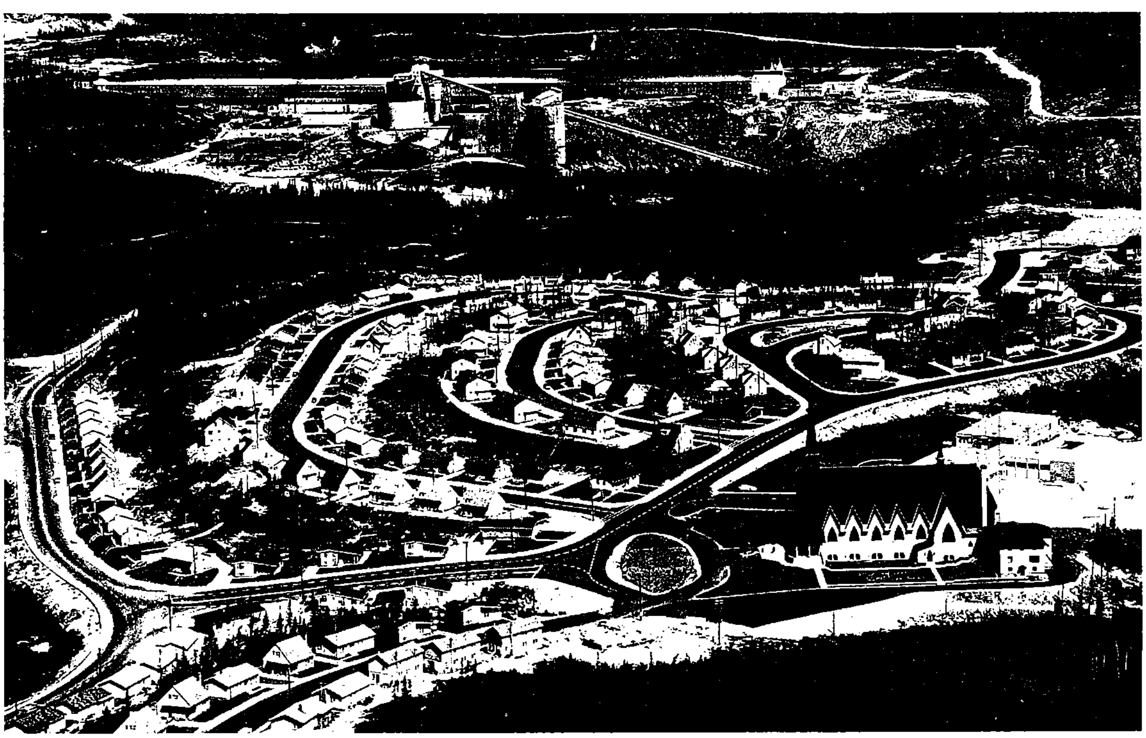
In north-central Manitoba, The International Nickel Company of Canada, Limited, started production in March 1961 from its giant Thompson nickel mine and refinery (above). By July, output was up to the rated annual capacity of 75 million pounds of nickel. Shipments of nickel to Europe were made through Churchill on Hudson Bay. Power for the electrolytic refinery and mine operations is supplied by the new Kelsey hydroelectric plant on nearby Nelson River (below).

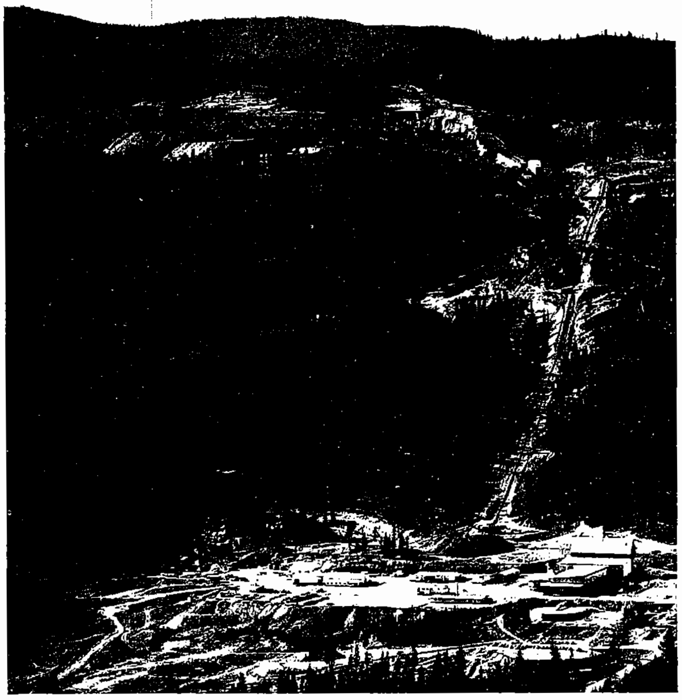




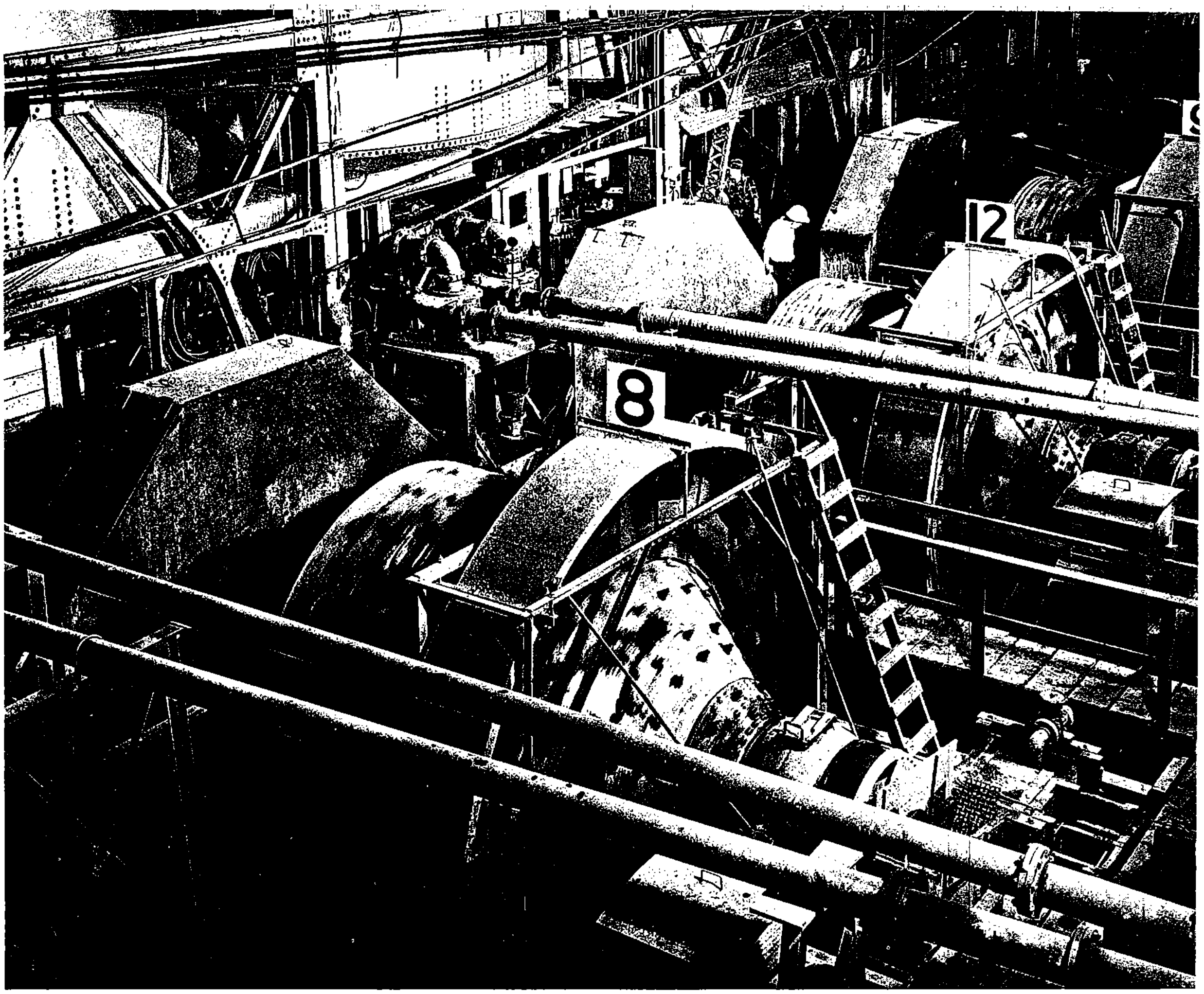
Also in northern Manitoba, at Lynn Lake 150 miles northwest of Thompson, Sherritt Gordon Mines Limited operates nickel-copper mines and a concentrator. The nickel concentrate is shipped to the company's plant at Fort Saskatchewan, Alberta, for refining by a unique chemical-metallurgical process which produces ammonium sulphate for fertilizer as well as pure nickel.

At Baie Comeau, Quebec, on the north shore of the St. Lawrence River, 200 miles downstream from Quebec City, Canadian British Aluminium Company Limited produces aluminum ingot and a variety of aluminum alloys as bars, wire, slabs, etc. Production is based on imported alumina, mainly from Guinea. Canada has no aluminum ore (bauxite) and the aluminum industry in Canada owes its existence to abundant and cheap hydroelectric power close to tidewater.





In south-central British Columbia, Craigmont Mines Limited began production from its copper mine. Ore from the open pit on the mountain slope (top) is trucked to a primary crusher and then carried on a one-mile cable belt to the mill and concentrator below (left). Concentrates are shipped to Japan and the United States.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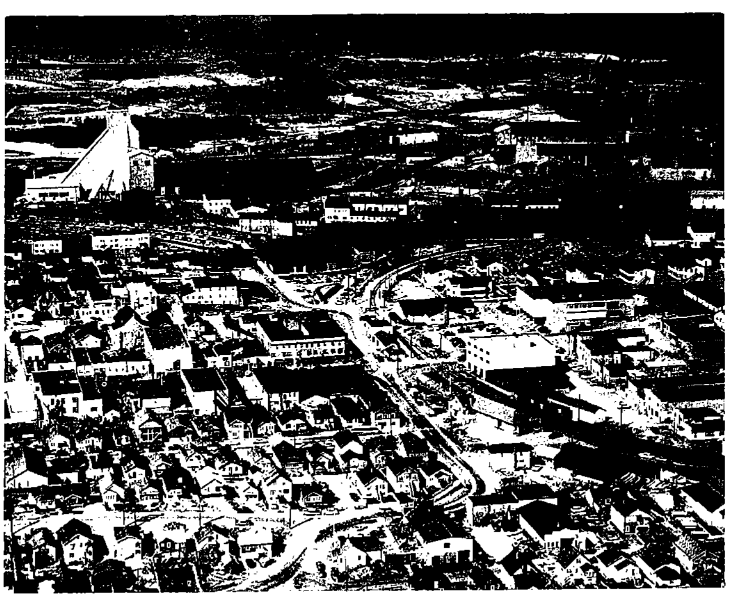
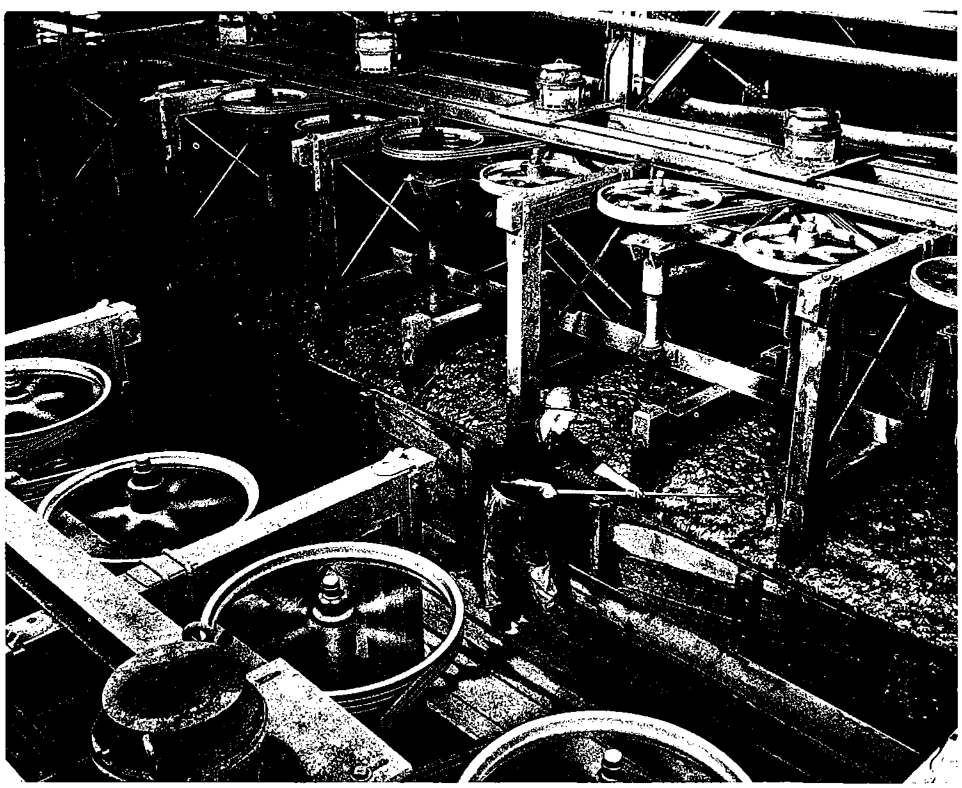
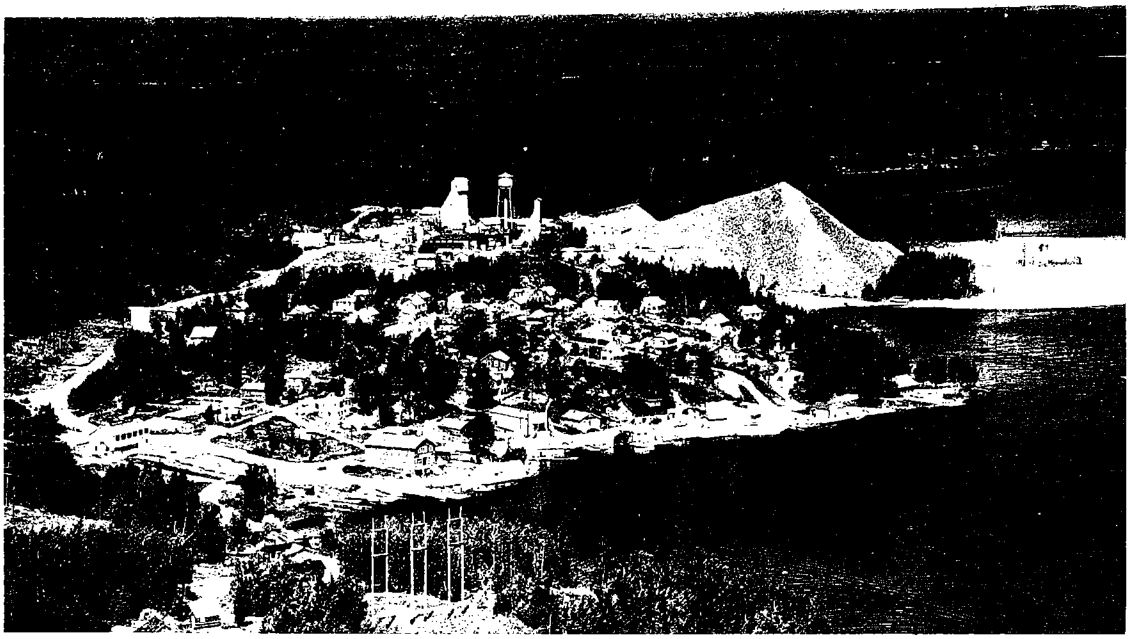


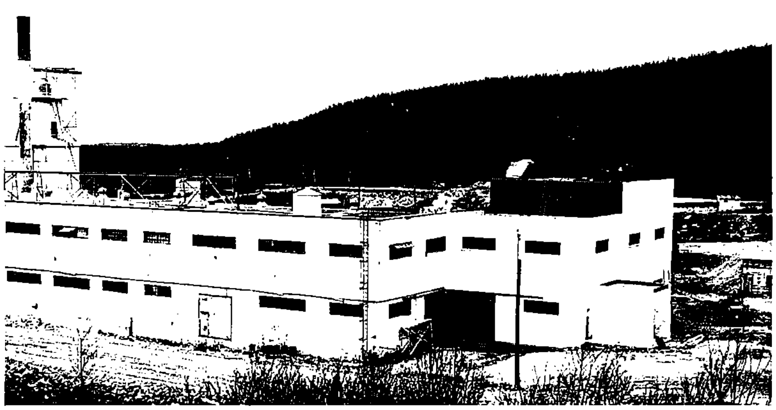
On the Manitoba-Saskatchewan boundary at Flin Flon, Hudson Bay Mining and Smelting Co., Limited, (bottom, opposite page) continued to produce refined zinc and cadmium, blister copper, and concentrates of lead, silver, gold and selenium. Part of the bank of ball mills in the concentrator is shown in the top photo opposite. In the photograph below, selective flotation of copper is underway.

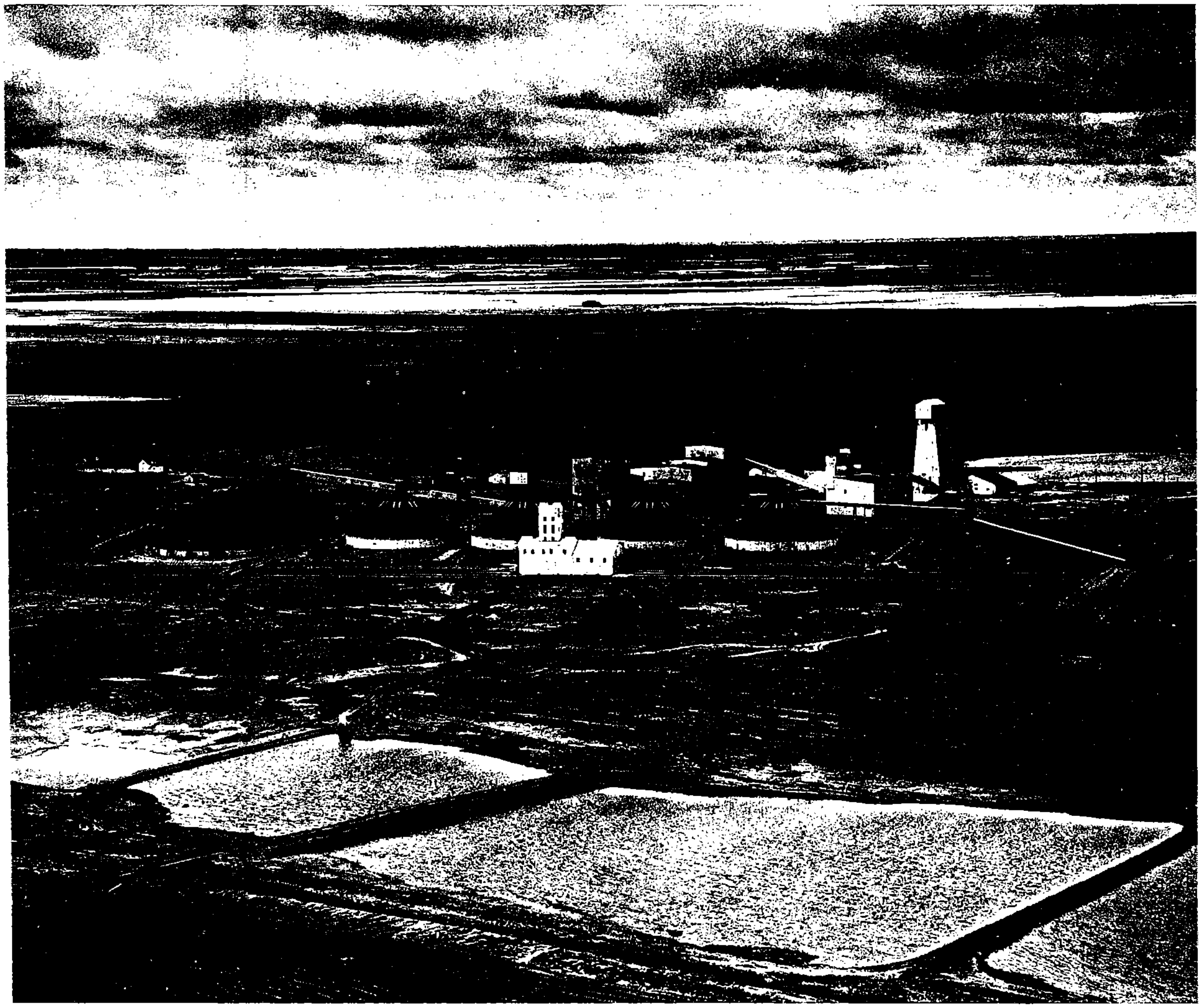




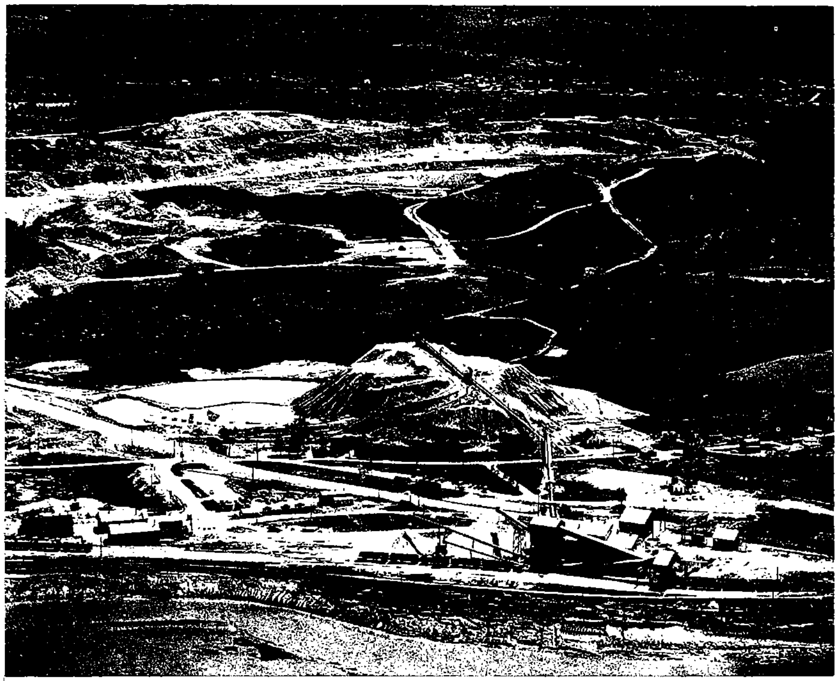
In the Red Lake district of western Ontario, about 100 miles north of Kenora, McKenzie Red Lake Gold Mines Limited produces gold from an auriferous quartz orebody. Five other lode gold mines operate in the district, producing about a half million ounces of gold a year.

In western Quebec, just north of Val d'Or, Quebec Lithium Corporation enlarged its chemical plant to produce lithium hydroxide monohydrate (used to increase the life of nickel-iron storage batteries) and reached an output of 6,000 pounds a day of high-purity lithium carbonate (used in glass, glazes and enamels by the ceramic industry). Proven reserves of more than 20 million tons of spodumene make the company's deposit one of the largest in the world. Much of the output is exported to the United States. (Photo by J. E. Reeves).

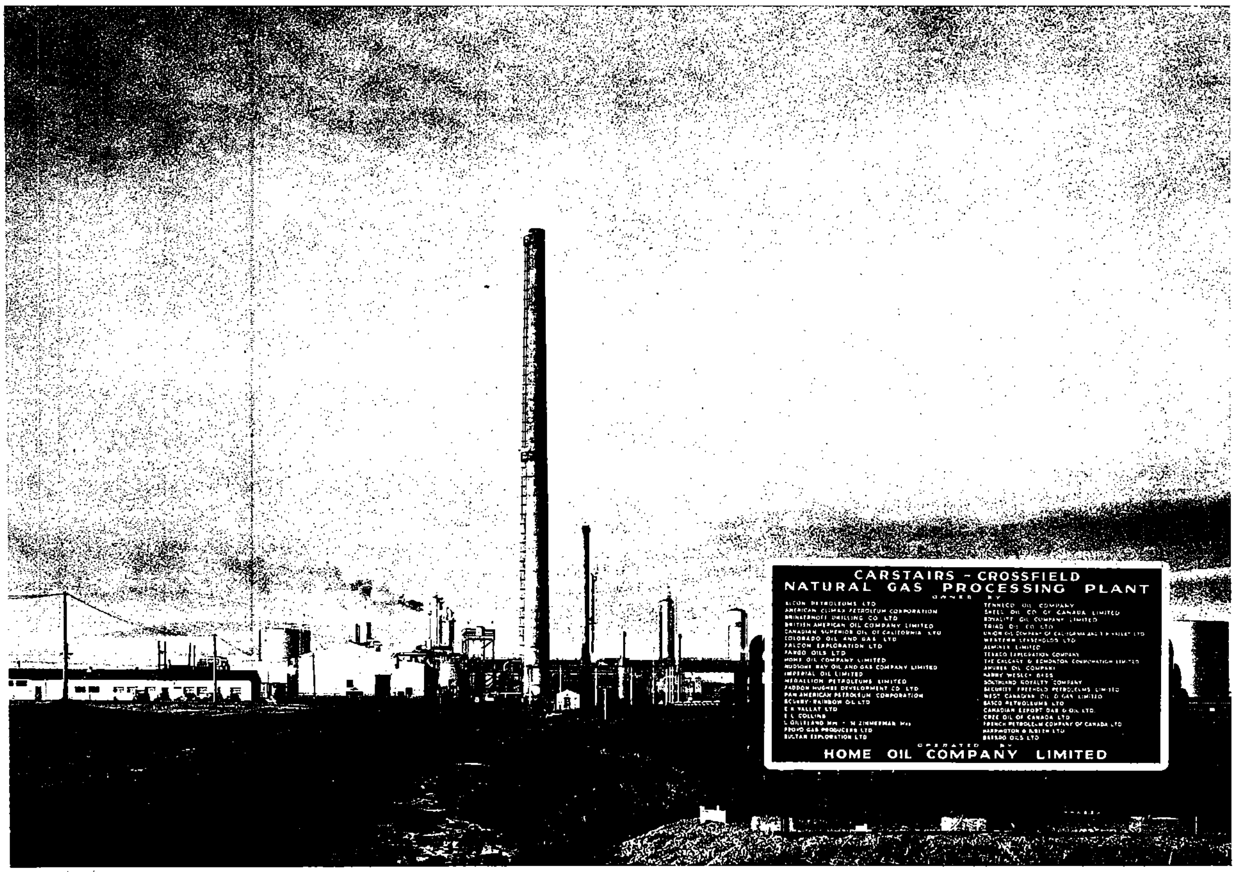




In southern Saskatchewan, near Saskatoon, Potash Company of America, Ltd. prepared to resume production interrupted late in 1959 by serious leakage of water into the mine shaft. Three sizes of potash grains are produced to suit the requirements of the fertilizer industry, in which potash, nitrogen and phosphate are mixed in various proportions. The photograph shows the mine shaft, the mill and the cone-shaped storage bins. Waste salt, separated from the potash feed in the mill, is pumped to disposal fields, some of which are shown in the foreground of the picture. Some fifteen companies are active in development of the Saskatchewan deposits which are the largest and richest known occurrences of potash in the world.



In central Nova Scotia, near Windsor, Canadian Gypsum Company Limited continued to produce gypsum, mainly for export to the United States for manufacture into plaster of paris and gypsum wallboard. In the photograph above, the quarry can be seen in the background, the waste dump in centre foreground and the mill and loading facilities in the foreground. The lower photograph shows the docks and storage facilities of the company at Hantsport, at low tide. During 1961, the Nova Scotia operations of the Company were taken over by Fundy Gypsum Company Limited. Nova Scotia produces about 85 per cent of Canada's gypsum production.



The Carstairs natural gas processing plant in Alberta, operated by Home Oil Company Limited and owned by 40 companies, expanded its raw gas capacity threefold in 1961 to 229 million cubic feet a day and added facilities to produce 40 tons of sulphur a day. Expansion of capacity and construction of new processing plants was general in 1961 as a result of joint Canada-United States approval for the export of large volumes of natural gas from Canada to the United States. (Photo courtesy Home Oil Company Limited).

Photos are by George Hunter
except where otherwise indicated.

Abrasives

J. S. Ross*

Abrasive raw materials and their products are both termed 'abrasives.' They may contain, or be composed entirely of, natural or artificial abrasive materials or both and are employed by many industries for their cutting, grinding, polishing, gripping or wear-resistant properties.

While most industrial and metallic minerals and man-made crude materials may be used as abrasives, only those with the most suitable physical properties are normally in demand. Abrasives may be classified not only by origin (natural or artificial) but by degree of abrasiveness. High-grade types include diamond, corundum and the chief artificial products, which are silicon carbide and fused alumina. Quartz and feldspar are examples of the low-grade type. Mild abrasives, commonly used for polishing and scouring, include lime and diatomite. Although all types are used by many industries, the high-grade variety has the widest application.

Canada's small annual production of natural abrasives is estimated to amount to at least 5,500 tons valued at more than $100,000. It consists of grindstone, garnet, granite, natural iron oxide, feldspar, and silica and beach sand. Most of these are produced mainly for nonabrasive purposes and are dealt with as separate commodities in other reviews. Exports of natural abrasives amount to only a few tons each year. Re-exports of industrial diamonds, however, are appreciable in value, and were worth $4,124,748 in 1961. Imports of natural abrasives were also high in value in 1961, amounting to almost half the value of all types of abrasives imported. As usual, the greater part of these natural-abrasive values was derived from industrial diamonds.

Canada's production of crude artificial abrasives is the largest industry of its kind in the world. The output consists virtually of fused alumina and silicon carbide, the most commonly used artificial abrasives. Production, which is governed by the export demand, amounted in 1961 to 125,290 tons of crude fused alumina valued at $13,036,000 and 79,188 tons of crude silicon carbide worth $12,479,000. The output of fused alumina was 33 per cent less than in 1960, and that of silicon carbide was 6 per cent less.

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* Mineral Processing Division, Mines Branch.

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TABLE 1

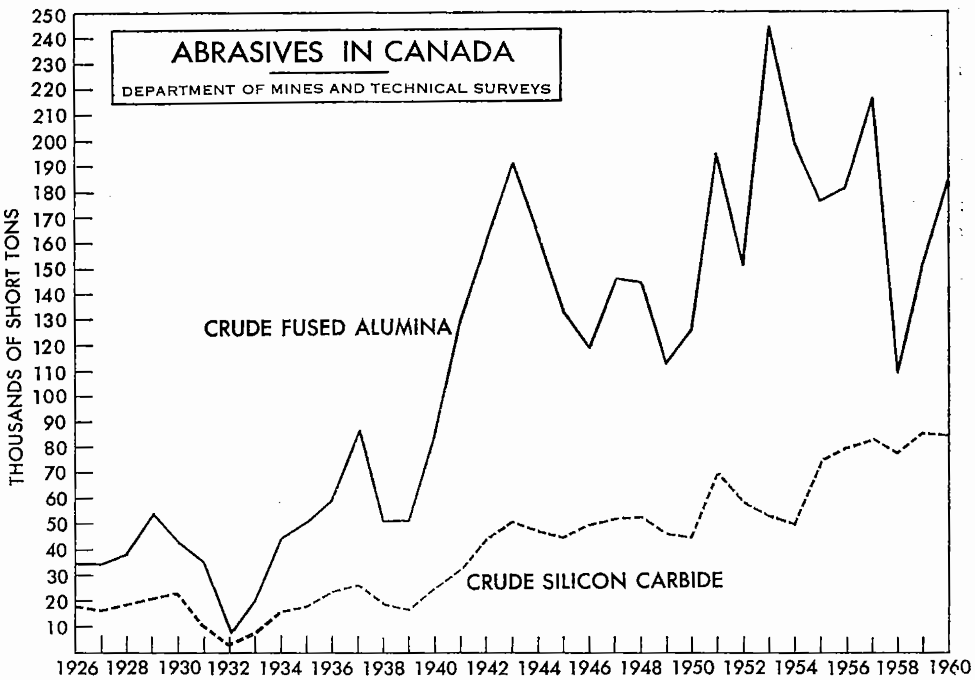
ABRASIVES—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
Artifical abrasives				
Crude silicon carbide[1]	79,188	12,479,000	84,611	13,026,009
Crude fused alumina[1]	125,290	13,036,000	187,105	19,417,568
Abrasive wheels and segments		6,849,000		6,425,394
Sharpening stones and files	[2]	[2]		264,477
Other products[3]	[2]	[2]		9,435,521
Total				48,568,969
Imports				
Natural and artificial abrasives				
Artificial-abrasive grains		2,366,931		2,046,966
Diamond dust, and bort and black diamonds for borers		5,733,917		4,339,852
Emery in bulk[4]		189,406		202,157
Grinding wheels, bonded, with natural or artificial grains		2,010,950		1,948,297
Grinding stones or blocks manufactured by bonding together either natural or artificial abrasives, not otherwise provided for		361,707		376,439
Grindstones not otherwise provided for		12,005		16,441
Pumice and pumice stone, lava and calcareous tufa, not further manufactured than ground		167,707		195,340
Coated abrasive paper and cloth		1,306,592		1,142,682
Manufactures of abrasives, not otherwise provided for		559,694		585,366
Total		12,708,909		10,853,540
Exports				
Natural and artificial abrasives				
Abrasives, natural, not elsewhere specified	5	4,945	17	9,099
Fused alumina, crude and grains	133,321	14,723,100	191,771	19,756,589
Silicon carbide, crude and grains	84,327	12,795,554	82,558	11,928,750
Abrasive paper and cloth		788,548		743,723
Abrasive wheels and stones		132,926		46,317
Abrasive basic products not elsewhere specified		963,394		121,490
Total		29,408,467		32,605,968
Re-exports				
Diamonds, industrial, and diamond dust or bort		4,124,748		3,858,667
	1960		1959	
Consumption (incomplete)[5]				
Abrasives, natural and artificial, in the production of artificial abrasive products				
Natural-abrasive grains				
Garnet	234	64,449	232	66,481
Emery	42	5,301	101	16,895
Quartz or flint	105	6,797	142	9,457
Other		545		726
Total		77,092		93,559

TABLE 1 (*cont'd*)

	1960		1959	
	Short Tons	$	Short Tons	$
Artificial-abrasive grains for wheels, paper, etc.				
Fused alumina	2,472	714,619	2,583	811,551
Silicon carbide	2,036	582,891	2,625	641,867
Total	4,508	1,297,510	5,208	1,453,418

SOURCE: Dominion Bureau of Statistics. [1] Includes material for use in refractories and for other nonabrasive purposes. [2] Not available. [3] Includes abrasive cloth, abrasive paper, abrasive tile, artificial pulpstone, boron carbide and fused magnesia. [4] Includes also corundum and garnet. Separation is not possible. [5] 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.



In addition to these crude products, finished or secondary products were manufactured. They consisted of abrasive wheels, segments, and other shapes, sharpening stones and files, and coated abrasives. In 1960, the value of these products was $16,125,392, and the total for the whole artificial-abrasives industry was $48,568,969. Although crude fused alumina and silicon carbide are included in the over-all total, they are not used entirely by the abrasives industry.

In 1961, fused alumina and silicon carbide made up 94 per cent of the total abrasive-export value, which was $29,408,467. The exports of these two commodities were in direct proportion to their production, fused alumina being the chief product. The rest of the exports consisted almost entirely of finished manufactured products. The value of artificial-abrasive imports amounted to less than half the $12,708,909 that constituted the import total. The largest item was silicon carbide and fused alumina re-imported from the United States as refined grains. The bulk was in the form of finished, manufactured products.

PRODUCERS

Few plants in Canada produce only natural abrasives. Most of their output results from the processing of industrial minerals used chiefly for other purposes. The materials they market as abrasives are beach sand, silica sand, feldspar, iron oxide, garnet, granite and sandstone.

Sand for sandblasting is produced from quartzite by Dominion Industrial Minerals Corporation at Lachine, Quebec, and by Nova Scotia Sand and Gravel Limited near Shubenacadie, Nova Scotia. Pulverized silica for soaps and cleaners is supplied by Canadian Silica Corporation Limited, and feldspar from near Buckingham, Quebec, is marketed for the same purpose. At Red Mill, Quebec, bog iron oxide is processed by The Sherwin-Williams Company of Canada, Limited, and part of the output is sold as crocus and jeweller's rouge. Garnet concentrate is produced near River Valley, Ontario, by Industrial Garnet Company Limited, and H. C. Reid manufactures grindstone from sandstone recovered in the Bathurst district of New Brunswick. A few other companies produce small quantities of natural abrasives.

Fused alumina and silicon carbide constitute virtually all the domestic production of crude artificial abrasives. At four plants in Ontario and four in Quebec, six companies produce one or both of these commodities. In 1961, the silicon-carbide and fused-alumina units were respectively at 81 and 36 per cent of their rated capacities. With the exception of insignificant amounts for domestic use, shipments depend mainly on the United States export market, which, in turn, varies with the output of metal products. These shipments normally make up three quarters of the North American output of abrasives.

TABLE 2

CANADIAN PRODUCERS OF CRUDE ARTIFICIAL ABRASIVES

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

Fourteen secondary-abrasives plants manufacture bonded and coated abrasives. Twelve are in southern Ontario; the others in Quebec and British Columbia.

USES

The demand for natural and artificial abrasives is widespread. Although each abrasive has many uses, its range of application is normally limited owing to cost and performance.

Natural abrasives are numerous. Silica and beach sand are used in sandblasting, silica flour in soaps and cleaners, and silica sand in coated abrasives. Both natural and synthetic diamonds are employed in grinding, cutting and boring metallic and nonmetallic materials and in polishing glass. Emery provides 'nonslip' surfaces for concrete and asphalt and is a constituent of grinding-wheels and other shapes and of coated abrasives. Garnet is used in polishing and sandblasting and in coated abrasives. Corundum serves as a grinding medium in wheels and in the form of loose grains. Iron oxide and diatomite are employed in polishes, and feldspar in scouring soaps and cleaners. In addition, these industrial minerals have other, less common, abrasive uses.

Silicon carbide and fused alumina are the most popular artificial abrasives. Some of their applications are reviewed here. In North America, about one quarter of the silicon carbide and a much smaller amount of the fused alumina are used for nonabrasive purposes, as in refractories. In the form of loose grains, silicon carbide serves in grinding, polishing, wire-sawing and sandblasting, and gives a nonslip surface. Bonded in wheels, sticks, rubs, etc., it is used in abrading metal, industrial-mineral products, rubber, leather and wood. In coated abrasives it is used to abrade similar products. The applications of fused alumina are similar to those of silicon carbide, and for some of these the two abrasives compete. In the form of loose grains, fused alumina is used for grinding and polishing and in nonslip surfaces. Bonded, it is employed mainly to abrade metals. As a constituent of coated abrasives, it serves the metalworking, woodworking and leather industries.

PRICES

In 1960, the prices per short ton for abrasive grains used in the production of artificial abrasives averaged as follows: garnet, $275; emery, $126; quartz, $65; fused alumina, $289; and silicon carbide, $286.

Aggregates, Lightweight

H. S. Wilson*

Reflecting a general improvement in the construction industry, the value of lightweight-aggregate production was 3 per cent higher in 1961 than in the preceding year.

The value of construction in Canada reached a peak in 1958. In 1959 it decreased by 0.2 per cent, and in 1960 by 2.7 per cent. In 1961, it recovered by 2.2 per cent to reach $7,039 million.

TABLE 1

CHANGES IN TYPES OF CONSTRUCTION IN CANADA IN 1961

Type of Construction	Percentage of Total Value	Percentage Change
Engineering	42	+ 4.2
Residential	28	+ 2.0
Commercial	11	+ 2.4
Institutional	9	+ 6.7
Industrial	6	−10.9
Other	4	− 3.9
Total	100	+ 2.2

SOURCE: Dominion Bureau of Statistics.

In 1961, expanded-slag production had the greatest increase in volume—18 per cent—and its value increased 15 per cent. For the first time, it surpassed its 1956 peak.

Expanded-clay and -shale aggregates were 9 per cent higher in volume and 7 per cent higher in value than in 1960. Two new plants—at Regina, Saskatchewan, and St. Boniface, Manitoba—went into operation. The plant at Ottawa, which had not been running since 1953, was put back in operation during the year. Two previously operated plants—at Regina and at St. François du Lac, Quebec—did not produce in 1961. At Laprairie, Quebec, a plant was under construction at the end of the year. Only in 1958 did expanded clay and shale show a break in their continuous production growth.

In 1961, the production of exfoliated vermiculite increased 1 per cent in volume and 3 per cent in value. It thus renewed a little of the volume it lost during 1960.

*Mineral Processing Division, Mines Branch.

TABLE 2

PRODUCTION OF LIGHTWEIGHT AGGREGATES

	1961*		1960	
	Cubic Yards	$	Cubic Yards	$
From domestic raw materials				
Expanded clay and shale	395,753	2,203,716	363,600	2,061,600
Expanded slag	266,890	628,758	226,046	544,846
From imported raw materials				
Exfoliated vermiculite	316,000e	2,403,000e	312,067	2,343,817
Expanded perlite	92,000e	740,000e	104,000	832,000
Pumice		34,650		60,000
Total		6,010,124		5,842,263

SOURCE: Information provided directly by the producers.
eEstimated.
*Subject to revision.

Expanded perlite decreased for the third consecutive year—12 per cent in volume and 11 per cent in value from the 1960 totals. The Montreal plant did not produce during the year.

The value of pumice used as lightweight aggregate decreased for the second consecutive year—to 42 per cent less than in 1960.

The production and value of the individual types of aggregates produced in 1960 and 1961 are shown in Table 2. The accompanying graph shows the production of the principal lightweight aggregates for the period 1954-61.

USES OF LIGHTWEIGHT AGGREGATES

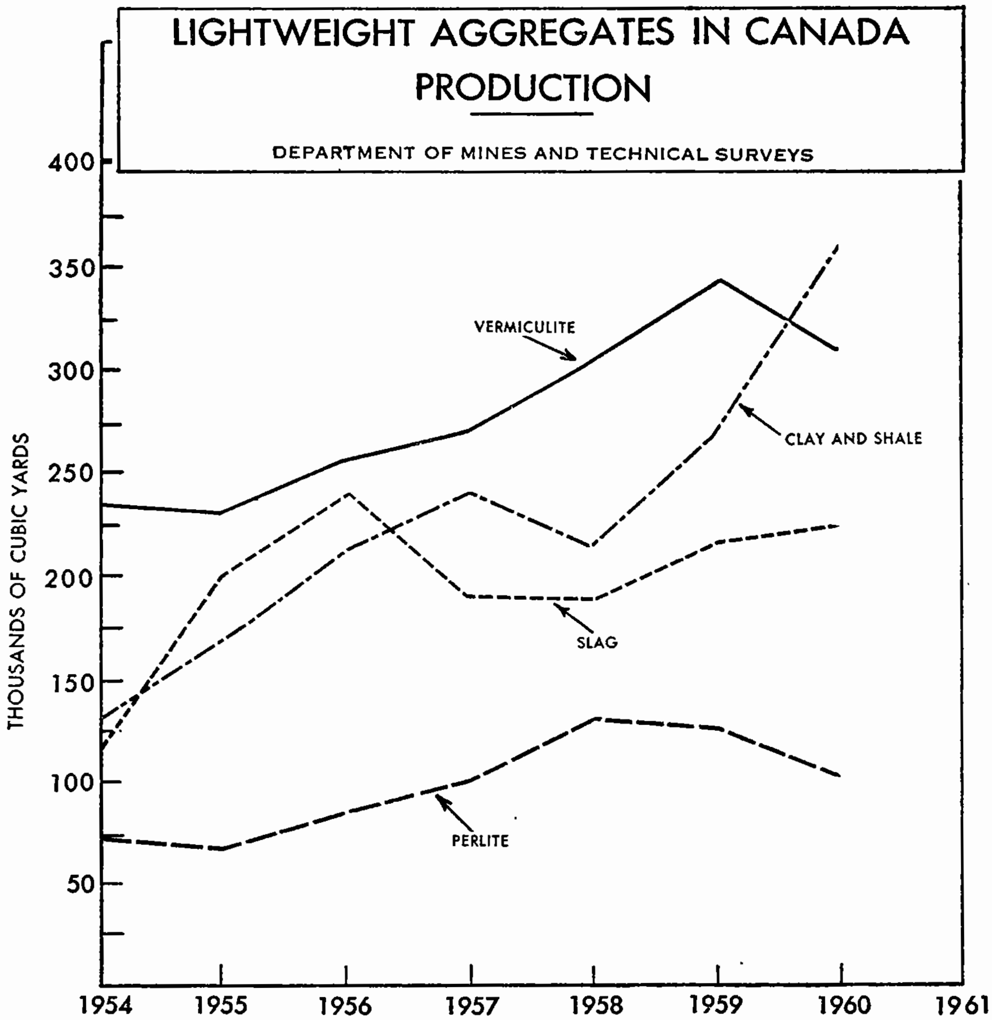
Lightweight aggregates are used in structural concrete, masonry units and insulating concrete. Structural concrete is made with expanded-clay, -shale, and -slag aggregates. All the lightweight aggregates can be used in masonry units, but in Canada this application of vermiculite and perlite is limited. Vermiculite is used mainly as loose insulation, and perlite largely as plaster aggregate. These two, because of their insulating properties and low unit weights, are employed as aggregates in insulating concrete. Lightweight aggregates also serve as roofing gravel and oil-well concrete, in stucco and for horticultural and acoustical purposes.

RAW MATERIALS

The shales and common clays are the most widespread raw materials used for lightweight-aggregate manufacture. Most plants obtain their raw material from nearby deposits. One is supplied from 15 miles away. Eleven plants were in operation in 1961 as follows: Ontario—Ottawa and Cooksville; Manitoba—St. Boniface (2); Saskatchewan—Regina (2); Alberta—Calgary (2) and Edmonton (2); and British Columbia—Saturna Island. One plant is under construction at Laprairie, Quebec.

Expanded blast-furnace slag is a by-product of the iron-and-steel industry. It is produced at Hamilton and Port Colborne, in Ontario, and at Sydney, Nova Scotia.

Vermiculite is a type of hydrous mica that exfoliates, when heated, to form a highly cellular material possessing good insulating properties. All the raw vermiculite exfoliated in Canada is imported from the United States and the



Transvaal, Union of South Africa. Four companies produce vermiculite from imported raw materials at 10 locations: British Columbia—Vancouver (2); Alberta—Calgary; Saskatchewan—Regina; Manitoba—Winnipeg; Ontario—St. Thomas, Rexdale and Toronto; and Quebec—Lachine and Montreal.

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

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. None is produced in Canada because the known deposits are either too small or too far from transportation facilities.

TABLE 3

LIGHTWEIGHT AGGREGATE PLANTS IN CANADA

Company	Location	Aggregate
Producing Plants		
Atlas Light Aggregate Ltd.	St. Boniface, Man.	Expanded clay
Cindercrete Products Limited	Regina, Sask.	" "
Echo-Lite Aggregate Ltd.	St. Boniface, Man.	" "
Edmonton Concrete Block Co. Ltd.	Edmonton, Alta.	" "
Hobbs Concrete Blocks Ltd.	Edmonton, Alta.	" "
Light Aggregate (Sask.) Limited	Regina, Sask.	" "
British Columbia Lightweight Aggregates Ltd.	Saturna Island, B.C.	Expanded shale
Burtex Industries Limited	Calgary, Alta.	" "
Consolidated Concrete Limited[1]	Calgary, Alta.	" "
Domtar Construction Materials Ltd.[2]	Cooksville, Ont.	" "
Hayley-Lite Limited	Ottawa, Ont.	" "
Dominion Iron & Steel Limited	Sydney, N.S.	Expanded slag
National Slag Limited	Hamilton, Ont.	" "
	Port Colborne, Ont.	" "
Grant Industries Ltd.[3]	Vancouver, B.C.	Vermiculite
	Calgary, Alta.	"
	Regina, Sask.	"
	Winnipeg, Man.	"
F. Hyde & Company, Limited	Montreal, Que.	"
	Toronto, Ont.	"
	St. Thomas, Ont.	"
Western Gypsum Products Limited[4]	Vancouver, B.C.	"
Vermiculite Insulating Limited	Rexdale, Ont.[5]	"
	Lachine, Que.	"
Canadian Gypsum Company Limited	Hagersville, Ont.	Perlite
Domtar Construction Materials Ltd.[6]	Caledonia, Ont.	"
Laurentide Perlite Inc.[7]	Beauport, Que.	"
	Charlesbourg West, Que.	"
Perlite Industries Reg'd.	Ville St. Pierre, Que.	"
Western Gypsum Products Limited[4]	Vancouver, B.C.	"
Perlite Products Ltd.	Winnipeg, Man.	"
Western Perlite Co. Ltd.	Calgary, Alta.	"
Evans, Coleman and Evans Limited	Vancouver, B.C.	Pumice
Nonproducing Plants		
Aggregates and Construction Products Ltd.	Regina, Sask.	Expanded clay
Featherock Inc.	St. François du Lac, Que.	" "
Miron Company Ltd.	Montreal, Que.	Perlite
Plant under Construction		
Aggrite Inc.	Laprairie, Que.	Expanded shale

[1] Formerly Consolidated Concrete Industries Ltd.
[2] Formerly Cooksville-Laprairie Brick Limited.
[3] Formerly Insulation Industries (Canada) Ltd.
[4] Formerly Perlite Industries Limited.
[5] Formerly Siscoe Vermiculite Mines Limited.
[6] Formerly Gypsum, Lime & Alabastine Limited.
[7] Formerly Perlite Atlas Limited.

CONSUMPTION

Expanded Clay and Shale

Masonry units and precast shapes accounted for 80 per cent of the aggregates produced, 7 per cent less than in 1960. Cast-in-place structural concrete took 17 per cent, 7 per cent more than in the previous year. Three per cent was used in concrete brick and low temperature refractories, as field track surfacing and insulation, and for agricultural purposes. As the total production of expanded clay and shale increased 9 per cent during 1961, the use of this type of aggregate increased in all sectors.

Expanded Slag

Ninety-six per cent of these aggregates was used in concrete masonry units, 3 per cent more than in the previous year. Precast shapes accounted for 2 per cent of the output, or 1 per cent less. Cast-in-place structural concrete took 2 per cent of production, 1 per cent less than in 1960. The 18-per-cent increase in the production of expanded slag all went into masonry units, the quantities used in precast shapes and cast-in-place concrete being less than in 1960.

Exfoliated Vermiculite

Seventy-seven per cent of the 1961 output was used as insulation, 3 per cent more than in 1960. Plaster accounted for 14 per cent, or 4 per cent less. As in the preceding year, 3 per cent was used in insulating concrete. Other products, such as soil and fertilizer conditioners, stucco aggregate, refractories and underground-pipe insulation, took 6 per cent of the output, 1 per cent more than in 1960. All uses except plaster took larger quantities in 1961.

Expanded Perlite

Plaster aggregate accounted for 91 per cent of the 1961 production, instead of 86 per cent, as in 1960. Four per cent was used as aggregate in insulating concrete, 1 per cent less than in 1960. Horticulture, insulation, stucco, etc., accounted for 5 per cent of production in both 1960 and 1961. Only in plaster aggregate did consumption increase in 1961.

Pumice

As in previous years, all the pumice used was imported. It served as aggregate in masonry units.

PRICES

Expanded-clay and -shale aggregates sold at $5 to $7.40 a cubic yard, and expanded slag at $2.25 to $3.60 a cubic yard. Vermiculite sold at 25 to 30 cents a cubic foot, and perlite at 25 to 35 cents a cubic foot. Vermiculite and perlite were marketed in bags of 3 and 4 cubic feet. All prices shown are f.o.b. plant.

Aluminum

W. H. Jackson*

Primary production decreased by 13 per cent in 1961 to 663,173 tons, or 76 per cent of the nominal rated capacity of 872,000 tons. The operating rates of the six Canadian smelters, five of which are owned by Aluminum Company of Canada, Limited, varied with the marketing position of each company or the economics of smelter operations within a corporate group.

The unused capacity results from marketing difficulties arising from the rapid expansion that has taken place in the industry in recent years throughout the world. The full effect of much of this expansion is, however, difficult to assess, particularly in vertical integration, market restrictions occasioned by the rise of trading blocs, and government policies that have affected the choice of location for new smelters.

In 1961, Canadian exports of primary aluminum decreased to 487,034 tons from the 552,155 tons exported in 1960. Primary exports to the six countries of the European Economic Community decreased by 45 per cent to 60,548 tons, while those shipped to Britain dropped by 13 per cent to 156,575 tons. Although manufacturing in Europe slackened, an increase in the requirements of nonintegrated manufacturers in the United States raised shipments to that country by 17 per cent to 117,760 tons.

The aluminum imported by Britain totalled 263,383 tons. Canada's share, according to The British Bureau of Non-Ferrous Metal Statistics, was 155,798 tons. The use of primary decreased because shipments of semifabricated aluminum from British mills and foundries dropped from the 1960 total of 451,920 tons to 415,240 tons for 1961. The greatest decline occurred in the industrial demand for rolled products, and a reduction in the requirements of the automotive industry caused a falling-off in the use of gravity and pressure die castings.

* Mineral Resources Division.

TABLE 1

ALUMINUM—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
Ingot	663,173		762,012	
Imports				
Bauxite and alumina for refining				
British Guiana	1,003,889	11,010,867	1,613,824	8,199,211
Jamaica	437,175	27,785,220	418,182	26,500,248
Guinea	380,627	4,823,876	499,983	2,793,869
Surinam	276,871	1,642,097	218,132	1,242,758
United States	109,127	7,164,552	—	—
Australia	5,862	347,894	5,802	334,533
France	—	—	8,432	458,653
Total	2,213,551	52,774,506	2,764,355	39,529,272
Cryolite				
Denmark	3,307	528,000	4,423	687,833
United States	142	32,691	192	46,478
Italy	573	121,071	3,724	652,823
West Germany	10	2,444	—	—
Britain	2	396	—	—
Total	4,034	684,602	8,339	1,387,134
Aluminum products				
Semimanufactured		8,405,685		6,200,971
Fully manufactured		19,862,141		19,484,575
Total		28,267,826		25,685,546
Exports				
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars				
Britain	156,575	71,552,826	179,618	78,873,365
United States	117,760	54,670,004	100,689	47,358,659
West Germany	40,981	17,876,532	76,724	32,942,522
Japan	26,188	11,678,867	15,168	6,421,568
Brazil	14,988	6,759,951	12,048	5,027,415
Union of South Africa	12,827	5,865,050	8,773	3,776,018
Australia	12,335	5,647,895	25,030	10,967,293
Czechoslovakia	12,224	5,582,579	1,608	756,917
Hong Kong	12,025	5,425,099	17,207	7,327,235
Argentina	10,682	4,663,921	5,547	2,284,420
Italy	8,349	3,673,470	12,398	5,268,747
Other countries	62,100	28,130,534	97,345	42,029,841
Total	487,034	221,526,728	552,155	243,034,000
Bars, rods, plates, sheet, circles, castings and forgings				
United States	10,846	7,366,752	7,480	4,712,020
India	7,918	3,910,464	8,877	4,348,727
Britain	1,024	726,463	219	179,383
Portugal	987	486,985	661	300,944
Venezuela	922	577,331	1,041	584,513
Other countries	1,272	820,275	11,845	5,945,144
Total	22,969	13,888,270	30,123	16,070,731

TABLE 1 (cont'd)

	1961		1960	
	Short Tons	$	Short Tons	$
Foil				
United States	54	51,834	33	38,635
Colombia	20	21,175	31	33,678
Britain	40	43,054	3	4,205
Peru	11	13,052	7	7,837
Venezuela	9	13,128	8	10,104
Other countries	13	18,855	49	50,367
Total	147	161,098	131	144,826
Fabricated materials not elsewhere specified[1]				
New Zealand	2,625	1,339,868		
Brazil	2,371	1,022,503		
Mexico	1,531	737,864		
Colombia	647	313,042		
Bulgaria	550	276,261		
Other countries	3,913	2,559,430		
Total	11,637	6,248,968		
In ore and concentrates (alumina)[2]				
Spain	10,779	624,816		
Norway	6,763	405,282		
United States	1,253	157,970		
Other countries	81	12,571		
Total	18,876	1,200,639		
Scrap				
Italy	9,381	3,249,765	9,758	3,557,405
Japan	8,368	3,095,476	5,374	2,047,200
United States	7,377	1,833,924	7,149	1,670,838
West Germany	2,746	778,665	3,316	1,075,431
Britain	779	296,019	1,702	624,168
Other countries	788	179,974	271	74,360
Total	29,439	9,433,823	27,570	9,049,402
Consumption (producers' domestic shipments)	127,000[e]		105,708	

SOURCE; Dominion Bureau of Statistics.

[1]No comparable statistics for previous years.

[2]Not available as a separate class prior to 1961.

[e]Estimated.

TABLE 2

PRIMARY ALUMINUM—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

(short tons)

	Production	Imports	Exports	Consumption*
1951	447,095	270	354,414	86,241
1952	499,758	13	412,590	90,287
1953	548,445	35	459,692	88,548
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	505,342	89,000
1960	762,012	501	552,155	105,708
1961	663,173	636	487,034	127,000•

SOURCE: Dominion Bureau of Statistics.
*Producers' domestic shipments.
•Estimated.

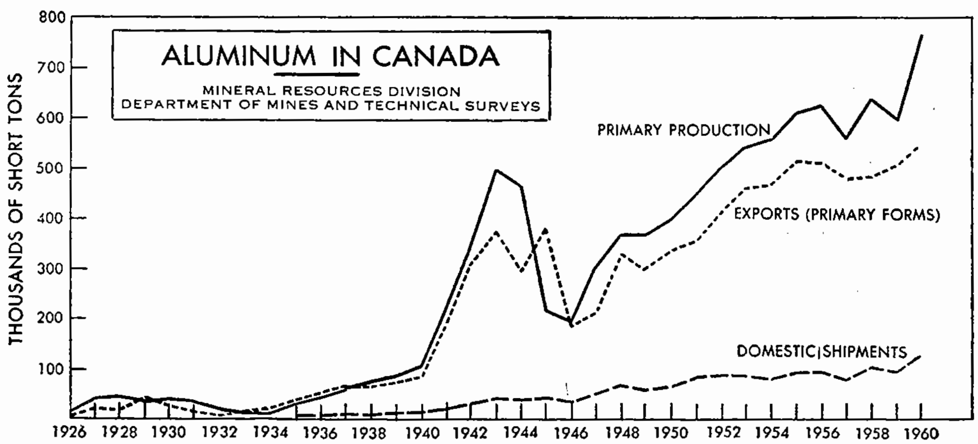


TABLE 3

WORLD PRODUCTION OF ALUMINUM

	1961	1960
Free World		
North America	2,567,211	2,776,509
South America	20,172	20,034
Western Europe	1,016,579	948,619
Africa	52,445	48,434
Australia	26,880	13,216
Asia	198,222	174,066
Soviet bloc	1,062,000	1,021,600
Total	4,943,509	5,002,478

SOURCE: American Bureau of Metal Statistics.

As ingot producers in the United States are integrated, have excess capacity and export aluminum, that country's market is highly competitive. In 1961, the United States, with a capacity of 2,483,750 tons, produced 1,904,037 tons of primary aluminum and shipped 1,956,168 tons. It exported 128,344 tons of primary and imported 194,073 tons. The Canadian share, which in 1960 was 40.7 per cent less than in 1959, recovered slightly in 1961, Canadian shipments across the International Boundary representing 6.02 per cent of United States shipments and 60.68 per cent of United States imports. A further improvement is expected for 1963, when a hot-rolling mill of 100,000 tons capacity is to be completed at Oswego, New York.

In 1961 the classification of Canadian exports was changed slightly. The headings in Table 1 indicate the content, and statistics for 1960 are omitted where no comparison is possible. Exports of aluminum in primary forms are comparable and exports of semifabricated products are mainly so.

CANADIAN DEVELOPMENTS

Aluminum Company of Canada, Limited (Alcan), produced 549,000 tons of primary aluminum in 1961, exclusive of the output of the Beauharnois plant, which is leased to Chryslum Limited. Alcan reports that this tonnage represents an average operating rate of 73 per cent of capacity for the year. The year-end operating rate was 77 per cent.

To permit the removal of rockfalls and repair of the 10-mile tunnel leading from the reservoir to the Kemano powerhouse, the smelter at Kitimat, British Columbia, ceased operating in June. Power was restored on September 12, and by November the smelter was back in normal operation. The Kemano power project has a firm installed capacity of 1,050,000 horsepower, and the site has a potential of 2,400,000 horsepower. Available power is sufficient to service an additional 100,000 tons of smelter capacity. Work on buildings that will eventually house new potlines is proceeding slowly, but the construction of 80,000 tons of additional capacity at Kitimat has been suspended since 1957. Hydroelectric power plants operated by the company on the Saguenay and Peribonca rivers in Quebec have a firm generating capacity of 2,600,000 horsepower. Some of this is sold under long-term contracts, but enough is available to expand aluminum-smelting capacity by roughly 100,000 tons.

Canadian British Aluminium Company Limited announced that construction will start in 1963 on a 45,000-ton addition to the smelter at Baie Comeau, Quebec, which will cost $36 million and raise capacity by 1965 to 135,000 tons. Originally designed to produce remelt ingot, the smelter now turns out wire bars, extrusion ingot and slab in a variety of alloys, as well as master alloys (hardeners). Much of the power is supplied by the Manicouagan Power Company, which has an installed capacity of 292,400 horsepower. The rest is supplied by the Quebec Hydro-Electric Commission. In the Baie Comeau area, development of the complete Manicouagan-Outardes basin for hydro generation could add 6 million horsepower of new generating capacity in 12 to 15 years. Quebec Hydro currently has an installed capacity of 4,696,300 horsepower, and expansion plans indicate a total installation of 11.6 million by 1975. There is, accordingly, no shortage of power for aluminum-smelting.

Chryslum Limited, which has held the Beauharnois plant on lease since mid-1959, produces aluminum alloys for the Chrysler Corporation of Canada and Chrysler automobile plants in the United States. Power is purchased.

Smelter locations in relation to the flow of bauxite and alumina are shown on the accompanying map.

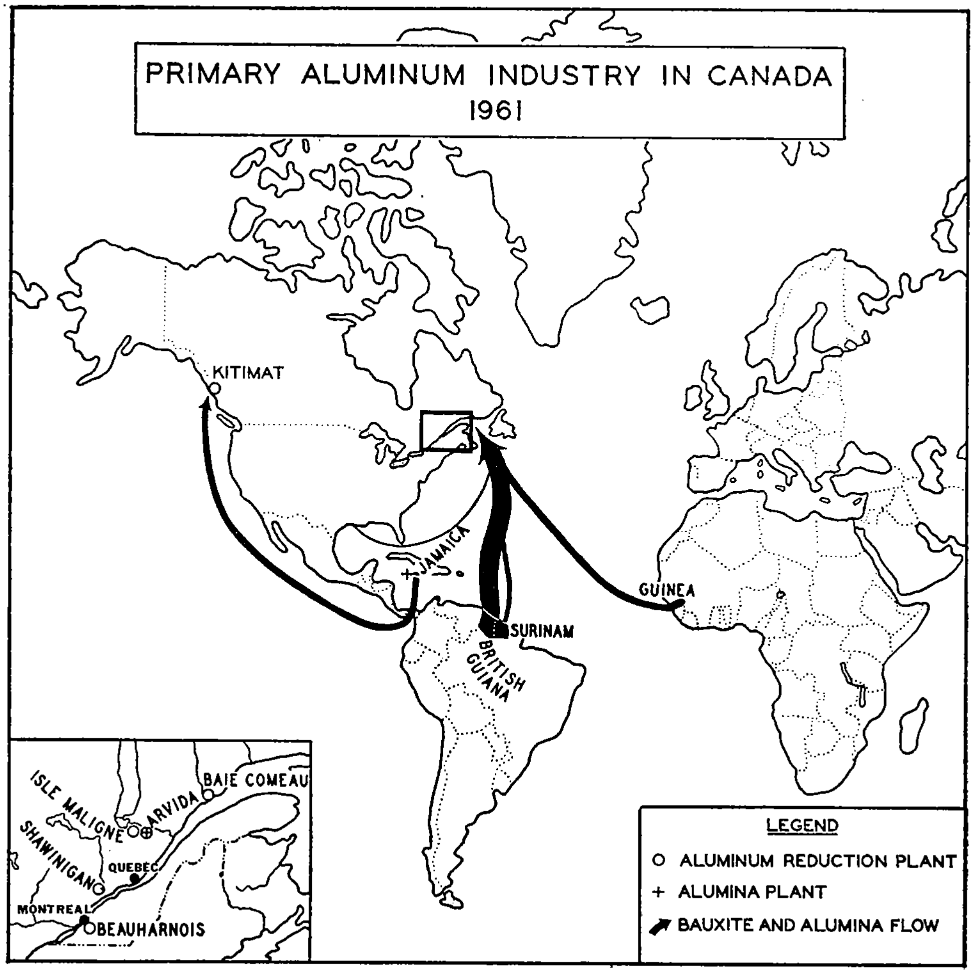


Table 4

CAPACITIES OF CANADIAN ALUMINUM PLANTS AT DECEMBER 31, 1961

Company and Plants	Short Tons
Aluminum Company of Canada, Limited (ALCAN)	
Arvida, Que.	367,000
Beauharnois, Que.*	38,000
Shawinigan, Que.	70,000
Isle Maligne, Que.	115,000
Kitimat, B.C.	192,000
Canadian British Aluminium Company Limited (CBA)	
Baie Comeau, Que.	90,000
Total	872,000

*Leased to Chryslum Limited.

The aluminum-smelting industry of North America is dependent on mines in the Caribbean area for all the bauxite it uses except that shipped from Guinea or produced in the United States. British Guiana and Surinam have long been the main producers. Since World War II, Jamaican mines have been extensively developed; Haiti and the Dominican Republic are the most recent producers. The bauxite required by the alumina plant at Arvida, Quebec, is obtained from the British Guiana and Surinam operations of the Demerara Bauxite Company. In addition to shipping bauxite, the company began production early in 1961 from its 245,000-ton-capacity alumina plant at Mackenzie, British Guiana. Alcan Jamaica Limited operates two alumina plants—the Kirkvine plant, with an annual capacity of 540,000 tons, and the Ewarton plant, with an annual capacity of 270,000 tons. Other sources of alumina include the Corpus Christi, Texas, plant of Reynolds Metals Company and the alumina plant of the Fria consortium in Guinea. In 1961, Canadian imports of bauxite and alumina totalled 2,213,551 tons. As bauxite-mining and alumina-refining are usually carried out by the same companies or sold on long-term contract, prices are not quoted by ore buyers. High-grade Surinam bauxites are valued at $5.90 a ton and alumina from $63.50 to $65.65 a ton.

FOREIGN DEVELOPMENTS

Many considerations lead to aluminum-smelter construction. The incentive may be solely economic—sources of raw materials, power or markets—or it may be, in part, national policies for the development and processing of natural resources. In countries where the balance-of-payments problem is important, a high-cost smelter may be made profitable, with some distortion of the economy, if its production and subsequent manufacturing operations are protected by tariffs or quotas or are encouraged by special inducements.

Relatively few areas of the world have the resources to produce large quantities of low-cost metal in excess of domestic needs. Norway, Australia-New Zealand and certain countries in West Africa, whose internal consumption is low in relation to their production potential, most closely approach Canada's position.

Norway is considering the expansion of its industry for potential markets in Europe. A number of projects could result in the production of hydro power at less than 3 mills a kilowatt-hour. Because of the location, this rate would be competitive with developments in Canada. If all proposals are implemented in the next decade, Norway's production capacity will be surpassed only by that of Canada and the United States.

The bauxite deposits at Weipa, in Queensland, Australia, are being prepared for production. On the basis of these deposits, the small smelter at Bell Bay, Tasmania, will be expanded. There are plans for construction of power facilities and a related smelter at Invercargill, New Zealand. Another project under consideration involves the construction of an alumina plant at Kwinana, Western Australia, to supply a smelter at Geelong, Victoria, based on thermal power from brown coal.

Vast bauxite reserves occur in Cameroun, Guinea and Ghana near undeveloped waterpower sites. With stability and a favorable investment climate, substantial primary-aluminum industries should develop. A small plant already

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exists at Edea in Cameroun. In Ghana, work will start with United States aid on the Volta River power project, which will cost about $196 million. The Fria consortium now processes bauxite in Guinea, and initial shipments of alumina were made to Canada and other countries late in 1960. Bauxite had also been mined at Kassa for some years by Bauxites du Midi, a French subsidiary of Aluminium Limited. Mining by the company and bauxite shipments to Canada were suspended after expropriation, which resulted from a disagreement between the company and the government of Guinea over the timing of the Boké project, a bauxite-and-alumina program that was begun in 1957 and would have cost $175 million.

Expansion is continuing in France, Italy and Yugoslavia. Brazil, the only producer in Latin America, is increasing its facilities. By 1965 Mexico, Surinam and Venezuela expect to be producers. Negotiations taking place in Argentina and Peru may result in the establishment of smelters by 1970.

The world trend is at present toward vertical integration, the smelter output in various countries being tied to the needs of associated fabricating plants. Future smelter projects based on noncaptive markets must therefore be carefully assessed in relation to changing trade patterns. Despite the rapid capacity expansion that has occurred in recent years in both Europe and North America, realization of the projected world demand would afford the competitive exporter ample opportunity. If, however, world demand does not grow as expected or if there is a recession, excess capacity could unduly burden primary producers.

In the United States, the possibility of disposing of government stockpiles is being discussed. Aluminum stocks total 1,929,000 tons, of which 1,127,000 tons are in the national stockpile and 802,000 tons are in the inventories that are subject to the Defense Production Act. Some 729,000 tons are considered surplus to emergency requirements.

The only cryolite mine, in Greenland, may close in 1963. The 800,000 metric tons averaging 60 per cent cryolite that are stockpiled near the mine are enough to feed concentrators in Denmark and the United States for 17 years.

Bauxites mined range from 40 to 60 per cent alumina (Al_2O_3). Most plants recover alumina from ores containing large quantities of the mineral gibbsite with smaller amounts of boehmite, diaspore and impurities. Some European plants can use ores that are high in boehmite or even diaspore if these minerals are soluble enough in the leaching process. Although one plant in the Union of Soviet Socialist Republics uses nepheline as a source of alumina, its commercial use or that of clays and shales in the western hemisphere is still far in the future. A possible exception may be shale mined with coal under special economic and marketing conditions.

Of more immediate interest are the pilot smelting plants of the Pechiney organization in France and of Aluminum Company of Canada, Limited. These companies are investigating thermal methods of producing aluminum directly from bauxite without the intermediate production of alumina. If found economic in an industrial-sized plant in competition with the established electrolytic method, which was developed in 1886 by Hall and Hérault, changes could be expected in the structure of the industry. Meagre information shows that similar work has been going on in the U.S.S.R., where, according to reports, aluminum was produced on December 30, 1960, in a six-electrode furnace at the Irkutsk aluminum plant. Whether production was on an industrial or a pilot-plant scale is not known.

CONSUMPTION AND USES

In 1961 Canadian manufacturers, with allowance for inventory adjustment, used 127,015 tons of primary-aluminum ingot and alloys, 8,316 tons of secondary aluminum and 12,879 tons of outside scrap. With these materials, 134,840 tons of semifabricated products were made, as shown in Table 6.

Aluminum finds its main destructive uses in the form of deoxidizers for steelmaking, as a component of galvanizing baths, as an alloy with magnesium, as a powder in paints and thermite, and in the manufacture of magnet alloys.

TABLE 5

MAIN CONSUMERS OF PRIMARY ALUMINUM

Use							Company
Castings	Extrusions	Sheet	Rod	Forgings	Alloying	Deoxidizers	
						x	Algoma Steel Corporation, Limited, The
	x						Alsco Products of Canada, Limited
x							Alumaloy Castings, Limited
x	x	x	x	x			Aluminum Company of Canada, Limited
	x						Aluminum Extruders, Limited
		x					Aluminum Goods, Limited
						x	Atlas Steels Limited
x							Barber Die Casting Company, Limited
x					x		Bay Bronze, Ltd.
x					x		Canada Metal Company, Limited, The
x					x		Canadian General Electric Company Limited
	x						Canadian Mouldings, Limited
x							Canadian Steel Improvement, Limited
	x						Chromedge (Canada) Limited
x							Dominion Die Casting
						x	Dominion Foundries and Steel, Limited
	x				x	x	Dominion Magnesium Limited
x							Dunbar Aluminum Foundry Limited
x							Electrolux (Canada) Limited
x							Eureka Foundry and Manufacturing Co., Limited
x					x		Federated Metals Canada, Limited
x							Hoover Co., Limited, The
x							Lakeshore Die Casting Limited
x							McKinnon Industries, Limited
					x		Metals and Alloys, Limited
x							Monarch Fabricating Company Limited
x							Outboard Marine Corporation
x							Precision Dies & Castings, Limited
	x						Price-Acme of Canada Limited
		x					Reynolds Aluminum Co. of Canada Ltd.
						x	Steel Company of Canada, Limited, The
		x					Supreme Aluminum Industries, Limited
x							Thompson Products Limited
x	x						Werner (Canada) Limited, R. D.

Castings have varied end-uses, and aluminum rod goes into the making of electrical wire and cable. Building sheet, household utensils, foil, and slugs for making collapsible tubes are well-known end-uses for sheet. Extrusions are used mainly in conjunction with sheet in curtain-wall systems of building construction and in the manufacture of doors and windows. In assessing the future of aluminum consumption it should be remembered that curtain-wall construction was not in use 15 years ago.

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TABLE 6

CANADIAN CONSUMPTION OF ALUMINUM

(Short tons)

	1961	1960
Castings		
Sand	1,183	1,284
Permanent-mould	2,348	2,375
Die	3,520	3,662[r]
Other	593	1,105
Total	7,644	8,426[r]
Wrought products		
Extrusions	30,524	29,764
Sheet, plate, coil and other (including rod, forgings and slugs)	94,944	80,929
Total	125,468	110,693
Destructive uses (available data)		
Nonaluminum-base alloys	232	271
Deoxidizers	1,496	1,441
Total	1,728	1,712
Total consumed	134,840	120,831[r]
Secondary aluminum produced	9,644	9,109

Receipts and inventories at plants

	Metal Entering Plant		On Hand Dec. 31	
	1961	1960	1961	1960
Primary-aluminum ingot and alloys	126,352	111,862	43,241	43,904
Secondary aluminum	8,014	11,458	1,300	1,602
Scrap originating outside plant	13,115	11,340	1,225	989

SOURCE: Dominion Bureau of Statistics, as reported by consumers.
[r]Revised from previously published figures.

PRICES

In 1961, the Canadian base price of primary aluminum in 50-pound ingots, purity 99.5 per cent, f.o.b. shipping point, was 23.25 cents a pound. This price had been in effect since December 16, 1959. On overseas markets the price was 23.25 cents (U.S. funds). In September, the domestic price in the United States declined from 26 to 24 cents.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Bauxite and alumina	free	free	free
Aluminum and aluminum alloys			
Pigs, ingots, blocks, notch bars, slabs, billets, blooms, and wire bars	"	1¼¢ per lb	5¢ per lb
Bars, rods, plates, sheets, strips, circles, squares, disks and rectangles	"	3¢ per lb	7½¢ per lb
Angles, channels, beams, tees, and other rolled, drawn or extruded sections and shapes	"	22½%	30%
Wire and cable, twisted or stranded or not, and whether reinforced with steel or not	"	22½%	30%
Pipes and tubes	"	22½%	30%
Leaf not otherwise provided for or foil, less than 0.005 inch in thickness, plain or embossed, with or without backing	"	30%	30%
Aluminum powder	"	27½%	30%
Aluminum leaf less than 0.005 millimetre in thickness.	"	free	free
Aluminum scrap	"	"	"
Manufactures of aluminum not otherwise provided for.	15%	22½%	30%
Kitchen or household hollow-ware of aluminum, not otherwise provided for	20%	22½%	30%

United States	
Bauxite	free
Aluminum and aluminum alloys in which aluminum is the component material of chief value	
In crude form (not including scrap)	1½¢ per lb
In bars, blanks, circles, coils, disks, plates, rectangles, rods, sheets, squares and strips	2½¢ per lb
Aluminum scrap	free
Aluminum manufactures not otherwise provided for, wholly or in chief value of aluminum	19%
Table, household, kitchen and hospital utensils, and hollow or flat ware, whether or not containing electrical heating elements as constituent parts, wholly or in chief value of aluminum	3½¢ per lb and 17% ad valorem

Antimony

J. W. Patterson*

Canada's output of antimony from domestic ores and concentrates is in the form of antimonial lead resulting from lead-refining. In 1961 the antimony content of the antimonial lead produced was 1,331,297 pounds, or 19.4 per cent less, than in 1960.

The Consolidated Mining and Smelting Company of Canada Limited (Cominco) is Canada's only producer of antimonial lead. From 1938 to 1944, Cominco produced antimony metal in an electrolytic refinery at Trail, British Columbia. Since the closure of the refinery in 1944, however, most of the company's antimony has been in an antimonial-lead alloy that normally contains about 25 per cent antimony. The rest, consisting of small amounts of high-purity antimony, was produced for the electronics industry from imported antimony metal in the electronic-materials plant at Trail, which in 1960 completed its first full year of operation.

Most of the antimonial lead produced at Trail is derived from lead concentrates obtained from ores of the company's Sullivan mine, at Kimberley, British Columbia. The remainder is obtained from smaller company mines and from lead-silver ores and concentrates shipped by other mining companies to Trail for treatment. The lead bullion produced from the smelting of these ores and concentrates contains about 1 per cent antimony, which is recovered in anode residues and furnace drosses resulting from the electrolytic refining of the bullion. The residues and drosses are further refined to yield antimonial lead alloy, to which refined lead may be added to produce a marketable product.

In 1961, world production of antimony, as shown in Table 3, was 60,000 tons.

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*Mineral Resources Division.

Table 1

ANTIMONY—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Production				
Antimony content of antimonial-lead alloys and antimony recovered from flue dust and dore slag	1,331,297	469,948	1,651,786	538,482
Imports				
Regulus				
China (Communist)	550,534	106,938	229,642	36,826
Yugoslavia	88,506	23,235	—	—
Britain	69,058	14,327	353,869	65,624
Belgium and Luxembourg	33,600	8,918	232,195	50,539
United States	5,000	1,129	6,014	1,795
U.S.S.R.	24,698	2,651	22,074	3,482
Netherlands	61,151	12,992	—	—
Total	832,547	170,190	843,794	158,266
Antimony oxide				
Britain	170,560	45,869	253,375	56,216
United States	100,150	23,189	139,476	31,211
France	44,000	10,160	—	—
Belgium and Luxembourg	44,007	11,077	44,000	9,221
Total	358,717	90,295	436,851	96,648
Antimony salts				
United States	45,028	23,341	37,251	17,846
Exports				
Antimony content of antimonial-lead alloys	1,192,820		1,123,050	
Consumption				
Antimony regulus in production of:				
Antimonial-lead alloys	500,877		576,996	
Babbitt	121,417		113,311	
Solder	22,674		10,518	
Type metal	132,667		100,849	
Other commodities*	251,284		150,042	
Total	1,028,919		951,716	

Source: Dominion Bureau of Statistics.

*Includes antimony oxide, foil, bronze, secondary metals, pipe and sheet, lead-base alloys, drop shot and other minor commodities.

TABLE 2

ANTIMONY—PRODUCTION, IMPORTS AND CONSUMPTION 1951-1961

(pounds)

	Production[1] (all forms)	Imports (regulus)	Consumption[2] (regulus)
1951	6,702,164[3]	1,362,260	1,480,000
1952	2,330,900	1,721,622	1,334,000
1953	1,488,105	1,729,253	1,606,000
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

SOURCE: Dominion Bureau of Statistics.

[1]Antimony content of antimonial-lead alloys and antimony recovered from flue dust and dore slag. All is derived from Canadian ores.

[2]Consumption of antimony regulus as reported by consumers. Does not include antimony in antimonial lead produced by The Consolidated Mining and Smelting Company of Canada Limited.

[3]Includes antimony in flue dust and dore slag produced in 1949 and 1950 but not previously recorded.

TABLE 3

WORLD PRODUCTION OF ANTIMONY, ON MINE BASIS EXCEPT AS OTHERWISE INDICATED

(short tons)

	1961	1960
China (Communist)	18,500[e]	19,000[e]
Republic of South Africa (exports)	11,804	13,538
U.S.S.R.	6,600[e]	6,600[e]
Bolivia (exports)	7,429[1]	5,872[1]
Mexico	3,977[1]	4,664[1]
Yugoslavia	2,715	2,657
Czechoslovakia	1,800[e]	1,800[e]
Turkey	2,774	1,650
Algeria	827	886
Other countries	3,600	4,300
Total[2]	60,000	61,000[3]

SOURCE: U.S. Bureau of Mines and American Bureau of Metal Statistics.

[1]Includes the antimony content of smelter products derived from mixed ores.

[2]Antimony is also produced in Hungary, but production data are not available.

[3]Rounded.

[e]Estimated.

The amount of antimony metal consumed annually in Canada has remained fairly constant in recent years, never varying much from 1 million pounds. In 1961, consumption totalled 1,028,919 pounds.

In 1961, the United States, to which Canada ships most of its antimonial lead, consumed 12,697 tons of primary antimony. In 1960 its consumption amounted to 13,267 tons and in 1959 to 13,317 tons. The country's mines provided primary metal as follows: 689 tons in 1961; 635 tons in 1960; and 678 tons in 1959. Imports, which, in order of importance, included ores and concentrates, metal, antimony oxide, antimonial lead and antimony sulphide, contained 13,942 tons of antimony. Their antimony content amounted in 1960 to 14,515 tons and in 1959 to 13,273 tons. The main sources of the 1961 imports were Britain, Mexico, the Republic of South Africa and Yugoslavia.

OCCURRENCES

Several Canadian occurrences or deposits of the principal antimony mineral, stibnite (Sb_2S_3), have been explored and partly developed, but results generally have not been encouraging. The better-known occurrences are: Mortons Harbour mine, New World Island, Notre Dame Bay, Newfoundland; West Gore deposits, Hants county, Nova Scotia; Lake George property, Prince William parish, York county, New Brunswick; South Ham deposit, Wolfe county, Quebec; Stuart Lake mine, near Fort St. James, British Columbia. Other deposits are situated as follows: British Columbia—near Bralorne, in the Bridge River district, and near Slocan City and Sandon, in the southeastern part of the province; Yukon Territory—south of Whitehorse, in the Wheaton River area, and near Highet Creek, in the Mayo district.

USES AND CONSUMPTION

Antimony finds its main use as an ingredient in many lead alloys largely because of the hardening and strengthening effect it has on the alloys and, to a lesser extent, because of its expansion on solidification. The alloys receive their ability to expand from the antimony.

Antimonial lead is employed chiefly in the manufacture of storage batteries. Alloys used for this purpose contain between 3 to 12 per cent antimony. Antimonial-lead alloys also serve in the manufacture of type metal, bearing metal, solder and cable sheathing.

Certain compounds of antimony, because of their fire-retardant properties, are used in flameproof 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 used in the manufacture of white paint, which is superior to common white lead paints because of its finer texture, its greater opacity and its whiteness. The oxide, when used in white enamels, lessens the blistering effects normally accompanying the use of tin oxide and adds to the brilliancy of the enamel.

The thermoelectric properties shown by various alloys of antimony when used with such metals as bismuth, selenium, silver and tellurium and the use of an aluminum-antimony alloy in the manufacture of transistors and rectifiers have given high-purity antimony a wider application.

PRICES AND TARIFFS

The price of antimony, boxed, New York, as quoted by *E & M J Metal and Mineral Markets,* was 32.59 cents a pound until April 3, when it rose to 36.25 cents. On the same date, the bulk price, f.o.b. shipping point, which had been 29 cents a pound, was raised to 32.5 cents. These increased prices remained in effect for the rest of 1961.

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$\frac{1}{16}$ cents pound; antimony oxide, 1 cent a pound; antimony, liquated or needle, ¼ cent a pound; and antimony sulphides and other compounds, ad valorem rates plus fixed amounts. Antimony ores and concentrates enter the United States duty-free.

Asbestos

H. M. Woodrooffe*

In 1961, sales of Canadian asbestos reached a record for the second consecutive year. Shipments amounted to 1,173,695 tons valued at $128,955,900, or 55,000 tons more than in 1960. All producing provinces reported an increase in shipments, the greatest demand being for the long- and medium-fibre grades.

A recent major development in the asbestos industry was the conversion of the Jeffrey mine of Canadian Johns-Manville Company, Limited, to an open-pit operation after several years of underground mining. The transition was virtually complete by the end of 1961.

During the year, the Quebec Asbestos Mining Association, which represents the asbestos mines of the Province of Quebec, established a testing unit jointly with the University of Sherbrooke. Known as the Asbestos Fibre Standards Laboratory, the unit is to carry out impartial testing to ensure uniformity of grading throughout the province.

Deposits in the western part of the United States were of growing interest. In California, Jefferson Mining Corporation was developing Calaveras county's Copperopolis deposit for production in 1962, and Johns-Manville Corporation was developing its mine at Coalinga for production early in the same year. The latter operation will supply short-fibre grades to the west-coast market.

Domestic consumption of asbestos remains small, almost all production being exported to world markets. In value, exports to the United States were nearly equal to 40 per cent of all the asbestos shipments made by Canadian producers. Canada imports crocidolite and amosite from the Republic of South Africa.

Chrysotile asbestos occurs in several places in northern Ontario and in Quebec, Newfoundland, British Columbia and Yukon Territory, but many of the occurrences are not of economic grade. Consequently, production is restricted to British Columbia, Ontario and Quebec, the last contributing 95 per cent of Canada's output of asbestos fibre. Production has been continuous since 1878.

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*Mineral Processing Division, Mines Branch.

TABLE 1

ASBESTOS—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
By shipments				
Crude	163	143,296	330	337,114
Milled fibres	548,230	95,583,906	483,183	87,694,929
Shorts	625,302	33,228,698	634,943	33,367,972
Total	1,173,695	128,955,900[1]	1,118,456	121,400,015[1]
By province				
Quebec	1,103,545	115,944,729	1,054,424	107,788,172
British Columbia	45,103	8,648,503	40,748	9,482,923
Ontario	25,047	4,362,668	23,284	4,128,920
Total	1,173,695	128,955,900	1,118,456	121,400,015
Exports				
Fibres				
Crude				
West Germany	62	54,338	26	22,727
Japan	67	59,082	54	46,765
United States	28	31,834	88	104,405
Other countries	19	18,268	73	73,113
Total	176	163,522	241	247,010
Milled				
Group 3 grades				
United States	13,801	6,040,637	15,571	7,324,214
Britain	2,603	972,039	3,138	1,400,256
West Germany	3,184	1,292,214	2,556	1,070,936
Japan	1,834	693,589	1,506	654,158
France	1,689	669,867	1,678	746,227
Italy	670	248,990	782	321,957
Spain	630	240,511	360	152,451
Belgium and Luxembourg	289	109,431	470	192,279
Brazil	55	20,761	237	85,613
Australia	23	8,503	123	41,314
Other countries	2,826	1,106,172	2,641	1,177,268
Total	27,604	11,402,714	29,062	13,166,673
Group 4 and 5 grades				
United States	131,482	22,933,302	131,077	22,277,411
West Germany	48,430	8,644,742	38,811	6,647,655
Britain	34,963	6,426,134	33,474	5,994,337
Japan	51,094	6,752,460	37,268	4,962,052
France	36,490	6,726,486	22,721	4,067,381
Belgium and Luxembourg	23,535	4,209,109	28,943	5,107,067
Australia	22,315	3,460,172	20,327	3,146,056
Italy	18,953	3,559,569	9,363	1,626,455
Brazil	12,973	2,267,729	10,465	1,815,028
Spain	10,175	1,945,169	4,458	878,675
Other countries	109,310	19,462,358	92,084	16,113,859
Total	499,720	86,387,230	428,991	72,635,976

TABLE 1 (cont'd)

	1961		1960	
	Short Tons	$	Short Tons	$
Exports (cont'd)				
Total, fibres, groups 3, 4 and 5				
United States	145,283	28,973,939	146,648	29,601,625
West Germany	51,614	9,936,956	41,367	7,718,591
Japan	52,928	7,446,049	38,774	5,616,210
Britain	37,566	7,398,173	36,612	7,394,593
Belgium and Luxembourg	23,824	4,318,540	29,413	5,299,346
France	38,179	7,396,353	24,399	4,813,608
Australia	22,338	3,468,675	20,450	3,187,370
Brazil	13,028	2,288,490	10,702	1,900,641
Italy	19,623	3,808,559	10,145	1,948,412
Spain	10,805	2,185,680	4,818	1,031,126
Other countries	112,136	20,568,530	94,725	17,291,127
Total	527,324	97,789,944	458,053	85,802,649
Short-fibre grades				
United States	412,722	21,556,498	450,102	24,198,276
Britain	36,950	2,052,007	38,204	1,992,144
Japan	44,618	3,815,841	32,592	2,836,041
West Germany	26,633	1,374,457	37,759	1,897,645
Belgium and Luxembourg	13,212	1,024,761	7,001	411,594
France	11,662	662,208	6,846	378,626
Netherlands	7,547	474,473	8,170	444,409
Other countries	36,036	2,427,098	29,525	1,905,064
Total	589,380	33,387,343	610,199	34,063,799
Total, exports of asbestos fibre	1,116,880	131,340,809	1,068,493	120,113,458
Manufactured products				
Brake linings and clutch facings				
Cuba		199,892		29,827
Venezuela		52,623		47,601
United States		43,467		4,811
Lebanon		37,088		21,320
United Arab Republic (Syria)		20,491		20,988
El Salvador		20,634		17,960
Greece		19,695		20,509
Ecuador		23,481		22,207
Other countries		195,374		193,759
Total		612,745		378,982
Asbestos and asbestos-cement building materials[2]				
United States		98,331		
Cuba		4,190		
Trinidad		880		
Bermuda		315		
Jamaica		231		
Other countries		2,004		
Total		105,951		

(Continued)

TABLE 1 (cont'd)

	1961		1960	
	Short Tons	$	Short Tons	$
Exports (cont'd)				
Asbestos and asbestos-cement basic products not elsewhere specified[2]				
United States		119,708		
Britain		19,888		
Switzerland		51,704		
Colombia		10,858		
Finland		10,141		
Cuba		22,018		
Other countries		27,515		
Total		261,832		
Total, asbestos and asbestos-cement building materials and asbestos-cement basic products not elsewhere specified[3]				
United States		218,039		441,560
Britain		19,888		84
Switzerland		51,704		51,348
Colombia		10,858		—
Finland		10,141		3,800
Cuba		26,208		—
Other countries		30,945		122,363
Total		367,783		619,155
Total, exports of manufactured products		980,528		998,137
Imports				
Packing	248	429,600	250	378,831
Auto brake linings		804,368		630,451
Auto clutch facings		296,713		282,776
Other brake linings and clutch facings		187,888		408,935
Other asbestos manufactures		3,553,166		2,797,506
Total		5,271,735		4,498,499

SOURCE: Dominion Bureau of Statistics. [1]Does not include the value of the containers. This amounted to $3,791,778 in 1960 and an estimated $4,404,380 in 1961. [2]New classes effective in 1961. No comparable classes exist for previous years. [3]The sum of the two classes covered by footnote 2 is in part comparable with the total of exports of manufactured asbestos products for the years prior to 1961. Beginning with the 1961 statistics, some exports of manufactured asbestos products appear in fully fabricated classes, where their identity is lost.

TABLE 2

ASBESTOS—PRODUCTION AND EXPORTS, 1951-61

(short tons)

	Production*				Exports			
	Crude	Milled	Shorts	Total	Crude	Milled	Shorts	Total
1951	748	333,001	639,449	973,198	660	324,594	617,060	942,314
1952	741	351,644	576,954	929,339	692	339,818	561,548	902,058
1953	781	326,340	584,105	911,226	638	316,588	561,304	878,530
1954	725	326,653	596,738	924,116	641	312,844	574,243	887,728
1955	724	395,096	667,982	1,063,802	586	365,980	635,261	1,001,827
1956	717	392,983	620,549	1,014,249	560	377,044	586,317	963,921
1957	622	404,016	641,448	1,046,086	638	393,311	636,611	1,030,560
1958	605	342,562	582,164	925,331	483	318,280	547,867	866,630
1959	432	404,019	645,978	1,050,429	416	401,583	611,923	1,013,922
1960	330	483,183	634,943	1,118,456	241	458,053	610,199	1,068,493
1961	163	548,230	625,302	1,173,695	176	527,324	589,380	1,116,880

SOURCE: Dominion Bureau of Statistics. *Producers' shipments.

What are believed to be the world's largest deposits of asbestos occur in the part of Quebec commonly referred to as the Eastern Townships, 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 persistence of the mineral at depth, as established by drilling, indicates that reserves are sufficient for many years.

TECHNOLOGY

While there are a number of asbestiform minerals, the principal ones that have an industrial or commercial application are *chrysotile*, a hydrous magnesium silicate; *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. To all these minerals, industry applies the broad term 'asbestos.'

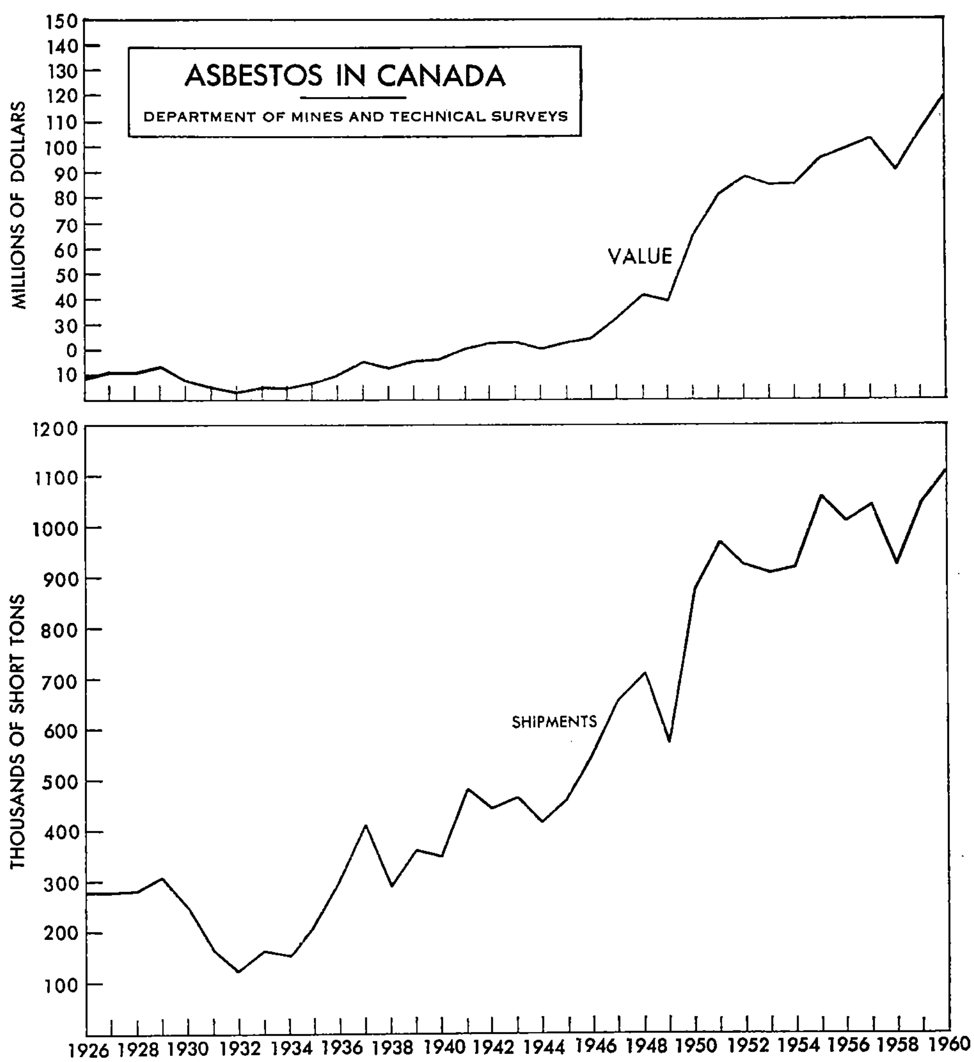
Chrysotile, by far the most important asbestiform mineral, provides upwards of 90 per cent of the world's commercial asbestos.

It is the only variety mined in Canada and occurs in two forms—'cross fibre' and 'slip fibre.'

In the former, individual fibres lie parallel across the vein so that the vein width is an approximate indication of fibre length. Many of the partings often found in the veins are caused by the inclusion of magnetite or other minerals. Some fibres are as long as 5 inches, but most of the fibre recovered commercially is half an inch or less in length.

Slip fibre, which frequently occurs along the Pennington Dike east of Thetford Mines, is normally found along fault planes in heavily sheared peridotite or serpentine bodies. Fibres of this type are arranged in an overlapping manner.

Many industrial uses of chrysotile are rather a result of the mineral's physical characteristics than of its chemical nature. These properties vary to some degree with the occurrence. Whereas Quebec is able to produce a fine, silky fibre ideally suited for spinning and being 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 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 and Australia.

Amosite, a heat-resistant type of anthophyllite, is used principally in the manufacture of thermal insulation. No Canadian occurrence is known.

Other asbestos minerals—fibrous tremolite, actinolite and anthophyllite—occur in Canada, but none are 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, it was reported that a small amount of tremolite was being produced in eastern Ontario.

Chrysotile is mined in Canada by both open-pit and underground methods. It is prepared for the market 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 considered.

PRODUCTION AND DEVELOPMENT

Newfoundland

Chrysotile occurs in several places in this province. A recent discovery of a semiharsh-fibre deposit near Baie Verte, on the northeast coast of the island, was being developed by Advocate Mines Limited. Substantial reserves had been established, and the deposit was being prepared for early production. The company is controlled by an international group of asbestos firms headed by Canadian Johns-Manville Company, Limited.

Quebec

Asbestos is produced in the southern part of the province, in the counties of Richmond, Arthabaska, Megantic and Beauce. There were 13 producing mines in the vicinities of Thetford Mines, Black Lake, East Broughton and Asbestos.

The world's largest asbestos mine, 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 property, 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 has embarked upon an extensive conversion program, which it has well in hand. Most mill feed is now recovered by open pit.

Asbestos Corporation Limited had three mills in operation in the Thetford Mines area. Two—the British Canadian, at Black Lake, and the Normandie, in Ireland township—processed ore recovered from adjacent open pits. At Thetford Mines, the operations of the Beaver pit and King underground mine have been integrated with those of 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, produced the mineral from an open pit at Black Lake, where a 4,000-ton mill was placed in operation in 1954.

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

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

Lake Asbestos of Quebec, Ltd., a subsidiary of American Smelting and Refining Company, operated a 5,000-ton-a-day mill at 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 Philip Carey Manufacturing Company, was in production with a 2,500-ton mill at its new property near Tring Junction, in Beauce county, east of Thetford Mines.

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

Murray Mining Corporation Limited was actively exploring an occurrence in Ungava, northern Quebec, about 30 miles south of Deception Bay. By the end of 1961 the company reported an asbestos zone bearing reserves of 20 million tons of ore.

Ontario

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

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 over the Alaska Highway to Whitehorse, Yukon Territory, on the White Pass & Yukon Route (railway) to Skagway, Alaska.

WORLD REVIEW

To meet the diversified requirements of the market, world production of asbestos, including all varieties, rose in 1961 to a record level. World output is estimated to have amounted to 2.9 million short tons, of which Canada contributed 40 per cent.

During the past few years, the Union of Soviet Socialist Republics 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 close to 1 million tons a year. The U.S.S.R. exports about 15 per cent of its production and competes with Canadian asbestos in overseas markets.

Africa also makes an important contribution to the world's asbestos output. In 1961, the Federation of Rhodesia and Nyasaland produced 161,610 tons of chrysotile. Rhodesian fibre, because of its freedom from magnetic iron, finds a ready market in asbestos products used by the electrical industry.

The asbestos-mining industry of the Republic of South Africa is the dominant world producer of crocidolite and amosite. In 1961, the production of all varieties totalled 194,834 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 supply and distribution and in the disposal of sewage waste is now well established. The durability of the pipe and its resistance to corrosion have been of 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 a 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, including woven and moulded brake linings, clutch facings and pressure gaskets. Undercoating compounds provide an important use for very short grades of fibre.

PRICES

Asbestos prices at the end of 1961 were virtually the same as in 1960. By grades, normal prices for carload lots, in Canadian dollars per short ton f.o.b. Quebec producers, were as follows:

No. 1 Crude	$1,400	No. 4T Crude	$ 181	No. 7K Crude	$ 50
No. 2 Crude	750	No. 4Z Crude	181	No. 7M Crude	44
No. 3K fibre	480	No. 5D Crude	142	No. 7R Crude	43
No. 3R fibre	408	No. 5K Crude	142	No. 7T Crude	41
No. 3T fibre	370	No. 5R Crude	120	No. 7R F floats, no test	44
No. 3Z fibre	345	No. 6D Crude	86	No. 7T F floats, no test	44
No. 4H fibre	208	No. 7D Crude	75	No. 8S no test	29
No. 4K fibre	200	No. 7F Crude	71	No. 8T no test	22
No. 4M fibre	200	No. 7H Crude	61		

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Barite

J. S. Ross*

Barite shipments continued in 1961 to fluctuate markedly with export requirements. Production amounted to 191,404 tons valued at $1,799,119, thus exceeding by 24 per cent the unusually low level of 1960. This increase reflected a rise in the consumption of Canadian barite in the United States. The upswing occurred despite a small decrease in that country's import total and in the activity of its well-drilling industry, which constitutes the chief market. The production increase was almost entirely in the crude variety.

Five barite deposits were worked by four companies in two provinces to produce both crude and ground barite. Statistics indicate that less than 7 per cent was of the ground variety, but about 17 per cent is eventually ground in Canada, some of it in provinces other than the province of origin. The remainder is either exported or used in the crude form.

In 1960, when the world had an estimated output of 3.1 million short tons, Canada was the sixth-ranking producer. In 1961, 3 million short tons were produced and Canada was in fourth place. More than half the world's production for that year came from the United States, West Germany, Mexico and Canada, in that descending order.

Ninety per cent of Canada's 1961 output was exported, and about 92 per cent went to the United States mainly in the crude form. Smaller amounts of ground barite were shipped to Trinidad and Venezuela. The rise in domestic production paralleled the 27-per-cent-increase in exports, which was due to the more successful competition of domestic crude barite in the United States. Although many countries competed for this market, Mexico, Canada, and Peru remained the chief suppliers. There was a notable decline in United States imports of barite from Greece and Mexico.

Imports were of the ground chemical variety and amounted only to 1,889 tons almost entirely from the United States and West Germany.

Domestic consumption of the commodity varies with the needs of the well-drilling industry but is not subject to major fluctuations. In 1961 the apparent consumption amounted to 21,597 tons; in 1960 it totalled 21,341 tons. Available statistics indicate that 18,723 tons were used in 1961.

* Mineral Processing Division, Mines Branch.

TABLE 1

BARITE—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (mine shipments)				
Crushed and lump	178,864	1,540,168	142,789	1,231,258
Ground	12,540	258,951	11,503	230,954
Total	191,404	1,799,119	154,292	1,462,212
Imports (ground)				
United States	1,582	83,654	1,639	80,328
West Germany	282	9,632	337	9,610
Britain	25	962	45	1,241
Total	1,889	94,248	2,021	91,179
Exports				
United States	157,920	1,782,876	115,987	1,096,465
Trinidad	9,856	182,336	10,080	186,480
Venezuela	3,920	33,323	8,905	75,694
Total	171,696	1,998,535	134,972	1,358,639
Consumption*				
Paints	910		953	
Rubber goods	301		218	
Glass	412		364	
Miscellaneous chemicals	80		23	
Miscellaneous nonmetallic products	9		116	
Well-drilling	17,011		23,809	
Total	18,723		25,483	

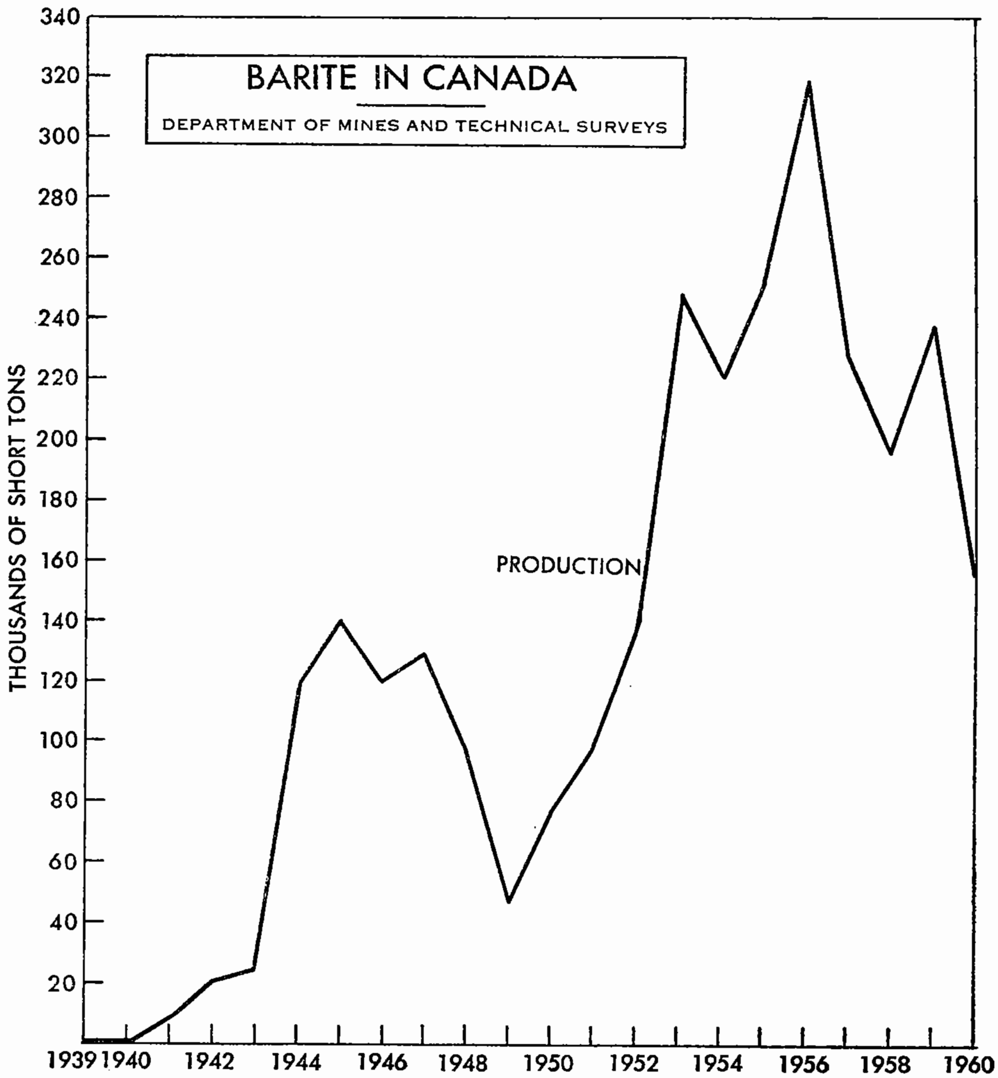
SOURCE: Dominion Bureau of Statistics. *These quantities are calculated from information provided by the Dominion Bureau of Statistics.

Small quantities of the metals barium and strontium are produced by Dominion Magnesium Limited at Haley, Ontario, and are exported to the United States.

PRODUCTION

Barite is known to occur in all provinces except Alberta, Saskatchewan and Prince Edward Island.

It is mined in Nova Scotia, where one deposit is in production, and in British Columbia, where three companies conduct operations at four deposits. From time to time a fifth deposit is mined in the west-coast province. The entire output of British Columbia is shipped to other provinces for processing. All production from Nova Scotia is shipped elsewhere, and most is processed in the United States.



Nova Scotia

Normally, about 90 per cent of Canada's barite output is obtained from the mine of Magnet Cove Barium Corporation, near Walton.

During the year, the company estimated the ore reserves of this mine at 1,960,000 short tons. Ore was recovered by blast-hole stoping and block-caving methods above the 850-foot level. It was concentrated at a beneficiation plant at the mine site and trucked to the port of Walton. Crushed and lump barite, as well as occasional cargoes of the ground variety, are shipped, mainly by water, to the United States, Trinidad, Venezuela and other parts of Canada, and occasionally to the Middle East and other South American countries. With the exception of a few minor shipments, this barite is pulverized and used in well-drilling. In the latter part of the year the company started to mine a lead-silver deposit associated with the footwall zone of the barite orebody.

British Columbia

Mountain Minerals Limited mined barite from two vein deposits near Brisco and Parson. Ore was recovered by open-pit and underground methods and shipped to various other provinces. Much of it was processed at the company's grinding plant at Lethbridge, Alberta, for use in well-drilling muds.

Baroid of Canada, Ltd., began to produce barite on a commercial scale from tailings at the Giant mine, near Spillimacheen. The mineral is recovered as a concentrate and shipped to the company's grinding plant at Onoway, Alberta, for further processing and eventual sale to the well-drilling industry.

At the Mineral King mine of Sheep Creek Mines Limited, near Invermere, barite is recovered as a by-product during the open-stope mining of lead-zinc ore. It is shipped, as crude, to grinding plants in Alberta and processed for use mainly as a heavy medium in well-drilling.

Alberta

No barite is mined in Alberta. In the province, however, there are three grinding plants that process most of the barite shipped from British Columbia. The plant at Magcobar Mining Company, Limited, is at Rosalind and that of Mountain Minerals Limited is at Lethbridge. The plant of Baroid of Canada, Ltd., is at Onoway.

Quebec

Barite is occasionally purchased and processed in Montreal by Industrial Fillers Limited.

OTHER OCCURRENCES

In most provinces there are many other barite deposits, some of which have been mined intermittently, particularly during the early part of this century. 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 near Invermere, and Mile 397 on the Alaska Highway, in British Columbia. Witherite (barium carbonate) occurs in a large deposit near Mile 497 on the British Columbia section of the Alaska Highway. Witherite, barylite, barytocalcite and other, rarer, barium minerals occur in Canada but have not yet been utilized.

Barite deposits in British Columbia, the Northwest Territories, Quebec and Nova Scotia were explored during the year.

The proven reserves in the deposits now being worked are sufficient to meet the normal requirements of more than a decade. In addition, there are a number of notable deposits that are not being mined.

USES AND SPECIFICATIONS

Barite is used for either its physical or its chemical properties. The physical properties are important owing to its relatively high specific gravity, its inertness under normal conditions, and its occasional whiteness. It is used in chemical processes because of its barium content.

Barite is marketed in lump, crushed or ground form. By far the largest part of world production serves as a heavy medium in well-drilling muds, in which it helps to control fluid pressures and float drill cuttings. The welfare of the industry consequently depends upon barite consumption in well-drilling. Barite, normally the most desirable commodity for this purpose, is not likely to be replaced to any extent in the near future by other heavy media. Although air and gas drilling, whether with or without fluids other than mud, has shown a marked increase in recent years, particularly in North America, it has not had any noticeable effect on barite consumption.

In Canada and throughout the world, about 93 per cent of the barite consumed is employed as a heavy medium in oil- and gas-well drilling. Virtually all the barite exported by Canada is used for this purpose. Specifications, which vary according to the particular needs of the consumer, may require a minimum specific gravity of 4.2 to 4.25, a minimum of 90 per cent barium sulphate and a mesh size that is 90 to 95 per cent minus-325. Soluble salts are objectionable, but a content of several per cent iron is not.

About 7 per cent of the domestic consumption serves as a conventional type of filler in paints, varnishes, rubber goods and paper. In all except rubber products, in which the required whiteness may vary with the product and the process, barite must have high reflectivity, a usual minimum of 94 per cent barium sulphate, and a particle size of less than 200-mesh.

Barite is used as a chemical in glass manufacture. In this it acts as a flux, makes the melt more workable and increases the lustre of the finished product. When so employed, it must contain a minimum of 98 per cent barium sulphate and less than 0.15 per cent ferric oxide and be between 20- and 200-mesh.

Because the barium-chemicals industry is almost nonexistent in Canada, its 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 a filler in paper; lithopone, a mixture of barium sulphate 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. Because barium titanate has a high dielectric constant and piezoelectric and ferroelectric properties, its use in relatively minor amounts has become widespread, particularly in miniature electronic components and the communications industry. 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 1 per cent ferric oxide.

Crushed barite is used occasionally as a heavy aggregate in concrete employed as a shield against atomic radiation.

Available statistics on some of the barium chemicals consumed in Canada are given in Table 2.

TABLE 2

BARIUM COMPOUNDS—IMPORTS AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Imports				
Lithopone (70% $BaSO_4$)	630	91,250	893	121,667
Blanc fixe and satin white	1,144	101,149	1,205	113,492
	1960		1959	
Consumption of some barium compounds in the chemical and allied-products industries				
Barium chloride	297		627	
Barium nitrate	58		66	
Blanc fixe	284		495	
Lithopone	1,058		877	

SOURCE: Dominion Bureau of Statistics.

PRICES

Prices for barite received at United States Gulf ports, as quoted in *E & M J Metal and Mineral Markets* of December 21, 1961, showed a reduction from the 1960 range of $16 to $18 to one of $12.50 to $14 a ton for 1961. All other prices were unchanged. A listing follows:

Canada	
Crude, in bulk, f.o.b. shipping point, per long ton	$11.00
Ground, in bags, per short ton	16.50
Missouri	
Water-ground and floated, bleached, carload lots, f.o.b. mill, per short ton	45.00-$49.00
Crude ore, min. 94% $BaSO_4$ less than 1% Fe, per short ton	16.00- 18.00
Crude oil-well-drilling, min. specific gravity 4.3, bulk, per short ton	18.00
Ground, oil-well grade, per short ton	26.75
U.S. Gulf ports	
Foreign, crude, oil-well grade, min. specific gravity 4.25, bulk, c.i.f. ports, per short ton	12.50- 14.00

In 1961 Canadian shipments of unprocessed and semiprocessed barite concentrates averaged $8.61 per short ton at the mine or mill. For the ground product, the value was $20 to $25. The corresponding prices for 1960 were $8.62 and about $20 to $25 a ton.

TARIFFS

The following import tariffs are those currently in effect in Canada and the United States.

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

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

Bentonite

J. S. Ross*

Although small in comparison with most other mineral industries, Canada's bentonite industry has grown appreciably in the last three years. Despite the flourishing condition of the bentonite industry in the United States, Canadian consumers have, for the most part, quickly accepted Canadian bentonite products for about half their requirements. The crucial challenge, however, which was first encountered in 1960, requires that the Canadian industry become competitive in providing substantial quantities of high-quality bentonite for the pelletizing of iron-ore concentrates. If this could be accomplished, Canada would be virtually self-sufficient in bentonite. By the end of 1963, the domestic market will be about three times current production.

In industry, the term 'bentonite' is normally used to designate clay consisting chiefly of clay minerals of the montmorillonite group. These minerals have ions in their structures that can be exchanged for others. Although there are various classifications, bentonites may be roughly classified into two main types—swelling and non-swelling. In the swelling variety, the predominant exchangeable ion is sodium; in the nonswelling type it is calcium. When immersed in water, swelling bentonite increases noticeably in volume and forms a permanent colloidal suspension. Nonswelling bentonite can adsorb certain impurities from liquids and, when it is activated, its adsorption properties may increase appreciably. Fuller's earth is a naturally active nonswelling bentonite.

Swelling, nonswelling and activated bentonites, the most commonly used types, are produced by three companies in western Canada.

PRODUCTION AND TRADE

Mainly owing to the low number of producers, complete statistics for bentonite in Canada are not available. Trade statistics indicate, however, that about half the quantity consumed in 1961 was supplied by domestic producers.

Alberta has two producing bentonite deposits and processing plants and Manitoba has one of each. Magcobar Mining Company, Limited, recovers several

* Mineral Processing Division, Mines Branch.

TABLE 1

BENTONITE—TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Imports				
Activated bentonite[1]				
United States		1,006,916		936,029
Fuller's earth				
United States		150,576		155,494
West Germany		4,619		5,184
Britain		1,807		629
Total		157,002		161,307
Bentonite for use in drilling mud				
United States	14,224	364,252	16,191	493,105
Exports				
Earths or clays artificially activated[2]				
United States	4,503	191,841	5,892	248,418
Consumption[3]				
Well-drilling	36,664		39,144	
Iron and steel foundries	12,912		13,283	
Pelletizing	10,213		8,500[e]	
Petroleum-refining	2,265		1,871	
Paper	227		277	
Miscellaneous chemicals	251		568	
Miscellaneous nonmetallic products	736		1,228	
Total	63,268		64,871[e]	

Source: 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). [3]Includes fuller's earth and is calculated from data provided by the Dominion Bureau of Statistics. [e]Estimated.

grades of swelling bentonite from the Edmonton formation near Rosalind, Alberta. The clay is dried, ground and sized at Rosalind and marketed for various uses. Near Onoway, Alberta, Baroid of Canada, Ltd., recovers swelling bentonite from the Edmonton formation and dries, pulverizes and sizes it at Onoway for use in well-drilling and foundries. Pembina Mountain Clays Ltd. mines nonswelling bentonite from the Vermilion River formation near Morden, Manitoba, from where it ships pulverized bentonite for use in certain types of pelletizing, foundry castings and insecticides. At its Winnipeg plant the company activates bentonite to produce a good-quality bleaching clay for use in the refining of animal, vegetable and mineral oils.

In 1961, Canada exported 4,503 tons of artificially activated bentonite to the United States. Imports were chiefly from the United States, had a value of $1,528,170 and consisted of 14,224 tons of the swelling type and an unknown amount of the natural and artificially activated varieties. In addition, about 10,200 tons were imported for pelletizing and an unknown amount for other uses.

Table 2

BENTONITE—PRODUCTION, IMPORTS AND CONSUMPTION, 1951-61

	Production[1]	Imports[2]	Consumption	
	Bentonite ($)	Bentonite ($)	Fuller's Earth (short tons)	Bentonite (short tons)
1951	499,556	374,200	7,050	30,670
1952	388,542	460,734	8,620	30,622
1953		443,510	15,982	35,167
1954		835,433	1,732	23,844
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[3]
1960		1,590,441	[4]	64,871[3]
1961		1,528,170	[4]	63,268[3]

Source: Dominion Bureau of Statistics except where otherwise indicated. [1]The value of producers' shipments is not available for publication for the years after 1952. [2]Activated clays for oil-refining. They include clay catalysts in addition to adsorptive clays. [3]The larger totals are due in part to an increase in the survey coverage, particularly in well-drilling. It includes fuller's earth. Calculated from data provided by the Dominion Bureau of Statistics. [4]Included with bentonite.

CANADIAN OCCURRENCES

The more extensive bentonite deposits are in formations of Cretaceous and Tertiary age in the four western provinces. In Manitoba, nonswelling bentonite occurs in the Vermilion River formation and the semiswelling variety in the Riding Mountain formation. Both formations extend from the United States border, near Morden, northwest to Swan River. In Saskatchewan, semiswelling bentonite is in the Ravenscrag formation in the southwestern part of the province, while the nonswelling horizons are in the Vermilion River and Riding Mountain formations in the southeastern part and in the Ravenscrag formation near Rockglen.

The better types of swelling bentonite in Alberta are in the Edmonton and Bearpaw formations, which are near such communities as Rosalind, Onoway, Camrose, Drumheller-Rosedale, Irvine-Bulls Head, Bickerdike and Grande Prairie.

In British Columbia, bentonite is in Tertiary formations, chiefly near Princeton, Merritt, Kamloops and Clinton.

CONSUMPTION AND USES

Some 63,268 tons of bentonite, including fuller's earth, were consumed in Canada in 1961. Fifty-eight per cent was used in well-drilling, 20 per cent in iron and steel foundries and 16 per cent in pelletizing.

Natural and activated nonswelling bentonite are used mainly for decolorizing mineral, animal and vegetable oils. Smaller quantities are used to decolorize beverages, syrups, sugar and vinegar and as catalysts in the refining of petroleum. The natural variety has some use as a binder.

Swelling bentonite is consumed in much greater quantities than the nonswelling type. It has numerous uses but is employed principally in well-drilling fluids, foundry mouldings and the pelletizing of iron-ore concentrates. In drilling fluids, bentonite controls viscosity, prevents the settling of drill cuttings and retains drilling fluids by coating the walls of holes. In the foundry industry and the pelletizing of iron-ore concentrates, it commonly serves as a binder. The recent trend toward the use of pelletized blast-furnace feed has increased bentonite consumption.

Canada's use of bentonite in pelletizing has not been large, but in 1963, when Iron Ore Company of Canada completes a pelletizing plant at Carol Lake, Labrador, the domestic consumption will increase almost by half. In addition, a plant of this type that is being built by Jones and Laughlin Steel Corporation near Kirkland Lake, Ontario, is scheduled to begin operation in 1964, and several more will probably be constructed. In most of these plants binding agents will have to be added and, if bentonite remains competitive as a binder, its consumption may thus increase severalfold.

Swelling bentonite 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 water-bearing horizons; and in sealing such structures as dams and reservoirs. A slurry of bentonite, normally dropped from low-flying aircraft, is effective in firefighting. In the last few years, it has been used successfully for this purpose in western Canada and the United States. Although this application will probably become more popular, it will not require bentonite in large quantities.

PRICES AND TARIFFS

Bentonite prices vary depending on the type, quality and quantity required. Domestic swelling bentonite may range in price from $11 to $25 a ton at the mill. The average cost of the drilling mud imported in 1961 was $25.61 a ton. Exports of the artificially activated clays averaged $42.60 a ton.

In the United States, carload lots of bagged swelling bentonite cost about $14 a ton, f.o.b. the mines, and about $7 to $8 a ton in bulk.

The Canadian and United States tariffs on bentonite remained unchanged and were as follows:

Canada	British Preferential	Most Favored Nation	General
Clays, unmanufactured, including clay for drilling mud	free	free	free
Activated clays			
For refining oils	10%	10%	25%
Not for refining oils	15%	20%	25%

United States	
Bentonite, per long ton	
Unwrought and unmanufactured	37 1/2¢
Wrought and manufactured	84 1/4¢
Clays, artificially activated	1/10¢ per lb plus 12 1/2% ad valorem

Bismuth

J. W. Patterson*

Bismuth production rose to 478,118 pounds for the year from the 423,827 pounds produced in 1960. Sixty per cent of the 1961 output was recovered from lead-zinc-silver ores treated by The Consolidated Mining and Smelting Company of Canada Limited (Cominco) at its Trail, British Columbia refinery, 9 per cent from copper ores treated by Gaspé Copper Mines, Limited, at its copper smelter at Murdochville, Quebec, and 27 per cent from molybdenite ore produced by Molybdenite Corporation of Canada Limited at Lacorne, Quebec. The remaining 4 per cent was recovered in a silver-lead-bismuth bullion obtained in the refining of silver-cobalt ores from the Cobalt-Gowganda area of northern Ontario.

World output amounted to 2,750 tons, Peru, Mexico, Canada and Bolivia, in that order, being the principal producers. Communist China, another leading producer, produced an estimated 300 tons. United States production is not reported separately.

DOMESTIC SOURCES

British Columbia

The main source of the bismuth produced at Trail is the lead concentrate derived from the lead-zinc-silver ore of Cominco's Sullivan mine, at Kimberley. The lead bullion obtained at the Trail smelter from this concentrate and from other concentrates originating mainly at mines in British Columbia and Yukon Territory contains about 0.05 per cent bismuth. The residue resulting from the electrolytic refining of the bullion is treated for the recovery of bismuth (99.99+ per cent pure), antimony and precious metals. High-purity (up to 99.9999 per cent) bismuth is produced for research and electronic uses. Late in 1961, Cominco began the construction of a plant at Trail to produce thermoelectric materials, of which bismuth telluride is one of the best known.

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*Mineral Resources Division.

TABLE 1

BISMUTH—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Production				
All forms[1]				
British Columbia	283,363	637,567	213,009	419,628
Quebec	174,832	297,670	172,983	297,018
Ontario	19,923	22,388	37,835	45,402
Total	478,118	957,625	423,827	762,048
Refined metal[2]	288,000		248,000	
Imports				
Metal and residues				
Bolivia	10,149	8,193	—	—
Yugoslavia	4,409	8,992	—	—
United States	2,000	4,670	1,050	2,319
Netherlands	1,425	2,712	6,598	12,723
Total	17,983	24,567	7,648	15,042
Salts				
Britain	12,856	32,644	8,164	19,119
United States	1,551	7,217	1,916	6,897
Total	14,407	39,861	10,080	26,016
Exports				
Refined and semirefined metal	389,500		286,000	
Consumption				
Refined metal				
Fusible alloys and solders	34,484		31,127	
Other uses[3]	8,144		13,582	
Total	42,628		44,709	
Bismuth salts				
Chemical and allied-products industries			9,049	

SOURCE: Dominion Bureau of Statistics.

[1]Refined metal from Canadian ores, plus the bismuth content of the 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.

TABLE 2

BISMUTH—PRODUCTION, EXPORTS AND CONSUMPTION, 1951-61
(pounds)

	Production		Exports[2]	Consumption[3]
	All Forms[1]	Refined Metal		
1951	230,298	208,000	90,000	108,000
1952	162,373	142,000	34,000	106,000
1953	117,366	72,000	—	68,000
1954	258,675	226,000	134,000	74,000
1955	265,896	160,000	56,000	92,000
1956	285,861	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	288,000	389,500	42,600

SOURCE: Dominion Bureau of Statistics.
[1]Refined metal from Canadian ores, plus the bismuth content of bullion and concentrates exported.
[2]From 1951 to 1957 inclusive—refined metal; from 1958 to 1961 inclusive—refined and semirefined.
[3]Refined metal reported by consumers.

TABLE 3

WORLD PRODUCTION OF BISMUTH
(pounds)

	1961	1960
Peru[1]	1,044,980	913,106
Mexico[1]	600,000[e]	599,300
Canada[2]	478,118	423,827
Bolivia[3]	465,200	403,600
South Korea (in ore)	323,000[e]	317,000
Japan (metal)	287,000[e]	261,089
Yugoslavia (metal)	216,348[e]	231,582
Other countries	2,085,354	2,150,496
Total[4]	5,500,000	5,300,000

SOURCE: U.S. Bureau of Mines, Mineral Trade Notes, June 1962.
[1]Refined metal plus the bismuth content of bullion exported.
[2]Refined metal plus the bismuth content of bullion and concentrates exported.
[3]Bismuth content of ore and bullion exported except that in tin concentrates.
[4]United States production is not available for publication.
[e]Estimated.

Quebec

During the year ending on September 30, 1961, Molybdenite Corporation of Canada Limited produced impure ingots containing 132,246 pounds of bismuth. This bismuth was derived from molybdenite-bismuth ore mined at the Lacorne mine, 23 miles northwest of Val d'Or. At the mine, a bulk concentrate containing about 8 per cent bismuth is obtained by flotation. By leaching, the bismuth is separated as bismuth oxychloride, which is smelted in electric-arc furnaces to produce a 98-per-cent-bismuth bullion containing minor amounts of lead and silver and traces of copper, iron and antimony.

Gaspé Copper Mines, Limited, produced 43,700 pounds of bismuth from the treatment of flue dust recovered in copper-smelting operations at Murdochville.

Ontario

Deloro Smelting & Refining Company, Limited, at Deloro, in southeastern Ontario, and operators of a refinery at Cobalt recovered bismuth in silver-lead-bismuth bullion from the refining of silver-cobalt ores originating in the Cobalt-Gowganda area. The bullion so produced was shipped from time to time to a custom smelter. In March the Deloro plant was closed permanently.

USES AND CONSUMPTION

Bismuth, in amounts up to 50 per cent, is used with tin, lead and cadmium to make various low-melting-point alloys that find application in fire-protection devices, electrical fuses and solders. Because bismuth expands on solidification and imparts expansion to its alloys, it is used in making type metal. Bismuth has another important use in compounds for medical and cosmetic preparations.

Several possible new applications for bismuth are being studied. For example, there is the alloy, bismuth telluride, which is gaining recognition as the thermoelectric material most suitable for the development of nonmechanical refrigerating units. In this type of refrigeration, the thermoelectric materials must produce coldness when an electric current flows through them in one direction and heat when the current flows in the opposite direction. Research is being done on the feasibility of using intermetallic compounds of bismuth to generate electricity efficiently from solar and atomic-reactor heat sources without intervening mechanisms.

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

TABLE 4

BISMUTH—UNITED STATES CONSUMPTION, BY PRINCIPAL USES

(pounds)

	1961	1960
Fusible alloys	683,804	515,570
Other alloys	222,241	239,757
Pharmaceuticals	520,723	710,631
Experimental uses	9,742	24,667
Other uses	41,913	36,627
Total	1,478,423	1,527,252

SOURCE: U.S. Bureau of Mines, Mineral Industry Surveys.

PRICES AND TARIFFS

Canadian prices quoted by The Consolidated Mining and Smelting Company of Canada Limited in 1961 were $2.25 a pound in lots of 1 ton or more and $2.50 a pound in lots of less than 1 ton delivered to eastern Canadian points. United States prices, which were the same as Canadian prices, have remained constant since September 5, 1950.

Bismuth metal enters Canada free of duty. In the United States there is a $1\frac{7}{8}$-per-cent ad valorem duty on bismuth metal and a 35-per-cent ad valorem duty on chemical compounds, mixtures and salts.

Cadmium

J. W. Patterson*

In Canada cadmium is recovered as a by-product in the treatment of zinc ores and, to a lesser extent, in the treatment of lead ores. In both, it is present in minor amounts as a sulphide intimately associated with sphalerite. The metal is produced at 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. While mines owned by Cominco and Hudson Bay are the main sources of the concentrates treated at these plants, mines operated by other companies are important supplementary sources. In addition to the Canadian output of cadmium metal, some cadmium, not all of which is reported, is recovered by foreign smelters from the treatment of lead and zinc concentrates received from Canadian producers.

In spite of the growing demand for cadmium and the price increases that have resulted, world production of cadmium metal changed little in 1961. The United States continued, by a wide margin, to be the leading producer. Canada, with a refined output of 2,233,804 pounds, easily kept second place. Other major producers, not listed in Table 3, were Mexico and South West Africa. While most of Mexico's production was exported to the United States in zinc concentrates and lead- and zinc-smelter flue dusts, some metal was recovered domestically from flue dust. The whole cadmium output of South West Africa was contained in lead and zinc concentrates, which were shipped principally to the United States, Britain and Belgium. There the contained metals were recovered. The cadmium content of the flue dust and concentrates exported in 1961 by these two countries amounted respectively to about 2,500,000 and 1,747,000 pounds.

*Mineral Resources Division.

TABLE 1

CADMIUM—PRODUCTION, EXPORTS AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Production				
All forms[1]				
British Columbia	907,432	1,451,891	1,778,866	2,525,990
Manitoba	182,622	292,195	110,138	156,396
Yukon Territory	142,685	228,296	145,496	206,604
Saskatchewan	125,135	200,216	256,498	364,227
Quebec	—	—	66,499	94,429
Total	1,357,874	2,172,598	2,357,497	3,347,646
Refined[2]	2,223,804		2,238,233	
Exports				
Cadmium in ores and concentrates[3]				
United States	88,300	120,733		
Cadmium metal				
Britain	1,374,009	1,616,849	1,030,116	1,371,545
United States	517,450	707,414	992,581	1,211,372
Brazil	6,439	9,048	16,976	22,422
India	4,047	5,876	16,653	21,929
Other countries	17	419	7	163
Total	1,901,962	2,339,606	2,056,333	2,627,431
Consumption[4]				
Plating	147,326		173,675	
Solders	18,574		12,759	
Other products[5]	5,076		3,982	
Total	170,976		190,416	

Source Dominion Bureau of Statistics.

[1]Production of refined cadmium from domestic ore plus the cadmium content of some of the ores and concentrates exported.

[2]Includes metal derived from foreign lead and zinc ores.

[3]Not available as a separate class before 1961.

[4]As reported by consumers.

[5]Include chemicals, pigments and pipe, and alloys other than solder.

In 1961, exports accounted for nearly the whole Canadian output. Canada maintained its traditional markets, exporting mainly to Britain and the United States. The increase in exports to Britain was more than offset, however, by a decline in exports to other countries. As shown in Table 1, domestic fabricators used the equivalent of only a small part of the year's production.

DOMESTIC SOURCES

British Columbia

Cominco, in 1961, produced 963 tons of cadmium metal at its Trail refinery. A large part of this was recovered from zinc concentrate produced in Cominco's 10,000-ton lead-zinc mill at Kimberley, which treats ore from the Sullivan mine. Other sources were concentrates produced at the company's H.B. mine near Salmo, its Bluebell mine at Riondel and at several other mines whose production was shipped to Trail for treatment.

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TABLE 2

CADMIUM—PRODUCTION, EXPORTS AND CONSUMPTION, 1951-61

(pounds)

	Production		Exports	Consumption[3]
	All Forms[1]	Refined[2]		
1951	1,326,920	1,266,000	824,850	290,000
1952	948,587	820,000	620,344	232,000
1953	1,118,285	978,000	969,563	254,000
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	2,233,804	1,901,962	170,976

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]For 1951—producer's domestic shipments of refined metal; from 1952 to 1961 inclusive—consumption as reported by consumers.

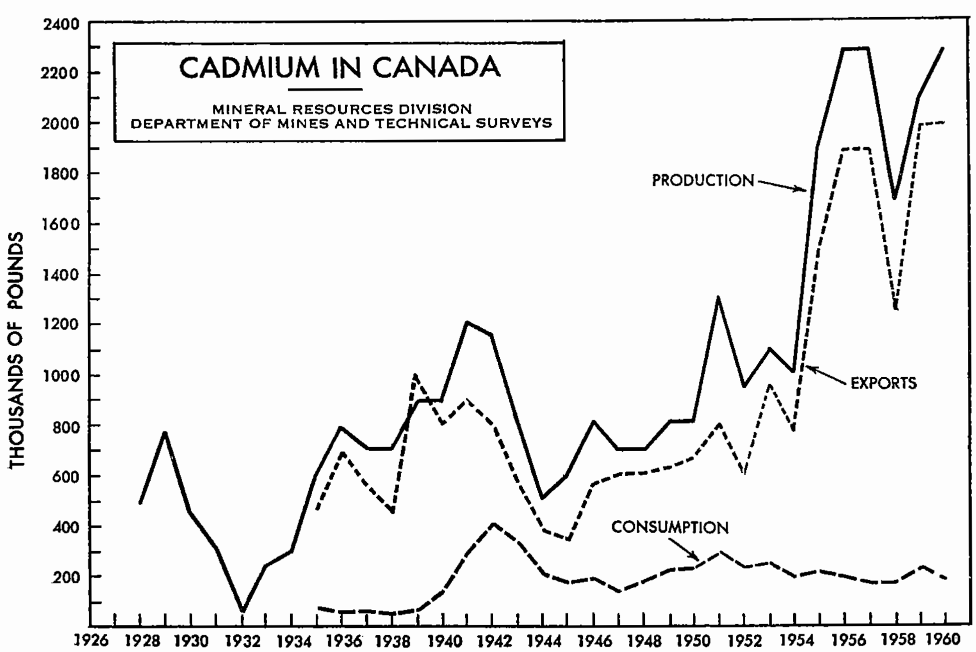


TABLE 3

WORLD PRODUCTION OF CADMIUM METAL

('000 pounds)

	1961	1960
United States	9,943	10,180
Canada	2,234*	2,238*
Belgium	295	1,583
Japan	1,350	1,251
Republic of the Congo	419	1,113
U.S.S.R.	1,100	1,035
Other countries	4,594	4,581
Total	19,935	21,981

Source: U.S. Bureau of Mines, *Mineral Trade Notes*, except where otherwise indicated.
*Dominion Bureau of Statistics.

Companies other than Cominco that in 1961 produced substantial amounts of zinc concentrate containing cadmium are the following:

Company	Location of Mine	Cadmium Production (pounds)
Canadian Exploration, Limited	Salmo	267,936
Howe Sound Company	Britannia Beach	*
Mastodon-Highland Bell Mines Limited	Beaverdell	7,877
Reeves MacDonald Mines Limited	Remac	192,444
Sheep Creek Mines Limited	Toby Creek	53,160
ViolaMac Mines Limited	New Denver	3,361

*Not available. In 1960 the company produced 47,236 pounds.

Yukon Territory

In the fiscal year that ended on September 30, 1961, United Keno Hill Mines Limited, an important producer of lead, zinc and silver, produced 202,432 pounds of cadmium in zinc concentrate obtained from 186,116 tons of ore. The previous year's output was 181,132 pounds from 176,745 tons of ore.

Saskatchewan and Manitoba

In 1961, the output of Hudson Bay Mining and Smelting Co., Limited, Canada's second-ranking producer of cadmium, decreased to 307,757 pounds from the 366,636 pounds produced in 1960. Most of this was obtained from copper-zinc ores of the Flin Flon mine, at Flin Flon, and the nearby Coronation and Schist Lake mines, in the Flin Flon area. Some came from zinc-lead-copper ore mined at Chisel Lake, near Snow Lake, Manitoba.

Eastern Canada

All zinc concentrates produced in eastern Canada are exported. For the most part, no payment is received for the contained cadmium, and the amount recovered is not reported.

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. Where price is not important, cadmium is preferred to zinc as a coating because it can be deposited more uniformly in the 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. In the field of atomic energy, cadmium is used in devices to control the fissionable elements in reactors. Cadmium is used in the manufacture of sterling silverware because it has a hardening effect when added to silver in small amounts.

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 in their behavior at low temperatures. Because of these characteristics, they are being used in airplanes, earth satellites, missiles, and ground equipment for polar regions.

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 sticks, according to *E & M J Metal and Mineral Markets,* was as follows:

	Jan. 1 to April 2	Apr. 3 to Year-end
Ton lots	$1.50	$1.60
Less than a ton	$1.60	$1.70

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.

The United States duty on cadmium metal during 1961 was 3.75 cents a pound. Cadmium flue dust was duty-free.

Calcium

W. H. Jackson*

Calcium-metal shipments increased, rising from the previous year's 86,158 pounds to a 1961 total of 99,355. If the market demand should improve, production would be no problem and output could be rapidly increased. Statistics on Canadian production and exports are shown in the accompanying tables.

The present uses of calcium, while diversified, require only small quantities. Consumption in Canada is negligible, and nearly the whole output is exported.

Dominion Magnesium Limited is Canada's sole producer of calcium. The main product of the company's smelter, at Haley, Ontario, is magnesium. The others are thorium, zirconium, titanium and master alloys of these, as well as barium, strontium and lithium.

The four grades of calcium metal produced range in purity from the 98 per cent of Commercial Grade to the nominal 99.9 per cent of Chemical Standard Grade. The maximum impurities in calcium of Commercial Grade are 0.5 to 1.5 per cent magnesium, 1.0 per cent nitrogen and 0.35 per cent aluminum. They become progressively less in other grades and are present only in trace amounts in Chemical Standard Grade, which is available only in the form of granules in the size range of minus 4 to plus 80 mesh. Other grades are produced as granules, crystalline lumps, ingots, billets and extruded shapes. Wire, tubes or other shapes, and strip are also manufactured.

To produce Commercial Grade calcium, powdered lime (200-mesh) and commercial-purity aluminum (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.

USES

Calcium is silvery white, soft, ductile and malleable. Although it is extremely light and has interesting physical properties, its chemical reactivity with water, oxygen and nitrogen has prevented the development of structural uses.

*Mineral Resources Division.

TABLE 1

CALCIUM—PRODUCTION AND EXPORTS

	1961		1960	
	Pounds	$	Pounds	$
Production (metal)*	99,355	100,851	134,801	159,241
Exports (metal)**				
Belgium and Luxembourg	43,800	31,525		8,980
United States	24,400	30,439		14,918
West Germany	9,900	10,890		21,415
India	18,700	28,171		15,870
Britain	9,200	10,803		19,201
Other countries	4,700	5,013		6,773
Total	110,700	116,841		87,157

SOURCE: Dominion Bureau of Statistics.
*1961—shipments; 1960—production.
**Quantities are not available for the years before 1961.

TABLE 2

PRODUCTION* OF CALCIUM METAL, 1951-61

	Pounds	$
1951 to 1955 inclusive	(not available for publication)	
1956	394,900	515,305
1957	221,225	282,378
1958	25,227	31,256
1959	67,429	76,409
1960	134,801	159,241
1961	99,355	100,881

SOURCE: Dominion Bureau of Statistics.
*1961—shipments; 1956-1960—production.

As an additive, calcium is used in alloys of aluminum and magnesium, in the preparation of catalysts from silver-calcium alloys, in the control of graphitic carbon in cast iron, in lead alloys for battery plates, cable sheaths and bearings. It finds another type of use as a reducing agent to make metals of the rare earths, uranium, thorium, titanium, zirconium and beryllium. It also helps to purify rare gases such as argon and to deoxidize or desulphurize special alloys containing nickel, copper or iron. The calcium-silicon normally used in such alloys is made in an electric furnace from lime, silica and a carbonaceous reducing agent. These calcium alloys are extremely cheap. If, however, impurity control is important, the additive used is calcium metal.

PRICES

The basic Canadian prices quoted by Dominion Magnesium Limited throughout 1961 ranged from 80 cents a pound for Commercial Grade to $1.40 a pound for Chemical Standard Grade.

The nominal price quoted in New York, as reported by *E & M J Metal and Mineral Markets* was $2.05 a pound in ton lots, slabs etc.

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 semiprocessed form	15%	20%	25%
United States			
Calcium metal		17½%	

Under negotiated revisions of the General Agreement on Tariffs and Trade, the United States tariff will be reduced to 15 per cent ad valorem by June 30, 1962.

Cement

J. S. Ross*

In value, cement production made a record in 1961 but remained in tenth place. A 7-per-cent increase in shipments over those of 1960 resulted from the industry's recovery of the markets it had acquired in 1959, the peak year. This recovery is attributed to an increase in exports and a rise that brought construction close to the 1959 level.

Production facilities did not expand in 1961, but the rated capacities of several Ontario and Quebec plants were increased by small amounts, mainly through improvements in techniques. The result was that the year-end rated annual capacity—51.8 million barrels, or about 9.1 million tons—was 4 per cent higher than in 1960. At the end of 1961 the excess annual capacity continued large at 2,859,052 tons, or 46 per cent of production, and 32 per cent of the total capacity. The comparable percentages for the end of 1960 were 51 and 34.

Integration of cement- and concrete-products companies continued, two substantial concrete-products operations being acquired by large cement firms. There was a notable increase in the expansion of cement-distributing facilities for Canadian cement both in Canada and in the United States.

At mid-year, a major strike of construction employees in and near Toronto adversely affected the consumption of cement in that heavy-usage area for a long and critical period. A strike that occurred at four producing plants as the year drew to a close affected Canada's cement-producing capacity but not the national rate of shipments, which were appreciably higher in November and December than in the corresponding period of 1960.

* Mineral Processing Division, Mines Branch.

TABLE 1

CEMENT—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production[1]				
Ontario	2,226,923	35,671,569	2,007,044	30,699,800
Quebec	2,029,159	31,412,617	1,875,997	28,315,159
Alberta	677,914	12,420,025	663,856	11,474,865
British Columbia	417,366	7,122,046	384,853	6,432,752
Manitoba	395,134	7,768,334	429,788	8,105,802
Saskatchewan	201,950	4,985,021	169,282	3,997,809
New Brunswick	170,953	2,754,052	163,245	2,546,622
Newfoundland	86,549	1,789,980	93,160	1,688,664
Total	6,205,948	103,923,644	5,787,225	93,261,473
Exports				
Portland cement				
United States	249,294	3,864,477	180,897	2,816,579
Other countries	83	1,756	220	4,428
Total	249,377	3,866,233	181,117	2,821,007
Imports				
Portland cement, normal[2]				
United States	1,037	30,246		
Britain	132	3,100		
Netherlands	110	2,258		
West Germany	73	1,037		
Japan	29	324		
Total	1,381	36,965		
White cement[2]				
Britain	5,676	165,928		
West Germany	3,188	105,879		
Belgium and Luxembourg	2,758	82,960		
Denmark	1,568	46,135		
France	1,706	48,560		
United States	1,161	49,990		
Japan	37	895		
Total	16,094	500,347		
Cement, not otherwise provided for[2]				
Britain	9,982	288,011		
United States	1,367	74,994		
West Germany	386	20,477		
Denmark	7	220		
Total	11,742	383,702		
Total, cement				
Britain	15,790	457,039	9,384	266,633
United States	3,565	155,230	5,596	214,930
West Germany	3,647	127,393	3,876	140,622
Belgium and Luxembourg	2,758	82,960	587	17,044
Denmark	1,575	46,355	1,570	50,068
France	1,706	48,560	1,465	38,754
Netherlands	110	2,258	—	—
Japan	66	1,219	—	—
Total	29,217	921,014	22,478	728,051

CEMENT—PRODUCTION AND TRADE (*cont'd*)

	1961		1960	
	Short Tons	$	Short Tons	$
Imports (cont'd)				
White-cement clinker				
Denmark	14,560	268,521	13,104	230,415
United States	5,243	120,249	4,676	101,626
Total	19,803	388,770	17,780	332,041

SOURCE: Dominion Bureau of Statistics.
[1]Producers' shipments plus quantities used by producers.
[2]Separate classes not available prior to 1961.

TABLE 2

CEMENT—PRODUCTION, TRADE AND CONSUMPTION, 1951-61
(short tons)

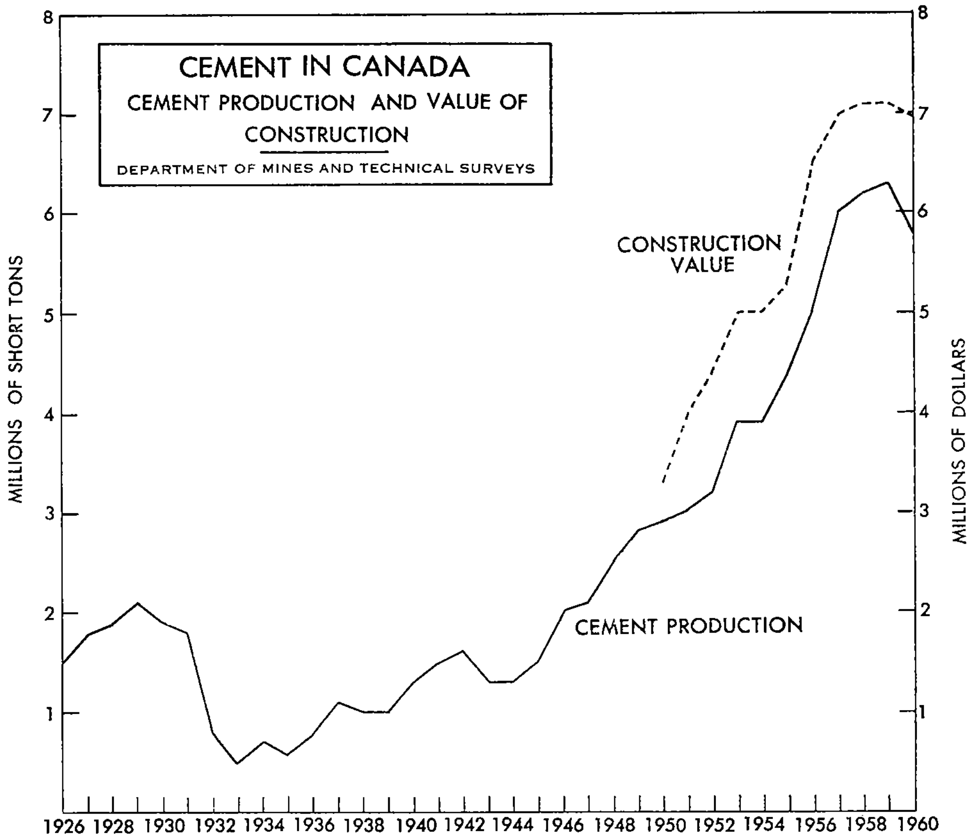
	Production[1]	Exports	Imports[2]	Apparent Consumption[3]
1951	2,976,367	453	407,300	3,383,214
1952	3,241,095	754	509,947	3,750,288
1953	3,891,708	2,577	434,487	4,323,618
1954	3,926,559	21,638	401,135	4,306,056
1955	4,404,480	168,907	517,890	4,753,463
1956	5,021,683	124,566	599,624	5,496,741
1957	6,049,098	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

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

The Canadian cement industry produces portland, masonry and oil-well cement and manufactures white cement from imported clinker. Most of the output is of the normal portland variety used in general construction. Other types of portland cement and the air-entrained equivalents of most types are available from many plants. Production statistics for each general type are being compiled for 1961 but are not available for previous years. Special cements for large construction projects are produced on request.

The industry operated at 68 per cent of its year-end capacity. Shipments continued to rise in 1961 after decreasing in 1960 for the first time since 1944. They amounted to 6,205,948 tons with a record value of $103,923,644, thus being 7 per cent higher in volume and 11 per cent higher in value than in 1960 but below the quantity shipped in 1959. In all provinces except Manitoba and Newfoundland, the output increased over that of the previous year. More than half the increase took place in Ontario despite the strikes that affected the province's construction industry and cement-plants operation. Quebec and Ontario supplied 69 per cent of the total.



Cement clinker was produced in all provinces except Nova Scotia and Prince Edward Island by 19 plants containing 45 kilns. Four of the operations employed dry processing. All are listed in Table 3 and are located on the accompanying map. Eleven are in Ontario and Quebec and represent 67 per cent of the rated production capacity.

In addition, two separate clinker-grinding plants were in operation. Clinker from the Exshaw, Alberta, plant is ground by Canada Cement Company, Limited, at Clover Bar, Alberta. Medusa Products Company of Canada, Limited, grinds imported clinker from Pennsylvania at Paris, Ontario, for the production of white cement.

World production of cement continued to rise. *Minerals Yearbook 1961*, U.S. Bureau of Mines, shows a record total of 373 million short tons for that year. The most noteworthy change was with China, which dropped to eighth place from fifth place in 1960. The United States, Russia and West Germany continued as the leading producers, in that order. Canada remained in twelfth place.

TRADE

Because cement has a low unit value and is produced in quantity by most countries, it is not normally traded to any great extent.

In 1961, Canadian cement exports increased to a relatively high level. They amounted to 249,377 tons, or 38 per cent more than in 1960, and were valued at $3,866,233. Almost the entire quantity exported went to the United States. Imports continued small in quantity as they have been since 1957 but their

TABLE 3

APPROXIMATE PLANT CAPACITIES[1] AT END OF 1961

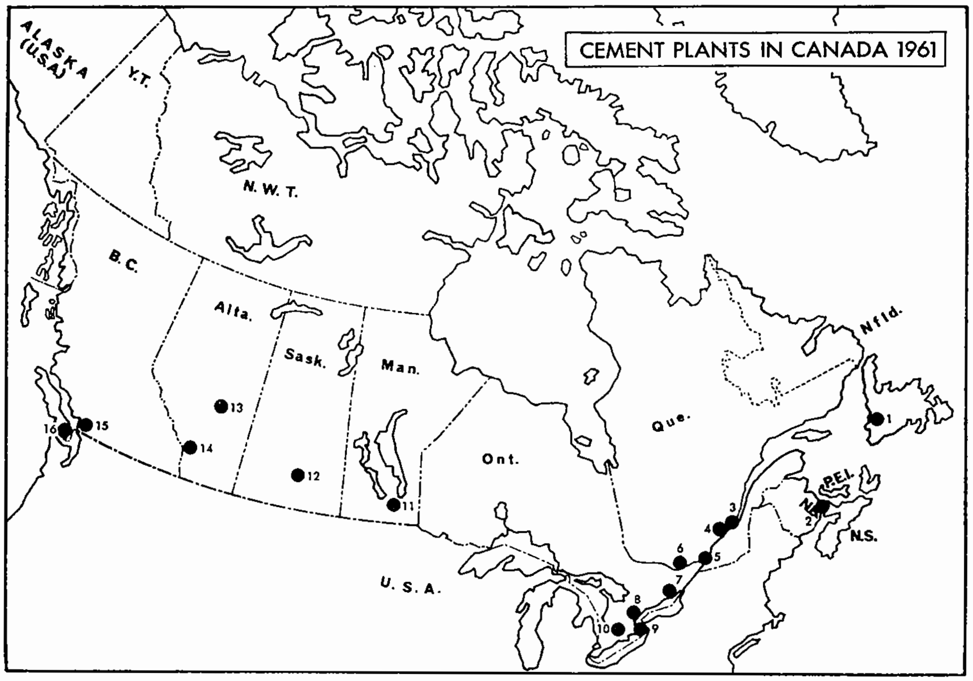
Company	Location	Barrels/Year	Short Tons/ Year[3]
Newfoundland			
North Star Cement Limited (1)[2]	Corner Brook	600,000	105,000
New Brunswick			
Canada Cement Company, Limited (2)	Havelock	850,000	149,000
Quebec			
St. Lawrence Cement Company (3)	Villeneuve	2,000,000	350,000
Ciment Quebec Inc. (4)	St. Basile	1,800,000	315,000
Miron Company Ltd. (5)	St. Michel	4,000,000	700,000
Canada Cement Company, Limited (5)	Montreal	7,500,000	1,313,000
Canada Cement Company, Limited (6)	Hull	1,100,000	193,000
Ontario			
Lake Ontario Portland Cement Company Limited (7)	Picton	2,400,000	420,000
Canada Cement Company, Limited (7)	Belleville	4,000,000	700,000
St. Lawrence Cement Company (8)	Clarkson	4,200,000	735,000
Canada Cement Company, Limited (9)	Port Colborne	1,200,000	210,000
Canada Cement Company, Limited (10)	Woodstock	3,250,000	568,000
St. Mary's Cement Co., Limited (10)	St. Mary's	3,300,000	578,000
Manitoba			
Canada Cement Company, Limited (11)	Fort Whyte	3,100,000	542,000
Saskatchewan			
Saskatchewan Cement Company Limited (12)	Regina	1,300,000	228,000
Alberta			
Inland Cement Company Limited (13)	Edmonton	3,400,000	595,000
Canada Cement Company, Limited (14)	Exshaw	3,000,000	525,000
British Columbia			
Lafarge Cement of North America Ltd. (15)	Lulu Island	1,500,000	262,000
British Columbia Cement Company Ltd. (16)	Bamberton	3,300,000	577,000
Total		51,800,000	9,065,000

SOURCE: Company correspondence.
[1]Not including the capacities of the separate grinding plants.
[2]The numbers in parentheses refer to location on the map.
[3]Calculated.

value was $921,014. They consisted chiefly of special types, mainly of white cement. In addition, white-cement clinker, valued at $388,770, was imported. Denmark, Britain, the United States and West Germany were the principal suppliers. Some North American producers have suggested that in 1961 certain European suppliers dumped cement in the United States and Canada.

DEVELOPMENTS

In contrast with recent years, there was little construction of cement-producing facilities in 1961. Because of an improvement in efficiency at four plants in Ontario and Quebec, the rated capacity nevertheless increased by 1.8 million barrels a year, or 4 per cent. Increases in rated capacities, in terms of millions of barrels per annum, took place as follows: St. Lawrence Cement Company, Clarkson, Ontario, from 3.5 to 4.2, and Villeneuve, Quebec, from 1.5 to 2.0; St. Mary's Cement Co., Limited, St. Mary's, Ontario, from 3.0 to 3.3; and Lake Ontario Portland Cement Company Limited, Picton, Ontario, from 2.1 to 2.4.



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

The trend toward the use of gas as fuel continued, with the conversion of the Montreal plant of Canada Cement Company, Limited, and the Clarkson, Ontario, plant of St. Lawrence Cement Company.

Extensive storage and distribution facilities were added for the handling of cement produced in Canada. Saskatchewan Cement Company Limited built two additional storage silos at a cost of $250,000. Mohawk Valley Cement Company Inc., a subsidiary of Lake Ontario Portland Cement Company Limited, built a $1-million eight-silo cement-storage and -distribution plant at Rome, New York, from which cement produced at Picton, Ontario, is distributed to the central, eastern and northern parts of the state. Another subsidiary, Rochester Portland Cement Corp., added three storage silos to its Rochester, New York, distribution centre, which supplies Picton cement to western New York. Canada Cement Company, Limited, increased the cargo capacity of its vessel, the S.S. *Bulkarier*.

Construction of a new automatically controlled plant for the crushing and screening of raw materials was completed by British Columbia Cement Company Limited at Bamberton, British Columbia.

A strike that took place at Canada Cement Company's Montreal, Belleville, Port Colborne and Woodstock plants and its Toronto warehouse and lasted from November 16 to December 20 affected a third of Canada's cement-producing capacity.

In British Columbia, pozzolan-production facilities continued to expand. Canada's second plant for the processing of shale for pozzolan began operation at Britannia Beach. At this plant, Canadian Pozzolan Industries Ltd. started to grind and size shale from the centre of the province. British Columbia Cement Company Limited produces the commodity at Bamberton. Holdfast Natural Resources Ltd. started construction of a rotary-kiln plant at Saltspring Island and expects production from shale to begin there early in 1962.

Further integration of companies producing construction materials took place when cement companies acquired two large concrete-products firms. Early in the year, St. Lawrence Cement Company took over Associated Quarries & Construction (Amalgamated) Limited, Toronto, with its subsidiaries—Dufferin Construction Co., The Dual Mixed Concrete and Materials, Limited, and Hagersville Quarries Ltd. Canada Cement Company, Limited, purchased the controlling interest in Mount Royal Paving and Supplies Limited, Montreal, one of the largest cement consumers and the owner of the largest crushed-limestone producer in Canada. Subsidiaries of Mount Royal Paving include National Quarries Limited (Ville St. Michel), Francon Limited (Montreal), Highway Paving Company (Montreal) and Ottawa Pre-Mixed Concrete Limited. There were also mergers and acquisitions involving other concrete-products companies, particularly in Ontario and Saskatchewan.

In a brief to the Department of Finance, the National Concrete Products Association requested the removal of the sales tax from most concrete products. In support of its request, the association pointed out that there is no sales tax on poured-in-place concrete and that the tax is an additional burden to the house buyer.

CONSUMPTION AND USES

Cement is used almost exclusively for construction. Thus, plant shipments and consumption are directly proportionate to construction expenditures, as indicated by the accompanying graph. Statistics for 1961 show that the value of Canadian construction increased 2.3 per cent over that of 1960 to $7,040 million. The record, made in 1959, was $7,076 million. In 1961 there was a corresponding increase in the apparent domestic cement consumption, which was 6 per cent higher than in the previous year.

According to the Dominion Bureau of Statistics, the estimated value of the construction planned for 1962 is $7,381 million. If this forecast is realized, a record will be set, and domestic cement consumption should also reach a record by increasing about 4 per cent.

Most of the cement is used in general construction; the remainder, amounting to more than one third, goes into concrete products. In 1959, more than 2.2 million tons were consumed in the manufacture of such products as ready-mixed concrete, concrete blocks, bricks, pipe and tile, and numerous other shapes.

TABLE 4

PRODUCTION OF CONCRETE PRODUCTS

	1961	1960
Concrete bricks (number)	103,631,717	95,302,943
Concrete blocks (except chimney blocks)		
Gravel (number)	102,011,164	97,995,559
Cinder (number)	8,960,377	7,783,206
Other (number)	35,391,748	28,005,969
Concrete drain pipe, sewer pipe, water pipe and culvert tile (tons)	820,612	767,396
Concrete, ready-mixed (cubic yards)	8,333,706	7,312,228

SOURCE: Dominion Bureau of Statistics.

The use of cement is increasing in soil-stabilized road bases and, to a small extent, in road surfacing. Alberta, Saskatchewan and New Brunswick are the main consumers for these purposes. This use should increase still further, particularly in Alberta, Saskatchewan and Manitoba.

Cement is also consumed in the manufacture of many asbestos products and certain paints.

SPECIFICATIONS, PRICES AND TARIFFS

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

Prices vary, depending on supply and demand, location and the type of cement required.

Canadian import tariffs per 100 pounds, unchanged from 1960, 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*

Chrome ore (chromite) imports increased in 1961 for the third consecutive year and totalled 71,268 tons valued at $1,908,920. Chromite consumption amounted to 52,134 tons, and on December 31 consumers' stocks were at 57,172 tons. Ferrochrome consumption amounted to 8,093 tons (2,580 tons high-carbon and 5,513 low-carbon).

Exports of ferrochrome, at 1,642 tons, were the lowest since 1943, when the Dominion Bureau of Statistics first listed them as a separate export item. The Bureau does not list ferrochrome imports as a separate item, but in 1961 imports from the United States totalled 2,356 tons.† They were mostly of the low-carbon type, which is not made in Canada. Ferrochrome was also received from Europe. Industry reports that the increase in stainless-steel production is expected to make the market for chromium alloys expand in 1962 but that the increase in the importation of low-priced foreign material may cause Canada's output of chromium alloys to decline.

On October 15, the United States price for high-carbon ferrochrome was reduced from 28.75 cents to 24.00 cents a pound of contained chrome and the low-carbon ferrochrome was increased from 31.75 cents to 33.00 cents a pound of contained chrome. These two products make up about 71 per cent of the United States consumption of chromium additives (low-carbon—40 per cent; high-carbon—31 per cent).

Canada has no known deposits of commercial-grade chrome 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 of low grade—about 26 per cent chromic oxide (Cr_2O_3) and 12 per cent iron. The chromium-to-iron ratio is about 1.4:1.

Chromite is consumed in Canada by Union Carbide Canada Limited, Metals and Carbon Division, at Welland, Ontario, where high-carbon ferrochrome

*Mineral Resources Division. †U.S. Department of Commerce, *United States Exports of Domestic and Foreign Merchandise* (Report FT 410, Part II), 1961.

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TABLE 1

CHROMIUM—TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Imports (chromite)				
Philippines	34,861	790,568	38,912	892,684
United States	22,341	702,159	13,343	442,375
Republic of South Africa	4,690	79,633	1,132	12,135
Rhodesia and Nyasaland	5,456	173,004	2,155	55,772
Cyprus	3,920	163,556	2,822	99,154
Cuba	—	—	659	19,692
Total	71,268	1,908,920	59,023	1,521,812
Exports (ferrochrome)				
United States	1,546	335,555	1,866	487,614
West Germany	71	14,050	—	—
Mexico	12	5,426	12	4,732
Cuba	12	3,819	6	1,859
Norway	—	—	2,727	476,422
Other countries	1	176	—	—
Total	1,642	359,026	4,611	970,627
Consumption (chromite)	52,134		54,331	

SOURCE: Dominion Bureau of Statistics.

TABLE 2

CHROMIUM—TRADE AND CONSUMPTION, 1951–61

(short tons)

	Imports	Exports	Consumption	
	Chromite	Ferrochrome	Chromite	Ferrochrome
1951	146,998	43,731	128,570	5,100
1952	148,343	44,290	101,919	6,362
1953	118,092	33,824	92,678	4,986
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	8,093

SOURCE: Dominion Bureau of Statistics.

and ferrochrome-silicon are produced; by Chromium Mining & Smelting Corporation, Limited, 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 the United States Bureau of Mines, estimated world production of chromium ore for 1961 was 4,655,000 tons which is a decrease of some 275,000 tons from 1960. The Republic of South Africa was the only producing country to show a significant increase in production from the previous year. This trend, which has been in progress for four years, has elevated the Republic from fourth position as a world producer of chromite to second.

Owing to increases expected in the production of stainless steel, the production and consumption of chromite will probably rise in 1962. The growth in stainless-steel output is expected to be large in the United States, modest in Japan and slight in Europe. The European increases are being looked for particularly in Britain.

TABLE 3

WORLD PRODUCTION OF CHROME ORE

	1961	1960
U.S.S.R.	1,015,000	1,010,000
Republic of South Africa	989,718	850,916
Philippines	705,811	809,579
Southern Rhodesia	590,888	668,401
Turkey	443,932	530,676
Albania	330,000	315,300
Other countries	579,651	745,128
Total	4,655,000	4,930,000

SOURCE: U.S. Bureau of Mines, *Mineral Trade Notes, August 1962.*

The United States is the leading importer and consumer of chromite, Rhodesia, the Republic of South Africa and the Philippines being the principal suppliers. In past years Turkey supplied the bulk of the metallurgical-grade ore, the Philippines the bulk of the refractory-grade ore and the Republic of South Africa the bulk of the chemical-grade ore. Since 1959, however, Southern Rhodesia has replaced Turkey as the principal supplier of metallurgical-grade ore. In 1961, the United States imported 1,222,761 tons of chromite; of this, 448,082 tons were of metallurgical grade, 284,125 of refractory grade bulk of its concentrates (containing about 38.5% Cr_2O_3) to the United States amounted to 82,260 tons, all of it coming from the Mouat mine at Nye, Montana, operated by American Chrome Company. American Chrome shipped the bulk of its concentrates (containing about 38.5% Cr_2O_3) to the United States government stockpile; some was consumed by the company in its ferrochrome pilot plant, near the mine.

Southern Rhodesia and the Republic of South Africa have been the traditional suppliers of chrome ore, but in recent years they have become aware of the desirability of processing the chromite and exporting chrome alloys. In 1961, plans to expand South Africa's ferroalloy industry were published in several announcements, the most notable of which were those made by Windsor Ferroalloys (Pvt.), Limited; Transalloys (Pty.), Limited; and RMB Alloys, Limited.

Windsor Ferroalloys was formed in 1961 to take over Windsor Chrome Mines (Pvt.), Limited, in Southern Rhodesia, and to build a ferrochrome smelter for treating the Windsor ores at Que Que, Southern Rhodesia. Smelter capacity is expected to be 12,000 tons of high-carbon ferrochrome a year.

Transalloys, Limited, is a new company formed in partnership by Anglo-American Corporation of Britain and Avesta Jernverks Aktiebolag of Sweden. Transalloys intends to build a plant near Witbank, South Africa, for the manufacture of low-carbon ferrochrome from the low-grade chrome ores of the Transvaal.

At its plant at Germiston, South Africa, RMB Alloys, Limited, a subsidiary of Rand Mines, Limited, successfully finished developing its method of producing low-carbon ferrochrome from Transvaal chemical-grade ore and completed its first commercial shipment of ferrochrome, which went to Sheffield, England.

In only a few countries have chrome-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 chrome ore were recently estimated at several hundred million tons. Russia and Albania, of the Soviet bloc, are known to have large economic deposits of chrome 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 five years, the metallurgical industry has accounted for 62 per cent of all chromite consumed, the refractory industry for 27 per cent and the chemical industry for 11 per cent. In Canada during 1959 and 1960 the metallurgical industry accounted for about 35 per cent of the chromite consumed.

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 consumed in the steel indus-

* Stanley, R., Department of Mines, Southern Rhodesia. *Chromium in Southern Rhodesia*, page 16.

try as ferrochrome alloys made by electric smelting processes. Manufacturers of chrome exothermic additives may use chrome ores of less rigid specifications than those outlined.

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

Chromium metal is used in high-temperature corrosion-resistant alloys and 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 up their own alloy compositions. 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 wearing qualities and performance.

Refractory-grade Chromite

Specifications for refractory-grade chromite are not so 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 10 and 5 per cent. The ore must be hard and lumpy and above 10-mesh. Chromite fines are suitable for the manufacture of brick cement or chrome-magnesite brick.

Bricks made from refractory-grade chromite are used extensively for lining furnaces. Because of its high melting point and chemical inactivity, chromite is widely used where contact with basic or acid fluxes is involved. Hence, it is common practice to use chromite bricks near the slag line in open-hearth furnaces and between the silica bricks of the roof and of the sides. Chrome refractory materials are used for patching brickwork and in making ramming mixtures for furnace bottoms.

Chemical-grade Chromite

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

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

PRICES

E & M J Metal and Mineral Markets of December 28, 1961, quotes chrome prices in United States currency as follows:

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	(")
48% Cr_2O_3, no ratio	\$27.00 - \$28.00	(")
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%, 3:1)		
48% Cr_2O_3, 3:1 ratio, lump and concentrates	\$36.00 - \$38.00	(nominal)
46% Cr_2O_3, 3:1 ratio, lump and concentrates	\$33.50 - \$34.00	(")

E & M J Metal and Mineral Markets of December 21, 1961, quotes the following prices:

Ferrochrome, carload lots, delivered, lump, continental U.S. per lb contained Cr	
High-carbon, all grades C, 67-71% Cr	24.00¢
Low-carbon, 0.75% C, 67-73% Cr	33.00¢
Special, 0.025% C, 68-73% Cr.	33.50¢
Charge chrome, 5.25% C, 58-65% Cr.	22.00¢
Refined chrome, 4.25% C, 58-65% Cr	24.00¢

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Chrome ore	free	free	free
Chrome metal in lumps, powder, ingots, blocks or bars and in scrap of alloy metal containing chromium for use in alloying	free	free	free
Ferrochrome	free	5%	5%
Materials for use in the manufacture of chromium oxide	free	free	20%

United States

Chrome ore	free
Chromium metal	10½%
Ferrochrome	
Less than 3% C	10½%
3% or more C	⅝¢. per lb on Cr content
Chromic acid	12½%
Chromium carbide; chromium-nickel, -silicon, and -vanadium	12½%
Chrome brick	25%
Chrome colors	12½%

Clays and Clay Products

J. G. Brady*

The established statistical pattern shows that the value of clay imports is greater than the combined values of clays exported and clay produced and marketed as such in Canada. In 1961, the value of clay products made in Canada from domestic and imported clays was 6.7 per cent greater than in 1960 but 5 per cent less than in 1959, the peak year. The increase over 1960 was due to the greater value of the clay products manufactured from imported clays. The value of clay-products imports was about the same as in 1960 but 11 per cent below the previous high, reached in 1956.

Clay statistics may be classified under clays or clay products. The term 'clay products' applies to such materials as fire-clay refractories, common and face 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 others are prepared bodies and, in addition to clay, may contain ground silica, feldspar, nepheline syenite, talc or other components of whiteware-type bodies.

Clays and shales suitable for structural-clay products, sewer pipes, conduits, flue lining, drain tile and other manufactures requiring only clay as the principal constituent, occur in most parts of Canada. Deposits of such high-quality clays as china clay (kaolin), ball clay and very refractory fire clay are scarce. Consequently, most clays of this type are imported. In addition, low-grade fire clays and stoneware clays are occasionally imported for the manufacture of face brick and sewer pipe, particularly in Ontario and Quebec.

PRODUCTION, TRADE AND CONSUMPTION

The clay imported into Canada in 1961 was worth $4.6 million, which is approximately $3.4 million higher than production from domestic sources and exports.

The value of clay products manufactured in Canada was $61.6 million, or about $3.0 million higher than in 1960. Structural-clay products, drain tile, sewer pipe, some fire-clay refractories and other manufactures, made mainly from domestic clays and shales, accounted for $35.7 million. The remaining

*Mineral Processing Division, Mines Branch.

TABLE 1

CLAYS AND CLAY PRODUCTS—PRODUCTION AND TRADE

($)

	1961	1960
Production		
Domestic sources		
Clays, including bentonite	1,275,963	1,130,081
Clay products from:		
Common clay	29,008,821	30,101,393
Stoneware clay	5,002,263	4,873,304
Fire clay	778,272	816,206
Other products	917,629	1,305,554
Total	36,982,948	38,226,538
Foreign sources		
Clay products from imported clays	25,900,000[e]	21,524,752
Total production	62,882,948	59,751,290
Imports		
Clay		
Fire clay, ground	373,613	415,292
China clay, ground	2,666,656	2,375,213
Pipe clay, ground	32,640	22,981
Clays, ground, not otherwise provided for	602,529	508,533
Activated clay for refining of oils	1,006,916	936,029
Total	4,682,354	4,258,048
Clay products		
United States	22,404,491	23,381,646
Britain	14,672,251	14,051,594
Japan	3,471,501	2,970,262
Other countries	1,882,087	2,001,764
Total	42,430,330	42,405,266
Exports		
Clays, ground or unground*		
United States	6,159	263,279
Britain	1,500	3,338
Other countries	10,207	1,790
Total	17,866	268,407
Clay products		
United States	3,663,604	3,491,639
Cuba	311,446	26,523
Chile	200,771	239,567
Brazil	175,337	103,785
Mexico	126,564	182,083
West Germany	79,810	152,327
Belgium and Luxembourg	79,515	178,460
Other countries	1,140,567	622,974
Total	5,777,614	4,997,358

SOURCE: Dominion Bureau of Statistics. *For 1961 and subsequent years activated clays are excluded.
[e]Estimate.

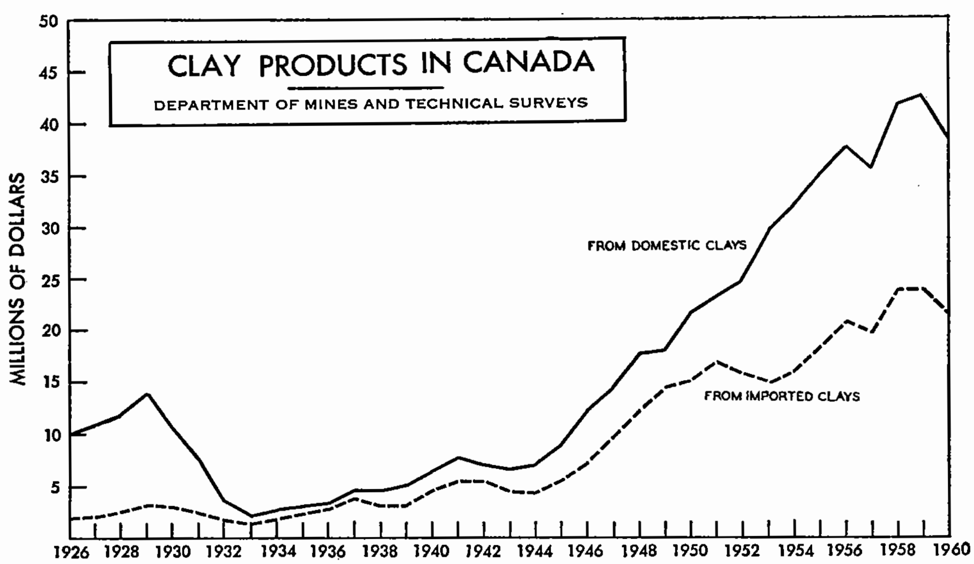
TABLE 2

CLAYS AND CLAY PRODUCTS—PRODUCTION AND TRADE, 1951-61

($ millions)

	Production			Imports	Exports
	From Domestic Clays	From Imported Clays	Total		
1951	23.5	16.9	40.4	39.8	2.5
1952	25.0	15.7	40.7	33.5	2.5
1953	29.8	14.9	44.7	36.5	1.9
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	25.9[e]	62.9	47.1	5.8

SOURCE: Dominion Bureau of Statistics. [e]Estimate.



$25.9 million was accounted for mainly by products made from imported clays—for example, sanitary ware, electrical porcelain, miscellaneous whitewares, and refractories.

Such clay products as face brick, common brick, structural tile, partition tile, conduit, quarry tile and drain tile were produced by 77 plants from domestic raw materials, particularly common clay and shale and stoneware clay. Most of the brick plants are modern or improved installations operating the entire year. Most of the drain tile plants suspend operations in the winter.

Nine plants manufactured clay sewer pipe, flue lining or conduits. Plants of this type use mainly such domestic materials as low-grade fire clay, stoneware clay, common clay and plastic shale but three in Ontario and Quebec use low-grade fire clay imported from the United States. The imported material is usually mixed with local common clay to form suitable production mixtures.

Fifteen refractory plants in Canada used refractory clay as one of the principal ingredients of their products. Only four, all in western Canada, utilized domestic clays. There are no domestic sources of fire clay in the populated areas of Ontario and Quebec, where most of the plants are concentrated. The known domestic materials are suitable for high-duty refractories or lower-quality products. Very refractory fire clay, kaolin and ball clay are imported.

Three sanitary-ware plants, seven electrical-porcelain plants, three wall-tile plants, one dinnerware plant and numerous souvenir and art potteries were the principal users of ceramic-grade kaolin and ball clay. Raw kaolin was used mainly by the paper industries.

The value of imported clay products, refractories included, was $42.4 million, as in 1960, or 11 per cent less than in 1956, the year of the previous high. The value of imported clays, $4.6 million, was slightly greater than in 1960 and about the same as in 1956 and 1957, when the previous highs were reached.

The export of clays, exclusive of activated bentonite, was negligible. At $5.7 million, the value of the clay products exported including refractories was about $0.8 million more than in 1960 and higher than in any previous year.

The value of the clay products consumed amounted to $99.2 million, or $3.1 million more than in 1960 and about $5.4 million less than in the peak year 1959.

Consumption statistics are not available for any clays except kaolin.

TABLE 3

CONSUMPTION OF CHINA CLAY, BY INDUSTRIES

(short tons)

	1961	1960
Paper	63,689	85,432
Rubber and linoleum	11,325	11,814
Ceramics	10,028	6,736
Other products*	23,236	5,596
Total	108,278	109,578

SOURCE: Dominion Bureau of Statistics. *These include paints, 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. 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 occurs in a crude form, which is beneficiated 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 39.5 per cent and combined water 13.96 per cent—gives a very refractory mixture that is nearly white in both the unfired and the fired condition. Good-quality commercial kaolins have minor amounts of alkalis, alkaline material, and iron and titanium compounds and usually approach closely the theoretical composition of kaolinite.

Because of problems associated with beneficiation and the limited extent 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 small, 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 met with success.

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 the Province 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 extent of the deposit is not definitely known and no proper development has been undertaken, possibly because of its remoteness. Preliminary drilling indicates that the material varies from very plastic to very sandy. The upper beds are considerably iron-stained.

A clay deposit at Arborg, Manitoba, contains colloidal iron, considerable quartz and some other impurities in addition to kaolinite. Kaolinized material 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 anorthite with about 25 per cent kaolinite. In the past two or three years, various companies have shown considerable interest in Quebec's kaolinized deposits because of their kaolinite content and the possible uses of the unbeneficiated material in the face-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 tonnage of a light-brown iron-stained type containing excessive quartz. Kaolinite also occurs in the quartzite of this area. At St. Remi d'Amherst, restricted development by open-pit and underground mining and by beneficiation through the removal of china clay from quartzite were discontinued in 1948 because of operational difficulties.

The Laurentian Art Pottery Inc., St. Jerome, Quebec, used clay from the Brebeuf deposit for several years but stopped doing so some 15 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.

Ball Clay

Ball clays are used in whiteware slips and to impart plasticity and a high green strength to whiteware 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.

Ball clays are known to occur in Canada 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 and has been tested in the United States. Lack of proper quality control and distance from large markets have been the principal disadvantages affecting the use of this material. A plant established near the Willows deposits at Assiniboia, Saskatchewan, for processing the ball clay and sandy kaolin of that province, chiefly for use as fillers and fertilizer coating, suspended operations in 1960 because of operational difficulties.

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 (approximately 1,699°C) to 32½ (approximately 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 superduty 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 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 utilized 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 neighboring plant, 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. Some recent prospecting has been discontinued, but various companies are still interested in this area.

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 Clays

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

Stoneware clays are plastic buff-firing materials that fire to a dense condition over a long 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 stonewares 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 a large quantity of clay, which was used mainly at Medicine Hat, Alberta. Stoneware-clay pits were recently opened 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, face 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 face 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 and Quesnel and close to the Alaska Highway. Quebec and Ontario import their stoneware clay.

Common Clays and Shales

Common clays and shales are the principal type of raw material available in Canada for the manufacture of clay products. They are used mainly for the manufacture of common and face 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 face brick, sewer pipe and flue lining.

Because of the presence of iron from various sources, common clays and shales usually fire to a salmon color or red. Their fusion points are low—usually well below cone 15 (approximately 1,430°C), which is considered to be the lower limit of the softening point for 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 is 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 the quality of the ware is lowered. Many clays and shales contain calcite or dolomite or both, and these, if present in sufficient quantities, cause the clay to fire to a buff color and make it difficult to fire the product to strength and high density. Common clays and shales are usually higher in alkalis, alkaline materials and iron-bearing minerals and much lower in alumina than the higher-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 negligible quantities, good drying and firing properties are essential.

Bentonite

Bentonite is dealt with on page 42.

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 commercial 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, while low-grade fire clays, stoneware clays, and common clays and shales are usually sold in bulk.

The following, taken from *Oil, Paint and Drug Reporter* of December 25, 1961, is typical of china- and ball-clay prices.

China clay, U.S. dry-ground, air-floated, 99% 325-mesh, bags, car lots, works, Georgia, per short ton	$11.00-$17.00
Ball clay, car lots, Tennessee, per short ton	
Bags, air-floated..............................	$17.00-$21.50
Bulk, crushed, containing shed moisture..........	$ 8.00-$11.25

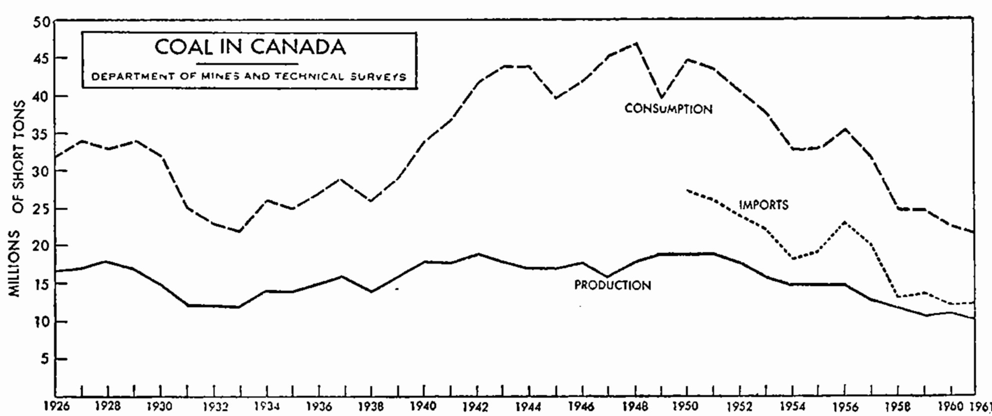
Coal and Coke

COAL

T. E. Tibbetts*

Despite government support of the coal industry through freight-subvention payments, other financial assistance and research on utilization, coal production and consumption continued their downward trend in 1961, the industry becoming more and more the victim of competition from other fuels. Closure of mines operating at a high cost, increased productivity per man-day and more and improved coal-cleaning and quality control have not been enough to improve or stabilize the coal market.

Production has declined since 1951 by 8 million tons and consumption by 22.5 million. Imports for this period have declined from more than 26 million tons to 12 million. The only encouragement is that exports have more than doubled since 1951, mainly owing to the growth of the exports of western bituminous coking coal to the western United States and Japan.



*Fuels and Mining Practice Division, Mines Branch.

TABLE 1

COAL—PRODUCTION, TRADE AND CONSUMPTION, 1952-61

(short tons)

	Production	Imports[1]	Exports	Consumption		
				Domestic[2]	Imported[3]	Total
1952	17,579,002	24,430,271	388,960	16,749,316	24,603,789	41,353,105
1953	15,900,673	22,417,571	255,274	15,240,105	22,900,392	38,140,497
1954	14,913,579	18,428,036	219,346	14,466,212	18,322,056	32,788,268
1955	14,818,880	19,372,505	592,782	14,060,039	19,322,134	33,382,173
1956	14,915,610	23,001,325	594,166	14,115,095	22,198,049	36,313,144
1957	13,189,155	19,937,133	396,311	12,478,626	19,041,030	31,519,656
1958	11,687,110	13,325,905	338,544	11,054,757	14,154,121	25,208,878
1959	10,626,722	13,604,021	473,768	10,589,263	13,958,996	24,548,259
1960	11,011,138	12,290,054	852,921	9,973,308	13,276,599	23,249,907
1961	10,397,704	12,132,449	939,336	9,572,805	12,057,086	21,629,891

SOURCE: Dominion Bureau of Statistics.

[1]Imported coal 'landed in Canada.'

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

[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

In 1961 production, at 10.4 million tons, was 5.6 per cent below the 1960 level of 11 million tons and far below the 19.1 million tons obtained in 1950.

TABLE 2

PRODUCTION OF COAL, BY PROVINCES AND TERRITORIES

(short tons)

		Bituminous[1]	Subbituminous[1]	Lignite[1]	Total
Nova Scotia	1961	4,300,758	—	—	4,300,758
	1960	4,570,240	—	—	4,570,240
New Brunswick	1961	887,903	—	—	887,903
	1960	1,028,064	—	—	1,028,064
Saskatchewan	1961	—	—	2,208,851	2,208,851
	1960	—	—	2,170,797	2,170,797
Alberta	1961	666,226	1,361,600	—	2,027,826
	1960	851,122	1,540,577	—	2,391,699
British Columbia and Yukon Territory	1961	972,366	—	—	972,366
	1960	850,338[2]	—	—	850,338
Total	1961	6,827,253	1,361,600	2,208,851	10,397,704
	1960	7,299,764	1,540,577	2,170,797	11,011,138
Value	1961	$60,550,410	$5,732,916	$3,769,357	$70,052,683
	1960	$64,088,851	$6,753,760	$3,833,629	$74,676,240

SOURCE: Dominion Bureau of Statistics.

[1]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: D388-38).

[2]Includes 6,470 tons from Yukon Territory.

The production of bituminous coal in British Columbia increased by more than 14 per cent although the over-all production of bituminous coal in Canada decreased by 6.5 per cent. Subbituminous coal, mined solely in Alberta, decreased by 11.6 per cent. The production of lignite, mined only in Saskatchewan, increased about 1.8 per cent.

Nova Scotia was the leading producer, 41.4 per cent of Canada's output coming from that province. Alberta produced 19.5 per cent, Saskatchewan 21.2 per cent, New Brunswick 8.5 per cent, and British Columbia and Yukon Territory the remaining 9.4 per cent.

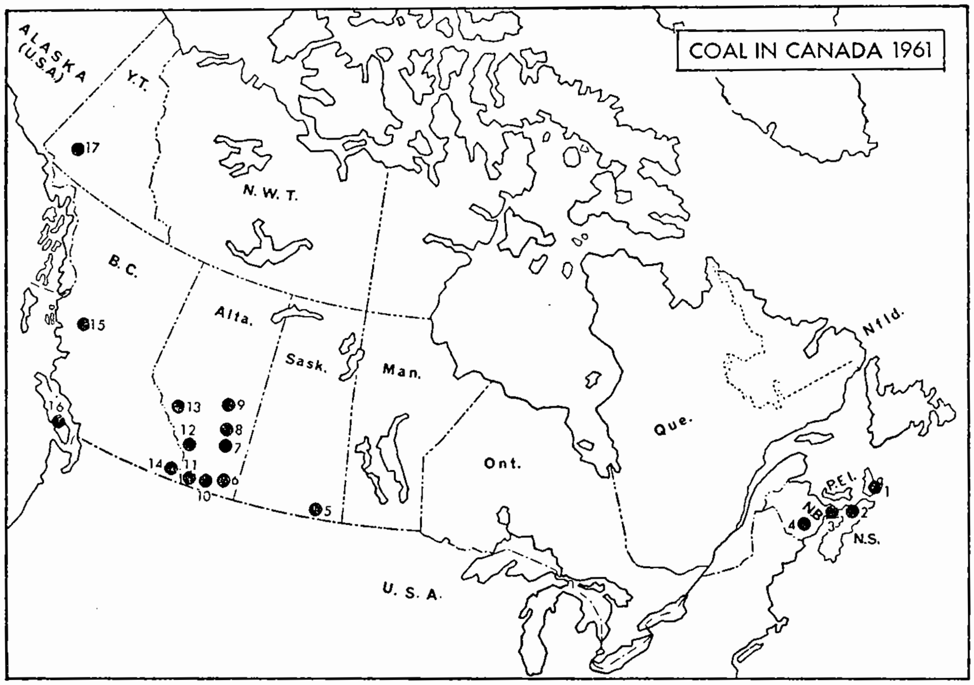
At 4.3 million tons, Nova Scotia's output was 5.9 per cent less than in the previous year; New Brunswick's production decreased by 13.6 per cent. In Alberta the production of bituminous coal decreased by 21.7 per cent. This and the 11.6-per-cent decrease in the output of subbituminous coal already referred to resulted in a general decrease of 15.2 per cent. The increase in Saskatchewan's lignite production resulted from the use of coal in that province's new Boundary Dam thermoelectric generating station. At 2.2 million tons, the output was 1.8 per cent higher than in 1960. Production in British Columbia and Yukon Territory increased 14.4 per cent.

TABLE 3

PRODUCTION OF COAL, BY TYPE OF MINING, AND AVERAGE OUTPUT PER MAN-DAY, 1961

	Production		Average Output per Man-day
	Short Tons	%	Short Tons
Nova Scotia			
Strip mines	—	—	—
Underground	4,300,758	100.0	2.801
New Brunswick			
Strip mines	728,965	82.1	5.259
Underground	158,938	17.9	1.792
Saskatchewan			
Strip mines	2,208,851	100.0	42.247
Underground	—	—	—
Alberta			
Strip mines	970,369	47.9	14.874
Underground	1,057,457	52.1	4.826
British Columbia			
Strip mines	86,762	9.0	28.215
Underground	877,901	91.0	4.678
Yukon Territory			
Underground	7,703	100.0	3.231
Canada			
Strip mines	3,994,947	38.4	15.413
Underground	6,402,757	61.6	3.149
All mines	10,397,704	100.0	4.536

SOURCE: Dominion Bureau of Statistics.



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

COAL AREAS AND PRINCIPAL PRODUCERS

(approximate production in thousands of short tons)

Nova Scotia

1. Sydney and Inverness areas (high-volatile bituminous)	
Beaver Coal Co., Ltd.	5
Bras d'Or Coal Co. Ltd. (Four Star mine)	103
Chestico Mining Corp. Ltd.	19
Dominion Coal Co., Ltd.	3,129
Evans Coal Mines Ltd.	30
Indian Cove Coal Co., Ltd.	38
Old Sydney Collieries, Ltd.	537
S. J. Doucet and Sons Ltd.	6
2. Pictou area (medium- and high-volatile bituminous)	
Acadia Coal Co. Ltd.	240
Drummond Coal Co. Ltd.	51
Greenwood Coal Co., Ltd.	20
3. Springhill and Joggins areas (high-volatile bituminous)	
Joggins Coal Co., Ltd.	46
River Hebert Coal Co. Ltd.	25
Springhill Coal Mines Ltd.	50

New Brunswick

4. Minto area (high-volatile bituminous)	
Avon Coal Co. Ltd.	236
A. W. Wasson, Ltd.	45
Dufferin Mining Ltd.	58
D. W. and R. A. Mills Ltd.	187
McEwan Mining Co. Ltd.	6
Michiels Ltd.	22
Miramichi Lumber Co. Ltd.	232
Newcastle Coal Co., Ltd.	35
V. C. McMann, Ltd.	61

Saskatchewan

5. Souris Valley area (lignite)	
Great West Coal Co., Ltd.	746
Manitoba and Saskatchewan Coal Co. Ltd.	450
North West Coal Co. Ltd.	73
Utility Coals Ltd.	940

Alberta

6. Brooks and Taber areas (subbituminous)	
Alberta Coal Sales Ltd.	45
Kleenbirn Collieries, Ltd., The	8

7. Drumheller, Sheerness and Carbon areas (subbituminous)	
Amalgamated Coals Ltd.	156
Century Coals Ltd.	141
Federated Co-operatives Ltd.	46
Great West Coal Co., Ltd.	156
Halbert Coal mine	5
Nottal Bros.	11
Red Deer Valley Coal Co., Ltd.	24
Subway Coal Co.	14
8. Castor, Ardley and Camrose areas (subbituminous)	
Allyn Mann Construction Co.	16
Battle River Coal Co. Ltd.	183
Camrose Collieries Ltd.	21
Conger mine	13
Forrestburg Collieries Ltd.	288
Lynass, John	12
Stettler Coal Co. Ltd.	8
9. Edmonton, Tofield and Pembina areas (subbituminous)	
Alberta Coal Ltd.	37
Black Gem Coal Co. Ltd.	12
Black Nugget Coal Ltd.	10
Egg Lake Coal Co. Ltd.	15
Jet Construction Ltd.	10
Star-Key Mines Ltd.	44
Warburg Coal Co. Ltd.	15
Whitemud Creek Coal Co. Ltd.	18
10. Lethbridge area (high-volatile bituminous)	
Lethbridge Collieries Ltd.	78
11. Crowsnest area (medium-volatile bituminous)	
Coleman Collieries Ltd.	333
West Canadian Collieries, Ltd.	11
12. Cascade area (low-volatile bituminous and semianthracite)	
Canmore Mines Ltd., The	230
13. Coalspur area (high-volatile bituminous)	
Blackstone Collieries Ltd.	
British Columbia	
14. East Kootenay (Crowsnest) area (medium-volatile bituminous)	
Crow's Nest Pass Coal Co., Ltd., The	878
15. Northern area (medium- and high-volatile bituminous)	
Bulkley Valley Collieries, Ltd.	6
16. Vancouver Island (Comox) area (high-volatile bituminous)	
Comox Mining Co. Ltd.	75
Yukon Territory	
17. Carmacks area (high-volatile bituminous)	
Yukon Coal Co. Ltd.	8

In 1961 strip mines accounted for 38.4 per cent of the coal produced in Canada, and the average output per man-day for all strip mines increased from 15.1 to 15.4 tons. Saskatchewan's whole output was from strip mines, the average per man-day being 42.2 tons, substantially more than the 33.9 tons produced in 1960. Because of heavier overburden and related mining problems in the other provinces where coal is strip-mined, the proportion of the output mined in this way and the average output per man-day were lower than in 1960. In Alberta's strip mines, whence 47.9 per cent of this province's coal is derived, the average output per man-day decreased from the 1960 level of 15.1 tons to 14.9; in those of British Columbia, which strip-mines 9 per cent of its production, this average dropped from 29.2 to 28.2 tons; and in those of New Brunswick, which account for 82.1 per cent of the provincial total, the average output per man-day decreased from 6.19 to 5.26 tons.

In underground mining the trend to mechanization continued. In Nova Scotia's Sydney area, both longwall and room-and-pillar operations are mechanized. In the Minto area of New Brunswick, experiments continued during the year with a mechanized longwall operation. Although conditions in Alberta and British Columbia are not highly favorable, mechanized mining is being furthered in those provinces wherever possible. The output per man-day in underground mines increased in 1961 by 0.182 tons to 3.149 tons.

All provinces increased their average output per man-day, Alberta leading with 4.826 tons, or 0.5 tons more than in 1960. The next highest was British Columbia's—4.678 tons, or 0.46 tons more. There was a significant increase, 0.13 tons, in the average output per man-day from Nova Scotia's deep mines. Yukon Territory showed a decrease.

The value of Canada's 1961 coal output was $70,052,683 f.o.b. the mines. Subbituminous and lignite coals were lower in value than in the previous year, subbituminous coal having dropped in value per ton to $4.210 from $4.383 and lignite to $1.706 from $1.766. The value of a ton of bituminous coal increased by $0.089 to $8.868. This was due mainly to an increase of $1.519 a ton in the value of Alberta bituminous coals.

TABLE 4

COMPARISON OF AVERAGE VALUES OF CANADIAN COALS, 1961

	Average Btu/lb[1]	Average Value per Short Ton[2]	Average Value per Million Btu
		($)	(¢)
Nova Scotia			
Bituminous	13,450	9.700	36.06
New Brunswick			
Bituminous	11,900	8.477	35.62
Saskatchewan			
Lignite	7,400	1.706	11.53
Alberta			
Bituminous	12,950	7.115	27.47
Subbituminous	9,000	4.210	23.39
British Columbia			
Bituminous	13,800	6.690	24.24
Yukon Territory			
Bituminous	11,450	14.830	64.76
Canada			
Bituminous	13,250	8.868	33.46
Subbituminous	9,000	4.210	23.39
Lignite	7,400	1.706	11.53
Average	11,450	6.737	29.42

[1]Department of Mines and Technical Surveys, *Analysis Directory of Canadian Coals.* "Supplement No. 2—1960" (Mines Branch Monograph No. 868).

[2]Dominion Bureau of Statistics.

At 11.53 cents per million Btu, lignite maintained its position as by far the cheapest source of coal-derived energy. If the small output of Yukon Territory is excluded, Nova Scotia coal, at 36.06 cents per million Btu, is the most expensive, followed closely by New Brunswick coal at 35.62 cents.

The more stringent market requirements arising from the consumer's effort to get as much heat as possible from his fuel purchases are among the main reasons for the increase in emphasis on coal preparation. These requirements have also resulted in quality improvement, particularly in bituminous coals, as indicated by the revised calorific averages shown in Table 4. Another factor behind the movement toward coal-cleaning is the deterioration that mechanization has caused in the run of mine coal. Still another is that the exhaustion of the best reserves and the consequent necessity of mining inferior coal are forcing the industry to adopt coal-preparation techniques to meet the competition of other fossil fuels.

Mine mechanization and the greater friability of the seams worked are causing fine coal, widely recognized as the least amenable to present coal-cleaning methods, to appear in the mine run in increasing quantities. Because of this, the Mines Branch is directing much of its research on coal toward the upgrading and combustion of fine coal.

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, and noncoking high-volatile bituminous coal 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. Nova Scotia coal finds its greatest single use in the manufacture of metallurgical coke for the provincial steel industry. The railways are no longer important consumers of eastern Canadian coal.

Much of the coal produced in Nova Scotia and New Brunswick is shipped to Quebec and Ontario. In 1961, Nova Scotia shipped more than 62 per cent of its output to other parts of the country, almost 86 per cent of this to central Canada, where it was to be 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 more than 15 per cent of its output to central Canada and more than 12 per cent to the United States.

Saskatchewan

Saskatchewan produces only lignite, mainly in the Bienfait and Estevan areas of the Souris Valley. The Estevan area serves the provincially owned

TABLE 5

INTERPROVINCIAL SHIPMENTS OF COAL, 1961

(short tons)

Destination	Originating Province				
	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia
Newfoundland	112,392	—	—	—	—
Prince Edward Island	37,264	77	—	—	—
New Brunswick	231,100	—	—	—	—
Quebec	2,106,205*	131,973	—	—	—
Ontario	211,454	3,625	88,620	35,466	12,478
Manitoba	—	—	771,326	159,744	146,969
Saskatchewan	—	—	—	232,848	817
Alberta	—	—	—	—	396
British Columbia	—	—	—	321,909	—
Total	2,698,415	135,675	859,946	749,967	160,660

SOURCE: Dominion Bureau of Statistics, *The Coal Mining Industry* (1961).

*Approximately 35 per cent of this coal was transshipped to markets in Ontario.

thermoelectric generating stations, which in 1961 used about 32 per cent more lignite than in 1960 and consumed about 43 per cent of the output.

About 39 per cent of the output for 1961 went to Manitoba and Ontario for industrial, commercial and household use. The remainder was used within the province for similar purposes.

TABLE 6

EXPORTS OF COAL, 1961

(short tons)

Destination	Shipments from Mines[1]						
	From Nova Scotia Mines	From New Brunswick Mines	From Saskatchewan Mines	From Alberta Mines	From British Columbia Mines	From All Mines	Total Exports[2]
St. Pierre	6,090	—	—	—	—	6,090	4,569
United States	—	108,074	—	18,144	9,041	135,259	249,504
Japan	—	—	—	343,757	375,487	719,244	685,263
Total	6,090	108,074	—	361,901	384,528	860,593	939,336
Value							$8,540,749

SOURCE: Dominion Bureau of Statistics. *The Coal Mining Industry, 1961; Trade of Canada, Exports, 1961.*
[1]Direct to destination.
[2]Cleared through Customs. 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 circumstances apply to New Brunswick, Alberta and British Columbia coals going to the United States.

Alberta

Alberta produces coals ranging from semianthracite, obtained in the Cascade area, to subbituminous (almost lignite).

The greatest output was from the subbituminous mines, 53 such mines operating in 1961 producing 67 per cent of Alberta's coal. These mines are in the following areas: Drumheller, Edmonton, Brooks, Camrose, Castor, Carbon, Sheerness, Taber, Pembina, Ardley, Tofield, Redcliff, Champion, Halcourt, Gleichen, Westlock, Wetaskiwin and Whitecourt. Their production is used mainly for commercial and household heating, increasing quantities being employed industrially, particularly for thermoelectric power generation.

Bituminous coking coals were produced in the Crowsnest area. A large part of this production was exported in 1961 to Japan, where it is used to upgrade the Japanese coal blends for metallurgical use. A total of 343,757 tons of Alberta coal went to Japan and more than 18,000 tons to the United States. A new bulk-loading dock at Port Moody, British Columbia, facilitates the export of coal from western Canada.

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 37 per cent of Alberta's coal production was shipped to other provinces, Saskatchewan and British Columbia taking respectively 11.5 and 15.9 per cent. Nearly 8 per cent went to Manitoba and 1.7 per cent to Ontario.

British Columbia

Bituminous coking coal was mined on Vancouver Island (Comox area only) and in the Crowsnest (East Kootenay) district. Very small tonnages were produced in the Northern and Nicola-Princeton districts. Almost 92 per cent of the coal production was from the Crowsnest area, and 375,487 tons were exported to Japan for metallurgical use. About 15 per cent of the output was shipped to Manitoba and 1.3 per cent to Ontario. Small quantities went to Saskatchewan and Alberta.

Subvention Assistance

In 1961 there was an increase of 11.6 per cent in the coal tonnage to which the federal government applied subvention payments through the Dominion Coal Board. The value of this assistance, which in 1960 amounted to $16,344,196, rose in 1961 to $17,854,456. The federal government also made payments under the Atlantic Provinces Power Development Act, 1958, which indirectly aids the marketing of coal. In 1961, these payments totalled about $1.57 million.

TABLE 7

COAL MOVED UNDER SUBVENTION

(short tons)

Origin of Coal	1961	1960
Nova Scotia	2,323,684	2,048,073
New Brunswick	146,201	173,063
Saskatchewan	104,807	79,377
Alberta and British Columbia	758,011	685,797
Total	3,332,703	2,986,310

SOURCE: Dominion Coal Board.

IMPORTS

Coal imports decreased in 1961 by 9.2 per cent to a little more than 12 million tons. Imports of anthracite coal declined 18.4 per cent while those of bituminous coal from the United States, which makes up the bulk of coal imports, decreased 8.2 per cent. Of the total of bituminous coal imported almost 43 per cent was high-grade coking coal used in the metallurgical industry, mainly in Ontario.

TABLE 8

IMPORTS OF COAL FOR CONSUMPTION[1]

(short tons)

Country of Origin		Anthracite	Bituminous	Total
United States	1961	1,004,931	11,008,750[2]	12,013,681
	1960	1,232,601	11,994,420[3]	13,227,021
United Kingdom	1961	53,226		53,226
	1960	64,866	509	65,375
Total	1961	1,058,157	11,008,750	12,066,907
	1960	1,297,467	11,994,929	13,292,396
Value	1961	11,442,615	59,076,971	70,519,586
	1960	13,577,411	61,990,786	75,568,197

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

[1]Includes briquettes but not coal imported and subsequently sold for use on board ship.

[2]Includes lignite (quantities not separately reported) and 9,664 tons of briquettes.

[3]Includes lignite (quantities not separately reported) and 15,528 tons of briquettes.

CONSUMPTION

The slow-up in the expansion of the Canadian economy continued in 1961 and, combined with increasing competition from oil and gas in most of the markets formerly dominated by coal, resulted in a further decrease of 7 per cent in coal consumption. Some 21.6 million tons of coal, of which about 9.6 million tons, or about 44 per cent, were Canadian-produced, were consumed in 1961.

Ten years ago the railways provided an annual market for 9.8 million tons of coal but in 1961 used only 11,000 tons.

TABLE 9

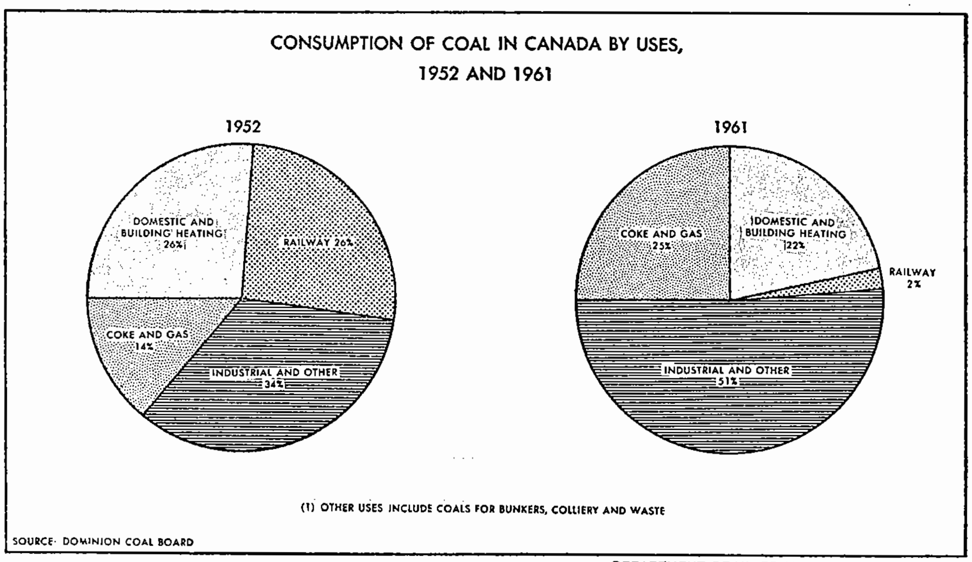
CONSUMPTION OF CANADIAN AND IMPORTED COAL, 1952-61

	Canadian		Imported		Total
	Short Tons[1]	% of Consumption	Short Tons[2]	% of Consumption	Short Tons
1952	16,749,316	40.5	24,603,789	59.5	41,353,105
1953	15,240,105	40.0	22,900,392	60.0	38,140,497
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

SOURCE: Dominion Bureau of Statistics.

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

[2]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.



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

In 1961 the consumption of coal for household and commercial-building heating was more than 600,000 tons below the consumption of the previous year, mainly owing to competition from oil and gas.

The 9.8 million tons of coal used in 1961 by industrial consumers, including thermoelectric power plants, represented a decrease of 0.4 per cent in this market. Fifty-two per cent of this coal was Canadian.

At 5.3 million tons, the consumption of coal in the production of coke was about the same as in 1960. The consumption of Canadian coal in coke-making was more than 27 per cent lower than in 1960, and less than 12 per cent of the total used for this purpose was Canadian.

TABLE 10

FUEL CONSUMED BY RAILWAY LOCOMOTIVES AND RAIL MOTOR CARS, 1952-61

	Coal[1] (thousands of tons)[3]	Fuel and Diesel Oil[1] (millions imp. gal)	Estimated Heat Equivalent of Oil in Terms of Coal[2] (thousands of tons)	Estimated Heat Equivalent of Oil as % of Total of Coal and Oil
1952	9,798	291.9	1,990.2	16.9
1953	8,323	308.2	2,101.3	20.2
1954	6,502	326.6	2,226.8	25.5
1955	5,587	384.6	2,622.2	31.9
1956	5,587	444.6	3,031.3	35.2
1957	3,322	419.4	2,859.3	46.3
1958	1,394	390.6	2,662.8	65.6
1959	554	400.2	2,728.6	83.1
1960	77	352.9	2,406.1	96.9
1961	11	342.3	2,333.8	99.5

[1]Dominion Bureau of Statistics, *Railway Transport*.

[2]Estimated in terms of coal at 13,000 Btu/lb, oil being taken at 9.33 lb/gal with a calorific value of 19,000 Btu/lb.

[3]Inclusive of briquettes.

TABLE 11

BITUMINOUS COAL USED TO MAKE COKE

(short tons)

	1961	1960
Imported	4,696,421	4,415,680
Canadian	634,121	872,537
Total	5,330,542	5,288,217

SOURCE: Dominion Bureau of Statistics.

TABLE 12

CONSUMPTION OF FUELS FOR DOMESTIC AND BUILDING HEATING, 1952-61

	Coal and Coke[1] (short tons)	Fuel Oil and Distillate[2] (barrels)	Natural Gas[3] (M cubic feet)	Manufactured Gas[3] (M cubic feet)
1952	10,515,475	34,863,926	43,328,304	22,527,092
1953	8,941,428	38,585,104	46,390,654	21,418,959
1954	8,599,993	46,808,256	56,864,148	22,090,283
1955	8,283,432	52,861,644	68,591,360	15,742,947
1956	8,048,673	61,276,831	77,937,257	16,392,636
1957	6,952,821	63,170,085	92,217,497	13,478,976
1958	6,061,924	68,108,400	112,939,734	5,232,899
1959	5,751,361	74,003,854	142,682,865	1,318,286
1960	4,717,156	77,375,067	161,298,388	823,734
1961	4,111,146	81,341,806	179,677,388[4]	772,286[4]

SOURCE: Dominion Bureau of Statistics in the publications referred to in the numbered footnotes.
[1]*The Coal Mining Industry*, "Sales of Coal and Coke Reported by Retail Fuel Dealers."
[2]*The Petroleum Products Industry*, "Consumption of Petroleum Fuels."
[3]*The Crude Petroleum and Natural Gas Industry*—manufactured and natural gas for household and commercial purposes.
[4]Estimated from *Sales of Manufactured and Natural Gas* (monthly reports).

TABLE 13

INDUSTRIAL CONSUMPTION OF COAL

(short tons)

Type of Coal	1961	1960
Canadian		
Bituminous	3,441,027	3,562,038
Subbituminous	241,660	274,231
Lignite	1,469,079	1,121,138
Total	5,151,766	4,957,407
Foreign		
Anthracite	228,723	239,473
Bituminous	4,468,003	4,695,165
Total	4,696,726	4,934,638
All coal	9,848,492	9,892,045

SOURCE: Dominion Bureau of Statistics.

BRIQUETTES

Both the production and the consumption of briquettes continued to decrease in 1961. In Saskatchewan the output dropped by 7.9 per cent, but the new market opened by the development of a special 'charcoal'-type briquette from Saskatchewan lignite has been an important factor in the maintenance of production. In Alberta the output declined 21.5 per cent. There was no production of briquettes in British Columbia in 1961.

Railway consumption of briquettes was reduced in 1961 by 22.7 per cent to 6,293 tons, which was 8.3 per cent of Canada's output.

TABLE 14

BRIQUETTES—PRODUCTION AND CONSUMPTION

(short tons)

	1961	1960
Production		
Saskatchewan	32,132	34,885
Alberta[1] and British Columbia	35,195	46,297
Total, Canada	67,327	81,182
Consumption		
Briquettes available for consumption[2]	77,431	95,968

SOURCE: Dominion Bureau of Statistics.
[1]Alberta production includes 491 tons of char for 1961 and 1,216 tons for 1960.
[2]Production (including char) plus 'landed' imports less exports.

COKE

E. J. Burrough*

In Canada, coal finds its greatest nonfuel use in the production of coke. The coke is used mainly in the making of pig iron and, to a lesser extent, in foundry practice, base-metal recovery and chemical processes.

Canadian-produced by-product coke is usually manufactured in Canada in batteries of slot-type ovens of some 50 units to a battery. The coal capacity of the ovens is about 18 tons, and the mean width is 17 inches. The plants at present in operation vary in annual coal capacity from 500,000 to 2 million tons.

In Canada, petroleum coke is used mainly in the production of electrodes for the aluminum industry; and 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.

Although the plants that produce manufactured gas and domestic coke have reached the point of near extinction, the capacity for the production of metallurgical coke for the steel and base-metal industries has been sustained.

The gas industry, which has continued to expand its facilities for the distribution of natural gas, is contending for space-heating and other domestic and commercial outlets. The gas-retort plants, which for many years were the main producers of manufactured gas and also a source of domestic coke, have now been superseded. In areas where natural gas is not available, propane or other liquid petroleum gases are distributed. Liquid petroleum gases are also used as source materials for stand-by plants and the peak-load requirements of several natural-gas distribution systems.

The standard by-product-coke-oven plants, with the exception of a few custom plants built primarily for the production of domestic coke, are owned and operated by the steel plants.

* Fuels and Mining Practice Division, Mines Branch.

TABLE 15

COKE—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production[1]				
From bituminous coal				
Ontario	3,138,141		2,931,929	
Newfoundland, Nova Scotia, New Brunswick, Quebec, Manitoba, Alberta and British Columbia	761,404		940,873	
Total	3,899,545		3,872,802	
Of pitch coke	3,204		3,414	
Of petroleum coke	528,426		534,979	
Total	4,431,175		4,411,195	
Bituminous coal used to make coke[2]				
Imported	4,696,421		4,415,680	
Canadian	634,121		872,537	
Total	5,330,542		5,288,217	
Imports (all types)				
United States	654,423	11,118,960	700,979	11,230,457
Britain	136	4,464	119	3,534
Total	654,559	11,123,424	701,098	11,233,991
Exports (all types)				
United States	156,929	2,349,423	151,508	2,167,214
Britain	5,390	237,687	8,918	393,465
Other countries	64,384	893,652	764	22,758
Total	226,703	3,480,762	161,190	2,583,437

SOURCE: Dominion Bureau of Statistics.

[1] The value of coke production and the selling price of coke are not available, the Dominion Bureau of Statistics having discontinued publication of *The Coke and Gas Industry* after 1959.

[2] Includes additional quantities of coke (used as catalytic carbon) not reported prior to 1958.

In recent years the uses of metallurgical coke have changed owing to 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, which is done mainly with coke breeze, have resulted in an increase in the demand for small sizes of coke or 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 liquid and gaseous fuels in iron blast furnaces have led to an increase in the throughput of standard furnaces and a reduction in the quantity of by-product coke used for each ton of pig iron produced. An increase in the use of electrical reduction for the production of pig iron has also increased the demand for low-volatile fuels, such as coke breeze, for the carbon required in the process. The changes have contributed materially to a more efficient use of coke in the production of pig iron as well as to a considerable increase in the capacity or throughput of standard blast furnaces. In essence, more 'work' is being done outside the blast furnace than was done under former methods of operation.

The Canadian steel industry's expansion of recent years, together with a corresponding increase in coke-oven capacity, is expected to continue. Dominion Foundries and Steel, Limited, The Steel Company of Canada, Limited, and The Algoma Steel Corporation, Limited, which have reported coke-oven-capacity increases, are considering further expansion.

Apart from the standard by-product-coke ovens, Canada has a Curran Knowles carbonization plant at the Crowsnest Pass collieries in Michel, British Columbia, and a distinctive stoker-type coking plant designed and operated by Shawinigan Chemicals Limited, Shawinigan, Quebec.

About 80 per cent of the coal used in the production of coke is processed at five plants in eastern Canada, namely: Dominion Steel and Coal Corporation, Limited, at Sydney, Nova Scotia, with a rated annual capacity of 1,001,900 tons of coal; Quebec Natural Gas Corporation, at Ville La Salle, Quebec, with a rated annual capacity of 656,000 tons; The Algoma Steel Corporation, Limited, with a metallurgical-coke plant at Sault Ste. Marie, Ontario, which has a rated annual capacity of 2 million tons; Dominion Foundries and Steel, Limited, at Hamilton, Ontario, with an annual capacity of 930,000 tons; and The Steel Company of Canada, Limited, also at Hamilton, with a rated capacity of 1,470,000 tons of coal a year.

Cobalt

V. B. Schneider*

In 1961 cobalt production amounted to 3,182,897 pounds valued at $4,751,543. This is a decrease of 385,914 pounds from 1960, partially attributable to the fact that the cobalt content of the silver ores from the Cobalt and Gowganda areas in Ontario was not recovered in 1961. Reported sales for 1961 were 4.6 million pounds, compared with 3.8 million pounds in 1960.

No cobalt ores have been produced in Canada since 1957, but cobalt has been obtained as a by-product from the smelting and refining of nickel-copper ores from Sudbury, Ontario, and Lynn Lake and Thompson, Manitoba, and as a by-product of silver refining at Deloro, Ontario.

Deloro Smelting & Refining Company, Limited, ceased all smelting and refining operations at its plant at Deloro, Ontario, on April 21, 1961. Production for 1961 amounted to 27,754 pounds of cobalt in metal, oxides and salts from ore concentrates received in October 1960 and from the clean-up of low-grade residues accumulated over the years.

The Deloro smelter began to operate about 1868, when gold was discovered in Hastings county; and the gold ores, which were arsenical, were milled and refined at Deloro from that year until 1903. The rich silver ores from Cobalt, Ontario, which also contained arsenic and were recognized as suitable raw material, were then used for the continued operation of the refinery. In 1912, through the combined efforts of Professor H. T. Kalmus of Queen's University, the Government of Ontario, and Deloro Smelting & Refining, cobalt was first produced in Canada. The Deloro smelter was producing it on a commercial scale by 1914 and remained the leading producer until 1925 when Belgian refineries began to produce cobalt from the copper-cobalt deposits of Katanga, Belgian Congo. During the lifetime of the plant's operations 28,227,832 pounds of cobalt were produced as metal and in oxides and salts.

*Mineral Resources Division.

TABLE 1

COBALT—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Production[1]				
All forms, cobalt content	3,182,897	4,751,543	3,568,811	6,763,016
Exports				
Cobalt metal				
United States	468,849	836,263	459,912	788,807
Britain	69,681	104,009	108,700	163,645
Sweden	57,750	87,294	27,300	39,517
West Germany	6,650	9,924	26,600	38,102
India	1,001	1,583	—	—
Austria	—	—	99,300	136,476
United Arab Republic (Egypt)	—	—	88,188	153,254
Other countries	—	—	34,293	48,000
Total	603,931	1,039,073	844,293	1,367,801
Cobalt alloys[2 3]				
United States			1,664	5,137
Colombia			210	1,220
Hong Kong			64	1,698
Total			1,938	8,055
Cobalt oxides and salts[3]				
Britain	1,521,000	2,106,608	1,068,857	1,624,663
United States	—	—	51,715	61,409
Other countries	—	—	54,634	66,454
Total	1,521,000	2,106,608	1,175,206	1,752,526
Imports				
Oxides[3]				
Britain	26,064	30,738	17,227	19,384
United States	2,300	4,086	3,000	5,245
Total	28,364	34,824	20,227	24,629
Consumption[4]				
Cobalt metal and cobalt contained in oxides and salts	390,091		252,050	

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 International Nickel, but includes the cobalt content of Falconbridge shipments of nickel-copper matte to Norway.

[2]Not recorded as a separate class after 1960.

[3]Gross weight.

[4]As reported by consumers.

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TABLE 2

COBALT—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

(pounds)

	Production[1]	Exports				Imports		Consumption[2]
	All Forms	Cobalt in Ores and Concentrates	Metallic Cobalt	Cobalt Alloys[3]	Cobalt Oxides and Salts[3]	Cobalt Ores	Cobalt Oxides[3]	
1951	951,607	35,300	192,260	730	659,486	3,687,800	—	114,000
1952	1,421,923	—	315,500	20,445	785,976	14,943,400	—	164,000
1953	1,602,545	37,100	769,369	11,874	932,499	4,288,000	28,500	192,000
1954	2,252,965	3,300	1,139,039	4,926	836,205	10,400	6,935	122,000
1955	3,318,637	—	1,542,988	12,357	1,640,282	37,800	8,000	224,000
1956	3,516,670	16,000	1,432,884	11,343	1,289,145	1,900	11,353	262,000
1957	3,922,649	15,100	2,155,742	12,400	620,042	800	10,340	153,000
1958	2,710,429	—	1,024,667	9,712	522,144	—	16,230	260,000
1959	3,150,027	—	680,323	3,280	1,100,734	—	24,716	188,000
1960	3,568,811	—	844,293	1,938	1,175,206	—	20,227	182,000
1961	3,182,897	—	603,931	[4]	1,521,000	—	28,364	307,000

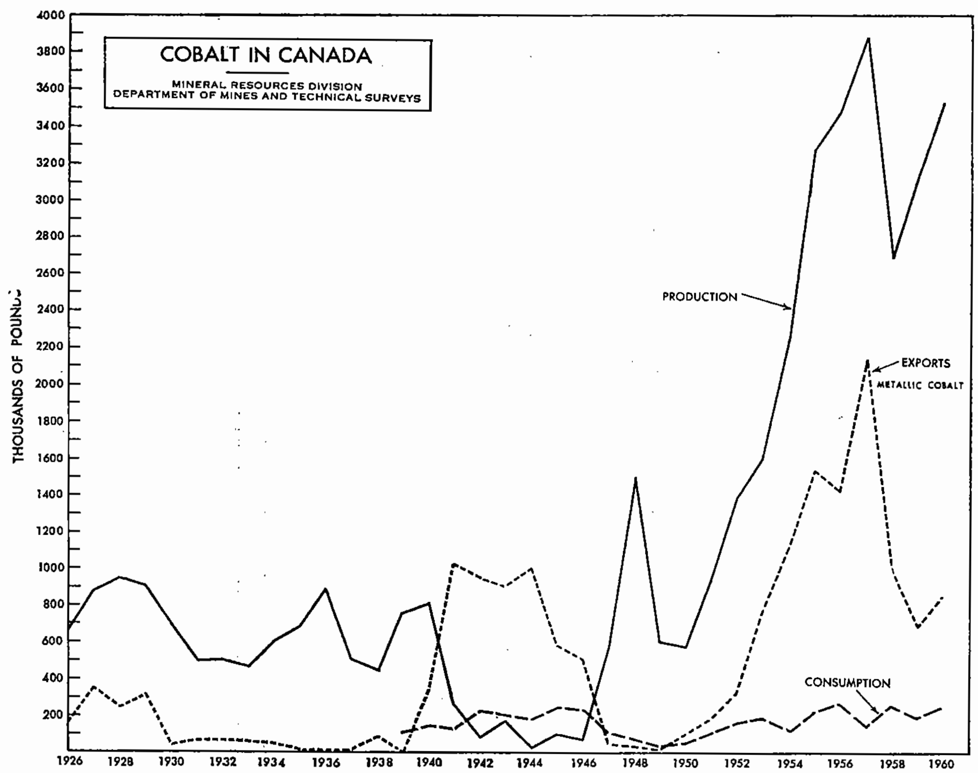
SOURCE: Dominion Bureau of Statistics.

[1]Metallic cobalt from Canadian ores and the cobalt content of oxides, alloys and salts sold and concentrates exported.

[2]Producers' domestic shipments, refined metal only. From 1959, consumption of cobalt metal as reported by consumers.

[3]Gross weight.

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



PRODUCERS

Ontario

The International Nickel Company of Canada, Limited, (Inco) recovered cobalt from its nickel-refining operations at Port Colborne, Ontario, and Clydach, Wales. High-purity electrolytic cobalt is produced at the Port Colborne refinery; cobalt oxides and salts are produced by The International Nickel Company (Mond) Limited, a British subsidiary, at Clydach. In 1961, International Nickel reported production of 2,103,437 pounds of cobalt, including the production at the Clydach refinery.

Falconbridge Nickel Mines, Limited, produced electrolytic cobalt in the refining of nickel-copper matte exported to its refinery at Kristiansand, Norway. Metal deliveries reported for 1961 amounted to 1,462,461 pounds, or 635,744 pounds more than in 1960.

Manitoba-Alberta

Sherritt Gordon Mines, Limited, produced 191,043 pounds of cobalt, down 119,367 pounds from 1960. This decrease was caused by the use of the cobalt circuit for a custom-pilot-plant project during the latter half of the year. Sherritt Gordon recovers cobalt as a by-product at its nickel refinery at Fort Saskatchewan, Alberta, from its Lynn Lake, Manitoba, nickel-copper ores. It markets its cobalt in the form of briquettes, powder and cobalt strip, and is developing processes for the production of cobalt rod and wire. Briquettes measure $1\frac{1}{2}'' \times \frac{3}{4}'' \times \frac{1}{2}''$ (weight about $1\frac{1}{3}$ ounces).

TABLE 3

TYPICAL ANALYSIS OF SHERRITT'S COBALT BRIQUETTES

Cobalt*	99.9%	Iron	0.01%
Nickel	0.1%	Sulphur	0.005%
Carbon	0.008%	Copper	0.001%

*Including nickel.

TABLE 4

TYPICAL ANALYSIS OF SHERRITT'S 'S' GRADE COBALT POWDER

Cobalt*	99.9%	Iron	0.01%
Nickel	0.1%	Sulphur	0.03%
Carbon	0.05%	Copper	0.001%

*Including nickel.

TABLE 5

TYPICAL ANALYSIS OF SHERRITT'S COBALT STRIP

Cobalt	99.9%	Iron	0.018%
Nickel	0.10%	Sulphur	0.004%
Copper	0.005%	Carbon	0.014%

Inco produced cobalt oxide at its Thompson, Manitoba, refinery as a by-product in its nickel-refining operations.

WORLD MINE PRODUCTION

Preliminary estimates place the Free World cobalt production during 1961 at 16,900 tons of contained cobalt. This is 200 tons more than in 1960 but less than in 1959 which, with 17,500 tons, marks the all-time high. Production increased slightly in Katanga, Northern Rhodesia and Germany. Although production figures are no longer available for the United States, it is assumed that production there has again decreased, owing to the closure of the National Lead Company refinery at Fredericktown, Missouri.

The Republic of the Congo (Leopoldville) is by far the largest producer of cobalt. Its output since 1955 has been about 57 per cent of the world's total. Preliminary estimates of production in the Congo, which is derived from the copper mines of Union Minière du Haut-Katanga, are 9,260 tons. This would represent a slight increase over the 1960 production. The opening of the new electrolytic plant at Liulu in 1960 did not bring about an appreciable increase in Union Minière's output. This installation has a capacity of 1,750 tons of cobalt a year and in all probability will be brought to full production sometime during 1962.

In Morocco, cobalt is derived from the mines of Minière de Bou-Azzer et du Graara. Moroccan cobalt production, which is sufficient to meet French requirements, is derived from arsenical ores and, like the ore from Cobalt, Ontario, must be treated in smelters that specialize in this raw material.

In Northern Rhodesia, Rhokana Corporation Ltd. and Chibuluma Mines Ltd. recover cobalt as a by-product of copper refining. Chibuluma is selling its cobalt to the United States government as payment on a $14-million loan. It was expected that by June 30, 1962, the loan would have been repaid. Rhokana produced some 950 tons of cobalt in 1961 and Chibuluma, 1,051 tons.

Very little is known about the production and consumption of cobalt in the Communist bloc countries. It is generally believed that the use of cobalt is restricted because the bloc is deficient in cobalt. Soviet cobalt production is confined to the nickel-cobalt smelters in the Kola peninsula, Norilsk and the Urals.

TABLE 6

FREE WORLD PRODUCTION OF COBALT

(short tons)

	1961	1960	1959
Republic of the Congo (Leopoldville)	9,294	9,061	9,294
Northern Rhodesia	2,001	1,929	2,372
Canada	1,618	1,784	1,575
Morocco	1,422	1,475	1,391
Germany	1,000e	1,640	1,620
Other countries	1,565e	811	1,265
Total, Free World	16,900e	16,700	17,517

SOURCES: Dominion Bureau of Statistics; U.S. Bureau of Mines, *Minerals Yearbook 1960* (Preprint) and *Mineral Trade Notes*, July 1962; Cobalt Information Center, Brussels, Belgium, *Cobalt*, No. 14, March 1962.

eEstimated.

CONSUMPTION AND USES

Free World cobalt production capacity, some 18,000 tons a year, is more than ample to meet consumption. However, since 1958 the increase in the rate of consumption has far outpaced the increase in productive capacity. In 1958 production at 14,750 tons exceeded consumption by about 6,000 tons; by 1960 the excess of production over consumption was less than 2,000 tons. Most of the excess production was acquired by the United States for its various stockpiles. In March 1962 figures released by the United States government showed 48,524 tons of cobalt in stockpile, of which 39,024 were declared surplus. The surplus is equivalent to more than 4 years' consumption.

The United States is the leading consumer and importer of cobalt. It is also the only country that publishes complete statistical data for its domestic cobalt industry. Prior to 1960, when production figures were withheld to avoid disclosing individual company confidential data, the United States production amounted to about 27 per cent of the country's requirements. Preliminary reports indicate that the United States consumed 9.3 million pounds of cobalt in 1961 as against 8.9 million pounds in 1960[1]. Imports for consumption were 10.5 million pounds as against 12.2 million pounds in 1960[2].

Prior to 1954, United States consumption accounted for more than half of world cobalt consumption. However, since then and particularly since 1958 there has been a tremendous increase in the use of cobalt outside the United States, particularly in Europe. By 1960 the United States consumption was only 30 per cent of total consumption.

The table showing consumption of cobalt by uses in the United States illustrates that the general pattern of distribution among the various uses has not altered greatly during the period 1959-61. Notable is the decline in the proportion consumed by permanent-magnet alloys and the slight increase in the proportion being used in nonferrous alloys and other metallic products.

[1]U.S. Bureau of Mines, *Mineral Industry Surveys*, "Mineral Market Report No. 3363," December 29, 1961.

[2]U.S. Bureau of Mines, *Mineral Industry Surveys*, "Cobalt Report No. 153," January 28, 1962.

TABLE 7

UNITED STATES CONSUMPTION OF COBALT, BY USES

(percentages of total consumption)

Use	1959	1960	1961
Metallic (steel)			
High-speed steel	2.1	1.8	2.3
Other tool and alloy steel	6.3	7.0	6.1
Permanent-magnet alloys	30.2	26.9	25.6
Cutting and wear-resisting materials	1.4	2.9	2.7
High-temperature high-strength materials	24.5	22.5	24.5
Alloy hard-facing rods and materials	4.1	5.0	5.7
Cemented carbides	3.4	3.6	3.1
Nonferrous alloys and other metallic uses	6.6	6.8	8.4
Total, metallic	78.6	76.5	78.4
Nonmetallic (exclusive of salts and driers)			
Ground-coat frit	5.5	5.2	5.5
Pigments	2.0	2.1	2.0
Other materials	2.6	3.1	3.3
Total, nonmetallic	10.1	10.4	10.8
Salts and driers			
Lacquers, varnishes, paints, inks, pigments, enamels, feed, electroplating, etc. (estimated)	11.3	13.1	10.8
Grand total	100.0	100.0	100.0

SOURCE: U.S. Bureau of Mines, *Mineral Industry Surveys*, "Cobalt Report No. 155, Supplement," April 26, 1962.

TABLE 8

COBALT CONSUMPTION IN CANADA 1959-61

(pounds of contained cobalt)

	1959	1960	1961
Cobalt metal	188,371	181,966	307,459
Cobalt oxide	50,244	57,869	47,715
Cobalt salts	11,431	12,215	34,917
Total	250,046	252,050	390,091

SOURCE: Dominion Bureau of Statistics.

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 the jet-engine and gas-turbine-engine industry 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' for the 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-feed nutrient.

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; Indiana Steel Products Company of Canada Limited, Kitchener; Ferro Enamels (Canada) Limited, Oakville; Atlas Steels Limited, Welland; in Quebec—Dominion Glass Company, Limited, and Mallinckrodt Chemical Works Limited, both of Montreal; Canadian General Electric Company Limited, Quebec City.

St. Lawrence Chemical Company, Limited, Canadian sales agent for The Mond Nickel Company, Limited, supplies the domestic market with cobalt salts in the form of acetate, carbonate, hydrate, and sulphate. Its sales in 1961 to manufacturers were in the following proportions:

Ceramics	2%
Chemical	17%
Animal feed	30%
Drier	51%
Total	100%

PRICES

Cobalt prices in the United States at the end of 1961, according to *E & M J Metal and Mineral Markets,* were 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	$1.50
Cobalt oxide (350-lb containers) per lb	
72 1/2%-73 1/2% Co	
East of Mississippi	$1.15
West of Mississippi	$1.18
70%-71% Co	$1.12 to $1.15
Cobalt ore, per lb Co, free market	
10% Co content	$0.60 (nominal)
11% Co content	$0.70 (nominal)
12% Co content	$0.80 (nominal)

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Ore	free	free	free
Cobalt metal	free	10%	25%
Cobalt oxide	free	10%	10%

United States	
Ore	free
Metal	free
Cobalt oxide	4c. lb
Cobalt sulphate	2½c. lb
Cobalt linoleate	5c. lb
Other cobalt compounds and salts	15%

Copper

A. F. Killin*

Supply and demand were in reasonable balance on world copper markets in 1961. Production remained slightly ahead of consumption, thus stabilizing prices when various producing areas were immobilized by labor disturbances or political unrest. Since mid-1960, in fact, price stability has been a marked feature of the copper markets. Factors that maintained the supply-demand balance and contributed to price stability were a broader market base, an increase in production capacity and a surplus capacity that resulted when some of the leading producers in the United States and Africa reduced their output.

Canada's production in 1961 reached a total of 439,088 tons valued at $255,157,626. This output was 174 tons less than that of 1960; its value was $9,689,011 less, partly owing to a decrease in prices. The production of refined copper declined to 406,438 tons from the 417,029 produced in 1960, but its domestic consumption rose to 141,808 tons from the 117,636 consumed in 1960. The tonnage and value of virtually all classes of exports declined.

Barring widespread labor disturbances at the producing mines, all indications are that 1962 will be a year of record-breaking production.

Exploration for copper and the development of new copper properties increased during 1961. Five new mines came into production, and 13 properties were in the process of development. Exploration and production on the Pacific coast have been stimulated by Japan's ready market for ores and concentrates. Japanese firms are not only willing to enter into long-term contracts for the purchase of raw materials but have advanced funds to help some mines to prepare for production. Although Japan's industrial expansion slackened late in 1960, its copper smelters and refiners have planned to increase their capacity from that year's 250,000-ton level to 400,000 tons a year by 1970. Since the country's own mining industry produces only about 100,000 tons of copper a year in ores and concentrates, the remainder of the smelter feed will have to be made up of scrap, ores and concentrates from abroad. Canada's west coast is favorably situated to supply these requirements in increasing amounts, and at least two mines on the east coast are also planning to ship concentrates to Japan.

*Mineral Resources Division.

TABLE 1

COPPER—PRODUCTION, EXPORTS AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production[1]				
All forms				
Ontario	211,647	122,421,860	206,272	123,750,235
Quebec	149,007	86,990,202	157,470	95,395,158
Saskatchewan	33,479	19,545,019	31,785	19,255,437
British Columbia	15,845	9,205,938	16,559	9,982,552
Newfoundland	15,752	9,195,817	13,863	8,398,362
Manitoba	12,454	7,271,252	12,793	7,749,877
Northwest Territories	463	270,440	520	315,016
Yukon Territory	441	257,098	—	—
Nova Scotia	—	—	—	—
Total	439,088	255,157,626	439,262	264,846,637
Refined	406,438		417,029	
Exports				
In ore and matte				
Norway	19,443	8,498,144	18,723	10,237,168
United States	14,660	6,388,623	17,151	9,363,236
Spain	2,854	1,314,393	—	—
Britain	2,218	1,172,882	1,739	954,251
Japan	2,237	971,323	9,094	4,936,447
Belgium and Luxembourg	862	145,931	393	212,688
West Germany	612	138,687	533	290,984
Other countries	8	6,000	—	—
Total	42,894	18,635,983	47,633	25,994,774
Refinery shapes				
Britain	115,859	66,292,159	110,540	67,518,140
United States	64,189	39,396,990	104,602	65,033,398
France	15,885	8,961,796	12,880	7,618,932
Japan	11,207	6,461,158	4,861	2,823,187
West Germany	13,355	7,485,155	12,940	7,867,171
Netherlands	8,992	5,024,545	5,318	3,186,530
India	6,732	3,874,331	10,908	6,758,987
Belgium and Luxembourg	5,745	3,249,048	4,480	2,661,692
Poland	6,103	3,466,131	—	—
Sweden	4,894	2,720,129	2,522	1,427,400
Italy	3,497	1,882,353	2,516	1,451,595
Other countries	9,789	5,595,718	6,499	3,806,126
Total	266,247	154,409,513	278,066	170,153,158
Scrap, slag, skimmings, sludge				
Japan	2,647	1,366,126	1,915	833,946
West Germany	1,260	625,721	4,814	2,402,901
United States	1,919	612,638	1,501	680,570
Spain	855	476,241	442	227,304
India	528	292,776	387	212,443
Netherlands	375	183,060	774	403,607
Australia	145	155,057	22	12,125
Other countries	355	176,175	1,671	847,868
Total	8,084	3,887,794	11,526	5,620,764

TABLE 1 (*cont'd.*)

	1961		1960	
	Short Tons	$	Short Tons	$
Bars, rods and shapes (sections) not elsewhere specified and plates, sheet, strip and flat products				
Switzerland	6,310	3,476,612	5,437	3,098,777
Norway	6,244	3,608,396	—	—
Britain	3,213	2,027,479	3,711	2,447,680
United States	2,016	1,482,900	3,628	2,922,697
Denmark	896	525,409	448	261,553
New Zealand	521	425,941	360	299,960
Pakistan	620	330,185	562	379,263
Other countries	1,324	887,640	270	253,533
Total	21,144	12,764,562	14,416	9,662,563
Pipe and tubing				
United States	2,221	2,255,535	3,834	4,434,662
New Zealand	913	813,678	636	667,058
Cuba	654	580,435	130	135,097
Colombia	425	401,737	336	297,867
Puerto Rico	446	429,926	467	469,578
Philippines	308	347,326	150	170,848
Britain	263	284,938	257	284,536
Venezuela	205	212,430	227	220,939
Greece	137	149,602	82	93,595
Other countries	998	1,064,575	719	781,022
Total	6,570	6,540,182	6,838	7,555,202
Wire and cable not insulated				
United States	151	98,016		102,485
Dominican Republic	45	33,325		2,430
Mexico	27	30,133		—
Bermuda	35	27,819		16,018
Hong Kong	47	26,757		—
Pakistan	15	11,480		3,400
Netherlands	10	10,791		—
Britain	6	10,273		—
Other countries	72	54,433		153,969
Total	408	303,027		278,302
Wire and cable insulated				
United States	5,634	3,989,287		2,721,229
Venezuela	211	211,962		285,785
Dominican Republic	136	108,246		229,772
Peru	106	128,356		18,677
Panama	125	107,607		159,189
Other countries	782	716,340		1,173,805
Total	6,994	5,261,798		4,588,457
Consumption[2]				
Refined	141,807		117,636	

SOURCE: Dominion Bureau of Statistics.

[1]Blister copper plus recoverable copper in matte and concentrates exported.

[2]Producers' domestic shipments.

TABLE 2

COPPER—PRODUCTION, TRADE AND CONSUMPTION 1951-61

(short tons)

	Production		Exports			Imports	Consumption[3]
	All Forms[1]	Refined	In ore and Matte	Refined	Total	Refined	
1951	269,971	245,466	36,853	101,832	138,685	1,511	134,174
1952	258,038	196,320	34,437	113,675[2]	148,112	12,973	130,347
1953	253,252	236,966	51,158	131,994[2]	183,152	5,515	105,482
1954	302,732	253,365	47,411	156,130[2]	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	406,438	42,894	266,247	309,141	3	141,807

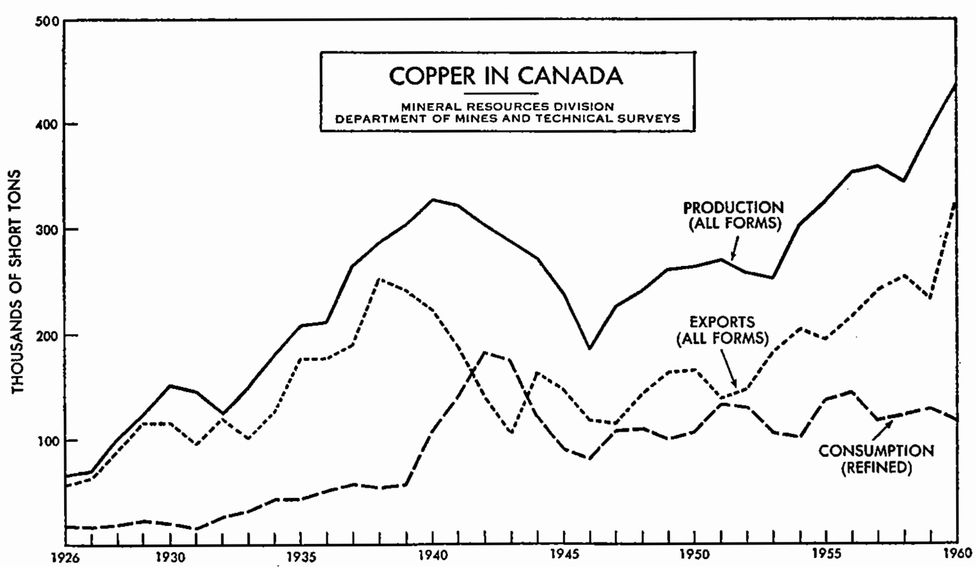
SOURCE: Dominion Bureau of Statistics.

[1]Blister copper plus recoverable copper in matte and concentrate exported.

[2]Includes blister and anode copper exported for refining as follows:
1952—27,974 short tons
1953— 3,527 short tons
1954— 4,712 short tons

[3]Producers' domestic shipments.

Under the regulations at present proposed, Canada's copper producers have little to fear from the European trade blocs or changes in their membership. Western Europe is a traditional market for about 50 per cent of Canada's output of primary copper, and there is no apparent reason to believe that it will cease to be so in the near future. The annual rate of more than 6 per cent at which western Europe's copper consumption has been increasing since 1955 is not regarded as likely to continue. The increase in industrial output expected



from the formation of the European trading blocs should, however, result in an annual growth rate of at least 4 per cent. This will mean the consumption of an additional 100,000 tons of copper a year, and it is reasonable to assume that Canada will maintain its due share of this amount.

PRODUCTION AND DEVELOPMENTS

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

Newfoundland

Copper production in 1961 amounted to 15,752 tons valued at $9,195,817 Atlantic Coast Copper Corporation Limited joined the two established Newfoundland producers in May, when production started at its Little Bay mine. Atlantic Coast ships concentrates to the Murdochville smelter of Gaspe Copper Mines, Limited.

Exploration for copper in Newfoundland has been most active in the area of the Burlington Peninsula and Notre Dame Bay. Two of the many interesting prospects investigated seem to be of sufficient merit to warrant production planning. At Whales Back Pond, about 4 miles west of Little Bay, British Newfoundland Exploration Limited (Brinex) has discovered and partially drilled a copper prospect. A mineralized zone at least 600 feet long and from 35 to 130 feet wide is indicated as having an average grade of 2 per cent copper. Consolidated Rambler Mines Limited, at Baie Verte, has started the sinking of a production shaft to develop its copper-gold-silver property.

New Brunswick

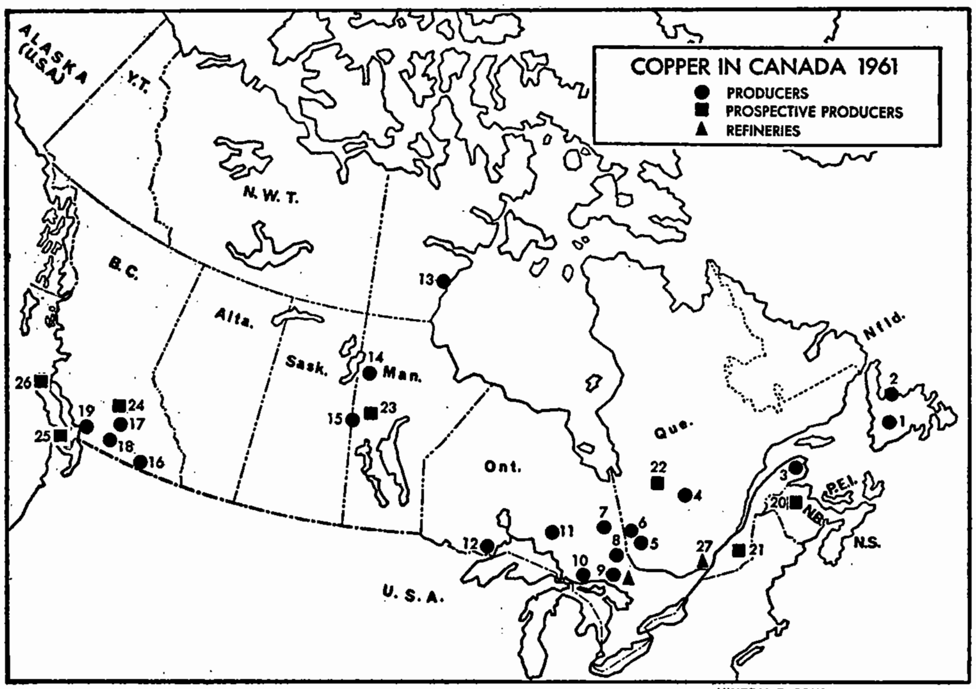
No production was reported in 1961 but this province is expected to join the ranks of the copper producers in 1962. The Consolidated Mining and Smelting Company of Canada Limited continued development of its Wedge mine on the Nepisiguit River about 36 miles southwest of Bathurst. Production, at 750 tons a day, was scheduled to begin in January 1962, when the company will truck ore from this mine to the mill of Heath Steele Mines Limited, about 10 miles south of the Wedge. Heath Steele has been conducting a program of underground exploration and development at its mine, and the results are reported to be encouraging.

Quebec

Copper production declined to 149,007 tons from the record of 157,470 tons set in 1960. The decrease resulted from 10-per-cent cuts in production at the Horne mine of Noranda Mines, Limited, and the mines of Waite Amulet Mines, Limited, and Gaspe Copper Mines, Limited, and from a strike at the mine of Opemiska Copper Mines (Quebec) Limited.

One new mine came into production and several properties were under active development. Exploration parties were active in most areas, and there was more activity in base-metal prospecting than at any time since 1957.

Vauze Mines Limited, which adjoins Waite Amulet Mines, Limited, on the north and east, started production in October. A 350-ton-a-day mill was built, and copper and zinc concentrates were recovered. Copper concentrate is shipped to Noranda for smelting and zinc concentrate to smelters in the United States. In the same area, Lake Dufault Mines, Limited, sparked a rush of prospecting and diamond-drilling by the discovery of a sizable body of copper-zinc ore. The property adjoins Waite-Amulet on the east. North of Amos, Joutel Copper Mines Limited was preparing to sink a three-compartment shaft to explore and develop an orebody indicated by surface diamond-drilling.



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. Gaspe Copper Mines, Limited (smelter)
4. Campbell Chibougamau Mines Ltd. (4 mines)
   Copper Rand Chibougamau Mines Ltd. (3 mines)
   Merrill Island Mining Corporation, Ltd.
   Opemiska Copper Mines (Quebec) Limited
5. East Sullivan Mines Limited
   Manitou-Barvue Mines Limited
   Noranda Mines, Limited (smelter)
   Quemont Mining Corporation, Limited
   Vauze Mines Limited
   Waite Amulet Mines, Limited
6. Normetal Mining Corporation, Limited
7. Kam-Kotia Porcupine Mines, Limited
8. Temagami Mining Co. Limited
9. Falconbridge Nickel Mines, Limited (6 mines, 1 smelter)
   International Nickel Company of Canada, Limited, The (7 mines, 2 smelters, 2 refineries)
10. Rio Algom Mines Limited, Pronto Division
11. Geco Mines Limited
    Willroy Mines Limited
12. North Coldstream Mines Limited
13. North Rankin Nickel Mines Limited
14. Sherritt Gordon Mines, Limited
15. Hudson Bay Mining and Smelting Co., Limited (4 mines, 1 smelter)
16. Consolidated Woodgreen Mines Limited
    Phoenix Copper Company Limited
17. Craigmont Mines Limited
18. Giant Mascot Mines Limited
19. Howe Sound Company, Britannia Division

PROSPECTIVE PRODUCERS

20. Consolidated Mining and Smelting Company of Canada Limited, The (Wedge mine)
    Heath Steele Mines Limited
21. Solbec Copper Mines, Ltd.
22. Mattagami Lake Mines Limited
    New Hosco Mines Limited
    Orchan Mines Limited
23. Hudson Bay Mining and Smelting Co., Limited (Stall Lake and Osborne Lake mines)
24. Bethlehem Copper Corporation Ltd.
25. Cowichan Copper Co. Ltd. (Sunro mine)
26. Consolidated Mining and Smelting Company of Canada Limited, The (Benson Lake mine)

REFINERY

27. Canadian Copper Refiners Limited

Table 3

PRODUCING COMPANIES, 1961

Province and Company	Location	Mill Capacity (tons/day)	Ore Produced, 1961 (short tons)	Grade: Copper (%)	Grade: Zinc (%)	Grade: Nickel (%)	Ore Produced, 1960 (short tons)	Developments during Year
Newfoundland								
American Smelting and Refining Company (Buchans Unit)........	Buchans	1,200	387,000	1.11	12.88	—	386,000	Preparation of MacLean orebody for production.
Atlantic Coast Copper Corporation Limited.........................	Little Bay	2,000	226,536	1.27	—	—	—	Mill completed and milling started, May 1961.
Maritimes Mining Corporation Limited.............................	Tilt Cove	1,000	814,748	1.68	—	—	791,684	Routine development and exploration.
Quebec								
Campbell Chibougamau Mines Ltd. (Main, Kokko Creek, Cedar Bay and Henderson mines)..........	Doré Lake	3,000 (at Main mine)	712,493	2.45	—	—	742,045	Underground exploration and development at the Main, Cedar Bay and Henderson mines.
Copper Rand Chibougamau Mines Ltd. (Machin Point, Chibougamau Jaculet and Portage Island mines)........................	Gouin Peninsula	1,500 (at Machin Point mine)	604,480	2.44	—	—	—	Underground exploration and development of the Machin Point and Eaton Bay zones and deepening of the No. 4 shaft, all at the Machin Point mine. Exploration and development at the Chibougamau Jaculet and Portage Island mines.
East Sullivan Mines Limited.......	Val d'Or	3,000	1,028,201	0.69	0.47	—	974,532	Extensive outside exploration.
Gaspe Copper Mines, Limited......	Murdochville	6,500	2,589,390	1.37	—	—	2,542,000	Installed third jaw crusher underground. Erected 10,000-ton-capacity concentrate-storage building.

TABLE 3 (*cont'd.*)

Province and Company	Location	Mill Capacity (tons/day)	Ore Produced, 1961 (short tons)	Grade: Copper (%)	Grade: Zinc (%)	Grade: Nickel (%)	Ore Produced, 1960 (short tons)	Developments during Year
Manitou-Barvue Mines Limited....	Val d'Or	1,300	298,385 162,860	1.18 —	— 5.88	— —	292,065	Deepened internal shaft; established five new levels; started ore-pass system. Drifting and diamond-drilling to explore zinc orebody at depth.
Merrill Island Mining Corporation, Ltd............................	Doré Lake	650	154,301	2.30	—	—	160,657	Shaft-sinking to explore and develop recently discovered mineralization.
Noranda Mines, Limited...........	Noranda	3,300	1,340,881	N.A.	—	—	1,330,686	Deepening of main shaft.
Normetal Mining Corporation, Limited............................	Normetal	1,000	355,001	3.10	4.54	—	347,164	Shaft-sinking and exploration of orebody at depth.
Opemiska Copper Mines (Quebec) Limited........................	Chapais	2,000	599,061	2.88	—	—	751,453	Routine exploration and development.
Quemont Mining Corporation, Limited..............................	Noranda	2,300	822,275	1.33	2.53	—	856,632	Started using deslimed mill tailings for fill. Routine exploration and development.
Waite Amulet Mines, Limited......	Noranda	2,000				—	297,062	
Vauze Mines Limited..............	Noranda	350	22,300	4.90	3.94	—	—	Mill completed and milling started October 1961.
Ontario								
Falconbridge Nickel Mines, Limited (Falconbridge, East, McKim, Hardy, Boundary, Onaping, Fecunis Lake and Longvack mines)	Sudbury	3,000 at Falconbridge 1,500 at Hardy 2,400 at Fecunis	*	—	—	*	2,429,803	McKim and Longvack mines closed and Onaping and Boundary mines put into production.

International Nickel Company of Canada, Limited, The (Frood-Stobie, Frood open-pit, Murray, Garson, Creighton, Clarabelle, Ellen and Levack mines).......	Sudbury	30,000 at Copper Cliff 12,000 at Creighton 6,000 at Levack	17,489,000 (includes ore mined at Thompson, Man.)	—	—	*	16,768,000	Two new open-pit mines (Clarabelle and Ellen) started to produce. Development work to open up the lower levels of the Creighton, Garson and Murray mines was continued. The Frood-Stobie open pit was completed and all mining done there will be underground.
Geco Mines Limited..............	Manitouwadge	3,300	1,276,778	1.54	3.99	—	1,294,077	No. 1 shaft deepened and orebody explored and developed.
Kam-Kotia Porcupine Mines, Limited............................	Timmins	900	235,136	1.59	—	—	—	Production started in April. A zinc circuit will be added to the mill in 1962.
North Coldstream Mines Limited..	Kashabowie	1,000	332,783	2.17	—	—	266,154	Exploration and development of orebodies below 800-foot level.
Rio Algom Mines Limited, Pronto Division, Pater mine............	Spragge	750	238,600	1.62	—	—	—	Mine and mill completed and production started January 1961. Shaft-sinking and level development.
Temagami Mining Co. Limited....	Timagami	750	*	*	—	—	*	
Willroy Mines Limited............	Manitouwadge	1,100	421,772	1.34	6.68	—	429,309	Shaft-sinking and installation of primary crusher at 2,000-foot level.
Manitoba-Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited (Flin Flon, Coronation, Schist Lake and Chisel Lake mines)...........	Flin Flon, Man.	6,000 at Flin Flon	1,682,693	2.57	5.4	—	1,698,256	Normal development at Flin Flon, Coronation and Chisel Lake. Shaft-sinking at Schist Lake.
Sherritt Gordon Mines, Limited...	Lynn Lake, Man.	3,150	1,219,157	*	—	*	1,151,419	Exploration of A and EL plugs from Farley shaft. Vigorous off-property exploration program.

TABLE 3 (*cont'd.*)

Province and Company	Location	Mill Capacity (tons/day)	Ore Produced, 1961 (short tons)	Grade: Copper (%)	Grade: Zinc (%)	Grade: Nickel (%)	Ore Produced, 1960 (short tons)	Developments during Year
British Columbia								
Consolidated Woodgreen Mines Limited........................	Greenwood	1,000	201,123	0.5	—	—	202,047	Routine mining of open-pit ore.
Cowichan Copper Co. Ltd..........	Cowichan Lake, Vancouver Island	500	—	—	—	—	71,561	Mine closed in 1961 and part of plant moved to Sunro property at Jordan River.
Craigmont Mines Limited..........	Merritt	4,000	484,073	1.57	—	—	—	Production from open pit and milling started in September. Underground development and exploration continuing.
Giant Mascot Mines, Limited......	Choate	1,000	260,583	0.30	—	1.06	212,400	Underground exploration and development of the Pride of Emory and Brunswick orebodies.
Howe Sound Company, Britannia Division........................	Britannia Beach	4,000	458,429	1.62	0.83	—	409,751	Routine exploration and development.
Phoenix Copper Company Limited.	Greenwood	1,000	392,767	0.75	—	—	335,144	Mill and plant will be expanded to treat 1,500 tons a day by April 1962.
Northwest Territories								
North Rankin Nickel Mines Limited............................	Rankin Inlet	250	79,411	0.75	—	2.93	72,044	Off-property exploration for new orebodies.

SOURCE: Company reports.
*Not available.

TABLE 4

PROSPECTIVE PRODUCING COMPANIES,* 1961

Province and Company	Location	Type of Ore	Mill Capacity (tons/day)	Production to Start	Destination of Concentrates
New Brunswick					
Consolidated Mining and Smelting Company of Canada Limited, The (Wedge mine).....	Bathurst-Newcastle	Cu-Zn	Ore will be shipped to mill of Heath Steele Mines Limited at 750 tons a day	January 1962	Japan
Heath Steele Mines Limited...	Bathurst-Newcastle	Zn-Cu	1,500	1962	Not known
Quebec					
Solbec Copper Mines, Limited.	Stratford Place	Cu-Zn	1,000	January 1962	Japan
Mattagami Lake Mines Limited	Mattagami	Zn-Cu-Pb	2,000	1963	Not known
New Hosco Mines Limited....	Mattagami	Zn-Cu	900	1963	Not known
Orchan Mines Limited.........	Mattagami	Zn-Cu	1,000	1963	Not known
British Columbia					
Cowichan Copper Co. Ltd. (Sunro mine)................	Jordan River, Vancouver Island	Cu	1,500	February 1962	Japan
Consolidated Mining and Smelting Company of Canada Limited, The (Benson Lake mine)	Benson Lake, Vancouver Island	Cu	750	1962	Japan
Bethlehem Copper Corporation Ltd..........................	Highland Valley	Cu	3,000	1963	Japan

SOURCE: Company reports.

*Includes only mines with announced production plans.

Production plans have been announced for Mattagami Lake Mines Limited, Orchan Mines Limited and New Hosco Mines Limited, which are near Mattagami Lake. A road had been completed to this area, and a railroad is to be built. Several prospects in the area are being explored by surface work and diamond-drilling.

In the Eastern Townships, Solbec Copper Mines, Ltd., near Stratford Centre, in Stratford township, Wolfe county, completed initial shaft-sinking and underground development at its mine; its plant and mill was scheduled for production in January 1962. The mill will have capacity of 1,000 tons a day and will produce a copper and a zinc concentrate. Parties exploring along the mineralized zone in which Solbec's deposit occurs have discovered at least two more occurrences that warrant further development.

Exploration parties in New Quebec have staked claims over copper mineralization near Duncan Lake, east of Fort George, on the Kaniapiskau River north of Fort McKenzie, and on the Koksoak River about 60 miles west of Fort Chimo.

Ontario

For 1961, copper production in Ontario amounted to 211,647 tons, to which it rose from the 206,272 tons produced in 1960. This record resulted from an increase in output at the large nickel-copper mines of the Sudbury district and the start of production at two new mines.

In the Timmins area Kam-Kotia Porcupine Mines, Limited, began to produce from its open pit and milled the ore in a 900-ton-a-day concentrator. Concentrate was shipped to Noranda for smelting. Rio Algom Mines Limited, Pronto Division, started production at 750 tons a day from the Pater mine near Spragge. The ore is milled in a modified section of the Pronto mill, and the concentrate is shipped to Europe for smelting.

In the Sudbury district The International Nickel Company of Canada, Limited, started production at its Clarabelle and Ellen open-pit mines. Falconbridge Nickel Mines, Limited, stopped production at the McKim and Longvack mines and started to produce from the Onaping and Boundary mines, on the north side of the Sudbury basin. Shaft-sinking and development continued at Falconbridge's Strathcona mine.

Manitoba-Saskatchewan

Copper production from these provinces totalled 45,933 tons, 1,355 tons more than in 1960. The whole output came from Sherritt Gordon Mines, Limited, at Lynn Lake, Manitoba, and from the Saskatchewan-Manitoba operations of Hudson Bay Mining and Smelting Co., Limited. Sherritt Gordon continued underground exploration from the Farley shaft at Lynn Lake with moderate success. Its prospectors have made an interesting copper-zinc discovery at Fox Lake, about 30 miles south of Lynn Lake.

Hudson Bay continued a program of exploration in Manitoba, Saskatchewan, Quebec and British Columbia. The company started lateral development from the shaft at the Stall Lake mine and collared a shaft and started construction of a mining plant at the Osborne mine. Both mines are in the Snow Lake area of Manitoba.

British Columbia

British Columbia continued to recover from the slump that started in 1958, when copper production amounted to only 6,010 tons. In 1961, production at 15,845 tons was about the same as in 1960, and exploration and development continued at an accelerated pace, stimulated mainly by the Japanese market.

In September, Craigmont Mines Limited, near Merritt, became British Columbia's newest producer. Ore from its open pit is milled in the 4,000-ton-a-day concentrator. The company has contracts to ship concentrates to Japan and to Tacoma, Washington. Cowichan Copper Co. Ltd. closed its mine at Cowichan Lake and started development of the Sunro mine, at Jordan River, on the southwest coast of Vancouver Island. A 1,500-ton-a-day mill will operate underground, and concentrate will be shipped to Japan. Production was scheduled to start in January 1962.

The Consolidated Mining and Smelting Company of Canada Limited has started mill and plant construction and a program of underground development at the Benson Lake mine of Coast Copper Company Limited. Production at 750 tons a day will start in 1962 and the concentrate will be shipped to Japan. In Highland Valley, 30 miles east of Ashcroft, Bethlehem Copper Corporation Ltd. was preparing its open-pit copper mine for production. Excavation for the mill and plant buildings was started, and stripping of overburden from the East Jersey zone had been started in preparation for mining. Production at 3,000 tons a day is scheduled for late 1962 or early 1963, and the concentrate will be shipped to Japan. A number of companies were exploring interesting occurrences in the Highland Valley-Merritt district. In the Kamloops area several were investigating the Kamloops copper belt, which includes the old Iron Mask mine. In northern British Columbia, Newmont Mining Corporation of Canada Limited continued exploration of the Granduc property and other deposits on the Unuk River.

Northwest Territories and Yukon Territory

North Rankin Nickel Mines Limited, at Rankin Inlet, was the source of the 463 tons of copper produced in the Northwest Territories in 1961. The company has continued a program of exploration in an area along the west coast of Hudson Bay.

Johobo Mines Limited, near Kathleen Lake, Yukon Territory, shipped to Japan ore containing 441 tons of copper and started a program of exploration and underground development on its property.

DOMESTIC CONSUMPTION AND USES

Domestic consumption of refined copper amounted in 1961 to 141,807 tons, having risen from the 117,636 tons consumed in 1960. The gain is attributed to a higher level of industrial activity rather than to any increase in fabricating capacity.

The principal copper and brass fabricators in Canada are: British Columbia—Western Copper Mills Ltd., Vancouver; Ontario—Anaconda American Brass Limited, New Toronto; Canada Wire and Cable Company 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 and Brass Limited, Montreal East; Pirelli Cables, Conduit Limited, St. Johns; and Northern Electric Company Limited, Montreal.

TABLE 5

CONSUMPTION OF PRIMARY COPPER IN MANUFACTURE OF SEMIFABRICATED PRODUCTS, 1960[1]

(short tons)

Copper mill products—sheet, strip, bars, rolls, pipe, tube, etc.	35,961
Brass mill products—plate, sheet, strip, rods, bars, rolls, pipe, tube, etc.	2,691
Wire and rod mill products	78,028
Miscellaneous	4,825
Total	121,505[2]

SOURCE: Consumers' reports.

[1]Partial analysis.

[2]No information is available on stocks on hand.

SMELTERS AND REFINERIES

Salient statistics on Canada's six copper smelters and two refineries are given in the accompanying table. In 1961, the smelters operated close to capacity and treated about 95 per cent of the domestic ores and concentrates. All the blister and anode copper produced was refined in Canada. Nickel-copper matte from the Falconbridge smelter was shipped to Norway for treatment.

TABLE 6

CANADIAN COPPER AND COPPER-NICKEL SMELTERS

Operator	Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1961 (short tons)	Blister or Anode Copper Produced, 1961 (short tons)
Falconbridge Nickel Mines, Limited, 44 King St. W., Toronto, Ont.	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.	*	*
Gaspe Copper Mines Limited, 44 King St. W., Toronto, Ont.	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.	256,160	43,230
Hudson Bay Mining and Smelting Co., Limited, 500 Royal Bank Bldg., 504 Main St., Winnipeg, Man.	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.	410,927	40,104
International Nickel Company of Canada, Limited, The, Copper Cliff, Ont.	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.	*	*

International Nickel Company of Canada, Limited, The, Copper Cliff, Ont........	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.	*	*
Noranda Mines, Limited, 44 King St. W., Toronto, Ont...........................	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.	1,556,010 (of which 834,705 were custom material)	159,423

SOURCE: Company reports.
*Not available.

TABLE 7

CANADIAN COPPER REFINERIES

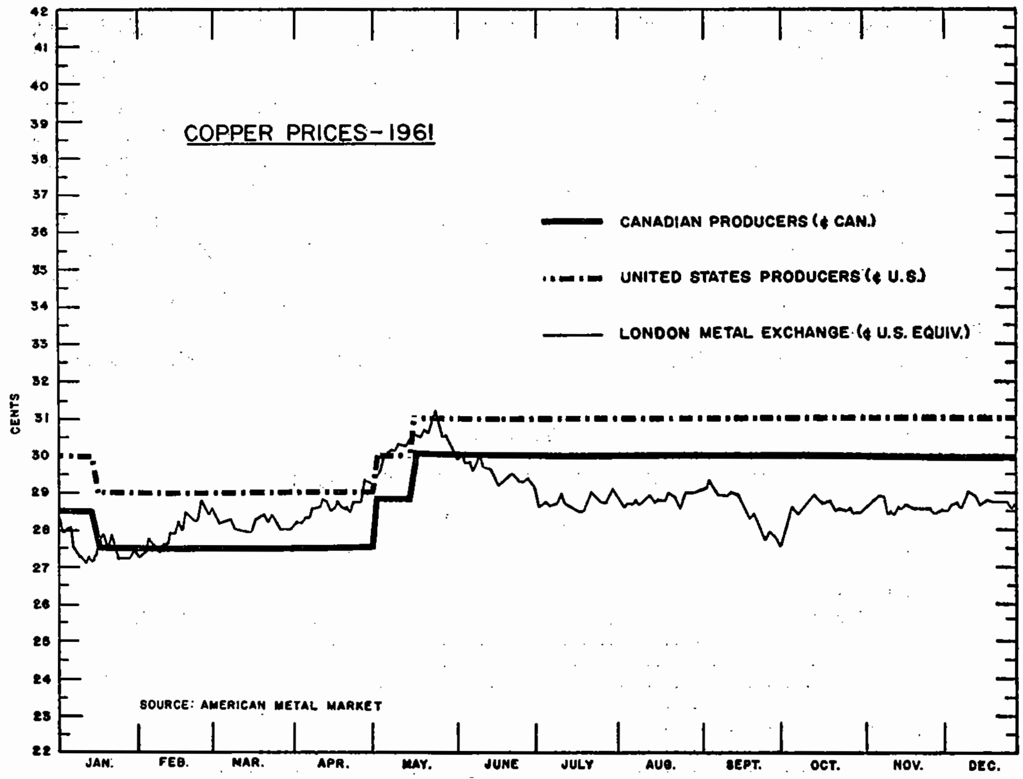
Operator	Location	Product	Rated Annual Capacity (tons)	Remarks
Canadian Copper Refiners Limited	Montreal East, Que.	CCR Brand electrolytic copper wire bars, ingot bars, ingots, cathodes, cakes and billets.	270,000	Controlled by Noranda Mines, Limited. Refines anode copper from Noranda and Gaspe smelters, blister copper from Flin Flon smelter and purchased scrap. Copper sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from anode slimes.
International Nickel Company of Canada, Limited, The, 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.

PRICES

The price of copper in Canada rose from a low of 27.5 cents a pound in January to a high of 30 cents a pound in May, and there it remained for the rest of 1961.

Prices in leading world markets, as shown in the accompanying graph, were remarkably stable throughout the year.



TARIFFS

Although Canada has no tariff on copper in ores and concentrates, various tariff rates are in effect for copper in bars, rods, wire, semifabricated forms and fully processed products. The following table summarizes the Canadian tariff rates on copper and its products.

	British Preferential	Most Favored Nation	General
Ores and concentrates	free	free	free
Pigs, blocks, ingots, and cathodes	1c. lb	1.5c. lb	1.5c. lb
Scrap	1c. lb	1.5c. lb	1.5c. lb
Anodes	5%	7.5%	10%
Oxide	free	15%	15%
Bars or rods, tubing not less than 6 ft. in length, unmanufactured; copper in strips, sheets or plates, not polished, planished or coated	5%	10%	10%
Bars and rods for the manufacture of wire cable	free	10%	10%
Tubing not more than ½ in. in diameter and not less than 6 ft. long	5%	10%	10%
Alloys of copper consisting 50% or more, by weight, of copper in sheets, plates, bars, rods and tubes	7.5%	15%	25%

The United States tariff on ores, concentrates and primary shapes is 1.7 cents a pound on copper content; on fabricated materials it goes as high as 4.5 cents a pound plus 1.7 cents a pound on copper content.

WORLD MINE PRODUCTION

The world output of primary copper amounted in 1961 to 4,672,026 tons, having risen from the 4,538,798 tons produced in 1960. Production losses, which resulted from political unrest in Africa and strikes against some of the leading producers in Chile and Australia, were offset by the resumption of full production at the United States mines of Kennecott Copper Corporation and Phelps Dodge Corporation. These properties had been operating at about 90 per cent of capacity since late in 1960 but resumed full production in mid-1961.

Production from the mines and plants of Union Minière du Haut Katanga in Katanga province, Republic of the Congo, was interrupted by warfare, and the company suspended trading in copper from December 12, 1961, until January 3, 1962. Full production was not resumed and it will be some time before the facilities are again operating at capacity.

World smelter production for 1961 is estimated at 5,169,477 short tons.

TABLE 8

WORLD PRODUCTION OF COPPER, 1961

(short tons)

Mines production	
United States	1,159,556
Northern Rhodesia	633,534
Chile	603,629
Russia	550,000[e]
Canada	439,088
State of Katanga	324,422
Peru	218,249
Japan	106,317
Other countries	637,231
Total, world	4,672,026
Smelter production	
United States	1,323,224
Northern Rhodesia	624,325
Chile	577,539
Russia	550,000[e]
Canada	401,000
West Germany	335,473
State of Katanga	324,422
Japan	305,343
Peru	200,586
Australia	69,384
Other countries	458,181
Total, world	5,169,477

SOURCE: American Bureau of Metal Statistics. For Canada, Dominion Bureau of Statistics.

[e]Estimated.

Feldspar

J. E. Reeves*

The production figure of 10,507 tons shows a continuing decline in Canadian output of feldspar. All shipments in 1961 originated at the Buckingham, Quebec, plant of International Minerals & Chemical Corporation (Canada) Limited.

Trade in this commodity is of only minor importance. Some feldspar was exported from Quebec to the northeastern United States, and some was imported from the United States to western Canada.

Available Canadian statistics indicate that 3,183 short tons of feldspar were exported in 1960, mostly to the United States. However, according to reported shipments in Canada and United States statistics on imports of Canadian feldspar in that year, it appears that this export figure should be at least 6,600 tons.

PRODUCER

International Minerals & Chemical Corporation's main source of feldspar is the Back Mine, located on a large granitic pegmatite in Derry township, Quebec, whence the hand-cobbed material is trucked to Buckingham, a few miles to the south, for grinding. Glass-grade feldspar is no longer being produced, and output consists essentially of finer-ground, higher-priced grades.

HISTORY

The abundance of very coarse-grained granitic pegmatites in southwestern Quebec and southeastern Ontario has supported the continuous production of feldspar in Canada since 1890. In general, however, the level of total production has never been very high, and with the advent of nepheline syenite, particularly for use in glass manufacturing, output has declined considerably.

There have been only small quantities shipped from most deposits, the most noteworthy exception being the Back Mine, which has been operated continuously for more than 30 years.

* Mineral Processing Division, Mines Branch.

TABLE 1

FELDSPAR—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)				
Quebec	10,507	229,626	13,862	239,273
Imports				
United States	1,721	36,235	1,338	27,545
Exports				
United States	2,626	62,786	3,082	70,680
West Germany	—	—	101	3,131
Total	2,626	62,786	3,183[1]	73,811
	1960		1959	
Consumption (available data)				
Whiteware	5,808		6,066	
Porcelain enamel	721		833	
Glass	—		2,853[2]	
Soaps and cleansers	628		377	
Other	18		—	
Total	7,175		10,129	

SOURCE: Dominion Bureau of Statistics.
[1]In view of reported shipments and United States import statistics, this should possibly be about 6,600 tons.
[2]Revised.

TABLE 2

FELDSPAR—PRODUCTION AND TRADE, 1951-61

(short-tons)

	Production	Imports	Exports
1951	40,749	194	19,832
1952	20,267	155	6,360
1953	21,246	336	6,848
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

SOURCE: Dominion Bureau of Statistics.

Recent attempts to produce on a large scale were not sustained. Spar-Mica Corporation Ltd. was unsuccessful with a large glass-grade feldspar operation in eastern Quebec, and Quebec Lithium Corporation was forced to discontinue the production of by-product glass-grade feldspar at its operation near Val d'Or, Quebec, when the output of spodumene concentrate was sharply curtailed by changes in lithium markets.

TECHNOLOGY

The feldspar group of minerals consists of aluminum silicates of potassium, sodium, and calcium. They are common minerals that occur generally in small grains in many rock types but also in natural concentrations in some coarse-grained granitic pegmatites.

Such natural concentrations have been the traditional sources of feldspar, and are still of some importance. Mining is frequently done on a relatively small scale, and the broken feldspar is cleaned of minor amounts of associated minerals by hand cobbing. As many of the natural concentrations have become depleted, there has developed a trend toward the use of pegmatites in which the feldspar is finer-grained and too intimately mixed with other minerals for hand-cobbing. The use of some beneficiation technique, generally flotation, to concentrate the feldspar permits the efficient production of large quantities of this commodity.

Feldspar is valued by makers of ceramics because of its contents of alumina and alkalis (potash and soda) and its relatively low firing temperature, and by some other users because of its abrasive properties of hardness and particle shape.

USES AND SPECIFICATIONS

Feldspar is sold mainly to the ceramics industries, but small amounts are employed in abrasive cleaning compounds and for decorative purposes.

It is still used extensively as a source of alumina and alkalis in the manufacture of glass, where it can compete economically with nepheline syenite. 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, in terms of 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 very low quartz and iron-mineral contents, 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 an important 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 21, 1961, prices in the United States, f.o.b. point of shipment, North Carolina, in bulk, per short ton, were as follows:

200-mesh	$17.00
325-mesh	$17.00
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 as follows:

Canada	British Preferential	Most Favored Nation	General
Crude only	free	free	free
Ground but not further manufactured	"	15%	30%

United States	
Crude	12 ½c. per long ton
Ground	7½ % ad valorem

Fluorspar

C. M. Bartley*

Canadian fluorspar production, obtained largely in Newfoundland, increased slightly in value to $1,990,200 for 1961. In Newfoundland it rose, but in Ontario it dropped sharply. A small amount of crystal fluorspar was exported from the Madoc area of eastern Ontario.

PRODUCTION AND TRADE

More than 98 per cent of 1961 output came from Newfoundland and was used in the production of aluminum at Arvida, Quebec. Both exports and imports were substantially lower than in 1960. Metallurgical requirements were filled almost entirely by imports from Mexico. Some of the metallurgical-grade fluorspar used in western Canada was obtained from Montana. A small amount of crystal fluorspar with a relatively high value was exported to Britain.

The bulk of Canada's output, which comes from one property in Newfoundland, is produced as a shipping concentrate grading about 75 per cent CaF_2 (fluorspar). At the company's Quebec consuming plant, this concentrate is improved by grinding and flotation to a grade of about 97 per cent CaF_2.

In recent years the output from Ontario's Madoc area has been in the form of a coarse metallurgical-grade concentrate grading about 85 per cent CaF_2. This material is obtained from veins of crystalline fluorspar, usually in limestone, and can be produced by such simple treatment as crushing and screening and the minor hand-cobbing of waste fragments.

CANADIAN SOURCES

The Burin Peninsula of southeastern Newfoundland is the most important source of fluorspar in Canada, in terms both of present production and of reserves for the future. There fluorspar is found in veins and in zones containing veins and stringers. Because the host rock is granitic, the silica content of the ore is usually higher than is desirable for metallurgical fluorspar, which is used in coarse fragments. The ore is an excellent source of acid-grade fluorspar since silica can be eliminated by the fine grinding and flotation required to obtain this product. Two companies with mines and processing plants in the area have produced fluorspar for many years. Both plants are less than a mile from the sea coast, and shipments can be made throughout the year.

* Mineral Processing Division, Mines Branch.

TABLE 1

FLUORSPAR—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)[1]				
Newfoundland		1,951,800		1,820,769
Ontario		38,400		100,811
British Columbia		—		240
Total		1,990,200		1,921,820
Exports				
United States	2,048	53,326	10,310	262,114
Britain	—	—	2[2]	49,875[2]
Total	2,048	53,326	10,312	311,989
Imports				
Mexico	31,927	871,468	51,359	1,241,772
United States	700	36,041	925	46,834
Britain	142	6,712	580	22,408
Union of South Africa	—	—	6,826	175,093
Total	32,769	914,221	59,690	1,486,107
Consumption				
Metallurgical flux			25,784	
Glass			628	
Other (including aluminum production)			85,423	
Total			111,835	

Source: Dominion Bureau of Statistics.

[1]Producers' shipments. Tonnages after 1957 are not available for publication.

[2]Shipments of clear crystal fluorides for optical use.

Newfoundland Fluorspar Limited, a subsidiary of Aluminum Company of Canada, Limited, is the leading producer and ships concentrate to Arvida, Quebec, where it is used in the production of aluminum. Production comes entirely from the Director mine, which is one of the largest fluorspar mines in the world. Ore mined and crushed underground is processed by heavy-media methods on the surface to produce a shipping concentrate containing about 75 per cent CaF_2. At Arvida the concentrate is further processed by flotation to about 97 per cent CaF_2 and is used to make hydrofluoric acid for the manufacture of cryolite and aluminum fluoride.

Operations in 1961 were at a higher level than in 1960, and changes both underground and in the surface plant will permit expanded production in the future. The shaft was deepened to 950 feet, and the excavation of ore passes and the new underground crusher location was completed. Hydraulic and bulk back-filling went into operation. The insufficiency of hydroelectric power in the area made it necessary to increase company Diesel-electric generating facilities to more than 2,200 kilowatts. At present the plant can process 1,000 tons a day to produce 100,000 tons of end-product a year.

Table 2

FLUORSPAR—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

(short tons)

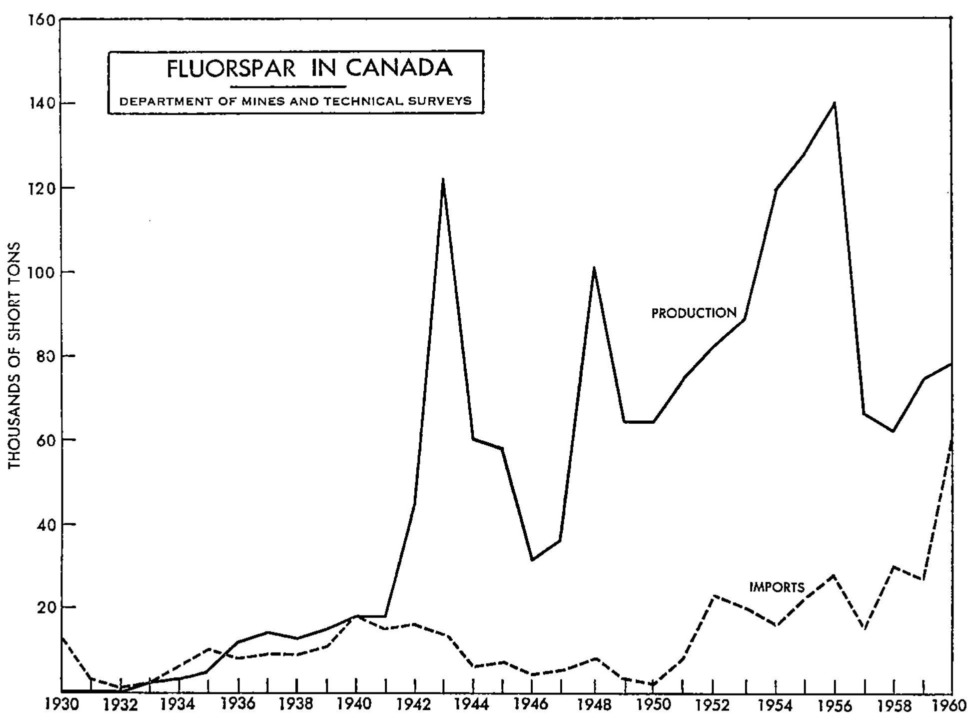
	Production[1]	Exports[2]	Imports	Consumption
1951	74,211	21,461	8,188	57,526
1952	82,187	18,675	22,714	68,748
1953	88,569	22,079	20,161	83,116
1954	118,969	34,756	16,240	80,610
1955	128,114	58,390	21,774	87,927
1956	140,071	78,380	28,148	96,126
1957	66,245	23,630	14,547	70,761
1958	62,000[3]	7	30,408	89,933
1959	74,000[3]	3,774	26,588	96,016
1960	77,000[3]	10,312	59,690	111,835
1961	76,200[3]	2,048	32,769	

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 1951 to 1954 inclusive are as reported in the United States import statistics but are not shown in the official Canadian export statistics. Exports after 1954 are as recorded in *Trade of Canada* (DBS).

[3]Estimates reported by the U.S. Bureau of Mines.



St. Lawrence Corporation of Newfoundland Limited, holds an adjoining property and has produced various grades of fluorspar concentrate since 1933.

Operations have been on a reduced scale since 1957, chiefly because of competition from Mexican, Spanish and Italian fluorspar in the United States, the main market.

Numerous fluorspar veins have been found and several have been mined. Reserves are not known accurately but are believed to be substantial. Processing consists in crushing and heavy-media separation for primary concentration and grinding and flotation to produce acid-grade concentrate. The production capacity probably exceeds 30,000 tons a year of acid-grade concentrate or more than double this amount of the lower-grade, heavy-media concentrate.

In 1961 underground development was carried out at four of the company's mines and one export shipment was made, but operations were on a reduced scale compared with those of other years.

Huntingdon Fluorspar Mines Limited, at Madoc, in eastern Ontario, produced a small amount of metallurgical fluorspar from the Coe Lake property and made an export shipment of crystal fluorspar.

Rexspar Minerals & Chemicals Limited holds a property north of Kamloops, British Columbia, on which a large deposit of fine-grained fluorspar has been outlined by diamond-drilling. The average grade is a little lower than that normally considered desirable, but large tonnage and proximity to rail and power make the deposit interesting. Efforts are being made to develop milling methods that will give a cleaner and higher-grade concentrate. It is expected that the property will go into production if these attempts are successful.

Ball Prospecting Syndicate reported that development work was carried out in 1961 at a property in the Wilberforce area of eastern Ontario. Formerly operated by Topspar Fluorite Mines Limited, this occurrence contains massive to disseminated purple fluorspar and some molybdenite. Small shipments of fluorspar were made from the property many years ago.

To date fluorspar has been produced in Canada from the Rock Candy Mine, in British Columbia, several mines in Ontario's Madoc and Wilberforce areas, one or two near Lake Ainslie, on Cape Breton Island, Nova Scotia, and from the large mines in Newfoundland. Numerous other occurrences of fluorspar have been found in Yukon Territory, British Columbia, Ontario, Quebec and the Maritime provinces, and some of these may be of interest in the future.

WORLD REVIEW

World production and consumption of fluorspar continues to increase, partly in direct relation to steel and aluminum production but particularly because of a rapidly increasing demand for hydrofluoric acid for the manufacture of fluorine chemicals. Details of world consumption are not available to illustrate these trends precisely, but apart from such unusual accumulations as the United States stockpiles of strategic materials, fluorspar inventories are relatively stable and production thus closely reflects consumer demand.

With the expansion of steel production in such industrialized areas as North America, Europe and Japan and its strengthening in such less developed countries as India and China, the demand for metallurgical fluorspar is increasing throughout the world. The fluorspar needed for aluminum production is being consumed in a few large plants strategically located to take advantage of raw-material and power supplies and to serve certain markets. Consumption increases in these plants will be more evident and significant than the smaller and more scattered increases arising from steel production.

In the United States and western Europe, fluorine-based aerosols and refrigerants are serving a rapidly growing market. As the prosperity of western

TABLE 3

WORLD PRODUCTION OF FLUORSPAR

(short tons)

	1961	1960
Mexico	425,596	399,859
China	275,000[e]	275,000[e]
U.S.S.R.	230,000[e]	210,000[e]
France	220,462	130,073
United States	205,083	229,782
Italy	166,214	178,957
Spain	155,000[e]	122,377
West Germany	120,614	143,521
Britain	111,139	109,249
Union of South Africa	95,862	113,550
Canada	76,200[e]	77,000[e]
Other countries	218,830	200,632
World total	2,300,000	2,190,000

Source: U.S. Bureau of Mines, *Mineral Trade Notes*, volume 55, No. 4.
[e]Estimated.

Europe grows, European consumption of these goods is expected to rise and increase the demand for fluorspar.

The fluorspar produced throughout the world is apparently sufficient for all needs, and large-scale imports hold prices in the United States at levels with which producers in that country and in Canada, with their higher capital and labor costs, find it hard to compete. At the request of domestic producers, tariff agencies in both countries have intensively studied the situation, but for various reasons the tariff has not been changed.

Consumption trends, gradual changes in processing and the steady depletion of many small-tonnage high-grade supplies indicate that in future the fluorspar demand will be more and more for acid-grade rather than metallurgical-grade material. Interest in larger ore bodies will consequently grow even though they may average a lower grade and require additional processing. Future demand and its rate of increase are difficult to estimate, but it seems likely that in spite of the apparent adequacy of present supplies consumption will increase faster than production.

In 1960 North America produced 700,000 tons of fluorspar and consumed 800,000, of which 200,000 tons were imported from western Europe. In the same year western Europe produced 660,000 tons and, with allowance for exports, apparently consumed 450,000 tons. Spain and Italy, which alone among the countries of Europe seem to have an excess supply, should logically serve the needs of that continent, where fluorspar consumption is on the increase. North American increases would therefore have to come from North American or other sources.

At about 207,000 tons, United States production was considerably lower in 1961 than in the preceding year, but consumption increased to 660,000 tons.

Mexico's fluorspar output rose to 425,596 tons. Two new flotation mills under construction will raise the country's acid-grade capacity in 1962 from 240,000 tons to nearly 350,000 tons a year. Mexico produces and exports large amounts of metallurgical-grade fluorspar.

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Under mining laws introduced in 1961 and designed to increase Mexican control of the country's mining industry, tax concessions and other inducements were offered to companies operating under such control. Fluorspar, however, is exported, and it is therefore unlikely that production will be discouraged.

The role of the Communist-bloc in world fluorspar trade has not been significant. In 1960 the Union of Soviet Socialist Republics and Communist China together produced nearly 500,000 tons, most of which was consumed in the U.S.S.R. In recent years the Union (now the Republic) of South Africa has become an important producer and exporter.

As fluorspar consumption increases in North America and Europe, Canada's deposits, particularly those in Newfoundland, should receive more favorable attention.

TECHNOLOGY

The technology of fluorspar preparation and use is undergoing a gradual change that can be seen only on a long-term basis. Supplies of natural 'gravel' (course crystalline fluorspar) for metallurgical use are becoming more difficult to obtain, and there is an increasing trend toward the use of fines, briquetted or pelletized to the proper particle size. Attempts are being made, particularly in the United States, to develop methods of recovering fluorspar from low-grade and complex ores that have not been satisfactory sources in the past. These efforts will continue as the demand increases and the output of larger producing plants steadily replace high-grade material obtained directly from natural sources.

A United States company reports the development of a method of recovering anhydrous hydrogen fluoride from silicofluorides, and another has been reported from the U.S.S.R. Such recovery, at plants that process phosphate fertilizer, has been under investigation for several years. New hydrofluoric-acid plants have been built in a few countries. Additional capacity in the United States has increased competition and narrowed profits by lowering the price of acid but will probably encourage the manufacture of fluorine chemicals.

In the United States and Britain, new facilities were built in 1961 for the production of sulphur hexafluoride, a high-performance dielectric material for transformers and similar electrical equipment. New uses for fluorine plastics and an increase in their production were reported in the United States.

A new Mexican plant at Parral, Chihuahua, began to produce acid-grade concentrate from a large supply of lead-zinc tailings. Fluorspar is derived from similar sources in England.

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 and elimination of associated waste. When it is a source material for chemicals, preparation of the raw material is more detailed and the specifications are 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 $\frac{3}{8}$ inch), since fine material would float on the surface of the melt or be carried up the stack by draft.

For ceramic purposes, a finer-grained and purer concentrate is used—for example, as a flux in glass and in enamel melts.

Large amounts of fluorspar are consumed in aluminum production, and no adequate substitute is known. 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 and thus reduce the formation of dental cavities in children. 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, propellent 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—Used for metallurgical purposes, this is usually sold on a specification of a minimum of 85 per cent CaF_2 (fluorspar) and maxima of 5 per cent SiO_2 (silica) and 0.3 per cent sulphur. Fines should not exceed 15 per cent.

Ceramic, glass or enamel grade—This calls for not less than 94 per cent CaF_2 with maxima of 3.5 per cent $CaCO_3$ (calcium carbonate), 3 per cent SiO_2, and 0.1 per cent Fe_2O_3 (ferric oxide). The material must be in mesh sizes ranging from coarse to extra-fine.

Acid grade—This has the most rigid specifications. It must be more than 97 per cent CaF_2 and not more than 1 per cent SiO_2. Like the ceramic grade, it is used in powdered form.

PRICES

Canada			
Ceramic grade, 94% CaF_2, coarse, Aluminum Company of Canada, Limited, per net ton f.o.b. Arvida, Quebec	$61.50		
Acid grade, Mexican, offered Canadian trade at U.S. price minus $8.50 U.S. import duty, per ton, in Canadian funds, approximately	$36.00		
United States (per short ton as reported in *E & M J Metal and Mineral Markets* of Dec. 21, 1961)			
Metallurgical grade, f.o.b. Kentucky and Illinois			
Effective CaF_2 content $72\frac{1}{2}$%	$37.00	—	$41.00
" CaF_2 " 70%	$36.00	—	$40.00
" CaF_2 " 60%	$33.00	—	$36.00
Acid-grade concentrates, dry basis, f.o.b. Illinois			
Bulk, carloads	$45.00		
Bulk, less than carloads	$50.00		
Bags, extra	$ 3.00		
Pellets, bulk, carloads	$55.00		
Pellets, bulk, less than carloads	$60.00		
Ceramic grade			
95% CaF_2	$45.00	—	$48.00
93–94% CaF_2, calcite and silica variable, Fe_2O_3 0.14%, bulk, f.o.b. Kentucky and Illinois	$43.00	—	$45.00
In 100-lb paper bags	$ 3.00 extra		
European, c.i.f. U.S. ports, duty paid, Metallurgical, effective CaF_2 $72\frac{1}{2}$%			
Spot	$31.00	—	$33.00
Contracts	$30.00	—	$33.00

Acid grade, 0.3% moisture maximum			
Spot	$51.00		
Contracts	$50.00		
Large discount for high moisture			
Mexican, f.o.b. border, effective CaF_2 72½%			
All rail, duty paid	$27.00	—	$28.00
Barge, Brownsville, Tex. duty paid	$31.50	—	$32.50
Tampico, Mexico, vessel, cargo lots	$22.50	—	$23.00
U.S. Atlantic ports, cars, duty paid	$35.50	—	$36.50
Lake Erie, cars, duty paid	$38.50	—	$39.50

TARIFFS

Canada	
Fluorspar	free
United States	
Fluorspar containing not more than 97% CaF_2, per long ton	$ 8.40
Fluorspar containing more than 97% CaF_2, per long ton	$ 2.10

Gold

T. W. Verity*

Although in 1961 the Royal Canadian Mint price for gold was the highest since 1951, production decreased by 3.4 per cent.

The year's output amounted to 4,473,699 troy ounces valued at $158,637,366. The final total for 1960 was 4,628,911 troy ounces valued at $157,151,527. In 1961, Quebec, Manitoba and Newfoundland were the only provinces that recorded an increase in output. Ontario remained the principal producer, with 59.0 per cent of the total, followed by Quebec with 23.6, the Northwest Territories with 9.1 per cent and British Columbia 3.7 per cent.

The output of auriferous-quartz (lode-gold) mines decreased to 3,774,522 troy ounces, or by 4.0 per cent from the 3,930,366 troy ounces produced in 1960. Gold recovered as a by-product from base-metal ores rose to 629,937 troy ounces from the previous year's total of 617,741. Placer-gold production decreased to 69,240 troy ounces from 80,804 recovered in 1960.

Among the minerals produced in Canada, gold maintained its position as sixth in value. It followed crude petroleum, nickel, copper, uranium oxide and iron ore. In the Free World, Canada was second to the Republic of South Africa, the chief gold-producing country. The United States Bureau of Mines reports that in 1961 world gold production reached a total of 48 million troy ounces, the highest on record, the Republic of South Africa contributing 22,941,561 troy ounces (48.1 per cent), followed by the Union of Soviet Socialist Republics (U.S.S.R.) with an estimated 12 million (25.1 per cent), Canada with 4,473,699 (9.4 per cent) and the United States of America with 1,566,800 (3.3 per cent).

An amendment to the Emergency Gold Mining Assistance Act, assented to on July 7, 1960, extended the Act to the end of the calendar year 1963. To qualify for cost assistance, Canadian gold mines must have operating costs

*Mineral Resources Division.

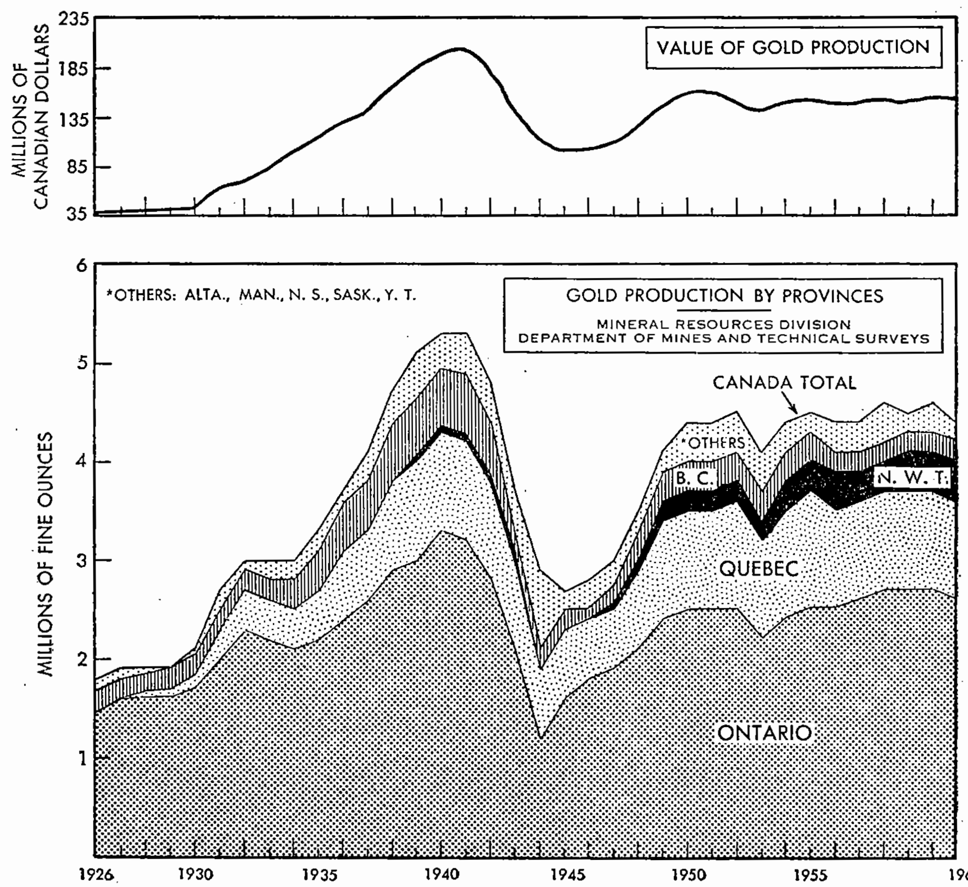
PRODUCTION OF GOLD
(troy ounces)

		1961[2]	1960[1]
Nfld.	Base-metal mines	14,429	13,515
N.B.	Base-metal mines	—	—
N.S.	Auriferous quartz	—	3
Que.	Auriferous quartz		
	Bourlamaque-Louvicourt	307,409	287,156
	Cadillac-Malartic	289,710	298,635
	Noranda-Belleterre	34,640	36,479
	Chibougamau	—	19,043
	Miscellaneous	—	—
	Total	631,759	641,313[r]
	Placer operations	478	—
	Base-metal mines	421,792	394,601[r]
	Total	1,054,029	1,035,914
Ont.	Auriferous quartz		
	Porcupine	1,075,161	1,084,537
	Red Lake and Patricia	523,465	511,323
	Larder Lake	520,868	592,244
	Kirkland Lake	301,806	332,939
	Thunder Bay (Port Arthur)	110,081	106,358
	Sudbury	37,934	39,035
	Miscellaneous	133	97
	Total	2,569,448	2,666,533
	Base-metal mines	68,272	66,140
	Total	2,637,720	2,732,673
Man.	Auriferous quartz	31,025	31,172
	Base-metal mines	26,722	21,590
	Total	57,747	52,762
Sask.	Base-metal mines	70,784	84,775
Alta.	Placer operations	171	191
B.C.	Auriferous quartz	134,816	173,241[r]
	Base-metal mines	27,167	37,120[r]
	Placer operations	2,484	2,498
	Total	164,467	212,859
N.W.T.	Auriferous quartz	407,474	418,104
Y.T.	Placer operations	66,107	78,115
	Base-metal mines	771	—
	Total	66,878	78,115
Canada	Auriferous quartz	3,774,522	3,930,366[r]
	Base-metal mines	629,937	617,741[r]
	Placer operations	69,240	80,804
	Total	4,473,699	4,628,911
Canada	Total value	$158,637,366	$157,151,527
	Average value per ounce	$35.46	$33.95

SOURCE: Dominion Bureau of Statistics.
[1]Production.
[2]Shipments.
[r]Revised from previously published figures.

more than $26.50 a troy ounce of gold and are eligible for this assistance only to the extent that they sell their gold to the Royal Canadian Mint. During 1961, there were 53 producing lode-gold mines, of which 40, producers of about 53 per cent of Canada's 1961 output, received cost assistance under the Act. Most of the remaining gold was available for sale in the open market.

The gold mines benefited from an increase of about $1.50 an ounce that occurred during the year in the price of gold. This was offset, however, by wage increases and higher mining and underground-development costs. Higher equipment and material costs also lessened the benefits of the price increase, especially in Ontario, where a 3-per-cent sales tax went into effect on many items on September 1. No large lode-gold mine has come into production in Canada since 1949, and depletion of ore reserves has forced many old producers to cease operations. Production from the newly opened lode-gold mines cannot make up for the loss of output caused by the closing of the larger lode-gold mines.



PRODUCTION OF GOLD, 1951-61

(troy ounces)

Year	Auriferous-quartz Mines	%	Placer Operations	%	From Base-metal ores	%	Total Gold Production	Total Value in Canadian Dollars	Average Value per ounce in Canadian Funds	Gold-% of All Mineral-production Value
1951	3,709,601	84.5	96,441	2.2	586,709	13.3	4,392,751	161,872,873	36.85	13.0
1952	3,823,747	85.5	92,843	2.1	555,135	12.4	4,471,725	153,246,016	34.27	11.9
1953	3,509,527	86.6	77,505	1.9	468,691	11.5	4,055,723	139,597,985	34.42	10.4
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[r]	84.9	80,804	1.7	617,741[r]	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

SOURCE: Dominion Bureau of Statistics.

[r]Revised from previously published figures.

LODE-GOLD MINES OPENED OR CLOSED, 1960 and 1961

Lode-gold Mines Closed				Lode-gold Mines Opened		
Mining Company	Province	Date Milling Started	Date Mining Terminated	Mining Company	Province	Date Mining Started
1) Anacon Lead Mines Limited (Chibougamau Operation)..........	Que.	Feb. 1956	Aug. 1960	1) Akasaba Gold Mines Limited (trucks ore to Bevcon mill).....	Que.	Mar. 1960
2) Kirkland Minerals Corporation Limited	Ont.	May 1919	Sept. 1960	2) McKinney Gold Mines Limited (trucks ore to smelter at Trail, B.C.)................	B.C.	Aug. 1960
3) Bralorne Pioneer Mines Limited (Pioneer Division)..	B.C.	May 1928	Oct. 1960	3) H.G. Young Mines Limited.............	Ont.	Aug. 1960
4) French Mines Ltd....	B.C.	Aug. 1957	May 1961	4) Marban Gold Mines Limited (trucks ore to Malartic Gold Fields Mill)....	Que.	July 1961
5) Carium Mines Limited.............	Ont.	July 1928	July 1961			
6) Sylvanite Gold Mines, Limited.............	Ont.	Mar. 1927	Aug. 1961			

SOURCE: Mineral Resources Division.

Consolidated Mosher Mines Limited, a large new lode-gold mine at Geraldton, Ontario, was scheduled to start trucking ore to the adjoining mill of MacLeod-Cockshutt Gold Mines Limited in January 1962, but the output of this new mine will only replace the declining production of the MacLeod-Cockshutt mine, whose ore reserves are dwindling.

The prospect for Canada's gold mining industry is a gradual decline in the production of lode-gold and placer-gold operations and some increase in the recovery of gold from base-metal mines. A large increase in the price of gold could result in the opening of new mines and an increase in production.

OPERATIONS AT PRODUCING MINES*

Newfoundland

Gold was recovered as a by-product from the lead-zinc ores of the Buchans Unit, American Smelting and Refining Company, in the central part of the province, 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 the northeast coast. Gold production was 6.8 per cent higher than in 1960.

Maritime Provinces

No gold production was reported from Nova Scotia, New Brunswick or Prince Edward Island.

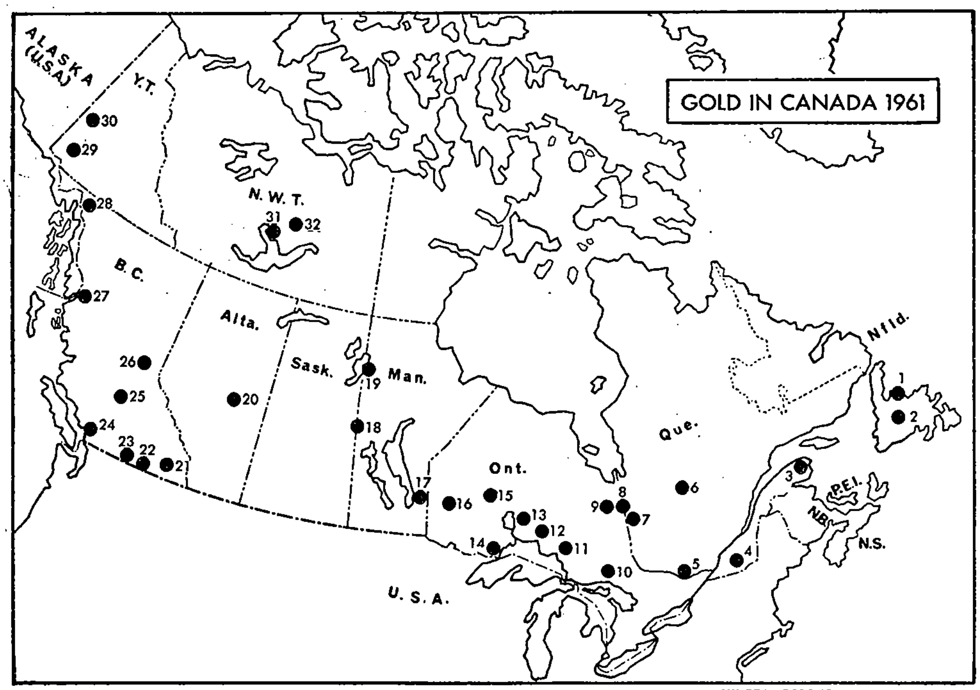
Quebec

Gold was produced from 13 lode-gold mines and as a by-product from base-metal mines. A small amount of placer gold was recovered from the Eastern Townships. One small lode-gold mine started to produce in the Malartic area. Production increased by 1.7 per cent owing to an increase in the gold output of base-metal mines. Gold from auriferous-quartz ores amounted to 59.9 per cent, base-metal ores 40.0 per cent and placers 0.05 per cent.

* See map.

Auriferous-quartz Mines

Bourlamaque-Louvicourt District—Five lode-gold mines continued to operate in the district, and gold production increased by nearly 7 per cent. All lode-gold mines in the district had an increase in gold output. Akasaba Gold Mines Limited had its first full year of production. Bevcon Mines Limited milled Akasaba ore as well as ore from its own mine. Lamaque Mining Company Limited, Quebec's largest lode-gold mine, completed the sinking of its shaft in the new No. 3 mine to a depth of 762 feet and established stations on five new levels. Sigma Mines (Quebec) Limited completed the sinking of its new No. 3 internal shaft, and lateral development was under way on six new levels, the lowest 4,050 feet below the surface. Sullivan Consolidated Mines, Limited, increased its mill rate to more than 700 tons a day and intensified its underground exploration and development work.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRODUCERS AND PROSPECTIVE PRODUCERS

*Base metals
**Auriferous quartz
***Placer
****Prospective producer

Newfoundland

1. Maritimes Mining Corp. Ltd. (Tilt Cove)*
   Atlantic Coast Copper Corp. Ltd. (Little Bay)*
2. American Smelting and Refining Co. (Buchans Unit)*

Quebec

3. Gaspe Copper Mines, Ltd.*
4. Beauce Placer Mining Co. Ltd.***
5. New Calumet Mines Ltd.*
6. Chibougamau District
   Campbell Chibougamau Mines Ltd.*
   Copper Rand Chibougamau Mines Ltd.*
   Merrill Island Mining Corp., Ltd.*
   Opemiska Copper Mines (Quebec) Ltd.*
7. Rouyn-District
   Elder Mines and Developments Ltd.**
   Eldrich Mines Ltd.**
   Noranda Mines, Ltd.*

Quemont Mining Corp., Ltd.*
Waite Amulet Mines, Ltd.*
Cadillac-Malartic District
Barnet Mines Ltd.**
Canadian Malartic Gold Mines Ltd.**
East Malartic Mines, Ltd.**
Malartic Gold Fields Ltd.**
Marban Gold Mines Ltd.**
Norlartic Mines Ltd.**
Bourlamaque-Louvicourt District
Akasaba Gold Mines Ltd.**
Bevcon Mines Ltd.**
Lamaque Mining Co. Ltd.**
Sigma Mines (Quebec) Ltd.**
Sullivan Consolidated Mines, Ltd.**
East Sullivan Mines Ltd.*
Manitou-Barvue Mines Ltd.*
Duparquet District
Normetal Mining Corp., Ltd.*

Ontario

8. Larder Lake District
Kerr-Addison Gold Mines, Ltd.**
Kirkland Lake District
Lake Shore Mines, Ltd.**
Macassa Gold Mines Ltd.**
Sylvanite Gold Mines, Ltd.**
Teck-Hughes Gold Mines, Ltd., The**
Upper Canada Mines, Ltd.**
Wright-Hargreaves Mines, Ltd.**
9. Porcupine District
Aunor Gold Mines Ltd.**
Broulan Reef Mines Ltd.**
Carium Mines Ltd.**
Delnite Mines, Ltd.**
Dome Mines Ltd.**
Hallnor Mines, Ltd.**
Hollinger Consolidated Gold Mines, Ltd.**
Hollinger Ross mine**
Hugh-Pam Porcupine Mines Ltd.**
McIntyre-Porcupine Mines, Ltd.**
Pamour Porcupine Mines, Ltd.**
Paymaster Consolidated Mines, Ltd.**
Preston Mines Ltd.**
10. Sudbury Mining Division
International Nickel Co. of Canada, Ltd.*
Falconbridge Nickel Mines, Ltd.*
11. Renabie Mines Ltd.**
12. Port Arthur Mining Division
Geco Mines Ltd.*
Willroy Mines Ltd.*
13. Leitch Gold Mines Ltd.**
MacLeod-Cockshutt Gold Mines Ltd.**
Consolidated Mosher Mines Ltd.** ****
14. North Coldstream Mines Ltd.*
15. Patricia Mining Division
Pickle Crow Gold Mines, Ltd.**
16. Red Lake Mining Division
Campbell Red Lake Mines Ltd.**
Cochenour Willans Gold Mines, Ltd.**
Dickenson Mines Ltd.**
Madsen Red Lake Gold Mines, Ltd.**
McKenzie Red Lake Gold Mines Ltd.**
H. G. Young Mines Ltd.**

Manitoba

17. Forty-Four Mines Ltd.**
San Antonio Gold Mines Ltd.**
18. Hudson Bay Mining and Smelting Co., Ltd.*
19. Sherritt Gordon Mines, Ltd.*

Alberta

20. Small Placer Operations on North Saskatchewan River.***

British Columbia

21. Consolidated Mining and Smelting Co. of Canada Ltd., The (Sullivan and Bluebell mines)*
22. McKinney Gold Mines Ltd.**
Phoenix Copper Company Ltd.*
Consolidated Woodgreen Mines Ltd.*
French Mines Ltd.**
23. Craigmont Mines Ltd.*
24. Howe Sound Company (Britannia Division)*
Texada Mines Ltd.*
25. Bralorne Pioneer Mines Ltd. (Bralorne Division)**
26. Cariboo Gold Quartz Mining Co., Ltd., The**
Small placer operations***
27. Bermah Mines Ltd.*
28. Small placer operations***

Yukon Territory

29. Action Mining Co. Limited***
Burwash Mining Co. Ltd., The*** and smaller operations
30. Yukon Consolidated Gold Corp. Ltd., The***
Ballarat Mines Ltd.*** and smaller operations***

Northwest Territories

31. Consolidated Mining and Smelting Co. of Canada Ltd., The (Con and Rycon mines)**
Giant Yellowknife Mines Ltd.**
32. Consolidated Discovery Yellowknife Mines Ltd.**
Taurcanis Mines Ltd.** ****
and other small gold mines****

Cadillac-Malartic District—Six lode-gold mines were operating, and Marban Gold Mines Limited began to ship ore to the mill of Malartic Gold Fields Limited on July 1. The output of the district was lower, all mines except Barnat Mines Ltd. and Norlartic Mines Limited showing a reduction. Barnat Mines Ltd. increased ore shipments to the Malartic Gold Fields custom mill. Canadian Malartic Gold Mines Limited was preparing a section of its mill to treat nickel ore from Marbridge Mines Limited on a custom basis. East Malartic

Mines, Limited, Quebec's second-ranking lode-gold producer, finished sinking its No. 4 internal shaft, the bottom level (thirty-first) being 4,845 feet below the surface. Exploration of the main ore zone and east porphyry ore zone, 3,000 feet to the east, were under way. Norlartic Mines Limited increased its ore shipments to the mill of Malartic Gold Fields Limited. This custom mill was running at full capacity, but it processed a smaller amount of ore from its own mine.

Noranda-Belleterre District—Elder Mines and Developments Limited and its subsidiary, Eldrich Mines Limited, continued to truck silica ore to the smelter of Noranda Mines, Limited, where it is used as a flux and the gold content is recovered as a by-product.

Chibougamau District—The district's only lode-gold mine, Anacon Lead Mines Limited (Chibougamau Operation), closed down indefinitely in August 1960, and no lode gold production was recorded for the district.

Base-metal Mines

Nearly all the copper concentrates from base-metal mines in Quebec are shipped to the smelter of Noranda Mines, Limited. More than 400,000 troy ounces of gold a year are recovered through the Noranda custom smelter and the Montreal East refinery of Canadian Copper Refiners Limited.

Placer Operations

On August 12, Beauce Placer Mining Co. Ltd. began to operate a 6,000-cubic-yard-a-day electric dredge on the Gilbert River near Beauceville East. This was the province's first large placer-gold operation since 1899.

Ontario

Thirty auriferous-quartz mines operated, one fewer than in 1960, and two mines closed during the year. Gold production from lode-gold mines decreased by 3.6 per cent and gold from base-metal mines increased by nearly 3 per cent. Only the Red Lake, Patricia and Port Arthur mining divisions increased their output.

Auriferous-quartz Mines

Porcupine Mining Division—Thirteen lode-gold mines continued to operate in the district, which has been Canada's leading gold-producing area since 1914, except for a period between 1931 and 1934, when the Kirkland Lake camp took the lead. Gold production was lower in 1961, and Carium Mines Limited ceased operations in July. At many of the mines, operating costs continued to rise. The decrease in production and the increase in costs were offset, however, by the higher price of gold.

Hollinger Consolidated Gold Mines, Limited, Canada's second-ranking gold producer, McIntyre-Porcupine Mines, Limited, and Dome Mines Limited all had small decreases in gold production. The only mines showing an increase were Aunor Gold Mines Limited, Broulan Reef Mines Limited, Delnite Mines, Limited, and the Hollinger Ross mine.

Exploratory crosscuts were driven from the Delnite 3,875- and 4,975-foot levels into Aunor ground. Dome began to sink a new internal shaft below the 4,000-foot level. McIntyre finished sinking its No. 15 internal shaft to 7,955 feet in August. Preston Mines Limited was preparing its Midcamp ore zones for production. Hollinger Ross completed the deepening of its shaft to 2,650 feet. Hallnor Mines, Limited, was scheduled to start the sinking of a new internal shaft from the twenty-first level in January 1962.

Carium Mines Limited, incorporated on December 19, 1960, took over the operation of Coniaurum Mines, Limited, on March 1, 1961. On March 17, Coniaurum changed its name to Coniaurum Holdings Limited.

Red Lake and Patricia Mining Divisions—Six lode-gold mines continued to operate in the Red Lake mining division and one in the Patricia mining division. Gold production was 2.4 per cent higher, mainly owing to the first full-year's production from H. G. Young Mines Limited.

The leading producers, Campbell Red Lake Mines Limited, Madsen Red Lake Gold Mines Limited and Dickenson Mines Limited, all had a lower gold output. Campbell was opening new levels while Madsen and Dickenson were shaft-sinking. Cochenour Willans Gold Mines, Limited, was driving from the 1,300-foot level into the adjoining property of Consolidated Marcus Gold Mines Limited. In September, McKenzie Red Lake Gold Mines Limited began to deepen its inclined shaft 300 feet to 1,950 feet. Pickle Crow Gold Mines, Limited, in the Patricia mining division, was also shaft-sinking to open four new levels down to the 3,500-foot horizon.

Larder Lake Mining Division—Kerr-Addison Gold Mines Limited, Canada's leading gold producer, had discouraging results from the development of its lower levels, and its gold recovery decreased by 12 per cent.

Kirkland Lake District—Six lode-gold mines operated. Sylvanite Gold Mines, Limited, ceased operating in August and the district's gold production was 9 per cent lower. In September, Macassa Mines Limited, the leading producer, merged with Bicroft Uranium Mines Limited to form Macassa Gold Mines Limited. Macassa was shaft-sinking to 6,600 feet depth to open six new levels. Upper Canada Mines, Limited, modified its mill, installed a hoist for its new internal shaft on the 3,625-foot level and was developing new levels. Its gold output increased almost to the total of Wright-Hargreaves Mines, Limited, and exceeded that of Lake Shore Mines, Limited. The Teck-Hughes Gold Mines, Limited, continued to operate but at a lower rate.

Port Arthur Mining Division—MacLeod-Cockshutt Gold Mines Limited, at Geraldton, brought its production to the highest point since 1952. Leitch Gold Mines Limited had a small decrease.

Sudbury Mining Division—Renabie Mines Limited had a 3-per-cent decrease in production.

Base-metal Mines

The gold recovered fom Ontario's base-metal ores amounted to only 2.6 per cent of the provincial total. The chief sources of by-product gold were The International Nickel Company of Canada, Limited, Geco Mines Limited, Falconbridge Nickel Mines, Limited, and North Coldstream Mines Limited.

Manitoba-Saskatchewan

Two lode-gold mines produced in the Rice Lake area of Manitoba. Gold recovery increased at San Antonio Gold Mines Limited but declined at its subsidiary, Forty-Four Mines Limited. Levels were under development in Forty-Four's new internal-shaft area. There was an increase in the recovery of by-product gold, which came from the 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.

All gold recovered in Saskatchewan came from the Saskatchewan operations of Hudson Bay Mining and Smelting Co., Limited. Recovery decreased by 16.5 per cent.

Alberta

A small amount of placer gold was recovered from the gravels of the North Saskatchewan River near Edmonton.

British Columbia

Production from auriferous-quartz-mining declined by nearly 22 per cent and that from base-metal-mining by 27 per cent. There was a small decrease in placer output. Four lode-gold mines operated.

The Bralorne Division of Bralorne Pioneer Mines Limited, in the Bridge River area, has completed a new 500-ton cyanide mill to replace its original plant. The Cariboo Gold Quartz Mining Company, Limited, in the Wells area, was developing new ore in the Burnett and Mosquito fault zones of its property. French Mines Ltd. near Hedley, ceased operating in May. McKinney Gold Mines Limited, near Rock Creek in the Greenwood mining division, reopened an old gold mine and, in October 1960, began to ship hand-picked ore to the Trail smelter of The Consolidated Mining and Smelting Company of Canada Limited.

By-product gold from base-metal mines came mainly from the Sullivan and Bluebell mines of Consolidated Mining and Smelting and from Phoenix Copper Company Limited, Bermah Mines Ltd., Silback Premier Mines, Limited, Howe Sound Company (Britannia Division) and Consolidated Woodgreen Mines Limited. Small amounts of placer gold were recovered from the Wells-Barkerville, Atlin and Manson Creek districts.

Northwest Territories

All gold recovered came from lode-gold mines. Four mines continued to operate but production was lower by nearly 2.5 per cent. Giant Yellowknife Mines Limited, Canada's third-ranking gold producer, was the only mine to increase its gold output. Consolidated Discovery Yellowknife Mines Limited had disappointing results in developing its new bottom levels and started an exploratory drive to the south from the 18th level. The Consolidated Mining and Smelting Company of Canada Limited (Con mine) completed the sinking of B3 internal shaft, the bottom level being at 3,500 feet. Lateral development was started to the west on the bottom level.

Yukon Territory

Almost all gold came from placers. Gold recovery from the dredging and hydraulic operations of The Yukon Consolidated Gold Corporation Limited, in the Dawson City area, was considerably lower than in 1960 but amounted to nearly 80 per cent of the output. Other relatively important gold producers were Ballarat Mines Limited, Action Mining Co., The Burwash Mining Company Limited and Yukon Placer Mining Company. The last-mentioned company ceased its operations in the Sixty Mile River area in August. Some 25 other small placer operators were working throughout the territory.

DEVELOPMENTS AT OTHER PROPERTIES

Quebec

Malartic Hygrade Gold Mines Limited (Paquette mine), near Val d'Or, diamond-drilled from the surface, constructed a surface plant and was carrying out underground development. Norbeau Mines (Quebec) Limited did not work on its gold prospect in the Chibougamau district in 1961. Marcon Mines Limited carried out exploration work on the property of a former gold producer in the Rouyn area.

Ontario

In the Red Lake mining division, Cochenour Willans Gold Mines, Limited, continued driving exploration headings into the adjoining Consolidated Marcus Gold Mines Limited. Diamond-drilling was also carried out in the adjoining property of Wilmar Mines Limited. Campbell Red Lake Mines Limited ceased exploration work on the adjoining property of Craibbe-Fletcher Gold Mines Limited. In the Sudbury mining division, Pick Mines Limited, near Lochalsh, started to mill development ore in March 1961 but closed in June, pending underground development. Lindsay Explorations Limited was diamond-drilling on its gold prospect near Atikokan, in the Fort Frances mining division. In the Larder Lake mining division, Thorncliffe Mines Limited leased a property from Buffonta Mines Limited in Garrison township, east of Matheson, assembled a small mill and surface equipment bought from Tyranite Mines, Limited, and was deepening a shaft sunk 111 feet by former operators. Some milling of development ore was reported.

British Columbia

Bralorne Pioneer Mines Limited was diamond-drilling on the optioned property of Ace Mining Company Ltd., in the Bridge River area. New Privateer Mine Limited was diamond-drilling on the property of a former gold producer in the Zeballos area of Vancouver Island. Berton Gold Mines Limited continued development of a gold prospect in the Alberni mining division, Vancouver Island. Near McDame Creek, Hanna Gold Mines Ltd. drove a tunnel into a vein containing free gold.

Northwest Territories

Taurcanis Mines Limited was shaft-sinking on its property in the MacKay Lake area. Mack Lake Mining Corporation Ltd. was trenching on the property of Salmita Consolidated Mines, Limited, north of Taurcanis.

Yukon Territory

Klondike Lode Gold Mines Ltd. carried out extensive trenching and churn-drilling operations between the forks formed by the junction of Eldorado and Bonanza creeks, but the results were not encouraging. An access road was reconditioned between Carmacks and the gold prospect of Ormsby Mines Limited, on Freegold Mountain.

WORLD GOLD PRODUCTION

The statistics in the table that follows, which shows world gold estimates for 1960 and 1961, are summarized from tables compiled by the Division of Minerals, Bureau of Mines, United States Department of the Interior. World estimates for 1961 are subject to further revision and Canada's total has been revised to show the final Dominion Bureau of Statistics estimate. The Bureau of Mines estimates show total Free World production in 1961 as 35.73 million troy ounces, exclusive of the output of the U.S.S.R., or about 1.33 million more than in 1960. The Republic of South Africa contributed 22.94 million, or 64.2 per cent of this Free World total, Canada 4.47 million ounces, or 12.5 per cent, and the United States, 1.57 million ounces, or 4.4 per cent. The U.S.S.R. does not publish its gold production, but this is estimated by the Bureau of Mines in 1961 as 12 million ounces.

USES

Throughout history, gold has been prized for its rarity, beauty, lustre and 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 settle international trade balances.

In modern jewelry, gold is used 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. Its color may vary from natural yellow through various shades of green and even white, depending on the alloying elements present.

66076-1—16

Because gold is resistant to corrosion and oxidation and is extremely ductile and highly conductive, it has found many applications in industry. It is used in the chemical industry and in dentistry and glass-making. Gold in solution is applied like lacquer to decorate pottery. It has electronic uses in radio tubes, gold-plated printed circuits, gold-film thermometers, X-ray tubes, bolometers,

WORLD GOLD PRODUCTION

(troy ounces)

	1961	1960
North America		
Canada	4,473,699	4,628,911[r]
United States (including Alaska)	1,566,800	1,679,800
Mexico	268,684	300,256
Nicaragua	226,250	210,200[r]
Other countries	2,567	3,833[r]
Total	6,538,000	6,823,000[r]
South America		
Colombia	399,877	433,947
Peru	133,570	141,001[r]
Brazil	180,000[e]	180,000[r]
Chile	110,000[e]	109,055[r]
Other countries	139,553	133,997[r]
Total	963,000[e]	998,000[r]
Europe		
U.S.S.R.	12,000,000	11,000,000
Sweden	110,000[e]	91,100[r]
Yugoslavia	64,300[e]	63,980[r]
Other countries	525,700	444,920[r]
Total	12,700,000[e]	11,600,000[r]
Asia		
Philippines	423,983	410,618
Japan	293,954	261,482[r]
Korea (including North Korea)	214,105	195,414[r]
India	156,510	160,593
Other countries	351,448	361,493
Total	1,440,000	1,390,000[r]
Africa		
Union of South Africa	22,941,561	21,383,019
Ghana	970,135	893,113[r]
Southern Rhodesia	570,095	562,703
Republic of the Congo	232,611	316,195[r]
Other countries	195,598	204,970
Total	24,910,000	23,360,000[r]
Oceania		
Australia	1,070,467	1,086,014[r]
Fiji	83,417	72,203
New Guinea	41,820	45,019
Other countries	28,424	33,458
Total	1,224,128	1,236,694[r]
World total (estimated)	47,732,000	45,400,000[r]

SOURCE: U.S. Bureau of Mines.

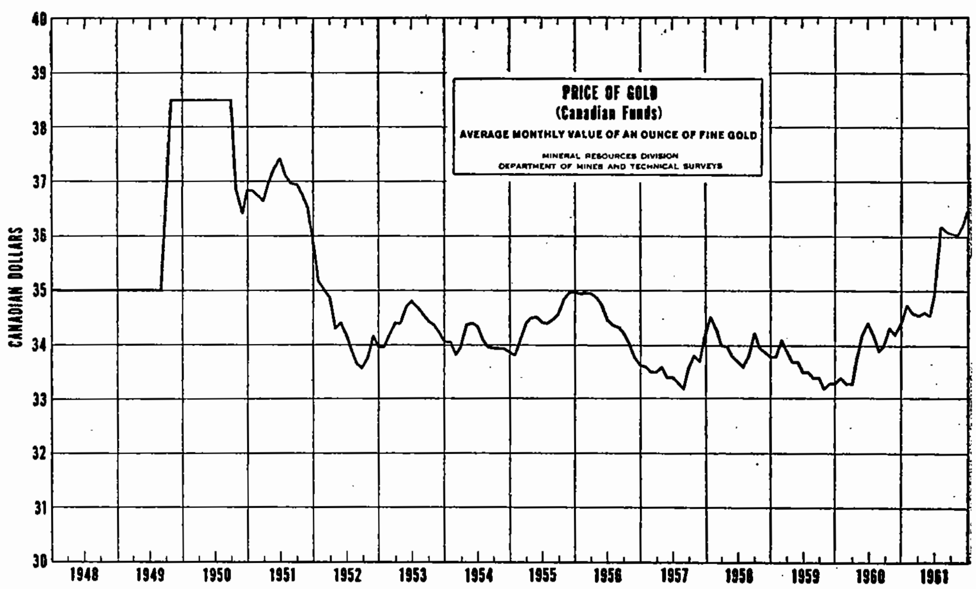
[r]Revised from previously published figures. [e]Estimate.

transparent windows and semiconductors. The electrical industry employs it in electrical-contact alloys, resistance alloys, heating elements, condenser plates and thermal fuses. In the textile industry it is used in connection with spinnerets and gold thread. It has provided lining for liquid-fuel reactors. Many applications of gold and gold alloys are linked to the optical characteristics of this metal. Because in very thin sheets it is an excellent reflector of infrared radiation, it has found increasing use in modern aircraft missiles and even in earth satellites and space vehicles.

The Platronics Company of Linden, New Jersey, has developed a new method of plating gold directly on molybdenum. Gold-plated molybdenum disks are used in electronics. Alloys Unlimited has developed a gold-tin 'laminate' that enables a silicon diode to be bonded to the 'dumet' steel of the conventional glass-diode package in one operation. This laminate is used in the semiconductor industry. A new gold alloy, said to be as hard as steel and as easily processed, has been developed in the U.S.S.R., according to a Tass report. This would have wide application in watchmaking, jewelry, electronics and radio.

PRICES

The average Royal Canadian Mint value for a troy ounce of fine gold in Canadian dollars increased to \$35.44 from the 1960 average of \$33.95. The price was at its lowest, \$34.45 an ounce, in the week of March 6-10. The Hon. D. M. Fleming, Minister of Finance, announced in Parliament on June 20 during his budget speech that the federal government would take action to reduce the value of the Canadian dollar in relation to the United States dollar. The result was that the Mint value for gold increased to \$36.35 an ounce in the week of July 3-7. It remained above \$36 an ounce for the remainder of the year and in the week of December 11-16 reached \$36.51 an ounce, the highest Mint value for gold since November 1951. The price graph below shows the average monthly value of a troy ounce of gold for each year from 1948 to 1961 inclusive.



66076-1—16½

The flow of gold from United States reserves to European countries continued during 1961. International Monetary Fund statistics show that, in terms of United States dollars, the reserves decreased by $5,900 million in four years and that the 1961 reduction amounted to $900 million. The loss of gold occurred because surpluses in international trade were offset by military expenditures incurred by the United States government, economic aid and loans to foreign countries and the volume of the long- and short-term outflow of private capital. The short-term capital flow was due mainly to the higher interest rates on European investments. In a message delivered to Congress on February 6, 1961, President Kennedy nevertheless firmly declared that the United States dollar would not be devalued and outlined the measures to be taken to improve the balance-of-payments position.

In London, after January 1961, variations in the price of gold took place only within narrow limits, and for the rest of the year the price did not exceed $35.20 a troy ounce. There was no sharp increase in the price of gold such as occurred in October 1960.

In September 1961, the International Monetary Fund arranged for the development of a $6,000-million 'standby' fund to reduce the need to keep large amounts of gold or currency in its reserves. Ten of the leading monetary countries, including Canada, agreed to lend some of their currencies to the IMF in time of need.

Graphite

J. E. Reeves*

One ton of fine-ground, high-purity graphite was shipped in 1961 for use in lubricants. The source was the small mill of Laurentide Mineral Products Corporation at Labelle, Quebec. This was the first shipment of natural graphite in Canada since 1954, when the Black Donald mine was closed.

Imports of natural graphite come from many countries and in several different forms. The United States, Britain and Mexico are the main suppliers, but graphite from the United States and Britain originates elsewhere, and most of it undergoes processing before being shipped to the Canadian market.

Artificial graphite is produced by Electro Metallurgical Company, Division of Union Carbide Canada Limited, at Welland, Ontario, by electric-furnace treatment of petroleum coke. The company exports some artificial-graphite electrodes to the United States and a number of other countries but these exports are now much smaller than in previous years. It has been reported that Great Lakes Carbon Corporation (Canada), Ltd., will start to produce graphite electrodes and specialty items at Berthierville, Quebec, late in 1962.

CANADIAN OCCURRENCES

Graphite is relatively common in the Precambrian limestones and gneisses of southeastern Ontario and southwestern Quebec, in which it occurs mainly as a disseminated fine- to medium-grained flake. Almost all the graphite mined in Canada from 1846 to 1954 came from such deposits. A deposit a few miles southeast of Perth and another near Bancroft, both in Ontario, are being investigated.

*Mineral Processing Division, Mines Branch.

TABLE 1

GRAPHITE—PRODUCTION, IMPORTS AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)	1	146	—	—
Imports				
Unmanufactured				
Mexico		19,290		43,164
United States		18,482		14,985
Norway		4,510		8,233
Ceylon		4,415		3,047
Britain		398		4,653
France		355		—
Other countries		—		1,632
Total		47,450		75,714
Ground and manufactured				
United States		833,893		755,425
Britain		75,332		83,078
West Germany		27,692		54,285
Japan		6,409		11,433
Ceylon		1,117		—
Mexico		420		975
France		395		—
Other countries		—		560
Total		945,258		905,756
Crucibles and covers				
United States		139,231		131,858
Britain		76,557		104,290
Total		215,788		236,148
Foundry facings				
United States		199,505		182,424
Britain		1,977		84
West Germany		701		5,359
Switzerland		62		—
Total		202,245		187,867
	1960		1959	
Consumption*				
Foundry facings	1,216		787	
Steel	682		865	
Batteries	147		178	
Lubricants	81		57	
Carbon brushes etc	42		52	
Paints and polishes	33		34	
Rubber	7		10	
Other	735		554	
Total	2,943		2,537	

SOURCE: Dominion Bureau of Statistics. *Available data.

TABLE 2

GRAPHITE—PRODUCTION AND TRADE, 1951-61

	Production*	Exports	Imports		
	Natural Graphite (short tons)	Natural Graphite (short tons)	Unmanufactured ($)	Crucibles ($)	Ground and Manufactured ($)
1951	1,569	1,152	96,725	215,297	476,511
1952	2,040	1,686	97,658	213,429	434,650
1953	3,466	3,253	125,740	217,066	481,982
1954	2,463	2,156	54,385	156,516	548,824
1955	—	—	64,798	202,864	561,394
1956	—	—	87,926	260,000	815,384
1957	—	—	74,089	237,333	748,732
1958	—	—	53,219	166,056	909,226
1959	—	—	64,014	224,204	976,250
1960	—	—	75,714	236,148	905,756
1961	1	—	47,450	215,788	945,258

SOURCE: Dominion Bureau of Statistics. *Producer's shipments.

WORLD PRODUCTION

Much of the world's graphite originates in countries in which there is relatively little industrialization. Their production depends on exports, and this dependence results in a considerable amount of world trade in all types. The most common variety traded is amorphous graphite, and Korea, Austria and Mexico are the main sources. The amorphous graphite used in Canada comes mostly from Mexico and to a small extent from Hong Kong. The Malagasy Republic (formerly Madagascar) is the traditional source of large, tough flake for use in crucibles; Ceylon provides a coarse, massive graphite, frequently with a naturally high carbon content; and West Germany and Norway are suppliers of small-flake graphite.

TABLE 3

WORLD PRODUCTION OF GRAPHITE, 1961

(short tons)

Republic of Korea	97,542	Mexico	21,500
Austria	89,255	Malagasy Republic	17,000*
North Korea	55,000*	West Germany	13,600*
Russia	55,000*	Ceylon	10,016
China	45,000*	Other countries	46,087
Total			450,000

SOURCE: U.S. Bureau of Mines, Mineral Trade Notes, July 1962. *Estimated.

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 higher-grade products from the first and second types of occurrence, and 'amorphous,' which comprises products from the last type of occurrence and some of the low-grade products from the first two.

Graphite is of industrial importance because of its chemical composition and its varied 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

Much graphite is used in foundry facings and steelmaking. Foundry facings are mixtures of ground and blended grades of graphite (mostly amorphous), clay and other materials. These mixtures provide a smooth surface on sand moulds. In the steel industry, low-cost amorphous graphite is used for recarburizing. Imported graphite crucibles, covers, stoppers and nozzles are used in the melting of 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 pigment in some polishes and anticorrosion paints; 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, and in packings.

Artificial graphite is employed chiefly in the form of electrodes used in some types of metallurgical and chemical plants. It is also employed in lubricants and in the manufacture of electric brushes, refractory brick, nuclear-reactor components and numerous special shapes. In powdered form it is of high purity but is granular rather than flaky and competes with natural graphite only in a few industries.

Specifications for natural graphite are many and varied and change periodically. They are mainly a matter of negotiation between supplier and consumer. The carbon content, particle size and type of graphite are the principal factors involved.

PRICES

Graphite prices in the United States, according to *E & M J Metal and Mineral Markets* of December 21, 1961, were:

Crystalline, f.o.b. source, in bags per metric ton (2,205 pounds)	
Malagasy Republic	$ 70-$200
Norway	80- 140
West Germany	110- 320
Per long ton (2,240 pounds)	
Ceylon	95- 250

Amorphous	
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:

Canada	British Preferential	Most Favored Nation	General
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	
Amorphous*	
Artificial	5%
Other	2½%
Crystalline chip, dust or lump	7½%
Crystalline flake valued per lb	
At less than 2¾¢	0.4125¢ per lb
From 2¾¢ to 5½¢	15%
At more than 5½¢	0.825¢ per lb

* Amorphous graphite or amorphous plumbago, crude or refined, valued at not over $50 per long ton, is duty free if entered during the two-year period beginning on May 14, 1960. Public Law 86-453, 74 Stat. 103, T.D. 55139.

Gypsum and Anhydrite

R. K. Collings*

GYPSUM

Gypsum, a hydrous calcium sulphate, is important chiefly because of its use in the manufacture of plaster and plaster products for the building-construction industry. Most of Canada's production is from Nova Scotia, which annually accounts for 85 to 90 per cent of the total, but the province's output is largely for export to the United States. Gypsum is also produced in Ontario, British Columbia, Manitoba, New Brunswick and Newfoundland.

In 1961 production totalled 4,940,037 tons, or about 5 per cent less than in the previous year. The value, which showed a decrease of 18 per cent, was $7,750,748, or about $1.57 a ton.

Exports of crude gypsum were 10.6 per cent below those of 1960. At 3,819,345 tons, they represented 77.3 per cent of production and were shipped to markets along the eastern seaboard of the United States. Imports of crude gypsum, which came mainly from Mexico and were mostly for consumption in British Columbia, totalled 66,075 tons.

Because of their nature, gypsum products such as plaster of paris and wallboard are not traded in large quantities. Statistics on exports of gypsum products are not available for 1961. Imports totalled 9,881 tons valued at $370,734.

OCCURRENCES

Canada's largest known gypsum deposits are in the Atlantic Provinces. Overburden usually does not exceed 15 feet, but at one or two quarries it is as much as 50 feet. The Newfoundland deposits are in the St. George's Bay area, in the southwestern section of the island; those in Nova Scotia occur throughout the central and northern parts of the mainland and on Cape Breton Island; in New Brunswick, the chief occurrences are near Hillsborough, in the south-eastern part of the province.

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* Mineral Processing Division, Mines Branch.

TABLE 1

GYPSUM—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)				
Crude gypsum				
Nova Scotia	4,113,188	5,693,653	4,490,427	7,515,244
Ontario	425,287	991,944	355,603	871,408
British Columbia	153,300	459,900	112,400	337,200
Manitoba	122,233	366,699	122,063	366,189
New Brunswick	85,330	136,856	90,892	267,002
Newfoundland	40,699	101,696	34,346	141,668
Total	4,940,037	7,750,748	5,205,731	9,498,711
Imports				
Crude gypsum				
Mexico	63,600	181,260	58,300	164,009
United States	2,448	35,740	1,681	29,450
Britain	27	888	30	1,090
Total	66,075	217,888	60,011	194,549
Plaster of paris, wall plaster				
United States	9,256	344,908	12,124	389,057
Britain	301	5,350	352	6,164
France	9	1,781	8	1,553
West Germany	4	205	3	129
Italy	—	—	7	430
Total	9,570	352,244	12,494	397,333
Wallboard and lath				
United States	311	18,490	285	16,267
Totali mports	75,956	588,622	72,790	608,149
Exports				
Crude gypsum				
United States	3,819,345	5,553,551	4,273,668	7,053,690
Plaster of paris, wall plaster				
Bermuda			30	1,164
United States			2	60
Jamaica			1	277
Total			33	1,501
Total exports*			4,273,701	7,055,191

SOURCE: Dominion Bureau of Statistics.

* Exports of plaster of paris and wall plaster not available as a separate class after 1960. Therefore, total exports comparable with previous years not available.

TABLE 2

GYPSUM—PRODUCTION AND TRADE, 1951-61

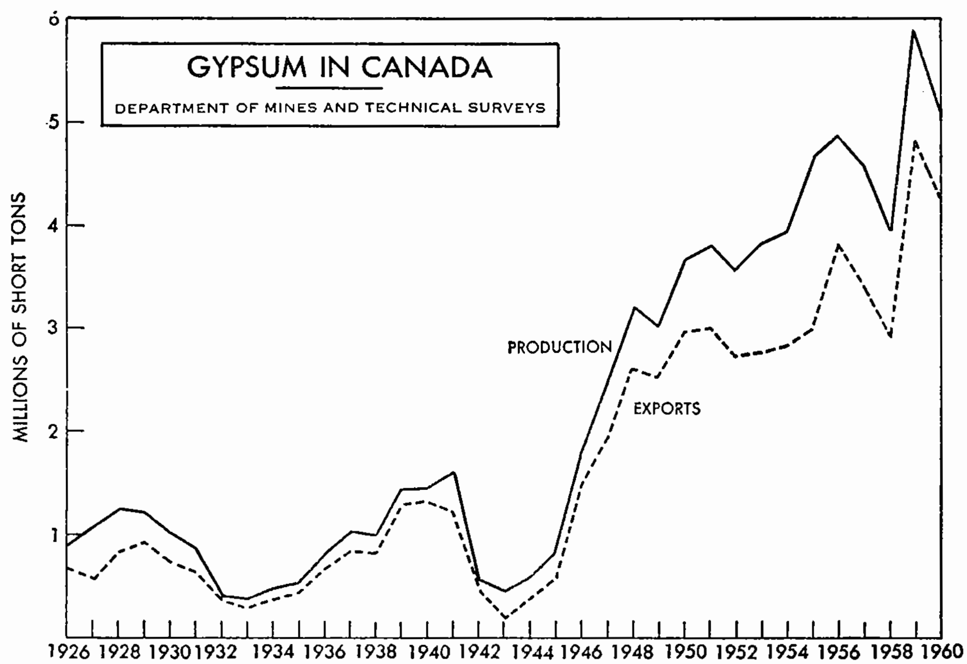
(short tons)

	Production[1]	Imports[2]	Exports[2]
1951	3,802,692	848	3,028,336
1952	3,590,783	649	2,763,492
1953	3,841,457	547	2,769,990
1954	3,950,422	4,958	2,830,945
1955	4,667,901	16,104	3,039,192
1956	4,895,811	70,436	3,840,721
1957	4,577,492	92,139	3,410,684
1958	3,964,129	108,038	2,898,230
1959	5,878,630	117,830	4,848,576
1960	5,205,731	60,011	4,273,668
1961	4,940,037	66,075	3,819,345

SOURCE: Dominion Bureau of Statistics.

[1] Producers' shipments. For 1951 these statistics include both crude and calcined. After 1951 only crude-gypsum tonnages are used.

[2] Include crude and ground but not calcined.



The known gypsum occurrences of Quebec are on the Magdalen Islands, in the Gulf of St. Lawrence. These deposits are extensive, outcrop over large areas and are up to 50 feet in thickness.

The chief deposits in Ontario are in the Moose River area, in the northeast, and in the Grand River area, south and west of Hamilton. The Moose River deposits are 15 to 20 feet thick and are generally covered by 10 to 30 feet of overburden; those of the Grand River area are thin and lens-like and occur as deep as 200 feet.

TABLE 3

CONSUMPTION OF CRUDE GYPSUM, 1961

(short tons)

In gypsum-products industry	375,514
In cement-manufacturing industry	297,785
Total	673,299

SOURCE: Dominion Bureau of Statistics.

TABLE 4

WORLD PRODUCTION OF GYPSUM, 1961

('000 short tons)

United States	9,500
Canada	4,946
France	4,245
Britain	4,102
U.S.S.R.	5,000
Spain	2,360
West Germany	1,213
Italy	2,205
Other countries	9,395
Total	42,960

SOURCE: Canada—Dominion Bureau of Statistics; all other countries—U.S. Bureau of Mines, *Minerals Yearbook 1961, Gypsum Preprint.*

Both Manitoba and Alberta have large gypsum deposits. In Manitoba, the main occurrences are at Gypsumville, where beds 30 feet or more in thickness are exposed, and at Amaranth, where a 40-foot seam is found at a depth of 100 feet. In Alberta, the main occurrences are in Wood Buffalo Park, where gypsum is exposed along the banks of the Peace River between Peace Point and Little Rapids. Gypsum also occurs along the banks of the Slave and Salt rivers north and west of Fort Fitzgerald, and narrow seams of gypsum have been found interbedded with anhydrite at a depth of 500 feet at McMurray, in northeastern Alberta. Outcrops of gypsum have been noted near Mowitch Creek, within the northern boundary of Jasper Park, and at the headwaters of Fetherstonhaugh Creek, near the Alberta-British Columbia border.

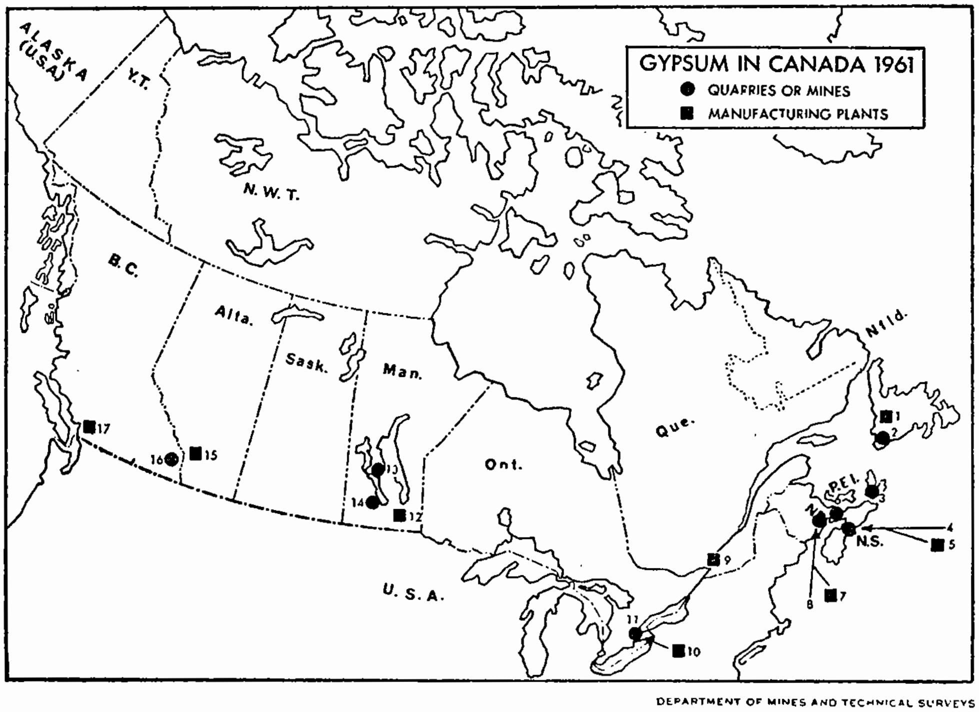
CURRENT OPERATIONS*

Nova Scotia

Crude gypsum quarried in Nova Scotia made up 83 per cent of Canada's 1961 production. More than 90 per cent of Nova Scotia production was exported to the United States.

Fundy Gypsum Company Limited, a subsidiary of Panama Gypsum Company, which in turn is a subsidiary of United States Gypsum Company, of Chicago, was formed during the year to take over the Nova Scotia operations of Canadian Gypsum Company Limited. Fundy Gypsum operated quarries at Wentworth and Miller Creek, near Windsor, and exported their output to the United States. A heavy-media plant, which upgrades gypsum from the Went-

*See the map.



QUARRIES OR MINES

2. Atlantic Gypsum Limited, Flat Bay Station
3. Little Narrows Gypsum Company Limited, Little Narrows
4. Fundy Gypsum Company Limited, Wentworth and Miller Creek
   National Gypsum (Canada) Ltd. Milford, Walton, and Cheverie
   Gypsum, Lime & Alabastine Limited, McKay Settlement
6. Gypsum, Lime & Alabastine Limited, Nappan
8. Canadian Gypsum Company Limited, Hillsborough
11. Canadian Gypsum Company Limited, Hagersville
   Gypsum, Lime & Alabastine Limited, Caledonia
13. Gypsum, Lime & Alabastine Limited, Gypsumville
14. Western Gypsum Products Limited, Amaranth
16. Western Gypsum Products Limited, Windermere

MANUFACTURING PLANTS

1. Atlantic Gypsum Limited, Humbermouth
5. Gypsum, Lime & Alabastine Limited, Windsor
7. Canadian Gypsum Company Limited, Hillsborough
9. Canadian Gypsum Company Limited, Montreal
   Gypsum, Lime & Alabastine Limited, Montreal
10. Canadian Gypsum Company Limited, Hagersville
   Gypsum, Lime & Alabastine Limited, Caledonia
12. Gypsum, Lime & Alabastine Limited, Winnipeg
   Western Gypsum Products Limited, Winnipeg
15. Gypsum, Lime & Alabastine Limited, Calgary
   Western Gypsum Products Limited, Calgary
17. Gypsum, Lime & Alabastine Limited, Port Mann
   Western Gypsum Products Limited, Vancouver

worth quarry by removing anhydrite and is the first used by the gypsum industry in Canada, was installed at the company's Wentworth crushing-and-screening plant.

National Gypsum (Canada) Ltd., a subsidiary of National Gypsum Company, of Buffalo, New York, operated a large gypsum quarry near Milford, 30 miles north of Halifax. The output was exported mostly to the United States, and minor amounts were shipped to Quebec. Gypsum for export was also obtained from quarries at Walton and Cheverie, in Hants county.

Little Narrows Gypsum Company Limited, a subsidiary of Panama Gypsum Company, quarried gypsum at Little Narrows, on Cape Breton Island, and shipped crude gypsum to the United States and Montreal for use in the manufacture of plaster and plaster products.

Gypsum, Lime & Alabastine Limited, with head offices in Toronto, obtained gypsum from a deposit near Nappan for use at a company-owned plant in Montreal. This company also operated a calcining mill at Windsor, producing plaster of paris for consumption in Nova Scotia, eastern Quebec and Ontario. Gypsum for use in this plant was from deposits at McKay Settlement, near Windsor.

Bestwall Gypsum Company, of Ardmore, Pennsylvania, is developing a gypsum quarry at River Denys Station, Inverness county, and constructing storage and shipping facilities at Point Tupper on the Strait of Canso. Active quarrying and shipping were scheduled to begin early in 1962, most of the gypsum being for export to company plants along the eastern seaboard of the United States.

Ontario

Gypsum was mined at Caledonia, near Hamilton, by Gypsum, Lime & Alabastine Limited, and at Hagersville, southwest of Caledonia, by Canadian Gypsum Company Limited. This gypsum was for the manufacture of plaster and wallboard at company-owned plants near each of the mines.

Western Gypsum Products Limited, of Winnipeg, is investigating the possibility of using an underground gypsum deposit near Drumbo as a source of crude for a gypsum-products plant the company is constructing at Clarkson. Gypsum samples for evaluation were obtained from a 400-foot, 44-inch-diameter hole drilled to intersect the deposit. The Clarkson unit, expected to be on stream early in 1963, will be Ontario's third gypsum-products plant. Western Gypsum Products Limited is a subsidiary of British Plaster Board (Holdings) Limited, of London, England.

Manitoba

Gypsum obtained from an underground deposit at Amaranth by Western Gypsum Products Limited was shipped to Winnipeg for use in the manufacture of plaster and wallboard at a company-owned plant.

Gypsum was quarried at Gypsumville by Gypsum, Lime & Alabastine Limited for use in the manufacture of plaster and plaster products at company-owned plants in Winnipeg and Calgary.

British Columbia

Western Gypsum Products Limited operated a gypsum quarry near Windermere, in the southeastern part of the province. The quarry supplied crude gypsum for the company's gypsum-products plants at Calgary and Vancouver, the Calgary plant of Gypsum, Lime & Alabastine Limited and cement plants in British Columbia and Alberta.

New Brunswick

Gypsum was quarried near Hillsborough by Canadian Gypsum Company Limited for use in the manufacture of plaster and wallboard at a company-owned plant at Hillsborough.

Canada Cement Company, Limited, obtains gypsum from a quarry near Havelock, west of Moncton, as needed for the manufacture of cement at Havelock.

Newfoundland

Atlantic Gypsum Limited produced gypsum plaster and wallboard at a plant at Humbermouth, on the west coast. This plant, owned by the Government of Newfoundland, was operated by The Flintkote Company of Canada Limited, Toronto, a subsidiary of Flintkote Company of New York. Crude gypsum for its operation was obtained from quarries at Flat Bay Station, 62 miles by rail southwest of Humbermouth. At year's end, construction of a 6-mile aerial conveyor from the Flat Bay area to St. George's, on St. George's Bay, and of water shipping facilities at St. George's was nearing completion. The two projects were scheduled to be finished early in 1962, when crude gypsum was to be exported to Flintkote's gypsum-product plants in the United States and to cement plants in Quebec.

OTHER PROCESSING PLANTS

Quebec

Gypsum, Lime & Alabastine Limited and Canadian Gypsum Company Limited operated gypsum-products plants in Montreal East. Crude gypsum from quarries in Nova Scotia was used by these plants in the manufacture of plaster of paris, wallboard and other gypsum products.

Alberta

Gypsum, Lime & Alabastine Limited and Western Gypsum Products Limited each produced plaster and wallboard in Calgary. Gypsum for these plants was obtained from quarries in British Columbia and Manitoba.

British Columbia

Gypsum, Lime & Alabastine Limited and Western Gypsum Products Limited also have plants in Vancouver for the production of gypsum plaster and wallboard. The former obtained its crude gypsum from Mexico; the latter was 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 it 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 leguminous crops.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Gypsum, crude	free	free	free
Gypsum, ground, not calcined	10%	12½%	15%
Plaster of paris and prepared wall plaster, per 100 lb	free	11c.	12½c.
Gypsum wallboard	15%	22½%	35%
Gypsum lath	15%	20%	25%

United States	
Gypsum, crude	free
Gypsum, ground or calcined, per long ton	$1.19
Gypsum wallboard and lath	15%

ANHYDRITE

Anhydrite, or anhydrous calcium sulphate is commonly associated with gypsum. It was produced by Fundy Gypsum Company Limited at Wentworth, Nova Scotia, and for National Gypsum (Canada) Ltd. by B. A. Parsons at Walton, Nova Scotia. The Department of Mines of the Province of Nova Scotia reported that in 1961 production totalled 173,777 tons, most of which 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.

Nova Scotia anhydrite production is included in crude gypsum production and trade statistics.

Indium

D. B. Fraser*

Indium is one of the rare metals found in trace amounts in certain ores of zinc, lead, tin, tungsten and iron. It is usually associated with sphalerite, the common zinc mineral. The metal is produced commercially from the treatment of residues and slags derived from zinc- and lead-smelting operations.

Statistics on the production of indium are not available, since the few companies that recover indium do not publish these data. 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.

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. The potential annual production at Trail is at present 1 million troy ounces, or about 35 tons.

Indium enters the Trail metallurgical plants with the zinc concentrates. In the electrolytic zinc process indium remains in the zinc calcine during roasting and in the insoluble residue during leaching. The residue is then delivered to the lead smelter for the recovery of contained lead and residual zinc. In the lead blast furnaces, the indium enters the lead bullion and the blast-furnace slag in about equal proportions. From the slag, it is recovered along with zinc and lead during slag-fuming. The fume is leached for the recovery of zinc, and indium again remains in the residue, which is re-treated in the lead smelter. From the lead bullion, indium is removed in the bullion dross. The dross is

*Mineral Resources Division.

re-treated for the 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 (20-25 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) of indium or a high-purity grade (approximately 99.999 per cent). 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 not only because it has electronic properties but also 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 only 25 years, indium and its compounds are relatively new materials whose potential applications are still being explored. Uses have been found in intermetallic semiconductors, electrical contacts, resistors, thermistors and photoconductors. Indium can be used as an indicator in atomic reactors, since artificial radioactivity is easily induced in indium by neutrons of low energy. Indium compounds added to lubricants have been found to have a beneficial anticorrosive effect. Indium 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.

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PRICES

Prices of indium, 99.97 per cent, quoted per troy ounce for **1961** in *E & M J Metal and Mineral Markets* were as follows:

January 1-5	
Small lots	**$2.25**
More than 5,000 ounces	**$1.35-$2.25**
January 12	
Small lots	**$2.25**
Ingot, 100 to 10,000 ounces	**$1.35-$1.65**
November 23	
25-ounce lots	**$2.25**
Ingot, 100 to 10,000 ounces	$1.50-$1.80

Iron Ore

R. B. Elver*

Because of increasing competition, a weakening in world markets and a low level of shipments, the Canadian iron-ore industry put greater effort in 1961 into product research and the installation of new ore-beneficiation facilities. For most of the year in the United States, Canada's principal market, stockpiles were relatively large and the ore-consumption rate was low, but conditions improved enough in the fourth quarter to bring a late upswing in shipments. Venezuela, a producer since 1950 and Canada's main competitor in exports to the United States, suffered its first shipment decline. Canada experienced such declines in 1958, 1960 and 1961.

The bargaining position of Canada, like that of several other traditional suppliers, has tended to weaken because of the present and near-future availability of iron ore in some of the countries of Asia, South America and Africa, particularly in Liberia. In 1961, moreover, most of the leading steel-producing countries operated at a reduced rate and shipments to Britain and western Europe accordingly showed a decrease. The softening of the western European market can nevertheless be regarded as a short-term pause in the strong growth that developed during the 1950's and is expected to continue well into the 1960's.

In Japan, steel producers have been using imported iron ore at an exceedingly rapid rate and Canadian ore from the British Columbia coast has found a ready market, the volume of shipments being limited only by the companies' ability to produce.

Domestic consumption of Canadian iron ore increased in 1961 as iron and steel production reached record levels. Prior to 1939, when Canada produced only insignificant quantities of ore, most of Canada's iron-ore requirements were met by imports from the United States Lake Superior district and Newfoundland. Since that time, Newfoundland has joined Confederation and several new mines have been brought into production in Quebec, Labrador, Ontario and British Columbia. As Canadian ores have become available, the domestic steel industry has used them in increasing quantities. Since the Canadian steel industry has part ownership of or commercial ties with the United States iron-mining industry, changes in the sources of supply have not been as rapid as one might expect.

* Mineral Resources Division.

TABLE 1

IRON ORE—PRODUCTION AND TRADE

	1961		1960	
	Long Tons	$	Long Tons	$
Production (shipments)[1]				
Newfoundland	6,795,839	59,889,125	6,795,862	54,673,717
Ontario	5,154,164	62,350,773	4,754,640	48,399,442
Quebec	5,035,653	53,627,608	6,658,903	61,752,485
British Columbia	1,192,025	12,082,541	1,032,408	10,256,879
Total	18,177,681	187,950,047	19,241,813	175,082,523
By-product iron ore (shipments)[2]	329,263	—	297,176	—
Ilmenite shipments for iron-making[3]	1,032,122	—	863,726	—
Imports				
United States	3,959,192	45,579,195	4,342,285	46,625,201
Brazil	172,713	1,851,460	156,901	1,606,273
Italy	300	1,213	—	—
Venezuela	—	—	15,400	137,957
Other countries	75	1,185	10	872
Total	4,132,280	47,433,053	4,514,596	48,370,303
Exports (crude, concentrated, agglomerated and calcined)[4]				
United States	9,380,832	96,709,353	10,433,244	101,903,339
Britain	2,314,562	20,227,324	3,359,919	27,721,660
Japan	1,159,361	10,152,146	1,040,563	9,424,029
Netherlands[5]	725,925	6,335,673	912,237	7,775,700
West Germany	821,820	5,556,920	957,711	6,855,339
Belgium and Luxembourg	348,175	2,729,519	163,986	1,280,310
Italy	104,036	754,815	74,480	512,101
France	11,955	90,857	—	—
Trinidad	1,500	9,375	—	—
Total	14,868,166	142,565,982	16,942,140	155,472,478

SOURCES: Dominion Bureau of Statistics and supplementary data from individual companies.

[1] Includes for the first time data obtained from some by-product producers.

[2] Total of shipments of by-product iron ore compiled from data supplied by individual companies to the Mineral Resources Division.

[3] Ilmenite ore used to produce titania slag and pig iron. Company data.

[4] Includes by-product iron ore.

[5] About 582,700 tons from the 1961 total and 740,000 tons from the 1960 total were transshipped to West Germany.

TABLE 2

IRON ORE—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

	(long tons)			
	Production (shipments)	Imports	Exports	Consumption (indicated)*
1951	4,179,027	3,420,909	2,880,149	4,719,787
1952	4,707,008	3,810,409	3,434,820	5,082,597
1953	5,812,337	3,721,046	4,303,549	5,229,834
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

SOURCE: Dominion Bureau of Statistics.
*Shipments plus imports less exports, but no account is taken of changes in stocks at consuming plants.

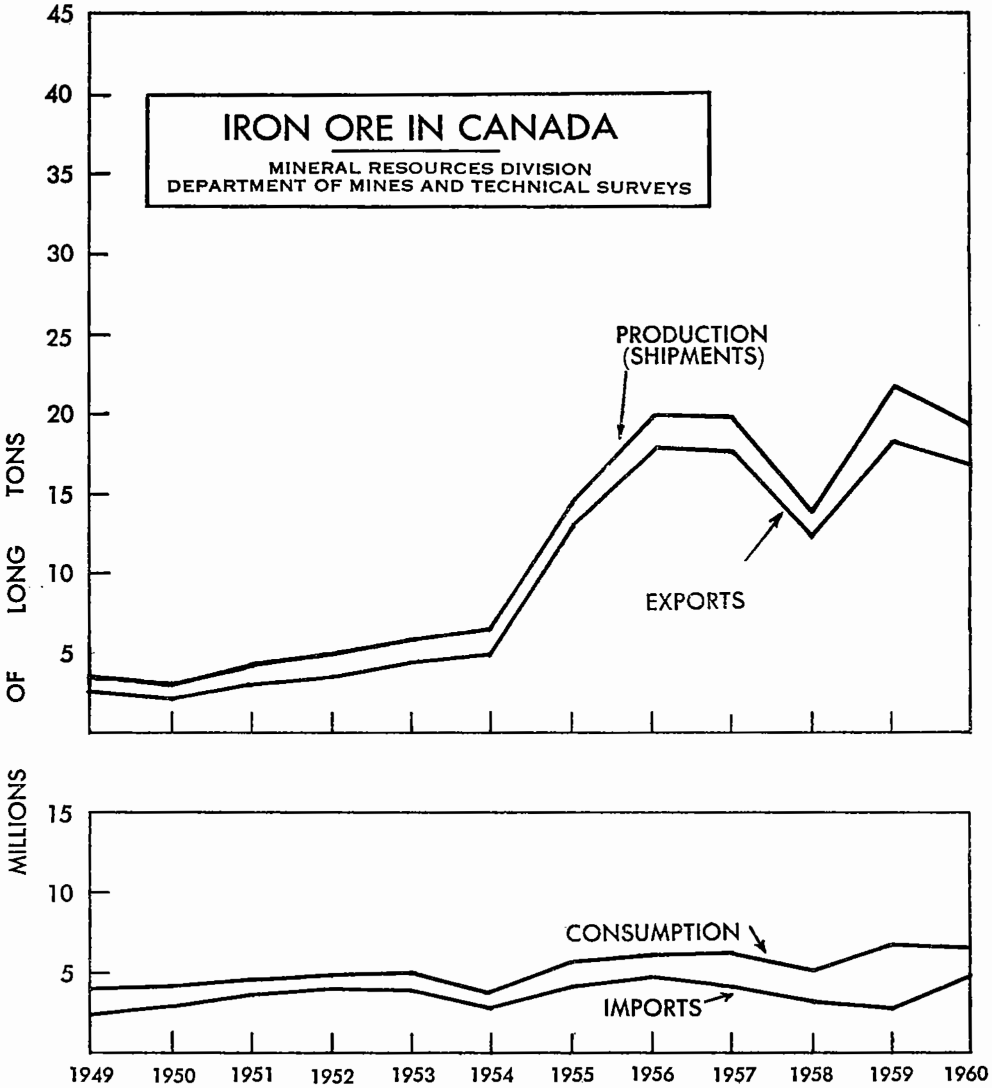
International trade has been and continues to be affected by the improvement in the quality and the increase in the quantity of the iron ore available. From 1950 to 1959, world trade in this commodity increased from 43.7 million to 130.5 million tons† a year, and the trend is still upward. In 1950 the main exporters of ore were Sweden and France, but by 1959 Canada, Venezuela and the Union of Soviet Socialist Republics had also become important. Significant exports are now coming from several countries in Africa and Asia as well as from other countries in South America, and projects in various parts of the world are being developed for production by 1965.

Three Labrador-Quebec projects recently completed or now at the construction stage will raise Canada's annual production capacity from the 26.5 million tons estimated for 1961 to more than 40 million tons by 1965. In Liberia, where in 1960 one producer had a demonstrated capacity of 3 million tons, advanced undertakings that are all to be completed by 1964 will give a capacity of nearly 20 million tons a year. Many other projects now being carried out in Peru, Chile, India, Malaya, Angola, Mauretania, Swaziland and Australia, will each add at least 1 million tons of production capacity a year for export markets. Quality ores will clearly be abundantly available in the 1960's. As in the past, no country will have a monopoly.

Not all Canadian companies experienced a shipment decline in 1961. Ontario and Quebec producers of high-grade concentrates or agglomerates increased their shipments, as did one Ontario producer of direct-shipping medium-grade ore. On the whole, however, producers of medium-grade ores, whether direct-shipping or beneficiated, made smaller shipments than in 1960. The leading producer, Iron Ore Company of Canada, had the greatest decline.

As shown in Table 6, an additional company began to ship in 1961, thus raising the number of mining operations to 13. An increase brought to three the number of companies obtaining by-product iron ore from the processing of sulphide ores for the recovery of sulphur dioxide or such other metals as nickel and cobalt. Another company is expected to start by-product production

†Unless otherwise designated, the unit used throughout is the long (gross) ton (2,240 pounds). Other units that may be encountered are the short (net) ton (2,000 pounds) and the metric ton (2,205 pounds).



early in 1962. A fifth mines ilmenite ore for smelting in its electric-furnace plant at Sorel, Quebec; its products include titania slag, which is used in pigment manufacture, and pig iron.

WORLD PRODUCTION

The nine countries listed in Table 3 accounted for 72 per cent of the world's 1960 iron-ore output. Only Canadian and, to a lesser extent, Venezuelan production were less than in 1959. In 1961, production decreased also in the United States, Britain and West Germany but remained relatively constant in France. In the Union of Soviet Socialist Republics and Sweden it continued to increase.

Although preliminary estimates for China are lacking, it seems that in 1961 Canada ranked sixth among the world iron-ore-producing nations, that Britain displaced Venezuela in seventh position and that West Germany slipped from eighth place to ninth.

TABLE 3

PRODUCTION OF IRON ORE, BY COUNTRY

	('000 long tons)		
	1961[1]	1960[1]	1959[1]
U.S.S.R.	116,137	105,310	92,900
United States	71,543	88,784	60,276
France	66,324	65,854	59,956
China	59,053	54,100	44,300
Sweden	22,647	20,975	17,999
Canada	18,178	19,215	21,865
Venezuela	15,255	19,182	17,018
West Germany	18,568	18,571	17,778
Britain	16,521	17,056	14,872
Sub total	404,226	409,047	346,964
Other countries	100,490	98,042	84,745
World total	504,716	507,089	431,709

[1] American Iron and Steel Institute.

DOMESTIC CONSUMPTION

Iron ore is used primarily as a raw material in the making of iron and steel. Small tonnages, not normally referred to as iron ore, are used in the manufacture of paint, as heavy aggregate in concrete, as heavy media in some beneficiation plants, and for agricultural purposes. Most of the iron ore consumed is fed into blast furnaces to be made into pig iron, some of which is used by iron foundries. Most pig iron, however, along with steel scrap, goes into furnaces for the production of crude steel. Some iron ore is also used in steelmaking furnaces. The following table summarizes statistics on the consumption of iron ore in Canadian iron and steel plants.

TABLE 4

CONSUMPTION OF IRON ORE IN CANADIAN IRON AND STEEL PLANTS

	(long tons)	
	1961	1960
In blast furnaces, direct	5,388,755	4,813,358
In steel furnaces, direct	353,875	335,367
In sintering plants before ore is charged to blast or steel furnaces	1,400,259	1,266,979
Miscellaneous	59	224
Total	7,142,948	6,415,928

SOURCE: American Iron Ore Association, Cleveland, Ohio.

TABLE 5

CANADIAN CONSUMPTION OF IRON ORE AND PRODUCTION OF PIG IRON AND CRUDE STEEL

	1961 (long tons)	1960 (long tons)
Total receipts at iron and steel plants[1]	7,159,660	7,084,119
Receipts imported[1]	4,173,955	4,539,125
Receipts from domestic sources[1]	2,985,705	2,544,994
Stocks at iron and steel plants Dec. 31 of previous year[1]	3,465,440	2,738,815
Stocks at iron and steel plants Dec. 31 of year at top of column[1]	3,489,587	3,465,440
Net change in stocks	+24,147	+726,625
Consumption of iron ore[1 2]	7,142,948	6,415,928
Pig-iron production[3]	4,925,395	4,278,425
Capacity at Dec. 31[3]		4,914,900
Steel-ingot and castings production[3]	6,466,324	5,789,570
Capacity at Dec. 31[3]		7,843,950

[1]American Iron Ore Association, Cleveland, Ohio.

[2]Consumption figures are compiled from company submissions and cannot be calculated from the statistics shown in this table.

[3]Dominion Bureau of Statistics.

CANADIAN DEVELOPMENTS

Newfoundland

The medium-grade ore of Wabana Mines Division of Dominion Steel and Coal Corporation, Limited, met with increasing competition in overseas markets. Heavy lay-offs were pending as the year ended. In its efforts to meet competition, the company is striving mainly to increase its mine efficiency.

Quebec-Labrador (Newfoundland)

Iron Ore Company of Canada, like other companies, continued to feel the effect of the competition that is severe for all ores of the direct-shipping, medium-grade type. To meet this competition, the company has had a comprehensive ore-beneficiation program underway since the opening, in 1960, of its new research laboratory. In 1961 Iron Ore Company's mining operations in the Schefferville area of Quebec continued to be the centre of the Canadian iron-ore industry. They are now routine, although problems still exist and new techniques are still being introduced. At Sept Iles, in its expanded stockpile area, which now has a capacity of 3 million tons, the company has installed a new single-boom stacker. The ore-drying plant completed in August 1960 was operated in 1961 near its rated capacity of some 1.2 million tons a year.

Iron Ore Company's Carol Lake project, to the west of Wabush Lake, Labrador, is expected to be in production by mid-1962. The Smallwood deposit, which is being developed on ground subleased from Labrador Mining and Exploration Company Limited, is one of several the company holds. The deposits are conservatively estimated to contain more than 1,500 million tons of material that grades 36 to 38 per cent iron and is largely of specular-hematite, quartz iron formation.

Included in the program, which will require an expenditure of $125 million to $150 million, are the following: a 38-mile rail line that runs westward from Mile 224 on the Quebec North Shore and Labrador Railway, having been built jointly by the company and Wabush Iron Co. Limited and completed in 1960; a 120,000-horsepower hydroelectric plant that is being constructed at Twin Falls by the company, Wabush Iron Co. Limited and British Newfoundland Corporation Limited for completion in 1962; development of the Smallwood open-pit mine, in which 100-ton tractor-trucks will be used; a new concentration plant based principally on dry autogenous grinding and spiral concentration for the treatment of 50,000 tons of crude ore a day and the production of 7 million tons of concentrate a year; a 5.8-mile, fully automated rail line between the Smallwood mine and the new concentration plant; and a new town, Labrador City, which will house and completely accommodate an immediate population of 3,000 and an eventual one of 6,000.

Carol Pellet Company was formed by the American principals of Iron Ore Company of Canada to construct a pellet plant adjacent to the Carol Lake concentrator. Construction of the $60-million plant began late in 1961 and is scheduled for completion by mid-1963. The plant, to be operated by Iron Ore Company of Canada, is designed to pelletize 5.5 million tons a year of the 7-million-ton production from the adjacent concentrator.

Wabush Mines and associated companies proceeded with plans to develop their deposit, which contains 1,000 million tons grading 37 per cent iron. Shipments from this deposit, which lies southeast of Wabush Lake, will begin late in 1964 or early in 1965. In 1961, Dominion Foundries and Steel, Limited, of Hamilton, Finsider of Italy and two West German firms became participants in the Wabush Mines project. The planned production rate was thus increased from a range of 4.5-5.0 million tons a year to one of 5.5-6.0 million tons and the estimates of capital requirements were raised from $200 million to $250 million. Pittsburgh Steel Company also exercised its option, acquired in 1959, to purchase an 8-per-cent interest in the company. The $25- to $30-million program for 1961 included work on the following: construction of a 25-mile railway to Pointe Noire from Mile 8 on the Quebec North Shore and Labrador Railway; an ore-handling, transfer, stockpiling and boat-loading system with docks and a dredged channel; erection of a townsite near Labrador City; further exploration of the deposit and operation of its 300-ton-a-day pilot plant completed in 1960; and, in conjunction with Iron Ore Company of Canada and British Newfoundland Corporation Limited, construction of the 120,000-horsepower hydro plant at Twin Falls. Approximately 42,000 tons of concentrate were shipped for testing in 1960 and 55,000 tons in 1961.

Labrador Mining and Exploration Company Limited, under the agreement by which it subleased parts of its Wabush Lake area concession to Iron Ore Company of Canada, was guaranteed one third of the reserves discovered. Nevertheless, because the final negotiations to determine the reserves it will receive have not yet taken place, Labrador Mining has itself extensively explored various deposits previously explored by Iron Ore Company and may

TABLE 6

CANADIAN PRODUCERS OF IRON ORE, 1961

Company and Property Location	Participating Companies	Product Mined (average natural grade)	Product Shipped (average natural grade)	Shipments[1] ('000 long tons)	
				1960	1961
Algoma Ore Properties Division; mines and sinter plant near Wawa, Ont.	Algoma Steel Corp., Ltd., The	Siderite from open-pit and underground mines (33.9% Fe)	Ore beneficiated by sink-float and sintered (50.36% Fe, 2.84% Mn)	1,439	1,644
Caland Ore Co. Ltd.; E. arm of Steep Rock Lake, N. of Atikokan, Ont.	Inland Steel Co..................	Hematite and goethite from open-pit mines (52.6% Fe)	Direct-shipping ore (52.46% Fe)	765	1,009
Canadian Charleson, Ltd.; S. of Steep Rock Lake, near Atikokan, Ont.	Oglebay Norton Co..............	Hematite-bearing gravels (11% Fe)	Jig and spiral concentrate (55.76% Fe)	112	18
Empire Development Co., Ltd.; Elk River, 8 miles E. of Port Alice, Vancouver Island, B.C.	Loram Ltd.; Quatsino Copper-Gold Mines Ltd.	Magnetite from open-pit mine (48.4% Fe)	Magnetite concentrate (57.84% Fe)	414	265
Hilton Mines, Ltd.; near Bristol, Que., 40 miles NW. of Ottawa	Steel Co. of Canada, Ltd., The; Jones & Laughlin Steel Corp.; Pickands Mather & Co.	Magnetite from open-pit mine (approximately 20% Fe)	Iron-oxide pellets (66.02% Fe)	747	800
Iron Ore Company of Canada; Labrador-Quebec near Schefferville, Que.[2]	M. A. Hanna Co., The; Hollinger Cons. Gold Mines Ltd.; Armco Steel Corp.; Bethlehem Steel Corp.; Hanna Coal & Iron Corp.; National Steel Corp.; Republic Steel Corp.; Wheeling Steel Corp.; Youngstown Sheet and Tube Co.	Hematite-goethite from open-pit mines (53.42% Fe)	Direct-shipping ore (48.2–57.29% Fe)	9,809	7,444
Lowphos Ore, Ltd.; Sudbury area, 20 miles N. of Capreol, Ont.	National Steel Corp.; M. A. Hanna Co., The	Magnetite from open-pit mine (31.37% Fe)	Magnetite concentrate (59.81% Fe)	519	578
Marmoraton Mining Co., Ltd.; near Marmora, in southern Ontario.	Bethlehem Steel Corp............	Magnetite from open-pit mine (35–37% Fe)	Iron-oxide pellets (65.1% Fe)	282	529

Nimpkish Iron Mines Ltd.; 26 miles W. of Beaver Cover, Vancouver Island, B.C.	International Iron Mines Ltd.; Standard Slag Co.	Magnetite from open-pit mine (41.6% Fe)	Magnetite concentrate (59.9% Fe)	251	378
Quebec Cartier Mining Co., Gagnon, Quebec.	United States Steel Corp..........	Specular hematite from open-pit mine (31.7% Fe)	Specular hematite concentrate (64.4% Fe)	—	1,240
Steep Rock Iron Mines Ltd.; Steep Rock Lake N. of Atikokan, Ont.	Premium Iron Ores Ltd.; Cleveland-Cliffs Iron Co., The; and others	Hematite-goethite from open-pit and underground mines (40.5-52.91% Fe)	Direct-shipping ores and gravity concentrate (51.9–55.1% Fe)	1,586	1,214
Texada Mines Ltd.; Texada Island, B.C.	Private company.................	Magnetite from open-pit mine (41.20% Fe)	Magnetite concentrate (61.42% Fe)	374	446
Wabana Mines Division; Bell Island, Conception Bay, E. coast of Newfoundland.	Dominion Steel and Coal Corp., Ltd.	Hematite-chamosite from underground and open-pit mines (49.8% Fe)	Heavy-media concentrate (50.38%)	2,808	2,292
By-product Producers					
Consolidated Mining and Smelting Co. of Canada Ltd., The, Kimberley, B.C.	—	Pyrrhotite flotation concentrates roasted for acid production. Calcine pelletized and sintered (65.4% Fe)	Iron-oxide pellets (65.0% Fe) further processed into pig iron at plant	—	41
International Nickel Co. of Canada, Ltd., The; mines and plant in Sudbury area of Ontario.	—	Pyrrhotite flotation concentrates treated	Iron-oxide pellets (68% Fe)	192	231
Noranda Mines, Ltd.; mines near Noranda, Que.; plant at Cutler, Ont.; Port Robinson, Ont., plant shut down in 1959	—	Pyrrhotite and pyrite flotation concentrates treated	Iron-oxide calcine (64–66% Fe)	106[3]	57[3]
Quebec Iron and Titanium Corp.; mine in Allard Lake area, Que.; electric smelter at Sorel, Que.	Kennecott Copper Corp., New Jersey Zinc Co., The	Ilmenite-hematite from open-pit mine (40% Fe, 35% TiO^2)	TiO^2 slag and various grades of desulphurized iron or 'remelt iron'	864[4]	1,032[4]

SOURCES: Company reports, personal communications and others.

[1]Statistics supplied by the companies to the Mineral Resources Division. For many companies, the 1961 tonnages shown are only preliminary estimates, and provincial totals will not necessarily correspond.

[2]Under the lease agreement with Hollinger North Shore Company Limited and Labrador Mining and Exploration Company Limited, Iron Ore Company of Canada mines ore for the account of the two concession companies, and this ore is here included in the totals. In 1961, the shipments amounted respectively to 609,454 and 816,764 tons.

[3]Production.

[4]Ilmenite ore consumed.

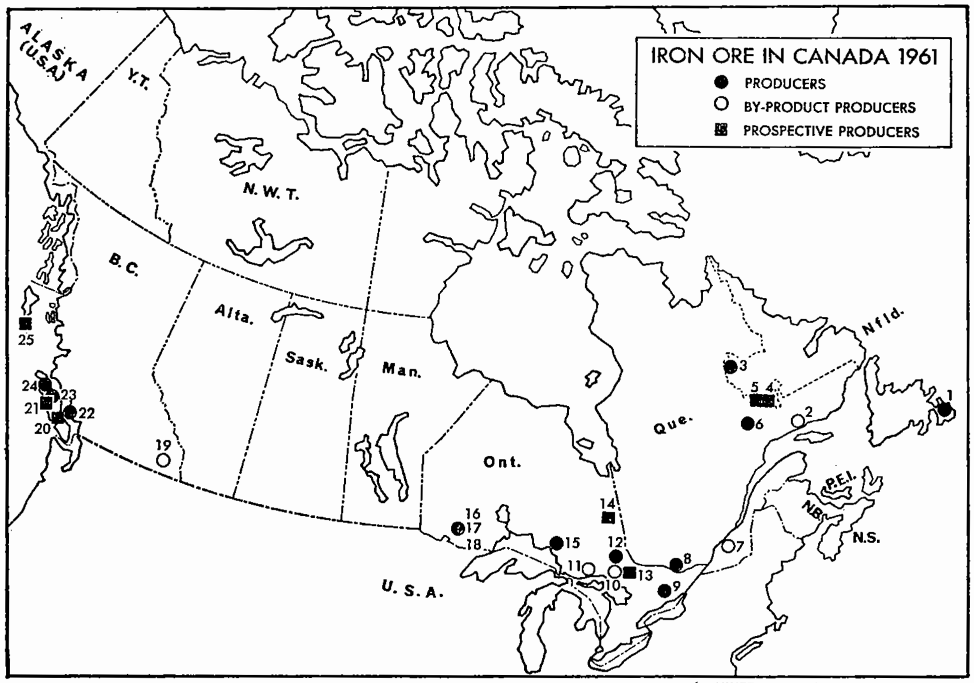
TABLE 7

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
Carol Pellet Company (mid-1963)	Adjacent to Iron Ore Co. of Canada's concentrator, Labrador City, Lab.	As for Iron Ore Co. of Canada with exception of Hollinger Cons. Gold Mines Ltd.	Company's plant to be operated by Iron Ore Company of Canada to process concentrate into pellets	Pellets (64–65% Fe)	5.5 million long tons
Iron Ore Co. of Canada (mid-1962)	Labrador City, Lab., 190 miles N. of Sept Iles, Que.	As in preceding table	Specular-hematite iron formation from open-pit mines (37–38% Fe)	Concentrate (64–65% Fe)	7,000,000 long tons (5,500,000 long tons to be pelletized, starting in 1963)
Jedway Iron Ore Ltd. (1962)	Moresby Island, Queen Charlotte Islands, B.C.	The Granby Mining Co. Ltd.	Magnetite from open-pit mine (51.9% Fe)	Magnetite concentrate (plus 60% Fe)	400,000 long tons
Jones & Laughlin Steel Corp. (1964)	Boston tp., near Kirkland Lake, Ont.	—	Magnetite iron formation from open-pit mine (25% Fe)	Pellets (65–66% Fe)	1,000,000 long tons
Noranda Exploration Co., Ltd. (1962)	Kennedy Lake, W. coast of Vancouver Island, B.C.	Noranda Mines, Ltd.	Magnetite from open-pit mine (plus 50% Fe)	Magnetite concentrate (plus 60% Fe)	700,000 long tons
Wabush Mines, Pickands Mather & Co., managing agent, (1964–65)	Wabush Lake, near Labrador City, Lab., 190 miles N. of Sept Iles	At Nov. 1, 1961: Steel Co. of Canada, Ltd.; Dom. Foundries and Steel, Ltd.; Mannesmann Canadian Iron Ores Ltd.; Hoesch Iron Ores Ltd. and Wabush Iron Co. Ltd. (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 possibly pellets (64–65% Fe)	5,500,000 long tons (test shipments of concentrate: 1960, 42,000 long tons; 1961, 55,000 long tons)

Zeballos Iron Mines Ltd. (1962)	Near Zeballos, W. coast of Vancouver Island, B.C.	International Iron Mines Ltd.	Magnetite from open-pit (48% Fe)	Magnetite concentrate (plus 60% Fe)	500,000 long tons
By-product Producers					
Falconbridge Nickel Mines, Ltd.	Mines and plant in Sudbury area, Ont.	—	Pyrrhotite flotation concentrates to be used	Iron oxide (67–68% Fe)	100,000 long tons
International Nickel Co. of Canada, Ltd., The (1963)	Mines and plant in Sudbury area of Ontario	—	Pyrrhotite flotation concentrates to be used	Iron-oxide pellets (68% Fe)	Capacity to be increased to 750,000 long tons

SOURCES: Company reports, personal communications and others.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Producers

Algoma Steel Corporation, Limited, The (Algoma Ore Properties Division)	15
Caland Ore Company Limited	16
Canadian Charleson, Limited	17
Dominion Steel and Coal Corporation, Limited (Wabana Mines Division)	1
Empire Development Company, Limited	24
Hilton Mines, Ltd.	8
Iron Ore Company of Canada	3
Lowphos Ore, Limited	12
Marmoraton Mining Company, Ltd.	9
Nimpkish Iron Mines Ltd.	23
Quebec Cartier Mining Company	6
Steep Rock Iron Mines Limited	18
Texada Mines Ltd.	22

By-product Producers

Consolidated Mining and Smelting Company of Canada Limited, The	19
International Nickel Company of Canada, Limited, The (mines and plant)	10
Noranda Mines, Limited (plant)	11
Quebec Iron and Titanium Corporation (mine)	2
Quebec Iron and Titanium Corporation (plant)	7

Prospective Producers (by 1965)

Falconbridge Nickel Mines, Limited (1962)	13
Iron Ore Company of Canada (1962)	5
Jones & Laughlin Steel Corporation (1964)	14
Noranda Exploration Company, Limited (1962)	20
Jedway Iron Ore Limited (1962)	25
Wabush Iron Co. Limited (1964-65)	4
Zeballos Iron Mines Limited (1962)	21

bring one or more of them into production as a separate operation. The amount produced by Iron Ore Company at Schefferville for Labrador Mining increased from 622,955 tons in 1960 to 816,764 tons in 1961.

Quebec

On July 4, when it made its first ore shipment, Quebec Cartier Mining Company completed a construction and mine-development program in two and a half years that cost $250 million. Sometime in 1962, the company expects to be producing at a rate equivalent to 8 million tons of concentrate a year. The main projects in its program were; the development of a 300-million-ton deposit for production at the rate of 20 million tons of crude ore (30 per cent iron) a year; the erection of a concentration plant—one of the world's largest—to treat 60,000 tons of crude ore a day; the building of a 193-mile railway; the excavation of a deep-sea harbor from solid rock; and the establishment of a 60,000-horsepower hydroelectric plant and two towns—Port Cartier and Gagnon. In addition to the completion of railway ballasting and housing and other construction work, two major projects are conceivable within the next few years. They are the building of a pellet plant to treat some of the concentrate produced and the opening of a new mine to keep the concentrator provided with crude ore as the flexibility of mining at the Lac Jeannine deposit declines.

Quebec Iron and Titanium Corporation operated its Lac Tio mine at a record rate and the 1962 outlook for shipments of ilmenite to the Sorel smelter is encouraging. The markets for titania slag and 'remelt iron' have strengthened considerably within the last two years. The iron market will be further strengthened when Atlas Steels Limited completes, at Sorel, a new electric-furnace plant for the production of stainless steel from molten iron.

Hilton Mines, Ltd., continued to operate its mine and beneficiation plant at a near-capacity rate. The addition of new units increased this capacity from 600,000 tons a year in 1960 to 800,000 in 1961.

Throughout the province there were many companies with properties of varying merit, but exploration was at a low ebb and no new production plans were formulated. The condition of a few deposits is such that decisions to proceed with production could be imminent. Marketing and financing are the main problems.

Ontario

At Wawa, Algoma Ore Properties Division of The Algoma Steel Corporation, Limited, opened its new MacLeod mine to replace the Helen mine. The MacLeod mine, which Algoma Ore Properties began to develop in 1951, extends beneath and east of the Helen and Victoria mines.

It has been opened on three levels and goes to a depth of 2,000 feet. The $20-million project included the following: the mine; a 1-mile aerial ropeway that brings the ore up a 22-degree slope to the surface and an additional 2 miles of ropeway to the beneficiation plant; a doubling in the capacity of the heavy-media concentration plant; the closing of an old heavy-media plant; and the erection of heavy-media cyclone facilities to treat ore fines.

The shipments made by Steep Rock Iron Mines Limited from the Steep Rock Lake area, 140 miles west of Port Arthur, were about as low as in the 1949-54 period. The company expects that the market, having improved, will require 1.5 million tons in 1962. The 'G' open pit was in the last stages of development in preparation for mining, scheduled to start in 1962. The Hogarth open pit, nearing exhaustion, was not expected to be very productive. The Errington underground mine continued as a year-round operation. Only one of the two concentrators was in service, and development work at the Hogarth underground mine was suspended. Research work on Steep Rock ore continued, as did exploration and laboratory testing of the company's Lake St. Joseph deposit.

Canadian Charleson, Limited, two miles south of Steep Rock Lake, did not operate its mine and concentration plant, although small shipments were made from the stockpile. Early in the year, Oglebay Norton Company of Cleveland gained control of the company from Charleson Iron Mining Company of Hibbing, Minnesota.

In 1960, Caland Ore Company Limited began to produce from newly developed mines in the drained east arm of Steep Rock Lake, the Lime Point mine being sole producer. Production started at the Mink Point mine on July 31, 1961. A rock fall in May rendered the Lime Point crushing station inoperative for seven weeks but did not impair the year's scheduled output.

The open-pit mine and concentrator of Lowphos Ore, Limited, operated smoothly throughout the year, production in several months exceeding the rated capacity, which is 550,000 tons a year.

Marmoraton Mining Company, Ltd., operated near capacity for most of the year. For the first time, sizable shipments of pellets were made to the Canadian steel industry. Previously, all the company's shipments went to Lackawanna, New York.

The International Nickel Company of Canada, Limited, proceeded with its plans to triple its present plant capacity by 1963 to about 800,000 tons of high-grade, iron-oxide pellets a year. The plant would then treat 1.2 million short tons of nickeliferous pyrrhotite concentrate a year in its iron-ore plant.

Falconbridge Nickel Mines, Limited, proceeded with plans to convert its by-product iron-ore plant to commercial operation by early 1962. Elsewhere in Ontario, several companies with properties in various stages of exploration and development continued to evaluate the economic and technical feasibility of producing and marketing iron ore and various iron-ore products.

Early in 1962, Jones & Laughlin Steel Corporation announced plans for a $30-million iron-ore-pellet project in Boston township, near Kirkland Lake, Ontario. Initial production at the rate of 1 million tons a year is scheduled for 1964. The decision to start construction has been pending for about three years.

Prairie Provinces

In Saskatchewan, Interprovincial Steel and Pipe Corporation Ltd. and Kelsey Lake Development Company Limited, holders of ground underlain by a continuous deposit of concentrating-grade iron formation beneath 2,000 feet of younger sedimentary rocks, have extensively studied the feasibility of producing iron ore and sponge iron but have initiated no development or production plans.

In northwestern Alberta, Premier Steel Mills Ltd. continued its detailed program, begun in 1959, of evaluating all aspects of the utilization of its Peace River deposits. In 1960, it shipped 4,800 tons of material to Alabama for testing in the R-N process, and in 1961 it sent some of the resulting R-N briquettes to Japan for further testing. If a Japanese market develops, the company will build an iron-ore-reduction plant at the minesite. It is considering the building of a 400-mile pipeline to the west coast, where a second plant would be needed to briquette the fine, reduced iron, and is also studying rail transportation of briquetted iron.

British Columbia

Empire Development Company, Limited, Nimpkish Iron Mines Ltd. and Texada Mines Ltd. were this province's iron-ore producers in 1961. The Consolidated Mining and Smelting Company of Canada Limited, began to produce by-product iron ore from the residues of its sulphuric-acid operations at Kimberley. The ore was smelted in a new electric-furnace plant.

In 1962 the deposits operated by Empire and Nimpkish will be nearly depleted, but it is expected that deposits being developed by three other companies will go into production about the same time, thus assuring the continued growth of the province's iron-ore output, at least for the next few years.

Noranda Mines, Limited, continued with a $5-million to $6-million program that includes mine development and the building of a concentrator, a 7-mile haulage road and dock and ship-loading facilities. A company contract with Japanese steel interests requires the sale of 5 million tons of concentrate over a seven-year period.

International Iron Mines Ltd. holds a contract with Japanese steel firms for the shipment, in a six-year period, of 3 million tons of concentrate. Development involves the expenditure of more than $2 million and includes mine development and the construction of a concentrator, a difficult 3.5-mile mine-access road, an inclined tramline and dock and ship-loading facilities.

Jedway Iron Ore Limited is developing for production the property formerly held by Silver Standard Mines Limited. Its contract with Japanese interests calls for the delivery of 2 million tons of concentrate over a four-year period. The initial capital expenditures are expected to approach $4.5 million.

PRICES AND TARIFFS

The prices in Table 8 have been in effect since early in 1957, the year of the last increase. Prices for ore shipments made to Canadian and United States consumers traditionally reflect the Lake Erie price, which is that paid per long ton of iron ore delivered at rail of vessel in Lake Erie ports. The Canadian mine price can be estimated by deducting the appropriate handling, rail and boat 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.

The increases that have taken place in production costs, many of them not offset by an increase in productivity, would ordinarily result in an increase in iron-ore prices. Early in 1961, however, it was announced that a decrease—the first to affect the Lake Erie base price since 1940—had reduced the price of normal-grade Lake Superior ores by 80 cents a ton. Since, from the point of view of producer-consumer relationships, much of the North American market is 'captive', prices in North America are less affected by supply and demand than those encountered in overseas markets.

TABLE 8

LAKE ERIE BASE PRICES, 1957-61

Iron-ore Class	$ U.S.	
	Per Long Ton	Per Unit
Mesabi: Non-Bessemer	11.45	0.222
Bessemer	11.60	0.225
Old Range: Non-Bessemer	11.70	0.227
Bessemer	11.85	0.230

SOURCE: *Cliffs Iron Ore Analyses 1962*, The Cleveland-Cliffs Iron Company, Cleveland, Ohio.

Neither Canada nor any country with which it trades maintains tariffs on iron ore. In January 1959, the United States Tariff Commission held public hearings on competition and the effects of iron-ore imports on the United States iron-mining industry. At the time, no opposition to imports was voiced, but in October 1960 the Commission held public hearings to determine whether, owing to the customs treatment accorded under the General Agreement on Tariffs and Trade, iron-ore imports had seriously injured the domestic iron-mining industry. If the Commission had found evidence of 'serious injury,' it would have been bound to recommend restrictive measures against imports. Early in 1961, however, it ruled that iron-ore imports had not injured the domestic industry. Since then, various Senate committees have been under pressure to inaugurate one or more forms of protection against imports, such that the situation, although not critical, should be noted.

Lead

J. W. Patterson*

For 1961, the recoverable lead content of ores and concentrates exported and the metal produced from domestic ores totalled 230,435 short tons, having increased from 205,650 tons, their total for 1960. The gain was due, in part, to the increase in metal production that occurred at Canada's only lead smelter and electrolytic refinery, operated by The Consolidated Mining and Smelting Company of Canada Limited (Cominco) at Trail, British Columbia. Refinery production increased by 13,322 tons—from 158,510 in 1960 to 171,832 in 1961.

Little change took place in the production of the other provinces and Yukon Territory. Their combined output fell for the year to 37,635 tons from the 38,703 tons produced in 1960. Increases in Quebec and Manitoba were more than offset by decreases in Newfoundland and Yukon Territory. Output from Ontario—the smallest producer—remained about the same.

Canada's total production, reckoned according to a recently adopted system of reporting, which is based on the lead content of the ore and concentrates produced rather than on exports and bullion production, was 182,557 tons in 1961, having decreased from the 212,229 tons produced in 1960.

Cominco treated most of the lead concentrates from British Columbia and Yukon Territory at its Trail smelter and refinery. American Smelting and Refining Company and The Bunker Hill Company treated the remainder at plants in the United States. Lead concentrates produced in the eastern provinces, including Manitoba, were exported to smelters in Europe and the United States, most going to Europe. As in previous years, the main customers for Canada's lead ores and concentrates during 1961 were Belgium and Luxembourg, the United States and West Germany. During the year, exports totalled 70,967

*Mineral Resources Division.

tons; in 1960, their total was 51,336 tons. Of these exports, United States smelters received 48.6 per cent, Belgian and Luxembourg smelters 33.8 per cent, West German smelters 17.2 per cent and smelters in other countries 0.4 per cent. Most of the increase was attributable to a rise of 12,555 tons in shipments to Belgium and Luxembourg. Comparison of 1961 with 1960 showed that Canada's exports of lead metal had increased from 96,449 tons to 117,637 and that most of the increase had gone to the United States, India and the Netherlands. Exports to Britain dropped drastically—from 54,032 tons to 42,538.

Trends in Canada's lead output, exports and consumption are shown in the graph.

The slight increase that occurred in the consumption of primary and secondary lead combined—to 73,418 tons from the 72,087 consumed in 1960—is attributable largely to an increase in the use of primary lead in the manufacture of storage batteries, lead pigments and such semifinished products as pipe, sheet, traps, bends, etc.

Manufacturers of storage batteries and tetraethyl lead have reported that lead consumption in the United States, Canada's principal market, increased substantially in 1961. These increases and others were partially offset by decreases in the lead used in the manufacture of bearing metal, solder, red lead, litharge, and pipes, traps and bends. The year's consumption of lead in the United States totalled 1,022,300 tons, or slightly more than 1,021,172 tons consumed in 1960.

UNITED STATES QUOTAS

On October 1, 1958, the United States government placed annual quotas on imports of unmanufactured lead and zinc for consumption. Under these quotas, Canada's quarterly allotments are 7,960 tons of lead metal and 6,720 tons of lead contained in concentrates. As in 1959 and 1960, all quarterly allotments for lead were filled.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group, organized in 1959 under United Nations sponsorship, held two meetings in 1961, the first in Mexico City, from March 20 to 24, and the second in Geneva, from October 18 to 24. At the March meeting, the Group estimated that the year's lead production would be about equal to the current demand but that world stocks of lead were abnormally high. The United States offered to barter surplus agricultural products for lead stocks accumulated outside the United States by several major producers before January 1, 1961. This was to bring the total supply more into line with demand. Barter contracts completed by the end of August involved 100,000 tons of lead from stocks.

At the Mexico City meeting, certain countries suggested that more attention be given to long-term problems affecting the lead and zinc industries. Accordingly a special 11-country working group was set up to make a preliminary examination of the problems of these industries and of possible solutions. Its report was presented in October at the meeting in Geneva, where a further statistical review was made of lead and zinc supply and demand and of the outlook for 1962. The Group announced that for lead it expected an approximate balance between demand and new supplies through the first quarter of 1962 and for zinc a similar balance through the first half of 1962.

LEAD—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
British Columbia	192,800	39,369,815	166,947	35,659,900
Newfoundland	21,969	4,485,938	24,022	5,131,091
Yukon Territory	8,385	1,712,198	10,143	2,166,638
Quebec	3,392	692,694	2,670	570,195
Manitoba	3,054	623,558	1,037	221,574
Ontario	835	170,562	831	177,490
Nova Scotia	—	—	—	—
Total	230,435	47,054,765	205,650	43,926,888
Mine output[2]	182,557		212,229	
Refined[3]	171,832		158,510	
Exports				
In ores and concentrates				
United States	34,525	4,713,789	26,895	4,928,731
Belgium and Luxembourg	24,001	2,911,276	11,446	1,970,536
West Germany	12,177	1,464,902	12,220	2,024,806
Japan	210	32,613	775	162,666
Taiwan	33	4,543	—	—
Britain	21	4,864	—	—
Total	70,967	9,131,987	51,336	9,086,739
In pigs, blocks and shot				
Britain	42,538	5,817,023	54,032	8,385,574
United States	55,947	9,635,247	28,866	5,476,005
Japan	6,676	1,000,029	10,380	1,598,054
India	5,749	800,637	811	123,225
Netherlands	4,508	618,426	588	90,492
Taiwan	617	95,227	760	115,965
Other countries	1,602	223,364	1,012	168,779
Total	117,637	18,189,953	96,449	15,958,094
Lead and lead-alloy scrap				
United States	2,381	249,282	5,657	782,663
Jamaica	30	2,485	52	3,120
West Germany	10	1,000	—	—
Britain	72	16,151	943	135,204
Other countries	13	3,473	35	76,882
Total	2,506	272,391	6,687	997,869
Lead-fabricated materials not elsewhere specified				
United States	411	125,382		65,355
Colombia	16	5,268		3,022
Nicaragua	7	4,417		—
Other countries	12	4,835		28,609
Total	446	139,902		96,986

LEAD—PRODUCTION, TRADE AND CONSUMPTION (*conc.*)

	1961		1960	
	Short Tons		Short Tons	
Imports				
Lead in pigs and blocks	1,121	238,064	620	150,277
Lead in bars and sheets	63	17,848	45	12,066
Litharge	511	155,184	626	186,557
Lead manufactures		335,826		276,974
Miscellaneous lead products		279,571		255,396
Total		1,026,493		881,270
Consumption				
Primary lead				
Antimonial lead	1,072		256	
Batteries and battery oxides	16,427		12,309	
Cable covering	4,204		4,980	
Chemical uses (white lead, red lead, litharge, tetraethyl lead, etc.)	13,442		11,828	
Copper alloys (brass, bronze, etc.)	245		307	
Lead alloys				
Solders	1,637		1,562	
Other (including babbitts, type metal, etc.)	566		248	
Semifinished products (pipe, sheet, traps, bends, block for caulking, ammunition, foil, collapsible tubes, etc.)	9,155		7,779	
Other	2,017		966	
Total	48,765		40,235	
Secondary lead				
Antimonial lead	14,422		19,115	
Batteries and battery oxides	339		349	
Cable covering	1,868		1,591	
Chemical uses (white lead, red lead, litharge, tetraethyl lead, etc.)	1,649		1,803	
Copper alloys (brass, bronze, etc.)	91		142	
Lead alloys				
Solders	1,339		1,860	
Others (incl. babbitts, type metal, etc.)	1,957		3,985	
Semifinished products (pipe, sheet, traps, bends, block for caulking, ammunition, foil, collapsible tubes, etc.)	1,730		1,805	
Other	1,258		1,202	
Total	24,653[4]		31,852[4]	
Consumption summary				
Primary lead	48,765		40,235	
Secondary lead	24,653		31,852	
Total	73,418		72,087	

SOURCE: Dominion Bureau of Statistics.

[1] Lead content of base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus the estimated recoverable lead in domestic ores and concentrates exported.

[2] Lead content of domestic ores and concentrates produced.

[3] Primary refined lead from all sources.

[4] Includes all remelt scrap lead and scrap lead used to make antimonial lead.

LEAD—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

(short tons)

	Production		Exports			Imports	Consumption
	All Forms[1]	Refined[2]	In Ore and Concentrates	Refined	Total	Refined[3]	Refined[4]
1951	158,231	162,000	19,648	105,736	125,384	727	60,348
1952	168,842	182,943	23,967	129,740	153,707	355	62,466
1953	193,706	165,752	61,683	102,879	164,562	255	67,718
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	171,832	70,967	117,637	188,604	1,121	73,418

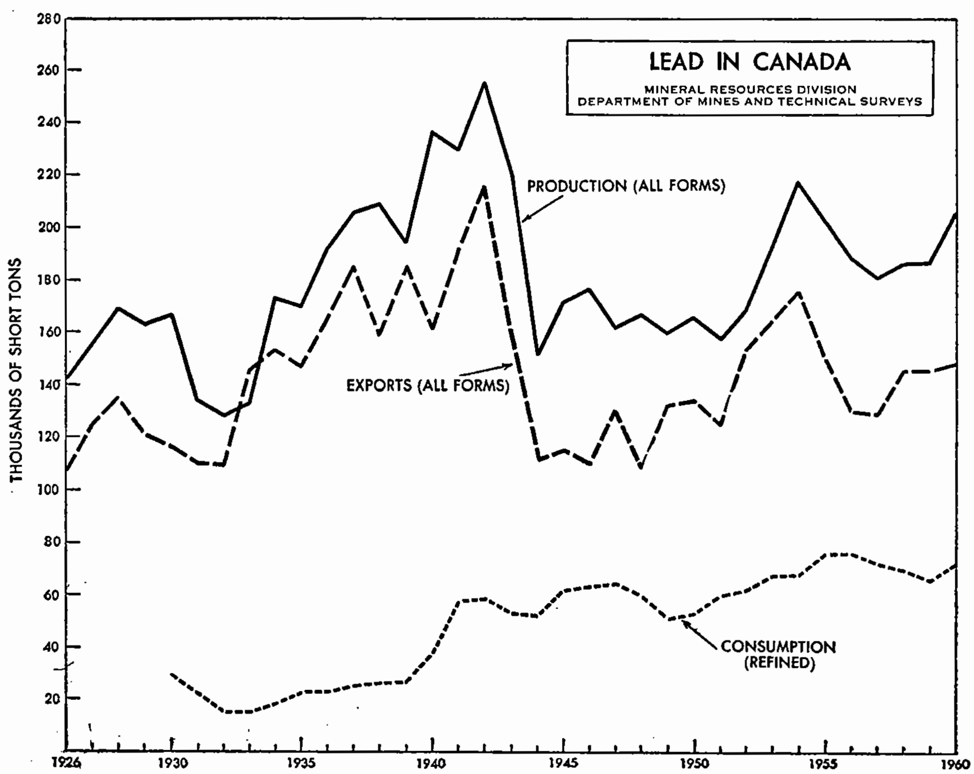
Source: Dominion Bureau of Statistics.

[1]Lead content in base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable lead in domestic ores and concentrates exported.

[2]Primary refined lead from all sources.

[3]Lead in pigs and blocks.

[4]Refined lead, both primary and secondary in origin. Prior to 1960 all scrap lead consumed was not reported.



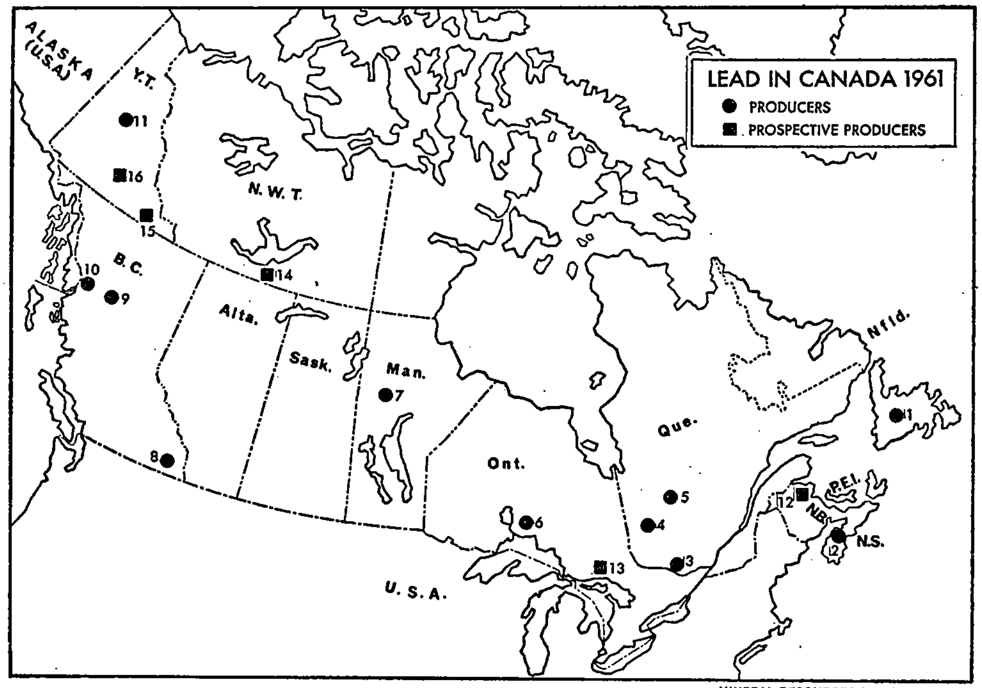
PRINCIPAL LEAD PRODUCERS IN CANADA, 1961

Company	Mine	Location	Mill Capacity (short tons/ day)	Grade of Ore				Ore Produced 1961 (short tons)	Ore Produced 1960 (short tons)	Lead Produced 1961 (short tons)
				Lead (%)	Zinc (%)	Copper (%)	Silver (oz/ton)			
Yukon Territory										
United Keno Hill Mines Limited[1]	Calumet	Mayo district	500	5.83	4.84	—	41.16	186,116	176,745	8,956
	Elsa	Mayo district								
	Hector	Mayo district								
British Columbia										
Consolidated Mining and Smelting Company of Canada Limited, The	Sullivan	Kimberley	10,000	*	*	*	*	2,461,695	2,522,554	106,333
	Bluebell	Riondel	700	*	*	*	*	252,821	255,571	11,223
	H.B.	Salmo	1,200	*	*	*	*	472,731	464,408	3,650
Canadian Exploration, Limited	Jersey	Salmo	1,900	2.22	4.53	—	*	374,032	364,424	7,730
Mastodon-Highland Bell Mines Limited	Highland-Bell	Beaverdell	70	2.09	2.66	—	47	18,953	18,204	377
Reeves MacDonald Mines Limited	Reeves MacDonald	Remac	1,000	1.39	4.25	—	*	420,508	411,282	4,905
Sheep Creek Mines Limited	Mineral King	Toby Creek	500	2.43	5.96	*	1.22	211,010	194,607	4,963
Manitoba										
Hudson Bay Mining and Smelting Co., Limited	Chisel Lake	Snow Lake	[2]	1.6	15.3	0.46	2.45	271,877	104,903	3,214
Ontario										
Geco Mines Limited	Geco	Manitouwadge	3,300	*	3.99	1.54	1.52	1,276,778	1,294,077	403
Willroy Mines Limited	Willroy	Manitouwadge	1,200	0.21	6.68	1.34	1.74	421,772	429,309	497
Quebec										
Coniagas Mines, Limited, The[3]	Coniagas	Bachelor Lake	325	1.73	17.75	—	9.15	79,826	0	668
Manitou-Barvue Mines Limited[4]	Golden Manitou	Val d'Or	1,300	0.76	5.88	—	5.67	162,860	164,690	1,036
New Calumet Mines Limited[1]	New Calumet	Calumet Island	750	2.00	7.31	—	4.08	96,872	100,463	1,877
Nova Scotia										
Magnet Cove Barium Corporation	Magnet Cove	Walton	125	6.92	4.42	0.51	14.73	9,333	0	591
Newfoundland										
American Smelting and Refining Company (Buchans Unit)	Buchans	Buchans	1,250	7.38	12.88	1.11	4.59	387,000	386,000	27,523

SOURCE: Mineral Resources Division.
[1]Production for the fiscal year ending on September 30, 1961.
[2]Chisel Lake ore is concentrated at the 6,000-ton Flin Flon mill.
[3]Production started in March 1961.
[4]Manitou-Barvue also mills copper ore in a separate circuit. In 1961, the copper content of this ore was 1.18 per cent.
—Not recovered, if present.
*Not available.

PRODUCING MINES*

As shown in the table, a few mines accounted for most of the production, the most important being Cominco's Sullivan mine at Kimberley, British Columbia, which produced about 46 per cent of the total. Other important sources were the Buchans mine in Newfoundland, Cominco's Bluebell mine and Canadian Exploration's Jersey mine, Reeves MacDonald's mine and Sheep Creek's mine, all in southeastern British Columbia, Hudson Bay's Chisel Lake mine, in Manitoba, and United Keno Hill's mines, in Yukon Territory. These mines, together with the Sullivan, produced 174,847 tons, or about 76 per cent of Canada's output.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRODUCERS†

1. American Smelting and Refining Company (Buchans Unit)
2. Magnet Cove Barium Corporation
3. New Calumet Mines Limited
4. Manitou-Barvue Mines Limited
5. Coniagas Mines, Limited, The
6. Geco Mines Limited
   Willroy Mines Limited
7. Hudson May Mining and Smelting Co., Limited (Chisel Lake mine)
8. Canadian Exploration, Limited
   Consolidated Mining and Smelting Company of Canada Limited, The (also lead smelter and lead refinery)
   Bluebell mine
   H. B. mine
   Sullivan mine
   Mastodon-Highland Bell Limited
   Reeves MacDonald Mines Limited
   Sheep Creek Mines Limited
   ViolaMac Mines Limited
   Western Exploration Company Limited
9. New Cronin Babine Mines Limited
10. Silbak Premier Mines Limited
11. United Keno Hill Mines Limited

PROSPECTIVE PRODUCING AREAS

12. Bathurst
13. Sudbury basin
14. Great Slave Lake
15. Watson Lake
16. Pelly River

*See map.
†Omitted are several producers, most of which are in British Columbia.

The Chisel Lake mine is a relatively new producer, having started on September 1, 1960, at 1,000 tons a calendar day. In Ontario, Geco Mines Limited added a lead-concentrate recovery circuit to its mill in July and then produced 788 tons of lead concentrate before the end of the year. Quebec's increase in output was due to production from a lead-zinc-silver mine at Bachelor Lake, northeast of Senneterre. This mine, with its 325-ton mill, was placed in production in March by The Coniagas Mines, Limited. When Magnet Cove Barium Corporation began to produce a bulk lead-zinc-silver concentrate late in the year at the Magnet Cove mine at Walton, the province of Nova Scotia became a producer of lead for the first time since Mindamar Metals Corporation Limited* ceased mining operations at Stirling, Cape Breton Island, in April 1956. Magnet Cove's mill capacity is 125 tons a day.

Other British Columbia mines that produced in 1961 include the Black Fox, Kootenay Belle, Ottawa and Utica and those owned by Western Exploration Company Limited, and ViolaMac Mines Limited, all in the Slocan area. Silbak Premier Mines Limited and New Cronin Babine Mines Limited produced high-grade ores, the former at the Premier mine, north of Prince Rupert, near Stewart, and the latter at the New Cronin Babine mine, near Smithers, about mid-way between Prince George and Prince Rupert.

OTHER DEVELOPMENTS

British Columbia

Late in 1961 Dolly Varden Mines Ltd. announced that it would start development of the Dolly Varden, North Star and Wolf silver-lead-zinc mine properties in the upper Kitsault valley, near Alice Arm, north of Prince Rupert. The Dolly Varden property adjoins that of Torbrit Silver Mines Limited, which, during the period 1949 to 1959, produced more than 18 million ounces of silver and 5,000 tons of lead. Late in the year, Western Mines Limited reported encouraging exploration results on its Buttle Lake copper-lead-zinc-silver property on Vancouver Island.

New Brunswick

Brunswick Mining and Smelting Corporation Limited announced in July that the copper-lead-zinc properties it owns in the Bathurst area will be brought into production at a rate of 3,000 tons of ore a day. East Coast Smelting and Chemical Company Limited, recently formed, will erect a smelter to treat the lead and zinc concentrates. Construction of the concentrator is planned for 1962; construction of the smelter is not expected to begin until 1963. Late in the year, also in the Bathurst area, Heath Steele Mines Limited, began to prepare its mill to produce at 1,500 tons a day early in 1962. Half of the mill feed was to be copper ore from Cominco's Wedge mine; the remainder was to be copper-lead-zinc ore from the Heath Steele mine. Other companies active in the Bathurst area included The Anaconda Company (Canada) Ltd., Anacon Lead Mines Limited and New Jersey Zinc Exploration Company (Canada) Ltd.

Northwest Territories

The completion in November of the location survey for a 438-mile railway from Grimshaw, northwestern Alberta, to Great Slave Lake, in the Northwest Territories, was followed by a call for right-of-way clearance tenders by the Canadian National Railway Company. Completion of the line will enable Pine Point Mines Limited, a Cominco subsidiary, to begin production at its large high-grade lead-zinc deposits at Pine Point on Great Slave Lake.

*This name was changed on September 14, 1961, to United Mindamar Metals Limited.

USES

The main industrial applications and the tonnages used in each are shown on pages 3 and 4.

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, 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 paints and tetraethyl lead.

Among more recent developments, some of which may eventually result in an appreciable increase in lead consumption, is the use of lead in jetliners and buildings as a sound barrier, in skyscraper foundations as a vibration absorber, in the mounting of certain types of operating equipment such as air-conditioning systems, in which control of vibration is important, in lead-alloy anodes in impressed-current cathodic systems for the protection of bridges, piers and ship's hulls against corrosion, in reactor installations as shielding against nuclear radiation, and in containers for storing and shipping radioactive substances.

Canada's principal consumers of lead include: The Canada Metal Co., Limited; Electric Storage Battery Company (Canada) Limited; Ethyl Corporation of Canada Limited; Federated Metals Canada Limited; General Motors of Canada Limited; Hart Battery Company (1957) Limited; Prest-O-Lite Battery Co., Limited; Toronto Refiners & Smelters Limited.

WORLD PRODUCTION OF LEAD

The countries in the following table are the world's leading producers of refined lead. Omitted are the countries of the Soviet bloc, which in 1961 produced some 628,100 tons.

PRODUCTION OF REFINED LEAD, BY PRINCIPAL PRODUCING COUNTRIES

(short tons)

	1961	1960
United States[1]	461,047	409,258
Australia	237,375	268,152
West Germany[2]	224,447	227,948
Mexico	209,839	183,701
Canada	171,832	158,510
Belgium	110,109	102,189
France	107,571	121,086
Yugoslavia	99,649	98,262
Spain	85,068	78,262
Japan[2]	91,803	81,783
Peru	84,312	81,726
Italy	49,769	48,056
Sweden	42,745	49,112
Argentina	29,200	32,400
Morocco	26,994	33,870
Tunisia	21,816	21,215
Burma	17,830	19,093
Northern Rhodesia	16,955	16,419
Austria	12,783	12,900
Total	2,101,144	2,043,942

Source: American Bureau of Metal Statistics.
[1]Includes metal derived from imported ores and base bullion, and metal derived from scrap at primary refineries.
[2]Includes some metal derived from scrap.

PRICES

During 1961, the price of lead was 10 cents a pound until June 28, when it increased to 10.50 cents. The price remained unchanged until November 13, when it declined to its former level of 10 cents. This decline was followed on November 29 by an advance to the year-end price of 10.25 cents.

TARIFFS

Canadian tariffs on ore and concentrates and certain semifabricated forms were as follows:

	British Preferential	Most Favored Nation	General
Lead ores and concentrates	free	free	free
Pig-lead scrap and blocks	0.75¢ lb	1¢ lb	1¢ lb
Lead bars and sheets	15%	22½%	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 was 0.75 cent a pound. On pig lead, lead bullion, scrap lead and various lead alloys, it was 1.0625 cents a pound on the lead content. Varying tariffs were applied to imports of lead in other forms.

Lime

J. S. Ross*

For the second consecutive year, lime production has fallen considerably. In 1961 it was at its lowest since 1957. The decrease occurred largely because the lime requirements of the Ontario uranium industry were about half those of 1959. During the same two years, the total of lime shipments for other industries was also falling. In 1961 there were no major changes in production facilities.

In the year under review, while the lime industry was at about half its rated capacity, shipments amounted to 1,415,290 tons valued at $19,217,371, or 8 per cent less in volume than in 1960. Of this, 1,142,354 tons were high-calcium, magnesian and dolomitic quicklime and 272,936 tons were the hydrated counterparts. All provinces except Ontario and New Brunswick registered small increases over their 1960 tonnages. Ontario's decrease amounted to 13 per cent of that province's 1960 output. In 1960 and 1961, production in all provinces was virtually constant except in Ontario, where there were large reductions.

Exports are small and go mainly to areas of the United States that are more favorably situated in relation to Canadian plants. Imports are greater in quantity than exports and consist partly of special types not produced in Canada.

PRODUCTION

Both quicklime, the oxide, and hydrated lime, the hydroxide, are produced in Canada. The bulk is of high-calcium quicklime containing not less than 90 per cent calcium oxide and up to 5 per cent magnesia. Dolomitic quicklime containing 25 to 45 per cent magnesia and small amounts of magnesian quicklime are also produced. The hydrated counterparts of each type are obtainable.

Suitable limestone for the manufacture of lime is available in surface deposits in all provinces except Prince Edward Island. Lime production, however, is nonexistent not only in Prince Edward Island, but also in Nova Scotia, Newfoundland and Saskatchewan. About 90 per cent of the output is supplied by Ontario and Quebec. The high-calcium type is made in all producing provinces, and dolomitic lime is obtained from Manitoba and Ontario and occasionally from New Brunswick.

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* Mineral Processing Division, Mines Branch.

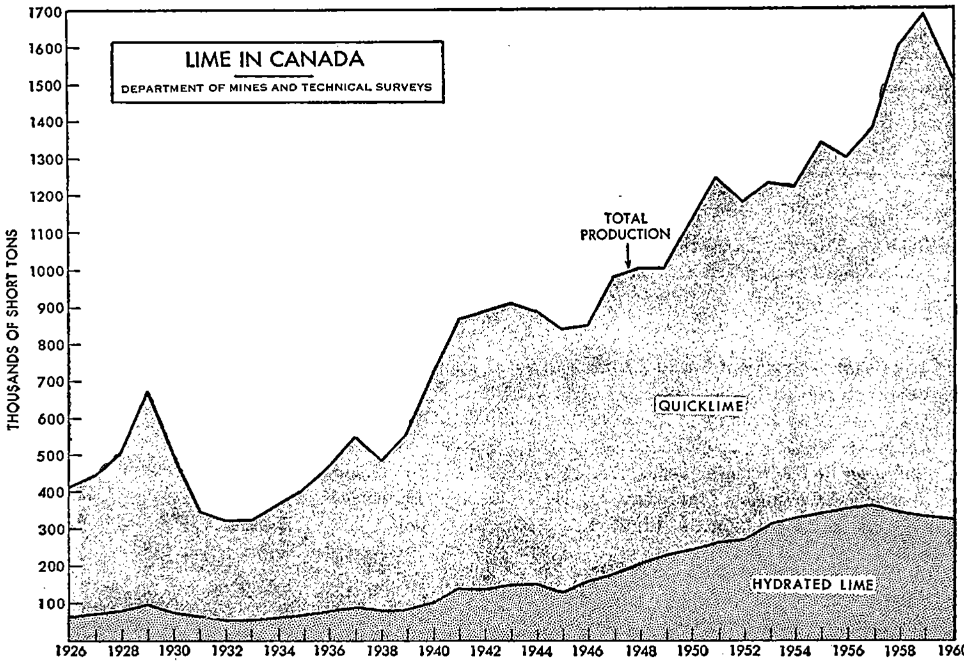
TABLE 1

LIME—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production*				
By type				
Quicklime	1,142,354	15,631,387	1,213,597	15,609,573
Hydrated lime	272,936	3,585,984	315,971	3,692,217
Total	1,415,290	19,217,371	1,529,568	19,301,790
By province				
Ontario	865,130	11,548,132	990,088	12,278,630
Quebec	407,427	5,086,976	399,874	4,449,164
Manitoba	48,791	833,238	48,383	834,698
Alberta	47,506	838,365	43,731	756,499
British Columbia	32,616	602,633	30,765	603,541
New Brunswick	13,820	308,027	16,727	379,258
Total	1,415,290	19,217,371	1,529,568	19,301,790
Imports				
United States	38,046	531,701	33,437	425,559
Britain	407	4,253	383	4,053
Total	38,453	535,954	33,820	429,612
Exports				
United States	30,355	528,949	18,802	399,941
Bermuda	54	2,203	55	2,464
St. Pierre	4	173	11	348
British Guiana	784	6,916	2,800	22,882
Total	31,197	538,241	21,668	425,635

SOURCE: Dominion Bureau of Statistics.
*Producers' shipments plus quantities used by producers.

In operation during 1961 were 35 plants with 98 vertical and 27 rotary kilns with a combined rated capacity of about 7,825 tons of primary quicklime a day. The large decrease in the number of vertical kilns from the total indicated for 1960 resulted from a decision to discount kilns lacking enough accessory equipment to be readily available for use. In addition, two separate hydrating plants processed purchased lime in Manitoba. A large unknown amount of secondary lime was recovered from calcium-carbonate sludges and recycled at a number of pulp-and-paper plants. Statistics regarding secondary lime are not available.



DEVELOPMENTS

Mainly because of high-excess plant capacity and a decrease in consumption, there was no major expansion of domestic lime-producing facilities in 1961. The demand for lime did increase, however, in most provinces.

Gypsum, Lime & Alabastine Limited began the construction of a new crushing-and-screening plant at its lime operations at Joliette, Quebec, and is to complete it before mid-1962. The company has announced that it intends to construct a new kiln at this plant in 1962.

Dominion Magnesium Limited, while expanding its magnesium-producing facilities at Haley, Ontario, began to use natural gas to fire its lime kilns.

Because of the great interest shown by a number of domestic lime producers, a nonprofit organization known as the Canadian Lime Association is being incorporated. The association's aim will be to develop new uses for lime and to increase its present use in Canada.

CONSUMPTION AND USES

Lime is used by most industries throughout the world. It is the most commonly demanded alkali chiefly because it is easily available and relatively cheap. It also has numerous applications in construction. The consumers of lime are in four main groups—the chemical, metallurgical and related industries; building; agriculture; and other industries—as shown in Table 3.

Most of the lime produced in Canada is consumed by the chemical, metallurgical and related industries, which in 1960 received 88 per cent of the producers' shipments. More than one third of Canada's output was consumed captively, mainly in the production of calcium compounds, and is listed under 'other industries.' Most of this lime is used in the manufacture of calcium carbide, calcium cyanamide, calcium chloride and their derivatives.

TABLE 2

LIME PRODUCERS, 1961

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 Limited	Lime Ridge	" *
Lamothe, N.	Pont Rouge	"
Raffinerie de Sucre de Québec	St. Hilaire	"
Shawinigan Chemicals Limited	Shawinigan	"
Gypsum, Lime & Alabastine Limited	Joliette	" *
	St. Marc des Carrieres	"
Ontario		
Bonnechere Lime Limited	Grattan tp.	High-calcium
Brunner Mond Canada, Limited	Anderdon tp.	"
Canada & Dominion Sugar Co. Ltd.	Chatham	"
Canadian Gypsum Company Limited	Guelph tp.	Dolomitic*
Carleton Lime Products Co.	Carleton Place	High-calcium
Chemical Lime Limited	Beachville	"
Cobo Minerals Limited	Coboconk	"
Cyanamid of Canada Limited	Niagara Falls	"
	Ingersoll	"
Dominion Magnesium Limited	Haley	Dolomitic
Gypsum, Lime & Alabastine Limited	Hespeler	" *
	Beachville	High-calcium*
Rockwood Lime Company, Ltd.	Rockwood	Dolomitic*
Manitoba		
Building Products and Coal Co. Ltd.	Inwood	" *
Manitoba Sugar Company Limited, The	Fort Garry	High-calcium
Winnipeg Supply & Fuel Company Limited, The	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	"
Gypsum, Lime & Alabastine Limited	Blubber Bay	" *
	Granville Island	"

*The hydrated varieties are also produced.

The uranium industry utilizes large quantities to control hydrogen-ion concentration during uranium extraction, to recover sodium carbonate and to neutralize waste sludges. The amount of lime shipped to uranium plants rose from 75,257 tons in 1957 to a peak of 286,738 tons in 1959 but fell to 127,616 tons in 1961. Lime is used as a flux and in the neutralization of waste pickling liquors in steel plants and as a flux in the smelting of nonferrous ores. The iron and steel plants required 185,630 tons in 1961.

For the last few years, the amount of primary lime consumed by the pulp-and-paper industry has been gradually diminishing owing to improvements in technology and despite an increase in pulping capacity. This industry uses it in the preparation of dissolving fluids for the sulphite, sulphate and soda processes. In the production of beet sugar, lime serves to precipitate impurities from the sucrate. High-calcium and dolomitic varieties are used in the production of glass. In the recovery of metals and minerals, lime is utilized to regulate alkalinity in flotation and cyanidation processes. It is also used in the tanning of leather and in the manufacture of many materials such as fertilizers, insecticides, fungicides, pigments, glue, acetylene, precipitated calcium carbonate, calcium hydroxide, calcium sulphate, magnesia and magnesium metal.

TABLE 3

CONSUMPTION OF LIME

(producers' shipments, by usage)

Uses	1960 Short Tons	1960 $	1959 Short Tons	1959 $
Chemical and other industrial				
Uranium mills	214,626	2,589,930	286,738	3,464,612
Iron and steel plants	173,711	2,079,593	162,244	1,904,349
Pulp and paper mills	166,527	2,195,109	185,524	2,482,283
Nonferrous smelters	138,662	739,947	130,054	714,147
Sugar refineries	31,086	471,966	34,324	451,419
Glass works	19,539	236,380	21,075	252,719
Cyanide and flotation mills	20,023	240,069	31,828	370,065
Tanneries	4,689	61,106	4,986	60,351
Fertilizer plants	7,406	52,340	1,754	19,071
Insecticides, fungicides	1,522	27,262	1,202	23,522
Other industries	574,681	7,360,143	615,019	7,735,492
Building trade				
Mason's lime	58,630	987,529	78,963	1,283,591
Finishing lime	74,576	1,682,635	94,464	2,066,517
Sand-lime brick	12,336	138,746	16,070	181,192
Agricultural	7,731	102,301	8,515	86,224
Other	23,823	336,734	12,965	208,467
Total	1,529,568	19,301,790	1,685,725	21,304,021

SOURCE: Dominion Bureau of Statistics.

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In 1961, about 10 per cent of the output was utilized by the construction industry as an ingredient in plaster, mortar, artificial stone and brick. In addition, small amounts included under 'other industries' were used for such construction purposes as soil stabilization and ready-mixed mortar. Canada lags far behind the United States in the use of lime for soil stabilization. This represents a potential major outlet, particularly in western Canada, and is being investigated by the Canadian Lime Association.

The agricultural industry, which uses lime as a fertilizer and in manufactured fertilizers, is the third-ranking, although a minor, consumer.

The fourth or 'other' class in Table 3 includes the users of lime in water and sewage treatment.

PRICES

Lump quicklime is marketed in bulk, and pebble and pulverized lime are sold in bulk or in bags. Hydrated lime is normally shipped in bags. Specific prices vary with the type of product, supply and demand, and the amount sold. The quicklime and hydrated lime produced in 1961 averaged respectively $13.68 and $13.14 a short ton at the plants.

Limestone

J. S. Ross*

The output of all types of limestone reached the record amount of 49.0 million tons in 1961. Similarly, after increasing fivefold from 1945 to 1959, shipments for purposes other than the production of cement and lime were at an all-time high. Increases in quantities required for concrete aggregate and agricultural limestone were the main reasons that limestone production for noncement and nonlime uses rose to 38.2 million tons valued at $48.0 million from the 1960 total of 36.5 million tons valued at $45.4 million. These statistics include small amounts of marble and marl.

In 1961, 478 quarries were operated in all provinces except Saskatchewan and Prince Edward Island. Quebec was again the leading producer, providing with Ontario more than 93 per cent of the national total for noncement and nonlime purposes. Quebec accounted for the most of the increase; there were smaller gains in Ontario and British Columbia. Otherwise, fluctuations by province have been relatively minor.

Of the 59,677,011 tons of stone of all types quarried during 1961 in Canada, 10,718,386 tons, or 19 per cent, were of types other than limestone. Most of this percentage consisted of igneous rocks and sandstone; the remainder was shale and slate. Structural and crushed stone of all types exclusive of that used in the manufacture of cement remained in thirteenth place in value among the minerals produced in Canada.

Canada's trade in limestone with the United States is remarkably large in both value and tonnage despite the low price of the commodity and the United States tariff. It is small, however, in relation to these countries' output. There are no separate Canadian trade statistics on limestone. During the year, Canada exported 732,694 tons of crushed stone valued at $1,091,027. Imports were valued at $1,185,454 for 790,482 tons, or appreciably less than in 1960. This trade was virtually all in crushed limestone for construction and was carried on chiefly between Ontario and the United States. The bulk of the chemical-grade limestone traded is exported from British Columbia, Alberta and Ontario and imported into Ontario. Building, ornamental, and monumental limestone is imported from several foreign countries.

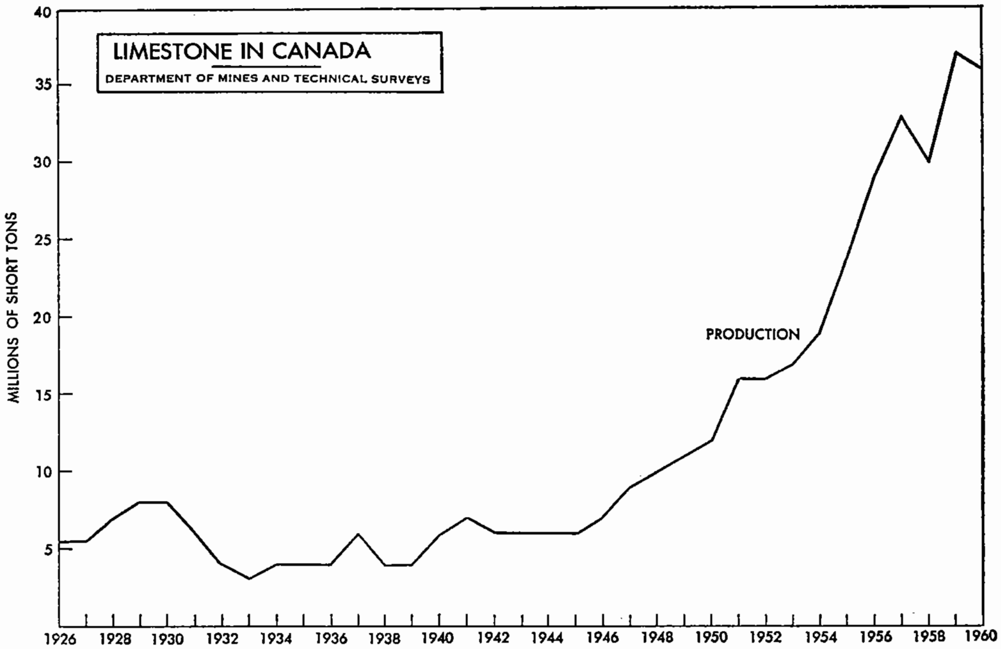
A few new quarries were opened during the year and the usual minor expansion took place at some crushing-and-screening plants. The larger expansions included the completion of a $750,000 crushing-and-screening plant at the Bamberton, British Columbia, operations of British Columbia Cement Company Limited. The plant is operated by remote control from a central station for crushing, conveying and bin-filling. With

*Mineral Processing Division, Mines Branch.

LIMESTONE—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
By province[1]				
Newfoundland	322,032	630,123	380,273	641,738
Nova Scotia	75,264	207,327	171,384	422,884
New Brunswick	346,744	793,465	299,046	495,981
Quebec	19,006,556	23,713,138	17,784,980	21,925,129
Ontario	16,688,807	19,551,695	16,158,994	19,138,844
Manitoba	594,340	985,624	636,510	1,012,819
Alberta	81,483	283,300	70,173	235,175
British Columbia	1,105,162	1,794,887	974,011	1,541,253
Total	38,220,488	47,959,559	36,475,371	45,413,823
By use				
Metallurgical	1,912,640	2,081,473	2,009,913	2,298,017
Pulp-and-paper	612,355	1,644,575	437,614	1,403,734
Glass-making	50,263	160,356	46,662	160,204
Sugar-refining	35,624	74,145	27,924	55,968
Other chemical uses	274,752	277,683	323,664	271,737
Pulverized for agricultural and fertilizer uses	1,234,038	3,262,240	896,377	2,270,512
Pulverized for other uses	262,746	864,266	219,302	738,992
Road metal	19,740,454	21,036,857	19,375,150	21,398,317
Concrete aggregate	9,309,635	10,277,302	7,947,937	9,022,705
Rubble and riprap	1,090,777	1,232,520	1,074,913	978,014
Railroad ballast	573,386	633,240	729,475	728,311
Structural[2]	88,100	2,519,009	68,035	1,880,220
Other uses	3,035,648	3,895,893	3,318,405	4,207,092
Total	38,220,418	47,959,559	36,475,371	45,413,823
	1961		1960	
Exports				
Crude stone not elsewhere specified				
United States	732,694	1,091,027	715,544	1,130,248
Crushed, ground and broken limestone imported by United States from Canada[3]	286,823	440,698	121,449	269,435
Imports				
Total crushed stone from United States	790,482	1,185,454	940,330	1,321,675
Crushed, ground and broken limestone exported by United States to Canada[4]	747,201	1,387,874	905,102	1,630,285
Consumption				
In production of cement	8,145,376		7,965,872	
In production of lime	2,592,831		2,669,574	
Miscellaneous	38,220,418		36,475,371	
Total	48,958,625		47,110,817	

SOURCE: Dominion Bureau of Statistics.
[1]Does not include limestone produced for the lime and cement industries but includes small amounts of marl and marble.
[2]Includes building, monumental and ornamental stone as well as flagstone and curbstone.
[3]U.S. Department of Commerce, *United States Imports of Merchandise for Consumption* (Report FT 110).
[4]U.S. Department of Commerce, *United States Exports of Domestic and Foreign Merchandise* (Report FT 410).



the aid of television, one operator controls all phases after primary crushing up to and including bin-filling and completes them daily in five hours. The rated capacity is 500 tons an hour. Near the end of the year, Gypsum, Lime & Alabastine Limited began the construction of a new crushing-and-screening plant at Joliette, Quebec, as part of a $2-million program. The plant was scheduled to go into operation in the first half of 1962 at a rated capacity of 400 tons a day.

DISTRIBUTION OF DEPOSITS

Canada has suitable occurrences of limestone in most of its populated regions, particularly in the southern parts of Ontario and Quebec, where more than 90 per cent of the limestone is quarried and consumed. This material, 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 provinces also supply the high-calcium variety.

USES

Because of its physical properties, its abundance in Canada and its low value, limestone is normally the most preferred type of stone. The greatest factor determining the extent of use of a particular limestone is generally the distance to markets. Other factors include the chemical composition, accessibility, texture, hardness and color of the rock as well as the thickness and extent of the beds and the formation.

Limestone has many uses in many types of industry. In descending order of importance, the main outlets are construction, cement and lime production, metallurgy and agriculture. The rock may be used in large pieces as rubble and riprap, chemical stone, flagstone, curbstone or building, monumental or ornamental stone. For most other purposes, it is crushed and possibly pulverized before being sized, the sizes being 6 inches or less.

Most Canadian limestone and its products go to the construction industry, which uses them in the following descending order of importance: as road metal; in the production of cement; as concrete aggregate, rubble and riprap, railroad ballast and fillers in asphalt and other products; in the production of mason's and finishing lime; and as structural and ornamental stone, terrazzo chips and stucco dash. Except when limestone is used in the production of cement or lime, the physical properties that make it suitable for construction are its most important.

Limestone employed for its chemical content is normally of the high-calcium or highly dolomitic variety. For the production of portland cement, it is usually of the calcium variety that contains minor amounts of magnesia.

High-calcium limestones, which are commonly desired for most purposes, are the source of high-calcium lime. They are used as fluxes in the smelting of ferrous and nonferrous ores and are employed by the pulp-and-paper industry in the preparation of calcium-bisulphite dissolving liquor. They are also consumed in the production of glass and other ceramic products and, serve as fillers in the manufacture of such materials as paint, rubber, floor tile, plastics, paper and asphalt products. In some of these materials limestone is used as whiting substitute. It also serves to reduce pollution from acid-bearing waste products.

Highly dolomitic limestone is used as a flux in the smelting of ferrous ores and in the manufacture of pulp and paper. It is a raw material in the production of glass and certain types of lime. Dominion Magnesium Limited consumes this stone in the production of magnesium metal near Haley, Ontario. Steetley of Canada Limited dead-burns dolomitic limestone near Dundas, Ontario, for use as a refractory and as a constituent in refractory products for open-hearth and electric furnaces.

Brucitic limestone is used as chemical stone by pulp mills and as a source of magnesia and lime. Aluminum Company of Canada, Limited, quarries brucitic limestone near Wakefield, Quebec, and from it manufactures magnesia and lime.

High-calcium, calcium and dolomitic limestones are pulverized for use as natural fertilizers to control acidity and serve as a source of calcium and magnesium. They are also constituents of manufactured fertilizers and stock foods. In several of Canada's provinces, unprocessed marl is used solely as a fertilizer.

PRICES AND TARIFFS

Limestone screenings may be sold for as little as 50 cents a ton, whereas dry-ground whiting substitute is marketed for about $12 a ton at the plant. Crushed limestone for construction is sold for about $1.25 a ton at the plant, but the prices vary according to the location, local supply and demand, quantity of sale, type, quality, and degree of preparation of the product. Transportation costs often make up a large part of the final price.

There is no tariff on crushed limestone entering Canada under the British preferential or the most favored nation categories, but there is a 25-per-cent ad valorem tariff on the general category.

The United States tariff classification of limestone is as follows:

Crude, broken or crushed when imported for use in manufacture of fertilizers	free
Not suitable for use as monumental or building stone; crude or crushed, but not pulverized	$1\frac{1}{4}$¢ per 100 lb
Suitable as monumental or building stone	
Dressed	21%
Unmanufactured, rough	$7\frac{1}{2}$¢ per cu ft

During 1961, Aggregate Producers Association of Ontario submitted a brief to the federal government requesting equalization of the tariffs on crushed stone shipped between the United States and Canada.

Lithium Minerals

J. E. Reeves*

Canada's only lithium-mineral producer, Quebec Lithium Corporation, continued to diversify its operations during 1961. The company enlarged its chemical plant to accommodate facilities for the production of lithium hydroxide monohydrate and announced plans for the production of lithium chloride and bromide and, ultimately, of lithium metal and lithium hydride. The output of the initial chemical product, high-purity lithium carbonate, reached a rate of 6,000 pounds a day and near the end of the year was being doubled to provide feed for the hydroxide monohydrate operation.

The company's mine and concentrator were operated on a restricted basis. The chemical-grade and ceramic-grade spodumene concentrates produced contained more than 6 per cent lithia (Li_2O). Ceramic-grade concentrate differs mainly in having a controlled iron content.

Elsewhere, the Canadian lithium-minerals industry was dormant.

PRODUCTION AND TRADE

Quebec Lithium Corporation reported that shipments, in terms of pounds of contained lithia, were considerably greater than in 1960 but still much smaller than from 1956 to 1959 inclusive, when chemical-grade spodumene concentrate was being shipped to the United States under contract to Lithium Corporation of America, Inc. The 1961 shipments consisted of spodumene concentrate and lithium carbonate.

The spodumene concentrate was exported to the United States. Most of the lithium carbonate was exported to the United States, but some was sold in Britain and Canada.

Available data indicate that the value of imports of lithium chemicals from the United States increased from about $85,000 in 1959 to more than $167,000

* Mineral Processing Division, Mines Branch.

in 1960. Included were lithium hydroxide monohydrate, lithium carbonate, lithium chloride, lithium bromide and lithium fluoride.

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 proven reserves of more than 20 million tons with an average of 1.15 per cent Li_2O.

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 small amounts of lepidolite and lithiophilite occur.

In 1959, a spodumene-bearing pegmatite was discovered about 80 miles northwest of Chibougamau, near Assinica Lake. Sirmac Mines Limited reported that a surface examination revealed an extensive area averaging 2.7 per cent Li_2O.

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 other Canadian deposits. Zones containing large quantities of spodumene, lepidolite and amblygonite and an unusual concentration of the cesium mineral, pollucite, make this deposit one of considerable interest. Lithium-mineral reserves have been estimated at 9 million tons containing more than 2 per cent Li_2O.

Other Occurrences

Many occurrences of spodumene-bearing pegmatites have been discovered in several areas of northwestern Ontario, most notably in the Beardmore area, near Lake Nipigon. 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 a dominant producer and consumer of lithium minerals, chemicals and metal. Its main sources of raw material are the large spodumene-bearing pegmatites in North Carolina and the vast brine deposits of Searles Lake, California. From the latter source, by-product dilithium sodium phosphate is obtained. The reserves in both areas are immense.

The basic problem confronting the industry in the United States is the great excess of production capacity, which will be relieved only by the development of new applications and a large expansion of markets.

Southern Rhodesia is the principal world source of lepidolite and petalite and also produces much smaller quantities of spodumene, amblygonite and eucryptite. Most of its output is shipped to the United States, particularly to the glass industry, and lesser amounts go to European countries and Japan. In 1960, ore reserves were reported to total almost 6 million tons containing 2.90 per cent Li_2O.

TECHNOLOGY

Lithium is not uncommon as a constituent of the earth's crust, but commercial concentrations occur 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	$LiAlSi_2O_6$	8.03	4 to 7.5
Lepidolite	$KLi_2AlSi_4O_{10}F_2$	7.65	3 " 5
Amblygonite	$LiAlFPO_4$	10.10	7.5 " 9
Petalite	$LiAlSi_4O_{10}$	4.89	3 " 4.5
Eucryptite	$LiAlSiO_4$	11.86	5.5 " 6.5
Zinnwaldite	$LiKFeAl_2F_2Si_3O_{10}$	3.40	2 " 3
Lithiophilite-triphylite	$Li(MnFe)PO_4$	9.52	2 " 6

The most common method of concentrating lithium minerals is flotation, although hand-picking is still in use, notably in Southern Rhodesia.

A small proportion of the lithium-mineral concentrates produced is consumed directly. Lepidolite, with its lithia and fluorine content, is a low-melting source of alumina for special glasses; petalite is a source of lithia with a low potash and soda content and a readily controllable iron content. Most spodumene concentrate and a considerable proportion of the other concentrates (and all the by-product dilithium sodium phosphate) are converted to various lithium chemicals, chiefly lithium carbonate and lithium hydroxide monohydrate. Only a small amount of lithium metal is produced.

Lithium minerals and chemicals are important for certain properties that one or more of them possess. Many of these properties are referred to in the description of uses.

USES

The ceramics industry is a principal consumer of lithium chemicals, especially of 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, the carbonate being used when a high percentage of lithia is required. 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 have higher electrical, chemical and thermal resistance.

Another important consuming industry is the manufacture of lubricating greases. Lithium stearate, which is derived from lithium hydroxide monohydrate, combines the best characteristics of sodium and calcium soaps, permitting 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, and lithium chloride and fluoride are added to welding and brazing fluxes to remove the oxide film from aluminum and magnesium surfaces.

Lithium as a metal has limited application. It 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, made from butyl chloride and lithium, is used as a catalyst in the production of synthetic rubber.

PRICES

There are few published prices for lithium-mineral concentrates. In Britain during 1961, Southern Rhodesian petalite and lepidolite containing a minimum of 3.5 per cent Li_2O were selling for about \$6.50 a short-ton unit (20 pounds), and amblygonite with 7 per cent Li_2O was selling for about \$10.50. These commodities were f.o.b. the port of Beira.

Prices of the principal lithium chemicals, per pound, according to *Oil, Paint and Drug Reporter* of December 25, 1961, were:

Lithium carbonate	\$0.57
Lithium hydroxide monohydrate	\$0.54
Lithium chloride	\$0.87
Lithium bromide	\$2.60
Lithium fluoride	\$1.75 to \$1.90
Lithium stearate	\$0.47½

The prices of lithium carbonate and lithium hydroxide monohydrate were respectively 10 and 18 cents a pound below those quoted for the previous year.

E & M J Metal and Mineral Markets of December 28, 1961, gives the selling price of lithium metal, 99.5 per cent, as \$9 to \$11 a pound.

Magnesite and Brucite

J. S. Ross*

The chief raw materials for the production of high-magnesia products are brines, sea-water bitterns, sea water, magnesite and brucite. Only magnesite and brucite are recovered in Canada for this purpose, with dolomitic magnesite and brucitic limestone being the raw materials. As in other countries, magnesia is used mainly in the manufacture of basic refractories and its consumption closely parallels that of the metallurgical industry.

In 1961, the value of production of caustic calcined magnesia from brucite and of a dead-burned magnesian product from dolomitic magnesite remained at a high level of $3,064,403, but was 6.6 per cent below that for the record year of 1960. Quebec was the sole producer.

For 1961, world production of crude magnesite mined was estimated at 8,600,000 short tons.† More than one third was supplied by U.S.S.R., Austria and China, in that order. The world production of crude magnesia from brine and sea water is not known, yet more than two thirds of the United States magnesia output originates from these sources.

For industrial mineral commodities, magnesia products have high unit values and as a result are traded widely throughout the world. Canadian export statistics of products of magnesite and brucite are not shown separately. However, in 1961, exports of crude refractory materials, comprised of some of the crushed stone, all of the dolomite and brucite products, and part of the other nonmetallic minerals 'not otherwise provided for,' amounted to $1,719,357. The United States was by far the chief market with a minor amount going to Britain. According to United States statistics, the value of all refractory magnesia products imported from Canada amounted to $2,637,431 in 1961.

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*Mineral Processing Division, Mines Branch.

†U.S. Bureau of Mines, *Mineral Trade Notes, August 1962.*

MAGNESITE AND BRUCITE—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production[1] (Quebec)				
Dolomitic magnesite and brucite		3,064,403		3,279,021
Imports				
Magnesia, dead-burned and sintered				
United States	17,454	1,455,663	18,438	1,422,808
Yugoslavia	4,405	245,048	5,531	299,446
Italy	63	4,665	—	—
Britain	22	2,691	210	17,323
Total	21,944	1,708,067	24,179	1,739,577
Magnesia, caustic calcined				
United States	2,724	185,890	2,836	199,841
Austria	70	3,672	—	—
India	27	4,535	12	1,966
Other countries	15	899	2	251
Total	2,836	194,996	2,850	202,058
Magnesian firebrick				
United States		356,201		323,682
West Germany		75,266		202,860
Britain		60,011		159,385
Total		491,478		685,927
Magnesium carbonate and magnesium oxide				
United States	981	110,456	1,097	119,994
Britain	216	35,468	272	41,591
Total	1,197	145,924	1,369	161,585
Magnesium salts				
United States	1,683	379,082	1,137	254,692
West Germany	125	5,636	33	1,724
Britain	66	39,494	132	59,526
Italy	—	491	—	—
Total	1,874	424,703	1,302	315,942
Magnesium sulphate, or Epsom salts				
West Germany	1,849	37,104	1,733	32,551
United States	667	27,645	667	27,867
Britain	75	4,775	34	3,580
Total	2,591	69,524	2,434	63,998
Magnesia pipe covering				
United States		22,330		27,488

	1961		1960	
	Short Tons	$	Short Tons	$
Exports				
Crude refractory materials not otherwise specified (part of 'crushed stone,' all of 'dolomite and brucite,' part of 'other nonmetallic minerals not otherwise provided for')				
United States		1,711,929		
Britain		7,428		
Total		1,719,357		
United States[2]				
Magnesite, dead-burned	685	255,515	678	108,098
Refractory material of magnesia and lime	4,234	224,393	12,911	549,837
Magnesite brick and shapes	13,183	2,157,523	15,589	2,503,206

SOURCE: Dominion Bureau of Statistics except where otherwise indicated.

[1]Includes the value of brucitic magnesia shipped, and of dead-burned dolomitic magnesite and a small quantity of serpentine used or shipped.

[2]Not recorded separately in the official Canadian trade statistics. The figures shown are reported in *United States Imports of Merchandise for Consumption* (Report FT 110). These materials are also exported from Canada to other countries, but the quantities are not available.

Canadian imports of magnesium compounds are also noteworthy and those in the table amounted to $2,543,214 in 1961. The bulk of this came from the United States and more than half was dead-burned magnesia. Yugoslavia, Italy, Britain, Austria, India and West Germany also shipped magnesium compounds to Canada. These included dead-burned magnesia; caustic calcined magnesia; magnesium carbonate, oxide, sulphate; and other compounds. In addition, magnesian firebrick valued at $491,478 was imported.

PRODUCTION

Primary high-magnesia products are produced only in southern Quebec and by one separate plant for each of the two products.

Magnesite occurs as dolomitic magnesite at the Kilmar, Quebec, mine of Canadian Refractories Limited. The rock is comprised mainly of magnesite, dolomite and magnesium silicates. At Kilmar, it is mined by underground methods, beneficiated in a heavy-media separation plant, blended, dead-burned in a rotary kiln, and crushed and sized. Most of the output is consumed at the company's Marelan, Quebec, plant in the production of refractory bricks and other shapes. The remainder is either marketed domestically or exported, mainly to the United States, for use as a refractory in open-hearth furnaces. There has been no production from the other deposits of magnesite occurring in British Columbia, the Northwest Territories, Saskatchewan, Quebec, Nova Scotia and Newfoundland.

Caustic calcined magnesia is produced near Wakefield, Quebec, by Aluminum Company of Canada, Limited. Brucitic limestone is quarried and calcined at this operation. The product is hydrated and separated into magnesia and lime. The magnesia fraction is graded and sold for use in the manufacture of high-magnesia basic refractories, in agriculture, and for other chemical and industrial applications.

During the year, token shipments of brucitic limestone were made from the Rutherglen, Ontario, area—the first recorded production of this rock in Ontario. Brucite also occurs in British Columbia, Nova Scotia, Quebec and Ontario.

Four plants produce magnesia products from imported magnesia. The Marelan, Quebec, operation of Canadian Refractories Limited and General Refractories Company of Canada Limited at Smithville, Ontario, produce basic refractories in the form of mixes, bricks, and other shapes. At Bronte, Ontario, Refractories Engineering and Supplies Limited operates a mixing plant for the production of basic ramming mixes. Imported magnesia is fused at Chippawa, Ontario, by Norton Company.

TECHNOLOGY

Caustic calcined magnesia, a chemically active commodity, is a product of mild calcination. Dead-burned magnesia is chemically inactive and is produced by intense calcination. In industry, the term 'periclase' refers to the dead-burned product containing minor amounts of iron and a minimum of 92 per cent magnesia. These commodities may be produced either from magnesite, brucite, sea water, brines or sea-water bitterns.

The minerals magnesite and brucite theoretically contain 47.6 and 69.0 per cent magnesia, respectively, and may be converted to magnesia by calcination. When beneficiated, calcined dolomite may be used as a source of this commodity. Since 1954, there has been an appreciable increase in the use of brines, sea water, and sea-water bitterns as sources of magnesia. More than two thirds of the United States output is derived in this manner. A high-purity product is obtained by the calcination of magnesium hydroxide or magnesium chloride resulting from treatment of these magnesium-bearing solutions.

CONSUMPTION AND USES

Dead-burned magnesia is the most commonly consumed type of magnesia and is used almost entirely in the production of refractory products. Its outstanding property is its ability to withstand the effects of basic slags and as a result, is employed as an ingredient in various refractory bricks and shapes, hearth clinker, gunning and ramming mixes, and cements and mortars.

Much attention has been given recently to the application of dead-burned dolomite with coal-tar pitch in reinforced blocks for open-hearth and electric furnace linings. Extensive use of this type of refractory would cut down the consumption of refractories containing higher-purity magnesia.

The use of caustic calcined magnesia is increasing with the present trend in paper-pulp manufacture towards the use of a magnesian dissolving liquor. In some cases, calcined magnesia is used as a raw material in the production of the dead-burned product. It is a source of magnesium metal and magnesium-oxychloride and magnesium-oxysulphate cements. The commodity is also used to control acidity in chemical processing, as a constituent of manufactured fertilizers and in the production of certain insulation, heating elements, rayon, rubber, petrochemicals, magnesium chemicals and welding-rod coatings.

PRICES AND TARIFFS

The following United States prices per short ton are extracted from *E & M J Metal and Mineral Markets* of December 21, 1961:

Magnesite, crude, bulk, carload lots	$27.50
Magnesia, calcined, pebble	$37.50
Magnesia, dead-burned, grain, f.o.b. Chewelah, Wash.	
In bulk	$46.00
In bags	$52.00

66076-1—20

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
Magnesite, dead-burned or sintered; magnesite, caustic calcined; plastic magnesia	15%	15%	30%
Magnesium carbonate, basic or otherwise, excepting 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	
Crude magnesite	15/64c. per lb
Caustic calcined magnesite	15/32c. per lb
Dead-burned and grain magnesite, and periclase, not suitable for manufacture into oxychloride cement	23/60c. per lb
Magnesite brick	3/8c. per lb and 5% ad valorem
Magnesium carbonate, precipitated	1/2c. per lb
Magnesium chloride, anhydrous	1c. per lb
Magnesium chloride, not specifically provided for	0.53c. per lb
Magnesium oxide or calcined magnesia	2 1/2c. per lb
Magnesium sulphate (Epsom salts)	3/8c. per lb
Manufactures of carbonate of magnesia	1c. per lb
Dolomite ore, crude	free

Magnesium

W. H. Jackson*

Magnesium shipments and production continued at a high level. Shipments amounted to 7,802 tons, having increased from their 1960 total of 7,428 tons. Output, at 7,635 tons, was up for the second consecutive year. The main outlet for Canada's production is exports; and 90.6 per cent of the 1961 exports went to Britain, where unwrought Commonwealth magnesium is admitted duty-free while a 10-per-cent tariff is imposed on the metal originating in other countries. British imports of magnesium and its alloys, which in 1960 totalled 4,488 tons, amounted in 1961 to 5,879 tons. Small shipments were sent to 17 other countries.

The tariff on magnesium entering the United States from Canada will be cut from 50 to 40 per cent by June 30, 1962, according to new terms accepted under the General Agreement on Tariffs and Trade. This reduction is not expected, however, to make commercial shipments from Canada any more feasible. The bulk of the magnesium imported for Canadian manufacturers continued to come from the United States. Sheet, the main item not produced domestically, was imported duty-free.

The magnesium ingot consumed in Canada amounted for 1961 to 2,776 tons, having risen from the 1960 total of 2,199 tons. The increase in its use in castings, extrusions and aluminum alloys is shown in Table 1 under 'consumption'.

Dominion Magnesium Limited was expanding its smelter capacity at Haley, Ontario, from 8,000 to 10,000 short tons by the addition of four natural-gas-fired furnaces. By early December two of the new furnaces were in operation, and the kilns and melt plant had been converted to natural-gas firing.

Dolomite of exceptional purity, averaging 21 per cent magnesium oxide, is quarried next to the smelter. In the mill, whose capacity is 225 tons a day, the ore is ground, sized and calcined. Magnesium is obtained by thermal reduction of a pellet mixture consisting of calcined dolomite and ferrosilicon in retorts evacuated to low pressure. Other metals produced by similar methods but from different raw materials are calcium, strontium, barium, titanium, zirconium and thorium.

The following grades and purities of magnesium are available: Standard, 99.5 per cent; Special, 99.97 per cent; and Refined, 99.99 per cent. These are produced in 20-pound, 5-pound, and 1-kilogram ingots, as billets from 4 to 20 inches in diameter, and as granules in minus 4 plus 50 mesh size. The other magnesium products are rods, bars, wire and structural shapes.

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* Mineral Resources Division.

66076-1—20½

Table 1

MAGNESIUM—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (metal)	7,635	4,307,570	7,289	4,313,987
Imports (alloys)				
United States		416,538		193,063
Britain		10,028		143,485
Total		426,566		336,548
Exports (metal)[1]				
Britain	5,465	3,188,691		2,290,382
France	119	100,558		189,612
United States	53	84,121		264,716
Sweden	51	28,730		140
Hungary	47	26,742		70,425
Poland	77	43,210		—
Czechoslovakia	143	79,330		35,768
Switzerland	27	19,719		11,840
Other countries	42	37,422		369,922
Total	6,030	3,608,523		3,232,805
Consumption (metal)				
Castings	395		158	
Extrusions (structural shapes, tubing)	251		230	
Aluminum alloys	1,604		1,339	
All other products[2]	526		472	
Total	2,776		2,199	

Source: Dominion Bureau of Statistics.

[1] Quantities were not available prior to 1961.

[2] Including other alloys and magnesium used for cathodic protection and as a reducing agent.

TABLE 2

MAGNESIUM—PRODUCTION, TRADE AND CONSUMPTION 1951-61

	Production[1] (short tons)	Imports[2] ($)	Exports[3] ($)	Consumption[4] (short tons)
1951		113,391		1,332
1952		136,742		1,119
1953		144,253		1,414
1954		99,944		1,308
1955		186,034	4,887,980	833
1956	9,606	366,837	5,153,509	1,003
1957	8,385	276,742	4,535,570	840
1958	6,796	255,768	2,871,991	711
1959	6,102	273,021	3,879,588	1,668
1960	7,289	336,548	3,232,805	2,199
1961	7,635	426,566	3,608,523	2,776

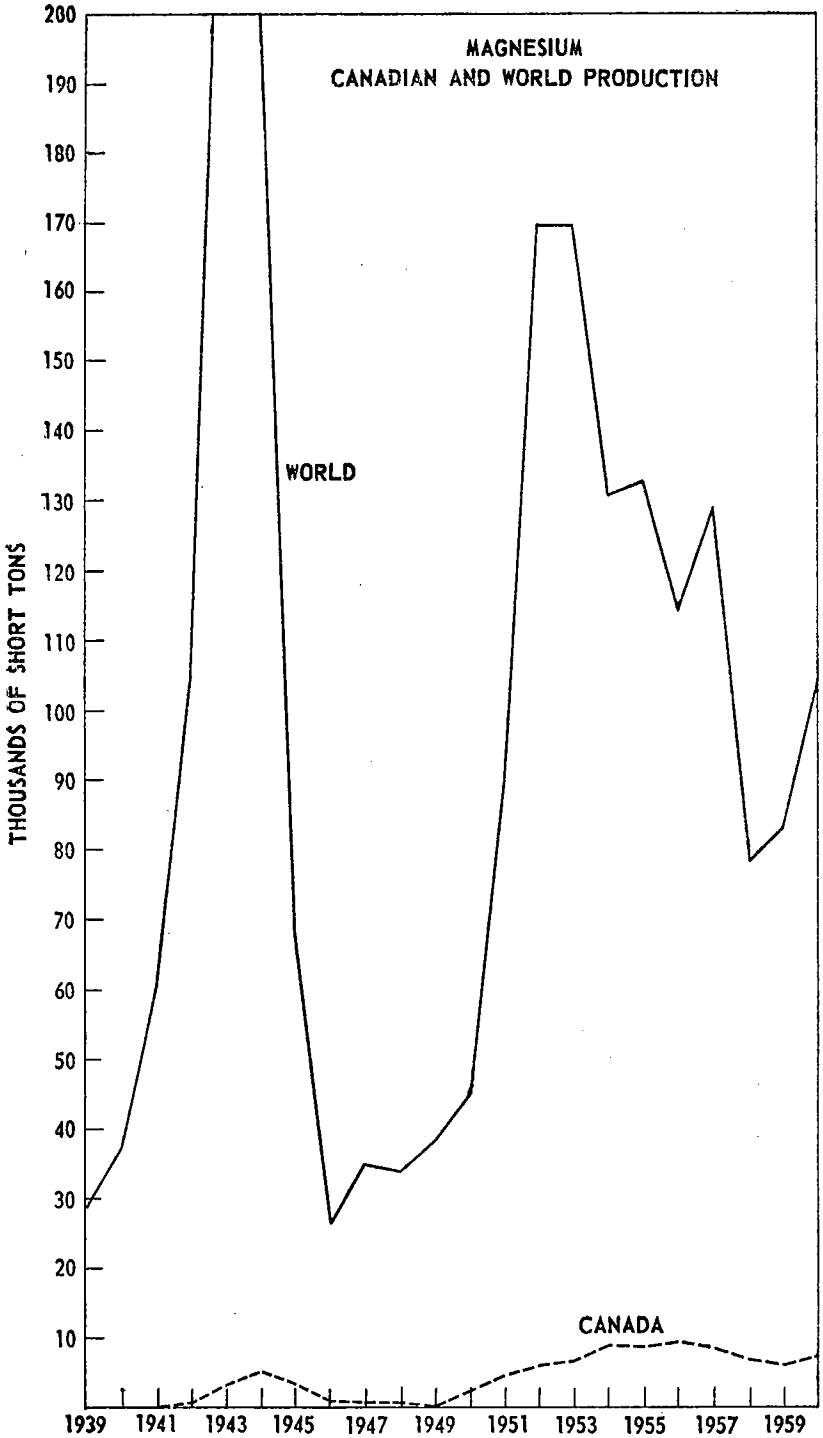
SOURCE: Dominion Bureau of Statistics.
[1]Production statistics for 1951 to 1955 inclusive are not available for publication.
[2]Magnesium alloys.
[3]Statistics for 1951 to 1954 are not separately available.
[4]Increased consumer coverage for 1959 and the years following.

TABLE 3

WORLD PRODUCTION OF MAGNESIUM

	(short tons)		
	1961	1960	1959
United States	40,745	40,070	31,033
U.S.S.R.	34,000	27,600	22,000
Norway	16,038	11,372	10,567
Canada[1]	7,635	7,289	6,102
Italy	6,192	6,003	4,967
Britain[2]	4,200	4,119	2,387
Japan	2,477	2,363	1,724
France	2,336	2,443	1,937
China	1,100	1,100	1,100
West Germany[2]	397	298	214
Total, world	115,300	102,600	82,400

SOURCE: American Bureau of Metal Statistics, 1961, for all countries except Canada.
[1] Dominion Bureau of Statistics.
[2] Includes remelt alloys.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

The graph showing Canadian and world production of magnesium illustrates problems that the world industry has partly overcome. Production capacity was greatly built up during World War II, but in the immediate postwar years many plants were closed and subsequently dismantled. When the Korean War broke out, there was another increase in military demand. It was followed by a further slump, partial recovery and then a decline caused by a decrease in the volume of aircraft production. In October 1959, partly owing to difficulty in obtaining low-cost magnesium chloride and partly because of a recession, Aluminum Company of Canada Limited closed its Arvida plant. The increase in commercial application and the proportionate decline in military use give reason to expect that the recovery experienced in magnesium in 1960 and 1961 will be more enduring.

Destructive uses of magnesium are increasing, and the usefulness of the properties that have made this metal important in aircraft components and contributed to the success of the German automotive industry is being extended into other fields. One German manufacturer who for automotive purposes needed only 2,184 tons of magnesium in 1951 used 29,820 tons in 1960.

As the demand increases, plant expansion in a number of countries progresses. Developments in Canada—at Dominion Magnesium Limited—have already been mentioned. Dow Chemical Company, of the United States, is to reopen part of its Freeport, Texas, plant, closed since 1958. The reason is that sales have increased and inventories have been depleted. United States production amounted in 1960 to 40,070 tons and in 1961 to 40,745. In Norway, *Norsk Hydro-Elektrisk* is planning further expansion that will be carried out during 1963-65 and will raise the annual capacity of its Heroya plant from 14,000 to 28,000 tons. At Bolzano, Italy, *Società Italiana per il Magnesio e Leghe di Magnesio, S.P.A.* is raising its capacity from 4,400 to 7,700 tons. In Britain, at Hopton, near Wirksworth, Derbyshire, Magnesium Elektron Limited is erecting a 5,000-ton-a-year reduction plant in which locally mined dolomite will be reduced by the ferrosilicon process in oil-fired furnaces. The Bitterfield plant in East Germany, reported to be under reconstruction, may have a capacity of 7,000 tons. West Germany's *Knapsack-Griesham A.G.*, of Cologne, is scaling up a pilot plant to a capacity of 3,000 tons a year, to be reached in 1962. In Japan, Furukawa Magnesium Company is increasing its capacity from 2,000 to 4,500 tons.

USES

Magnesium is a constituent of aluminum-base alloys that possess high strength and resistance to corrosion. In Canada, this use accounts for the largest quantity. Magnesium finds other destructive applications in the cathodic protection of steel structures by magnesium anodes, pyrotechnics, the production of nodular cast iron, and use as a reducing agent in the production of uranium, titanium, beryllium, zirconium and platinum.

Foundries can produce intricate and high-quality castings that fully utilize the high strength-to-weight ratio and excellent machinability of magnesium. Magnesium-base alloys that contain aluminum, zinc and manganese are used in castings and extrusions. For high-temperature and high-strength applications, alloys containing zirconium and thorium as additives have been developed. Research is being carried out on a group of magnesium-lithium alloys. End products range from ladders to aircraft-engine components. The use of die castings for small engines and appliances is increasing. For substantial penetration of the automotive market, the cost per finished casting must be equal to or lower than that of competing materials. Magnesium sheet, on being heated, can be deep-drawn in one operation to a greater depth than any other light alloy. Examples of resultant sheet products are lightweight suitcases and dockboards.

PRICES

In 1961, representative base prices for magnesium were as follows: Canada, f.o.b. Haley, 31 cents a pound; United States, in 5-ton lots, f.o.b. Velasco, Texas, for consumption in the United States, 35.25 cents a pound; United Kingdom delivered, 2s. 3d. a pound.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Sheet or plate of magnesium or alloys of magnesium, plain, corrugated, pebbled, or with a raised surface pattern for use in Canadian manufacturing	free	free	25%
Alloys of magnesium, viz: ingots, pigs, sheets, plates, strips, bars, rods, and tubes	5%	10%	25%
Magnesium scrap	free	free	free

United States	Common External Tariff
Metallic magnesium and metallic magnesium scrap (duty on scrap suspended until June 30, 1962)	50%
Magnesium alloys, powder, ribbons, sheets, tubing, wire, and all other articles of magnesium not specifically provided for	20¢ per lb on magnesium content plus 10% ad valorem
Other magnesium alloys, magnesium content	17¢ per lb plus 8½% ad valorem

United Kingdom	Commonwealth	Most Favored Nation
Unwrought magnesium	free	10%

Manganese

V. B. Schneider*

Canada's imports of manganese ore amounted in 1961 to 76,016 tons valued at $3,465,313. Imports of manganese alloys, at 14,294 tons, were considerably less than in 1960. They were nevertheless at the second highest level so far reached and again adversely affected Canadian production of ferromanganese. Domestic consumption of manganese ore reached 78,642 tons for the year, or 5,623 tons more than in 1960.

No manganese ore is produced in Canada. In past years, however, small amounts have been mined from bog deposits in New Brunswick, Nova Scotia and British Columbia. Large low-grade deposits found in New Brunswick and Newfoundland may in time, through technological advances, become economically important. The most notable, situated near Woodstock, New Brunswick, has been estimated to contain more than 50 million tons grading 11 per cent manganese and 14 per cent iron.

Strategic Materials Corporation, through its subsidiary, Stratmat Ltd., owns the Woodstock deposit, and Strategic-Udy Metallurgy Limited, controlled by Stratmat, has been conducting research to find a method of processing the ore economically. The company hopes eventually to produce high-carbon ferromanganese and high-phosphorus pig iron. The pig iron would be processed to refined steel in an electric furnace.

WORLD PRODUCTION AND TRADE

Production reports and the increase in world steel output indicate that the 14.8 million tons of manganese ore estimated[1] to have been recovered in 1960 were slightly exceeded in 1961.

Manganese ore reserves in Russia, which leads in manganese-ore production, are estimated to constitute more than half the world's total. The bulk of the remaining known manganese deposits is in India, South Africa, Ghana, Gabon, Brazil and British Guiana. India's and Brazil's reserves have each been estimated at 100 million tons, and Gabon's at 160 million tons. The United States Bureau of Mines[2] puts the global total of high-grade manganese ore at more than 1,000 million tons. At best, however, estimates of world manganese reserves are broad approximations.

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*Mineral Resources Division. [1]U.S. Bureau of Mines, *Minerals Yearbook 1960* (preprint). [2]U.S. Bureau of Mines, *Materials Survey*, "Manganese," October 1952.

TABLE 1

MANGANESE—TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Imports				
Manganese ore				
Ghana	25,484	1,080,474	22,399	811,363
Brazil	16,785	701,392	6,522	253,701
India	13,291	350,582	—	—
French West Africa	13,928	584,569	—	—
United States	6,388	691,595	4,345	613,390
Japan	83	32,712	4	1,733
Britain	44	22,579	44	12,614
France	13	1,410	4	701
Republic of the Congo	—	—	17,032	704,012
Republic of South Africa	—	—	5,488	142,331
Mexico	—	—	512	3,918
Total	76,016	3,465,313	56,350	2,543,763
Ferromanganese under 1% silicon				
Republic of South Africa	9,672	1,268,512	10,113	1,310,580
Japan	1,438	376,562	982	257,455
United States	513	136,223	2,460	467,365
France	387	132,128	1,843	335,063
Britain	55	14,317	97	15,938
Italy	56	16,475	—	—
Total	12,121	1,944,217	15,495	2,386,401
Silicomanganese over 1% silicon				
United States	1,115	189,434	1,493	340,358
Japan	668	118,891	700	115,933
Belgium and Luxembourg	332	45,150	—	—
Norway	—	—	122	15,900
Chile	—	—	51	10,348
West Germany	2	994	—	—
Yugoslavia	56	7,650	—	—
Total	2,173	362,119	2,366	482,539
Exports				
Ferromanganese				
United States	216	36,008	668	269,566
Colombia	22	7,988	1	125
Other countries	—	—	60	12,150
Total	238	43,996	729	281,841
Consumption				
Manganese ore				
Metallurgical grade	76,620		70,652	
Battery and chemical grade	2,022		2,367	
Total	78,642		73,019	

SOURCE: Dominion Bureau of Statistics.

TABLE 2

MANGANESE—TRADE AND CONSUMPTION, 1951-61
(short tons)

	Imports			Exports	Consumption
	Manganese Ore	Manganese Alloys		Ferromanganese	Ore
		Under 1% Silicon	Over 1% Silicon		
1951	222,082	292	338	67,508	223,328
1952	194,405	1,629	153	31,290	169,560
1953	66,682	1,044	18	683	69,533
1954	48,962	8,527	19	3,639	66,052
1955	175,282	3,945	272	29,404	113,075
1956	207,977	2,191	1,130	59,445	219,141
1957	131,318	743	2,257	46,733	195,088
1958	42,060	2,483	2,185	225	46,143
1959	118,454	2,334	2,989	193	90,311
1960	56,350	15,495	2,366	729	73,019
1961	76,016	12,121	2,173	238	78,642

SOURCE: Dominion Bureau of Statistics.

TABLE 3

WORLD PRODUCTION OF MANGANESE ORE, 1961
(short tons)

U.S.S.R.	6,500,000[e]
China (Communist)	1,100,000[e]
Union of South Africa	1,562,718
India	1,338,200
Brazil	1,100,000[e]
Ghana	431,580
Morocco	629,512
Republic of the Congo	344,185
Japan	326,695
Other countries	1,600,110
Total	14,933,000

SOURCE: U.S. Bureau of Mines, *Mineral Trade Notes, Sept. 1961.*
[e]Estimated.

The United States, which is the leading importer of manganese ore, took 2,105,780 tons in 1961, the smallest quantity since 1951. Its four main suppliers were Brazil (749,588 tons), Ghana (223,836), the Republic of South Africa (219,862) and Mexico (181,640)[1]. India, which until recently ranked as the leading supplier of manganese ore to the United States, slipped from second position in 1960 to fifth in 1961.

The Soviet Union reported exports amounting to 896,000 metric tons for 1961 and continued in 1962 to expand its export market. The Republic of South Africa reported the production of 1,562,718 tons of manganese ore, or 246,594 tons more than in 1960. For the first ten months of 1961 its exports decreased by 87,871 tons to 591,497 tons while its domestic sales increased by 93,585 tons to 448,036 tons[2].

[1] U.S. Bureau of Mines, *Mineral Industry Surveys*, "Manganese Report No. 190." March 15, 1962.
[2] Republic of South Africa, Department of Mines, *Minerals* (quarterly information circular), July-September 1961.

CONSUMPTION, 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 3 per cent and the chemical industry for the remaining 2 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 1 or 2 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 to eliminate the need for a carbon stabilizer. It serves the aluminum industry in the production of high-purity aluminum 'hardener' alloys; in brass mills it is added either as metal or as a 30-70 manganese-copper master alloy in the production of manganese bronzes. Foote Mineral Company and Union Carbide Metals Company are the only manufacturers of electrolytic manganese in the United States, but American Potash & Chemical Corp., Los Angeles, expects to be producing electrolytic manganese in its plant at Aberdeen, Mississippi, early in 1962.

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 the order given.

For making ferromanganese, the manganese-iron ratio should be 7:1 or more because the production capacity of 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 purchases ores from more than one source.

General specifications for metallurgical-grade manganese ore are as follows: a minimum of 48 per cent manganese; maxima of 7 per cent iron, 8 per cent silica, 0.15 per cent phosphorus, 6 per cent alumina and 1 per cent zinc. The ore should be in hard lumps of less than 4 inches, and not more than 12 per cent should pass a 20-mesh screen.

Battery-grade Manganese Ore

Manganese ore for dry-cell use must be pyrolusite of not less than 75 per cent MnO_2 and not more than 1.5 per cent iron, and should be very low in such metals as 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, at Sault Ste. Marie, Ontario; Dominion Steel and Coal Corporation, Limited, at Sydney, Nova Scotia; The Steel Company of Canada, Limited, and Dominion Foundries and Steel, Limited, both at Hamilton, Ontario; and Atlas Steels Limited, at Welland, Ontario.

Electrolytic manganese imported from the United States is used by Atlas Steels Limited, Welland, Ontario, in making low-carbon stainless steel. It is also used by the aluminum-, magnesium- and copper-alloy industries.

Consumers of battery-grade ore are National Carbon Limited and Mallory Battery Company of Canada Limited, both of Toronto; Burgess Battery Company, Limited, Niagara Falls; and Ray-O-Vac (Canada) Limited, Winnipeg.

PRICES

Prices of manganese in the United States, according to *E & M J Metal and Mineral Markets* of December 28, 1961, were as follows:

Manganese ore	
Per long-ton unit, 46-48% Mn, c.i.f. U.S. ports, import duty extra	
Indian (Al+Si 13%)	87.00¢ to 90.00¢ (nominal)
South African (Al+Si 13%, Fe 9%, P 0.05%)	87.00¢ to 90.00¢ (")
Manganese metal	
Per lb, 99.9%, electrolytic, f.o.b. shipping point, freight allowed east of Mississippi, carload	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	9.50¢ - 11.00¢
Medium-carbon (80-85% Mn, 1¼-1½% C), f.o.b. shipping point	24.00¢
Low-carbon (85-90% Mn, max. 0.07% C), basis as for medium-carbon	35.10¢
Silicomanganese	
Per lb carload lots, lump, f.o.b. shipping point	
1.5% C max., 18-20% Si	11.00¢ - 11.60¢
2% C max., 15-17½% Si	10.70¢ - 11.30¢
3% C max., 12-14½% Si	10.50¢ - 11.10¢
Spiegeleisen	
Per gross ton, carload lots, lumps, f.o.b. Palmerton, Pa.	
3% Max. Si, 16-19% Mn	\$ 96.00 - \$ 99.00
3% Max. Si, 19-21% Mn	\$ 98.00 - \$101.00
3% Max. Si, 21-23% Mn	\$100.50 - \$103.50

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Manganese ore	free	free	free
Ferromanganese (on Mn content)	"	1¢ per lb	1¼¢ per lb
Silicomanganese (on Mn content)	"	1½¢ per lb	1¾¢ per lb
Electrolytic manganese metal	"	5%	2.0%

United States	
Manganese ore	¼¢ per lb on Mn content
Ferromanganese*	
Not over 1% C	0.8¢ per lb on Mn content and 6% 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	
Over 1% C**	75¢ per long ton
Less than 1% C	15/16¢ per lb on Mn content and 7½% ad valorem
Manganese metal	1 7/8¢ per lb on Mn content and 15% ad valorem

*These classes must contain 30 per cent or more Mn.
**In this class, to contain under 30% Mn.

Mica

J. E. Reeves*

In 1961, the production of mica in Canada increased by almost 7 per cent over the output of 1960. The value of production increased by 33 per cent because of higher proportions of the higher-priced electrical grades and of ground mica.

Imports of unmanufactured mica declined somewhat, although the value increased. The statistics indicate higher unit costs in 1961 from all sources. The value of imported manufactured mica was also higher than in 1960.

Export statistics show considerable variation from year to year, reflecting variations in the sale of small rough and trimmed electrical phlogopite to Japan and scrap phlogopite to Belgium and the United States.

PRODUCERS

Mica production in 1961 consisted of small phlogopite sheet, phlogopite scrap, ground phlogopite and ground muscovite schist.

The phlogopite originated in the southwestern part of Quebec within a few miles of Ottawa, and in the Westport-Perth area of Ontario. In Quebec, Blackburn Brothers, Limited, mined sheet phlogopite and dry-ground scrap phlogopite near Cantley, in Hull township. The rest came mostly from several small intermittent producers in Quebec and from the Bobs Lake area near Westport, Ontario.

Muscovite schist was mined by Georgian Mineral Industries Ltd. near Cedarside, British Columbia, and partly processed in a plant at Cedarside. With the co-operation of Magnet Cove Barium Corporation Ltd., the fine grinding and classification take place at the latter's plant at Rosalind, Alberta. Diamond-drilling has indicated reserves of 200,000 tons containing 85 to 90 per cent muscovite.

*Mineral Processing Division, Mines Branch.

Phlogopite, or amber mica, varies considerably in dielectric strength, hardness, structural strength, and other properties, but its thermal resistance, which is higher than that of muscovite, gives it some value. It is found in parts of southwestern Quebec and southeastern Ontario, frequently in irregular veins with green apatite and pink calcite. Its properties vary with the wide variation in its composition, and it may range from almost colorless to a deep brown.

When ground to a fine powder, mica maintains its flaky particle shape, which is advantageous in its many uses as a filler and dusting agent.

USES

Mica is used in three forms—natural sheet, splittings, and ground mica.

Natural-sheet mica is used for electrical insulation in a wide variety of electrical and electronic equipment and appliances for industrial and household purposes. 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. There has developed a trend toward the use of other materials where possible, but the highest-quality muscovite is in increasing demand.

Mica splittings are used in the manufacture of built-up sheet and mica 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, within the limits of its dielectric characteristics, in place of natural sheet, 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 a mica paper has been developed as a substitute for built-up sheet. It is produced by grinding clean scrap and bonding it into a paper-like sheet.

Ground mica makes up the bulk of the mica consumed. Dry-ground mica, muscovite or phlogopite, is used for dusting asphalt products, such as pipeline wrap, 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. The wet-grinding of select muscovite scrap and waste yield a polished, well-delaminated white powder for use 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. For grading size, this classification uses the area of minimum rectangle and the minimum dimension of one side; for grading visual quality, it uses 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.

MARKETS

The following Canadian companies buy mica: all grades—Walter C. Cross & Co., 209 Eddy Street, Hull, Quebec; block and sheet—Mica Company of Canada Ltd., 4 Lois Street, Hull, Quebec; scrap—Blackburn Brothers, Limited, 85 Sparks Street, Ottawa, Ontario.

There is currently a small demand for high-quality small phlogopite sheet and for clean phlogopite scrap.

PRICES

Prices offered by Canadian purchasers for sheet phlogopite vary with the quality and with the degree of trimming and grading. Prices for well-graded good-quality small sheet are approximately as follows:

Size (inches)	Value ($ per lb)
1 x 1 and 1 x 2	0.70 to 1.00
1 x 3	0.90 to 1.10
2 x 3	1.20 to 1.30

Prices for larger sheet may be obtained from the buyer.

Clean scrap phlogopite sells for $20 to $25 a ton delivered at the plant.

Prices for mica in the United States, according to *E & M J Metal and Mineral Markets* of December 21, 1961, included:

Punch mica, per lb	$ 0.07-$ 0.12
Wet-ground mica, per short ton	$140.00-$155.00
Dry-ground mica, per short ton	$ 30.00-$ 55.00
Scrap mica, per short ton	$ 20.00-$ 30.00

66076-1—21½

Mineral Pigments and Fillers

J. S. Ross*

Few natural mineral pigments are now being recovered anywhere in the world. Those that are must be processed, at times by elaborate methods, to meet rigid specifications. They are derived from insoluble, inert, natural mineral products and are used to impart color or opacity to materials. Iron oxides are the only true natural mineral pigments produced in Canada. Such commodities as whiting, talc and barite are also produced but are commonly used as fillers and for whiteness simultaneously and not for color alone. Iron-oxide pigments have many applications in industry, but the amount consumed is small.

Natural mineral fillers, on the other hand, are numerous. They may be defined as industrial minerals that generally show a relative chemical inertness in their applications, impart desirable physical properties and take the place of more expensive materials in industrial products. The mineral fillers produced in Canada include asbestos, barite, bentonite and various other clays, cement, whiting and other types of limestone, mica, nepheline syenite, shale, silica, talc and diatomite. Aggregates for concrete and masonry products are types of filler. Some of these products also impart color and, on a smaller scale, serve as pigments but, because of their low hiding power and limited color range, are rarely used solely as pigments. Whiting is the only filler considered in detail in this review. Others are specifically dealt with elsewhere in this review series.

IRON OXIDE

Owing to a decrease in the needs of the gas-manufacturing industry and to competition in both quality and range of color from synthetic oxides, shipments of crude and calcined natural iron-oxide pigments again decreased appreciably in 1961. They amounted to 808 tons valued at $68,199. This was 11 per cent less in quantity than in 1960 and 94 per cent below the record total of 1950. In addition, synthetic oxide is produced chemically from non-mineral sources. The proportion between Canada's production of iron oxide

* Mineral Processing Division, Mines Branch.

TABLE 1

IRON OXIDES—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)				
Natural (crude and calcined)	808	68,199	909	76,780
Exports				
Natural and synthetic iron oxides				
United States	1,751	292,698	1,740	263,397
West Germany	203	37,184	125	22,176
France	93	16,573	137	24,682
Australia	53	9,174	260	52,027
Cuba	44	9,048	31	5,320
Other countries	64	11,492	230	37,017
Total	2,208	376,169	2,523	404,619
Imports				
Ochres, siennas, umbers				
United States	574	59,797	572	60,473
Britain	48	4,024	30	2,342
Spain	27	1,116	—	—
Sweden	—	—	13	664
Total	649	64,937	615	63,479
	1960		1959	
Consumption				
Coke and gas industries*			100	1,211
Paint industry				
Calcined and synthetic iron oxide	1,859	440,614	1,889	442,477
Ochres, siennas, umbers	150	48,241	138	40,281

SOURCE: Dominion Bureau of Statistics. *Not available after 1959.

from natural materials and the quantity used by the producer gas industry was constant until 1958 but then decreased sharply.

Exports of synthetic- and natural-iron-oxide pigments, which have been decreasing in recent years, amounted in 1961 to 2,208 tons valued at $376,169. Imports of ochres, siennas and umbers have also been diminishing and are of minor quantity.

Occurrences and Production

In Canada, pigment-grade iron oxide is known to occur only in bog deposits formed by the precipitation of iron oxides leached from ferruginous rocks and overburden. Many such bog deposits occur in Champlain county, Quebec, principally near Three Rivers. Several of these are worked by The Sherwin-Williams Company of Canada, Limited, the sole producer of iron-oxide pigment from natural sources. The ore is trucked to the company's mill at Red Mill, Quebec, air-dried, calcined when necessary, ground and sized. Much of the current output is exported.

In addition, bog iron oxide occurs in Laviolette county, Quebec; Colchester county, Nova Scotia; near New Westminster, British Columbia; and in other localities in British Columbia, Saskatchewan, Manitoba and Ontario.

TABLE 2

IRON OXIDES—PRODUCTION TRADE AND CONSUMPTION, 1951-61
(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
1951..........	13,342	1,470	4,552	3,646	10,310	2,946	249
1952..........	11,487	998	4,215	3,060	8,302	2,441	227
1953..........	10,308	1,171	5,258	3,048	7,989	2,456	243
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		1,859	150
1961..........	808	649	4,903	2,208			

SOURCE: Dominion Bureau of Statistics. * Partial. **Not available after 1959.

Uses and Specifications

Until 1958, the domestic output of refined bog iron oxide was consumed mainly by the coke and gas industries in the purification of manufactured gas. Most of the refined bog iron oxide now in use serves not as a pigment but as an abrasive for glass- and metal-polishing. Much of it is exported.

As pigments, the natural and synthetic varieties compete, but natural iron oxide has lost much of its popularity owing to the variety of qualities available in the synthetic product. Both types are extensively used in paints, rubber, linoleum, plastics, ceramics, concrete, mortar and oilcloth and in wood, paper, leather stains and other materials. Iron oxide is desired because of the variety and permanence of its color and its ability to inhibit the oxidation of metal surfaces. For pigmentary use it should either compare with a standard color or have tinting strengths that can be conditioned to compare with those of standards. The particle size should be less than 325-mesh, and the oil absorption should approximate that of a specific standard. The degree of opacity and hiding power is important. Chemical composition, within limits, is not.

Prices

E & M J Metal and Mineral Markets of December 21, 1961, quotes the price of ochre per ton, bagged, f.o.b. mills in Georgia, at $26.50 to $32. Natural iron oxide produced in Canada averaged $84.40 a ton, f.o.b. Red Mill, Quebec.

WHITING SUBSTITUTE

Whiting substitute is pulverized white or near-white limestone composed mainly of calcium carbonate. True whiting is ground chalk, whereas precipitated whiting or chalk is fine calcium-carbonate precipitate.

Only whiting substitute is produced in Canada. It comes chiefly from two deposits in Missisquoi county, Quebec. In 1961, shipments amounted to 14,301

TABLE 3

WHITING—PRODUCTION, IMPORTS AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
Stone processed for whiting	14,301	178,579	10,313	124,902
Imports[1]				
Whiting, gilder's whiting and paris white				
United States	3,949	183,217	4,210	189,221
Britain	2,613	39,281	2,629	44,940
France	1,846	10,865	1,996	16,346
Total	8,408	233,363	8,835	250,507
Consumption[2]				
Ground chalk, whiting and whiting substitute				
Explosives	—		156	
Pharmaceuticals	156		1,672	
Paints	16,970		16,071	
Soaps and toilet preparations	216		116	
Ceramics	1,470		922	
Linoleum, oilcloth and asbestos products	22,010[3]		15,442[3]	
Rubber goods	9,047[3]		8,398[3]	
Tanneries	357		305	
Gypsum products	5,632[3]		5,253[3]	
Adhesives	441		267	
Pulp and paper	2,799		1,939	
Miscellaneous chemicals	307		182	
Starch and glucose	13		69	
Miscellaneous	3,024		1,434	
Total	62,442[3]		52,226[3]	

SOURCE: Dominion Bureau of Statistics. [1]Import statistics for whiting substitute are not available. [2]These quantities are calculated from information provided by the Dominion Bureau of Statistics. [3]Includes some ground, off-white limestone.

short tons. In addition, a considerable amount of off-white limestone was produced in several provinces, and some of this was used as a lower-grade type of filler.

Whiting substitute is rarely exported, and the quantities involved are not reported separately. Imports consist of true and precipitated whiting and whiting substitute. In 1961, 8,408 tons of the true and precipitated varieties valued at $233,363 were imported, mainly from the United States and Britain. Separate import statistics for whiting substitute are also unavailable.

Uses

All types of whiting are used to improve physical characteristics or to replace more expensive materials in industrial commodities. Any type may be employed to increase opacity, smoothness, absorption and weight, or as a diluent. Whiting and whiting substitute are commonly used as white fillers because they are among the least expensive, but their opacity is low in comparison with that of such synthetic pigments as titanium dioxide, zinc oxide, lithopone and white lead. For these reasons, their filler properties are the

TABLE 4

WHITING—PRODUCTION, IMPORTS AND CONSUMPTION, 1951-61
(short tons)

	Production[1]	Imports[2]	Consumption[3]
1951	18,380	20,565	25,866
1952	17,527	11,986	25,554
1953	16,913	12,247	27,668
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]

SOURCE: Dominion Bureau of Statistics. [1]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.

most important. Pulverized limestone lacking the reflectivity of whiting is competitive in the manufacture of certain linoleum products and other uses.

Whiting is employed mainly as a filler in oil-base paints and as a pigment as well in cold-water paints. In these applications, color, particle size, chemical composition, bulk density and, for oil-base paints, oil absorption are important. This commodity is used in quantity as a filler in the preparation of floor tile, rubber products and oilcloth. Most of the calcium carbonate introduced into gypsum products would be classified as pulverized off-white limestone. In addition, whiting is employed in the manufacture of paper, pharmaceuticals, ceramics, adhesives, explosives, soaps and toilet preparations, leather products, starch and glucose, and many other chemicals and products. The physical and chemical characteristics important in these uses are similar to those required for paints.

SOME OTHER PIGMENTS

Synthetic pigments have largely replaced the natural types. Canada is a leading producer of synthetic iron-oxide pigments with Northern Pigment Company, Limited, New Toronto, Ontario, as the sole supplier. The bulk of the iron oxide consumed and exported in Canada is of the synthetic variety.

Canada is one of the leading world suppliers of titanium-dioxide pigments, although its plant capacity is small compared with that of the United States, the top-ranking producer. World capacity has been estimated at 1.1 million short tons for 1960.* In 1961, Canadian Titanium Pigments Limited completed a $6-million expansion program, thus increasing the capacity of its plant at Varennes, Quebec, which constitutes the whole of Canada's annual rated capacity, from 16,000 to 25,000 tons a year. This company produces refined titanium dioxide by the sulphuric-acid process from titania slag supplied by Quebec Iron and Titanium Corporation, of Sorel, Quebec. The slag is a derivative of ilmenite ore from near Havre St. Pierre, Quebec.

At Ville-de-Tracy, Quebec, British Titan Products (Canada) Limited is constructing a plant with an annual rated output of 22,000 tons of titanium-dioxide pigment. The plant which is to begin production in 1962, will employ a process similar to the Varennes operation, using slag from Sorel.

*U.S. Bureau of Mines, ***Minerals Yearbook 1960.***

Continental Titanium Corp., which in 1960 carried out preliminary construction work on a titanium-dioxide-pigment plant at Baie St. Paul, Quebec, proposes to obtain this pigment by producing 7,000 tons of ilmenite a year from nearby deposits. A continuous pressure-leaching process is to be employed.

Production statistics for titanium-dioxide pigment are not available. There were no exports reported as such in 1961. Imports and consumption of the commodity are given in Table 5.

TABLE 5

TITANIUM DIOXIDE—IMPORTS AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Imports				
Titanium dioxide and extended titanium-dioxide pigment				
United States	15,924	3,503,991	16,674	3,386,029
Britain	10,382	4,460,194	9,675	4,052,615
Italy	—	—	249	104,091
Belgium and Luxembourg	—	—	170	62,987
Czechoslovakia	103	36,324	106	35,972
Japan	209	65,253	22	6,584
Netherlands	2	871	—	—
West Germany	1	226	—	—
Total	26,621	8,066,859	26,896	7,648,278
Consumption				
Refined titanium dioxide				
Paints			16,334	
Pulp and paper			2,461	
Linoleum and coated products			1,860	
Rubber			766	
Synthetic textiles			46	
Toilet preparations			14	
Industrial chemicals			7	
Other chemicals			302	
Total			21,790	
Extended titanium-dioxide pigments				
Paints			13,986	

SOURCE: Dominion Bureau of Statistics.

Molybdenum

V. B. Schneider*

Shipments of molybdenum contained in molybdic oxide (MoO_3) and molybdenite (MoS_2) concentrates amounted in 1961 to 771,358 pounds valued at $1,092,201. The value increased by $76,821 despite a decrease of 1,724 pounds in shipments, thus reflecting a 12-per-cent price increase that became effective on June 1.

Free World production is estimated to have been slightly lower than in 1960, when an all-time high of 89 million pounds was reached.

The leading producer is American Metal Climax, Inc., which has its mine at Climax, Colorado. In 1961, the output at Climax amounted to 48,074,000 pounds of molybdenum, or slightly less than the record of 1960. Second in rank is Kennecott Copper Corporation, which in 1961 obtained 25,814,000 pounds of by-product molybdenite from its copper-mining operations in the United States and Chile.

In its annual report for 1961, American Metal Climax estimates that the year's Free World industrial demand for molybdenum reached a new high. The previous record year was 1960, when an estimated 73 million pounds were consumed.

Details of molybdenum production and consumption by the Soviet bloc are not available, but it is generally believed that Russia's production of molybdenum is sufficient for its domestic requirements. Substantial shipments of ferromolybdenum and molybdenite to western Europe were reported in 1961.

PRODUCTION

Canada

Molybdenite Corporation of Canada Limited was the sole Canadian producer of molybdenite in 1961. The company's property is at the junction of La Motte, Lacorne, Vassan and Malartic townships, 23 miles north of Val d'Or, Quebec. Bismuth is produced as a by-product. On October 1 ore reserves amounted to 260,477 tons that assayed 0.34 per cent MoS_2 and were blocked out or broken in stopes, plus 800,000 tons indicated. During the year, the concentrator, operating on a six-day week, treated an average of 730 tons of ore a day.

At Lacorne, Molybdenite Corporation operates a roasting plant to convert molybdenite to technical-grade molybdic oxide, the material from which all types of molybdenum salts and compounds are produced. Most molybdic oxide is used as a steel-alloying agent either included in the furnace charge or added to the molten metal. The company also operates a plant at Lacorne for the production of lubricant-grade molybdenum disulphide.

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* Mineral Resources Division.

TABLE 1

MOLYBDENUM—PRODUCTION, IMPORTS AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Production (shipments)[1]	771,358	1,092,201	767,621	1,015,380
Imports				
Molybdic oxide[2]				
United States	266,399	212,172	215,603	191,425
U.S.S.R.	—	—	440,459	404,544
Total	266,399	212,172	656,062	595,969
Calcium molybdate (grouped with vanadium oxide and tungsten oxide for the manufacture of steel)				
United States	44,662	84,135	236,936	332,248
Ferromolybdenum				
United States[3]	211,779	323,725	230,600	256,265
Consumption (Mo content)				
By type				
Molybdic oxide	703,520		612,000	
Ferromolybdenum	354,520		358,000	
Calcium molybdate	*		16,000	
Sodium molybdate	*		37,947	
Molybdenum metal	4,166		3,584	
Molybdenum wire	5,821		3,763	
Other forms[4]	67,583		10,783	
Total	1,135,610		1,042,077	
By end-use				
Ferrous and nonferrous alloys	1,066,040		1,004,000	
Lubricants and pigments	53,538		21,377	
Electrical and electronic products	5,829		3,788	
Unspecified	10,203		12,912	
Total	1,135,610		1,042,077	

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 in its *United States Exports of Domestic and Foreign Merchandise* (Report 410, Part II). Imports of ferromolybdenum are not available separately in official Canadian trade statistics. [4] Molybdic acid, molybdenum disulphide, ammonium molybdate and barium molybdate, and in 1961 calcium molybdate and sodium molybdate.
* Included under 'Other Forms'.

Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada Limited, holds a substantial interest, owns 3,550 acres in Preissac township, Quebec. In 1960 electric power was brought to the property, and a headframe for a new three-compartment shaft was erected. Early in 1961, shaft-sinking operations begun in 1960 were completed to a depth of 615 feet. The company expects that a 1,200-ton mill and a roasting plant will be in operation in 1963. Ore reserves are reported to total 2,400,000 tons.

Anglo-American Molybdenite Mining Corporation continued development and exploration work on its property about 5 miles north of Cadillac, in Preissac township. Shaft-sinking operations were completed to 375 feet, and stations were cut at the 150-foot and 300-foot horizons.

TABLE 2

MOLYBDENUM—PRODUCTION, TRADE AND CONSUMPTION, 1951-61
(pounds)

	Production[1]	Exports[2]	Imports			Consumption[6]
			Calcium Molybdate[3]	Molybdic Oxide[4]	Ferromolybdenum[5]	
1951.....	228,958	[7]	62,364	566,334	315,394	662,000
1952.....	303,578	[7]	169,392	520,104	439,476	709,271
1953.....	194,344	[7]	197,758	358,124	201,626	548,455
1954.....	451,450	[7]	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[8]	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	[7]	236,936	656,062	230,600	1,042,077
1961.....	771,358	[7]	46,648	266,399	211,779	1,135,610

SOURCE: Dominion Bureau of Statistics. [1] From 1951 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] 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] Not available. [8] 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.

Noranda Mines, Limited, commenced a pilot-plant study at Gaspe Copper Mines, Limited, a wholly-owned subsidiary, to investigate the economics of recovering by-product molybdenum. In October, Noranda announced that it intended to examine its Mount Boss, British Columbia, property by underground exploration to confirm surface diamond-drilling results. The company acquired an option on the Mount Boss property of H. H. Huestis and associates in March 1961, American Metal Climax, Inc., having terminated its option in January.

United States

In 1961, the production and consumption of molybdenum, at 66.6 million and 66.7 million pounds* respectively, were only slightly below the all-time highs of 1960. Exports of molybdenum in concentrates and molybdic oxide, at 35.7 million pounds of contained molybdenum, were higher than in any previous year. Exports of ferromolybdenum, at 358,523 pounds,* were slightly less than in 1960. Year-end producers' stocks of molybdenum products were generally lower than those of the previous year.

Molybdenum concentrates were produced in six states with Colorado leading, followed by Utah, Arizona, California, New Mexico and Nevada.*

Molybdenum Corporation of America continued exploration of its molybdenite deposit at Questa, Taos county, New Mexico. The deposit is low-grade but is reported to contain hundreds of millions of tons, which could well make it second in size in the world only to the Climax mine.

The big deposit at Climax, Colorado, first explored in 1917, is at the site of the world's leading producer and is the only United States mine operated chiefly for molybdenum. Among the major producers of by-product molybdenum, are Kennecott Copper Corporation, Bagdad Copper Corporation, Phelps

* U.S. Bureau of Mines, *Mineral Industry Surveys*, "Molybdenum Report," August 1962.

Dodge Corporation, San Manuel Copper Corporation, Union Carbide Nuclear Company, American Smelting and Refining Company and Duval Sulphur and Potash Company.

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.

Chile

Chile is second in the Free World as a producer of molybdenum, all of which is obtained as a by-product of the country's 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 on 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.

Other Countries

Japan, Norway and Yugoslavia are minor producers. China, North Korea and the Union of Soviet Socialist Republics also produce molybdenum, but data on their output are not available. Recent reports indicate 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 the provinces of Shansi and Kirin. The United States Bureau of Mines has estimated that Russian production totalled 9.9 million pounds in 1959 and 11 million in 1960. This would place Russia second to the United States, with an annual output a little less than three times that of Chile.

TABLE 3

WORLD PRODUCTION OF MOLYBDENUM IN ORES AND CONCENTRATES
(short tons)

	1961	1960
United States	33,282	34,118
U.S.S.R.	5,950	5,500
Chile	1,850	2,220
China	1,650	1,650
Japan	414	420
Canada	386	384
Norway	275	271
Other countries	143	187
Total	43,950	44,750

SOURCES: Dominion Bureau of Statistics; U.S. Bureau of Mines, *Mineral Trade Notes*, August 1962.

CONSUMPTION AND USES

About 70 per cent of the molybdenum consumed is in the form of molybdic oxide, which is followed 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 throughout heavy 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 in high-temperature applications and is used extensively in the electronics industry and for missile parts that have a short working life; but the solid-fuel rocket engines now being designed 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, in the hydrogenation of coal and shale oils to produce liquid fuels and in desulphurization. About 55 per cent of the molybdenum consumed by the pigment industry is employed in the production of molybdenum orange. The use of molybdenum as a trace element in agriculture, 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 own particular alloying properties but 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	1960	1959
Steel			
High-speed	1,740	1,756	2,488
Other alloys	21,202	19,480	19,091
Miscellaneous[1]	592	613	764
Gray and malleable castings	2,578	2,757	3,182
Rolls (steelmills)	953	1,152	1,028
Welding rods	245	259	233
High-temperature alloys	1,398	1,346	1,333
Molybdenum metal (wire, rod and sheet)	1,476	2,336	2,206
Chemicals			
Catalysts	370	372	236
Pigments and other color compounds	831	856	901
Miscellaneous[2]	1,236	910	888
Total	32,621	31,837	32,350

SOURCE: U.S. Bureau of Mines, *Minerals Yearbook*. [1] Includes castings as well as hot-work and tool steels. [2] 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 Limited, Welland; The Algoma Steel Corporation, Limited, Sault Ste. Marie; Dominion Foundries and Steel, Limited, Hamilton; Welland Electric Steel Foundry, Limited, Welland; Canadian General Electric Company Limited, Toronto; The Steel Company of Canada, Limited, Hamilton; and Dominion Colour Corporation Limited, New Toronto; in Quebec—L'Air Liquide, Montreal; 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 28, 1961 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 (effective June 1, 1961), cost of container 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

Canada	British Preferential	Most Favored Nation	General
Calcium molybdate and molybdic oxide	free	free	5%
Molybdenum strip	free	free	30%
Molybdenum wire, rod, and tubing and molybdenum imported by manufacturers of radio tubes and parts	free	free	30%
Ferromolybdenum	free	5%	5%
Molybdenum ores and concentrates	free	free	free

United States	
Molybdenum ores and concentrates per lb contained Mo.	30¢
Calcium molybdate, ferromolybdenum, metallic molybdenum, molybdenum powder and all other alloys and compounds of molybdenum, per lb contained Mo	25¢ plus $7\frac{1}{2}$% ad valorem
Molybdenum bars, ingots, sheets, shot, wire and other forms not specifically provided for, and scrap containing more than 50% molybdenum carbide, or combinations thereof	
Bars, ingots, scrap,* shot	21%
Other forms	$25\frac{1}{2}$%

* Duty on scrap suspended June 30, 1962.

Natural Gas

D. W. Rutledge*

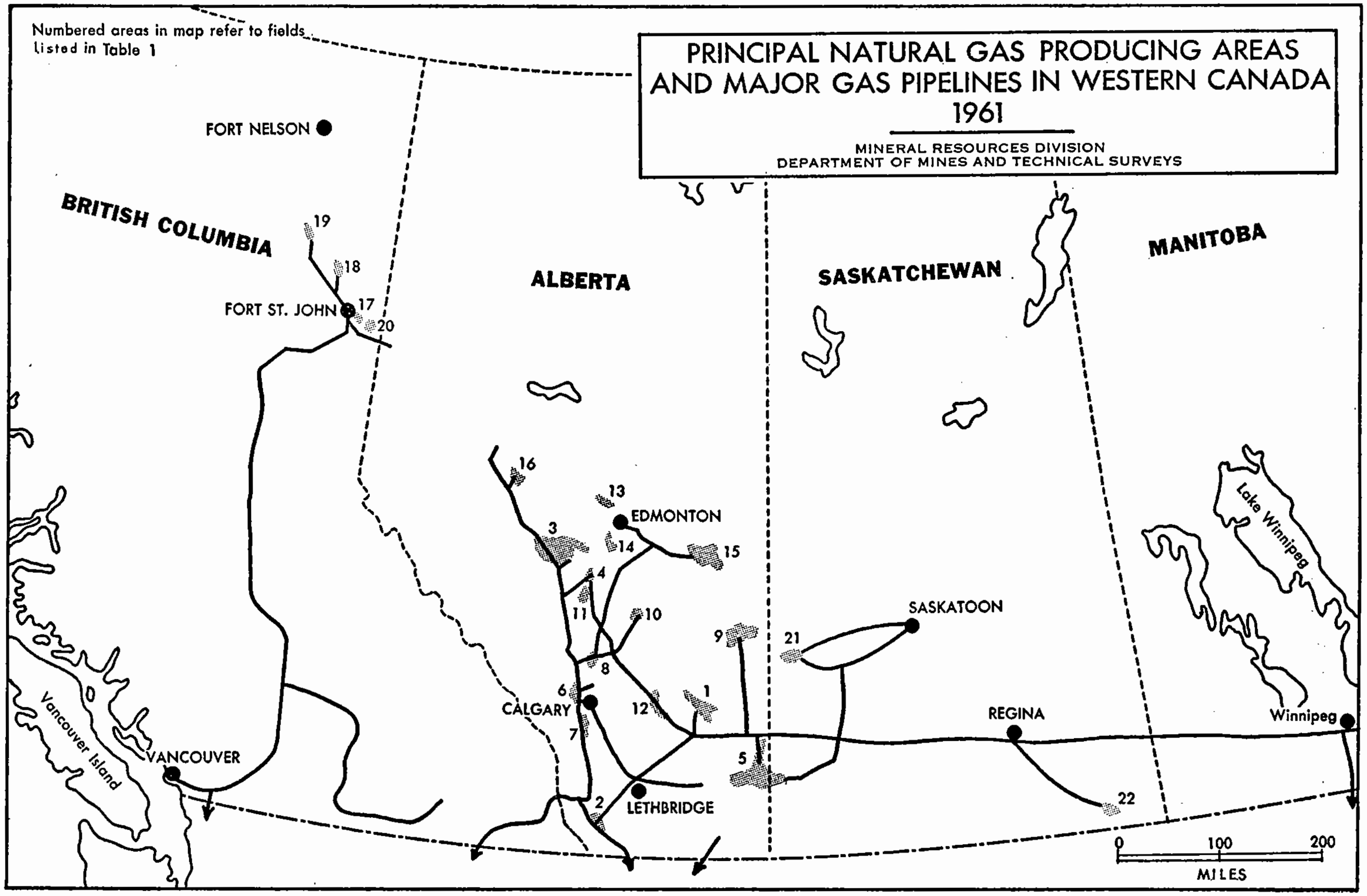
The year was marked by important capital investment and a large production increase in Canada's natural-gas industry. The main cause of this renewal of activity was the authorization given by the governments of Canada and the United States in 1960 for the movement of large volumes of Canadian natural gas to the United States. The issuance of export permits resulted in the building of a gas pipeline from Alberta to California and the construction of additional gathering facilities in Alberta. This first full year of operation of the gas-export pipeline of Trans-Canada Pipe Lines Limited, which crosses the International Boundary at Emerson, Manitoba, greatly benefited Canadian gas producers.

PRODUCTION

In 1961 the net new production of natural gas, exclusive of gas flared and wasted, increased 25.4 per cent to 655,738 million cubic feet, or 1,796 million cubic feet a day. Alberta produced nearly 76.4 per cent, British Columbia 15.7 per cent, Saskatchewan 5.7 per cent and Ontario 2.2 per cent. New Brunswick and the Northwest Territories produced comparatively minor quantities, and Manitoba had no commercial production. Output increased 30.5 per cent in Alberta, 20.4 per cent in British Columbia, 4.8 per cent in the Northwest Territories and 1.7 per cent in Saskatchewan. Output decreased 14.4 per cent in Ontario and 2.4 per cent in New Brunswick.

(text continued on page 246)

*Mineral Resources Division.


Numbered areas in map refer to fields listed in Table 1
PRINCIPAL NATURAL GAS PRODUCING AREAS AND MAJOR GAS PIPELINES IN WESTERN CANADA
1961
MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
FORT NELSON
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
FORT ST. JOHN
19
18
17
20
16
13
EDMONTON
3
14
15
4
11
10
9
21
SASKATOON
8
6
CALGARY
12
1
7
REGINA
Winnipeg
Lake Winnipeg
Vancouver Island
VANCOUVER
5
2
LETHBRIDGE
22
0
100
200
MILES

66076-1—22

TABLE 1

NATURAL-GAS FIELDS PRODUCING 10,000,000 MCF[1] OR MORE

('000 cubic feet)

	1961	1960
	(gross reservoir withdrawals)	
Alberta		
Cessford (1)[2]	46,609,048	31,209,841
Pincher Creek (2)	46,456,637	46,039,637
Pembina (3)	34,427,668	34,521,769
Westerose South (4)	31,476,682	823,963
Medicine Hat (5)	25,431,249	18,211,114
Jumping Pound (6)	24,437,709	25,704,254
Turner Valley (7)	23,838,913	22,510,342
Carstairs (8)	23,454,855	15,626,175
Provost (9)	22,054,307	16,993,343
Nevis (10)	17,993,352	13,588,697
Homeglen-Rimbey (11)	16,873,574	1,270,791
Hussar (12)	16,595,197	12,635,865
Alexander (13)	14,308,502	14,155,709
Leduc-Woodbend (14)	13,909,231	12,393,867
Viking-Kinsella (15)	12,434,416	13,463,300
Windfall (16)	11,385,648	6,470,604
British Columbia		
Fort St. John (17)	12,689,371	14,302,426
Buick Creek West (18)	11,161,782	14,173,416
Jedney (19)	10,894,047	11,386,147
Fort St. John Southeast (20)	9,825,779	12,459,104
Saskatchewan		
Coleville-Smiley (21)	15,169,169	15,615,677
Steelman (22)	18,277,492	15,534,036

SOURCE: Provincial-government reports.

[1]Mcf=1,000 cubic feet.

[2]The numbers in parentheses locate the fields on the accompanying map.

TABLE 2

PRODUCTION OF NATURAL GAS[1]

	1961		1960	
	Mcf[2]	$	Mcf[2]	$
Gross new production[3]				
New Brunswick	96,318		98,701	
Ontario	14,544,165		16,987,056	
Saskatchewan	58,414,635		52,811,896	
Alberta	559,422,522		428,076,175	
British Columbia	103,916,428		86,376,327	
Northwest Territories	41,678		39,785	
Total, Canada	736,435,746		584,389,940	
Waste and Flared				
Saskatchewan	21,222,040		16,240,263	
Alberta	58,578,622		44,393,189	
British Columbia	897,440		784,161	
Total, Canada	80,698,102		61,417,613	
Net new production[4]				
New Brunswick	96,318	143,215	98,701	151,603
Ontario	14,544,165	5,614,048	16,987,056	6,573,990
Saskatchewan	37,192,595	4,050,274	36,571,633	3,722,992
Alberta	500,843,900	48,882,365	383,682,986	34,148,675
British Columbia	103,018,988	9,714,690	85,592,166	7,587,403
Northwest Territories	41,678	17,326	39,785	12,219
Total, Canada	655,737,644	68,421,918	522,972,327	52,196,882

SOURCE: Dominion Bureau of Statistics, Department of Northern Affairs and National Resources, provincial government reports.

[1]14.65 pounds per square inch absolute, but 14.414 for Alberta and British Columbia in 1960.

[2]Mcf = 1,000 cubic feet.

[3]Excludes withdrawals from storage.

[4]Derived by subtracting waste and flared from gross new production.

Table 3

VALUE OF GAS PRODUCTION, 1958-61

	1958		1959		1960		1961	
	Total Value ($)	Value per Mcf[1] Average (¢)	Total Value ($)	Value per Mcf[1] Average (¢)	Total Value ($)	Value per Mcf[1] Average (¢)	Total Value ($)	Value per Mcf[1] Average (¢)
Alberta	20,080,166[2]	8.4[2]	24,995,790	8.4	34,148,675	8.9	48,882,365	9.8
British Columbia	3,915,239	6.15	4,558,023	6.6	7,587,403	8.9	9,714,690	9.4
Saskatchewan	1,881,980	10.0	3,327,684	9.9	3,722,992	10.1	4,050,274	10.9
Northwest Territories	8,197	34.0	22,718	33.8	12,219	30.7	17,326	41.6
Ontario	5,974,755	37.0	6,516,784	38.7	6,573,990	38.7	5,614,048	38.6
New Brunswick	197,199	159.0	188,394	160.3	151,603	154.0	143,215	148.7
Total, Canada	32,057,536	9.5	39,609,393	9.5	52,196,882	10.0	68,421,918	10.4

Source: Dominion Bureau of Statistics.

[1]Mcf=1,000 cubic feet.

[2]Includes the value of gas withdrawn from storage in 1958.

TABLE 4

NATURAL GAS—PRODUCTION, TRADE AND SALES, 1950-61

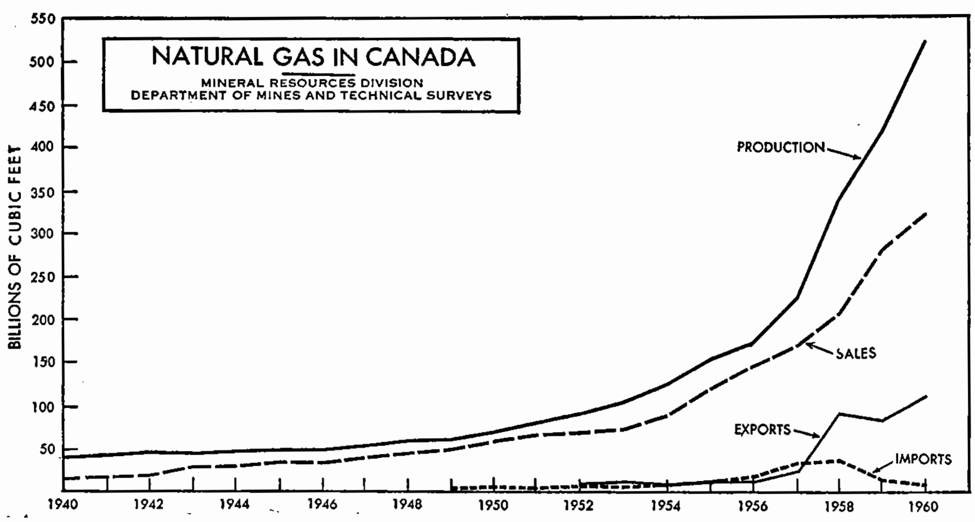
('000 cubic feet)

	Production	Imports	Exports[1]	Sales[2]
1950	67,822,230	3,253,523		58,098,290
1951	79,460,667	3,698,763		65,056,253
1952	88,686,465	5,981,635		66,005,785
1953	100,985,923	6,097,001		70,667,965
1954	120,735,214	6,235,859		87,466,838
1955	150,772,312	11,165,756		117,800,311
1956	169,152,586	15,695,359		143,725,649
1957	220,006,682	30,550,944	15,731,072	168,783,456
1958	337,803,726	34,716,151	86,971,932	206,553,170
1959	417,334,527	11,962,811	84,764,116	283,230,089
1960	522,972,327	5,570,949	91,045,510	325,609,411
1961	655,737,644	5,574,355	168,180,412	377,064,902

SOURCE: Dominion Bureau of Statistics: production and sales—*The Crude Petroleum and Natural Gas Industry;* imports and exports—*Trade of Canada.*

[1]Export statistics are not available for the years preceding 1957.

[2]For further details on the disposition of natural gas in 1960 and 1961, see Table 11.



EXPLORATION AND DEVELOPMENT

British Columbia

In 1961, exploratory drilling in British Columbia decreased slightly, in both the number of wells and the footage drilled. The 77 exploratory wells resulted in 42 dry holes, but 26 natural-gas discoveries were made, compared with 22 in 1960. At least three of the gas discoveries are important. Pan American Beaver River d-73-K intersected 960 feet of net pay zone in Devonian carbonate below 12,380 feet to become Canada's deepest gas well. The discovery is immediately south of the Yukon boundary 16 miles west of the Liard River. Hudson's Bay Cypress b-27-F intersected a Triassic gas zone in a comparatively unexplored region 30 miles west of the Blueberry field. Devonian gas was found by Texaco N.F.A. Tsea b-68-K, 20 miles south of the Petitot River gas wells.

In development drilling, 38 gas wells were completed, more than twice as many as in 1960. Development drilling was the most active in the Beg field, which was extended 6 miles to the northwest. At the end of the year, northeastern British Columbia had 293 gas wells capable of production, but many were isolated from market areas by a lack of pipelines.

Alberta

Most of Alberta's 113 natural-gas discoveries of 1961 are in the southern and western parts of the province. Although no major gas fields were indicated, several discoveries are considered moderately important. Hudson's Bay-Union Kaybob 11-27-62-20W5, a well 5 miles southwest of the Kaybob field, encountered two gas-productive horizons—the Devonian Beaverhill Lake and the Lower Cretaceous Cadomin. Drilling in the southern Foothills resulted in two noteworthy gas discoveries. Shell Jumping Pound West 11-5-26-6W5 found a Mississippian gas pool 6 miles west of the Jumping Pound field; and 20 miles northwest of it Imperial Benjamin 11-33-28-7W5 also made a Mississippian gas discovery. Development drilling resulted in 231 gas-well completions, many more than in 1960. The Medicine Hat field gained the largest number of wells through development drilling. It was followed by the Provost, Calgary and Hussar fields. At the end of the year, Alberta had 1,088 gas wells capable of production, or 138 more than a year previously.

Saskatchewan and Manitoba

Two small natural-gas discoveries were made in southwestern Saskatchewan near the Alberta boundary. Only five gas-development wells were completed during the year. Much of the province's natural gas is produced, however, as solution gas from oil wells, notably in the Steelman field, where 17 new oil wells were completed. In Manitoba, no gas wells were drilled and the commercial production of natural gas remained nonexistent.

Northwest Territories and Yukon Territory

Fifteen wells were completed in the northern territories, 14 of which were dry. The gas discovery, Imperial Sun Netla F-7, was drilled 50 miles north of the British Columbia boundary between the Liard River and Trout Lake. The first deep exploratory well was drilled in the Arctic Islands to test one of the many structures in their potentially oil- or gas-bearing Paleozoic rocks. The well, Dome et al Winter Harbour No. 1, did not find oil, but small accumulations of gas were encountered at comparatively shallow depths.

TABLE 5

WELLS COMPLETED,* 1960 and 1961

	Gas Wells		Oil Wells		Dry and Abandoned Holes		Total	
	1961	1960	1961	1960	1961	1960	1961	1960
Alberta	344	276	783	985	445	443	1,572	1,704
Saskatchewan	7	10	484	444	152	161	643	615
Manitoba	—	—	11	52	16	14	27	66
British Columbia	64	37	88	47	55	66	207	150
Northwest Territories and Yukon Territory	1	2	—	—	14	30	15	32
Total, western Canada	416	325	1,366	1,528	682	714	2,464	2,567
Ontario	81	92	55	49	114	125	250	266
Quebec	17	—	—	—	40	5	57	5
Maritimes	—	—	—	—	—	3	—	3
Total, eastern Canada	98	92	55	49	154	133	307	274
Total, Canada	514	417	1,421	1,577	836	847	2,771	2,841

SOURCE: Provincial-government reports and Department of Northern Affairs and National Resources
*Service wells excluded.

Table 6

FOOTAGE DRILLED IN CANADA, BY PROVINCES, 1960 AND 1961[1]

	Exploratory	Development	All Wells
		1961	
Alberta	2,956,024	6,986,248	9,942,272
Saskatchewan[2]	456,681	1,861,377	2,318,058
British Columbia	428,868	645,474	1,074,342
Manitoba	29,347	32,281	61,628
Northwest Territories and Yukon Territory	74,337	—	74,337
Total, western Canada	3,945,257	9,525,380	13,470,637
Ontario	161,758	201,014	362,772
Quebec	17,588	3,645	21,233
Maritimes	—	—	—
Total, eastern Canada	179,346	204,659	384,005
Total, Canada	4,124,603	9,730,039	13,854,692
		1960	
Alberta	2,938,449	7,210,648	10,149,097
Saskatchewan[3]	549,765	1,781,701	2,331,466
British Columbia	472,478	294,120	766,598
Manitoba	36,875	110,073	146,948
Northwest Territories and Yukon Territory	102,756	—	102,756
Total, western Canada	4,100,323	9,396,542	13,496,865
Ontario	184,080	217,761	401,841
Quebec	4,288	—	4,288
Maritimes	22,863	—	22,863
Total, eastern Canada	211,231	217,761	428,992
Total, Canada	4,311,554	9,614,303	13,925,857

Sources: Provincial-government departments and agencies; for Manitoba, Canadian Petroleum Association; for Quebec and the Maritimes, *Canadian Oil & Gas Industries*, April 1962 and April 1961; for territories, Dept. of Northern Affairs and National Resources.

[1]For oil and gas. Service wells included.

[2]Excludes 67,979 feet of water-source and gas-storage drilling.

[3]Excludes 12,774 feet of water-source drilling.

Eastern Canada

In Ontario, 267 wells including service wells were completed in 1961, compared with 306 in 1960. The average well depth was 1,359 feet, or slightly more than in 1960. Eleven gas discoveries were made, nine of them in Silurian strata. Seventy gas-development wells were completed, most of them as Silurian producers. Eight exploratory and 28 development wells were drilled in Lake Erie.

An unusually large number of wells were drilled in Quebec as a result of new interest in gas accumulations in Pleistocene drift. Fifty-seven exploratory and development wells were drilled, many of them in the region around the small Pointe du Lac gas field near Three Rivers. Most of the holes were between 150 and 500 feet in depth; 40 of them were dry. One deep Silurian test on the Gaspé Peninsula encountered no reservoir beds.

RESERVES

The Canadian Petroleum Association's compilation shows that after allowance for the year's production Canada's reserves of natural gas increased in 1961 by 2,863,798 million cubic feet to a year-end recoverable total of 33,537,850 million cubic feet. The Alberta Oil and Gas Conservation Board estimated Alberta's marketable reserves at 31,227,000 million cubic feet, a little more than the Canadian Petroleum Association estimate of recoverable reserves shown in Table 7. The difference arises mainly because the Conservation Board allows for some reserves in 'probable areas.' Significant deductions from reserves were made by the Conservation Board in the Pincher Creek, Savanna Creek and Carstairs fields, while important additions were made to reserves in the Crossfield East, Carson Creek, and Minnehik-Buck Lake fields. The Crossfield and Medicine Hat fields are the province's largest.

TABLE 7

ESTIMATED YEAR-END RECOVERABLE RESERVES OF NATURAL GAS

(millions of cubic feet)

	1961	1960
Alberta	28,370,122	26,014,370
British Columbia	3,618,629	3,097,930
Saskatchewan	1,264,227	1,305,759
Eastern Canada	221,062	217,068
Northwest Territories	62,563	37,366
Manitoba	1,247	1,559
Total	33,537,850	30,674,052

SOURCE: Canadian Petroleum Association.

TRANSPORTATION

The highlight of the year in the natural-gas transportation sector was the completion of the Alberta-California gas pipeline. The main line consists of 1367 miles of large-diameter pipe, all 36-inch except the most northerly 126-mile section, which is 30-inch. In addition, 221 miles of gathering lines were built in Alberta to serve the new pipeline. The Alberta Gas Trunk Line Company owns the Alberta section of the system, which extends from near Whitecourt, about 105 miles northwest of Edmonton, to the Crowsnest Pass. The 106-mile section that crosses southeastern British Columbia from the Crowsnest Pass to Kingsgate is owned by Alberta Natural Gas Company. The two companies that use the pipeline—Alberta and Southern Gas Co. Ltd. and Westcoast Transmission Company Limited—have been authorized to export a maximum of 610.75 million cubic feet a day at the boundary between British Columbia and Idaho.

The Alberta Gas Trunk Line Company also completed a 66-mile pipeline from the Waterton and Pincher Creek fields to the Montana boundary near Cardston, Alberta. Canadian-Montana Pipe Line Company has a permit to export a maximum of 36 million cubic feet a day via this route. The export line of Trans-Canada Pipe Lines Limited that runs through Emerson, Manitoba, had its first full year of operation, carrying 59,139 million cubic feet out of the country. Saskatchewan Power Corporation, which, as in previous years, was the principal builder of gas pipelines in Saskatchewan, installed an 88-mile line from Hatton to Success and added smaller lines elsewhere.

TABLE 8

GAS-PIPELINE MILEAGE IN CANADA, 1956-61

	1956	1957	1958	1959	1960	1961
Gathering*						
New Brunswick	10	11	11	6	6	6
Ontario	851	941	940	955	910	1,315
Saskatchewan	99	92	311	280	285	274
Alberta	948	972	1,634	1,860	2,075	2,852
British Columbia	6	120	213	335	410	429
Total	1,914	2,136	3,109	3,436	3,686	4,876
Transmission*						
New Brunswick	11	11	11	15	15	14
Quebec	—	26	26	25	25	25
Ontario	1,284	2,520	3,466	3,530	3,565	3,135
Manitoba	—	354	375	390	445	457
Saskatchewan	635	1,093	1,395	1,780	2,100	2,274
Alberta	1,797	2,127	2,581	3,095	3,460	4,088
British Columbia	37	1,101	1,101	1,105	1,105	1,225
Total	3,764	7,232	8,955	9,940	10,715	11,218
Distribution						
New Brunswick	65	65	65	30	30	32
Quebec	—	963	971	1,025	1,115	1,124
Ontario	4,667	5,770	8,095	9,145	9,530	10,184
Manitoba	146	433	510	690	835	854
Saskatchewan	339	879	947	1,060	1,205	1,273
Alberta	1,879	2,075	2,202	2,455	2,560	2,896
British Columbia	925	1,902	2,380	2,710	3,135	3,183
Total	8,021	12,087	15,170	17,115	18,410	19,546

SOURCE: Dominion Bureau of Statistics.

*Some lines in Ontario and Saskatchewan were reclassified or discontinued in 1961, and some in New Brunswick were discontinued.

PROCESSING OF NATURAL GAS

In 1961, natural gas processing facilities were again greatly expanded, although fewer new gas-processing plants went on stream than in 1960. More emphasis was placed on the building of very large plants than in previous years. Large-scale expansion was completed on the Carstairs gas plant, and construction was finished on a major plant at Balzac, near Calgary. Several other large plants were nearing completion as the year ended. Most of the new plants are, or will be, serving the recently completed Alberta-California and Alberta-Montana pipelines. At the end of the year, 68 plants were in operation, of which Alberta had 60, Saskatchewan five, British Columbia two and Ontario one. The daily throughput capacity for raw gas was 2,759 million cubic feet, 43 per cent greater than a year previously.

TABLE 9

NATURAL GAS PROCESSING PLANTS IN OPERATION AT END OF 1961

(millions of cubic feet a day)

Fields Served	Raw-gas Capacity	Residue Gas Produced
Alberta		
Acheson	5	4
Alexander	55	52
Black Butte	10	10
Bonnie Glen, Glen Park, Wizard Lake	30	24
Calgary	150	125
Carbon	67	65
Carstairs, Crossfield	225	200
Cessford	125	120
Cessford	22	20
Cessford	12	12
Cessford	8	8
Chigwell	3	3
Clive	8	7
Countess	18	17
Enchant	5	5
Gilby	18	17
Gilby	15	14
Harmattan-Elkton	15	12
Homeglen-Rimbey, Westerose South	326	280
Hussar, Chancellor	60	60
Innisfail	15	10
Jumping Pound	110	90
Leduc-Woodbend	35	31
Makepeace	20	20
Minnehik-Buck Lake	55	50
Morinville, St. Albert-Big Lake, Campbell-Namao	25	25
Nevis	50	43
Nevis, Stettler, Fenn-Big Valley	35	24
Okotoks	30	13
Oyen	3	3
Pembina (group of nine plants)	96	77
Pembina	8	6
Pincher Creek	204	145
Prevo	4	4
Princess	22	21
Princess	13	12
Princess	4	4
Princess	3	3
Provost	90	85
Provost	17	12
Redwater	11	8
Samson	3	3
Sedalia	5	5
Sibbald	6	5
Three Hills	5	5
Turner Valley	100	87
Wayne-Rosedale	10	10
Wayne-Rosedale	6	5
Wildcat Hills	40	35
Windfall	30	0
Wood River	5	5

TABLE 9 (Cont'd)

Fields Served	Raw-gas Capacity	Residue Gas Produced
Saskatchewan		
Alida, Nottingham, Carnduff	9	6
Coleville	60	56
Smiley	4	3
Steelman	33	26
Success	25	24
British Columbia		
Fields in Fort St. John area	365	330
Boundary Lake	10	10
Ontario		
Fields in southwestern Ontario	16	16

SOURCE: Department of Mines and Technical Surveys, *Natural Gas Processing Plants in Canada* (Operators List 7), January 1962.

TABLE 10

PRODUCTION OF BY-PRODUCTS FROM NATURAL GAS (ALBERTA, SASKATCHEWAN AND BRITISH COLUMBIA), 1951-61

	Propane (barrels)	Butane (barrels)	Natural Gasoline[1] (barrels)	Plant Condensate (barrels)	Sulphur[2] (short tons)
1951	248,554	84,527	515,027	—	—
1952	337,678	140,228	579,873	—	8,931
1953	433,083	198,401	602,771	—	18,298
1954	529,117	245,189	682,378	18,083	22,320
1955	796,482	492,051	868,416	160,100	29,093
1956	925,716	591,638	913,572	164,573	33,464
1957	1,111,355	747,709	968,162	153,278	100,706
1958	1,123,797	748,972	978,085	116,568	184,930
1959	1,690,114	1,424,452	1,396,979	862,434	292,337
1960	2,064,623	1,536,621	1,444,687	1,015,962	453,142
1961	2,875,823	2,157,309	1,875,001	3,569,033	546,201

SOURCE: Provincial-government reports.
[1]Partly a by-product of crude-oil production.
[2]Elemental sulphur from natural gas.

MARKETS AND TRADE

In 1961, exports and domestic sales of natural gas increased by 50 and 16 per cent, respectively, compared with 35 and 15 per cent in 1960. Industrial sales accounted for 52.3 per cent of domestic sales, and residential sales for 32.4 per cent. The remaining sales were to commercial and miscellaneous customers. Alberta continued as the leading user of natural gas, accounting for

TABLE 11

NATURAL GAS—SUPPLY AND DEMAND

(millions of cubic feet)[1]

	1961		1960	
Supply				
Gross new production[2]	732,460		574,063	
Field waste and flared gas	−80,262		−60,598	
Net new production		652,198		513,465
Removed from storage	23,688		27,443	
Placed in storage	−51,074		−37,117	
Net withdrawals from storage		−27,386		−9,674
Net supply of domestic gas		624,812		503,791
Imports		5,574		5,551
Total supply		630,386		509,342
Demand				
Exports		168,180		112,484
Residential sales	122,030		110,133	
Industrial sales	197,282		164,234	
Commercial sales	57,648		51,122	
Miscellaneous sales	105		121	
Total, domestic sales		377,065		325,610
Production uses and losses, pipeline consumption[3]		70,616		67,670
Losses and metering differences		13,204		5,972
Line-pack changes		1,317		− 1
Residual error		+4		−2,393
Total demand		630,386		509,342
Total domestic consumption[4]		462,206		396,858
Average daily domestic consumption		1,266		1,084

SOURCES: For 1961—Dominion Bureau of Statistics, National Energy Board and provincial-government reports; for 1960—Dominion Bureau of Statistics, *Gas Utilities (Distribution Systems) 1960.*

[1]Pressure data are standardized to 14.73 pounds per square inch absolute.

[2]Excludes gas reproduced from storage.

[3]Consumption and losses: The Alberta total comprises lease fuel, fuel returned to lease, plant fuel and waste, process shrinkage, gathering-line losses and metering differences; the Saskatchewan total comprises field fuel, gas injection and lift, and miscellaneous uses and losses; the British Columbia total comprises lease use, plant waste and fuel, process shrinkage, gathering-line losses and metering differences.

[4]The total demand (630,386 and 509,342) minus exports (168,180 and 112,484).

38.7 per cent of all domestic sales. Ontario customers continued to increase their share of the Canadian market, buying 33.2 per cent of the 377,065 million cubic feet sold in Canada, compared with 32.1 per cent of the amount sold in 1960.

Exports totalled 168,180 million cubic feet. Their substantial rise is attributable to two main factors: the first full year of operation of the Manitoba export pipeline of Trans-Canada Pipe Lines Limited and the start, in December, of deliveries through the Alberta-California pipeline.

TABLE 12

SALES OF NATURAL GAS IN CANADA, 1961

	Mcf*	$	Average $/Mcf*	Number of Customers Dec. 31, 1961
New Brunswick	88,359	248,027	2.81	2,968
Quebec	24,210,359	20,360,915	0.84	236,042
Ontario	125,130,845	111,053,131	0.89	519,232
Manitoba	16,488,802	10,387,702	0.63	46,342
Saskatchewan	35,438,012	15,825,306	0.45	75,619
Alberta	146,083,994	42,003,514	0.29	213,700
British Columbia	29,624,530	26,799,899	0.90	133,755
Total, Canada	377,064,901	226,678,494	0.60	1,227,658
Previous totals				
1960	325,609,411	194,422,714	0.60	1,149,101
1959	283,230,089	159,781,809	0.56	1,062,976
1958	206,553,170	115,242,246	0.56	1,035,591

SOURCE: Dominion Bureau of Statistics.
*Mcf=1,000 cubic feet.

TABLE 13

SALES OF NATURAL GAS IN CANADA, ON PERCENTAGE BASIS

	1961	1960
Alberta	38.74	43.64
Ontario	33.19	32.08
Saskatchewan	9.40	9.37
British Columbia	7.86	7.94
Quebec	6.42	3.40
Manitoba	4.37	3.55
New Brunswick	0.02	0.02
Total	100.00	100.00

SOURCE: Dominion Bureau of Statistics.

Imports form a comparatively small item in Canada's natural-gas trade, being equivalent to only 3 per cent of natural-gas exports. Ontario received 98.7 per cent of the 5,574 million cubic feet imported in 1961 and will continue to take about the same amount annually until 1967, when the export licence expires. The remaining 1.3 per cent entered Alberta.

Nepheline Syenite

J. E. Reeves*

Nepheline syenite has increasingly gained acceptance as an industrial raw material for use in the manufacture of glass and other ceramic products.

Production has increased steadily throughout most of the industry's history. In 1961, however, there was a minute decline in the volume produced and, because of lower prices, a decrease of 11 per cent in value.

Exports were only fractionally greater than in 1960. Sales to the United States, where much nepheline syenite is consumed, declined by 3 per cent. The operation of a large new feldspar flotation plant in Connecticut reduced sales in that area and caused a reduction in prices. Overseas exports showed marked increases in many areas. Despite new production in Norway, shipments to Britain and continental Europe were greater than those of 1960.

PRODUCERS

The capacity of the two producers on Blue Mountain in Methuen township, southeastern Ontario, is sufficient for current requirements and can be expanded with relative ease to meet increases in demand. Industrial Minerals of Canada Limited (formerly American Nepheline Limited) operates a 600-ton mill at the southwestern end of the deposit and derives its ore principally from the Cabin Ridge and Craig quarries. The latter, which is more than 3 miles northeast of the mill, was first opened during the second half of 1961 to increase the alkali (soda and potash) and alumina content of glass-grade nepheline syenite. As well as glass-grade, which is the principal product, the company also makes three fine-ground grades, chiefly for the whitewares industry; several by-product grades with a higher iron content; a small amount of minus 2 inch crude; and, periodically, small quantities of magnetite concentrate.

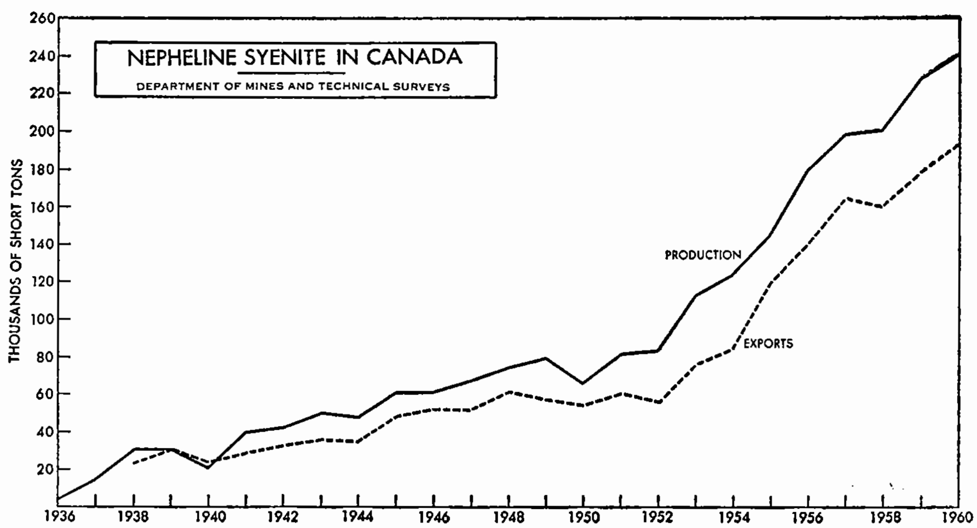
* Mineral Processing Division, Mines Branch.

NEPHELINE SYENITE—PRODUCTION, EXPORTS AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)	240,320	2,572,169	240,636	2,891,095
Exports				
United States	177,740	1,972,665	183,864	2,231,761
Britain	10,170	144,436	6,808	98,132
Puerto Rico	1,450	21,665	900	12,225
Netherlands	774	13,810	94	1,698
Belgium and Luxembourg	2,692	44,058	353	6,326
West Germany	392	7,559	368	6,820
Australia	455	21,571	181	3,264
Other countries	925	23,584	730	13,128
Total	194,598	2,249,348	193,298	2,373,354
	1960		1959	
Consumption*				
Glass	27,366		21,949	
Glass fibre	4,529		5,431	
Mineral wool	1,534		4,708	
Other ceramic products	2,372		2,370	
Other products	248		103	
Total	36,049		34,561	

Source: Dominion Bureau of Statistics.

*Available data.



International Minerals & Chemical Corporation (Canada) Limited operates a quarry and a 400-ton processing plant at the northeastern end of Blue Mountain. Its products are glass-grade nepheline syenite and small amounts of two fine-ground grades.

OTHER CANADIAN OCCURRENCES

Nepheline-bearing rocks are common in many parts of Canada.

In the Bancroft and Gooderham areas of southeastern Ontario there are numerous small deposits of nepheline gneiss, in many of which the nepheline content, although slightly erratic, is relatively high. Some of these were mined to a small extent before 1942. Elsewhere in Ontario, nepheline syenite occurs in two relatively large deposits in Bigwood township, northeast of Georgian Bay; in extensive deposits along the north shore of Lake Superior near Port Coldwell; and in small occurrences adjacent to Sturgeon Lake, east of Sioux Lookout. Denison Mines Limited has been mapping and drilling and investigating the beneficiation of the Port Coldwell nepheline syenite.

In southeastern British Columbia, nepheline syenite occurs in national parkland in the Ice River area near Field and in less known deposits in the vicinity of the Big Bend of the Columbia River.

In several places in northern Ontario and southeastern Quebec, nepheline is common in alkaline-rock complexes.

FOREIGN OCCURRENCES

Nepheline rocks occur in many other parts of the world, but are being exploited commercially as sources of ceramic raw materials only in Russia and Norway.

Norway's important deposit is a large mass of nepheline syenite on the island of *Stjernøy* off the northern coast, some distance north of the Arctic Circle. The mining and dry processing of this rock to produce glass-grade and finer-ground ceramic-grade products began late in 1960.

Russia places great importance on nepheline as an industrial raw material, which it uses primarily as an aluminum ore and also as a ceramic ingredient. The large and famous Khibiny apatite-nepheline deposits, near Kirovsk, in the Kola Peninsula, are a source of by-product nepheline concentrate. Its high alumina (29 per cent Al_2O_3) and alkali content (11 per cent Na_2O and 9 per cent K_2O) makes this nepheline suitable for glass manufacture, although its high iron content (about 4 per cent Fe_2O_3) limits this use to green glass. Other nepheline deposits, particularly in the area west of Lake Baikal, are reportedly to be used as sources of aluminum ore.

TECHNOLOGY

Nepheline syenite is a quartz-free crystalline rock consisting principally of nepheline (a sodium-potassium-aluminum silicate), soda feldspar and potash feldspar. It also contains small quantities of such iron-bearing minerals as magnetite, biotite and hornblende, which must be almost completely removed. High-intensity magnetic separators are used to reduce the iron content of Blue Mountain nepheline syenite from about 2 per cent to less than 0.1 per cent Fe_2O_3.

Ground and beneficiated nepheline syenite is industrially valuable because of its comparatively high alumina and alkali content, and its relatively low melting temperature.

USES AND SPECIFICATIONS

Nepheline syenite is important primarily as a source of the alumina and alkalis used in glass-manufacturing. In the glass industry of eastern Canada and the northeastern United States, it has largely replaced feldspar. The specification for particle size is minus 30 mesh and 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 necessary.

Fine-ground nepheline syenite is used as a frit ingredient for porcelain enamels, chiefly because of its relatively low fusion temperature. Specifications are similar to those for whitewares.

Fine-ground material has found some acceptance as an extender pigment 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 which the higher iron content is of no importance. Some crude is sold for use in the manufacture of mineral wool.

PRICES

Prices are not generally quoted for Canadian nepheline syenite. The approximate price of glass-grade, f.o.b. the Blue Mountain area, is $9 a ton. According to *Canadian Chemical Processing* of October 1961, the finest-ground, high-quality product, bagged, in carlots, f.o.b. works, is $28 a short ton.

Nickel

C. C. Allen*

In 1961, nickel production in Canada reached an all-time high of 232,991 short tons. This was 8.6 per cent over the record total of 214,506 tons, reached in 1960. Sales were good and supply was adequate to demand. The year was marked by the beginning of production in northern Manitoba from the Thompson project of The International Nickel Company of Canada, Limited, and a 10-per-cent price increase that went into effect on July 1.

The year brought little change in world supply. Canada and New Caledonia continued to provide the bulk of the nickel used by the Free World. The quantity from Canada, where nickel-producing companies operated at their rated mill capacity, made up more than 75 per cent. Russia and Cuba supplied most of the needs of the Soviet bloc. Nickel-oxide sinter from Nicaro, Cuba, was being marketed in Europe by Czechoslovakia and may be expected to compete for markets with nickel from Canada and France. In the United States, Britain, western Europe and Japan, however, markets are firm. The outlook thus remains encouraging.

In the United States, the nickel inventory of the Defense Materials Procurement Agency (DPA) as at September 30 was estimated at 120 million pounds. In March 1962, the total of all nickel stockpiles was given as 438,702,000 pounds, of which 115,702,000 pounds were considered surplus.

MINE PRODUCTION AND DEVELOPMENT

Ontario

Most of Canada's nickel output came, as usual, from the Sudbury area.

The ore that International Nickel mined there in 1961 amounted to more than 16 million short tons. During the year, the company delivered 372,460,000 pounds of nickel, of which 48,240,000 pounds came from the United States government or its suppliers.

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* Mineral Resources Division.

66076-1—23½

TABLE 1

NICKEL—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
Ontario	196,218	295,423,149	201,650	277,924,234
Manitoba	32,978	50,039,745	9,059	12,400,485
British Columbia	2,090	3,194,037	1,890	2,645,915
Northwest Territories	1,705	2,604,789	1,907	2,669,645
Total	232,991	351,261,720	214,506	295,640,279
Exports				
In ores, concentrates, matte or speiss				
Britain	54,103	81,814,986	39,822	53,759,359
Norway[2]	36,056	43,506,966	33,242	44,877,578
Japan	2,339	2,265,543	—	—
United States	431	459,887	846	1,141,830
West Germany	9	9,674	—	—
Total	92,938	128,057,056	73,910	99,778,767
In oxide sinter				
United States	11,015	14,325,608	5,645	6,801,596
Britain	1,956	1,730,741	2,034	1,763,649
France	1,257	1,749,696	1,826	2,470,056
Italy	947	1,341,189	1,066	1,441,361
Sweden	950	1,317,056	1,179	1,594,767
Australia	745	913,033	607	728,229
Norway	425	491,614	—	—
Belgium and Luxembourg	403	571,471	529	711,820
Other countries	324	454,650	371	490,847
Total	18,022	22,895,058	13,257	16,002,325
Nickel and nickel-alloy scrap[3]				
United States	313	266,255		
West Germany	127	58,010		
Norway	85	61,264		
Netherlands	54	15,559		
Other countries	39	25,652		
Total	618	426,740		
Anodes, cathodes, ingots, rods and shot				
United States	98,674	136,596,934	63,413	80,652,622
Britain	14,273	19,830,036	9,770	12,373,032
U.S.S.R.	5,998	9,171,327	3,748	5,323,092
West Germany	4,690	6,853,505	6,645	9,220,237
Sweden	1,939	2,837,802	3,419	4,822,627
Belgium and Luxembourg	1,460	2,143,184	7,651	10,848,262
Italy	1,403	2,047,334	2,576	3,587,781
France	908	1,324,196	2,989	4,252,406
Austria	856	1,245,868	1,340	1,878,123
Other countries	3,303	5,163,546	6,799	9,591,313
Total	133,504	187,213,732	108,350	142,549,495

TABLE 1 (*cont'd*)

	1961		1960	
	Short Tons	$	Short Tons	$
Nickel and nickel-alloy fabricated materials not elsewhere specified[3]				
United States	2,631	3,794,481		
Britain	104	372,798		
India	38	66,371		
Brazil	23	32,702		
Other countries	55	167,254		
Total	2,851	4,433,606		
Imports				
Semifabricated[4]				
United States	1,793	4,217,059	1,689	3,837,125
Norway	2,495	4,230,702	62	87,094
Britain	14	49,200	8	15,053
Other countries	2	7,870	3	12,131
Total	4,304	8,504,831	1,762	3,951,403
Manufactures				
United States		1,636,254		1,244,898
Britain		240,215		181,986
West Germany		243,500		203,555
Other countries		182,459		125,706
Total		2,302,428		1,756,145
Total imports		10,807,259		5,707,548
Consumption[5]				
All forms	4,935		4,861[r]	

SOURCE: Dominion Bureau of Statistics.

[1]Includes refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported.

[2]For refining and re-export.

[3]These export classes became separately available in 1961.

[4]Nickel in bars, rods, strips, sheets and wire; nickel and nickel-silver in ingots; nickel-chromium in bars.

[5]Consumption of nickel, all forms, as reported by consumers.

[r]Revised from previously published figures.

As the year ended, its ore reserves in the Sudbury area and Manitoba combined totalled 297,419,000 tons containing 8,937,300 tons of nickel-copper. International Nickel operated its five Sudbury-area mines—the Frood-Stobie, Creighton, Garson, Levack and Murray—throughout the year. It stopped production at the Frood open pit and started to produce at the new Clarabelle open pit and the smaller Ellen. Underground development continued at the Crean Hill property. Major projects in progress on treatment facilities at Copper Cliff were the construction of a fluid-roast plant and the enlargement of the capacity of the iron-recovery plant from 300,000 to 900,000 tons of

TABLE 2

NICKEL—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

	Production[1]	(short tons) Exports					
	All Forms	In Matte etc.	In Oxide Sinter	Refined Metal	Total Total	Imports[2]	Consumption[3]
1951	137,903	57,882	944	72,357	131,183	1,306	2,744
1952	140,559	63,753	1,211	77,058	142,022	1,650	2,223
1953	143,693	63,909	1,299	79,909	145,117	3,083	2,275
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	4,059[r]
1960	214,506	73,910	13,257	108,350	195,517	1,762	4,861[r]
1961	232,991	92,938	18,022	133,504	244,464	4,304	4,935

SOURCE: Dominion Bureau of Statistics.
[1]Refined metal and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported.
[2]Nickel in semifabricated forms; including 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, as reported by consumers.
[r]Revised from previously published figures.

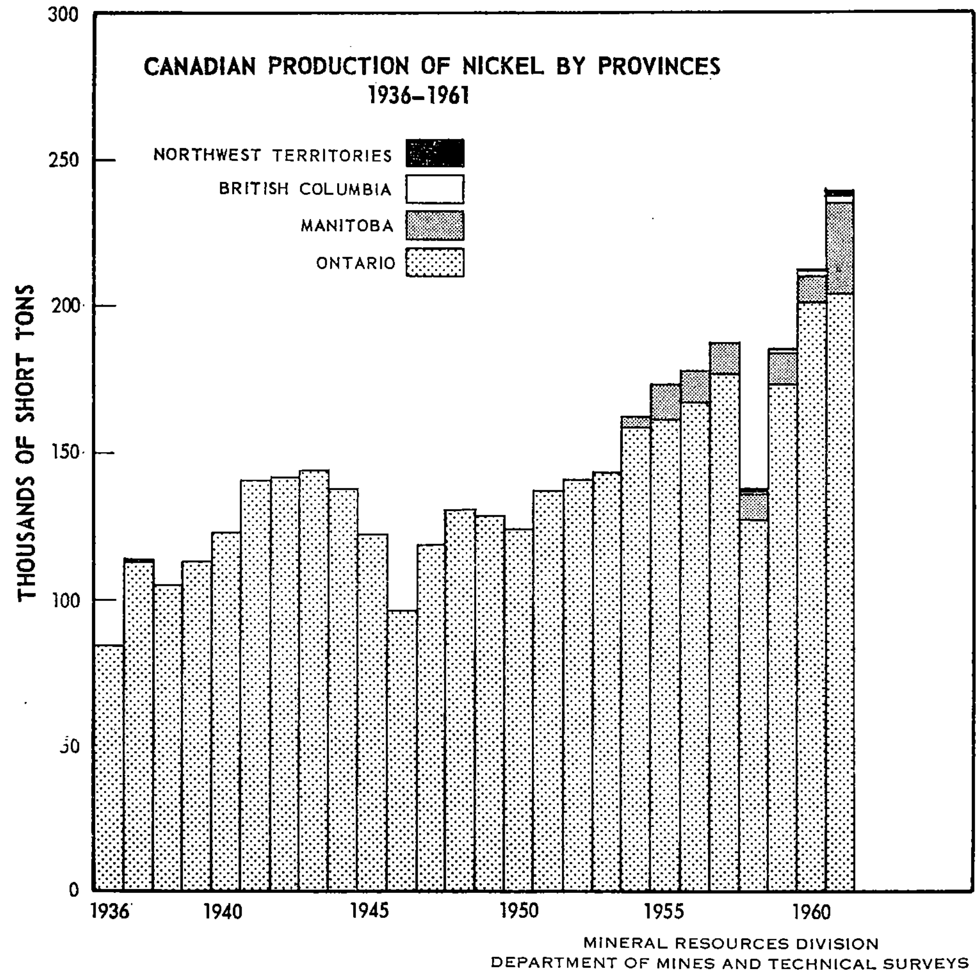
pellets a year. The latter project is scheduled to be completed in 1963. International Nickel sold Alloy Metals Sales Ltd., a wholly owned subsidiary with warehouse in Toronto, to Atlas Steels Ltd., of Welland, Ontario.

Falconbridge Nickel Mines Limited, also near Sudbury, had its Falconbridge, East, Hardy and Fecunis mines in continuous operaton. The Longvack and McKim mines were closed, but the Boundary and Onaping mines started production. At the large Strathcona deposit, development work progressed. Work continued at the Falconbridge mills on the refinement of operations for the production of a pyrrhotite concentrate for the iron plan and an all-sinter feed for the smelter. At Falconbridge's refinery at Kristiansand, Norway, a pilot plant was operating on a modified refinery process which, if successful, would necessitate major refinery adjustments. Ore delivered to the Falconbridge treatment plants totalled 2,639,897 tons. Ore reserves at the end of the year amounted to 46,247,200 tons averaging 1.45 per cent nickel and 0.80 per cent copper.

Manitoba

Sherritt Gordon Mines Limited milled 1,219,157 tons during the year. Ore reserves at December 31 were 14 million tons averaging 0.92 per cent nickel and 0.53 per cent copper.

Development of the Lynn Lake deposit on the 2,000-foot level continued from the Farley shaft. The refinery at Fort Saskatchewan, Alberta, treated Lynn Lake concentrates, bulk purchases of nickel-copper concentrates and nickel for refining on a toll basis. From the stockpile of the United States General Services Administration at Fredericktown, Missouri, Sherritt Gordon bought 3,431 tons of material containing 19 per cent nickel and 13 per cent cobalt in the form of calcine. It also purchased an additional 87 tons of nickel-copper-cobalt matte and expanded its powder-rolling facilities for the production of coinage blanks.



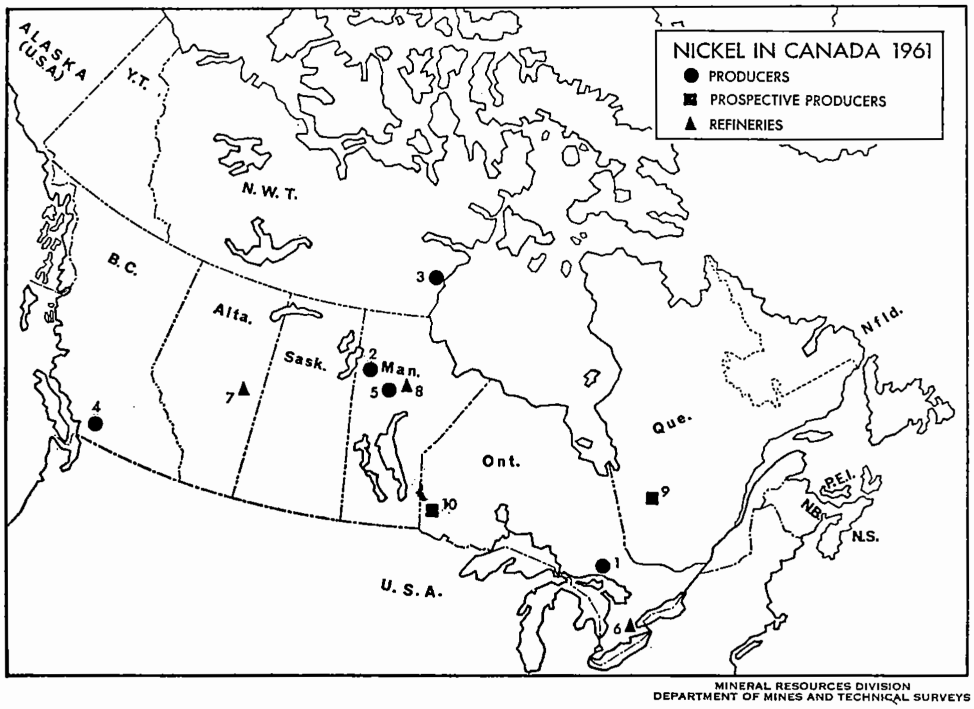
International Nickel's Thompson operation was officially started on March 25 and by mid-year was up to the rated annual capacity of 75 million pounds of nickel. Production may exceed the rated Thompson capacity. During the summer, the shipment of electrolytic nickel to Europe through the port of Churchill, Manitoba, was begun. The ore mined during the year amounted to more than 1 million tons. The reserves are included in the company total given under Ontario.

Northwest Territories

North Rankin Nickel Mines Limited operated its mine on Rankin Inlet, on the west coast of Hudson Bay, throughout the year. It shipped nickel-copper concentrates to the Sherritt Gordon's Fort Saskatchewan refinery.

British Columbia

Giant Nickel Mines Limited signed a contract on March 1 with Sumitomo Metal Mining Co., Ltd., for Giant's entire output of nickel-copper concentrate for a further three-year period. An accelerated exploration program raised the indicated nickel-copper ore reserves to 1,100,000 tons. The daily mill capacity was increased from 900 tons to 1,200 tons, but during the construction period, from mid-November until the end of the year, the mill was closed. Mine production for the year totalled 267,767 tons of ore.



Producers

1. Sudbury area
   International Nickel Company of Canada, Limited, The (7 mines, 2 smelters)
   Falconbridge Nickel Mines Limited (6 mines, 1 smelter)
   Norduna Mines Limited
2. Sherritt Gordon Mines Limited, Lynn Lake, Manitoba
3. North Rankin Nickel Mines Limited
4. Giant Nickel Mines Limited, near Hope, British Columbia
5. International Nickel Company of Canada, Limited, The (Thompson mine)

Refineries

6. International Nickel Company of Canada, Limited, The, Port Colborne, Ontario
7. Sherritt Gordon Mines Limited, Fort Saskatchewan, Alberta
8. International Nickel Company of Canada, Limited, The, Thompson, Manitoba

Prospective Producers

9. Marbridge Mines Limited
10. Nickel Mining & Smelting Corporation

EXPLORATION AND DEVELOPMENT

Ontario

Nickel Mining & Smelting Corporation announced its decision to bring its Gordon Lake property, in northwestern Ontario, into production. Shaft-deepening was in progress, and regular production is planned for September 1962 at a daily mill rate of 500 tons. Nickel-copper concentrates will be trucked to Lac du Bonnet, Manitoba, and shipped by rail to Sudbury for smelting by International Nickel.

Fatima Mining Company Limited, at its nickel property 20 miles southeast of Timmins, carried out additional ground geophysical surveys and surface diamond-drilling.

Cochenour Willans Gold Mines Limited continued to explore its nickel-copper claims on Pipestone Bay, at the west end of Red Lake, in northwestern Ontario. The claims were subsequently optioned to Falconbridge Nickel Mines Limited.

The Bicroft Division of Macassa Gold Mines Limited, formerly Bicroft Uranium Mines Limited, explored a nickel-copper prospect south of Bancroft, Ontario. Indicated reserves to the 500-foot horizon amount to 2,200 tons of unspecified grade per vertical foot.

Manitoba

Marmal Nickel Mines Limited, which has property in the Cross Lake area, was formed from the holdings of Consolidated Marbenor Mines Limited, National Malartic Gold Mines Limited and Rio Tinto Canadian Exploration Limited. The Marmal claims were then optioned to Falconbridge Nickel Mines, Limited for further exploration and development.

Quebec

Preparations for production continued at Marbridge Mines Limited, in La Motte township. Initial production at a minimum rate of 300 tons of ore a day is scheduled for the spring of 1962. Marbridge is owned by Falconbridge and Marchant Mining Company Ltd. Concentrates will be shipped to Falconbridge for smelting.

Raglan Nickel mines Limited continued exploration on its concession near Ungava Bay, New Quebec. Diamond-drilling has indicated reserves of 3.5 million tons grading 1.3 per cent nickel and 0.5 per cent copper.

Dumont Nickel Corporation carried out diamond-drilling on nickel-copper mineralization in Marrias township, northwestern Quebec, and in the Laurentian area, some 30 miles from Ottawa.

WORLD DEVELOPMENT AND PRODUCTION

In New Caledonia, *Société Anonyme Le Nickel* has four electric furnaces in operation for the production of ferronickel and a fifth under construction for the same purpose. The blast furnaces for production of matte from lateritic ore are being modernized. The matte is refined at Le Havre, France. Production in 1960 amounted to 11,408 metric tons of nickel in ferronickel and 11,428 metric tons of nickel from matte. The production of lateritic ore in New Caledonia in 1960 totalled 2,261,800 metric tons, about half of which was treated by *Le Nickel*. The remainder was exported to Japan.

Hanna Mining Company, which produces a 45-per-cent ferronickel at Riddle, Oregon, is now selling on the open market rather than to the United States government stockpile.

Finland is now producing nickel regularly. Nickel concentrates from the Kotalahti mine and copper concentrates carrying nickel from the Outokumpu mine go to Harajavalta, where concentrates are flash-smelted and processed into electrolytic nickel. The national capacity is about 2,000 tons of nickel a year. Arrangements are being made to export the nickel in excess of domestic requirements.

Cuba's Nicaro plant is in production under the auspices and direction of foreign technicians. *Tass,* the Soviet news agency, reported that the Moa Bay property will be brought into production to recover metal. New drawings are being prepared for additional buildings, and the facilities will pesumably largely duplicate the Freeport installation at Port Nickel, Louisiana. Before the Nicaro and Moa Bay properties were seized by the Cuban government, their rated capacities were respectively 27,000 and 25,000 tons of nickel a year. According to the Havana press, Nicaro's 1961 output was 36 million pounds of nickel in nickel-oxide sinter. Nickel-oxide sinter from Nicaro is being marketed in Europe.

In the Dominican Republic, the pilot plant for treating lateritic nickel ores of *Minera y Beneficiadora Falconbridge Dominicana C. por A.* was in operation, and the company plans to make further tests until late in 1962.

Japanese nickel interests conducted exploration in Indonesia with a view to increasing Japan's imports of nickel-bearing laterite. Japan has the capacity to produce 20,000 tons of nickel a year, 14,000 tons in the form of ferronickel and the rest as electrolytic nickel. When the demand exceeds the output, electrolytic nickel is imported under licence.

After exploration and evaluation, International Nickel dropped its interest in the Larimna nickel deposits, in Greece. *Société Anonyme Le Nickel* is now investigating these deposits.

TABLE 3

FREE WORLD* NICKEL-PRODUCTION CAPACITY, 1961

(short tons)	
International Nickel (including Thompson)	192,500
Falconbridge	35,000
Sherritt Gordon	13,750
New Caledonia (French and Japanese)	45,000
Hanna Nickel Smelting Company	11,750
Finland	2,000
South Africa	3,000
Total	303,000

SOURCE: Company reports.
*Cuba excluded.

TABLE 4

WORLD PRODUCTION OF NICKEL, 1961

(short tons)	
Canada	232,991*
Russia	83,000
New Caledonia	53,823
Cuba	8,000
United States	11,176
Republic of South Africa	2,900
Finland	2,203
Other countries	307
Total	394,400

SOURCE: American Bureau of Metal Statistics for all countries except Canada.
*Dominion Bureau of Statistics.

CONSUMPTION AND USES

Free World nickel consumption, by products, as outlined by International Nickel, is as follows:

	1958	1959	1960	1961
Stainless steels	27%	29%	32%	34%
High-nickel alloys	16%	16%	15%	14%
Electroplating	13%	15%	16%	14%
Nickel-alloy steels	16%	15%	13%	15%
Foundry products	12%	12%	12%	11%
Copper-nickel alloys	6%	4%	4%	4%
All other products	10%	9%	8%	8%

Consumption gained in stainless and nickel-alloy steels, stainless steels now accounting for one third of the nickel used in the Free World.

Among the new developments was the introduction by International Nickel of a new 18- to 25-per-cent-nickel alloy steel of unmatched toughness at the highest strength levels of traditional alloy steels.

Atlas Titanium Limited and W. W. Wells, Limited, developed a new nickel-electroplating process in which the place of the present conventional anodes is taken by small squares of electrolytic nickel in nylon bags in special titanium containers.

PRICES

The Canadian price of electrolytic nickel, f.o.b. Port Colborne, Ontario, was 72.75 cents a pound from January 1 to June 29, 1961. On June 30 the price was raised to 82.500 cents a pound. This price remained for the rest of the year.

The United States price, including the 1¼¢ United States import duty, was 74¢ (U.S.) a pound from January 1 to June 29, 1961. On June 30 the price was raised to 81.250 cents a pound. This price prevailed for the rest of the year.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Nickel, and alloys consisting 60% or more of nickel by weight, not otherwise provided for, viz: ingots, blocks and shot; shapes or sections, billets, bars and rods, rolled, extruded or drawn (not including nickel processed for use as anodes); strip; sheet and plate (polished or not); seamless tube	free	free	free
Rods, consisting 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 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%

United States

Nickel ore, nickel matte and nickel oxide	free
Nickel, and alloys in which nickel is component material of chief value:	
In cathodes, cubes, grains, ingots, pigs, shot or similar forms	1¼ lb
In anodes, bars, castings, electrodes, plates, rods, sheets, strands, strips or wire	12½%
In tubes or tubing	6¼%
Any of the foregoing, if cold-drawn, cold-rolled or cold-worked, shall be subject to an additional duty as follows:	
Tubes and tubing	2½%
Other forms	5%

Niobium (Columbium) and Tantalum

V. B. Schneider*

In 1961 Canadian production of columbium concentrates amounted to 62,229 pounds of contained columbium pentoxide (Cb_2O_5) valued at $65,619. The pentoxide was contained in pyrochlore mined by St. Lawrence Columbium and Metals Corporation from its property at Oka, Quebec. This was the first Canadian production of Cb_2O_5 since 1955 when small quantities were produced from a lithium-tantalum-columbium property 70 miles east of Yellowknife, Northwest Territories.

St. Lawrence Columbium and Metals Corporation completed its mill at Oka, about 35 miles northwest of Montreal, by mid-1961 and commercial production began in September. The mill, which is designed to handle 500 tons of feed a day, can be readily expanded to handle 1,000 tons a day. Mill feed, assaying about 0.5 per cent Cb_2O_5, is supplied by open-pit operations. In 1960 St. Lawrence Columbium appointed South American Minerals and Merchandise Corp. (SAMINCORP), of New York, as agents for the sale of its columbium concentrates. SAMINCORP agreed to sell a minimum of 500,000 pounds of concentrate (minimum 50 per cent Cb_2O_5) during the 15-month period beginning October 1, 1961. A typical analysis of pyrochlore produced by St. Lawrence Columbium in September 1961 is as follows:

Cb_2O_5	52+ %	F	2.5 % - 4.05%
CeO_2	3.0 % - 6.0%	CaO	15.0% -20.0 %
Fe_2O_3	2.7 % - 5.0 %	MgO	0.0 % - 2.10%
Ta_2O_5	0.09% - 0.5 %	Al_2O_3	0.23% - 0.70%
MnO_2	0.07% - 0.74%	SiO_2	0.2 % - 0.6 %
Gd_2O_3	0.0 % - 0.2 %	P_2O_5	0.1 % - 0.6 %
SrO	0.42% - 1.2 %	Na_2O	3.3 % - 3.70%
U_3O_8	0.05% - 0.20%	K_2O	0.20% - 0.80%
ThO_2	0.07% - 0.30%	S	0.1 % - 0.4 %
ZrO_2	0.80% - 1.3 %	WO_3	Traces
TiO_2	4.0 % - 6.5 %	SnO_2	Traces

* Mineral Resources Division.

TABLE 1

NIOBIUM (COLUMBIUM) AND TANTALUM—PRODUCTION, TRADE AND CONSUMPTION

	1961 Pounds	1961 $	1960 Pounds	1960 $
Production				
Columbium pentoxide (Cb_2O_5)	62,229	65,619	—	—
Imports				
From United States[1]				
Columbium metal and alloys, semifabricated	5	1,600	11	1,448
Tantalum metal and alloys, crude and scrap	2,028	30,937	7,216	62,772
Tantalum metal, semifabricated	340	38,124	320	15,060
Exports				
To United States[2]				
Columbium ore and concentrates	35,575	32,918	—	—
Consumption				
By steel industry—				
ferrocolumbium and ferrotantalum-columbium (Cb and Ta-Cb content)	22,000		16,000	

SOURCE: Dominion Bureau of Statistics.
[1]From *United States Exports of Domestic and Foreign Merchandise* (Report FT 410, Part II).
[2]From *United States Imports of Merchandise for Consumption* (Report FT 110).

Columbium Mining Products Ltd. continued to conduct investigations concerning the addition of columbium in steelmaking and improvements in concentrating the pyrochlore ore from its property at Oka and Quebec Columbium Limited continued a diamond-drilling exploration program on its property in the same area.

Dominion Gulf Company has not done any work since 1959 on its property in Chewett township, 17 miles northeast of Chapleau, Ontario. Pilot-plant investigations were completed at the Colorado School of Mines Research Foundation, in December 1961, on 400 tons shipped from the Chewett property in 1959. The company reports that the ore has been found amenable to direct chemical treatment by either of two distinctly different processes with recoveries of Cb around 90 per cent.

Geo-Met Reactors Limited, Ottawa, was formed in 1961, and began producing two grades of ferrocolumbium and a columbium additive that it markets under the trade name of 'Pycol.' It is a mixture of pyrochlore and a reductive such as aluminum or ferrosilicon. Much of the research and development work behind the processes employed by Geo-Met was initiated by the Mines Branch, Department of Mines and Technical Surveys.

CANADIAN OCCURRENCES

Northwest Territories

There are many columbium-tantalum occurrences in the Yellowknife area, north of Great Slave Lake. The presence of columbite-tantalite has been noted in many pegmatite dikes in association with beryl, spodumene and amblygonite.

British Columbia

The placer deposits on Bugaboo, Vowell and Forster creeks about 45 miles southeast of Golden consist of columbium-bearing gravel. In 1956, Quebec Metallurgical Industries Ltd., at Billings Bridge, Ontario, processed gravity concentrates to produce high-purity columbium oxide, columbium alloys and columbium sponge. The project was discontinued, however, as uneconomical.

Manitoba

Minor 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 by-product of a cesium-lithium operation.

Ontario

The columbium-uranium deposits of Nova Beaucage Mines Limited are 6 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). The Consolidated Mining and Smelting Company of Canada Limited acquired controlling interest in Nova Beaucage Mines Limited in 1958. Since then investigations related to concentration of the company's pyrochlore have been conducted at Kimberley, British Columbia, at the company plant at North Bay, and at the Mines Branch of the Department of Mines and Technical Surveys in Ottawa.

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.

Multi-Minerals Limited has outlined two pyrochlore-bearing deposits on its Nemegos property, about 14 miles southeast of Chapleau.

Quebec

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 control large pyrochlore deposits near the town of Oka, 20 miles west of Montreal.

The mineral deposits associated with and contained in what is referred to as the Oka complex are about 2 miles east of Oka, at La Trappe. Few outcrops are to be seen, as the overburden varies from 6 to 100 feet in thickness and in places may be as much as 200 feet thick.

The grade and quantity of the mineralized material in the Oka area is not known. One estimate of reserves suggests that 18,000 million tons grading 0.25 per cent Cb_2O_5 may be present, but a grade of 0.25 per cent Cb_2O_5 cannot be considered economic at present.

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 8 pounds of Cb_2O_5 per ton or an average 0.4 per cent Cb_2O_5.

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

Free World production of columbium and tantalum concentrates amounted to 7,370,000 pounds in 1961. This would mark the third consecutive year that Free World production of columbium and tantalum concentrate has increased after declining from a record high of 11,730,000 pounds in 1955 to 4,880,000 pounds 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 in nature, 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 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 generally speaking is seldom present in any appreciable amounts.

Nigeria leads in the production of columbium concentrate (columbite); the Republic of the Congo is the principal source of tantalum concentrate (tantalite). Southern Rhodesia ranks second as a producer of tantalite, with a 1961 production of 138,000 pounds. Sources of columbium ore are far more numerous than those of tantalum.

A pyrochlore deposit at Araxá, Brazil, is the largest known source of columbium. It is believed to contain some 7,500 short tons of columbium in ore assaying more than 3 per cent Cb_2O_5 and is controlled jointly by Molybdenum Corporation of America and Wah Chang Corporation.

The Sove mine, in the Fen area, near Ulefoss, which is 72 miles southwest of Oslo, Norway, produces a 50-per-cent-Cb_2O_5 concentrate. This concentrate, with a columbium-tantalum ratio of 100:1, is shipped to the European market.

TABLE 2

FREE WORLD PRODUCTION OF COLUMBIUM-TANTALUM CONCENTRATE, 1961

(pounds)

Nigeria	5,283,510
Norway	707,677
Republic of the Congo	277,362
Mozambique	279,621
Brazil	233,288
Federation of Malaya	206,080
Other countries	382,462
Total	7,370,000

Source: U.S. Bureau of Mines, *Mineral Trade Notes, October 1962.*

CONSUMPTION AND USES

In the United States, capacitors for electronic and communications equipment provided the largest single use for pure tantalum metal in 1961. Most of the output of pure columbium metal was purchased by the United States government in the form of bars and mill products for nuclear applications.

In Canada, the need is for ferrocolumbium and ferrotantalum-columbium. In 1961, about 11 tons of columbium addition agents were consumed by the Canadian iron-and-steel industry. Indications are that an increase in consumption is imminent, with wider application in carbon steels in which columbium provides higher strengths. This could be important in the fabrication of skelp and plate for use in oil- and gas-transmission piping.

Union Carbide Canada Limited, Metals and Carbon Division; Metallurgical Products Company Limited; and Metallurg (Canada) Ltd. are the principal Canadian suppliers of ferrocolumbium. Metallurgical Products is the sales agent for Geo-Met Reactors Limited.

The more important Canadian consumers of columbium and tantalum are: Ontario-Atlas Steels Limited, Welland; the William Kennedy and Sons Limited, Owen Sound; Dominion Foundries and Steel, Limited, Hamilton; Canadian Westinghouse Company, Limited, Hamilton; Quebec-Shawinigan Chemicals Limited, Shawinigan.

PRICES

The following quotations are from *E & M J Metal and Mineral Markets*. All prices are from the issue of December 28, 1961, except that for ferrocolumbium, which is from the issue of December 21, 1961.

Columbium metal, 99½%, per lb		
Roundels	$ 36.00	
Rough ingots	$ 50.00	
Tantalum metal, f.o.b. shipping point, per lb.		
Powder	$ 30.00 -	$ 58.60
Sheet	$ 50.35 -	$ 59.18
Rod	$ 73.04 -	$ 80.23
Ferrocolumbium, 50-60% Cb, max. 0.4% C, max. 8% Si, ton lots, lump (2 inches), packed, delivered continental U.S.A., per lb contained Cb	$ 3.45	
Columbite ore, 65% Cb_2O_5 and Ta_2O_2, f.o.b. shipping point, per lb		
Ratio 10 to 1	$ 1.18 -	$ 1.25
Ratio 8½ to 1	$ 1.05 -	$ 1.10

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Columbium and tantalum ores and concentrates	free	free	free
Ferrocolumbium, ferrotantalum, ferrotantalum-columbium	"	5%	5%
Columbium metal or tantalum metal in pure form, in lumps, powder, blocks, ingots	"	15%	25%
Columbium metal or tantalum metal if in alloy form, in rods, sheet or any semiprocess form	15%	20%	25%

United States	
Columbium and tantalum ores and concentrates	free
Columbium and tantalum metal	12½%
Ductile columbium or niobium metal, ductile nonferrous alloys of columbium or niobium metal or tantalum metal, and ductile tantalum metal	40%
Ferrocolumbium, ferrotantalum, ferrotantalum-columbium	12½%

Petroleum

D. W. Rutledge*

Crude-oil production increased sharply as the petroleum industry re-oriented its supply pattern to reach the oil-production targets of the national oil policy, which the Government announced in February 1961. The goals for crude oil and natural-gas liquids were set at an average of 640,000 barrels a day for 1961 and about 800,000 barrels a day for the end of 1963. The output was raised by increasing the sales of Canadian oil to refineries in the United States and Ontario.

Canada's production of all liquid hydrocarbons—crude oil plus natural-gas liquids—amounted to 234,687,529 barrels for the year, or an average of 642,980 barrels a day. The output of crude oil alone was recorded at 220,848,080 barrels, or 16.5 per cent above the 1960 record total. Alberta produced 20.9 per cent more crude oil and 22.8 per cent more liquid hydrocarbons. Saskatchewan, which produces comparatively small amounts of natural-gas liquids, increased its crude oil output by 7.6 per cent. Manitoba's declining reserves and production capability led to a 6.0-per-cent decrease in crude-oil yield, while a similar situation in New Brunswick caused a 15.0-per-cent decline in that province's small output. Spurred by the completion of an oil pipeline that gave access to Vancouver markets, British Columbia's crude-oil production passed the million-barrel mark for the first time. The province's high output of wet gas resulted in a yield of 1.29 million barrels of natural-gas liquids, which helped make up the 12.7-per-cent increase in the provincial production of liquid hydrocarbons. Ontario's crude-oil output, 14.3 per cent greater than in 1960, established a new record. In the Northwest Territories, production increased by 10.3 per cent.

Alberta provided 71.5 per cent of Canada's output of crude oil (68.9 in 1960); Saskatchewan 25.3 per cent (27.4 in 1960); Manitoba 2.0 per cent (2.5 in 1960); and Ontario, British Columbia, the Northwest Territories and New Brunswick the remaining 1.2 per cent (1.2 in 1960).

Producing oil wells in western Canada at the end of 1961 totalled 13,722, with 8,938 in Alberta, 3,910 in Saskatchewan, 729 in Manitoba, 114 in British Columbia and 31 in the Northwest Territories. Oil wells capable of production

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*Mineral Resources Division.

66076-1—24½

Table 1

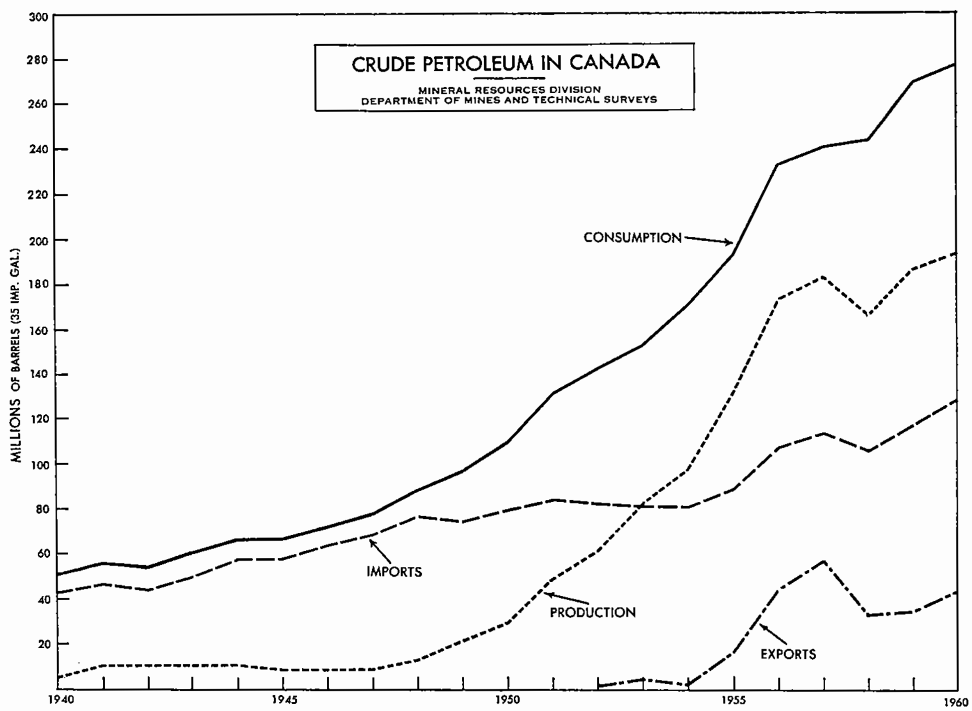
PRODUCTION OF CRUDE OIL, BY PROVINCE AND FIELD

	1961		1960	
	Barrels	$	Barrels	$
Alberta				
Pembina(1)[1]	42,733,575		39,310,358	
Redwater(3)	15,416,554		12,560,447	
Leduc-Woodbend(2)	15,136,404		13,357,643	
Innisfail(6)	2,524,727		2,256,634	
Swan Hills(4)	8,376,621		4,904,289	
Bonnie Glen(2)	6,343,722		5,064,747	
Fenn-Big Valley(8)	6,111,136		5,466,087	
Joffre(5)	5,666,283		6,186,082	
Wizard Lake(2)	3,469,534		2,301,274	
Joarcam(7)	3,322,581		3,394,695	
Sturgeon Lake South(9)	3,166,044		2,826,784	
Judy Creek(4)	3,058,977		970,522	
Golden Spike(2)	2,852,353		1,516,973	
Acheson(2)	2,555,059		1,752,445	
Virginia Hills(4)	2,444,770		988,081	
Kaybob(10)	2,409,558		1,986,117	
Harmattan-Elkton(6)	2,184,331		1,412,918	
Harmattan East(6)	1,912,139		1,474,722	
Stettler (8)	1,755,254		1,613,289	
Willesden Green(1)	1,558,142		934,456	
Crossfield(6)	1,476,387		603,219	
Gilby(5)	1,456,869		1,444,876	
Westerose(2)	1,453,808		971,208	
Erskine(8)	1,272,820		1,262,579	
West Drumheller(8)	1,271,025		1,179,110	
Sundre(6)	1,247,749		1,162,545	
Turner Valley(11)	1,147,974		1,198,647	
All other fields and pools	15,487,316		12,406,221	
Total[2]	157,811,712	355,530,845	130,506,968	302,841,423
Saskatchewan				
Weyburn(13)	11,741,155		10,687,067	
Steelman(14)	8,450,279		8,460,855	
Midale(13)	4,602,937		3,726,019	
Dollard(18)	4,029,599		4,034,094	
Nottingham(15)	2,742,165		2,558,666	
Parkman(16)	2,160,383		1,085,381	
Coleville-Smiley(17)	2,010,618		2,269,178	
Fosterton(19)	1,986,983		1,951,053	
Instow(18)	1,842,969		1,786,523	
Carnduff(14)	1,571,558		1,911,670	
Hastings(15)	1,475,957		1,204,697	
Success(19)	1,421,789		1,400,979	
Queensdale(15)	1,350,838		1,382,927	
Alida(15)	1,335,385		1,584,204	
Other fields and pools	9,137,489		7,865,115	
Total	55,860,104	115,719,791	51,908,428	103,957,009

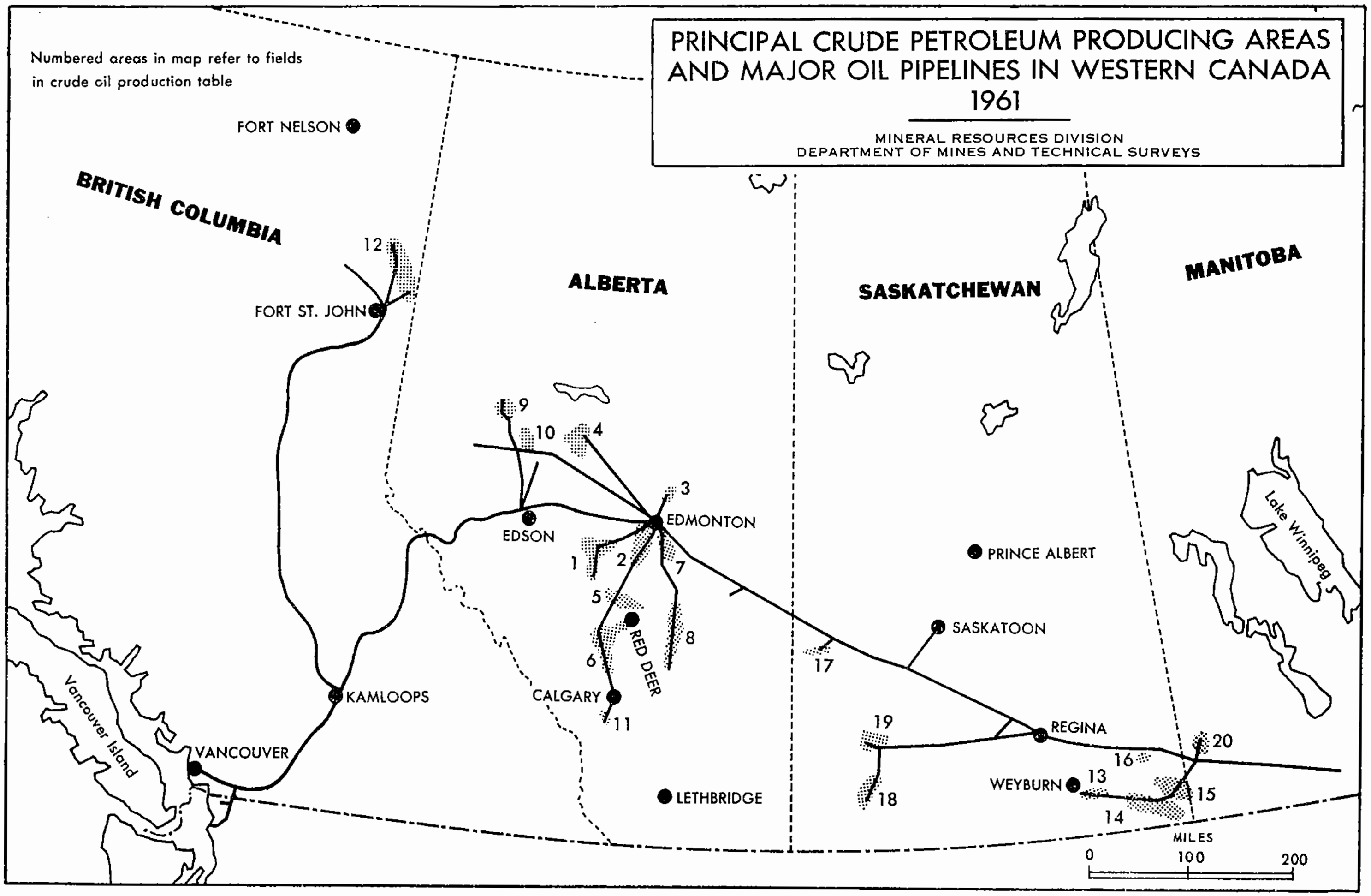
PRODUCTION OF CRUDE OIL, BY PROVINCE AND FIELD (cont'd.).

	1961		1960	
	Barrels	$	Barrels	$
Manitoba				
Virden-Roselea(20)	1,333,986		1,314,713	
North Virden-Scallion(20)	1,538,308		1,768,452	
Other fields and pools	1,608,054		1,680,880	
Total	4,480,348	10,156,000	4,764,045	10,690,384
Ontario	1,149,087	3,546,740	1,005,030	3,150,065
British Columbia(12)	1,017,826	1,859,873	867,057	1,626,590
Northwest Territories	516,979[3]	730,160	468,545	641,219
New Brunswick	12,024	16,833	14,148	19,807
Total, Canada	220,848,080	487,560,242	189,534,221	422,926,497

SOURCE: Dominion Bureau of Statistics and provincial reports.
[1] The numbers in parentheses locate the fields on the accompanying map.
[2] Excludes field condensate, which in 1960 amounted to 2,369,493 barrels valued at $5,494,684.
[3] Excludes base stock reinjected into the reservoir.



totalled 16,481, but market conditions kept 2,759 wells inoperative at the end of the year. Thus, despite a great increase in production, the number of inoperative wells was proportionately higher than at the end of 1960. This was the result of heavy development drilling in many fields.



PRINCIPAL CRUDE PETROLEUM PRODUCING AREAS AND MAJOR OIL PIPELINES IN WESTERN CANADA 1961

MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

TABLE 2

PRODUCTION OF NATURAL-GAS LIQUIDS, BY PROVINCE

	1961	1960
	Barrels	Barrels
Alberta		
Natural gasoline	1,649,042	1,444,422r
Field condensate	3,277,622	2,369,493r
Plant condensate	2,755,309	514,405r
Propane	2,288,129	1,846,830r
Butane	1,596,768	1,231,774
Propane-butane mix	84,657	83,425
Total	11,651,527	7,490,349r
Saskatchewan		
Natural gasoline	225,959	
Propane	432,981	
Butane	241,310	
Total	900,250	602,061
British Columbia		
Plant condensate	813,724	750,848r
Propane	154,717	125,366r
Butane	319,231	303,187r
Total	1,287,672	1,179,401r
Total, Canada	13,839,449	9,271,811r

SOURCE: Dominion Bureau of Statistics. rRevised from previously published figure.

TABLE 3

CRUDE OIL—PRODUCTION, TRADE AND RECEIPTS AT REFINERIES, 1948-61

(barrels)

	Production[1]	Imports[2]	Exports[2]	Receipts at Refineries[3]		
				Domestic[4]	Imported[5]	Total
1948	12,286,660	75,535,943	—	11,941,677	75,463,113	87,404,790
1949	21,305,348	73,934,543	—	20,032,098	76,186,071	96,218,169
1950	29,043,788	78,648,571	—	26,666,376	82,476,476	109,142,852
1951	47,615,534	83,283,171	341,780	47,185,925	83,139,573	130,325,498
1952	61,237,322	81,199,086	1,424,456	58,894,631	82,467,322	141,361,953
1953	80,898,897	79,477,343	2,507,314	69,345,587	81,406,110	150,751,697
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

SOURCE: Dominion Bureau of Statistics.
[1]*Crude Petroleum and Natural Gas Production* (DBS). Alberta field condensate is excluded from the statistics for 1960 and 1961.
[2]*Trade of Canada* (DBS). Imports include partly processed crude for all years.
[3]For 1948-50 inclusive—as reported in *Petroleum Products Industry* (DBS); for 1951-59 inclusive—receipts at refineries as reported in *Refined Petroleum Products* (DBS).
[4]'Domestic' includes crude naphtha and absorption gasoline to 1950 only.
[5]'Imported' includes partly processed crude for all years.

RESERVES

At the end of 1961, Canada's recoverable reserves of crude oil as listed by the Canadian Petroleum Association amounted to 4,173,569,000 barrels, or 13.5 per cent more than the 1960 year-end total. The most notable changes in the 1961 tabulations were the substantial increases for Alberta and British Columbia. The reserves also increased in Saskatchewan, but only slightly. In other regions, the drain of production and the addition of only minor amounts to previously outlined accumulations resulted in a net decrease.

The Alberta Oil and Gas Conservation Board's estimate of recoverable crude-oil reserves in the province as at December 31, 1961, was 3,510 million barrels. Three fields—Pembina, Redwater and Swan Hills—accounted for 46.5 per cent of the total. The reserves remaining in the big Pembina field, in production since 1953, were three quarters of the originally recoverable 1,000 million barrels, while the Leduc-Woodbend field had only one quarter of its originally recoverable 249 million barrels.

TABLE 4

RESERVES OF CRUDE OIL

Province or Region	At End of 1961 ('000 barrels)	% of Total 1961	% of Total 1960	Net Change since 1960 ('000 barrels)
Alberta	3,512,809	84.2	83.0	461,617
Saskatchewan	504,277	12.1	13.6	2,199
British Columbia	80,382	1.9	1.2	35,426
Northwest Territories	51,002	1.2	1.4	− 496
Manitoba	17,545	0.4	0.6	−3,205
Eastern Canada	7,554	0.2	0.2	− 514
Total, Canada	4,173,569	100.0	100.0	495,027

SOURCE: Canadian Petroleum Association.

The rapidly increasing production of natural gas in Canada is resulting in a sharp rise in the output of natural-gas liquids, which are obtained in many natural-gas fields as by-products. The natural-gas liquids, including condensate, natural gasoline, propane, butane and pentanes plus, compete to a certain

TABLE 5

RESERVES OF LIQUID HYDROCARBONS AT END OF 1961

	Natural-gas Liquids (N.G.L.) ('000 barrels)	Crude Oil plus N.G.L. ('000 barrels)	% of Total
Alberta	519,694	4,032,503	84.9
Saskatchewan	19,743	524,020	11.0
British Columbia	36,222	116,604	2.5
Other areas	—	76,101	1.6
Total, Canada	575,659	4,749,228	100.0

SOURCE: Canadian Petroleum Association.

extent with crude oil and hence have been combined with it in the following table to give an over-all picture of liquid-hydrocarbon reserves. In British Columbia, natural-gas liquids form 31 per cent of the liquid-hydrocarbon reserves, a notably high proportion. Canada's year-end reserves of liquid hydrocarbons made up 10.9 per cent of the total for the United States and Canada combined instead of the 9.9 per cent they formed at the end of the previous year. At the 1961 rate of production, Canada's proven reserves represent 20.2 years' supply.

EXPLORATION AND DEVELOPMENT

Geophysical activity had been declining in western Canada since 1953, but toward the end of 1961 the downtrend finally levelled off. The seismic survey remained the main method of geophysical exploration, but there was a significant increase in the number of gravity surveys performed. British Columbia, Saskatchewan, Manitoba and the northern territories realized an increase in the number of crew-months of seismic work, but Alberta, accounting for about two thirds of the activity, had a decrease. In terms of crew-months, seismic-survey work in the western provinces was as follows: Alberta, 394; British

TABLE 6

WELLS* DRILLED TO COMPLETION—WESTERN CANADA

	Oil Wells		Gas Wells		Dry Holes		Total	
	1961	1960	1961	1960	1961	1960	1961	1960
Alberta	783	985	344	276	445	443	1,572	1,704
Saskatchewan	484	444	7	10	152	161	643	615
Manitoba	11	52	—	—	16	14	27	66
British Columbia	88	47	64	37	55	66	207	150
Northwest Territories and Yukon Territory	—	—	1	2	14	30	15	32
Total	1,366	1,528	416	325	682	714	2,464	2,567

SOURCES: Provincial-government reports and the Department of Northern Affairs and National Resources
*Service wells excluded.

TABLE 7

OIL WELLS IN WESTERN CANADA AT END OF YEAR

	Producing Wells			Wells Capable of Production		
	1961	1960	1959	1961	1960	1959
Alberta	8,938	8,633	8,281	10,529	9,878	9,217
Saskatchewan	3,910	3,685	3,445	4,827	4,435	4,090
Manitoba	729	755	730	874	893	876
British Columbia	114	52	37	191	104	59
Northwest Territories	31	31	29	60	60	62
Total	13,722	13,156	12,522	16,481	15,370	14,304

SOURCES: Provincial-government reports and the Department of Northern Affairs and National Resources.

Columbia, 116; Saskatchewan, 44; Manitoba, 11; Yukon Territory and the Northwest Territories mainland, 51. There was a big increase in seismic activity on Devonian reefs in central Alberta and Devonian gas-bearing carbonates in British Columbia.

Petroleum and natural-gas land holdings in western Canada decreased from 256 million acres to 254.6 million. The decrease occurred in all the provinces except Alberta and on the mainland of the northern territories, but was largely offset by an increase in holdings on the Arctic Islands and in offshore areas. When the year ended, land holdings were as follows: Alberta, 74.9 million acres; British Columbia, 33.8 million; Saskatchewan, 19.0 million; Manitoba, 3.2 million; northern territories' mainland, 59.9 million; the Arctic Islands and offshore areas of the Atlantic and Pacific coasts, 63.8 million.

Drilling in western Canada in the search for and development of oil and natural gas increased from 13,496,865 feet in 1960 to 13,854,642 feet in 1961. A smaller proportion of the footage drilled was for exploratory purposes—29.8 per cent instead of the previous year's 31 per cent. The proportion of development drilling increased owing to an increase in activity in known gas fields. In oil fields it declined, chiefly because of a lack of major new fields. The trend of recent years toward the drilling of deeper exploratory wells continued. In 1961 their average depth was 5,367 feet; in 1960 it was 5,250 feet. The deepest wells, especially those greater than 10,000 feet, were drilled mainly in or near the Foothills, where the principal hydrocarbon is natural gas.

DEVELOPMENT, BY AREAS

Alberta

On a footage basis, both exploratory and development drilling decreased slightly in 1961. Of the 9,942,272 feet drilled, 29.7 per cent was for exploratory purposes, the remainder being development drilling. No new oil field of major size was discovered. A well completed in June, Mic Mac Twining 6-4, resulted in the discovery of the Twining field, probably the most important of the year. This medium-sized reservoir is 50 miles northeast of Calgary between the Wimborne and West Drumheller fields. In northwestern Alberta, a well drilled 4 miles east of the Kaybob field, Pacific Kaybob 10-4, found a significant new oil pool in the Beaverhill Lake formation. A Devonian D-2 oil discovery made in 1960 just west of the Fenn-Big Valley field was followed in 1961 by several more D-2 discoveries in that area. Formations of several geological ages yielded oil discoveries in a number of wells drilled along the Medicine River west of Sylvan Lake. Early in 1961, a new oil-bearing region was indicated by a well in north-central Alberta, 50 miles north of Fort Vermilion, near the Melvin River. The discovery proved to be noncommercial but has led to plans for further drilling in the area.

The decrease in development drilling was due mainly to the fact that the development of the two largest fields found during the past decade, the Pembina and the Swan Hills, was nearing the final stages. The Swan Hills and Pembina fields had respective net increases of 118 and 108 new 'producible' oil wells, but these increases were much below those of previous years. Other fields in the Swan Hills group—Judy Creek, Judy Creek West, Virginia Hills and Carson Creek North—all producing from the Beaverhill Lake formation, were actively developed. Three fields which, like the Pembina, produce mainly from the sand of the Cardium formation were developed extensively. These and their net increases were: Willesden Green, 99 wells capable of production; Crossfield, 50; and Garrington, 23.

British Columbia

Drilling in the search for and development of hydrocarbon reserves in British Columbia in 1961 exceeded 1 million feet for the first time. Sixty per cent of the drilling, or 645,474 feet, was for the development of known fields. The construction of the pipeline of Western Pacific Products & Crude Oil Pipelines Ltd., which opened Vancouver markets to northeastern British Columbia's oil, resulted in an accelerated development-drilling program in the Boundary Lake oil field, where 68 new 'producible' wells were added to the 1960 year-end total of 62. Although doubled in area during the year, the field has not yet been fully delimited. Only minor development was carried on in other oil fields.

Exploratory drilling was confined to the northeastern corner of the province, east of the mountains in the Fort St. John-Fort Nelson region, with the exception of one dry exploratory hole drilled in the Queen Charlotte Islands. The exploratory total, 428,868 feet, was less than in 1960. Nearly all the successful exploratory wells were natural-gas discoveries, oil discoveries being of comparatively minor importance. One of the more significant finds was made between the Peejay and the Milligan Creek fields by Pacific et al Peejay d-33-I.

Saskatchewan

An increase in the demand for Saskatchewan crude in Ontario and the United States Great Lakes region resulted in a higher rate of field-development drilling; and this growth in field development was the sole reason for the 9.0-per-cent increase to 484 in the number of oil-well completions. Exploration drilling, on the other hand, decreased, mainly because in recent years there has been a discouraging lack of discoveries of important new fields. The total exploration and development footage increased to a lesser extent than the number of wells drilled because the development wells, although more numerous, were relatively shallow.

In 1961, as in 1960, development drilling was most intensively concentrated in the Dodsland field, where the 1960 year-end total of 74 was augmented by 104 new producible wells. Other fields with notable net increases in the number of wells capable of producing were: Parkman, 43; Midale, 41, Workman, 28; Weyburn, 31; and Hastings, 28.

The most successful exploratory drilling was carried on near the Workman field, in the southeastern corner of the province just north of the United States boundary. There, early in the year, a new pool was found by Kissinger et al Carievale 3-4, and many subsequent wells considerably enlarged the productive area. Other successful exploratory wells were drilled between the Parkman field and the Manitoba boundary.

Manitoba

Oil exploration and field development in Manitoba declined to the extent that there was seldom more than one drilling rig in operation. In the peak period, 1954 to 1957, more than 200 wells were completed annually, but in 1961 there were only 27 completions. Fifty-five per cent of all wells drilled were development wells in established fields and pools. Near Pierson, one comparatively small oil discovery was made, but follow-up tests were disappointing. Because new wells were not brought in rapidly enough to replace those depleted, the province's year-end total of oil wells capable of production was less than it had been a year previously.

Northwest Territories and Yukon Territory

Fewer wells were drilled than in 1960. One important natural-gas discovery was made, but there were no oil discoveries. One deep exploratory well, Dome et al Winter Harbour No. 1, the first to be drilled in Canada's Arctic Islands, attracted widespread attention but was abandoned early in 1962, after reaching a depth of 12,543 feet. No oil was found, but minor showings of natural gas were intersected at shallow depths.

Eastern Canada

Well completions in Ontario in 1961 amounted to 267, including 17 service wells; their total for 1960 was 306. Drilling totalled 362,722 feet, or 9.7 per cent less, but the average well depth increased slightly to 1,359 feet. In exploratory drilling, only two oil discoveries were made, both in Ordovician strata. Of the 85 exploratory holes, 72 were dry and eight were offshore wells in Lake Erie. The number of successful oil-development wells increased from 47 to 53, of which 38 produced from Devonian strata, four from Silurian, and 11 from Ordovician-Cambrian. Most of the Devonian producers were drilled in the Rodney field. Nine new oil wells were drilled in the Gobles field, the 1960 Cambrian oil discovery.

In Quebec, no oil discoveries were made, although a group of gas wells were drilled in Pleistocene drift near Three Rivers. No reservoir beds were found in the one exploratory well drilled on the Gaspé Peninsula. Five Ordovician tests near the Three Rivers gas area were also dry. In the Atlantic Provinces, no exploratory drilling was done.

PIPELINES

The oil-pipeline systems of Canada at the end of 1961 consisted of more than 9,550 miles of trunk and gathering lines, the two principal components being the systems of Interprovincial Pipe Line Company and Trans Mountain Oil Pipe Line Company. The Interprovincial pipeline extends from the Edmonton area to Port Credit, near Toronto, a right-of-way distance of 1,928 miles. The Trans Mountain pipeline runs 718 miles from Edmonton to Vancouver. In addition, about 40 other pipeline companies gather or distribute crude oil, natural-gas liquids or petroleum products in Canada.

By the end of 1961, the 505-mile 12-inch trunk line of Western Pacific Products & Crude Oil Pipelines Ltd. was essentially completed and was undergoing tests. This oil pipeline, the most important laid in Canada in several years, runs from Taylor, in northeastern British Columbia, to Kamloops, where it joins the Trans Mountain pipeline, thus making possible large-scale deliveries of British Columbia crude to Vancouver refineries. British Columbia Oil Transmission Co. Ltd. completed a 66-mile 8-inch line from the Blueberry field to the head of the Western Pacific pipeline, at Taylor. Also serving the Western Pacific line is the previously built system of Trans-Prairie Pipelines, Ltd.

In Alberta, the Kaybob field was linked with Edmonton by a 161-mile 12-inch pipeline, the longest laid in 1961. This system, owned by Peace River Oil Pipe Line Co. Ltd., was connected to the Windfall field by an 8-mile 8-inch lateral. Rimbey Pipe Line Co. Ltd. installed a 64-mile 8-inch line for the transfer of natural-gas liquids from the new Rimbey gas-processing plant to Edmonton. Rangeland Pipe Line Company Limited built a 41-mile line from the Waterton and Pincher Creek fields to export natural-gas liquids to the United States, but by the end of the year no Presidential permit had been granted to construct a line across the International Boundary. In Saskatchewan, Producers Pipelines Ltd. added 44 miles of new pipeline to its system.

TABLE 8

MILEAGE IN CANADA OF PIPELINES FOR CRUDE OIL, NATURAL-GAS LIQUIDS AND PRODUCTS

Year-end	Miles	Year-end	Miles
1950	1,423	1956	6,051
1951	1,577	1957	6,873
1952	2,500	1958	7,148
1953	3,794	1959	7,945
1954	4,656	1960	8,435
1955	5,079	1961	9,550

SOURCE: Dominion Bureau of Statistics, *Oil Pipe Line Transport, 1961.*

Implementation of the national oil policy led to significant increases in the deliveries made by the two largest oil-pipeline systems. Interprovincial Pipe Line Company benefited by a 14-per-cent increase in long-haul deliveries to Ontario, although its deliveries to the Prairie Provinces decreased slightly. Greater use of Canadian crude in the lower Great Lakes area of the United States brought about an increase in tanker movements and deliveries to the Buckeye Pipe Line Company at Port Huron, Michigan. Trans Mountain Oil Pipe Line Company raised its throughput to the State of Washington to 58 per cent from the 44-per-cent level of 1960. Deliveries at Kamloops to Trans Mountain from the new Western Pacific pipeline started early in 1962.

TABLE 9

DELIVERIES OF CRUDE OIL

Company	Destination	(millions of barrels) 1961	1960	1959
Interprovincial	Western Canada	32.3	34.2	32.7
	United States	33.3	23.0	20.3
	Superior, Wisconsin (for tankers)	1.2	0.9	—
	Ontario	79.1	69.8	69.9
	Total	145.9	127.9	122.9
Trans Mountain	British Columbia	23.9	23.3	22.6
	State of Washington	33.2	18.1	13.3
	Total	57.1	41.4	35.9

SOURCES: Annual reports of Interprovincial Pipe Line Company and Trans Mountain Oil Pipe Line Company.

PETROLEUM-REFINING

The net effect of the closing of two small refineries, the opening of a new one and the expansion of existing facilities was to increase Canada's crude-oil-refining capacity in 1961 from 950,260 barrels a day to 961,760. In December, the new 8,500-barrel-a-day plant of Golden Eagle Refining Company of Canada, Limited, came on stream at Holyrood, near St. John's, Newfoundland, to become the province's first petroleum refinery. Pacific Petroleums, Ltd., expanded its plant at Taylor, in northeastern British Columbia, to 3,300 barrels a day but suspended operations at its 2,800-barrel-a-day plant at nearby Dawson Creek. At Hartell, Alberta, Anglo American Exploration Ltd. closed its small refinery, which had served the historic Turner Valley for 22 years. The Regina refinery of Consumers' Co-operative Refineries Limited was expanded from 16,000 to 22,500 barrels a day. A total of 43 refineries were in operation at the end of 1961, ranging in size from a 300-barrel-a-day plant at Weldon, New Brunswick, to the 94,000-barrel-a-day refinery of Imperial Oil Limited at Sarnia, Ontario. Quebec has the largest refinery capacity of all the provinces—297,000 barrels a day—but Ontario will surpass this in 1963 when present refinery construction and expansion programs are completed.

TABLE 10

CRUDE-OIL-REFINING CAPACITY, BY REGIONS

	1961		1960		1955	
	Bbl/Day	%	Bbl/Day	%	Bbl/Day	%
Maritimes	106,300	11.1	96,800	10.2	18,300	3.0
Quebec	297,000	30.9	297,000	31.3	210,000	34.0
Ontario	260,820	27.1	260,820	27.4	148,800	24.0
Prairies and Northwest Territories	200,340	20.8	196,940	20.7	174,850	28.3
British Columbia	97,300	10.1	98,700	10.4	66,500	10.7
Total, Canada	961,760	100.0	950,260	100.0	618,450	100.0

SOURCE: Department of Mines and Technical Surveys, *Petroleum Refineries in Canada* (Operators List 5), January 1962.

TABLE 11

CANADIAN CRUDE OIL AS PERCENTAGE OF REFINERY RECEIPTS, BY REGIONS

	1961	1960	1959	1955	1950	1945	1940
Maritimes	0	0	0	0	0	0	0
Quebec	0	0	0	0	0	0	0
Ontario	97.1	95.2	96.8	78.8	1	0.5	1.2
Prairies and Northwest Territories	100	100	100	100	99	58.2	92.3
British Columbia	100	100	100	100	0	0	0
Total, Canada	54.1	54.1	56.6	54.7	24.4	11.7	16.4

SOURCE: Calculations based on statistics published by Dominion Bureau of Statistics.

MARKETING AND TRADE

Receipts of crude oil at Canadian refineries totalled 290.41 million barrels in 1961, 14.32 million barrels, or 5.2 per cent, more than in 1960. In both years, Canadian crude oil constituted 54.1 per cent of refinery receipts, but as net imports of petroleum products declined in 1961, Canadian crude actually supplied about 1 per cent more of the domestic market for all oils than it did in 1960.

Receipts of imported crude increased by 6.40 million barrels, or 5.1 per cent. Refiners in the Atlantic Provinces and Quebec continued to use only imported crude. Partly because two new eastern refineries had their first full year of operation, imports of crude increased while imports of refined petroleum products decreased from their 1960 total of 36.04 million barrels to 29.67 million for 1961. Attainment of crude-oil-production targets under the national oil policy was helped substantially by the 11.7-per-cent increase in the use of Canadian crude in Ontario refineries. By the last two months of the year, importation of foreign crude oil into Ontario had ceased for the first time in many years. Petroleum products transferred into Ontario from Quebec declined from 25 million to 23 million barrels. In the Prairie Provinces, where natural gas has taken over much of the fuel-oil market, refinery crude-oil receipts decreased by 1.9 per cent. British Columbia recorded a 2-per-cent increase in refinery receipts, all Canadian crude. Newfoundland started to import crude oil late in the year to supply its new, and only, refinery.

Venezuela remained the leading supplier of the crude oil imported into Canada, providing 8.72 million barrels more than in 1960, or 61.6 per cent of all the crude oil imported. Saudi Arabia, Kuwait, Iran and Qatar supplied 36 per cent of crude imports but 2.35 million barrels less than the Middle East countries did in 1960. The relatively small imports of crude oil from Trinidad increased slightly, while those from the United States ceased.

TABLE 12

CRUDE OIL RECEIVED AT CANADIAN REFINERIES, 1961

(barrels)

Location of Refineries	Country of Origin				Total Received
	Canada	Middle East	Trinidad	Venezuela	
Atlantic Provinces	—	13,706,659	—	17,178,777	30,885,436
Quebec	—	34,371,248	3,102,966	62,491,810	99,966,024
Ontario	80,551,174	—	—	2,374,288	82,925,462
Prairies and Northwest Territories	52,075,500	—	—	—	52,075,500
British Columbia	24,555,589	—	—	—	24,555,589
Total, Canada	157,182,263	48,077,907	3,102,966	82,044,875	290,408,011

SOURCE: Dominion Bureau of Statistics, *Refined Petroleum Products, 1961.*

TABLE 13

REGIONAL CONSUMPTION OF PETROLEUM PRODUCTS—NET SALES, 1961*

('000 barrels)

	Motor Gasoline	Kerosene, Stove Oil, Tractor Fuel	Diesel Oil	Light Fuel Oils 2 and 3	Heavy Fuel Oils 4, 5 and 6
Newfoundland	1,102	827	1,054	919	1,993
Maritimes	6,358	2,589	2,420	5,120	7,037
Quebec	22,403	5,262	5,558	17,156	19,768
Ontario	39,195	4,259	5,377	30,079	13,086
Manitoba	5,494	323	1,308	2,544	1,461
Saskatchewan	7,700	404	2,565	2,432	1,170
Alberta and Northwest Territories	11,039	284	4,032	1,311	683
British Columbia and Yukon Territory	9,511	1,893	3,880	4,043	6,158
Total, Canada	102,802	15,841	26,194	63,604	51,356

SOURCE: Dominion Bureau of Statistics, Industry and Merchandising Division, *Net Sales of Finished Petroleum Products, 1961.*

TABLE 14

IMPORTS OF REFINED-PETROLEUM PRODUCTS

(millions of barrels)

	1961	1960	1959
Heavy fuel oil	10.47	13.44	12.43
Light fuel oil	7.36	6.98	8.91
Stove oil	2.50	3.67	5.47
Motor gasoline	0.74	0.89	2.72
Aviation gasoline	1.04	1.74	2.83
Diesel fuel	2.38	2.69	1.63
Lubricating oil	1.10	1.17	1.17
Petroleum coke	1.76	1.94	1.51

SOURCE: Dominion Bureau of Statistics, *Refined Petroleum Products, 1961.*

Imports of petroleum products dropped by 17.7 per cent in 1961 to 29,673,607 barrels. The largest decline occurred in heavy fuel oil, which accounted for 35 per cent of these imports. The Netherlands Antilles, the United States and Venezuela are the main sources. Some products, such as heavy fuel oil, come from as far away as Kuwait.

The year's most marked change in the marketing of Canadian petroleum took place in crude-oil exports. Exports of crude oil, including natural-gas liquids mixed in the pipeline stream, increased by 54 per cent—from 42.2 million barrels, their 1960 total, to 65.2 million barrels for 1961. The crude was all exported to the United States—50.5 per cent to three refineries on Puget Sound and 49.5 per cent to the Great Lakes region. Canada also exported small amounts of petroleum products, mainly to the United States and the island of St. Pierre. These exports, consisting mainly of fuel oil, gasoline and liquefied petroleum gas, totalled 2.3 million barrels, or about one quarter less than in 1960.

There is no tariff on crude oil entering Canada. There is a United States import tax of 5¼ cents a barrel on Canadian crude oil testing under 25° A.P.I. gravity and 10½ cents a barrel on oil testing at or above that gravity.

TABLE 15

SUPPLY AND DEMAND—ALL OILS

(barrels)

	1961*	1960
Supply		
Production		
Crude oil (excluding field condensate)	220,848,080	189,534,221
Natural-gas liquids (including field condensate)	13,839,445	9,271,811 r
Total, Canada	234,687,525	198,806,032 r
Total, Canada, barrels per day	642,980	543,186 r
Imports*		
Crude oil (including natural gasoline)	133,225,748	126,824,208
Refined-petroleum products	29,673,607	36,036,591
Total	162,899,355	162,860,799
Change in stock		
Crude oil	−252,148	−1,022,119
Refined-petroleum products	−5,747,322	−2,814,661
Net changes in stock	−5,999,470	−3,836,780
Oils not accounted for	+613,381	+1,712,406 r
Total supply	392,200,791	359,542,457
Demand		
Exports		
Crude oil	65,222,523	42,234,937
Products	2,195,214	3,190,441
Total	67,417,737	45,425,378
Domestic sales		
Motor gasoline	102,801,766	100,271,514
Middle distillates	111,986,460	108,844,277
Heavy fuel oil	51,355,784	49,328,005
Other products	32,281,461	32,541,984
Total	298,425,471	290,985,780
Uses and losses		
Refinery	23,961,120	22,016,983
Field and pipeline	2,396,463	1,114,316
Total	26,357,583	23,131,299
Total demand	392,200,791	359,542,457

SOURCES: Dominion Bureau of Statistics and provincial-government reports.
*Received at refineries. r Revised.

Phosphate

J. E. Reeves*

In 1961, for the first time, Canada imported more than a million short tons of phosphate rock for the manufacture of fertilizers and elemental phosphorus. Imports in eastern Canada come from Florida, in western Canada from Montana. The average value is about $7 a short ton.

The import statistics also include materials with a low fluorine content, for use as animal-feed supplements. The United States supplies defluorinated phosphate rock and dicalcium phosphate, Japan and Belgium similar low-fluorine products and the Netherlands Antilles a naturally low-fluorine phosphate rock. These have average prices that greatly exceed that of ordinary phosphate rock, and their inclusion in the table considerably inflates the value of phosphate-rock imports.

In 1961, imports of phosphate fertilizers continued to decline. The quantity of triple superphosphate was lower than in 1960, after several years of regular increases. Imports of normal superphosphate increased slightly from those of 1960, but were considerably lower than in previous years. Most of these fertilizers are consumed in eastern Canada.

Canada produces a surplus of ammonium phosphate fertilizers in the western part of the country. Large quantities are exported—mainly to the United States. In 1961, total exports were lower than in 1960 because of the loss of overseas markets.

Several developments in the fertilizer manufacturing industry took place during the year. Electric Reduction Company of Canada, Ltd. commenced operating at Port Maitland, Ontario, Canada's first triple superphosphate plant. The process uses concentrated wet-process phosphoric acid (containing 54 per cent P_2O_5) derived from the treatment of calcined phosphate rock from Florida and sulphuric acid from the neighboring zinc smelter of Sherbrooke Metallurgical Company Limited. Also produced are phosphoric acid for liquid fertilizers and dicalcium phosphate for animal feed. Electric Reduction, which is Canada's only producer of elemental phosphorus, furnace-grade phosphoric acid and industrial phosphorous chemicals, entered the fertilizer field in 1959 by acquiring the normal superphosphate plant of Dominion Fertilizers Limited, at Port Maitland.

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*Mineral Processing Division, Mines Branch.

TABLE 1

PHOSPHATE—TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Imports				
Phosphate rock[1]				
United States	1,039,910	9,043,670	935,745	7,999,906
Netherlands Antilles	12,833	402,842	1,825	81,975
Japan	1,546	108,376	1,102	69,966
Belgium and Luxembourg	2,563	123,456	3,326	168,282
Britain	33	300	—	—
Total	1,056,885	9,678,644	941,998	8,320,129
Phosphate fertilizers				
Triple superphosphate				
United States	67,435	3,392,272	83,142	3,925,911
Superphosphate not otherwise provided for				
United States	119,748	2,171,850	117,382	2,145,433
Netherlands	—	—	2,307	32,924
Venezuela	4,816	60,263	—	—
Total	124,564	2,232,113	119,689	2,178,357
Phosphate fertilizer not otherwise provided for				
United States	6,679	567,193	1,868	203,533
Tunisia	—	—	4,375	32,356
Morocco	50	2,132	—	—
Total	6,729	569,325	6,243	235,889
Total, phosphate fertilizers	198,728	6,193,710	209,074	6,340,157
Phosphoric acid and phosphorous compounds	6,991	1,491,283	5,816	1,212,474
Exports				
Phosphate-nitrogen fertilizers				
United States		19,625,313		18,965,467
Philippines		46,481		39,276
Guatemala		8,699		81,212
Thailand		4,863		29,425
India		—		826,845
Colombia		—		644,660
Korea		—		296,545
Other countries		—		19,425
Total		19,685,356		20,902,855
Consumption of phosphate rock (available data)	1961		1960	
Fertilizers[2]	826,192		731,102	
Chemicals	150,339		160,686	
Miscellaneous	108		106	
Total	976,639		891,894	

SOURCE: Dominion Bureau of Statistics. [1]Includes some defluorinated phosphate rock and dicalcium phosphate for use as animal-feed supplements. [2]Includes small amounts used for animal-feed supplements.

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TABLE 2

PHOSPHATE ROCK—IMPORTS AND CONSUMPTION, 1951-61

(short tons)

	Imports	Consumption		Imports	Consumption
1951	499,711	519,143	1957	723,220	772,715
1952	470,913	511,757	1958	744,164	728,906
1953	576,500	512,090	1959	797,063	786,044
1954	644,860	628,061	1960	941,998	891,894[r]
1955	588,209	585,326	1961	1,056,885	976,639
1956	627,648	552,646			

SOURCE: Dominion Bureau of Statistics. [r]Revised from previously published figures.

Cyanamid of Canada Ltd. began construction of a plant at Port Robinson, Ontario, for the production of triple superphosphate and diammonium phosphate—the first ammonium phosphate to be produced in eastern Canada. The new operations of Electric Reduction Company and Cyanamid of Canada will reduce imports of superphosphate fertilizers in Ontario and Quebec and provide exports to the northeastern United States.

In western Canada, an increase in the production capacity for ammonium phosphate is planned. The Consolidated Mining and Smelting Company of Canada Ltd. will build a new plant at Kimberley, British Columbia.

Canadian participation in the development of foreign phosphate rock deposits was announced during 1961. A Canadian company, Midepsa Industries Ltd., was formed to develop vast deposits in the Sechura Desert in Peru. Canadian Husky Oil Ltd. is planning the joint development, with International Minerals & Chemical Corporation of Skokie, Illinois, of deposits in Idaho.

PRODUCTION AND OCCURRENCES

There has been no significant domestic production of phosphatic raw material in many years. Imports of low-cost sedimentary phosphate rock have killed the apatite-mining industry that flourished in the late nineteenth century, particularly in the Buckingham area of Quebec, on a type of deposit that is common in southwestern Quebec and southeastern Ontario. It is usually relatively small, irregular, coarse-grained and associated with pyroxenite, and frequently contains phlogopite and pink calcite.

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 about 20 per cent apatite, large quantities of titaniferous magnetite, and minor amounts of the niobium mineral pyrochlore. The niobium deposits in the Oka area, near Montreal, contain small amounts of apatite, which is potentially recoverable as a by-product in future niobium-mineral production.

Apatite also occurs on the north shore of the Saguenay River near Arvida, Quebec, as an essential constituent in titaniferous-magnetite deposits associated with anorthosite.

Sedimentary phosphate rock occurs between Banff, Alberta, and the Crowsnest-Fernie area of southeastern British Columbia, but is too low-grade to be commercial.

WORLD PRODUCTION

Deposits of sedimentary phosphate rock, or phosphorite, supply almost 90 per cent of the world's requirements of phosphate. The rest comes from apatite and, to a minor extent, guano deposits.

World production in 1961 was reportedly more than 3 per cent higher than in 1960. The United States is the principal producer with about 20 million short tons of sedimentary rock in 1961. This rock is derived from Florida, the Western States (Montana, Idaho, Utah and Wyoming) and Tennessee. Other major sources of sedimentary phosphate rock are Morocco, Tunisia, Russia and the island of Nauru in the southern Pacific. Russia is the largest producer of apatite (about two thirds of its total output of phosphatic raw material), from the large apatite-nepheline deposits in the Kola Peninsula. Peru and Chile are the main guano producers. The Netherlands Antilles markets a low-fluorine phosphate rock, which is used in stock and poultry feeds.

TABLE 3

WORLD PRODUCTION OF PHOSPHATE, 1961

('000 short tons)

United States	20,786	Nauru	1,436
Southern Morocco	8,763	Brazil	997
Russia	8,490	Christmas Island	777
Tunisia	2,184	Other countries	5,589
		Total	49,022

SOURCE: U.S. Bureau of Mines, *Minerals Yearbook 1961.*

TECHNOLOGY

Phosphorus, an essential constituent of animal and plant life, is mainly derived from sedimentary phosphate rock or primary apatite, each of which is essentially calcium phosphate. These raw materials are graded chemically, analyses being reported in terms of the P_2O_5 content or the B.P.L. (bone phosphate of lime), which is the tricalcium phosphate, or $Ca_3(PO_4)_2$, content (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 P_2O_5 and is produced by treating phosphate rock with phosphoric acid. These fertilizers are mostly used 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.

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 proportion 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 3 per cent Fe_2O_3 plus Al_2O_3, and be mostly coarser than 5-mesh.

PRICES

According to *E & M J Metal and Mineral Markets* of December 21, 1961, the United States prices of Florida land-pebble phosphate rock per long ton were as follows:

% B.P.L.	f.o.b. Mine or Mill	f.o.b. Vessel	% B.P.L.	f.o.b. Mine or Mill	f.o.b. Vessel
77 to 76	$8.21	$10.50	72 to 70	$6.21	$ 8.30
75 " 74	$7.21	$ 9.50	70 " 68	$5.56	$ 7.75
			68 " 66	$5.16	$ 7.10

Phosphate rock enters Canada duty-free.

Platinum Metals

C. C. Allen*

Production of platinum metals in Canada amounted in 1961 to 418,278 troy ounces valued at $24,534,349; in 1960 it totalled 483,604 ounces valued at $28,873,508. The difference in value resulted solely from lower volume, not from price changes.

The platinum metals comprise platinum, palladium, rhodium, ruthenium, iridium and osmium. All except osmium are produced in Canada as by-products of the treatment of nickel-copper ores.

In 1961, the market for platinum metals was quiet. The only price change was a slight reduction in that of osmium. Russian platinum metals were available at prices slightly lower than the regular.

Canada continues to be one of the three leading producers. The other two—the Republic of South Africa and the Union of Soviet Socialist Republics—do not publish production statistics. The sales of Rustenburg Platinum Mines Limited, South Africa's top-ranking producer, were down for the first seven months of the year in the United States but improved elsewhere. The company, however, increased its output so that its metal inventories would be adequate to any demand. Platinum metals make up Rustenburg's primary production; nickel and copper are its by-products. In Russia, platinum metals are obtained from the placer deposits of the Urals and as by-products of the nickel-copper operations at Norilsk, Petsamo and Monchegorsk.

TABLE 1

WORLD PRODUCTION, 1961

	(troy ounces)
Canada	418,278*
Republic of South Africa	357,000ᵉ
U.S.S.R.	350,000ᵉ
United States	43,248
Colombia	28,227
Other countries	6,247
	1,203,000

SOURCE: U.S. Bureau of Mines, *Mineral Trade Notes, August 1962.*
*Dominion Bureau of Statistics.
ᵉEstimated.

*Mineral Resources Division.

TABLE 2

PLATINUM METALS—PRODUCTION AND TRADE

	1961 Troy Ounces	1961 $	1960 Troy Ounces	1960 $
Production				
Platinum, palladium, rhodium, ruthenium, iridium....	418,278	24,534,349	483,604	28,873,508
Exports				
Domestic origin				
Platinum metals in ores and concentrates				
Britain	596,356	24,773,501		
Norway	21,249	979,358		
United States	9,271	156,579		
Japan	—	—		
Cuba	—	—		
Total	626,876	25,909,438		
Platinum metals				
Japan	1,603	151,211		
Britain	1,856	188,640		
Cuba	666	61,406		
United States	385	16,487		
Venezuela	109	3,919		
Total	4,619	421,663		
Total, platinum metals in ores and concentrates[1]				
Britain	598,212	24,962,141	374,201	14,793,907
Norway	21,249	979,358	19,519	860,924
United States	9,656	173,066	6,000	98,512
Japan	1,603	151,211	3,490	312,865
Cuba	666	61,406	30	2,520
Venezuela	109	3,919	—	—
Total	631,495	26,331,101	403,240	16,068,728
Foreign origin[2]				
Platinum metals refined and semiprocessed				
United States	346,590	9,820,374	199,563	8,404,563
Imports				
Platinum metals semiprocessed and manufactured				
United States		268,549		264,222
Britain[3]		10,973,779		12,686,823
West Germany		—		375
Total		11,242,328		12,951,420
Platinum crucibles				
United States		1,304,278		1,979,363
Britain		53,398		2,826
Total		1,357,676		1,982,189
Catalysts for refining petroleum				
United States		2,288,329		1,871,582
Britain		9,040		8,194
Total		2,297,369		1,879,776

SOURCE: Dominion Bureau of Statistics.

[1]For 1961 and the years following, separate classes have been instituted for platinum in ores and concentrates and for platinum metals. The total of these two classes corresponds to the 1960 total for platinum metals in ores and concentrates.

[2]Exports from Canada to the United States of platinum metals in a refined or semiprocessed state. They are considered exports of foreign produce since they are derived from imports from Britain (see the following footnote).

[3]Derived from Canadian concentrates refined and processed in Britain.

TABLE 3

PLATINUM METALS—PRODUCTION AND TRADE, 1951-61

	Production[1]			Exports			Imports[4]
	Platinum (troy oz)	Other Platinum Metals (troy oz)	Total (troy oz)	Domestic[2] ($)	Foreign[3] ($)	Total ($)	($)
1951..........	153,483	164,905	318,388	15,411,319	14,928,891	30,340,210	17,077,931
1952..........	122,317	157,407	279,724	17,609,955	12,919,157	30,529,112	17,373,023
1953..........	137,545	166,018	303,563	15,357,335	10,921,621	26,278,956	16,517,392
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..........			483,604	16,068,728	8,404,563	24,473,291	12,951,420
1961..........			418,278	26,331,101	9,820,374	36,151,475	11,242,328

SOURCE: Dominion Bureau of Statistics.

[1]Platinum metals, content of residues, concentrates and matte shipped to Britain and Norway for treatment. For 1951 and 1952 small quantities of alluvial platinum are included.

[2]Value of platinum metals in concentrates exported for treatment.

[3]Exports of platinum metals refined and semiprocessed. Since these are essentially re-exports of platinum metals from Britain, they are considered exports of foreign produce.

[4]These are largely imports from Britain of refined and semiprocessed platinum metals derived from Canadian concentrates and residues shipped to Britain for treatment.

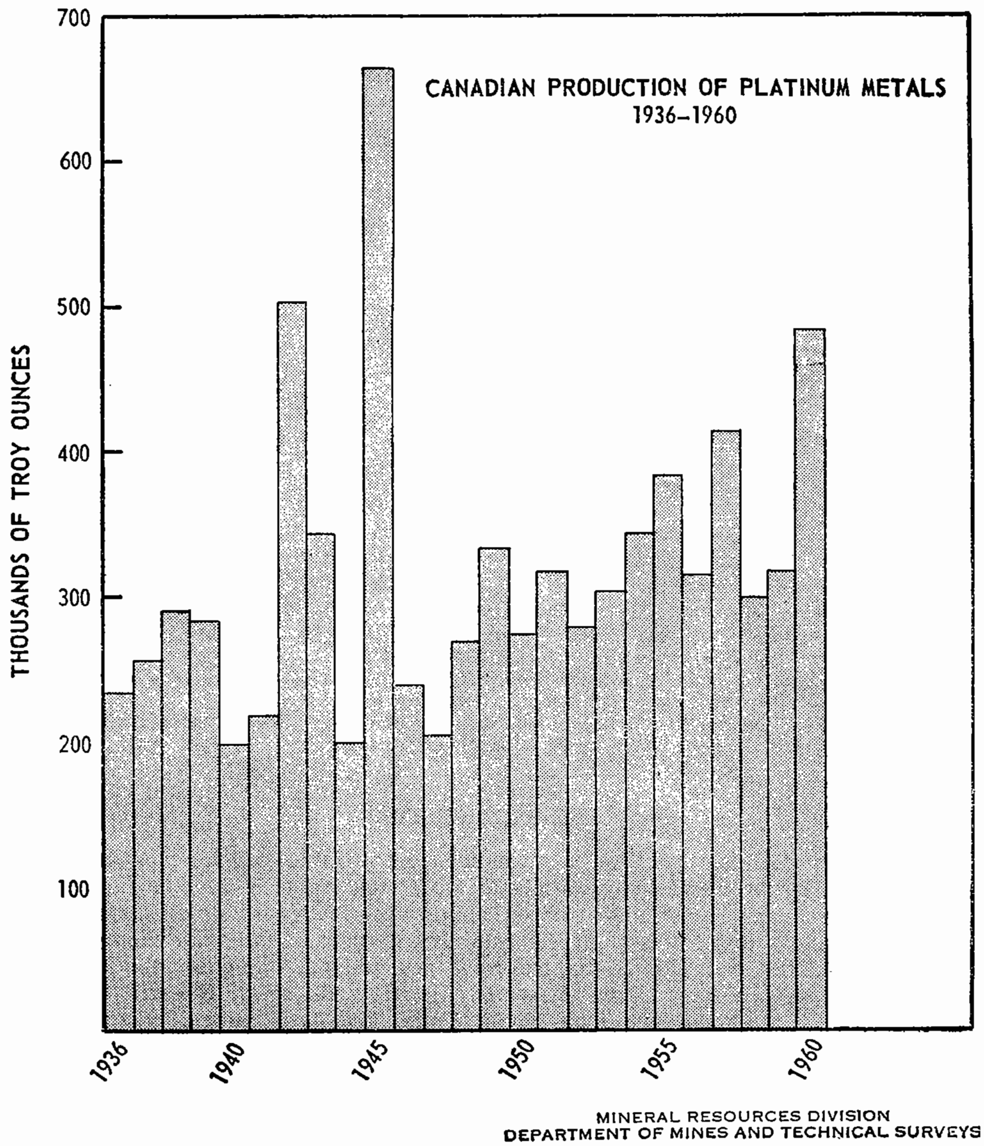
MINE PRODUCTION

Platinum metals occur with most nickel-copper sulphide ores and are recovered as by-products in pyrometallurgical treatment. Although the values are low, the large ore tonnage treated yields appreciable quantities. Canada's entire production has come from the Sudbury district of Ontario, though production from Thompson, Manitoba, can now be expected. The chemical-leaching process used at the Fort Saskatchewan, Alberta, refinery of Sherritt Gordon Mines, Limited, to treat ore from Lynn Lake, Manitoba, and North Rankin Nickel Mines Limited, in the Northwest Territories, does not result in the recovery of platinum metals.

Producers in the Sudbury district are The International Nickel Company of Canada, Limited, and Falconbridge Nickel Mines, Limited.

International Nickel operated its five mines—the Frood-Stobie, Creighton, Garson, Levack and Murray—throughout the year. It stopped production at the Frood open pit and started to produce at the new Clarabelle open pit and the smaller Ellen. Underground development continued at the Crean Hill property. The ore the company mined during the year in the Sudbury area amounted to more than 16 million short tons. As the year ended, its ore reserves in the Sudbury area and Manitoba combined totalled 297,419,000 tons containing 8,937,300 tons of nickel-copper.

Falconbridge Nickel Mines, Limited, also near Sudbury, had its Falconbridge, East, Hardy and Fecunis mines in continuous operation. The Longvack and McKim mines were closed, but the Boundary and Onaping mines started production. At the large Strathcona deposit, development work progressed. Work continued at the Falconbridge mills on the refinement of operations for the production of a pyrrhotite concentrate for the iron plant and an all-sinter



feed for the smelter. At Falconbridge's refinery at Kristiansand, Norway, a pilot plant was operating on a modified refinery process which, if successful, would necessitate major refinery adjustments. Ore delivered to the Falconbridge treatment plants totalled 2,639,897 tons. Ore reserves at the end of the year amounted to 46,247,200 tons averaging 1.45 per cent nickel and 0.80 per cent copper.

International Nickel's Thompson operation was officially started on March 25 and by mid-year was up to the rated annual capacity of 75 million pounds of nickel. Production may exceed the rated Thompson capacity. During the summer, the shipment of electrolytic nickel to Europe through the port of Churchill, Manitoba, was begun. The ore mined during the year amounted to more than 1 million tons.

Giant Nickel Mines Limited, in British Columbia, signed a contract on March 1 with Sumitomo Metal Mining Co., Ltd., of Japan, for Giant's entire output of nickel-copper concentrate for a further three-year period. An accelerated exploration program raised the indicated nickel-copper ore reserves to 1,100,000 tons. The daily mill capacity was increased from 900 tons to 1,200 tons, but during the construction period, from mid-November until the end of the year, the mill was closed. Mine production for the year totalled 267,767 tons of ore.

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 platinum-metal slimes from the electrolytic cells are refined by Engelhard Industries Incorporated at Newark, New Jersey.

EXPLORATION AND DEVELOPMENT

Production of nickel-copper concentrates for Marbridge Mines Limited, in La Motte township, Quebec, is expected to start in the spring of 1962 at a planned rate of at least 300 tons of ore a day. The company is owned by Falconbridge and Marchant Mining Company Ltd. Falconbridge will smelt the concentrates.

Nickel Mining & Smelting Corporation announced production plans for its Gordon Lake property, 55 miles northwest of Kenora, Ontario. Shaft-sinking and mill construction are under way, and production is expected to start in September 1962 at a mill rate of 500 tons a day. The precious-metal content, estimated to be worth $3 a ton, consists chiefly of platinum and palladium, an estimated 50 per cent of which is recoverable. Nickel-copper concentrates will be trucked to Lac du Bonnet, Manitoba, and thence shipped by rail to Sudbury for smelting by International Nickel.

Quebec Cobalt and Exploration Limited announced a copper-platinum discovery in Guillet township, some 8 miles southeast of Belleterre, Quebec. Platinum assays ranged from 0.05 ounce to 0.70 ounce per ton. The property was subsequently optioned to Asarco Exploration Company of Canada, Limited.

NEW USES

The 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 consumed. Iridium, osmium, ruthenium and rhodium are used mainly as alloying elements to modify properties of platinum and palladium. Rhodium is also used extensively in rhodium plating.

Engelhard Industries Incorporated, announced the development of Trilay and Platinel. Trilay is a composite consisting of a central layer of platinum alloy bonded between two layers of wrought platinum or platinum alloy. It is designed for use in high temperatures and under corrosive conditions, primarily in the glass industry. Platinel is a thermocouple combination, in which the electrodes have a varied platinum-alloy composition. As a means of countering corrosion, the addition of as little as 0.1 per cent palladium to pure titanium is finding increasing acceptance. This alloy is more resistant to the corrosion caused by many reducing-acid solutions than pure titanium. The practice of adding small amounts of platinum metals to help prevent corrosion has been extended to stainless steel and, more recently, to chromium.

New palladium alloys are being used to make the purest hydrogen gas so far known.

In the broad field of research on fuel cells, more designs are requiring that a platinum metal be placed in or on the electrode structure.

PRICES

E & M J Metal and Mineral Markets of December 28, 1961, gives the United States prices of platinum metals per troy ounce as follows:

Platinum	\$ 80 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 and plates; platinum, palladium, iridium, osmium, ruthenium, and rhodium, in lumps, ingots, powder, sponge or scrap	free	free	free
Platinum crucibles	free	free	free
Platinum retorts, pans, condensers, tubing and pipe, and preparations of platinum for use in manufacture of sulphuric acid	free	free	free
Platinum and black oxide of copper for use in manufacture of chlorates and colors	free	10%	10%

United States

Ores of platinum metals	free
Platinum, unmanufactured or in bars, ingots, plates or sheets not less that $\frac{1}{8}$ in. thick, scrap and sponge	free
Iridium-osmium, palladium-rhodium and ruthenium and native combinations thereof with one another or with platinum	free
Chemical compounds, mixtures and salts of which gold, platinum, rhodium or silver constitutes element of chief value	12½%

Potash

C. M. Bartley*

Although progress on potash-development projects in Saskatchewan seemed slow in 1961, several aspects of the year's work indicate that the problems are being brought under control and that large-scale production will start soon. Substantial progress was reported by one company on the rehabilitation of its shaft near Saskatoon; the Blairmore formation was successfully penetrated in the Esterhazy area by a shaft equipped with cast-iron tubbing; and a shaft near Unity, flooded by the Blairmore in June, was being cleared and sealed as the year ended.

The solution-mining project west of Regina aroused great interest through the industry because it is generally assumed that solution mining would provide a quicker, cheaper and easier means of recovering potash than underground mining. Although the comparative efficiency of these two methods will not be known until the determination of the cost of full-scale production, it is apparent that each has attractive features. In spite of the slow progress and the many unexpected delays of the past 10 years, there is little doubt that potash-mining through shafts can result in large tonnages from Saskatchewan's rich shallower deposits, which can be mined on a large scale for many years at low cost per unit of potash. On the other hand, successful solution-mining methods may reach production on lower capital and in much less time. Information on their efficiency and the cost of producing by such methods has not been released, but they will inevitably be of increasing interest in the exploitation of deposits beyond the reach of shaft mines and will vastly increase the potash reserves available.

In 1961 several companies continued exploration drilling, one company sank three holes for shaft-location information, and numerous technical and economic studies were under way. There were reports of proposals and negotiations concerning mergers and of joint operations between companies with potash deposits and financing partners. Representations were made to railways concerning freight rates and to governments regarding taxation and mining legislation.

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*Mineral Processing Division, Mines Branch.

TABLE 1

POTASH—PRODUCTION AND IMPORTS

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
K_2O content	—	—	..	178,700
Imports				
Potash fertilizers				
Muriate of potash				
United States	107,267	[illegible],540,186	89,342	1,906,550
West Germany	32,750	943,991	28,660	732,122
France	24,310	729,801	17,150	431,545
U.S.S.R.	5,450	187,555	5,581	174,597
Spain	—	—	5,952	137,113
Total	169,777	4,401,533	146,685	3,381,927
Sulphate of potash				
United States	17,324	665,888	12,924	444,951
France	9,054	352,949	5,559	184,220
West Germany	100	4,073	5,461	196,715
Total	26,478	1,022,910	23,944	825,886
Sulphate of potash magnesia				
United States	4,880	76,133	5,064	68,366
West Germany	300	7,877	500	11,512
Total	5,180	84,010	5,564	79,878
Total, potash fertilizers	201,435	5,508,453	176,193	4,287,691
Potash chemicals and compounds	9,837	1,981,589	12,268	1,969,819

SOURCE: Dominion Bureau of Statistics. . . Not available for publication.

Officers of industry and government held preliminary meetings to plan and set up what is to be known as the Canadian Potash Research Foundation. This organization will immediately undertake research on problems of ground mechanics encountered in underground mining, but the scope of its future activity is expected to be much broader.

POTASH MINERALS AND THEIR SOURCES

The term 'potash,' applied to materials containing potassium in useful amounts, is derived from 'pot ashes.' In the 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 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. Consideration is now being given to changing fertilizer terminology so that the potash content can be quoted in terms of potassium (K) rather than of K_2O. 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 values 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	$K_2SO_4.2MgSO_4$	22.6	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 brines in bodies of water (such as 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 Union of Soviet Socialist Republics, Spain and the United States and, more recently, in Saskatchewan.

South America's first production of muriate of potash may result from a project under development in Peru. In the Sechura Desert, on the northern part of that country's coast, Miderea Industries Limited, a Canadian company based in Montreal, controls phosphate and potash rights. Potash in the form of potassium-chloride brines has been found in numerous depressions and could be concentrated by solar evaporation before processing and crystallization. Low-cost production and shipping from a nearby seaport would make this potash competitive with other sources in many markets.

THE 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 were started in 1951 near Unity and have since continued.

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 forms a huge basin structure underlying southern Saskatchewan and adjacent parts of Manitoba and Alberta. It is tilted slightly to the southwest, and the shallow northern edge lies at depths 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, and the potash zones represent 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.

POTASH ACTIVITIES IN CANADA

In Saskatchewan since 1951 five companies have made six attempts to produce potash by solution mining or through the use of shafts. These projects, together with the exploration drilling of some 200 holes, technical studies and various kinds of test work, have resulted to date in the expenditure of an estimated $100 million. The potash captial invested in New Mexico since 1930 was recently estimated, on the other hand, at $150 million. The Saskatchewan expenditures indicate not only the technical difficulties and the high cost of potash development in the Canadian province, but also the favorable opinion that prompts major companies to persist in their efforts and to invest on a large scale.

TABLE 2

SUMMARY OF POTASH PROJECTS IN SASKATCHEWAN

Date	Company	Location	Method	Present Status
1951	Western Potash Corporation Limited	Unity	Solution-mining test	Abandoned
1953	Same, name changed in 1955 to Continental Potash Corporation Limited	Unity	Shaft	Work resumed in 1961
1954	Potash Company of America	Saskatoon	Shaft	Shaft being repaired in 1961
1957	International Minerals & Chemical Corporation (Canada) Limited	Esterhazy	Shaft	Shaft to be completed and operation begun in 1962
1958	General Petroleums of Canada Limited	Nokomis	Solution-mining test	Abandoned
1960	Standard Chemical Limited	Moose Jaw	Solution-mining test	In progress

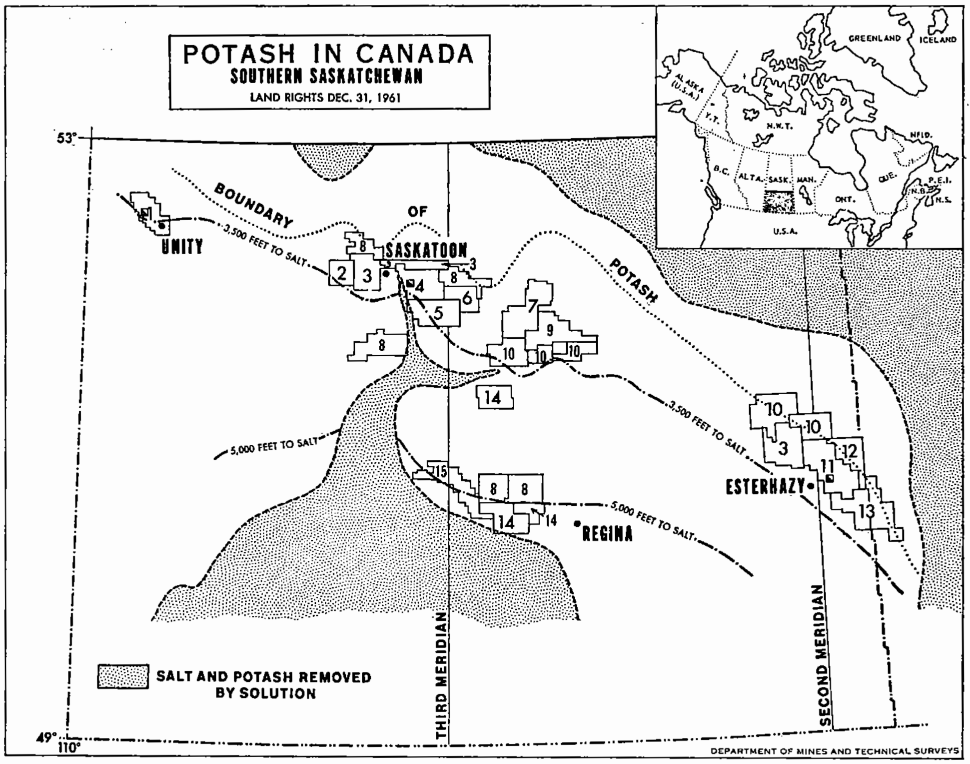
The accompanying map shows the properties held by 15 companies on December 31, and the general features of the potash area. It is assumed that the companies along the shallow northern edge of the area will produce through shafts and that those farther south, in the central region north of Moose Jaw and Regina, will operate by solution mining.

Several companies in addition to those now active hold potash deposits and have the financial resources to develop them but have been hesitating to do so. As the first companies to reach production have the best opportunity to establish export markets, this hesitation has caused some perplexity. Two factors are playing an important part in the delay—uncertainty regarding the most satisfactory method of penetrating the Blairmore formation and the uncertainty that has recently arisen over the effect of successful solution-mining techniques on the economics of underground mining through shafts. The companies now under development have a great advantage in time, but the degree of success or failure of any of the present undertakings will exert a strong influence on the development plans of companies starting new projects.

International Minerals & Chemical Corporation (Canada) Limited successfully penetrated the Blairmore formation at Esterhazy by deep-freezing and the installation of cast-iron 'tubbing.' As the year ended, sinking continued through the more competent formations below the Blairmore. Progress, however, was slower than expected because, even in more stable formations, wet or porous zones had to be completely grouted and sealed and the increase in hydrostatic pressure with depth sometimes made this difficult. The company expects to reach the potash zone by mid-1962 and to start mill operation in late summer or early autumn.

During 1961 the company mill, designed to produce 420,000 tons of potash a year, was being enlarged to a capacity of 1,200,000 tons a year. Changes were being made in the underground ventilation system, and continuous-mining machines were being tested. Plans for a second shaft were being considered.

Potash Company of America, Ltd., continued repair work on its shaft near Saskatoon by thawing the ice wall around the shaft and by grouting in



POTASH LAND RIGHTS, DECEMBER 31, 1961

1. Continental Potash Corporation Limited
2. National Potash Company
3. Duval Sulphur and Potash Company
4. Potash Company of America
5. United States Borax & Chemical Corporation
6. Consolidated Morrison Explorations Limited
7. Alwinsal Potash of Canada Limited
8. Northwest Company, Limited
9. Kerr-McGee Oil Industries, Inc.
10. Southwest Potash Corporation
11. International Minerals & Chemical Corporation (Canada) Limited
12. Canberra Oil Company Ltd.
13. Tombill Mines Limited
14. Standard Chemical Limited
15. Sifto Salt (1960) Limited

stages to seal existing leaks and prevent new ones. Progress was necessarily slow because each zone had to be sealed completely before work could progress to the next. Some of the frozen areas thawed very slowly, and grouting occasionally had to be repeated to obtain complete sealing.

Equipment in the mine and mill was being modified and reconditioned for a resumption of production, but the nature of the shaft-repair program made it impossible to predict a completion date.

Underground workings at the property were opened in 1958 and are reported to have since given little indication of ground movement. This evidence of ground stability is of great interest to companies planning potash mines in Saskatchewan.

Continental Potash Corporation Limited resumed shaft-sinking at its property near Unity and used grouting, excavation and lining in a cycle. Satisfactory progress was made into the Blairmore formation, but Blairmore sand and water flooded the shaft in June to within 400 feet of the surface. During the summer the sand was removed by an airlift, with the water level maintained to exert a hydrostatic pressure on the formation. A concrete plug was then poured to seal the shaft bottom, and at the end of the year water was being pumped out and the shaft repaired for the resumption of sinking.

The company reports that financing to complete the shaft and build a concentration plant of 400,000 tons' annual capacity has been negotiated. By November, work on the property had cost $3,400,000.

In 1961, Standard Chemical Limited, the Canadian subsidiary of Pittsburgh Plate Glass Company, built and started to operate a solution-mining test plant northeast of Moose Jaw in an area where potash occurs at a depth of more than 5,000 feet. The $1-million project, financed jointly by Pittsburgh Plate Glass Company and Armour Agricultural Chemical Company, of the United States, is designed to test the technical and economic efficiency of a potash-solution-mining method developed by the former. If satisfactory results are obtained from this work, the company will build a multimillion-dollar production plant in the area.

At the end of the year it was reported that a subsidiary of Armour and Company had obtained potash rights in Yorkshire, England, and was planning to test solution mining of deep potash deposits situated there if sufficient reserves were found.

Solution mining consists in introducing water into the solid potash deposit through drilled holes, dissolving potash, pumping the solution to the surface and recovering solid potash from it. Because potash is associated with salt ($NaCl$) and both are soluble, it is difficult to recover a concentrated solution of potash without dissolving salt. Previous efforts to produce potash by this method were not efficient enough to be of economic interest. The method now being used by Standard Chemical Limited is believed to employ novel means of solving this problem, but no details have been released.

Alwinsal Potash of Canada Limited drilled three holes, using great care to recover all the core possible. Core from these holes will provide detailed information on the formations to be penetrated by a shaft on the company's property in the Lanigan area east of Saskatoon. Alwinsal, controlled by one French and two West German potash companies, has carried out much careful investigation on its Saskatchewan holdings. Its investment to date on potash in the province is estimated at $2 million. The company has not yet announced underground development, but it has the potash-mining experience and the financial resources to develop a large mining and processing operation.

In 1961, United States Borax & Chemical Corporation and Homestake Mining Company of California jointly investigated the possibility of a major potash operation on the holdings of the former south of Saskatoon. A decision on development was expected by mid-1962.

Southwest Potash Corporation and Duval Sulphur & Potash Company carried on drilling and reported that they were considering the solution mining of potash.

Two Canadian companies—Tombill Mines Limited and Consolidated Morrison Explorations Limited—conducted drilling during the year. Tombill plans to complete financing and start development during 1962.

Associated Mining Construction Ltd., the Canadian subsidiary of four large West German shaft-sinking companies, opened an office in Regina in 1961. This subsidiary, which designed and installed cast-iron tubbing in the shaft of International Minerals & Chemical Corporation (Canada) Limited at Esterhazy, reports that most of the shafts—more than 200—its parent companies have sunk in Europe by freezing methods have been lined with such tubbing. This type of lining has been used on that continent since 1885, and some of the shafts have been in service for more than 50 years.

Associated Mining suggests that if the serious problems of the Blairmore and other wet zones had been recognized when the first Saskatchewan shafts were started, cast-iron tubbing, although costly, would probably have been used. Time would thus have been saved and production would by now be established. Saskatchewan is expected to have 10 or 12 major shafts of this kind sunk by 1970.

TABLE 3

WORLD PRODUCTION OF POTASH (K_2O EQUIVALENT), 1961
(short tons)

United States	2,732,602
West Germany	2,252,901
France	1,850,000[e]
East Germany	1,764,000[e]
U.S.S.R.	1,300,000[e]
Spain	298,000[e]
Italy	154,300[e]
Israel	132,300[e]
Poland	30,000[e]
Other countries	15,897[e]
World total	10,530,000

SOURCES: U.S. Bureau of Mines, *Mineral Trade Notes*, July 1962; British Sulphur Corporation Limited, *Phosphorus & Potassium*, April 1962. [e]Estimated.

THE OUTLOOK FOR THE CANADIAN POTASH INDUSTRY

In 1961, for the first time, the potash in fertilizer sold in Canada exceeded 100,000 short tons of K_2O equivalent and was thus double the 1948 tonnage. Domestic consumption, however, will provide markets for only a small fraction of the potash that may be expected from the Saskatchewan deposits. The future of the Canadian industry depends consequently on export sales, and these depend on world production and consumption and the degree to which Canadian potash can compete in foreign markets with potash from other sources.

It is generally agreed that Canada's deposits are the largest and highest-grade known sources in the western world and perhaps in the whole world. Such deposits can be operated on a large scale over long periods by highly efficient methods and equipment and will produce at a low cost per unit of potash.

The main problem in marketing the Saskatchewan products seems to be the cost of moving it by rail to available markets in the United States and to ports for shipment overseas. To make it competitive in these markets, an effort is being made to obtain bulk shipping rates on Canadian railways.

World production of potash, which amounted to 4.8 million tons of K_2O in 1948, rose to 10 million tons in 1960 and increased by an additional $5\frac{1}{2}$ per cent in 1961. The growing demand seems, however, to have absorbed the increases. During the year, potash supplies were limited and in the United States prices increased more than 3 per cent. Traditional potash sources in Europe and the United States are known in some detail, and it is not expected that they will afford an appreciable improvement in grade or an increase in tonnage. Some, indeed, are showing signs of decline. New sources, such as those in Italy and the State of Utah, in the United States, and new operations in such known areas as Germany, Spain, Israel-Jordan and New Mexico add to the supply but do not seem capable of satisfying the continually increasing demand. Other prospective sources such as Ethiopia, Yorkshire (England) and Morocco might serve local markets.

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The potash demand is at present increasing by about 5 per cent annually. This means that an additional 540,000 tons of K_2O will be needed in 1962. In terms of 60 per cent muriate, this is about 900,000 tons; in terms of a 20-per-cent-K_2O ore, it is about 3 million tons. In effect, a large new mine is required every year and, although the addition to supply already mentioned may be sufficient in the next few years, the development of several new producing facilities in western Canada before 1970 seems to be the only assurance that the long-term supply of potash will continue to be adequate.

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 and 5 per cent 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

The *Oil, Paint and Drug Reporter* of December 25, 1961, quotes the following prices:

Potassium muriate		
Standard		
Bulk, car lots, works, unit-ton	\$ 0.37	\$ 0.39
Bagged, 60% min. K_2O, same basis, ton	\$27.20	\$28.40
Granular		
Bulk, car lots, works, unit-ton	\$ 0.40	\$ 0.41
Bagged, 60% min. K_2O, same basis, ton	\$29.00	\$30.20
Potassium sulphate, 50% min. K_2O, agricultural, bulk, car lots, works, unit-ton	\$ 0.70½	\$ 0.72½

NOTE: The prices in the inside column apply to material contracted for before July 1, 1961. The prices in the outside column apply to material contracted for after July 1, 1961, but also for delivery during the current month.

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	"

Roofing Granules

F. E. Hanes*

The value of all the types of roofing granules consumed in 1961 was $3,286,670. This was 10.95 per cent more than the $2,962,363 recorded for 1960, which was within $180,000 of the low for 1951–61. The increase in the value of granules after 1960 was barely enough to bring the total for 1961 to 73 per cent of the all-time high of 1958.

In 1961 the volume of granules consumed amounted to 123,486 tons; in 1960, to 113,826 tons. The 1961 volume was thus equivalent to 83.5 per cent of the 147,877 tons that set a record in 1955.

The large consumption of granules reported for 1958–59 resulted directly from a great increase in residential construction; the lower values of 1960 and 1961 reflected a decrease in this field.

The Dominion Bureau of Statistics indicated early in the year that housing starts had dropped from 141,345 units in 1959 to 108,858 units in 1960, that completions had declined to 123,757 units for 1960 and that houses under construction as the year began were 16,132 units fewer than 12 months previously.

The slow recovery shown in the consumption of granules during 1961 is understandable in view of the poor conditions that prevailed in residential construction at the beginning of the year. After decreasing about half of 1 per cent in 1960, however, the value of construction materials as a whole trended upward. This general improvement and the recovery made by the granule industry in 1961 after the poor start it had at the beginning of the year are the basis for the general increase in granule consumption forecast for 1962. Some of this optimism may nevertheless be offset by a new trend in urban living—the growing practice of building large apartment blocks, often many storeys in height, which in the past year or two has been accelerated. The number of individual and duplex dwellings, each with its own roof, will necessarily decrease, thus affecting the volume of granules used in the manufacture of roofing shingles.

The price of granules, which declined during 1959 and 1960 from the 1958 high average of $31.82 a ton, rose from $26.03 in 1960 to $26.62 a ton in 1961. This increase was due in part to a percentage rise in the use of imported granules. For 1959, 1960 and 1961 the percentages corresponding to the Canadian granules consumed were respectively 37.1, 44.8 and 35.8. Granules from outside

*Mineral Processing Division, Mines Branch.

Table 1

ROOFING GRANULES—CONSUMPTION AND IMPORTS*

	1961		1960	
	Short Tons	$	Short Tons	$
Consumption				
By kind				
Naturally colored	47,441	954,657	36,217	672,199
Artificially colored	76,045	2,332,013	77,609	2,290,164
Total	123,486	3,286,670	113,826	2,962,363
By color				
Black and gray-black	41,353	916,134	32,722	707,249
Green	23,430	670,839	25,624	701,480
Red	9,122	242,303	9,569	237,146
Blue	4,784	185,701	5,214	201,787
White	19,702	697,458	17,344	593,081
Gray	19,180	383,086	16,964	311,779
Buff	674	24,702	805	28,483
Brown and tan	4,205	122,974	3,922	115,115
Coral, cream and yellow	641	25,729	1,121	42,296
Turquoise	395	17,744	462	21,105
Not classified	—	—	79	2,842
Total	123,486	3,286,670	113,826	2,962,363
Imports				
United States				
Naturally colored	35,421	762,164	24,851	507,331
Artificially colored	43,882	1,438,647	38,103	1,253,044
Total	79,303	2,200,811	62,954	1,760,375

*Compiled from figures supplied to the Mines Branch by consumers.

Canada carry a higher price because of the additional tariff charged on manufactured imported goods. To date, the greater quantity of imported granules used in Canada probably results from the greater variety of types and colors obtainable from the United States. Two Canadian trends are now developing—an increase in the price of the domestic granule and an increase in its available color variety.

In 1961, while the total granule consumption rose by 8.5 per cent, the consumption of imported artificially colored granules increased by 15.2 per cent. Gains of 22 to 35 per cent were made in the consumption of the popular white, green, red and black varieties. The imported blue, turquoise, buff and coral-cream-yellow types decreased 13 to 45 per cent in volume of consumption.

The consumption of Canadian artificially colored granules was down by more than 18 per cent in volume and almost 14 per cent in value, all but the blue granules showing losses. In 1961 the first production of Canadian-made brown and tan, coral-cream-yellow, and turquoise colored granules was reported.

The four most popular Canadian-manufactured colored granules—green, black, white and red, in the order named—went down 17 to 28 per cent in consumption. The only Canadian-made granule showing an increase was the blue, which gained 54 per cent over its 1960 volume.

Black-slag granules imported from the United States increased in volume from 20,935 short tons in 1960 to 28,340 in 1961. Their value increased from $451,659 to $625,839. An average price of $22.08 a ton was paid in 1961, 51 cents a ton more than in 1960. The natural black-slag granule made up 23 per cent of Canada's granule consumption for 1961.

CANADIAN ROOFING-GRANULE PRODUCERS

Manufacturers of Canadian-made granules are located in Havelock, Ontario, and Montreal, Quebec. A very small output of slate granules is reported from British Columbia.

Minnesota Minerals Limited, at Havelock, produces a fine-grained, dark-colored basalt crushed stone for base granules. Color is applied to these granules under controlled conditions* of heating, spraying and drying. Granules and pigments are brought together in a solution of sodium silicate. Two basic methods, one involving a low temperature (400°F), the other a high temperature (900-1,000°F), are employed. They differ principally in their results and in the type of pigments fired. A final solution, usually a mixture of aluminum and ammonium chlorides, is used to spray the granules after the heat treatment and sometimes carries part of the pigment.

Industrial Granules Ltd., of Toronto, is ready to market a black slag granule produced at its Montreal plant. Waste slag obtained from steam generating plants is used in this process. Controlled methods of cooling are required to produce granules of the required particle shape. The content of acicular-shaped particles in the product must be low because such particles, if too numerous, would be detrimental to efficient shingle coverage. Considerable trouble is encountered in granule production if an iron-bearing or contaminated coal is used. Only certain coals are satisfactory for a slag suitable for the production of granules. Selection of plants using the right kind of coal is important if the slag for granule manufacture is to be suitable.

ROOFING AND SIDING PLANTS IN CANADA

Shingles and siding manufactured in 1961 by the application of roofing granules to an asphalt-impregnated felt base were processed in 17 plants operated by eight companies. The companies and their plants are as follows:

Company	Location
Barrett Company Limited, The	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.
Philip Carey Company Ltd., The	Lennoxville, Que.
Sidney Roofing and Paper Company Limited	Burnaby, B.C. Lloydminster, Alta.

*Patent No. 3,001,852 (September 26, 1961).

ESSENTIAL QUALITIES OF A GOOD GRANULE-BASE ROCK

The rock must be hard and tough enough to resist the strain of operational handling, quarrying and transportation, and of crushing, screening, cleaning and heating in the coloring stages of processing. It must also be free of minerals that cause chemical interaction when, during manufacture or use on a roofing shingle, the granule is in contact with atmospheric impurities.

The rock must be adaptable to the coloring process so that when it is heated, the presence of iron compounds will not cause it to become unduly discolored. Minerals containing molecular water are unsuitable because spalling may occur during heating and leave uncolored spots on the granule.

For resistance to the penetration of fluids during the processing and life of the granule, the rock must have low porosity. Water may seep through a porous granule and thus cause blistering of the shingle and deterioration of the roof. Rocks of low absorptive quality will require smaller amounts of color-covering materials during processing and thus less pigment.

Granule-base rock must resist mechanical failure and chemical alteration when subjected to normal weathering. If the rock cannot stand up to exposure, it cannot insure the permanence of the color coating or protect the asphalt-impregnated felt on which it is fixed.

One of the most important properties of a base rock suitable for granule use is its ability to resist the passage of ultraviolet light, which rapidly deteriorates the asphalt. The industry has strict specifications regarding such opacity.

Good adhesion is essential to insure satisfactory bonding between the rock base and the color-covering medium, and between the granule and the asphalt on the felt backing (shingle).

CANADIAN PRICES OF ARTIFICIALLY COLORED GRANULES

Domestic granules of all artificially colored types commanded a much higher price in 1961 than in 1960. The average price paid for blue granules was $6.42 a ton higher, and the increases for the remaining color types were, on the average, no lower than $1.09 and as high as $1.98 a ton.

TABLE 2

AVERAGE PRICES FOR IMPORTED AND CANADIAN ARTIFICIALLY COLORED GRANULES

($ per short ton)

Granule Color	Imported		Canadian	
	1961	1960	1961	1960
Red	27.94	27.42	25.04	23.19
Green	30.96	30.88	29.69	28.53
Black	27.13	26.05	21.12	20.03
Blue	39.04	39.29	37.14	30.72
White	36.32	36.21	33.13	31.15
Gray	27.18	28.75	25.79	24.62
Buff	32.36	34.52	39.18	37.25
Brown and tan	29.58	29.35	25.35	—
Coral, cream and yellow	40.69	37.73	28.89	—
Turquoise	44.99	45.68	39.30	—

Imported artificially colored granules showed higher prices for the black, red, brown and tan, white, green and coral-cream-yellow types, averaging as much as $2.96 and as little as 8 cents a ton more than in 1960. The price decreases of the imported granules of the remaining colors had a high average of $2.16 and a low of 25 cents a ton.

The cost the consumer pays depends on the type, color quality and durability of the granule. Transportation costs varying with the distance between producer and consumer must be considered, as well as the price differences due to tariffs on imported granules.

Salt

R. K. Collings*

Canada's salt production has remained virtually constant during the last three years at an annual total of slightly more than 3.2 million tons. It reached this level in 1959 after increasing from a 1954 output of less than 1 million tons. The reason for the rapid increase was the establishment of the three rock-salt mines now in operation—one at Ojibway, Ontario, opened in 1955, and one each at Goderich, Ontario, and Pugwash, Nova Scotia, opened in 1959. Rock salt from these mines, obtained by standard room-and-pillar methods, at present accounts for 40 per cent of the national salt output.

In addition to these mines there are eight plants for the production of fine salt from underground deposits by brining followed by evaporation. These fine-salt operations, which in 1961 accounted for about 14 per cent of Canada's salt output, are at Nappan, Nova Scotia; Goderich, Sarnia, Sandwich, and Amherstburg, in Ontario; Neepawa, Manitoba; Unity, Saskatchewan; and Lindbergh, Alberta. Salt recovered in chemical operations and salt brine for direct use by the chemical industry accounted for the remaining 46 per cent. Salt brine for the chemical industry is produced from underground rock salt deposits at Amherstburg, Sandwich, and Sarnia, in Ontario, and at Duvernay, Alberta.

Salt brine is obtained from underground deposits of rock salt by the use of 'wells' that extend from the surface to the salt horizon. These wells, which are usually churn-drilled, are 8 to 10 inches in diameter and contain two concentric pipes—an 8- to 10-inch casing pipe that lines the hole to the top of the salt horizon, and an inner, 3- to 4-inch pipe extending to the bottom of the salt. Fresh water is pumped down the annulus between the pipes and, upon contact with the salt, forms brine, which is brought to the surface through the inner pipe. Sometimes the water is pumped down the centre pipe and the brine brought up through the annulus. On occasion, water may be pumped down one well and brine recovered from another, connected well.

* Mineral Processing Division, Mines Branch.

TABLE 1

SALT—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)				
By type				
Fine vacuum salt	446,712	9,649,614	433,538	9,195,429
Mined rock salt	1,294,988	7,714,077	1,322,856	8,235,380
Salt recovered in chemical operations	24,966	110,242	14,899	55,123
Salt content of brines used and shipped	1,479,861	2,078,073	1,543,627	1,869,726
Total	3,246,527	19,552,006	3,314,920	19,355,658
By province				
Ontario	2,861,705	13,586,373	3,007,599	13,994,545
Nova Scotia	225,875	2,659,119	163,901	2,256,423
Alberta	83,880	1,355,074	72,431	1,206,433
Saskatchewan	51,964	1,322,311	49,064	1,337,096
Manitoba	23,103	629,129	21,925	561,161
Total	3,246,527	19,552,006	3,314,920	19,355,658
Imports (by type)				
Table				
United States	1,353	121,753	705	52,898
Britain	20	352	46	3,079
Total	1,373	122,105	751	55,977
For fisheries				
Spain	55,361	227,725	35,312	137,494
Bahamas	3,808	18,945	24,827	100,261
Jamaica	550	2,145	4,297	15,561
United States	550	2,054	500	4,679
St. Pierre	106	2,063	142	2,553
Denmark	50	616		
Netherlands	68	1,267		
Britain	22	729	22	688
Total	60,515	255,544	65,100	261,236
Other, in bulk				
Mexico	64,194	79,444	74,837	89,571
United States	62,291	357,220	41,082	231,287
Total	126,485	436,664	115,919	320,858
Other, in bags, barrels and other covering				
United States	10,641	222,187	9,833	196,560
Britain	351	6,721	337	6,346
Total	10,992	228,908	10,170	202,906
Total imported	199,365	1,043,221	191,940	840,997

TABLE 1 (*cont'd*)

	1961		1960	
	Short Tons	$	Short Tons	$
Exports*				
United States		2,695,429		3,398,350
Cuba		71,472		—
Britain		57,862		55,815
Bermuda		1,630		6,933
Jamaica		1,551		268
Other countries		1,194		—
Total		2,829,138		3,461,366

SOURCE: Dominion Bureau of Statistics.

*For 1961 exports do not include table salt which was part of a miscellaneous classification.

TABLE 2

SALT—PRODUCTION AND TRADE, 1951-61

(short tons)

	Production[1]	Imports	Exports
1951	964,525	258,822	4,561
1952	971,903	288,125	2,844
1953	954,928	307,333	2,354
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
1960	3,314,920	191,940	[3]
1961	3,246,527	199,365	[3]

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]Not available.

The use of interconnected wells is becoming more and more common because it usually results in rapid brine saturation and a notable increase in the recovery of salt from a particular area. Adjacent wells are connected by a process known as 'hydrofracturing,' which consists essentially in pumping water down one well under enough pressure to fracture the salt formation. This allows the water to penetrate along the fracture, which is gradually extended until it breaks through to the second well, wherepon the salt-saturated water rises to the surface and is recovered.

In developing a brine field, holes or wells are usually laid out in a straight line on the surface at distances of 300 to 400 feet to form a gallery. Adjacent galleries are laid out parallel to the first at intervals of about 600 feet. The

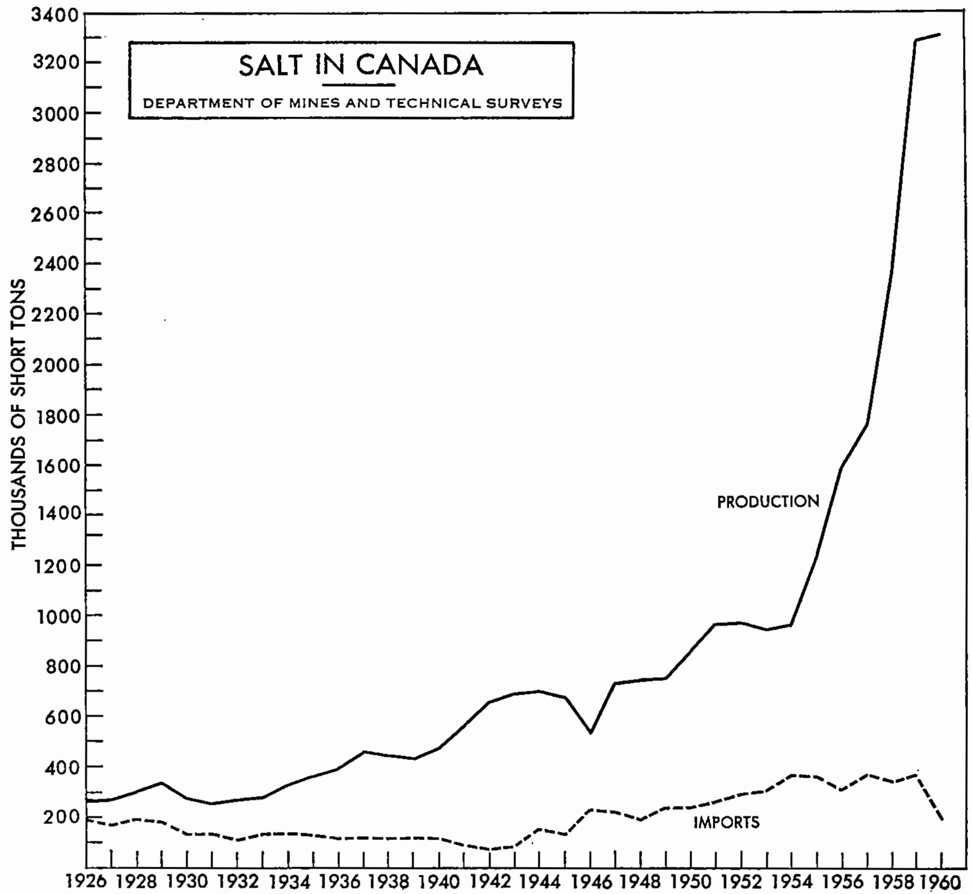


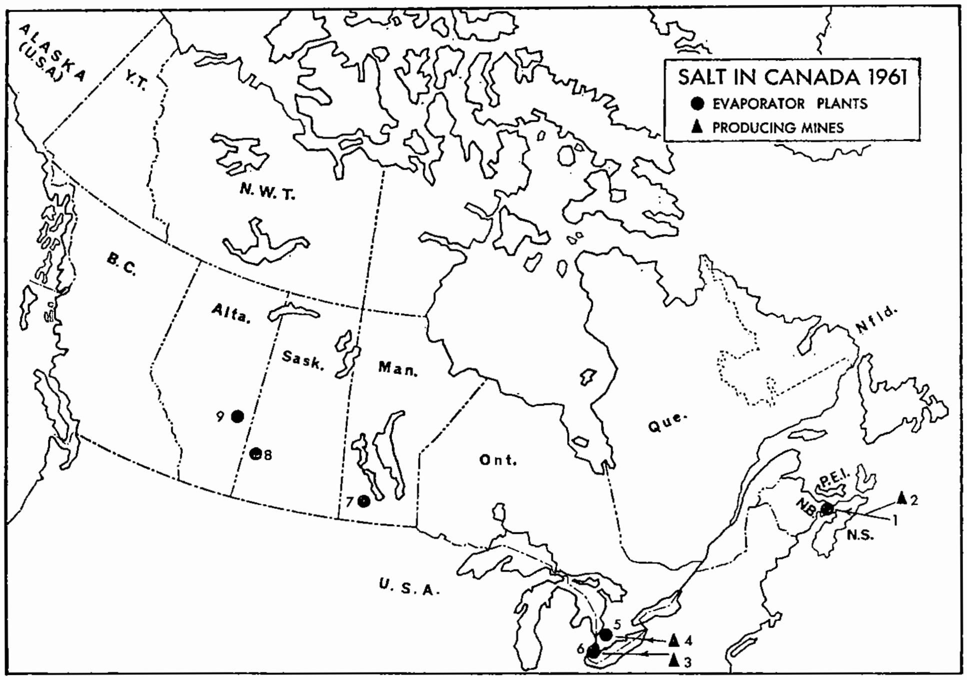
TABLE 3

WORLD PRODUCTION, 1961

('000 short tons)

United States	25,707
China	15,400
U.S.S.R.	9,000
United Kingdom	6,353
West Germany	5,159
France	4,189
India	3,825
Canada	3,247
Other countries	23,520
Total	96,400

SOURCE: U.S. Bureau of Mines, *Minerals Yearbook 1961*, Salt Preprint.



DEPARTMENT OF MINES AND TECHNICAL SURVEYS

EVAPORATOR PLANTS

1. Sifto Salt (1960) Limited, Nappan
   Canadian Rock Salt Company, The, Pugwash (under construction)
5. Sifto Salt (1960) Limited, Goderich and Sarnia
6. Canadian Salt Company Limited, The, Sandwich
   Brunner Mond Canada, Limited, Amherstburg
7. Canadian Salt Company Limited, The, Neepawa
8. Sifto Salt (1960) Limited, Unity
9. Canadian Salt Company Limited, The, Lindbergh

PRODUCING MINES

2. Canadian Rock Salt Company Limited, The, Pugwash
3. Canadian Rock Salt Company Limited, The, Ojibway
4. Sifto Salt (1960) Limited, Goderich

direction of fracturing cannot always be positively controlled; hence fractures may occur between holes in different galleries rather than between adjacent holes in the same gallery.

In 1961 salt production totalled 3,246,527 tons, or 2 per cent less than in the previous year. The value increased by 1 per cent to $19,552,006.

Salt imports increased slightly during 1961 to 199,365 tons valued at $1,043,221. The value of exports decreased by a little more than 18 per cent to $2,829,138. Most of these exports were in the form of brine and were shipped to a chemical plant in the United States.

PRODUCERS*

Ontario

Ontario, the chief salt-producing province, accounted in 1961 for almost 90 per cent of Canada's output. Salt in Ontario is obtained from beds that lie 800 to 1,800 feet below the surface in the area between Goderich and Amherstburg, in the southwestern section of the province.

Rock salt is produced at two mines, one operated by The Canadian Rock Salt Company Limited at Ojibway, the other by Sifto Salt (1960) Limited, a subsidiary of Dominion Tar & Chemical Company Limited, at Goderich. 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.

Fine salt, obtained by evaporation of brine from local wells, is produced by Sifto Salt (1960) Limited at Goderich and Sarnia and by The Canadian Salt Company Limited at Sandwich. The latter company also operates a fusion plant at Sandwich for the production of coarse salt from fine evaporated salt.

Canadian Brine Limited, a subsidiary of The Canadian Salt Company Limited, supplies a chemical plant in Detroit with large quantities of brine from wells at Sandwich. This brine is pumped to Detroit through pipelines in the bed of the Detroit River.

In the production of caustic soda and chlorine at Sarnia, Dow Chemical of Canada, Limited, utilizes brine from company-owned wells. At Amherstburg, Brunner Mond Canada, Limited, produces industrial salt, soda ash, calcium chloride and other chemicals, using brine from local wells.

Nova Scotia

The Canadian Rock Salt Company Limited operates a rock-salt mine at Pugwash. Here salt is obtained from a 20-foot section at a depth of 630 feet. During the year a shed of 8,000 tons' capacity for the bulk storage of salt was completed at the Pugwash wharf. At the minesite, construction work was started on an evaporation plant, which is expected to be in production late in 1962. The plant will utilize salt fines from the rock-salt operation to produce refined salt.

At Nappan, Sifto Salt (1960) Limited produces fine evaporated salt from brine obtained from salt beds at depths between 1,100 and 1,800 feet.

Prairie Provinces

The Canadian Salt Company Limited produces fine salt at Neepawa, Manitoba, by evaporating natural brine obtained from a deposit 1,400 feet below the surface, and at Lindbergh, Alberta, by using an artificial brine from salt beds 3,600 feet below the surface. Part of the Lindbergh output is fused, crushed and screened for the production of a coarse, high-purity salt. Sifto Salt (1960) Limited produces fine salt at Unity, Saskatchewan, by evaporating brine from salt beds 3,000 feet below the surface.

Western Chemicals Limited, of Calgary, Alberta, uses brine from salt beds 3,600 feet below the surface to produce caustic soda, chlorine and hydrochloric acid near Duvernay, Alberta.

OTHER OCCURRENCES

Salt beds occur at depth on the west coast of Cape Breton Island; under Hillsborough Bay, Prince Edward Island; and in the area south of Moncton, New Brunswick.

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*See the map.

Beds of salt varying from a few feet to several hundred feet in thickness underlie large sections of the Prairie Provinces. The beds occur in a huge southwesterly-dipping basin that extends from northeastern Alberta southeasterly through central Saskatchewan and thence into southwestern Manitoba. These beds vary from less than 400 feet below the surface in northern Alberta to 6,000 feet or more in southern Saskatchewan.

USES AND TECHNOLOGY

Salt is important chiefly as a raw material for the chemical industry, which uses salt brine for the production of sodium hydroxide, chlorine and hydrochloric acid. These, in turn, are employed in the manufacture of soda ash and a variety of other chemicals.

Fine salt, produced by the vacuum-pan evaporation of brine, is used in food- and leather-processing, the salting and curing of meats and fish, textile-dyeing and chemical manufacture, for dairy purposes and in cattle and stock feed.

Salt is also used as a soil stabilizer, a glazing agent in the manufacture of sewer pipes and drain tile, and a drilling-mud ingredient for drilling through underground salt seams.

The coarser grades of salt are generally preferred for fish-curing, ice and dust control on highways, dairy and food purposes and the regeneration of calcium and magnesium zeolites in water softeners, as well as for refrigeration, meat-packing and the curing and tanning of hides and skins.

The coarser grades are usually obtained by mining, crushing and screening rock salt. The four standard sizes produced are:

No. 2	$-\frac{3}{8}+\frac{1}{2}$ inch
No. 1	$-\frac{1}{2}+\frac{1}{4}$ inch
C.C.	$-\frac{1}{4}+\frac{1}{8}$ inch
F.C.	$-\frac{1}{8}$ inch

One of the major problems encountered in rock-salt-mining is the excessive production of fines (i.e. minus $\frac{1}{8}$ inch material), which, although useful as a source of salt for chemical purposes, have limited commercial application. These fines are formed into briquettes or are pressed between rolls to form a thin ribbon of salt. The compressed salt is crushed and screened to obtain the coarser, more useful varieties.

Fine salt from evaporator plants is also pressed to form blocks or briquettes, which in turn are crushed and screened for the coarse variety. Coarse salt also is obtained from fine by fusion, the salt being melted at about 1,500°F in large furnaces similar to those employed by the glass industry. The molten salt is discharged into conveyor-mounted metal briquette moulds, where it quickly hardens. The salt briquettes are then crushed and screened to the desired sizes.

Mined rock salt, although usually of high purity, sometimes contains such impurities as gypsum, anhydrite, limestone and dolomite. These impurities may be partly reduced by crushing followed by selective screening or by the use of the 'thermoadhesive' beneficiation method developed by International Salt Company, of Cleveland, Ohio. The latter technique is based on the fact that pure salt crystals transmit infrared rays of a certain wave length, whereas the gangue minerals absorb the rays and become heated. If salt containing the gangue minerals is subjected to infrared rays before being discharged to a conveyor belt coated with a heat-sensitive polystyrene resin, the heat-absorbing gangue minerals will adhere to the belt. Thus the salt crystals are discharged at the end of the conveyor, while the gangue minerals travel around the end roller and are removed from the underside of the conveyor belt by a scraper.

Table 4

AVAILABLE DATA ON CONSUMPTION OF SALT IN SPECIFIED CANADIAN INDUSTRIES, 1959[1]

(short tons)

Chemical products (dry salt and salt content of brine)	1,078,404
Food preparation and stock and poultry feed	63,294
Slaughtering and meat-packing	62,784
Pulp and paper mills	47,765
Fish-processing	18,517
Leather tanneries	8,272
Soap and cleaning preparations	1,824
Dyeing and finishing textiles	1,692
Breweries	924
Other industries[2]	1,102,390

Source: Dominion Bureau of Statistics.

[1]The latest year for which all data are available.

[2]Apparent consumption (1959) less the amount used by specified industries. Includes coarse rock salt for winter maintenance of roads and railways, refrigeration, chemical use, etc., as well as fine salt.

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Fishery salt	free	free	free
Bulk salt	free	3c. per 100 lb	5c. per 100 lb
Salt in bags, barrels, etc	free	3.5c. per 100 lb	7.5c. per 100 lb
Table salt	5%	10%	15%

United States	
Bulk salt	1.7c. per 100 lb
Salt in bags, barrels, etc	3.5c. per 100 lb

Sand, Gravel and Crushed Stone

F. E. Hanes*

The production of sand, gravel and crushed stone in 1961 was 202.5 million short tons valued at $149.4 million. It thus decreased 12.0 per cent in volume and 4.9 per cent in value from the 1960 record of 230,035,503 short tons valued at $157,047,416.

The decrease was due solely to a slackening in sand and gravel production, crushed stone having exceeded its 1960 volume and value.

SAND AND GRAVEL

The 1961 output of sand and gravel amounted to an estimated 158.3 million tons valued at $98.4 million. Its decreases of 30.7 million tons in volume and $11.2 million in value were both shared by all but three provinces. The first exception was Prince Edward Island, which produced a greater volume in 1961 but did so at a reduced value. The other two were Nova Scotia and New Brunswick, with respective volume reductions of 36.2 and 20.0 per cent. The output of these two provinces, however, brought a much better price than in 1960, Nova Scotia gaining by 8.2 per cent and New Brunswick by 30.0.

Ontario and Quebec produce about two thirds of Canada's output of sand and gravel. Ontario's production decreased by 11.5 million tons (15.2 per cent) and Quebec's by 5.1 million tons (11.0 per cent), while the corresponding decreases in value amounted to 12.5 and 10.5 per cent. Other large decreases in volume were reported from Manitoba (33.2 per cent) and Saskatchewan (25.1 per cent), with corresponding decreases in value of 3.8 and 20.0 per cent.

In view of the fair stability shown by Canadian structural materials in 1959, 1960 and 1961, the large decrease reported for the last-mentioned year in the sand-and-gravel industry is hard to explain. While this decrease was occurring, the value of all the structural materials produced, which in 1959 had reached a high of $324.6 million, amounted to $331.3 million, or $8,751,455 more than in 1960. Had sand and gravel maintained their 1959 and 1960 rates of

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* Mineral Processing Division, Mines Branch.

66076-1—27½

TABLE 1

PRODUCTION OF SAND, GRAVEL AND CRUSHED STONE

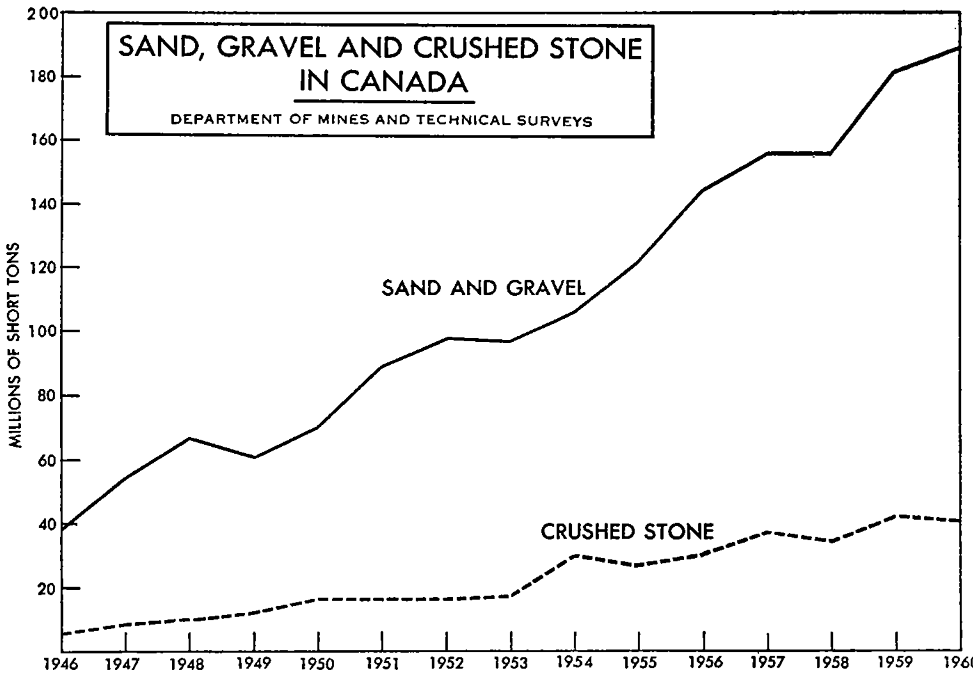
	Sand and Gravel*				Crushed Stone				Total Production Sand, Gravel and Crushed Stone			
	1961		1960		1961		1960		1961		1960	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
By Province												
Newfoundland	3,200,192	2,670,495	3,736,112	2,939,111	36,451	75,166	18,570	10,050	3,236,643	2,745,661	3,754,682	2,949,161
Prince Edward Island	530,322	373,559	474,184	422,587	225,000	225,000	750,000	750,000	755,322	598,559	1,224,184	1,172,587
Nova Scotia	5,560,665	6,506,346	8,710,841	6,012,829	917,860	1,147,886	799,054	1,094,615	6,478,525	7,654,232	9,509,895	7,107,444
New Brunswick	4,942,685	2,713,614	6,179,963	2,086,784	2,860,256	2,667,091	1,805,148	955,451	7,802,941	5,380,705	7,985,111	3,042,235
Quebec	40,820,686	20,116,438	45,890,491	22,486,074	21,308,283	24,871,333	19,448,988	22,510,380	62,128,969	44,987,771	65,339,479	44,996,454
Ontario	63,878,383	37,414,463	75,342,010	42,757,926	16,489,703	19,524,550	16,084,089	19,749,635	80,368,086	56,939,013	91,426,099	62,507,561
Manitoba	7,239,800	5,674,422	10,843,601	5,897,180	244,803	196,303	365,404	349,741	7,484,603	5,870,725	11,209,005	6,246,921
Saskatchewan	6,662,161	3,751,426	8,895,159	4,691,204	—	—	—	—	6,662,161	3,751,426	8,895,159	4,691,204
Alberta	12,153,275	10,723,637	13,383,843	11,854,526	19,584	58,664	102,253	71,705	12,172,859	10,782,301	13,486,096	11,926,231
British Columbia	13,309,567	8,489,372	15,498,136	10,499,585	2,134,886	2,222,575	1,707,657	1,908,033	15,444,453	10,711,947	17,205,793	12,407,618
Total	158,297,736	98,433,772	188,954,340	109,647,806	44,236,826	50,988,568	41,081,163	47,399,610	202,534,562	149,422,340	230,035,503	157,047,416
By Type												
Sand												
Building, roadwork, etc.	12,909,498	10,737,876	16,075,366	12,996,753								
Sand and gravel												
Concrete, roadwork, etc.	114,727,145	63,056,042	137,594,684	68,857,398								
Railway ballast	6,282,593	3,307,455	7,765,514	3,960,814								
Crushed gravel	24,378,500	21,332,399	27,518,776	23,832,841								

Table 1 (concluded)

PRODUCTION OF SAND, GRAVEL AND CRUSHED STONE

	Sand and Gravel*				Crushed Stone				Total Production Sand, Gravel and Crushed Stone			
	1961		1960		1961		1960		1961		1960	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Crushed stone												
Concrete aggregate........					11,495,107	14,377,121	9,335,165	12,015,603				
Railway ballast..........					1,874,678	2,041,619	2,561,072	2,882,592				
Road metal..............					24,966,426	27,485,722	23,785,760	26,184,006				
Rubble and riprap........					2,731,721	3,033,932	1,770,089	1,913,810				
Terrazzo, stucco and artificial stone..........					48,259	587,403	51,658	598,914				
Other uses................					3,120,635	3,462,771	3,577,419	3,804,685				
Total......................	158,297,736	98,433,772	188,954,340	109,647,806	44,236,826	50,988,568	41,081,163	47,399,610				

*A changed sand-and-gravel schedule used by the Dominion Bureau of Statistics in 1961 shows statistics for crushed gravel by types of application. Sand and gravel production statistics by types for 1961 are therefore not comparable to previous years. However, the general and provincial totals for sand and gravel production are comparable.



production gain, the 1961 value of structural materials would have made an all-time record. The average value of sand and gravel for the years 1959 to 1961 inclusive increased, moreover, from 57 cents to 62 cents a ton.

Sand aggregate and gravel aggregate for building and road construction dropped off. The reason was partly a decrease in the volume of sand and gravel used in Ontario's municipal and township road construction and partly an increase in the use of crushed stone produced for application as road metal. The decrease in the volume of sand and gravel used for this purpose amounted to 22.9 million tons. Crushed gravel (not to be confused with crushed stone) not specifically classified by use went down in volume by 3.1 million tons, and railroad ballast dropped by 1.5 million tons. The rest of the decrease was due to a decline of 3.2 million tons in sand production.

CRUSHED STONE

Crushed stone for use as concrete aggregate, railroad ballast, and aggregate for terrazzo, stucco and artificial stone increased in 1961 in volume and value. The total of crushed stone of all types reached an all-time high, amounting to an estimated 44.2 million tons valued at $51.0 million. This record was due to large increases in the production of road metal and rubble and riprap.

Crushed stone, on the other hand, made up 21.8 per cent of the combined production total for sand, gravel and crushed stone. It thus rose significantly over the 17.9-per-cent share it obtained in 1960 and made a record of its own. The average value for all types of crushed stone in 1961 was $1.15 a ton.

PRODUCTION OF CRUSHED STONE, BY PROVINCES

For 1961, Prince Edward Island, Manitoba and Alberta reported production decreases in both volume and value. Alberta and Prince Edward Island were the

TABLE 2

PRODUCTION OF CONSTRUCTION STONE BY TYPE AND BY PROVINCE, 1961
(sand and gravel excluded)

	Granite[1]		Limestone[2]		Marble		Sandstone		Slate		Asphalt Filler	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Newfoundland	788	3,840	35,663	71,326	—	—	—	—	—	—	—	—
Prince Edward Island	—	—	—	—	—	—	225,000	225,000	—	—	—	—
Nova Scotia	833,881	1,063,785	1,660	2,075	—	—	85,351	231,129	—	—	27,000	54,000
New Brunswick	415,240	655,737	250,568	356,746	690	14,000	2,194,822	1,646,177	—	—	1,143	9,144
Quebec	2,713,817	6,637,317	17,724,638	20,215,902	16,424	267,620	876,000	932,531	1,250	1,750	86,287	194,540
Ontario	1,554,573	3,339,593	14,973,326	16,932,000	20,041	254,309	25,381	425,796	—	—	61,478	125,144
Manitoba	51	13,841	254,139	715,133	—	—	—	—	—	—	46,209	25,322
Saskatchewan	—	—	—	—	—	—	—	—	—	—	—	—
Alberta	—	—	4,345	5,079	—	—	20	100	—	—	4,823	24,115
British Columbia	688,854	729,412	542,077	633,437	—	—	819,725	618,044	—	—	2,000	12,000

Source: Dominion Bureau of Statistics.
[1]All igneous rocks are included.
[2]Includes dolomite.

most affected, while Ontario's production was increased by 405,614 tons and its value decreased by $225,000. Quebec increased its volume by about 2 million tons and its value by $2.4 million; New Brunswick increased its volume by about 58.4 per cent and its value by approximately 179 per cent. Nova Scotia and British Columbia reported notable increases in their production of crushed stone.

PRODUCTION OF CRUSHED STONE INCLUDING BUILDING STONE, BY TYPE AND PROVINCE

The construction-stone production total is made up of crushed stone for all uses, building stone included. It does not, however, embrace sand or gravel, which are reported by province and type in Table 1.

The statistics given in Table 2, which represent the output from natural bedrock formations, show the relative importance of the producing provinces within each stone type and their relative importance as producers of all types combined.

Asphalt filler, which does not appear in previous reviews or in Table 1 of this review, is included in Table 2 because of its increased use and importance in the construction of roads. In a normal crushing operation, which leaves a large volume of fines, it is obtained as a by-product; when the fines are low, it is specially produced. In 1961 the production of asphalt filler amounted to 228,940 tons valued at $444,265.

CONSTRUCTION SAND, GRAVEL AND CRUSHED STONE

Gravel has been defined as a product consisting of naturally formed fragments of rock that are classified according to the proportion of their igneous to their sedimentary components. Other parameters for grading gravel are certain physical requirements and limitations of deleterious content. Construction-type gravels are further classified as crushed, screened or pit-run. Crushed and screened gravels, the latter sometimes referred to as rounds, are distinguished from pit-run gravel by their higher quality specifications. Specifications also vary with local conditions.

Sand or fine aggregate may consist of natural sand or materials like it. All material must have durable particles and be reasonably free from deleterious constituents. Sand is graded to meet the requirements of the work in which it is to be used. It may be needed, for example, for concrete or bituminous pavement mixes, for mortar or for use in various kinds of manufacturing.

Crushed stone is obtained from bedded formations or massive bodies of rock by quarrying and crushing to specified aggregate sizes. Stone used for aggregate must be free from such undesirable material as shale interbeds or clay-ball inclusions, alkali reactive siliceous minerals and intrusive rocks of different composition, any of which might react differently from the host rock. The crushing characteristics of a rock should be such that suitable grading results without padding.

Fine-sized material produced from normal crushing is known as crusher fines. In special cases, where the crushing procedure is designed for the purpose, the product is called manufactured sand and is becoming increasingly important as natural sand deposits are depleted. The procedures used to test crushed-stone sands are similar to those used to assess the suitability of natural sands.

To meet the specifications laid down by the construction industry today, aggregate production must be under rigid quality control during all phases of quarrying, crushing and beneficiation.

IMPORTS AND EXPORTS

Because of its small volume and value, the quantity of sand, gravel and crushed stone imported or exported is of small significance and has little effect on the over-all economy of the Canadian industry.

Occasionally a Canadian crushed stone is produced that is in demand in the United States, but trade in low-priced materials requires direct water transportation to be competitive. Resistance to trade of this kind is not long in developing, in the form either of protective tariffs imposed by the importing country or of the production of competitive materials.

A large body of traprock at present under development on the north shore of Lake Huron has potential markets in many of the north-central states of the United States. The qualities of the aggregate produced from this stone give it a rating comparable to that of the best stone used in highway construction. The Ontario Department of Highways, in fact, specifies a traprock for H-1 use. Traprock also makes an excellent concrete aggregate and has application in the mineral-wool, roofing-granule and other industries.

In 1961, imports declined almost by half a million tons, or more than 27 per cent. Sand and gravel accounted for almost 350,000 tons of this decrease, and crushed-stone imports went down by nearly 150,000 tons. The amount imported was worth $84,900 less than in 1960 but cost the Canadian buyer more per ton, the average price per ton having risen in 1961 to $1.27 from the 97 cents of the previous year.

Exports of sand and gravel increased by 86.2 per cent, from their 1960 total of 209,172 tons to 389,495 tons for 1961. The value per ton, however, decreased by 50 per cent, from $2.58 to $1.31. Crushed-stone exports made a small gain of 17,200 tons. The value of all exports decreased by $68,076, thus lowering the average price from $1.81 to $1.43 a ton.

TABLE 3

SAND AND GRAVEL AND CRUSHED STONE—IMPORTS AND EXPORTS

	1961**		1960	
	Short Tons	$	Short Tons	$
Imports				
Sand and gravel	537,972	495,609	885,604	444,292
Crushed stone	790,482	1,185,454	940,330	1,321,675
Total	1,328,454	1,681,063	1,825,934	1,765,967
Exports				
Sand*	337,421	461,188		
Gravel*	52,074	49,734		
Total, sand and gravel	389,495	510,922	209,172	540,415
Stone, crude, not elsewhere specified	732,735	1,091,665	715,544	1,130,248
Total	1,122,230	1,602,587	924,716	1,670,663

Source: Dominion Bureau of Statistics. *Not available separately for the years before 1961. **All 1961 figures are subject to revision.

CONSUMPTION OF AGGREGATES

The decrease in the production of sand and gravel no doubt coincided with the completion of several large contracts. The decline felt during 1961 is probably the same as the one that was experienced in the United States in 1960 and that marked the first drop in sand and gravel output in 10 years. In 1961, however, United States production recovered and rose 3 per cent in volume and value over the record of 1959. It totalled 752 million short tons valued at $751 million, of which 728 million tons valued at $687 million were for construction. Most of the increase was due to road-building, public construction and new housing.

Because construction values in Canada have become stabilized near the record level in the 1959-61 period and construction in the United States has shown strong recovery, the future of the Canadian industry is promising.

A significant development of 1961 that affected the construction industry was that, for the first time, representatives of government and industry jointly investigated foreign markets. They toured several Central American countries, studying the operating methods of the construction industry and exchanging ideas on trade relationships in the hope of finding new outlets for some of the home industries. They expected that the contacts thus made would bring the Canadian industry new ideas and result in the development of new types of products with greater appeal for the foreign market.

A good start for 1962 is indicated by reports that in the early months construction-contract awards increased by more than 25 per cent.

Selenium and Tellurium

A. F. Killin*

SELENIUM

Selenium is a grayish semimetal with a semimetallic lustre and electrical properties characteristic of the semiconductor group of metalloid elements. Commercial production is obtained from the treatment of tank muds resulting from the electrolytic refining of copper anodes. Although selenium is widely distributed in the earth's crust in the native state and in the selenides of copper, silver, lead, mercury, bismuth and thallium, it is never found in deposits worth working for the selenium content alone.

In 1961, selenium production decreased to 430,612 pounds valued at $2,798,978. Its 1960 total was 521,638 pounds valued at $3,651,466. The output of refined selenium from all sources declined to 422,955 pounds in 1961 from the 524,659 pounds refined in 1960. The drop is probably related to the decrease that occurred in 1961 in Canada's production of refined copper. At 13,160 pounds, domestic consumption was 1,301 pounds less than in 1960.

Canada has two selenium refineries, one at each of its copper refineries. In addition to the primary selenium produced, a small amount of selenium is recovered from scrap left over from the manufacture of dry-plate rectifiers and from mold rectifiers.

In conjunction with its electrolytic copper refinery at Copper Cliff, Ontario, The International Nickel Company of Canada, Limited, operates a selenium- and tellurium-recovery plant, where it processes selenium-bearing materials from the Copper Cliff refinery and from its nickel refinery at Port Colborne, Ontario. The plant has the capacity to produce 240,000 pounds of minus 200 mesh, 99.7-per-cent selenium powder a year.

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*Mineral Resources Division.

TABLE 1

SELENIUM—PRODUCTION, EXPORTS AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	214,998	1,397,487	279,759	1,958,313
Ontario	164,800	1,071,200	144,500	1,011,500
Saskatchewan	41,270	268,255	73,021	511,147
Manitoba	9,544	62,036	24,358	170,506
Total	430,612	2,798,978	521,638	3,651,466
Estimated refined[2]				
Quebec			273,000	1,638,000
Ontario			145,100	970,600
Saskatchewan			73,196	439,176
Manitoba			24,804	148,824
Total			516,100	3,196,600
Refined[3]	422,955		524,659[r]	
Exports				
Metal and salts				
Britain	212,500	1,413,520	213,532	1,601,638
United States	100,100	618,945	125,912	744,322
France	7,100	53,156	110	1,040
Hungary	7,000	46,080	1,135	8,118
China (Communist)	6,100	39,651	30,547	196,592
Republic of South Africa	3,800	23,588	3,400	25,330
Brazil	2,000	12,149	3,137	23,872
Italy	1,500	9,885	3,527	33,111
Australia	1,100	8,400	3,710	34,398
Other countries	4,600	26,128	19,400	127,986
Total	345,800	2,251,502	404,410	2,796,407
Consumption[4]	13,160		14,461	

SOURCE: Dominion Bureau of Statistics for all but the selenium covered by footnote 2.

[1]Recoverable selenium content of the blister copper produced from domestic ores, plus refined selenium from stockpiled sludge.

[2]Selenium derived from the treatment of ores as reported directly by producers.

[3]Includes production from scrap.

[4]As reported by consumers.

[r]Revised from previously published figure.

TABLE 2

SELENIUM—PRODUCTION, EXPORTS AND CONSUMPTION, 1951-61

(pounds)

	Production		Exports	Consumption[3]
	All Forms[1]	Refined[2]	Metals and Salts	
1951	382,603	371,060	370,473	13,647
1952	242,030	254,478	244,121	11,767
1953	262,346	307,903	253,620	14,465
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[r]	404,410	14,461
1961	430,612	422,955	345,800	13,160

SOURCE: Dominion Bureau of Statistics.

[1]Recoverable selenium content of the blister copper produced from domestic ores, plus refined selenium.

[2]Includes production from scrap.

[3]To 1958 inclusive, producers' domestic shipments of selenium and selenium salts (selenium content); for 1959 and the years following, consumption as reported by consumers.

[r]Revised from previously published figure.

TABLE 3

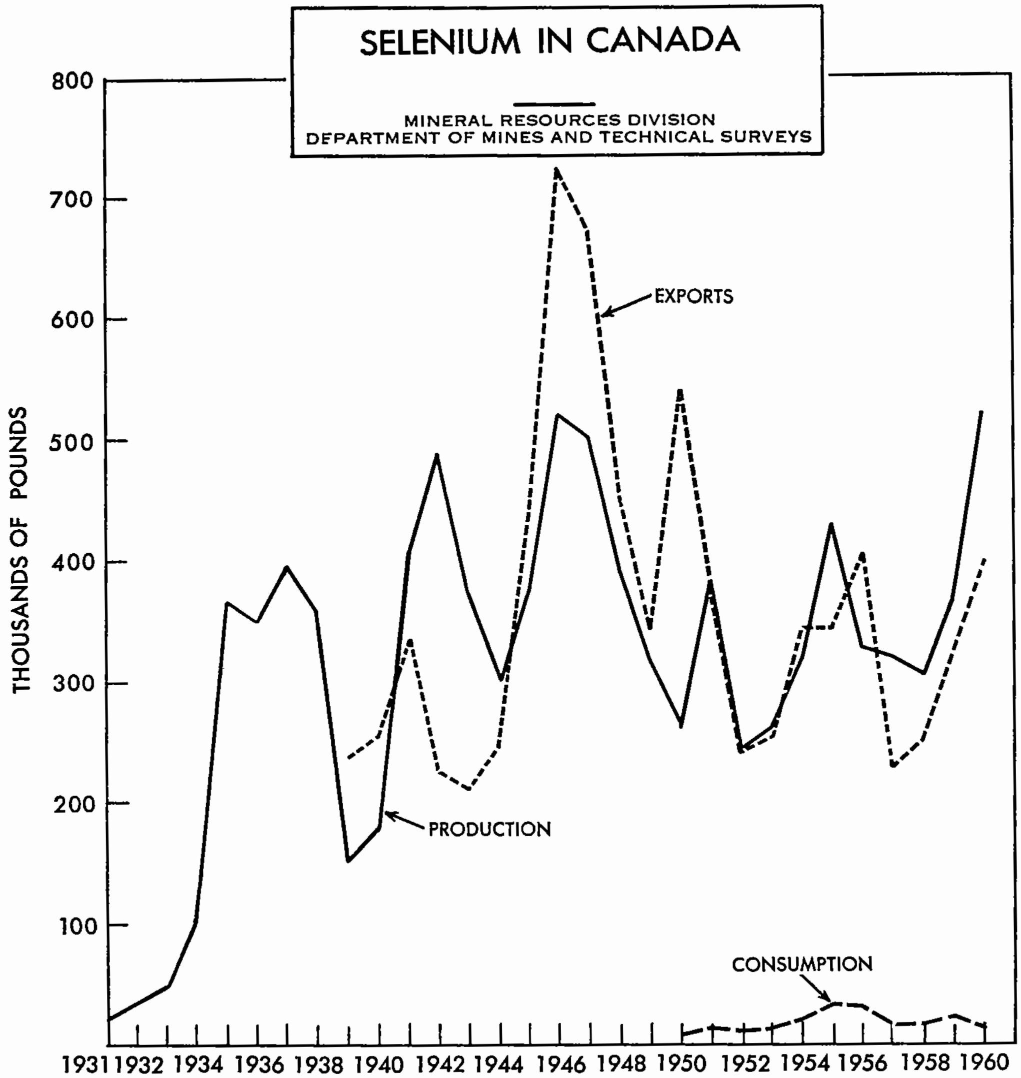
FREE WORLD PRODUCTION OF SELENIUM, 1961

(pounds)

United States	1,022,000
Canada	430,612
Japan	275,696
Sweden (exports)	156,500
Belgium and Luxembourg (exports)	55,100
Other countries	77,092
Total	2,017,000

SOURCE: U.S. Bureau of Mines, *Mineral Trade Notes, August 1962.*

At Montreal East, Canadian Copper Refiners Limited operates Canada's largest selenium plant, using tankhouse slimes resulting from the electrolytic refining of copper anodes and blister copper. The anodes come from the company's smelters at Noranda and Murdochville, in Quebec; the blister copper from the smelter of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba. Canadian Copper Refiners' 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 (H.P.) selenium metal (99.9% Se), the refinery can produce a great variety of metallic and organic selenium compounds.



CONSUMPTION AND USES

The decline in consumption reflects the decrease in the electronics industry's use of selenium in dry-plate rectifiers. In 1959, the manufacture of such rectifiers accounted for more than one third of all the selenium used in Canada but in 1960 for only a little more than one fifth. This use has continued to decline owing to the substitution of silicon and germanium for selenium in the manufacture of rectifiers.

Selenium and compounds containing it are used by the glass, rubber and alloy-steel industries. A small amount of selenium added to copper forms a free-machining alloy.

In glass-making, selenium added to the glass batch in small quantities helps to neutralize the green color imparted by iron in the glass sand. Larger quantities of selenium produce orange-to-ruby-red colors, according to the quantity added. Selenium ruby glass, which is of a brilliant red, is used in stop lights, signal lights, automotive taillights, marine equipment and decorative tableware. The ceramics and paint industries use selenium as a pigment to obtain orange-to-dark-maroon colors and in the coloring of printing inks for glass containers.

The pharmaceutical industry employs selenium and selenium compounds in the preparation of various proprietary medicines for the control of dermatitis in humans and animals and the correction of dietary deficiencies in animals. The chemical industry uses selenium as a catalyst in the manufacture of cortisone and nicotinic acid.

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.

The porosity of stainless-steel castings is improved by the addition of selenium in proportions from 0.20 to 0.35 per cent. The machinability and other properties of stainless steel are improved by the addition of ferroselenium (55-57% Se).

TABLE 4

PARTIAL ANALYSIS OF CANADIAN INDUSTRIAL USE OF SELENIUM, 1960

(pounds of contained selenium)

By end-use	
Electronics	3,822
Glass	5,761
Other[1]	4,878
Total	14,461
By type	
Ferroselenium	3,201
High Purity	3,822
Metal Powder	5,291
Other[2]	2,147
Total	14,461

SOURCE: Consumers' reports.
[1]Rubber, stainless steel, pharmaceuticals.
[2]Selenium dioxide, sodium selenate, sodium selenite and selenium sulphide.

TABLE 5

CONSUMERS OF SELENIUM AND PRODUCTS

Quebec
- Abbot Laboratories Ltd., 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
- Needco Cooling Semiconductors Ltd., Montreal
- Shawinigan Chemicals Limited, Shawinigan

Ontario
- Atlas Steels Limited, Welland
- Canadian Line Materials Limited, Toronto
- Fahralloy Canada Limited, Orillia
- Ferro Enamels (Canada) Limited, Oakville
- Syntron (Canada) Limited, Stoney Creek

British Columbia
- Consolidated Mining and Smelting Company of Canada Limited, The, Trail

PRICES

In 1961, *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. 5	\$6.50 to \$7.00	\$9.50
Jan. 12	\$6.50	\$7.50
Nov. 16	\$5.75	\$6.75

TELLURIUM

Tellurium, like selenium, is a semimetal and exhibits semiconductor properties. Metallic tellurium is a steel-gray, brittle substance more inclined to form compounds with other metals than is selenium. Although tellurides of gold, silver, mercury, bismuth, copper and lead have been found widely distributed in the earth's crust, no commercial deposits of these compounds have been discovered. Tellurium is less abundant than selenium, the present commercial sources being the anode slimes resulting from the electrolytic refining of copper and lead. Gold and silver tellurides are known to occur in Canadian gold mines, but no tellurium is being recovered in Canada from gold ores or lead ores.

Tellurium is recovered with selenium at the Copper Cliff, Ontario, refinery of The International Nickel Company of Canada, Limited, and at the Montreal East refinery of Canadian Copper Refiners Limited. International Nickel treats the anode slimes from its Copper Cliff copper refinery and its Port Colborne, Ontario, nickel refinery. Canadian Copper Refiners produces tellurium as it produces selenium—by treating tankhouse slimes obtained from the electrolytic refining of copper anodes and blister copper, the anodes being from the Noranda and Murdochville smelters and the blister copper from the Flin Flon smelter.

Production of tellurium in all forms amounted to 77,609 pounds valued at \$376,404; its 1960 total was 44,682 pounds. The output of refined tellurium was 81,050 pounds, 39,294 pounds more than in 1960.

TABLE 6

TELLURIUM—PRODUCTION AND CONSUMPTION

	1961		1960	
	Pounds	\$	Pounds	\$
Production				
All forms[1]				
Quebec	63,904	309,934	29,925	104,738
Saskatchewan	4,596	22,291	5,482	19,187
Ontario	8,050	39,043	7,450	26,075
Manitoba	1,059	5,136	1,825	6,388
Total	77,609	376,404	44,682	156,388
Estimated plant output[2]				
Quebec			33,000	115,500
Saskatchewan			5,976	20,916
Ontario			7,250	25,375
Manitoba			2,024	7,084
Total			48,250	168,875
Refined[3]	81,050		41,756	
Consumption (refined)[4]	4,843		4,238	

SOURCE: Dominion Bureau of Statistics for all but the tellurium covered by footnote 2.
[1]Includes the recoverable tellurium content of the blister and anode copper treated, plus refined tellurium from stockpiled sludge.
[2]As reported directly by producers. [3]Refinery output from all sources. [4]As reported by consumers.

TABLE 7

PRODUCTION OF TELLURIUM 1951-61

(pounds)

	All Forms[1]	Refined[2]
1951	8,913	6,301
1952	6,035	5,710
1953	4,694	17,295
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

SOURCE: Dominion Bureau of Statistics.
[1]Includes the recoverable tellurium content of blister copper, which was not necessarily recovered in the year designated. Also includes some refinery output.
[2]Refinery production from all sources.

TABLE 8

FREE WORLD PRODUCTION OF TELLURIUM, 1961

(pounds)

United States	205,000
Peru	76,280
Canada	77,609
Japan	16,486
Other countries	25
Total	375,400

SOURCE: U.S. Bureau of Mines, *Minerals Yearbook 1961*, (Minor Metals Preprint).

CONSUMPTION AND USES

Tellurium is being consumed in increasing quantities because of its application in thermoelectric devices. When alloyed with bismuth, selenium and other semiconductors, tellurium is used in couples for the direct conversion of heat into electricity and for refrigeration. The use of thermoelectric cooling is increasing, and industry and the United States Bureau of Mines are seeking new sources of tellurium.

Tellurium is nontoxic, but when absorbed into the body by direct contact or inhalation, it imparts a strong odor of garlic to the breath and perspiration. Because of this adverse physiological effect, industry has used tellurium less than selenium.

The rubber industry uses tellurium powder and tellurium diethyldithiocarbamate to improve the aging and mechanical properties of sulphurless and low-sulphur stocks of natural and GR-S (synthetic) rubber. The addition of the tellurium diethyldithiocarbamate reduces the porosity of thick rubber sections. Tellurium rubber is particularly resistant to heat and abrasion and is used mainly for jacketing portable electric cables used in mining, dredging, welding, etc. Tellurium diethyldithiocarbamate plus mercaptobenzothiazol is one of the fastest known accelerators for butyl rubber.

The depth of chill in gray-iron castings can be controlled by the addition of tellurium powder to the molten iron. A 99.5-per-cent-copper and 0.5-per-cent-tellurium alloy has good hot-working properties and can also be extensively cold-worked and forged. This alloy, which has good thermal and electrical conductivity, is used in the manufacture of welding tips and in radio and communications equipment. Lead containing 0.02 to 0.1 per cent tellurium is corrosion-resistant and is used in marine-cable sheathing and as linings in tanks subject to chemical corrosion.

TABLE 9

REFINED TELLURIUM USED IN CANADA

(pounds of contained tellurium)

	1961	1960
By end-use		
Metal alloys	1,875	1,578
Other[1]	2,968	2,660
Total	4,843	4,238
By type		
Metal pellets	1,259	2,578
Other[2]	3,584	1,660
Total	4,843	4,238

SOURCE: Consumers' reports.
[1]Rubber, electronics.
[2]Lump, powder and compounds.

PRICES

United States prices for a pound of tellurium in 100-pound lots, powdered, have been reported for 1961 by *E & M J Metal and Mineral Markets* as follows:

Jan. 1–May 4	$4.00
May 5–Dec. 31	$5.25

Silica

R. K. Collings*

Silicon dioxide, or silica, occurs in nature chiefly as quartz. Quartz is found in many forms such as sand, sandstone, quartzite and vein quartz, but only those in which the silica content is high are of commercial interest. Most of the silica produced in Canada is lump quartzite, lump sandstone or natural sand, all of which are for use as metallurgical flux. More than 80 per cent of the 1960 output was consumed as smelter flux. Smaller quantities of sand, sandstone, quartzite and quartz are produced for a variety of purposes.

At 2,194,054 tons, Canada's production of silica minerals was 3 per cent lower in 1961 than in the previous year. It was valued at $3,152,882 or an average of $1.44 a ton.

Imports consisted mostly of high-purity silica sand from the United States and, with firebrick excluded, were 4 per cent less than in 1960. Imports of high-purity sand for use in the glass, silicon carbide, silica-chemicals and foundry industries will probably continue the downward trend of the last few years as Canadian producers expand and continue their efforts to produce a premium sand. Canada's two main producers of high-purity sand currently supply 25 to 30 per cent of the domestic market.

Exports of silica, consisting mainly of quartzite for use in the production of ferrosilicon in the United States, amounted to 26,774 tons, or more than twice their 1960 total. They were valued at $116,109, or about $4.34 a ton.

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* Mineral Processing Division, Mines Branch.

TABLE 1

SILICA—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production[1]				
Quartz and silica sand				
By province				
Ontario	1,540,016	827,061	1,659,410	998,281
Quebec	302,432	1,717,502	357,165	1,835,960
Saskatchewan	144,348	90,940	169,903	107,039
British Columbia	40,967	171,877	64,887	272,433
Nova Scotia	1,044	5,772	9,281	52,813
Manitoba	165,247	339,730	120	179
Total	2,194,054	3,152,882	2,260,766	3,266,705
By use				
Flux	1,883,184	1,276,031	1,886,590	1,342,135
Ferrosilicon	91,344	392,870	146,457	521,865
Silicon carbide	74,122	521,207	73,931	566,704
Glass	50,073	322,930	52,110	329,578
Foundry	24,798	163,025	16,790	86,996
Other uses	70,533	476,819	84,888	419,427
Total	2,194,054	3,152,882	2,260,766	3,266,705
Imports				
Silica sand for glass and carborundum manufacture and for use in steel foundries, filtration plants and sandblasting				
United States	691,928	2,470,753	719,958	2,394,595
Norway	544	5,412	214	3,589
Australia	459	10,178	135	3,385
Belgium and Luxembourg	279	4,345	519	3,116
Total	693,210	2,490,688	720,826	2,404,685
Quartz				
Silex, or crystallized quartz, ground or unground[2]	10,327	191,336	10,521	161,239
Piezoelectric quartz	5	185,777	2	126,208
Total	10,332	377,113	10,523	287,447

TABLE 1 (cont'd)

	1961		1960	
	Short Tons	$	Short Tons	$
Imports (cont'd)				
Flint and ground flint stones				
United States	1,100	16,829	1,072	15,195
Denmark	145	6,492	110	4,668
France	94	7,632	50	1,540
Total	1,339	30,953	1,232	21,403
Firebrick containing not less than 90% silica				
United States		1,179,779		945,683
West Germany		26,426		9,420
Britain		8,183		6,709
Total		1,214,388		961,767
Exports				
Quartzite				
United States	26,774	116,109	13,057	44,505

SOURCE: Dominion Bureau of Statistics.
[1]Producers' shipments, including crude and crushed quartz, crushed sandstone and quartzite, and natural silica sands. For 1960, the quartz used to make silica brick is included.
[2]Mostly from the United States.

TABLE 2

AVAILABLE STATISTICS ON CONSUMPTION OF SILICA BY SPECIFIED INDUSTRIES, 1960

Industry	Short Tons
Smelter-flux	1,886,590†
Glass-manufacturing (including fiber-glass)	310,326
Foundry-sand	150,463
Ferrosilicon	102,520
Artificial-abrasives	140,285
Cement-manufacturing	25,921
Chemical	26,785
Soap-and-cleanser	798
Fertilizers, stock and poultry feed	29,389
Asbestos-products	2,495
Ceramics	11,833
Other industries	22,264
Total	2,709,669

SOURCE: Dominion Bureau of Statistics.
†Includes low-grade sand and gravel as well as crushed quartz.

TABLE 3

SILICA—PRODUCTION AND TRADE, 1951-61

	Production		Imports				Exports
	Quartz and Silica Sand	Silica Brick	Silica Sand	Silex, or Crystallized Quartz	Flint and Ground Flint Stones	Ganister	Quartzite
	(short tons)	('000 bricks)		(short tons)			(short tons)
1951.....	1,904,885	3,510	692,937	30,398	1,231	144	281,379
1952.....	1,783,081	3,544	642,880	26,174	481	260	193,955
1953.....	1,785,574	3,720	703,221	30,534	1,106	286	200,169
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	[1]	17,074
1959.....	2,163,546	1,926	792,129	13,815	786	[1]	147,412
1960.....	2,260,766	[2]	720,826	10,521	1,232	[1]	13,057
1961.....	2,194,054	[2]	693,210	10,327	1,339	[1]	26,774

SOURCE: Dominion Bureau of Statistics.
[1]Not available separately. Included with miscellaneous stone imports from January 1, 1958.
[2]Not available. Silica used to make silica brick included in the production of quartz and silica from 1960.

PRINCIPAL PRODUCERS

Nova Scotia

Dominion Iron & Steel Limited obtains quartzite, as required, from Chegoggin Point, Yarmouth county, for use in the manufacture of silica brick at Sydney.

Quebec

Electro Metallurgical Company, Division of Union Carbide Canada Limited, quarries quartzitic sandstone at Melocheville, Beauharnois county, for use in ferrosilicon manufacture at Beauharnois. Fines from this operation are sized and used in foundry work, in cement manufacture and as metallurgical flux.

E. Montpetit et Fils Ltée also quarries sandstone in the Melocheville area. This sandstone is used by Chromium Mining & Smelting Corporation, Limited, for ferrosilicon production at Beauharnois.

Dominion Silica Corporation Limited quarries quartzite at St. Donat de Montcalm for use in the manufacture of silica sand and flour at Lachine. Production from the Lachine plant is used in the manufacture of glass and silicon carbide and for other products requiring high-quality silica. During the year, this company announced plans for the construction of a plant at Ste. Agathe des Monts, about 20 miles south of St. Donat, to replace that now operated at Lachine.

Canadian Silica Corporation Limited, Toronto, produces silica sand and flour at St. Canut, Two Mountains county, from a large deposit of Potsdam sandstone. The sand is used for foundry purposes and for the manufacture of glass and silicon carbide. The flour is used by steel foundries, as a filler in asbestos-cement products and in various cleaners. Considerable progress was made in a $1-million plant expansion designed to provide a threefold increase in production. This development, in which provision is made for wet-treatment, probably will be completed by July 1962.

During the year, Silica & Brick Mills Limited, of Ste. Clothilde, produced a variety of sand sizes from an occurrence of Potsdam sandstone near that community. This material was sold for glass manufacture, as poultry grit and for other purposes.

Ontario

Canadian Silica Corporation operates quarries at Sheguiandah, Manitoulin Island, in the Lorraine quartzite formation that extends along the northwest end of Georgian Bay. Most of the output is exported to the United States for ferrosilicon manufacture, and the remainder is used for the production of silica flour at Whitby, Ontario.

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; Flin Flon and Thompson, in Manitoba; and Trail, British Columbia.

Large deposits of sand, sandstone and quartzite exist in all provinces, but most are too impure or too far from markets to warrant development.

SPECIFICATIONS AND USES

Lump Silica

Silica Flux

Quartz and quartzite, as well as sandstone and sand, are used as fluxes in smelting base-metal ores of low silica content. The composition of the flux and the amount of silica used depend upon the composition of the ore, but the silica content should be high. In small amounts, impurities such as iron and alumina are not objectionable. Silica used as flux is generally —1, +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 less than 1 per cent each and the total iron-and-alumina content less than 1½ per cent. Lime and magnesia should each be less than 0.2 per cent. Phosphorus and arsenic are objectionable as they cause deterioration and disintegration of the manufactured product. The silica use is generally —6, +1 inch in size.

Silica Brick

Quartz and quartzite, crushed to pass an 8-mesh screen, are used in the manufacture of silica brick for high-temperature refractory furnace linings. The silica content should be at least 97 per cent. The iron and alumina should be less than 1 per cent each, and other impurities, such as lime and magnesia, should be low.

Other Uses

Lump quartz and quartzite, shaped to proper size, are used as lining in ball and tube mills and as lining and packing for acid towers. Naturally occurring flint pebbles are used as grinding media for the reduction of various nonmetallic ores.

Silica Sand

Glass Manufacture

Naturally occurring sand and sand produced by crushing quartz, 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: glass sand should be between 20-mesh and 100-mesh size with a minimum of coarse or fines.

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; and 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

Silica sand is used in the hydraulic fracturing of oil-bearing formations. The sand 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 must be closely controlled 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 to grain size are used extensively in the foundry industry for moulding. Silica 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 sand with a rounded grain is preferred.

Sodium Silicate and Other Chemicals

Sand used in the manufacture of sodium silicate and other chemicals 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 sand is 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 for paint and as an abrasive ingredient in soaps and scouring powders.

Quartz Crystals

Quartz crystals possessing desirable piezoelectric properties are used in radio-frequency-control apparatus, radar and other electronic devices. Crystals used for this purpose must be water-clear, perfectly transparent and free of all visible impurities or flaws. The individual crystals should weigh 100 grams or more and measure at least 2 inches in length and 1 inch or more in diameter.

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 from Ottawa, Illinois, in carload lots f.o.b. Montreal, sells for about $10 a ton.

TARIFFS

Canada

Sand and ganister	free
Silex, or crystallized quartz, ground or unground	"

United States

Sand containing 95% or more silica and not more than 0.6% oxide of iron and suitable for use in the manufacture of glass, per long ton	50¢
Quartzite, sand, not specifically provided for	free
Silica, crude, not specifically provided for, per long ton	$1.75

Silver

J. W. Patterson*

Silver production dropped in 1961 to 31,381,977 ounces from the 1960 record of 34,016,829. The decrease in Ontario's output to 8,870,402 ounces from the 1960 total of 11,220,823, most of which was due to a slump in the Cobalt area, was virtually the whole cause of the decline.

Lead-zinc and silver-lead-zinc ores, the greater part of which were mined in British Columbia, were by far the most important of the various sources of silver, accounting for 58 per cent of production. Copper, copper-nickel and copper-zinc ores accounted for 25 per cent, silver-cobalt ores for 15 per cent and lode- and placer-gold ores for 2 per cent.

Canada's 19 principal producers are shown in Table 3 and on the map. The leading producers were the Sullivan mine, in British Columbia, operated by The Consolidated Mining and Smelting Company of Canada Limited (Cominco), and the Calumet mine, in Yukon Territory, operated by United Keno Hill Mines Limited, their combined production in 1961 being equal to 27 per cent of Canada's total. Most of the refined silver, which amounted to 17,952,914 ounces, was produced by Cominco at Trail, British Columbia, from lead and zinc ores, Canadian Copper Refiners Limited, at Montreal East, Quebec, from blister copper, and The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario, from nickel-copper ores. Other producers were Hollinger Consolidated Gold Mines, Limited, Timmins, Ontario, and the Royal Canadian Mint, Ottawa, Ontario, both of which produced silver in refining gold bullion, and Deloro Smelting & Refining Company, Limited, Deloro, Ontario, which produced silver in refining silver and cobalt ores. In March, owing to an insufficiency in the supply of silver-cobalt ores resulting partly from a decline in the price of cobalt, Deloro closed its refinery.

The closing of the Deloro refinery brought an increase in the shipments of silver concentrates to the United States for treatment, and in 1961 Canada's exports of silver in ores and concentrates, which came mainly from the Cobalt and Gowganda areas of Ontario, totalled 10,352,700 ounces. In 1960 they amounted to 8,897,402 ounces. Bullion exports for the same periods were respectively 10,783,414 and 12,761,063 ounces.

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*Mineral Resources Division.

Table 1

SILVER—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Troy Ounces	$	Troy Ounces	$
Production				
By provinces				
Ontario	8,870,402	8,361,240	11,220,823	9,976,434
British Columbia	8,391,640	7,909,960	8,447,440	7,510,619
Yukon Territory	6,937,086	6,538,897	7,217,361	6,416,956
Quebec	4,315,844	4,068,115	4,115,105	3,658,740
Manitoba and Saskatchewan	1,643,993	1,549,628	1,665,482	1,480,780
Newfoundland	1,145,105	1,079,376	1,271,126	1,130,158
Northwest Territories	77,890	73,419	79,473	70,659
Nova Scotia	—	—	—	—
Alberta	17	16	19	17
Total	31,381,977	29,580,651	34,016,829	30,244,363
By sources				
Base-metal ores	26,041,639		26,002,253 r	
Gold ores	645,734		841,824 r	
Silver-cobalt and silver ores	4,680,536		7,155,909 r	
Placer-gold ores	14,068		16,843	
Total	31,381,977		34,016,829	
Refined silver	17,952,914		21,932,773	
Exports				
In ores and concentrates				
United States	8,648,932	8,120,385	6,809,755	6,408,677
Belgium and Luxembourg	1,377,351	1,104,378	1,123,162	990,772
West Germany	316,764	220,707	365,538	305,071
Japan	9,653	8,819	596,041	548,091
Britain	—	—	2,906	2,583
Total	10,352,700	9,454,289	8,897,402	8,255,194
Silver, refined metal				
United States	10,656,655	9,972,630	12,738,617	11,294,327
Brazil	121,258	114,168	20,353	18,903
Venezuela	5,344	5,839	2,093	2,139
Other countries	157	904	—	—
Total	10,783,414	10,093,541	12,761,063	11,315,369
Manufactures[1]				
United States				9,990
New Zealand				976
Bermuda				932
Barbados				651
Jamaica				526
Other countries				1,121
Total				14,196

TABLE 1

SILVER—PRODUCTION, TRADE AND CONSUMPTION (*cont'd*)

	1961		1960	
	Troy Ounces	$	Troy Ounces	$
Imports				
Unmanufactured				
United States	10,785,630	10,225,999	3,323,014	3,002,439
Mexico	1,471,221	1,339,659	300,000	270,000
Bahamas	18,142	16,869	21,512	18,353
Britain	3,020	2,946	3,092	2,874
Peru	—	—	200,596	178,530
Other countries	456	475	901	803
Total	12,278,469	11,585,948	3,849,115	3,472,999
Manufactured articles of silver, including toilet articles of sterling silver				
Britain		369,218		380,841
United States		283,669		238,306
West Germany		90,373		60,903
Denmark		30,945		27,491
Other countries		36,855		31,237
Total		811,060		738,778
Consumption				
By use				
Coinage	5,141,894		7,481,617	
Silverware	1,392,825		1,645,647	
Photography	1,558,576		1,410,166	
Wire and rod	42,390		46,257	
Brazing and lead-silver alloys	229,834		129,946	
Miscellaneous[2]	1,248,564		1,028,431	
Total	9,614,083		11,742,064	

SOURCE: Dominion Bureau of Statistics.

[1]Not available for 1961 as a separate class.

[2]Includes sheet, anodes for electroplating, and silver used in the manufacture of electrical equipment and jewelry.

[r]Revised from previously published figure.

TABLE 2

SILVER—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

(troy ounces)

	Production		Exports			Imports	
	All Forms[a]	Refined Silver	In Ore and Concentrate	In Bullion	Total	Unmanufactured	Consumption[b]
1951	23,125,825	23,177,138	2,413,288	15,381,276	17,794,564	1,050,299	7,973,635
1952	25,222,227	21,045,592	3,546,448	14,928,515	18,474,963	145,898	8,031,873
1953	28,299,335	25,360,632	5,686,518	14,632,914	20,319,432	287,497	8,518,441
1954	31,117,949	19,424,154	8,672,340	14,467,015	23,139,355	60,165	5,996,563
1955	27,984,204	19,354,223	5,873,873	16,598,577	22,472,450	87,128	5,161,445
1956	28,431,847	21,599,798	6,924,414	14,341,753	21,266,167	1,010,180	7,710,925
1957	28,823,298	20,004,360	5,979,459	12,799,990	18,779,449	1,859,131	10,730,255
1958	31,163,470	24,620,142	5,098,788	16,026,550	21,125,338	2,701	9,299,809
1959	31,923,969	21,770,510	6,814,865	15,140,830	21,955,695	2,807,774	10,202,769
1960	34,016,829	21,932,773	8,897,402	12,761,063	21,658,465	3,849,115	11,742,064
1961	31,381,977	17,952,914	10,352,700	10,783,414	21,136,144	12,278,469	9,614,083

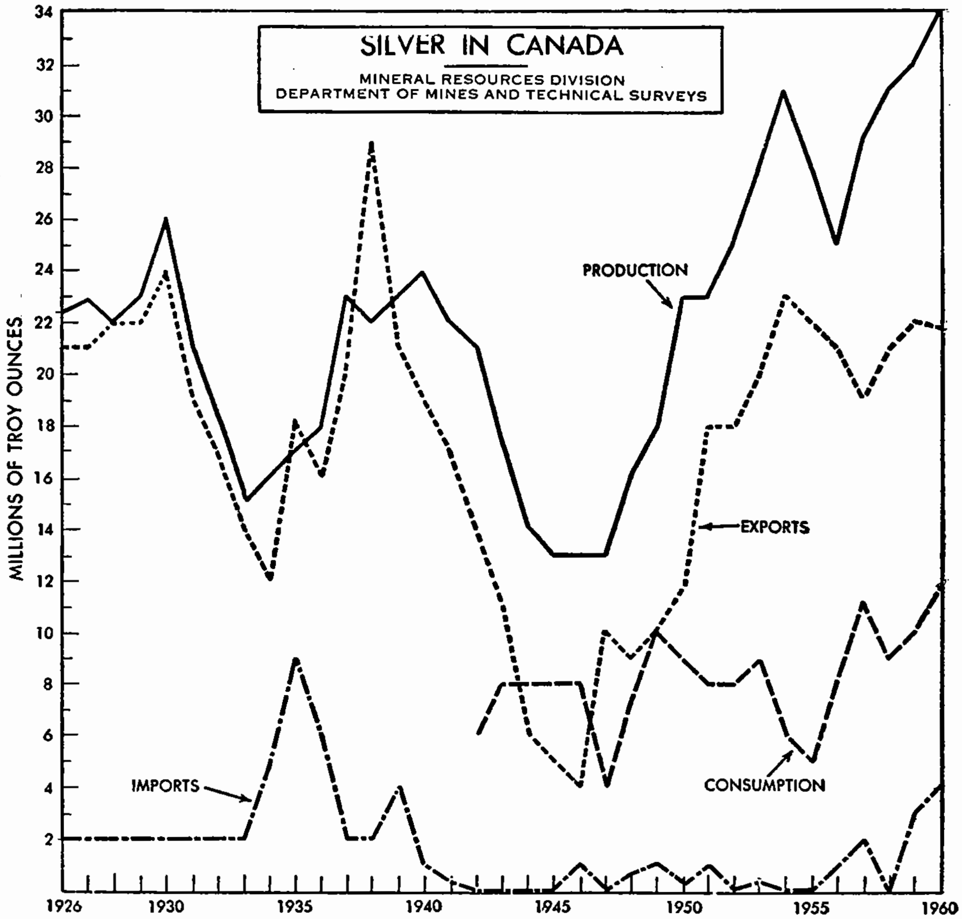
SOURCE: Dominion Bureau of Statistics.

(a) 1. Recoverable silver in ores, concentrates and matte shipped for export.
2. Silver in crude gold bullion produced.
3. Silver in blister and anode copper made at Canadian smelters.
4. Silver in base bullion made by The Consolidated Mining and Smelting Company of Canada Limited at Trail, British Columbia.
5. Silver bullion produced from the treatment of cobalt-silver ores.

(b) Includes consumption for coinage.

Although the United States was Canada's chief silver customer, it was also Canada's chief supplier of foreign silver. Other markets for Canadian silver included Belgium and Luxembourg, Brazil and West Germany, and the other chief supplier was Mexico. The large increase in silver imports was due, for the most part, to an increase in purchases by the Royal Canadian Mint.

The consumption of silver in Canada fell to 9,614,083 ounces from the 1960 total of 11,742,064 ounces. The decrease occurred because of a drop—from 7,481,617 to 5,141,894 ounces—in the use of silver for coinage manufacture. In contrast, industrial consumption, which amounted to 4,260,477 ounces for 1960, totalled 4,472,189 ounces for 1961.



OTHER DEVELOPMENTS

Yukon Territory

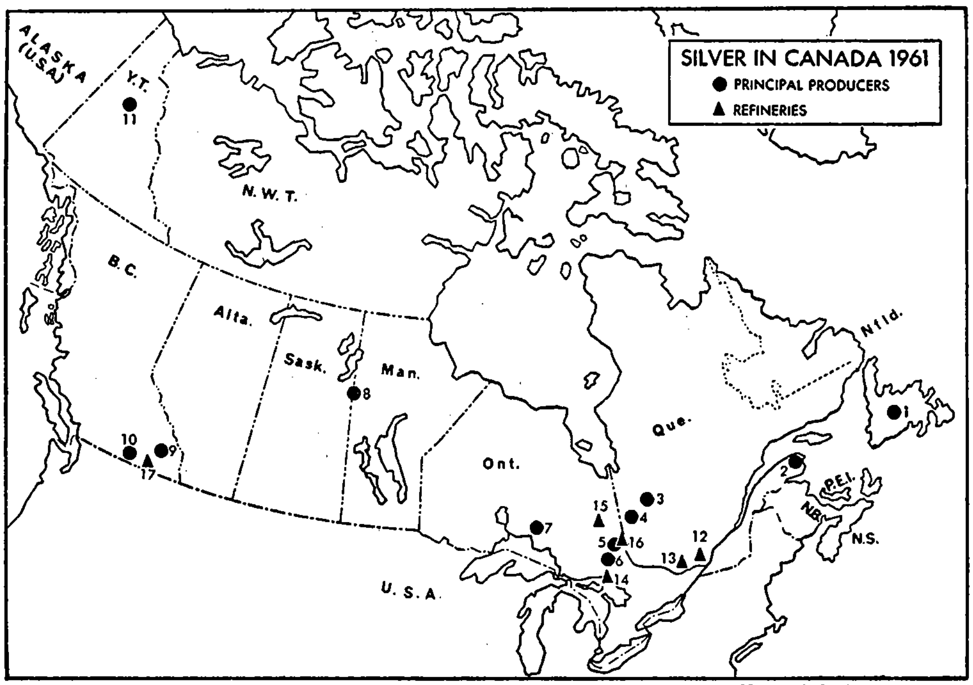
Toward the end of 1961, Conwest Exploration Company Limited and Central Patricia Mines, Limited began to explore a silver-lead property at the headwaters of the Liard River. As the results of this initial exploration were encouraging, the companies have planned a more extensive program for 1962. Work on a 125-mile tote road was started in December.

Peso Silver Mines Limited did both surface and underground exploration on a group of claims lying between Secret and Haggart creeks, 28 miles north of Mayo. By the end of the year, several rich silver veins had been explored. More work is planned for 1962.

Kootenay Base Metals Limited worked on its silver-lead prospect near Teslin Lake and built 5½ miles of road to connect the property with the Alaska Highway.

British Columbia

Late in 1961, Dolly Varden Mines Limited announced its intention to start development of the Dolly Varden, North Star and Wolf silver-lead mine properties, which are on the upper Kitsault River, near Alice Arm, at the north end of the British Columbia coast. The Dolly Varden property adjoins the mine property of Torbrit Silver Mines Limited, from which ore containing more than 18 million ounces of silver was mined during the period 1949-59.



MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Producers*

1. American Smelting and Refining Company (Buchans Unit)
2. Gaspe Copper Mines, Limited
3. Coniagas Mines Limited, The
4. Manitou-Barvue Mines Limited
   East Sullivan Mines Limited
   Noranda Mines, Limited
   Quemont Mining Corporation, Limited
   Waite Amulet Mines, Limited
   Normetal Mining Corporation, Limited
5. Silver Miller Mines Limited
   Agnico Mines Limited
   Deer Horn Mines Limited
   Langis Silver & Cobalt Mining Company Limited
   McIntyre-Porcupine Mines, Limited, Castle Division
   Siscoe Metals of Ontario Limited
6. International Nickel Company of Canada, Limited, The
7. Geco Mines Limited
   Willroy Mines Limited
8. Hudson Bay Mining and Smelting Co., Limited
9. Consolidated Mining and Smelting Company of Canada Limited, The
   Bluebell mine
   Sullivan mine
10. Mastodon-Highland Bell Mines Limited
11. United Keno Hill Mines Limited

Refineries

12. Canadian Copper Refiners Limited
13. Royal Canadian Mint
14. International Nickel Company of Canada, Limited, The
15. Hollinger Consolidated Gold Mines, Limited
16. Cobalt Refinery
17. Consolidated Mining and Smelting Company of Canada Limited, The

*Some small producers are omitted.

Table 3

PRINCIPAL SILVER PRODUCERS IN CANADA, 1961

Company	Mine	Location	Mill Capacity	Type of Ore Mined	Silver Content	Ore Produced 1961	Ore Produced 1960	Silver Produced 1961
			(tons/day)		(oz./ton)	(short tons)	(short tons)	(ounces)
Yukon Territory								
United Keno Hill Mines Limited[1]	Calumet	Mayo district						
	Elsa	Mayo district	500	Ag, Pb, Zn	41.16	186,116	176,745	7,231,908
	Hector	Mayo district						
British Columbia								
Consolidated Mining and Smelting Company of Canada Limited, The	Sullivan	Kimberley	10,000	Pb, Zn, Ag	*	2,461,695	2,522,554	3,908,831
	Bluebell	Riondel	700	Pb, Zn, Ag	*	252,821	255,571	[2]
	H. B.	Salmo	1,200	Zn, Pb, Ag	*	472,731	464,408	[2]
Mastodon-Highland Bell Mines Limited	Highland-Bell	Beaverdell	70	Ag, Pb, Zn	47	18,953	18,204	892,153
Manitoba and Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited	Flin Flon	Flin Flon district	6,000	Cu, Zn	1.04	1,014,925	1,250,026	
	Coronation	Flin Flon district		Cu	0.10	312,145	192,775	1,638,316
	Schist Lake	Flin Flon district		Cu, Zn	0.94	98,802	114,686	
	Chisel Lake	Snow Lake, Man.		Zn,Pb,Cu,Ag	2.45	271,877	104,903	
Ontario								
Geco Mines Limited	Geco	Manitouwadge	3,300	Cu, Zn	1.52	1,276,778	1,294,077	1,526,976
Willroy Mines Limited	Willroy	Manitouwadge	1,200	Cu,Zn,Ag,Pb	1.74	421,772	429,309	486,466
International Nickel Company of Canada, Limited, The	Creighton	Sudbury district	12,000	Ni, Cu	*			
	Levack	Sudbury district	6,000	Ni, Cu	*			
	Murray	Sudbury district		Ni, Cu	*			
	Garson	Sudbury district		Ni, Cu	*	17,489,000[4]	16,768,000	1,315,000[5]
	Frood-Stobie	Sudbury district	30,000[3]	Ni, Cu	*			
	Clarabelle	Sudbury district		Ni, Cu	*			
	Ellen	Sudbury district		Ni, Cu	*			
Agnico Mines Limited	Christopher	Cobalt district	400	Ag, Co	*	*	95,940	727,718[6]
	Nipissing-O'Brien	Cobalt district						
Deer Horn Mines Limited	Cross Lake-O'Brien	Cobalt district	90	Ag, Co	17.22	8,725	15,398	134,779

Table 3

PRINCIPAL SILVER PRODUCERS IN CANADA, 1961 (*conc.*)

Company	Mine	Location	Mill Capacity	Type of Ore Mined	Silver Content	Ore Produced 1961	Ore Produced 1960	Silver Produced 1961
			(tons/day)		(oz./ton)	(short tons)	(short tons)	(ounces)
Ontario—*Concl.*								
Langis Silver & Cobalt Mining Company Limited	Langis	Cobalt district	175	Ag, Co	25.32	29,434	23,383	687,519
Silver Miller Mines Limited[7]	Kerr Lake	Cobalt district	300	Ag, Co	9.78	55,247	*	528,687
	Conisil	Cobalt district		Ag, Co				
McIntyre-Porcupine Mines, Limited, Castle Division	Castle	Gowganda district	125	Ag, Co	43 [8]	23,386	23,291	1,009,140
	Capitol	Gowganda district		Ag, Co				
Siscoe Metals of Ontario Limited	Miller Lake-O'Brien	Gowganda district	275	Ag, Co	21 [8]	67,215	64,534	1,421,122
Quebec								
Coniagas Mines Limited, The	Coniagas	Bachelor Lake	350	Ag, Zn, Pb	9.15	79,826	0	524,200
Gaspe Copper Mines, Limited	Gaspe	Murdochville	6,500	Cu	0.19	2,589,390	2,541,500	443,242
Manitou-Barvue Mines Limited	Golden Manitou	Val d'Or	1,300	Cu,Zn,Ag,Pb	5.67	162,860[9]	164,690[9]	794,595
Noranda Mines, Limited	Horne	Noranda	3,200	Cu	*	961,502	1,330,686	*
Normetal Mining Corporation, Limited	Normetal	Normetal	1,000	Cu, Zn	2.15	355,001	347,164	584,452
Newfoundland								
American Smelting and Refining Company (Buchans Unit)	Buchans	Buchans	1,250	Ag,Zn,Pb,Cu	4.59	387,000	386,000	1,542,459

Source: Mineral Resources Division.

[1]Production is for the year ending September 30, 1961.

[2]Statistics on the production of silver from the Bluebell and H. B. mines are not available. Cominco's total silver production, including that from purchased ores and concentrates, was 8,816,141 ounces.

[3]Ore from the last five mines was concentrated at the Copper Cliff mill.

[4]Ore production includes the output of the Thompson mine, in Manitoba, which the company does not report separately.

[5]Silver production includes all silver deliveries.

[6]Shipments via the Temiskaming Testing Laboratory.

[7]Production is for the year ending April 30, 1961.

[8]Approximate mill grade.

[9]Production does not include the copper ore milled in a separate circuit.

*Not available.

Elsewhere in the province, especially in the Slocan area, exploration for silver ores and rehabilitation of former producers was more intensive than in recent years. In 1961 several hundreds of tons of high-grade silver ores and concentrates were shipped from properties in the Slocan area, the most important of which were those held by Western Exploration Company, Limited, near Silverton, ViolaMac Mines Limited, near Sandon, Yale Lead & Zinc Mines Limited, near Ainsworth, and Ottawa Silver Mines Ltd., near Slocan City. Other small producers of high-grade silver ores and concentrates included New Cronin Babine Mines Limited, near Smithers, in the central part of the province, and Silbak Premier Mines, Limited, near Stewart, north of Prince Rupert.

Ontario

After the Deloro refinery was closed, the output of the Cobalt and Gowganda areas, which had formerly been sent to Deloro, was shipped to the United States, with the exception of 156 tons of concentrates treated at the Cobalt Refinery. From August, when it was officially opened, to the end of the year, this refinery shipped 50,290 ounces of fine silver to the Royal Canadian Mint.

In 1961, activity was at a high level in the Cobalt and Gowganda areas, where some 13 companies were actively engaged in exploration and development. One of them was Mentor Exploration and Development Co., Limited, which is credited with being the first Cobalt-area company in many years to start shaft-sinking from surface. Among other companies that carried out underground exploration and development were Glen Lake Silver Mines Limited, Professor Silver Mines Limited, Rix-Athabasca Uranium Mines Limited and Silvermaque Mining Limited, all near Cobalt, and Keeley-Frontier Mines Limited, in South Lorrain township, south of Cobalt.

Quebec

More than 500,000 ounces of silver were added to Quebec's annual production by Coniagas Mines Limited, which in March began production of silver-zinc-lead ores from its mine at Bachelor Lake, in Northwestern Quebec. During 1962, Coniagas is expected to become Quebec's leading silver producer and will probably produce at an annual rate of 1 million ounces.

Vauze Mines Limited, in production since October, also contributed to Quebec's silver production. Its mine, essentially a copper-zinc producer, is a few miles north of Noranda.

Solbec Copper Mines Limited, in the Eastern Townships, is destined to become an important producer of by-product silver, which it will recover from its copper-zinc ores. Milling at 1,000 tons a day started early in 1962.

Mattagami Lake Mines Limited, New Hosco Mines Limited and Orchan Mines Limited have announced that they intend to start the production of zinc-copper ore in 1963 in the Mattagami Lake area, 130 miles northeast of Noranda, at respective rates of 3,000, 900 and 1,000 tons a day. By-product silver from this ore will add appreciably to Quebec's output.

Nova Scotia

In September, when Magnet Cove Barium Corporation started to mill silver-lead-zinc ore at the Magnet Cove barium mine, Nova Scotia became a producer of silver for the first time since 1956, when Mindamar Metals Corporation Limited (renamed United Mindamar Metals Limited in 1961) stopped mining base-metal ore on Cape Breton Island. Magnet Cove, which yielded

66076-1—29

114,730 ounces of silver and a considerable amount of lead, zinc and by-product copper during the short time it operated in 1961, gives promise of becoming an important producer of silver and base metals.

USES

Chiefly because it is of an attractive color, resists corrosion, has favorable alloying properties and is scarce in comparison with most other metals, silver finds its greatest use in coinage. Also attributable to these properties, as well as to its high malleability, ductility and ability to take a fine finish, is its use in jewelry, silverware and silverplate. On account of the sensitivity to light and the ease of reduction of certain silver compounds, silver is continually being demanded in large quantities by manufacturers of photographic films and sensitized paper. The low melting point of silver-copper and silver-copper-zinc alloys, their resistance to corrosion, their high tensile strength and their ability to join together nearly all nonferrous metals and alloys as well as iron and silver give silver a major part to play as a constituent of soldering alloys that are widely used in refrigeration, air-conditioning and automotive equipment.

Silver is used increasingly in the manufacture of highly efficient jet-aircraft and missile batteries, in water-purification systems and, for its important catalytic effect, in the manufacture of synthetic organic chemicals.

PRICES

The Canadian price of silver, fluctuating almost daily, ranged from a low of 90.63 cents an ounce in March to a high of $1.10 in December. The opening and closing prices for 1961 were respectively 91.38 cents and $1.10.

TARIFFS

	British Preferential	Most Favored Nation	General
Silver ores or concentrates	free	free	free
Anodes of silver	5%	7½%	10%
Silver in ingots, blocks, bars, drops, sheets or plates; sweepings, scrap, jewelry	free	free	free
Silver leaf	12½%	25%	30%
Manufactures of silver, not otherwise provided for	17½%	27½%	45%

WORLD REVIEW

Production

On a mine-production basis, Mexico led the world for the forty-third consecutive year with an output of 40,342,397 ounces. Canada, in fourth place with its 31,381,977 ounces, was surpassed by the United States with 34,900,000 and Peru with 33,581,997. The chief producing countries of 1961 are shown in Table 4.

TABLE 4

WORLD PRODUCTION OF SILVER, 1960

(troy ounces)	
Mexico	40,342,397
United States	34,900,000*
Peru	33,581,997
Canada	31,381,977
Russia	25,000,000[e]
Australia	13,000,000[e]
Japan	7,946,570
Other countries	45,861,059
Total	232,014,000

SOURCE: U.S. Bureau of Mines, *Mineral Trade Notes, November, 1962.*

* Refinery production from domestic ores and concentrates. The mine production was 30,766,727 ounces.

[e]Estimated.

Consumption and Prices

In 1960, for the second consecutive year, the gap between Free World production and consumption was more than 100 million ounces. New production amounted to 202,500,000 ounces; consumption to 319,300,000 ounces.

While in 1961 consumption increased by some 25 million ounces, production remained virtually unchanged and the gap between consumption and production was thus widened. In recent years, until late in 1961, the United States Treasury Department met most of the deficiency by filling its coinage requirements from its free stocks of silver and by selling from the same stocks to domestic industrial consumers. On November 28, President Kennedy announced that Treasury Department sales of free silver to commercial buyers and the use of free silver for coinage were being suspended and that in the future silver for coinage would be obtained by the retirement from circulation of the requisite number of $5 and $10 certificates.

Because this action eliminated an important source of silver—21.5 million ounces were sold to United States industrial consumers in 1960—it had an immediate effect on prices. The United States price rose from 91.38 cents an ounce to $1.0075; the Canadian price from 95.88 cents to $1.0575 (Canadian funds); and Britain's price from 93.33 to 98.58 cents (United States equivalent). At the end of the year, the United States, Canadian and British prices were respectively, $1.0475, $1.1000 and $1.0266 an ounce.

66076-1—29½

Sodium Sulphate

C. M. Bartley*

Production of Saskatchewan's natural sodium sulphate increased substantially in 1961 to a new high of 250,996 tons valued at $4,036,625. Exports rose appreciably and imports increased slightly.

During 1961 the recovery and processing of sodium sulphate were maintained at a high rate at the four plants that have been producing in recent years; and at Bishopric, Saskatchewan, a fifth plant was being readied to resume operations.

Drilling was done in New Brunswick, to evaluate the economics of producing sodium sulphate from an occurrence of glauberite (sodium-calcium sulphate). Production in the Maritimes would find ready markets in local kraft-paper plants and possibly in nearby United States paper plants. It would compete more with sodium sulphate imported from Europe and by-product material from the eastern United States than with the product known commercially as 'salt cake' that is obtained in western Canada.

DEPOSITS

Many of southern Saskatchewan's lakes and ponds contain concentrations of sodium sulphate in the form of permanent and intermittent crystal beds and various concentrations of brine. Sulphates in the soil of this region are dissolved by normal precipitation, and the solutions collect in closed drainage basins. There the high rate of summer evaporation reduces the water content, and solid crystals of sodium sulphate form and are deposited in the lake bottom as cool fall weather chills the brine below the saturation point. The seasonal repetition of this process over many years has considerably thickened these sodium-sulphate crystal beds.

Sodium sulphate occurs in nature as the mineral Glauber's salt, or mirabilite ($Na_2SO_4.10H_2O$). In dry air or when this salt is dried by the various processes used, the water of crystallization is driven off. The remaining solid, known

*Mineral Processing Division, Mines Branch.

TABLE 1

SODIUM SULPHATE—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)	250,996	4,036,625	214,208	3,499,155
Imports				
Crude sodium sulphate, or salt cake				
United States	22,643	373,364	14,270	247,451
Britain	9,651	201,149	10,419	224,247
West Germany	16	502	17	386
Total	32,310	575,015	24,706	472,084
Glauber's salt				
West Germany	771	20,520	871	21,409
United States	124	7,830	277	16,407
Britain	4	673	3	534
Total	899	29,023	1,151	38,350
Exports				
Crude sodium sulphate				
United States	87,048	1,320,928	63,831	1,025,632
Consumption				
Pulp and paper			154,099	
Glass, including glass wool			3,080	
Medicinals			106	
Soaps			3,248	
Other products			626	
Total			161,159	

Source: Dominion Bureau of Statistics.

mineralogically as thenardite (Na_2SO_4), is salt cake, which may be described as impure anhydrous sodium sulphate. High-grade anhydrous sodium sulphate is prepared by refining crude salt cake.

RECOVERY AND PROCESSING

The production of sodium sulphate in Saskatchewan consists in obtaining natural crystals from the deposits and then processing them to marketable quality. Various methods, similar in purpose but differing in technique, are used in both operations.

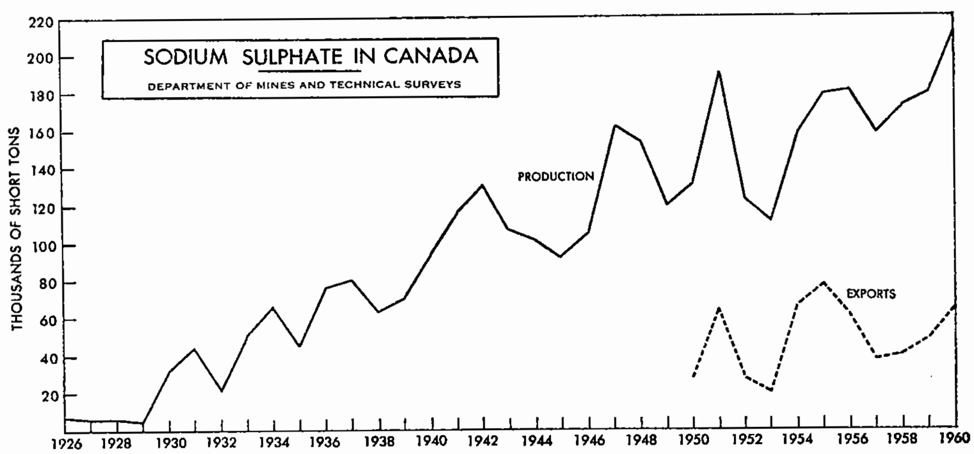
In late summer it is common practice to pump highly concentrated brines from the lakes into prepared reservoirs. The cold temperatures of fall and winter chills the brine and the contained sodium sulphate precipitates and forms a thick crystal bed. The liquid, which contains several undesirable impurities, is then pumped back into the lake, and what remains is a concentrated deposit of relatively pure, clean sodium sulphate. This material is moved into the

TABLE 2

SODIUM SULPHATE—PRODUCTION, TRADE AND CONSUMPTION, 1951-61
(short tons)

	Production[1]	Imports		Exports[2]	Consumption
		Salt Cake	Glauber's Salt		
1951	192,371	19,432	3,234	63,179	144,144
1952	122,590	19,576	4,577	27,144	116,786
1953	115,565	32,802	5,493	20,132	129,698
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[r]
1960	214,208	24,706	1,151	63,831	183,062[r]
1961	250,996	32,310	899	87,132	192,414[e]

Source: Dominion Bureau of Statistics except where otherwise indicated.
[1]Producers' shipments of crude sodium sulphate.
[2]Exports to the United States from 1951 to 1954 inclusive 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).
[r]Revised from previously published figure. [e]Estimate



processing plant, as required, by means of drag-line scrapers or conveyors. One company uses a floating dredge to excavate and pump crystal and concentrated brine from the lake bed directly to the plant through a 10-inch pipeline.

Processing methods vary considerably. Dehydration may be carried out in rotary kilns, in convection evaporators or in submerged-combustion evaporators. In recent years several of the last-mentioned have been installed and are reported to be highly satisfactory.

The main problems arise from the corrosive effects of some fuels, the handling, storage and maintenance of these fuels, and accumulations of sodium-sulphate scale in processing equipment. As natural gas has become available, most plants have changed to this fuel and thus notably improved production efficiency and reduced maintenance problems. Natural gas made possible the successful use of submerged-combustion units for the processing of sodium sulphate. Heat efficiency is high because the burning gas flame is completely submerged in the slurry. The concentrated slurry from submerged-combustion evaporation is fed to rotary driers, and there the remaining moisture is driven off. In the United States the use of centrifuges to reduce the moisture content between the submerged-combustion units and the driers has reduced fuel costs, but at present no centrifuges are being used in Saskatchewan.

PRODUCTION AND TRADE

Despite sizable fluctuations, the trend of Canada's sodium-sulphate production, as Table 2 shows, has been generally upward. The increase that has been maintained since 1957 is expected to continue, at least in the immediate future. More than 90 per cent of the salt cake consumed is used by the kraft-paper industry, which therefore dominates sodium-sulphate sales. Other factors, however, are believed to have contributed in recent years to the increase in the sales of this Saskatchewan product. For example, the output of some United States and European sources of by-product sodium sulphate seems to be declining and thus leaving natural sodium sulphate a larger share of the market.

The price of sodium sulphate at Saskatchewan producing plants is considerably lower than the prices of comparable material in the United States, but freight charges for shipment to the United States and eastern Canada have had an equalizing effect. Competition in these and west-coast markets is thus often difficult for Saskatchewan producers. With their present equipment, however, most plants could recover and process larger tonnages. Consequently, production increases may lead to a reduction in costs.

Imports of sodium sulphate come mostly from the United States. Smaller amounts are obtained from Britain and negligible amounts from West Germany. These imports are marketed in eastern Canada.

About one third of Canada's output of sodium sulphate is usually exported to the United States, which has constituted the entire export market. Occasional inquiries from overseas seem to justify hope that the market will eventually be broadened.

PRODUCING COMPANIES

Midwest Chemicals Limited

Midwest operates a plant near Palo, on Whiteshore Lake, in the west-central part of Saskatchewan. The use of its submerged-combustion units is followed by drying in two or three rotary kilns. In this part of the province moisture conditions are better than farther south and dry summers are not a serious problem. In 1961 the company operated at a high rate. It retains a sales agent in Chicago to handle export sales in that area.

Ormiston Mining and Smelting Co. Ltd.

This company operates a plant at Ormiston, on Horseshoe Lake, south of Moose Jaw. Late in 1960 natural gas was supplied to the plant, and in 1961 two submerged-combustion units were installed and coal furnaces in the driers were replaced by gas. The rate of production was high. The dredge operation was reported satisfactory and it was noted that dredge excavation will eventually produce a reservoir in which the climatic cycle will precipitate crystals for later excavation. As this operation continues and insoluble material is gradually reduced, the quality of the product should improve.

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

In operation in January 1962.

Sybouts Sodium Sulphate Co., Ltd.

Near Gladmar, close to the southern boundary of the province, this company collects solid crystal from the lake deposit in winter and dehydrates it, using two coal-fired rotary kilns. Operations were at a high level during 1961.

Saskatchewan Minerals, Sodium Sulphate Division

The Chaplin plant operated near capacity in 1961. Late in the year it was announced that additional capacity would be obtained by reopening the idle Bishopric plant on Frederick Lake, some 30 miles southwest of Moose Jaw. The company reports its sales at a record level in both Canada and the United States.

The decision to reopen the Bishopric plant was prompted by the rising demand for salt cake and the fact that only limited additions to production could be obtained at Chaplin without overtaxing the plant. Natural gas will be supplied to Bishopric and the initial operation will be based on a stockpile of raw crystal at the plant while a process designed specifically for this deposit is tested and installed. The plant went into operation in January 1962.

Saskatchewan Minerals investigated other Saskatchewan sodium-sulphate deposits in the province to obtain information with which future expansion could be planned. The company is continuing its efforts to improve the specifications of its product and thus widen and enlarge its markets.

Sifto Salt (1960) Limited

During 1961 Sifto Salt (1960) Limited, a subsidiary of Dominion Tar & Chemical Company, Limited, drilled several holes in the glauberite deposits near Weldon, New Brunswick. Core samples will be used in the investigation of methods of recovering sodium sulphate from the glauberite, which contains 51 per cent Na_2SO_4. From the deposits, which are at a depth of more than 1,000 feet, ore would be brought to surface and processed for the removal of gangue minerals and the recovery of sodium sulphate. Salt (NaCl) occurs below the glauberite.

OUTLOOK FOR THE CANADIAN INDUSTRY

The outlook for Canada's sodium-sulphate industry continues promising: production, domestic consumption and exports are increasing. Fast freight delivery by rail to consumers in eastern Canada has made marketing easier for producers.

With their large reserves of raw material, the high fuel efficiency of the natural gas they use and their long experience in operating with the help of the Saskatchewan climate, western producers seem capable of meeting any future demand. At the same time, they are continually trying to improve their product, reduce recovery and processing costs and widen markets. The present high rate of activity in kraft-paper manufacture, which is the main outlet for sodium sulphate, suggests that the demand will continue during 1962.

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 production machinery to operate at higher speed. Sodium sulphate is also consumed in the manufacture of glass, detergents, mineral-feed supplements, and chemical and medicinal products.

The physical and chemical specifications for sodium sulphate vary. Material of 95- to 96-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 may call for grades above 99 per cent.

Grain size, uniformity and free-flowing characteristics are important in handling and use, and whiteness is wanted for detergents.

PRICES

Canada

The Canadian price of sodium sulphate (salt cake), bulk, carload, f.o.b. works, as reported by *Canadian Chemical Processing* in October 1961 was $16.50 a ton.

United States

According to the *Oil, Paint and Drug Reporter* of December 25, 1961, United States prices of sodium sulphate were as follows:

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

Canada	British Preferential	Most Favored Nation	General
Crude, or salt cake, per lb	1/5¢	1/5¢	3/5¢

United States	
Crude, or crude salt cake	free
Anhydrous, per long ton	$1.27
Crystallized, or Glauber's salt, per long ton	$1.00

Stone, Building and Ornamental

F. E. Hanes*

The 1961 value of stone production, at $6,705,590, was 21.5 per cent higher than the 1960 value, which amounted to $5,518,198; but the 174,598 short tons quarried and sold represented a 12.9-per-cent volume decrease from the 200,496-ton output of 1960.

The structural materials used by Canadian industries in 1956, 1957 and 1958 showed a sharp rise in value and in 1959 reached a high of $324.6 million. In 1960 and 1961 they fell slightly below this amount. The value of stone production of all types rose to a high in 1958 and then dropped about 13 per cent in 1959 and almost 16 per cent further in 1960. In 1961 there was an increase of 21.6 per cent in value from the $5.52 million of 1960 to $6.71 million.

Because of the fluctuation in demand and the variation in price of some types of stone, significant variations can occur in the annual statistical total. This fluctuation and the wide difference in price between rough and dressed stone make it difficult to estimate future production.

The point is illustrated by the variations that have taken place over the last three years (1959-61) in the values of Ontario's sandstone and granite output. In this period, the annual average for sandstone varied between $18.50 and $21.94 a short ton, and the annual aggregate between $416,000 and $534,000. The volume varied from the 1960 high of 76,569 short tons to 24,000 for 1959 and 22,000 for 1961.

The statistics for granite in Ontario indicate a similar trend. The wide year-to-year fluctuation is shown by the quantities annually produced—1,989 short tons in 1959; 3,566 in 1960; and about 1,900 in 1961. The production value of granite for these years, like that of sandstone, was unpredictable. In 1960, at $112,535, it was about twice as great as in 1959 and 3.6 times the $31,034 for 1961. In 1959, on the other hand, Ontario's sandstone production was more profitable than in the two years following.

* Mineral Processing Division.

Table 1

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, 1961

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Building												
Rough	15,385	232,467	35,360	377,207	107	2,460	16,047	335,523	—	—	66,899	947,657
Dressed	18,962	1,999,283	45,106	1,956,146	2,744	155,540	2,733	112,823	—	—	69,545	4,223,792
Total	34,347	2,231,750	80,466	2,333,353	2,851	158,000	18,780	448,346	—	—	136,444	5,171,449
Monumental												
Rough	15,270	399,967	—	—	—	—	—	—	—	—	15,270	399,967
Dressed	8,997	987,154	—	—	—	—	—	—	—	—	8,997	987,154
Total	24,267	1,387,121	—	—	—	—	—	—	—	—	24,267	1,387,121
Flagstone	700	9,800	4,783	27,656	—	—	6,581	75,478	500	1,000	12,564	113,934
Curbstone	756	20,056	—	—	—	—	—	—	—	—	756	20,056
Paving	425	6,640	—	—	—	—	142	6,390	—	—	567	13,030
Total	1,881	36,496	4,783	27,656	—	—	6,723	81,868	500	1,000	13,887	147,020
Grand Total	60,495	3,655,367	85,249	2,361,009	2,851	158,000	25,503	530,214	500	1,000	174,598	6,705,590

Table 2

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, BY PROVINCES, 1961

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Maritime	1,608	198,392	1,024	4,606	—	—	2,898	113,588	—	—	5,530	316,586
Quebec	51,160	3,380,558	19,628	883,632	2,851	158,000	94	540	500	1,000	74,233	4,423,730
Ontario	1,896	31,034	55,250	953,776	—	—	22,491	415,986	—	—	79,637	1,400,796
Western	5,831	45,383	9,347	518,995	—	—	20	100	—	—	15,198	564,478
Total	60,495	3,655,367	85,249	2,361,009	2,851	158,000	25,503	530,214	500	1,000	174,598	6,705,590

TABLE 3

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, 1960

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Building												
Rough	16,123	355,736	35,237	348,011	32	1,485	69,811	350,988	—	—	121,203	1,056,220
Dressed	15,860	1,595,754	25,204	1,505,045	45	1,500	1,290	49,016	—	—	42,399	3,151,315
Total	31,983	1,951,490	60,441	1,853,056	77	2,985	71,101	400,004	—	—	163,602	4,207,535
Monumental												
Rough	11,276	276,939	—	—	—	—	—	—	—	—	11,276	276,939
Dressed	8,806	887,823	—	—	—	—	10	900	—	—	8,816	888,723
Total	20,082	1,164,762	—	—	—	—	10	900	—	—	20,092	1,165,662
Flagstone	849	11,886	7,517	24,179	—	—	7,676	84,154	—	—	16,042	120,219
Curbstone	261	3,908	—	—	—	—	—	—	—	—	261	3,908
Paving	233	8,874	—	—	—	—	266	12,000	—	—	499	20,874
Total	1,343	24,668	7,517	24,179	—	—	7,942	96,154	—	—	16,802	145,001
Grand total	53,408	3,140,920	67,958	1,877,235	77	2,985	79,053	497,058	—	—	200,496	5,518,198

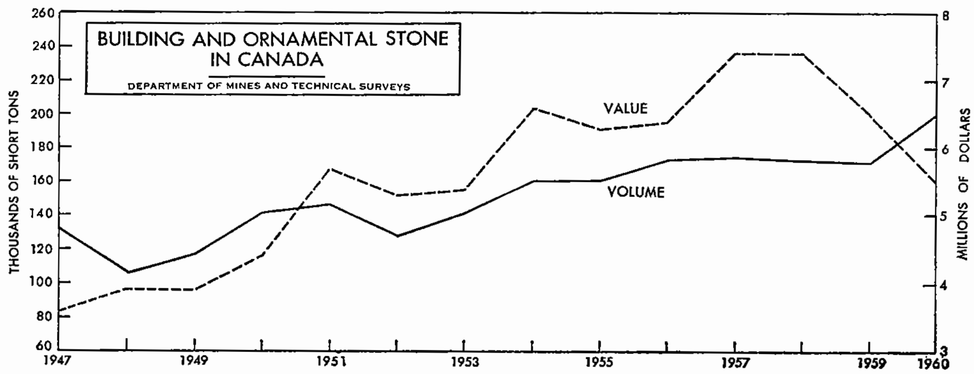
Source: Dominion Bureau of Statistics.

TABLE 4

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, BY PROVINCES, 1960

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Maritime	2,757	296,908	1,102	6,938	—	—	2,240	62,816	—	—	6,099	366,662
Quebec	42,699	2,681,932	17,707	910,706	77	2,985	—	—	—	—	60,483	3,595,623
Ontario	3,566	112,535	38,914	492,640	—	—	76,459	424,695	—	—	118,939	1,029,870
Western	4,386	49,545	10,235	466,951	—	—	354	9,547	—	—	14,975	526,043
Total	53,408	3,140,920	67,958	1,877,235	77	2,985	79,053	497,058	—	—	200,496	5,518,198

Source: Dominion Bureau of Statistics.



Although in 1961 the volume of rough and dressed limestone exceeded the volume of granite production by 24,754 tons, the granite was more valuable. Limestone made up 49 per cent and granite 35 per cent of all the stone produced. Quebec's granite accounted for 85 per cent of the granite total and was worth \$3.38 million, or almost 93 per cent of the value of all the granite produced in Canada. The value of Quebec's granite production was, in fact, 50.4 per cent of the value of all types of Canadian-produced stone.

Canada produced 85,249 tons of limestone valued at \$2.36 million, which is 35.2 per cent of the value of the year's stone output. Ontario's production was 2.8 times that of Quebec and averaged \$17.26 a ton. Quebec's average of \$45.02 a ton resulted directly from its greater output of much higher priced, dressed-stone products. Ontario, however, produced considerably more low-priced, rough building stone.

Stone from the provinces east of Quebec and west of Ontario, where it is quarried by a comparatively small number of operators, is presented in this review under the respective headings 'maritime' and 'western.' Quebec and Ontario, where industrialization and the stone industry are highly developed, are reported separately.

Sandstone is third in importance in Canada. It is obtained from numerous quarries in Ontario and quarries in the Atlantic Provinces. The output and value for 1961, which amounted to 25,503 tons and \$530,214, made up respectively 14.6 and 7.9 per cent of the country's total for stone. Ontario accounted for 88.2 per cent of the volume and 78 per cent of the value of Canada's sandstone output. The average value of this province's sandstone was \$18.50 a ton; that of the national total was \$20.79.

The recovery made in the average value of stone as a whole and the record volume attained by granite despite a decline in its average value were perhaps the most significant developments of 1961. In 1960, while a record volume of stone was being produced, the average for all stone had dropped to \$27.52 a ton. The large volume of low-priced sandstone produced in 1960 was probably the result of an attempt to compete with the rapid initial development of the industries turning out artificial stone, precast concrete and exposed aggregate.

In 1961, the average of stone values rose to \$38.41 a ton, which was about the same as the values (\$39.45 to \$38.16) that prevailed during the stable years from 1955 to 1959 inclusive. Production, however, dropped to a six-year low, mainly because the sandstone output was lower than in 1960. Granite rose to a record of 60,495 tons with an average value of \$60.42 a ton, compared to the 1960 value of \$58.81. In 1961, although lower than in the 1955-59 period, both the volume and the value of limestone showed a slight gain. The average value of limestone per ton for the year set a record for the five years from 1957 to 1961.

The output of marble and of slate and shale is too small to influence the Canadian production trend.

IMPORTS AND EXPORTS

The value of imported building, ornamental, and monumental stone increased 17.5 per cent from $2,842,490 for 1960 to $3,339,032 for 1961.

All the types of granite imported in 1961 were higher-priced. Individual gains ranged from 20.3 per cent to 43.7 per cent; the gain on the total was 32.2 per cent.

Imports of rough marble and of two types of sawn or sand-rubbed marble increased in value by 89.5, 13.0 and 19.7 per cent respectively. Ornamental marble and other marble manufactures decreased by 11.6 and 12.4 per cent. The over-all value of marble imports increased by 9.1 per cent.

Slate imports dropped in 1961 by 29.0 per cent, from a 1960 value of $100,653 to $71,486. Other unclassified stones, such as limestone and sandstone, increased only 1.9 per cent in volume but 23.2 per cent in value.

Canadian stone exports declined in 1961 in both volume and value. The decrease in volume amounted to 23.1 per cent; the decrease in value to 10.4 per cent only. Because of this disproportion, the value per ton was better than in 1960.

In 1961 the value of Canada's stone imports was 11.6 times higher than its exports.

TABLE 5

BUILDING AND ORNAMENTAL STONE—IMPORTS AND EXPORTS

	1961		1960	
	Quantity	$	Quantity	$
Imports				
Granite				
Rough, not hammered or chiselled		398,578		331,396
Sawn		131,137		96,041
Manufactures		442,409		307,850
Total		972,124		735,287
Marble				
Rough, not hammered or chiselled		119,090		62,833
Sawn or sand-rubbed, not polished		859,427		760,549
Not further manufactured than sawn for the manufacture of tombstones		40,816		34,102
Ornamental or decorative		177,182		200,328
All other marble manufactures		171,813		196,174
Total		1,368,328		1,253,986
Slate				
Roofing (squares)	497	10,836	1,194	30,112
Manufactures		60,650		70,541
Total		71,486		100,653
Building stone other than marble or granite (short tons)	30,039	927,094	29,477	752,564
Total, building, ornamental and monumental stone		3,339,032		2,842,490
Exports				
Building stone, rough[1] (short tons)	12,579	238,116	16,362	286,436
Natural-stone basic products[2]		49,634		34,771
Total		287,750		321,207

Source: Dominion Bureau of Statistics. [1]Building stone, rough, includes building stone, unwrought, and granite and marble, unwrought. [2]Includes all kinds of dressed stone.

DIMENSION STONE

Large blocks or slabs quarried from deposits of igneous, metamorphic or sedimentary rocks are classified as 'dimension stone' when the composite is indurated enough to ensure a sound, quality product. Dimension stone may be used in simple walls and unadorned supporting columns or in ornamented or polished facings, courses, columns, statuary and obelisk-like structures such as appear on memorials and in churches and cathedrals. By polishing and buffing, the textural and structural qualities, which are numerous and varied, can usually be so enriched as to make the rock suitable for monumental stones and building units in the form of slabs, blocks and columns of durable quality and long-lasting beauty. The stone is carefully selected on the basis of its individual physical qualities and the location of the structure in which it is to be used.

It is therefore essential that a deposit be carefully examined so that any weakness or defect that could result in structural failure or low-quality material may be detected before quarrying is started.

Structural failure in blocks quarried from near the surface or at depth often goes unnoticed until the blocks are lifted from the quarry. Some defects, not seen on the surface, show up only after sawing and polishing and result in downgrading of the finished stone product.

Many of these hazards may be avoided before a large capital investment has been made by careful consideration of the following points in the order of their presentation:

1. A deposit of potentially marketable stone should be assessed for its probable production capacity from surface showings. The general and local geological association of the type of stone must be considered.

2. Outcrops not only of the main deposit but of similar deposits in the same area should be broadly sampled by surface channelling or other suitable methods to detect surface expressions of deep-seated faults or defects.

3. When the information gathered under Nos. 1 and 2 has been analyzed, the services of an experienced geologist or quarryman should be obtained.

4. The deposit must be investigated at depth, and the most economical method of doing this is core-drilling.

5. A coring pattern suited to the particular conditions of the area and rock should then be outlined.

6. Detailed study of cores is the best assurance against unnecessary expenditure in premature full-scale quarrying. From it, structural and textural information should be obtained by a study of the following:

(*a*) the type and character of the sheeting, bedding planes and fracture zones;

(*b*) the nature and extent of intrusive material, inclusions and concretions;

(*c*) local variation in rock mass, color permanence, mineralogical associations, and zones of porosity and permeability;

(*d*) the presence of deleterious iron-staining oxides and sulphides, chert and harmful siliceous minerals, clay and carbonaceous material;

(*e*) the extent of suitable rock for possible quarry operation as assessed from visual and petrographic study;

(*f*) doubtful sections of core requiring further assessment by chemical and physical test procedures to determine weatherability and durability.

VALUE OF BUILDING AND ORNAMENTAL STONE

Prosperity in the building and ornamental-stone industry depends on the number of large contracts, many of them government, for the construction of office buildings, provincial and federal headquarters, civic auditoriums, hotels, churches, and other big structures, in part of which some natural stone is usually employed. Dressed building granite is valued from \$50 to \$100 a ton. Monumental-quality granite properly dressed will sell for \$200 to \$400 a ton and, if the stone is flawless and highly polished and has the desirable coloring, grain size and structure, can go as high as \$800 a ton.

Limestone products, on the other hand, are considerably lower in value. Quarry operators dealing through brokers or directly with the consumer have averaged as much as \$70 to \$90 a ton for dressed building stone of the best quality.

Quality sandstone for dressed building products is priced at approximately \$50 a ton. Only occasionally, however, is sandstone used for monuments. When it is so employed, its price is about the same as that of dressed building stone.

Although in the past Canada has produced many fine marbles, it quarries very few stones or rough blocks today. All but a few of the old dimension-stone quarries still operating are being used as sources of crushed aggregate. The marble dimension stone obtained from those that continue to produce competes with popular imported marbles that have a wide range of colors and textural qualities.

For convenience, slate and shale have been reported under one heading. Slate has not been quarried commercially for many years. Well-indurated shale (lacking slate cleavage) has been marketed for flagstone use, but the output of shale is negligible in comparison with that of the principal stones produced in Canada.

DEPOSITS OF BUILDING AND ORNAMENTAL STONE

Suitable building and monumental stone is found in most igneous and metamorphic rocks. 'Black granite' is the term applied to ferromagnesian rocks containing plagioclase feldspar, augite, pyroxene and hornblende.

Granite quarries are operated in six provinces. Prince Edward Island has no potential granite production, but Saskatchewan may, in the future, develop northern outcrops of igneous rocks on the Precambrian Shield. Newfoundland's production, which is hindered only by the province's position with respect to markets, consists principally of stone for local consumption. A labradorite granite, the production of which is now being developed, is quarried at a distant northern point on the Labrador coast. Alberta does not produce granite.

In Quebec, almost all types of igneous rocks are quarried, as well as a number of the metamorphic rocks that are suitable for use as building or dimension stone. British Columbia, Ontario, New Brunswick, Manitoba and Nova Scotia provide fine-quality granite stone.

Very fine dimension limestone is obtained from quarries in Ontario, Quebec, Manitoba and New Brunswick; and very different and distinctive types of limestone come from the areas around St. Marc des Carrières, Quebec, St. Davids, near Ontario's Niagara Falls, and Garson, Manitoba, which is a few miles north of Winnipeg. Each productive area is ideally situated near large industrial and residential centres, and each has access to transportation routes.

Sandstone is produced in two provinces, the bulk coming from Ontario. A considerable amount of good-quality sandstone is also obtained in Nova Scotia. In New Brunswick and Alberta production is sporadic.

Only Quebec reports the production of dimension marble. Deposits potentially suitable as sources of building and monumental stone are found, however, in New Brunswick and Ontario and at isolated spots in Manitoba and British Columbia.

66076-1—30

What follows is a more detailed description of the stone available, most of which is at present being quarried, and an indication of the general location of the quarries. This information is classified under type of stone, and each classification is subdivided according to province.

Granite

Nova Scotia

Gray 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 sporadically produced near Halifax, while quartzitic rocks sometimes 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, gray-brown granite is produced near St. Stephen, and fine- to medium-grained, gray, pink and blue-gray granites are quarried in the Hampstead (Spoon Island) district. A brown, pink-gray, coarse-grained granite is sporadically quarried near Bathurst. A light-pink to salmon-colored, medium-grained granite is available in the Antinouri Lake district. Black granite is quarried in the Bocabec River area and southwest of the Hampstead area.

Quebec

Numerous quarries south of the St. Lawrence River supply fine- to medium-grained, gray and gray-white granites. These quarries are in the vicinities of Stanstead, Stanhope, St. Samuel-St. Sebastien, and St. Gerard. Fine- and medium-grained, dark gray-blue essexite is quarried on Mount St. Gregoire. A coarse-grained, dark-green nordmarkite is sporadically quarried in the Lake Megantic mountain area. A fine-grained, green granite is also produced near St. Gerard. A potential source of medium-grained, black granite with a slight reddish-brown cast has been found in the Stanstead area.

Various granite rocks of many colors and textures are quarried north of the St. Lawrence River. Red, brown and black (anorthosite) granites are quarried in the Lake St. John-Chicoutimi area; blue-gray, rose-gray, deeper pink-gray and black-and-white gneissic granites come from the Rivière à Pierre district; pink, fine-grained granite is quarried near Guenette; St. Alban supplies a pink-red granite, and St. Raymond a banded gneiss; brown-red to green-brown granites are quarried in the Grenville district; and an augen-type, coarse-grained, rose-pink granite is obtained south of Mont Tremblant. A potential source of fine-quality labradorite is being quarried in Coast of Labrador. A red granite is produced in the Ville Marie area. A deposit of black and red granite is being developed in an area along the north shore of Lake Superior.

Ontario

A salmon-pink, medium-grained granite is quarried near Vermilion Bay, and a black anorthosite is produced in the River Valley area. Rough building blocks are quarried near Parry Sound from a multicolored gneissic rock.

Manitoba

A durable, red granite of good quality is being quarried in the Lac du Bonnet area, 70 miles northeast of Winnipeg.

British Columbia

A light-gray and blue-gray, even-grained granite is produced on Nelson Island. Haddington Island is a source of fine-grained, bluish-gray and buff andesite.

Limestone

New Brunswick

Limestone for building construction is produced in the Saint John area.

Quebec

A fine- to medium-grained, fossiliferous, brownish-gray limestone is produced at several quarries in the vicinity of St. Marc des Carrières. 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 situated near Montreal, particularly on Ile Jésus, north of the city.

Ontario

Much of Ontario's production comes from deposits of a dense, hard, gray-blue limestone in the Niagara Falls area. A thin-bedded, dense, buff to buff-gray limestone is quarried on the Bruce Peninsula, near Wiarton and Owen Sound, and some dark-gray limestone is quarried near Ottawa.

Manitoba

A mottled, buff-brown to gray-brown dolomitic limestone is obtained from several quarries in the Garson area. It usually finds effective use in rough and sawn finishes but takes a high polish and can serve as a decorative stone.

Sandstone

Nova Scotia

A massive-textured, fine- to medium-grained, olive-buff stone is quarried in the Wallace area. A coarser, darker stone is sporadically quarried near Antigonish.

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 varicolored in light buff, brown and deep brown-red. Medium-grained, buff to cream-colored stone is quarried near Bell's Corners. 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-gray sandstone, sometimes referred to as 'Rundle stone,' is quarried in Alberta. It is used as rough building stone.

Marble

Quebec

A small quantity of light- and dark-gray and green-white mottled marble is quarried in the Philipsburgh area, near the United States border south of Montreal. Sporadic quarrying of a white-gray marble is carried on in the western part of the Stukely area.

66076-1—30½

Sulphur

C. M. Bartley*

Several plants designed to recover elemental sulphur from the processing of natural gas were under construction in Alberta in 1961. Their completion in 1962 made Canada one of the world's leading sulphur producers.

In 1961 sulphur production in Canada from all sources was slightly less than 1 million tons. In 1962, on the basis of present gas contracts, the output of elemental sulphur alone will probably exceed this amount, and before 1970 it should reach 2 million tons.

Few mineral industries in Canada or elsewhere can equal the rate of growth of western Canada's elemental-sulphur output. Sulphur was first produced from natural gas at an Alberta plant in 1952. By the end of 1961 it was being recovered in this manner at 11 plants in Alberta and one each in British Columbia and Saskatchewan. Elemental sulphur was also produced in 1961 in four other provinces, and its total for the year in this form amounted to more than 400,000 tons. At the same time, pyrites and smelter gas, the original sources of Canada's sulphur output, continued in three provinces to contribute substantial quantities in the form of sulphur-dioxide gas.

The amount of sulphur produced from natural gas is directly proportional to the volumes of cleaned gas supplied to domestic and foreign consumers. Because the increasing demand for natural gas is being met under long-term contracts, future sulphur production can therefore be estimated with reasonable accuracy.

In Canada and elsewhere, natural gas is considered the cheapest source of sulphur. As hydrogen sulphide, the source of sulphur in natural gas, is toxic and is also highly corrosive of metals and thus harmful to pipelines, it must be removed before the gas can be distributed as fuel. The elemental sulphur recovered in the process is generally a by-product, but sometimes it is the most valuable product and the primary interest.

* Mineral Processing Division, Mines Branch.

TABLE 1

SULPHUR—PRODUCTION AND TRADE

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
Pyrite and pyrrhotite[1]				
Gross weight	517,258	1,830,566	1,032,288	3,316,378
Sulphur content	255,376		437,790	
Sulphur in smelter gases[2]	277,056	2,708,110	289,620	2,854,623
Elemental sulphur[3]	394,762	7,287,881	274,359	4,298,906
Total sulphur content	927,194	11,826,557	1,001,769	10,469,907
Imports (elemental sulphur)				
United States	329,480	7,087,760	328,743	6,627,241
France	76	6,456	15	1,773
Britain	—	—	7	225
Total	329,556	7,094,216	328,765	6,629,239
Exports				
Sulphur in ores (pyrite)				
United States		860,599		1,041,456
Taiwan		39,156		—
Netherlands		—		110,275
Britain		—		73,840
Belgium and Luxembourg		—		33,580
Total		899,755		1,259,151
Sulphur, crude and refined				
United States	199,374	3,710,992	143,040	2,762,372
Taiwan	16,534	234,200	—	—
Australia	1,682	14,642	—	—
Malaya	276	8,050	—	—
Total	217,866	3,967,884	143,040	2,762,372

SOURCE: Dominion Bureau of Statistics. [1]Producers' shipments of by-product pyrite and pyrrhotite from the processing of metallic-sulphide ores. Included are quantities used by companies to produce sulphur dioxide and quantities used to produce by-product iron sinter. For 1961, the quantities used to produce by-product iron sinter are not included. [2]Includes 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.

The large-scale necessary production of sulphur in western Canada has drawn attention to transportation and marketing. These problems, together with sulphur developments in Canada and the position of the country as a major sulphur producer, are outlined in what follows.

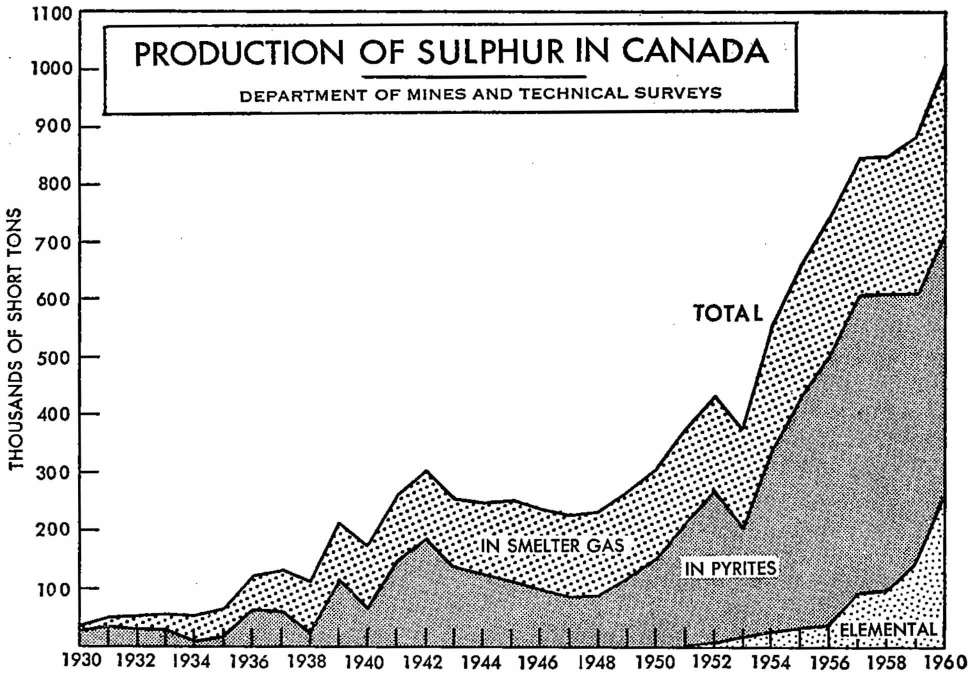
Table 2

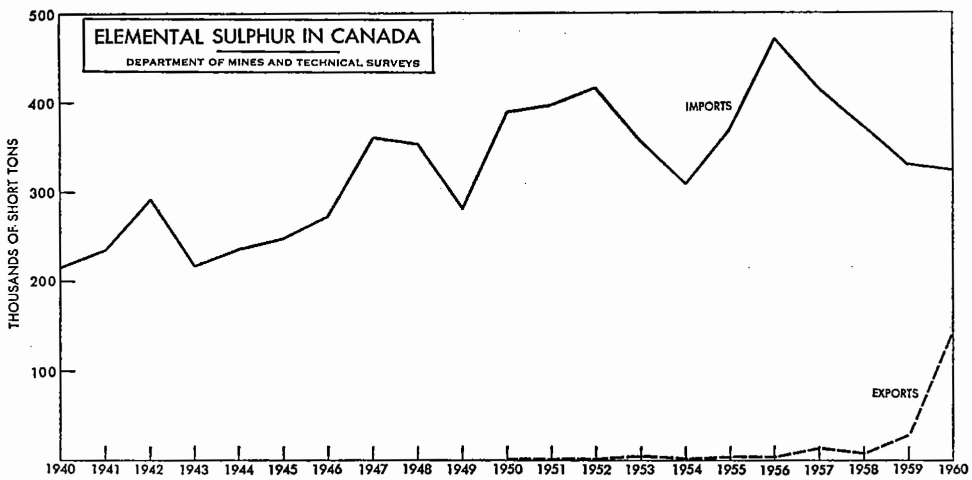
SULPHUR—PRODUCTION, TRADE AND CONSUMPTION, 1951-61

(short tons)

	Production				Imports	Exports		Consumption
	In Pyrites Shipped[1]	In Smelter Gases[2]	Elemental Sulphur[3]	Total		In Pyrite[4]	Other Sulphur[5]	Elemental Sulphur[6]
1951	215,363	156,427	—	371,790	395,928	178,039	44	415,335
1952	263,241	160,547	8,931	432,719	415,185	197,897	—	387,617
1953	186,650	172,200	18,298	377,148	359,205	129,608	4,633	352,466
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 r
1960	437,790	289,620	274,359	1,001,769	328,765	$1,259,151	143,040	507,810 r
1961	255,376	277,056	394,762	927,194	329,556	$ 899,755	217,866	489,881 e

Source: Dominion Bureau of Statistics. [1]The sulphur content of the pyrite and pyrrhotite shipped by producers was not necessarily all recovered. The statistics for 1952–55 include the sulphur content of the acid made by roasting zinc-sulphide concentrate at Arvida, Quebec. The quantities used in 1961 to make by-product iron sinter are not included. [2]Sulphur in liquid sulphur dioxide and sulphuric acid from the smelting of metal-sulphide ores. The statistics for 1956 and the years following include sulphur in acid made from roasting zinc-sulphide concentrates. [3]Elemental sulphur produced from natural gas. The statistics for the period 1952–56 refer to production. From 1957 on, the statistics refer to sales. Those for 1957 and the years following include some elemental sulphur derived from the treatment of nickel-copper sulphide matte at Port Colborne, Ontario. [4]Exports of pyrite, sulphur content. The quantities for 1955 and the years following are not available for publication. [5]Exports of sulphur produced from natural gas and other sources. [6]Consumption of elemental sulphur by industries. The coverage is incomplete. [r]Revised from previously published figure. [e]Estimate.





PRODUCTION AND TRADE

In 1961 the production (shipments) of sulphur in all forms totalled 927,194 tons valued at more than $11 million.

In Canada's mineral statistics, 'production' is based on shipments from plants. Large stockpiles are normal with producers of elemental sulphur, and it should be noted that the physical output in western Canada was considerably greater than officially stated and that production in all forms totalled nearly 1,200,000 tons valued at more than $15 million. The quantities obtained from both smelter gas and elemental sources were greater in 1961, but the official total for all sulphur was lower because of changes in the method of reporting the pyrites used as a source of sulphur or iron.

Imports of elemental sulphur, mostly into eastern Canada, increased slightly to 329,556 tons. Freight charges have made it difficult for western Canadian sulphur producers to compete in eastern markets, but recent rate reductions have resulted in some shipments.

The value of Canada's sulphur exports increased more than 40 per cent. Exports of pyrites were lower, but shipments of elemental sulphur to the United States and countries bordering the Pacific increased from 143,040 tons in 1960 to 217,866 tons in 1961. These changes reflect the adjustments now taking place in world sulphur-trade patterns as new sources in Mexico, France and Canada compete for markets traditionally served by United States Frasch sulphur.

During the year, Canadian railways reduced their freight rates on shipments to west-coast ports for export and to the Great Lakes and eastern Canada. The result was an increase in export and domestic shipments. Domestic consumption of Canadian-produced elemental sulphur increased from 86,000 tons in 1958 to 178,000 tons in 1961.

Canada and adjacent parts of the United States, among the markets that will be open to Canadian sulphur in the immediate future, are expected to provide an increase in sales. The United States Midwest, with Chicago as the focal point, reportedly uses 700,000 tons of sulphur annually. Current rail freight rates make it possible for sulphur from western Canada to compete in this area.

TABLE 3

PRODUCERS OF PYRITE AND PYRRHOTITE CONCENTRATES

Company	Location	Products	Uses
Consolidated Mining and Smelting Company of Canada Limited, The	Kimberley, B.C.	SO_2	H_2SO_4
		Iron Ore	Steel plant
Howe Sound Company*	Britannia Beach, B.C.	Pyrite concentrate	Sale
International Nickel Company of Canada, Limited, The	Copper Cliff, Ont.	SO_2	H_2SO_4
		SO_2	Liquid SO_2
		Iron ore	Sale
		SO_2	H_2SO_4
		Iron Ore	Sale
Noranda Mines, Limited*	Noranda, Que.	Pyrite concentrate	"
Quemont Mining Corporation, Limited*	" "	" "	"
Normetal Mining Corporation, Limited*	Normetal, "	" "	"
Solbec Copper Mines, Ltd.*	Quebec, "	" "	"

*These companies sell pyrite concentrate to consumers.

Shipments of 18,490 tons of sulphur to Taiwan, Australia and Malaya were made in 1961 and efforts are being made to increase sales in these and other countries of the Pacific area. In particular, the quickening pace of industrial activity in Japan and the determined attempt at industrialization in India will increase the need of those countries for sulphur and thus provide opportunities for large-scale sales of Canadian material. Export sales of sulphur, like those of other Canadian products, were stimulated when the Canadian dollar fell below the United States dollar.

PYRITES—PYRITE, PYRRHOTITE AND OTHER SULPHIDES

Until fairly recent years pyrites and smelter gas were the only domestic source of sulphur in Canada, and substantial production, consumption and exports have been recorded since before 1900.

Pyrite and pyrrhotite are iron-sulphide minerals often associated with base-metal ores of nickel, copper, lead and zinc in large, massive to disseminated bodies. In the crushing, grinding and treatment necessary to concentrate and recover the base metals, it is usually easy to concentrate and recover the associated pyrite and pyrrhotite. Pyrite and pyrrhotite concentrates are produced when there are markets for sulphur-dioxide gas or iron ore.

Pyrites cannot compete when raw sulphur is available, but in places distant from supplies the freight charges on raw sulphur often make by-product pyrites competitive. Where base metals are mined and smelted pyrites are usually obtainable. They are produced and used at Copper Cliff, Ontario, and Kimberley, British Columbia, and pyrite from the Noranda area of Quebec has, for many years, been used in Canada and exported in large quantities. Japan and Europe produce and use large amounts because domestic sulphur supplies are inadequate.

Canada's 1961 pyrites activities are indicated in the accompanying tables. The change in the method of reporting pyrite and pyrrhotite explained in Table 1, footnote 1, does not signify any substantial change in the quantity produced as a source of sulphur.

SMELTER GAS

In 1961 the sulphur obtained from smelter gases amounted to 277,056 tons, or almost 77 per cent more than in 1951 and 12,564 tons less than in 1960. Gases evolved in the roasting and smelting of base-metal sulphide ores are collected and concentrated both because they are valuable and because their release causes air-pollution problems. Several smelters in Canada recover these gases and transfer them to adjacent plants, where they are used to produce sulphuric acid or liquid sulphur dioxide.

ELEMENTAL SULPHUR FROM SULPHIDES

Elemental sulphur, which in past years was produced from sulphide materials at several plants in Canada, is now being obtained at the two refineries of The International Nickel Company of Canada, Limited, by the electrolysis of nickel-sulphide matte.

At Copper Cliff, Ontario, an experimental plant for the production of sulphur from sulphur-dioxide roaster gas was tested during 1960 and 1961, but commercial operation has not yet been reported.

Elemental sulphur was produced by Noranda Mines, Limited, at Port Robinson, Ontario, during the period 1954-59 and by The Consolidated Mining and Smelting Company of Canada Limited at Kimberley in 1936-43.

SULPHUR FROM OIL REFINERIES

From hydrogen-sulphide gas removed from sour crude oils, elemental sulphur is recovered at two Canadian plants by processes similar to those used for its recovery in natural-gas plants. At its 30,000-ton-a-year plant in Montreal East, Laurentide Chemicals & Sulphur Ltd. uses hydrogen sulphide from several nearby oil refineries; and at Saint John, New Brunswick, Irving Refining Limited operates a similar but smaller plant. A sulphur-producing plant has been suggested for Ontario's Port Credit and Clarkson area, where hydrogen sulphide would be available from oil refineries.

The output of sulphur from sour crude oil is not expected to be large in Canada. Foreign crude imported into eastern Canada often contains recoverable quantities, but the amount of sulphur in the Canadian crude usually processed at refineries in other parts of the country is small.

OTHER SULPHUR

At Fort Saskatchewan, Alberta, Sherritt Gordon Mines, Limited, uses an ammonia leach process to treat nickel-sulphide ores. Sulphur in the ore combines with ammonia, and by-product ammonium sulphate is recovered. It is estimated that the equivalent of 30,000 tons of sulphur is consumed annually in this process.

SULPHUR IN NATURAL GAS

The large volumes of natural gas rich in hydrogen sulphide that have been discovered in Alberta and British Columbia during the past 10 years have provided the base for Canada's rapid rise as a major producer of elemental sulphur. In natural gas low concentrations of hydrogen sulphide are fairly common, but high concentrations are unusual.

The plants that recover sulphur from natural gas process the raw gas by separating and collecting the various valuable fractions while removing the unwanted parts. The main product is normally fuel gas of definite specifications, but varying amounts of liquid petroleum gases, refinery feed stocks and elemental sulphur are also recovered. Hydrogen sulphide is concentrated in a collecting solution (usually monomethylamine) and the enriched gas stripped from this solution is burned in a Claus furnace to produce a mist of sulphur droplets. The mist is condensed to liquid sulphur and pumped to storage vats.

Two important facts are implicit in the production of sulphur from sour natural gas. First, the removal of hydrogen sulphide is necessary if the gas is to be used as fuel; second, at least two products of value are obtained from the raw gas. This means that the cost of exploration and production may cover two products. If, on the other hand, the hydrogen sulphide is considered waste material, the cost of obtaining the sulphur is very low because the source material is free.

At the end of 1961 Canada's reserves of recoverable sulphur in sour natural gas had increased to about 90 million tons, of which 88 million tons were in 32 Alberta fields, where the hydrogen-sulphide content ranges from less than 1 per cent to more than 85 per cent. There is little doubt that when drilling exploration is complete, the sulphur in the gas fields of western Canada will be found to amount to three times the present estimated reserves.

In 1961 three new sulphur plants with a total daily capacity of 1,300 tons were completed and four other plants with a combined capacity of 2,800 tons a day were in the final stages of construction. The completion of these plants early in 1962 brought western Canada's sulphur-production capacity to more than 6,000 tons a day, thus raising Canada's capacity for production from natural gas from 700,000 tons a year to more than 2 million. It is expected that 10 additional plants will be built, but the time of their construction, as well as the actual sulphur output of the plants now operating, depends directly on the quantities of natural gas that can be marketed. The accompanying map shows the location of the plants. This, together with the plant capacities and the hydrogen-sulphide content of the gases, is also shown in Table 4.

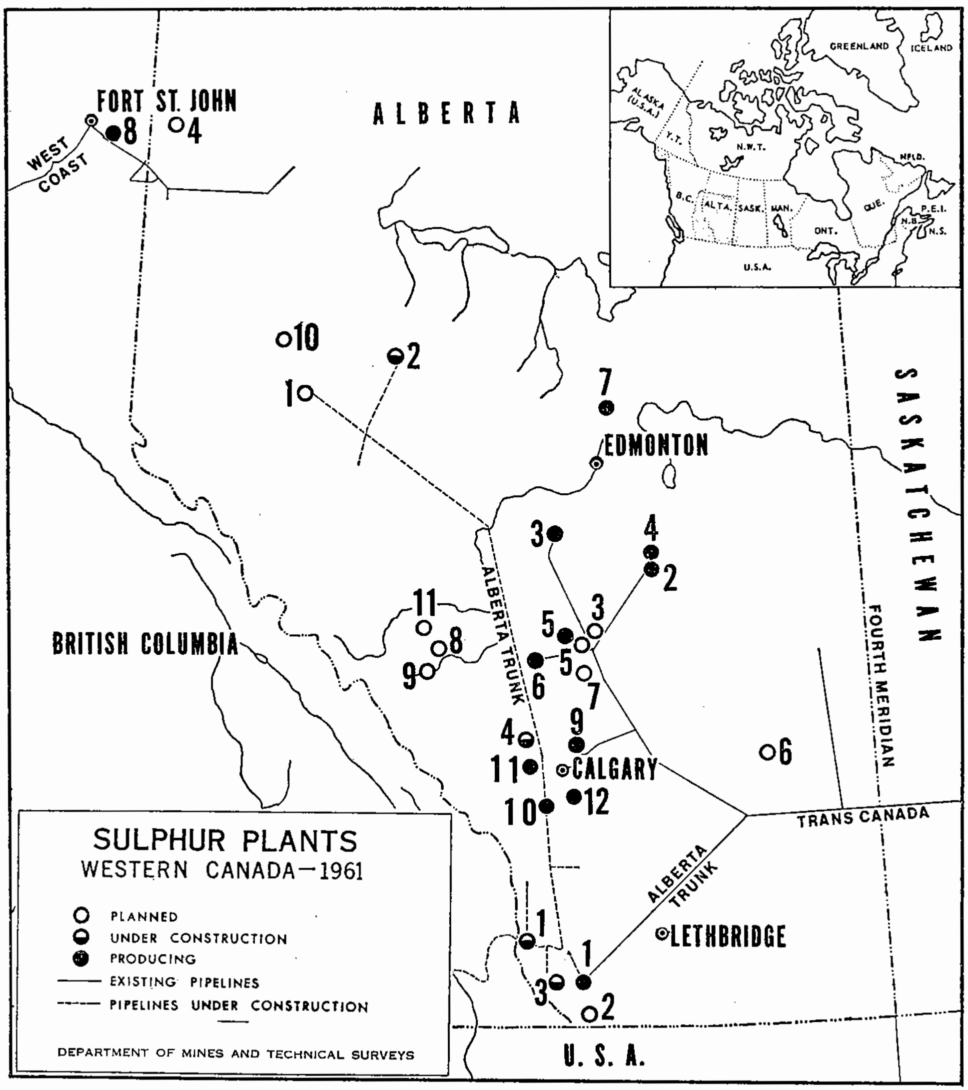


TABLE 4

SULPHUR PLANTS, WESTERN CANADA, 1961

Operating Company	Location	Approximate Percentage H_2S	Capacity in Short Tons	
			Daily	Annual[1]
Producing plants (indicated on map by ● and number)				
1. British American Oil Company Limited, The	Pincher Creek, Alta.[2]	10	755	264,000
2. Same company	Nevis, Alta.[2]	4–6	85	30,000
3. Same company	Rimbey, Alta	2	280	98,000
4. California Standard Company, The	Nevis, Alta.[2]	6	130	45,000
5. Canadian Oil Companies, Limited	Innisfail, Alta.[2]	14	110	38,000
6. Home Oil Company Limited	Carstairs, Alta.[2]	1	56	19,600
7. Imperial Oil Limited	Redwater, Alta.[2]	3	10	3,500
8. Jefferson Lake Petrochemicals of Canada Ltd	Taylor Flats, B.C.	3	330	115,000
9. Petrogas Processing Ltd	Calgary, Alta	16	965	337,700
10. Royalite Oil Company, Limited	Turner Valley, Alta.[2]	4	33	11,500
11. Shell Oil Company of Canada, Limited	Jumping Pound, Alta.[2]	4	110	38,000
12. Texas Gulf Sulphur Company	Okotoks, Alta.[2]	35	415	145,000
13. Steelman Gas Limited	Steelman, Sask. (not shown on map)[2]	1	7	2,400
Totals			3,286	1,147,700
Plants under construction (indicated on map by ◒ and number)				
1. Jefferson Lake Petrochemicals of Canada Ltd	Coleman, Alta	14	420	147,000
2. Pan American Petroleum Corporation	Windfall, Alta.[2]	15–20	730[3]	255,500
3. Shell Oil Company of Canada, Limited	Waterton, Alta.[2]	22–27	1,550	542,500
4. Western Leaseholds Ltd	Wildcat Hills, Alta.[2]	4	117	41,000
Totals			2,817	986,000
Cumulative totals			6,103	2,133,700
Probable future plants (shown on map by ○ and number)				
1. British American Oil Company Limited, The	Berland River, Alta.[2]	15	280	98,000
2. Same company	Lookout Butte, Alta.[2]	3	28	9,800
3. Same company	Wimborne, Alta.[2]	15	110	38,000
4. Imperial Oil Limited	Waiparous Creek, Alta.[2]	5	11	3,800
5. National Sulphur Company	Olds, Alta.[2]	6	33	11,500
6. Pan American Petroleum Corporation	Bigstone, Alta.[2]	12	28	9,800
7. Same company	Crossfield East, Alta.[2]	38	380	133,000
8. Shell Oil Company of Canada, Limited	Burnt Timber, Alta.[2]	6	45	15,700
9. Same company	Panther River, Alta.[2]	87	425	148,700
10. Same company	Simonette, Alta.[2]	14	135	47,200
11. Texas Gulf Sulphur Company	Wildhorse Creek, Alta.[2]	6	33	11,500
Totals			1,508	527,000
Cumulative totals			7,611	2,660,700

SOURCES: Oil and Gas Conservation Board of Alberta and others. [1]Calculated on the basis of 350 operating days a year. [2] A gas field rather than a community. [3]Capacity will increase later to more than 1,800 tons a day.

TABLE 5

CONSUMPTION OF ELEMENTAL SULPHUR IN CANADA, 1960

(short tons)

Pulp and paper	286,293
Heavy chemicals, fertilizer	197,212
Rubber goods	3,200
Medicinals	15
Adhesives	—
Starch	282
Sugar-refining	113
Petroleum-refining	198
Iron and steel	1,224
Miscellaneous chemicals	19,273
Total	507,810

SOURCE: Dominion Bureau of Statistics.

WORLD REVIEW

Free World sulphur production for 1961 is estimated at more than 21 million tons, or about 7.7 per cent more than in 1960. Consumption, estimated at less than 21 million tons, showed slower growth in 1961. Production in the Communist countries increased appreciably to 4.6 million tons. The sources of Free World sulphur—elemental, pyrites and all other forms—were in the proportions 11:8:3. Although elemental sulphur and pyrites supply the major part of world needs, sulphur in other forms is important in some parts of Europe and Asia. In Britain, for example, sulphuric acid, ammonium sulphate and cement are produced on a large scale from anhydrite. Few of these sources could be operated for sulphur values alone, but the production of other materials makes the integrated operation stable and profitable.

World trade in elemental sulphur showed only a slight gain in 1961. The United States is the leading producer, consumer and exporter; other major producers are Mexico and France. During 1961 increased production at Lacq, in southern France, found ready markets in Europe and reduced European imports from the United States and Mexico. France's share of world sulphur trade consequently increased from 10 to 15 per cent, while that of the United States fell by about 5 per cent. Exports from Poland and the Union of Soviet Socialist Republics to other parts of Europe increased, but the domestic demand these countries have to meet makes it doubtful that such movements will be important in world trade. The transatlantic shipments made in 1960 and 1961 from France to Cuba were unusual movements for sulphur.

About 90 per cent of the elemental sulphur sold throughout the world in 1961 came from the United States (41 per cent), Mexico (30 per cent), France (15 per cent) and Canada (5 per cent). The major producers control adjacent markets mainly because of low transportation costs, but markets at intermediate and greater distances are influenced by a variety of factors, of which distance is the least important. Mexico, for example, can compete with United States Frasch sulphur for markets on the United States Atlantic coast by shipping in vessels of foreign registry that provide transportation at lower cost. The United States, on the other hand, supplied 95 per cent of South America's sulphur imports and 65 per cent of Asia's. One factor behind this is believed to be the shipping economies effected by grouping several shipments on one vessel and thus sending large tonnages to overseas stockpiles. Another is thought to be the attractive credit made possible by the channelling of all United States sulphur exports through one organization, the Sulphur Export Corporation.

Throughout the world, the past 10 years' increase in the production of elemental sulphur, particularly in Mexico, France and Canada, has intensified competition, lowered prices and brought about a gradual redistribution of markets. Since French production is just now reaching full capacity and Canadian production is on the way to a substantial increase for 1962, competition will continue and marketing patterns will probably be further adjusted.

Noteworthy among activities in the United States in 1961 were Freeport Sulphur Company's successful year-long operation of its Grand Isle sulphur mine, off the Louisiana coast, and its rapid development, in collaboration with Texas Gulf Sulphur Company, of facilities for the transportation and handling of liquid sulphur. Production in the United States increased appreciably, but exports and consumption were lower than in 1960.

In Mexico, production, consumption and exports were lower and stockpiles increased moderately. Liquid shipments were made by Pan American Sulphur Company, mostly to the United States.

The sulphur demand was a little lower in Europe. In France, rising production and the apparent solidity of pyrite markets resulted in appreciably larger exports. The increased output of Communist countries came mainly from the Ukraine's Rozdolski mine and Poland's Tarnobrzeg mine. Other mining operations contributed and new mines were being developed.

TABLE 6

ESTIMATED WORLD PRODUCTION OF SULPHUR IN ALL FORMS[1]

('000 short tons)

	1961					1960
Country	Frasch	Other Solid Sulphur	In Pyrites	In Other Forms[2]	Total	Total
United States	6,031	1,062	447	491	8,031	7,400
Mexico	1,286	87	—	?	1,363	1,483
Japan	—	276	1,830	227	2,333	1,900
France	—	1,218	137	93	1,448	1,010
U.S.S.R.	—	1,120	?	303	1,423	1,350
Spain	—	46	1,071	41	1,158	1,145
Canada	—	596[3]	250[4]	311	1,157[4]	1,245
Italy	—	119	793	117	1,029	868
China	—	268	594	?	861	800
West Germany	—	92	247	241	580	568
Cyprus	—	—	521	—	521	576
Norway	—	68	348	19	435	471
Portugal	—	9	331	—	340	345
East Germany	—	112	51	143	306	312
Poland	—	145	85	60	290	205
Other countries	—	202	2,479	1,654	4,340	4,132
Total	7,318[5]	5,420[6]	9,184[5]	3,700[6]	25,622	23,780

[1]Compiled from various sources. Because of the rounding of listed figures, the data do not all add exactly to the totals shown. [2]Sulphur in smelter gas, anhydrite-gypsum, spent oxide, hydrogen sulphide (other than elemental) and smaller sources. [3]Total output rather than shipments. [4]Note the change in the method of reporting pyrite statistics (Table 1, footnote 3). [5]U.S. Bureau of Mines. [6]British Sulphur Corporation Limited, *Sulphur*, December 1961.

SULPHURIC ACID

Sulphuric-acid production in Canada was lower in 1961 than in the two preceding years because less was consumed in uranium-ore-processing. Between 1955 and the end of 1959, the annual output increased from 950,000 tons to 1,739,000 tons, mainly to meet the needs of the uranium industry. While the

TABLE 7

SULPHURIC ACID—PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1951-61

(short tons of 100% acid)

	Production	Imports	Exports	Apparent Consumption
1951	820,867	1,162	57,000	765,029
1952	816,270	85	33,135	783,220
1953	822,608	70	47,889	774,789
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	29,500	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	1,672,687	9,526	43,430	1,638,783
1961	1,621,161	7,275	38,914	1,589,522

SOURCE: Dominion Bureau of Statistics.

TABLE 8

AVAILABLE DATA ON CONSUMPTION OF SULPHURIC ACID, BY INDUSTRIES, 1960

(net tons of 100% acid)

Iron and steel mills	48,149
Other iron and steel	12,440
Electrical products	4,945
Vegetable-oil mills	96
Sugar refineries	332
Leather tanneries	2,083
Textile-dyeing and -finishing plants	54
Pulp and paper mills	25,925
Processing of uranium ore	373,337
Manufacture of mixed fertilizers	101,821
Manufacture of plastics and synthetic resins	20,257
Manufacture of soaps and cleaning compounds	15,000
Other chemical industries	9,529
Manufacture of industrial chemicals[1]	833,890
Petroleum-refining	16,931
Mining[2]	49,670
Miscellaneous[3]	60,026
Total accounted for	1,574,485

SOURCE: Dominion Bureau of Statistics. [1]Includes consumption of 'captive' or 'own make' of acid by firms classified to these industries. [2] Includes consumption in both metal and nonmetal mines, mineral fuels and structural materials. [3] Includes consumption in synthetic textiles, explosives and ammunition, other petroleum and coal, sausage and sausage casings.

NOTE: Because of the change brought about in the industry's concept by the implementation of the new Standard Industrial Classification (SIC), the figures shown by industry for 1960 are not necessarily comparable with those of previous years. A further result of the new SIC concept is that some industries are not shown in the table.

requirements of uranium-processing have decreased by nearly 50 per cent, the outlet provided by other uses has increased. The result has been that the slacking in consumption from 1959 to 1961 amounted to less than 200,000 tons. In some parts of Canada production capacity is at present considerably excessive, but in other areas the demand is growing.

At 1,672,687 tons, the 1960 output of sulphuric acid was about one tenth that of the United States, but it put Canada in eighth place among the world's 12 major producers.

USES

Sulphur is one of the basic materials of modern manufacturing, and its consumption is a measure of industrial activity. Most sulphur is consumed as sulphuric acid in the fertilizer, chemical and metallurgical industries. In this form, however, it is not recognizable, and its importance is thus rarely appreciated. It has been estimated that some 35 pounds of sulphur are needed to manufacture the materials for one automobile.

Almost everything produced in an industrial country requires sulphur. Among the more important products in which it is used are steel, paint, plastics, medicine, matches, paper, metals, fertilizers, glass, textiles, rubber, soap and explosives.

PRICES

In the last quarter of 1961, 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 25, 1961, 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	24.00
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 consisting more than 25% of sulphur.	"

Talc and Soapstone; Pyrophyllite

J. E. Reeves*

Canada's production of talc and soapstone was a little more than 10 per cent greater in 1961. This was due essentially to larger shipments from Quebec, production in Ontario remaining about the same.

There was a further substantial increase in shipments of pyrophyllite from Newfoundland. The volume in 1961 was more than 20 per cent and the value 54 per cent higher.

Imports of ground talc increased slightly and, as usual, consisted of relatively high quality grades from the United States and Italy. The latter country is the source of cosmetic and pharmaceutical talc of specially high quality.

Export data on talc and soapstone are no longer available separately, but it is estimated that about 2,000 tons were exported in 1961, a greater quantity than in the previous year. All the pyrophyllite is exported.

PRODUCERS

Quebec

Baker Talc Limited obtains talc and soapstone from the Van Reet mine, near South Bolton, in southern Quebec. Lower-priced grades of ground talc, as well as soapstone blocks for sculpturing, are produced at the mill near High-water, about 10 miles south of the mine

Broughton Soapstone & Quarry Company, Limited, produces lower-priced grades of ground talc, metalworkers' soapstone crayons and a small quantity of refractory soapstone blocks near Broughton Station, in the Eastern Town-ships. The talc originates at a deposit about 6 miles northwest of the millsite and the soapstone at a quarry about 2 miles southwest of it.

Ontario

Canada Talc Industries Limited mines and grinds talc at Madoc, in south-eastern Ontario. The various grades of talc produced are mainly of lower quality.

Newfoundland

Newfoundland Minerals Limited obtains high-quality pyrophyllite from lenses near Manuels and ships it, with no processing other than primary crushing, to American Encaustic Tiling Company Inc., at Lansdale, Pennsyl-vania.

* Mineral Processing Division, Mines Branch.

TABLE 1

PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production (shipments)				
Talc and soapstone				
Quebec[1]	16,274	178,911	14,222	157,611
Ontario[2]	7,417	107,660	7,189	102,645
Total	23,691	286,571	21,411	260,256
Pyrophyllite				
Newfoundland	24,425	404,059	20,225	262,925
Imports[3]				
United States	18,846	829,752	17,574	736,368
Italy	1,348	67,234	1,579	71,061
Other countries	11	1,848	—	—
Total	20,205	898,834	19,153	807,429
Exports[4]				
United States			1,550	22,292
Nicaragua			45	562
Ecuador			39	859
Cuba			15	375
Other countries			11	184
Total			1,660	24,272
	1960		1959	
Consumption[5,6]				
Roofing	7,656		8,318	
Paints and wall-joint sealing compounds	7,539		8,804	
Ceramic products	4,022		3,758	
Insecticides	2,552		2,027	
Paper	2,363		1,710	
Rubber	2,157		3,108	
Toilet preparations	1,639		1,173	
Gypsum products	922		1,347	
Asphalt products	583		[7]	
Cleaning compounds	532		325	
Pharmaceutical preparations	243		1,326	
Leather products	20		19	
Other products	228		1,788	
Total	30,456		33,703	

SOURCE: Dominion Bureau of Statistics.
[1]Ground talc, soapstone blocks and crayons.
[2]Ground talc.
[3]Talc.
[4]Talc and soapstone. Not available as a separate class after 1960.
[5]Available data.
[6]Ground talc.
[7]Not reported separately.

TABLE 2

PRODUCTION AND TRADE, 1951-61

(short tons)

	Production[1]		Imports[2]	Exports[3]
	Talc and Soapstone	Pyrophyllite		
1951	24,846		9,283	3,743
1952	25,032		8,749	3,435
1953	27,408		11,867	2,937
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[e]

SOURCE: Dominion Bureau of Statistics. [1]Producers' shipments. [2]Talc. [3]Talc and soapstone. [e]Estimated.

TECHNOLOGY

The mineral talc is a hydrous magnesium silicate. It is soft, has a greasy feel or 'slip,' is flaky or fibrous according to its mode of origin and grinds to a white powder. Chemically, it is relatively inert. It has a low moisture and oil absorption, a high fusion point and low electrical and thermal conductivity.

Many commercial talcs are mixtures of talc and certain other minerals. The deposits in southern Quebec were formed by the alteration of serpentinized peridotite and contain, in addition to talc, some unaltered serpentine, iron-bearing minerals such as chlorite, and magnesite. These impurities cause the ground products to be light gray. Such products can be used where color specifications are not exacting, or higher-quality products can be obtained by removing much of the impurity by some process of beneficiation. The Madoc deposits represent altered white dolomite and consist principally of talc, tremolite and dolomite in various proportions. Ground products are white and naturally low in iron but are 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 desirable properties to commercial talcs for many uses.

Soapstone is essentially a relatively impure talcose rock from which blocks and crayons can be readily sawn. The soapstone in southeastern Quebec was altered from serpentine rock and is gray because of the impurity content.

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 is entirely acceptable to industry, but the impurities must be limited.

USES AND SPECIFICATIONS

Commercial talc is a versatile raw material that has had scores of applications in industry, mostly as an industrial filler. Most of the talc used in Canada is consumed by a few industries.

High-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. The paint industry's specifications relate principally to whiteness, particle size and shape, and oil-absorption characteristics. Paper manufacturers require talc of high brightness, high retention in the pulp, low abrasiveness and freedom from chemically active substances. The ceramic industry

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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 preparations.

Particle-size specifications for most uses require the talc to be basically minus 325 mesh. The paint industry demands from 99.8 to 100 per cent minus 325 mesh. For rubber, ceramics, insecticides and pipeline enamels 95 per cent minus 325 mesh is the usual minimum. In the wall-tile industry 90 per cent minus 325 mesh is usually required. For roofing grades the specification is minus 40 mesh or minus 80 mesh and 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 is still used in the manufacture of metalworkers' crayons and for artistic carvings.

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 low impurity content, fine particle size and a high degree of whiteness command higher prices. There are no published prices for Canadian products, but a range of United States prices of ground talc is quoted periodically in *E & M J Metal and Mineral Markets.*

TARIFFS

Tariffs in effect at the time of writing include the following:

Canada	British Preferential	Most Favored Nation	General
Talc or soapstone	10%	15%	25%
Pyrophyllite for use in Canadian manufacture	free	free	25%
Micronized talc	"	5%	25%

United States	
Talc, steatite or soapstone	
Crude and unground	1/8¢ per lb.
Cut or sawed, or in blanks, crayons, cubes, disks or other forms	1/2¢ "
Ground, powdered, pulverized or washed (except toilet preparations)	
Not more than $14 a ton	8¾%
More than $14 a ton	15%

Thorium

J. W. Griffith*

Canada began to produce 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, however, has a designed capacity for 150 to 200 tons of thorium compounds a year.

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.

The principal known deposits of thorium in Canada are the uranium ores of the Elliot Lake district (Blind River area), which are estimated to average 0.06 per cent ThO_2 (thorium dioxide).

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*Mineral Resources Division. †Rio Tinto Dow was formed by The Rio Tinto Mining Company of Canada Limited and Dow Chemical of Canada, Limited.

FREE WORLD PRODUCTION AND RESERVES OF THORIUM

Country	Products	Approximate Annual Production (short tons)	Year	Principal Types of Deposits	Average Grade of Ore (%Th)	Approximate Reserves† of Thorium (short tons)
Australia	High-grade concentrates	396	1960	Monazite sand	5.8 —6	44,000
Brazil	Monazite concentrates (5% ThO_2)	50	1960	Monazite sand	4 —5	33,000
Canada	Sludge (10–20% Th), oxide and thorium metal	*	*	Mainly monazite and other minerals in uraniferous conglomerates	0.06	180,000
Ceylon	Monazite concentrates (8–10% ThO_2)	36	1960	Monazite sand	7 —8	1,000
Egypt	*	*	*	Monazite sand	4	8,800
Formosa	*	*	*	Monazite sand	5	500
India	Thorium nitrate	128	1960	Monazite sand	6 —8	176,000
Korea (South)	Monazite concentrates	13	1960	Monazite stream placers and beach deposits	*	*
Malagasy Republic (Madagascar)	Concentrates of uranothorianite (60% Th) (a) and monazite (b)	616(a) 470(b)	1960	Monazite and uranothorianite placers	6 —8	10,000
Malaya	Monazite concentrates	47	1960	Monazite, by-product of tin placers	*	*
Nigeria	Concentrates of monazite and thorite	15	1960	Monazite and thorite in tin placers and thorite in granite	4.5 —7	13,200
Nyasaland	*	*	*	Monazite sand	5.6	8,800
South Africa	*	*	*	Monazite veins	3.6 —4.5	13,200
United States	Nitrate, oxide and metal	222	1960	Monazite-bearing stream placers and thorite veins	3	8,800

SOURCES: (1)*Statistical Summary of the Mineral Industry* (world production, exports and imports), 1955–60, Mineral Resources Division, Overseas Geological Surveys (British); (2)Van Wambeke, L., *Ressources et Réserves en Matières Fissiles du Monde Libre*, published by EURATOM, September 27, 1961; (3)Bowie, S. H. U., "The Uranium and Thorium Resources of the Commonwealth," *Journal of the Royal Society of Arts*, September 1959; (4)Lang, A. H., J. W. Griffith and H. R. Steacy, *Canadian Deposits of Uranium and Thorium*, Economic Geology Series No. 16 (second edition), Geological Survey of Canada, Department of Mines and Technical Surveys, 1962. †These are exploitable reserves from which concentrates can be produced at $10 a pound or less for ThO_2. They do not include potential reserves, which in some countries are considerably larger than the reserves shown here. Several additional countries have significant deposits of thorium but have not been included because details on reserves are lacking. *Not available.

The thorium is carried in the minerals monazite, uraninite and brannerite. The ores near Bancroft that are now being mined for uranium are estimated to carry about 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 seem to carry considerably more thorium.

The uranium-ore reserves of the Elliot Lake and Bancroft areas are estimated to contain 180,000 tons of thorium. At the 1961 rate of uranium production in these camps it would be possible to recover annually 4,000 tons of thorium oxide as a by-product.

Other types of deposits containing large tonnages of low-grade thorium have been found in Canada. The principal ones consist of dolomite containing monazite or are placers containing various thorium minerals. Several large deposits containing pyrochlore are being investigated as possible producers of niobium and by-product uranium and thorium, but a compilation of the reserves of such deposits has not been undertaken. In addition, there are several smaller deposits in Canada that are much richer in thorium-bearing minerals.

Virtually no prospecting has been done in Canada for thorium alone. If this should be warranted, other large deposits, perhaps of higher grade, would probably be found.

EXTRACTION PROCESS

The Rio Tinto Dow thorium-recovery plant, near Elliot Lake, was constructed at a cost of $1 million. The first operating unit was put up near the Quirke mine, which is now inactive, of Rio Algom Mines Limited. Early in 1961 the closing of the Quirke mine led to the construction of another such 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 utilize 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. 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, requires large extraction tanks and tanks for stripping and thickening. The extraction tanks take the thorium from the barren uranium liquor; the stripping tanks remove the thorium from the solvent; and the thickeners precipitate thorium slurry. Wet thorium sludge is filtered on a rotary filter. Crude thorium sludge is scraped off in the final stage of drying and is gravity-fed to a packaging area. This 'cake' contains about 15 to 20 per cent pure thorium.

About 30 per cent of the cake is further refined to metallurgical-grade thorium oxide (99.8+% ThO_2) at the Quirke location. One hundred pounds of thorium oxide contain about 88 pounds of pure 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 could be recovered, with thorium, from the effluent of the uranium-treatment plants in the proportion of 1 pound to every 3 or 4 pounds of thorium.

*Foreign plants use the sulphuric-acid process or that of caustic attack on monazite. Thorium products are then separated from the accompanying rare earths.

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 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 finds 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 finds application 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 2 to 10 per cent ThO_2. This alloy is said to be more heat-resistant than the superalloys 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 producers utilizing monazite sands, 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 sold in the United States and Britain. Canada is the major source of United States imports of thorium.

Metallurgical-grade thorium dioxide is priced at \$5 a pound, and the fluoride (metallurgical-grade ThF_4) is \$4.25 a pound.* The prices of thorium compounds that a leading producer offered for sale in 1960 in lots of 100 pounds or more are reported by the United States Bureau of Mines as follows:

Thorium Compound	Per Cent ThO_2	Price per Pound
Carbonate	80—85	\$6.25—\$8.00
Chloride	50	\$7.00
Fluoride	80	\$5.50
Nitrate (mantle grade)	46	\$3.00
Oxide	97—99	\$5.50—\$8.50
Other forms		
Metal (nuclear grade)	—	\$19.55
Thorium hardener (for alloying)	20—40	\$12.50—\$15.00

*Source: Rio Tinto Dow Limited.

For obvious reasons, Rio Tinto Dow Limited has not published production costs. If, however, the expense of all mining, milling and leaching of the ore was borne by the uranium mine, the cost of recovering the thorium by the inexpensive solvent-extraction process must have been very low.

The Canadian tariff rates that follow 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% plus 5% surcharge	20% plus 5% surcharge	25%
Thorium bases or salts for the manufacture of incandescent-gas mantles	free	free	free

United States	
Thorium metals and alloys	12½%
Nitrates, oxides and other salts	30%
Monazite sand and other thorium ores	free

Tin

W. H. Jackson*

Canada's small output of tin is reported as the combined tin content of concentrates and of a primary lead-tin alloy derived from smelting. For 1961, production totalled 500 tons; †for 1960 it amounted to 278 tons. Owing to sales from the Canadian stockpile, imports of tin metal, which came to 3,525 tons, were slightly lower than in 1960. Consumption totalled 3,953 tons, and tin stocks in the hands of consumers at December 31 amounted to 674 tons.

Minor tin occurrences, both lode and placer, have been recorded over the years, but none have any significance. Exploration is at present limited to a new prospect some 30 miles southwest of Fredericton, New Brunswick, where fine-grained cassiterite has been found associated with showings of low-grade copper-zinc sulphides.

Canadian tin is a by-product obtained by The Consolidated Mining and Smelting Company of Canada Limited (Cominco) from its lead-zinc mining operations. Mill tailings from the zinc circuit at the company's Sullivan mine contained about 1.2 pounds of tin to the ton. The tin concentrate produced from the tailings assays about 65 per cent tin. It was smelted at Kimberley from 1942 to 1952 but has since been exported for treatment. A minor amount of tin is also derived in the form of a lead-tin alloy from the refining of indium. In limited quantity, Cominco also makes Tadanac Brand high-purity tin (99.999 per cent) and Tadanac Brand special-research-grade tin (99.9999 per cent). The former contains 2 parts per million (ppm) lead and less than 1 ppm each of nickel, antimony and copper; the latter, zone-refined, contains 0.1 to 0.2 ppm each of lead and copper, with no other impurities detectable spectroscopically.

At Canada's first detinning plant, which went into operation in Hamilton, Ontario, in November, M & T Products of Canada Limited treats high-quality tinplate scrap from can-making operations to produce potassium and sodium stannate. These chemicals are used in tin electroplating and in the immersion coating of aluminum pistons for engines. Some of the output will be exported. Other chemicals available domestically are stannous fluoborate from Allied Chemical Canada, Ltd., Valleyfield, Quebec, and stannous octoate and oleate from Nuodex Products of Canada Limited, Leaside, Ontario.

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* Mineral Resources Division. †Long tons (2,240 pounds) are used throughout this review.

TABLE 1

TIN—PRODUCTION, IMPORTS AND CONSUMPTION

	1961		1960	
	Long Tons	$	Long Tons	$
Production				
Tin content of tin concentrates and lead-tin alloy produced..	500	727,578	278	522,243
Imports				
Blocks, pigs, bars				
Malaya	1,601	4,009,328	1,961	4,326,843
United States	414	968,777	357	776,309
Belgium and Luxembourg	620	1,625,349	1,190	2,587,092
Britain	636	1,670,950	100	220,962
Bolivia	126	293,904	29	60,777
West Germany	128	325,100	111	243,534
Netherlands	—	—	20	42,108
Total	3,525	8,893,408	3,768	8,257,625
Tinplate				
Britain	1,872	404,995	4,231	834,645
United States	1,208	186,894	1,359	241,140
Australia	—	—	36	7,516
Total	3,080	591,889	5,626	1,083,301
	Pounds		Pounds	
Tin foil				
United States	26,445	36,971	20,584	21,411
Britain	175	145	—	—
Other countries	—	—	648	604
Total	26,620	37,116	21,232	22,015
Babbitt metal				
United States	52,700	24,831	35,800	3,953
Britain	24,400	4,263	29,500	24,565
Total	77,100	29,094	65,300	28,518
	Long Tons		Long Tons	
Consumption				
Tinplate and tinning	2,108		2,112	
Solder	1,162		1,179	
Babbitt	299		255	
Bronze	234		158	
Galvanizing	7		9	
In other products including foil and collapsible tubes	143		167	
Total	3,953		3,880	

SOURCE: Dominion Bureau of Statistics.

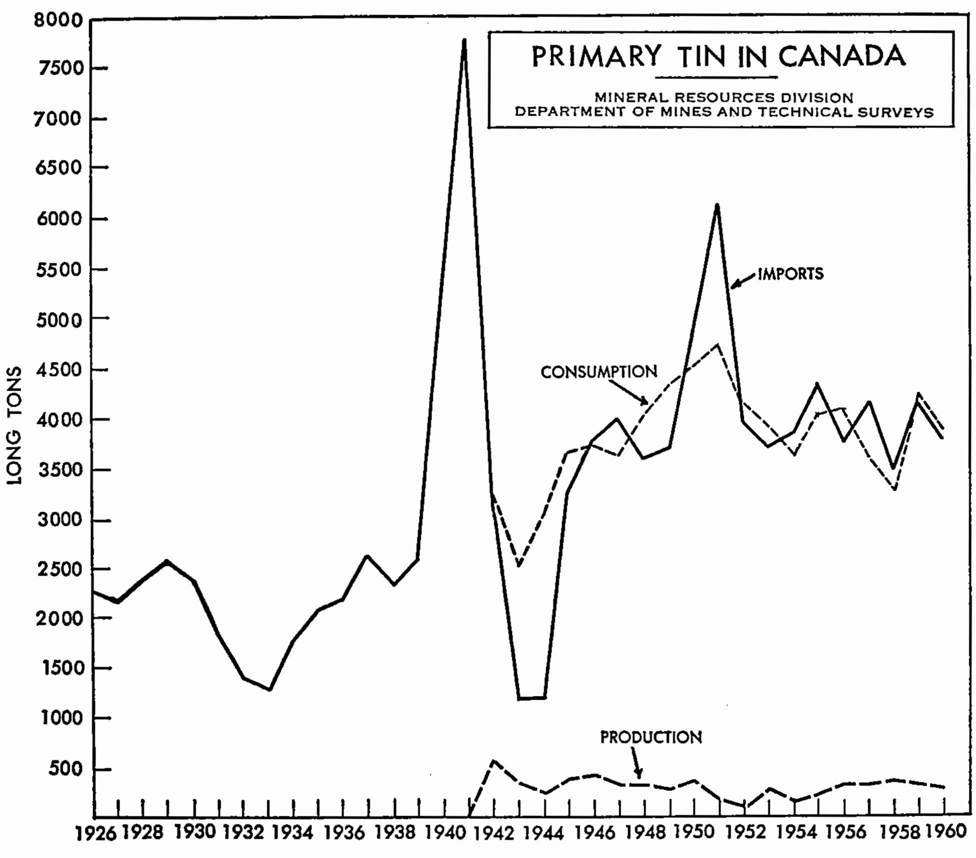
Table 2

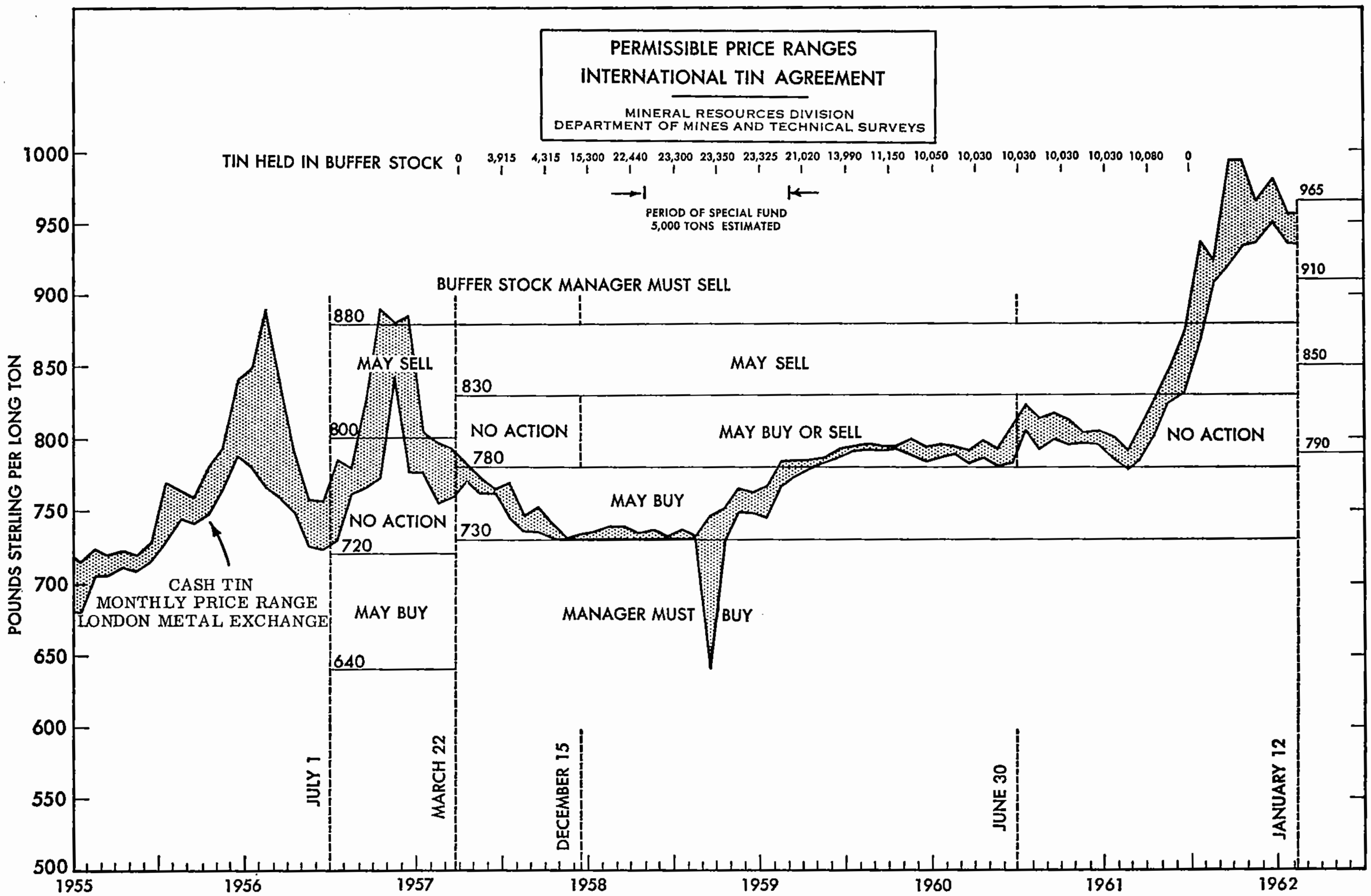
TIN—PRODUCTION, IMPORTS AND CONSUMPTION, 1951-61

(long tons)

	Production	Imports				Consumption
	Tin Content	Blocks, Pigs, Bars	Tin Foil	Babbitt Metal	Tinplate	Virgin Tin
1951	155	6,135	4	13	1,531	4,731
1952	95	3,949	1	18	1,287	4,190
1953	287	3,702	7	22	6,442	3,903
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

Source: Dominion Bureau of Statistics. *Subject to revision.





PERMISSIBLE PRICE RANGES
INTERNATIONAL TIN AGREEMENT
MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
TIN HELD IN BUFFER STOCK
0 3,915 4,315 15,300 22,440 23,300 23,350 23,325 21,020 13,990 11,150 10,050 10,030 10,030 10,030 10,030 10,080 0
PERIOD OF SPECIAL FUND
5,000 TONS ESTIMATED
BUFFER STOCK MANAGER MUST SELL
MAY SELL
MAY SELL
NO ACTION
NO ACTION
MAY BUY OR SELL
NO ACTION
MAY BUY
MAY BUY
MANAGER MUST BUY
CASH TIN
MONTHLY PRICE RANGE
LONDON METAL EXCHANGE
880
830
800
780
720
730
640
965
910
850
790
POUNDS STERLING PER LONG TON
1000
950
900
850
800
750
700
650
600
550
500
JULY 1
MARCH 22
DECEMBER 15
JUNE 30
JANUARY 12
1955
1956
1957
1958
1959
1960
1961
1962

WORLD DEVELOPMENTS

The First International Tin Agreement was in force from July 1, 1956, to June 30, 1961. Controls on production and exports were in effect from December 1957 to September 1960 to balance supply and demand. In addition, price movements were modified by means of a buffer stock operated by a manager appointed by the International Tin Council. In June 1961, prices on the London Metal Exchange rose to the point at which the sale of buffer-stock holdings became obligatory and the stock was exhausted by June 20, before the termination of the Agreement. The Second International Tin Agreement, drawn up for a five-year period, went into effect provisionally on July 1, 1961, but definitive entry into force was not possible by the end of the year. In January 1962, the Tin Council agreed to raise the permissible ranges as shown on the accompanying price graph, which illustrates the price movements of the last seven years.

TABLE 3

TYPICAL METHOD OF CALCULATING CHARGES FOR SMELTING TIN CONCENTRATE

- A. Gross assay of dry tin concentrate
  - Deductions
    - Fe — For each 5% above 5% deduct 0.1% Sn
    - WO_3 — For each 5% above 5% deduct 0.1% Sn
    - Sn — For 74% or less concentrate deduct 1 unit[1]
    - Sn — For each 0.1% below 74% deduct 0.01 unit
- B. Net assay
- C. Gross value = B multiplied by market price of tin metal[2]
  - Deductions per ton of concentrate
    - Basic smelter charge $25.56
    - Sn — For each 0.2% below 74% deduct $0.06
    - S — 1% free; over 1% deduct $1.42
    - As — For each 0.1% over 0.1% deduct $0.57
    - Cu, Pb, Bi, Sb combined—For 0.1% deduct $1.15 plus $0.57 for each 0.1% above
    - Sb — Over 0.1% deduct $1.15 plus $0.57 for each 0.1% above
- D. Total of deductions
- E. Net return for concentrate delivered to smelter—C minus D.

[1] 1 unit=22.4 pounds. [2] Per long ton, usually on the basis of London or Singapore prices.

Table 6, which shows the Free World tin position, indicates that for 1961 consumption exceeded smelter production but not the available supply. Commercial stocks, sales from the buffer stock and sales from government noncommercial stocks made up the difference. The only countries known to have noncommercial stocks are now Italy, Canada and the United States. In 1957 Canada gave notice of its intention to sell a 2,678-ton stockpile, and sales through an appointed agent began at a slow rate in August 1961. The timing was affected by the world statistical position. As a member of the Tin Council, Canada entered into full consultation with interested governments, industry and its own government departments before authorizing sales within its boundaries. A lower price limit was set, but the influence of the London, Singapore and New York markets kept the actual prices substantially higher.

Starting in May 1959, Britain sold 2,500 tons of noncommercial stocks; and after December of that year it sold the remaining 2,417 tons. In March 1960 the government of Italy began to dispose of its 2,500-ton stockpile. By the second half of 1961, the United States government had sold most of a special tin stock of 3,933 tons, but had made no decision on the Congress release of 50,000 tons of tin from the strategic stockpile. The stocks at present held by the United States government are made up as follows: the national stockpile, 341,000 tons; the supplemental stockpile, 7,505 tons; the Defense Production Act inventory, none. Of the total, 164,000 tons have been declared surplus to defence needs.

TABLE 4

ESTIMATED WORLD PRODUCTION OF TIN-IN-CONCENTRATES

(long tons)

	1961	1960
Malaya	56,028	51,979
China	24,000	24,000
Indonesia	18,574	22,599
Bolivia	20,664	19,407
Thailand	13,270	12,081
Republic of the Congo and Ruanda Urundi	8,044	10,177
Federation of Nigeria	7,779	7,675
Other countries	13,640	12,085
Total	162,000	160,000

SOURCE: *International Tin Council Statistical Bulletin.* Russia not included.

TABLE 5

ESTIMATED WORLD PRODUCTION OF PRIMARY TIN METAL

(long tons)

	1961	1960
Malaya and Singapore	79,114	76,130
Britain	24,449	26,286
China	24,000	24,000
United States	8,500	13,500
Belgium	6,002	7,947
Netherlands	2,729	6,393
Republic of the Congo	2,400	3,500
Other countries	15,806	12,244
Total	163,000	170,000

SOURCE: *International Tin Council Statistical Bulletin.* Russia not included.

The bulk of world tin production comes from placer mining in Indonesia, Malaya and Thailand, but the lode deposits of Bolivia, China, the Republic of the Congo and Nigeria, as well as their placer mines, are also important. Minable grades very greatly according to labor costs, mining methods, mill recovery and transportation to the smelter. The charges levied by a particular

Titanium

V. B. Schneider*

The value of titanium shipped in 1961 in ore, heavy aggregate and titanium-bearing slag was $16,923,743. This was $3,976,743 above the previous all-time high for Canadian production recorded in 1960. Nearly all of this was accounted for by titanium-dioxide slag produced from Allard Lake ilmenite and smelted at Sorel.

The Canadian titanium industry, which attained its present status in 1950 when Quebec Iron and Titanium Corporation (QIT) commenced its Sorel operations, is based mainly on the mining of ilmenite for the production of titanium-dioxide slag used in making pigments. To a minor degree ilmenite is also used as heavy aggregate and for the manufacture of ferrotitanium. Ilmenite is mined in the Allard Lake and St. Urbain areas of Quebec. Most of the Allard Lake ore 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. Most of the slag is exported, mainly to the United States, for use as raw material in the manufacture of titanium-base pigments. Some is shipped to Canadian Titanium Pigments Limited, at Varennes, Quebec. In recent years most of the ore from the St. Urbain area has been used as heavy aggregate. In 1961 Atlas Titanium Limited began producing ferrotitanium at Welland, Ontario.

The production of titanium dioxide pigments began in 1918, but their use developed very slowly at first. It is estimated that in 1950 world consumption of titanium dioxide (TiO_2) in pigments was approximately 730 million pounds; in 1961 world consumption was probably around 1,500 million pounds.

The development of the TiO_2 pigment industry has been more rapid in the United States than elsewhere and installed capacity by January 1962 was about 667,000 short tons of TiO_2. This capacity is expected to approach 700,000 tons a year by 1963.† Increased demand for pigment-bearing slag during 1961 made it possible for QIT, which is the only commercial producer of slag, to operate at capacity throughout the year. When slag is used in the manufacture of pigments instead of ilmenite concentrate the capital outlay for the plant is far less and acid consumption is about 30 per cent lower. On the other hand, the unit cost of the titanium-dioxide content of the slag is higher. Kennecott Copper Corporation, QIT's parent company, announced in its 1961 annual report that an agreement had been reached with National Lead Company whereby QIT will conduct a joint engineering evaluation of the treatment of Norwegian ilmenite concentrate to produce titanium slag and iron.

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* Mineral Resources Division.

† U.S. Bureau of Mines, *Minerals Yearbook 1960*, volume 1, page 1130.

TABLE 1

TITANIUM IMPORTS

(titanium oxide and pigments containing not less than 14 per cent titanium oxide)

	1961		1960	
	Short Tons	$	Short Tons	$
United States	15,924	3,503,991	16,674	3,386,029
Britain	10,382	4,460,194	9,675	4,052,615
Japan	209	65,253	22	6,584
Czechoslovakia	103	36,324	106	35,972
West Germany	1	226	—	—
Italy	—	—	249	104,091
Belgium and Luxembourg	—	—	170	62,987
Netherlands	2	871	—	—
Total	26,621	8,066,859	26,896	7,648,278

SOURCE: Dominion Bureau of Statistics.

E. I. du Pont de Nemours and Co., Inc., announced plans to expand its plant at New Johnsonville, Tennessee, where it uses a chloride, rather than a sulphate, process. Also of significance is that the company has successfully used Australian rutile for the manufacture of TiO_2 pigment. *The Australian Mineral Industry*, volume 14, No. 2, December 1961, reports: "East-coast producers have been asked to tender for initial quantities of 30,000 tons of rutile per annum with deliveries to commence in 1962."

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 checker-board 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 4 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.

Heavy aggregate is used for shielding nuclear reactors, as a weighting material for oil- and gas-transmission lines and as Diesel-locomotive ballast. The value of aggregate varies according to size and specific gravity but is about $6 a ton for pipeline grade and $10 for reactor grade, f.o.b. shipping point.

Two thirds of the refined titanium dioxide and extended titanium dioxide pigments consumed in Canada are used in the manufacture of paints; 11 per cent in the manufacture of floor covering; 5 per cent in the manufacture of rubber and plastics; and 18 per cent in the manufacture of pulp, paper, oilcloth and miscellaneous products. An estimated 250 tons of ferrotitanium are used each year by Canada's primary iron and steel industry.

PRODUCTION AND DEVELOPMENTS IN CANADA

Quebec Iron and Titanium Corporation (QIT)

This company operates eight electric-arc smelting furnaces at its Sorel, Quebec, smelter. An expansion program, commenced in 1960 and completed early in 1961, increased the plant's ore-treating capacity from 864,000 tons to 1,100,000 tons a year.

Prior to treatment in the electric furnaces ilmenite ore 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 eliminate sulphur. Electric smelting of the calcine, in arc furnaces with powdered anthracite coal, yields a slag, containing about 70.5 per cent TiO_2 and 14 per cent FeO, and a low-phosphorus iron containing about 0.12 per cent sulphur and 2.25 per cent carbon.

QIT 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 reserve is in the Allard Lake area of Quebec about 22 miles north of Havre St. Pierre, which is about 500 miles downriver from Sorel.

TABLE 2

QIT PRODUCTION

(gross tons)

	1961	1960
Ore treated	1,032,122	863,726
Titanium slag produced	413,715	345,213
Iron produced	277,107	221,945

SOURCE: Kennecott Copper Corporation's annual report for 1961.

TABLE 3

ANALYSIS RANGE OF QIT TITANIA SLAG

(per cent)

	Pigment Grade	Metal Grade
TiO_2	70 —72	74.0 —76.0
FeO	12.0 —15.0	8.0 —11.0
Fe (uncombined)	1.5 max.	1.5 max.
SiO_2	3.5 — 5.0	3.5 — 5.0
Al_2O_3	4.0 — 6.0	4.0 — 6.0
CaO	1.2 max.	1.2 max.
MgO	4.5 — 5.5	4.5 — 5.5
Cr_2O_3	0.25 max.	0.25 max.
V_2O_5	0.5 — 0.6	0.5 — 0.6
MnO	0.2 — 0.3	0.2 — 0.3
C	0.03— 0.10	0.03— 0.10
S	0.03— 0.10	0.03— 0.10
P_2O_5	0.025 max.	0.025 max.
Ti_2O_3 as TiO_2	10.0 —15.0	13.0 —20.0

SOURCE: Company's sales literature.

Continental Titanium Corp.

Continental Titanium Corp., formerly Continental Iron & Titanium Mining Limited, owns mining rights in the St. Urbain area about 8 miles north of Baie St. Paul, which is on the north shore of the St. Lawrence River 60 miles downriver from Quebec City. The company reports measured and indicated reserves of 12.5 million tons averaging 35 per cent iron and 37 per cent TiO_2 and inferred reserves of 8 million tons. Work, which began on a pigment plant at Baie St. Paul in October 1960, was suspended shortly afterwards. However, the company expects to resume work on this plant in 1962.

Canadian Titanium Pigments Limited

This company, a wholly owned subsidiary of National Lead Company, of New York, continued full-time operations throughout 1961 of its titanium dioxide pigment plant at Varennes, Quebec. During the final quarter of the year, an expansion project, increasing the capacity of the plant from 16,000 tons to 25,000 tons per year, was completed at a cost of approximately $6,000,000. The growing market for the company's pigments necessitated these additions to the existing plant at Varennes. The company manufactures anatase and rutile-type titanium dioxide pigments. As in previous years, titanium-bearing slag from the QIT operation at Sorel, and liquid sulphur, recovered by Laurentide Chemicals & Sulphur Ltd. from waste oil-refinery gases at Montreal East, continued as the two main raw material sources. 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 and expects to complete construction by mid-1962. The plant, which will have an initial rated capacity of 44 million pounds of pigments a year, will use titanium-dioxide slag from QIT and will initially buy sulphuric acid. Ultimately, the BTP(C) Ltd. plant will manufacture its own acid.

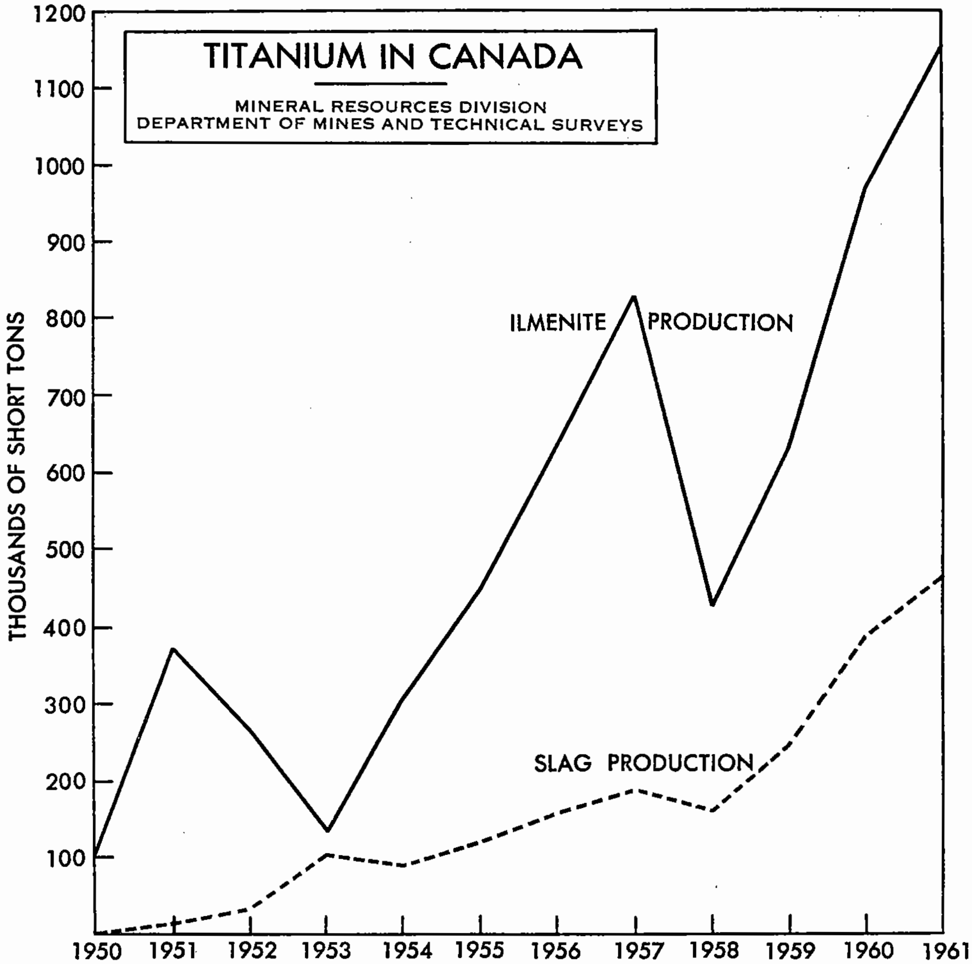
TABLE 4

PRODUCTION OF ILMENITE AND TITANIUM-DIOXIDE SLAG AND IMPORTS OF TITANIUM OXIDE AND PIGMENTS, 1951-61

(short tons)

	Production		Imports
	Ilmenite[1]	Titanium-dioxide Slag (TiO_2 content)[2]	Titanium Oxide and Pigments[3]
1951	373,786	14,123	29,648
1952	266,461	30,805	24,205
1953	129,965	100,527	31,900
1954	304,550	88,408	32,106
1955	445,635	117,042	35,799
1956	630,197	157,374	37,872
1957	824,432	186,422	34,234
1958	420,932	161,312[4]	29,439
1959	626,310	243,670[4]	30,598
1960	967,373	386,639[4]	26,896
1961	1,155,977	463,316[4]	26,621

SOURCES: Dominion Bureau of Statistics for production from 1951 to 1957 inclusive and for imports from 1951 to 1961 inclusive; company annual reports for production from 1958 to 1961 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% TiO_2.



SOURCE: D. B. S. 1950-1957
COMPANY ANNUAL REPORTS 1958-1960

According to a brief submitted to the Tariff Board by Canadian Titanium Pigments Limited and British Titan Products (Canada) Limited, January 9, 1961 (Reference No. 120), the domestic consumption of titanium dioxide is about 70 million pounds annually and is expected to increase to 92 million pounds by 1965.

With a combined annual capacity of 94 million pounds the two Canadian pigment producers will be able to meet domestic requirements. Either plant is capable of ready expansion to meet any unexpected increase in domestic needs or export requirements. Canadian imports of titanium-based 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, at about 15,000 tons and 10,000 tons respectively. It is probable that imports, particularly from Britain, will be sharply reduced when the new plant at Ville-de-Tracy is completed.

WORLD PRODUCTION OF TITANIUM ORES, CONCENTRATES, AND SLAGS

In 1961 world production of titanium concentrates exceeded 2.5 million tons. Thus for the second consecutive year production established a new record; production in 1960 was approximately 2.3 million tons of ilmenite and rutile concentrate, and titanium slag.

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, Russia. Generally, however, only ilmenite and rutile are considered commercially important. The maximum titanium-dioxide content of ilmenite is theoretically 53 per cent; that of rutile is theoretically 100 per cent.

By far the greatest percentage of 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 QIT 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 excessive. At Sorel, a pyrometallurgical process is used to separate the iron as molten metal from the ilmenite and associated hematite.

In the United States it is expected that TiO_2 production in 1961 will have been slightly higher than that of 1960, which was 455,000 tons, but below the record of 506,000 tons established in 1959. Production of ilmenite rose to an estimated 837,000 tons, a new high. Production of titanium tetrachloride was 29,300 tons, the highest since 1957 when 78,600 tons were produced; production and consumption of ingot were 9,371 and 8,878 tons respectively, also the highest since 1957, when production and consumption of ingot were 10,009 and 10,428 tons.*

Laporte Titanium Limited, London, England, announced the letting of a contract for the construction of a pigment plant at Bunbury, Australia. The plant, which is expected to be in operation by late 1963, will have the capacity to produce 10,000 tons of TiO_2 pigments a year.

TABLE 5

PRODUCTION OF RUTILE CONCENTRATES

(short tons)

	1961	1960	1959
Australia	113,344[r]	99,266	91,734
United States	9,045	8,808	9,466
Union of South Africa	3,483	3,695	3,381
Other countries (not including Russia)	2,428[e]	2,431[r]	1,819[2]
Total	128,300[e]	114,200[r]	106,400

SOURCE: U.S. Bureau of Mines, *Minerals Yearbook 1961* (Titanium Preprint).

[r]Revised from previously published figure.

[e]Estimate.

* U.S. Bureau of Mines, *Mineral Industry Surveys*, "Titanium Metal Quarterly Report No. 20," February 14, 1962.

TABLE 6

PRODUCTION OF ILMENITE CONCENTRATES

(short tons)

	1961	1960	1959
United States	782,412	786,372	634,886
Canada*	463,362	389,586 r	270,477
India	191,800	275,575	334,024 r
Norway	342,820	255,643 r	249,274
Australia	193,312	120,096	93,606
Finland	21,272	92,219	94,966
Union of South Africa	99,009	90,432	87,233
Other (not including Russia) e	219,313	194,877 r	172,434 r
Total	2,313,300	2,204,800 r	1,936,900 r

SOURCE: U.S. Bureau of Mines, *Minerals Yearbook 1961* (Titanium Preprint).
*Production of slag containing about 72 per cent TiO_2 and small quantities of titanium ore.
r Revised from previously published figure.
e Estimate.

TITANIUM METAL PRODUCTION AND FABRICATION

Using technical-grade titanium dioxide manufactured by Canadian Titanium Pigments Limited, Dominion Magnesium Limited, near Haley Station, Ontario, produced titanium in the form of sintered pellets weighing from 5 to 7 grams each. The principal application for these pellets is for special fuses and production is sold almost entirely in Britain. Shipments in 1961 amounted to slightly more than 12,000 pounds.

Commercial producers of titanium metal in the United States are: Union Carbide Metals Company, Ashtabula, Ohio; E. I. du Pont de Nemours and Co., Inc., Newport, Delaware; Reactive Metals Inc., Ashtabula, Ohio; and Titanium Metals Corporation of America, Henderson, Nevada. Metal producers in Japan are: Osaka Titanium Manufacturing Co., Osaka; Toho Titanium Industry Co., Tokyo; and Nippon Soda Co., Ltd., Tokyo. In Britain, Imperial Chemical Industries Limited, Birmingham, is the principal producer. There is no available information about the titanium industry in the Union of Soviet Socialist Republics.

During 1961 sponge-metal production and consumption in the United States increased for the second successive year. According to the United States Bureau of Mines, sponge production was 6,100 tons, up almost 800 tons from 1960; sponge consumption was 6,400 tons, up almost 1,000 tons.*

Atlas Titanium Limited, a subsidiary of Atlas Steels Limited, completed the installation of its reactive metals research laboratory. Installed equipment includes a production vacuum melting furnace with a capacity of 11,000 pounds of titanium or 19,000 pounds of steel. As in previous years much of Atlas Titanium's production was material converted for United States companies.

*U.S. Bureau of Mines, *Mineral Industry Surveys*, Mineral Market Report M.M.S. 3317, "Titanium in 1961 (Preliminary)," December 5, 1961.

Macro Division of Kennametal Inc., Port Coquitlam, British Columbia, manufactures tungsten-titanium carbide and titanium-carbide powder for use in cemented-carbide alloys. Rutile and refined titanium dioxide are the company's sources of titanium.

TITANIUM PIGMENTS AND OTHER TITANIUM PRODUCTS

Outstanding properties of titanium-dioxide pigments that recommend them for many applications include their high opacity and covering power, chemical inertness, and low specific gravity. These pigments are used in the manufacture of paint, ceramics, cosmetics, paper, and textiles.

Although ilmenite, slag, or manufactured titanium dioxide may be used as a source of titaniferous material in welding-rod coatings, titanium dioxide in the natural form of rutile is considered the most desirable material for this purpose. Artificially prepared crystals of titanium dioxide have a very high index of refraction and are used as gem stones. High-, medium- and low-carbon ferrotitanium, the major grades of alloys of titanium with iron, are made for use as iron and steel additives. As an additive, ferrotitanium acts as a deoxidizer, provides fluxing action for some slags, prevents segregation of carbon and sulphur in rail steels, reduces grain size in cast steel and improves ductility. In stainless steel it forms titanium carbides, thus allowing chromium to remain in solution when the steel is heated.

Of 1960 Canadian consumption of titanium products, only that of ferrotitanium, 257 short tons, was known at this writing. Consumption in 1959 is given in Table 7.

TABLE 7

CANADIAN CONSUMPTION OF REFINED TITANIUM DIOXIDE, EXTENDED TITANIUM-DIOXIDE PIGMENTS AND FERROTITANIUM, 1959

	Short Tons	$
Refined titanium dioxide (TiO_2)		
Paints	15,316	7,985,330
Polishes and dressings	128	75,239
Pulp and paper	2,244	1,093,697
Linoleum and oilcloth	2,301	1,259,474
Rubber goods	871	437,118
Miscellaneous nonmetallic minerals	516	280,498
Total	21,376	11,131,356
Extended titanium-dioxide pigments		
Paints	14,489*	3,214,999
Ferrotitanium		
Primary iron and steel	101	

SOURCE: Dominion Bureau of Statistics.

*Estimated TiO_2 content 4,300 tons.

PRICES

The quotations which follow are from *E & M J Metal and Mineral Markets.* Prices for ilmenite, rutile and titanium metal are from the issue of December 28, 1961; the price for ferrotitanium is from the issue of December 21, 1961.

Ilmenite, per gross ton f.o.b. cars Atlantic ports	
$59\frac{1}{2}$% TiO_2	\$ 23.00 - \$ 26.00
54% TiO_2	\$ 21.00 - \$ 21.50
Rutile, per short ton delivered within 12 months, 94% TiO_2	\$ 80.00 (nominal)
Titanium metal, A-1, 99.3%, per lb, f.o.b. shipping point	
Fe 0.3% max.	\$ 1.50
Fe 0.15% max.	\$ 1.60
Ferrotitanium	
Per lb contained Ti, lots of ton or more, lump ($\frac{1}{2}$), packed, delivered NE. U.S.	
40% Ti max., 0.1% C max.	\$ 1.35
25% Ti max., 0.1% C max.	\$ 1.50
Per net ton, carload lots, lump, packed, delivered NE. U.S.	
17-21% Ti, 3-5% C	\$290.00 - \$295.00
15-19% Ti, 6-8% C	\$240.00 - \$245.00

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	$12\frac{1}{2}$%	15%
Ingots, blooms, slabs, billets of titanium, or titanium alloys for use in Canadian manufactures (expires June 30, 1964)	free	free	25%

United States	
Titanium ore, crude	free
Titanium metal	20%
Ferrotitanium	11%
Titanium potassium oxalate and all compounds and mixtures containing titanium.	15%

Tungsten

V. B. Schneider*

Canada has produced no tungsten 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 the United States General Services Administration. The company still holds a stockpile containing approximately 37,000 short-ton units of tungsten trioxide (WO_3).

Canada Tungsten Mining Corporation Limited continued exploration and development work on its property near 61°57'N. and 128°16'W., which is just east of the Yukon-Northwest Territories boundary and 135 miles north of Watson Lake. Diamond-drilling indicated a tungsten deposit of 1.65 million tons grading 2.4 per cent tungsten trioxide, and beneficiation tests have proven that a commercially acceptable scheelite ($CaWO_4$) concentrate can be obtained from the ore. In 1961, some 400 feet of drifting in the form of an adit and some 5,000 feet of underground and surface diamond-drilling were completed.

A 130-mile two-operation road-building program continued throughout the year and will be completed in 1962. In its effort to develop the Northwest Territories, the federal government is assuming the cost of 80 miles of the road. The federal authorities will also pay for two thirds of the remaining 50-mile access road to the property, and the company will bear the cost of one third. Some 3,500 tons of freight shipped over a winter road to the minesite during the winter of 1961-62 and materials flown in earlier and during the winter have made it possible for the company to complete its building program and be ready to ship concentrate late in 1962.

Under an arrangement announced by Canada Tungsten early in 1961, American Metal Climax Inc., Dome Mines Limited and Ventures Limited agreed to finance the property and bring it into production. Open-pit mining, at the rate of 100,000 tons a year, is expected to start in the summer of 1962, and milling by early fall.

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*Mineral Resources Division.

Table 1

TUNGSTEN—IMPORTS AND CONSUMPTION

	1961		1960	
	Pounds	$	Pounds	$
Imports				
Scheelite[1]				
United States	250,000	247,775	200,000	214,967
Korea	50,000	42,088	454,000	400,901
Peru	—	—	134,900	101,490
Thailand	—	—	110,800	82,385
Bolivia	91,600	48,338	107,700	68,794
Argentina	55,100	29,095	94,400	57,777
Brazil	55,100	36,031	55,100	36,694
Total	501,800	403,327	1,156,900	963,008
Ferrotungsten[2]				
Britain	445,400	217,796	976,000	541,445
Belgium and Luxembourg	58,300	62,037	—	—
Austria	6,600	6,836	—	—
Portugal	6,100	7,346	—	—
United States	1,900	3,401	4,700	2,075
Total	518,300	297,416	980,700	543,520
Consumption (W content)				
Scheelite	641,368		711,160	
Tungsten metal and metal powder	19,595		13,841	
Tungsten wire	8,482		7,775	
Ferrotungsten	80,567		91,192	
Tungsten-carbide powder	78,854		112,637	
Sodium tungstate and tungstic oxide	14,362		10,617	
Total	843,228		947,222	

Source: Dominion Bureau of Statistics.
[1]As reported in *Trade of Canada*. The tungsten-trioxide content is not given.
[2]As reported in *Trade of Canada*. The tungsten content is not given.

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. Wolframite has been found in stream gravels and in quartz veins in the Atlin area of northern British Columbia and Yukon Territory.

TABLE 2

TUNGSTEN—PRODUCTION, TRADE AND CONSUMPTION 1951-61

(pounds)

	Production[1] (WO$_3$ content)	Imports[2] Tungsten	Imports[2] Ferrotungsten	Exports[3] Scheelite (W content)	Consumption[4] (W content)
1951	2,833	56,400	1,008,300		290,618
1952	1,493,111	112,300	493,100	1,700,000	595,412
1953	2,446,028	254,100	62,000	1,236,000	259,100
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

Source: Dominion Bureau of Statistics.

[1]Producers' shipments of scheelite.

[2]As reported in *Trade of Canada*. The 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.

WORLD PRODUCTION, TRADE AND USES

The year's trade reports indicate that the production and consumption of tungsten were somewhat more than in 1960, for which the output has been estimated at 69,400 short tons of tungsten trioxide.[1] The downturn in the market caused a decrease in prices in both New York and London. The London Metal Market price decreased from 148 shillings a long-ton unit of tungsten trioxide in December 1960 to 89 shillings in December 1961, the basis being 65 per cent. The New York price dropped from $18.50 a short-ton unit of tungsten trioxide to $12.75 in the same period. The British ton unit is 22.4 pounds; the United States and Canadian is 20.0 pounds. The increased sale of Communist-bloc tungsten ore in western Europe has added to the difficulties of Free World producers.

The United States is the leading importer and consumer of tungsten ores and concentrates. At 2,170,000 pounds of contained tungsten,[2] however, its 1961 imports of concentrates for consumption were the lowest since 1931, when they totalled 1.5 million pounds. The country's production, most of which was used to supply the domestic market, amounted to 8,026,000 pounds of contained tungsten, or more than 77 per cent of its domestic consumption. This indicates that United States producers are attaining a strong competitive position. The principal mines producing in 1961 were the following: the Pine Creek mine of Union Carbide Nuclear Company, near Bishop, California; the Climax mine of American Metal Climax, Inc., at Climax, Colorado; the Hamm mine of Tungsten Mining Corporation, in Vance county, North Carolina; and the Calvert mine of Minerals Engineering Company, in Beaverhead county, Montana. Several small mining and milling operations were reported in other areas. South Korea, Bolivia, Australia and Portugal supplied 83 per cent of the United States imports; minor amounts were imported from Spain, Mexico, the Netherlands, British East Africa, Brazil and Argentina.

[1] U.S. Bureau of Mines, *Mineral Trade Notes, Oct. 1962.*

[2] U.S. Bureau of Mines, *Mineral Industry Surveys*, "Tungsten Report No. 120," February 26, 1962.

TABLE 3

WORLD PRODUCTION OF TUNGSTEN ORE AND CONCENTRATES, 1961*

(short tons)

China[e]	22,000
Russia[e]	11,000
North Korea[e]	5,500
South Korea	7,529
United States[1]	8,245
Bolivia[2]	3,104
Portugal	3,213
Other countries	13,609
Total	74,200

Source: U.S. Bureau of Mines, *Mineral Trade Notes, Oct. 1962.*
*Basis—60 per cent WO_3.
[e]Estimated.
[1]Shipments.
[2]Exports.

CONSUMPTION AND USES

The use of cemented tungsten carbide increased enormously during the last decade through improvements in the technology of tungsten-carbide manufacture. One pound of tungsten in the form of carbide tools does as much work in metal-cutting as 60 pounds used in tool steel that is 18 per cent tungsten. This has changed the pattern of the end-uses of tungsten. About 15 years ago, 90 per cent of the tungsten consumed went into the manufacture of ferrous alloys and 5 per cent into the manufacture of tungsten carbides. Today, in the United States, 37 per cent of all tungsten consumed is used in the manufacture of tungsten carbides, 32 per cent in ferrous alloys, 15 per cent as tungsten metal, 14 per cent in high-temperature and other nonferrous alloys and 2 per cent in chemicals.

Tungsten carbide is used for tipping such tools as milling cutters, reamers, punches and drills; as dies for wire- and tube-drawing; in such wear-resistant parts as gauges, valve seats and valve guides; and as cores in armor-piercing shells.

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 pure metal is used in ignition and other contact points in the automotive industry. It is also used for incandescent-lamp filament and in making certain types of bronze.

Some consumers of tungsten in Canada are: in Ontario—Atlas Steels Limited, Welland; Canadian General Electric Company Limited, A. C. Wickman Limited, Johnson, Matthey and Mallory Limited and J. K. Smit and Sons of Canada Limited, all of Toronto; Canadian Westinghouse Company, Limited, Hamilton; Dominion Colour Corporation Limited, New Toronto; Deloro Smelting

& Refining Company, Limited, Belleville; and Wheel Trueing Tool Company of Canada Limited, Windsor; in Quebec—Crucible Steel of Canada, Limited, Sorel; and in British Columbia—Kennametal of Canada Limited, Victoria, and Boyles Bros. Drilling Company, Ltd., Vancouver.

Atlas Steels Limited is Canada's leading consumer of tungsten in the form of scheelite or ferrotungsten.

Macro Division of Kennametal Inc., Port Coquitlam, British Columbia, is the only manufacturer of tungsten-carbide powder in Canada. Besides pure tungsten carbide, the company manufactures pure tungsten-trioxide powder, tungsten-metal powder and tungsten-titanium carbide. It makes such other products as tungsten-carbide ball-mill balls and 'Kenspray', a composition of tungsten-carbide particles bonded with a suitable matrix powder ready for application by conventional thermal spraying techniques. As raw material, the company uses wolframite, hubnerite and scheelite concentrates of standard grade.

PRICES

According to *E & M J Metal and Mineral Markets* of December 28, 1961, tungsten prices in the United States were as follows:

Tungsten ore	Per short-ton (20-lb) unit WO_3, basis 65%, foreign, c.i.f. U.S. ports, import duty extra	
	Wolfram	\$12.75 to \$13.25
	Scheelite	\$12.75 " \$13.25
Tungsten metal	Per lb	
	98.8% min., 1,000-lb lots	\$ 2.75
	Hydrogen reduced 99.99%	\$ 2.70 to \$ 3.55
Ferrotungsten	Per lb contained W, 70-80%, lots 5,000 lb or more, f.o.b. destination U.S.	\$ 2.45 (nominal)
Tungstic acid	Per lb, 1,000-lb lots in drums (according to *Oil, Paint and Drug Reporter,* Dec. 25, 1961)	\$ 2.25

TARIFFS

Canada	British Preferential	Most Favored Nation	General
Tungsten ores and concentrates	free	free	free
Tungsten oxide in powder or lumps or in briquettes made with binding material used in steel manufacture	"	"	5%
Tungsten carbide, in metal tubes for use in Canadian manufacturing	"	"	free
Ferrotungsten	"	5%	5%
Tungsten rod and tungsten when used in Canadian manufacture	"	5%	25%

United States	
Tungsten ore and concentrates	50¢ per lb on tungsten content
Tungsten carbide and metal and combinations or mixtures containing carbide or tungsten metals, all the foregoing in grains, lumps or powder	42¢ per lb on tungsten content plus 25% ad valorem
Chromium-cobalt tungsten, chromium tungsten, ferrochromium tungsten, tungsten nickel and all other alloys of tungsten not specifically provided for	42¢ per lb on tungsten content plus 12½% ad valorem
Tungstic acid and all other compounds of tungsten not specifically provided for	42¢ per lb on tungsten content plus 20% ad valorem
Ferrotungsten	42¢ per lb on tungsten content plus 12½% ad valorem

Uranium

J. W. Griffith*

Uranium deliveries continued to decline in 1961 as the industry made further adjustments to meet the new conditions of delivery under the stretch-out plan. Shipments of uranium oxide decreased to about 9,641 tons valued at $196 million from the 12,748 tons and 15,892 tons shipped in 1960 and 1959 respectively. The production decline is expected to continue for the next five years, as indicated in the accompanying graph.

To meet the arrangements offered under the stretch-out plan, which was announced by the federal government in November 1959, 12 mines were closed between the early part of 1960 and the end of 1961 and their unfulfilled contracts were transferred to other producers. Three of these mines closed in 1961, but by the middle of the year the industry was sufficiently stabilized to allow eight mines, operated by seven companies, to remain in production until the dates shown in the graph, at which their contracts are to be fulfilled. When these dates were set, no account was taken of private sales, the stockpiling of concentrates or the possibility of additional contracts.

On December 31, 1961, the amount of uranium oxide (U_3O_8) remaining to be delivered under the stretch-out plan, which will be in effect until November 1966, was approximately 21,000 tons. This does not include 12,000 tons of unallocated uranium scheduled for delivery to the United Kingdom Atomic Energy Authority (UKAEA) under letters-of-intent between March 31, 1963, and December 31, 1966. During the latter half of 1961, however, the UKAEA was renegotiating delivery date and price. When the year ended, complete agreement had not been reached, but further talks between Canadian and British officials were planned.

The number of employees in Canadian uranium mines declined from about 6,000 at the beginning of 1961 to about 4,650 at the end of the year. The all-time high, 13,626, was reached in mid-1959.

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*Mineral Resources Division.

TABLE 1

URANIUM—PRODUCTION AND EXPORTS

	1961		1960	
	Short Tons	$	Short Tons	$
Production (U_3O_8)—shipments				
Ontario	7,485	151,060,610	9,897	211,983,533
Saskatchewan	2,156	44,631,014	2,312	48,722,961
Northwest Territories	—	—	539	9,231,698
Total	9,641	195,691,624	12,748	269,938,192
Exports (U_3O_8)				
United States		173,914,072		236,594,407
United Kingdom		18,255,934		25,904,553
West Germany		512,658		293,971
Japan		39,733		147,011
India		—		570,480
Sweden		—		27,720
Other countries		—		2,790
Total		192,722,397		263,540,932

Source: Dominion Bureau of Statistics.

PRODUCERS

Ontario

In the Elliot Lake district, four mines were still producing at the end of the year—Denison Mines Limited, Stanrock Uranium Mines Limited and two mines (Milliken and Nordic) owned by Rio Algom Mines Limited. At all four mines, however, operating costs were lower than in 1960. To prolong its production, Rio Algom closed its Quirke mine in January and its Panel mine in June and reduced manpower and substantially lowered the production rates at Milliken and Nordic. Some buildings and land at the Quirke mine were leased to the provincial government for use as a reform institution. Preston Mines Limited closed its Stanleigh mine in January, and Algom agreed to deliver virtually all of what remained under Stanleigh's contract.

Early in 1961, the Government of Ontario granted interest-free loans to the town of Elliot Lake. The community is to receive $1,132,000 in each of the years 1961, 1962 and 1963 and $976,000 in 1964. The loans are to be repaid one by one between 1965 and 1976, and the 1960 property tax will be allowed to prevail until 1964. This arrangement was made to permit Elliot Lake to continue operating on the same basis and to provide funds to meet contracted debt charge without increasing municipal taxation above the 1960 level.

In the Bancroft area, two mines remained in production—Bicroft Uranium Mines Limited and Faraday Uranium Mines Limited. The former merged with Macassa Mines Limited and a new company, Macassa Gold Mines Limited, was

Table 2

CANADIAN URANIUM PRODUCERS—WORKING RESULTS FOR 1961

Company and Location	Production (s.t. U_3O_8)	Value of Production ($ millions)	Scheduled Deliveries[1] for 1961 (s.t. U_3O_8)	Ore Treated (s.t.)	Average Mill Rate (tons ore/day)	Mill Capacity (tons ore/day)	Millhead Grade (lb U_3O_8/ton)	Percentage Recovery	Mine Operating Costs ($ per lb U_3O_8)	Number of Employees	Published Year-end Ore Reserves[2] (s.t.)	Grade of Reserves (lb U_3O_8/ton)
Elliot Lake District, Ont.												
Denison Mines Ltd.	2,690	*	2,040	2,033,483	5,827	6,000	2.85	93.18	*	*	2,800,000[3]	*
Rio Algom Mines Ltd.	3,493	67.5	3,580[4]	2,850,921	*	6,400[5]	2.55	94.1	3.61[6]	600 (Nordic) * (Milliken)	20,022,943[7]	2.27
Stanrock Uranium Mines Ltd.	1,066	22.9	1,041	1,036,937	*	3,000	2.01	—	—	660	1,893,808	2.10
Bancroft Area, Ont.												
Faraday Uranium Mines Ltd.	398	8.3	390	339,659	931	1,500	2.44	95.06	3.96[8]	247	931,293	2.36
Macassa Gold Mines Ltd. (Bicroft)	343	6.72	342	388,760	923	1,400	1.96[9]	94.3	6.17[10]	398	559,000[11]	2.00
Beaverlodge Area, Sask.												
Eldorado Mining & Refining Ltd.	1,107	23.3	1,275	542,157	1,485	2,000	4.38	93.3	*	584	2,653,200	4.60
Gunnar Mining Ltd.	1,170	*	1,050	744,227	2,039	2,000	*	95.5	*	392	[12]	*

Source: Company annual reports unless otherwise indicated.

[1]Scheduled deliveries to Eldorado under master contract (House of Commons Special Committee on Research, Minutes and Proceedings, No. 4, March 9, 1961).

[2]Most of these are proven and probable reserves. Possible reserves at Elliot Lake, together with reserves at certain mines that have closed or whose operators do not publish every category, are estimated by the Department of Mines and Technical Surveys to total 271,866,394 tons grading 2.51 pounds of U_3O_8 per ton, which when added to the total in the table, gives a grand total for December 31, 1961, of 300,726,638 tons grading 2.51 pounds of U_3O_8 per ton. This is equivalent to 377,412 short tons of U_3O_8. Allowance for 20-per-cent dilution and unrecoverable pillars reduces this to 301,930 tons of recoverable U_3O_8.

[3]Represents positive reserves with a known grade. The Department estimates possible reserves at 100 million tons.

[4]Includes 332 tons of U_3O_8 scheduled for delivery on behalf of Preston Mines Limited.

[5]Includes Milliken (3,000 tons a day) and Nordic (3,400 tons a day) but does not include Panel, which closed in June 1961.

[6]Based on $8.65 per ton of ore as the mine's average operating cost. Does not include administrative expense, interest, the Ontario mining tax or depreciation, but includes shutdown and idle-mine expenses and write-offs of obsolete supplies.

[7]Proven and probable reserves for Milliken and Nordic mines only. Does not include reserves at Lacnor, Panel, Pronto, Quirke or Stanleigh, which are estimated at 73.6 millions tons of proven and probable ore.

[8]Based on (1) the total cost of development, mining and milling at $9.17 per ton of ore, (2) a millhead grade of 2.44 pounds of U_3O_8 per ton and (3) 95.06-per-cent recovery.

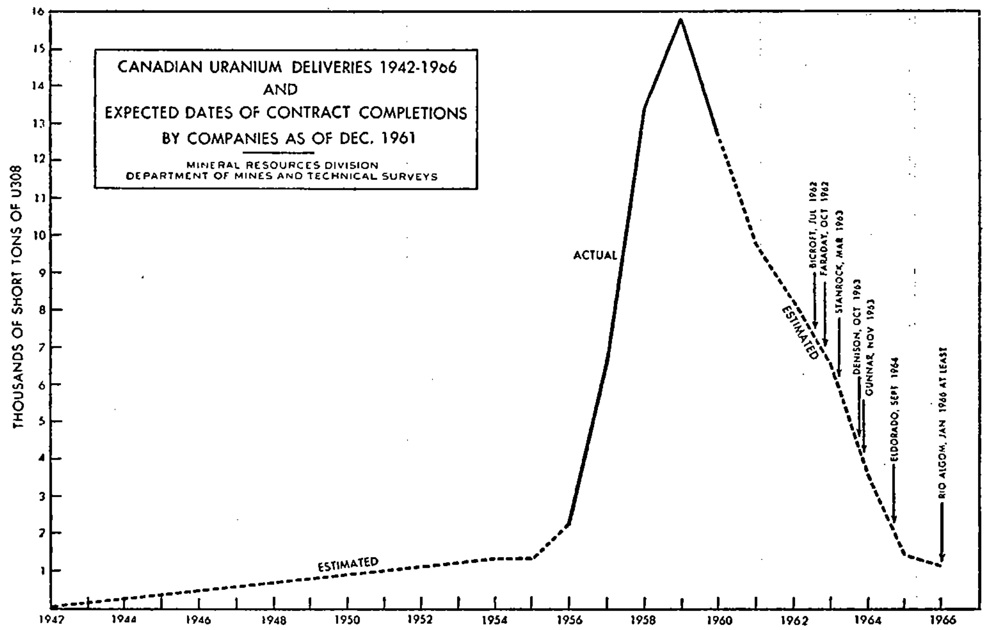
[9]Obtained through personal communication with the mine manager.

[10]Based on (1) the total cost of development, mining and milling and general mine expense at an over-all rate of $11.43 per ton of ore, (2) a millhead grade of 1.96 pounds of U_3O_8 per ton and (3) 94.3-per-cent recovery.

[11]As at January 1, 1961. The amount shown is the tonnage above the tenth level. Since January 1961 three new levels have been established below the tenth.

[12]Gunnar reported that at December 31, 1961, reserves totalled 6,700,000 pounds of uranium oxide contained in proven reserves of ore and products awaiting shipment.

*Not available.



formed. Bicroft completed its contract in October and operated on a stand-by basis for a short time pending the completion of an interim contract with Eldorado Mining and Refining Limited for the sale of an additional 342,000 pounds of uranium oxide. The new contract is expected to be completed in July 1962. The price paid will be on a cost basis and will apply to any allotment Bicroft may receive as its share under the 12,000-ton contract with the UKAEA. In September, the company laid off about 200 employees, but by the end of the year many of them had been recalled.

Saskatchewan

In the Beaverlodge Lake area of northern Saskatchewan, two mines remained in production during the year—that of the government-owned Eldorado Mining and Refining Limited and that of Gunnar Mining Limited. Eldorado's major undertakings were the installation of a $3-million hydroelectric power plant, the sinking of the main shaft another 1,650 feet and the installation, in the treatment plant, of four electronic ore-sorter units that will eliminate 270 tons of waste rock a day. From its rated capacity of 2,000 tons a day Eldorado reduced its mill throughput to about 1,600 tons a day to stretch out deliveries under its contract to September 1964. The exploration undertaken by Eldorado in the Northwest Territories was discontinued and the company announced that it would retire from mineral exploration.

Open-pit mining at Gunnar, which had reached a depth of 380 feet, ceased in November, and mill feed was obtained thereafter from underground operations that began in 1958. Underground production was increased to an average of 2,000 tons of ore a day.

DEVELOPMENTS

Many uranium producers of the past and present are diversifying their interests, both in the mineral industry and in other ventures. Most producing companies hope to become less dependent on uranium as a source of revenue, and their 1961 mineral exploration has revealed several promising new mineral occurrences other than uranium.

Rio Algom, for example, is now producing copper concentrates from its Pater mine, at Spragge, Ontario. Part of the nearby Pronto uranium mill was converted to treat the copper ore. Rio Algom has been searching throughout Canada for a variety of metals, as has Denison for metallic and industrial minerals. Denison has acquired interests in oil lands in Alberta, a phosphate deposit in Peru and ready-mixed-concrete and aggregate companies with sand and gravel deposits and has purchased an interest in a cement-manufacturing company.

Faraday has continued its efforts to diversify its mining projects. The most important of these is Nickel Mining & Smelting Corporation, which Faraday is financing in the development of a nickel-copper orebody at Gordon Lake, in the Kenora area of Ontario. Bicroft has discovered a new nickel-copper deposit near Coe Hill, in southeastern Ontario, and in November Canadian Dyno Mines Limited reported the discovery of a copper deposit in Quebec, 70 miles east of James Bay.

Gunnex Limited, an exploration company wholly owned by Gunnar Mining Limited, has been active in mineral exploration throughout North America. Rix-Athabasca Uranium Mines Limited has reopened an old silver mine in Ontario's Cobalt area. Lake Cinch Mines Limited, which amalgamated in 1960 with New Dickenson Mines Limited to form Dickenson Mines Limited, has acquired property in the Porcupine area and has an interest in the adjoining copper property of Kam-Kotia Porcupine Mines, Limited, which has built a 750-ton-a-day copper concentrator.

Rayrock Mines Limited has been conducting mineral exploration in the Northwest Territories, British Columbia, Ontario, Manitoba and the southwestern United States.

HISTORY

The vicissitudes that have marked the life of Canada's uranium industry have resulted, in less than 10 years, in a rapid rise in production followed by a sharp decline. The large surpluses now on hand in the United States and Britain, the major consuming countries, to which Canada has been shipping, make it unlikely that the demand will rise again before the 1970's. Although the story of this unusual variation in production is well known, it is recapitulated in the following paragraphs so that the events of 1960 and 1961 may be more readily understood.

In 1950 exploration for uranium by the general public and private mining companies had just begun; by 1955 all the important discoveries were being either mined or prepared for mining. That year's output amounted to 1,300 tons of U_3O_8. In 1959, Canada's peak year for uranium production, 23 mines were in operation and shipments of U_3O_8 totalled 15,892 tons valued at $331 million. Most of this uranium was sold under contract to the United States Atomic Energy Commission (USAEC), and a small amount went to the UKAEA. As a result of the discoveries of large deposits in other countries, particularly in the United States, there suddenly developed a large surplus of uranium in the Western World and, owing to lack of markets, Canada had to cut production.

The United States announced in 1959 that it would not exercise its options on additional uranium from Canada. Accordingly, to prevent a collapse of the industry in 1962 and 1963, when the contracts were to expire, the Government of Canada, through Eldorado Mining and Refining Limited, negotiated a delivery stretch-out for the uranium already under contract. This plan also permitted the transfer of contracts between companies. By November 1966, when the stretch-out period ends, most companies will have fulfilled their original contracts and any additional ones they may have acquired before that date through transfers from other companies. Negotiation of the British contract for 12,000 tons, if and when finally completed, should extend the life of the present Canadian producers by at least one year. At the end of 1961, however, the production of this quantity had not been allocated among them.

Part of the history of the industry is illustrated in the graph, which depicts the rapid increase in production and the rapid decline that subsequently resulted when the USAEC decided not to exercise its purchase option on additional Canadian uranium. The graph also shows shipments scheduled for the period 1962-66 under the stretch-out plan. Not shown are the dates when 25 uranium mines began production and the dates and names of the mines that have closed.

PRICES AND MARKETING

The prices paid to the producers for the sale of mill concentrates (yellowcake under government contract are confidential and vary with each company, having been originally calculated to provide a profit after allowances for the amortization of the major estimated capital costs and the estimated operating costs. Under most contracts, the maximum price paid is $10.50 per pound of U_3O_8 contained in the yellowcake. Before the announcement of the stretch-out plan, a few contracts were extended from March 31, 1962, to March 31, 1963; the price under these is either the original contract price or $8 (U.S.) a pound plus the amortization factor, whichever is the lower.

The procurement and marketing of most of the uranium produced in Canada is the responsibility of the Crown corporation, Eldorado Mining and Refining Limited. Canadian producers are permitted, however, to make small sales of surplus uranium (U_3O_8) to countries that do not hold agreements with Canada for co-operation in the peaceful uses of atomic energy. The maximum amount any such country may receive from Canada is 2,500 pounds. Larger amounts may be sold under permit from the Atomic Energy Control Board to countries that hold bilateral agreements with Canada, but sales of this nature have been very small owing to the smallness of the demand.

CONSUMPTION AND USES

In the field of nuclear energy, purchases for military uses and military stockpiles continued to dominate the uranium market, but the requirements of nuclear power plants are slowly increasing. Many experts predict that the need for large quantities of uranium for nonmilitary purposes will not begin to grow appreciably until the 1970's. One reason for this is that the United Kingdom, which has been leading all other countries in the development and use of nuclear electric power, announced in June 1960 that its nuclear-power program would be slowed down. The original plan called for the installation by 1966 of nuclear power plants having a combined capacity of 5,000 to 6,000 megawatts. Under an extension of the time allowed, the plan now requires that the 1966 capacity be only 3,400 megawatts. Nuclear-energy goals in the United States and Europe have also been deferred. Technological advances in the field of nuclear power plants throughout the Western World have not been fast enough to offset stabilized or decreasing costs in conventional thermal power plants.

Uranium has found its most important peaceful use to date as a fuel in nuclear electric-power plants. It is also applicable as a source of energy in nuclear-powered ships, the production of radioisotopes and nuclear reactors that generate steam for industrial purposes.

RESEARCH ON NEW USES FOR URANIUM

The Mines Branch of the federal Department of Mines and Technical Surveys, in collaboration with Eldorado Mining and Refining Limited and the Canadian Uranium Research Foundation, continued its research into nonnuclear uses of uranium. The new uranium-bearing steel developed by the Mines Branch more than a year ago is undergoing tests for commercial use, and The Steel Company of Canada, Limited, is making metallurgical and economic studies of it. The first commercial-size heat (112 tons) of uranium-bearing steel was poured in May by The Algoma Steel Corporation, Limited, and was forged into grinding-balls for test purposes. Early in 1961, eight test bars of uranium steel were installed in various areas of the uranium-treatment plant of Denison Mines Limited, at Elliot Lake, so that their resistance to corrosion could be tested for about a year. Atlas Steels Limited poured a heat of drill-rod steel containing uranium and conducted mill tests to determine how the alloy stood up under the battering of rolling mills. The drill rods were being tested at uranium mines owned by Rio Algom Mines Limited. Further tests and economic studies will be necessary to determine what benefits uranium holds for the steel industry.

Besides its research on uranium as an additive material in steel, the Mines Branch also began experiments on the use of uranium in alloys of copper, zinc and cast iron.

Early in 1961, the Government appointed a body known as the House of Commons Special Committee on Research to consider the policy, operations and expenditures of Eldorado Mining and Refining Limited, Atomic Energy of Canada Limited and the National Research Council and from time to time to report their observations and opinions thereon. Some of the recommendations made by the Committee concerning the uranium industry in Canada are as follows:

"The finding and development of new uses for uranium is so vital to the future of the Canadian uranium industry that this Committee recommends that the full resources of the appropriate agencies of Government, and of the uranium industry itself, be marshalled in support of a co-ordinated and vigorous program of research in this field. . . .

". . . in view of the functions of Eldorado Mining and Refining Limited as the government's purchasing and sales agent for uranium and as contract allocating body, a thorough study of its involvement in the competitive mining field should be made."

The Committee was of the opinion that "a feasibility study of marketing, engineering and the economics of a uranium enrichment plant in Canada should be made" and that such a study should "consider Canada's long-term uranium export markets as part of the economic analysis of feasibility. Because Canadian enrichment facilities would increase export possibilities for domestic uranium production, it is expected that Canadian uranium producers should play their part in such a study."

DEVELOPMENTS IN NUCLEAR ENERGY IN 1961

By the end of 1961, Canada's first experimental nuclear power plant, NPD-2, near Rolphton, Ontario, was nearly completed and early in 1962 it went into operation. This station was built by Atomic Energy of Canada Limited, a Crown corporation, in co-operation with The Hydroelectric Power Commission of Ontario and Canadian General Electric Company Limited. It is fueled with natural uranium and moderated and cooled by heavy water.

The CANDU station, now under construction at Douglas Point on Lake Huron and scheduled to go into operation in 1964, will be Canada's first full-scale nuclear power plant. It will be a base-load station producing 200,000 kilowatts of electricity and will also be fueled by natural uranium and cooled and moderated by heavy water. About 66 tons of uranium oxide (UO_2) will be needed for initial loading, but it is expected that, once in operation, the plant will not require more than 25 tons of uranium a year.

ZINC

D. B. Fraser*

Production of recoverable zinc in 1961 totalled 416,004 short tons, or 9,131 tons more than in 1960. Output in British Columbia dropped to 194,486 tons. There were significant increases in Ontario, where output from the Manitouwadge district rose to a record 51,937 tons, and in northern Manitoba and Saskatchewan, where more than 74,000 tons were produced. In Quebec, output was maintained at 54,005 tons; two new mines, the Coniagas and the Vauze, were opened during the year. Production from the Buchans mine in Newfoundland and from the mines of the Mayo district in Yukon Territory was about the same as in 1960.

Canadian mine output, in terms of zinc contained in zinc and other concentrates, totalled 443,100 tons in 1961, or 13,000 tons more than in 1960.

The zinc refinery of The Consolidated Mining and Smelting Company of Canada Limited (Cominco) at Trail, British Columbia, and that of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba, operated at capacity during the year. A total of 268,000 tons of refined zinc was produced; output in 1960 was 260,968 tons.

The mine output of Manitoba and Saskatchewan was refined at Flin Flon. Most of the zinc concentrates produced in British Columbia and Yukon Territory were refined at Trail, and the rest was exported to refineries in the northwestern United States. The zinc production of mines in eastern Canada was exported in concentrates to smelters in the United States and Europe.

Exports of refined zinc sent to Britain and the United States, the major markets, were moderately lower in 1961 than in the previous year. Those sent to Asia, principally to India and Japan, and to western Europe exclusive of Britain were considerably higher. The total of refined-zinc exports was substantially the same as in 1960.

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*Mineral Resources Division.

TABLE 1

ZINC—PRODUCTION, TRADE AND CONSUMPTION

	1961		1960	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
British Columbia	194,486	48,971,608	203,833	54,423,436
Ontario	51,937	13,077,755	45,230	12,076,326
Quebec	54,005	13,598,467	49,808	13,298,602
Manitoba	46,509	11,710,925	24,390	6,512,255
Newfoundland	34,638	8,722,020	34,208	9,133,517
Saskatchewan	28,360	7,141,004	42,703	11,401,580
Yukon Territory	6,069	1,528,100	6,701	1,789,287
Nova Scotia	44	11,070	—	—
Total	416,004	104,749,879	406,873	108,635,003
Mine output[2]	443,099		430,049	
Refined[3]	268,006		260,968	
Exports				
Zinc blocks, pigs and slabs				
Britain	86,068	16,596,924	92,435	19,710,897
United States	70,443	15,615,353	75,237	18,294,936
India	15,387	2,881,957	13,362	2,747,404
Japan	13,527	2,444,655	10,227	2,140,592
Netherlands	5,273	1,082,379	3,417	782,477
West Germany	4,268	884,129	1,512	318,945
Turkey	2,227	414,067	—	—
Brazil	2,705	512,772	1,437	304,316
Philippines	2,893	547,328	2,747	581,247
Thailand	2,089	383,714	1,380	298,414
South Korea	406	85,841	2,541	556,979
Other countries	2,986	587,635	2,796	618,418
Total	208,272	42,036,754	207,091	46,354,625
Zinc contained in ore and concentrates				
United States	131,490	10,728,277	137,375	13,365,830
Belgium and Luxembourg	22,265	1,815,306	5,862	586,374
West Germany	21,349	1,979,885	5,329	528,582
Britain	11,581	940,516	6,441	705,037
France	5,794	459,229	5,044	487,534
Netherlands	1,085	78,187	995	95,510
Norway	5,758	385,859	8,848	883,674
Total	199,322	16,387,259	169,894	16,652,541
Zinc- and zinc-alloy scrap, dross and ashes				
Belgium and Luxembourg	1,704	101,306	1,917	142,449
United States	959	120,273	1,148	175,767
Japan	366	62,588	568	100,545
Britain	181	12,321	598	39,612
Netherlands	184	10,013	596	47,325
Switzerland	93	5,265	—	—
West Germany	58	7,687	505	21,260
Total	3,545	319,453	5,332	526,958

TABLE 1

ZINC—PRODUCTION, TRADE AND CONSUMPTION *(Conc.)*

	1961 Short Tons	1961 $	1960 Short Tons	1960 $
Exports (cont'd)				
Zinc fabricated materials, not elsewhere specified				
Britain	224	90,168		1,267
United States	121	74,769		96,662
Brazil	93	18,300		—
Trinidad	44	17,719		500
Other countries	16	5,844		39,176
Total	498	206,800		137,605
Imports				
Zinc in pigs, slabs, blocks, anodes	771	199,651	49	21,861
Zinc bars, rods, plates, sheet	869	470,338	943	485,784
Zinc dross and zinc scrap	127	15,479	54	4,543
Zinc dust and granules	864	256,244	793	256,639
Zinc slugs, discs, shells		201,601		172,180
Zinc manufactures, not otherwise provided for.		2,685,775		2,150,407
Zinc chloride	192	38,604	154	28,956
Zinc sulphate	904	77,897	886	74,981
Zinc white oxide	2,239	455,097	759	201,428
Lithopone	630	91,250	893	121,667
Total		4,491,936		3,518,446

	(short tons) 1961 Primary	Secondary	Total	1960 Primary	Secondary	Total
Consumption—zinc used for or in the manufacture of:						
Copper alloys (brass, bronze, etc.)	7,229	229	7,458	5,337	223	5,560
Galvanizing:						
Electro	690	36	726	617	55	672
Hot-dip	34,127	637	34,764	32,108	717	32,825
Zinc diecast alloy	9,921	—	9,921	9,408	—	9,408
Other products (including rolled and ribbon zinc, zinc oxide)	8,911	1,973	10,884	8,333	2,345	10,678
Total	60,878	2,875	63,753	55,803	3,340	59,143
Stocks on hand at end of year	7,051	1,366	8,417	7,103	1,066	8,169

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.

For 1961, exports of zinc in concentrates totalled 199,322 tons, having increased from the 169,894 tons of the previous year. Exports to the United States, which in 1960 accounted for 81 per cent of the zinc exported in concentrates, accounted for 66 per cent in 1961. Exports to western Europe and the United Kingdom were about double those of 1960.

Domestic consumption of slab zinc amounted to 63,753 tons for 1961, increasing from the 59,143 tons consumed in the previous year. Producers' domestic shipments of primary slab zinc increased to 63,327 tons from the 53,457 tons shipped in 1960.

TABLE 2

ZINC—PRODUCTION, EXPORTS AND CONSUMPTION, 1951-61

(short tons)

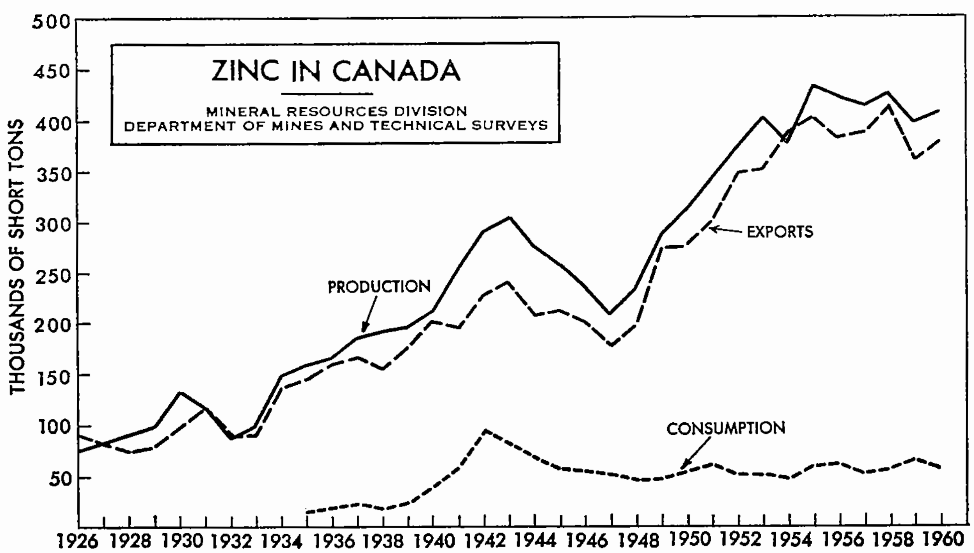
	Production		Exports			Consumption[3]
	All Forms[1]	Refined[2]	In Ore and Concentrates	Refined	Total	
1951.........	341,112	218,578	154,593	146,132	300,725	61,023
1952.........	371,802	222,200	181,754	166,864	348,618	51,581
1953.........	401,762	250,961	192,656	158,388	351,044	50,717
1954.........	376,491	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	183,728	383,041	61,173
1957.........	413,741	247,316	187,141	202,007	389,148	52,713
1958.........	425,099	252,093	217,823	195,708	413,531	56,097
1959.........	396,008	255,306	181,084	179,552	360,636	64,788
1960.........	406,873	260,968	169,894	207,091	376,985	55,803
1961.........	416,004	268,006	199,322	208,272	407,594	60,878

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.



The history of zinc production in Canada since 1926 and the importance of export markets are shown in the accompanying graph. In 1961 Canada was the second-ranking Free World producer of zinc ores and the third-ranking producer of refined zinc. In mine output the United States was the principal producer, with a total of 466,576 tons. Other leading mine producers were Australia (271,139 tons), Mexico (296,489 tons), Peru (194,306 tons) and Japan (185,019 tons). Leading producers of refined zinc were the United States (843,698 tons), Belgium (270,668 tons), Japan (234,163 tons), West Germany (204,503 tons), France (178,608 tons) and Australia (155,000 tons).

In 1961, Free World consumption of slab zinc rose from the 1960 level by an estimated 5 per cent. Consumption in the United States amounted to 931,213 tons, or 53,329 tons more. Other substantial increases were reported from Japan, France and India. In Britain, consumption fell by 30,700 tons to 379,000 tons.

UNITED STATES QUOTAS

The import quotas on unmanufactured lead and zinc imposed by the United States government by proclamation dated September 22, 1958, continued in effect throughout 1961, limiting commercial imports to 80 per cent of their annual average for the five-year 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.

United States imports of zinc ores and concentrates from all countries for 1961, as reported by the United States Department of Commerce, amounted to 415,700 tons of contained zinc, or 35,860 tons more than the total annual quota. Imports from Canada were 119,113 tons, or 13,847 tons less than the quantity allowable under the quota.

The same source reports that zinc metal imported by the United States from all countries during 1961 amounted to 127,562 tons, or 13,558 less than the quota. Imports from Canada were 71,628 tons, or 4,052 tons less than the amount permitted by the quota.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group, organized in May 1959 under the auspices of the United Nations, held its third session in March 1961, in Mexico City and its fourth in October at Geneva. The statistical surveys of the Group indicated that the consumption and production of zinc would continue to increase. Current and forecast supplies were found to be only slightly in excess of demand, and for this reason it was decided to take no action within the Group other than to keep supply and demand under close review.

Eleven of the 25 members of the Group met in New York from May 31 to June 10, 1961, as a special working group to examine long-term problems of the lead-zinc industry and possible solutions. Their report was presented at the fourth session, at which provision was made for further study of specific questions.

PRODUCING MINES

Zinc concentrates from the three mines of The Consolidated Mining and Smelting Company of Canada Limited, Canada's leading lead-zinc producer, were treated in the company's electrolytic refinery at Trail, British Columbia.

TABLE 3

PRINCIPAL ZINC MINES IN CANADA, 1961

Company	Mine	Location	Mill Capacity (s.t./day)	Grade of Ore (Principal Metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1961 (s.t.)	Ore Produced 1960 (s.t.)	Contained Zinc Produced 1961 (s.t.)	Contained Zinc Produced 1960 (s.t.)
British Columbia											
Consolidated Mining and Smelting Company of Canada Limited, The	Sullivan	Kimberley	10,000	*	*		*	2,461,695	2,522,554	100,299	117,065
	Bluebell	Riondel	700	*	*		*	252,821	255,571	14,579	14,952
	H.B.	Salmo	1,200	*	*		*	472,731	464,408	22,080	19,359
Reeves MacDonald Mines Limited	Reeves MacDonald	Remac	1,000	1.39	4.25		*	420,508	411,282	16,449	12,397
Canadian Exploration, Limited	Jersey	Salmo	1,900	2.22	4.53		*	374,032	364,424	15,754	14,750
Sheep Creek Mines Limited	Mineral King	Toby Creek, southwest of Invermere	500	2.43	5.96		1.22	211,010	194,607	11,123	8,490
Howe Sound Company	Britannia	Howe Sound	4,500		0.83	1.62	0.18	458,429	409,751	3,327	4,453
Mastodon-Highland Bell Mines Limited	Highland-Bell	Beaverdell	70	2.09	2.66		47	18,953	18,204	486	592
ViolaMac Mines Limited[1]	Victor	Sandon	150	9.81	8.49		19.69	3,174	6,227	252	601
Yukon Territory											
United Keno Hill Mines Limited[2]	Calumet	Mayo district		5.83	4.84		41.16	186,116	176,745	7,756	7,220
	Elsa	" "	500								
	Hector	" "									

Manitoba and Saskatchewan											
Hudson Bay Mining and Smelting Co., Limited	Flin Flon	Flin Flon district	6,000	0.2	4.0	2.45	1.04	1,014,925	1,250,026	83,239	74,262
	Coronation	Flin Flon "			0.3	4.73	0.10	312,145	192,775		
	Schist Lake	Flin Flon "		0.2	7.7	3.67	0.94	98,802	114,686		
	Chisel Lake	Snow Lake, Man.		1.6	15.3	0.46	2.45	271,877	104,903		
Ontario											
Geco Mines Limited	Geco	Manitouwadge	3,300	*	3.99	1.54	1.52	1,276,778	1,294,077	42,005	28,362
Willroy Mines Limited	Willroy	"	1,200	0.21	6.68	1.34	1.74	421,772	429,309	22,934	27,500
Quebec											
Coniagas Mines, Limited, The[3]	Coniagas	Bachelor Lake	325	1.73	17.75		9.15	79,826		11,962	
Manitou-Barvue Mines Limited[4]	Golden Manitou	Val d'Or	1,300	0.76	5.88		5.67	162,860	164,690	8,847	9,381
New Calumet Mines Limited[2]	New Calumet	Calumet Island	750	2.00	7.31		4.08	96,872	100,463	6,817	6,890
Normetal Mining Corporation, Limited	Normetal	Normetal	1,000		4.54	3.10	2.15	355,001	347,164	12,469	10,313
Quemont Mining Corporation, Limited	Quemont	Noranda	2,300		2.53	1.33	0.85	822,275	856,632	15,250	16,591
Sullico Mines Limited	East Sullivan	Val d'Or	2,800		0.47	0.69	0.19	1,028,201	974,532	3,423	8,494
Vauze Mines Limited[5]	Vauze	Noranda	350		3.94	4.90	1.76	22,300		307	
Waite Amulet Mines, Limited	Waite Amulet	"	2,000		2.71	5.72	1.06	248,829	297,062	2,255	7,350
Newfoundland											
American Smelting and Refining Company (Buchans Unit)	Buchans	Buchans	1,250	7.38	12.88	1.11	4.59	387,000	386,000	46,413	44,738
Nova Scotia											
Magnet Cove Barium Corporation[6]	Magnet Cove	Walton	125	6.92	4.42	0.51	14.7	9,333		345	

SOURCE: Company reports.

[1] Operations were suspended on January 31, 1962.
[2] Production is for the fiscal year ending on September 30, 1961.
[3] Production was started in March 1961.
[4] Manitou-Barvue also milled, in a separate circuit, 298,385 tons of copper ore grading 1.18 per cent copper.
[5] Production was started late in 1961.
[6] Production was started in September 1961.
* Not available.

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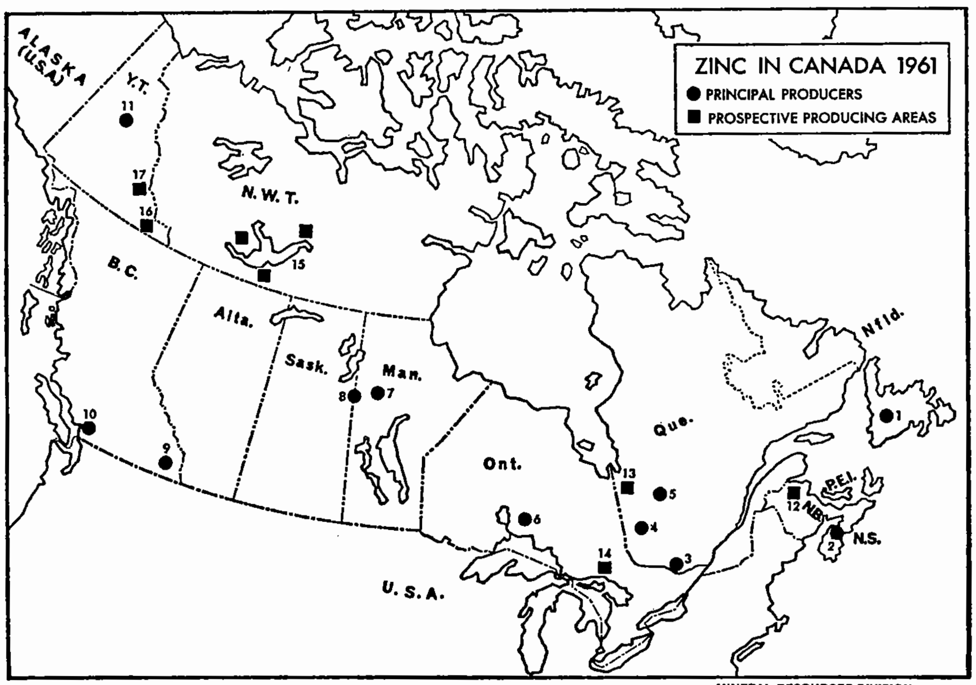
These mines supplied 80 per cent of the lead and zinc produced at Trail. Stockpiles of zinc-plant residues and lead-blast furnace slag supplied 7 per cent, and 13 per cent came from ores and concentrates purchased principally from Canadian shippers. The company's output of zinc from all sources was 193,649 tons. In the previous year 194,989 tons were produced.

Hudson Bay Mining and Smelting Co., Limited, Canada's second-ranking producer, operated three mines in the Flin Flon district, on the Manitoba-Saskatchewan border, and one near Snow Lake in Manitoba. Copper, zinc and lead concentrates were produced in the Flin Flon mill. From the treatment of zinc concentrates and fume and stack dust in the electrolytic zinc plant, a record total of 74,869 tons of slab zinc was produced. In 1960, the slab-zinc output totalled 67,093 tons.



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. New Calumet Mines Limited
4. Manitou-Barvue Mines Limited
   Normetal Mining Corporation, Limited
   Quemont Mining Corporation, Limited
   Sullico Mines Limited
   Vauze Mines Limited
5. Coniagas Mines, Limited, The
6. Geco Mines Limited
   Willroy Mines Limited
7. Hudson Bay Mining and Smelting Co., Limited
   Chisel Lake Mine
8. Hudson Bay Mining and Smelting Co., Limited (also refinery)
   Flin Flon mine
   Coronation mine
   Schist Lake mine
9. Canadian Exploration, Limited
   Consolidated Mining and Smelting Company of Canada Limited, The (also refinery)
   Sullivan mine
   H.B. mine
   Bluebell mine
   Mastodon-Highland Bell Mines Limited
   Reeves MacDonald Mines Limited
   Sheep Creek Mines Limited
   ViolaMac Mines Limited
10. Howe Sound Company (Britannia Division)
11. United Keno Hill Mines Limited

Prospective Producing Areas

12. Bathurst	15. Great Slave Lake
13. Mattagami Lake	16. Watson Lake
14. Sudbury	17. Pelly River

The mine production of Cominco and Hudson Bay and that of other principal zinc producers are summarized in Table 3.

OTHER DEVELOPMENTS

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited carried out underground exploration of the Red Bird lead-zinc property, in the Salmo area, and continued surface drilling at the Duncan Lake lead-zinc property, in the Lardeau district.

Manitoba

Hudson Bay Mining and Smelting Co., Limited, began shaft-sinking at Osborne Lake, 13 miles northeast of Snow Lake, where surface drilling was completed in 1955. A road and a transmission line to the property were completed. Previous work outlined an orebody of 443,000 tons averaging 4.01 per cent copper and 1.7 per cent zinc.

Quebec

In November 1961 a group of five mining companies in Quebec and Ontario announced plans to build an electrolytic zinc-reduction plant at Valleyfield, near Montreal. Construction was scheduled to begin in the spring of 1962, and production at a rate of 73,000 tons annually was scheduled for the end of 1963. Each of the five companies will supply zinc concentrates to the new plant on an ownership basis, as follows: Mattagami Lake Mines Limited, 62.5 per cent, Orchan Mines Limited, 18.75 per cent; Geco Mines Limited, 9.0 per cent; Normetal Mining Corporation, Limited, 4.0 per cent; and Quemont Mining Corporation, Limited, 5.75 per cent. In 1961, Mattagami Lake Mines Limited carried out underground development of its Watson Lake property, for which a 3,000-ton concentrator is planned. Orchan Mines Limited began shaft-sinking at its property adjoining that of Mattagami Lake; it will build a 1,000-ton concentrator, with a separate 900-ton unit to treat the ore of New Hosco Mines Limited.

In March, The Coniagas Mines, Limited, at Bachelor Lake, began production of zinc and lead concentrates from a 325-ton mill. Late in 1961, Vauze Mines Limited, 12 miles north of Noranda, opened a 350-ton mill for the production of copper and zinc concentrates.

Exploration and underground development was continued at the copper-zinc-lead property of Solbec Copper Mines, Ltd., near Weedon, in Wolfe county. A 1,000-ton mill was completed, and production began in January, 1962.

New Brunswick

Brunswick Mining and Smelting Corporation Limited announced its intention of bringing one of its two large zinc-lead-copper orebodies near Bathurst into production in 1963. Construction of a 3,000-ton mill is scheduled to begin in 1962.

Heath Steele Mines Limited continued exploration and development of its property 32 miles northwest of Newcastle. The 1,500-ton mill, which had been closed since March 1958, was reopened in January 1962 to treat copper ore of the Wedge copper mine, operated by The Consolidated Mining and Smelting Company of Canada Limited, at a rate of about 750 tons a day.

Nova Scotia

Magnet Cove Barium Corporation began production late in 1961 from a lead-zinc deposit within the company's barite mine at Walton and opened a 125-ton mill.

Northwest Territories

On September 29, implementing the report of the Royal Commission on the Great Slave Lake Railway, made in June 1960, and the survey of the western route, carried out during 1961, the federal government approved Bill C-126, which provides for the construction of a 440-mile railway from Grimshaw, in northwestern Alberta, to Great Slave Lake. An agreement between the federal authorities and Pine Point Mines Limited requires this company to bring its lead-zinc property on the south shore of Great Slave Lake into production by December 31, 1966, the date on which the line is expected to be finished. The estimated cost of railway construction, which officially began on February 12, 1962, is $75 million. That of the mine project is $20 million.

USES

The principal uses of zinc and the tonnage consumed in each are tabulated in Table 1, under 'consumption'.

Zinc finds its greatest use in galvanizing, in which it is applied as a protective coating to iron and steel products to prevent rusting. The Steel Company of Canada, Limited, and Dominion Foundries and Steel, Limited, both of Hamilton, are the principal consumers of zinc for galvanizing. Each operates continuous-strip galvanizing lines.

Zinc-base die castings are widely used for 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 4 per cent aluminum, 0.04 per cent magnesium and from 0 to 1 per cent copper. Schultz Die Casting Company of Canada Limited, at Lindsay, Ontario, and Barber Die Casting Company Limited and Pressure Castings of Canada Limited, in the Toronto-Hamilton area, are among the leading consumers of zinc for die-casting.

Brass, a copper-zinc alloy containing as much as 40 per cent zinc, is used in many industrial fields 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 and Brass Limited, Montreal.

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) Limited, both in Montreal, and Canadian Felling Zinc Oxide 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 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; Prime Western, for galvanizing.

In Canada, the electrolytic process is used to produce Special High Grade and High Grade zinc. To meet consumer requirements for Prime Western, Canadian producers add lead in small amounts to the higher grades.

TABLE 4

UNITED STATES CONSUMPTION, BY END USE, 1958-61

	(short tons) 1958	1959	1960	1961
Galvanizing	381,229	361,027	371,589	382,077
Brass products	101,375	129,278	99,023	128,523
Zinc-base alloy	316,830	389,331	338,373	341,766
Rolled zinc	40,616	42,949	38,696	41,204
Zinc oxide	13,331	18,248	15,593	18,137
Other uses	14,946	15,364	14,610	19,506
Estimated undistributed consumption	—	—	—	—
Total	868,327	956,197	877,884	931,213

SOURCE: U.S. Bureau of Mines—1958-59-60, *Minerals Yearbook 1960*, p.1218; 1961, *Mineral Industry Surveys*, "Zinc Monthly Report for July 1962."

RESEARCH

Research on zinc at the Mines Branch, Department of Mines and Technical Surveys, was continued and expanded in 1961. Attention was concentrated on three separate projects undertaken in co-operation with the Canadian Zinc Research and Development Committee and the American Zinc Institute Expanded Research Program.

In previous studies of the hot-dip galvanizing process, the influence of common alloying and impurity elements normally encountered in galvanizing projects was investigated. New work initiated along the same lines is designed to cover various elements that are of considerable importance in ferrous- and nonferrous-alloy metallurgy, but about which little or nothing is known regarding their potential value in galvanizing. As before, the structure and properties of laboratory-prepared sheet galvanized coatings are being examined to determine the influence of each of the addition elements selected. This project is now nearing completion.

A new project, also dealing with zinc coatings, is concerned with study of the elevated-temperature behavior of hot-dip and electroplated coatings on steel sheet. This involves evaluation of the effects of continuous and intermittent exposure to heat on the structure and properties of the coatings as well as on the steel base.

Fundamental research on the influence of temperature and composition upon the viscosity, density and surface tension of molten zinc and some of its alloys has progressed and is continuing. Experimental evaluation of various grades of pure zinc is essentially complete and attention is being concentrated on some binary-alloy systems.

PRICES AND TARIFFS

The Canadian price of Prime Western zinc, on the basis of deliveries at Montreal and Toronto, was 12 cents a pound from December 19, 1960, to March 9, 1961, when it rose to 12.25 cents. Subsequent price changes in 1961 were as follows:

	Cents a Pound
June 8	11.75
July 5	12.00
Nov. 13	11.50
Dec. 1	12.00
Dec. 6	11.50
Average for the year	11.97

The United States price, East St. Louis, Illinois, dropped half a cent on January 4 to 11.50 cents a pound and remained at that level until December 1, when it rose to 12 cents. At the beginning of 1960, the United Kingdom price of zinc was £80¼ sterling per ton of 2,240 pounds; at the end of the year it was £72 sterling.

Zinc ores and concentrates entered Canada duty-free; slab zinc was subject to a 0.75-cent-a-pound British preferential duty, a 1-cent-a-pound most favored nation duty, and a 2-cent-a-pound general duty. Varying schedules were applied to imports of zinc in semifabricated forms.

The United States tariff on the zinc content of zinc ores and concentrates was 0.6 cents a pound. On slab zinc it was 0.7 cents a pound. Varying tariffs were applied to imports of zinc in other forms.

Index to Companies