Foreword

This annual report has been prepared by the Mineral Resources Division in collaboration with the Mineral Processing Division and Fuels and Mining Practice Division of the Mines Branch of the Department. The report is based on the preliminary reviews issued as separate pamphlets during 1960. It contains reviews of the metallic minerals, industrial minerals and mineral fuels produced or consumed in commercial quantities in Canada in 1959, and is a continuation of a series of similar annual publications dating back to 1886. Its purpose is to provide an historical record of the industry.

Unless otherwise indicated, statistics on Canadian production, trade and consumption are final. Statistics were collected by the Dominion Bureau of Statistics which has acted as this Department's mineral statistics agent since 1921. Specific company figures were supplied directly by company officials or obtained from company reports. Market quotations are mainly from standard marketing reports issued in Montreal, London and New York.

The Division 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

Photo Credits

Page	
Frontispiece	Courtesy of Iron Ore Company of Canada.
40	No. 3040 by J. Lavoie, courtesy of Canadian British Aluminium Company Limited.
87	No. 98525 by the National Film Board of Canada.
118	No. B 7689-34M by Parade Studios Inc., Cleveland, Ohio, courtesy of The M.A. Hanna Company.
125	(a) Courtesy of Iron Ore Company of Canada. (b) Photo 11508 by George Hunter, courtesy of Steep Rock Iron Mines Limited.
170	No. 6622 by George Hunter, courtesy of The International Nickel Company of Canada, Limited.
177	No. 5021 by D. Dunbar, courtesy of The International Nickel Company of Canada, Limited.
186	No. 3217 by D. Dunbar, courtesy of The International Nickel Company of Canada, Limited.
193	No. 12439 by D. Dunbar, courtesy of The International Nickel Company of Canada, Limited.
269	By A. Courchesne, Pierreville, Quebec, courtesy of Featherock, Inc.
391	No. 2864-23 by Len Hillyard, Saskatoon, Sask., courtesy of Potash Company of America.

53470-1—1½

Contents

Summary

Metallic Minerals

Industrial Minerals

Mineral Fuels

Index to Companies 513

Photographs

Summary

B. F. Burke*

Production

Revised preliminary statistics for 1959 place the value of Canada's mineral production at $2,409.0 million. This is $308.3 million, or 14.7 per cent, more than the final 1958 total of $2,100.7 million.

Metallic minerals rose by $240.5 million, or 21.3 per cent, to $1,370.6 million, their output accounting for 56.9 per cent of the value of Canada's mineral production. Most of this increase resulted from increases in the production values of the main metals. Rising substantially in volume, nickel had a value increase of $62.9 million. Iron-ore shipments went up by nearly 8 million long tons and their value by $66.5 million. Copper, chiefly because of higher prices, increased by $58.7 million. Uranium, with an increase of more than 4 million pounds of U_3O_8, advanced by $51.6 million.

The value of industrial-mineral production was $502.8 million. This comprised $178.2 million for nonmetallic minerals and $324.6 million for structural materials. Industrial minerals accounted for 20.9 per cent of the value of all 1959 mineral production, exceeding the 1958 output of this category by $43.0 million, or 9.3 per cent. Asbestos, with a 13.5-per-cent increase in tonnage shipped, rose $15.2 million in value. Gypsum was up $3.2 million and salt $3.0 million. The value of the output of clays and clay products increased by $0.8 million, and sand and gravel went up by $8.4 million. Stone production was up $5.4 million.

The production value of mineral fuels in 1959 amounted to $535.6 million, or 22.2 per cent of all mineral production. This represented an increase of $24.8 million, or 4.9 per cent, over the previous year's output. Crude petroleum accounted for $23.3 million of this increase. The output of natural gas was up 23.5 per cent in quantity and 23.6 per cent in value. Coal production continued to decline, decreasing by more than 1 million tons in volume and $6.1 million in value.

*Mineral Resources Division

Table 1

Mineral Production of Canada

	Unit of Measure	1959 Quantity	1959 $000	1958 Quantity	1958 $000
Metallics					
Antimony	000 lb	1,658	540	859	284
Bismuth	000 lb	335	590	413	771
Cadmium	000 lb	2,160	2,765	1,756	2,669
Calcium	000 lb	67	76	25	31
Cobalt	000 lb	3,150	5,955	2,710	5,308
Copper	000 s.t.	395	233,103	345	174,431
Gold	000 troy oz	4,483	150,508	4,571	155,334
Indium	000 oz	**	**	*	*
Iron ore	000 l.t.	21,865	192,666	14,041	126,131
Iron (remelt)	000 s.t.	**	7,187	*	5,121
Lead	000 s.t.	187	39,617	187	42,414
Magnesium	000 lb	12,204	3,180	13,592	4,065
Molybdenum (Mo content)	000 lb	749	941	888	1,153
Nickel	000 s.t.	187	257,009	140	194,142
Platinum metals	000 troy oz	178	5,917	154	4,840
Platinum	000 oz	150	11,015	146	9,481
Selenium	000 lb	368	2,577	307	2,302
Silver	000 troy oz	31,924	28,023	31,163	27,053
Tellurium	000 lb	13	28	38	65
Thorium	000 lb	47	106	-	-
Tin	000 lb	747	630	795	625
Titanium ore	000 s.t.	13	130	-	-
Tungsten (WO_3 content)	000 lb	-	-	691	1,899
Uranium (U_3O_8)	000 lb	31,784	331,143	26,805	279,539
Zinc	000 s.t.	396	96,943	425	92,502
Total, metallics			1,370,649		1,130,160
Nonmetallics					
Arsenious oxide	000 lb	1,578	64	2,323	95
Asbestos	000 s.t.	1,050	107,433	925	92,277
Barite	000 s.t.	239	2,255	196	2,196
Feldspar	000 s.t.	18	301	20	360
Fluorspar	000 s.t.	**	1,851	*	1,543
Gypsum	000 s.t.	5,879	8,394	3,964	5,189
Iron oxide	000 s.t.	1	108	2	113
Lithia	000 lb	2,756	1,422	3,853	2,048
Magnesite, dolomite and brucite		**	3,051	*	2,529
Mica	000 lb	814	63	1,505	90

(table continued on page 3)

Mineral Production of Canada (cont'd)

	Unit of Measure	1959 Quantity	1959 $000	1958 Quantity	1958 $000
Nonmetallics (cont'd)					
Mineral water	000 gal	369	203	317	173
Nepheline syenite	000 s.t.	229	2,931	201	2,613
Peat moss	000 s.t.	184	6,227	149	4,779
Potash (K_2O)		...	1,408	-	-
Pyrite, pyrrhotite	000 s.t.	1,100	3,433	1,192	4,249
Quartz	000 s.t.	2,164	3,437	1,454	2,538
Salt	000 s.t.	3,290	18,035	2,375	14,990
Silica brick	000's of bricks	1,926	354	2,815	472
Soapstone, talc	000 s.t.	39	512	35	429
Sodium sulphate	000 s.t.	180	2,882	173	2,863
Sulphur in smelter gas	000 s.t.	277	2,716	241	2,361
Sulphur, elemental	000 s.t.	146	2,621	94	1,873
Titanium dioxide	000 s.t.	**	8,507	*	6,575
Diatomite	s.t.	5	0.1	27	0.5
Grindstone	s.t.	60	9	-	-
Total, nonmetallics			178,217		150,355
Fuels					
Coal	000 s.t.	10,627	73,876	11,687	79,963
Natural gas	millions of cu ft	417,335	39,609	337,804	32,058
Crude petroleum	000 bbl	184,778	422,093	165,496	398,748
Total, fuels			535,578		510,769
Structural materials					
Clay products			42,515		41,710
Cement	000 s.t.	6,284	95,148	6,153	96,414
Lime	000 s.t.	1,686	21,304	1,596	19,466
Sand and gravel	000 s.t.	185,124	104,651	160,211	96,282
Stone	000 s.t.	46,440	60,959	38,157	55,583
Total, structural materials			324,577		309,455
Total, all minerals			2,409,021		2,100,739

*Not available for publication.
- Nil.

Historical Trend in Mineral Production

In 1957 the per capita value of mineral production amounted to $132.03 but in 1958 it declined 6.7 per cent to $123.22. In 1959, reflecting an increase both in population and in production value, it advanced 12.1 per cent to an all-time record of $138.12

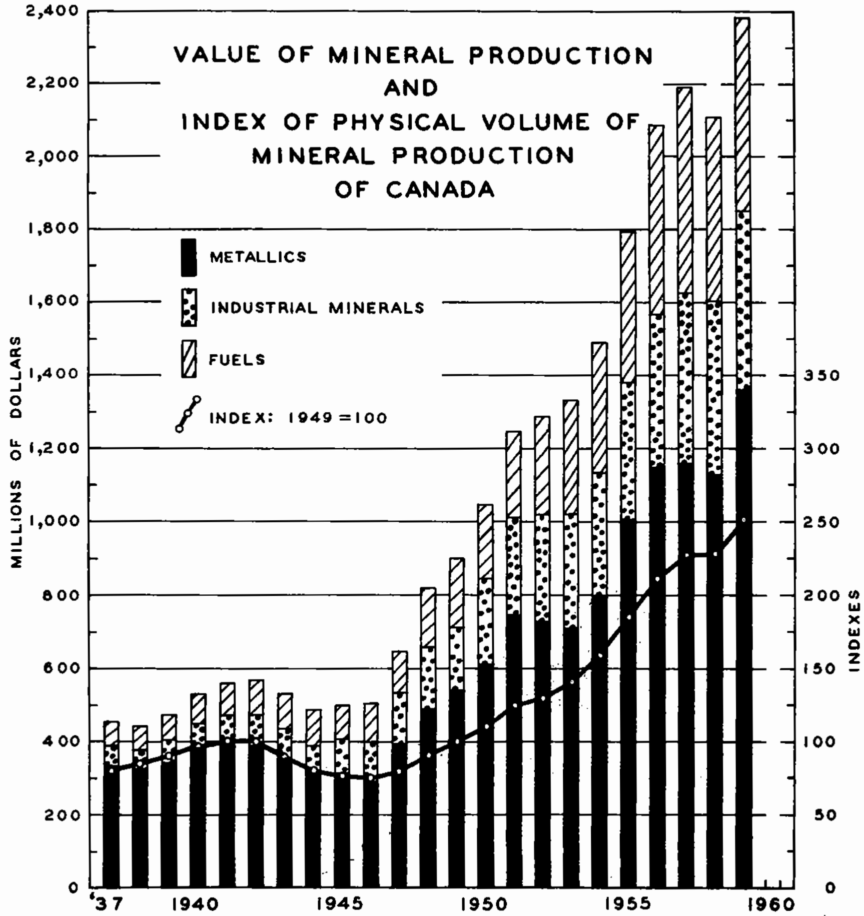
Table 2

Mineral Production of Canada and Its Per Capita Value

	Production				Per Capita Value
	Metallics ($ millions)	Industrial Minerals ($ millions)	Fuels ($ millions)	Total ($ millions)	($)
1921	49	45	78	172	19.56
1926	115	56	69	240	25.61
1931	121	55	54	230	22.21
1936	260	43	60	363	32.82
1941	395	80	85	560	49.06
1946	290	110	103	503	40.86
1951	746	266	233	1,245	88.90
1956	1,146	420	519	2,085	129.65
1957	1,159	466	565	2,190	132.03
1958	1,130	460	511	2,101	123.22
1959	1,371	503	535	2,409	138.12

Physical Volume of Production

The physical-volume index (base 1949 = 100) measuring mineral output advanced to 251.1 in 1959. This was an increase of 10.6 per cent over the index of the previous year. The volume of output of all industry increased 7.6 per cent and that of manufacturing 6.6 per cent. Considerable strength was shown in the industrial-mineral sector of the mineral industry, where the increase in volume of output amounted to 12.6 per cent. According to the index, the 1959 production volume of metals was higher than that of 1958 by 11.6 per cent, and the production volume of fuels was higher by 10.2 per cent.



SOURCE: D.B.S.

MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Table 3

Indexes* of Industrial Production
(1949 = 100)

	Total, All Industry	Manufacturing	Mining			
			Total	Metal	Industrial Minerals	Fuels
1935	41.4	39.0	60.8	72.1	39.1	49.3
1940	63.9	60.4	96.2	114.5	67.3	77.7
1945	90.1	92.9	77.2	83.5	87.0	70.0
1950	106.9	106.2	109.5	103.5	139.1	112.1
1951	116.6	115.0	123.4	107.9	156.3	143.5
1952	120.9	118.5	131.0	110.3	155.5	163.9
1953	129.1	126.4	142.1	115.7	152.9	192.7
1954	128.5	122.9	158.7	129.0	161.4	215.6
1955	142.3	134.7	185.2	142.7	180.2	273.2
1956	154.9	145.1	212.3	151.0	187.6	344.7
1957	155.4	142.9	227.8	170.0	179.0	358.2
1958	154.4	140.7	227.0	180.3	170.9	329.5
1959	166.2	150.0	251.1	201.3	191.4	363.1

*Unadjusted.

Net Value of Production

To compare the production values of the various commodity-producing industries, it is necessary to use statistics on net values of production. Certain costs are removed to eliminate duplication and permit a more meaningful assessment of the value added by the industry in question.

The mineral industry in 1958, the latest year for which net-value statistics are available, recorded a net value of production of $1,311 million. It constituted 30.6 per cent of the net value of production of the primary industries, among which it ranked second, after agriculture. Between 1954 and 1958 the net value of mineral production increased 45.5 per cent, which was more than the increase shown by any other commodity industry over the same period.

Table 4

Net Value of Production in Canada, by Industry
($ millions)

	1954	1955	1956	1957	1958
Primary industries					
Agriculture	1,575(1)	1,949(1)	2,143(1)	1,676(1)	1,927(1)
Forestry	584	664	761	663	515
Fisheries	97	91	106	94	117
Trapping	10	17	12	11	11
Mineral industry	901	1,062	1,224	1,308	1,311
Electric-power industry	489	543	594	633	685
Total, primary	3,656	4,326	4,840	4,385	4,566
Secondary industries					
Manufacturing	7,902	8,754	9,605	9,822	9,792
Construction	2,608	2,770	3,344	3,714	3,720
Total, secondary	10,510	11,524	12,949	13,536	13,512
Grand total	14,166	15,850	17,789	17,921	18,078

(1) Series revised for certain purchased services.

Provincial Distribution of Mineral Production

All the provinces of Canada recorded mineral production in 1959.

Ontario, the leading mineral-producing province, accounted for 58.8 per cent of Canada's metal production and a substantial output of industrial minerals. Its total mineral production was valued at $970.8 million, which was more than double that of Quebec, the second-ranking province.

Quebec, which is the leading producer of industrial minerals and is rapidly increasing its production of metallic minerals, accounted for 18.3 per cent of the national mineral total.

Alberta and Saskatchewan, with their large output of crude petroleum and natural gas, followed, contributing respectively 15.6 per cent and 8.7 per cent.

British Columbia, which is chiefly a metal-producing province but is rapidly increasing its production of crude petroleum and natural gas, accounted for 6.6 per cent.

Newfoundland, Canada's newest province, with substantial quantities of copper, lead and zinc, and increasing shipments of iron ore, accounted for 3.0 per cent.

Falconbridge Nickel Mines Limited has completed its expansion program and the annual production capacity is now about 30,000 tons of nickel.

Sherritt Gordon Mines Limited completed its mill expansion to a rated capacity of 3,500 tons a day. This expansion will offset a lowering of mine grade and enable the company to maintain a steady output in terms of nickel.

North Rankin Nickel Mines Limited, in the Northwest Territories, continued to ship to the Fort Saskatchewan refinery of Sherritt Gordon Mines Limited. The contract between these two companies was extended, North Rankin contracting to deliver 28 million pounds of nickel in concentrates over the next four years.

Giant Nickel Mines Limited, in British Columbia, resumed production. Its mill capacity is 1,000 tons a day. Shipments of concentrates to Japan under a three-year contract begin in 1960.

Copper

Copper production increased by 50,156 tons over its 1958 total. Its value, at $233.1 million, was $58.7 million, or 33.6 per cent higher.

In the United States, work stoppages affecting the main producers reduced copper production, but outside the United States production was at a record level and there was a threat of overproduction. The strikes in the United States, however, were prolonged, and there were sporadic strikes in South America and Africa. The general loss of production that resulted from these work stoppages tended to diminish world oversupply.

The copper industry in Canada experienced moderate expansion. Exports of ore and matte were up slightly, while those of refined copper were down. Domestic consumption of refined copper was up 7,080 tons.

Six domestic smelters treated copper and copper-nickel ores and concentrates, and refined copper was produced at two domestic copper refineries.

Exploration for new deposits and development of known deposits were stimulated by higher prices and the short-term prospect of an increased demand for copper. North Coldstream Mines Limited, in Ontario, resumed production early in 1960 at a milling rate of 1,000 tons a day. Atlantic Coast Copper Corporation Limited, in Newfoundland, has announced production plans for the near future.

Iron Ore

Iron-ore shipments in 1959 reached a record high, exceeding the shipments of the recessional year 1958 by 55.7 per cent and those of 1956, the previous record year, by 9.6 per cent.

The prolonged United States steel strike of 1959 closed that country's iron-ore mines. To enable Ontario blast-furnace producers, traditionally dependent on the United States for a large part of their ore requirements, to maintain their output, a higher proportion of Canadian iron-ore production was consumed domestically. The result was a record rate of blast-furnace operation in Ontario.

Exports to western Europe and Japan were at an all-time high. Those to the United States, the largest consumer of Canadian iron ore, were at a high level despite the steel strike because of the record consumption rate that preceded the expected strike and the build-up of stockpiles during the strike in anticipation of an ore shortage during the winter of 1959-60.

In 1959, three new mines were brought into production - two in British Columbia and one in Ontario. Two firms in Ontario and one in Quebec produce iron by-products that are not included in iron-ore-production statistics.

The opening of the new St. Lawrence Seaway during the year brought a major change in the iron-ore shipping pattern, which resulted in lower transportation costs to some market areas. By 1970 as much as 25 million tons of iron ore from Labrador-Quebec is expected to be shipped through the Seaway annually.

Within the last decade, particularly since 1954, iron-ore production has increased rapidly - to such an extent that Canada ranks fourth among the world's iron-ore producers. By 1965, Canada's annual production capacity will have increased to more than 40 million tons, or nearly twice the record amount produced in 1959. Three projects under way in Labrador-Quebec will contribute most of the expected increase: Quebec Cartier Mining Company (8 million tons by 1961), Iron Ore Company of Canada (7 million tons by 1962) and Wabush Iron Company Limited (4 to 5 million tons by 1964-5).

<u>Gold</u>

Gold production declined by 87,931 ounces, or 1.9 per cent, from the level of the previous year. Its output value, at $150.5 million, was 3.1 per cent lower.

Most of Canada's gold production is obtained from lode gold mines. Output from this source declined 1.9 per cent. Production from base-metal mines, about 12.5 per cent of the total, was also down. Output from placer mining operations increased slightly.

Conditions for Canada's gold-mining industry were less favorable in 1959. A decline in the Canadian dollar in relation to the United States dollar brought about a decrease in the price of gold. The average for the year was $33.57 an ounce, compared with $33.98 in 1958. Costs were increased at most mines through new labor agreements signed late in 1958 or early in 1959.

There were 52 large lode gold mines operating in Canada during 1959, one fewer than in 1958. One new producer in the Malartic area of Quebec began production in June. A number of small prospective gold mines were under development during the year in various parts of Canada.

The Emergency Gold Mining Assistance Act was extended in September 1958 to cover the calendar years 1958, 1959 and 1960 and to provide for a 25-per-cent increase in the amount of cost assistance payable. In January 1960 it was announced that the Act was to be extended for a further three-year period at the same rate of assistance.

Zinc

Production of recoverable zinc in 1959 was 29,091 tons, or 6.8 per cent, less than in the previous year. The value of production, reflecting higher zinc prices, was up $4.4 million, or 4.8 per cent.

The reduction in zinc output was due to the United States quotas, effective October 1, 1958, imposed on imports of unmanufactured lead and zinc. Under these quotas the Canadian quarterly share of the United States import market for zinc contained in ores and concentrates was set at 33,240 tons. Shipments of zinc in ores and concentrates exceeded this quota in each quarter, and the excess was held in bond at United States smelters. Shipments of refined zinc to the United States were also lower, as were shipments of both refined zinc and zinc in concentrates to the United Kingdom and continental Europe. Domestic shipments of refined zinc increased, partly offsetting the drop in exports.

Canada in 1959 was the second-ranking producer of zinc, following the United States. Other leading producing countries were Mexico, Australia, Peru and Japan.

In British Columbia The Consolidated Mining and Smelting Company of Canada Limited carried out underground work at the Duncan lead-zinc property in the Lardeau area. Hudson Bay Mining and Smelting Co. Limited, in Manitoba-Saskatchewan, brought a new mine into production in April 1960, and another new mine is expected to be producing by the end of the year. Production in 1960, however, is expected to remain about the same. Work continued in the Mattagami Lake area of Quebec, where reserves of about 26 million tons of zinc ore have been outlined. The lead-zinc mining operations of Heathe Steele Mines Limited, in New Brunswick, were suspended in March 1958 and no further work was done in 1959, but it is expected that operations will be resumed in 1960 at the rate of 2,000 tons of ore a day.

Lead

Canada's lead production, at 186,696 tons, was virtually the same in 1959 as in the previous year. The average price for the year was lower and the value of production was down $2.8 million, or 6.6 per cent.

Lead production in Canada comes from relatively few sources, the most important being the mines of The Consolidated Mining and Smelting Company of Canada Limited, in British Columbia, the deposit of American

Smelting and Refining Company (Buchans Unit), in Newfoundland, and the Yukon mines of United Keno Hill Mines Limited.

The continuing United States quotas on imports of unmanufactured lead had a depressing effect on mine exploration and development. No important discoveries of lead mineralization were reported in 1959.

Early in the year the more important lead producers of the Western World indicated that they would voluntarily reduce production or commercial dealings to a level more in agreement with demand. At the end of the year, because large surpluses continued to exist, the voluntary curtailments were still being maintained.

Silver

Silver production in 1959 increased 2.4 per cent in quantity and 3.6 per cent in value over its 1958 total. Most of the increase came from Ontario and Yukon Territory. In British Columbia there were significant increases in the recovery of silver from lead-zinc ores, and in Yukon Territory richer silver ore was mined by United Keno Hill Mines Limited.

Canada ranked second as a producer of silver, following Mexico, whose production was 44,075,452 ounces. World output was estimated at 217 million ounces. The year was marked by a substantial increase in the world demand for silver.

Most of Canada's silver is derived from base-metal ores. Of the year's output, 54 per cent came from lead-zinc and silver-lead-zinc ores, 23 per cent from copper, copper-zinc and nickel-copper ores, 21 per cent from silver-cobalt and silver ores and 2 per cent from lode and placer gold operations.

Platinum Metals

The production value of platinum metals amounted to $16.9 million in 1959, an increase of $2.6 million over the previous year's total.

All the platinum metals produced in Canada are obtained at present from the treatment of the Sudbury nickel-copper ores, which average about 0.025 ounce platinum metals per ton. The mines of The International Nickel Company of Canada, Limited, and of Falconbridge Nickel Mines Limited are the sources of platinum metals.

An increase in Falconbridge's production is expected to follow completion of a major expansion program. International Nickel's annual production will also be increased early in 1961, when production begins at the Thompson mine in Manitoba.

Titanium

The value of titanium shipped in 1959 as ore, heavy aggregate or titanium-bearing slag, was $8.6 million, or about $2.1 million more than in 1958. The Canadian titanium industry is based almost entirely on ilmenite for the electric-furnace production of titanium-dioxide slag and by-product 'Sorelmetal' (pig iron) at Sorel, Quebec. A large part of the slag produced is exported to the United States for pigment manufacture. Minor amounts of ilmenite are used as heavy aggregate in construction and the manufacture of ferrotitanium.

Quebec Iron and Titanium Corporation, holding some of the largest ilmenite reserves in the world at Allard Lake, Quebec, produces ilmenite for its electric smelting facility and minor amounts for heavy-aggregate use. Continental Iron and Titanium Mining Limited mines small amounts of ilmenite in the St. Urbain area for use as heavy aggregate. Canadian Titanium Pigments Limited, the only manufacturer of titanium-base pigments in Canada, manufactures pigments in a plant at Varennes, Quebec, from titanium-dioxide slag received from Quebec Iron and Titanium's Sorel smelter. British Titan Products (Canada) Limited, a subsidiary of a United Kingdom firm, announced plans to build at Sorel Canada's second pigment-manufacturing plant, at which Sorel slag is to be used as the raw material.

Fuels

Petroleum

Production of crude petroleum amounted to 184.8 million barrels valued at $422.1 million. This is an all-time record in terms of quantity and value, which were respectively 11.6 per cent and 5.9 per cent higher than in 1958.

Alberta's production was up 16.7 million barrels and accounted for 70.3 per cent of Canada's output. Saskatchewan showed a moderate increase - from 2.8 million barrels to 47.4 million barrels, which was 25.7 per cent of the national total. Manitoba's production, which declined by 0.8 million barrels, accounted for 2.7 per cent. Ontario's production of 1.0 million barrels was up 0.2 million barrels. British Columbia showed an increase of 0.4 million barrels. The Northwest Territories and New Brunswick registered a lower output. Production from the last three accounted for 0.7 per cent of the national total.

As 1959 ended, western Canada had 14,312 wells capable of production, of which 12,522 were producing. Lack of markets kept 1,790 wells inoperative.

Reserves of crude oil were increased during the year by 514.9 million barrels, which gave proved reserves a year-end total of 3,497.1 million barrels. Of these, Alberta had 2,898.9 million barrels, Saskatchewan 495.8 million, the Northwest Territories 52.0 million, Manitoba 23.0 million, British Columbia 19.4 million and Ontario 8.0 million barrels. New Brunswick's reserves amounted to 63,000 barrels.

Geophysical work continued to decline except in the northern areas, where there was an increase in geophysical exploration. Exploratory drilling was greater than in the previous year but was still below the 1957 level.

By the end of 1959 the construction of loops, extensions and new feeder systems had increased the length of crude-oil pipelines in Canada to 7,945 miles, or 797 miles more than in the previous year. Alberta accounted for 481 miles of this total, Saskatchewan for 709 and Manitoba for 3.3

When the year ended, Canada had 40 operating refineries and its refining capacity totalled 853,262 barrels of crude oil a day. Two new refineries were under construction and scheduled to come on stream in 1960. One of these, in New Brunswick, will have a capacity of 40,000 barrels a day. The other, in Montreal East, Quebec, will have a capacity of 25,000 barrels a day. These plants will raise Canada's refinery capacity to more than 900,000 barrels a day.

Crude oil from domestic oil fields delivered to Canadian refineries amounted to 151.5 million barrels, about 12.6 per cent more than in 1958. Imports of foreign crude oil amounted to 116.3 million barrels. Exports, which went entirely to the United States, amounted to 33.4 million barrels, having increased from the 31.7 million barrels exported in the previous year.

Imports of petroleum products, which in 1958 totalled 30 million barrels, continued at a high level, amounting in 1959 to 38 million barrels. Most of these products consist of both light and heavy fuel oils.

During 1959, the Royal Commission on Energy completed its study of the Canadian oil industry and made recommendations concerning marketing.

Natural Gas

Output of natural gas in 1959 reached an all-time high of 433,229 million cubic feet. This represents an increase of 95,425 million cubic feet, or 30.9 per cent, over the total of the previous year. The value of production amounted to $39.6 million, or 23.4 per cent more.

Exploration for new gas sources continued throughout the year. Drilling for additional reserves was extended into northwestern Alberta, northern British Columbia and the Northwest Territories, with success in the first two areas. In contrast with the lack of demand for crude oil, the requirements of gas-pipeline companies to fill contractual agreements were very high.

Exploration continued in eastern Canada with disappointing results except in Ontario, where discoveries made mostly in the Port Maitland area, increased gas-production potential by 5 million cubic feet a day.

In western Canada, natural-gas-processing plants have been constructed at a rapid rate during the past few years. Thirty-three plants were in operation at the end of 1959, and plans call for the building of about a dozen more in the near future. The need to remove propane, butane, pentanes and hydrogen sulphide from most Canadian natural gas before it can be sold will provide large quantities of these products. Present gas-processing plants have a raw-gas capacity of 1,600 million cubic feet a day. Production of elemental sulphur from these plants is now about 1,500 tons a day.

Exports of natural gas in 1959 declined slightly. In the near future, however, when export applications now before the National Energy Board are approved, natural-gas exports will be greater than domestic sales, which in 1959 amounted to 282,358 million cubic feet.

Coal

Coal production in 1959 showed a further decline, amounting to 10.6 million tons, which was 1.0 million tons, or 9.1 per cent, below the total of the previous year. The value, at $73.9 million, was 7.6 per cent less.

In the past decade, Canada's coal production has dropped from the 19.1-million-ton output of 1950 to the level just given, while the number of operating mines has decreased from 363 to 133 and the number of men employed at the mines has fallen from 23,418 to 11,485.

Competition from oil and, more recently, from natural gas has been largely the cause of the decline in coal output, and the widespread use of Diesel engines has resulted in the loss of the railway market. The loss of traditional markets during the past decade has brought about an economic depression in the coal-mining industry at a time of unparalleled Canadian business expansion.

In an effort to hold down production costs, the mechanization of mining operations has been accelerated. In strip mines, larger drag-line machines and shovels have been introduced. It is hoped that an increase in efficiency and growth of the thermal-power market will enable the industry to regain some of its production loss.

At the end of 1959, a Royal Commission on Coal was established to inquire into the Canadian coal industry in view of recent changes in the energy demand.

Nonmetallic Minerals

Asbestos

A strengthening in the world market for asbestos in 1959 brought an increase in Canadian production. Output increased 125,098 tons to 1,050,429 tons, and the value of production, at $107.4 million, was $15.2 million above the 1958 total.

The improvement in demand applied to most grades, particularly to Groups 5 and 6. Shipments of these grades increased 33 per cent and 20 per cent respectively. The strike in the United States steel industry, which uses large quantities of heat-protective clothing made of asbestos, affected the market for textile-grade asbestos. An increase in the use of vinyl-asbestos tile, in which 'shorts' (Group 7) are used, caused a shortage in this grade.

Gypsum

Gypsum production increased 1.9 million tons to 5.9 million tons. The value of production was up 61.8 per cent to $8.4 million.

The substantial increase of 1959 was due to the settlement of a labor dispute, which had curtailed 1958 quarry operations in Nova Scotia.

A new quarry was opened at Nappan, Nova Scotia, by Gypsum, Lime and Alabastine Limited. The same company is completing a new gypsum-product plant in Calgary, Alberta. A board-and-plaster plant was built by Western Gypsum Products Limited in Vancouver, British Columbia. A new gypsum deposit was discovered near Drumbo, in southwestern Ontario.

Salt

The salt industry experienced considerable expansion in 1959. The year's production of 3.3 million tons was 38.5 per cent above that of the previous year. The value of production increased by 20.3 per cent to $18.0 million.

The growth in production was due chiefly to an increase in the output of rock salt and in the production of brine for export.

During 1959, two new rock-salt mines came into production, one in Ontario and one in Nova Scotia. Their opening brought to three the number of salt mines operating in Canada.

At Sandwich, Ontario, Canadian Brine Company produces for export a considerable amount of salt in the form of brine. This operation, begun in 1958, now accounts for more than half of Canada's salt exports.

Sulphur

The sulphur in pyrite and pyrrhotite production, the sulphur in smelter gases and elemental sulphur totalled 868,297 tons in 1959.

The most significant aspect of the Canadian sulphur industry is the rapid growth, in western Canada, of the production of elemental sulphur from natural gas. Sulphur recovered in absorption plants from the cleaning of sour natural gases amounted for the year to 143,000 tons. Recovery plants operating in western Canada at the end of 1959 were capable of producing about 615,450 tons of sulphur a year. Canada still has an annual import total of more than 300,000 tons of elemental sulphur. It seems, however, that dependence on imports will diminish and that domestically produced sulphur will be utilized in increasing quantities.

In 1959 the production of pyrite and pyrrhotite amounted to 1,099,564 tons with a sulphur content of 465,611 tons. Large amounts of pyrite and pyrrhotite are produced by base-metal mines in British Columbia, Manitoba, Ontario and Quebec. Some of the mines produce pyrite and pyrrhotite concentrates to make sulphur compounds and iron ore, which are sold. Others produce the concentrates for direct sale only.

Two companies use smelter gas as a source of sulphur. At its Trail plant, The Consolidated Mining and Smelting Company of Canada Limited recovers sulphur-dioxide gas from smelter gases to produce sulphuric acid. At the plant of The International Nickel Company of Canada, Limited, sulphur dioxide is recovered from smelter gases and is used to make sulphuric acid, and concentrated sulphur-dioxide gas is recovered to produce liquid sulphur dioxide, which is sold to pulp mills.

Cement

Cement output continued to increase. The 6.3 million tons produced in 1959 were 2.1 per cent above the output of the previous year. The value of production decreased 1.3 per cent to $95.1 million.

For a number of years following World War II Canadian cement production was insufficient to meet domestic demand, and considerable quantities were imported. At present Canadian production is adequate for domestic demand, and imports are consequently insignificant. About 5 per cent of production is being exported to the United States.

In 1959 a large cement plant was constructed near Montreal, Quebec. This plant, the largest in Canada, with a capacity of 4 million barrels of clinker a year, went into production early in 1960. It raises the number of cement plants in Canada to 19 with a combined annual capacity of more than 8.5 million tons. Consumption of 'ready-mixed' concrete has grown remarkably and now provides a market for more than 25 per cent of all the cement used in Canada.

Fluorspar

Owing to the rising requirements of the aluminum industry and the high rate of steel output, the 1959 value of fluorspar production increased 20.0 per cent over the 1958 level to $1.9 million.

More than 96 per cent of Canada's fluorspar comes from Newfoundland. In 1959 two companies operated. Newfoundland Fluorspar Limited, a subsidiary of Aluminum Company of Canada, Limited, produced submetallurgical-grade at a somewhat lower rate than normal owing to a decrease in aluminum production. St. Lawrence Corporation of Newfoundland Limited, after being closed down since the latter part of 1957, reopened on a small scale in 1959. Huntingdon Fluorspar Mines Limited, in Ontario, almost doubled its shipments in 1959. Its output is consumed in Canadian steel mills.

Potash

In 1959, Canada's first potash production was recorded when, after 10 years of exploration and development in western Canada, Potash Company of America, Ltd., brought the country's first potash mine into successful operation. The output was valued at $1,408,462.

Shipments from Potash Company of America's Patience Lake property in Saskatchewan continued throughout 1959 until November, when the plant was closed down for repairs. Shipments were made to the United States and Asia. In operation, the company experienced difficulty caused by high-pressure water flow in the shaft. This was successfully overcome by freezing the water-bearing areas around the shaft.

International Minerals & Chemical Corporation (Canada) Limited expects that by 1961 it will have completed development work and will be in production. Continental Potash Corporation Limited has sunk a shaft to 1,600 feet and plans to produce 200,000 tons of muriate a year.

When 1959 ended, 12 other companies were holding leases in western Canada.

Reserves of potash in western Canada have been estimated at 6,400 million tons of recoverable potash grading more than 25 per cent K_2O.

Clays and Clay Products

Domestic clays and clay products produced in Canada in 1959 were valued at $42.6 million, 1.9 per cent more than in 1958; and clay products from imported clays had an estimated value of $22.2 million. Their combined value was $67.4 million, compared with the 1958 total of $65.4 million.

To keep up with the demand for building-brick Cooksville-Laprairie Brick Limited installed a new tunnel kiln at its Laprairie plant, and Diamond Clay Products Limited constructed a new tunnel kiln at Hamilton, Ontario. New equipment was installed by Medicine Hat Brick and Tile Company Limited for the manufacture of colored, glazed face brick. The production of this type of brick reflects the present trend toward the greater exterior and interior use of more decorative types of brick and tile.

Canada in Relation to the World

Canada is an important producer of minerals. In 1959 it led the world in nickel and asbestos and in 1958 it was in first place with uranium. In 1959, according to recent information, Canada was second in uranium, the United States having taken the lead.

The latest available statistics on Canada's position in the world as a producer of the more important minerals are given in Table 6. If the production statistics (estimates only) for the Union of Soviet Socialist Republics are disregarded, Canada ranks second to the United States in the production of aluminum and zinc and second to the Union of South Africa in gold production. Canada's position in copper and lead, that of the U.S.S.R. being excluded, is fourth.

Table 6

WORLD ROLE OF CANADA AS PRODUCER OF CERTAIN IMPORTANT MINERALS

YEAR	METAL OR NONMETAL	WORLD PRODUCTION	RANK 1	2	3	4	5	6
1959	Nickel (short tons)	309,000 100%	CANADA 186,555 60.4%	U.S.S.R. 60,000 19.4%	New Caledonia 28,105 9.1%	Cuba 19,658 6.4%	U.S.A. 11,606 3.8%	Union of S.A. 2,900 0.9%
1959	Asbestos (short tons)	2,270,000 100%	CANADA 1,050,429 46.3%	U.S.S.R. 600,000 26.4%	Union of S.A. 182,405 8.0%	S. Rhodesia 119,699 5.3%	China 88,000 3.9%	Italy 49,594 2.2%
1959	Uranium (short tons)	(Free World) 43,450 100%	U.S.A. 16,390 37.7%	CANADA 15,892 36.6%	Union of S.A. 6,445 14.8%	Belgian Congo 2,300 5.3%	France 1,000 2.3%	Australia 1,000 2.3%
1959	Platinum and platinum metals (troy ounces)	1,009,000 100%	Union of S.A. 380,352 37.7%	CANADA 328,095 32.5%	U.S.S.R. 250,000 24.8%	Colombia 31,498 3.2%	U.S.A. 15,485 1.5%	Japan 11,413 0.1%
1959	Cadmium (000's pounds)	19,660 100%	U.S.A. 8,602 43.8%	CANADA 2,160 11.0%	Belgium 1,488 7.6%	S.W. Africa 1,193 6.1%	Mexico 1,151 5.9%	Japan 1,082 5.5%
1959	Gypsum (000's short tons)	42,260 100%	U.S.A. 10,900 25.8%	CANADA 5,878 13.9%	U.K. 4,520 10.7%	France 4,079 9.7%	U.S.S.R. 3,860 9.1%	Spain 2,094 5.0%
1959	Silver (troy ounces)	216,800,000 100%	Mexico 44,075,452 20.3%	CANADA 31,923,969 14.7%	U.S.S.R. 25,000,000 11.5%	Peru 24,767,581 11.4%	U.S.A. 23,000,000 10.6%	Australia 14,800,000 6.8%
1959	Zinc (short tons)	3,070,826 100%	U.S.A. 416,965 13.6%	U.S.S.R. 415,000 13.5%	CANADA 396,008 12.9%	Mexico 290,936 9.5%	Australia 232,089 7.6%	Japan 155,738 5.1%
1959	Aluminum (short tons)	4,389,988 100%	U.S.A. 1,953,017 44.5%	U.S.S.R. 625,000 14.2%	CANADA 593,630 13.5%	France 190,693 4.3%	W. Germany 166,629 3.8%	Norway 159,669 3.6%
1959	Gold (troy ounces)	42,800,000 100%	Union of S.A. 20,064,105 46.9%	U.S.S.R. 10,000,000 23.4%	CANADA 4,483,416 10.5%	U.S.A. 1,635,000 3.8%	Australia 1,089,574 2.5%	Ghana 913,200 2.1%

1959	Barite (short tons)	2,984,000 100%	U.S.A. 867,201 29.1%	W. Germany 428,034 14.4%	CANADA 238,967 8.0%	Mexico 198,579 6.7%	Greece 165,000 5.5%	France 132,000 4.4%
1959	Cobalt (short tons)	17,600 100%	Belgian Congo 9,374 53.3%	N. Rhodesia 2,372 13.5%	CANADA 1,575 8.9%	Fr. Morocco 1,391 7.9%	U.S.A. 1,165 6.6%	New Caledonia 160 0.9%
1959	Bismuth (short tons)	2,560 100%	Peru 388 15.2%	Mexico 262 10.2%	Bolivia 240 9.4%	CANADA 167 6.5%	Korea 114 4.5%	Yugoslavia 100 3.9%
1959	Iron Ore (long tons)	392,326,031 100%	U.S.S.R. 92,908,143 23.7%	France 59,934,610 15.3%	U.S.A. 58,734,000 15.0%	CANADA 21,864,576 5.6%	China 20,551,140 5.2%	Sweden 17,997,016 4.6%
1959	Titanium Concentrates (ilmenite) (short tons)	1,909,100 100%	U.S.A. 634,886 33.3%	India 334,000 17.5%	Norway 249,453 13.1%	CANADA 247,858 13.0%	Finland 94,966 5.0%	Union of S. A. 87,232 4.6%
1959	Magnesium (short tons)	104,600 100%	U.S.S.R. 45,000 43.0%	U.S.A. 31,033 29.7%	Norway 10,582 10.1%	CANADA 6,102 5.8%	Italy 4,967 4.7%	U.K. 2,458 2.3%
1959	Copper (short tons)	3,977,358 100%	U.S.A. 840,000 21.1%	Chile 601,855 15.1%	N. Rhodesia 598,834 15.1%	U.S.S.R. 510,000 12.8%	CANADA 395,269 9.9%	Belgian Congo 310,952 7.8%
1959	Lead (short tons)	2,311,070 100%	U.S.S.R. 340,000 14.7%	Australia 331,529 14.3%	U.S.A. 253,260 11.0%	Mexico 210,187 9.1%	CANADA 186,696 8.1%	Peru 130,917 5.7%
1959	Molybdenum (short tons)	35,100 100%	U.S.A 25,478 72.6%	U.S.S.R. 4,950 14.1%	Chile 1,893 5.4%	China 1,650 4.7%	Japan 397 1.1%	CANADA 374 1.1%
1959	Pyrites (sulphur contents) (short tons)	7,853,000 100%	Spain 1,047,200 13.3%	Italy 754,880 9.6%	Japan 730,240 9.3%	Cyprus 499,520 6.4%	U.S.A. 489,440 6.2%	CANADA 465,611 5.9%

Trade

Exports of Minerals and Their Products

Canada's exports of minerals in all degrees of manufacture, from raw material to fully fabricated goods, amounted to $1,972.1 million in 1959. This was 15.4 per cent over the 1958 total.

Exports of iron ore (in 'raw material' under 'iron and its products' in Table 7) increased $50.1 million, or 46.5 per cent. Gains in nonferrous metals and products were substantial, but on a percentage basis the increases in the exports of nonmetallic minerals and products (including fuels) were larger.

Between 1958 and 1959 the exports of mineral raw material increased 15.0 per cent in value, and the relative importance of these products rose from 14.0 per cent to 15.4 per cent of all mineral exports (see Table 8). In 1958, the exports of fully manufactured mineral products amounted to 7.2 per cent of the value of all mineral exports; in 1959 they increased to 8.7 per cent.

Exports of all domestic products were valued at $5,060.9 million for 1959. Of this total, $1,972.1 million, or 39.0 per cent, represented mineral products in varying degrees of manufacture. This percentage was 35.4 in 1958.

Table 7

Exports of Minerals and Their Products
($ millions)

	1959	1958	Increase or Decrease	
			$ Millions	%
Iron and its products				
Raw material	157.8	107.7	+ 50.1	+46.5
Semiprocessed	51.1	43.4	+ 7.7	+17.7
Fully manufactured	354.5	281.3	+ 73.2	+26.0
Total	563.4	432.4	+131.0	+30.3
Nonferrous metals and products				
Raw material	459.8	425.4	+ 34.4	+ 8.1
Semiprocessed	597.6	557.2	+ 40.4	+ 7.2
Fully manufactured	57.1	44.0	+ 13.1	+29.8
Total	1,114.5	1,026.6	+ 87.9	+ 8.6
Nonmetallic minerals and products (including fuels)				
Raw material	160.2	143.1	+ 17.1	+11.9
Semiprocessed	104.1	84.1	+ 20.0	+23.8
Fully manufactured	29.9	23.2	+ 6.7	+28.9
Total	294.2	250.4	+ 43.8	+17.5

(table continued on page 23)

Exports of Minerals and Their Products (cont'd)
($ millions)

	1959	1958	Increase or Decrease $ Millions	Increase or Decrease %
Total, minerals and their products				
Raw material	777.8	676.2	+101.6	+15.0
Semiprocessed	752.8	684.7	+ 68.1	+ 9.9
Fully manufactured	441.5	348.5	+ 93.0	+26.7
Total	1,972.1	1,709.4	+262.7	+15.4

Table 8

Exports of Minerals and Their Products
in Relation to Total Export Trade

	1959		1958	
	$ Millions	% of Total	$ Millions	% of Total
Raw material	777.8	15.4	676.2	14.0
Semiprocessed	752.8	14.9	684.7	14.2
Fully manufactured	441.5	8.7	348.5	7.2
Total	1,972.1	39.0	1,709.4	35.4
Total, exports of all products	5,060.9	100.0	4,826.4	100.0

Table 9

Exports of Minerals and Their Products,
by Destination, 1959

($ millions)

	United Kingdom	United States	Other Countries	Total
Iron and its products	31.6	405.0	126.8	563.4
Nonferrous metals and products	238.5	641.7	234.3	1,114.5
Nonmetallic minerals and products	14.1	224.2	55.9	294.2
Total, minerals and products	284.2	1,270.9	417.0	1,972.1
Percentage	14.4	64.4	21.2	100.0

Imports of Minerals and Their Products

Imports of minerals and their products were valued at $3,269 million for 1959, or 10.2 per cent over the 1958 total.

Semiprocessed and fully fabricated imports in the iron and iron-products group increased 117.7 and 12.3 per cent respectively in value. Imports of raw material (iron ore) in this group declined 6.2 per cent.

Raw-material imports under 'nonferrous metals and products' increased 19.1 per cent in value. This material consists largely of bauxite and alumina for the aluminum industry.

Semiprocessed and fully manufactured imports of 'nonmetallic minerals and products' increased 11.7 and 8.9 per cent respectively in value. In this group, semiprocessed products consist largely of stone and clay products, and fully manufactured goods consist chiefly of petroleum products, glass and glass products, and coal and coal products.

Fully manufactured goods in the iron and iron-products group accounted for more than 60 per cent of Canada's mineral imports. These products, which are completely fabricated, are composed entirely or chiefly of iron and/or steel. All kinds of machinery, tools and implements, and automobile parts are included.

Mineral imports, with their total value of $3,269 million, constituted 57.8 per cent of the value of all imports, 48.1 per cent of which was derived from mineral products in a fully manufactured state. From 1958 to 1959, Canadian imports of these goods increased 11.5 per cent in value - from $2,437.6 million to $2,717.4 million. For the same years, the value of all products imported increased 8.9 per cent.

Table 10

Imports of Minerals and Their Products

($ millions)

	1959	1958	Increase or Decrease $ Millions	Increase or Decrease %
Iron and its products				
Raw material	27.1	28.9	- 1.8	- 6.2
Semiprocessed	34.4	15.8	+ 18.6	+117.7
Fully manufactured	2,030.6	1,807.5	+223.1	+ 12.3
Total	2,092.1	1,852.2	+239.9	+ 13.0
Nonferrous metals and products				
Raw materials	46.8	39.3	+ 7.5	+ 19.1
Semiprocessed	29.0	30.3	- 1.3	- 4.3
Fully manufactured	395.5	362.6	+ 32.9	+ 9.1
Total	471.3	432.2	+ 39.1	+ 9.0

(table continued on page 25)

Imports of Minerals and Their Products (cont'd)
($ millions)

	1959	1958	Increase or Decrease $ Millions	%
Nonmetallic minerals and products (including fuels)				
Raw material	396.2	399.2	- 3.0	- 0.8
Semiprocessed	18.1	16.2	+ 1.9	+11.7
Fully manufactured	291.3	267.5	+ 23.8	+ 8.9
Total	705.6	682.9	+ 22.7	+ 3.3
Total, minerals and products				
Raw material	470.1	467.4	+ 2.7	+ 0.6
Semiprocessed	81.5	62.3	+ 19.2	+ 3.1
Fully manufactured	2,717.4	2,437.6	+279.8	+ 4.3
Total	3,269.0	2,967.3	+301.7	+10.2

Table 11

Imports of Minerals and Their Products
in Relation to Total Import Trade

	1959 $ Millions	1959 % of Total	1958 $ Millions	1958 % of Total
Raw material	470.1	8.3	467.4	9.0
Semiprocessed	81.5	1.4	62.3	1.2
Fully manufactured	2,717.4	48.1	2,437.6	46.9
Total	3,269.0	57.8	2,967.3	57.1
Total,imports of all products	5,654.2	100.0	5,192.4	100.0

Table 12

Imports of Minerals and Their Products, by Source, 1959
($ millions)

	United Kingdom	United States	Other Countries	Total
Iron and products	254.1	1,666.3	171.7	2,092.1
Nonferrous metals and products	76.2	300.7	94.4	471.3
Nonmetallic minerals and products	31.2	296.8	377.6	705.6
Total, minerals and products	361.5	2,263.8	643.7	3,269.0
Percentage	11.1	69.2	19.7	100.0

Prices of Minerals and Their Products

The wholesale price of all commodities was 1.2 per cent higher in 1959. This is indicated by the general wholesale price index (base 1935-39 = 100),which stood at 230.6 in 1959 and 227.8 in the previous year.

The wholesale prices of products composed of iron and steel were 1.2 per cent higher. The prices of products of the nonferrous-metal group were 4.4 per cent higher at the wholesale level, while the prices of nonmetallic minerals and products were down 1.1 per cent.

Table 13

Annual Average of Prices,* Main Minerals, 1958 and 1959

	1959	1958	Increase or Decrease	
			Cents or Dollars	Percentage
Aluminum ingot, cents per lb	26.838	26.890	- 0.052	- 0.2
Antimony, N.Y., boxed, cents per lb	32.590	33.075	- 0.485	- 1.5
Bismuth, cents per lb	2.25	2.25	-	-
Cadmium, cents per lb	133.750	152.300	-18.550	-12.2
Calcium, dollars per lb	2.05	2.05	-	-
Chromium metal, dollars per lb	1.17	1.26	- 0.09	- 7.1
Cobalt metal, dollars per lb	1.77	2.00	- 0.23	-11.5
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	31.182	25.764	+ 5.418	+21.0
Gold, Canadian dollars per troy oz	33.57	33.98	- 0.41	- 1.2
Iron ore 51.5% Fe, dollars per l.t. Lower Lake ports				
Mesabi, 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	12.211	12.109	+ 0.102	+ 0.8
Magnesium ingot, cents per lb	35.250	35.250	-	-
Mercury, dollars per flask (76 lb)	227.484	229.057	- 1.573	- 0.7
Molybdenum metal, dollars per lb	3.35	3.35	-	-
Molybdenite 90-95% MoS_2, dollars per lb Mo contained	1.25	1.19	+ 0.06	+ 5.0
Nickel, f.o.b. Port Colborne (duty included), cents per lb	74.000	74.000	-	-
Platinum, dollars per troy oz	73.250	64.924	+ 8.326	+12.8
Selenium, dollars per lb	7.000	7.083	- 0.083	- 1.2
Silver, N.Y.,cents per troy oz	91.202	89.044	+ 2.158	+ 2.4
Sulphur, dollars per l.t.	23.50	23.50	-	-

Annual Average of Prices,* Main Minerals, 1958 and 1959 (cont'd)

	1959	1958	Increase or Decrease Cents or Dollars	Percentage
Tin, Straits, N.Y., cents per lb	102.053	95.127	+ 6.926	+ 7.3
Titanium metal, dollars per lb	1.67	2.03	- 0.36	-17.7
Titanium ore (ilmenite) 59.5% TiO_2, f.o.b. Atlantic ports, dollars per l.t.	23 to 26	24 to 28		
Tungsten metal, dollars per lb	2.85	3.15	- 0.30	- 9.5
Zinc, Prime Western, East St. Louis, cents per lb	11.448	10.309	+ 1.139	+11.0

*Except in the case of gold, prices are United States prices (U.S. currency) from E & M J Metal and Mineral markets. Canadian prices follow closely.

Employment, Salaries and Wages

In 1959 there were 140,647 employees, both salaried and wage-earning, in the Canadian mineral industry, and they earned $634.5 million. Among them were employees of the nonferrous-smelting and -refining industries, which include the aluminum-smelting industry. The employment and earnings statistics given for fuels in Table 14 do not cover the operation of petroleum refineries or of oil and gas pipelines.

In 1939, employees working in the mineral industry totalled 107,759. The salaries and wages they earned amounted to $152.4 million, or an average of $1,414 for the year.

By 1959 their numbers had increased by 30.5 per cent and their earnings by 316.3 per cent. The annual average of salaries and wages amounted to $4,511 or more than three times that of 20 years previous.

The average annual wage of hourly-rated employees in the Canadian metal-mining industry in 1959 was $4,640. Reflecting a substantial increase that had occurred in iron-ore production between 1949 and 1959, the total of all ore mined was 99.1 million tons; and the annual average per worker, which in 1949 was 1,047 tons, amounted in 1959 to 1,820 tons. The wage cost per ton mined was $2.55, having decreased 3.4 per cent from the 1949 level of $2.64.

Table 14

Employment and Salaries and Wages, Canadian Mineral Industry

	1939		1944		1949		1954		1959	
	Numbers	$ Millions	Numbers	$ Millions	Numbers	$ Millions	Numbers	$ Millions	Numbers	$ Millions
Metal-mining	45,594	79.2	34,559	71.9	46,181	132.3	51,599	195.2	63,871	307.0
Nonferrous smelting and refining	12,449	19.4	23,927	44.5	19,150	55.1	26,048	102.6	27,746	137.2
Industrial minerals	19,474	18.0	16,439	24.7	22,581	50.0	26,991	89.2	30,824	119.5
Fuels	30,242	35.8	29,953	63.7	28,595	72.2	24,807	78.3	18,206	70.8
Total	107,759	152.4	104,878	204.8	116,507	309.6	129,445	465.3	140,647	634.5
Annual average of salaries and wages		$1,414		$1,953		$2,657		$3,595		$4,511

Table 15

Labor Costs in Relation to Tons Mined in Metal Mines

	Number of Workmen	Total Wages	Average Annual Wage	Tonnage Mined	Average Annual Tonnage Mined per Worker	Wage Cost per Ton Mined
	(wage earners)	($ millions)	($)	(000 s.t.)	(s.t.)	($)
1959						
Auriferous-quartz mines	14,967	55.7	3,722	14,247	952	3.91
Copper-gold-silver mines	8,156	35.6	4,365	12,436	1,525	2.86
Nickel-copper mines	9,969	49.6	4,975	18,964	1,902	2.62
Silver-cobalt mines	415	1.3	3,133	197	475	6.60
Silver-lead-zinc mines	3,476	15.3	4,402	5,709	1,642	2.68
Iron-ore mines	6,169	31.6	5,122	32,398	5,252	0.98
Miscellaneous metal mines	11,288	63.5	5,625	15,130	1,340	4.20
Total, metal mines	54,440	252.6	4,640	99,081	1,820	2.55
1949						
Auriferous-quartz mines	20,233	53.6	2,649	16,000	791	3.35
Copper-gold-silver mines	6,534	18.6	2,847	8,245	1,262	2.26
Nickel-copper mines	6,500	20.0	3,077	10,924	1,681	1.83
Silver-cobalt mines	234	0.5	2,137	39	167	12.82
Silver-lead-zinc mines	4,778	13.2	2,763	3,915	819	3.37
Iron-ore mines						
Miscellaneous metal mines	3,103	8.3	2,675	4,208	1,356	1.97
Total, metal mines	41,382	114.2	2,760	43,331	1,047	2.64
1939						
Auriferous-quartz mines	27,959	46.8	1,674	17,106	612	2.74
Copper-gold-silver mines	5,587	8.8	1,575	8,475	1,517	1.04
Nickel-copper mines	5,685	10.7	1,882	7,859	1,382	1.36
Silver-cobalt mines	278	0.3	1,079	60	216	5.00
Silver-lead-zinc mines	1,375	2.3	1,673	2,195	1,596	1.05
Iron-ore mines	-	-	-	-	-	-
Miscellaneous metal mines	291	0.4	1,375	192	660	2.08
Total, metal mines	41,175	69.3	1,683	35,887	872	1.93

The statistics on employment and wages in Table 15 refer not only to companies actually producing but also to certain companies engaged principally in development and exploration work. The inclusion of these nonproducers tends to distort the average tonnage mined per worker and the average wage per ton mined, particularly in miscellaneous metal-mining. Also in the case of silver-cobalt mining, tonnages of ore mined were quite low because old tailings were largely used. Therefore, the wage cost per ton of ore mined is high since these tailing tonnages are not included in ore-mined figures.

The 99.1 million tons of metallic ores mined in 1959 were 17.6 per cent above the 1957 peak of 84.3 million tons. The total number of man-hours worked by the labor force, which comprises both hourly-rated and salaried employees, was 134.0 million. The average number of man-hours worked per ton of ore mined was 1.35, or 20.6 per cent above that of the previous year but 43.7 per cent below the number of man-hours worked per ton mined in 1952. This is due to an increase in the efficiency of the worker and a change in the type of ore mined. An increase in the tonnages of iron ore mined, which is largely open-pit, is reflected in a decrease in the number of man-hours worked per ton of ore mined.

The industrial minerals mined in 1959 totalled 90.7 million tons, or 10.5 per cent less than in 1957, a record year. The number of man-hours worked per ton mined amounted to 0.74. This is 11.9 per cent below the previous year and 47.1 per cent below the corresponding figure for 1952.

Table 16

Man-hours Worked and Tonnages of Ore Mined
in Metal Mines and in Production of Industrial Minerals

	Metal Mines			Industrial Minerals		
	Tonnage of Ore Mined (millions s.t.)	Man-hours Worked (millions)	Man-hours Worked per Ton Mined	Tonnage of Ore Mined (millions s.t.)	Man-hours Worked (millions)	Man-hours Worked per Ton Mined
1952	52.3	125.7	2.40	44.2	61.9	1.40
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

Details of the tonnages of ore mined and rock quarried are shown in Table 17. The tonnage decrease that occurred in nickel-copper mining in 1958 resulted chiefly from the prolonged labor strike of that year at International Nickel. The 1958 decrease in the iron-ore tonnage was brought about by a drop in the United States market demand caused by the general economic recession prevalent during most of the year.

Table 17

Tonnages of Ore Mined and Rock Quarried in Canadian Mineral Industry, 1956-58

(millions of short tons)

	1957	1958	1959
Metallic ores			
Gold-quartz	14.4	14.8	14.3
Copper-gold-silver	10.6	11.5	12.4
Silver-cobalt	0.2	0.2	0.2
Silver-lead-zinc	6.7	5.9	5.7
Nickel-copper	19.3	12.9	19.0
Iron	26.4	20.3	32.4
Miscellaneous	6.7	13.2	15.1
Total, metallic ores	84.3	78.8	99.1
Nonmetallic minerals			
Asbestos	22.6	22.4	23.1
Feldspar and nepheline syenite	0.3	0.3	0.4
Quartz	1.3	0.7	1.0
Gypsum and anhydrite	4.7	4.0	6.0
Other	1.6	1.6	2.7
Total, nonmetallic	30.5	29.0	33.2
Structural materials			
Stone, all kinds (exclusive of stone used for cement and lime)	40.3	38.2	46.4
Stone for manufacture of cement	8.7	8.5	8.0
Stone for manufacture of lime	2.6	2.8	3.1
Total, structural	51.6	49.5	57.5
Total, ore mined and rock quarried	166.4	157.3	189.8

The growth of the Canadian mineral industry is illustrated by the historical trend in ore mined and rock quarried.

In 1959, the tonnage of the metallic ores mined was more than seven times that of 1928, but the value of metallic-mineral production was almost 10 times as great.

The tonnage of the industrial minerals mined was almost five times that of 1928, and the value of production was more than seven times greater.

The tonnages of ore mined and rock quarried provide a physical measure of Canadian mineral output that is not directly influenced by commodity price changes.

Table 18

Tonnages of Ore Mined and Rock Quarried in Canadian Mineral Industry, Five-year Intervals, 1928-59

(millions of short tons)

	Metal Mines	Industrial Minerals	Total
1928	12.7	18.8	31.5
1933	15.0	6.4	21.4
1938	31.4	14.9	46.3
1943	38.7	20.8	59.5
1948	36.9	33.6	70.5
1953	54.4	47.2	101.6
1958	78.8	78.5	157.3
1959	99.1	90.7	189.8

Railway Transportation of Minerals

The tonnage of minerals and mineral products transported by Canadian railways totalled 71.2 million tons in 1959 and amounted to 42.9 per cent of all their revenue freight. If the fully manufactured products of mineral origin were included, this proportion would exceed 50 per cent.

Table 19

Mine Products Transported by Canadian Railways

(millions of short tons)

	1959	1958
Anthracite coal	1.6	1.6
Bituminous coal	12.0	12.9
Coke	1.6	1.6
Petroleum, crude	0.7	0.7
Copper ore and concentrates	0.5	0.5
Iron ore and concentrates	22.3	13.6

Mine Products Transported by Canadian Railways (cont'd)
(millions of short tons)

	1959	1958
Copper-nickel ore and concentrates	3.0	2.4
Aluminum ore and concentrates	2.7	2.5
All other ores and concentrates	2.4	2.4
Sand and gravel	6.4	7.0
Stone and rock	7.2	7.5
Asbestos	1.0	0.9
Gypsum, crude	4.8	1.9
Asphalt	0.4	0.5
Salt	1.1	1.0
All other mine products (chiefly industrial minerals)	3.5	2.9
Total, mine products	71.2	59.9
Total, all revenue freight	166.1	153.4
Mine products as a percentage of total freight	42.9	39.0

Taxes Paid by the Mineral Industry

Taxes paid by five main branches of the mineral industry to federal, provincial and municipal governments are shown in Tables 20 and 21. A reduction in the profits made by the mineral industry in 1959 is reflected in a 4.7-per-cent reduction in the taxes paid by the section of industry covered. Complete information on the taxes paid by the entire industry is not available.

Table 20

Taxes Paid by Five Important Divisions of Mineral Industry

($ millions)

	1959	1958	1957	1956	1955	1954
Auriferous-quartz-mining industry	7.0	6.1	5.9	6.2	6.2	5.9
Copper-gold-silver mining industry	13.0	8.5	19.2	26.1	18.1	13.0
Silver-lead-zinc mining-and-smelting industry	12.2	10.8	12.7	20.8	23.0	16.6
Nickel-copper mining, smelting and refining industry	12.1	22.4	46.6	48.9	24.6	27.6
Asbestos-mining industry	12.1	11.4	12.1	11.7	9.2	9.2
Total	56.4	59.2	96.5	113.7	81.1	72.3

Table 21

Taxes Paid to Federal, Provincial and Municipal Governments by Five Important Divisions of Mineral Industry, 1959

	Federal Income Tax	Provincial Tax	Municipal Tax	Total
Auriferous-quartz-mining industry	3,636,741	2,610,297	768,743	7,015,781
Copper-gold-silver mining industry	7,121,825	4,389,509	1,462,807	12,974,141
Silver-lead-zinc mining-and-smelting industry	8,371,059	2,836,939	1,036,389	12,244,387
Nickel-copper mining, smelting and refining industry	6,550,635	3,897,333	1,697,550	12,145,518
Asbestos-mining industry	7,141,321	3,711,814	1,213,498	12,066,633
Total	32,821,581	17,445,892	6,178,987	56,446,440

Federal income taxes declared by companies in the mineral industry for the taxation year 1958 amounted to $38.3 million. Income taxes declared by companies in the metallurgical and metal-fabricating industries amounted to $104.6 million, and those paid by companies producing nonmetallic mineral products totalled $23.0 million. Companies engaged in petroleum-refining and the production of petroleum and coal products declared income taxes amounting to $32.6 million.

The total of the income taxes declared by companies engaged in the production of basic minerals and by companies engaged in the manufacturing and fabricating of mineral products amounted to $198.5 million for the taxation year 1958. This was 18.8 per cent of all the federal income taxes declared by companies and corporations.

Table 22

Federal Income Tax Declared by Companies in Mining and Related Industries, Fiscal Year Ended March 31, 1958

($ millions)

Mining, quarrying and oil wells	
Gold-mining	3.3
Other metal-mining	20.7
Coal-mining	0.5
Oil and natural gas	4.2
Nonmetal-mining	6.9
Quarries	2.2
Mineral and oil prospecting	0.5
Total	38.3

(table continued on page 35)

Federal Income Tax Declared by Companies (cont'd)
($ millions)

Metallurgical and metal-fabricating industries	
Iron castings	9.9
Primary iron and steel	29.4
Agricultural implements	5.2
Boilers and fabricated structural steel	9.8
Hardware and tools	4.2
House, office and store machinery	10.8
Machine-shop products	1.0
Machine tools	0.3
Miscellaneous machinery	10.0
Sheet-metal products	9.2
Wire and wire products	3.0
Miscellaneous iron and steel products	3.1
Aluminum products	1.3
Other nonferrous metal products	7.4
Total	104.6
Nonmetallic mineral products	
Abrasives, asbestos, cement and clay products	10.2
Miscellaneous nonmetallic mineral products	8.4
Fertilizers and industrial chemicals	4.4
Total	23.0
Petroleum and products	
Petroleum-refining and products	22.7
Miscellaneous petroleum and coal products	3.5
Fuel, gasoline and other petroleum products	6.4
Total	32.6
Total, mining and related industries	198.5
Total, all industry	1,056.4

Capital Employed in the Mineral Industry

It is estimated that at the end of 1956 the capital employed in the mineral industry totalled $3,900 million. Table 23 shows the amount of capital employed, both resident-owned and nonresident-owned. These statistics include nonferrous smelting and refining. Included also is the capital employed by concerns engaged in the production, exploration and development fields of the petroleum and gas industries. Excluded are petroleum-refining and the transportation of oil and gas.

At the end of 1956 the total invested in all aspects of Canada's oil and gas industries, inclusive of petroleum-refining and oil and gas transportation, was estimated to be $3,500 million. Of this amount, $1,200 million was resident-owned and $2,300 million nonresident-owned. Of the latter total, $2,100 million was controlled from the United States. This information is not given in Table 23.

Table 23

Capital Employed in Mineral Industry

($ millions)

	Resident-owned	Nonresident-owned	Total Capital Employed
1926	400	200	600
1930	500	300	800
1939	500	300	800
1948	700	400	1,100
1951	800	800	1,600
1952	900	1,100	2,000
1953	1,100	1,400	2,500
1954	1,300	1,700	3,000
1955	1,300	2,100	3,400
1956	1,600	2,300	3,900

Consumption of Fuels and Electricity

The total value of fuels and electricity purchased by the mineral industry in 1959 amounted to $154.9 million. Of this total, $96.9 million, or 62.6 per cent, was for fuels used in the metal-mining and nonferrous-smelting and -refining industries.

The total value of electricity purchased amounted to $75.6 million. Of this total, $36.0 million, or 47.6 per cent, was for fuels used in the nonferrous-smelting and -refining industries, chiefly in the production of aluminum metal, which requires large quantities of electricity.

The production of industrial minerals accounted for the large quantities of coal and coke used. The value of coal and coke purchased amounted to $16.2 million, or 41.9 per cent, of the purchases made of these fuels by the entire mineral industry. About $10 million of this was the value of bituminous coal used in cement manufacture.

Table 24

Consumption of Fuels and Electricity in Canadian Mineral Industry, 1959

	Metal-mining	Nonferrous Smelting and Refining	Total, Metal-mining and Nonferrous Smelting and Refining	Industrial Minerals	Mineral Fuels	Total, Mineral Industry
Coal and coke						
Short tons	226,078	1,215,781	1,441,859	1,470,301	94,989	3,007,149
$	3,336,868	18,643,287	21,980,155	16,190,476	578,347	38,748,978
Gasoline and kerosene						
Gal	3,122,285	721,787	3,844,072	13,047,404	6,802,302	23,693,778
$	1,273,444	244,191	1,517,635	4,673,598	2,577,971	8,769,204
Fuel oil						
Gal	48,669,428	64,144,687	112,814,115	66,143,082	5,322,113	184,279,310
$	8,733,277	5,772,787	14,506,064	8,300,723	1,169,431	23,976,218
Liquefied petroleum gas						
Gal	444,535	49,203	493,738	578,956	1,439,586	2,512,280
$	127,611	18,357	145,968	118,252	489,868	754,088
Manufactured gas						
M cu ft	4,860	117,541	122,401	868,884	-	991,285
$	2,085	66,320	68,405	213,071	-	281,476
Natural gas						
M cu ft	59,814	6,364,943	6,424,757	15,154,216	3,498,468	25,077,441
$	32,190	1,473,376	1,505,566	4,043,329	456,871	6,005,766
Other fuels						
$	379,761	62,444	442,205	359,406	5,185	806,796
Total, fuels						
$	13,885,236	26,280,762	40,165,998	33,898,855	5,277,673	79,342,526
Electricity purchased*						
Millions of kwh	3,300	14,575	17,875	1,511	352	19,738
$	20,666,212	36,039,614	56,705,826	12,447,312	6,424,502	75,577,640
Total value, fuels and electricity purchased						
$	34,551,448	62,320,376	96,871,824	46,346,167	11,702,175	154,920,166
Electricity generated by industry for own use						
Millions of kwh	505	1,060	1,565	34	12	1,611

*To obtain the total kwh of electricity consumed add the electricity generated by the industry for its own use.

Table 25

Capital and Repair Expenditures of Mineral Industry

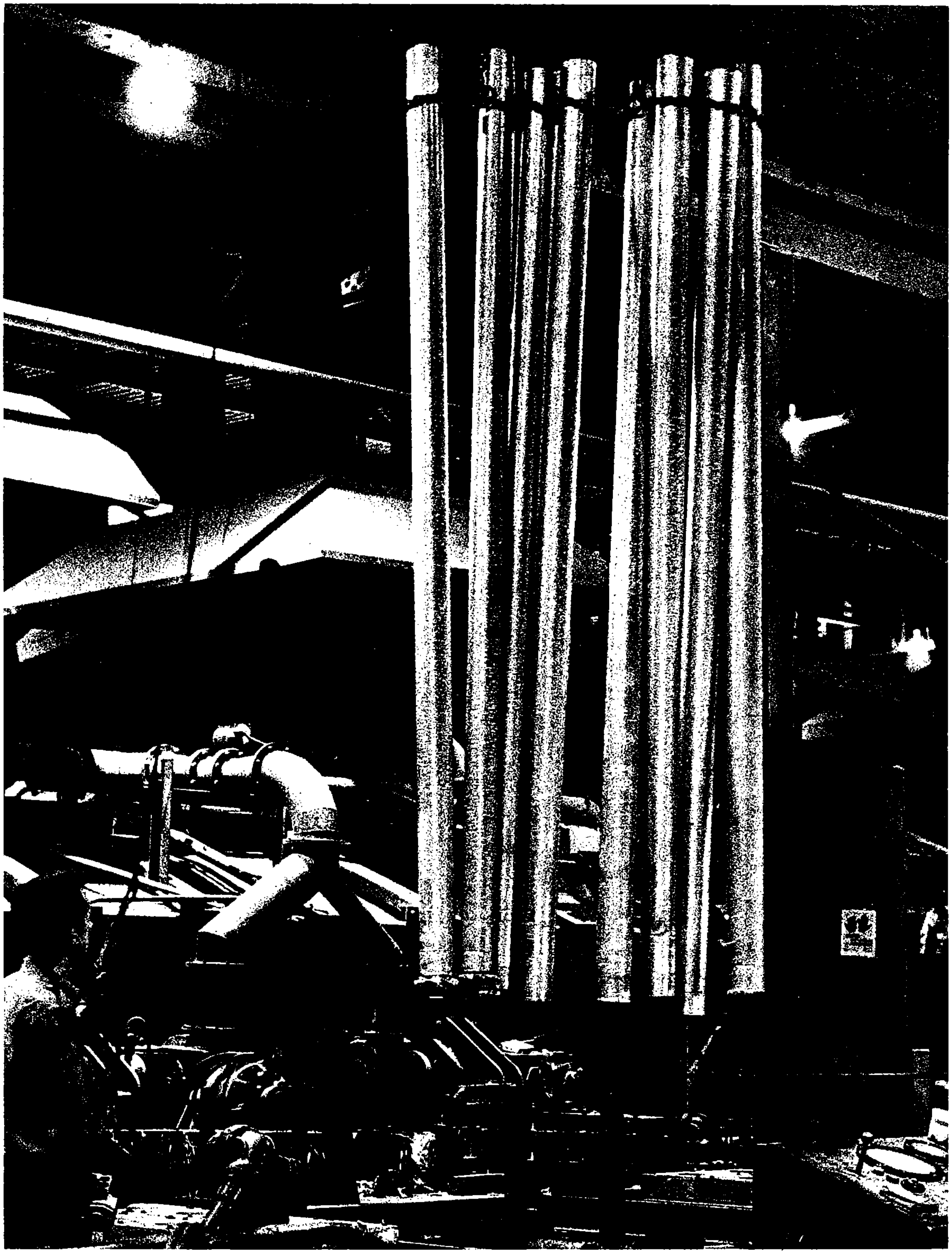
($000)

	1959 Capital	1959 Repair	1959 Total	1958 Capital	1958 Repair	1958 Total
Metals						
Gold	8,801	9,147	17,948	7,137	8,840	15,977
Copper-gold-silver	14,148	8,928	23,076	11,101	7,645	18,746
Iron	57,393	15,749	73,142	31,741	14,938	46,679
Nickel-copper	15,299	12,075	27,374	14,596	9,446	24,042
Silver-cobalt	370	223	593	761	132	893
Silver-lead-zinc	2,525	2,341	4,866	1,949	5,451	7,400
Uranium	14,348	9,433	23,781	42,981	10,015	52,996
Total, metals	112,884	57,896	170,780	110,266	56,467	166,733
Nonmetallics						
Asbestos	7,596	10,994	18,590	16,630	8,370	25,000
Gypsum	2,969	1,414	4,383	591	719	1,310
Miscellaneous nonmetallics and quarrying	21,820	15,383	37,203	28,215	15,557	43,772
Total, nonmetallics	32,385	27,791	60,176	45,436	24,646	70,082
Fuels						
Coal	3,474	3,526	7,000	3,878	4,814	8,692
Petroleum and natural gas	191,914	18,885	210,799	181,545	12,896	194,441
Total, fuels	195,388	22,411	217,799	185,423	17,710	203,133
Total, mineral industry	340,657	108,098	448,755	341,125	98,823	439,948

Capital and Repair Expenditures

The mineral industry's capital and repair expenditures include amounts spent by companies on new capital construction and the installation of new machinery and equipment as well as on the repair of existing structures, machinery and equipment.

The statistics on capital and repair expenditures presented in Table 25 do not include what was spent by the nonferrous-smelting and -refining industries, the petroleum-refining industry and oil-pipeline companies. Also excluded are expenditures undertaken by mining companies for the construction of railways and electric-power plants. Expenditures of the latter type are classified under the transportation and electric-power industries respectively.



Production of aluminum billets, Baie Comeau, Quebec.

ALUMINUM

W.H. Jackson**

Recovery from the manufacturing decline that continued to affect markets in the preceding year was evident in 1959, particularly in its second half. Production, which amounted to 593,630 tons,* was nevertheless 40,472 tons below the output of 1958. World production, on the contrary, increased - from the 1958 total of 3,881,000 tons to an estimated 4,390,000 tons. As the world rate of increase in consumption did not match the growth in production capacity, competition for markets was intensified, with the result that countries normally considered to be net importers of aluminum had metal for export. Also, the control of captive markets by other producers tended to reduce Canadian participation in some export markets. The result of these developments was that, owing to the need to balance production, demand and accumulated inventories, a number of Canadian smelters operated for part of the year at production rates that were low in relation to the industry's 865,600-ton capacity.

While production in relation to capacity declined, the volume of exports rose 4.3 per cent for primary forms and 58.4 per cent for semi-fabricated forms. On a value basis, exports increased only 1.3 per cent for primary forms but 39.9 per cent for semifabricated forms, and manufactures increased 48 per cent. The accompanying tables show the comparison in more detail.

The United States remains the largest single outlet for Canadian primary production, although shipments declined by 20.3 per cent in 1959 to 169,841 tons, or 7.9 per cent of United States consumption. In 1959, Canadian exports of primary forms to the United States amounted to 70.2 per cent of the primary aluminum imported by that country, which totalled 241,796 tons; in 1958 they came to 83.5 per cent. Shipments to the United Kingdom, the second largest market, amounted to 164,795 tons. This represents a rise of 2.9 per cent and comprises 50.9 per cent of United Kingdom consumption as measured by 'dispatches' to consumers. These dispatches rose 24 per cent in 1959 to 323,630 tons.

Producers' domestic shipments in Canada declined to 88,797 tons in 1959 from the 101,886 tons shipped in 1958.

---

*Short tons (2,000 pounds) are used throughout this review.

**Mineral Resources Division

Aluminum - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
Ingot	593,630		634,102	
Imports				
Bauxite and alumina				
British Guiana	1,253,394	6,929,208	1,400,075	7,623,166
Jamaica	301,051	19,072,234	291,818	18,506,245
Guinea	264,892	1,542,353	233,504	1,271,616
Surinam	205,170	1,189,684	215,840	1,249,074
France	47,490	2,611,276	25,257	1,633,262
United States	1	90	2	775
Total	2,071,998	31,344,845	2,166,496	30,284,138
Cryolite				
Denmark	5,779	971,102	4,502	883,040
Italy	112	16,529	1,653	312,286
France	-	-	560	101,888
Other countries	123	29,813	120	30,427
Total	6,014	1,017,444	6,835	1,327,641
Aluminum products				
Semimanufactured		6,365,911		9,992,671
Fully manufactured		18,999,593		19,674,616
Total		25,365,504		29,667,287
Exports				
Primary forms				
United States	169,841	73,487,906	213,147	92,568,071
United Kingdom	164,795	68,393,148	160,193	68,518,218
West Germany	34,334	14,274,078	28,674	12,640,050
France	18,952	7,975,635	3,740	1,638,968
Australia	16,404	6,885,695	15,995	6,868,730
Japan	10,424	4,288,589	12	5,430
Hong Kong	10,403	4,274,265	2,517	1,020,054
Belgium	9,725	4,040,749	9,891	4,381,932
Switzerland	9,285	3,832,526	2,419	1,047,123
Other countries	61,179	24,835,112	47,850	20,803,905
Total	505,342	212,287,703	484,438	209,492,481
Semifabricated				
India	8,909	4,495,576	8,320	4,386,662
United States	5,932	4,002,806	3,169	2,669,564
Brazil	2,061	712,798	31	21,492
France	1,949	802,951	-	-
Venezuela	1,046	573,075	391	243,228
Pakistan	1,014	542,803	6	6,982
Other countries	4,247	2,385,503	3,962	2,334,252
Total	25,158	13,515,512	15,879	9,662,180

Aluminum - Production, Trade and Consumption (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Manufactured				
United States		400,993		368,952
Spain		370,000		-
Colombia		171,212		49,716
Venezuela		169,396		148,499
Other countries		630,428		610,007
Total		1,742,029		1,177,174
Scrap				
United States	9,019	2,523,352	10,022	2,530,105
Japan	2,410	846,280	127	38,003
Italy	2,317	736,234	835	255,348
Germany	1,935	649,868	1,566	449,347
Other countries	497	124,531	63	14,983
Total	16,178	4,880,265	12,613	3,287,786
Consumption*				
Ingot	88,797		101,886	

*Producers' domestic shipments.

Aluminum - Production, Trade and Consumption, 1949-59

(short tons)

	Production	Imports (primary forms)	Exports (primary forms)	Consumption (ingot)
1949	369,466	40	296,906	58,767
1950	396,882	63	335,727	65,185
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	88,797

Primary Production

In 1939, Canada's capacity for the production of aluminum ingot was 90,000 tons a year. Twenty years later, at the close of 1959, its capacity was 865,600 tons, and the basis had been laid for expansion of the industry to more than 1 million tons should market increases make additional smelter construction economic. Locations of aluminum smelters are shown on the accompanying map.

Aluminum Company of Canada, Limited (ALCAN)

The company is the main subsidiary of Aluminium Limited. While engaged primarily in the production of aluminum metal and alloys, the company is also a major fabricator in Canada. Its fabricating capacity in Canada is estimated to be about 118,000 tons. Smelters operated by ALCAN have an annual installed primary capacity of 744,000 tons, distributed as follows: Kitimat, 192,000 tons; Arvida, 367,000; Isle Maligne, 115,000; and Shawinigan, 70,000. By year-end the operation of these plants had risen to about 77 per cent of capacity from the rate of 65 per cent maintained earlier in the year. A further 80,000 tons' capacity, now subject to deferred construction, could be completed at Kitimat when warranted.

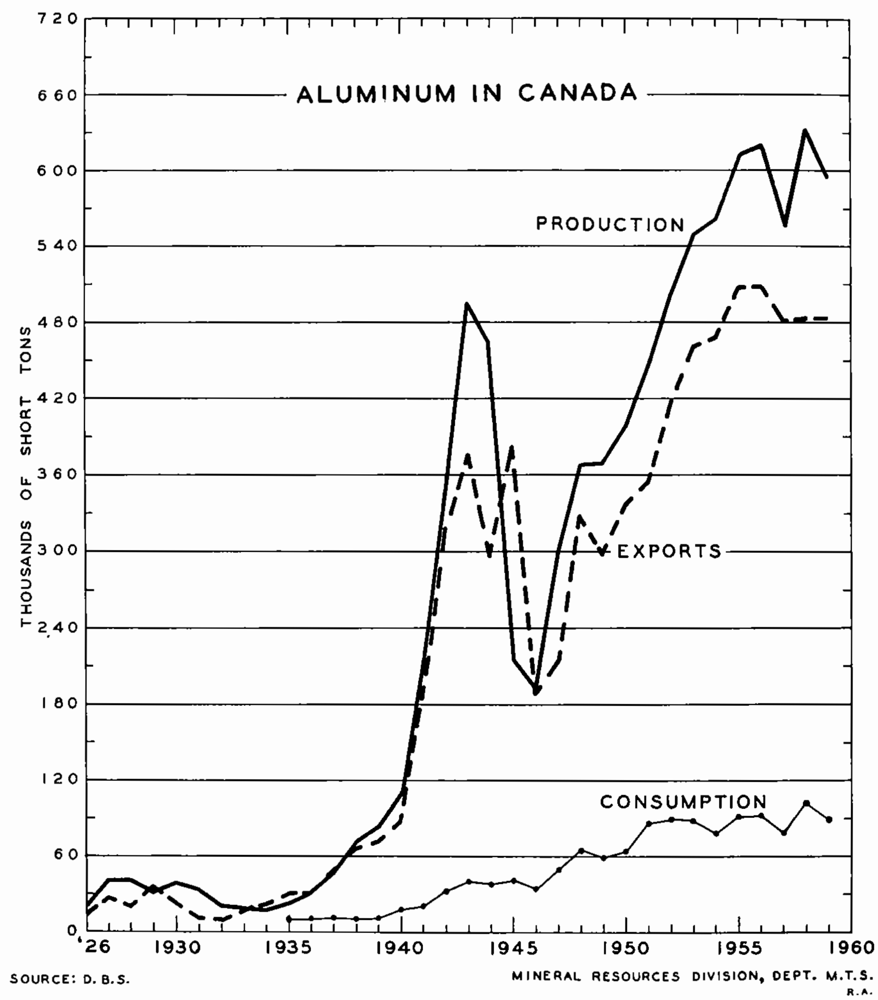
The Kitimat smelter in British Columbia is supplied with electricity from the Kemano plant, which at present has a generating capacity of 1,050,000 horsepower, sufficient to support the production of 300,000 tons of aluminum annually. Generating capacity to service other company smelters in the Saguenay district of Quebec is 2,600,000 horsepower. The Chute-des-Passes project on the Peribonca river in Quebec was completed in 1959 and, when ancillary equipment is installed, another 1 million horsepower will be available for the transmission network.

Canadian British Aluminium Company Limited (CBA)

The second unit of the Baie Comeau smelter went into full production in May 1959, having started partial production in October 1958. The first unit began operation in November 1957. The smelter has a total capacity of 89,600 tons, divided evenly between the two units. The capacity planned is 179,200 tons.

Electrical power is supplied by the Manicouagan Power Company and the Bersimis Power Station of the Quebec Hydro-Electric Commission. The latter made power available for the second unit on March 10, 1959, and will supply additional power for any future expansion of the smelter.

Initially, most of the plant output was in the form of ingot, but a diversity of shapes is now available. Most of the production is sold in the United Kingdom, but by agreement with British Aluminium Company Limited markets are being developed in Canada. This endeavor may be facilitated by the indirect association with Reynolds Metal Company, whose subsidiary, Reynolds Aluminum Company of Canada Limited, is a major fabricator.



Canadian British Aluminium is associated with the newly incorporated Phillips/CBA Conductors Limited in the construction of a cable-manufacturing plant at Brockville, Ontario.

Part of the production at CBA is shipped to ALCAN in payment for alumina purchases.

Chryslum Limited

The Beauharnois smelter, capacity 38,000 tons, has been leased by this company from ALCAN. The plant will now produce aluminum alloys for automobile plants of the Chrysler Corporation of Canada, Limited, and affiliated automobile plants in the United States.

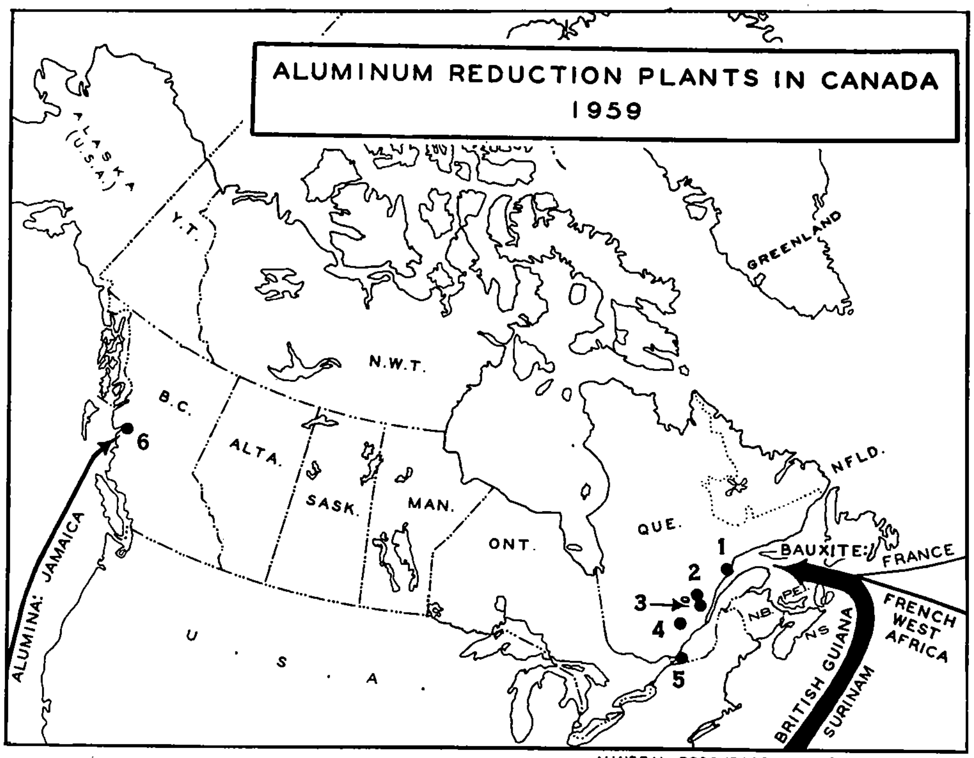
Aluminum Fabricators

The following companies not previously mentioned are among the major consumers of aluminum ingot and ingot alloys in Canada:

Algoma Steel Corporation, Limited	Sault Ste. Marie, Ont.
Atlas Steels Limited	Welland, Ont.
Barber Die Casting Co., Limited	Hamilton, Ont.
Bay Bronze Ltd.	Winnipeg, Man.
Canada Metal Company Limited, The	Toronto, Ont.
Canadian General Electric Company, Limited	Peterborough, Ont.
Canadian Steel Improvement Limited	Toronto, Ont.
Dominion Foundries and Steel Limited	Hamilton, Ont.
Dominion Magnesium Limited	Haley Station, Ont.
Dunbar Aluminum Foundry Limited	Kitchener, Ont.
Electric Tamper & Equipment Co. of Canada Limited	Lachine, Que.
Electrolux (Canada) Limited	Montreal, Que.
Eureka Foundry & Manufacturing Co. Limited	Scarborough, Ont.
Hoover Co. Limited, The	Hamilton, Ont.
McKinnon Industries Limited	St. Catharines, Ont.
Metals and Alloys Limited	Leaside, Ont.
Pioneer Saws Ltd.	Burnaby, B.C.
Precision Dies & Castings Limited	Toronto, Ont.
Primco Limited	Hull, Que.
Reynolds Aluminum Company of Canada Ltd.	Cap-de-la-Madeleine, Que.
Schultz Die Casting Co. of Canada, Limited	Wallaceburg, Ont.
Steel Company of Canada, Limited, The	Hamilton, Ont.
Supreme Aluminum Industries Limited	Toronto, Ont.
Z. Wagman & Son Limited	Toronto, Ont.
R.D. Werner (Canada) Limited	Oshawa, Ont.

Sources of Raw Materials

Owing to the geological history of the country, bauxite ores are not found in Canada. Anorthosites, nepheline syenites, shales and clays are abundant but are all high in silica and contain only 25 to 30 per cent alumina. Although some work has been directed toward the recovery of aluminum from these rocks, a commercially feasible process to compete with bauxite has yet to be developed.



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Legend

1. Baie Comeau
2. Isle Maligne
3. Arvida
4. Shawinigan
5. Beauharnois
6. Kitimat

British Guiana is the main source of bauxite for the alumina works at Arvida, Quebec. A typical analysis of crude bauxite from this source shows it to contain 59 per cent alumina, 6 per cent silica, 2.5 per cent titania, 2.5 per cent iron oxide and 30 per cent combined water of hydration. The ore is mined by open-pit methods after stripping of the overburden. Upon beneficiation to remove most of the silica, the ore is dried to a uniform 15-per-cent moisture content. This material, having an average value for the year of $5.53 a ton, is shipped by sea to Port Alfred, Quebec, then blended with ore from other sources such as Guinea to form the mill feed at Arvida. The Arvida works, some 20 miles from Port Alfred, have a production capacity of about 1,200,000 tons of alumina. Roughly 4 to 5 tons of bauxite are needed to produce 2 tons of alumina, which in turn will produce 1 ton of aluminum.

Also needed to service the alumina plants are soda ash, lime, starch, heat and power. These are available in Canada.

Alumina for the Kitimat smelter is shipped by sea from Jamaica.

World production of bauxite is estimated for 1959 at 25,800,000 tons; in 1958 it was 23,508,000 tons. The bauxite imported by Canada from each of the supplying countries, expressed as a percentage of the total output of each country, is as follows: British Guiana 66.8 per cent of 1,874,880 tons; Guinea 79.6 per cent of 332,640 tons; Jamaica, 10.5 per cent (bauxite equivalent) of 5,740,000 tons; Surinam, 5.4 per cent of 3,781,120 tons; France 2.4 per cent of 1,954,400 tons.

ALCAN, through Alumina Jamaica Limited, brought into production during the year a second alumina plant in Jamaica known as Ewarton Works. Its annual capacity of 270,000 tons supplements the 540,000-ton Kirkvine plant completed in 1957. Another plant with a capacity of 245,000 tons, now being built in British Guiana by Demerara Bauxite Company Limited, will be completed in 1960.

To produce aluminum metal, the electrolytic reduction plants need complex chemical and electrical equipment, rectifier stations and transmission lines, the components of which are obtained from many sources. The fluorspar used in producing the electrolyte, chiefly artificial cryolite and other fluorides, comes from the St. Lawrence area of Newfoundland. Petroleum coke for electrodes, consumed in quantities of about 60 per cent, by weight, of the metal produced, is partly imported along with pitch, carbon and anthracite, usually from the United States, but some items may come from as far away as the United Kingdom or Japan. In addition to labor and technology, the main Canadian contribution is hydroelectric power close to tidewater and shipping lanes, and strategic location with respect to markets. It is also important that the electricity is continuously available, not subject to interruption owing to the needs of other industries.

Uses and Consumption

Lightness and strength, resistance to corrosion, and the mechanical properties obtainable by alloying and tempering make aluminum desirable for many structural purposes. The metal can be cast, rolled, stamped, spun, drawn, extruded and forged. Wide dissemination of technical data, continuing research on new products and the existence of a rapidly growing fabricating industry help to promote market expansion. A stable pricing system permits potential users to assess cost factors with reasonable accuracy.

Weight for weight, aluminum is a better conductor of electricity than copper. This accounts for its use in electrical cables. Such properties as heat conductivity, ease of forming and the ability to take a good finish make it desirable in the manufacture of appliances and utensils. In some applications - the deoxidation of iron and steel or use as a reducing agent, for example - chemical properties are the determining factor.

In descending order of tonnage, semifabricated aluminum is consumed in Canada in the following forms: sheet and plate, cable, extrusion, castings, foil, wire rod and bar, forgings, paste and powder, slugs for impact extrusion, rivets and nails.

Established markets expanded in 1959, and applications, particularly in the building industry, increased. The automotive field provided the most significant new market, with the advent of aluminum engines in both the United States and the United Kingdom.

Prices

On December 15 the Canadian price rose to 23.25 cents a pound from the prevailing price of 22.5 cents. The latter had been in effect since April 1, 1958, when a two-cent decrease took place.

In the United States the price was 24.7 cents a pound till December 18, when it rose to 26 cents.

The basic export price for both Canadian and United States companies is now 23.25 cents (U.S.) a pound.

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Alumina	free	free	free
Sulphate of alumina	"	10%	15%
Cryolite	"	free	free
Bauxite	"	"	"
Aluminum pigs, ingots, blocks, notch bars, slabs, billets, blooms, wire bars	"	1 1/4¢ per lb	5¢ per lb
Aluminum bars, rods, plates, sheets, strips, circles, squares, disks, and rectangles	"	3¢ per lb	7 1/2¢ per lb
Aluminum angles, channels, beams, tees, and other rolled, drawn or extruded sections and shapes	"	22 1/2%	30%
Aluminum wire and cable twisted or stranded or not and whether reinforced with steel or not	"	22 1/2%	30%

Canada (cont'd)

	British Preferential	Most Favored Nation	General
Aluminum pipes and tubes	free	22 1/2%	30%
Pipes and tubes	"	22 1/2%	30%
Leaf or foil less than .005 inch in thickness, plain or embossed, with or without backing	"	30%	30%
Aluminum powder	"	27 1/2%	30%
Aluminum leaf, less than .005 millimetre in thickness	"	free	free
Aluminum scrap	"	"	"
Manufactures of aluminum not otherwise provided	15%	22 1/2%	30%
Kitchen or household hollow ware of aluminum, not otherwise provided	20%	22 1/2%	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)	1 1/4¢ per lb
In bars, blanks, circles, coils, disks, plates, rectangles, rods, sheets, squares and strips	2 1/2¢ per lb
Table, household, kitchen and hospital utensils, and hollow or flat ware not specifically provided for, whether or not containing electrical heating elements as constituent parts, and wholly, or in chief value, of aluminum	3 1/2¢ per lb plus 17% ad valorem

ANTIMONY

J. W. Patterson*

Antimony is recovered in Canada in antimonial lead as a by-product of lead-refining. In 1959, recovery increased to 1,657,797 pounds from the 858,633 pounds produced in 1958.

The Consolidated Mining and Smelting Company of Canada Limited (Cominco) is the only producer of antimony in Canada. Cominco began to produce antimony in 1938 in an electrolytic antimony refinery at Trail, British Columbia. Since 1944, when the refinery was closed, its production has been in the form of antimonial lead alloy, which normally contains about 25 per cent antimony, though other grades are also produced.

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 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.

World production of antimony in 1959, as reported by the Bureau of Mines, United States Department of the Interior, was an estimated 52,000 tons. The principal producing countries, on a mine basis, were: China, 16,500 tons; the Union of South Africa, 13,619; Bolivia, 6,065; and Mexico, 3,621. In 1958, consumption of primary antimony in the United States, the chief consumer, dropped to 11,880 tons, the lowest recorded since 1949. Domestic mines provided 705 tons of the primary metal. In addition, 19,515 tons were recovered in the United States from secondary material. Consumption for 1959 was 13,317 tons, of which 678 tons were derived from domestic sources. An estimated total of 20,000 tons was recovered from secondary material.

As a result of changes in demand for primary antimony, Canada's output has varied considerably from year to year, as shown in the graph on page 54. Peak production was reached in 1951.

---

*Mineral Resources Division

Antimony - Production, Trade and Consumption

	1959		1958	
	Pounds	$	Pounds	$
Production				
Antimony content of antimonial lead alloy	1,657,797	540,276	858,633	284,208
Total	1,657,797	540,276	858,633	284,208
Imports				
Regulus				
Netherlands	433,078	73,218	243,987	41,265
United Kingdom	341,334	75,335	85,360	16,045
Belgium	89,600	18,360	117,793	23,194
Mexico	89,594	19,184	-	-
West Germany	81,227	13,870	42,860	7,778
China	57,305	12,942	249,671	40,332
Other countries	78,658	17,986	68,382	12,182
Total	1,170,796	230,895	808,053	140,796
Antimony oxide				
United Kingdom	300,000	64,803	184,000	40,742
United States	80,254	18,021	71,200	16,103
West Germany	88,184	19,249	-	-
Belgium	42,714	8,657	67,781	13,815
Total	511,152	110,730	322,981	70,660
Antimony salts				
United States	38,838	19,889	42,451	20,253
Exports				
Antimony content of antimonial lead alloy	1,118,460		630,140	
Consumption				
Antimony regulus in production of:				
Antimonial lead alloys	650,282		705,992	
Type metal	147,012		140,510	
Babbitt	112,090		126,982	
Solder	21,136		34,216	
Cable alloys			1,420	
Antimonial oxide	204,199		511	
Batteries			140	
Other commodities			17,047	
Total	1,134,719		1,026,818	

Antimony - Production, Imports and Consumption, 1949-59

(pounds)

	Production[1] (all forms)	Imports (regulus)	Consumption[3] (regulus)
1949	158,288	2,583,635	1,534,000
1950	643,540	3,212,784	1,994,000
1951	6,702,164[2]	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

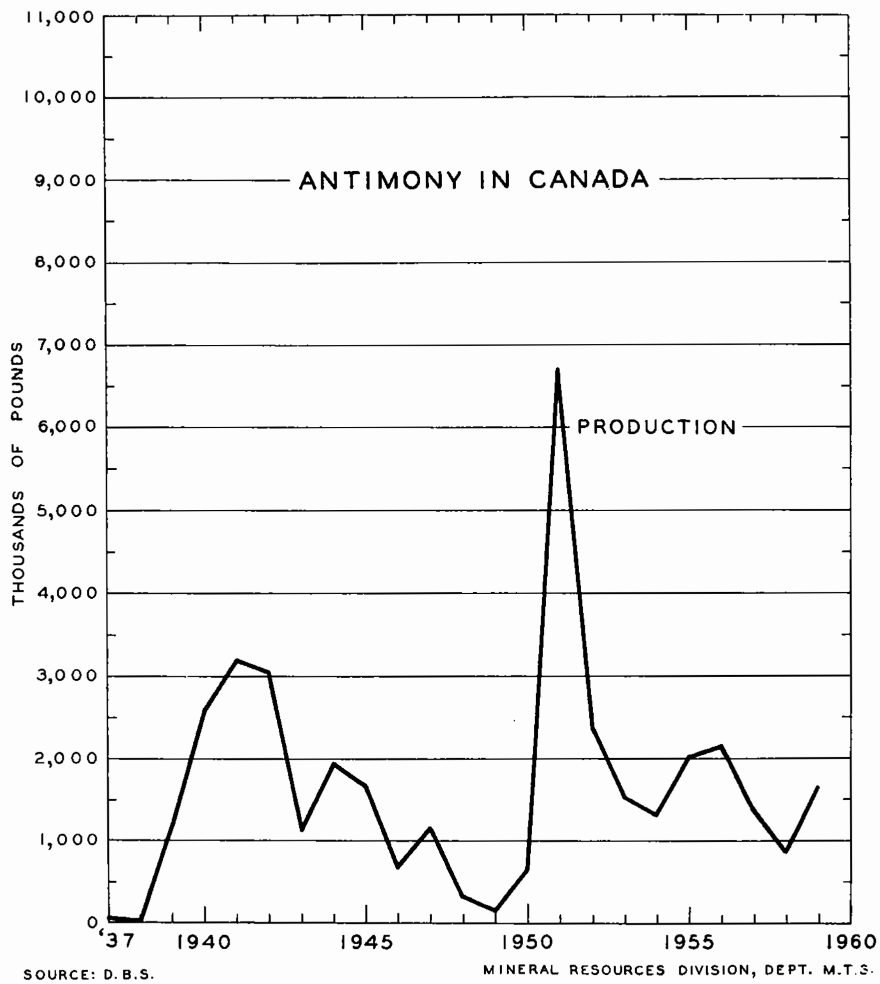
(1) Antimony content of antimonial lead alloys and antimony recovered from flue dust and dore slag. All derived from Canadian ores.
(2) Includes antimony in flue dust and dore slag produced in 1949 and 1950 but not previously recorded.
(3) Consumption of antimony regulus as reported by consumers. Does not include antimony in antimonial lead produced by The Consolidated Mining and Smelting Company of Canada Limited.

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; Gray Rock property, near Bralorne in the Bridge River district, Stuart Lake mine, near Fort St. James, and the Caroline property, near Slocan City in the West Kootenay district, British Columbia; Highet Creek deposit, Mayo district, and the Wheaton River deposits near Whitehorse, Yukon Territory.

Uses and Consumption

Antimony is used primarily to impart hardness and stiffness to various lead alloys. Antimonial lead containing from 3 to 12 per cent antimony, employed in the manufacture of storage batteries, is the major outlet. Antimony is also an important constituent in lead cable sheathing, type metal, bearing metal and solder.



Compounds of antimony are used in the manufacture of paints, rubber and plastics, and to make certain types of materials fire-resistant by surface application. An aluminum-antimony alloy is used by the electronics industry in the manufacture of transistors and rectifiers.

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 throughout 1959. The bulk price, f.o.b. shipping point, was 29 cents a pound for the whole year.

Antimony metal and antimony salts enter Canada free of duty. Ad valorem duties of 12 1/2 per cent (most favored nation) and 15 per cent (general) are applied to imports of antimony oxide.

The United States imposes the following duties: antimony regulus, 2 cents a pound; the lead content of antimonial lead, 1 1/16 cents a pound; antimony oxide, 1 cent a pound; antimony, liquated or needle, 1/4 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.

BISMUTH

J.W. Patterson*

In 1959, Canada produced 334,736 pounds of bismuth. Its 1958 production amounted to 412,792 pounds. This output was a by-product, most of it being recovered in the treatment of lead, molybdenite and copper ores. About 93 per cent of it consisted of refined metal produced by The Consolidated Mining and Smelting Company of Canada Limited (Cominco) at Trail, British Columbia, and semirefined metal produced by Molybdenite Corporation of Canada Limited, at Lacorne, in western Quebec, and by Gaspe Copper Mines, Limited at Murdochville, Quebec. The remaining 7 per cent was recovered in a silver-lead-bismuth bullion by Deloro Smelting & Refining Company, Limited at Deloro, Ontario, in the refining of silver-cobalt ores from the Cobalt-Gowganda area of northern Ontario.

The demand for bismuth has been generally small and erratic, with the result that there have been large fluctuations in Canada's annual production, as is shown in the graph on page 59. Since World War II the demand has been more constant; consequently prices are no longer as variable. A steadier production trend has developed. In 1959, as in previous years, most of Canada's production was exported, the chief importing countries being the United States and the United Kingdom.

World output in 1959, as reported by the United States Bureau of Mines, was 2,560 tons, with Peru, Mexico, Bolivia, Canada, and South Korea, in that order, as the leading producers, United States production is not reported separately.

Domestic Sources

British Columbia

Bismuth produced at Trail originates for the most part in the lead-zinc-silver ores from Cominco's Sullivan mine at Kimberley. Lead bullion produced at the Trail smelter contains about 0.05 per cent bismuth. The residue resulting from the electrolytic refining of the bullion is treated for the recovery of bismuth, antimony and precious metals. The refined bismuth is more than 99.99 per cent pure.

*Mineral Resources Division

Bismuth - Production, Trade and Consumption

	1959 Pounds	1959 $	1958 Pounds	1958 $
Production				
All forms(1)				
Quebec	151,576	264,228	240,177	436,420
British Columbia	151,703	288,236	154,034	308,068
Ontario	31,457	37,748	18,581	26,779
Total	334,736	590,212	412,792	771,267
Refined metal(2)	182,000		172,000	
Imports				
Bismuth metal and residues				
Peru	9,859	20,210	7,856	15,655
United States	2,043	4,490	4,450	9,417
Netherlands	1,100	2,129	-	-
Other countries			551	1,106
Total	13,002	26,829	12,857	26,178
Bismuth salts				
United Kingdom	9,557	23,930		17,824
United States	664	2,338		2,717
Total	10,221	26,268		20,541
Exports(3)				
Metal	363,000		352,000	
	1958		1957	
Consumption				
Metal (by industries)				
Medicinals and pharmaceuticals	14,125		8,544	
White-metal foundries	23,732		34,871	
Miscellaneous	2,000(e)		12,000(e)	
Total	39,857		55,415	
Bismuth salts				
Chemical and allied-products industries	17,306		18,811	

(1) Refined metal from Canadian ores, plus the bismuth content of the bullion and concentrates exported.
(2) Refined metal from domestic and foreign ores.
(3) Bismuth metal, refined and semirefined.
(e) Estimated

Bismuth - Production, Exports and Consumption, 1949-59

(pounds)

	Production		Exports(2)	Consumption(3)
	All Forms(1)	Refined Metal		
1949	102,913	210,000	178,000	36,000
1950	191,621	194,000	114,000	66,000
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	40,000
1959	334,736	182,000	363,000	

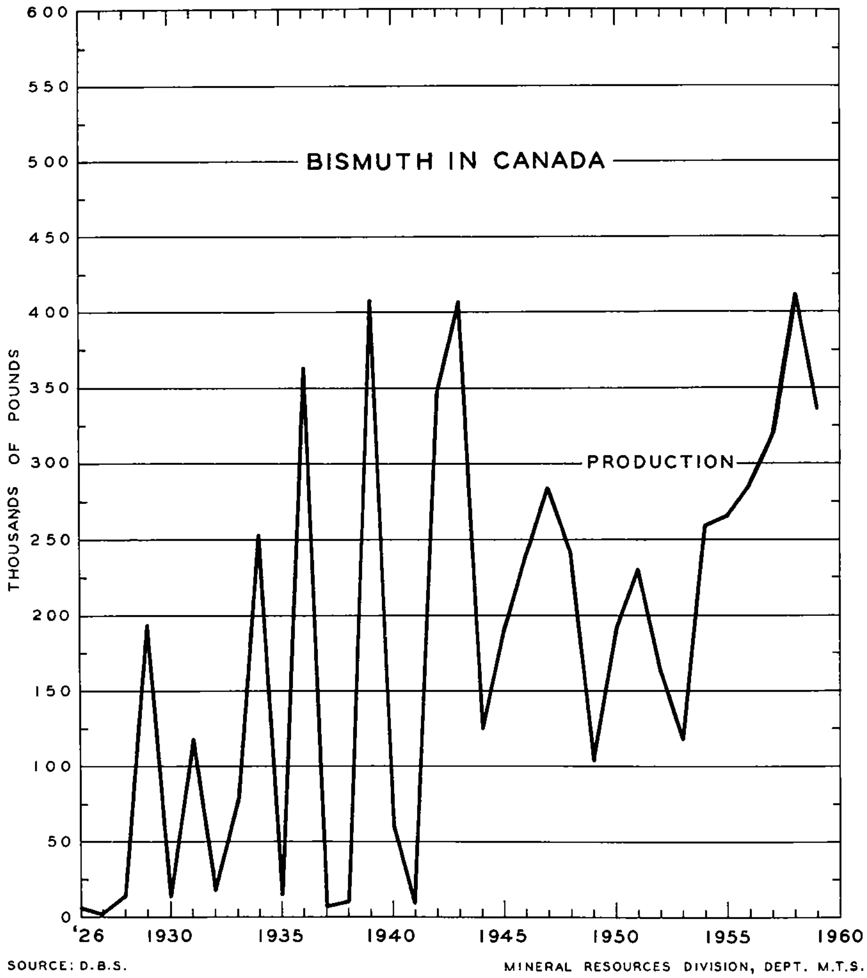
(1) Refined metal from Canadian ores, plus the bismuth content of the bullion and concentrates exported.
(2) 1949 to 1957, inclusive - refined metal; 1958 and 1959 - refined and semi-refined.
(3) Refined metal reported by consumers.

Quebec

In ores from the Lacorne mine, which is 23 miles northwest of Val d'Or and is operated by Molybdenite Corporation of Canada Limited, both molybdenite and bismuth are of economic importance. The flotation process produces a bulk concentrate containing about 7 per cent bismuth. This is separated by leaching to form bismuth oxychloride, which is smelted in electric-arc furnaces to produce a bullion containing about 97 per cent bismuth.

Because the company, in 1959, changed its fiscal-year end from December 31 to September 30, production figures are available only for the first nine months. Production during this period was 93,016 pounds of bismuth from 153,322 tons of milled ore.

From the treatment of cottrell dust recovered in copper-smelting operations at Murdochville, Gaspe Copper Mines, Limited produced semirefined ingots of bismuth.



Ontario

Deloro Smelting & Refining Co., Limited, at Deloro, in southeastern Ontario, recovered bismuth in silver-lead-bismuth bullion from the refining of silver-cobalt ores originating in the Cobalt-Gowganda district. The bullion so produced, which contains about 20 per cent bismuth, is shipped from time to time to a custom smelter for treatment.

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.

The relative importance of the various uses of bismuth is shown in the following table on United States consumption during 1959.

Bismuth - United States Consumption, by Principal Uses, 1959

(pounds)

Fusible alloys	478,542
Other alloys	300,911
Pharmaceuticals	483,554
Experimental uses	161,040
Other uses	56,692
Total	1,480,739

Source: Mineral Industry Surveys, Bureau of Mines, U.S. Department of the Interior.

Prices and Tariffs

Throughout 1959, as in 1958, bismuth metal in ton lots sold at $2.25 a pound.

Bismuth metal enters Canada free of duty. In the United States there is a 1 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*

Cadmium, a minor constituent of most zinc ores in Canada, is present as a sulphide in intimate association with sphalerite. At the two cadmium refineries in Canada - 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 - cadmium is recovered as a by-product in the treatment of zinc concentrates. While most of the zinc concentrates are produced from mines owned by Cominco and Hudson Bay, a small proportion is from other mining companies. Some cadmium, not all of which is reported, is recovered by foreign smelters from the treatment of zinc concentrates exported from Canada.

At Trail and Flin Flon, cadmium is obtained from cadmium-rich precipitates produced in purifying the zinc-bearing solutions prior to electrolysis. The precipitates, which contain about 55 per cent cadmium, are leached, and the cadmium is extracted electrolytically. About 70 per cent of the cadmium in zinc concentrate is recoverable, and metal not less than 99.95 per cent pure is produced in the form of balls, sticks or slabs.

Since 1949, Canada's yearly output of cadmium per ton of zinc produced has varied from a low of 2.55 pounds in 1952 to a high of 5.73 pounds in 1957. In 1959, output per ton of zinc rose to 5.46 pounds from the 4.14-pound output of 1958. The output in 1958 was low because of a reduction in the market demand for cadmium and the consequent reduction in its output at Trail.

World production of cadmium in 1959, on a mine basis, was 19,700,000 pounds. The United States, Canada, and Belgium were the leading producers. Most of Canada's production is exported to the United States and the United Kingdom.

Domestic Sources

British Columbia

Cominco is Canada's chief producer of cadmium. This company, at its Trail refinery, recovered 838 tons of cadmium, mainly from zinc concentrates obtained from its Sullivan mine at Kimberley, which average about 0.14 per cent cadmium. Other sources of cadmium were the company's H.B. mine

*Mineral Resources Division

Cadmium - Production, Exports and Consumption

	1959		1958	
	Pounds	$	Pounds	$
Production				
All forms(1)				
British Columbia	1,695,821	2,170,651	1,252,724	1,904,140
Saskatchewan	253,697	324,732	302,593	459,941
Yukon Territory	141,750	181,440	160,739	244,323
Manitoba	69,095	88,442	39,994	60,791
Total	2,160,363	2,765,265	1,756,050	2,669,195
Refined(2)	1,999,222		1,634,209	
Exports				
United States	1,045,293	1,127,447	691,480	948,470
United Kingdom	821,506	998,776	571,920	783,915
Netherlands	89,600	92,373	-	-
Brazil	20,566	21,645	-	-
Other countries	2,673	4,052	217	750
Total	1,979,638	2,244,293	1,263,617	1,733,135
Consumption				
(by industries)				
Aircraft			5,890	
Automotive	207,056(3)		22,648	
Electrical			33,377	
Hardware			52,079	
Solders	14,769		2,714	
Miscellaneous	4,463		53,184	
Total	226,288		169,892	

(1) Production of refined cadmium from domestic ore plus the cadmium content of ore and concentrates exported.
(2) Includes some metal derived from foreign ores.
(3) Chiefly plating uses.

Cadmium - Production, Exports and Consumption, 1949-59

(pounds)

	Production		Exports	Consumption(3)
	All Forms(1)	Refined(2)		
1949	846,541	846,000	633,607	222,000
1950	848,406	838,000	676,005	232,000
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	1,999,000	1,979,638	226,000

(1) Production of refined cadmium from domestic ores plus the cadmium content of ores and concentrates exported.
(2) Includes some metal derived from foreign ores.
(3) 1949 to 1951 inclusive - producers' domestic shipments of refined metal; 1952 to 1959 inclusive - consumption as reported by consumers.

near Salmo, its Bluebell mine at Riondel and numerous custom shippers of zinc concentrates.

Several other mining companies produced zinc concentrates containing cadmium. Canadian Exploration Limited produced 258,216 pounds at its Jersey mine near Salmo; Reeves MacDonald Mines Limited, at Remac, produced 160,734 pounds; Sheep Creek Mines Limited, in the Lake Windermere district, produced 48,436 pounds; Violamac Mines Limited, at its Victor mine near Sandon, produced 6,989 pounds. Cadmium was also produced by Howe Sound Company at its Britannia Beach copper-zinc mine, at which mining was resumed in January after a closure of about 10 months.

Yukon Territory

In the fiscal year ended on September 30, 1959, United Keno Hill Mines Limited recovered 220,281 pounds of cadmium in zinc concentrate; in the previous fiscal year it recovered 229,308 pounds. The drop in cadmium production was due to the decrease in the production of zinc concentrate. As in previous years, zinc concentrate produced from the company's Mayo-district mines averaged 0.8 per cent cadmium.

Saskatchewan and Manitoba

The 1959 production of 322,792 pounds of cadmium was obtained from copper-zinc ores mined by Hudson Bay Mining and Smelting Co., Limited from the Flin Flon mine on the provincial boundary and from the Schist Lake mine 3 1/2 miles southeast of Flin Flon. Zinc concentrates produced from Flin Flon ores average about 0.12 per cent cadmium.

Eastern Canada

Zinc concentrates exported by mines in eastern Canada contain an average of about 0.2 per cent cadmium. No payment is received for the cadmium contained in these concentrates, nor is any report made of the amount recovered.

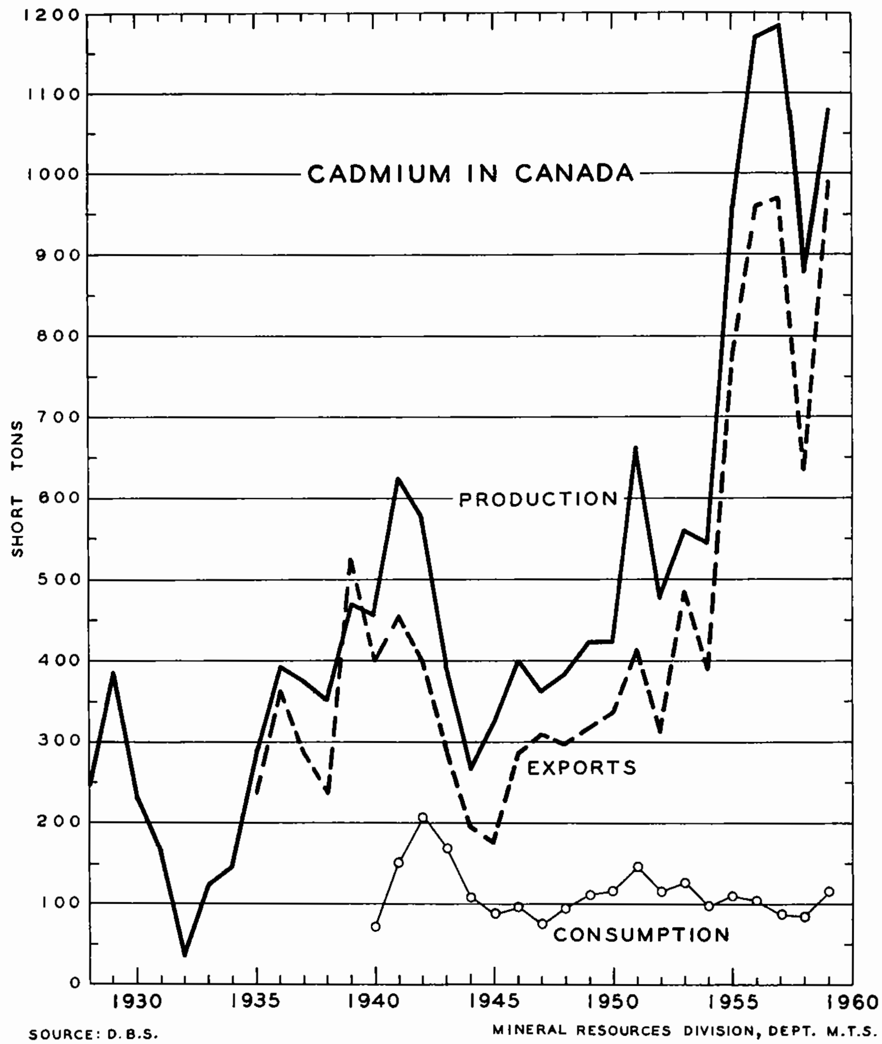
Uses

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, because it is more ductile, because it is slightly more resistant to atmospheric corrosion and because it 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-cadmium storage batteries is increasing. These batteries, each containing up to 7 pounds of cadmium, 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 earth satellites, missiles and ground equipment for polar regions.


CADMIUM IN CANADA
PRODUCTION
EXPORTS
CONSUMPTION
SHORT TONS
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1930
1935
1940
1945
1950
1955
1960
SOURCE: D.B.S.
MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Cadmium sulphide and cadmium sulphoselenide are used where bright, high-quality yellow or red colors are required for paints, inks, ceramic glazes, paper, rubber and glass. Cadmium oxide, cadmium hydrate and cadmium chloride are used 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 of cadmium commercial sticks, according to E & M J Metal and Mineral Markets, was $1.45 a pound from the beginning of 1959 until April 1, when it dropped to $1.30 a pound. This price prevailed for the rest of the year.

The United States duty on cadmium metal during 1959 was 3 3/4 cents a pound. Cadmium flue dust was duty-free.

CALCIUM

W.H. Jackson*

Calcined limestone is the raw material from which calcium is produced in Canada. The metal is subject to a variation in demand because there are few industrial uses that require it in quantity. Output in 1948 was 895,203 pounds. In 1959 it was 67,429 pounds, substantially less although an improvement over the 1958 figure of 25,227 pounds.

Production

Dominion Magnesium Limited

Calcium is one of several metals produced by this company at its plant near Haley Station, Ontario. Calcium is produced with the same equipment as magnesium.

The thermal process used consists essentially of the following steps. Powdered lime and aluminum are briquetted and charged into horizontal retorts which project through the furnace wall. Under vacuum and at high temperatures the lime is reduced by the aluminum. Calcium metal is distilled, collecting as crystalline rings in the cooler head sections of the retorts.

Four grades of metal are produced. They range in purity from the Chemical Standards Grade, nominally 99.9 per cent calcium, to the Commercial Calcium Grade, which contains 98 to 99 per cent. The maximum impurities contained in the Commercial Calcium Grade are 0.5 to 1.5 per cent magnesium, 1.0 per cent nitrogen and 0.35 per cent aluminum. These impurities become progressively less in the other grades and in the Chemical Standards Grade are present only in trace amounts. While calcium of the Chemical Standards Grade is available only as granules in the range of minus 4 to plus 80 mesh size, other grades may be produced as granules and are also available in crystalline lumps and as extruded forms, billets and ingots. Wire, tubes or shapes, and strip are manufactured in some grades.

Consumption and Trade

Industrial demand in Canada is small, the metal being consumed largely by companies producing lead alloys for battery plates and oil filters. It is also used by the producer, Dominion Magnesium Limited, in the reduction of titanium.

*Mineral Resources Division

Calcium - Production and Exports

	1959		1958	
	Pounds	$	Pounds	$
Production (metal)	67,429	76,409	25,227	31,256
Exports (metal)				
United Kingdom		36,250		13,488
India		14,000		3,427
Belgium		9,910		25,110
United States..................		7,070		22,067
West Germany		6,325		14,936
Total		73,555		79,028

Calcium-metal Production, 1949-59

	Pounds	$
1949	520,069	1,040,138
1950 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

Note: 1949 to 1955, producers shipments; 1956 onward, production.

Exports have always been the main outlet for Canada's production. As shown in the accompanying tables, demand in the United Kingdom and India resulted in shipments that partly offset a decline in sales to Belgium, the United States and West Germany.

The main markets for calcium as a reducing agent are dependent on the size and stage of development of nuclear programs. When uranium metals is produced in large quantities from its oxide, it becomes economical to invest in equipment to use magnesium as a reducing agent. For smaller quantities the economics favor the use of calcium. To cite an example, at Springfield in the United Kingdom there has been a change from a calcium to a magnesium reduction process, while at Bombay, India, more calcium is being used for metal production.

Uses

Calcium, a powerful reducing agent, is used mainly in the production of other metals such as uranium, thorium, titanium, zirconium and chromium. Lead alloys containing calcium are of increasing importance for batteries. An alloy equivalent to one containing 9 per cent antimony contains only 0.1 per cent calcium and has better conductivity and resistance to sulphation. Small additions of calcium also impart useful properties to alloys of aluminum, magnesium, platinum and silver. In the treatment of steel, nickel and copper, it can be used as a deoxidant, desulphurizer or degasifier. Other minor uses include the removal of water from alcohol, the separation of argon from nitrogen and the desulphurization of petroleum fractions.

Low strength and chemical reactivity have prevented the development of structural uses for the metal, which reacts with water and tarnishes quickly in the presence of oxygen or nitrogen.

Prices

The Canadian price varies with the form and grade. Throughout 1959, Dominion Magnesium Limited quoted 90 cents a pound for ingots of Commercial Calcium Grade and $3.50 for calcium of the Chemical Standards Grade in the form of granules.

The United States price of calcium metal, according to E & M J Metal and Mineral Markets, was $2.05 a pound, ton lots, throughout 1959.

Tariffs

CANADA

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

UNITED STATES

Calcium metal	17 1/2% ad valorem

CHROMIUM

V.B. Schneider*

Canadian imports of chrome ore (chromite) in 1959 increased to 48,678 tons valued at $1,525,438 from the 1958 total of 38,136 tons valued at $812,286. Sales of ferrochrome were appreciably greater in 1959 as compared with 1958. This reflected the generally increased rate of steel and iron operations, particularly in the production of stainless steel. Since most chromium is used in stainless and alloy steels, chromite consumption is quickly and materially affected by changes in the output of these materials. Exports of ferrochrome in 1959, at 7,514 tons, were the lowest in more than a decade. Some of this ferrochrome was consigned to the United States stockpile because of a contract that required Canadian companies to convert chrome ore for the United States market to chromium alloys.

In 1959 the value of ferrochrome imported from the United States was $1,770,223. This was mostly low-carbon ferrochrome, which is not made in Canada.

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 Electro Metallurgical Company, Division of Union Carbide Canada Limited, at Welland, Ontario, where high-carbon ferrochrome and ferrochrome-silicon are produced; by Chromium Mining and Smelting Limited at Sault Ste. Marie, Ontario, where exothermic chromium alloys are produced; by Canadian Refractories Limited at its refractories plant at Marelan, about 50 miles west of Montreal; and by General Refractories Company of Canada Limited, Smithville, Ontario.

World Production and Trade

World production in 1959, according to the United States Bureau of Mines, was estimated at 4,255,000 tons. The leading producing countries were Russia (940,000), the Union of South Africa (749,873), the Phillipines, 718,149 tons, The Federation of Rhodesia and Nyasaland, 543,104 tons,

*Mineral Resources Division

Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Imports (chrome ore)				
United States	22,245	778,268	3,889	149,575
Philippines	11,760	220,605	33,118	629,935
Rhodesia and Nyasaland	8,687	313,395	1,129	32,776
U.S.S.R.	2,645	94,410	-	-
Malta	2,251	89,804	-	-
Cuba	1,090	28,956	-	-
Total	48,678	1,525,438	38,136	812,286
Exports (ferrochrome)				
United States	7,394	1,961,664	10,206	2,306,199
Mexico	76	22,132	29	11,241
United Kingdom	42	9,983	210	49,915
Other countries	2	399	15	3,968
Total	7,514	1,994,178	10,460	2,371,323
Consumption (chromite)	58,532		36,297	

and Turkey, 395,957 tons. Their production amounted to 79 per cent of the world's total. Minor amounts are produced in Albania, the United States and India.

The United States is the largest importer and consumer of chromite, Rhodesia, Turkey and the Philippines being the principal suppliers. Traditionally Turkey supplied the bulk of the metallurgical-grade ore, the Philippines the bulk of the refractory-grade ore and the Union of South Africa the bulk of the chemical-grade ore. In 1959, however, the Federation of Rhodesia and Nyasaland replaced Turkey as the principal supplier of metallurgical-grade ore. A result of technological advances is that Transvaal ores, used primarily for the manufacture of chromium chemicals, are being used more and more in the manufacture of cheaper low-chrome alloys.

On and after December 31, 1959, chemical-grade and refractory-grade chromite were eligible for acquisition for the United States supplemental stockpile.

Trade and Consumption, 1949-59
(short tons)

	Imports	Exports	Consumption	
	Chromite	Ferrochrome	Chromite	Ferrochrome
1949	66,246	18,149	55,793	2,587
1950	119,325	32,916	90,798	3,589
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

Uses

Chromite ore 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 64 per cent of all chromite consumed, the refractory industry for 26 per cent and the chemical industry for 10 per cent. In Canada the metallurgical industry accounts for more than 80 per cent of all 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 industry as ferrochrome alloys made by electric smelting processes. Manufacturers of chrome exothermic additives may use chrome ores of less rigid specifications than those outlined.

The several grades of ferrochrome made are distinguished by their carbon and silicon content. Low-carbon ferrochrome of various grades ranging from 0.02 to 2 per cent 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 bronzes, 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 wearing qualities and performance.

Refractory-grade Chromite

Specifications for refractory-grade chromite are not so rigid as for metallurgical-grade. The chromium-iron ratio is of little consequence in this grade, but the ore must be hard and lumpy and above 10-mesh. Combined chromic oxide and alumina should not be less than 57 per cent, and iron and silica should usually be 10 and 5 per cent respectively. 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 acid or basic 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 as rigid as for metallurgical and refractory grades. Standard chemical ores contain 44 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), 20 per cent iron oxide (FeO), and 3 per cent silicon dioxide (SiO_2); the sulphur must be low. The chromium-iron ratio is usually about 1.5:1. Fines are preferred because the ore is ground in processing to 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 metal.

Prices

E & M J Metal and Mineral Markets of December 31, 1959, quoted chrome prices in United States currency as follows:

Chrome metal	Per lb delivered, electrolytic, 99.8%, according to size of lot	\$ 1.15 to \$ 1.19	
Chrome ore	Per long ton, dry basis, subject to penalties if guarantee not met, f.o.b. Atlantic ports		
Rhodesian	Term contracts		
	48% Cr_2O_3, 3:1 ratio	\$34 " \$44	(nominal)
	48% Cr_2O_3, 2.8:1 ratio	\$30 " \$32	(")
	48% Cr_2O_3, no ratio	\$25 " \$26	(")
South Africa	Transvaal		
	48% Cr_2O_3, no ratio	\$24 " \$26	
	44% Cr_2O_3, no ratio	\$18.25 " \$19	
Turkish	Basis 48%, 3 to 1		
	48% Cr_2O_3, 3:1 ratio, lump and concentrates	\$36 " \$37	(nominal)
	46% Cr_2O_3, 3:1 ratio, lump and concentrates	\$33.50 " \$34	(")
Ferrochrome	Per lb contained Cr, carload lots, delivered, lump, continental U.S.		
	High-carbon, 4 to 9% C, 65 to 70% Cr	28.75¢	
	Low-carbon, 0.10% C, 67 to 72% Cr	38.50¢	
	Special, 0.01% C, 63 to 66% Cr	37.75¢	

During the year the Canadian price quoted for ferrochrome remained between 25 and 35 cents a pound of contained chromium, price variations depending upon the size, quantity and analysis of the material purchased.

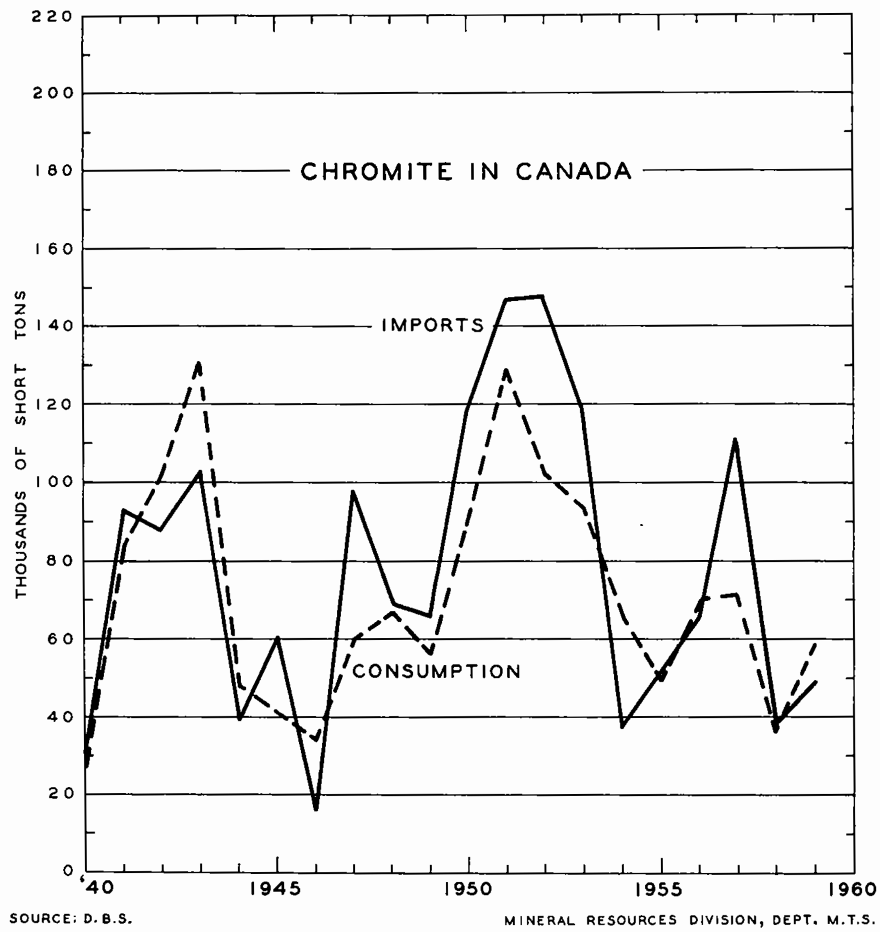
Tariffs

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	"	"	"
Ferrochrome	"	5% ad valorem	5% ad valorem
Materials for use in the manufacture of chromium oxide	"	free	20% " "

United States

Chrome ore	free
Chromium metal	10 1/2% ad valorem
Ferrochrome	
Less than 3% C	10 1/2% " "
3% or more C	5/8¢ per lb on Cr content
Chromic acid	12 1/2% ad valorem
Chromium carbide; chromium-nickel, -silicon and -vanadium	12 1/2% " "
Chromic acid	12 1/2% " "
Chrome brick	25% " "
Chrome colors	12 1/2% " "


CHROMITE IN CANADA
IMPORTS
CONSUMPTION
THOUSANDS OF SHORT TONS
220
200
180
160
140
120
100
80
60
40
20
0
'40
1945
1950
1955
1960
SOURCE: D.B.S.
MINERAL RESOURCES DIVISION, DEPT. M.T.S.

COBALT

V.B. Schneider*

Cobalt production Canada in 1959 recovered partially from the effects of the 1958 decline. It increased to 3,150,027 pounds valued at $5,954,916, thus rising 439,598 pounds above the output of 1958 and regaining 36 per cent of the amount of the decline that followed the peak reached in 1957.

Domestic consumption dropped, as did exports to the United States. These losses, however, were offset by a rise in exports to the United Kingdom and the Netherlands and the resumption of exports to West Germany and Mexico.

No cobalt ores were mined in Canada during 1959. Production was obtained as a by-product from the silver ores of the Cobalt and Gowganda areas of Ontario and from the smelting and refining of nickel-copper ores of the Sudbury and Lynn Lake areas of Ontario and Manitoba respectively.

Producers

Ontario

Sudbury Area

The International Nickel Company of Canada, Limited, 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 Mond Nickel Company Limited, a subsidiary in the United Kingdom. In 1959, the company reported deliveries of 2,400,000 pounds of contained cobalt in all forms. This is 230,000 pounds more than in 1958.

Falconbridge Nickel Mines Limited produced electrolytic cobalt in the refining of nickel-copper matte exported to its nickel refinery at Kristiansand, Norway. Metal deliveries reported for 1959 amounted to 732,000 pounds, or 24,000 pounds less than for the preceding year.

Cobalt-Gowganda Area

Silver ore shipped via the Temiskaming Testing Laboratories in 1959 contained 222,054 pounds of cobalt. These concentrates, from companies in the Cobalt-Gowganda area, were shipped mainly to Deloro Smelting

(text continued on page80)

*Mineral Resources Division

Cobalt - Production, Trade and Consumption

	1959 Pounds	1959 $	1958 Pounds	1958 $
Production[1] (all forms, cobalt content)	3,150,027	5,954,916	2,710,429	5,308,298
Exports				
Cobalt metal				
United States	516,828	921,170	993,517	1,811,671
United Kingdom	102,095	174,210	4,000	7,690
West Germany	50,900	89,300	-	-
Netherlands	10,000	17,600	-	-
Other countries	500	675	27,150	52,688
Total	680,323	1,202,955	1,024,667	1,872,049
Cobalt alloys[2]				
France	2,915	13,134	6,985	36,621
Hong Kong	152	2,673	60	1,126
United States	114	568	50	140
Brazil	99	457	2,617	8,250
Total	3,280	16,832	9,712	46,137
Cobalt oxides and salts[2]				
United Kingdom	893,039	1,315,529	401,571	706,766
United States	127,165	158,824	64,334	85,903
Netherlands	35,200	46,490	6,605	9,098
Mexico	19,700	23,861	-	-
Brazil	19,556	24,893	25,434	33,938
Other countries	6,074	7,906	24,200	33,621
Total	1,100,734	1,577,503	522,144	869,326
Imports				
Oxides[2]				
United Kingdom	14,716	21,508	4,180	6,014
United States	10,000	18,193	12,050	24,602
Total	24,716	39,701	16,230	30,616
Consumption (cobalt metal and cobalt contained in oxides and salts)	250,046[4]		303,433[3]	

(1) Production of cobalt metal from domestic ores and production of cobalt contained in alloys, oxides, salts and concentrates. Excludes the cobalt content of nickel-oxide sinter shipped to the United Kingdom by International Nickel, but includes the cobalt content of Falconbridge shipments of nickel-copper matte to Norway.

(2) Gross weight.

(3) Consumption as indicated by the cobalt content of producers' domestic shipments.

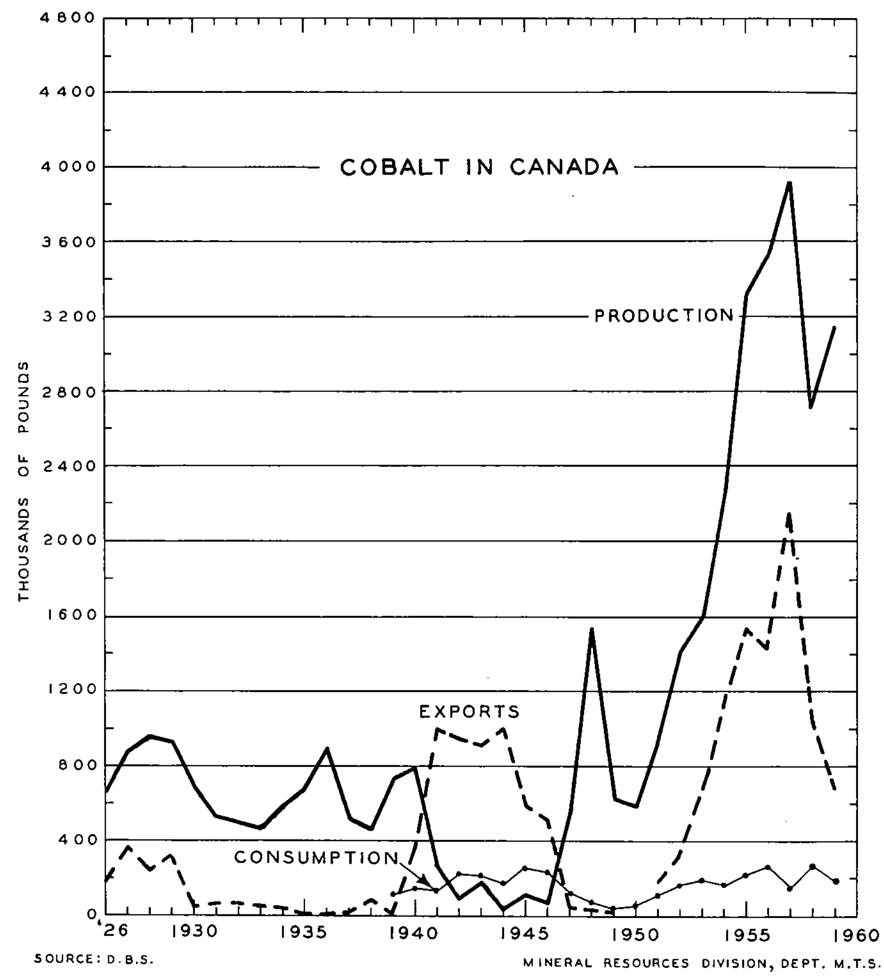
(4) Consumption as reported by consumers.

Cobalt – Production, Trade and Consumption 1949–59
(pounds)

	Production[1]	Exports				Imports		Consumption[2]
	All Forms	Cobalt in Ores and Concentrates	Metallic Cobalt	Cobalt Alloys	Cobalt Oxides and Salts	Cobalt Ores	Cobalt Oxide	Metal
1949	619,065	49,300	12,000	34,179	590,538	81,400	1,000	32,000
1950	583,806	16,700	–	1,011	388,203	3,912,500	25,880	54,000
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

(1) Metallic cobalt from Canadian ores and the cobalt content of oxides, alloys and salts sold and concentrates exported

(2) Producers' domestic shipments, metal only. 1959 consumption of cobalt metal as reported by consumers.



Refining Company, Limited. The more important shippers were Agnico Mines Limited, Langis Silver & Cobalt Mining Company Limited and Castle-Trethewey Mines Limited.

Deloro Smelting & Refining Company, Limited

Deloro Smelting & Refining Company, Limited, Deloro, produced cobalt metal, alloy, oxides and salts from the Cobalt-Gowganda silver ores and concentrates. A stockpile of residue that had accumulated at Deloro from the operations of previous years, together with residues from the refinery of Eldorado Mining and Refining Limited, was also treated during the year.

Manitoba-Alberta

Sherritt Gordon Mines Limited produced 314,000 pounds of cobalt. This is an increase of 39,635 pounds over the 1958 output. Production comes from the copper-nickel ore of the company's mine at Lynn Lake, Manitoba; the metal is obtained at the company's nickel refinery at Fort Saskatchewan, Alberta.

World Mine Production

	1959 Short Tons	1958 Short Tons
Belgian Congo	9,374	7,166
N. Rhodesia	2,372	1,792
Canada	1,575	1,355
Fr. Morocco	1,391	1,021
U.S.A.	1,165	2,012
New Caledonia	160	44
Total, world	17,600	14,600

Source: Mineral Trade notes, December 1960, U.S. Department of the Ontario, Bureau of Mines

The Belgian Congo is by far the world's largest producer of cobalt. Its production since 1948 has been approximately 65 per cent of the world's total, averaging more than 8,600 tons annually. Production in the Belgian Congo is derived from the copper mines of Union Minière du Haut-Katanga. In French Morocco cobalt is derived from the mines of La Sociéte Minière de Bou-Azzer et du Graara. In Northern Rhodesia, Rhokana Corporation Ltd. and Chibuluma Mines Ltd. recover cobalt as a by-product of copper refining. Chibuluma is selling its cobalt production to the United States government as payment on a $14 million loan. Owing to unforeseen events, the commencement of production from the nickel-cobalt deposits at Moa Bay, Cuba, did not materialize in 1959. The cobalt capacity is 2,200 tons a year.

Consumption and Uses

Free World cobalt production capacity is now in excess of 16,000 tons a year. In 1950 it was 7,000 tons. The average Free World consumption over the last six years has been about 8,000 tons a year. The United States is the largest consumer and importer of cobalt; the United States Bureau of Mines reports that 1959 imports amounted to 10,606 tons of contained cobalt.

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- and gas-turbine-engine industry and in guided missiles. The metal is an important constitutent 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.

Industrial reports indicate that the consumption of cobalt in the manufacture of ground-coat frits and in paint driers has increased greatly in Canada during recent years; the same is true of the consumption of cobalt in the manufacture of high-speed steels.

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 1959, by industries, were in the following proportion:

Ceramics-manufacturing	15%
Chemical-manufacturing	7%
Drier-manufacturing	15%
Animal-feed-manufacturing	63%

Sherritt Gordon Mines Limited sells its cobalt as cobalt-metal powder. In 1959 the domestic market accounted for about 3 1/2 per cent of the company's sales.

Deloro Smelting & Refining Company, Limited sells cobalt in the following forms: gray and black oxide, carbonate, sulphate and metal shot. In 1959, the company's production of cobalt in various forms was: oxide,62 per cent; metal,37 per cent; salts,1 per cent.

Prices

Cobalt prices in the United States at the end of 1959, according to E & M J Metal and Mineral Markets, were as follows:

Cobalt metal	
Per lb, f.o.b. New York	
500-lb lots	\$1.75
100-lb "	\$1.77
Less than 100 lb	\$1.82
Fines	\$1.75
Cobalt oxide	
(ceramic grade, 350-lb containers)	
Per lb, 72 1/2 to 73 1/2% Co	
East of Mississippi	\$1.33
West of Mississippi	\$1.36
Per lb, 70 to 71% Co	\$1.29 to \$1.32

Tariffs

Canada

Ore	free
Cobalt metal	
British preferential	"
Most favored nation	10%
General	25%
Cobalt oxide	
British preferential	free
Most favored nation	10%
General	10%

United States

Ore	free
Metal	"
Cobalt oxide	4¢ lb
Cobalt sulphate	2 1/2¢ lb
Cobalt linoleate	5¢ lb
Other cobalt compounds and salts	15%

COPPER

A.F. Killin*

Sustained demand for copper in the United States and Canada, a softening in demand in Europe, a reduction in purchases from the Soviet bloc and a strike - the longest in history - involving all the major United States producers were the highlights of the copper industry in 1959. At the beginning of the year it was estimated that, barring work stoppages, world production would exceed consumption by approximately 100,000 tons. Work stoppages did occur, affecting most of the major producers and custom smelters in the United States, and by year-end the estimated loss of production amounted to more than 250,000 tons.

During 1959, no work stoppages occurred at Canadian mines and, profiting from increased prices and continuing demand, the industry experienced moderate expansion. Production from Canada's mines, at 395,269 tons, was 14.5 per cent higher than in 1958. The value of Canada's copper output rose to $233,102,813 from the $174,430,930 obtained in the preceding year. Production of refined copper rose to 365,366 tons from the 329,239 tons reported in 1958. Consumption of refined copper in Canada increased as did exports of wrought shapes.

Despite the great duration of the strikes at the United States plants, which induced a growing shortage of refined copper toward the end of the year, prices did not reach the high levels of 1955 and 1956, when strikes likewise disrupted production. Several factors combined to keep prices in check during 1959: fabricators had purchased large stocks of copper at the beginning of the year in anticipation of strikes in the summer; the 'soft' European market allowed copper to be diverted to the American market as needed; production outside the United States reached record levels, and overproduction threatened to result if the strike was of short duration.

Depletion of world stocks of copper owing to the prolonged strikes in the United States and sporadic strikes in South America and Africa, coupled with a steady rise in world demand, will provide a ready market for copper in the first half of 1960. It is expected that the supply of refined copper will equal the demand by the end of the second quarter and that it will be in excess of needs by the third quarter.

---

*Mineral Resources Division

Copper - Production, Exports and Consumption

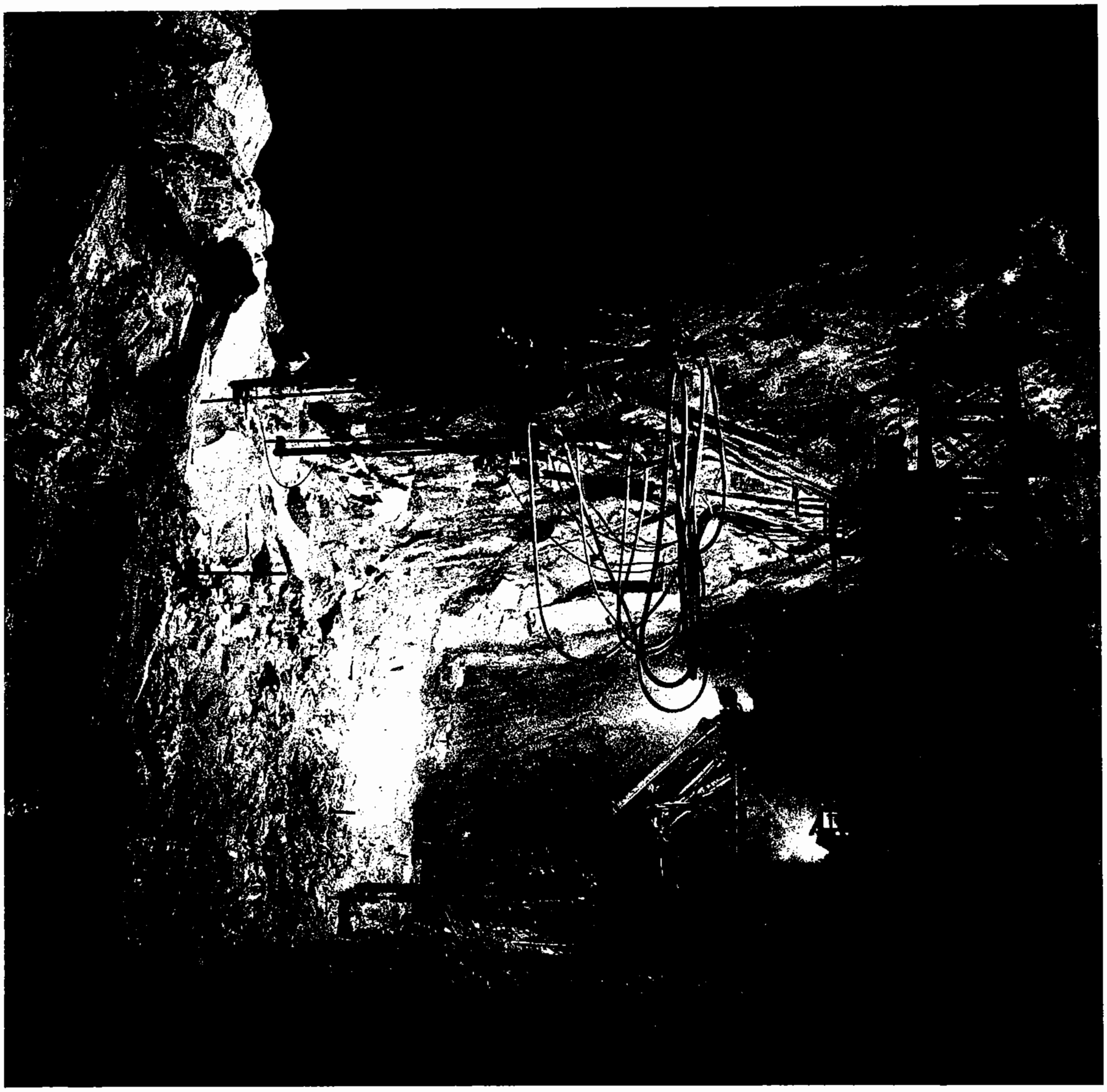
	1959		1958	
	Short tons	$	Short tons	$
Production(1)				
All forms				
Ontario	188,272	110,547,037	142,035	71,267,895
Quebec	134,912	79,894,820	131,445	66,826,788
Saskatchewan	35,536	21,044,574	37,510	19,070,139
Newfoundland	14,989	8,876,570	14,751	7,499,372
Manitoba	12,945	7,666,147	12,601	6,383,403
British Columbia	8,121	4,781,508	6,010	2,995,902
Northwest Territories	494	292,157	434	220,748
New Brunswick	-	-	328	166,683
Total	395,269	233,102,813	345,114	174,430,930
Refined	365,366		329,239	
Exports				
In ore and matte				
Norway	16,974	9,023,805	14,876	6,631,682
United States	7,311	3,891,662	10,704	4,801,669
Japan	5,999	3,150,125	2,208	1,051,222
United Kingdom	1,079	578,044	1,253	547,167
Belgium	442	233,649	692	311,988
West Germany	265	140,110	582	259,728
Total	32,070	17,017,395	30,315	13,603,456
Ingots, bars, slabs, etc.				
United States	101,501	60,323,522	63,865	32,902,035
United Kingdom	83,488	48,203,218	90,927	43,356,092
France	10,038	5,870,194	20,807	9,862,680
West Germany	9,510	5,469,552	14,051	6,810,006
India	7,619	4,534,156	11,652	5,684,978
Belgium	3,738	2,133,038	1,008	487,080
Netherlands	2,939	1,645,647	9,089	4,490,159
Other countries	3,604	2,067,619	13,239	6,311,127
Total	222,437	130,246,946	224,638	109,904,157
In scrap, slag and skimmings				
United States	2,745	1,330,017	5,199	1,858,518
West Germany	1,047	490,559	3,931	1,682,284
Japan	931	444,288	-	-
India	460	234,740	241	98,942
Netherlands	457	215,589	670	256,821
Other countries	596	294,309	1,046	426,707
Total	6,236	3,009,502	11,087	4,323,272

Copper - Production, Exports and Consumption (cont'd)

	1959		1958	
	Short tons	$	Short tons	$
Exports (cont'd)				
Rods, strips and sheets				
United States	4,856	3,903,574	3,881	3,189,684
Switzerland	3,854	2,128,521	4,006	1,710,842
United Kingdom............	2,054	1,279,397	3,327	1,834,889
China.....................	1,120	613,402	-	-
Other countries	785	627,869	574	454,342
Total.....................	12,669	8,552,763	11,788	7,189,757
Copper tubing				
United States	1,537	1,707,015	77	120,606
Cuba	681	658,518	794	712,290
Venezuela	597	526,249	487	391,521
New Zealand	359	375,833	398	382,761
Other countries	1,047	1,072,838	828	791,745
Total.....................	4,221	4,340,453	2,584	2,398,923
Wire and cable, screening and other copper manufactures				
United States		904,504		778,081
Venezuela		644,635		413,125
Pakistan		277,557		44,393
Dominican Republic		272,499		137,066
India		122,710		11,767
Other countries		678,047		892,324
Total.....................		2,899,952		2,276,756
Consumption(2)				
Refined....................	129,973		122,893	

(1) Blister copper, plus recoverable copper in matte and concentrate exported.

(2) Producers' domestic shipments.



Room-and-pillar mining at Gaspe Copper Mines, Limited, Murdochville, Quebec.

Copper - Production, Trade and Consumption 1949-59
(short tons)

	Production		Exports			Imports	Consumption(3)
	All Forms(1)	Refined	In Ore and Matte	Refined	Total	Refined	Refined
1949	263,457	226,083	37,058	127,160	164,218	9	100,905
1950	264,209	238,204	32,299	134,244	166,543	122	106,876
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	30,315	224,638	254,954	1	122,893
1959	395,269	365,366	32,070	222,437	254,507	105	129,973

(1) Blister copper, plus recoverable copper in matte and concentrates exported.

(2) Includes blister and anode copper exported for refining as follows:

1952	27,974 short tons
1953	3,527 " "
1954	4,712 " "

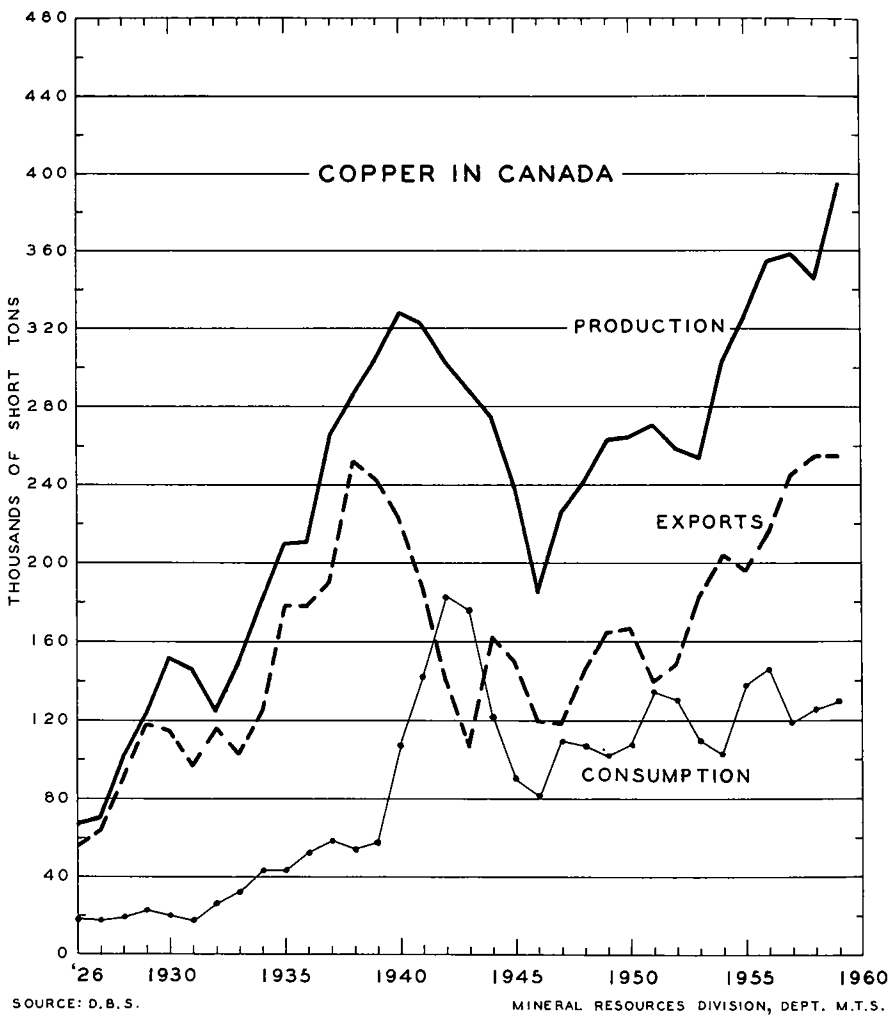
(3) Producers' domestic shipments.

Domestic Smelter and Refinery Production

Ninety-eight per cent of the copper and copper-nickel ores and concentrates produced from Canadian mines was reduced in the six domestic smelters, and the remainder was shipped to smelters in the United States and Japan.

The Copper Cliff and Coniston smelters of The International Nickel Company of Canada, Limited, in Ontario, treated ores and concentrates from the company's mines in the Sudbury district. Ores and concentrates from the Horne mine and most mines in eastern Canada were treated at the smelter of Noranda Mines, Limited, at Noranda,Quebec. This smelter produced 141,500 tons of anodes from the treatment of 1,495,000 tons of ore, concentrate, refinery slag, scrap copper and scrap brass. Toll shipments to the Noranda smelter amounted to 756,500 tons of copper-bearing materials.

Ores and concentrates from the mine of Gaspe Copper Mines, Limited and from the Tilt Cove, Newfoundland, mine of Maritimes Mining Corporation Limited, were treated in the Murdochville, Quebec, smelter of Gaspe Copper Mines, Limited, where 45,186 tons of anodes were produced during the year from



274,400 tons of concentrate and fluxing ore. At its smelter at Flin Flon, Manitoba, Hudson Bay Mining and Smelting Co.,Limited treated 434,890 tons of copper ore, concentrates and residues from the company's mines in Manitoba and Saskatchewan. Copper-nickel matte produced from the treatment of 658,432 tons of ore and concentrate was shipped by Falconbridge Nickel Mines Limited to its refinery in Kristiansand, Norway. Falconbridge's smelter and mines are located in the Sudbury district of Ontario.

The blister copper and copper anodes shipped from Canadian smelters were treated in the two refineries operating in Canada and a total of 365,366 tons of refined copper was produced. Blister copper from the International Nickel smelter was treated in the company's refinery at Copper Cliff, Ontario. Copper anodes from the Noranda and Murdochville smelters and blister copper from the Flin Flon smelter of Hudson Bay Mining and Smelting were treated in the Montreal East refinery of Canadian Copper Refiners Limited, which in 1959 produced 232,500 tons of refined copper.

Domestic Mine Production

Newfoundland

A copper mine and a copper-zinc mine produced all of the 14,989 tons of copper reported from Newfoundland.

American Smelting and Refining Company (Buchans Unit), in central Newfoundland, produced 110,160 tons of concentrate containing 3,762 tons of copper, 25,533 tons of lead, 42,041 tons of zinc, 9,861 ounces of gold and 1,387,506 ounces of silver, from 359,000 tons of ore milled. The copper concentrate produced was shipped to the American Smelting and Refining Company's smelter at Tacoma, Washington.

Maritimes Mining Corporation Limited, at Tilt Cove, on the northwest coast of Notre Dame Bay, produced 12,189 tons of copper. Concentrate is treated at the Murdochville smelter.

New Brunswick

No copper production was recorded from New Brunswick.

Quebec

Quebec's copper production increased 3,467 tons over the 1958 total to 134,912 tons.

Gaspe Copper Mines,Limited, Canada's third largest producer, obtained 33,411 tons of copper from its Murdochville mine. Anodes from the Murdochville smelter were shipped to Montreal East for refining.

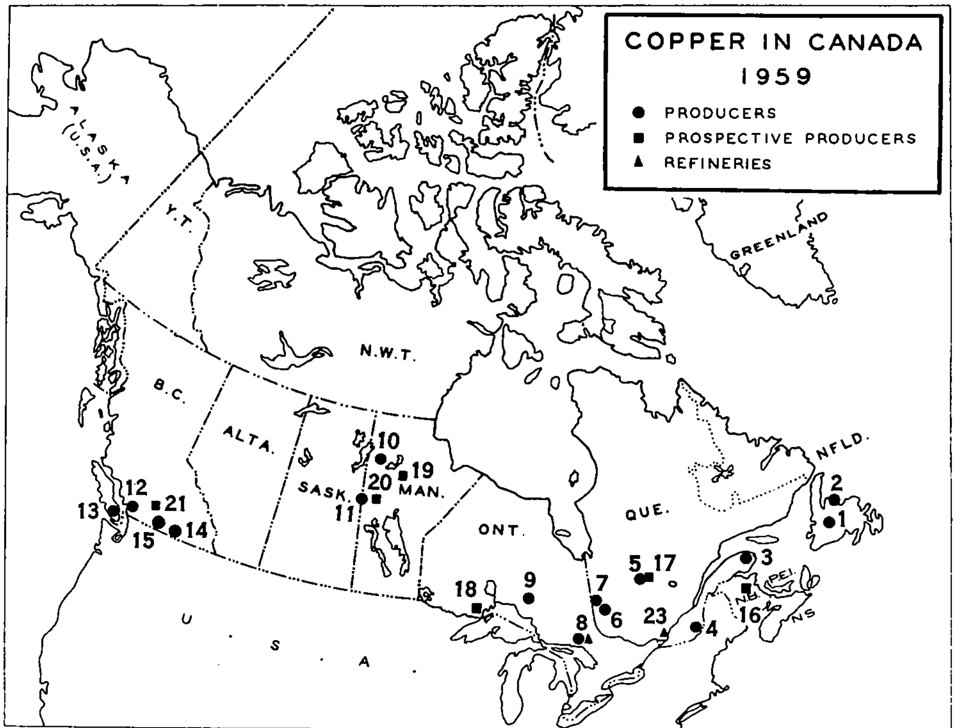
Ore milled during 1959 amounted to 2,344,000 tons.

Noranda Mines, Limited, produced 1,381,000 tons of ore yielding 26,480 tons of copper, from the Horne mine at Noranda.

Quemont Mining Corporation,Limited produced 60,698 tons of copper concentrate from the milling of 850,099 tons of ore. Contained metals in the copper concentrate amounted to 10,373 tons of copper, 108,282 ounces of gold and 360,362 ounces of silver.

Normetal Mining Corporation, Limited, at Normetal, produced 376,360 tons of ore containing 11,257 tons of copper from its mine 55 miles north of Noranda.

Waite Amulet Mines,Limited produced 311,405 tons of ore averaging 4.36 per cent copper 3.73 per cent zinc, 0.033 ounce of gold per ton and 0.97 ounce of silver per ton from its mine north of Noranda. The 58,279 tons of copper concentrate produced contained 12,829 tons of copper, 7,132 ounces of gold and 198,956 ounces of silver.



R.A.

MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Producers

1. American Smelting and Refining Company (Buchans Unit)
2. Maritimes Mining Corporation Limited
3. Gaspe Copper Mines, Limited (smelter)
4. Weedon Pyrite & Copper Corporation Limited
5. Opemiska Copper Mines (Quebec) Limited
   Campbell Chibougamau Mines Ltd.
   Merrill Island Mining Corporation Ltd.
   Anacon Lead Mines Limited (Chibougamau Operation)
6. Manitou-Barvue Mines Limited
   East Sullivan Mines Limited
   Noranda Mines, Limited (smelter)
   Quemont Mining Corporation, Limited
   Waite Amulet Mines, Limited
7. Normetal Mining Corporation, Limited
8. International Nickel Company of Canada, Limited, The (6 mines, 2 smelters, 2 refinerie
   Falconbridge Nickel Mines Limited (5 mines, 1 smelter)
9. Geco Mines Limited
   Willroy Mines Limited
10. Sherritt Gordon Mines Limited
11. Hudson Bay Mining and Smelting Co., Limited (4 mines, 1 smelter)
12. Howe Sound Company (Britannia Division)
13. Cowichan Copper Co. Ltd.
14. Phoenix Copper Company Limited
    Consolidated Woodgreen Mines Limited
15. Mid-West Copper and Uranium Mines Ltd.

Prospective Producers

16. Bathurst area
17. Copper Rand Chibougamau Mines Ltd.
    Chibougamau Jaculet Mines Limited
    Portage Island (Chibougamau) Mines Limited
18. North Coldstream Mines Limited
19. International Nickel Company of Canada, Limited, The (smelter)
20. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake, Stall Lake)
21. Bethlehem Copper Corporation Ltd.
    Craigmont Mines Limited

Refinery

23. Canadian Copper Refiners Limited

East Sullivan Mines Limited, produced 32,100 tons of copper concentrate at its mine in the Val d'Or district. Contained copper in the concentrate produced amounted to 7,182 tons.

Manitou-Barvue Mines Limited continued production from the copper and zinc orebodies at its mine 9 miles east of Val d'Or. During the year the company milled 297,650 tons of copper ore, from which were produced some silver and gold and 8,866.3 tons of copper concentrate containing 28.73 per cent copper.

Campbell Chibougamau Mines Ltd. produced 695,287 tons of ore in 1959. Copper production amounted to 14,180 tons. Campbell's main mine is located on Merrill Island, Doré Lake, in the Chibougamau district of north-western Quebec. Ore from the Kokko Creek and Cedar Bay mines on the north shore of Doré Lake was treated in the Campbell mill and is included in the total production figures quoted.

Merrill Island Mining Corporation, Ltd., milled 143,066 tons of ore in 1959, from its Merrill Island mine, which adjoins the Campbell Chibougamau property.

Opemiska Copper Mines (Quebec) Limited, at Chapais, 25 miles west of Chibougamau, milled 443,444 tons of ore, from which were produced concentrates containing 14,277 tons of copper, 13,080 ounces of gold, and 169,300 ounces of silver.

Anacon Lead Mines Limited (Chibougamau Operation), produced 98,108 tons of ore containing 389 tons of copper and 17,955.197 ounces of gold from its copper-gold mine 26 miles south of Chibougamau.

Weedon Pyrite & Copper Corporation Limited suspended operations in November at its copper-zinc-pyrite mine at Fontainebleau, 75 miles south of Quebec City. Suspension of operations was forced by collapse of pillars in the upper sections of the mine which allowed the mine to flood. The mill produced 7,700 tons of copper concentrate containing 1,400 tons of copper.

Ontario

Ontario mines produced 188,272 tons of copper. This was 46,237 tons more than the amount produced in 1958, when mines of The International Nickel Company of Canada, Limited, were idle for part of the year because of strikes.

The International Nickel Company of Canada, Limited, which is Canada's largest copper producer, operated the Frood-Stobie, Murray, Garson, Creighton and Levack mines. The Levack mill was completed and put in operation about mid-year. Development of the Crean Hill mine was resumed.

Deliveries of refined copper amounted to 126,225 tons, and ore mined during the year totalled 15,316,000 tons.

Falconbridge Nickel Mines Limited, in the Sudbury district, produced ore from the East, Falconbridge, Longvack, McKim, Hardy and Fecunis mines. Production of copper reached an all-time high of 16,364 tons.

Geco Mines Limited milled 1,290,279 tons of ore from its mine in the Manitouwadge area. Mill heads averaged 2.10 per cent copper, 2.38 per cent zinc and 1.30 ounces of silver per ton, and the 93,050 tons of copper concentrate produced assayed 27.84 per cent copper, 14.65 ounces of silver per ton and 0.061 ounce of gold per ton.

Willroy Mines Limited, which adjoins the Geco mine, milled 371,186 tons of copper-zinc-lead ore and produced 12,233 tons of copper concentrate containing 2,642 tons of copper.

Manitoba-Saskatchewan

Copper production from Manitoba and Saskatchewan amounted to 48,481 tons. Production was obtained from the mines of Sherritt Gordon Mines Limited, in Manitoba, and Hudson Bay Mining and Smelting Co.,Limited, in Manitoba and Saskatchewan.

Hudson Bay Mining and Smelting Co.,Limited, with a mill and smelter at Flin Flon, Manitoba, is Canada's second largest copper producer. In 1959 the mill treated 1,671,089 tons of ore from the Flin Flon, Birch Lake and Schist Lake mines. In addition, 9,677 tons of ore were shipped directly to the smelter. A total of 434,890 tons of concentrate, residues and direct-shipping ore containing 44,124 tons of copper was smelted. In addition to copper, the blister contained 101,814 ounces of gold, 1,553,574 ounces of silver, 130,588 pounds of selenium and a small amount of tellurium.

Pre-production development continued at the Coronation mine in the Flin Flon district and at the Chisel Lake and Stall Lake mines in the Snow Lake district of Manitoba.

Sherritt Gordon Mines Limited, at Lynn Lake, Manitoba, operated two nickel-copper mines and a concentrator. The mill treated 988,541 tons of ore, producing a nickel-copper concentrate which was shipped to the company's refinery at Fort Saskatchewan, Alberta, and a copper concentrate which was shipped to the smelter at Noranda, Quebec. Copper sulphide recovered from the treatment of the nickel-copper concentrate at Fort Saskatchewan was also shipped to Noranda.

British Columbia

Copper production in British Columbia was obtained from five mines with the reopening of the Britannia, Phoenix, Woodgreen and Mid-West Copper and Uranium mines and continued production from the Cowichan Copper mine. Some curtailment of production was necessary when the Tacoma, Washington, smelter of American Smelting and Refining Company was closed by a strike.

All the mines except the Cowichan Copper ship concentrates to Tacoma and, after the strike began, the concentrates had to be stockpiled at the mines.

Mid-West Copper and Uranium Mines Ltd. resumed production from the old Velvet mine near Rossland in September.

Phoenix Copper Company Limited, a wholly owned subsidiary of The Granby Mining Company Limited, produced 175,945 tons of ore from the old Granby mine near Greenwood. The property is equipped with a 1,000-ton-a-day mill.

Howe Sound Company (Britannia Division), is a new company formed by the Howe Sound Company of New York to reopen and operate the mine of its former subsidiary, Britannia Mining & Smelting Co., Limited, at Britannia Beach. The mine was reopened on January 27 and by year-end had produced 17,248 tons of copper concentrate and 5,935 tons of zinc concentrate.

Cowichan Copper Co. Ltd., at Cowichan Lake, produced 8,165 tons of concentrate containing 2,252 tons of copper. Concentrates were shipped to Japan for treatment.

Consolidated Woodgreen Mines Limited, near Greenwood, resumed production in June and, by the end of the year, had produced 78,730 tons of ore.

Northwest Territories

The 494 tons produced were obtained from North Rankin Nickel Mines Limited, which is the only base-metal mine operating in the Northwest Territories east of Great Slave Lake.

Exploration and Development

Exploration for new deposits and development of known deposits were stimulated by higher prices and the short-term prospect of an increased demand for copper.

Newfoundland

Atlantic Coast Copper Corporation Limited at Little Bay, Notre Dame Bay, in northeastern Newfoundland, continued development of its copper property. Diamond-drilling and underground development have indicated reserves of 2 million tons averaging 2.1 per cent copper.

Maritimes Mining Corporation Limited, which controls the property of Gullbridge Mines Limited, about 20 miles from Badger, did no work on it. Previous work indicated reserves of 4,350,000 tons averaging 1.24 per cent copper.

New Brunswick

The Consolidated Mining and Smelting Company of Canada Limited started shaft-sinking on the Wedge property at the junction of the Nepisiguit River and Fortymile Brook, about 36 miles from Bathurst. A medium-sized copper orebody has been outlined by surface exploration and diamond-drilling.

Quebec

Copper Rand Chibougamau Mines Ltd. completed development work preparatory to bringing into production the company's Eaton Bay property on the Gouin peninsula in the Chibougamau district. A 1,500-ton-a-day mill was constructed, and production is scheduled for early 1960.

Copper Rand is also managing the shaft-sinking and level development at the property of Portage Island (Chibougamau) Mines Limited, on Lake Chibougamau, and the property of Chibougamau Jaculet Mines Limited, about 2 miles north of the Copper Rand mill.

Mattagami Lake Mines Limited continued exploration of the Watson Lake property of the Mattagami Syndicate. Diamond-drilling has indicated reserves in two zones with the following totals: zone 1 - 21 million tons averaging 12.8 per cent zinc, 0.7 per cent copper, 0.02 ounce of gold per ton and 1.3 ounce of silver per ton; zone 2 - 2 million tons averaging 12.9 per cent zinc, 0.9 per cent copper, 0.01 ounce of gold per ton and 1.0 ounce of silver per ton.

New Hosco Mines Limited continued a diamond-drilling program on its copper-zinc orebody on the Allard River in the Mattagami area. Results to date indicate 2,447,000 tons of copper ore averaging 2.64 per cent copper and 958,000 tons of zinc ore averaging 7.96 per cent zinc.

Orchan Mines Limited announced that further tonnages of copper-zinc mineralization have been found on its property adjoining Mattagami Lake Mines Limited on the south.

Bateman Bay Mining Company continued exploration of its property on Doré Lake in the Chibougamau district. Diamond-drilling and underground development on three levels have established that there are about 750,000 tons of copper-zinc mineralization.

Campbell Chibougamau Mines Ltd. started shaft-sinking and level development at the Henderson zone on the shore of Lake Chibougamau. The Henderson orebody, according to company reports, contains 3,200,000 tons of indicated ore averaging 2.66 per cent copper and 0.08 ounce of gold per ton and a further substantial tonnage of inferred ore.

Ontario

North Coldstream Mines Limited was incorporated to take over and put into production the property of Coldstream Copper Mines Limited, located 9 miles north of Kashabowie. The shaft is being unwatered and the mine rehabilitated.

British Columbia

Exploration for copper deposits was concentrated in the Highland Valley-Merritt district, although field parties were active throughout the province.

Bethlehem Copper Corporation Ltd. completed a preliminary program of underground exploration and bulk sampling of its property at Highland Valley, 25 miles southeast of Ashcroft.

Craigmont Mines Limited also carried out a program of underground development and diamond-drilling on its copper-iron prospect 10 miles northwest of Merritt.

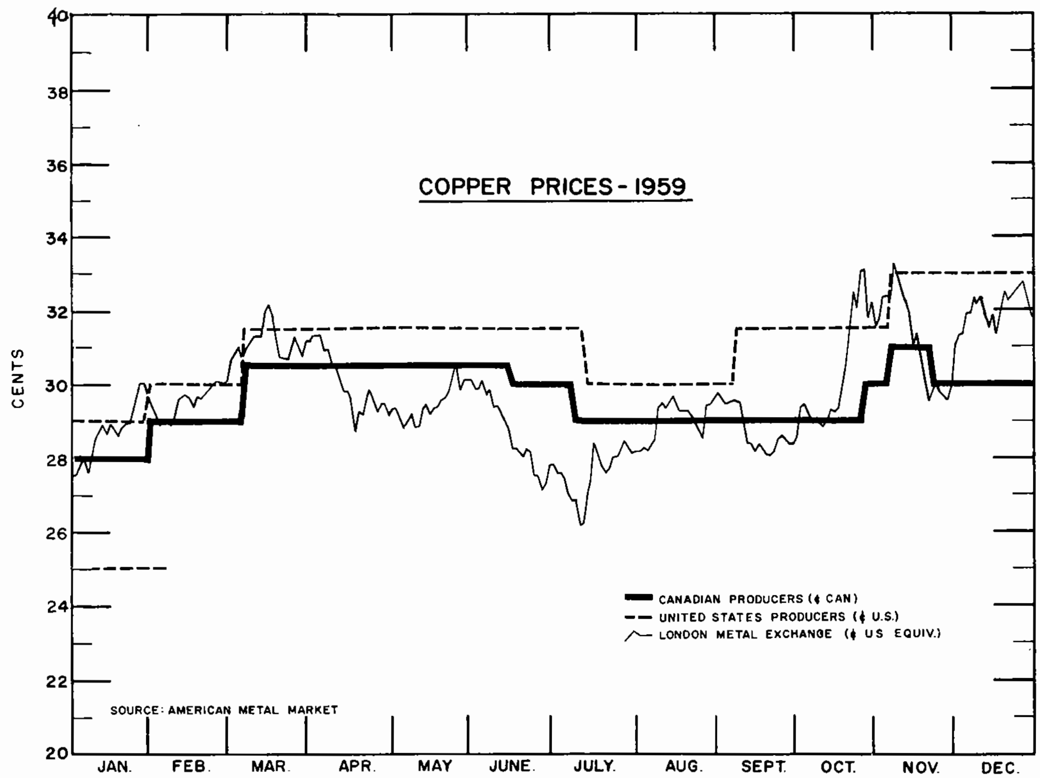
Domestic Consumption and Uses

The 129,973 tons of refined copper consumed in domestic plants was used in the production of wire, cable, copper and brass pipe, tubing, strip and sheet.

The principal copper and brass fabricators in Canada are: Ontario - Anaconda American Brass Limited, New Toronto; Canada Wire and Cable Company Limited, Toronto; Phillips Electrical Company Limited, Brockville; and Wolverine Tube Division of Calumet & Hecla of Canada Limited, London; Quebec - Noranda Copper and Brass Limited, Montreal East.

Prices

The accompanying graph shows the fluctuations in the United States and London Metal Exchange copper prices. These fluctuations closely followed the changes in market demand. In the first quarter of the year, sustained demand plus inventory building in anticipation of a mid-summer strike against producers in the United States caused prices to rise. Prices were stable in the second quarter as supply and demand were in balance. At the beginning of the third quarter, prices fell under pressure of increased supplies and the rumor that no strikes would occur. After the strikes were called, prices remained remarkably stable for the rest of the year and, except for a brief flurry at the start of the fourth quarter, showed no tendency to rise to excessive levels.



Tariffs

Although Canada has no tariff on copper in ores and concentrates, copper in bars, rods, wire, semifabricated forms and fully processed products is subject to various tariff rates. 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	1¢ lb	1 1/2¢ lb	1 1/2¢ lb
Scrap	1¢ lb	1 1/2¢ lb	1 1/2¢ lb
Anodes	5%	7 1/2%	10%
Oxide	free	15%	15%
Bars or rods, tubing not less than 6 feet in length, unmanufactured; copper in strips, sheets or plates, not polished, planished or coated	5%	10%	10%

(tariffs continued)

	British Preferential	Most Favored Nation	General
Bars and rods for the manufacture of wire and cable	free	10%	10%
Tubing not more than 1/2 inch in diameter and not less than 6 feet long	5%	10%	10%
Alloys of copper consisting 50% or more, by weight, of copper in sheets, plates, bars, rods and tubes	7 1/2%	15%	25%

The United States tariff is 1.7 cents a pound of copper content for ores, concentrates and primary shapes and up to 4 1/2 cents a pound plus 1.7 cents a pound of copper content for fabricated materials.

World Mine Production

Despite the loss of production from strikebound United States mines, world copper production, as reported by the Copper Institute, increased to 2,860,454 tons from the 2,713,412 tons produced in 1958. These figures exclude production from Russia, Japan, Australia, Yugoslavia, Norway, Sweden, Finland and the Messina mine in the Transvaal and the production of several other small countries from which reports are not available. Production inside the United States decreased to 805,875 tons from the 1,008,170 tons produced in 1958, while production from mines outside the Unites States increased to 2,054,579 tons over the 1,705,242 tons produced in 1958. Stocks of refined copper in the world increased in 1959 by 28,774 tons over the 262,544 tons held at the end of 1958, while stocks of refined copper in the United States decreased by 17,647 tons.

GOLD

T.W. Verity*

Conditions throughout Canada's gold-mining industry were less favorable in 1959 than in the preceding year. At first, with the Royal Canadian Mint price close to $34 a troy ounce, they seemed promising, but later the strong position of the Canadian dollar in relation to the United States dollar brought a decline in the price of gold. The low was reached in October, and by the end of the year there had been a small recovery. New labor agreements, signed by most of the gold mines late in 1958 or early in 1959, resulted in increased labor costs. The higher wage rates offered by the uranium mines at Elliot Lake and Bancroft, in Ontario, attracted many miners and caused a shortage of skilled miners in the major gold camps.

Gold production from all sources in 1959 came to 4,483,416 troy ounces valued at $150,508,275, compared to 4,571,347 ounces in 1958 and 4,433,894 ounces in 1957.

Gold production increased only in the Northwest Territories and Newfoundland. Ontario continued to be the principal producer, accounting for 60 per cent of Canada's total. Quebec followed with 22 per cent, the Northwest Territories with 9 per cent and British Columbia with 4 per cent.

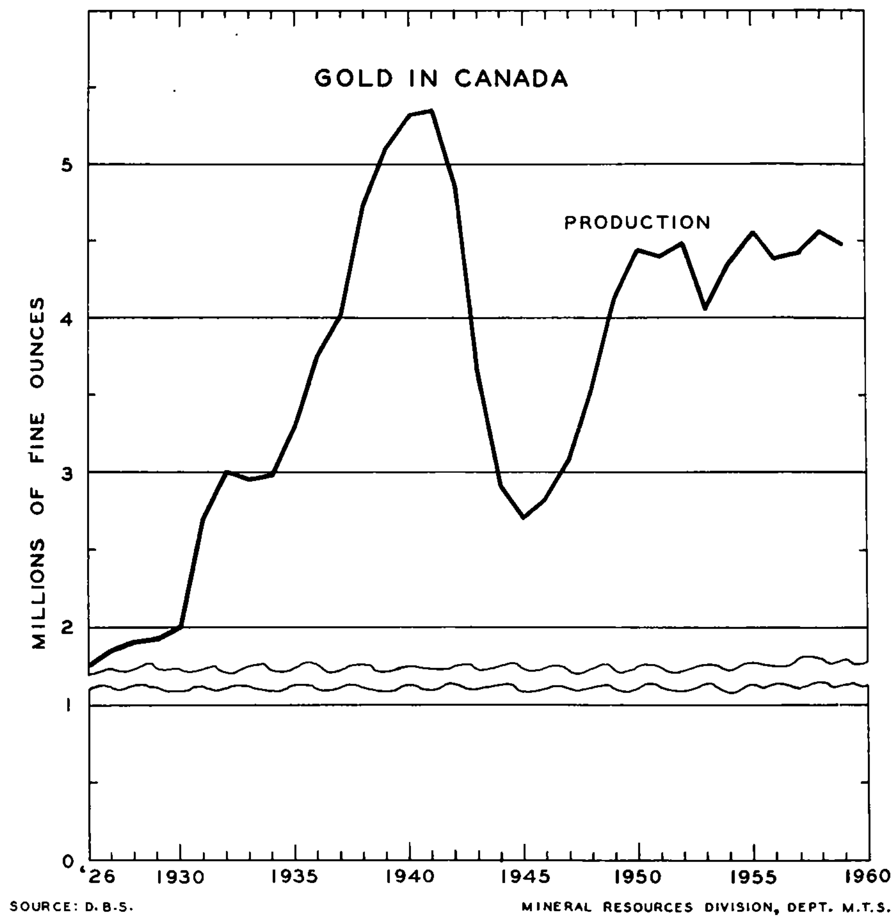
Gold declined to sixth place in value among minerals produced in Canada, following crude petroleum, uranium oxide, nickel, copper and iron ore. In Free World output Canada retained second place, following the Union of South Africa.

Production from auriferous-quartz (lode) gold mines was 3,852,074 troy ounces, 2 per cent less than the 1958 total. There were 52 large lode gold mines operating in Canada during 1959, one fewer than in 1958. Sullivan Consolidated Mines Limited reopened in the Bourlamaque area of Quebec in July 1958; the Nor-Acme mine at Snow Lake, Manitoba, being worked under lease by Howe Sound Company, closed in July 1958; Stadacona Mines (1944) Limited, in the Noranda area of Quebec, ceased milling at the end of 1958; Belleterre Quebec Mines Limited, near Ville Marie, Quebec, closed in

*Mineral Resources Division

Production of Gold
(troy ounces)

		1959	1958
Nfld.	Base-metal mines	13,411	13,381
N.B.	Base-metal mines	-	52
N.S.	Auriferous quartz	-	131
Que.	Auriferous quartz		
	Cadillac-Malartic	294,690	308,574
	Bourlamaque-Louvicourt	267,048	247,137
	Noranda-Belleterre	40,828	71,146
	Chibougamau	17,537	35,252
	Miscellaneous	8	801
	Total	620,111	662,910
	Base-metal mines	379,277	381,936
	Total	999,388	1,044,846
Ont.	Auriferous quartz		
	Porcupine	1,089,699	1,138,190
	Larder Lake	567,304	542,269
	Patricia	484,552	482,476
	Kirkland Lake	352,250	362,168
	Thunder Bay	103,228	107,124
	Sudbury	36,350	27,858
	Miscellaneous	129	109
	Total	2,633,512	2,660,194
	Base-metal mines	49,937	56,320
	Total	2,683,449	2,716,514
Man.	Auriferous quartz	29,487	67,889
	Base-metal mines	21,699	19,467
	Total	51,186	87,356
Sask.	Base-metal mines	78,588	86,590
Alta.	Placer operations	200	282
B.C.	Auriferous quartz	163,042	193,225
	Base-metal mines	15,456	13,459
	Placer operations	5,814	3,928
	Total	184,312	210,612
N.W.T.	Auriferous quartz	405,922	343,838
Yukon	Placer operations	66,960	67,745
	Base-metal mines	-	-
	Total	66,960	67,745
Canada	Auriferous quartz	3,852,074	3,928,187
	Base-metal mines	558,368	571,205
	Placer operations	72,974	71,955
	Total	4,483,416	4,571,347
Canada	Total value	$150,508,275	$155,334,370
	Average value per ounce	$33.57	$33.98



February 1959; Norlartic Mines Limited, a new producer in the Malartic area of Quebec, commenced shipping ore to the neighboring mill of Malartic Gold Fields Limited in June 1959. A number of small prospective gold mines were under development during the year in various parts of Canada.

Production of gold as a by-product from base-metal mines decreased to 558,368 troy ounces from the 571,205 ounces recovered in 1958. This was about 12.5 per cent of Canada's gold production. The decrease was due to a decline in production from base-metal mines in Ontario and the Prairie Provinces.

There was a small increase in placer-gold production to 72,974 troy ounces from 71,955 ounces in 1958. This was due, almost entirely, to the starting into production of a new placer operation in the Barkerville area of British Columbia.

Gold Production, 1949-59
(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
1949	3,566,152	86.3	96,614	2.4	460,752	11.3	4,123,518	148,446,648	36.00	16.5
1950	3,764,757	84.8	108,143	2.4	568,327	12.8	4,441,227	168,988,687	38.05	16.2
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

There were no serious disruptions of work in the gold-mining industry resulting from labor disputes. New agreements gave more stability in the labor market. Nearly all mines granted a 5-cent-an-hour pay increase in 1959 with other fringe benefits. Some granted a further 5 cents an hour for 1960.

The Emergency Gold Mining Assistance Act was extended in September 1958 to cover the calendar years 1958, 1959 and 1960 and to provide for a 25-per-cent increase in the amount of cost assistance payable. The Governor General, in his Speech from the Throne in January 1960, announced that the Government intended to extend the Act for a further three-year period, at the same rate of assistance.

One notable event of 1959 was the emergence of an international gold market in Toronto. On February 3, 1959, the Toronto Stock Exchange began to give daily quotations on the value of 1-kilogram gold bars. In October 1959, Samuel Montagu & Co. Ltd., gold-bullion merchants of London, England, announced that gold certificates of the Bank of Nova Scotia, in Toronto, were interchangeable at banking establishments in the United Kingdom, the Federal Republic of Germany and South Africa. The Toronto Gold Market Co. Ltd. also began to merchandise gold, using a system of warehouse receipts certified by Guaranty Trust Company of Canada, in Toronto.

Operations at Producing Mines*

Newfoundland

There was a small increase in the amount of gold recovered as a by-product from the base-metal operations of Buchans Mining Company Limited, in the central part of the province, and the Tilt Cove operation of Maritimes Mining Corporation Limited, on the northeast coast.

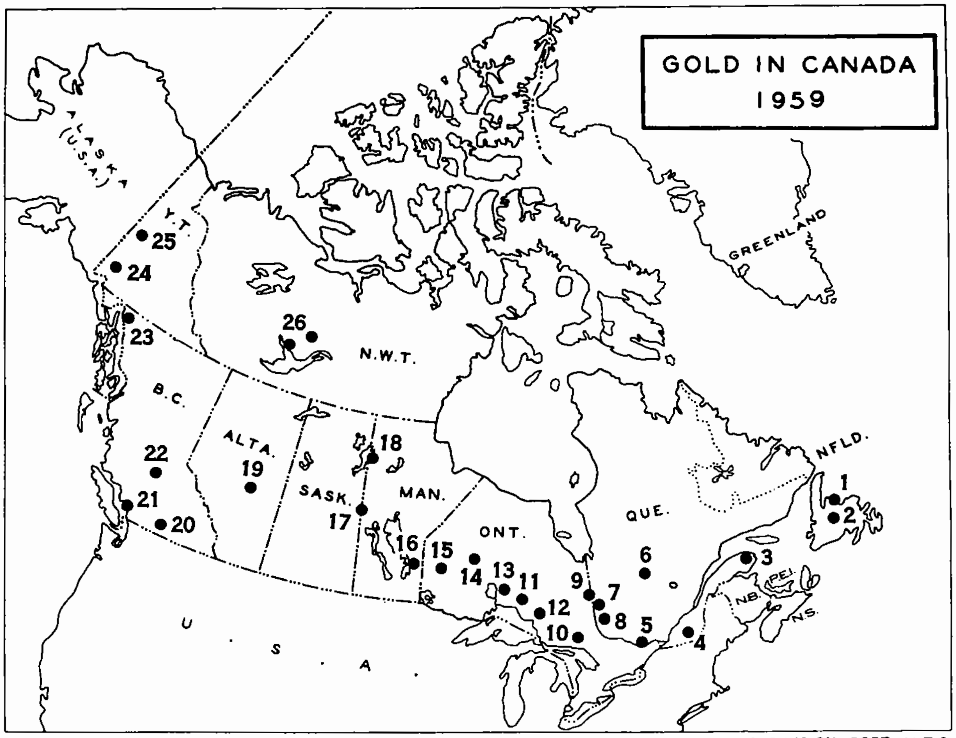
Maritime Provinces

New Brunswick reported a small amount of gold recovered from base-metal mining during 1958, but none was recorded in 1959. A small amount was recovered from auriferous-quartz veins in Nova Scotia. One small lode gold mine, East Hants Gold Mines Limited, operated near Halifax in 1958-59, producing small quantities of gold.

Quebec

Thirteen auriferous-quartz mines operated in 1959. The new producer, Norlartic Mines Limited, started shipping ore in June, but Belleterre Quebec Mines Limited ceased operations in February. Gold production from all sources declined by 4.4 per cent, and from auriferous-quartz-mining by 6 1/2-per-cent. The amount derived from base-metal-mining increased to nearly 38 per cent of the total production from the preceding year's 36.6 per cent. Tons milled by auriferous-quartz mines declined 4 per cent to 3,864,000 tons, and the average recovery grade of the ore milled, which in 1958 was 0.164 ounce gold per ton, dropped to 0.156 ounce gold per ton.

*See map on next page.



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Producers and Prospective Producers

*Base metals ***Placer
**Auriferous quartz ****Prospective producer

Newfoundland

1. Maritimes Mining Corp. Ltd. (Tilt Cove)*
2. Buchans Mining Co. Ltd.*

Quebec

3. Gaspe Copper Mines Ltd.*
4. Weedon Pyrite & Copper Corp. Ltd.*
   Chaudière River Placers*** ****
5. New Calumet Mines Ltd.*
6. Chibougamau District
   Campbell Chibougamau Mines Ltd.*
   Anacon Lead Mines Ltd. (Chibougamau Operation)**
   Copper Rand Chibougamau Mines Ltd.* ****
   Opemiska Copper Mines (Quebec) Ltd.*
   Merrill Island Mining Corp. Ltd.*

7. Rouyn-Noranda District
   Elder Mines Ltd.**
   Eldrich Mines Ltd.**
   Noranda Mines, Ltd.*
   Quemont Mining Corp., Ltd.*
   Waite Amulet Mines, Ltd.*
   Cadillac-Malartic District
   Barnat Mines Ltd.**
   Canadian Malartic Gold Mines Ltd.**
   East Malartic Mines Ltd.**
   Malartic Gold Fields Ltd.**
   Norlartic Mines Ltd.**

Bourlamaque-Louvicourt District
Bevcon Mines Ltd.**
Lamaque Gold Mines Ltd.**
Sigma Mines (Quebec) Ltd.**
Sullivan Consolidated Mines Ltd.**
East Sullivan Mines Ltd.*
Manitou-Barvue Mines Ltd.*
Duparquet District
Normetal Mining Corp., Ltd.*
8. Belleterre Quebec Mines Ltd.**

Ontario

9. Larder Lake District
Kerr-Addison Gold Mines Ltd.**
Kirkland Lake District
Kirkland Minerals Corp. Ltd.**
Lake Shore Mines Ltd.**
Macassa Mines Ltd.**
Sylvanite Gold Mines, Ltd.**
Teck-Hughes Gold Mines, Ltd., The**
Upper Canada Mines Ltd.**
Wright-Hargreaves Mines, Ltd.**
Porcupine District
Aunor Gold Mines Ltd.**
Broulan Reef Mines Ltd.**
Coniaurum 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 East Dome Mines, Ltd.**
10. Sudbury District
International Nickel Co. of Canada, Ltd., The*
Falconbridge Nickel Mines Ltd.*
11. Manitouwadge District
Geco Mines Ltd.*
Willroy Mines Ltd.*
12. Renabie Mines Ltd.**
13. Thunder Bay District
Leitch Gold Mines Ltd.**
MacLeod-Cockshutt Gold Mines, Ltd.**
Consolidated Mosher Mines Ltd.** ****
14. Patricia Portion
Pickle Crow Gold Mines Ltd.**
15. Campbell Red Lake Mines Ltd.**
Cochenour Willans Gold Mines, Ltd.**
Madsen Red Lake Gold Mines Ltd.**
McKenzie Red Lake Gold Mines Ltd.**
New Dickenson Mines Ltd.**
H.G. Young Mines Ltd.** ****

Manitoba

16. San Antonio Gold Mines Ltd.**
Forty-Four Mines Ltd.**
17. Hudson Bay Mining and Smelting Co., Ltd.*
18. Sherritt Gordon Mines Ltd.*

Alberta

19. Placer operations on Saskatchewan River***

British Columbia

20. Consolidated Mining and Smelting Co. of Canada Ltd., The (Kimberley)*
Phoenix Copper Company Ltd. (Greenwood)*
French Mines Ltd.**
21. Howe Sound Company (Britannia Division)*
22. Bralorne Pioneer Mines Ltd. (Bralorne and Pioneer Divisions)**
Cariboo Gold Quartz Mining Co. Ltd., The**
Small placer operations***
23. Small placer operations***

Yukon Territory

24. Burwash Mining Co. Ltd.***
and smaller operations***
25. Yukon Consolidated Gold Corp. Ltd., The***
Yukon Explorations Ltd.***
and smaller operations***

(map list continued)

Northwest Territories

26. Consolidated Mining and Smelting Co. of Canada Ltd., The (Con and Rycon mines)**
Giant Yellowknife Gold Mines Ltd.**

26. Consolidated Discovery Yellowknife Mines Ltd.**
Taurcanis Mines Ltd.** ****
and other small prospective gold mines

Auriferous-quartz Mines

Cadillac-Malartic District

Five lode gold mines operated in the district, one more than in 1958, but there was a 4.5-per-cent drop in gold production. The average recovery grade of the ore milled dropped to 0.156 ounce gold per ton from 0.164 in 1958. Only East Malartic Mines Limited, Quebec's second largest gold mine, had an increase in production. Malartic Gold Fields Limited, the district's second largest producer, with a mill capacity of 1,800 tons a day, has a limited supply of ore left in its own property and is now acting as a custom mill for other mines in the area. Barnat Mines Ltd. started stoping operations in its new porphyry-ore zone at the west end of the property and by year-end had increased mining output to about 1,100 tons a day. The Barnat mill has a capacity of only 700 tons a day, and shipments of excess ore to the Malartic Gold Fields mill were begun in November 1959.

The new mine in the area, Norlartic Mines Limited, deepened its shaft to 1,000 feet early in 1959, with the result that four levels were under development. Shipment of ore to the neighboring Malartic Gold Fields mill began on June 1. Preparations for shaft-sinking were also under way at Marban Gold Mines Limited, which adjoins Malartic Gold Fields to the north.

Bourlamaque-Louvicourt District

Gold output in this district increased 8.1 per cent owing entirely to the reopening, in August 1958, of Sullivan Consolidated Mines Limited. The other three mines in the district had a decrease in production. The average recovery grade of the ore milled was 0.165 ounce gold per ton, the same as in 1958. Lamaque Gold Mines Limited, Quebec's leading lode gold mine, discovered a possible new gold orebody at the east end of its property and was diamond-drilling the occurrence by year-end. Expansion programs were under way at the properties of Sigma Mines (Quebec) Limited, Sullivan Consolidated Mines Limited and Bevcon Mines Limited.

Noranda-Belleterre District

There was a 42.6-per-cent drop in gold production in the district, owing mainly to the closing of Stadacona Mines (1944) Limited at the end of 1958 and Belleterre Quebec Mines Limited in February 1959. The only lode gold mines still operating were the Elder Mines and Developments Limited (name changed from Elder Mines Limited in June 1959) and its subsidiary Eldrich Mines Limited, near Evain. Neither mine has a mill, but both ship fluxing ore to the Noranda smelter, where gold is recovered as a by-product. Mill recovery grade in the district dropped to 0.140 ounce gold per ton from 0.148 in 1958.

Chibougamau District

Anacon Lead Mines Limited (Chibougamau Operation), 40 miles west of Chibougamau, Quebec, can be considered a lode gold mine although some copper is recovered as a by-product. During 1959, the mill was closed between May 1 and October 14 while the mine shaft was sunk a further 608 feet to 2,145 feet.

Base-metal Mines

By-product gold from base-metal ores was slightly less than in 1958; but, owing to the decrease in gold from auriferous-quartz mines, the percentage of gold from base-metal sources rose to nearly 38 per cent of the gold from all sources in the province. Nearly 97 per cent of the gold recovered from base-metal ores was treated through the Noranda smelter and the Montreal East refinery of Canadian Copper Refiners Limited, a Noranda subsidiary.

Ontario

Thirty lode gold mines continued to operate in the province. Gold production from all sources decreased by 1.2 per cent, and from lode gold mines by 1 per cent. The recovery grade of the ore milled was 0.283 ounce gold per ton; in 1958 it was 0.286 ounce. Tons milled decreased to 9,225,000 from the 9,316,000 milled in 1958. The Porcupine, Kirkland Lake and northwestern Ontario districts showed a drop in gold output, while the Larder Lake and Sudbury districts increased their production.

Auriferous-quartz Mines

Porcupine District

Thirteen lode gold mines continued to operate in the district, which is Canada's leading gold-producing area. The quantity milled decreased by only 2 per cent to approximately 4,522,000 tons, but the average recovery grade of the ore milled dropped to 0.240 ounce gold per ton from the 0.246-ounce grade of 1958. The result was a 4 1/2-per-cent drop in gold output.

Hollinger Consolidated Gold Mines, Limited, the leading producer, had a 12-per-cent drop from the 297,746 troy ounces recovered in 1958. McIntyre Porcupine Mines Limited, the second largest producer, maintained production close to the 1958 level of 228,948 ounces. A possible new copper orebody was discovered in December 1959. Dome Mines Limited, the third largest producer, had a small drop from the 174,701 ounces recovered in 1958.

Aunor Gold Mines Limited had a 12-per-cent increase in tonnage milled, with the result that gold production increased. Broulan Reef Mines Limited had a drop in gold production while its subsidiary, Hugh-Pam Porcupine Mines Limited, by mining a higher-grade of ore, increased its output. A program of lower-level development is being carried out at both mines in an attempt to increase ore reserves. Coniaurum Mines Limited mined a higher grade of ore and increased its gold output by 6 per cent. Delnite Mines, Limited, on the other hand, mined a lower grade of ore and had a 3-per-cent decline in production. Development work at depth, however, resulted in an increase in ore reserves. Hallnor Mines,Limited had a 12-per-cent decline in gold production. Pamour Porcupine Mines, Limited, had a decrease in milled tonnage, but a higher grade of ore worked resulted in a small increase in gold production. Paymaster Consolidated Mines, Limited, was developing two new levels, and increased its milled tonnage but had a decrease in gold output. Preston East Dome Mines, Limited had a drop in tonnage milled and an 8 1/2-per-cent decrease in gold recovery. The Ross mine of Hollinger Consolidated Gold Mines, Limited, at Holtyre, produced less gold but was preparing to sink the main shaft 1,050 feet deeper in 1960.

Larder Lake District

This continued to be the second largest gold-producing district in Ontario, all its production coming from Canada's largest gold mine, Kerr-Addison Gold Mines Limited. An increase from 0.327 to 0.340 ounce gold per ton in the grade of ore recovered resulted in the production of 565,945 ounces, another all-time record. Ore reserves, however, dropped by 1,992,000 tons.

Patricia Portion

This district includes the five gold mines operating in the Red Lake mining division and the Pickle Crow mine in the Patricia mining division. The quantity milled increased slightly to 1,005,000 tons, and the amount of gold produced was close to the 1958 total. The recovery grade of the ore milled decreased from 0.488 to 0.476 ounce gold per ton.

Campbell Red Lake Mines Limited, the chief producer, increased the grade of ore milled and had a 8 1/2-per-cent increase over its 1958 high of 149,379 ounces of gold. The second largest producer, Madsen Red Lake Gold Mines Limited, milled a lower grade of ore and had a 4-per-cent decline from the 123,489 ounces recovered in 1958. New Dickenson Mines Limited was developing four new levels and increased its milled tonnage but had a 3-per-cent decrease in gold recovery. Cochenour Willans Gold Mines, Limited, established a new high with an 8-per-cent increase in tons milled and a 7-per-cent increase in gold output. McKenzie Red Lake Gold Mines Limited, virtually on a salvage basis since 1958, had considerable success in finding new ore on its lowest levels and increased gold production by 10 per cent. Pickle Crow Gold Mines Limited, at Pickle Lake, intensified underground development work, thus causing a decrease in mine ore grade and a 23-per-cent drop in gold output.

Kirkland Lake District

Seven lode gold mines continued to operate in the district. The quantity milled decreased by 4 1/2 per cent to 1,110,000 tons, but the recovery grade of the ore increased to 0.316 from 0.309 ounce gold per ton. The result was that the decline in gold production amounted only to 3 per cent.

Macassa Mines Limited, with more than 69,300 ounces, was the leading producer. Wright-Hargreaves Mines, Limited, had a 3 1/2-per-cent increase in production and was only slightly behind Macassa in gold output. Its lowest working level is at 8,100 feet, the deepest mine workings in North America. The adjoining Lake Shore Mines Limited, at one time the leading producer in the district, had a 5-per-cent decline in gold production. Its lowest working level is 8,075 feet below the surface. Upper Canada Mines Limited, at Dobie, increased its milled output to more than 200,000 tons during 1959 and had a 10-per-cent increase in gold recovery. Sylvanite Gold Mines, Limited, had a large decrease in tons milled and gold produced. Kirkland Minerals Corporation Limited also had a large drop in gold production. The Teck-Hughes Gold Mines, Limited, has been on a salvage basis for many years. Its gold production was down 6 per cent.

Port Arthur Mining Division (Thunder Bay)

MacLeod-Cockshutt Gold Mines, Limited, at Geraldton, increased its milled output by 5 per cent to more than 693,000 tons in 1959, and its gold production increased by 2 per cent. The recovery grade of the ore milled was only 0.096 ounce per ton, one of the lower-grade gold ores in Canada. During the year, the company gained control of the adjoining Consolidated Mosher Mines Limited and began to develop the property for future stoping operations. Leitch Gold Mines Limited, at Beardmore, had a 12 1/2-per-cent drop from its 1958 all-time high of 41,665 ounces.

Sudbury Mining Division

Renabie Mines Limited, near Missanabie, had an 11-per-cent increase in tons milled and a 30-per-cent increase in gold production.

Base-metal Mines

Production of gold as a by-product from base-metal mines in Ontario declined 11.3 per cent to 49,937 ounces. This represented less than 2 per cent of the gold production from all sources in the province. The International Nickel Company of Canada, Limited, Geco Mines Limited and Falconbridge Nickel Mines Limited were the chief sources of by-product gold.

Manitoba-Saskatchewan

The closing of the Nor-Acme mine at Snow Lake in July 1958 left only two lode gold mines operating in Manitoba during 1959. Gold production from all sources decreased by more than 41.4 per cent. San Antonio Gold Mines Limited and its subsidiary, Forty-Four Mines Limited, at Rice Lake, 185 miles by road northeast of Winnipeg, had a 13-per-cent drop in their combined gold production. By-product gold from base-metal mining increased 11.5 per cent. This gold came from the copper-zinc ores of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, on the Manitoba side of the border, and from the nickel-copper ores of Sherritt Gordon Mines Limited, at Lynn Lake.

All gold recovered in Saskatchewan came as a by-product from the Saskatchewan portion of the copper-zinc mines of Hudson Bay Mining and Smelting Co., Limited. There was a 9.2-per-cent decrease in recovery.

Alberta

A small amount of placer gold is recovered every year from the gravels of the North Saskatchewan River, near Edmonton.

British Columbia

Gold production from all sources continued to decline. It dropped 12.5 per cent - from the 210,612-ounce output of 1958 to 184,312 ounces.

Four lode gold mines continued to operate, but production declined by 15.6 per cent. Bralorne Mines Limited and Pioneer Gold Mines of B.C. Limited, in the Bridge River district, amalgamated under the name of Bralorne Pioneer Mines Limited which continued operations at both mines. Bralorne ships concentrates from its flotation mill to the smelter at Tacoma, Washington, for refining. A strike at the United States smelter in 1958 delayed several months' shipments of concentrates until 1959. The Cariboo Gold Quartz Mining Company Limited, at Wells, had some success in developing new ore in the Burnett-fault zone of the Island Mountain section of the property but had a large decrease in gold production. Cariboo's subsidiary, French Mines Limited, continued production in the Hedley area but also had a drop in gold output.

The reopening of several copper mines in the province during 1959 resulted in a 14.8-per-cent increase in the gold recovered from base-metal mines.

A large placer gold operation started by L.B. Roth Placers in Williams Creek, in the old Barkerville area, resulted in a 48-per-cent increase in the gold recovered from the province's placer operations.

Northwest Territories

All gold recovered came from lode gold mines, and production increased by 18 per cent. The principal producer was Giant Yellowknife Gold Mines Limited, at Yellowknife, which had a 44-per-cent increase over its 1958 output of 155,603 ounces.

Gold production from the Con and Rycon mines of The Consolidated Mining and Smelting Company of Canada Limited, also at Yellowknife, decreased by 15 per cent. Consolidated Discovery Yellowknife Mines Limited, which is some 65 air miles north of Yellowknife and operates Canada's highest-grade gold mine (recovery grade - 1.62 ounces gold per ton in 1959), maintained gold output close to the 1958 level.

Yukon Territory

Gold recovered from placer operations declined slightly, but the recovery of by-product gold from the operations of United Keno Hill Mines Limited, near Mayo, resulted in a small increase in the total gold production. The Yukon Consolidated Gold Corporation Limited, in the Dawson area, continued as the principal producer, with seven electric dredges and one hydraulic operation working. The other large producers were Ballarat Mines Limited, near Dawson; Yukon Explorations Limited, in the Sixty Mile River area; Bardusan Placers Limited, in the Mayo area; and Action Mining Company and Burwash Mining Co. Ltd., in the Kluane Lake area.

Developments at Other Properties

Quebec

Akasaba Gold Mines Limited, 11 miles north of the Bevcon mine, was constructing a new head-frame and a new 300-ton ore bin. Beauce Placer Mining Co. Ltd., which has been drilling exploratory churn-drill holes in river beds in the Eastern Townships for the past two summers, has purchased two dredges and plans to start dredging operations for placer gold in the Gilbert River basin in the spring of 1960.

Ontario

There was considerable activity in the Red Lake gold district during the year. H.G. Young Mines Limited, which adjoins Campbell Red Lake Mines Limited, completed a shaft to 1,052 feet and was driving long crosscuts toward favorable ore zones under Balmer Lake. Exploratory programs were also under way at the mines of Abino Gold Mines Limited, Cochenour Willans Gold Mines, Limited, New Dickenson Mines Limited and Campbell Red Lake Mines Limited.

British Columbia

Camp McKinney Gold Mines Limited reopened the former Cariboo-Amelia mine at Rock Creek and was planning to ship hand-sorted gold ore to the Trail smelter. Bedwell River Gold Mines Limited reopened the old Musketeer mine on Vancouver Island and recovered a small amount of gold.

Manitoba

Explorers Alliance Limited dewatered an old gold mine in the Herb Lake area, built a small 75-ton-a-day mill and milled some ore stockpiled by previous owners.

Northwest Territories

There was considerable gold exploration in the Territories during 1959, and it is expected to continue during 1960. Taurcanis Mines Limited, in the MacKay Lake-Courageous Lake area 150 miles northeast of Yellowknife, has been developing a gold mine for three years and has sunk a shaft 675 feet and developed five levels. The building of a 200-ton-a-day mill is being considered. Some work has also been done in the same area by Mack Lake Mining Corporation Ltd. and North Goldcrest Mines Ltd. A minor gold rush to the Walmsley Lake region, some 175 miles northeast of Yellowknife, was reported in 1959. Prospectors of Consolidated Northland Mines Limited staked gold showings at Fox Lake and Box Lake, and diamond-drilling indicated good gold values. Ruth Gold Mines Ltd. leased the old Ruth mine, 57 miles east of Yellowknife on Tam Lake, from The Consolidated Mining and Smelting Company of Canada Limited, did some underground work and milled a stockpile of ore left by the previous operation as well as some new development ore. Beneventum Mining Co. Ltd. sank a 125-foot inclined shaft on the A. L. group of claims in the Beaulieu River area, 50 miles east of Yellowknife. Vanguard Explorations Limited was carrying out exploration work on a group of claims 34 miles northeast of Yellowknife.

World Gold Production

The table on the next page shows world gold production estimates for the years 1958 and 1959. These figures were compiled by the Division of Minerals, Bureau of Mines, United States Department of the Interior. Dr. M.A. Kriz, of the First National City Bank of New York, estimates world gold production in 1959 to be 32.6 million fine ounces, exclusive of the production of the Union of Soviet Socialist Republics, or about 2.2 million ounces more than in 1958. The Union of South Africa contributed some 20.1 million ounces, the highest ever recorded by that country. Statistics on gold production in the U.S.S.R. are not published. Various non-Russian estimates put production during the last few years at from 10 to 17 million ounces a year. United States production declined by 0.2 million to 1.6 million ounces in 1959. The British Commonwealth produced approximately 85 per cent of the Free World's gold output in 1959, the Union of South Africa producing approximately 61.8 per cent and Canada 13.6 per cent.

Uses

Today, gold is used principally as a monetary reserve of governments and central banks to give stability to paper currencies and to settle international trade balances.

The International Monetary Fund, in its 1959 Annual Report, estimated that in 1958 about $570 million in gold was absorbed by the arts and industry or by private hoards. On the basis of a gold price of $35 a troy ounce, this would represent some 16.3 million fine ounces of gold or about 40 per cent of the world output of 40.4 million ounces of gold for that year. Some 15 per cent of the world output is used for industrial consumption, and about half of this for jewelry.

World Gold Production*
(fine ounces)

Country	1959	1958
North America		
Canada	4,483,416	4,571,347
United States	1,635,000	1,759,000
Mexico	313,662	332,246
Nicaragua	217,849	214,882
Other countries	7,073	6,525
Total	6,657,000	6,884,000
South America		
Colombia	397,929	371,715
Brazil	180,000	186,000
Peru	139,820	159,127
Chile	110,000	110,952
Other countries	134,251	159,206
Total	962,000	987,000
Europe		
U.S.S.R.	10,000,000	10,000,000
Sweden	88,000	100,953
Yugoslavia	59,640	55,364
Other countries	252,360	243,683
Total	10,400,000	10,400,000
Asia		
Philippines	402,615	422,833
Japan	258,010	260,630
Korea (including North Korea)	195,690	202,071
India	165,383	170,090
Other countries	408,302	404,376
Total	1,430,000	1,460,000
Africa		
Union of South Africa	20,064,105	17,665,739
Ghana	913,200	852,834
Southern Rhodesia	566,883	554,838
Belgian Congo	351,086	356,134
Other countries	194,726	160,455
Total	22,090,000	19,590,000
Oceania		
Australia	1,089,574	1,100,404
Fiji	72,565	86,794
Other countries	84,481	68,793
Total	1,246,620	1,255,991
World total (estimated)	42,800,000	40,600,000

*U.S. Department of the Interior, Bureau of Mines.

In the manufacture of jewelry and ornamentation of various kinds gold is used in many forms, such as plating, goldware, foil, leaf, lace, gilding, inserts, inlays and lettering. When used for such items as watchcases and rings, gold is usually alloyed with copper, silver, nickel or palladium to improve its hardness and wearing qualities. Different percentages of these alloying metals impart varying shades of green and even white to the natural yellow of the gold.

Because gold is resistant to corrosion and oxidation and is extremely ductile and highly conductive, it has found many applications in industry. Small but stable amounts of the metal are used in the chemical industry, dentistry and glass-making. It is also used in the ceramics industry and goes into the manufacture of delicate instruments and laboratory ware. Because in very thin sheets it is an excellent reflector of infrared radiation, it has found increasing use in modern aircraft and missiles and even in earth satellites.

The Ottawa laboratories of the Mines Branch, Department of Mines and Technical Surveys, have been carrying out a research program since 1958 with the objective of finding new industrial uses for gold.

Prices

Traditionally, the United States of America has controlled the greatest share of the world's supply of gold. The official United States price for gold was established as $35 (U.S.) per troy ounce under authority of the Gold Reserve Act of 1934 and has since remained at that price. The Royal Canadian Mint, in Ottawa, buys gold from Canadian producers and pays for the gold at the fixed United States price but in Canadian funds. In 1959, the average Mint price for gold in Canadian dollars was $33.57 a troy ounce; in 1958 it was $33.98. The average monthly price in 1959 ranged from a high of $34.12 in February to a low of $33.17 in October and was approximately $33.31 during the last week of the year.

The price of gold in the London Gold Market moved within a comparatively narrow range owing to the stabilizing effect of central-bank operations. The highest price quoted, recorded on May 14, 1959, and expressed in United States dollars, was $35.13 1/2-$35.15 1/2; the lowest, recorded on several occasions in March, November and December, was $35.04-$35.06.

INDIUM

D.B. Fraser*

Indium occurs in trace amounts in certain zinc, lead, tin, tungsten and iron ores, the largest concentrations being found with sphalerite, the common zinc mineral. Some zinc and zinc-lead ores contain as much as 1 per cent indium, but normally indium is present in much smaller amounts. The metal is produced commercially from the treatment of residues and slags derived from zinc- and lead-smelting operations.

Information on world output is vague, since the few companies that recover indium do not publish production data. Indium 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 of indium, The Consolidated Mining and Smelting Company of Canada Limited (Cominco), which has zinc and lead smelters and refineries at Trail, British Columbia, 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 production on a commercial scale began in 1952. At present, the potential annual production at Trail is 1 million troy ounces, or about 35 tons.

Indium enters the Trail metallurgical plants with the zinc concentrates. In the electrolytic zinc process, indium remains in the zinc calcine during roasting and in the insoluble residue during leaching. The residue is then delivered to the lead smelter for the recovery of contained lead and residual zinc values. 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 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.

---

*Mineral Resources Division

The slag recovered when the dross is re-treated 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 (approximating 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 shapes such as wire, ribbon, foil and sheet, powder, and disk and spherical pellets.

Properties and Uses

Indium is silvery white, very like tin or platinum in appearance; chemically and physically, it resembles tin more than any other metal. Its chief characteristics are its extreme softness and low coefficient of sliding friction. It is easily scratched by 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 and is extremely resistant to atmospheric and alkaline corrosion. As in the case of 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, which is still important, was in high-speed bearing alloys, where the addition of indium to silver-lead alloys 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 indium 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 solder alloys that require resistance to alkaline corrosion, and in gold dental alloys.

A newer use, one that is probably the greatest now, is in various semiconductor devices, in which high-purity indium modifies the properties of germanium. In this application, disks or spheres of indium are alloyed into each side of a wafer of germanium. In addition to having electronic properties, indium is especially suitable because it alloys readily with germanium at low temperatures and, being a soft metal, does not cause strains on contracting after alloying.

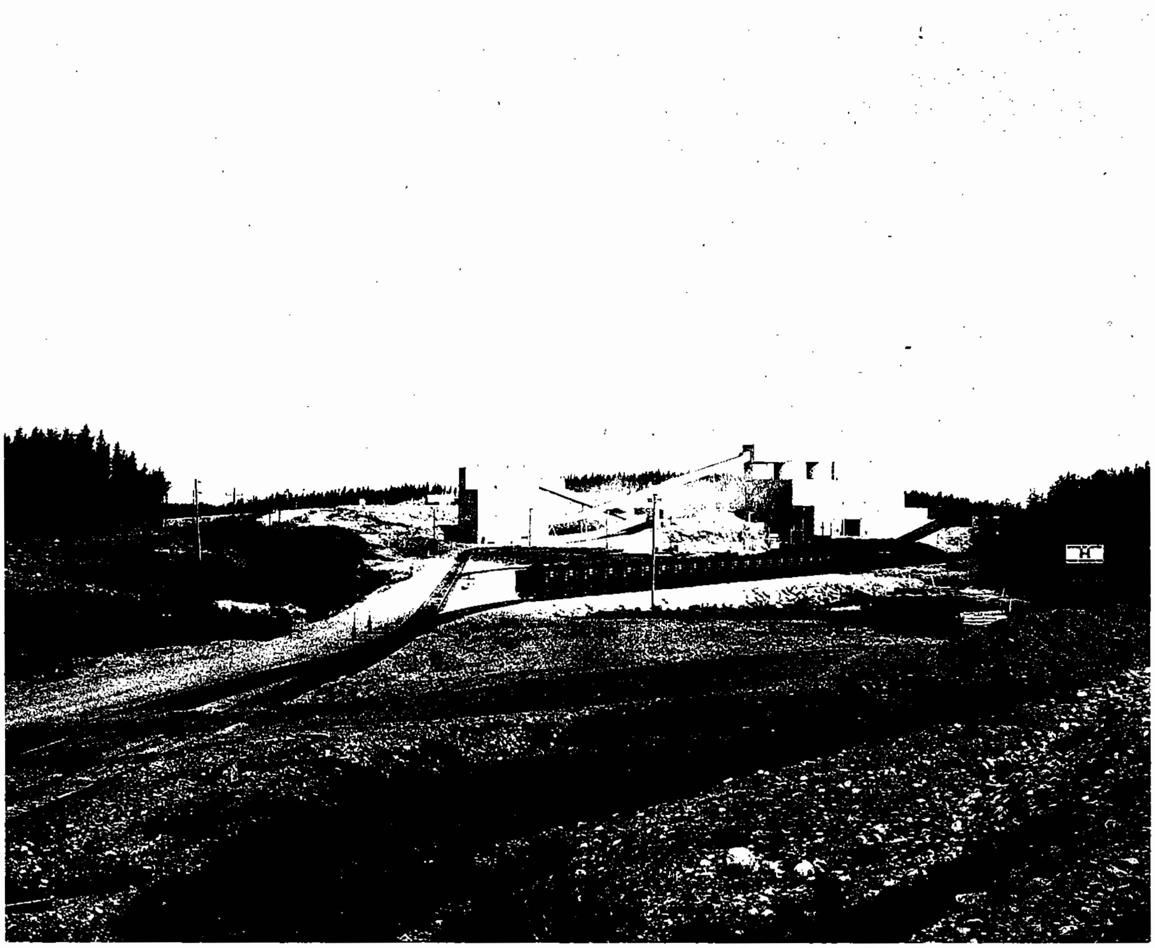
Discovered in 1863 and applied commercially only for the past quarter century, indium and its compounds are relatively new and their potential uses are still being explored. Uses have been found in intermetallic semiconductors, electrical contacts, resistors, thermistors and photoconductors. Indium can be used as an indicator in atomic reactors because its artificial radioactivity is easily induced by neutrons of low energy. Indium compounds added to lubricants have been found to be beneficially anticorrosive. Indium anodes have been used in the cells of light-weight storage batteries.

Trade and Consumption

No statistics are available on the export, import or domestic consumption of indium. Much of Canada's output is exported to the United States and the United Kingdom, and smaller amounts go to a number of countries in Europe.

Prices

The price of indium, 99.9 per cent, quoted in E & M J Metal and Mineral Markets throughout 1959 was $2.25 a troy ounce in small lots and $1.25 to $2.25 a troy ounce in lots of more than 5,000 ounces.



Moose Mountain mine, Lowphos Ore Limited, Sudbury area, Ontario.

IRON ORE

R.B. Elver

Canadian producers' shipments of iron ore reached an all-time high of 21,864,576 tons* in 1959. This was 9.6 per cent above the 1956 record of 19,953,820 tons and 55.7 per cent above the total for the recessional year 1958. Shipments from all producing provinces increased.

Owing to the steel strike in the United States, which lasted from July 15 to November 7 and closed that country's iron-ore mines, the traditional imports into Ontario from the Lake Superior area of the United States were lower than normal. To make up this deficiency in the iron-ore supply, Canadian producers greatly increased the proportion of their shipments to Canadian plants - to such an extent that Ontario blast furnaces operated at a record rate.

The United States, despite the strike, was again the main market for Canadian iron ore. Prior to the strike, shipments were high because United States blast furnaces were operating close to their rated capacity. During the strike, although most of the country's iron-ore and steel-producing facilities were idle, about 15 per cent of its steel-making capacity continued to operate, thus providing a market for some Canadian ore. Of more importance to Canadian producers was the expansion of stockpile facilities at United States ports for fear of an ore shortage expected for the winter of 1959-60. This expansion permitted Canadian and other foreign producers to ship large tonnages even during the strike.

Exports to Japan and western Europe increased slowly in the first part of the year, but an increase in industrial activity, particularily in western Europe, resulted in a strong demand toward the latter part of 1959. The demand for Canadian iron ore in relation to that for iron ore from other exporting countries was good. Several other countries, however, are in a strong competitive position for acquiring new iron-ore markets. Venezuelan exports to the United States, for example, remained large during the recession of 1958 while Canadian exports decreased sharply. The same situation exists in several of the western European market areas. Among the advantages Venezuelan producers have over their Canadian counterparts are higher-grade direct-shipping ores that are more easily mined the year round and all-year shipping.

---

*The long or gross ton (2,240 pounds) is used throughout unless otherwise stated.

*Mineral Resources Division

Iron Ore - Production, Trade and Consumption

	1959		1958	
	Long Tons	$	Long Tons	$
Production (shipments)				
Quebec	10,281,401	92,497,012	5,411,005	46,859,490
Newfoundland	5,451,624	42,974,837	4,813,192	38,226,828
Ontario	5,373,294	50,830,404	3,254,421	36,851,421
British Columbia	758,257	6,363,848	562,742	4,193,442
Total	21,864,576	192,666,101	14,041,360	126,131,181
Imports				
United States	2,402,523	26,008,830	2,984,663	28,021,942
Brazil	97,879	1,113,251	62,437	909,249
Liberia	485	6,575	-	-
Sweden	7	235	-	-
United Kingdom	-	-	201	862
Total	2,500,894	27,128,891	3,047,301	28,932,053
Exports				
United States	13,394,512	117,809,833	8,595,843	77,749,050
United Kingdom	2,822,240	22,427,925	2,000,526	16,212,753
Netherlands	823,393	6,480,108	464,540	3,765,352
West Germany	736,389	5,159,102	810,543	6,144,130
Japan	653,537	5,053,579	493,332	3,587,471
Belgium	81,748	634,185	26,530	215,502
Italy	40,669	249,370	-	-
Total	18,552,488	157,814,102	12,391,314	107,674,258
Consumption (indicated)*	5,812,982		4,697,347	

*Shipments plus imports less exports, but no account is taken of changes in stocks at consuming plants.

During 1959, three new mines were brought into production - two in British Columbia and one in Ontario. Direct-shipping ores accounted for 68.6 per cent of Canada's iron-ore shipments; concentrates and agglomerates for 18.6 and 12.8 per cent respectively. About 83 per cent of the ore shipped was of the hematite-goethite variety, and magnetite and sintered siderite accounted for 8.5 per cent each. About 80 per cent of the ore shipped came from open-pit mines.

In addition, three companies produced iron by-products that are not included in the normal iron-ore production statistics. One produced iron-oxide pellets as a coproduct, with nickel carbonates and sulphuric acid, from the treatment of nickeliferous pyrrhotite concentrate. Another produced iron-oxide sinter and calcine as coproducts, with sulphuric acid, from the treatment of pyrrhotite-pyrite concentrate. A third firm smelted ilmenite ore to produce titania slag for the manufacture of pigments and 'remelt iron', a type of pig iron.

The St. Lawrence Seaway, a deep-water canal system between Montreal and Lake Ontario, was opened on April 25, 1959. In previous years iron ore from the port of Seven Islands, Quebec, was shipped to the United States by one of three routes: to the east coast, then inland by rail; to Contrecoeur, Quebec, for transshipment to small canal boats that could pass through the old St. Lawrence canals to Lake Erie ports; or to Contrecoeur, then inland by rail. During 1959, shipments of iron ore through the newly opened Seaway totalled 5.3 million tons; in 1958 and 1957, shipments through the old St. Lawrence canal system amounted respectively to 1.3 million and 2.2 million tons. In 1959, shipments by water from Seven Islands to the United States east coast totalled 4.8 million tons; in 1958 and 1957 they amounted respectively to 4.4 million and 7.0 million tons. It is expected that by 1970 from 20 million to 25 million tons of iron ore will be shipped through the Seaway annually.

Within the last decade, particularly since 1954, the Canadian iron-ore industry has grown tremendously. Most of the recent growth has been based on large reserves of direct-shipping ore found in Labrador-Quebec and, to a lesser extent, in Ontario. Much more important are the technological advances in iron-ore beneficiation, which make possible the exploitation of many low-grade iron formations that are relatively common in Labrador, Quebec and Ontario. These advances, combined with the inability of direct-shipping deposits to meet the demand for iron ore, which is increasing, particularly in the United States, assure the growth of the industry and the accompanying expenditure of large sums of capital. In the last decade about $400 million has been spent on machinery and construction, and projects now being planned will probably require $700 million in the next five years.

World Production

In 1958 and 1959, the United States was displaced by the Union of Soviet Socialist Republics as the world's leading iron-ore producer. The reasons for this are the recession of 1958 and the 116-day strike of 1959. If the estimates for China are accurate, Canada ranks fouth as a world producer. Canadian properties under development for production in the next five years will increase annual production to more than 40 million tons. The nine countries listed in the accompanying table account for about 82 per cent of the world's iron-ore production.

Iron Ore Production, by Countries

(thousands of long tons)

	1959	1958	1957
U.S.S.R.	92,908	87,397	82,909
France	59,935	58,516	56,855
United States	58,734	67,947	106,148
Canada	21,865	14,041	19,886
China	20,551	19,685	18,210
Sweden	17,997	18,304	19,664
West Germany	16,271	17,701	18,481
Venezuela	16,179	15,239	15,135
United Kingdom	14,870	14,612	16,902
Subtotal	319,310	313,442	354,190
Other countries	73,016	67,720	71,461
World total	392,326	381,162	425,651

Source: American Iron and Steel Institute, 1959.

Canadian Production and Trade

Canada's modern iron-ore industry began in 1939 when Algoma Ore Properties, Limited,brought its Helen mine, in the Michipicoten area of Ontario, back into production after the mine had been closed for about 20 years. No iron ore was produced in Canada during the period from 1925 to 1938, although production of 5,878,178 long tons was recorded during the period from 1886 to 1924. Since production resumed in 1939, growth in iron-ore output has been rapid, especially since the mid-1940's. Annual production

Iron Ore - Production, Trade and Consumption, 1949-59
(long tons)

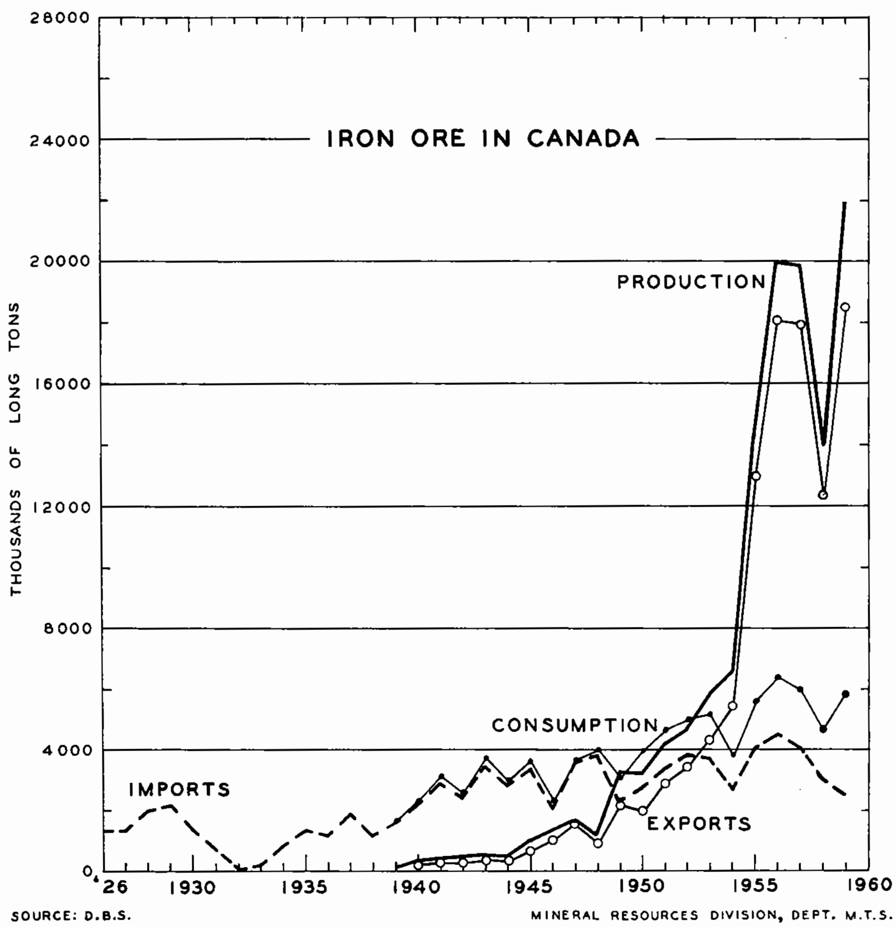
	Production (shipments)	Imports	Exports	Consumption (indicated)*
1949	3,281,336	2,247,531	2,277,053	3,251,814
1950	3,218,983	2,741,568	1,988,817	3,971,734
1951	4,179,027	3,420,909	2,880,149	4,719,787
1952	4,707,008	3,810,409	3,434,820	5,082,597
1953	5,812,337	3,721,046	4,303,549	5,229,834
1954	6,572,855	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

*Shipments plus imports less exports,but no account is taken of changes in stocks at consuming plants.

is expected to approach 50 million tons by the mid-1960's, and perhaps to reach 96 million tons by 1980.

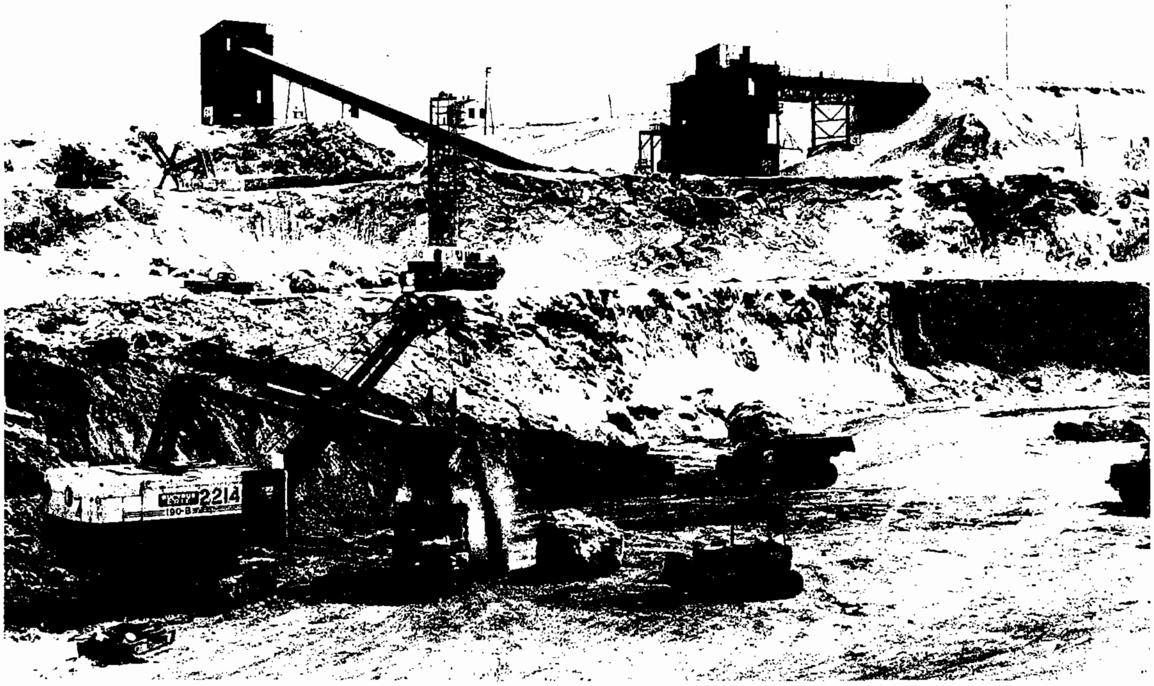
Most of Canada's iron-ore production is exported, by far the major portion going to the United States. Canada's proximity to the major steel-producing areas of the United States, its incentive taxation policies, its political stability, its immense reserves of iron ore, and Canadian-American company affiliations make it apparent that Canada will contribute an increasing proportion of the iron ore needed by the ever-expanding American iron-and-steel industry. The export of iron ore to the United Kingdom and western European countries by Dominion Wabana Ore Division of Dominion Steel and Coal Corporation,Limited, Iron Ore Company of Canada and associated companies has grown considerably in recent years. This upward trend is expected to continue and to grow even more rapidly as Europe's iron-ore reserves diminish and its steel output increases.

Iron ore imports for blast-furnace feed in Ontario come entirely from the United States. This is due principally to part-ownership by The Steel Company of Canada, Limited, of several iron-ore mining companies in the United States. The steel-makers' need of blending ores from different sources for blast-furnace feed also contributes to the need for imports. Ore from Brazil and Liberia is used mainly as open-hearth, lump-ore feed.



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 annually in the manufacture of paint, as heavy-weight 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 iron and steel scrap, goes into furnaces in the process of manufacturing crude steel. Some iron ore is put directly into open-hearth steel-making furnaces. The following is a summary of statistics on the consumption of iron ore in Canadian iron and steel plants.



Open-pit mine at Steep Rock Lake, Ontario.

Iron-ore mining at the Gagnon Mine, Schefferville, New Quebec.

Consumption of Iron Ore
in Canadian Iron and Steel Plants

(long tons)

	1958	1959
In blast furnaces, direct	3,819,718	4,891,873
In steel furnaces, direct	312,264	365,570
In sintering plants before ore is placed in blast or steel furnaces	905,901	1,281,203
Miscellaneous	165	70
	5,038,048	6,538,716

Source: American Iron Ore Association, Cleveland, Ohio

Consumption of Iron Ore and
Production of Pig Iron and Crude Steel
in Canada, 1957-58(1)

	1958 (long tons)	1959 (long tons)
Total receipts at iron and steel plants(2)	4,960,304	6,278,674
Receipts imported(2)	3,168,118	2,512,733
Receipts from domestic sources(2)	1,792,186	3,765,941
Stocks at iron and steel plants Dec. 31 of previous year(2)	3,082,646	2,992,084
Stocks at iron and steel plants Dec. 31 of year at top of column(2)	2,992,084	2,738,815
Net change in stocks	-90,562	-253,269
Consumption of iron ore (2) (3)	5,038,048	6,538,716
	(net tons)	(net tons)
Pig-iron production(4)	3,059,579	4,182,775
Capacity at Dec. 31	4,248,875	4,448,000
Steel-ingot production(4)	4,262,122	5,799,356
Capacity at Dec. 31	6,314,200	6,617,000

(1) Figures in this table do not correspond with those listed in the table entitled "Iron Ore - Production, Trade and Consumption" (page 120).
(2) American Iron Ore Association, Cleveland, Ohio.
(3) Consumption figures are compiled from company submissions and cannot be calculated from statistics shown in this table.
(4) Dominion Bureau of Statistics, Ottawa.

Canadian Developments

This section outlines some of the more important developments concerning present and future iron-ore producers.

Newfoundland (Labrador)

Iron Ore Company of Canada, in association with Wabush Iron Co. Limited, is constructing a 42-mile railway westward to the Wabush Lake area from Mile 224 on the Quebec, North Shore and Labrador Railway, which runs 360 miles north from Seven Islands to Schefferville, Quebec. The deposit under development is one of several on the west side of Wabush Lake that are conservatively reported to contain 1.5 billion* tons grading from 37 to 38 per cent natural iron. A concentration plant with an initial capacity of 7 million tons is to be built and put into production by 1962. The cost of the project is expected to approach $150 million. Some of the relatively coarse, 65-per-cent iron concentrate maybe used to upgrade part of the direct-shipping Schefferville ore at the Seven Islands terminal; the rest of it will be shipped as produced. A wash-ore plant, which would treat some of the offgrade ore, is being considered for Seven Islands.

On the east side of Wabush Lake, Wabush Iron Co. Limited is developing a deposit estimated to contain more than 1 billion tons of material grading about 37 per cent iron. Initial production, 4 million to 5 million tons of 65-per-cent iron concentrate, is expected for 1965. Ultimate plans provide for an annual capacity of 10 million tons. Capital expenditures are expected to approach $200 million.

In addition, the companies already mentioned and others hold several promising deposits between Wabush Lake and Mount Wright, 25 miles to the southwest in Quebec. Among the companies on the Labrador side of the border are Labrador Mining and Exploration Company Limited and The Javelin Corporation.

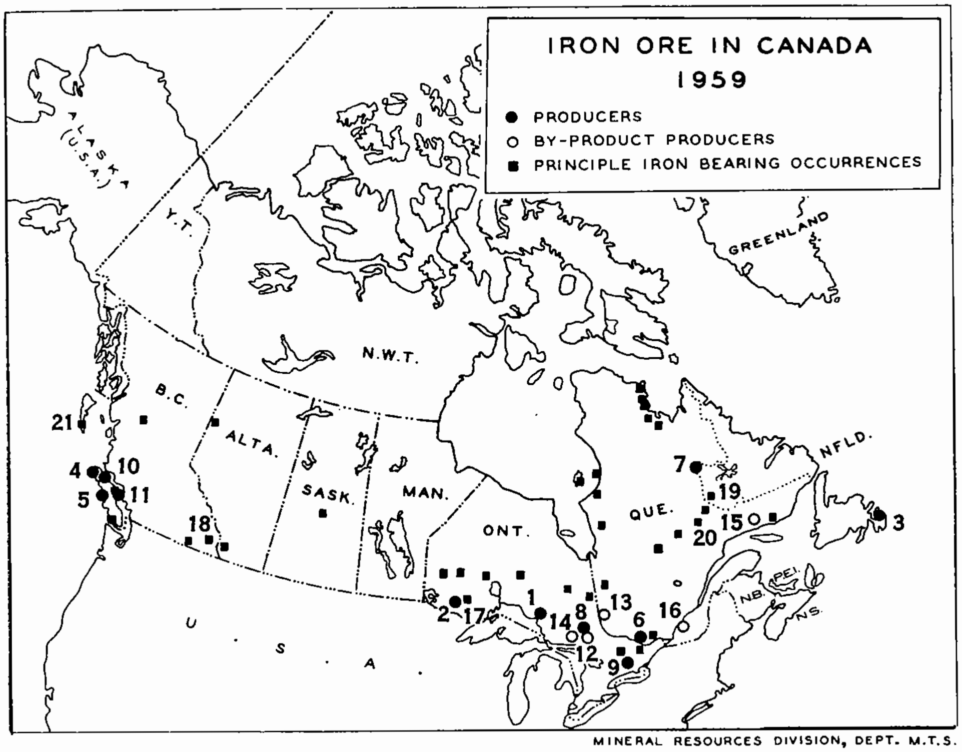
Quebec

During the year, The Hilton Mines' beneficiation plant operated near its rated capacity of 600,000 tons. By April 1960, this capacity will be increased to 800,000 tons per annum owing to an expansion program begun in August 1959. The program involves a balancing of crushing, grinding, concentrating and pelletizing facilities.

Quebec Iron and Titanium Corporation, after a six-month closure from October 1958 to March 1959 due to poor titania-slag market conditions, produced at a high rate for most of 1959. Product research carried out by the company enabled it to introduce several new grades of pig iron of varying carbon and silicon content in the expectation of supplying the Quebec iron-foundry market and expanding its sales in the United States.

(text continued on page 134)

*1 billion = 1,000,000,000.



Producers in 1959

1. Algoma Ore Properties, Limited
2. Canadian Charleson Limited
   Steep Rock Iron Mines Limited
3. Dominion Wabana Ore Division
4. Empire Development Company Limited
5. Hualpai Enterprises Limited
6. Hilton Mines, The
7. Iron Ore Company of Canada
8. Lowphos Ore Limited
9. Marmoraton Mining Company Limited
10. Nimpkish Iron Mines Limited
11. Texada Mines Limited

By-product Producers

12. International Nickel Company of Canada, Limited, The (mine and plant)
13. Noranda Mines Limited (mine)
14. Noranda Mines Limited (plant)
15. Quebec Iron and Titanium Corporation (mine)
16. Quebec Iron and Titanium Corporation (plant)

Prospective Producers (by 1965)

17. Caland Ore Company Limited (1960)
18. Consolidated Mining and Smelting Company of Canada Limited, The (1960)
19. Iron Ore Company of Canada (1962)
    Wabush Iron Company Limited (1964-65)
20. Quebec Cartier Mining Company (1961)
21. Silver Standard Mines Limited (1961)

Canadian Producers of Iron Ore during 1959

Company and Property Location	Participating Companies	Product Mined	Product Shipped	Shipments* (thousands of long tons) 1958	1959
Algoma Ore Properties,Ltd.; mines and sinter plant near Jamestown, Ont.	Algoma Steel Corp., Ltd.	Siderite from open-pit and underground mines (34% Fe)	Some ore beneficiated by sink-float and nearly all sintered (49.7% Fe, 2.86% Mn)	1,583	1,935
Canadian Charleson Ltd.; S. of Steep Rock Lake, near Atikokan, Ont.	Charleson Iron Mining Co.	Hematite-bearing gravels (15% Fe)	Jig and spiral concentrates(55.3% Fe)	40	179
Empire Development Co. Ltd.; Elk River, 8 miles E. of Port Alice, Vancouver Island, B.C.	Mannix Ltd.,Quatsino Copper-Gold Mines Ltd.	Magnetite from open-pit mine (32.3% Fe)	Magnetite concentrate (57.3% Fe)	245	360
Hualpai Enterprises Ltd., The, Head Bay, Nootka Sound, west coast of Vancouver Island,B.C.	Canadian Collieries Resources Ltd.	Magnetite from open-pit mine (40.7% Fe)	Magnetite concentrate (55.9% Fe)	-	25
Hilton Mines, The; 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 (18-20% Fe)	Iron-oxide pellets (65.7% Fe)	272	584

(table continued)

Company and Property Location	Participating Companies	Product Mined	Product Shipped	Shipments* (thousands of long tons) 1958	1959
Iron Ore Co. of Canada; Lab.-Que., near Schefferville, Que.	M.A. Hanna Co., 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 (52.5-55.0% Fe)	Direct-shipping ore (52.5-55.0% Fe)	7,967	13,059
Lowphos Ore Ltd., Sudbury area, 20 miles N. of Capreol, Ont.	National Steel Corp., M.A. Hanna, Co.	Magnetite from open-pit mine (30% Fe)	Magnetite concentrate (58.6% Fe)	-	173
Marmoraton Mining Co. Ltd.; near Marmora, in SE. Ont.	Bethlehem Steel Corp.	Magnetite from open-pit mine (37% Fe)	Iron-oxide pellets (64.6% Fe)	471	351
Nimpkish Iron Mines Ltd.; 26 miles W. of Beaver Cove, Vancouver Island, B.C.	International Iron Mines Ltd., Standard Slag Co.	Magnetite from open-pit mine (45% Fe)	Magnetite concentrate (59.1% Fe)	-	7
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 (52.5% Fe)	Mainly direct-shipping ore, but some gravity concentrate (52.5-55.0% Fe)	1,156	2,747
Texada Mines Ltd.; Texada Island, B.C.	Private company	Magnetite from open-pit mine (40% Fe)	Magnetite concentrate (62.1% Fe)	319	377

Wabana mines, Bell Island, Conception Bay, east coast, Nfld.	Dominion Steel and Coal Corp., Ltd.	Hematite-chamosite from underground mines (about 50% Fe)	Heavy-media concentrate (50.8% Fe, 0.9% P)	1,995	2,095
By-product Producers					
International Nickel Co. of Canada, Ltd., The; mines and plant in Sudbury area, Ont.	-	Pyrrhotite flotation concentrates treated	Iron-oxide pellets (68% Fe)	122	162
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 sinter (67-68% Fe)	40	142
Quebec Iron and Titanium Corp.; mine in Allard Lake area, Que.; electric smelter at Sorel, Que.	Kennecott Copper Corp., New Jersey Zinc Co.	Ilmenite-hematite from open-pit mine (40% Fe, 35% TiO_2)	TiO_2 slag and various grades of desulphurized iron or 'remelt iron'	105 (iron)	146 (iron)

*Statistics supplied by the companies to the Mineral Resources Division. For some firms the tonnages shown are only preliminary estimates, and provincial totals will not necessarily correspond.

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
Caland Ore Co. Ltd. (1960)	Steep Rock Lake N. of Atikokan, Ont.	Inland Steel Co.	Hematite-goethite from open-pit and underground mines (52.5% Fe)	Direct-shipping ore (52.5% Fe)	750,000 tons in 1960, to rise to 3,000,000 tons by 1969
Consolidated Mining and Smelting Co. of Canada Ltd., The (1960)	Kimberley, B.C.	-	Pyrrhotite flotation concentrates to be roasted, ground, pelletized and sintered prior to being charged into electric pig-iron furnace	Pig iron and possibly steel at later date	Sinter capacity - 100,000 tons; initial pig-iron capacity - 36,500 net tons
Iron Ore Co. of Canada (1962)	Wabush Lake, Lab., 190 miles N. of Seven Islands, Que.	(as in preceding table)	Specular-hematite-bearing iron formation from open-pit mines(37-38% Fe)	Concentrate (65% Fe)	7,000,000 tons
Quebec Cartier Mining Co. (1961)	Lac Jeannine, Mt. Reed and Mt. Wright areas of Que. Lac Jeannine deposit to be first mined	United States Steel Corp.	Specular-hematite-bearing iron formation from open-pit mines (30% Fe)	Concentrate (65% Fe)	8,000,000 tons

Silver Standard Mines Ltd. (1961 tentative)	Moresby Island, Queen Charlotte Islands, B.C.	Public stock company	Magnetite from open-pit mine (53–57% Fe)	Magnetite concentrate (plus 60% Fe)	250,000 tons
Wabush Iron Co. Ltd. (1964–65)	Wabush Lake, Lab., 190 miles N. of Seven Islands, Que.	Steel Co. of Canada Ltd., The, Pickands Mather & Co., Interlake Iron Corp., Youngstown Sheet and Tube Co., Inland Steel Co., Pittsburgh Steel Co.	Specular-hematite-bearing iron formation from open-pit mine (37% Fe)	Concentrate (65% Fe)	4,000,000 - 5,000,000 tons

Quebec Cartier Mining Company is developing one of its deposits in the Mount Reed area, at Lac Jeannine, for production early in 1961. About 20 million tons of crude ore grading 30 per cent iron from one open-pit mine will be required to produce 8 million tons of concentrate annually. The company is testing other known deposits of equal (300 million tons) or greater magnitude between Mount Reed and Mount Wright. The Lac Jeannine operation requires the excavation of a deep-water terminal at the new town of Port Cartier, the construction of another town near the mine, a 193-mile railway, a 60,000-horsepower power development and a beneficiation plant. The cost prior to production is expected to exceed $200 million.

Besides Quebec Cartier Mining Company, a dozen other companies have prospects in the Mount Wright area. Normanville Mining Company (Jones & Laughlin Steel Corporation) is one of the more active.

In the Albanel Lake area, about 100 miles northeast of Chibougamau, Albanel Minerals Limited is exploring large magnetite deposits with sufficient open-pit reserves to produce at least 200 million tons of 64-per-cent iron pellets. The company, owned by M.J. O'Brien, Limited, of Ottawa, and The Cleveland-Cliffs Iron Company, of Cleveland, is working on plans for a beneficiation plant to produce 3 million tons of pellets a year. Although no announcement of production has been made, it is understood that the company's preliminary plans are well advanced.

Oglebay Norton Company, of Cleveland, dropped its option on the Montgolfier township property of Atlin-Ruffner Mines (B.C.) Limited and signed an option on the Lyonne township property of Roberval Mining Corporation.

Great Whale Iron Mines Limited carried out additional exploration and ore-testing on its large iron prospect 35 miles inland from Hudson Bay.

In the Ungava Bay area, several companies held extensive deposits of concentrating-grade iron formation. Exploration and metallurgical testing is well advanced, and market and financial studies are continuing. Ungava Iron Ores Company Limited and Oceanic Iron Ore of Canada Limited are among the more active of the companies in the area. In 1959, the Quebec government granted extensions of the exploration leases.

Quebec South Shore Steel Corporation announced plans for the construction of a Strategic-Udy plant to produce steel at Varennes, Quebec. If financing is obtained and company plans are implemented, crude magnetite ore from the former property of Hull Iron Mines Limited would be used. This property, about 4 miles north of Hull, Quebec, is reported to contain 4.25 million tons of material grading 52 per cent iron. A total of about $22 million is required to bring the mine and the 150,000-ton-a-year iron-and-steel plant into production.

<u>Ontario</u>

Algoma Ore Properties, Limited, continued the development of three new levels in the Helen underground mine. The underground and surface aerial-ropeway haulage system, designed to serve the new section of the mine, was being installed during 1959. The development of these new levels for production, which is expected to be completed by 1961, will make available about 50 million tons of siderite ore.

In the Steep Rock Lake area, 140 miles west of Port Arthur, Steep Rock Iron Mines Limited operated both of its gravity-concentration plants and, in addition, shipped considerable tonnages of unbeneficiated ore. The new Hogarth shaft was completed and underground development commenced during the year. Dredging of the 'G' open-pit continued.

Caland Ore Company Limited neared the final stages of dredging the east arm of Steep Rock Lake. A considerable amount of ore was exposed, and development of both open-pit and underground mines was in progress during the year.

Two miles south of Steep Rock Lake, Canadian Charleson, Limited operated its 180,000-ton-a-year concentration plant at capacity. This was the second year of operation.

Lowphos Ore, Limited made its first shipment of concentrate in June after deferring initial production for one year owing to adverse iron-ore-market conditions prevailing in 1958.

Marmoraton Mining Company Ltd., was the only Canadian iron-ore producer directly affected by the United States steel strike: it had a similar contract-expiry date and its employees were associated with the same United States union. In consequence, operations had to be suspended for 118 days - from July 15 to November 9.

Anaconda Iron Ore (Ontario) Limited continued to explore its iron prospect 35 miles north of Nakina, and a 100-ton-a-day mill was installed at the property. Although no production plans have been announced, indications are that the company's plans are well advanced. About 400 million tons of concentrating-grade iron formation grading from 28 to 30 per cent iron have been outlined.

Iron Bay Mines Limited optioned its Bruce Lake property in north-western Ontario for one year to one of the major United States iron-ore merchant firms.

Jones & Laughlin Steel Corporation continued to explore and test its Boston-township deposit, near Kirkland Lake. Detailed technical and economic studies are under way.

Manitoba

New Manitoba Mining and Smelting Company Limited announced plans to mine and process its low-grade, nickel-copper deposit in the Bird River area, 100 miles northeast of Winnipeg. According to company plans, plant facilities near Winnipeg would produce sulphuric acid, nickel compounds, iron-oxide calcine and 60 tons of pig iron a day.

Saskatchewan

Interprovincial Steel Corporation Limited and Kelsey Lake Development Company Limited continued to explore the low-grade iron formations on their properties 40 miles east of Prince Albert. The deposits are beneath 2,000 feet of younger sedimentary rocks.

British Columbia

During 1959 Empire Development Company, Limited and Texada Mines Ltd. continued to produce iron ore. Two new producers made initial shipments during the year as outlined in the accompanying tables.

Silver Standard Mines Limited has signed an agreement for the sale of 1 million tons of plus-60-per-cent iron concentrates. The agreement is conditional on the report of Japanese engineers who were to visit the property on Moresby Island early in 1960.

The Consolidated Mining and Smelting Company of Canada Limited announced plans to erect a sinter machine to treat iron-oxide residues from its sulphuric-acid plant. The sinter will be smelted in a new 36,500-ton-a-year electric pig-iron furnace. Later expansion plans provide for an oxygen steel plant and rolling mills with a capacity of 100,000 tons a year.

Prices and Tariffs

Traditionally, prices received by most Canadian iron-ore producers are based on the Lake Erie price - the price paid per gross ton of iron ore delivered at the rail of vessel at Lower Lake ports. The Lake Erie price is based on an iron content of 51.5 per cent and is further classified as to source and phosphorous content. The structure of the ore and the nature of the impurities present also affect the price. Prices in the accompanying table have been in effect since the 1957 season. Although no price changes are expected for the 1960 season, the classification has been expanded by at least one company to include prices for screened ore from the Lake Superior district.

Neither Canada nor the United States maintains tariffs on iron ore, and there are no import duties on iron ore entering any of the countries to which Canada ships. In January 1959, the United States Tariff Commission held public hearings on the effects of iron-ore imports into the United States, but no proposals were made to change the existing tariff regulations. The chief reason for this decision was that United States steel firms have large investments in foreign deposits and expect that they will become even more dependent on these ore sources in the future.

Lake Superior Ores	U.S. $ per Long Ton
Mesabi non-Bessemer	11.45
Mesabi Bessemer	11.60
Old Range non-Bessemer	11.70
Old Range Bessemer	11.85
Open-hearth lump	12.70
High-phosphorous	11.45
Screened	
Lump (+1/2 inch)	12.85
Fines (-1/2 inch)	10.72

LEAD

J.W. Patterson*

Canada's production of lead in 1959 was 186,696 tons, or 16 tons more than in 1958. Only small changes in output occurred in the lead-producing provinces and Yukon Territory, the largest change being the Newfoundland decrease of 1,523 tons in mine output. As in previous years, the output from the mines of British Columbia was about 80 per cent of the Canadian total.

Refined-lead production in Canada increased to 135,296 tons in 1959 from 132,987 tons produced in 1958. It came from the smelter and electrolytic refinery of The Consolidated Mining and Smelting Company of Canada Limited (Cominco) at Trail, British Columbia.

Most of the lead concentrates produced in British Columbia and Yukon Territory were treated at Cominco's custom refinery at Trail. The remainder were exported to lead smelters in the United States for treatment. Lead concentrates produced in the eastern provinces were exported to smelters in Europe and the United States. The exports of primary lead decreased slightly from 146,432 tons in 1958 to 145,978 in 1959. Of these exports, the United States received 51 per cent, the United Kingdom 31 per cent, West Germany 9 per cent and Belgium 7 per cent. The remaining 2 per cent went in small shipments to 19 other countries.

Lead output, exports and consumption are shown graphically on page 5. The main production has come from relatively few sources, the most important being Cominco's Sullivan mine at Kimberley, British Columbia. Other important sources of current supply are the Buchans deposit in Newfoundland, Cominco's Bluebell mine at Riondel, British Columbia, and the Yukon mines of United Keno Hill Mines Limited.

Large deposits of lead-bearing ore have been outlined at Pine Point on the south shore of Great Slave Lake, and smaller deposits have been explored in the Pelly River and Hyland River areas of Yukon Territory, but no production has come from these deposits. In New Brunswick, in 1957 and 1958, Heath Steele Mines Limited produced small amounts of lead from its large zinc-copper-lead orebody near Bathurst. There are other large orebodies in the Bathurst area that contain appreciable quantities of lead, but there has been no production from them.

(text continued on page 141)

*Mineral Resources Division

Lead - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
All forms(1)				
British Columbia.....	148,922	31,601,233	147,416	33,493,047
Newfoundland	22,457	4,765,328	23,980	5,448,339
Yukon Territory	10,796	2,290,960	10,783	2,449,920
Quebec	2,910	617,412	3,150	715,620
Ontario	1,611	341,902	1,257	285,502
New Brunswick	-	-	94	21,377
Total	186,696	39,616,835	186,680	42,413,805
Refined(2)	135,296		132,987	
Exports				
In ore and concentrates				
United States	30,674	6,346,922	23,460	5,473,829
West Germany	12,685	1,773,363	13,781	2,332,101
Belgium	10,367	1,694,631	16,223	2,763,332
Other countries	-	-	617	108,011
Total	53,726	9,814,916	54,081	10,677,273
Refined				
United Kingdom	44,659	6,259,621	49,841	7,401,313
United States	44,507	8,473,117	40,503	7,666,272
Denmark	1,232	169,781	-	-
Uruguay.............	450	61,493	408	59,757
Korea	383	54,496	-	-
Other countries	1,021	164,769	1,599	249,175
Total	92,252	15,183,277	92,351	15,376,517
Scrap				
United States	2,904	325,491	367	37,728
West Germany	73	142,045	-	-
Jamaica	31	1,845	-	-
Other countries	17	2,030	64	7,269
Total	3,025	471,411	431	44,997
Lead pipe and tubing and lead manufactures				
United States		47,189		22,457
United Kingdom		4,730		787
Peru.................		2,559		-
Jamaica.............		2,200		-
Other countries		4,760		3,461
Total		61,438		26,705

Lead - Production, Trade and Consumption (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Imports				
Lead and lead products				
Compounds of tetraethyl lead......		not available		2,307,328
Lead in pigs and blocks		327,640		301,129
Lead in bars and sheets		30,581		12,608
Litharge		325,742		331,475
Lead manufactures ...		264,518		243,540
Miscellaneous lead products		210,322		257,273
Total				3,453,353
Consumption				
Primary refined lead				
Batteries and battery oxides	14,156			
Cable covering.......	3,980			
Antimonial lead	544			
Chemical uses (white lead, red lead, litharge, tetraethyl lead, etc.)	12,975			
Copper alloys........	309			
Lead alloys				
Solder	1,737			
Other..............	178			
Semifinished products (pipe, sheet, traps bends, blocks for caulking, ammunition, foil, collapsible tube, etc.)	10,695			
Other	1,591			
Total	46,165			
Consumption summary				
Primary lead	46,165		50,396	
Secondary lead	19,770		19,373	
Total	65,935		69,769	

(1) Primary lead in base bullion produced from domestic ores, plus recoverable lead in domestic ores and concentrates exported.

(2) Primary refined lead from all sources.

Lead - Production, Trade and Consumption, 1949-59
(short tons)

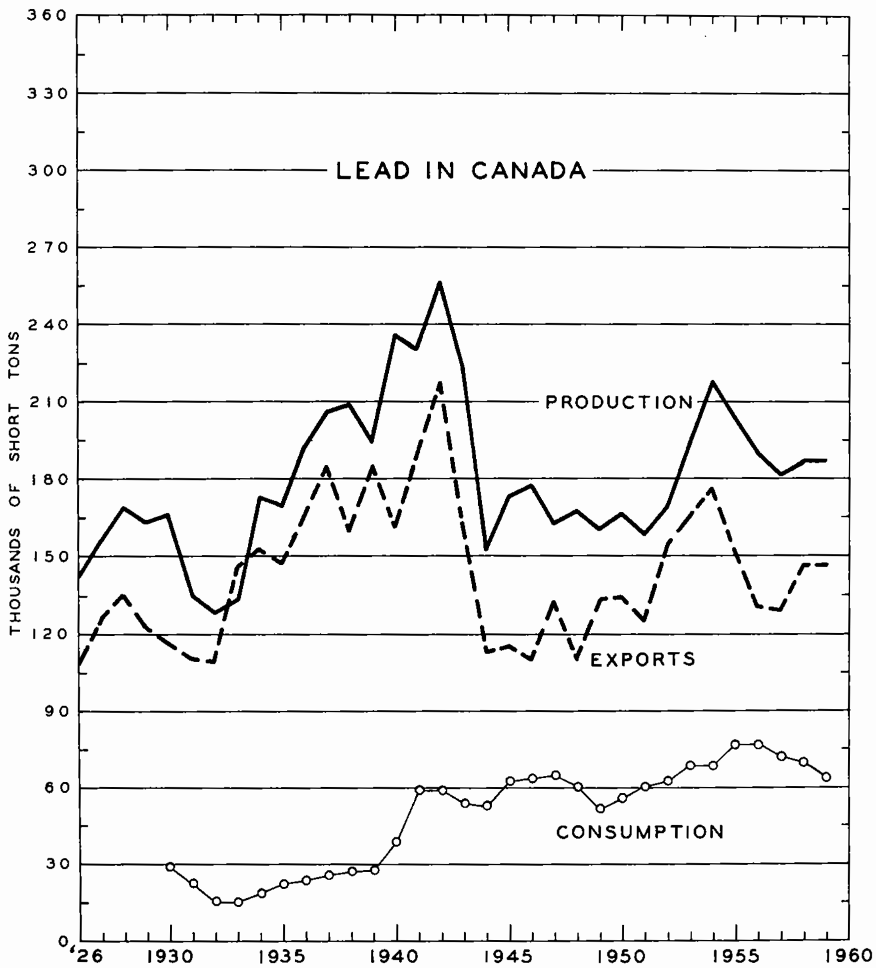
	Production		Exports			Imports	Consumption
	All Forms(1)	Refined(2)	In Ore and Concentrates	Refined	Total	Refined(3)	Refined(4)
1949	159,775	146,149	19,891	113,534	133,425	2,154	51,281
1950	165,697	170,023	19,276	115,168	134,444	1,237	54,723
1951	158,231	162,000	19,648	105,736	125,384	727	60,348
1952	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

(1) Primary lead in base bullion produced from domestic ores, plus 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.

Consumption of primary refined lead in 1959 decreased by 4,231 tons from the 1958 total, continuing the decline of the past several years, which is largely attributable to a decrease in the use of lead in cable covering. The consumption of secondary lead, 19,770 tons in 1959, was substantially unchanged from its 1958 total. It was accounted for largely by the production of antimonial lead and other alloys such as type metal, solder and babbitt.

Lead consumption in the United States, Canada's greatest market, increased from 986,387 tons in 1958 to 1,091,149 tons in 1959, principally because of increased use of lead in battery manufacture, pigments, solder and caulking lead.

United States import quotas on unmanufactured lead and zinc continued in effect throughout 1959. These quotas limited commercial imports to 80 per cent of their annual average for the five-year period from 1953 to 1957. Canada's quarterly allotment for lead concentrates was 6,720 short tons; for lead metal it was 7,960 short tons.



SOURCE: D.B.S.

MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Owing to the importers' practice of receiving commercial concentrate shipments in bond, imports of lead concentrates exceeded the annual quota allotment of 26,880 tons. By the end of the third quarter, the excess had increased to 3,709 tons. Available for immediate inclusion in the allotments at the beginning of each quarter, it caused them to be filled with increasing rapidity, as is shown in the following table.

Quarterly Quotas

Quarter	Year	Date Filled	
		Lead Concentrates	Lead Metal
First	1959	March 6	March 30
Second	1959	May 26	June 29
Third	1959	August 14	September 28
Fourth	1959	November 6	December 28
First	1960	January 4	March 29

The allotments of refined metal, unlike those of lead in concentrates, were filled steadily throughout each quarter, as the table indicates.

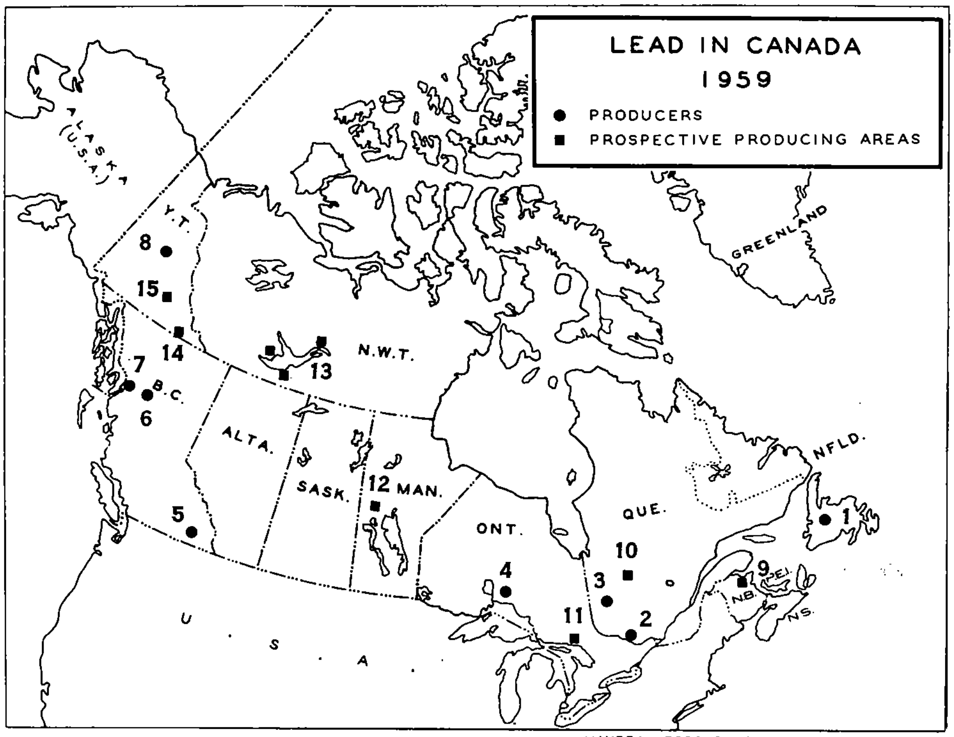
To consider problems of the world lead and zinc industries, the major lead- and zinc-producing and -consuming countries held three conferences during the period from September 1958 to May 1959. The third conference took place in New York in late April and early May. A lead-zinc study group consisting of representatives from 25 countries was formed and was to have its first plenary session early in 1960. At the conference many producers who had not previously curtailed production or commercial dealings indicated that they proposed to do so for the remainder of 1959. The comparison of a statistical assessment of production and estimated consumption prior to the date of the meeting with estimated production and consumption for the remaining months of 1959 indicated that the estimated world excess of lead in the second half of the year might be substantially reduced. By year-end, however, there were still large surpluses of lead. Hence, early removal of the voluntary curtailments of market supplies was not considered likely.

Developments at Producing Mines*

British Columbia

Mines in British Columbia operated by The Consolidated Mining and Smelting Company of Canada Limited produced 3,155,266 tons of lead-zinc ore in 1959; in 1958 they produced 3,157,956 tons. This company mined 2,440,396 tons from its Sullivan mine at Kimberley. From its other two lead- and zinc-producing mines, the Bluebell on the east shore of Kootenay Lake and the H.B. near Salmo, it mined 714,870 tons.

Lead concentrates produced at Cominco's three mines were treated at the Trail smelter together with purchased and custom concentrates obtained principally from mines in British Columbia and Yukon Territory. Output from all sources in 1959, including some metal sold in unrefined products, was 140,881 tons; in 1958 it was 134,827 tons. Of the combined lead and zinc production of 335,380 tons, approximately 64 per cent was derived from Sullivan concentrate, 14 per cent from the concentrates of the other two Cominco-owned lead and zinc mines, 11 per cent from purchased ores and concentrates and 11 per cent from the retreatment of stockpiles of zinc-plant residues and lead-blast-furnace slag.



Producers

1. American Smelting and Refining Company (Buchans Unit)
2. New Calumet Mines Limited
3. Manitou-Barvue Mines Limited
4. Willroy Mines Limited
5. 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
   Highland-Bell Limited
   Reeves MacDonald Mines Limited
   Sheep Creek Mines Limited
   Violamac Mines Limited
   Western Mines Limited
   Yale Lead and Zinc Mines Limited
6. New Cronin Babine Mines Limited
7. Silbak Premier Mines Limited
   Torbrit Silver Mines Limited
8. United Keno Hill Mines Limited

Prospective Producing Areas

9. Bathurst
10. Bachelor Lake
11. Sudbury Basin
12. Snow Lake
13. Great Slave Lake
14. Watson Lake
15. Pelly River

In spite of a 38-day labor strike in April and May at its Salmo operations, Canadian Exploration Limited produced more lead concentrate in 1959 than in 1958. From the company's Jersey mine, which is the only Canadian trackless mine producing lead and zinc, 325,564 tons of zinc-lead ore were mined, from which 10,750 tons of lead concentrate were recovered containing 8,142 tons of lead. Production in 1958 was 10,420 tons of lead concentrate containing 7,972 tons of lead.

Reeves MacDonald Mines Limited, at its zinc-lead mine 13 miles south of Salmo, treated 421,593 tons of ore from which 4,408 tons of lead were recovered in concentrates.

Sheep Creek Mines Limited, in the Lake Windermere district, milled 181,495 tons of zinc-lead ore in 1959; its 1958 mill output amounted to 192,426 tons. Zinc and lead concentrates were produced. The lead concentrates totalled 6,780 tons and graded 65 per cent lead. The grade of ore milled has increased owing to the higher-grade ore being mined from the lower levels. Information recently published by the company gives the ore-reserve grade as 2.49 per cent lead, 4.89 per cent zinc and 1.0 ounce silver. The grade estimated for 1957-58 was 1.88 per cent lead and 4.58 per cent zinc.

Yale Lead and Zinc Mines Limited continued to treat custom ores in its 250-ton mill at Ainsworth. The milling rate was about 25 tons a day. Most of the custom ore was mined by leasers from mines owned by this company and Western Mines Limited.

Violamac Mines Limited, near Sandon, recovered 534 tons of contained lead in concentrate produced from silver-lead-zinc ore from the Victor mine. This ore, together with some ore from leasing operations in the Sandon district, was treated at the 250-ton mill of Carnegie Mining Corporation Limited, a Violamac subsidiary.

Highland-Bell Limited, at Beaverdell, milled 18,029 tons of silver-lead-zinc ore and produced 2,147 tons of lead concentrates. Its principal metal output was 883,446 ounces of silver.

Torbrit Silver Mines Limited, in the Portland Canal area, milled 93,577 tons of silver-lead ore and recovered 446 tons of lead in lead concentrate and 850,627 ounces of silver in lead concentrate and bullion. Mining and milling at the Torbrit mine ceased in September owing to lack of ore. During the period between the commencement of production in 1949 to the date of closure, the mine produced 1,377,802 tons of ore from which 5,386 tons of lead, 18,706,847 ounces of silver and 305 tons of zinc were recovered.

Other producers were New Cronin Babine Mines Limited, near Smithers, and Silbak Premier Mines, Limited, near Stewart.

Ontario

From 371,186 tons of zinc-copper-lead ore milled, Willroy Mines Limited, at Manitouwadge, produced 3,272 tons of lead concentrate containing 1,630 tons of lead.

Quebec

New Calumet Mines Limited operates a zinc-lead-silver-gold mine on Calumet Island in the Ottawa River about 70 miles northwest of Ottawa. In its fiscal year ended on September 30, 1959, this company produced 1,990 tons of lead in concentrate.

Manitou-Barvue Mines Limited, Abitibi East county, treated 170,575 tons of zinc-lead ore and 297,650 tons of copper ore in a split-circuit mill, and produced 1,106 tons of lead in lead concentrate.

Newfoundland

American Smelting and Refining Company (Buchans Unit) milled 359,000 tons of ore and produced concentrates of zinc, lead and copper. The estimated recoverable lead content of all concentrates produced was 25,533 tons. Sinking of the MacLean shaft continued throughout 1959 and by year-end the shaft had reached a depth of 3,444 feet.

Yukon Territory

United Keno Hill Mines Limited, Mayo district, during the fiscal year ended on September 30, 1959, produced 11,128 tons of lead in lead and zinc concentrates. The concentrates were derived from 173,477 tons of silver-lead-zinc ore, most of which were mined from the Calumet and Hector mines. Development continued at the Elsa and Galkeno mines, most of the work being done in the Elsa mine. Ore production from development and limited mining at the Elsa mine accounted for about 16 per cent of the total ore supply.

Other Developments

Manitoba

Hudson Bay Mining and Smelting Co. Limited continued development of the Chisel Lake orebody, near Snow Lake. On the basis of surface diamond-drilling and underground exploration, this orebody, to the 850-foot level, contains 3,832,400 tons of ore averaging 11 per cent zinc, 0.91 per cent lead, 0.42 per cent copper, and 1.96 ounces of silver and 0.066 ounce of gold per ton. The orebody is being developed on five levels spaced 200 feet apart and starting at 250 feet below the shaft collar. During 1959, development work on these levels amounted to 9,900 feet of drifting and crosscutting.

Rails have been laid on the 52-mile branch line that connects Chisel Lake with Optic Lake on the Canadian National Railways' line from The Pas to Lynn Lake.

Northwest Territories

In June the federal government appointed a Royal Commission, headed by M.E. Manning, of Alberta, to make a recommendation on the selection of a route for a railway to Pine Point on Great Slave Lake, the site of important lead-zinc deposits held by Pine Point Mines Limited, a subsidiary of Cominco.

Uses and Consumption

The main industrial applications and the tonnages used in each are shown on page 140.

Lead is used principally in storage-battery manufacture and cable covering and in tetraethyl-lead compounds for improving the quality of gasoline. It is also used as acid-tank lining and pipe and in the manufacture of bearing metal, solder, paint and ammunition.

Several new applications have been developed for lead in recent years. It is now being used as shielding against nuclear radiation in reactor installations, in containers for storing and shipping radioactive substances, in jet liners to reduce noise, in air-conditioning systems to control sound and vibration, in lead-alloy anodes in impressed-current cathodic systems for the protection of bridges, piers and ships' hulls against corrosion, and in power-plant condensers.

In 1959 domestic consumption accounted for about 34 per cent of Canada's production of primary refined lead, and in 1958 for about 38 per cent. In addition to new lead, considerable quantities of refined lead and of lead alloy, such as antimonial lead, are recovered from scrap materials and re-used as battery plates, bearing metal, solder and type metal.

Among the principal consumers of lead in Canada are: Electric Storage Battery Company (Canada) Limited; Prest-O-Lite Battery Co., Limited; Hart Battery Company (1957) Limited; The Canada Metal Co., Limited; Federated Metals Canada Limited; Ethyl Corporation of Canada Limited; Northern Electric Company, Limited; Canada Wire and Cable Company, Limited; Carter White Lead Co. of Canada Limited; and McArthur Irwin (1957) Limited.

World Production of Lead

The countries in the following table are the world's leading producers of refined lead as given by the American Bureau of Metal Statistics. Omitted are Argentina, Burma and the countries of the Soviet bloc, which in 1958 produced 534,000 tons.

Production of Refined Lead, by Countries

	Short Tons	
	1959	1958
United States(1)	380,684	522,956
Australia	265,376	271,654
West Germany(2)	211,993	191,143
Mexico	207,525	219,029
Canada	135,296	132,986
Belgium	97,489	105,684
Yugoslavia	94,131	92,903
France	96,658	77,871
Spain	75,543	77,728
Japan(2)	70,633	45,767
Peru	62,574	71,044
Italy	49,638	52,912
Morocco	31,368	36,513
Tunisia	23,860	27,608
Northern Rhodesia	16,128	14,196
Austria	10,965	12,025
India	4,362	3,734
Total	1,834,223	1,955,753

(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 and Tariffs

The price of lead remained at 11.75 cents a pound from November 10, 1958, to January 6, 1959, when it declined to 11.50 cents. In February the price declined to 10.50 cents, and in March to 10.25 cents. In August the price advanced to 10.50 cents and in September to 10.75 cents,where it remained for the rest of the year. The average price for 1959 was 10.62 cents.

Lead ores and concentrates entered Canada duty-free; pig lead was subject to a British preferential duty of 0.75 cent a pound and to a most favored nation and general duty of 1 cent a pound. Varying schedules were applied to imports of lead in semifabricated forms.

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.

MAGNESIUM

W.H. Jackson

Magnesium production in Canada for the year amounted to 6,102 tons,* or 6.0 per cent of world production. The main reason for the decline from the 1958 total of 6,796 tons was the need to curtail output to reduce inventories. An indication of this is given by the statistics in the following table which show that exports exceed production in value.

Export markets absorb most of the output. A percentage breakdown by marketing area is as follows: United Kingdom, 45.7; European Common Market, 44.5; other European, 2.8; United States, 2.2; China, 1.6; Central and South America, 1.5; Australia, 0.8; India, 0.6. Small quantities totalling 0.1 per cent of shipments were sent to Israel and South Africa. Tariffs, transportation costs and the convertibility of foreign exchange, in addition to a competitive price structure, determine the position of Canadian metal in a particular market. The admission of the small amount of magnesium now entering the United States is due to an agreement permitting defence sharing. Owing to the tariff structure, competitive sales of ingots are not feasible.

Imports into Canada consist primarily of sheet and extrusions, there being no domestic facilities for rolling magnesium nor equipment to produce extruded shapes over 6 inches in cross section. The main supplier of these items is the United States.

The year 1959, like the preceding one, was difficult for the primary industry. It was characterized by an over-all operating rate of only 45 per cent, which resulted in high unit costs. This factor, along with low metal prices in extremely competitive markets, contributed toward one company's suspension of operations. The basic problem confronting producers in both Canada and the United States is to develop new markets for large tonnages of metal and thus to reduce dependence on uses arising from defence needs.

Statistics prepared by the United States Bureau of Mines place world production at 104,600 tons in 1959, only 700 tons over the previous year's revised estimate. Two developments in the world industry are of interest.

---

*Short tons (2,000 pounds) are used in this review unless it is otherwise indicated.

*Mineral Resources Division

Magnesium - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (metal)				
Ontario	4,072	2,202,392	4,544	2,747,755
Quebec	2,030	977,123	2,252	1,317,070
Total	6,102	3,179,515	6,796	4,064,825
Imports (alloys)				
United States		258,401		244,994
West Germany		12,207		7,524
United Kingdom		2,413		3,250
Total		273,021		255,768
Exports (metal)				
United Kingdom		1,779,079		1,297,697
West Germany		1,451,157		565,126
France		183,096		478,131
United States		86,155		58,730
Belgium		67,397		38,986
China		63,701		65,909
Switzerland		55,447		36,117
Yugoslavia		39,440		29,494
Other countries		154,116		301,801
Total		3,879,588		2,871,991
Consumption (magnesium metal)				
For structural purposes				
Castings	86			
Wrought products				
Extrusions (structural shapes, tubing)	50			
Other wrought products	16			
Total	152			
For distributive and sacrificial purposes				
Aluminum alloys	1,105			
All other purposes	411			
Total	1,516			
Total consumption	1,668			

Magnesium - Production, Trade and Consumption, 1949-59

	Production(1)	Imports(2)	Exports(3)	Consumption
	(short tons)	($)	($)	(short tons)
1949		63,755		487
1950		61,033		537
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(4)

(1) Production statistics for 1949 to 1955 inclusive are not available for publication.

(2) Magnesium alloys.

(3) Statistics for 1949 to 1954 inclusive are not separately available.

(4) This figure is larger because the consumption survey from which it is derived was more comprehensive than the surveys of previous years.

The Norwegian producer, Norsk Hydro-Elektrisk Kvaelstofaktieselskab, is expanding production from 9,500 to 13,000 metric tons. In the United States the new 7,000-ton plant of Alabama Metallurgical Corporation came into production in November.

Production Plant and Processes

Magnesium Company of Canada Limited (Magcan)

Prior to the suspension of operations at the 5,000-ton-capacity electrolytic reduction plant in October, 2,100 tons of magnesium were produced. The mineral brucite $Mg(OH)_2$ contained in the ore at Wakefield, Quebec, was the source of magnesia which, when converted to anhydrous magnesium chloride at the Arvida plant, formed the feed for the electrolytic cells. Products of the quarry are now sold for other purposes.

Magcan, a subsidiary of Aluminium Limited, sells magnesium on world markets. Agreements have been signed whereby its needs are supplied by Dow Chemical Company and Dominion Magnesium Limited.

Dominion Magnesium Limited (Domal)

The company is now the only active producer of primary magnesium in Canada. Its thermal reduction plant of 8,000 tons' capacity is located near Haley Station, Ontario. The magnesia content of the dolomite, obtained from a quarry adjacent to the plant, averages 21 per cent, or very nearly the theoretical content of this mineral. Metal recovery by the ferrosilicon process involves crushing and calcining the ore and then briquetting the calcine with ferrosilicon and fluorspar. The briquettes are charged into horizontal retorts that project through the furnace wall. When the charge is heated to 1,170°C under vacuum, magnesium is reduced by the ferrosilicon and is distilled to form crystalline rings in the water-cooled head sections of the retorts. When cast into ingots the resultant metal is typically 99.97 per cent pure.

Domal produced 3,717 tons of magnesium in 1959 and, in addition, disposed of a stockpile of some 2,500 tons accumulated over the two previous years. Other metals produced are calcium, thorium, titanium, zirconium, strontium and barium. Products include a wide range of magnesium alloys in various shapes, as well as master alloys of thorium and zirconium.

Uses

Aluminum alloys containing 0.2 to 10.0 per cent magnesium are becoming increasingly important and in Canada provide the largest single use. As a reducing agent magnesium is consumed in the production of the metals zirconium, titanium, beryllium and uranium. Other uses include the cathodic protection of steel structures by magnesium anodes, pyrotechnics and the production of nodular cast iron.

The lightness, high strength-to-weight ratio and excellent machinability shown by magnesium-base alloys have resulted in their being used in aircraft and automobile components and other structural items requiring a metal with these properties. Although not well adapted to cold-working, sheet, on being heated, can be deep-drawn in one operation to a greater depth than any other light alloy. Alloys containing up to 10 per cent aluminum and small quantities of zinc and manganese are used for castings and extrusions. In recent years applications requiring high temperature and high strength have been developed for magnesium alloys containing zirconium and thorium. The metal also forms useful alloys with silver and the rare earths.

Prices

The Canadian price quoted by Dominion Magnesium Limited throughout 1959 was 30 cents a pound f.o.b. Haley Station, Ontario. The United States base price of magnesium metal in pig form was 35.25 cents a pound in 10,000-pound lots, f.o.b. Velasco, Texas.

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 manufacture	free	free	free
Alloys of magnesium, viz ingots, pigs, sheets, plates, strips, bars, rods and tubes	5%	10%	25%
Magnesium scrap	free	free	free

	On Canadian Magnesium
European Common Market	
Metallic magnesium	10%
United States	
Metallic magnesium and metallic magnesium scrap (scrap exempt until June 30, 1960)*	50%
Magnesium alloys, powder, ribbons, sheets, tubing, wire and all other articles of magnesium not specially provided for	20¢ per lb on the magnesium content plus 10% ad valorem
Other, magnesium content	17¢ per lb plus 8 1/2% ad valorem

---

*May be extended.

MANGANESE

V.B. Schneider*

The increase that raised Canadian steel production to an all-time high in 1959 brought an increase in the imports of manganese ore, ferromanganese and silicomanganese. Ore imports totalled 118,454 tons* valued at $5,017,112, or $3,294,147 more than in 1958. There was a rise also in domestic shipments of manganese alloys, including silicomanganese, spiegeleisen and standard-grade, medium-carbon and low-carbon ferromanganese. Exports, however, which consisted of 193 tons of ferromanganese, were the lowest in a decade.

Negotiations continued between the Commodity Credit Corporation, agent for the United States government, and the Indian State Trading Corporation, agent for the Indian government, to establish an exchange of Indian manganese ore for United States surplus farm products. The negotiations have been going on since 1957, but recent announcements indicate that trade in these commodities will begin in 1960. No ore is to be stockpiled. Instead, about 186,000 tons of ferromanganese will be delivered to the United States stockpile. It is expected that 112,000 tons will be made in India and the remainder in the United States, Belgium, West Germany, France and Japan. By means of the barter India will obtain much-needed food grain as well as temporary relief for its depressed manganese-ore-producing industry.

No manganese ore is produced in Canada, although in past years small amounts have been mined from bog deposits in New Brunswick, Nova Scotia and British Columbia.

Canadian Occurrences and Development

There are no known commercial manganese deposits in Canada, nor are any likely to be found as there is no evidence of the special environment necessary for the formation of the large replacement-type deposits.

Large low-grade deposits have been found and technological advances may, in time, make some of them of economic importance. The most notable of these large-tonnage low-grade deposits is near Woodstock, New Brunswick. It has been estimated that this deposit contains in excess of 50 million tons grading 11 per cent manganese and 14 per cent iron.

---

*Short tons (2,000 pounds) unless otherwise specified.

---

*Mineral Resources Division

Manganese - Trade and Consumption

	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Imports				
Manganese ore				
Ghana	66,246	2,273,401	2,362	130,664
Brazil	20,115	848,199	-	-
United States	13,887	1,243,679	11,044	767,675
India	12,314	381,337	6,702	119,545
Belgian Congo	5,777	243,044	2,379	143,952
United Kingdom	111	26,077	112	30,056
Japan	3	1,216	-	-
France	1	159	2	232
China	-	-	10,312	197,592
Cuba	-	-	4,782	137,910
Union of South Africa	-	-	3,020	127,110
Mexico	-	-	1,344	68,161
Greece	-	-	1	68
Total	118,454	5,017,112	42,060	1,722,965
Ferromanganese under 1% silicon				
Japan	919	223,675	196	45,166
United States	822	180,698	635	146,537
Chile	541	105,201	312	66,337
France	52	10,636	223	43,596
India	-	-	1,117	155,176
Total	2,334	520,210	2,483	456,812
Silicomanganese over 1% silicon				
United States	1,660	471,376	1,095	244,688
Japan	1,283	342,473	1,054	293,722
Norway	46	6,468	31	4,956
United Kingdom	-	-	5	1,869
Total	2,989	820,317	2,185	545,235
Exports				
Ferromanganese				
United States	169	60,692	198	44,014
Colombia	21	4,913	9	2,354
Dominican Republic	3	604	-	-
El Salvador	-	-	18	4,040
Total	193	66,209	225	50,408

Manganese - Trade and Consumption (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Consumption				
Ore				
Metallurgical-grade ...			43,745	
Battery-grade			2,398	
Total	90,311		46,143	

Manganese - Trade and Consumption, 1949-59
(short tons)

	Imports			Exports	Consumption
		Manganese Alloys			
	Manganese Ore	Under 1% Silicon	Over 1% Silicon	Ferromanganese	Ore
1949	137,854	1,486	22	35,288	152,692
1950	135,698	1,017	82	26,571	123,096
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

Strategic Materials Corporation, through its subsidiary, Stratmat Limited, owns the Woodstock deposit,and Strategic-Udy Metallurgical and Chemical Processes Limited, controlled by Stratmat, has been conducting research to find a method of processing the ore economically. As a result of the test work, ferromanganese and pig iron were produced on a pilot-plant scale.

World Mine Production and Trade

World mine production of manganese ore in 1959 amounted to some 14,042,000 tons, according to an estimate made by the United States Bureau of Mines. Of this, it is estimated that Russia produced 5,952,500 tons, India 1,207,029, China 1,100,000, the Union of South Africa 1,069,195, Brazil 1,055,436 and Ghana 589,853. Brazilian ore came mainly from the Amapá mine, situated in the Serra do Navio district of the state of Amapá and owned jointly by Industria e Comércio de Minérios, S. A., and Bethlehem Steel Corporation.

The United States, which is the largest consumer and importer of manganese ore, imported the major portion of its requirements from Brazil; India supplied about half as much ore as Brazil.

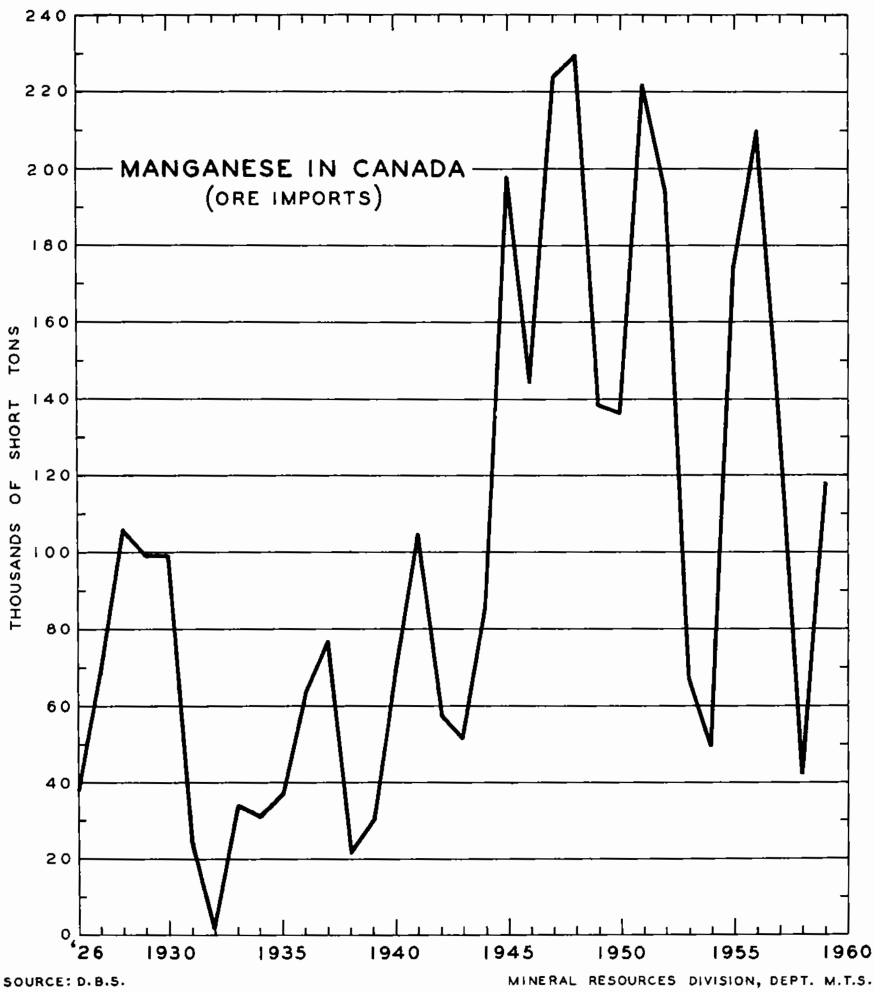
To offset the effects of lost manganese-ore markets and to implement its policy of reserving mineral resources and processing minerals before export, India has expanded its ferromanganese industry during the last two years. By the end of 1959, the reported annual ferromanganese capacity was 110,000 tons; two plants with an annual capacity of 60,000 tons were under construction and expected to be completed during 1960.

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.

Manganese is an important metal principally because its scavenging action in steel makes it the cheapest material known for desulphurization and dephosphorization. In small quantities of 1 or 2 per cent, it increases strength and toughness in steel. In amounts of 12 to 14 per cent, it greatly increases toughness and resistance to wear and abrasion.

Electrolytic manganese is made in an electrolytic cell, where the manganese is deposited on an electrode and stripped off as thin plates. Manganese metal (95 1/2% pure) is manufactured in electric furnaces by a submerged-arc process and is more costly. Under some conditions, however, consumers prefer the lumpier metal despite its higher cost and lower purity. Manganese metal and electrolytic manganese are used in place of low-carbon ferromanganese to reduce the carbon content of stainless steels and thus to eliminate the need of a carbon stabilizer. Electrolytic manganese is used by the nonferrous industries, particularly the aluminum industry and the brass industry. In the aluminum industry it is used for the production of high-purity aluminum 'hardener' alloys; in brass mills it is added either as metal or as a master alloy of 30-70 manganese-copper in the production of manganese bronzes.



Metallurgical-grade Manganese

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, all in the order given.

For the making of 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 manganese loss. In preparing their furnace charges, ferromanganese producers prefer to blend commercial ores to their own specifications. Since no single ore is generally considered ideal, consumers usually purchase 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

Manganese ore for dry-cell use must be manganese-dioxide (pyrolusite) ore 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; the material should be porous and moderately hard.

Chemical-grade Manganese

Chemical-grade manganese ore should contain at least 35 per cent manganese. It is used to make manganese-sulphate fertilizer and in the production of other salts for use in the glass, dye, paint, varnish and photographic industries.

Canadian Consumers

Electro Metallurgical Company, Division of Union Carbide Canada Limited, uses metallurgical-grade ore to manufacture silicomanganese and high- and low-carbon ferromanganese at its Welland, Ontario, plant. Chromium Mining and Smelting Corporation,Limited produces manganese alloys at its Beauharnois, Quebec, plant.

The large consumers of ferromanganese are: 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 metal imported from the United States is used at 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 General Dry Batteries 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 31, 1959, were as follows:

Manganese ore (Indian and South African)	Per long-ton unit, 46-48% Mn, c.i.f. U.S. ports, import duty extra	87.00¢ to 90.00¢ (nominal)
Manganese metal	Per lb, 95 1/2%, delivered, carload	
	Bulk	45.00¢
	Packed	45.75¢
	Per lb, 99.9% electrolytic, f.o.b. shipping point, freight allowed east of Mississippi, carload	34.00¢
	Per lb, 99%, electrolytic, f.o.b. shipping point, freight allowed east of Mississippi, ton lots	36.00¢
	Premium for hydrogen removed	00.75¢ lb
Ferromanganese	Per lb contained Mn, carload lots, lump	
	Standard (74-76% Mn), f.o.b. shipping point	12.25¢
	Medium-carbon (80-85% Mn, 1 1/4-1 1/2%C), f.o.b. U.S.	25.50¢
	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	12.80¢
	2% C max., 15-17 1/2% Si	12.60¢
	3% C max., 12-14 1/2% Si	12.40¢
Spiegeleisen	Per gross ton, carload lots, lumps, f.o.b. Palmerton, Pa.	
	3% max. Si, 16-19% Mn	$100.50
	3% max. Si, 19-21% Mn	$102.50
	3% max. Si, 21-23% Mn	$105.00

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Manganese ore	free	free	free
Ferromanganese (on Mn content)	free	1¢ per lb	1 1/4¢ per lb
Silicomanganese (on Mn content)	free	1 1/2¢ per lb	1 3/4¢ per lb

United States

Manganese ore	1/4¢ per lb on Mn content
Ferromanganese*	
Not over 1%C	0.8¢ per lb on Mn content and 6% ad valorem
Over 1% 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	0.8¢ per lb on the Mn content plus 6% ad valorem

*These classes must contain 30% or more Mn.

MOLYBDENUM

V.B. Schneider*

Molybdenite Corporation of Canada Limited,was the sole Canadian producer of molybdenite (MoS_2) and molybdic oxide (MoO_3) in 1959. Shipments of contained molybdenum amounted to 748,566 pounds valued at $940,596. The value of the molybdenum products exported in 1959 exceeded that of any previous year except 1957. That year the value of exports was unusually high because of a labor strike that closed a conversion plant in Langeloth, Pennsylvania. Molybdic oxide totalling 4,892,600 pounds was derived from concentrates imported from the United States for roasting in Canada and subsequent re-export to the United States.

In April 1959, Molybdenite Corporation reopened its roasting plant, which had shut down late in 1958 because of cost factors, and a large portion of the company's sales for that year were in the form of molybdic oxide.

The United States, the largest consumer of molybdenum, produces about 80 per cent and consumes about 55 per cent of the world output. The largest producer in the world is American Metal Climax Inc., at Climax, Colorado. The bulk of the molybdenum sold in competition with Climax products is a by-product of copper-mining in the United States and Chile.

Production

Canada

Molybdenite Corporation's property is at the junction of LaMotte, Lacorne, Vassan and Malartic townships, 23 miles north of Val d'Or, Quebec. Bismuth is produced as a by-product. The company announced that on October 1, 1959, its blocked-ore reserves were 240,889 tons and that its probable ore reserves, about the 750-foot level, were 600,000 tons grading 0.4+ per cent MoS_2. In addition, some 200,000 tons of ore were indicated between the 750- and 1,000-foot levels.

During the year the company completed shaft-deepening operations, and development work began on the 875- and 1,000-foot levels. When these new levels come into production, milling operations will be increased from the present 630 tons to 700 tons a day.

(text continued on page 164)

*Mineral Resources Division

Molybdenum - Production, Trade and Consumption

	1959*		1958	
	Pounds	$	Pounds	$
Production (shipments)(1)				
Mo content	748,566	940,596	888,264	1,152,838
Imports				
Molybdic oxide(2)				
United States	305,762	241,510	304,822	217,960
Calcium molybdate (grouped with vanadium oxide and tungsten oxide for manufacture of steel)				
United States	75,987	82,653	135,333	109,247
Ferromolybdenum				
United States(3)...........	164,366	184,926	196,000	210,038
Exports(2)				
Molybdic oxide and molybdenum concentrates				
Austria	1,684,900	1,519,591	504,800	479,314
United Kingdom...........	897,700	535,780	469,300	336,000
Japan	786,200	757,346	-	-
Netherlands	235,900	237,983	163,800	135,656
West Germany............	91,900	81,331	403,800	337,675
Sweden	43,000	34,504	49,600	69,036
Australia	8,700	5,750	5,100	4,345
United States	-	-	182,000	160,985
Italy	-	-	113,800	97,214
Total	3,748,300	3,172,285	1,892,200	1,620,225
Consumption (4)				
Mo content				
Molybdic oxide	483,191		298,078	
Ferromolybdenum	72,201		183,161	
Calcium molybdate........	30,000		7,888	
Sodium molybdate.........	172,130		24,983	
Molybdenum metal	151,485		3,213	
Molybdenum wire	8,135		1,801	
Other forms (5)	11,363		-	
Total	928,505		519,124	

(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 in United States Exports of Domestic and Foreign Produce. Imports of ferromolybdenum are not available separately from official Canadian trade statistics.

(4) Consumption increase in 1959 due to a greater survey coverage.

(5) Molybdic acid, molybdenum disulphide, ammonium molybdate and barium molybdate.

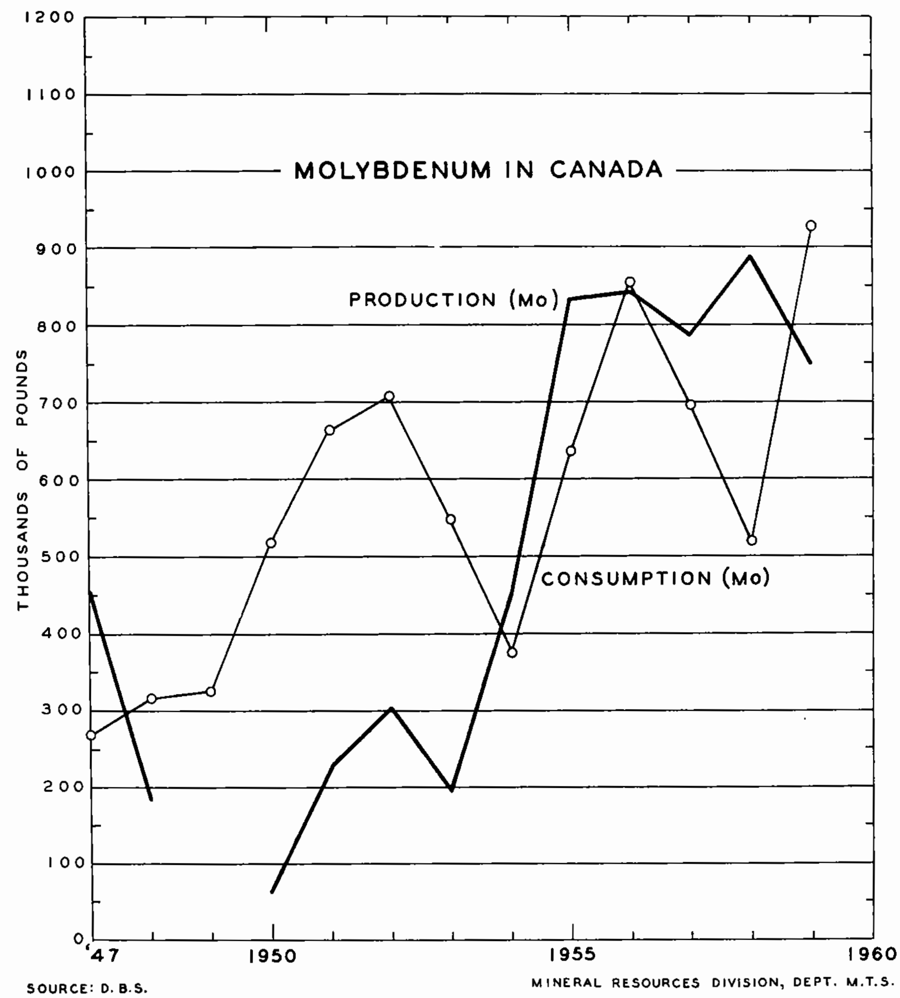
Molybdenum - Production, Trade and Consumption, 1949-59
(pounds)

	Production	Exports	Imports			Consumption
			Calcium. Molybdate	Molybdic Oxide	Ferro-molybdenum	
	(1)	(2)	(5)	(6)	(7)	(8)
1949	-	(3)	78,532	319,029	143,200	(3)
1950	62,130	(3)	141,544	444,185	250,550	486,140
1951	228,958	(3)	62,364	566,334	315,394	662,000
1952	303,578	(3)	169,392	520,104	439,476	709,271
1953	194,344	(3)	197,758	358,124	201,626	548,455
1954	451,450	(3)	121,339	423,344	79,856	374,118
1955	833,506	1,478,900	129,130	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(4)	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

(1) Producers' shipments of molybdenum concentrates (Mo content) 1949 to 1956 inclusive; 1957 to 1959, molybdic oxide and molybdenum concentrates (Mo content).
(2) 1955 and 1956, exports of molybdenum concentrates (gross weight); 1957 to 1959, exports of molybdic oxide and molybdenum concentrates (gross weight).
(3) Not available.
(4) 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.
(5) Including vanadium oxide and tungsten oxide.
(6) Gross weight.
(7) United States exports to Canada reported in United States Exports of Domestic and Foreign Produce. Gross weight.
(8) Molybdenum addition agents (Mo content) reported by consumers.

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 and which is added to iron and steel - either in the furnace charge or in the molten bath. Also at Lacorne, the company operates an experimental plant for the production of lubricant-grade molybdenum disulphide.

Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada Limited, holds a substantial interest, owns 2,800 acres in Preissac township, Quebec. Part of this property was formerly known as Indian Molybdenum Limited. During World War II it was operated by Dome Mines Limited and some 900,000 pounds of molybdenite were shipped to Wartime Metals Corporation. Ore reserves at this property are estimated to exceed 1 million tons averaging more than 0.4 per cent MoS_2.



American Metal Climax Inc. continued a diamond-drilling program on its Mount Boss molybdenum property, 50 miles east of Williams Lake, British Columbia.

Other molybdenum exploration programs were reported by: Jonsmith Mines Limited, on its property in DesRosiers township, about 30 miles northwest of Gogama, Ontario; Nortoba Mines Limited, on its property northwest of Beardmore, Ontario; Canol Metal Mines Limited, on the Raciot molybdenum property, on upper Sheep Creek, Yukon Territory; and Dumont Nickel Corporation, on the property of Anglo-American Molybdenite Mining Corporation, in Preissac township, about 5 miles north of Cadillac, Quebec.

United States

In 1959, the production and consumption of molybdenum increased 24.1 and 19.6 per cent respectively, according to the United States Bureau of Mines.* Production, however, at 50, 956, 000 pounds of contained molybdenum, was well below that of any year from 1954 to 1957 inclusive. The stock of molybdenum concentrates held by industry decreased, as did the stocks of molybdenum products (ferromolybdenum, molybdic oxide, and molybdenum salts and metal) at producers' and consumers' plants.

The United States Bureau of Mines reports**as follows: "Molybdenum concentrate was produced in six States in 1959; Colorado led, followed by Utah, Arizona, California, New Mexico, and Nevada. Output from mines operated chiefly for molybdenum increased 43 per cent compared with 1958; by product recovery from copper and tungsten plants decreased 9 per cent."

The large deposit at Climax, Colorado, which was first explored in 1917 and is at the site of the world's largest producer, is the only United States mine operated chiefly for molybdenum. Among the larger producers of by-product molybdenum in 1958 were Kennecott Copper Corporation, Bagdad Copper Corporation, Phelps Dodge Corporation, San Manuel Copper Corporation, Union Carbide Nuclear Company and American Smelting and Refining Company.

Molybdenum Corporation of America is second to American Metal Climax as a producer of molybdenum oxide and ferromolybdenum. Since 1937 Molybdenum Corporation has purchased a very large part of its molybdenum concentrate requirements from Kennecott.

Chile

Chile is second among non-Communist countries in the production of molybdenum, all of which is obtained as a by-product from its large porphyry copper deposits. 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. Output in 1959 was 3.785 million pounds.

Other Countries

Japan, Norway and Yugoslavia are producers of minor importance. China, North Korea and the Union of Soviet Socialist Republics also produce molybdenum, but data on their production are not available. The United States Bureau of Mines has estimated that Russian production was 9.9 million pounds in 1959. This would rank Russia second to the United States.

---

*U.S. Bureau of Mines, Molybdenum Report No. 3050, May 25, 1960.
**U.S. Bureau of Mines, Molybdenum Report No. 120, February 25, 1960.

Consumption and Uses

About 70 per cent of the molybdenum consumed is in the form of molybdic oxide, 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.

Molybdenum Consumption in the United States, by Use
(thousands of pounds of contained molybdenum)

	1959	1958	1957
Steel			
High-speed	2,488	1,072	2,335
Other alloys	15,532	13,776	17,891
Miscellaneous(1)	4,323	1,864	2,196
Gray and malleable castings	3,182	1,738	2,274
Rolls (steel mill)	1,028	601	832
Welding rods	233	249	237
High-temperature alloys	1,333	1,215	1,401
Molybdenum metal (wire, rod and sheet)	1,046	1,867	866
Chemicals			
Catalysts	236	391	492
Pigments and other color compounds	901	760	735
Miscellaneous(2)	2,048	698	757
Total	32,350	24,231	30,016

(1) Includes castings as well as hot-work and other tool steel.
(2) Includes special alloys, lubricants, pesticides, refractories, magnets and corrosion- and heat-resistant castings.

Sources: U.S. Bureau of Mines, Minerals Yearbook 1958, Molybdenum (preprint), and Bureau of Mines, Molybdenum Report No. 120 and No. 3050.

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 extensively used in the electronics industry and for missile parts that have a short working life.

Purified-molybdenite lubricants are manufactured as greases, oil dispersions, resin-bonded films and dry powder. Their consumption in the United States grew from almost nothing a few years ago to 225,000 pounds of contained molybdenum in 1958.

Molybdenum compounds are used in the ceramic industry for manufacturing white pigment, and in conjunction with other elements to make vitreous enamels adhere to iron and steel.

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.

Among the more important Canadian consumers of molybdenum primary products are: in Ontario - Atlas Steels Limited, Welland; 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 (1956) 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 31, 1959, quotes molybdenum prices in the United States as follows:

Molybdenum powder	Per lb, carbon-red, f.o.b. shipping point	\$3.35
Molybdenum orè	Per lb contained Mo 95% MoS_2, f.o.b. shipping point Climax (effective Nov. 1, 1958, cost of container extra)	\$1.25
Molybdic trioxide	Per lb Mo., f.o.b. shipping point	
	Bags	\$1.46
	Cans	\$1.47
Ferromolybdenum	Per lb contained Mo, lots 5,000 lb or more, f.o.b. shipping point	
	58-64% Mo, powdered, packed	\$1.82
	Other sizes, packed	\$1.76
Calcium molybdate	Per lb Mo, lumps, packed	\$1.50

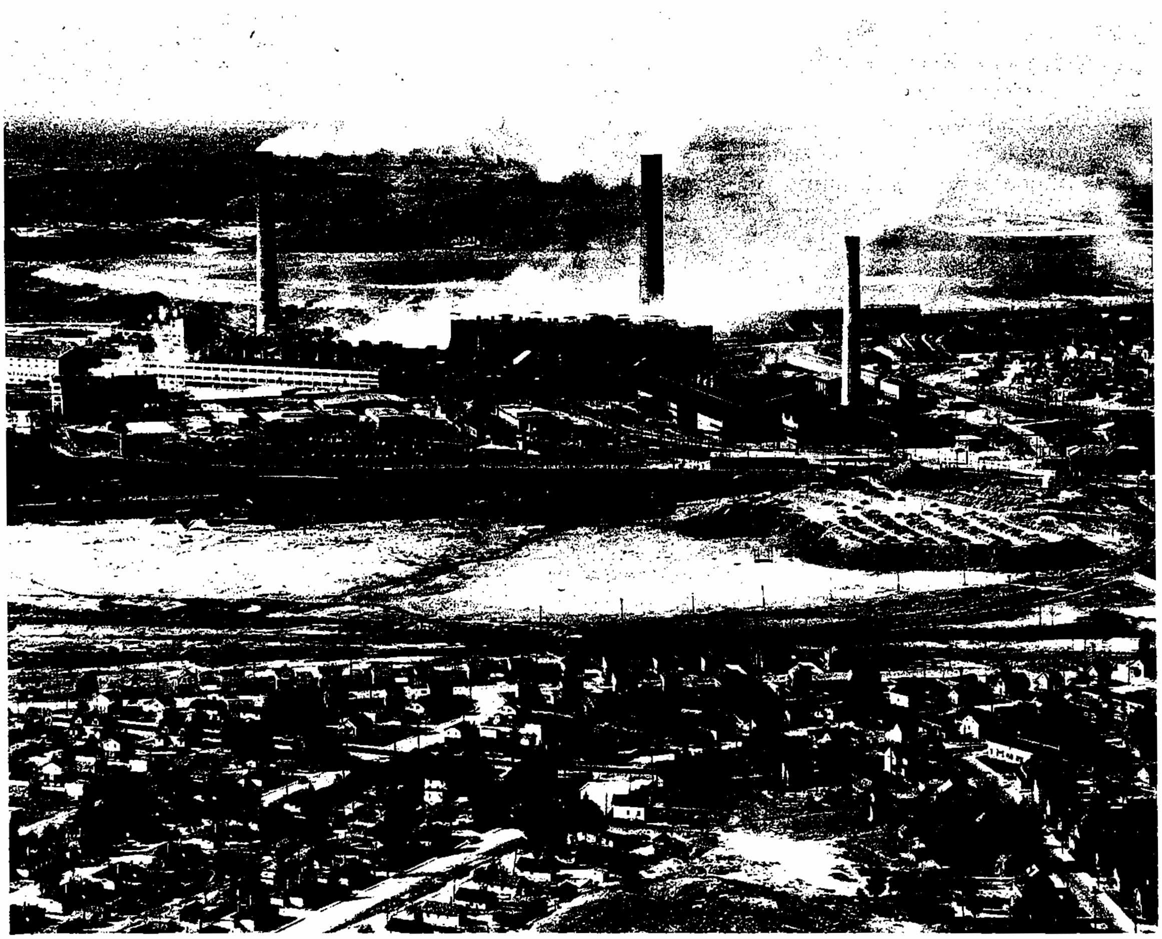
Tariffs

Canada

	British Preferential	Most Favored Nation	General
Calcium molybdate and molybdic oxide	free	free	5%
Molybdenum strip	"	"	30%
Molybdenum wire, rod and tubing and molybdenum imported by manufacturers of radio tubes and parts	"	"	30%
Ferromolybdenum	"	5%	5%
Molybdenum ores and concentrates	"	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 1/2% ad valorem
Molybdenum bars, ingots, sheets, shot, wire and other forms not specifically provided for, and scrap containing more than 50% molybdenum, molybdenum carbide or combinations thereof	
Bars, ingots, scrap, shot	21%
Other forms	25 1/2%



Located at Copper Cliff, Ontario, International Nickel Company's mill has a capacity of 30,000 tons of ore a day. The smelter has seven reverberatory furnaces and nineteen converters.

NICKEL

C.C. Allen

At a total of 186,555 tons, nickel production in Canada was 34 per cent greater in 1959 than in the preceding year and only 1,403 tons below the all-time high of 1957. All companies operated at peak capacity except The International Nickel Company of Canada, Limited, whose January production, affected by the three-month strike that occurred at the end of 1958, was partially curtailed.

Market conditions were generally favorable, supply and demand being in close balance. This condition resulted from the depletion of International Nickel's inventories during the strike and from an increase in industrial demand in the United States and Europe. The United States General Services Administration (G.S.A.) and International Nickel agreed to cancel the contracts between them for delivery of nickel to the United States government; and G.S.A. undertook to make up the difference between the contract and the market price by supplying the company with nickel-oxide sinter from Nicaro, Cuba. This arrangement was later amended to include 16 million pounds of nickel cathodes. Thus International Nickel had additional stocks for the general market and G.S.A. was able to dispose of surplus nickel and conserve funds. In January 1960 G.S.A. also announced the release of 19 million pounds of cathode nickel from inventory at market price for United States consumption.

The strike in the United States steel industry during the summer and fall of 1959 curtailed the production of stainless and other nickel steels, but the decline in the consumption of nickel in that field was partially offset by an increase in the European demand. In the United States, demand increased in anticipation of the strike. The lifting of the embargo, during the fall of 1958, on the sale of nickel to the Union of Soviet Socialist Republics has resulted in a demand for Canadian nickel in Russia.

The closure of Freeport Nickel Company's subsidiary, Moa Bay Mining Company, at Moa Bay, Cuba, because of restrictions, will reduce the expected Cuban production. Cuban Nickel Company, at Nicaro, is still in production.

(text continued on page 174)

---

*Mineral Resources Division

Nickel - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (all forms)[1]				
Ontario	173,964	240,053,265	127,144	177,168,918
Manitoba	10,139	13,523,225	9,778	13,328,056
Northwest Territories	1,921	2,689,239	1,933	2,648,538
British Columbia	531	743,072	704	996,507
Total	186,555	257,008,801	139,559	194,142,019
Exports				
In matte				
Norway[2]	29,408	39,787,120	26,062	35,571,977
United Kingdom	27,394	36,986,865	30,942	42,361,998
United States	7,831	10,614,076	9,160	12,511,363
Sweden	591	798,457	111	151,817
Other countries	433	584,684	1,384	1,898,649
Total	65,657	88,771,202	67,659	92,495,804
In oxide				
United States	2,389	2,852,886	488	650,829
United Kingdom	515	365,546	850	563,636
Sweden	459	610,888	-	-
Italy	270	359,328	-	-
Belgium	221	293,943	-	-
Other countries	303	375,622	55	83,267
Total	4,157	4,858,213	1,393	1,297,732
Refined metal				
United States	78,460	100,552,253	66,491	90,604,067
United Kingdom	6,947	8,866,599	7,479	9,875,782
Belgium	4,098	5,820,321	631	832,610
West Germany	2,732	3,926,726	4,936	7,395,965
Sweden	2,721	3,848,277	1,205	1,998,035
Czechoslovakia	2,274	3,178,785	186	277,909
Other countries	4,879	7,034,388	4,240	7,801,663
Total	102,111	133,227,349	85,168	118,786,031
Imports				
Semifabricated[3]				
United States	1,822	3,450,779	2,143	3,853,706
United Kingdom	30	73,608	12	40,051
Other countries	5	16,779	-	-
Total	1,857	3,541,166	2,155	3,893,757

Nickel - Production, Trade and Consumption (cont'd)

	1959*		1958	
	Short Tons	$	Short Tons	$
Manufactures				
United States.........		1,606,992		1,332,083
United Kingdom.......		196,473		168,799
West Germany		172,791		207,641
Other countries		169,592		125,830
Total		2,145,848		1,834,353
Total imports.........		5,687,014		5,728,110
Consumption (refined metal only)(4)..	3,689		4,099	

(1) Includes nickel matte exported, refined metal produced in Canada and nickel in oxides and salts sold or produced.
(2) For refining and re-export.
(3) Nickel in bars, rods, strips, sheets and wire; nickel and nickel-silver in ingots and nickel chrome in bars.
(4) 1958 - Producers' domestic shipments of refined metal.
1959 - Consumption reported by consumers.

Nickel - Production, Trade and Consumption, 1949-59
(short tons)

	Production(a)	Exports				Imports(b)	Consumption(c)
	All Forms	In Matte	In Oxide	Refined Metal	Total		
1949	128,690	56,902	1,151	69,088	127,141	1,444	1,749
1950	123,659	53,090	1,668	66,894	121,652	1,337	2,226
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	3,689

(a) Refined metal, plus content of oxide and matte exported.
(b) Nickel in semifabricated forms, including nickel in bars, rods, strips, sheets and wire: nickel and nickel-silver in ingots and nickel-chromium in bars.
(c) Producers' domestic shipments of refined metal.

Domestic Mine Production and Development

Ontario

International Nickel operated its five Sudbury-area mines - the Creighton, Frood-Stobie, Garson, Levack and Murray. Development work at the Crean Hill mine was resumed and construction on the Levack concentrator completed. This completion makes it possible to ship concentrates rather than ore to Copper Cliff. Construction has begun on a fluid-bed roast process that will replace sintering facilities. The 1959 deliveries,amounting to 158,520 tons of nickel, were at a record level. Ore mined totalled 15,316,000 tons. Ore reserves in the Sudbury-area mines on December 31, 1959, totalled 264,864,000 tons containing 7,964,900 tons of nickel and copper.

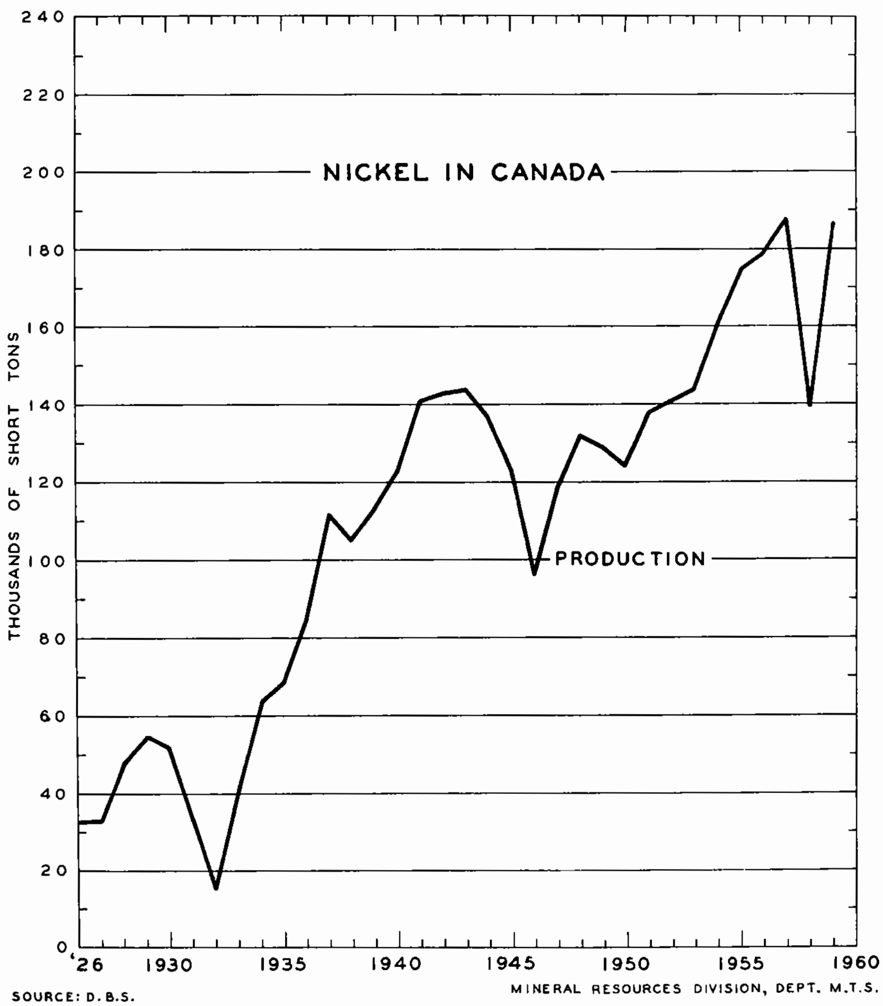
Falconbridge Nickel Mines Limited operated the Falconbridge, East and McKim mines in the Falconbridge area and the Hardy, Longvack and Fecunis mines in the Onaping area on the northwest side of the Sudbury Basin. The Fecunis mine is now in regular production. The Strathcona deposit was diamond-drilled further in 1959 and an underground development program may be commenced in 1960. The use of natural gas in steam and sintering applications will begin this summer, and initial consumption will be 1 million cubic feet a day. Having completed its expansion program, the company now has an annual production capacity of about 30,000 tons of nickel.

The ore reserves of Falconbridge Nickel in the Sudbury district total 46,182,450 tons averaging 1.45 per cent nickel and 0.81 per cent copper. This consists of 22,200,050 tons of developed ore averaging 1.56 per cent nickel and 0.87 per cent copper and 23,982,400 tons of indicated ore averaging 1.34 per cent nickel and 0.77 per cent copper. Nickel production was at the record level of 58,413,000 pounds.

Norduna Mines Limited, controlled by Falconbridge Nickel and The Mining Corporation of Canada, Limited, with property in Falconbridge township, completed pre-production development work. This includes a shaft to the 725-foot level and four development levels. The current production rate is about 500 tons a day, the ore being sold to Falconbridge.

Manitoba

Sherritt Gordon Mines Limited completed its mill expansion to a rated capacity of 3,500 tons a day. This expansion will offset the lowering of the mine grade and give the company a steady production in terms of nickel. Ore reserves at Lynn Lake at year-end were 14,158,000 tons averaging 0.96 per cent nickel and 0.54 per cent copper. In December the refinery at Fort Saskatchewan, Alberta, was producing at the rate of 32 million pounds of nickel a year. North Rankin Nickel Mines Limited and Sherritt extended their agreement, North Rankin contracting to deliver up to 28 million pounds of nickel in the form of concentrates over the next four years.



Construction at International Nickel's Thompson project in northern Manitoba is proceeding on schedule. Underground development work and the concentrator and smelter should be completed in 1960. The refinery, which will be finished last, will be ready for full-scale production early in 1961. The rated annual capacity at Thompson is 75 million pounds of electrolytic nickel, but production will probably exceed this. Damage from fire at the Kelsey power site on the Nelson River will delay the supply of power for three months. Hydroelectric power from a test run had been expected in March and full power from one unit by May 1960.

Northwest Territories

During the 1959 season North Rankin Nickel Mines Limited shipped to the Fort Saskatchewan refinery concentrates containing 5,095,999 pounds of nickel and 1,332,803 pounds of copper. A widespread exploration program was launched on the west side of Hudson Bay, and Rankin Inlet was used as a base.

British Columbia

Giant Nickel Mines Limited, near Hope, resumed production in June. Mill capacity is 1,000 tons a day and reserves are estimated at 1,072,000 tons averaging 1.18 per cent nickel and 0.30 per cent copper. Commencing in 1960 concentrates have been contracted for a three-year period to Sumitomo Metal Mining Company Limited of Japan.

Exploration in Canada

Ontario

Fatima Mining Company Limited, with property in Bartlett and Geikie townships, completed an exploratory shaft to the 790-foot horizon. Cross-cuts to the nickel-bearing zone were driven on the 450- and 742-foot levels. Bulk samples are now being treated.

Nickel Mining and Smelting Corporation Limited resumed work on the Gordon Lake property, in northwestern Ontario. The shaft was dewatered and deep diamond-drilling confirmed the downward extension of the 'A' and 'B' zones. Development work prior to the latest drilling program indicated 3.5 million tons grading 1.2 per cent nickel and 0.61 per cent copper. A winze is planned from the 1,200-foot to the 1,650-foot level.

Associated Arcadia Nickel Corporation Limited, a reorganization of Arcadia Nickel Corporation Limited, is negotiating a contract for the sale of nickel-copper concentrates. The company plans are to reopen its property in Drury township, Sudbury area,when this is completed.

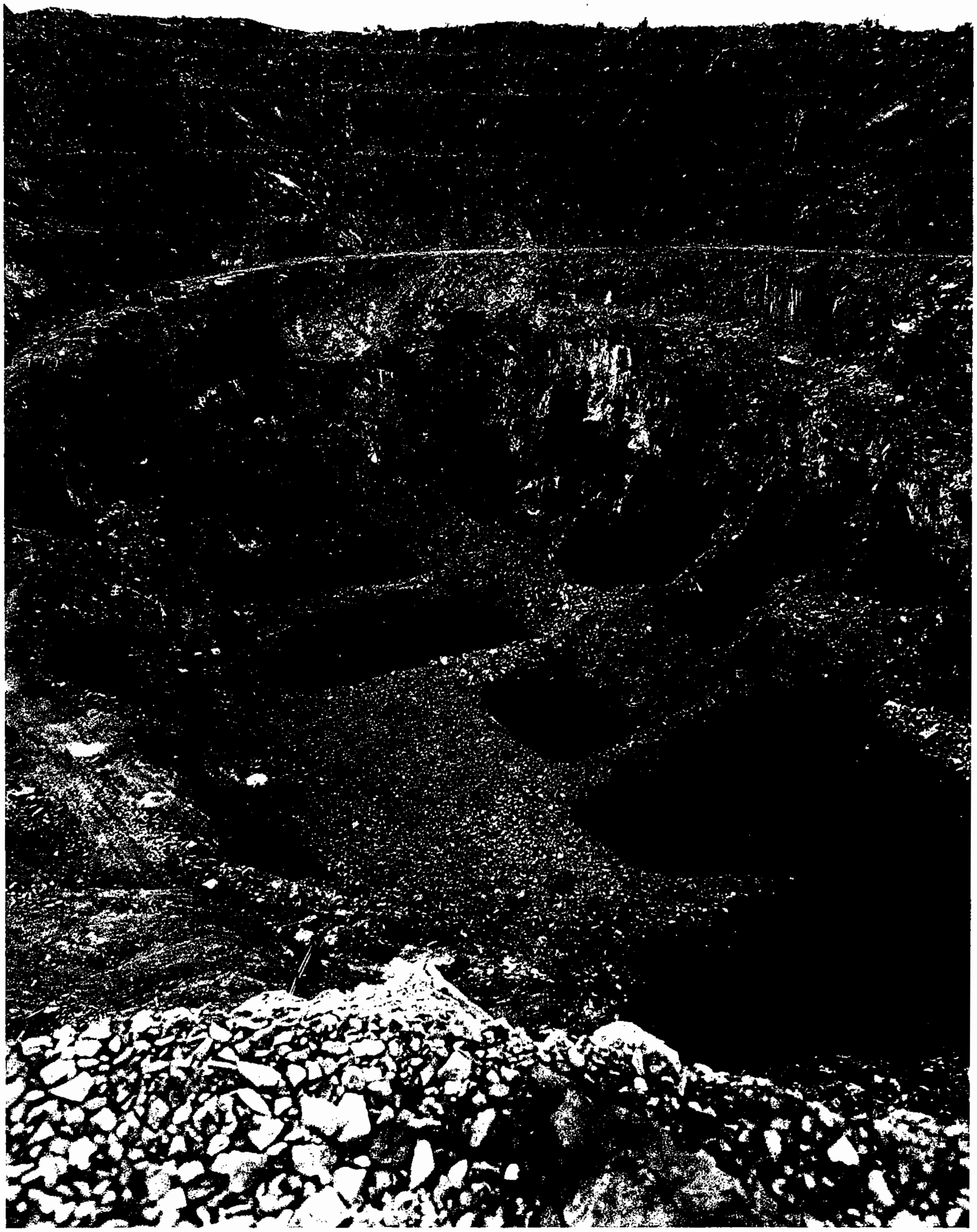
Quebec

Marchant Mining Company Ltd. optioned its property in La Motte township, northern Quebec, to Falconbridge. Indicated reserves are 352,961 tons averaging 2.95 per cent nickel. Falconbridge's first diamond-drill results were encouraging.

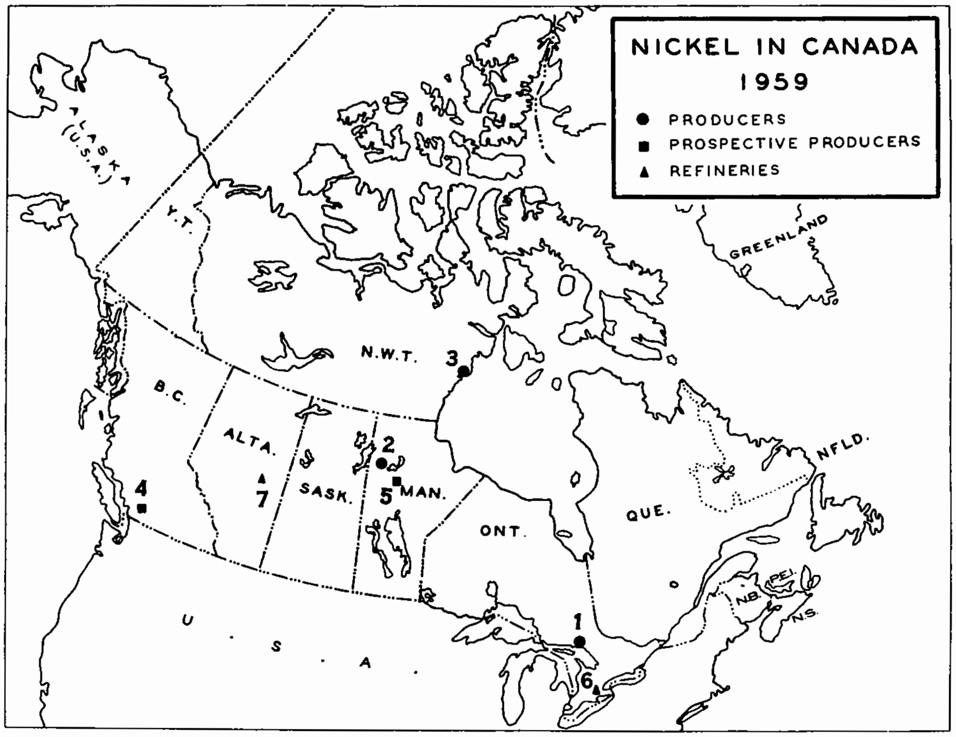
Manitoba

International Nickel is diamond-drilling and shaft-sinking on nickel deposits of large potential in northern Manitoba to the immediate west of the Thompson area.

New Manitoba Mining and Smelting Company Limited, which owns property in the Lac du Bonnet area, reports plans for production in conjunction with the recovery of sulphuric acid and a marketable iron concentrate as by-products.



Blast-hole stopes surfacing at the bottom of the Frood-Stobie open pit. Scale is indicated by the drill rigs at the upper left.



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Producers

1. Sudbury area
   International Nickel Company of Canada, Limited, The (5 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

Prospective Producers

5. International Nickel Company of Canada, Limited, The - Thompson project

Refineries

6. International Nickel Company of Canada, Limited, The, Port Colborne, Ontario
7. Sherritt Gordon Mines Limited, Fort Saskatchewan, Alberta

New Brunswick

St. Stephen Nickel Mines Ltd. completed additional surface diamond-drilling and shaft-sinking to the 300-foot level. Underground diamond-drilling is in progress.

World Development and Production

Cuba

The Cuban government's imposition of a tax increase on both producing and nonproducing mines was a danger signal for the Cuban nickel industry. The main tax is a 5-per-cent levy on mineral production plus 25 per cent on ores and minerals exported. This was not considered applicable to the Nicaro operation of the United-States-government-owned Cuban Nickel Company, which is covered by special agreement. However, the imposition of this tax on Nicaro exports resulted in temporary suspension of shipments from the Nicaro operation. A second law, interpreted as an alternative to the 25-per-cent-tax law, gives producers 95 per cent of the value of metal sales in Cuban pesos at the officially established rate of exchange.

The new laws directly affected Moa Bay Mining Company, a Freeport Nickel subsidiary, which was about ready to begin production at its Moa Bay operation at a rated annual capacity of 50 million pounds of nickel and to export nickel concentrates to Freeport's nickel refinery in Lousiana. A subsequent concession, by which Cuban Nickel Company was allowed a three-month period to export nickel-oxide sinter free of encumbrances, permitted Freeport Nickel to export nickel concentrates freely for testing purposes. On March 8, 1960, however, Freeport Nickel announced that it was closing down its entire Moa Bay project.

The United States government had previously put its $85 million Nicaro property up for public tender with December 1, 1959, as the closing date. Several bids were reported but, with the exception of three, were later withdrawn. The Cuban government has also shown interest in acquiring the plant. In 1959 the Nicaro plant operated at about 70 per cent of capacity and produced 39 million pounds of nickel.

Dominican Republic

Minera y Beneficiadora Falconbridge Dominicana C por A, a subsidiary of Falconbridge Nickel Mines Limited, has developed in the Cibao region lateritic-ore reserves totalling more than 50 million tons grading 1.55 per cent nickel. Samples have been tested in Canada, and a pilot plant in the Dominican Republic is planned for mid-1960.

Brazil

Société Morro do Niquel, comprising Société Anonyme Le Nickel, the Banque de l'Indochine, Crédit Foncier du Brésil and Mineração Sertaneja, S.A., has been formed to mine and produce ferronickel from deposits in the state of Minas Gerais.

Japan

Japanese interests have contracted for the three-year production of Giant Nickel Mines Limited, British Columbia. Shimura Kalso Chemical Processing has purchased an interest in Trojan Nickel Mine Limited at Bindura, Southern Rhodesia, and has agreed to build a nickel-smelting unit there. All production is to be exported to Japan.

Philippines

Plans for further bids on the nickel deposits in Surigao province have been shelved by the National Economic Council. Estimated reserves in Parcel 2, Surigao Mineral Reservation, are:

	Metric Tons	% Iron	% Nickel
Iron ore	104,000,000	47.55	0.79
Iron-nickel ore	26,000,000	43.36	1.48
Nickel ore	13,000,000	14.91	1.70

The National Economic Council believes that development should be reserved for Filipinos and should be delayed pending the outcome of loan applications for the integrated steel mill of National Shipyards and Steel Corporation.

New Guinea

United States Steel Corporation, in conjunction with three Dutch firms, is exploring nickel-iron laterite deposits.

New Caledonia

Société Anonyme Le Nickel now has two electrical furnaces producing ferronickel.

East Germany

The new nickel project at St. Egidien should be completed in 1961. A production rate of 4,500 tons is expected, about half electrolytic nickel and half 10 per cent ferronickel.

Free World nickel-production capacity, which is increasing rapidly, is as follows:

	Short Tons	
	1960	1961
International Nickel	155,000	192,500
Falconbridge	30,000	30,000
Sherritt Gordon	13,750	13,750
Cuban Nickel (Nicaro)	27,000	27,000
Freeport Nickel	25,000	25,000
New Caledonia (French and Japanese)	39,000	42,500
M.A. Hanna	10,000	10,000
	299,750	340,750

Consumption and Uses

Free World nickel consumption by products is shown as follows:

	1958	1959	% Change
Stainless steels	27%	29%	+2
High-nickel alloys	16%	16%	
Electroplating	13%	15%	+2
Nickel-alloy steels	16%	15%	-1
Foundry products	12%	12%	
Copper-nickel alloys	6%	4%	-2
All other products	10%	9%	-1

Nickel is making its greatest gains in stainless steels and nickel plating; its greatest loss is in copper-nickel alloys. The use of stainless steels has been expanded in the rocket-and-missile and automotive fields and in architectural trim, household effects and kitchenware. The use of thicker nickel coatings in decorative plating is also increasing consumption, especially in the automobile industry, in which a major advance has been the development of duplex or double plating that virtually eliminates buffing and polishing and extends service life. The nickel-cadmium battery is being favorably received in the aircraft industry and has a high rating for starting Diesel engines.

Prices

The Canadian price of electrolytic nickel, f.o.b. Port Colborne, Ontario, was 70 cents a pound throughout 1959.

The United States price, including the 1 1/4-cent United States import duty, remained at 74 cents (U.S.) f.o.b. Port Colborne.

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Nickel, and alloys consisting 60% or more of nickel by weight, not otherwise provided, 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 in spark plugs for use exclusively in the manufacture of such wire for spark plugs in their own factories	"	"	10%
Anodes of nickel	5%	7 1/2%	10%
Articles of iron, steel or nickel of which the chief component is iron, steel or nickel for use in the manufacture of storage batteries	10%	10%	20%

United States

Nickel ore, nickel matte and nickel oxide	free
Nickel, and alloys in which nickel is the component of chief value:	
In cathodes, cubes, grains, ingots, pigs, shot or similar forms	1 1/4¢ lb
In anodes, bars, castings, electrodes, plates, rods, sheets, strands, strip or wire	12 1/2%
In tubes or tubing	6 1/4%
Any of the foregoing, if cold-drawn, cold-rolled or cold-worked, shall be subject to an additional duty, as follows:	
Tubes and tubing	2 1/2%
Other forms	5%

PLATINUM METALS

C.C. Allen*

The platinum metals are in two groups: platinum-iridium-osmium and palladium-rhodium-ruthenium. With the exception of osmium, they are by-products of the treatment of Sudbury nickel-copper ores, which average about 0.025 ounce platinum metals per ton. In 1959 the production of platinum metals was 328,095 ounces valued at $16,932,438; in 1958 it was 300,458 ounces valued at $14,321,443.

The Union of South Africa, Canada and the Union of Soviet Socialist Republics continued to be the world's leading producers. South African production is associated, like Canada's, with nickel-copper sulphides. Formerly, Russian production was obtained entirely from placers in the Urals, but in recent years increasing amounts have been coming from the treatment of nickel-copper ores at Petsamo, Monchegorsk and Norilsk. In the nickel-copper deposit at Norilsk, which appears similar to that of the Merensky Reef of South Africa, nickel-copper values are low and platinum-metals values are about 0.064 ounce per ton, platinum and palladium being in the ratio of 1:2.

The output of platinum metals in the major producing countries during 1959 was as follows:

	Troy Ounces
Union of South Africa	380,352 (estimated)
Canada	328,095
U.S.S.R.	250,000 (estimated)
Colombia	31,498
United States	15,485

Domestic Mine Production

In 1959 The International Nickel Company of Canada, Limited delivered 384,600 ounces of platinum metals. The ore treated amounted to 15,316,000 tons from the five mines in the Sudbury Basin - the Creighton, Frood-Stobie, Murray, Garson and Levack. Proven ore reserves in the Sudbury area, practically the same as in the previous year, amounted to 264,864,000 tons containing 7,964,900 short tons of nickel-copper. International Nickel operated at peak capacity except that January production was curtailed because of the

---

*Mineral Resources Division

Platinum Metals - Production and Trade

	1959		1958	
	Troy Ounces	$	Troy Ounces	$
Production				
Platinum............	150,382	11,015,449	146,092	9,481,371
Palladium, rhodium, ruthenium, iridium..	177,713	5,916,989	154,366	4,840,072
Total	328,095	16,932,438	300,458	14,321,443
Exports				
Domestic produce				
Platinum and platinum metals in concentrates				
United Kingdom.....	333,749	11,652,381		14,795,041
Japan..............	2,319	174,455		195,177
Norway............	15,830	598,161		-
United States.......	6,000	72,224		23,323
India	-	-		780
Total..............	357,898	12,497,221		15,014,321
Platinum, old and scrap				
United States.......	816	45,595	159	3,140
United Kingdom.....	179	11,355	136	10,250
Total..............	995	56,950	295	13,390
Foreign produce(1)				
Platinum metals refined and semi-processed				
United States.......	238,235	8,676,998		4,893,616
Imports				
Platinum metals, semiprocessed and manufactured				
United Kingdom(2)...		6,237,527		8,204,343
United States........		228,753		437,017
Total		6,466,280		8,641,360
Platinum crucibles				
United States........		1,828,108		1,535,132
United Kingdom		452		-
Total		1,828,560		1,535,132

Platinum Metals - Production and Trade (cont'd)

	1959		1958	
	Troy Ounces	$	Troy Ounces	$
Imports (cont'd)				
Catalysts for refining petroleum				
United States........		2,234,702		2,603,792
United Kingdom		456,144		175,391
Total		2,690,846		2,779,183

(1) Exports from Canada to the United States of platinum metals in a refined and semiprocessed state. They are considered exports of foreign produce since they are derived from imports from the United Kingdom (see (2) below).
(2) Derived from Canadian concentrates refined and processed in the United Kingdom.

three-month strike that occurred at the end of 1958. Underground development at the Crean Hill mine has been resumed.

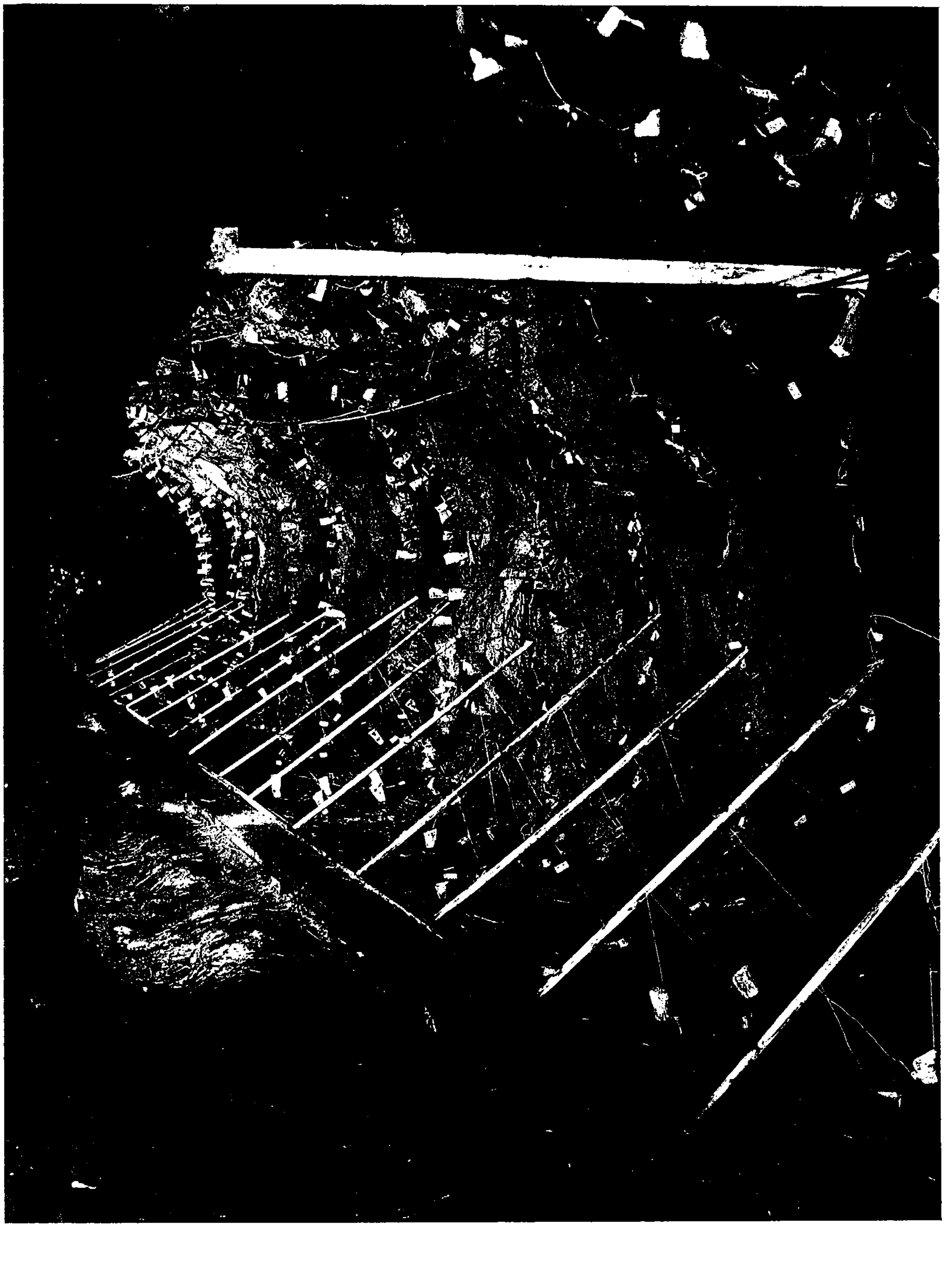
Falconbridge Nickel Mines Limited set a new production record for both nickel and platinum metals. Six mines are in regular production - the Falconbridge, East, McKim, Hardy, Longvack and Fecunis. Falconbridge also treated customs ore from Norduna Mines Limited at the rate of about 500 tons a day. Falconbridge ore reserves at year-end were 46,182,450 tons averaging 1.45 per cent nickel and 0.82 per cent copper. Ore milled during the year amounted to 2,005,374 tons. Falconbridge has just completed a major expansion program and its annual nickel-production capacity is at present slightly in excess of 30,000 tons of nickel. The Strathcona deposit was diamond-drilled further in 1959, and an underground development program may be started in 1960.

International Nickel is continuing construction and development of the Thompson mine and related facilities in northern Manitoba. The annual production capacity of the project is to be 75 million pounds of electrolytic nickel, and initial production is slated for early 1961. The Thompson ore also contains small amounts of platinum metals.

Minor amounts are recovered from the sludge formed at copper refineries in the electrolysis of blister copper or obtained as by-products of placer-gold operations.

World Production

Figures on the output of the world's leading platinum-metals producers are becoming more difficult to obtain. The United States Bureau of Mines estimates Russian production to be about 250,000 ounces a year, but Russia



Drill drift loaded for blasting, Frood-Stobie mine.

53470-1—13½

Platinum Metals - Production and Trade, 1949-59

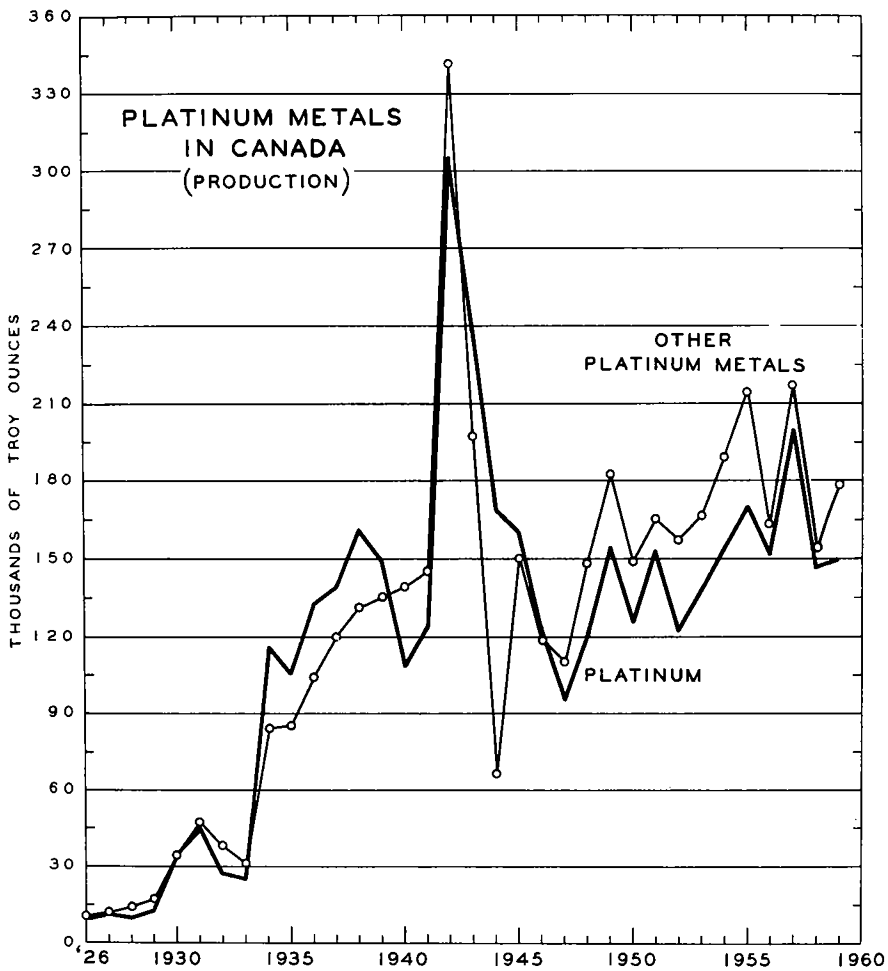
	Production(1)			Exports			Imports(4)
	Platinum	Other Platinum Metals	Total	Domestic(2)	Foreign(3)	Total	
	(troy oz)	(troy oz)	(troy oz)	($)	($)	($)	($)
1949	153,784	182,233	336,017	11,995,385	6,020,638	18,016,023	10,736,534
1950	124,571	148,741	273,312	11,549,811	9,650,977	21,200,788	21,339,915
1951	154,483	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	19,823,729	8,641,360
1959	150,382	177,713	328,095	12,497,221	8,676,998	21,174,219	6,466,280

(1) Platinum metals, content of residues, concentrates and matte shipped to the United Kingdom and Norway for treatment. For the years 1949 to 1952 production included small amounts of alluvial platinum.

(2) Value of platinum metals in concentrates exported for treatment.

(3) Exports of platinum metals, refined and semiprocessed. These are considered exports of foreign produce since they are essentially re-exports of platinum metals imported from the United Kingdom.

(4) These are largely imports from the United Kingdom of refined and semiproduced platinum metals derived from Canadian concentrates and residues shipped to the United Kingdom for treatment.



SOURCE: D.B.S. MINERAL RESOURCES DIVISION, DEPT. M.T.S.

has not published its output since 1926. In 1959 the Union of South Africa also stopped publishing such figures. Canada is now the only major producer reporting its platinum-metals output.

Rustenburg Platinum Mines Limited, in South Africa, was operating at about 50 per cent of capacity in 1958. In 1959 the mine in the Rustenburg Section and the one in the Union Section operated at a higher production rate. This rate exceeds the sales rate, and the surplus is added to inventory. Rustenburg Platinum's new policy is to carry an inventory of platinum metals adequate to all demands and amounting to "reasonably large stocks of refined metal".

Osmiridium, a natural alloy of osmium and iridium, is recovered in milling ore from the Rand gold mines. The annual production rate averages 6,500 ounces.

Consumption and Uses

The United States consumed about 89 per cent of the world production of platinum metals in 1959.

The chemical industry continued to be the largest user of platinum, which serves mainly as a catalyst in the manufacture of sulphuric and nitric acid, the hydrogenation of organic chemicals, gas purification and the production of high-octane gasoline. The demand from the oil industry has not been of major significance for the last two years, and this has facilitated greater use of modern research methods, with the result that less platinum is being used in the catalyst. Catalytic life is thus being extended and, in the reclaiming, less platinum is being lost. Other major outlets for this metal are the electrical industry and jewelry.

The electrical industry is by far the largest user of palladium. It is followed by chemicals and jewelry. In low-amperage circuits, palladium provides contacts that are noncorrosive and highly reliable under all operating conditions.

Platinum-gold and platinum-rhodium alloys are used extensively in spinnerets for the manufacture of synthetic fibres and as extrusion nozzles in the fiberglass industry. Iridium, rhodium and ruthenium are used primarily for alloying with palladium and platinum. The platinum metals are also being used as catalysts in the synthesis of artificial diamonds.

Canadian Consumers

The platinum-metals industry of Canada is led by Engelhard Industries of Canada Limited and Johnson Matthey and Mallory Limited. Both organizations have offices and plants in Toronto, are members of their respective world-wide organizations and act as importers, manufacturers and sales agents for platinum metals and alloys, manufactured articles and platinum-metals salts. Imperial Smelting & Refining Company Limited, Toronto, manufactures jewelry, and both Handy & Harman of Canada Limited and Williams Gold Refining Company of Canada Limited utilize platinum metals in dental alloys.

Prices

The prices of platinum metals in the United States according to E & M J Metal and Mineral Markets of December 31, 1959, were as follows:

	Per Troy Ounce
Platinum	\$ 77 to \$ 80 (average \$77)
Palladium	\$ 22 " \$ 24
Osmium	\$ 70 " \$ 90
Iridium	\$ 75 " \$ 80
Rhodium	\$122 " \$125
Ruthenium	\$ 55 " \$ 60

The average price of platinum at December 31, 1958, was $52 (U.S.) a troy ounce. Price increases of $5 and $10 an ounce were announced on February 17 and 21, 1959, respectively. A further rise of $10 was announced as effective March 9. These three increases brought the 1959 year-end average to $77 an ounce. Palladium also moved up an average of $6 an ounce. Offerings of the platinum metals by Russia in 1959 were probably not as great as in 1958. At best, they did not have the same depressing effect on market prices.

The platinum-metals production of International Nickel and Falconbridge are marketed by the Baker Platinum Division of Engelhard Industries, which has its headquarters in Newark, New Jersey. All South African production is refined and marketed by Johnson, Matthey and Company, Limited, Hatton Garden, London.

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Platinum wire and bars, strips, sheets and plates; platinum, palladium, iridium, osmium, ruthenium and rhodium, in lumps, ingots, powder, sponge or scrap	free	free	free
Platinum crucibles	"	"	"
Platinum retorts, pans, condensers, tubing and pipe, and preparations of platinum for manufacture of sulphuric acid	"	"	"
Platinum and black oxide of copper, for use in manufacture of chlorates and colors	"	10%	10%

United States

Ores of platinum metals	free
Platinum, unmanufactured or in bars, ingots, plates or sheets not less than 1/8" thick, scrap or sponge	"
Iridium, osmium, palladium, rhodium and ruthenium, and native combinations thereof with one another or with platinum	"
Chemical compounds, mixtures and salts, of which gold, platinum, rhodium or silver constitutes the element of chief value	12 1/2%

SELENIUM AND TELLURIUM

A.F. Killin*

SELENIUM

Selenium is a grayish, crystalline solid with a semimetallic lustre. Although found in the native state and in the selenides of copper, silver, lead, mercury, bismuth and thallium, it is obtained commercially only as a by-product of the electrolytic refining of copper anodes. One of the group of semiconductor metals, selenium is widely used in the electronics industry. Amounting to 368,107 pounds, selenium production in 1959 gained 61,117 pounds over its 1958 total. The output of refined selenium amounted to 372,410 pounds and, as in 1957 and 1958, was in excess of demand.

The gain is attributed to an increase in copper production from Quebec mines and particularly from the mine of Gaspe Copper Mines,Limited at Murdochville. Consumption and exports rose above the 1958 figures but did not reach the level of the peak years, 1954 to 1956. The long-range decrease in consumption and exports reflects the growing competition from ultrapure germanium and silicon in the electronics field.

The only companies producing primary selenium in Canada are Canadian Copper Refiners Limited, at Montreal East, Quebec, and The International Nickel Company of Canada,Limited,at Copper Cliff, Ontario. Some selenium is recovered from scrap left over in the manufacture of rectifiers and from old rectifiers.

At Montreal East, Canadian Copper Refiners Limited operates the world's largest selenium metal-and-salts plant, which has an annual capacity of 450,000 pounds of selenium. This plant produces commercial-grade selenium metal (99.5% Se), high-purity (H.P.) selenium metal (99.9% Se) and a wide range of metallic and organic selenium compounds. Among the most important selenium compounds produced are selenium dioxide (71% Se), sodium selenate (41% Se), sodium selenite (45% Se) and ferroselenium (55-75% Se). The selenium is produced from the tankhouse slimes obtained in the electrolytic refining of copper anodes from Quebec's Noranda and Murdochville smelters and from the treatment of blister copper from Manitoba's Flin Flon smelter.

International Nickel obtains selenium from the slimes resulting from the electrolytic refining of copper anodes produced in the smelting of the nickel-copper ores of Ontario's Sudbury district. The company's refinery,

*Mineral Resources Division

Selenium - Production, Exports and Consumption

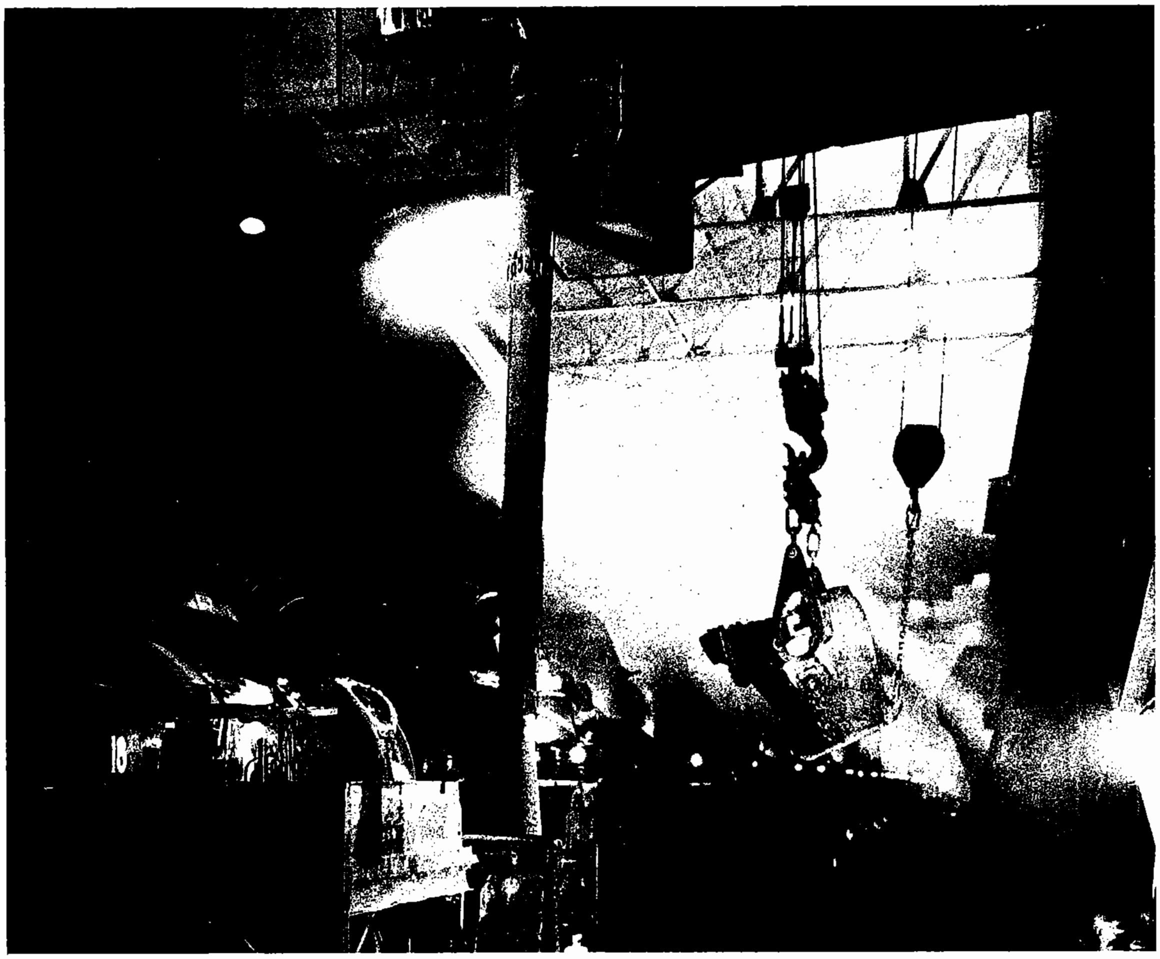
	1959		1958	
	Pounds	$	Pounds	$
Production(1)				
Quebec	194,233	1,359,631	179,397	1,345,478
Saskatchewan	57,677	403,739	30,234	226,755
Ontario	101,400	709,800	90,295	677,213
Manitoba	14,797	103,579	7,064	52,980
Total	368,107	2,576,749	306,990	2,302,426
Production (refined)(2)	372,410		342,141	
Exports (metals and salts)				
United States	169,564	664,996	138,253	871,118
United Kingdom	146,359	1,114,171	106,776	780,739
Union of South Africa	3,400	23,630	-	-
Argentina	2,477	13,005	-	-
Brazil	1,478	9,343	-	-
Other countries	2,434	21,339	5,322	49,049
Total	325,712	1,846,484	250,351	1,700,906
Consumption	21,981		16,600(3)	

(1) Recoverable selenium content of blister copper produced from domestic ores, plus some refined selenium.
(2) Includes production from scrap.
(3) Based on producers' domestic sales for 1958.
1959 consumption as reported by consumers.

located at Copper Cliff, Ontario, has an annual rated capacity of 240,000 pounds of minus 200 mesh, 99.7-per-cent-selenium powder. Selenium-bearing material is sent there from the company's copper refinery at Copper Cliff and its nickel refinery at Port Colborne, Ontario.

Consumption and Uses

Between World War I and World War II selenium and/or selenium compounds were used in the glass, rubber and alloy-steel industries. During World War II, selenium was used to some extent in the electronics industry for the manufacture of dry-plate rectifiers, but not until after 1947 did its use for this purpose become widespread. Today, the major part of the selenium used is consumed by the electronics industry in the manufacture of dry-plate rectifiers and photoelectric cells. Selenium dry-plate rectifiers, which



Converter aisle at the Copper Cliff smelter.

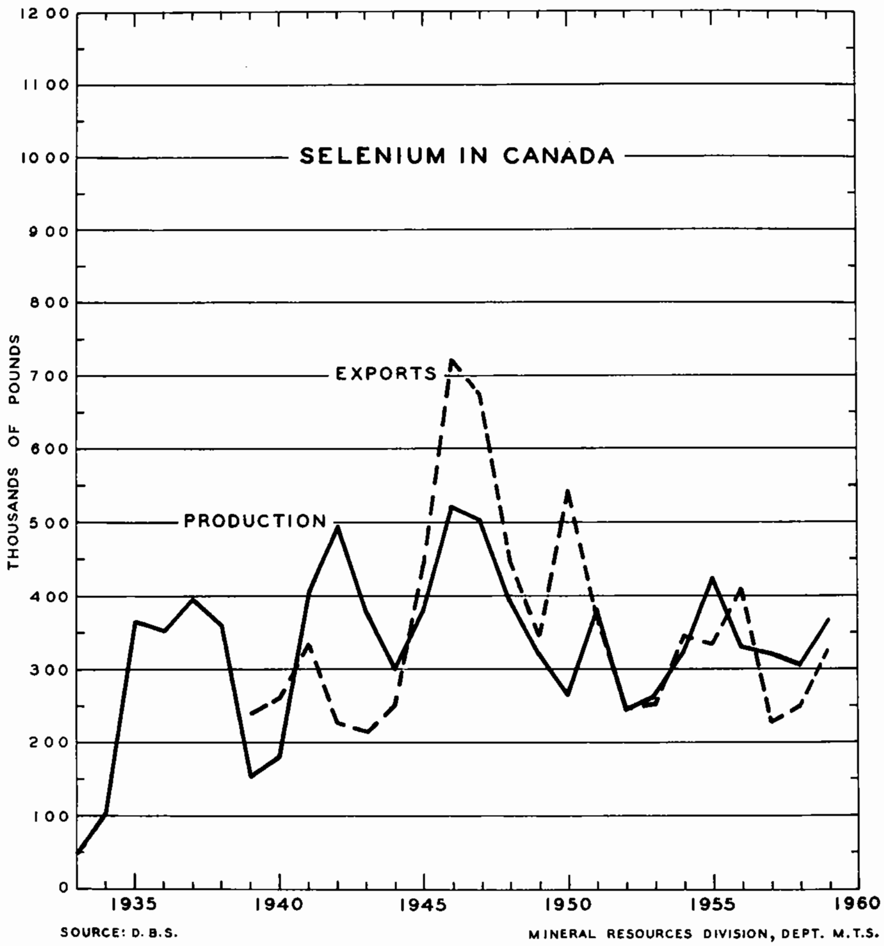
Selenium - Production, Exports and Consumption, 1949-59
(pounds)

	Production		Exports	Consumption[3]
	All Forms[1]	Refined[2]	Metals and Salts	
1949	318,225	288,116	343,784	3,625
1950	261,973	289,714	542,401	9,312
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	21,981

(1) Recoverable selenium content of blister copper produced from domestic ores, plus some refined selenium.
(2) Includes production from scrap.
(3) Producers' domestic shipments of selenium products (selenium content). For 1959, as reported by consumers.

require high-purity selenium for their manufacture, have the advantages of high electrical efficiency, compactness, long life, light weight and ruggedness. These qualities allow the use of selenium rectifiers in many industrial products, such as radio, television, battery chargers, electroplating equipment, magnetic brakes, shakers, agitators, circuit breakers and photoelectric cells in photographic-exposure meters. The photoelectric properties of high-purity selenium are used in xerography, a dry-print process. The consumption of selenium has decreased in recent years owing to an increase in competition from other semiconductor metals in the electronics field. Ultrapure silicon and germanium are finding increasing use in the rectifier field,and cesium is more efficient for use in photoelectric cells.

The glass industry uses selenium in the production of white or 'flint' glass. When added to the glass batch, selenium neutralizes the color imparted to the glass by iron contained in the glass sands. Ruby-red glass is obtained by the addition of larger quantities of selenium to the batch. The brilliant bright-red glass produced is used in stop lights, signal lights, automotive taillights, marine equipment and decorative tableware. The ceramics industry utilizes selenium to impart orange-to-dark-maroon colors to ceramic material for the coloring of glaze for chinaware, pottery, plastics and vitreous-enamel cover coats and the coloring of printing inks for glass containers. The pharmaceutical and chemical industries use selenium and selenium compounds to control dermatitis in the scalps of humans and the skins of animals and as a catalyst in the manufacture of cortisone and nicotinic acid. Commerical-grade



selenium is used in the rubber industry to increase heat, oxidation and abrasion resistance and to speed up the rate of vulcanization.

Greenhouse operators formerly used sodium selenate as a systemic insectioide, but this use is declining owing to the discovery of compounds easier to apply.

In the stainless-steel industry, ferroselenium added to certain grades of stainless steels improves the machinability and porosity of the castings without affecting corrosion resistance and working properties.

Among the more important consumers of selenium and selenium products in Canada are: Ontario - Syntron (Canada) Limited, Stoney Creek;

Canadian Line Materials Limited, Toronto; Bogue Electric of Canada Limited, Ottawa; Atlas Steels Limited, Welland; Ferro Enamels (Canada) Limited, Oakville; Fahralloy Canada Limited, Orillia; Quebec - Dominion Glass Company Limited, Montreal; Consumers Glass Company Limited, Ville St. Pierre; Shawinigan Chemicals Limited, Shawinigan; Needco Cooling Semiconductors Ltd., Montreal.

Prices

The prices of commercial-grade selenium and high-purity-grade selenium did not change during the year. These were quoted by E & M J Metal and Mineral Markets at $7 and $9.50 a pound respectively.

TELLURIUM

Tellurium, a steel-gray, brittle substance, is also a member of the semiconductor group of metals. Like selenium, tellurium occurs in the native state and as tellurides of gold, silver, mercury, bismuth, copper and lead. Commercially, tellurium is obtained from the anode slimes produced by the electrolytic refining of blister copper by The International Nickel Company of Canada,Limited,at Copper Cliff, Ontario, and Canadian Copper Refiners Limited at Montreal East, Quebec. No tellurium is recovered from gold, silver or lead ores in Canada.

As in the case of selenium, the source of International Nickel's tellurium is the copper-nickel ore of its deposits in the Sudbury district of Ontario. At Canadian Copper Refiners' plant at Montreal East tellurium is obtained from anode slimes from the electrolytic refining of blister copper from Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba, and from anodes from the smelters at Noranda and Murdochville, Quebec. Of the recoverable tellurium content of the blister and anode copper treated by Canadian Copper Refiners, approximately 20 per cent comes from the blister copper shipped by Hudson Bay Mining and Smelting from its Manitoba and Saskatchewan mines, about 7 per cent from anodes obtained from Ontario copper ores and the remaining 73 per cent from anodes produced by Quebec copper smelters.

Canada's production of tellurium in 1959 decreased to 13,023 pounds from the 38,250 pounds produced in 1958. The production of refined tellurium in any year is governed by the demand and the stocks on hand at the producer's plant. As shown in the tables on page 197 and the graph on page 198,Canadian production has varied considerably from year to year and greater production could be obtained if market conditions warranted it.

Tellurium - Production and Consumption

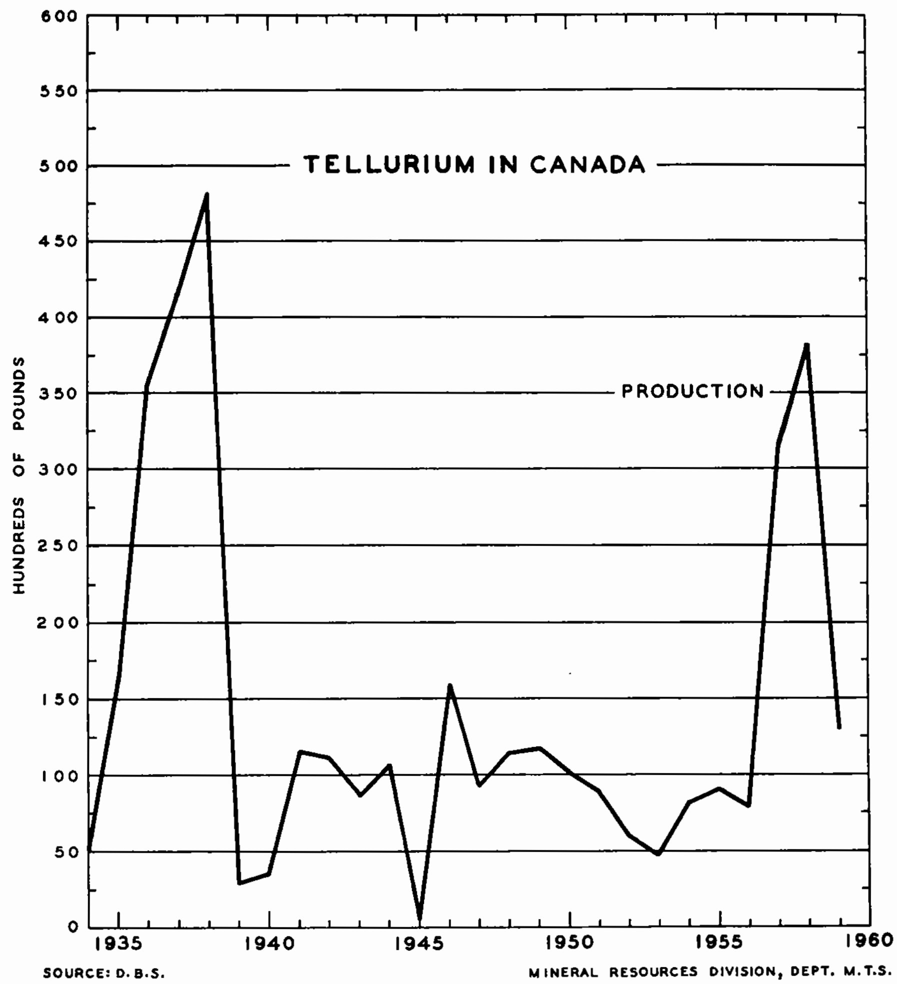
	1959*		1958	
	Pounds	$	Pounds	$
Production (all forms)(1)				
Quebec....................	1,662	3,573	29,457	50,077
Saskatchewan.............	3,552	7,637	1,707	2,902
Ontario..................	6,900	14,835	6,692	11,376
Manitoba.................	909	1,954	394	670
Total....................	13,023	27,999	38,250	65,025
Production (refined)(2)......	8,900		42,337	
Consumption (refined)(3)....	9,677		4,450	

(1) Includes the recoverable tellurium content of the blister and anode copper treated, plus some refined tellurium.
(2) Refinery output from all sources.
(3) Producers' domestic shipments of refined tellurium for 1958. 1959 consumption as reported by consumers.

Tellurium Production, 1949-59
(pounds)

	All Forms(a)	Refined(b)
1949	11,692	8,726
1950	10,075	6,010
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

(a) Includes the recoverable tellurium content of blister copper, which was not necessarily recovered in the year designated. Also includes some refinery output.
(b) Refinery production from all sources.



Consumption and Uses

Because of adverse physiological effects, tellurium is not so widely accepted and used as selenium. Tellurium compounds absorbed into the body by contact or inhalation give the breath a strong garlic odor which persists up to three months after exposure. Some progress is being made in solving this problem, and an increase in the use of high-purity tellurium in the field of electronics gives promise of wider application and expanded markets.

The largest single outlet for tellurium is the rubber industry, which adds small amounts of tellurium to natural or synthetic rubber to increase the rate of vulcanization, improve aging and mechanical properties and raise resistance to heat and abrasion. This improved rubber is used mainly in the production of insulation for portable electric cables on welding, mining and dredging machinery.

In the ferrous and nonferrous casting industries, tellurium in the form of controlled-size pellets is used to improve the properties of iron and copper. Tellurium, added to copper in proportions up to 0.5 per cent,is found to increase the machinability and hot-working properties of the metal without seriously affecting its conductivity or cold-working properties. This copper-tellurium alloy is used in the manufacture of welding tips and in the mass production of electrical connections. Small amounts of tellurium are added to iron castings to control the depth of chill and produce a hard, abrasion-resistant surface.

When tellurium is added to lead, the resultant alloy is harder and more resistant to corrosion and is thus suitable for use as tank-lining and piping for the handling of sulphuric acid. The corrosion resistance of lead-tellurium alloys makes them suitable as sheathing for submarine electrical cables.

Tellurium added to ceramics and glass imparts blue to brown colors.

Hydrochloric-acid solutions of tellurium chloride or tellurium dioxide are used to impart a permanent black antique finish to silverware.

Tellurium producers are conducting research into methods of producing high-purity tellurium for use in electronics and thermoelectronics. Interest has been stimulated in this field by the discovery that tellurides of bismuth and other semimetals are among the more efficient materials for thermocouples used in thermoelectric applications. Application of heat to the thermocouple will generate electricity, whereas passing an electric current through the thermocouple in the appropriate direction will establish a heat-sink and provide spot cooling.

Prices

Increased interest in tellurium for thermoelectric applications resulted in two rises in the United States price during the year.

The price quoted by E & M J Metal and Mineral Markets on January 1, 1959, was $1.65 to $1.75 a pound. This price rose to $2 a pound on May 14 and to $2.50 a pound in July.

SILVER

J.W. Patterson*

Silver production made a further gain in 1959, amounting for the year to 31,923,969 ounces. In 1958 and 1957 it totalled 31,163,470 and 28,823,298 ounces respectively. Most of the 1959 increase came from Ontario and Yukon Territory, which together surpassed their combined 1958 total by 1,364,671 ounces. The year's advance resulted mainly from significant increases in silver recovery from silver-cobalt and silver ores in Ontario and the mining of richer silver ore by United Keno Hill Mines Limited in Yukon Territory.

Fifty-four per cent of the total output was derived from lead-zinc and silver-lead-zinc ores, most of which were mined in British Columbia and Yukon Territory. Twenty-three per cent came from copper, copper-zinc and nickel-copper ores, 21 per cent from the silver-cobalt ores of northern Ontario and the remaining 2 per cent from lode- and placer-gold operations.

Fine silver was produced by The Consolidated Mining and Smelting Company of Canada Limited (Cominco), at Trail, British Columbia, from the refining of lead and zinc ores; Canadian Copper Refiners Limited, Montreal East, Quebec, in refining blister copper; Deloro Smelting & Refining Company, Limited, Deloro, Ontario, from the refining of silver-cobalt ores; The International Nickel Company of Canada, Limited, Copper Cliff, Ontario, from the refining of nickel-copper ores; and Hollinger Consolidated Gold Mines, Limited, Timmins, Ontario, and The Royal Canadian Mint, Ottawa, Ontario, in refining gold bullion.

World production of silver in 1959 was an estimated 217 million ounces. Mexico, with 44,075,452 ounces, was again the leading producer. Canada, with its 31,923,969 ounces, became the world's second largest producer. It was followed by the U.S.S.R. with 25,000,000 ounces. Labour strikes at major copper and lead refineries in the United States during the latter part of 1959 account for the sharp drop in United States production from 36,800,000 ounces in 1958 to 23,000,000 in 1959.

Demand throughout the world increased substantially. Consumption of world supplies in non-Communistic countries is estimated to have risen to 296 million ounces from a 1958 total of 250 million. The increase in demand is attributed in part to new currency programs in France and Italy. Coupled with a decrease in production, it caused temporary shortages. Canada, for the first time on record, placed an order for silver in London, which resulted in the purchase of more than 1 million ounces.

---

*Mineral Resources Division

Silver - Production and Trade

	1959		1958	
	Troy Ounces	$	Troy Ounces	$
Production				
By provinces				
Ontario	10,540,856	9,252,763	9,815,257	8,520,624
British Columbia and Alberta	7,463,304	6,551,289	8,013,456	6,956,481
Yukon Territory	7,054,632	6,192,556	6,415,560	5,569,348
Quebec	4,108,241	3,606,214	3,908,361	3,392,848
Manitoba and Saskatchewan	1,561,266	1,370,479	1,619,836	1,406,180
Newfoundland	1,125,110	987,622	1,267,078	1,099,950
Northwest Territories	70,560	61,937	72,779	63,179
Nova Scotia and New Brunswick	-	-	51,143	44,397
Total	31,923,969	28,022,860	31,163,470	27,053,007
By sources				
Base-metal ores	24,622,442		24,396,482	
Gold ores	629,581		707,433	
Silver-cobalt and silver ores	6,657,162		6,043,502	
Placer-gold ores	14,784		16,053	
Total	31,923,969		31,163,470	
Refined silver	21,770,510		24,620,142	
Exports				
In ore and concentrates				
United States	6,286,838	5,770,882	4,075,781	3,418,431
Belgium	326,727	270,215	472,046	399,259
West Germany	168,918	139,744	506,689	420,270
Other countries	32,382	29,334	44,272	36,528
Total	6,814,865	6,210,175	5,098,788	4,274,488
Silver bullion				
United States	15,075,769	13,452,501	15,428,386	13,749,848
West Germany	61,061	55,031	598,039	529,259
Cuba	4,000	3,645	-	-
Other countries	-	-	125	489
Total	15,140,830	13,511,177	16,026,550	14,279,596

Silver - Production and Trade (cont'd)

	1959		1958	
	Troy Ounces	$	Troy Ounces	$
Exports (cont'd)				
Manufactures				
United States		23,450		25,784
Union of South Africa		6,776		-
Bermuda.............		2,675		445
West Germany........		2,666		3,625
Other countries		3,331		105
Total		38,898		29,959
Imports				
Unmanufactured				
United Kingdom	1,005,051	889,354	2,100	1,858
United States	846,638	746,510	601	524
Mexico...............	753,943	667,950	-	-
Other countries	202,142	180,386	-	-
Total	2,807,774	2,484,200	2,701	2,382
Manufactured articles of silver, including toilet articles of sterling				
United Kingdom		362,075		398,020
United States		251,568		185,684
West Germany........		49,066		26,398
Denmark............		31,197		35,410
Other countries		25,048		30,985
Total		718,954		676,497

Developments at Producing Mines*

Yukon Territory

Silver production at the silver-lead-zinc mines of United Keno Hill Mines Limited in the Mayo district, Canada's largest single source of silver, reached an all-time high. In the fiscal year ended on September 30, 1959, production was 7,307,815 ounces. The previous year's output was 5,984,373

*See map on page 206.

53470-1—14½

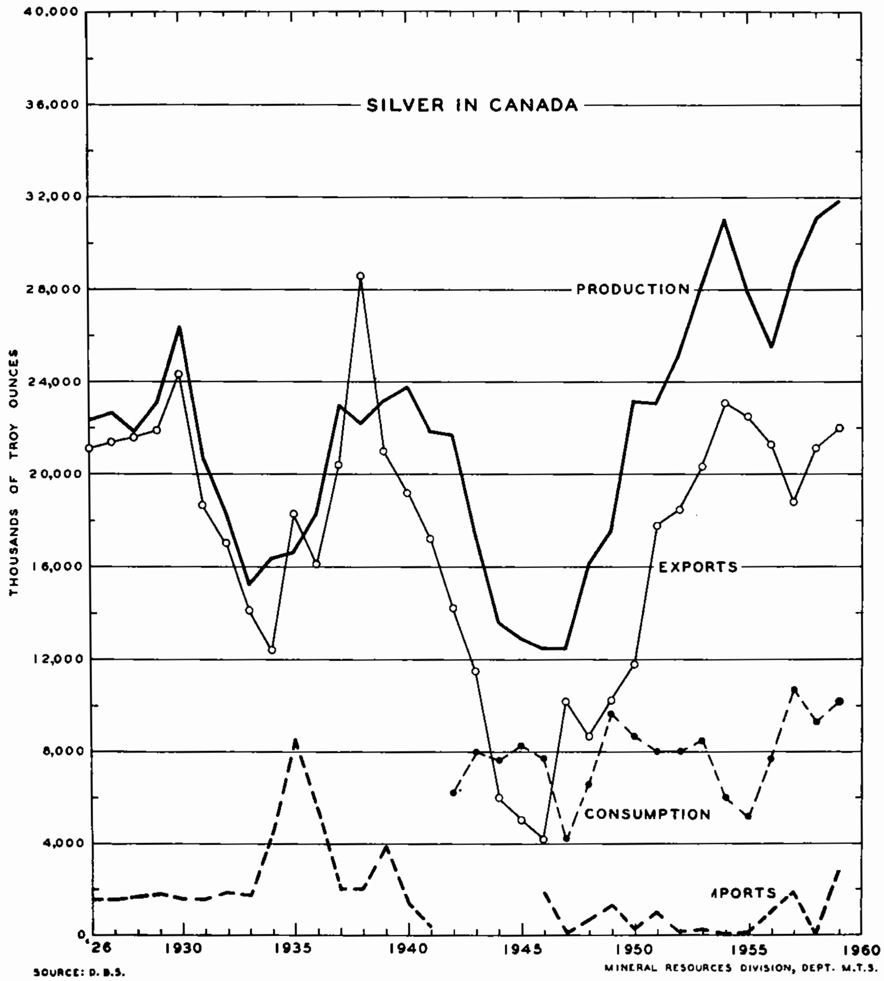
Silver - Production, Trade and Consumption, 1949-59

(troy ounces)

	Production		Exports			Imports	Consumption(b)
	All Forms(a)	Refined Silver	In Ore and Concentrates	In Bullion	Total	Unmanufactured	
1949	17,641,493	13,844,336	4,054,614	6,211,912	10,266,526	1,332,713	9,746,710
1950	23,221,431	19,435,644	3,494,107	8,355,183	11,849,290	341,605	8,668,866
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

(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, B.C.
5. Silver bullion produced from the treatment of cobalt-silver ores.

(b) Includes consumption for coinage.



ounces. The increase in silver production was attributable to the high-grade ore from the Elsa mine, which amounted to 28,262 tons and averaged 79.05 ounces of silver per ton. In addition to the Elsa production, 144,886 tons of ore were derived from the Hector and Calumet mines, and 509 tons from the development and clean-up of the Galkeno mine.

Northwest Territories

Practically all the silver production came from four gold mines in the Yellowknife and Giauque Lake areas.

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited, Canada's largest producer of refined silver, recovered 9,367,029 ounces from ore mined from its three base-metal mines - the Bluebell, the H.B. and the Sullivan - and from purchased ore, most of which was obtained from Canadian shippers. The principal source of silver was 2,440,396 tons of lead-zinc-silver ore extracted from the Sullivan mine at Kimberley. The Bluebell lead-zinc mine at Riondel produced 251,366 tons of ore, and the H.B. zinc-lead mine near Salmo produced 463,504 tons. Silver was recovered also on a custom basis from domestic and foreign ores and concentrates, the principal shippers being in British Columbia and Yukon Territory.

Torbrit Silver Mines Limited stopped production from its silver-lead mine near Alice Arm on September 27 owing to exhaustion of ore reserves. By that date, 93,577 tons of ore had been milled, and from this ore 850,627 ounces of silver were recovered. Torbrit Silver's production began in 1949 and was almost continuous to the date of closure. During this period, the mine produced 18,706,847 ounces of silver in addition to substantial amounts of lead.

Highland-Bell Limited, at Beaverdell, milled 18,029 tons of ore and produced lead and zinc concentrates having a gross value of $842,065, of which $716,325 was derived from silver.

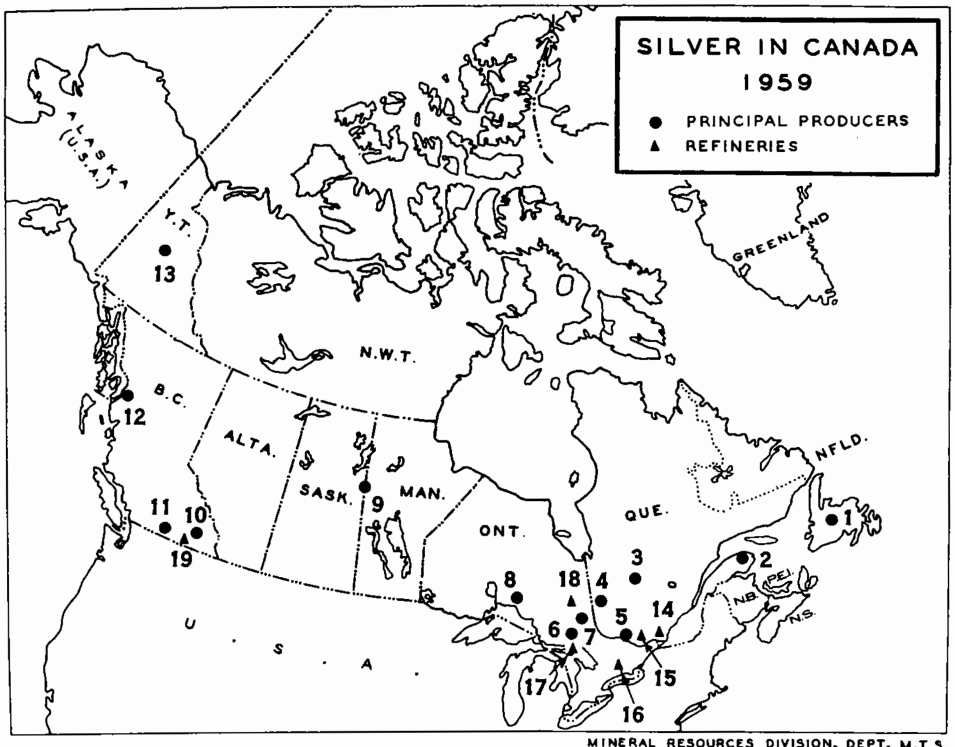
Violamac Mines Limited produced 6,028 tons of silver-lead-zinc ore from the Victor mine near Sandon. Of this, 38 tons were of shipping grade. The rest was treated in the 250-ton mill of a subsidiary, Carnegie Mining Corporation Limited. Silver production in ore and in lead and zinc concentrates was 131,931 ounces.

Sheep Creek Mines Limited milled 181,495 tons of zinc-lead ore assaying 1.27 ounces of silver per ton. From the lead and zinc concentrates produced, 228,400 ounces of silver were recovered.

Silver was also recovered from lead-zinc ores by Canadian Exploration Limited, near Salmo, and Reeves MacDonald Mines Limited, at Remac. Several other operators, mostly in the Slocan mining division, mined small quantities of high-grade ore. Some of this ore was treated on a custom basis in mills operated by Yale Lead and Zinc Mines Limited and Violamac Mines Limited; the remainder was smelted without prior concentration other than hand-sorting.

Some production was obtained from copper ores by Consolidated Woodgreen Mines Limited and Phoenix Copper Company Limited, in the Grand Forks area, by Howe Sound Company (Britannia Division), at Howe Sound, by Texada Mines Limited, on Texada Island,and by Cowichan Copper Co. Ltd., on Vancouver Island.

The rest of the output was by-product silver from gold operations.



Producers

1. Buchans Mining Company, Limited
2. Gaspe Copper Mines, Limited
3. Campbell Chibougamau Mines Ltd.
   Opemiska Copper Mines (Quebec) Limited
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. New Calumet Mines Limited
6. Silver-Miller Mines Limited
   Agnico Mines Limited
   Langis Silver & Cobalt Mining Company Limited
   Castle-Trethewey Mines Limited
   Siscoe Metals of Ontario Limited
7. International Nickel Company of Canada, Limited, The
   Falconbridge Nickel Mines Limited
8. Geco Mines Limited
   Willroy Mines Limited
9. Hudson Bay Mining and Smelting Co., Limited
10. Consolidated Mining and Smelting Company of Canada Limited, The (Bluebell and Sullivan mines)
    Sheep Creek Mines Limited
    Violamac Mines Limited
    Yale Lead and Zinc Mines Limited
11. Highland-Bell Limited
12. Torbrit Silver Mines Limited
13. United Keno Hill Mines Limited

Refineries

14. Canadian Copper Refiners Limited
15. Royal Canadian Mint
16. Deloro Smelting & Refining Company, Limited
17. International Nickel Company of Canada, Limited, The
18. Hollinger Consolidated Gold Mines, Limited
19. Consolidated Mining and Smelting Company of Canada Limited, The

Manitoba and Saskatchewan

Hudson Bay Mining and Smelting Co., Limited produced 1,538,038 ounces of silver contained in blister copper from copper-zinc mines of the Flin Flon area. The remainder, all of which was produced in Manitoba, was a by-product of operations of Sherritt Gordon Mines Limited at Lynn Lake and of gold mines at Rice Lake operated by San Antonio Gold Mines Limited and Forty-Four Mines Limited.

Ontario

About 50 per cent of the province's output comes from the silver-cobalt mines of the Cobalt-Gowganda area. Most of the production from this area passes through the sampling plant of Temiskaming Testing Laboratory, at Cobalt, as is shown in the accompanying table. Deloro Smelting & Refining Company, Limited is the chief refiner of these shipments.

Shipments via Temiskaming Testing Laboratory

Company	Silver Bullion	Silver Concentrates	Total Production
	(ounces)	(content in ounces)	(ounces)
Agnico Mines Limited............	598,554	705,263	2,126,131
Castle-Trethewey Mines Limited...	108,444	828,128	916,000
Coballoy Mines and Refiners, Limited	226	1,212	*
Langis Silver & Cobalt Mining Company Limited.........	77,184	1,007,264	1,129,763
Silver-Miller Mines Limited.......	33,010	108,210	*
Siscoe Metals of Ontario Limited...	230,682	945,598	1,444,425
Temiskaming Testing Laboratory...	–	15,549	*
Total..........................	1,048,100	3,611,224	

*Not available.

The International Nickel Company of Canada, Limited, at Copper Cliff, recovered 1,200,000 ounces of silver from the treatment of nickel-copper ores.

In the Manitouwadge area, Geco Mines Limited milled 1,290,279 tons of copper-zinc ore and recovered 1,363,525 ounces of silver in copper concentrates. Willroy Mines Limited, whose mine is adjacent to the Geco mine, treated 371,186 tons of zinc-copper-lead ore and produced copper and lead concentrates containing 820,246 ounces of silver.

The rest of the Ontario production came from Falconbridge Nickel Mines Limited, Temagami Mining Co. Limited and numerous lode-gold mines.

Quebec

The production is all by-product and comes mainly from copper ores. Copper concentrates shipped to Noranda are converted into anode copper along with Noranda ores; the anode copper is refined at Canadian Copper Refiners Limited, Montreal East, where the silver is recovered.

Other amounts are recovered from blister copper produced by Gaspe Copper Mines Limited and refined by Canadian Copper Refiners at Montreal East, and from lead and zinc concentrates obtained from several mines and shipped abroad for refining.

The principal producers in 1959 were: Noranda Mines, Limited, Manitou-Barvue Mines Limited, Normetal Mining Corporation, Limited, Quemont Mining Corporation, Limited, East Sullivan Mines Limited, and Waite Amulet Mines, Limited - all in the Noranda-Val d'Or area of western Quebec; New Calumet Mines Limited, 60 miles northwest of Ottawa; Gaspe Copper Mines, Limited, at Murdochville; and, in the Chibougamau area, Opemiska Copper Mines (Quebec) Limited, Anacon Lead Mines Limited, Campbell Chibougamau Mines Ltd. and Merrill Island Mining Corporation, Ltd.

Some silver was obtained as a by-product from the lode-gold mines of western Quebec.

Newfoundland

The Buchans unit of American Smelting and Refining Company treated 359,000 tons of zinc-lead-copper ore and produced zinc, lead and copper concentrates containing silver. These concentrates were exported for recovery of the contained metals.

Developments at Other Properties

Manitoba

Hudson Bay Mining and Smelting Co., Limited continued development of the Chisel Lake orebody near Snow Lake. On the basis of surface diamond-drilling and underground exploration, this orebody is estimated to contain 3,832,400 tons of zinc-lead-copper ore grading 1.96 ounces of silver per ton.

Quebec

Exploration of the Watson Lake zinc-copper deposit, held by Mattagami Lake Mines Limited, was continued under an option by Noranda Mines, Limited, Canadian Exploration Limited and McIntyre Porcupine Mines Limited. At year-end, diamond-drilling completed since exploration began in 1957 indicated 23 million tons of ore averaging about 12.5 per cent zinc, 0.7

per cent copper and 1.3 ounces of silver per ton. Other companies in the Watson Lake area, included in which are New Hosco Mines Limited and Orchan Mines Limited, have reported substantial reserves of copper and zinc ores containing appreciable values in silver.

Late in 1959, Consolidated Vauze Mines Limited announced plans to sink a three-compartment shaft on its copper-zinc property adjacent to and north of the property of Waite Amulet Mines,Limited in the Noranda district. Several copper-zinc orebodies containing economically recoverable values in gold and silver have been indicated by diamond-drilling.

Domestic Consumption

Although complete consumption data for 1959 are not available, 10.1 million ounces of silver are estimated to have been consumed in Canada. Consumption by arts and industries is estimated at 4.4 million ounces, the remainder having being consumed in coinage manufacture.

	Troy Ounces	
	1959	1958
Coinage	5,737,347	4,662,224
Silverware	1,513,929	1,509,971
Plating		1,118,390
Photography	1,376,004	1,306,300
Wire and rod	21,143	338,721
Brazing alloys		85,001
Lead-silver alloys	140,223	6,292
Sheet		2,116
Miscellaneous	1,414,123*	270,794
Total	10,202,769	9,299,809

* Includes: Anodes for electroplating, Sheet, Antimonial lead, Electrical uses, General jewellery.

Prices

The Canadian price of silver fluctuated between a high of 89.12 cents an ounce in March and a low of 86.75 cents in October and November. The opening and closing prices for 1959 were 87.13 and 87.38 cents respectively. The average price for the year was 87.79 cents.

TIN

W.H. Jackson**

Tin concentrates were smelted at Trail, British Columbia, from 1942 to 1952. Production of tin metal was then discontinued, and Canadian concentrates have since been exported.

All virgin tin now consumed in Canada is imported, originating for the most part in European and Malayan smelters. Imports from all sources, as shown in the accompanying statistical tables, amounted to 4,183 long tons* in 1959, 21 per cent more than in 1958. The demand for tin in the manufacture of tin plate is the main reason for the increase. There were also increases in the production of solder, babbitt and bronze.

Production and Exploration

Canada has many occurrences of tin minerals, but,unlike other countries, it has no known economically minable deposit. Cassiterite, the common mineral found, occurs in placers, in the marginal phases of certain granitic intrusives, and in associated veins and pegmatites. It is also a minor constituent of some lead-zinc ores, the cassiterite from the Sullivan mine, at Kimberley, British Columbia, being an example. Tin minerals are present in a similar geological environment in the Bathurst area of New Brunswick.

The Consolidated Mining and Smelting Company of Canada Limited remains the sole producer of tin concentrate, the Sullivan mine being its source of output. The cassiterite in the complex lead-zinc ores from this mine accompanies zinc minerals through the mill recovery process. The zinc-circuit tailings, which contain about 1.2 pounds of tin per ton, are subjected to flotation for the removal of iron sulphides and are then passed over blanket concentrators and shaking-tables. The final tin concentrate, containing about 65 per cent tin, is shipped abroad for refining. Production from this source in 1959 amounted to 334 tons of contained tin.

An occurrence of cassiterite was being evaluated in the St. Stephens area of New Brunswick,but otherwise there was little exploration during the year.

(text continued on page 213)

* Long tons (2,240 pounds) are used in this review.

**Mineral Resources Division

Tin – Production, Imports and Consumption

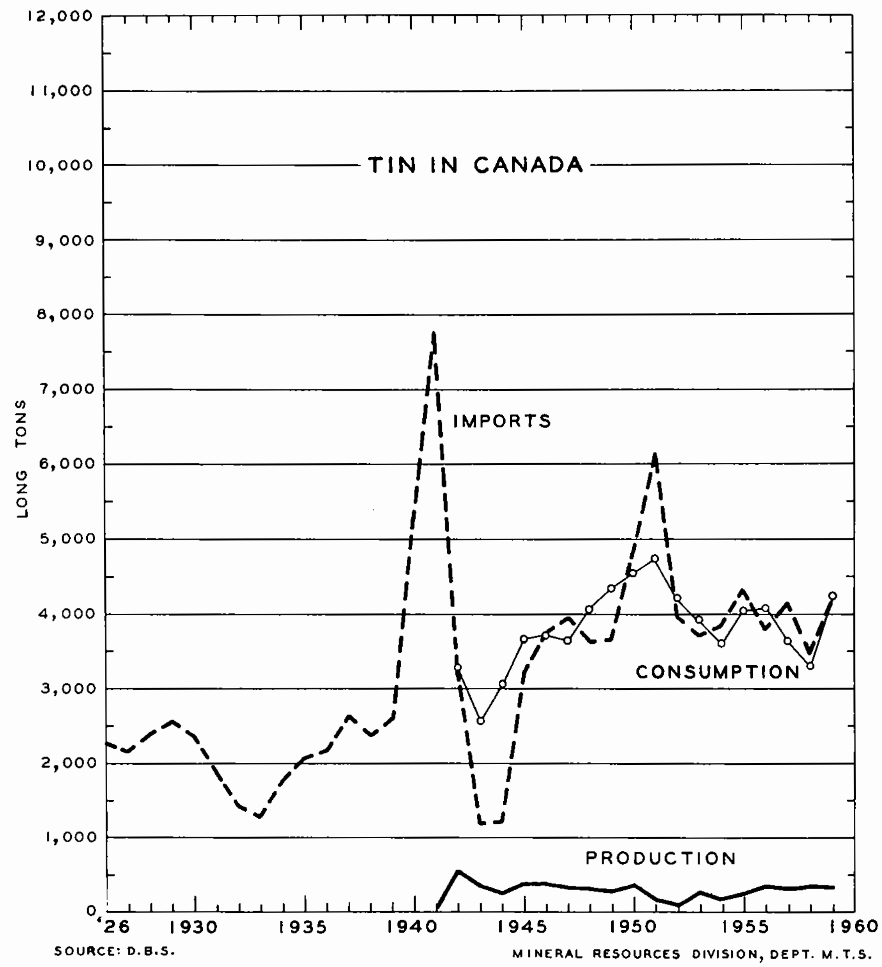
	1959		1958	
	Long Tons	$	Long Tons	$
Production				
Tin content of tin concentrates shipped............	334	630,094	355	625,260
Imports				
Blocks, pigs, bars				
United States	993	2,189,168	426	881,920
Belgium	990	2,146,403	970	1,939,432
United Kingdom	707	1,535,256	253	511,326
Malaya	952	2,121,381	937	1,951,603
Netherlands.........	395	877,249	740	1,517,147
West Germany	146	312,215	80	153,681
China	-	-	50	95,684
Hong Kong	-	-	5	9,594
Total	4,183	9,181,672	3,461	7,060,387
Tin plate				
United Kingdom	3,706	768,069	3,371	737,104
United States........	1,270	234,257	2,589	540,475
West Germany	1	263	-	-
Total..............	4,977	1,002,589	5,960	1,277,579
	Pounds		Pounds	
Tin foil				
United States	17,428	19,333	20,786	22,956
United Kingdom	-	-	183	141
Other countries	518	2,039		
Total...............	17,946	21,372	20,969	23,097
Babbitt metal				
United States........	27,700	24,587	18,300	16,442
United Kingdom......	38,000	5,689	4,100	3,023
Total	65,700	30,276	22,400	19,465

Tin - Production, Imports and Consumption (cont'd)

	1959		1958	
	Long Tons	$	Long Tons	$
Consumption				
Virgin tin				
Tin plate and tinning...........	2,278		1,673	
Solder	1,254		1,172	
Babbitt	274		230	
Bronze	146		117	
Galvanizing	12		14	
In other products including foil and collapsible tubes ..	259		87	
Total	4,223		3,293	

Tin - Production, Imports and Consumption, 1949-59
(long tons)

	Production	Imports				Consumption
	Tin Content of Concentrate	Blocks, Pigs, Bars	Tin Foil	Babbitt Metal	Tin Plate	Virgin Tin
1949	276	3,676	3	39	23,027	4,318
1950	356	4,817	15	60	1,488	4,526
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



A newly formed company, The Electro Tin Company of Canada Limited, announced plans, subject to completion of financing, to install a detinning plant at Oshawa, Ontario. The treatment of foreign tin ores is also contemplated.

World Production and Developments

Shipments of concentrate from mines to smelters contain from 45 to 76 per cent tin. The prices received vary according to assay, certain impurities which affect smelter charges, and the price of tin. When, for example, the metal is selling on the main metal exchanges for the equivalent of 95 cents a pound, a prospective Canadian producer may at present expect the price of a concentrate delivered to smelter and assaying 60 per cent tin to be roughly 53 to 54 cents a pound.

The grades of ore mined vary with the type and mineralogy of deposits, mining costs and geographical location with respect to smelters. In the Belgian Congo, by the use of open-cast methods, some operations mine 2 to 4 kilograms per metric ton and produce a concentrate of 76 per cent tin with more than 90 per cent recovery. At Catavi, Bolivia, ore grading 0.76 per cent is mined by block-caving methods. Large placer operations in Malaya may work ground containing only 0.25 to 1 pound of cassiterite per cubic yard.

World Production and Consumption of Tin*
(long tons)

	1955	1956	1957	1958	1959
Production of tin-in-concentrates	181,000	181,000	180,000	135,000	138,000
Smelter production of tin metal	182,000	182,000	175,000	140,000	132,000
Consumption of tin	154,000	160,000	155,000	149,000	163,000

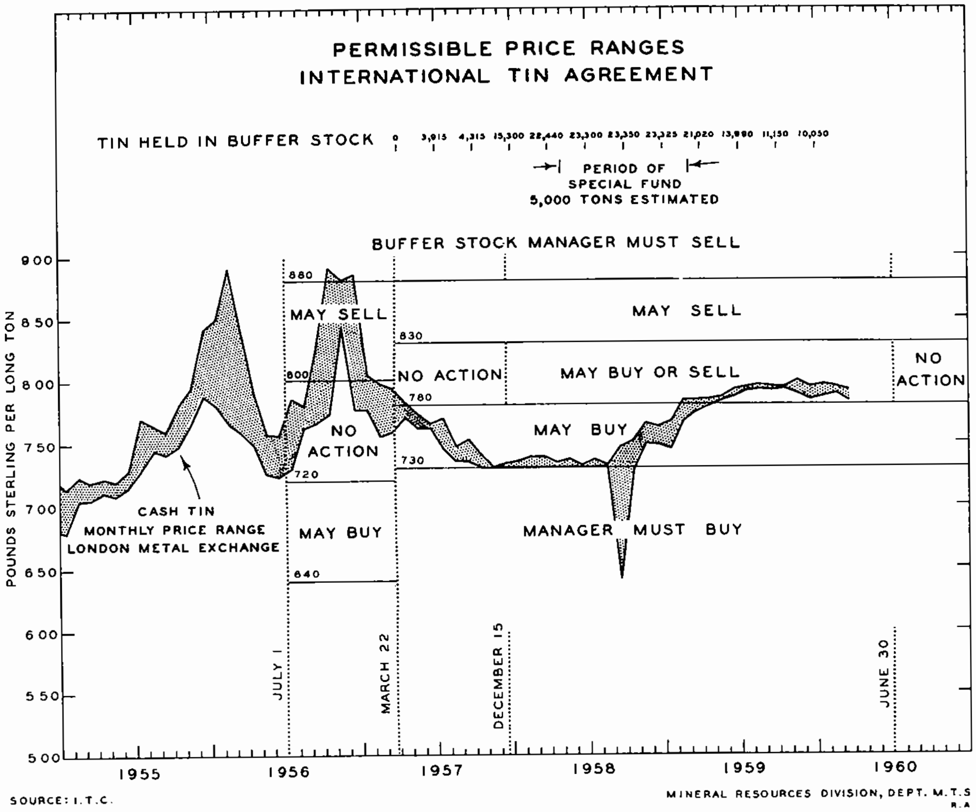
*Data for the Union of Soviet Socialist Republics are not included.

Owing to an unusual demand arising from defence needs, the price of tin reached a peak of £1,620 a ton in 1951. This fact,coupled with the accumulation of tin for national stockpiles and subsequent termination of stockpile programs, led eventually to oversupply. In 1953, in recognition of the need to protect the tin-mining industries in producing countries and the need to ensure adequate supplies of tin at reasonable prices in consuming countries, the United Nations held a tin conference. The International Tin Agreement, which was drawn up at this meeting and to which Canada is signatory, came into effect for a five-year period beginning on July 1, 1956.

Nations designated as producers and consumers hold equal votes in the governing body, the International Tin Council. Producing members must contribute to a buffer stock totalling 25,000 tons maximum and, under certain circumstances, the Council may institute quarterly export controls.

Permissible price ranges under the Agreement, with subsequent amendments by the Council, are shown on the graph on page 215 together with the actual price of cash tin on the London Metal Exchange. Reference should be made to the graph in connection with what follows in this text.

In 1957, heavy purchases of tin were made for the buffer stock, and on December 15 of that year export controls were instituted. The supply of tin in trade channels, however, in addition to unexpected exports by the Union of Soviet Socialist Republics, caused the Buffer Stock Manager to withdraw floor-price support for a brief period in September 1958 despite the creation of a special fund estimated at 5,000 tons. Stringent production restrictions were in effect from October 1958 to March 1959, and during this period the producers' exports amounted to only 53 per cent of precontrol output. Afterwards, the market for tin gradually improved to such an extent that in the first quarter of 1960 permissible exports were set at 36,000 tons,or 95 per cent of precontrol output.



The sale of all the special-fund stock by the end of February 1959 made it possible to sell from the buffer stock. The establishment, by the close of 1959, of a reasonable balance of supply, demand and stocks permitted an increase in production, with prices in the middle third of the price range. This situation, however, could not have been achieved so quickly except for three factors: (1) the imposition in August 1958, by some consumer signatories including Canada, of import controls, which were terminated early in 1959; (2) voluntary control of exports by the U.S.S.R.; (3) United States stockpiling purchases that were in addition to the producers' permissible export quotas. It is worthwhile to note that neither the United States nor the U.S.S.R. is a participant in the International Tin Agreement. In 1959, producers signatory to the Agreement accounted for four fifths of world output, and consumer signatories accounted for two fifths of world consumption.

Uses and Consumption

Tin is vital to the successful operation of modern industry. Throughout the world, as in Canada, it finds its main uses in tinplate, solder, bronze and babbitt. As these commodities are used in diverse industries from electronics to canning, tin consumption is a good indicator of manufacturing activity. In 1959, Canadian tin consumption increased by 28 per cent to 4,223 tons from the 3,293 tons consumed in 1958, a recessionary year.

New applications may eventually bring wider use. A few of these are worth noting. Organotin compounds are being developed as fungicides and can be used as stabilizers for polyvinyl chloride and related types of plastics. Titanium alloys that contain about 2.5 per cent tin are in increasing demand for aircraft construction. A compound having the formula Zr_5Sn_3 and melting at 2,000°C may be applicable in high temperature.

Tin metal or alloys are used in Canada by considerably more than a hundred companies. The tabulation on this page shows only the main consumers and the products with which they are concerned.

The quantities of tin used by Canadian manufacturers are shown on page 212.

Main Users of Tin in Canada

Tin Plate	Tinning	Solder	Babbitt	Bronze	Foil	Collapsible Containers	
x							Dominion Foundries and Steel Limited
x							Steel Company of Canada, Limited, The
	x						General Steel Wares Limited
	x						Canada Wire and Cable Company Limited
	x						Northern Electric Company Limited
	x						Phillips Electrical Company Limited
	x						Canadian Pacific Railway Stores Department
	x						Casavant Frères Ltée
		x	x				Federated Metals Canada Limited
		x	x	x			Canada Metal Company Limited, The
		x					Kester Solder Co. of Canada Limited
		x					Metals and Alloys Limited
				x			Anaconda American Brass Limited
				x			Noranda Copper and Brass Limited
				x			McKay Smelters Limited
					x		Canada Foils Limited
						x	Sun Tube Corporation of Canada Limited

Prices

The Canadian price of Straits tin f.o.b. Montreal was 100.95 cents a pound at the beginning of the year. It reached a high of 108.75 cents on February 27 and a low of 100.65 cents on December 28. The average for the year was 104.41 cents a pound.

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Tin, in blocks, pigs, bars, or granular form for use in Canadian manufacture	free	free	free
Tin-strip waste and tin foil	"	"	"
Phosphor tin and phosphor bronze in blocks, bars, plates, sheets and wire	5%	7 1/2%	10%
Oxide of tin	free	15%	15%
Bichloride of tin and tin crystals	"	10%	10%
Sheet or strip of iron-ore steel, corrugated or not, and whether or not with rolled surface pattern, coated with tin	10%	15%	25%
Sheet or strip of iron or steel coated with lead or with alloy of lead and tin	free	free	15%
Manufactures of tinplate, painted, japanned, decorated or not, and manufactures of tin, not otherwise provided	15%	20%	30%

United States

Tin ore and black oxide of tin	free
Tin in bars, blocks and pigs; alloys of tin not specifically provided for, in which tin is chief value; grain or granular scrap tin (including scrap tin plate)	"
Tin foil under 0.006 inch thick	35%
Powdered tin	12¢ per lb
Tin plate, taggers tin	0.8¢ per lb
Terneplate	1¢ per lb
Babbitt metal, type-metal solder	1 1/16¢ per lb on lead content
Chemical compounds and mixtures of tin	12 1/2%

TITANIUM

V.B. Schneider*

The value of titanium shipped in 1959 as ore, heavy aggregate or titanium-bearing slag was $8,636,714. This is $2,061,637 above the 1958 value.

The Canadian 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 this 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 TiO_2 (titanium dioxide), a high-quality pig iron and a complex calcium-magnesium-aluminum silicate. 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 was used as heavy aggregate. In 1959, however, some ore was shipped to Italy, where it was smelted to produce a titanium-dioxide slag. The consumption of ilmenite used as heavy aggregate is mostly domestic, but small amounts are exported to the United States.

The 1958 decline in the demand for the titanium-bearing slag used by the pigment industry reversed in 1959, and Quebec Iron and Titanium Corporation reported that slag production was 51 per cent greater than in 1958.

Heavy aggregate is used for shielding nuclear reactors, as a weighting material for oil- and gas-transmission lines and as Diesel-locomotive ballast. Sales of heavy aggregate for oil and gas lines were practically negligible during the year. The value of aggregate varies according to size and specific gravity but is about $6 a ton for pipeline grade and $10 a ton for reactor grade, f.o.b. shipping point.

Production and Developments in Canada

Quebec Iron and Titanium Corporation (QIT)

Quebec Iron and Titanium Corporation, the sole Canadian producer of titanium-dioxide slag for pigment manufacture, operates eight furnaces at its Sorel plant. They have a total annual capacity of 400,000 tons of titanium-dioxide slag and 300,000 tons of high-grade (remelt) iron. Two of the furnaces

---

*Mineral Resources Division

Titanium - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)				
Ore shipped from St. Urbain area and Allard Lake area to outside customers	26,777	129,565	-	-
Titanium-dioxide slag produced from Allard Lake ilmenite and smelted at Sorel	*	8,507,149	*	6,575,077
Total		8,636,714		6,575,077
Exports				
Titanium-dioxide slag				
United States	*		72,168	2,910,586
Japan	*		25,572	1,050,272
United Kingdom	*		11,312	464,600
Netherlands	*		3,364	108,144
Total			112,416	4,533,602
Imports				
Titanium oxide and pigments containing not less than 14% titanium oxide				
United States	17,682	3,545,123	18,550	3,814,991
United Kingdom	11,897	4,958,593	10,888	4,649,207
Belgium	771	272,267	1	492
Italy	246	100,395	-	-
Czechoslovakia	2	629	-	-
Total	30,598	8,877,007	29,439	8,464,690

*Not available.

were completed in 1958 in an expansion program begun in 1957, but their heating and charging was deferred until 1959. Near-capacity operation was planned for 1960.

Production of Ilmenite and Titanium-dioxide Slag
and Imports of Titanium Oxide and Pigments, 1949-59

(short tons)

	Production		Imports
	Ilmenite(1)	Titanium-dioxide Slag (TiO_2 content)(2)	Titanium Oxide and Pigments(3)
1949	540	-	20,793
1950	101,970	1,596	27,125
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	(4)	(4)	29,439
1959	(4)	(4)	30,598

(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% TiO_2.
(4) Not available for publication.

QIT owns one of the world's largest known reserves of ilmenite - 150 million tons averaging 35 per cent TiO_2 and 40 per cent iron. It is in the Allard Lake area of Quebec about 22 miles north of Havre St. Pierre, the north-shore Gulf of St. Lawrence shipping point, which is about 500 miles downriver from Sorel.

This company's production for 1958 and 1959 is as follows:

	Gross Tons	
	1959	1958
Ore treated	559,205	375,832
TiO_2 slag produced	217,589	144,029
Desulphurized iron produced	145,990	105,248

Continental Iron and Titanium Mining Limited

This company, formed in 1955, holds 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 estimates its reserves in the St. Urbain area at 20 million tons of ilmenite. The company reports that in 1959 it shipped not only to the domestic market but also to Italy, the United States and the United Kingdom.

Canadian Titanium Pigments Limited

A subsidiary of National Lead Company, of the United States, this company operates the only plant in Canada that manufactures titanium-base pigments. Its plant at Varennes, Quebec, operated continuously during 1959, manufacturing both rutile- and anatase-type titanium dioxide. Slag from QIT operations at Sorel and molten sulphur recovered from waste petroleum-refinery gases at Montreal East constituted the main raw materials for pigment manufacture. The company reported that the established use pattern was maintained in 1959 but that the applications of titanium-base pigments in the manufacture of paper and plastics are growing in relative importance.

British Titan Products (Canada) Limited

This subsidiary of British Titan Products Company Limited announced its intention of building a pigment-manufacturing plant at Sorel, Quebec, in 1960. QIT will supply the new plant with titanium-dioxide slag.

World Production of Titanium Ores and Concentrates

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 of Russia. Generally, however, only ilmenite and rutile are considered to be of commercial importance. Ilmenite theoretically contains a maximum of 53 per cent titanium dioxide, and rutile theoretically contains 100 per cent.

By far the greatest percentage of ilmenite produced is used in the manufacture of pigments. Pigment-grade TiO_2 is manufactured principally by treating ilmenite with sulphuric acid, removing the iron and grinding the titanium component to pigment size. Ilmenite mined by QIT does not lend itself to this process because hematite is finely disseminated throughout the ilmenite and cannot be removed by standard ore-dressing methods. At Sorel, by a pyrometallurgical process, the iron is separated from the ilmenite and associated hematite as molten metal, the remaining ingredients being contained in the slag.

The accompanying tables show the major producers of rutile and ilmenite concentrates in 1957, 1958 and 1959.

Production of Rutile Concentrates

(short tons)

	1959	1958	1957
Australia	91,900(e)	93,325	144,372
United States	9,466	7,406	10,702
Other countries	3,834	2,469	1,126
Total	105,200	103,200	156,200

(e) Estimated.
Source: U.S. Bureau of Mines, Minerals Yearbook 1958 (preprint) and U.S. Bureau of Mines, MMS No. 3003.

Production of Ilmenite Concentrates

(short tons)

	1959	1958	1957
United States	634,886	563,338	757,180
India	334,000	346,080	331,768
Canada*	247,858	161,312	269,690
Norway	249,453	233,585	231,693
Malaya	81,593	83,806	102,742
Finland	94,966	117,384	116,568
Other countries	266,344	216,395	162,659
Total	1,909,100	1,721,900	1,972,300

* Production of slag containing 70% TiO_2.
Source: Mineral Industry Surveys, U.S. Bureau of Mines and U.S. Department of the Interior, Mineral Market Survey No. 3078.

Titanium-metal Production and Fabrication

Using technical-grade titanium dioxide as the raw material, Dominion Magnesium Limited, near Haley Station, Ontario, produced titanium in the form of pellets weighing from 5 to 7 grams each. These are restricted in their use to shell fuses and alloying with nickel.

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; Mallory-Sharon Metals Corp., 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

Great Britain, Imperial Chemical Industries Limited, Birmingham, is the principal producer. Production in France and West Germany is on a minor scale. There is no available information about the titanium industry in the Union of Soviet Socialist Republics.

Sponge-metal production in the United States declined in 1959 to approximately 3,900 tons. In 1958 it amounted to 4,600 tons and in 1957 to 17,249. The decline was due to the cutback in military requirements. More and more, however, titanium is going into civilian aircraft, and its use in missiles appears to be increasing. Technological advances and the continued decline in the price of most titanium products - sponge, ingot, strip, plate and billet - have done much to increase the commercial potential of the metal.

Commercial production and fabrication of titanium mill products and forgings from imported ingots and billets is carried out by several Canadian companies. These include the following: in Quebec - Canadair Limited, Montreal; in Ontario - Atlas Titanium Limited, Welland; Thompson Products, Limited, St. Catharines; and Canadian Steel Improvement Ltd., Toronto.

Canadair reported the use of titanium metal in the production of the C1-28 'Argus' and the C1-44 aircraft, which contain 1,620 and 2,415 pounds of titanium respectively and are respectively 1,210 and 1,795 pounds lighter than if made of stainless steel. The titanium parts are associated with the power plant, where high temperatures and corrosive conditions prevent the use of other light metals.

Atlas Titanium Limited manufactured the following mill products, totalling some 700,000 pounds of titanium alloy: bar, sheet, strip, wire plate, welded tubing, forgings, billets and special machined shapes. Much of Atlas's production was material converted for United States firms. The greater portion of the company's raw material was alloy ingot composed 90 per cent of titanium, 6 per cent of aluminum and 4 per cent of vanadium. The company reported that it is in the process of developing zirconium alloy and titanium welded tubing, primarily for nuclear reactors.

Thompson Products, Limited, manufactured precision forgings using 90Ti-6A1-4V alloy bar.

Canadian Steel Improvement Ltd. manufactured compressor disks, seal rings, housings, compressor blades and general forgings. The predominant titanium alloy used was 90Ti-6A1-4V; the secondary was made up 7 per cent of aluminum, 4 per cent of molybdenum and 89 per cent of titanium.

Macro Division of Kennametal Inc., Port Coquitlam, British Columbia, manufactured tungsten-titanium carbide as well as titanium-carbide (TiC) powder for use in cemented-carbide alloys. Rutile and refined titanium dioxide were the company's source of titanium.

Titanium in Pigments and Other Applications

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. They are used as pigment in the manufacture of paint, ceramics, cosmetics, paper and textiles.

Although ilmenite, slag or manufactured TiO_2 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.

Consumption of Refined TiO_2, Extended TiO_2 Pigments and Ferrotitanium in Canada

	1958		1957	
	Short Tons	$	Short Tons	$
Refined titanium dioxide (TiO_2)				
Paints	14,400	7,568,123	12,558	6,869,018
Polishes and dressings	61	38,630	28	56,963
Pulp and paper	2,068	999,460	1,805	885,046
Linoleum and oilcloth	2,511	1,048,257	2,452	984,004
Rubber goods	771	387,137	720	371,696
Miscellaneous non-metallic minerals	469	268,236	409	210,868
Total	20,280	10,309,843	17,972	9,377,595
Extended titanium-dioxide pigments				
Paints	15,515	3,352,758	14,650	3,117,678
Estimated TiO_2 content	4,607		4,355	
Ferrotitanium				
Primary iron and steel	210	76,689	252	82,258

Prices

E & M J Metal and Mineral Markets of December 31, 1959, quotes the following United States prices:

Ilmenite	
Per gross ton, f.o.b. cars, Atlantic ports	
59 1/2% TiO_2	\$23 to \$26.00
54% TiO_2	\$21 " \$21.50
Rutile	
Per short ton, 94% TiO_2, delivered within 12 months	\$85 (nominal)

	Effective July 30-Dec. 31, 1959	Effective July 16, 1959	Effective Jan. 1, 1959
Titanium metal			
Per lb A-1, 99.3% max., f.o.b. shipping point			
Max. 0.3% Fe	\$1.60	\$1.60 to \$1.62	\$1.60 to \$1.82
Max. 0.5% Fe	\$1.50	\$1.50	\$1.70
Ferrotitanium			
Low-carbon			
Per lb contained Ti, ton or more lots, lump (1/2 in.+), packed, f.o.b. shipping destination NE. U.S.A.			
40% Ti, max. 0.10% C	\$1.35	\$1.35	\$1.35
25% Ti, max. 0.10% C	\$1.50	\$1.50	\$1.50
Medium-carbon			
Per net ton, carload lots, lump, packed, f.o.b. destination NE. U.S.A.			
17-21% Ti, 3-5% C	\$290 to \$295	\$290 to \$295	\$290 to \$295

High-carbon Basis as for medium-carbon, 15-19% Ti, 6-8% C	\$240 to \$245	\$240 to \$245	\$240 to \$245

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Titanium ore	free	free	free
Titanium oxide, and white pigments containing not less than 14% titanium dioxide, by weight	"	12 1/2%	15%
Ingots, blooms, slabs, billets of titanium or titanium alloys for use in Canadian manufactures (expires June 30, 1962)	"	free	25%

United States

Titanium ore, crude	free
Titanium metal	20%
Ferrotitanium	12 1/2%
Titanium potassium oxalate and all compounds and mixtures containing titanium	15%

TUNGSTEN

V.B. Schneider*

Canada produced no tungsten in 1959. In recent years this country's production has been confined to the scheelite concentrates obtained from the operations of Canadian Exploration Limited at Salmo, British Columbia. Those operations were closed down in July 1958 on completion of the sales contract with the United States General Services Administration. The company reported a stockpile of tungsten concentrates containing approximately 37,000 short-ton units of WO_3 and an undeveloped ore reserve of 386,000 tons grading 0.83 per cent WO_3.

Canada Tungsten Mining Corporation Limited announced the discovery of a scheelite deposit near the headwaters of the Flat River and near the Yukon-Northwest Territories border. Plans have been announced for a further diamond-drilling program to determine the extent and grade of the deposit.

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.

World Production, Trade and Uses

According to the United States Bureau of Mines(1) 9,838,000 pounds of tungsten were consumed in the United States during 1959. This consumption was the greatest since 1951 and some 85 per cent more than in 1958.

World production of tungsten concentrates, containing 60 per cent or more WO_3, amounted to 56,850 short tons in 1959, according to an estimate of the United States Bureau of Mines.(2) China produced 19,800 tons, followed by the Union of Soviet Socialist Republics (8,300), North and South Korea (8,161), United States (3,649) and Bolivia (2,671).

(1) U.S. Bureau of Mines, Tungsten Report No. 96, March 16, 1960.
(2) U.S. Bureau of Mines, Mineral Trade Notes, September 1960.

*Mineral Resources Division

Tungsten - Production, Trade and Consumption

	1959		1958	
	Pounds	$	Pounds	$
Production (shipments WO_3 content)	-	-	690,976	1,898,455
Imports				
Scheelite(1)				
Korea	415,600	234,997	56,000	20,837
Peru	110,100	42,137	-	-
Belgian Congo	110,000	30,724	-	-
United States	106,000	58,406	304,500	127,201
Australia	22,400	8,434	-	-
Bolivia	18,600	8,677	317,600	101,610
Spain	57,300	22,133	82,300	30,908
Burma	-	-	70,600	5,177
United Kingdom	-	-	53,100	14,422
Total	840,000	405,508	884,100	300,155
Ferrotungsten(2)				
United Kingdom	793,500	330,689	196,300	112,961
United States	34,100	36,782	700	1,156
Sweden	1,000	874	2,000	1,473
Total	828,600	368,345	199,000	115,590
Exports				
Tungsten concentrates(1)				
United States	-	-	1,028,300	2,073,068
Consumption(3) (W content)				
Scheelite	497,273		127,204	
Tungsten wire	6,109		3,312	
Ferrotungsten	66,000		68,892	
Tungsten metal	5,989		4,953	
Tungsten-metal powder			18,850	
Tungsten carbide	84,620		63,260	
Tungsten-carbide powder			22,991	
Miscellaneous(4)			7,276	
Total	659,991		316,738	

(1) Reported in Trade of Canada. WO_3 content not given.
(2) As reported in Trade of Canada. W content not given.
(3) Consumption 1959; survey coverage larger than in previous years.
(4) Includes tungsten chemicals.

Tungsten - Production, Trade and Consumption, 1949-59
(pounds)

	Production(1)	Imports(2)		Exports(3)	Consumption(4)
		Tungsten Ores	Ferrotungsten	Scheelite	
	(WO_3 content)			(W content)	(W content)
1949	252,380	55,600	301,900		298,279
1950	284,078	55,600	214,700		251,076
1951	2,833	56,400	1,008,300		290,618
1952	1,493,111	112,200	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

(1) Producers' shipments of scheelite.
(2) As reported in Trade of Canada. Tungsten content not available.
(3) Export shipments as reported by producers.
(4) Scheelite, ferrotungsten and other tungsten products reported by consumers. Prior to 1951, totals refer to tungsten content of ferrotungsten and scheelite only. The 1959 consumption survey covered a larger number of consumers.

During the year the price of tungsten ore increased about 60 per cent on the European and United States markets. The increase occurred partly because the demand for tungsten increased, but mainly because depressed prices, which resulted from the overproduction of the United States stockpiling period, forced nearly all producers to cease operations. In 1956 there were approximately 600 tungsten producers in the United States, albeit 15 of them accounted for 95 per cent of the total production. In 1959 two mines accounted for the entire production, and both recovered tungsten as a by-product.

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 tungsten 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, 35 per cent in ferrous alloys, 14 per cent as tungsten metal, 12 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-resisting alloys. The main use of the high-temperature alloys is 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 cutting 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.

The United States Bureau of Mines* announced the production of high-purity tungsten metal by a new process. High-purity tungsten was captured from a mixture of gases and simultaneously formed into simple shapes by metallurgists at the Bureau of Mines laboratories in Rolla, Missouri. The tungsten metal was more than 99.99 per cent pure. Besides allowing the formation of tungsten into tubing and other simple shapes, the process makes feasible the plating of high-purity tungsten on various surfaces.

Some consumers of tungsten in Canada are: Atlas Steels Limited, Welland, Ontario; Canadian General Electric Company Limited, A.C. Wickman Limited, Johnson, Matthey and Mallory Limited, J.K. Smit and Sons of Canada Limited, all of Toronto, Ontario; Canadian Westinghouse Company Limited, Hamilton, Ontario; Dominion Colour Corporation Limited, New Toronto, Ontario; Deloro Smelting & Refining Company, Limited, Belleville, Ontario; Wheel Trueing Tool Company of Canada Limited, Windsor, Ontario; Kennametal of Canada Limited, Victoria, British Columbia, and Boyles Bros. Drilling Company Limited, Vancouver, British Columbia.

Atlas Steels Limited is by far Canada's largest 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 tungsten-titanium carbide, an important constituent in cemented carbide for metal-cutting. It also makes tungsten-metal powders for parts made by powder-metallurgy processes and an alloying additive. As raw material the company uses wolframite, hubnerite and scheelite concentrates of standard grade.

*Department of the Interior, Information Service Release, September 22, 1959.

Prices

According to E & M J Metal and Mineral Markets of December 31, 1959, 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	\$18.25 to \$19.00
		Scheelite	\$18.25 " \$19.00
Tungsten metal	Per lb		
		98.8% min., 1,000-lb lots	\$ 2.75 " \$ 2.90
		Hydrogen reduced 99.99%	\$ 3.35 " \$ 4.25
Ferrotungsten	Per lb contained W, 70 to 80%, lots 5,000 lb or more, f.o.b. destination U.S.		\$ 2.15 (nominal)
Tungstic acid	Per lb, 1,000-lb lots in drums (according to Oil, Paint and Drug Reporter, Dec. 28, 1959)		\$ 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%

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 12 1/2% 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 12 1/2% ad valorem

URANIUM

J.W. Griffith*

The value of uranium production in Canada climbed to $333 million* in 1959, once again being higher than that of any other Canadian-produced metal. The year's uranium-oxide shipments totalled 15,909 tons.** In 1958, shipments amounted to 13,537 tons valued at $274 million. Despite this increase, Canada dropped to second place among the world's uranium producers.

During the year, 23 mines and 19 treatment plants were in operation throughout Canada, but by the year-end only 20 mines and 17 mills were operating. These plants treated a total of 14 million tons of ore having an average grade of 0.12 per cent U_3O_8.

The reserves of measured, indicated and inferred ore in Canada at November 1, 1959 - 308.5 million tons grading 0.12 per cent U_3O_8 - are equivalent to 370,200 tons of uranium oxide and are considered to be the largest uranium reserves in the world. This ore-reserve total is, however, considerably lower than figures previously published, largely because the statistics most recently released by some companies do not include inferred (possible) ore and perhaps because the estimate of 90 million tons of inferred ore added to the total of the table on pages 8 and 9 tends to be conservative. The reserves calculated for the Elliot Lake district constitute 96 per cent of Canada's total. The Beaverlodge and Bancroft camps are each credited with about 2 per cent.

The net result of the tremendous growth of the uranium industry in the Western World is that there is now an oversupply of uranium. The United States has emerged as the world's greatest producer, and its domestic supply is such that it is no longer dependent upon Canada. Consequently, the United States Atomic Energy Commission, on November 6, 1959, announced that after 1962 it would not exercise its options on the purchase of Canadian uranium. At the same time, Eldorado Mining and Refining Limited announced that arrangements had been made with the United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority to allow Canadian producers to stretch out the remainder of their undelivered uranium

---

*Source of the figures in this paragraph: Eldorado Mining and Refining Limited.
**Short tons (2,000 pounds) used throughout.

---

*Mineral Resources Division

Uranium - Production and Exports

	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Production (U_3O_8) (1) (shipments)				
Ontario	12,746	268,529,993	9,985	210,149,700
Saskatchewan	2,686	54,457,321	2,962	59,815,924
Northwest Territories	460	8,155,729	456	9,572,847
Total	15,892	331,143,043	13,403	279,538,471
Exports (U_3O_8)				
United States		278,912,726		262,674,640
United Kingdom		32,602,978		13,502,809
West Germany		129,262		314,065
Switzerland		121,760		-
Japan		106,831		14,443
Other countries		30,586		-
Total		311,904,143		276,505,957

(1) These totals, released by the Dominion Bureau of Statistics, are based on figures supplied by the mining companies.

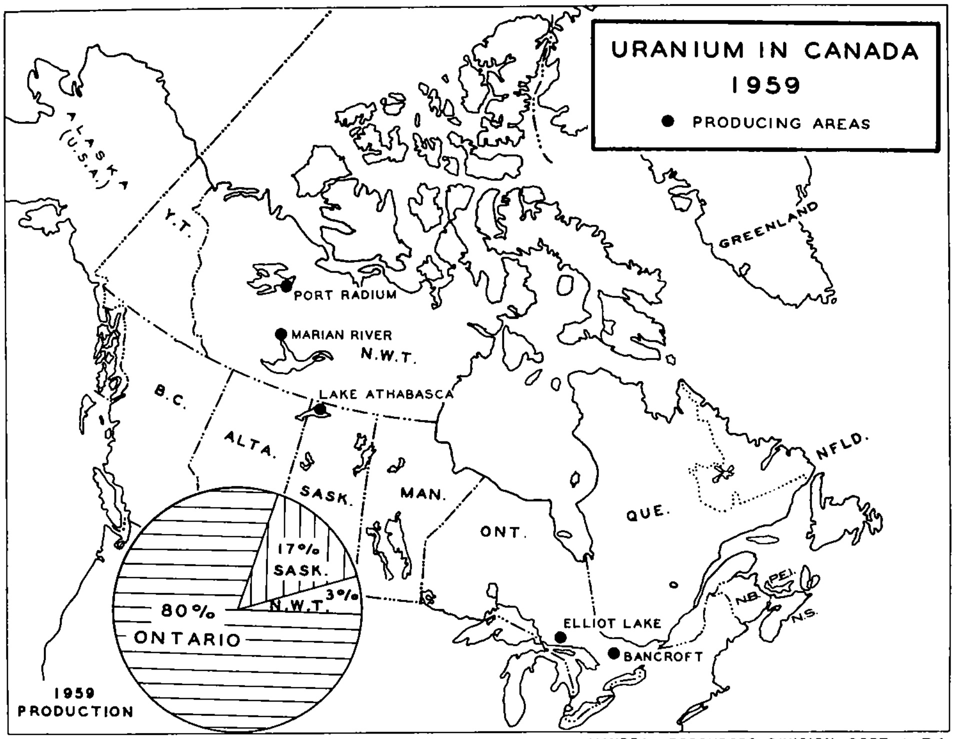
under firm contract until 1966 and at the same time permit the transfer of uranium sales contracts between companies. For some time to come, 1959 will undoubtedly be Canada's peak year in uranium production.

The number of persons directly employed by the uranium mines in Canada as at August 31, 1959, was 13,626, but by the following mid-January, the number had been reduced to 11,792. It is expected that by the end of 1961, this total will be about halved.

Number of Employees in the Canadian Uranium Mining Industry as at January 15, 1960

Mining Camp	Number of Mines	Number of Employees
Elliot Lake, Ont.	10	8,537
Uranium City, Sask.	6	1,632
Bancroft, Ont.	3	1,400
Port Radium, N.W.T.	1	223
Total	20	11,792

Source: Unemployment Insurance Commission.



Summary of Developments in 1959

Northwest Territories

The Port Radium mine on Great Bear Lake, owned by Eldorado Mining and Refining Limited, continued to produce, its rate being 280 tons of ore a day. The Port Radium deposit is nearly exhausted, and present plans call for the cessation of mining operations during the summer of 1960.

Owing to the failure to locate ore in economic quantities below the 500-foot level, Rayrock Mines Limited ceased mining and milling at its Marian River property on July 31. The company announced early in 1960 that it had negotiated an arrangement with Gunnar Mines Limited whereby Gunnar would supply U_3O_8 to Rayrock, under the terms of the stretch-out plan, so that the latter could fulfill its sales contract with Eldorado. Sales to Rayrock were to begin in January 1960.

Ontario

Elliot Lake District

Uranium production in the Elliot Lake camp reached an all-time high during the year, amounting to 11,403.6 tons of uranium oxide valued at $242 million. At December 31, 1959, the estimated reserves of measured, indicated and inferred ore were 297.3 million tons grading 0.12 per cent U_3O_8. In terms of uranium oxide, these deposits contain 356,760 tons.

There were 11 mines and 11 treatment plants in operation at the beginning of the year, but in February the Spanish American mine, owned by Northspan Uranium Mines Limited, was closed. In May, Algom Uranium Mines Limited entered into an extension contract with Eldorado for the delivery of 2,456,000 pounds of U_3O_8 at a price of $8 (U.S.) a pound between the date of completion of the original contract and March 1962. Similarly, Pronto Uranium Mines Limited was awarded an extension to March 1962 for an additional 1,508,000 pounds valued at about $12 million. Arrangements for these additional contracts had been confirmed several years previously.

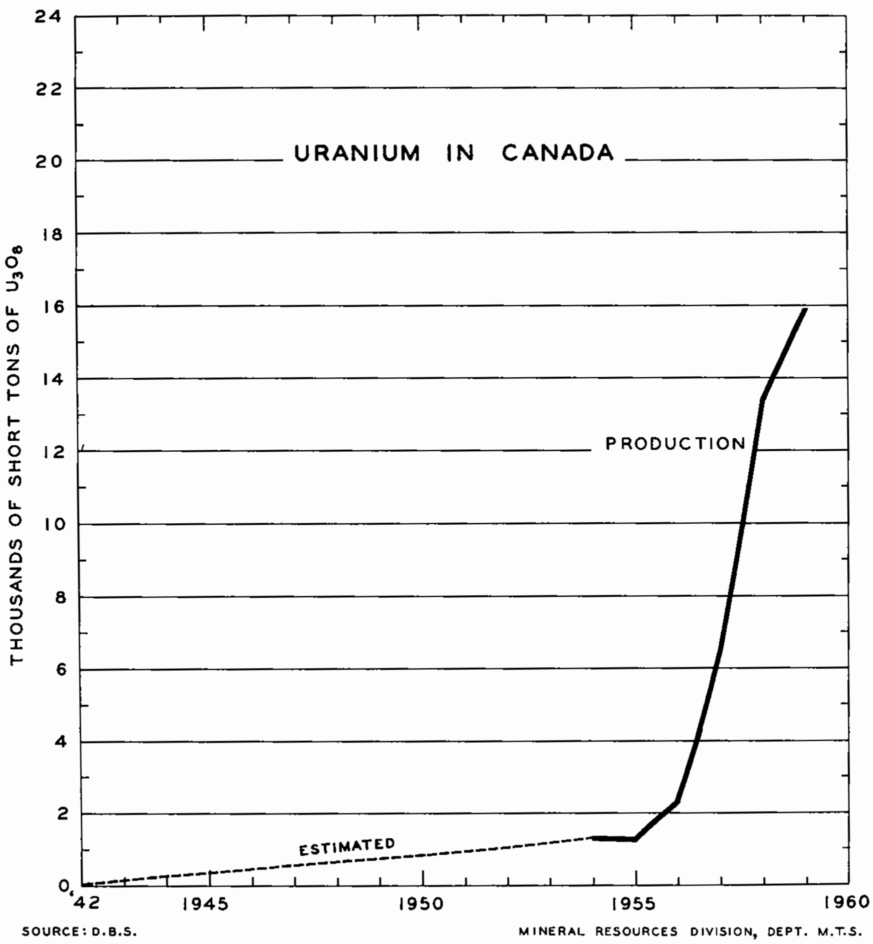
Can-Met Explorations Limited announced in October that underground rock conditions made cost-cutting procedures less effective and that a low treatment rate resulted in higher unit costs. Later it was announced that ore reserves at this property were insufficient to fulfill contract commitments.

Consolidated Denison Mines Limited operated at the rate of about 6,000 tons of ore a day. During the year, this mine produced 4,916,108 pounds of uranium oxide from 2,046,250 tons of ore. Production costs per pound of U_3O_8 were lowered to less than $4.

Milliken Lake Uranium Mines Limited operated at an average rate of 3,048 tons of ore a day. Several major advances were made - proven ore reserves were increased; a more efficient stoping cycle was attained; conventional rail-haulage equipment was installed; and improvements were made in the treatment plant - all of which helped to lower operating costs.

Northspan Uranium Mines Limited operated two mines - the Lacnor and the Panel. During 1959, three new levels were opened in the Lacnor mine. Lacnor, however, was unable to supply enough ore to keep the mill up to the rated capacity, and the deficiencies were made up by purchases, on a royalty basis, from Algom's Nordic and Quirke mines. Both Lacnor and Panel converted from trackless to rail-haulage mining methods, although trackless equipment is still used in some sections of both mines. Additional ore was discovered at the Panel mine, which also mined ore on a royalty payment basis from the adjoining Quirke property. The location of this ore, at the extreme east end of the Quirke property, would have necessitated a new shaft or an excessively long crosscut had Quirke decided to mine it.

Stanleigh Uranium Mining Corporation Limited reached the maximum rate of concentrate production allowed under its contract with Eldorado. The partial change-over from trackless to rail haulage was completed. Operating costs were reduced to less than $5 a pound of U_3O_8 (excluding deferred-development charges), and further reductions are expected as the efficiency of underground operations improves.



Stanrock Uranium Mines Limited went into receivership in May owing to financial difficulties. Montreal Trust Company was appointed receiver of the company's property and has been operating the mine without interruption. The mine reached capacity production during the year, and particular attention was paid to increasing efficiency and the control of costs. Conveyor haulage equipment was installed underground and a change-over in the mining method was underway. Stanrock has reported sufficient indicated ore to fulfill its sales contract with Eldorado.

Bancroft Area

In 1959 the producing mines in the Bancroft area of southeastern Ontario were Bicroft Uranium Mines Limited, Canadian Dyno Mines Limited and Faraday Uranium Mines Limited. A fourth mine, Greyhawk Uranium Mines Limited, had been shipping ore on a custom basis to the nearby Faraday treatment plant, but in April it ceased shipping and the mine was closed. The ore reserves of the three producers are estimated to total 5 million tons grading 0.094 per cent U_3O_8. During the latter part of the year, production at these mines totalled 3,800 tons of ore a day.

In August, Bicroft entered into an extension contract with Eldorado for the delivery of 260,000 pounds of U_3O_8 at $8 (U.S.) a pound between the date of completion of the original contract and March 1962. The average daily production in 1959 was 1,200 tons, but the mill is capable of handling 1,400 tons of ore a day. Mill-head grade in October was 0.094 per cent U_3O_8. During the year mining was concentrated mainly at the third, fourth, fifth and sixth levels while development was carried out on four lower levels. During the latter part of the year there were 60 working stopes. Ore reserves were reported by the company to be sufficient for the fulfilment of its sales contract.

Canadian Dyno continued to treat ore at the rate of about 1,100 tons a day. During the year the shaft was deepened to open five new levels. By October, the number of stopes had increased to 67. Difficulty was experienced in developing sufficient ore to keep the mill up to full capacity, and the grade was lower than originally expected. Early in 1960 the company announced that it had negotiated an arrangement with Gunnar Mines Limited whereby Gunnar would supply U_3O_8 to Dyno under the terms of the stretch-out plan. This would enable the latter to fulfill its sales contract with Eldorado. The Dyno mine was to close by the end of June 1960.

Faraday continued to treat more than 1,400 tons of ore a day and in October reached a maximum milling rate of 1,650 tons a day. The company reported, however, that to take advantage of the stretch-out provisions it would reduce its mill rate to about 1,200 tons a day after April 30, 1960, the date on which its three-year tax-exemption period was to expire. In 1959 Faraday produced 895,980 pounds of U_3O_8 valued at $9,465,685. Completion of the deepening of the main production shaft during the year provided four more levels below the 600-foot horizon. Additional ore of better-than-mine-average grade was found on the upper levels. The company reports that it has more than enough ore to fulfill its uranium-sales contract but that, owing to the irregularity of the ore deposits, a precise calculation of reserves is impracticable. The average mill-head grade in 1959 was 0.087 per cent U_3O_8.

Greyhawk ceased shipping to the nearby Faraday mill in April and its mine was closed. Since the beginning of the year the mine had shipped a total of 8,195 tons of ore of an average grade of 0.072 per cent U_3O_8. Greyhawk's contribution to Faraday's production during 1959 was 10,934 pounds of U_3O_8 valued at $114,041.

Saskatchewan

All uranium production in Saskatchewan comes from mines in the Beaverlodge Lake area near the north shore of Lake Athabasca. During 1959, six mines and three treatment plants were in operation. Production for the year was about 2,675 tons of U_3O_8, slightly less than in 1958.

Production at the Beaverlodge mine of Eldorado Mining and Refining Limited was maintained at 2,000 tons of ore a day, which included a small daily shipment of high-carbonate ore from Rix-Athabasca Uranium Mines Limited. About the same quantity of Eldorado low-carbonate ore was shipped to the custom mill of Lorado Uranium Mines Limited. Eldorado continued to mine and mill ore (average - 92 tons a day) from claims leased from Radiore Uranium Mines Limited. Proven and probable ore reserves at the Beaverlodge mine at December 31, 1958, were 1,799,000 tons grading 0.22 per cent U_3O_8. In addition, the reserves of possible ore are estimated to be 1,700,000 tons grading 0.22 per cent U_3O_8.

Gunnar Mines Limited continued to mine and mill ore at an average rate of 1,972 tons a day. As a result of overproduction, in excess of its allotted monthly shipments of concentrates to Eldorado, Gunnar had built up a stockpile of uranium concentrates. Mining costs increased slightly when the proportion of ore from the underground mining operation was raised. Shaft-sinking was completed in December 1959 to nearly 2,000 feet and five new levels were established. At the end of 1959, ore reserves proven by development work or detailed diamond-drilling amounted to 3 million tons averaging 0.18 per cent U_3O_8. In addition to its contract sales, Gunnar sold, under permit, 15,764 pounds of U_3O_8 in concentrate form and as special uranium products to various countries throughout the world.

The custom-treatment plant operated by Lorado Uranium Mines Limited continued to treat ore from its own mine as well as ore from Lake Cinch Mines Limited, Eldorado Mining and Refining Limited, Rix-Athabasca Uranium Mines Limited and Cayzor Athabaska Mines Limited and intermittent shipments totalling about 70 tons a week from about eight smaller properties. The Lorado mill handled an average of 435 tons a day during the period May 1 to August 1. This was well below the rated capacity of 750 tons a day, partly owing to the inability of some of the custom shippers to carry out adequate mining development and partly because of the negative results of the search for new orebodies. It became apparent as early as the latter part of 1958 that the supply of ore from custom shippers was not sufficient to keep the Lorado mill operating at full capacity. The Lake Cinch mine was the only one able to maintain and develop additional reserves and to ship to Lorado at a constant rate. Shipments from Lake Cinch totalled 55,826 tons of ore containing 267,866 pounds of U_3O_8.

Late in 1959 Black Bay Uranium Limited received a letter of intent from Eldorado for a contract that calls for the delivery of ore containing 176,000 pounds of U_3O_8 by March 15, 1962. Initial shipments were made early in 1960 from the Fishhook Bay property on Lake Athabasca to the Eldorado mill on Beaverlodge Lake.

CANADIAN URANIUM PRODUCERS - 1959
(reserves as of November 1959)

Mine	Contract Value	First Production	Per Cent of Contract Completed to End of 1959	Milling Capacity	Ore Reserves*	Grade	Remarks
	($ millions)		(approximate)	(tons/day)	(millions of tons)	(% U_3O_8)	
Elliot Lake district, Ont.							
Algom Uranium Mines Limited	226.6		61				
Nordic mine		Jan. 1957		3,700	7.4	0.118	Reserves do not include inferred ore.
Quirke mine		Sept. 1956		3,000	12.4	0.125	
Can-Met Explorations Limited	79.7	Oct. 1957	37	3,000	1.0(e)	0.092	To close in 1960. Contract sold to Consolidated Denison early in 1960.
Consolidated Denison Mines Limited	201.9	Sept. 1957	51	6,000	133.0	0.125	Acquired Can-Met contract early in 1960.
Milliken Lake Uranium Mines Limited	94.5	Mar. 1958	35	3,100	9.1	0.106	Reserves do not include inferred ore.
Northspan Uranium Mines Limited	275.0		36				Reserves do not include inferred ore.
Lacnor mine		Sept. 1957		4,400	6.8	0.110	
Panel mine		Mar. 1958		3,100	10.3	0.114	
Spanish American mine		Mar. 1958		2,000	8.0	0.10	Spanish American closed in Feb. 1959.
Pronto Uranium Mines Limited	67.0	Oct. 1955	61	1,500	1.3	0.125	To cease uranium production in 1960.
Stanleigh Uranium Mining Corporation Limited	90.5	Mar. 1958	34	3,300	10.0(e)	0.093	
Stanrock Uranium Mines Limited	95.2	Mar. 1958	27	3,300	8.0(e)	0.10	
Bancroft area, Ont.							
Bicroft Uranium Mines Limited	35.8	Nov. 1956	63	1,400	1.5(e)	0.095	
Canadian Dyno Mines Limited	34.9	May 1958	21	1,400	0.5	0.065	To close in June 1960. Gunnar to deliver remainder of Dyno contract.

Faraday Uranium Mines Limited	45.2	Apr. 1957	49	1,650	3.0(e)	0.104	
Greyhawk Uranium Mines Limited		Sept. 1957		No mill	0.2	0.065	Shipped to Faraday until April 1959, when mine closed.
Beaverlodge area, Sask.							
Cayzor Athabaska Mines Limited		May 1957		No mill			Shipped at rate of about 100 tons/day to Lorado. To close in March 1960.
Eldorado Mining and Refining Limited	211.0	Apr. 1953	70	2,000	3.0(e)	0.22	Contract includes Port Radium operation.
Gunnar Mines Limited	119.3	Sept. 1955	65	2,000	3.0	0.18	Acquired Rayrock and Canadian Dyno contracts early in 1960.
Lake Cinch Mines Limited		May 1957		No mill	0.05(e)	0.24(e)	Shipped an average of 153 tons/day to Lorado. To close in March 1960.
Lorado Uranium Mines Limited	64.4	May 1957	32	750			Sold contract to Eldorado early in 1960. All operations to cease in 1960.
Rix-Athabasca Uranium Mines Limited		Apr. 1954		No mill	0.006	0.192	Shipped to both Lorado and Eldorado at an average rate of 137 tons/day.
Northwest Territories							
Eldorado Mining and Refining Limited (Port Radium, Great Bear Lake)	(see Eldorado, Beaverlodge)	1942		300	0.04(e)	0.58	Reserves almost exhausted. Mine to close in 1960.
Rayrock Mines Limited (Marian River area)	15.8	June 1957	32	150	Nil		Ceased production in August 1959. Gunnar to deliver remainder of Rayrock contract.

* Reserves include measured (proven), indicated (probable) and inferred (possible) ore, unless otherwise indicated. It is estimated by the Department of Mines and Technical Surveys that an additional 90 million tons, grading 0.12%, of inferred ore can be added to the total in the table. This gives a grand total of 308.5 million tons averaging 0.12% U_3O_8.

(e) Estimated.

Prices

Nearly all the uranium produced in Canada is purchased by the Government through Eldorado Mining and Refining Limited. Eldorado negotiated contracts with producers on the basis of the matching contracts it was able to make with the United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority. Eldorado undertakes to purchase from the producers definite quantities of uranium in the form of 'yellowcake' (magnesium diuranate, sodium diuranate or a similar chemical compound), to be delivered according to a prescribed schedule and at a stated price. The prices paid to the companies are confidential and vary with each company because they were calculated to allow for a predetermined profit after allowance for estimated operating costs and amortization of certain capital and pre-production expenditures. The average price paid to the producers during 1959 was $10.50 per pound of U_3O_8.

Refining

Eldorado Mining and Refining Limited has been refining uranium at Port Hope, Ontario, since 1935. The company produces uranium metal and uranium compounds of consistent quality and the highest purity. The metal can be supplied in the form of machined ingots, forged,rolled and cast shapes and completely fabricated fuel elements. Uranium-dioxide fuel elements of ceramic grade can also be supplied.

Only a small percentage of the uranium concentrate from Canadian mines is refined at Port Hope. Most of it is shipped from the mines directly to the United States and the United Kingdom.

Markets

The United States has been the leading market for Canadian uranium, but agreements concluded by Eldorado to supply uranium to the United Kingdom went into effect in July 1958. About 89 per cent of Canada's 1959 production was exported to the United States. The rest was shipped to the United Kingdom (about 10 per cent), West Germany, Switzerland, Japan, India, Sweden, Austria, Denmark, and Atomic Energy of Canada Limited, Chalk River, Ontario.

Canadian producers are permitted to make individual sales of up to 2,500 pounds of surplus uranium to countries that do not hold agreements with Canada for co-operation in the peaceful uses of atomic energy. This is the maximum amount any such country may receive from Canada for all time. Sales were made under this policy to Japan, India, Sweden and Denmark, mostly by private producers.

Atomic Energy Developments in 1959

Two nuclear-power-station projects are now under way in Canada. A 20,000-kilowatt experimental station, known as NPD-2 (Nuclear Power Demonstration), is being built near Rolphton, Ontario, and is expected to go into operation in 1961. Detailed design for a 200,000-kilowatt station, known as CANDU (Canadian Deuterium Uranium), is now being done by Atomic Energy of Canada Limited. This station is scheduled for completion in 1964 at a site on Lake Huron 9 miles north of Kincardine, Ontario. Both reactors will use natural uranium as fuel.

To have Canada's nuclear research and development program operate at its maximum efficiency, the directors and management of Atomic Energy of Canada Limited recommended to the federal government that a new centre be built. The site chosen is about 60 miles northeast of Winnipeg, Manitoba.

In addition to the nuclear power projects, A.E.C.L. recently awarded the following:

(1) a $600,000 contract to Canadian General Electric Company, Limited, for a design study and associated development of an organic-cooled atomic power reactor (the reactor, known as OCDRE, may be suitable for use in the Canadian Arctic and other remote areas in Canada);

(2) a $200,000 contract to Canadian Westinghouse Company Limited for the study of a small nuclear power plant, operating on enriched uranium, for use in remote communities of the Canadian north.

World Production and Resources of Uranium

The table on page 12 shows Canada's position among world producers of uranium. It also shows that, although Canada's reserves of U_3O_8 are considered the largest, uranium is widely distributed throughout the world. Some of the figures are unofficial; the others are derived from various official sources including the Dominion Bureau of Statistics, Eldorado Mining and Refining Limited, United States Atomic Energy Commission, Transvaal and Orange Free State Chamber of Mines, Commonwealth of Australia Bureau of Mineral Resources, Proceedings of the Second United Nations Conference on the Peaceful Uses of Atomic Energy.

Thorium Production

In 1959 the new Elliot Lake thorium plant of Rio Tinto Dow Limited, the first of its kind in the world, produced 54,037 pounds of thorium concentrate valued at $116,141. The thorium is extracted from waste liquors supplied by the nearby Algom-Quirke uranium-recovery plant. In May of the same year, the Rio Tinto Dow plant began to turn out thorium salts, of which it is designed to produce 150 tons annually.

World Production and Resources of Uranium

Country	U_3O_8 Produced in 1959	Value of Product in 1959	Number of Treatment Plants in 1959	Ore Reserves	Grade	Reserves of U_3O_8
(in order of 1959 production)	(tons)	($ millions)		(millions of tons)	% (U_3O_8)	(tons)
United States	16,379	288	25	86.1	0.28	241,080
Canada	15,909(1)	333	19	309	0.12	370,800
South Africa	6,444	143	23	1,050	0.025	262,500
Soviet Union and East Germany	6,000(e)(2)					
Belgian Congo	2,326	35(e)	1	1.7(e)	0.35(e)	5,950(e)
France	951		4	40(e)	0.15(e)	55,500
Australia	900(e)		3	8(e)	0.15	12,000(e)
Portugal	50(e)					
Northern Rhodesia	35(e)		1	Nil		Nil
India	10(e)		1	15.7(e)	0.30(e)	47,100(e)
Sweden(3)	10		1			
Spain	10(e)		1		0.15(e)	
Japan	80 lb(e)		1(e)	1.5	0.05	750
Italy	160 tons by 1961		Nil	3.0(e)	0.2 (e)	6,000(e)
West Germany	16 " " 1961		1?	0.3	0.1	300
Argentina				0.3	0.1	300
Brazil	60 " " 1961?					
Finland				0.1	0.2	200

(1) Total deliveries reported by Eldorado.
(2) Probably a minimum figure.
(3) Sweden has 3,000 million tons of material grading 0.035% U_3O_8 which is not considered as ore.
(e) Estimated. Figures based on unofficial reports.

The deposits in the Elliot Lake area probably contain the largest potential reserve of thorium in North America. Most of the thorium in these conglomeratic ores is carried in the minerals monazite, brannerite and uraninite. The uranium deposits of both the Elliot Lake and the Bancroft areas are estimated to contain 180,000 tons of ThO_2 (thorium dioxide) in ores grading an estimated 0.06 per cent ThO_2.

Thorium finds an important use in magnesium alloys. Dominion Magnesium Limited produces a magnesium-thorium alloy at its plant at Haley Station, Ontario. In the field of nuclear energy, thorium has an important potential use as a fuel for breeder reactors.

ZINC

D.B. Fraser*

Production of recoverable zinc, according to the Dominion Bureau of Statistics, totalled 396,008 short tons in 1959, or 29,091 tons less than in 1958. The decline was due to a reduction in shipments to the United States under import quotas on unmanufactured zinc and lead, and to a curtailment of shipments' to other export markets.

Refined production by The Consolidated Mining and Smelting Company of Canada Limited, at Trail, British Columbia, and Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba, totalled 255,306 tons; in 1958 their output was 252,093 tons.

Exports of refined zinc and zinc contained in concentrates declined in 1959 by 52,900 tons to a total of 360,600 tons. Shipments of these products to the United States totalled 241,100 tons, 17,100 tons less than in 1958. Exports to western Europe, which consisted mainly of zinc concentrates, were reduced from 52,600 tons in 1958 to 19,000 tons in 1959, and exports to the United Kingdom, totalling 93,400 tons, consisting mostly of refined zinc, were only slightly lower than in 1958.

Offsetting the decline in exports to some extent was a sharp rise in the domestic consumption of primary refined zinc, which totalled 64,800 tons in 1959 and 56,100 tons in the previous year. The rise was attributable to an increase in all the major uses except that of brass.

Most of the zinc concentrates produced in British Columbia and Yukon Territory were refined at Trail. The remainder was exported to refineries in the northwestern United States. All of the mine output of Saskatchewan and Manitoba was refined at Flin Flon. The zinc production of mines in eastern Canada was exported in concentrates to smelters in the United States and Europe, except for a small amount that went to Japan.

The graph on page 251 shows how zinc output has varied over the years and how important the export market is to Canadian producers. Canada was the second largest Free World producer in 1959, following the United States, whose output was 417,000 tons. Other large producers were Mexico, Australia, Peru and Japan.

(text continued on page 249)

---

*Mineral Resources Division

Zinc - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
British Columbia .	203,092	49,716,804	217,304	47,285,427
Ontario	44,982	11,011,498	46,239	10,061,643
Saskatchewan	46,877	11,475,377	48,328	10,516,130
Quebec	47,058	11,519,794	56,923	12,386,340
Newfoundland	31,674	7,753,838	33,870	7,370,102
Manitoba	15,702	3,843,977	11,512	2,505,054
Yukon Territory..	6,623	1,621,375	7,761	1,688,811
New Brunswick ..	-	-	3,162	687,989
Total	396,008	96,942,663	425,099	92,501,496
Refined[2]	255,306		252,093	
Exports				
Refined				
United Kingdom ..	86,766	15,402,953	83,854	13,168,878
United States	84,592	16,854,554	95,395	17,820,248
Korea	3,136	554,252	2,108	329,473
Netherlands	2,577	486,891	4,361	706,894
Brazil	718	116,678	1,908	275,323
Denmark	448	84,176	560	71,650
West Germany ...	392	70,009	2,380	322,651
India	244	40,141	980	130,736
Chile	242	41,266	320	51,364
Taiwan	160	25,901	1,035	148,138
Other countries ..	277	54,831	2,807	402,439
Total	179,552	33,731,652	195,708	33,427,794
Zinc contained in ore and concentrates				
United States	156,552	18,851,431	162,849	18,744,896
Norway	6,792	532,713	11,707	649,521
Belgium	6,676	563,298	15,026	776,847
United Kingdom ..	6,631	680,975	10,007	568,694
Japan	2,324	115,703	-	-
Netherlands	1,770	144,469	1,392	76,020
Other countries ..	339	29,697	16,842	761,652
Total	181,084	20,918,286	217,823	21,577,630

Zinc - Production, Trade and Consumption (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Zinc scrap				
Belgium	3,538	197,816	2,036	92,683
United States	1,180	141,046	993	108,755
Netherlands	930	64,371	1,981	95,871
Japan	182	26,484	533	73,905
Other countries ..	154	17,648	48	7,932
Total	5,984	447,365	5,591	379,146
Zinc manufactures				
United States		175,139		107,222
Mexico		1,454		140
Belgium		457		16,573
Other countries ..		1,064		1,473
Total		178,114		125,408
Imports				
Zinc in pigs, slabs, blocks, anodes...	840	158,036	621	121,883
Zinc bars, rods, plates, sheet	1,172	605,070	1,100	553,176
Zinc dross and zinc scrap	28	2,954	3	266
Zinc dust and granules	675	198,134	544	154,152
Zinc slugs, disks, shells		191,802		234,027
Zinc manufactures not otherwise provided		2,239,835		2,184,964
Zinc chloride	166	28,670	112	22,741
Zinc sulphate	1,021	85,478	987	89,641
Zinc white oxide ..	724	183,993	695	185,526
Lithopone	979	138,039	1,242	179,954
Total		3,832,011		3,726,330

(table continued)

Zinc - Production, Trade and Consumption (cont'd)

(short tons)

	1959			1958		
	Primary	Secondary	Total	Primary	Secondary	Total
Consumption - zinc used for or in the manufacture of:						
Copper alloys (brass, bronze, etc.).	7,112	594	7,706	7,311	133	7,444
Galvanizing						
Electro	693	117	810	916	-	916
Hot dip......	35,748	478	36,226	28,458	268	28,726
Zinc diecast alloy........	10,260	2	10,262	8,800	8	8,808
Other products (including rolled and ribbon zinc, zinc oxide)...	10,975	1,955	12,930	10,612	1,036	11,648
Total.........	64,788	3,146	67,934	56,097	1,445	57,542
Stocks on hand at end of year .	8,808	1,103	9,911	8,002	130	8,132

(1) Refined zinc produced from Canadian ores, plus recoverable zinc in ores and concentrates exported.
(2) Refined zinc produced from domestic and imported ores.

The consumption of slab zinc in Free World countries increased in 1959 by an estimated 8 per cent over the yearly totals recorded during the 1957-58 recession. The greatest increase was in the United States, where consumption rose to 956,197 tons from 868,327 in 1958. European consumption continued its steady growth, rising to 1,139,000 tons, or 78,000 tons over the 1958 figure, according to data of the Zinc Development Association in London. The largest increases were 35,000 tons in the Federal Republic of Germany and 26,000 tons in the United Kingdom.

Zinc Production, Exports and Consumption, 1949-59

(short tons)

	Production		Exports			Consumption(3)
	All Forms(1)	Refined(2)	In Ore and Concentrates	Refined	Total	
1949	288,262	206,045	106,684	168,307	274,991	45,670
1950	313,227	204,367	129,561	146,880	276,441	54,370
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

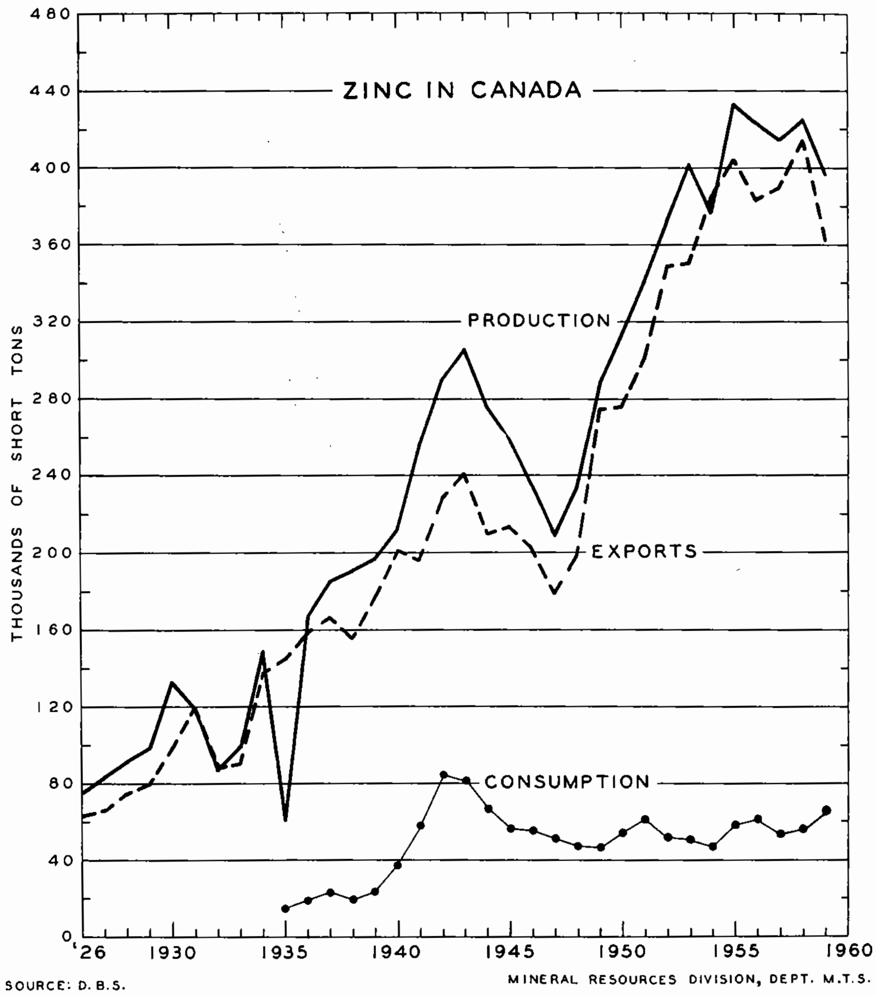
(1) Refined zinc produced from Canadian ores, plus recoverable zinc in ores and concentrates exported.

(2) Refined zinc produced from domestic and imported ores.

(3) Refined virgin zinc only.

The import quotas on unmanufactured lead and zinc imposed on September 22, 1958, by the United States government continued in effect throughout 1959, 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 short tons of contained zinc per quarter; on zinc metal it was 18,920 short tons per quarter. The allotments were filled for all quarters. In the case of zinc ores and concentrates, commercial imports exceeded the quotas, the excess being held in bond by United States smelters. On September 30, 1959, the latest date for which statistics are available, the zinc content of Canadian ores and concentrates held in bond totalled 19,581 tons. The zinc-ore quota was filled in 71 days of the first quarter of 1959, in 69 days of the second quarter, in 48 days of the third, in 43 days of the fourth and in 41 days of the first quarter of 1960. The zinc-metal quota was filled in 89 days of the first quarter, in 86 days of the second, in 91 days of the third, in 84 days of the fourth, and in 88 days of the first quarter of 1960.

The third conference of lead- and zinc-producing and -consuming countries under United Nations auspices was held in New York in May 1959. After reviewing the statistical position of zinc, the conference reported that production in 1958 and early 1959 was well in excess of industrial requirements but that, in view of increasing consumption and expected reductions in new supply, the excess would be substantially reduced in the second half of



1959. Arrangements were made at the New York meeting to establish a lead-zinc study group. The first meeting of the group took place in Geneva from January 27 to February 3, 1960. At this meeting the statistical survey carried out by the study group indicated that production and consumption were in approximate balance in 1959. It was reported that, in view of a possible excess of consumption over production in 1960, there appeared to be no need for continuing the curtailment of market supplies of zinc but that the matter should be kept under close review. The study group is expected to convene again early in September 1960.

Developments at Producing Mines*

British Columbia

Ore production from the three mines of The Consolidated Mining and Smelting Company of Canada Limited, Canada's largest producer, totalled 3,155,266 tons in 1959 and 3,157,956 tons in 1958. Production from the Sullivan mine at Kimberley amounted to 2,440,396 tons. Sinking was nearly completed on the 500-foot extension to the main shaft to open two new levels for production. From the H.B. mine near Salmo 463,504 tons were mined, and from the Bluebell mine, on the east shore of Kootenay Lake at Riondel, 251,366 tons.

Zinc concentrates from company mines, together with custom ores and concentrates obtained principally from Canadian shippers, were treated in the electrolytic refinery at Trail. Output from all sources, including some metal sold in unrefined products, was 194,499 tons of zinc; in 1958 it was 193,514 tons. Of the combined zinc and lead production of 335,380 tons, approximately 64 per cent was derived from Sullivan concentrates, 14 per cent from the concentrates from other company mines, 11 per cent from the retreatment of stockpiles of zinc-plant residues and lead blast-furnace slag and 11 per cent from purchased ores and concentrates.

Canadian Exploration Limited milled 325,564 tons of ore obtained from the Jersey mine near Salmo, and produced zinc and lead concentrates, the zinc concentrate totalling 20,791 tons containing 12,019 tons of zinc. Operations were interrupted by a strike that lasted from April 1 to May 9, 1959.

Reeves MacDonald Mines Limited, at Remac, 13 miles south of Salmo, treated 421,593 tons of ore and produced zinc and lead concentrates, the zinc content of which was 14,267 tons.

Sheep Creek Mines Limited, in the Lake Windermere district, milled 181,495 tons of ore and produced zinc and lead concentrates, the zinc concentrate totalling 13,071 tons containing 7,509 tons of zinc.

Howe Sound Company, Britannia Division, 28 miles north of Vancouver, which suspended production in March 1958 owing to low base-metal prices, resumed operations in January 1959. From 300,946 tons milled during the year, copper, zinc and pyrite concentrates were produced, the zinc production amounting to 5,935 tons of zinc concentrate containing 3,515 tons of zinc.

Violamac Mines Limited, near Sandon, recovered 540 tons of zinc in concentrates produced from the milling of 5,990 tons of silver-lead-zinc ore. The ore was treated by a subsidiary, Carnegie Mining Corporation Limited, which treated also custom ores of the district.

Highland-Bell Limited, at Beaverdell, milled 18,029 tons of silver-lead-zinc ore and produced 777 tons of zinc concentrate. Its principal metal output was 883,446 ounces of silver.

*See sketch map on page 254.

Yale Lead and Zinc Mines Limited, at Ainsworth, operated its 250-ton mill on a reduced scale, treating custom ores from the Slocan district.

Western Exploration Company, Limited suspended development operations near Silverton. The 100-ton mill remained closed during the year.

Manitoba and Saskatchewan

Hudson Bay Mining and Smelting Co., Limited, Canada's second largest zinc producer, mined 1,453,559 tons of copper-zinc ore from the Flin Flon mine on the provincial boundary, 98,108 tons from the Schist Lake mine 3 1/2 miles southeast of Flin Flon, and 132,032 tons of copper ore from the Birch Lake mine, 9 1/2 miles southwest of Flin Flon. The Flin Flon mill treated 1,671,089 tons, from which 110,709 tons of zinc concentrate and 325,989 tons of copper concentrate were produced. At the company's electrolytic zinc plant at Flin Flon, 110,881 tons of zinc concentrate and 54,302 tons of fume and stack dust were treated to produce 62,582 tons of slab zinc, or 2,733 tons more than in 1958. There were also produced 46,004 tons of zinc-plant residue, 45,234 tons of which were treated at the copper smelter for the subsequent recovery of zinc from zinc-oxide fume.

Ontario

All production was from two mines at Manitouwadge.

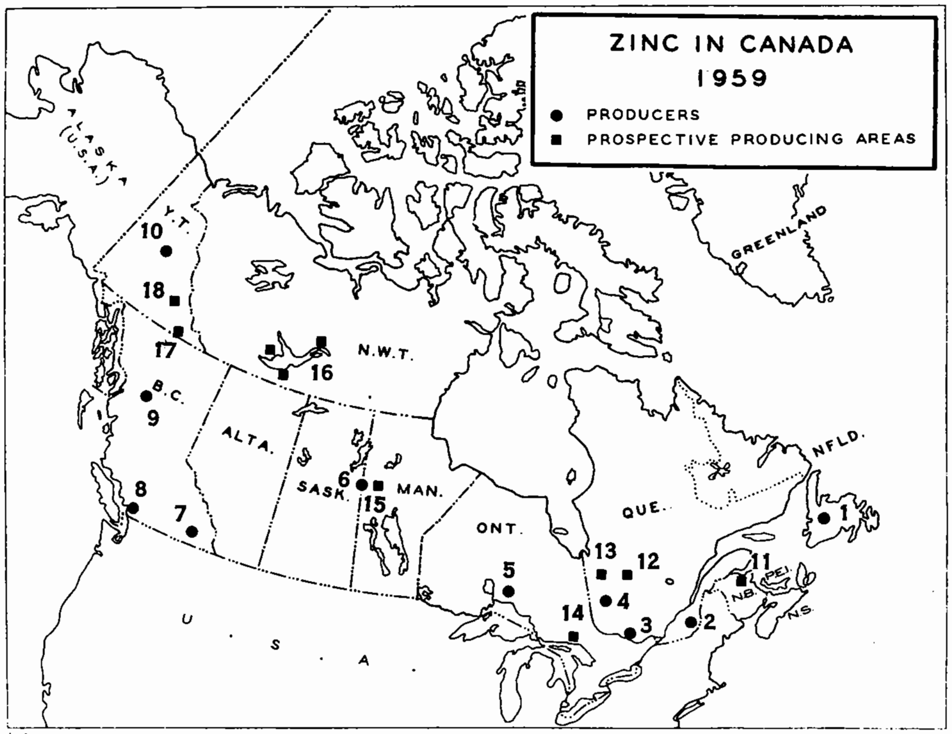
Geco Mines Limited milled 1,290,279 tons of copper-zinc ore and produced copper and zinc concentrates, the zinc concentrate totalling 42,178 tons containing 23,082 tons of zinc. Zinc production after late November, amounting to 4,317 tons of concentrate containing 2,378 tons of zinc, was stockpiled at the mine owing to restrictions on the market for zinc concentrates in the United States.

Willroy Mines Limited, adjoining Geco on the west, milled 371,186 tons of zinc-copper-lead ore and produced zinc, copper and lead concentrates, the zinc concentrate totalling 57,457 tons containing 31,903 tons of zinc.

Quebec

Quemont Mining Corporation, Limited, 2 miles north of Noranda-Rouyn, milled 850,099 tons of copper-zinc ore, producing copper, zinc and pyrite concentrates. Zinc-concentrate production totalled 32,071 tons containing 16,621 tons of zinc. Regular shipments of zinc concentrate were made to the United States, and, in addition, 4,398 tons were shipped to Japan.

Manitou-Barvue Mines Limited, 8 miles east of Val d'Or, treated 170,575 tons of zinc-lead ore and 297,650 tons of copper ore in a split-circuit mill, and produced 8,506 tons of zinc in zinc concentrates.



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Producers

1. American Smelting and Refining Company (Buchans Unit)
2. Weedon Pyrite & Copper Corporation Limited
3. New Calumet Mines Limited
4. East Sullivan Mines Limited
   Manitou-Barvue Mines Limited
   Normetal Mining Corporation, Limited
   Quemont Mining Corporation, Limited
   Waite Amulet Mines, Limited
   West Macdonald Mines Ltd.
5. Geco Mines Limited
   Willroy Mines Limited
6. Hudson Bay Mining and Smelting Co., Limited (also refinery)
   Flin Flon mine
   Schist Lake mine
7. Canadian Exploration Limited
   Consolidated Mining and Smelting Company of Canada Limited, The (also refinery)
   Sullivan mine
   H.B. mine
   Bluebell mine
   Highland-Bell Limited
   Reeves MacDonald Mines Limited
   Sheep Creek Mines Limited
   Violamac Mines Limited
   Western Exploration Company, Limited
   Western Mines Limited
   Yale Lead and Zinc Mines Limited
8. Howe Sound Company, Britannia Division
9. New Cronin Babine Mines Limited
10. United Keno Hill Mines Limited

Prospective Producing Areas

11. Bathurst
12. Bachelor Lake
13. Mattagami Lake
14. Sudbury
15. Snow Lake
16. Great Slave Lake
17. Watson Lake
18. Pelly River

Normetal Mining Corporation, Limited, at Normetal, 55 miles north of Noranda-Rouyn, milled 376,360 tons and produced copper, zinc and pyrite concentrates. The output of zinc concentrate, which totalled 18,162 tons and contained 9,442 tons of zinc, was shipped to the United States, except for 1,148 tons that were stockpiled owing to United States quota restrictions.

Waite Amulet Mines, Limited, 6 miles north of Noranda-Rouyn, milled 311,405 tons and produced copper, zinc and pyrite concentrates, the zinc production amounting to 16,630 tons of zinc concentrate containing 8,546 tons of zinc.

West Macdonald Mines Ltd., 7 miles northeast of Noranda-Rouyn, shipped 13,760 tons of zinc-pyrite ore to the Waite Amulet mill during January and February of 1959. Operations were suspended in February owing to the curtailment of zinc-concentrate markets in the United States.

East Sullivan Mines Limited, 3 miles east of Val d'Or, resumed production of zinc concentrate late in 1959, having recovered copper concentrate only after March 1958. A total of 957,137 tons was mined. Zinc production in concentrate totalled 1,256 tons.

New Calumet Mines Limited, on Calumet Island in the Ottawa River, milled 103,120 tons of zinc-lead ore in the fiscal year ended on September 30, 1959, and recovered 7,843 tons of zinc contained in concentrate.

Weedon Pyrite & Copper Corporation Limited, 50 miles east of Sherbrooke, recovered zinc as a by-product of copper-pyrite ore. Operations were closed for the year after the cave-in of a portion of the mine caused the mine to flood.

Newfoundland

American Smelting and Refining Company (Buchans Unit) milled 359,000 tons of zinc-lead-copper ore, 30,000 tons less than in the previous year, and produced zinc, lead, copper and gravity concentrates, the zinc concentrate totalling 62,208 tons. The zinc content of all concentrates produced was 42,041 tons. Sinking of the MacLean shaft continued, and a depth of 3,444 feet was reached at year-end.

Yukon Territory

United Keno Hill Mines Limited, Mayo district, milled 173,477 tons of silver-lead-zinc ore in the fiscal year ended on September 30, 1959, and produced 8,859 tons of zinc in zinc and lead concentrates. The Calumet mine supplied 52 per cent of the mill feed, the Hector mine 31 per cent and the Elsa mine 16 per cent. A small amount came from development and clean-up operations at the Galkeno mine.

Other Developments

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited carried out underground exploration at the Duncan lead-zinc property in the Lardeau area. A 990-foot adit was driven and in the main ore zone 1,200 feet of drifting was carried out.

Manitoba-Saskatchewan

Mine development continued at three mines in the Flin Flon area owned by Hudson Bay Mining and Smelting Co., Limited. At the Chisel Lake mine, 5 miles southwest of Snow Lake, in Manitoba, a production shaft was partially completed and stope development was started. Production at this property is scheduled to begin in the latter part of 1960. At the Stall Lake mine, 4 miles southeast of Snow Lake, the shaft was deepened and development on the lower levels was started. The new 52-mile rail branch connecting Chisel Lake with the Lynn Lake line of the Canadian National Railways was completed except for ballasting. The ore will be hauled to the Flin Flon mill for treatment. Stope development was continued during 1959 at the Coronation mine, 13 1/2 miles southwest of Flin Flon, in Saskatchewan, and production began in April 1960 after the cessation of mining operations at the nearby Birch Lake mine. Ore production schedules are expected to continue at about the same rate during 1960 but with a lower tonnage from the main mine at Flin Flon and a higher proportion from outlying properties.

Quebec

Mattagami Lake Mines Limited, in which Noranda Mines, Limited, Canadian Exploration Limited and McIntyre Porcupine Mines Limited have each a substantial interest, carried out further exploration of the Watson Lake deposits in the Mattagami Lake area. Reserves were confirmed at 23 million tons, 3 million tons more than in the previous year, grading 12.5 per cent zinc and 0.7 per cent copper. During 1960 a shaft will be sunk and underground development will begin.

Diamond-drilling on the adjoining property of Orchan Mines Limited indicated about 2 million tons averaging 12.5 per cent zinc and 1.4 per cent copper in two orebodies. Strong indications of a third orebody were obtained in the latest drilling.

Newmont Mining Corporation located a copper-zinc deposit in diamond-drilling south of the property of Orchan Mines Limited. Further work is planned to delimit the deposit and explore the area to the northwest.

New Hosco Mines Limited, in Daniel township in the Mattagami area, continued the exploration of copper-zinc mineralized zones, outlining 2,178,000 tons averaging 2.7 per cent copper, 958,000 tons averaging 7.96 per cent zinc, and a further possible 269,000 tons averaging 2.19 per cent copper.

New Brunswick

The mines and 1,500-ton mill of Heath Steele Mines Limited, 32 miles northwest of Newcastle, remained closed during 1959, having been placed on a stand-by basis in March 1958.

Development operations at the properties of Brunswick Mining and Smelting Corporation Limited, near Bathurst, were suspended in March 1958, and no further work was done during 1959. Early in February 1960, the company reached an agreement with Sogemines Limited, the Canadian subsidiary of Société Générale de Belgique, of Brussels, to bring the zinc-lead mine into production at an initial rate of 2,000 tons of ore a day. Under the agreement, Sogemines will carry out check drilling and examine the over-all development and operating aspects of the project. If satisfied, Sogemines will enter into a 15-year contract for the purchase of Brunswick's concentrate production and provide funds to bring the mine into production.

The New Jersey Zinc Company continued diamond-drilling of a base-metals deposit in the Portage Lakes district, 45 miles west of Bathurst.

The Anaconda Company (Canada) Ltd., drove a 500-foot exploration adit on its Caribou deposit 30 miles west of Bathurst.

Northwest Territories

No work was done during 1959 on the large zinc-lead deposit on the south shore of Great Slave Lake owned by Pine Point Mines Limited, a subsidiary of The Consolidated Mining and Smelting Company of Canada Limited. Intensive exploration of this deposit was carried out from 1948 to 1954 and a large tonnage was proven, but since transportation facilities were unsuitable for production, the development program was suspended in 1954. The nearest rail connections are some 400 miles south in northern Alberta - at Waterways and Grimshaw.

A Royal Commission was appointed in June 1959 to examine and report upon the route which a proposed railway to Pine Point should follow. At year-end, its report had not been made.

Uses

The principal uses of zinc and the tonnages consumed in each are shown on page 249.

The most extensive use is in galvanizing, in which zinc is applied as a protective coating to iron and steel products to prevent rusting. The zinc coating not only forms an impervious, moistureproof barrier, but provides protection through sacrificial corrosion at breaks in the coating surface. Galvanizing is done usually by hot-dipping methods, but for some purposes electroplating is used. The Steel Company of Canada,Limited and Dominion Foundries and Steel,Limited, both of Hamilton, Ontario, are the principal consumers of zinc for galvanizing. Each operates a continuous-strip galvanizing line, and in 1959 each company began the installation of a second line.

Zinc-base alloys containing high-purity zinc, to which are added 4 per cent aluminum, 0.05 per cent magnesium and from none to 1 per cent copper, are widely used for die-casting complex shapes, particularly automobile parts. Schultz Die Casting Company of Canada Limited, at Wallaceburg, 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 use in die-casting.

Brass, a copper-zinc alloy containing as much as 40 per cent zinc, has many industrial uses, particularly as sheets and strips, as tubes, rods and wire, and as castings and extruded shapes. Its use in the arts dates back many centuries. The principal makers of brass mill products in Canada 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 Durhams Industries (Canada) Limited, both in Montreal, and Canadian Felling Zinc Oxide Limited, Milton, Ontario.

Rolled zinc is used principally for making flashlight-battery cups, terrazzo strip, articles exposed to corrosion such as weather stripping, roofing drains and gutters, and anticorrosion plates for boilers and ships' hulls. Burgess Battery Company Limited, Niagara Falls, is the only producer of rolled zinc in Canada, 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. Among 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, zinc is refined by the electrolytic process only, by which Special High Grade and High Grade zinc are produced. To meet consumer requirements for Prime Western, Canadian producers add lead in small amounts to the higher grades.

The United States regularly consumes about one third of the world's zinc production. Industrial consumption of slab zinc in the United States in 1957, 1958 and 1959 was as follows:

	Short Tons		
	1957	1958	1959
Galvanizers	367,757	381,229	361,027
Brass mills	112,390	101,375	129,278
Die-casters	376,039	316,830	389,331
Rolling mills	41,269	40,616	42,949
Zinc-oxide plants	20,428	13,331	18,248
Other consumers	17,737	14,946	15,364
Estimated unreported	-	-	-
Total	935,620	868,327	956,197

Source: Mineral Industry Surveys, Bureau of Mines, U.S. Department of the Interior, mineral market Reports No. 2958 and 3111.

Under the auspices of the Canadian Zinc Research and Development Committee, research on hot-dip galvanized coatings was continued in 1959. This committee, formed in 1954, consists of members from zinc-producing and -consuming industries and from interested research laboratories, including that of the Mines Branch of the Department of Mines and Technical Surveys. The aims of the Committee are to develop new and improved zinc products, to improve existing techniques for the working and fabrication of zinc products and to provide a centre for the discussion of mutual problems. A step in this direction was the initiation, in 1957, of galvanizing research directed toward the broad goal of developing thicker and more ductile zinc coatings. To date, laboratory investigation of the influence of common bath-impurity and addition elements on the structure and properties of galvanized sheet coatings has been completed. Current studies, to run for two years, will cover bath additions of other elements as well as an examination of the galvanizing behavior of a variety of steel-sheet materials.

Prices and Tariffs

The Canadian price of Prime Western zinc, on the basis of deliveries at Montreal and Toronto, was 11.5 cents a pound from November 11, 1958, to January 6, 1959. Subsequent price changes were as follows:

January	6	11.75 cents a pound
February	9	11.25 " " "
April	6	10.75 " " "
May	11	11.25 " " "
August	4	11.50 " " "
August	20	11.75 " " "
October	15	12.25 " " "
October	20	12.75 " " "

The United States price, East St. Louis, Illinois, was 11.5 cents a pound until February 25, 1959, when the price dropped to 11.0 cents. There was no change until September 21, when the price advanced to 12.0 cents. There was a further increase to 12.5 cents on October 21, followed by a period of variable prices in the 12-to-13-cent range until November 5, when the price was stabilized at 12.5 cents. On January 8, 1960, the price advanced to 13.0 cents.

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 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.

ABRASIVES

J.S. Ross*

An abrasive product, employed for its grinding, polishing or cutting action, is composed completely or in part of artificial or natural abrasive materials.

Naturally occurring materials may be classified according to their attrition properties. The high-grade variety includes diamonds and corundum. The low-grade types include some of the rocks or minerals that have a high silica content, such as quartz and pumice. Mild abrasives used for polishing and scouring include lime and diatomite.

Artificial abrasives are those that are manufactured and, like natural abrasives, may be classified as to quality and use. The most common, silicon carbide and fused alumina, belong to the high-grade class.

The quantity and value of the natural abrasives produced in Canada are small and information on them is not available. Because few of these materials are employed solely for abrasive use, they are statistically listed with other commodities.

Canada is by far the largest producer of crude silicon carbide and crude fused alumina. Its shipments of these commodities are dependent upon export trade, more than 90 per cent normally going to the United States and most of the remainder to the United Kingdom. Crude-alumina production was 39 per cent higher in 1959 than in 1958, amounting to 152,319 short tons, and the output of crude silicon carbide increased 11 per cent to a record of 86,248 short tons. Since 1954, the production of silicon carbide has been generally increasing, owing mainly to new uses for the compound in the chemical, metallurgical and ceramic industries. The annual production of crude fused alumina is more erratic and varies directly with the North American steel output.

In 1959, the value of all crude and secondary abrasive materials produced amounted to $43,243,405, or 18.5 per cent above that of 1958.

Ninety-seven per cent of the exports of 1959 consisted of crude artificial abrasives. They reflected Canadian production and the relative North American and world demand for these materials. The value of exports of all

(text continued on page 264)

*Mineral Processing Division

Abrasives - Production, Trade and Consumption

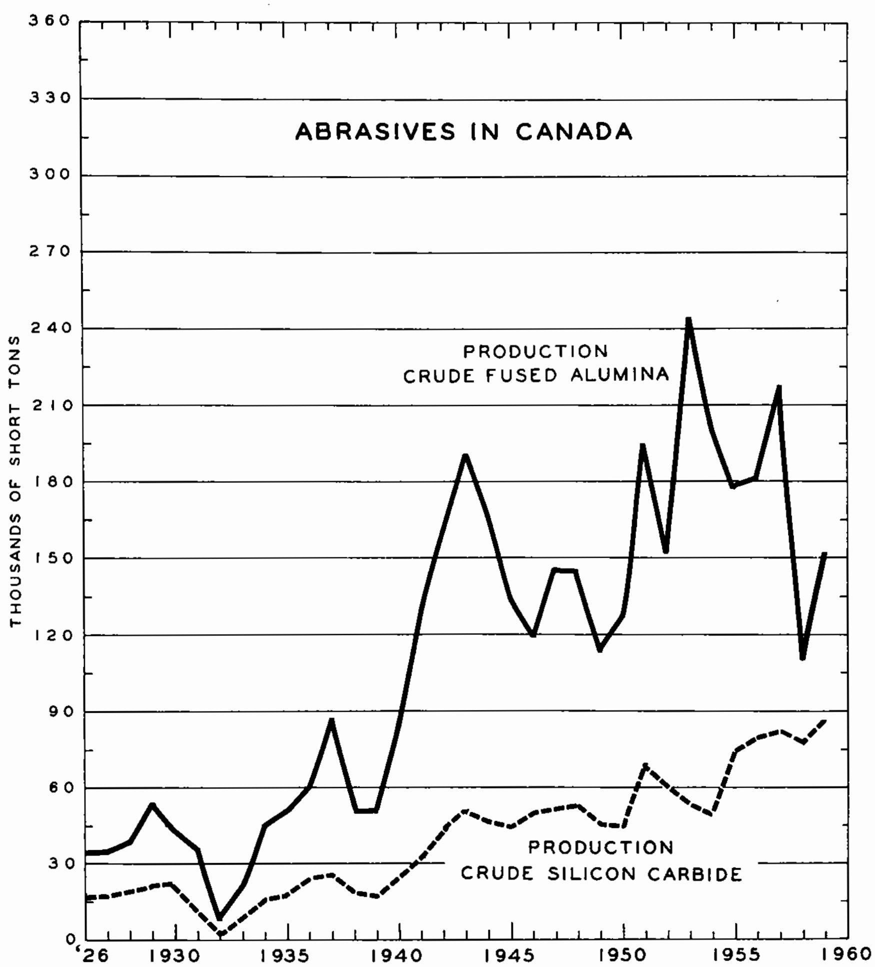
	1959		1958	
	Short Tons	$	Short Tons	$
Production				
Artificial abrasives				
Crude silicon carbide(1).	86,248	12,660,211	77,528	11,676,630
Crude fused alumina(1)..	152,319	15,414,241	109,507	10,994,270
Abrasive wheels and segments	(2)	7,550,473	(2)	6,013,543
Sharpening stones and files	(2)	280,505	(2)	256,585
Other products(3).......	(2)	7,337,975	(2)	7,540,404
Total		43,243,405		36,481,432
Imports				
Natural and artificial abrasives(4)				
Artificial-abrasive grains		2,373,079		1,921,437
Diamond dust, and black and bort for borers...		6,298,061		5,460,487
Emery in bulk(5)		240,845		235,041
Grinding wheels, bonded, with natural or artificial grains......		2,172,854		1,808,523
Grinding stones or blocks, manufactured by bonding together either natural or artificial abrasive, not otherwise provided		357,681		292,516
Grindstones, not otherwise provided		20,434		14,679
Pumice and pumice stone, lava and calcareous tufa, not further manufactured than ground...........		236,190		297,964
Coated abrasive paper and cloth		833,371		799,906
Manufactures of abrasives not otherwise provided.		692,680		580,604
Total		13,225,195		11,411,157

Abrasives - Production, Trade and Consumption (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Exports				
Natural and artificial abrasives(4)				
Abrasives, natural, not otherwise provided, in ore, bulk, crushed or ground form	66	29,667	23	8,861
Abrasives, artificial, crude	242,893	27,736,800	188,601	22,717,376
Abrasives, artificial, manufactured		210,368		41,236
Sandpaper and emery cloth		669,040		731,043
Grindstones, manufactured.		64,875		71,420
Total		28,710,750		23,569,936
Re-exports				
Diamonds, industrial, and diamond dust or bort....		3,806,923		5,045,474

	1958		1957	
Consumption (incomplete)(6)				
Abrasives, natural and artificial, in the production of artificial abrasive products				
Natural-abrasive grains				
Garnet	252	78,781	217	59,276
Emery	43	8,938	61	10,946
Quartz or flint	145	10,004	148	10,065
Other		1,306		1,800
Total		99,029		82,087
Artificial-abrasive grains for wheels, paper, etc.				
Fused alumina..........	1,656	440,657	2,748	798,644
Silicon carbide	3,237	761,568	2,182	621,083
Total	4,893	1,202,225	4,930	1,419,727

(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) Trade of Canada.
(5) Includes also corundum and garnet. Separation not possible.
(6) 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.



SOURCE: D.B.S. MINERAL RESOURCES DIVISION, DEPT. M.T.S.

abrasive products, which is of major importance to Canadian trade, amounted to $28,710,750, or 22 per cent more than in 1958. Most of the industrial diamonds and the greater part of the diamond dust imported into Canada are re-exported, and their statistics are listed under a special heading on page 3 .

Imports, of which industrial diamonds form a large part, increased in value during 1959 to $13,225,195. All Canadian requirements in refined artificial-abrasive grains were imported from the United States and were valued at $2,373,079.

Only partial statistics are available for the consumption of abrasives.

Domestic Producers

The small amounts of natural abrasives produced in Canada are derived from mineral products that are used mainly for other purposes. These include quartzite, beach sand, granite and feldspar.

Dominion Silica Corporation Limited markets quartzite for use in sandblasting and, with Canadian Silica Corporation Limited, produces silica flour for scouring powders and cleansers. Some feldspar from Quebec is used in the manufacture of scouring powders and cleaners. Valley Granite Products Ltd. and Kootenay Granite Products Limited produce crushed granite in southern British Columbia for sandblasting. Beach sands are used locally for the same purposes. During 1959, 60 tons of grindstones were produced from sandstone recovered from the Bathurst district, New Brunswick.

Crude fused alumina and/or crude silicon carbide are produced by six companies in eight plants. Four plants are in Ontario and four in Quebec. The Ontario plants are a few miles from the United States border - at or near Niagara Falls. During 1959, while Canadian silicon-carbide plants were at 88 per cent of rated capacity and fused alumina plants were at 44 per cent, Canada produced 70 per cent of North America's silicon carbide and 89 per cent of its fused alumina.

Canadian Producers of Crude Artificial Abrasives

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

Virtually all the crude silicon carbide and fused alumina manufactured in these plants are shipped to the grain-refining plants of the respective companies in the United States or, on occasion, to those in the United Kingdom.

The Sherwin-Williams Co. of Canada, Limited, processes bog iron ore at Red Mill, Quebec. Part of the output is exported for abrasive use as jewellers' rouge and crocus.

Artificial abrasive products include coated abrasive paper and cloth, grindstones, grinding-wheels and segments, pulpstones, certain tumbling media, refined grains, and various other shapes and products composed at least in part of artificial or natural abrasives. During 1959, the 10 secondary abrasives plants in southwestern Ontario and the one in Montreal marketed products valued at $15,168,953.

Uses

The natural abrasives produced in Canada are used for sandblasting or in scouring powders and cleansers.

Some of the natural abrasives imported and consumed in Canada include industrial diamonds, garnet, emery, corundum, pumice, pumicite, quartzite, diatomite and tripoli. Depending on their end-use, both natural and synthetic industrial diamonds and diamond dust are employed for such purposes as metal-grinding, concrete- and rock-boring, concrete- and rock-cutting, glass-polishing and -cutting and ceramic cutting. Garnet is used in coated abrasives for abrading wood, leather, rubber, plastics and brass. Loose grains are used for polishing glass and stone and for sandblasting. Emery is used in concrete and asphalt to provide nonslip smooth surfaces as well as in grinding-wheels, other shapes and coated papers. Corundum is consumed mainly in the manufacture of grinding-wheels.

Fused alumina and silicon carbide have many uses. During 1958, approximately 6 per cent of the former and 27 per cent of the latter were consumed in nonabrasive uses. As loose grains, silicon carbide may be used in the wire-sawing of stone, in concrete floors and stairs, in lapping operations and in pressure blasting. It may be employed in coated abrasives and in the metalworking, woodworking, plastics, leather, glass and stone industries. Silicon carbide is bonded into grinding-wheels, sticks, rubs, etc., for use in abrading metals, stone, ceramics, rubber, leather and wood.

Fused-alumina grains have uses similar to those of silicon carbide. They are used also for grinding and polishing glass and in buffing compounds. Coated abrasives containing fused alumina are employed in the metalworking, woodworking and leather industries. Bonded abrasives containing fused alumina are used mainly to abrade metals and wood.

Prices

Types of abrasive grains used in Canada in 1958 had the following values per short ton: emery, $208; garnet, $313; and quartz or flint, $69. During 1959, the average value of Canadian production per ton was $101 for crude fused alumina and $147 for crude silicon carbide.

LIGHTWEIGHT AGGREGATES

H.S. Wilson

Although the value of construction in Canada in 1959 was one half of 1 per cent greater than in 1958, the value of lightweight-aggregate production increased 19.3 per cent. The value of residential construction was almost identical with that of 1958, but industrial and institutional construction increased 4 per cent each, and commercial construction increased 10 per cent, over the 1958 value. Lightweight aggregates are used largely in nonresidential construction. The lightweight-aggregate industry continued to expand also because the whole construction industry is turning more to lightweight building materials.

Expanded-clay and -shale aggregates showed the greatest increase - 35.3 per cent in volume and 33.9 per cent in value. The majority of producers had an increase in output, and two new plants were in production for part of the year. One of these is near St. François du Lac, Quebec; the other is on Saturna Island, British Columbia. There are now 11 producing plants in Canada, all using the rotary-kiln process.

Expanded-slag production increased 16 per cent in volume and 18 per cent in value over the 1958 totals.

Most companies exfoliating vermiculite showed increased production. The volume of exfoliated vermiculite was 13 per cent greater than in the previous year, and the value was 23 per cent greater.

The value of pumice used as lightweight aggregate was 3 per cent higher than in 1958.

Expanded perlite was the only lightweight aggregate whose production decreased. About half the plants in operation had decreases; the rest had increases. The total volume and value were 3 per cent less than in 1958.

The production and value of the individual aggregates are shown in the following table. The graph on page 270 shows the production of the principal lightweight aggregates over the past six years.

*Mineral Processing Division

Production of Lightweight Aggregates*

	1959		1958	
	Cubic Yards	$	Cubic Yards	$
From domestic raw materials				
Expanded clay and shale...........	290,000	1,649,000	214,400	1,231,270
Expanded slag........	218,300	512,688	188,700	434,670
From imported raw materials				
Exfoliated vermiculite.........	344,430	2,298,337	304,430	1,866,640
Expanded perlite	127,000	999,000	131,600	1,031,497
Pumice		80,000		78,000
Total		5,539,025		4,642,077

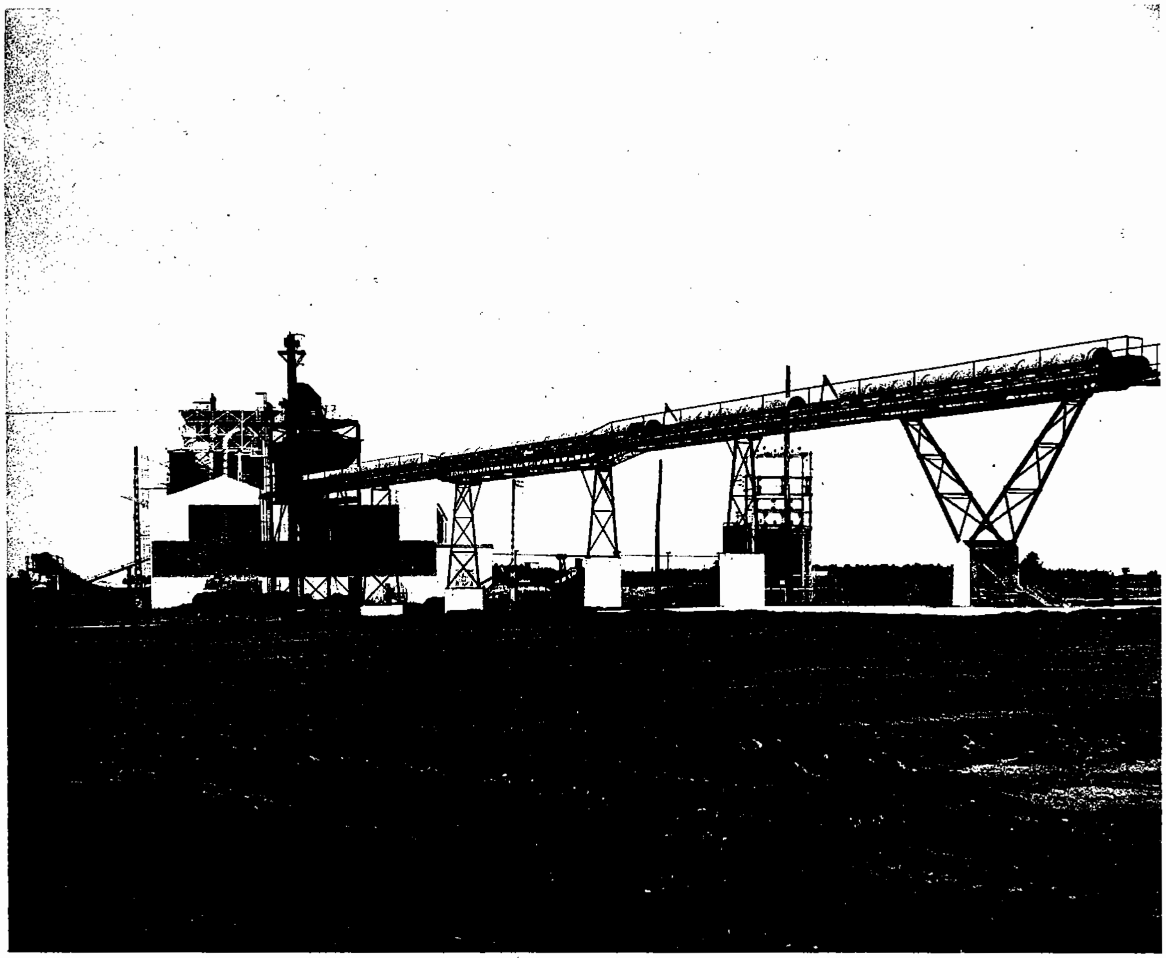
*Information supplied directly by the producers.

Uses of Lightweight Aggregate

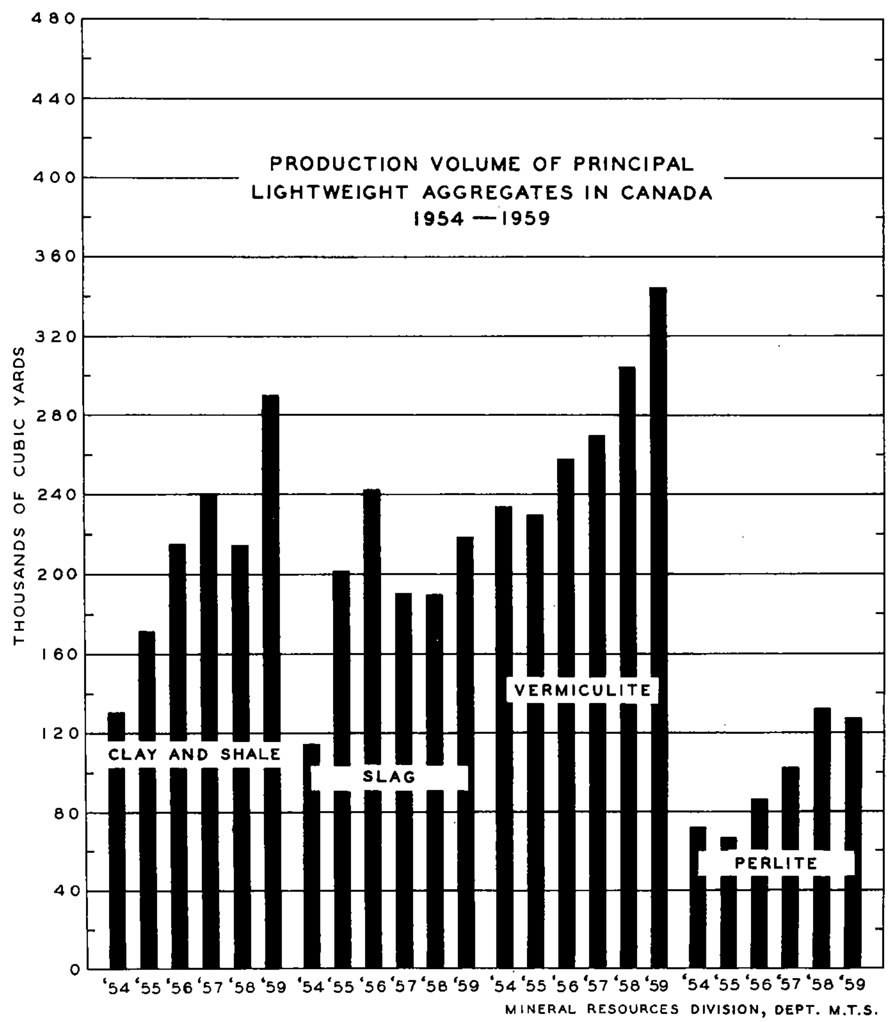
Three types of concrete can be made with lightweight aggregates, namely, structural concrete, masonry units and insulating concrete. Expanded clay, shale and slag, as well as pumice aggregate, can be used in structural concrete, but pumice is not used in Canada for this purpose. Although all lightweight aggregates can be used in masonry units, such use of vermiculite and perlite in Canada is limited. These two are used as aggregates in insulating concrete, owing to their low unit weights and good thermal-insulation qualities. Vermiculite is used largely as loose insulation, as aggregate in plaster and, to a lesser extent, in acoustic plaster, in horticulture, and in stucco and high-temperature insulating concrete. Perlite, in addition to serving as an insulating concrete aggregate, is used as plaster aggregate and, to a lesser degree, in acoustic tile and plaster, as a stucco admix, in oil-well-drilling, and in horticulture.

Raw Materials

The common clays and shales are the most widespread raw materials for lightweight-aggregate manufacture. Ten plants were in operation at the end of the year - at St. Francois du Lac, Quebec; Cooksville, Ontario; St. Boniface, Manitoba; Regina, Saskatchewan (2); Calgary (2) and Edmonton, Alberta; and at Abbotsford and on Saturna Island, British Columbia. One plant is under construction on Saltspring Island, British Columbia.



Lightweight-aggregate plant with stockpiling conveyor in the foreground, St. Francois du Lac, Quebec.



Expanded blast-furnace slag is a by-product of the iron-and-steel industry. It is produced at Hamilton and Port Colborne, 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 qualities. All of the raw vermiculite exfoliated in Canada is imported from the Transvaal, Union of South Africa, and the United States. Five companies produce vermiculite from imported raw material at 11 locations - Vancouver and New Westminster, British Columbia; Calgary, Alberta; Regina, Saskatchewan; Winnipeg, Manitoba; St. Thomas, Cornwall, Rexdale and Toronto, Ontario; and St. Laurent and Montreal, Quebec.

(text continued on page 272)

Lightweight-aggregate Plants in Canada

Producing Plants	Location	Aggregate
Aggregates and Construction Products Ltd.	Regina, Sask.	Expanded clay
Atlas Light Aggregate Limited	St. Boniface, Man.	" "
Edmonton Concrete Block Company Limited	Edmonton, Alta.	" "
Featherock Inc.	St. Francois du Lac, Que.	" "
Hobbs Concrete Blocks Ltd.	Edmonton, Alta.	" "
Light Aggregate (Sask.) Ltd.	Regina, Sask.	" "
British Columbia Lightweight Aggregates Limited	Saturna Island, B.C.	Expanded shale
Burtex Industries Limited	Calgary, Alta.	" "
Consolidated Concrete Industries Limited	Calgary, Alta.	" "
The Cooksville-Laprairie Brick Limited	Cooksville, Ont.	" "
Clayburn-Harbison Ltd.	Abbotsford, B.C.	" "
Dominion Iron and Steel Limited	Sydney, N.S.	Expanded slag
National Slag Limited	Hamilton, Ont.	" "
	Port Colborne, Ont.	" "
F. Hyde and Company Limited	Montreal, Que.	Vermiculite
	Toronto, Ont.	"
	St. Thomas, Ont.	"
Insulation Industries (Canada) Ltd.	Vancouver, B.C.	"
	Calgary, Alta.	"
	Regina, Sask.	"
	Winnipeg, Man.	"
Perlite Industries Limited	New Westminster, B.C.	"
Siscoe Vermiculite Mines Limited	Cornwall, Ont.	"
	Rexdale, Ont.	"

Lightweight-aggregate Plants in Canada (cont'd)

Producing Plants	Location	Aggregate
Vermiculite Insulating Limited	St. Laurent, Que.	Vermiculite
Canadian Gypsum Company Limited	Hagersville, Ont.	Perlite
Canadian Perlite Corporation	Montreal, Que.	"
Gypsum, Lime and Alabastine Limited	Caledonia, Ont.	"
Perlite Atlas Limited	Beauport, Que.	"
Perlite Industries Reg'd.	Ville St. Pierre, Que.	"
Perlite Industries Limited	New Westminster, B.C.	"
Perlite Products Ltd.	Winnipeg, Man.	"
Western Perlite Company Ltd.	Calgary, Alta.	"
McCleery and Weston Limited	Vancouver, B.C.	Pumice
Plant under Construction		
Alsam Manufacturing (B.C.) Ltd.	Saltspring Island, B.C.	Expanded shale

Perlite is a volcanic rock which 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, Ontario; Montreal, Ville St. Pierre and Beauport, Quebec; Winnipeg, Manitoba; Calgary, Alberta; and New Westminster, 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, as the known deposits are either too small or too far from transportation facilities.

Consumption

Clay and Shale

As in 1959, 96 per cent of production was used as aggregate in concrete. Eighty-seven per cent, or 5 per cent less than in 1958, went into masonry units and other precast shapes. Nine per cent was used in structural concrete during 1959; 5 per cent in 1958. Roofing gravel, insulating refractories, and loose insulation, etc. accounted for 4 per cent of consumption.

Slag

Consumption during 1959 was almost identical with that of 1958. Ninety-four per cent was used in masonry units. Another 5 per cent of production went into precast concrete. In both years, 1 per cent was used as roofing gravel, and as roof and floor fill, etc.

Vermiculite

Seventy-two per cent, or 8 per cent more than in 1958, was used as loose insulation. Insulating plaster accounted for 20 per cent, or 7 per cent less. Two per cent was used as aggregate in insulating concrete in 1959; 6 per cent in 1958. Other products, such as acoustic plaster, stucco, high-temperature insulating concrete and fertilizer conditioner, provided an outlet for 6 per cent in 1959 against 3 per cent in 1958.

Perlite

The quantity used in lightweight plaster was 81 per cent in 1959, 10 per cent less than in 1958. The amount used as aggregate in concrete increased from 3 per cent in 1958 to 13 per cent in 1959. In both 1958 and 1959, 3 per cent was consumed in the production of acoustic tile and plaster. Three per cent was used in oil-well cement and stucco admix and for horticultural purposes in both 1958 and 1959.

Pumice

In 1959, as in 1958, all the pumice was imported and used as aggregate in masonry units.

Prices

Expanded clay and shale aggregates sold at $5 to $6.50 a cubic yard, and expanded slag at $2.25 to $3.25 a cubic yard. Vermiculite sold at 20 to 35 cents a cubic foot, and perlite at 25 to 35 cents a cubic foot. Vermiculite and perlite are marketed in bags containing 4 cubic feet each. All prices shown are f.o.b. plant.

ARSENIC TRIOXIDE

J.S. Ross*

Refined arsenic trioxide, also known as arsenious oxide or white arsenic, is the source from which other arsenic compounds and arsenic metal are produced. Because of its toxic effects, it is necessary to recover the crude variety during the roasting of ores containing arsenic. Recovery usually far exceeds demand, and for this reason it is necessary to dispose of the excess in the crude state or as calcium arsenite.

Sales are dependent mainly upon exports. Owing chiefly to a 34-per-cent decrease in exports, shipments of arsenic trioxide were 32 per cent less than in 1958. Exports, which went mainly to the United States and to a minor extent to Iran, amounted to 72 per cent of production.

Canada is self-sufficient in arsenic trioxide and will be for the fore-seeable future. Imports of other arsenical compounds, which are relatively minor in value and quantity, varied slightly during 1959.

World production of arsenic trioxide amounted to an estimated 47,000 short tons during 1959, Sweden and Mexico producing more than half the total. Canada is a minor world supplier.

Domestic Production

All the Canadian output of refined arsenic trioxide is supplied by Deloro Smelting & Refining Company, Limited, of Deloro, Ontario. Owing to its toxic effects, the crude variety is recovered and refined from smelter gases during the smelting of silver-cobalt custom concentrates from the Cobalt-Gowganda area of northern Ontario. The amount recovered varies with the arsenic content of the concentrates and is normally greater than the demand.

Other Domestic Sources

To improve gold recovery, the following mining companies roast arsenical gold ores: Giant Yellowknife Gold Mines Limited and The Consolidated Mining and Smelting Company of Canada Limited, at Yellowknife, Northwest Territories; and Campbell Red Lake Mines Limited, Cochenour Willans Gold Mines, Limited, and New Dickenson Mines Limited, in the Red Lake, Ontario, area. The crude arsenic trioxide recovered by these

---

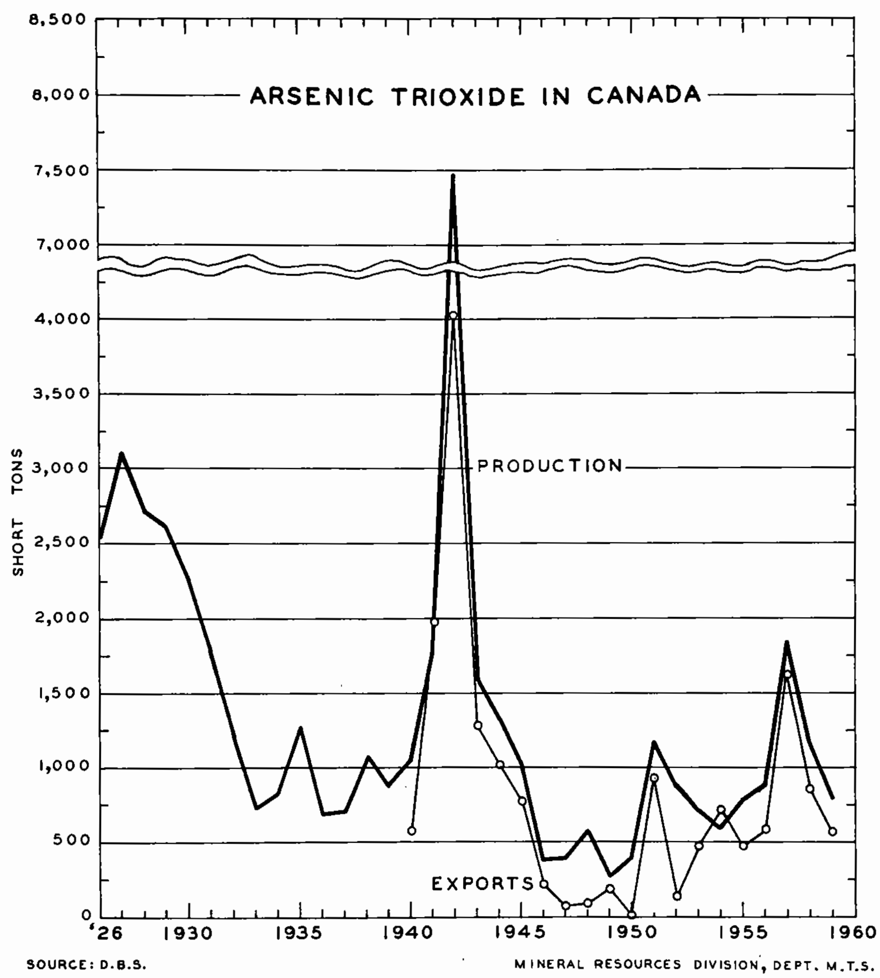
*Mineral Processing Division

Arsenic - Production, Trade and Consumption

	1959 Pounds	1959 $	1958 Pounds	1958 $
Production (shipments)				
Refined arsenic trioxide	1,578,307	63,786	2,323,320	94,542
Exports*				
United States	1,108,200	45,683	1,703,200	67,731
Iran	22,200	777	-	-
Total	1,130,400	46,460	1,703,200	67,731
Imports				
Arsenic acid				
United States	595,674	20,081	507,657	16,011
Arsenate of lead				
United States	73,248	16,718	130,400	25,854
United Kingdom	11,200	1,712	-	-
Total	84,448	18,430	130,400	25,854
Arsenate of lime				
Belgium	76,446	2,268	-	
United States	11,080	1,079	85,500	6,142
Total	87,526	3,347	85,500	6,142
Arsenate and binarseniate of soda				
United Kingdom	131,036	8,251	70,000	5,619
United States	76,098	32,668	51,921	25,787
Total	207,134	40,919	121,921	31,406
Total imports	974,782	82,777	845,478	79,413

	1958	1957
Consumption		
Refined arsenic trioxide		
Glass	269,344	377,331
White metal alloys	68,120	73,668
Miscellaneous chemicals	60,927	49,563
Total	398,391	500,562
Arsenic acid As_2O_5		
Miscellaneous chemicals	438,022	533,023
Metallic arsenic		
White metal alloys	12,582	16,848

*Does not include arsenic content of gold ores exported for treatment outside Canada.



companies is disposed of in dumps or in certain underground workings.

Arsenical residues from the treatment of uranium concentrates by Eldorado Mining and Refining Limited at Port Hope, Ontario, are disposed of in insoluble form in a dump.

Bralorne Mines Limited, in British Columbia, exports arsenical gold concentrates to the United States. Minor amounts of arsenic are present in many other metalliferous deposits in Canada.

Consumption and Uses

Throughout the world, arsenic compounds derived from white arsenic are consumed mainly in herbicides and for their toxic effects in insecticides, rodenticides and other pesticides. Calcium and lead arsenates are the compounds commonly used in these products. Such poisons are used intermittently with more popular and newer organic and inorganic poisons, mainly to control the boll weevil in the southern United States.

The glass industry is the largest consumer of arsenic trioxide in Canada. This compound is used as an additive to assist in the decolorizing and fining of glass.

Arsenic trioxide is also employed in the production of arsenic compounds and for the production of metallic arsenic. Metallic arsenic in turn is consumed in certain copper- and lead-base alloys. During the year it became prominent as a semiconductor.

Arsenic compounds are used in wood-preserving, hide-tanning and the manufacture of paint pigments. The newer method of killing and debarking trees with sodium arsenate is used under certain conditions. This method reduces peeling, drying and the cost of transporting pulpwood by road or rail.

The world outlook for arsenic consumption is not expected to change appreciably.

Prices and Tariffs

The price of refined white arsenic in barrels and carload lots varied mainly from 4 to 5 cents a pound f. o. b. United States east coast cities. The production statistics tabulated in this review show that the average value of production per pound in Canada was 4. 1 cents in 1958 and 4 cents in 1959.

The commodity enters Canada and the United States duty-free.

ASBESTOS

H.M. Woodrooffe*

World production of asbestos increased 10 per cent during 1959 to supply the diversified market for this useful mineral. The increase was largely a reflection of an improvement that occurred in the sales of Canadian fibre as consuming industries resumed near-normal purchases. The volume of Canadian shipments in 1959 was 1,050,429 tons, 13,373 tons below the record output of 1955. At $107,433,344, value reached a new peak.

One of the chief developments of 1959 was the decision by Canadian Johns-Manville Company, Limited, to convert the Jeffrey mine entirely to open-pit operation. In recent years, most of the ore taken from this mine has been recovered by extensive block-caving operations underground.

Exploration of chrysotile occurrences was continued, particularly in Newfoundland and Quebec.

Domestic consumption of asbestos remains small, almost all production being exported to world markets. In value, exports to the United States were equal to 50 per cent of all the asbestos sales made by Canadian producers. Canada imports its crocidolite and amosite from the Union of South Africa.

Chrysotile asbestos occurs in several places in northern Ontario, Quebec, Newfoundland, British Columbia and Yukon Territory, but in many cases 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.

What are believed to be the world's largest deposits of asbestos occur in the Eastern Townships of Quebec in a narrow band extending from east of the Chaudière River southwest almost to Sherbrooke, approximately 80 miles east of Montreal. All the producing deposits in the province are in this region. The persistence of the mineral at depth, as established by drilling, indicates that reserves are sufficient for many years.

Technology

Of the several varieties of asbestos marketed commercially, only chrysotile is mined in Canada. It occurs generally in two forms - a 'cross fibre' and a 'slip fibre'. In the former type, the individual fibres lie parallel

(text continued on page 282)

*Mineral Processing Division

Asbestos - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
By shipments				
Crude	432	480,383	605	599,066
Milled fibres	404,019	73,310,989	342,562	62,697,511
Shorts and refuse	645,978	33,641,972	582,164	28,980,171
Total	1,050,429	107,433,344*	925,331	92,276,748*
By provinces				
Quebec	992,196	95,226,769	873,603	82,028,699
British Columbia	33,883	7,878,947	30,078	6,398,679
Ontario	24,350	4,327,628	21,650	3,849,370
Total	1,050,429	107,433,344	925,331	92,276,748
Exports				
Crude				
United Kingdom	187	218,521	95	126,100
United States	111	97,685	285	258,684
West Germany	69	61,019	37	31,242
Japan	24	23,778	27	27,707
Italy	19	19,573	2	3,950
Other countries	6	5,665	37	31,293
Total	416	426,241	483	478,976
Milled fibres				
United States	145,667	28,757,149	131,938	24,815,414
West Germany	34,308	6,762,111	25,683	5,368,725
Japan	32,116	4,726,286	17,550	2,624,011
United Kingdom	32,043	7,052,135	27,086	5,799,091
France	22,453	4,706,532	19,182	4,234,339
Belgium	22,206	4,041,719	11,276	2,305,272
Australia	20,827	3,377,530	20,097	3,486,833
Netherlands	10,898	2,083,702	6,552	1,694,287
Other countries	81,065	14,868,689	58,916	11,002,060
Total	401,583	76,375,853	318,280	61,330,032

Asbestos - Production and Trade (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Short-fibre grades				
United States.......	483,453	25,783,343	450,143	23,351,902
United Kingdom	37,004	1,858,057	38,123	1,934,722
West Germany	31,737	1,734,176	18,358	980,457
Japan	23,108	1,987,068	10,416	892,594
Netherlands	6,976	372,419	5,729	251,697
France	5,631	316,930	8,255	412,250
Other countries	24,014	1,577,205	16,843	1,112,383
Total.............	611,923	33,629,198	547,867	28,936,005
Total exports, unmanufactured asbestos..........	1,013,922	110,431,292	866,630	90,745,013
Asbestos brake linings and clutch facings				
Cuba..............		82,596		47,414
Venezuela		50,504		30,516
Lebanon		31,838		20,126
Ecuador		21,328		28,777
Arabia		18,381		10,721
Other countries		182,183		310,120
Total.............		386,830		447,674
Asbestos packing				
United States.......		96		584
Pakistan...........		-		2,028
Peru..............		-		1,077
Other countries		-		249
Total.............		96		3,938
Asbestos manufactures, including asbestos roofing				
United States.......		302,283		292,040
Switzerland........		13,089		8,699
Bermuda..........		6,164		-
Other countries		1,636		24,614
Total		323,172		325,353

Asbestos - Production and Trade (cont'd)

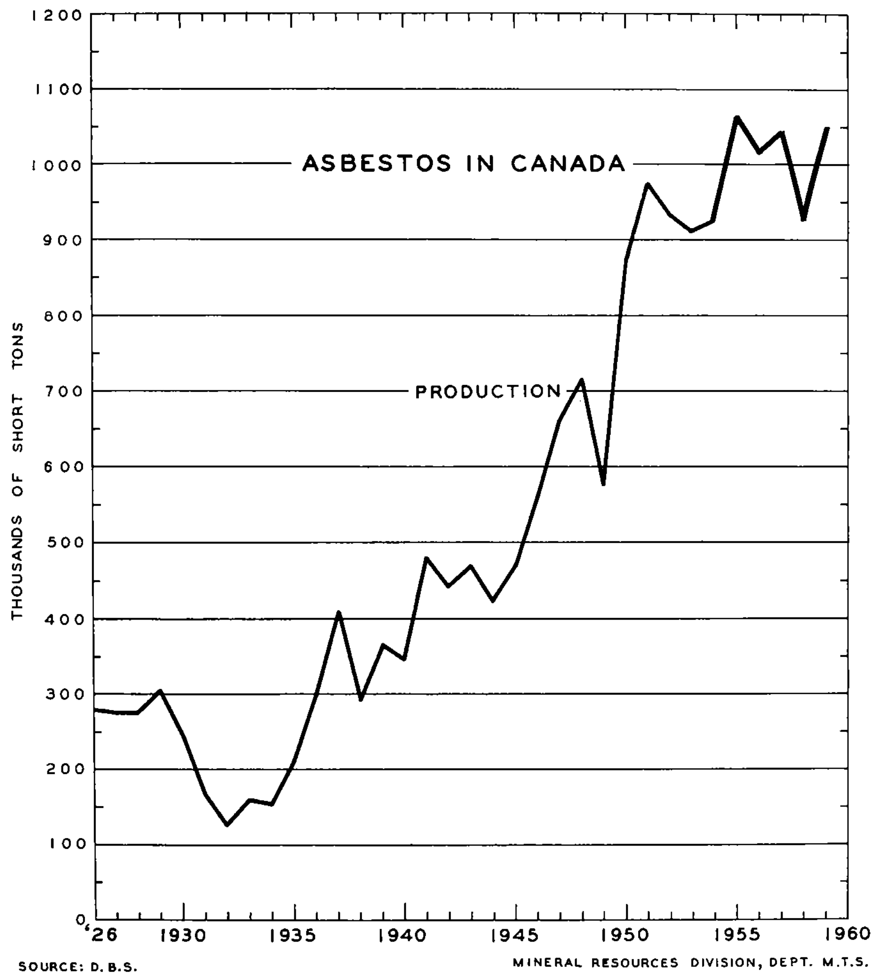
	1959		1958	
	Short Tons	$	Short Tons	$
Total exports, manufactured asbestos products		710,098		776,965
Imports (manufactures)				
Packing		284,914		260,624
Auto brake linings		611,631		503,086
Auto clutch facings		364,443		324,907
Other brake linings and clutch facings		248,413		118,043
Other asbestos manufactures		2,568,873		2,996,091
Total		4,078,274		4,202,751

*Does not include the value of containers. This amounted to $2,971,681 in 1958 and $3,534,945 in 1959.

Asbestos - Production and Exports, 1949-59
(short tons)

	Production**				Exports			
	Crude	Milled	Shorts and Refuse	Total	Crude	Milled	Shorts and Refuse	Total
1949	652	194,583	379,671	574,906	631	181,641	352,718	534,990
1950	904	305,194	569,246	875,344	845	289,798	539,336	829,979
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

**Producers' shipments.



across the vein, and the vein width is an approximate indication of fibre length. Although fibres as long as 5 inches are found, most fibre mined is one-half inch or less in length.

Slip fibre, which frequently occurs along the Pennington Dyke 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 a result of the mineral's physical characteristics rather 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.

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 during 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

This province has several occurrences of chrysotile asbestos. One important deposit of semiharsh fibre, which occurs near Baie Verte, on the Burlington peninsula, in the northeastern part of the island, is being developed by Advocate Mines Limited. 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 are 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. It was operated as an open-pit property for many years, but since the war extensive underground workings have been developed and much of the ore has been recovered by the block-caving mining method. To take advantage of technical improvements, the company is converting the mine again to open-pit operation.

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

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

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

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

Lake Asbestos of Quebec Ltd., a subsidiary of American Smelting and Refining Company, operates 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 Limited, a subsidiary of Philip Carey Manufacturing Company, is 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) Limited, recovers asbestos from a deposit along the Pennington Dyke a few miles east of Thetford Mines.

Golden Age Mines Limited operated a pilot plant on its property at Rivière aux Plantes near Beauceville.

Murray Mining Corporation Limited was actively exploring an occurrence 30 miles south of Deception Bay in northern Quebec.

Ontario

Canadian Johns-Manville Company, Limited, recently completed the conversion of its Munro mine to underground mining. The mine, which is east of Matheson in northern Ontario, is the only producing asbestos mine in the province.

British Columbia

Cassiar Asbestos Corporation Limited recovers 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 and Yukon Railway to Skagway, Alaska, and then by boat to Vancouver. The company is exploring other deposits in northern British Columbia and Yukon Territory. Mill capacity was increased by 50 per cent to 1,500 tons a day.

World Review

Since the Union of Soviet Socialist Republics does not publish statistics regarding the output of asbestos, it is possible only to estimate world production. Canada in 1959 contributed 46 per cent of a world output of 2 1/4 million tons. Asbestos in varying amounts is mined in some 35 countries.

The second-ranking producing country, the U.S.S.R., is believed to have a current annual output of 600,000 tons. In recent years, competing with Canadian exports, it has marketed asbestos fibre to the Free World in increasing amounts. Extensive deposits of chrysotile occur in the Urals and Siberia.

In 1959, Southern Rhodesia produced 120,000 tons of chrysotile. Rhodesian fibre, because of the freeness of its magnetic iron, finds a ready market in the manufacture of woven-asbestos products for electrical uses.

Many of the world's requirements in crocidolite and amosite are supplied by the asbestos-mining industry of the Union of South Africa. Chrysotile is also mined there.

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. Chrysotile is carded, spun and woven into cloths of different weights, thicknesses and qualities. These cloths are used in the manufacture of heat-resistant clothing, protective curtains and mats, electrical insulation and heat-resistant friction materials.

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 of asbestos has grown considerably since the war, and the resulting products are well established throughout the world. Although many asbestos-cement products are used 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.

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

The shorter-fibre grades of asbestos have the greatest number of uses. At present the volume of asbestos classified as short-fibre far exceeds that of all other grades combined. This type is used in the moulding of plastics, the manufacture of floor tiling, the manufacture of 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

Except for small adjustments in some grades, the prices of Canadian fibre were constant throughout the year. Prices for carload lots, in Canadian funds, per short ton, f.o.b. Quebec producers, were as follows:

No. 1	crude	$ 1,470
2	"	788
3K	fibre	504
3R	"	428
3T	"	402
3Z	"	370
4K	"	200
4M	"	200
4T	"	181
4Z	"	181
5D	"	142
5K	"	142
5R	"	120
6D	"	86
7D	"	75
7F	"	71
7H	"	61
7K	"	50
7M	"	44
7R	"	43
7T	"	41
7RF	floats	44
7TF	"	44
8S	"	29

BARITE

J.S. Ross*

To supply the well-drilling industry, new barite-mining and -processing operations were started in western Canada during 1959. Barite, the only barium mineral produced in Canada, was mined from five deposits in southeastern British Columbia and one in Nova Scotia. Sheep Creek Mines Limited, primarily a zinc-lead producer, began recovering and shipping lump barite as a by-product from its mining operations near Invermere, British Columbia. In the same area, Baroid of Canada, Limited, shipped crude barite from its Giant Mascot and Larrabee properties. Two new processing plants were constructed in Alberta, the one at Rosalind beginning production in March.

The sudden development of two new producing deposits and processing plants was due to the establishment in Alberta, and for the first time in Canada, by Magcobar Mining Company Limited and Baroid of Canada, Limited, of an integrated barite- and bentonite-processing industry. Initially, the products will be marketed for use in well-drilling muds. Each company intends to process the barite necessary for its requirements in its own plant and has sought new sources for the required barite.

During 1959, barite production increased 22 and 3 per cent in volume and value respectively over that of 1958. As for many years, the bulk of production came from Nova Scotia. The Canadian barite industry depends upon the export trade, and this increase was due primarily to the rise in shipments of the crushed and lump varieties to the United States and other countries. The apparent discrepancy in the increase in value is due to a change in statistical interpretation, with the designation of all production from British Columbia as crude. Practically all the output from that province is eventually ground at plants in Alberta.

Canada regained third place as a world barite producer. World production, which amounted to an estimated 3 million short tons for 1959, came mainly from the United States, West Germany and Canada, in that order of importance.

Occasionally Dominion Magnesium Limited, at Haley Station, Ontario, produces small quantities of barium metal for the electronics industry.

---

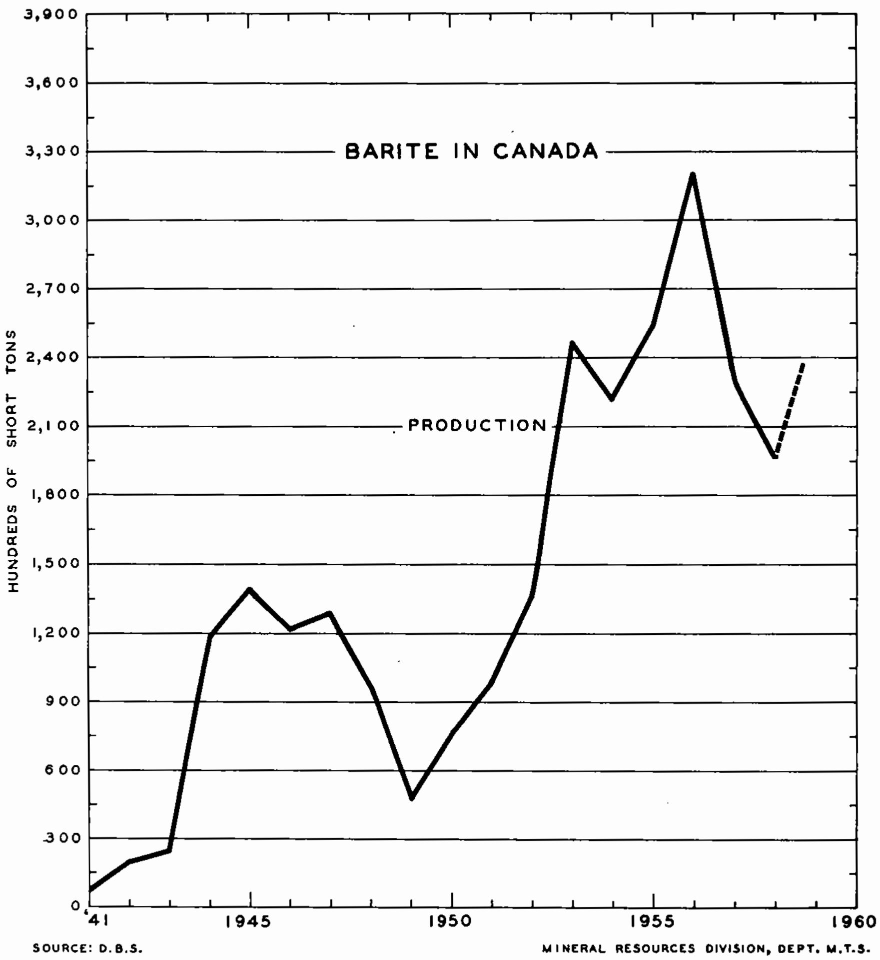
*Mineral Processing Division

Barite - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (mine shipments)				
Crushed and lump	214,977	1,817,962	150,687	1,283,833
Ground..................	23,990	436,620	45,032	912,551
Total	238,967	2,254,582	195,719	2,196,384
Imports (ground)				
United States	867	42,180	835	42,111
West Germany	750	20,671	547	14,533
United Kingdom	45	1,617	-	-
Total	1,662	64,468	1,382	56,644
Exports				
.....	221,721	2,248,199	172,942	1,741,640
	1958		1957	
Consumption (1)				
Paints	805		962	
Rubber goods	387		525	
Glass	215		301	
Miscellaneous chemicals..	12		93	
Asbestos products	30		64	
Miscellaneous nonmetallic .	600 (e)		600(e)	

(1) Exclusive of well-drilling.
(e) Estimated.

Canadian barite exports depend upon the well-drilling industry in foreign countries, especially in the United States. About 93 per cent of production is exported, mainly in the crude form, and 80 per cent of the crude output goes to the United States, principally to grinding plants at ports on the Gulf of Mexico. Imports are minor and consist of the ground variety. Consumption statistics for 1959 are not complete, but apparent consumption for that year is 18,908 tons. By far the greater part of this was eventually consumed in the ground form, and more than 90 per cent of all the barite produced was used as a weighting agent in well-drilling muds.



Productive Deposits

Barite is mined in Nova Scotia and British Columbia, and it is known to occur in all provinces except Alberta, Saskatchewan and Prince Edward Island.

Nova Scotia

Magnet Cove Barium Corporation Ltd. operates the largest Canadian barite mine, which is near Walton, Hants county. During 1959, this operation produced more than 90 per cent of the barite mined in Canada. The orebody, according to the 1958 estimate, the latest published, contained ore reserves of 1.8 million tons.

Ore is being recovered from underground blast-hole stopes and mine developments above the 690-foot level. It is concentrated at a beneficiation plant at the mine site and is trucked to Walton. Although crude barite is the major product, both the crude and the ground varieties are shipped from the port of Walton to the United States, Trinidad, Colombia, Venezuela, the Middle East and other parts of Canada. Except for occasional small shipments, this barite is consumed eventually by the well-drilling industry.

British Columbia

Mountain Minerals Limited mines two barite vein deposits by underground and open-pit methods near Brisco and Parson in the Kootenay district. Barite from the Parson deposit is of a high-quality white variety. Virtually all the ore mined is shipped by rail to the plant at Lethbridge, Alberta, where it is ground, mainly for use in oil-well-drilling muds. The remainder is sold in lump form.

Sheep Creek Mines Limited recovers by-product barite during the open-stope mining of zinc-lead ore at the Mineral King mine 28 miles southwest of Invermere. The exceptionally high-quality lump barite is trucked to Invermere, from where it is shipped by rail to the grinding plant of Magcobar Mining Company Limited, at Rosalind, Alberta. There it is ground and bagged for use as a weighting agent in well-drilling. This pulverizing plant, which is part of a bentonite-processing plant, began production in March.

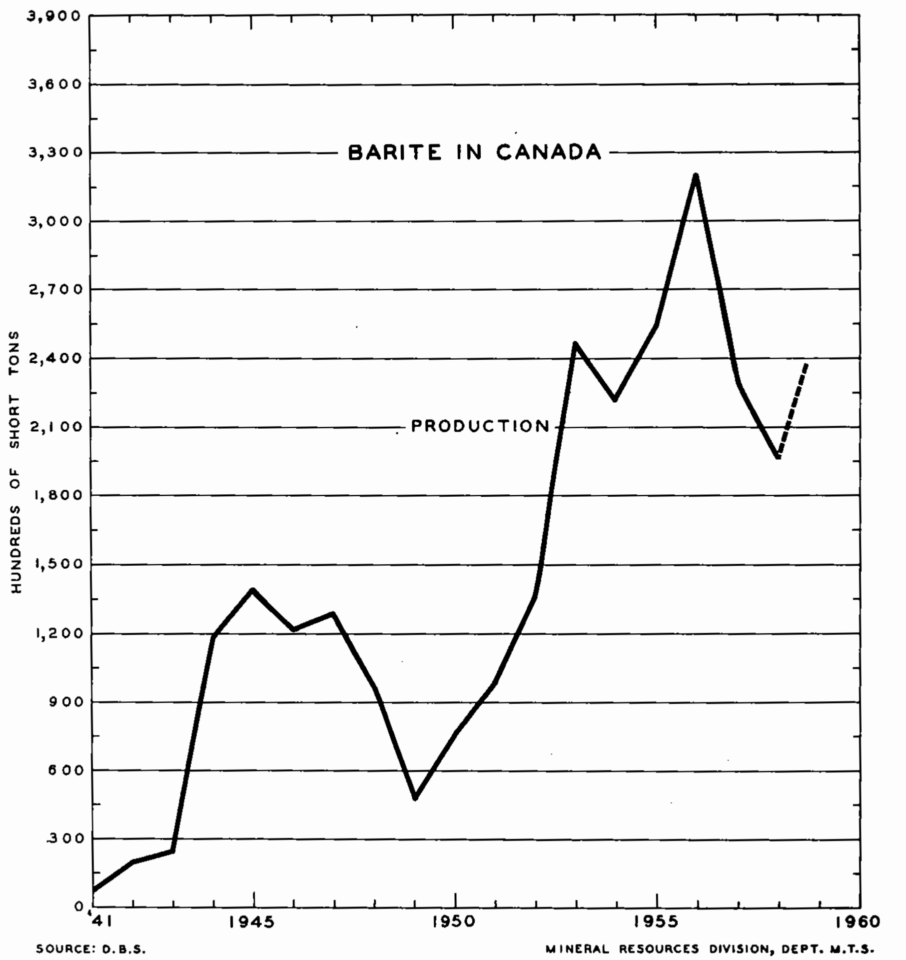
Baroid of Canada, Limited, has optioned the Silver Giant mine of Giant Mascot Mines Limited, near Spillimacheen. During the year Baroid mined barite from an open pit and shipped the lump material to its grinding plant at Onoway, Alberta. Baroid also mined the mineral from the new Larrabee deposit near Invermere and shipped it to Onoway. The barite-bentonite processing plant at Onoway was completed but was not operated during the year.

Quebec

The pulverizing plant of Industrial Fillers Limited, in Montreal, grinds barite as the eastern market requires.

Other Occurrences

Several smaller barite deposits have been mined intermittently. They were mined particularly during the early part of the century. There are numerous other barite occurrences in most provinces, the more noteworthy on McKellar Island, in Lake Superior; in Penhorwood township, Sudbury district, and Langmuir township, Timiskaming district, Ontario; and at Mile 397 on the Alaska Highway, British Columbia; and at Buchans mine, Buchans, Newfoundland. Witherite (barium carbonate) occurs with fluorite, quartz and barite in a large deposit at the Liard River crossing on the Alaska Highway in British Columbia.



Productive Deposits

Barite is mined in Nova Scotia and British Columbia, and it is known to occur in all provinces except Alberta, Saskatchewan and Prince Edward Island.

Nova Scotia

Magnet Cove Barium Corporation Ltd. operates the largest Canadian barite mine, which is near Walton, Hants county. During 1959, this operation produced more than 90 per cent of the barite mined in Canada. The orebody, according to the 1958 estimate, the latest published, contained ore reserves of 1.8 million tons.

Ore is being recovered from underground blast-hole stopes and mine developments above the 690-foot level. It is concentrated at a beneficiation plant at the mine site and is trucked to Walton. Although crude barite is the major product, both the crude and the ground varieties are shipped from the port of Walton to the United States, Trinidad, Colombia, Venezuela, the Middle East and other parts of Canada. Except for occasional small shipments, this barite is consumed eventually by the well-drilling industry.

British Columbia

Mountain Minerals Limited mines two barite vein deposits by underground and open-pit methods near Brisco and Parson in the Kootenay district. Barite from the Parson deposit is of a high-quality white variety. Virtually all the ore mined is shipped by rail to the plant at Lethbridge, Alberta, where it is ground, mainly for use in oil-well-drilling muds. The remainder is sold in lump form.

Sheep Creek Mines Limited recovers by-product barite during the open-stope mining of zinc-lead ore at the Mineral King mine 28 miles southwest of Invermere. The exceptionally high-quality lump barite is trucked to Invermere, from where it is shipped by rail to the grinding plant of Magcobar Mining Company Limited, at Rosalind, Alberta. There it is ground and bagged for use as a weighting agent in well-drilling. This pulverizing plant, which is part of a bentonite-processing plant, began production in March.

Baroid of Canada, Limited, has optioned the Silver Giant mine of Giant Mascot Mines Limited, near Spillimacheen. During the year Baroid mined barite from an open pit and shipped the lump material to its grinding plant at Onoway, Alberta. Baroid also mined the mineral from the new Larrabee deposit near Invermere and shipped it to Onoway. The barite-bentonite processing plant at Onoway was completed but was not operated during the year.

Quebec

The pulverizing plant of Industrial Fillers Limited, in Montreal, grinds barite as the eastern market requires.

Other Occurrences

Several smaller barite deposits have been mined intermittently. They were mined particularly during the early part of the century. There are numerous other barite occurrences in most provinces, the more noteworthy on McKellar Island, in Lake Superior; in Penhorwood township, Sudbury district, and Langmuir township, Timiskaming district, Ontario; and at Mile 397 on the Alaska Highway, British Columbia; and at Buchans mine, Buchans, Newfoundland. Witherite (barium carbonate) occurs with fluorite, quartz and barite in a large deposit at the Liard River crossing on the Alaska Highway in British Columbia.

Exploration work was carried out during the year on barite deposits in Nova Scotia, New Brunswick, Newfoundland, Ontario and British Columbia.

Canadian reserves are adequate to meet normal domestic requirements for many years.

Uses and Specifications

Barite is marketed in bulk (in lump or crushed form) and in bags (ground). It is consumed mainly because of its inertness and relatively high specific gravity (4.3 to 4.6).

Most of the barite produced in the world is used as a heavy medium in well-drilling muds, where it assists in controlling oil and gas pressures and in floating drill cuttings. Normally, barite is the most desirable commodity for this purpose and is generally not likely to be replaced by substitutes in the near future. More than 95 per cent of Canadian production goes into this use. Specifications, which vary according to the particular needs of the consumer, may require a minimum specific gravity of 4.2, a minimum of 90 per cent $BaSO_4$ (barium sulphate) and a mesh size of 90 to 95 per cent minus 325. Soluble salts are objectionable, but several per cent of iron is not.

Barite used in the chemical industry for the manufacture of barium chemicals must be in lump form and have a minimum of 94 per cent $BaSO_4$ and a maximum of 1 per cent Fe_2O_3 (ferric oxide). The more common barium compounds manufactured and some of their uses are: 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 sulphide, employed as a white pigment in paints; barium chloride, for case-hardening and preventing scumming of brick; and barium carbonate, used in oil-well-drilling fluids and 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 the miniature-electronic-components and communications industry.

As a filler in paints, rubber and paper, barite must have a high reflectivity and usually a minimum of 95 per cent $BaSO_4$ and a mesh size of minus 200.

In the glass industry, barite acts as a flux and makes glass more brilliant and workable. It must contain a minimum of 98 per cent $BaSO_4$, less than 0.15 per cent Fe_2O_3 and be between 20- and 200-mesh.

Barite fragments under three quarters of an inch in size are used as heavy aggregate in concrete to assist in the shielding against atomic radiation.

Lithopone, previously the main source of white pigment for paints, has been extensively replaced by titanium oxide, which has greater covering power. The steady decrease in the consumption of lithopone in Canada is expected to continue.

Barium Compounds - Imports and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Imports				
Lithopone (70% $BaSO_4$)....	979	138,039	1,242	179,954
Blanc fixe and satin white..	1,014	78,506	879	68,514
	1958		1957	
Consumption of the main barium compounds in the chemical and allied-products industries				
Barium chloride..........	611		361	
Barium nitrate...........	57		86	
Barite...................	816		970	
Blanc fixe	176		301	
Lithopone	1,064		1,379	

Prices

Prices quoted in E & M J Metal and Mineral Markets on December 3, 1959, were as follows:

Canada

Crude, in bulk, f.o.b. shipping point, per long ton	$11.00
Ground, in bags, per short ton	$16.50

Georgia

Crude, jig and lump, per short ton	$18.00
Beneficiated, per short ton	
In bulk	$21.00
In bags	$23.50 to $25.00

U.S. Gulf ports

Foreign, crude, oil-well grade, minimum specific gravity 4.25, bulk, c.i.f. ports, per short ton	$16.00 " $18.00

The average value of production per short ton for Canadian lump or crushed barite was $8.46; for the ground product it was $18.20

Tariffs

At present, the Canadian and United States tariffs on barite are as follows:

Canada

	British Preferential	Most Favored Nation	General
Barite, crude or ground	free	25%	25%
Barite, for drilling-mud use	"	free	free

United States

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

BENTONITE

R.M. Buchanan*

In geological usage the term 'bentonite' is applied only to clay materials formed by the alteration of volcanic ash. The clay minerals in these materials are predominantly montmorillonite or beidellite, members of the montmorillonite mineral group. In this review the term is extended in conformity with industrial usage to include all clay materials in which the principal constituent is a member of the montmorillonite group. This definition also includes most materials referred to as fuller's earth, adsorbent clay and decolorizing clay or earth, as well as clays that can be 'activated' by acid treatment.

Although bentonites vary greatly in properties, they are loosely classified as swelling (sodium) bentonite or nonswelling (calcium) bentonite. The chief feature of the first group is the ability to swell greatly in water and to form permanent colloidal suspensions. The second group is characterized by the property of decolorizing, by adsorption, many types of oils and other liquids, either in the natural state or after acid activation.

Canadian Occurrences

Bentonite deposits occur in many areas. The favorable rocks appear to be those of Cretaceous age or younger, and there is no known deposit east of Manitoba.

Manitoba

A prominent bentonite horizon occurs near the bottom of the Pembina member of the Vermilion River formation (Upper Cretaceous). It has been traced from the United States border northward to Miami, a distance of about 35 miles, and contains the nonswelling type. The deposits being mined by Pembina Mountain Clays Ltd., in the Thornhill-Miami area, are in this horizon, and another promising deposit has been reported as occurring on Deadhorse Creek. Other occurrences have been reported as far to the northwest as Swan River. One of these is on Henderson Creek, about 6 miles west of Laurier.

Saskatchewan

The largest known deposits of nonswelling bentonite occur north of Pelly, on the Swan River, in the Vermilion River formation. Similar material

*Mineral Processing Division

is found in the Riding Mountain formation (later Upper Cretaceous), which underlies a large area in the eastern part of the province. Swelling types occur in the St. Victor-Pickthall area, in the Ravenscrag formation; nonswelling bentonite occurs near Rockglen, also in the Ravenscrag formation (Tertiary). A large deposit of 'semibentonite' is known to exist at Knollys, in the Butler formation (Upper Cretaceous).

Alberta

Of the many known deposits of bentonite, none is significantly decolorizing in the natural state. The ones shown to have the best swelling characteristics occur in the Edmonton and Bearpaw formations (Upper Cretaceous). Several occurrences are known to exist in the Drumheller-Rosedale area, mostly in association with coal seams. One 3-foot bed not associated with coal has been mined intermittently for several years on a small scale. Other deposits in the Edmonton formation occur at Sheerness and near Busby, north of Edmonton. Near Dorothy, in the Bearpaw formation, there is a 20-foot bed of material that appears to be very pure but has been shown to be of poor quality. In the Upper Wapiti formation, which is northeast of Grande Prairie and is similar to the Edmonton formation, there is a 4-foot bed of bentonite that has been found to have fairly good swelling properties. A 6- to 8-foot bed of almost pure-white material occurs near Bickerdike, in the Saunders formation (Paleocene and/or Upper Cretaceous). It has been mined in the past for use in cosmetics, but the swelling and decolorizing properties are inferior.

British Columbia

Tertiary formations containing bentonite deposits are widely distributed in the interior plateau of British Columbia. A 14-foot bed, one of the thickest known deposits in Canada, is exposed in a railway cut south of Princeton. Test work has shown it to be a nonswelling bentonite that possesses some natural decolorizing power but is not amenable to acid activation.

Other deposits are located about 5 miles south of Princeton and at Quilchena, 15 miles east of Merritt. Occurrences have also been reported northwest of Kamloops, at the mouth of Gorge Creek, in the Deadman River valley; at 17 Mile House on the Cariboo Highway and in the banks of the Nechako River west of Prince George.

Production

Statistics on production in 1959 are not available for publication. In Manitoba, a nonswelling bentonite, which has important adsorptive properties in the natural state, is used by Pembina Mountain Clays Ltd., 945 Logan Avenue, Winnipeg, to produce an activated clay comparable to the best of imported bleaching earths. The clay is mined in the Thornhill-Miami area about 60 miles southwest of Winnipeg. After drying and crushing at a plant in Morden, the raw clay is shipped to the Winnipeg plant, where it is activated by sulphuric acid. Most of the company's output is used for mineral-oil clarification and the remainder for decolorizing vegetable and animal oils.

Uses

The nonswelling types of bentonite are used, in both the natural and the activated conditions, almost exclusively for the filtering and decolorizing of mineral, animal and vegetable oils. Smaller amounts are used for the clarification of such food products as wine, vinegar, corn syrup and sugar. Certain montmorillonite clays may also be used, after acid treatment, as catalysts in the catalytic cracking of petroleum.

Swelling bentonites find their principal uses in oil-well-drilling fluids and the moulding sands used in foundries. In drilling fluids, bentonite serves to control viscosity and form an impervious cake on the wall of the hole to prevent loss of the fluid to porous formations. In foundry moulds it binds the grains of moulding sand sufficiently when the mould is green but allows the sand to be readily shaken out of the casting after the molten metal has solidified. The increasing importance of beneficiation in the iron-ore industry has brought about an increase in the consumption of swelling bentonite, which is added to the concentrate in pelletizing in the proportion of 0.5 to 0.6 per cent. In recent experiments the use of bentonite in firefighting was investigated. When mixed with water, which is dropped from airplanes or sprayed on foliage, it increases the fire-retarding effect. Swelling bentonite has also been shown to be effective in the grouting of mine shafts that pass through water-bearing strata.

Swelling bentonites have many minor uses. They are used in the bonding and plasticizing of ceramic and refractory bodies; as the filler in paper, rubber and other products; as detergents in soaps and cleansers; as stabilizers in certain hydraulic cements; as carriers for insecticides and other pesticides; and in toileteries and medicinal preparations. Their application is also important in the grouting of dams and irrigation channels and the prevention of seepage around the foundations of buildings. Treated bentonite is a desiccant that keeps atmospheric moisture from entering packaged goods and serves as a coating to increase the bulk of small seeds.

Other developments in recent years have opened new fields of application for certain bentonites. The exchangeable cations are replaced by long-chain organic molecules, with the result that the bentonite swells in organic liquids and not in water. With the resulting 'bentones' are produced lubricants that do not liquefy at high temperatures and give promise of wide application in high- and low-temperature greases as well as in general lubrication.

Prices

The prices of bentonite materials vary widely depending on the amount of processing required. No prices have been published for Canadian materials.

In the United States, the price of domestic bentonite, according to the Oil, Paint and Drug Reporter, remained unchanged at $14 a short ton (minus 200 mesh, bagged, carload lots, at mines).

CEMENT

J.S. Ross*

The cement industry registered its twelfth consecutive year of record production during 1959. The demand for cement, which is dependent upon the construction industry, was greater owing mainly to increased exports and the record value of the total domestic construction. The increase in exports, which was greater than that in cement shipments, provided the industry with a market sufficient for a new production high.

Although cement-production capacity was well above demand in most regions and competition was keen, particularly in the Toronto-Montreal region, construction was started on one new major plant at St. Michel, Quebec, and expansion programs scheduled for completion in 1960 were begun at two established plants in western Canada. These programs will result in a 1-million-ton, or 14-per cent, increase in the annual production capacity. This is proportionally less than the increase in apparent domestic consumption plus exports from 1955 to 1959 inclusive.

In Ontario, one cement-distribution plant was put in operation, and plans for two more have been announced.

Production

The Canadian cement industry produces portland, masonry, air-entraining and oil-well cement. The bulk of production is of the portland variety used in general construction. High-early-strength and sulphate-resistant varieties are also available. Special cements for certain large construction projects may be produced on request.

Production reached a record total of 6,284,486 short tons, or 2.1 per cent more than in 1958, small gains being shown by five provinces. Value of production was 1.3 per cent lower and cement dropped from seventh to tenth place in value in Canada's mineral output. Since 1933 the rise in shipments has been generally continuous, and since 1944 they have increased with fair constancy, their average annual gain being 336,000 short tons.

Cement clinker was produced in 18 plants containing 42 kilns and situated in all provinces except Nova Scotia and Prince Edward Island. The locations of these are shown on the accompanying map. All are near industrialized areas, and 10 that represent 64 per cent of production capacity are between St. Mary's, Ontario, and Villeneuve, Quebec. During 1959, the industry operated at 84 per cent of its annual rated capacity of 7.5 million short tons, or 42.8 million barrels, Ontario and Quebec supplying 69 per cent of the output.

---

*Mineral Processing Division

Cement - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production*				
Ontario	2,386,334	31,731,767	2,400,158	35,195,552
Quebec	1,975,452	29,520,710	1,903,635	28,686,095
Alberta	689,854	11,678,577	635,516	10,676,668
Manitoba	402,562	7,314,552	378,823	6,580,276
British Columbia	427,181	7,049,638	409,397	6,755,619
New Brunswick	170,793	2,606,301	180,166	2,934,058
Saskatchewan	161,057	3,954,737	194,734	4,506,803
Newfoundland	71,253	1,291,516	50,992	1,079,071
Total	6,284,486	95,147,798	6,153,421	96,414,142
Exports				
Portland cement				
United States	303,032	5,001,126	141,137	2,465,058
Other countries	94	2,181	113	2,432
Total	303,126	5,003,307	141,250	2,467,490
Imports				
Portland cement				
United States	12,264	330,205	18,754	479,680
United Kingdom	8,187	243,767	13,476	275,425
West Germany	3,471	129,029	4,931	111,419
Belgium	2,071	62,182	2,427	70,597
Other countries	3,263	93,680	1,967	61,737
Total	29,256	858,863	41,555	998,858
Portland-cement clinker				
Denmark	10,158	178,255	-	-
United States	6,536	143,092	21,100	346,702
West Germany	-	-	2,694	60,536
Total	16,694	321,347	23,794	407,238

*Producers' shipments plus quantities used by producers.

Cement - Production, Trade and Consumption, 1949-59
(short tons)

	Production(1)	Exports	Imports(2)	Apparent Consumption(3)
1949	2,785,399	3,362	399,700	3,181,737
1950	2,929,820	4,184	242,588	3,168,224
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

(1) Producers' shipments plus amounts used by producers.
(2) Does not include cement clinker.
(3) Production plus imports less exports.

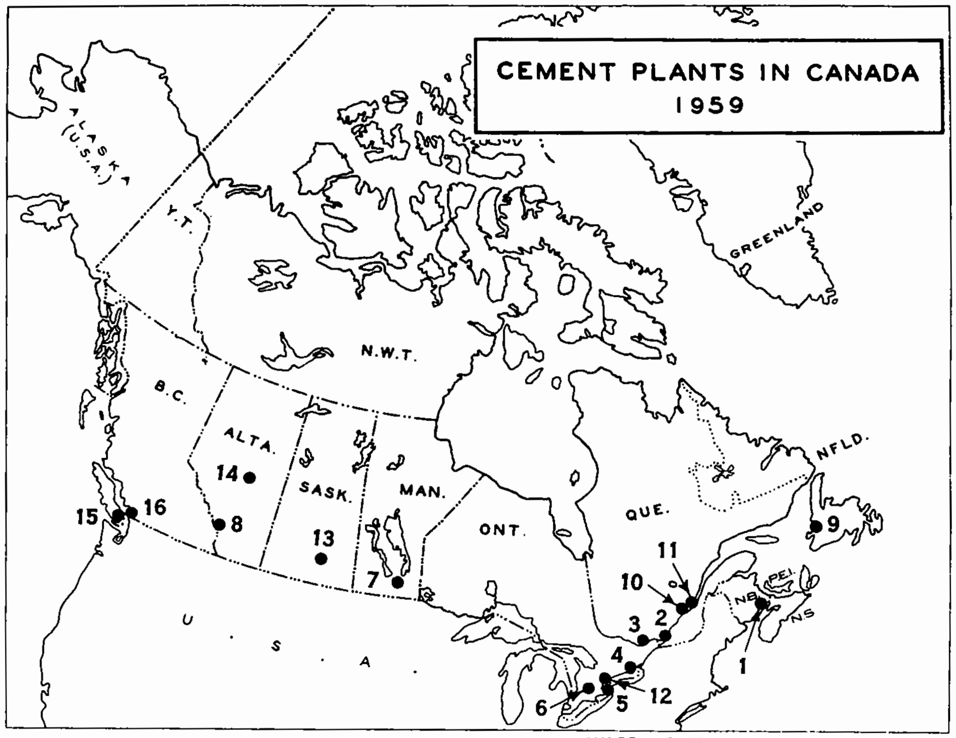
In addition, two separate clinker-grinding plants were in operation. Canada Cement Company Limited grinds clinker from Exshaw, Alberta, at its plant at Clover Bar, Alberta. Clinker imported from York, Pennsylvania, is ground at Paris, Ontario, by Medusa Products Company of Canada Limited for the production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

World production of cement increased rapidly during the last decade. In 1959, when a record output of 323 million short tons was reached, Canada was in tenth place.

Plant Capacities
(bbl/yr)

Company*	Approximate Capacity (end of 1959)
Canada Cement Company Limited	
(1) Havelock, N.B.	850,000
(2) Montreal, Que.	7,500,000
(3) Hull, Que.	1,100,000
(4) Belleville, Ont.	4,000,000
(5) Port Colborne, Ont.	1,200,000
(6) Woodstock, Ont.	3,250,000
(7) Fort Whyte, Man.	3,100,000
(8) Exshaw, Alta.	3,000,000
North Star Cement Limited	
(9) Corner Brook, Nfld.	600,000
Ciment Quebec Incorporated	
(10) St. Basile, Que.	700,000
St. Lawrence Cement Company Limited	
(11) Villeneuve, Que.	1,500,000
(12) Clarkson, Ont.	3,500,000
St. Mary's Cement Co. Limited	
(6) St. Mary's, Ont.	3,000,000
Saskatchewan Cement Company Limited	
(13) Regina, Sask.	800,000
Inland Cement Company Limited	
(14) Edmonton, Alta.	2,200,000
British Columbia Cement Company Limited	
(15) Bamberton, B.C.	3,300,000
Lake Ontario Portland Cement Company Limited	
(4) Picton, Ont.	1,700,000
Lafarge Cement of North America Limited	
(16) Lulu Island, B.C.	1,500,000
Total	42,800,000

*Numbers in brackets refer to locations on map.



Trade

Because cement is a commodity of relatively low unit value, it normally is not traded internationally to any great extent. However, because of insufficient production capacity prior to 1957, Canada imported about 10 per cent of its consumption, mainly from the United States and the United Kingdom. Since then, Canadian cement imports have been reduced drastically and are now mainly of special types. At the same time, partly owing to cheaper production costs, Canadian exports to the United States increased abruptly. Although the value of exports during 1959 amounted to more than $5 million, the quantity exported was only 5 per cent of domestic production.

Canadian cement exports to the United States have been a subject of controversy in that country. An investigation was carried out by the United States Tariff Commission to determine whether certain Canadian cement exports were being sold in the United States in violation of the International Antidumping Act. In March 1960, the Commission determined that these exports were not being sold in violation of the Act.

Developments

Miron Ciment Inc. has nearly completed construction of a new dry-process cement plant at St. Michel, Quebec, which contains what is believed to be the largest dry-process kiln in North America. The kiln is 550 feet long and 15 feet in diameter and has an estimated annual output of 4 million barrels. Three of the existing four dry-process plants have been under construction since 1956. The construction of this type of plant indicates a trend in Canada toward the use of dry-processing in cement production - a trend that has been accelerated by recent innovations in silo blending.

Inland Cement Company Limited has initiated a major expansion program at its Edmonton plant, whose annual rated capacity is being increased from 2.2 to 3.4 million barrels by the addition of one new kiln and additional equipment for preparing and storing raw and finished materials.

Owing to a general increase in demand and major construction projects that are in progress or that have been planned for Saskatchewan, such as the South Saskatchewan and the Squaw Rapids dams, Saskatchewan Cement Company Limited is currently expanding the production capacity of its Regina plant to 1.3 million barrels by the addition of a new grinding mill and dust-collecting equipment. This and the Inland Cement expansions are scheduled for completion in mid-1960.

Lafarge Cement of North America Limited has converted its equipment to operate on natural gas rather than oil.

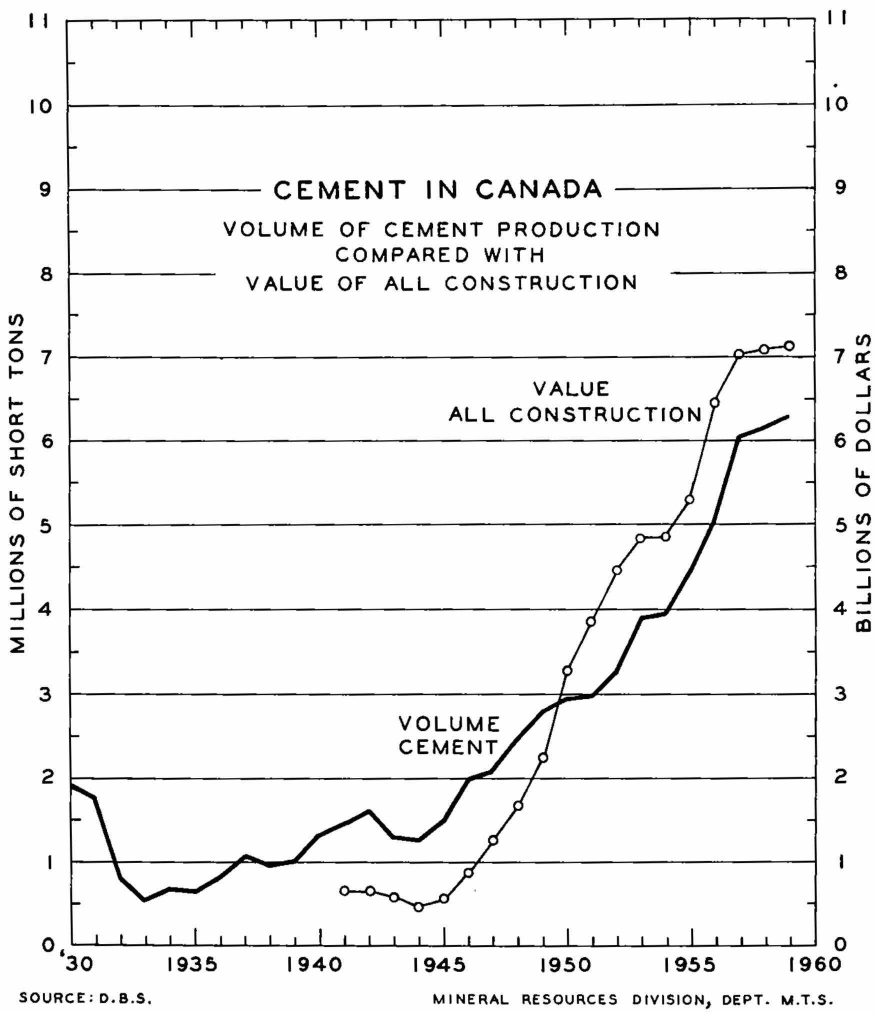
St. Lawrence Cement Company Limited opened a 4,000-ton-capacity bulk-cement-distribution plant near Fort William, Ontario, and began the construction of a 700-ton-capacity cement-distribution plant at Ottawa.

During the year, companies partly dependent upon the concrete-products industry showed a marked tendency to diversify their interests. Miron Ciment Inc., St. Michel, Quebec, a major consumer of cement, with subsidiaries producing, among other things, ready-mixed concrete and concrete products, is now constructing its own cement plant. Canada Cement Company Limited has acquired a substantial interest in Standard Paving and Materials Limited, a large concrete-products company in central Ontario.

In British Columbia, interest in pozzolana increased, and raw materials from the southern part of the province were investigated.

Consumption and Uses

As indicated by the graph, cement production has varied directly with construction expenditures. The quantity of cement consumed varies, however, with each type of construction, the nonresidential type requiring more than the residential per unit of cost. In 1959, construction expenditures increased 1/2 per cent to a record $7,129 million. Expenditures for building construction increased 4 per cent while those for engineering construction decreased 4 per cent.



The apparent domestic consumption of cement was 1/2 per cent less than in the record year of 1958. The value of the construction planned for 1960 is estimated at $7,317 million. This predicted increase should raise domestic cement consumption to a record high.

About one third of the cement consumed is used in the concrete-products industry - in the production of ready-mixed concrete and concrete blocks, bricks, pipe and tile. Statistics indicate that in 1959 the production of concrete bricks decreased 16 per cent, while the output of concrete blocks increased 6 per cent and that of pipe and tile 31 per cent.

Specifications, Prices and Tariffs

Cement produced in Canada falls into the catagories developed by the Canadian Standards Association. The types commonly manufactured have already been mentioned.

Although labor and transportation costs continued to increase during 1959, excess plant capacities and keen competition prevented a general increase in the price of cement. The average value of production was $15.14 a short ton or $2.65 a barrel.

The Canadian import duty on all types of portland cement in bulk, barrels or casks is 8 cents per 100 pounds. The United States import duty is 3 cents per 100 pounds for white cement and 2 1/4 cents per 100 pounds for portland cement.

CLAYS AND CLAY PRODUCTS

J.G. Brady*

The term 'clay products' includes such materials as fire-clay refractories, common and face brick, structural tile, partition tile, drain tile, quarry tile, sewer pipe, conduit, flue lining, electrical porcelain, sanitary ware, dinnerware and pottery. The principal raw materials used in the manufacture of these products are common clay and shale, stoneware clay, fire clay, ball clay and china clay (kaolin).

In 1959, the value of clay products manufactured in Canada from domestic and foreign clays continued to grow. During the past 10 years the yearly value of clay products manufactured from domestic clays and shales has increased about 1 1/2 times, while the price has advanced very little. In the same period, the value of clay products manufactured in Canada from imported clays, principally china clay, ball clay, and fire clay, has increased 53 per cent.

The value of imported clay products in 1959 was a substantial $43.6 million, which is 55 per cent greater than the 1949 value. Such materials as refractories and special clay products account for a large part of these imports. About half of the imports came from the United States.

Deposits of such high-quality clays as china clay, ball clay, and very refractory fire clay are scarce in Canada. Consequently, most clays of this type are imported.

Production and Trade

The value of clay products manufactured in Canada in 1959 was $ 65.8 million, or about $1.9 million more than the 1958 value. Of this total, domestic clays and shales accounted for $41.8 million and imported clays for $23.9 million. The value of domestic clays, including bentonite, not used in clay products was $0.7 million, slightly more than in the previous year.

The value of imported clay products was $43.6 million, some $3 million above the 1958 level. Clay imports rose from $4.2 million in 1958 to $4.5 million. The 1959 combined import total of $48.1 million was down $4.3 million from the import peak of 1956.

---

*Mineral Processing Division

Clays and Clay Products - Production and Trade

	1959 ($)	1958 ($)
Production		
Domestic sources		
Clays including bentonite	680,762	569,469
Clay products from:		
Common clay	34,541,553	34,275,592
Stoneware clay	5,682,548	5,535,404
Fire clay	771,212	638,817
Other products	859,373	690,621
Total	42,515,448	41,709,903
Foreign sources - from:		
Stoneware clays	746,648	678,483
Fire clays	2,859,287	2,733,497
China clays	20,341,009	20,274,990
Total	23,946,944	23,686,970
Total production	66,462,392	65,396,873
Imports		
Clay		
Fire clay, ground	483,423	426,623
China clay, ground	2,331,691	2,272,731
Pipe clay, ground	39,187	17,207
Clays, ground, not otherwise provided	556,892	498,492
Activated clay for refining of oils	1,082,593	980,585
Total	4,493,786	4,195,638
Clay products		
United States	24,160,938	21,526,611
United Kingdom	14,815,377	14,982,633
Other countries	4,635,419	4,122,380
Total	43,611,734	40,631,624
Exports		
Clay, unmanufactured		
United States	242,408	302,713
Other countries	250	3,943
Total	242,658	306,656
Clay products		
United States	3,550,965	2,554,824
Chile	296,437	48,957
Brazil	126,422	136,126
Belgium	123,879	58,498
Pakistan	118,950	18,808
India	103,917	334,171
Other countries	544,479	767,392
Total	4,865,049	3,918,776

Clays and Clay Products - Production and Trade, 1949-59
($ millions)

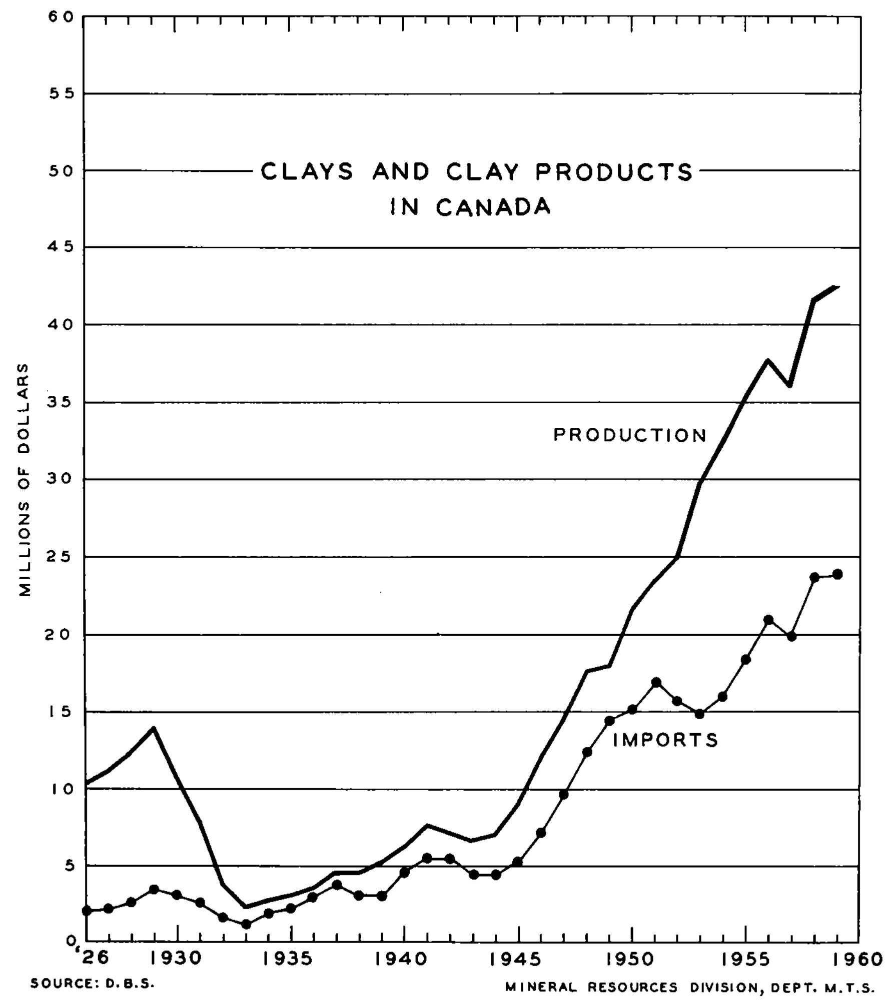
	Production			Imports	Exports
	From Domestic Clays	From Imported Clays	Total		
1949	18.0	14.5	32.5	30.8	1.7
1950	21.8	15.1	36.9	31.5	2.2
1951	23.5	16.9	40.4	39.8	2.5
1952	25.0	15.7	40.7	33.5	2.5
1953	29.8	14.9	44.7	36.5	1.9
1954	32.4	16.0	48.4	35.0	2.2
1955	35.3	18.4	54.8	41.0	2.7
1956	37.8	20.9	58.7	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

Exported clay products were worth $5.1 million, slightly more than in 1958.

The clay products consumed in Canada during 1959 were valued at $104.5 million. Imported goods, and goods manufactured from imported clays accounted for approximately 64 per cent of this total. This is due principally to the scarcity in this country of deposits of high-grade china clay (kaolin), fire clay and ball clay, all of which are used in the manufacture of such high-quality clay products as refractories, sanitary ware, electrical porcelain, dinnerware and pottery.

Sixteen refractory plants in Canada used refractory fire clay as one of the principal ingredients of their products. Only four, all in western Canada, were utilizing domestic material. Firebrick, refractory castables, refractory mortars, plastic firebrick, stove linings and miscellaneous refractory shapes are the principal products made in Canada from fire clay. Occasionally imported china clay or imported ball clay is used in products of this type. The known domestic materials are suitable for high-heat-duty refractory products or lower-quality products if they are used as the principal part of a refractory body. Because of the higher temperatures developed in many processes, the requirements for most refractory products are becoming more stringent. Consequently, Canada must look to other countries, particularly the United States, for the refractory-clay products and very high grade fire clay.

Three sanitary-ware plants, seven electrical-porcelain plants, three wall-tile plants, two dinnerware plants and numerous souvenir and art



potteries were the principal users of ceramic-grade kaolin. Raw kaolin was used principally by the paper and rubber industries. All the kaolin requirements of Canadian industry were imported.

Ball clay is needed by the plants that use ceramic-grade kaolin. This highly plastic, very refractory type of clay occurs in Saskatchewan. Nevertheless, the bulk of these industries' requirements is imported.

Ten plants manufactured clay sewer pipe and flue lining in 1959. Plants of this type use mainly such domestic materials as low-grade fire clay, stoneware clay, common clay and plastic shale. Three plants in Ontario and Quebec imported low-grade fire clay for the manufacture of sewer pipe. The imported material is mixed with local domestic clay to produce the sewer-pipe body.

From domestic raw materials, particularly common clay and shale, 84 plants manufactured such clay products as face brick, common brick, structural tile, partition tile, conduit, quarry tile and drain tile. Most of these plants are close to large centres of population and sources of raw materials. Almost half of them are large and modern and can operate during the winter.

Nature and Location of Deposits

China Clay (Kaolin)

China clay is a high-quality material used as a filler and coater in the paper industry, a raw material in ceramic products and a filler in the rubber and other industries. The crude kaolin is usually beneficiated for commercial use. Purified china clay consists almost entirely of the clay mineral kaolinite.

The paper industry consumes the bulk of the kaolin used in Canada. The main properties needed are intense whiteness, freedom from abrasive grit,and high retention. Kaolin 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. Commercial kaolin is very low in alkalis, alkaline material, iron, quartz and other impurities. The theoretical composition of pure kaolinte - silica 46.54 per cent, alumina 39.5 per cent and water 13.96 per cent - gives a very refractory mixture because of the high ratio of alumina to silica and the lack of fluxes.

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. The separated clay generally contains excessive grit and has a poor color in the raw and fired states. New methods of treating crude kaolin are being investigated at the Mines Branch, in Ottawa.

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 Mines Branch, the University of Saskatchewan and the Saskatchewan government, but so far beneficiation has not been successful. A clay-processing plant was established at Assiniboia, Saskatchewan, in 1958 to develop the use of Saskatchewan kaolins and ball clays.

A deposit of china clay occurs in 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 kaolin deposit at Arborg, Manitoba, contains colloidal iron, a large amount of quartz, and some other impurities. Kaolinized material occurs in Quebec at St. Remi d'Amherst, Papineau county; Chateau Richer, Montmorency county; Brebeuf, Terrebonne county; Lac Labelle, Labelle county; and Point Comfort on Thirtyone Mile Lake, Gatineau county. Some development by underground mining methods was carried out on the St. Remi d'Amherst deposit. This was discontinued in 1948 because of operational difficulties. Investigation of the remaining Quebec deposits has indicated that they are probably not extensive enough for exploitation.

Ball Clay

Ball clays are used chiefly in the manufacture of whitewares and refractories because of their good plasticity, white fired color and refractoriness. Mineralogically, Canada's ball clays are similar to high-grade, plastic fire clays. They are made up principally of a kaolinite-group clay mineral and some quartz and, because of their high content of very small particles, have extremely high dry strength.

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 for processing the ball clay and sandy kaolin of Saskatchewan, chiefly for use as fillers, was established at Assiniboia, Saskatchewan.

Fire Clay

Canadian fire clays are used chiefly for the manufacture of medium-heat and high-heat firebrick, and refractory specialties. High-heat refractories require raw materials having a PCE (pyrometric cone equivalent) of about 31 1/2 (3,090° F) to 32 1/2 (3,139° F). Intermediate-duty refractories require a raw material having a PCE of about 29 (3,018°F) or higher. Clays having a PCE of less than 29 but greater than 15 (2,606° F) may be suitable for low-heat 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 alumina. Good-quality fire clays are low in alkali, alkaline-bearing materials and iron-bearing minerals. The Canadian deposits are made up principally 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 some 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 by plants in Vancouver.

Fire clay deposits occur in the James Bay watershed along the Missinaibi, Abitibi, Moose and Mattagami rivers in northern Ontario. At the present time, Ventures Limited is exploring some of the clays 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 the production of ladle brick from them. A few carloads of fire clay from Musquodoboit, Nova Scotia, were being used by foundries in 1959.

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 buff-firing and plastic, have a long-firing range, and are similar to low-grade plastic fire clays. They contain less alkali, alkaline material and iron, and have more alumina than the common clays and shales. 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 Saskatchewan's Whitemud formation, particularly the part of it at Eastend, where it is selectively mined. It is then shipped to Regina, and to Medicine Hat, Alberta, for the manufacture of flue lining and sewer pipe. It is also used at Medicine Hat in face brick and such stoneware products as crocks and pottery. In addition, Saskatchewan stoneware is used for art pottery.

For many years the Whitemud formation has been known to extend, under a large amount of overburden, into the Cypress Hills of Alberta, which are a continuation of the Saskatchewan Cypress Hills. The first area suitable for development was found in 1957, and a pit was opened that year. The clay, which is of a stoneware type, is trucked to Medicine Hat and used in the production of sewer pipe and buff face brick. Three separate pits are now being used by Medicine Hat Brick and Tile Company Limited.

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 at Chimney Creek bridge, Williams Lake, and Quesnel, in British Columbia. Quebec and Ontario import their requirements of stoneware and low-grade fire clay.

Common Clays and Shales

Common clays and shales are the principal type of raw material available in Canada at present for the manufacture of clay products. Their fusion points are low - usually well below cone 15 (approximately 2,606°F), which is considered to be the lower limit of the softening point for fire clays. They are principally red-firing because of the presence of iron from various sources. Ordinarily, they are a heterogeneous mixture including clay minerals, quartz, feldspar, various micas, goethite, siderite, pyrite, carbonaceous material, gypsum, calcite, dolomite, hornblende and many other minerals. The clay minerals contained in Canadian common clays and shales are principally illitic, chloritic or illitic-chloritic, although occasionally 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 mix is reduced and the quality of the ware is lowered. Many clays and shales contain calcium carbonate, which has a marked effect on the fired properties if its proportion exceeds approximately 10 per cent. When they contain excess calcium carbonate, they fire to a buff color and are very difficult to fire to a hard, dense, uniformly sized product. Common clays and shales are usually higher in alkali and alkaline materials and iron-bearing minerals and are usually much lower in alumina than the higher-quality stoneware and fire clays. Since shales are less plastic than clays, they must be finely ground when used for extruded ware so that their plasticity may be developed, if possible, or they must be combined with a plastic clay or some other plasticizer.

Common clays and shales, which are found in all parts of Canada, are used for manufacturing such relatively low-priced articles as brick and tile. Thus, it is usually not economical to ship either the raw materials or the finished product any great distance. Consequently, deposits are developed close to centres of population. Because they are poor in plasticity, drying qualities or firing characteristics, most materials of this nature are not suitable for the manufacture of clay products. Deposits having excellent properties are generally scarce in Canada, and new deposits are constantly 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. In the process of manufacturing dry-press face brick, the raw materials used need not be very plastic and drying is not a critical problem. Soft-mud bricks are made in Canada only in negligible quantities, and the process by which they are manufactured is, on the whole, falling into disuse.

FELDSPAR

J.E. Reeves*

Production of feldspar in Canada in 1959 at 17,953 tons was 12 per cent lower than that of the previous year. Exports, made up of ground feldspar for the United States and a small shipment of crude, dental-grade feldspar for Switzerland, were also lower - 24 per cent in volume and 28 per cent in value. Imports, affected for the second successive year by a new whiteware industry in British Columbia, were about the same as in 1958.

Domestic consumption of Canadian feldspar has been limited for a number of years by the development of nepheline syenite, particularly in the glass industry in eastern Canada. The whitewares industries have become the dominant domestic market for Canadian production.

Producers

The Canadian Flint and Spar Department of International Minerals & Chemical Corporation (Canada) Limited was the largest producer of marketable feldspar. This consisted mostly of finely ground products for use in whitewares, but some crude dental-grade feldspar was also shipped. Grinding is done at Buckingham, Quebec, and the crude material used is mined mostly from the company's own property a few miles away.

Spar-Mica Corporation Ltd. shipped some glass-grade feldspar from its property near Baie Johan Beetz in eastern Quebec to the United States. In January 1960, the company was reported to have entered bankruptcy proceedings.

Glass-grade feldspar containing a minor amount of lithia (Li_2O) was obtained by Quebec Lithium Corporation as a by-product of its production of chemical-grade spodumene concentrate. Regular shipments were made until August, when the termination of the company's main contract for spodumene concentrate rendered feldspar production unpractical.

History and Occurrences

Almost all the feldspar mined in Canada has come from southeastern Ontario and southwestern Quebec, where very coarse-grained granitic pegmatites are relatively common. Nearly 200 properties have been operated since 1890, when production in Canada - in Quebec - was first recorded. Since that time production from southwestern Quebec has been almost continuous and has exceeded 630,000 short tons. Minor shipments have also been made from the eastern part of the province.

*Mineral Processing Division

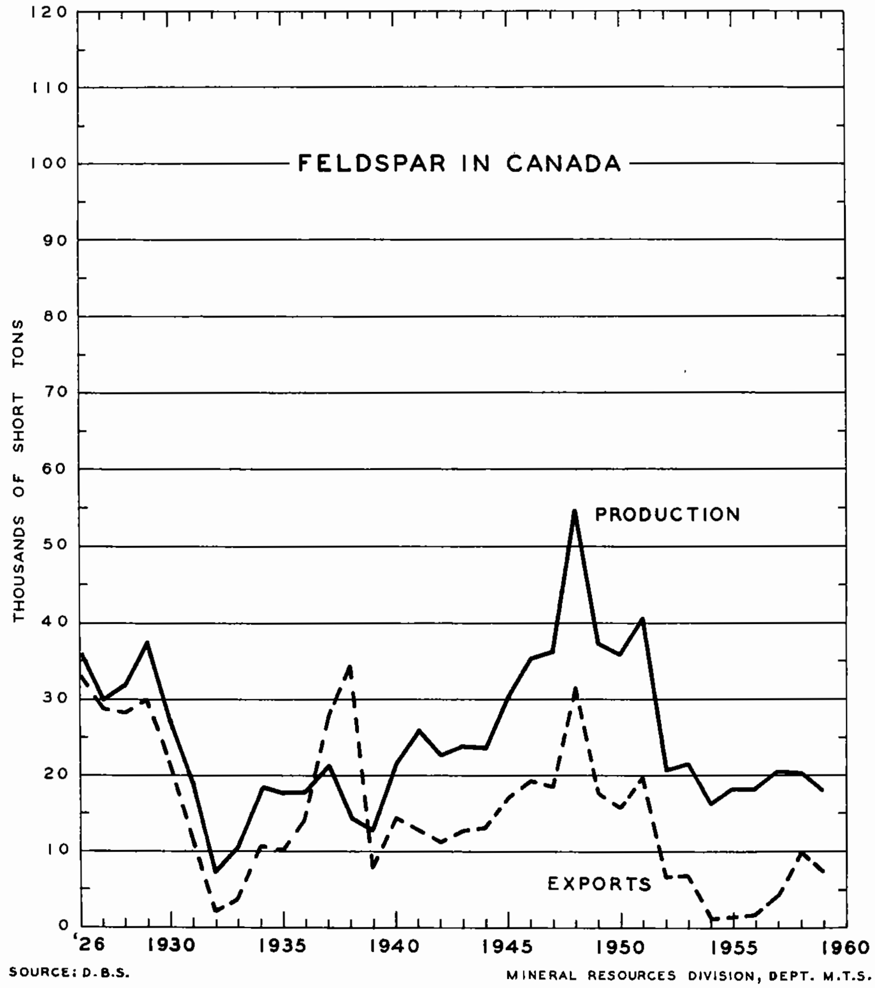
Feldspar - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)				
Quebec	17,953	301,372	20,387	359,966
Imports (ground)				
United States	1,161	23,067	1,140	22,753
Exports				
United States	7,530	113,263	9,924	158,071
Switzerland	22	1,848	-	-
Israel....................	-	-	32	2,550
Total	7,552	115,111	9,956	160,621
	1958		1957	
Consumption (domestic)**				
Clay products (pottery, tile, insulators, etc.).........	7,723		6,297	
Glass	974		5,316	
Scouring powders, cleansers	422		1,371	
Enamelling and miscellaneous	753		974	
Total	9,872		13,958	

*Available data.

Feldspar - Production and Trade, 1949-59
(short tons)

	Production	Imports	Exports
1949	36,498	228	17,570
1950	35,548	144	15,465
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



In Ontario, production was continuous from 1900 to 1954. During this period more than 666,000 short tons were shipped, about one third of them coming from one deposit in Bedford township, in the Kingston-Perth area. This and the Bancroft area have yielded most of the production from Ontario.

Between 1933 and 1939 more than 5,000 tons were produced near Pointe du Bois, in southeastern Manitoba. The area has the economic disadvantage of being rather far from feldspar markets, but it is possible that producers of lithium minerals or other economic minerals of pegmatitic origin will eventually lessen or overcome this difficulty by obtaining feldspar as a by-product.

Technology

Minerals of the feldspar group, which comprises aluminum silicates of potassium, sodium and calcium, are common to many types of rock. They are found mainly as small grains closely associated with other minerals, and important natural concentrations occur only in some very coarse-grained granitic pegmatites. The potash variety and, to a lesser extent, the soda variety have industrial applications.

It has been, and to some extent still is, customary to make use of such natural concentrations as sources of feldspar. Mining is frequently done on a relatively small scale, and the broken feldspar is hand-cobbed to remove any associated minerals. As many of the natural concentrations have become depleted, there has been a trend toward the use of pegmatitic sources in which the feldspar is more intimately mixed with quartz and other minerals, and the use of beneficiating techniques, which yield an acceptable product. To concentrate feldspar from such mixtures, Spar-Mica Corporation used electrostatic separation and Quebec Lithium Corporation used flotation. The latter process, which permits the use of poorer deposits and the efficient production of larger volumes of a marketable material, has found wide acceptance in recent years in the United States.

Feldspar is important in the ceramic industries because of its content of alumina and alkalis (potash and soda) and its relatively low firing temperature, and for certain abrasive uses because of its hardness and particle shape.

Uses and Specifications

Feldspar is used chiefly in the manufacture of glass, whiteware, pottery and porcelain enamel. Some select material is used in the manufacture of artificial teeth, and small amounts go into the making of scouring soaps and powders.

It is a source of the alumina and alkalis used in glass. Glass-grade feldspar is used in a relatively coarse, minus 20 mesh grain size to minimize the loss in the glass furnace due to fines. Its iron-oxide content should be less than 0.1 per cent.

For whiteware bodies and glazes, feldspar is used as a flux. It must be very finely ground (mostly minus 200 mesh), be essentially free of quartz and iron-bearing minerals and contain a high potash-soda ratio. Color is of no importance providing the fired product is white.

In the manufacture of porcelain enamels potash feldspar is used as a source of alumina, potash and silica. It must become white upon burning, have a very low iron-oxide content and be at least minus 120 mesh.

Dental spar is a selected potash feldspar of high purity. As much as 0.1 per cent iron oxide is tolerated but no tourmaline, biotite or other dark mineral that would leave specks in the product.

For cleansers, the material should be free of quartz and have an acceptable white color. Either potash or soda feldspar can be used.

Prices

Prices in the United States per short ton, according to E & M J Metal and Mineral Markets of December 3, 1959, were:

200-mesh, f.o.b. point of shipment, North Carolina	\$20.50 to \$21.00
325-mesh	\$20.50 " \$23.50
40-mesh, glass	\$13.50
20-mesh, semigranular	\$ 9.00

Tariffs

Canadian and United States feldspar tariffs, in effect at the time of writing, were:

Canada

	British Preferential	Most Favored Nation	General
Crude only	free	free	free
Ground but not further manufactured	"	15%	30%

United States

Crude	12 1/2¢ per long ton
Ground	7 1/2% ad valorem

FLUORSPAR

C.M. Bartley*

Growing demand in the aluminum industry and the high rate of Canada's steel production brought an upswing in 1959 in Canadian fluorspar production, consumption and trade. The value of production increased 20 per cent over that of 1958 to $1,850,497.

In the United States, which is the leading fluorspar consumer, a strike in the steel industry lowered the consumption of the metallurgical grade, but an increase in aluminum production and in the demand for fluorine chemicals raised the consumption of the acid grade. At year-end the trend was toward an increase in the demand for fluorspar in all the consuming industries.

Production and Trade

Fluorspar was produced in Newfoundland and Ontario and substantial increases over the 1958 output were reported from both provinces. Production from the Burin peninsula of Newfoundland comprises about 95 per cent of the total. The Newfoundland output was mostly of submetallurgical grade, which was later improved and used in the production of Canadian aluminum. Smaller amounts of metallurgical- and acid-grade fluorspar were also produced for export. The Madoc area of eastern Ontario produced metallurgical-grade for Canadian steel mills.

Exports of Canadian fluorspar, which went entirely to the United States, were well above the 1958 total but are still only a small fraction of the amounts exported in 1957 and earlier. Imports into the United States from such low-wage countries as Mexico, Spain and Italy have captured most of the market previously served by Canadian fluorspar, and imports from Mexico now supply most of Canada's metallurgical-grade requirements. Some acid-grade fluorspar was imported from the United States for purposes other than aluminum production.

Producing Companies

Two companies, Newfoundland Fluorspar Limited and St. Lawrence Corporation of Newfoundland Limited, operated fluorspar mines and mills during 1959 at St. Lawrence,on Newfoundland's Burin peninsula.

*Mineral Processing Division

Fluorspar - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)(1)				
Newfoundland		1,749,903		1,483,368
Ontario		100,594		57,834
British Columbia.......		-		1,387
Total		1,850,497		1,542,589
Exports(2)				
United States	3,774	73,078	7	980
Imports				
Mexico................	24,709	633,182	21,250	498,075
United States	1,519	72,466	6,019	202,628
Spain	-	-	2,750	48,864
United Kingdom........	360	13,126	209	8,401
Union of South Africa ...	-	-	180	5,470
Total	26,588	718,774	30,408	763,438
	1958		1957	
Consumption				
Steel furnaces	14,539		16,935	
Glass	455		628	
Heavy chemicals	74,939		53,198	
Total	89,933		70,761	

(1) Producers' shipments. The tonnages for 1958 and 1959 are not available for publication.

(2) Exports for 1958 and 1959 are as recorded in Trade of Canada.

Newfoundland Fluorspar Limited, a subsidiary of Aluminum Company of Canada, Limited, ships submetallurgical-grade concentrate to the parent company at Arvida, Quebec, for the manufacture of aluminum. During 1959, operations were at a lower-than-normal rate owing to lower aluminum production. At year-end, the demand for fluorspar was increasing; larger production is expected during 1960.

St. Lawrence Corporation of Newfoundland Limited, after being closed down during the latter part of 1957 and throughout 1958, operated on a small scale during 1959. Several export shipments were made. A new fluorspar vein was discovered and exploration was conducted on it.

Fluorspar - Production, Trade and Consumption, 1949-59
(short tons)

	Production(1)	Exports(2)	Imports	Consumption
1949	64,477	15,344	2,510	54,826
1950	64,213	14,238	1,572	52,137
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		7	30,408	89,933
1959		3,774	26,588	

(1) Producers' shipments. Only the dollar value reported after 1957.
(2) Exports for 1949 to 1954,inclusive,to the United States are recorded in United States import statistics but are not available from the official Canadian export statistics. The export figures for 1955 to 1959 inclusive are as recorded in Trade of Canada.

During the year acid and ceramic grades were produced, and at year-end plans were being made to increase production by reopening the Blue Beach mine.

Huntingdon Fluorspar Mines Limited, at Madoc in eastern Ontario, produced metallurgical-grade fluorspar, which was consumed in Canadian steel mills. Production during 1959 was considerably more than in 1958.

Other Occurrences

Other occurrences of fluorspar have been found in Canada and a few of these have been worked, but none are of economic interest now.

In addition to the deposits on the Burin peninsula, other small occurrences are known to exist in Newfoundland and Labrador.

Fluorspar and barite occur together near Lake Ainslie in Nova Scotia, but the low grade has limited production to a few tons obtained during wartime. An occasional small shipment has been made from the Wilberforce area of Ontario and from western Quebec, but the occurrences have not been capable of sustained production. Numerous small occurrences of fluorspar found along the north shore of Lake Superior are of interest but are not of importance at present.

In British Columbia, considerable amounts of fluorspar were produced in past years from the Rock Candy mine of The Consolidated Mining and Smelting Company of Canada Limited. Between 1918 and 1943, production of more than 42,000 tons was reported and large reserves are still believed to be available at the mine. Fluorspar occurs at the property of Rexspar Uranium and Metals Mining Co. Limited* near Birch Island, British Columbia. The mineral is finely disseminated and, although the total tonnage is large, no economic method of recovering the fluorspar has yet been reported. During 1959, work was continued at the property in an effort to solve the processing problem and reach production.

A large deposit of fluorspar, barite and witherite has been discovered in northern British Columbia, but its remote location makes it of little interest at the present time.

World Review

Owing to the recession in industry, fluorspar production, consumption and trade throughout the world were less in 1958 than in 1957, but they rose again in 1959 as industrial activity became closer to normal.

In the United States production was lower, although imports and consumption increased sharply. Production decreased when some mines closed after the United States government's refusal to grant protection to the domestic producers by means of increased tariffs or quotas. This is significant as an indication of the importance of adequate supplies of fluorspar to the consuming industries of the United States.

Resumption of steel production after a lengthy strike, and a growing demand for fluorine chemicals and aluminum raised fluorspar consumption in 1959 and encouraged larger imports from several countries. The main exporting nations - Mexico, Spain and Italy - supplied more than 533,000 short tons, and some 20,000 short tons were received from other countries including Canada. The upward trend in imports and consumption, particularly of acid-grade fluorspar, continued.

United States interest in Mexican fluorspar increased in 1959. Dow Chemical Company reported the active development of two large fluorspar deposits in northern Mexico not far south of the international boundary. The deposits will be worked by open-pit methods, and acid-grade concentrate will be made in Mexico at a flotation mill with a capacity of 100 tons a day. The concentrate will be trucked about 80 miles to rail connections at Marathon, Texas.

Several large United States companies have fluorspar mining and milling interests in Mexico; others, such as The Aluminum Company of America and The Minerva Company, are conducting exploration work.

---

* Name changed, August 14, 1959, to Rexspar Minerals and Chemicals Limited.

In Europe fluorspar is produced in the United Kingdom, France, West and East Germany, Italy and Spain. During 1959, the first three of these countries consumed most of their own production, but Italy and Spain exported large amounts of acid-grade fluorspar to the United States.

Japan produced less than 6,000 tons of fluorspar and imported more than 40,000 from China, the Union of South Africa, Korea, Mexico and other countries.

Fluorspar production and consumption in the Union of Soviet Socialist Republics has risen in recent years. Production was reported as amounting to at least 180,000 tons in 1958, and more than 129,000 tons were imported that year, mostly from China. In consumption, which is believed to have totalled more than 220,000 tons, the U.S.S.R. was second only to the United States.

Fluorspar produced in mainland China in 1958 was estimated by the United States Bureau of Mines at 165,000 tons. During 1959, Chinese metallurgical, ceramic and acid-grade fluorspar concentrates were offered for sale in United Kingdom trade publications.

The following table lists the approximate production, consumption and trade of the main fluorspar-producing nations and indicates the proportion of production in Western and Communist-bloc countries.

World Fluorspar Trade, 1958

	Production		Imports	Exports	Consumption
	(thousands of short tons)	(percentage of total)	(thousands of short tons)	(thousands of short tons)	(thousands of short tons)
Western countries					
United States	320	17.5	392	3	494
Mexico	308	16.8	Minor	308	Minor
Italy	154	8.4	N.A.	90	N.A.
West Germany	130	7.1	39	35	138
Spain	114	6.2	N.A.	73	N.A.
France	99	5.4	6	5	N.A.
United Kingdom	87	4.8	Minor	Minor	80
Canada	62	3.4	30	Minor	90
Union of South Africa	48	2.6	N.A.	34	6
Subtotal	1,322	72.1			
Communist countries					
U.S.S.R.	180	9.8	143	Minor	220
China	165	9.0	Minor	113	N.A.
East Germany	72	3.9	Minor	28	N.A.
Subtotal	417	22.7			
Other countries	91	5.0			
Total	1,830	100.0			

Sources: U.S. Bureau of Mines Publications and information published by various countries.

Technology

An improved process for the manufacture of hydrofluoric acid was developed in 1959 in Switzerland. Accurate blending of calcium fluoride and sulphuric acid to produce hydrofluoric acid of high quality and noncorrosive calcium sulphate is expected to reduce the cost of hydrofluoric acid and increase its use. A plant of this type will be built in the United States during 1960. The noncorrosive calcium sulphate may have sales value.

Research and development continued on safe methods of using fluorine compounds as high-energy missile fuels.

For fluorocarbon plastics such as Teflon, which are inert, a growing number of applications were announced - in greaseless bearings, anticorrosion pipe and fittings and miniature printed electronic circuits. It is expected that, as fabricators produce new articles and these gain the confidence of designers and builders, there will be large gains in sales, particularly in such equipment as Teflon-lined piping.

During 1959, sales of aerosol propellants accounted for 50 per cent of the 230 million pounds of fluorocarbon products sold in the United States. Refrigerants amounted to about 40 per cent.

Two officers of the Division of Dental Public Health, United States Public Health Service, have developed a process in which natural fluorspar, rather than fluorine chemicals, is used to fluoridate public water supplies. Equipment is simple and a considerable saving is reported in the operating cost. During 1959, some 41 Canadian communities fluoridated public water supplies to reduce the incidence of dental caries in children.

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 none are comparable to fluorspar in efficiency. Fluorspar for metallurgical purposes must be in coarse sizes (2 in. to 3/8 in.), 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 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 to reduce children's dental cavities. Recently, natural calcium fluoride (fluorspar) has also come to be 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 more than double in the next 10 years. 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 a maximum 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 ceramic grade, it is used in powdered form.

Prices

Canada

At the end of 1959, prices of coarse ceramic-grade fluorspar per net ton f.o.b. Arvida, Quebec, as quoted by Aluminum Company of Canada, Limited, were as follows: 100-lb bags - minimum carload or truckload, \$61.50; less-than-carload lots to 1 ton, \$70.70; less than 1 ton, \$76.85; in bulk - minimum carload or truckload, \$57.75.

United States

Fluorspar prices per short ton, as quoted in E & M J Metal and Mineral Markets of December 3, 1959, were as follows: metallurgical grade, effective CaF_2 content, f.o.b. Illinois and Kentucky - 72 1/2%, \$37 to \$41; 70%, \$36 to \$40; 60%, \$33 to \$36; acid grade, concentrates, bulk, carload lots, f.o.b.

Illinois, Kentucky and Colorado - spot, \$49; in bags, \$3 extra; ceramic grade - 95% CaF_2, \$45 to \$48; 93% to 94% CaF_2, calcite and silica variable, Fe_2O_3 0.14%, \$43 to \$45; in 100-lb bags, \$3 extra.

European Fluorspar

Prices per short ton, c.i.f. U.S. ports, duty paid, as given in E & M J Metal and Mineral Markets of December 3, 1959, were as follows: metallurgical grade, 72 1/2% effective CaF_2 - spot, \$33 to \$34; contract, \$32 to \$34; acid grade, 0.3% moisture maximum - contract, \$50; spot, \$1 more. A large discount was allowed for high moisture content.

Mexican Fluorspar

The price per short ton, f.o.b. border, all rail, duty paid, as quoted in the December 3 issue of the same publication, was as follows: metallurgical grade, 72 1/2% effective CaF_2 content, \$26.50 to \$27.50; barge, Brownsville, Texas, \$28.50 to \$29.50.

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

GRAPHITE

J.E. Reeves*

There has been no production of natural graphite in Canada since 1954. Several attempts have been made in the last few years to bring properties containing graphite deposits into production, but so far without success.

Natural graphite is imported from many countries in different forms. The import statistics available concern values only, and these show an appreciable increase for 1959 compared with 1958. The summary table on page 4 suggests, however, that the trend in imports has been somewhat erratic, particularly as regards unground graphite and graphite crucibles. In 1959, as in previous years, low-cost amorphous graphite from Mexico and graphite crucibles, other manufactured articles and specially ground and prepared grades of graphite from the United States and the United Kingdom made up a large part of Canada's graphite imports.

Artificial graphite is produced by Electro Metallurgical Company at Welland, Ontario, by the electric-furnace treatment of petroleum coke. There are considerable exports of artificial-graphite electrodes, as shown in the tables, although their value in 1959 was markedly reduced.

Canadian Occurrences

Graphite is a relatively common constituent of many Canadian rocks, particularly of the Grenville-type Precambrian limestones and gneisses of southeastern Ontario and southwestern Quebec, in which it occurs mainly as a comparatively fine-grained flake.

The earliest reported graphite-mining took place in 1846 in Grenville township, Quebec, about 60 miles east of Ottawa. Many properties in Quebec, especially in the vicinity of Buckingham, produced between then and 1936, but their output was mostly small and sporadic.

In Ontario, this mineral was first mined in 1870 in North Elmsley township, near Perth. The Black Donald mine, about 65 miles west of Ottawa, in Brougham township, was, however, the only Canadian operation of any considerable size and duration. Shipments were made from it almost continuously from 1897 to 1954. The ore consisted of fine- to coarse-grained, disseminated to nearly massive graphite in strongly folded, silicated, recrystallized limestone, and yielded various grades from low-quality amorphous material to smaller amounts of high-quality lubricating flake.

---

*Mineral Processing Division

Graphite - Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Imports				
Unmanufactured				
Mexico		41,779		28,393
United States		14,065		22,096
Norway................		5,269		1,116
Ceylon		1,976		-
Other countries		925		1,614
Total..................		64,014		53,219
Ground and manu-factured				
United States...........		744,551		831,309
United Kingdom		197,547		56,644
West Germany.........		28,460		20,576
Other countries		5,692		697
Total..................		976,250		909,226
Crucibles				
United States...........		138,853		100,167
United Kingdom		85,351		65,889
Total..................		224,204		166,056
Exports				
Carbon and artificial-graphite electrodes				
United Kingdom		194,260		3,180,725
Australia		42,300		75,841
Union of South Africa ...		40,584		-
Norway		32,389		127,385
United States...........		12,024		10,673
Other countries		18,800		14,515
Total..................		340,357		3,409,139
	1958		1957	
Consumption*				
Steel ingots and castings..............	871		1,258	
Heavy chemicals	606		319	
Iron castings	330		1,100	

Graphite - Trade and Consumption (cont'd)

	1958		1957	
	Short Tons	$	Short Tons	$
Consumption* (cont'd)				
Electrical apparatus	202		292	
Miscellaneous iron and steel	129		96	
Machinery	93		83	
Paints	48		59	
Brass and copper products ..	34		35	
Railway rolling stock.......	24		20	
Asbestos products	14		-	
Boilers and platework......	7		6	
Cooking and heating apparatus	4		4	
Machine tools	2		2	
Polishes and dressings	-		6	
Miscellaneous nonmetallics .	-		194	
Total	2,364		3,474	

*Available data.

Graphite also occurs elsewhere in Canada, but the only production has been a small quantity of amorphous-grade material obtained in the last century from impure, graphitic shales near Saint John, New Brunswick.

World Situation

Although graphite, in which there is much international trade, is used mainly by the highly industrialized nations, many of its best commercial deposits occur in the less industrialized countries. Mexico, Korea and Austria are the main sources of amorphous graphite; Madagascar is the traditional source of large, tough flake for use in crucibles but also produces other grades; Ceylon is best known for its coarse, massive graphite; and other countries such as Norway and West Germany are steady suppliers of small-flake graphite. The United States Bureau of Mines' estimate of the world's natural-graphite production for 1959 is 410,000 short tons; about 60 to 70 per cent of this is probably amorphous.

Technology

Graphite is the common form of natural crystalline carbon. Usually 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', Graphite - Production, Trade and Consumption, 1949-59

	Production[1]	Exports		Imports			Consumption[2]
		Natural Graphite	Carbon and Graphite Electrodes	Unground	Crucibles	Ground and Manufactured	
	(short tons)	(short tons)	($)	($)	($)	($)	(short tons)
1949	2,147	1,651	1,158,499	83,301	128,696	293,267	1,996
1950	3,586	3,044	1,194,964	71,440	164,142	330,442	2,219
1951	1,569	1,152	1,805,834	96,725	215,297	476,511	2,556
1952	2,040	1,686	2,824,885	97,658	213,429	434,650	2,845
1953	3,466	3,253	1,383,851	125,740	217,066	481,982	2,820
1954	2,463	2,156	1,251,411	54,385	156,516	548,824	5,076
1955	-	8	2,945,511	64,798	202,864	561,394	2,863
1956	-	-	2,802,932	87,926	260,000	815,384	3,078
1957	-	-	3,666,570	74,089	237,333	748,732	3,474
1958	-	-	3,409,139	53,219	166,056	909,226	2,364
1959	-	-	340,357	64,014	224,204	976,250	

(1) Producers' shipments of natural graphite.
(2) Available data.

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 mainly because of its various physical properties. It is soft and greasy, is a good conductor of heat and electricity and is highly resistant to the action of heat and chemicals.

Uses and Specifications

The iron-and-steel industry, which is the leading user, employs natural graphite mainly in the form of foundry facings and washes. In the melting of metals, nonferrous plants use imported graphite crucibles and such other manufactured graphite articles as ladle stoppers and pouring nozzles. Graphite is also used as a lubricant, particularly under conditions of high pressure and corrosion; in the paint industry as a pigment and anticorrosion element in protective coatings; in lead pencils; in corrosion-resistant pipes and fittings for the chemical industry; and in the manufacture of a wide range of close-tolerance, mechanical and electrical graphite products, such as electric brushes, pistons and rings for some types of engine and bearings for use under conditions of heat and corrosion. Graphite finds minor uses in the impregnating of the wood or metal surfaces of oilless bearings, in the manufacture of stove and other black polishes and as a polishing agent for lead shot and explosives.

Artificial graphite is employed chiefly in the manufacture of the electrodes used in some types of metallurgical and chemical plants and in the manufacture of electric brushes, refractory bricks and numerous special shapes. In recent years it has been used as a moderator in certain types of atomic reactors. In powdered form it is granular rather than flaky but is of very high purity and competes with natural graphite to a limited extent.

There are no standard specifications, graphite being sold on agreement between buyer and seller. The carbon content, particle size and type of graphite are the principal factors that govern its selection for a given use.

Prices

Graphite prices in the United States are listed periodically in E & M J Metal and Mineral Markets. For ground and concentrated flake graphite, the quoted price varies between about 7¢ and 40¢ a pound, c.i.f. United States ports, depending on the grade. Amorphous graphite costs about $15 to $19 a ton, f.o.b. point of origin.

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 of, not otherwise provided	15%	20%	25%
Graphite flakes	5%	5%	25%

United States

Crude or refined amorphous graphite	2 1/2%
Crystalline chip, dust or lump	7 1/2%
Crystalline flake valued per lb	
At less than 2 3/4¢	0.4125¢ per lb
From 2 3/4¢ to 5 1/2¢	15%
At more than 5 1/2¢	0.8254¢ per lb

GYPSUM AND ANHYDRITE

R.K. Collings*

GYPSUM

The mineral gypsum, a hydrous calcium sulphate, is produced in six of Canada's provinces. Nova Scotia, the chief producer, accounts annually for 80 to 85 per cent of the national output of crude gypsum. Most of Nova Scotia's output is exported to the United States. The other producing provinces, in order of importance, are Ontario, Manitoba, New Brunswick, British Columbia and Newfoundland.

Canada's production of crude gypsum showed a marked increase in 1959. At a record of 5,878,630 short tons, it was 48 per cent greater than in 1958 and more than 20 per cent greater than in 1956, the previous record year. The relatively large increase in 1959 over the total for 1958 was due, in part, to the fact that production was abnormally low in 1958 because of a lengthy strike by workers at the quarries of one of the major producers.

Exports of crude gypsum amounted to 4,848,576 short tons in 1959, 67.3 per cent more than in 1958. This gypsum, from Nova Scotia, was shipped to markets along the eastern seaboard of the United States. Imports of crude gypsum, mostly from Mexico, totalled 117,830 short tons in 1959.

Exports of finished gypsum products amounted to 373 short tons in 1959; imports totalled 19,745 short tons.

Occurrences

Gypsum deposits occur at numerous locations throughout Canada. Some are impure; others are too far from markets to be of economic importance. Many, however, are of good quality and are well situated with respect to transportation facilities and centres of population.

The largest deposits are in the Maritime Provinces. They are flat-lying and generally are covered by 10 to 15 feet of overburden. The Newfoundland deposits are confined to 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 southeastern part of the province.

(text continued on page 336)

*Mineral Processing Division

Gypsum - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)				
Crude gypsum				
Nova Scotia	5,036,411	6,462,658	3,149,719	3,259,423
Ontario	412,100	1,017,340	425,733	1,059,590
Manitoba	200,139	350,323	176,123	343,266
New Brunswick	98,250	132,735	105,749	170,876
British Columbia	94,010	282,030	70,498	211,494
Newfoundland	37,720	148,617	36,307	144,510
Total	5,878,630	8,393,703	3,964,129	5,189,159
Imports				
Crude gypsum	117,830	346,796	108,038	609,106
Plaster of paris, wall plaster				
United States	17,559	467,507	31,611	726,836
United Kingdom	181	21,317	159	1,697
France	11	2,059	14	712
West Germany	3	145	137	4,669
Other countries	3	193	1	65
Total	17,757	491,221	31,922	733,979
Wallboard and lath				
United States	802	41,303	24,177	786,928
Ireland	1,186	35,999	-	-
Total	1,988	77,302	24,177	786,928
Total imports	137,575	915,319	164,137	2,130,013
Exports				
Crude gypsum				
United States	4,848,576	9,844,602	2,898,230	4,871,440
Plaster of paris, wall plaster				
Bermuda	358	13,102	-	-
United States	15	306	-	-
Other countries	0.3	124	16	361
Total	373.3	13,532	16	361
Total exports	4,848,949.3	9,858,134	2,898,246	4,871,801

Gypsum - Production and Trade, 1949-59
(short tons)

	Production(1)	Imports(2)	Exports(2)
1949	3,014,249	566	2,544,617
1950	3,666,336	848	2,969,974
1951	3,802,692	1,700	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

(1) Producers' shipments. These tonnage figures include both crude and calcined to the end of 1951. Beyond 1951 only crude-gypsum tonnages are included.
(2) Include crude and ground but not calcined.

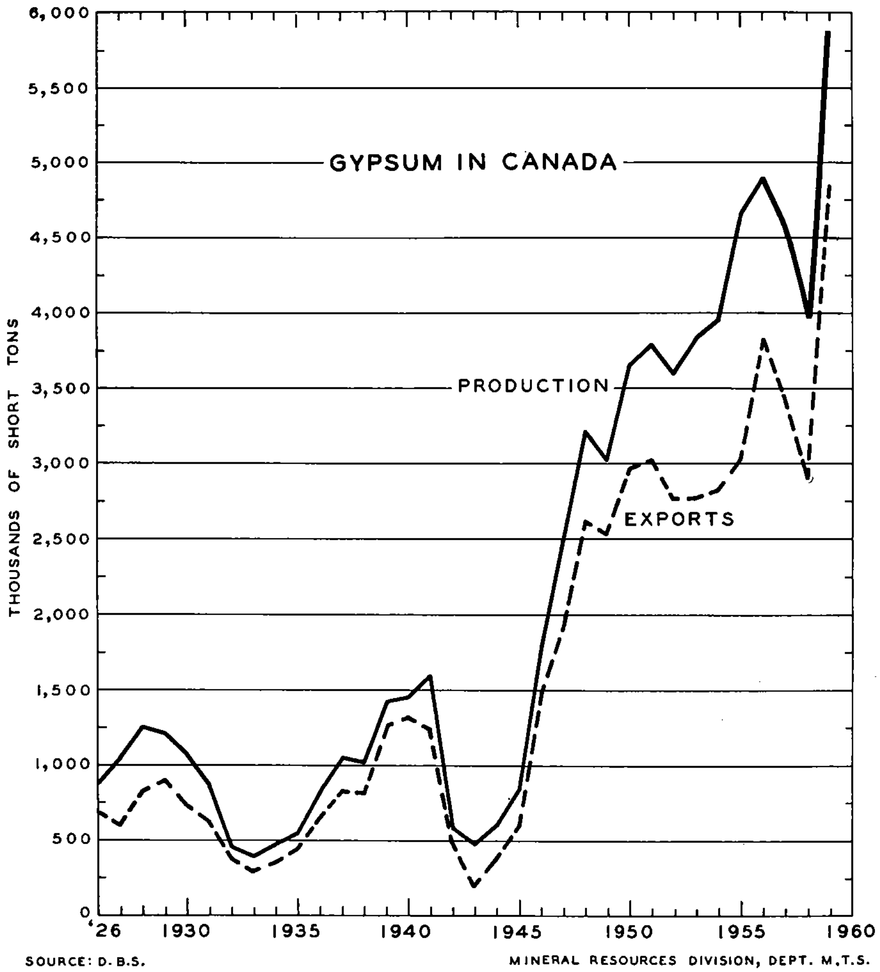
Consumption of Crude Gypsum
(short tons)

	1959	1958
In gypsum-products industry...............	954,632	971,982
In cement-manufacturing industry	278,298	293,514
Total....................................	1,232,930	1,265,496

In Quebec, the only known deposits are on the Magdalen Islands in the Gulf of St. Lawrence. They outcrop over wide areas and are up to 50 feet or more in thickness.

The chief deposits in Ontario are in the Moose River area in the northeastern part of the province, and in the Grand River area south and west of Hamilton. The Moose River deposits are 15 to 20 feet thick and usually are covered by 10 to 30 feet of overburden; those of the Grand River area are narrow and lens-like and occur at depths up to 200 feet.

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 the northeastern part of Alberta.

In British Columbia the main deposits are at Windermere, Mayook and Canal Flats in the southeastern part of the province, and at Falkland near Kamloops.

Producers*

Nova Scotia

Nova Scotia accounted for more than 85 per cent of Canada's output of crude gypsum in 1959. Most of the gypsum quarried in this province is exported to the United States.

---

*See map on page 340.

Canadian Gypsum Company Limited, a subsidiary of United States Gypsum Company of Chicago, Illinois, operates quarries for export purposes at Wentworth and Miller Creek, near Windsor.

National Gypsum (Canada) Limited, a subsidiary of National Gypsum Company of Buffalo, New York, operates a large gypsum quarry near Milford, 30 miles north of Halifax. Most of the production from this quarry is exported to the United States. Gypsum for export is also obtained from quarries at Walton and Cheverie, in Hants county.

Little Narrows Gypsum Company Limited, a subsidiary of United States Gypsum Company of Chicago, Illinois, quarries gypsum at Little Narrows on Cape Breton Island. Crude gypsum is shipped 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, quarries gypsum near Nappan for use in the manufacture of plaster, wallboard, and other products at a company-owned plant in Montreal. This company also operates a calcining mill at Windsor, producing plaster of paris for consumption in Nova Scotia, eastern Quebec and Ontario. Crude gypsum for use in this plant is obtained from deposits at McKay Settlement, near Windsor.

Ontario

Gypsum is mined at Caledonia, near Hamilton, by Gypsum, Lime & Alabastine Limited, and at Hagersville, southwest of Caledonia, by Canadian Gypsum Company Limited. This gypsum is used in the manufacture of plaster and wallboard at company-owned plants near the respective mines.

National Gypsum (Canada) Limited is investigating an underground occurrence of gypsum near Princeton, east of Woodstock. This deposit will be developed to supply crude rock to a gypsum-products plant that will be built in this area if current market studies indicate a need for it.

Manitoba

Gypsum is obtained from an underground deposit at Amaranth by Western Gypsum Products Limited and is shipped to Winnipeg for use in the manufacture of plaster and wallboard at a company-owned plant. Western Gypsum Products Limited is a subsidiary of British Plaster Board (Holdings) Limited, of London, England.

Gypsum is 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.

New Brunswick

Gypsum is 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, for use in the manufacture of cement at Havelock.

British Columbia

Western Gypsum Products Limited operates a gypsum quarry near Windermere, in southeastern British Columbia. This quarry supplies crude gypsum to the company's gypsum-products plant at Calgary and to cement plants in British Columbia and Alberta. The construction of the Vancouver plant of Western Gypsum Products Limited was nearing completion at year-end. This plant, scheduled to begin production of plaster, wallboard and other gypsum products early in 1960, will use Windermere gypsum.

Newfoundland

Atlantic Gypsum Limited, operated by Bellrock Gypsum Industries, of London, England, produces gypsum plaster and wallboard at a plant at Humbermouth, on the west coast of Newfoundland. This plant, owned by the Government of Newfoundland, obtains crude gypsum from a quarry, also government-owned, at Flat Bay Station, 62 miles by rail southwest of Humbermouth.

Other Processing Plants

Quebec

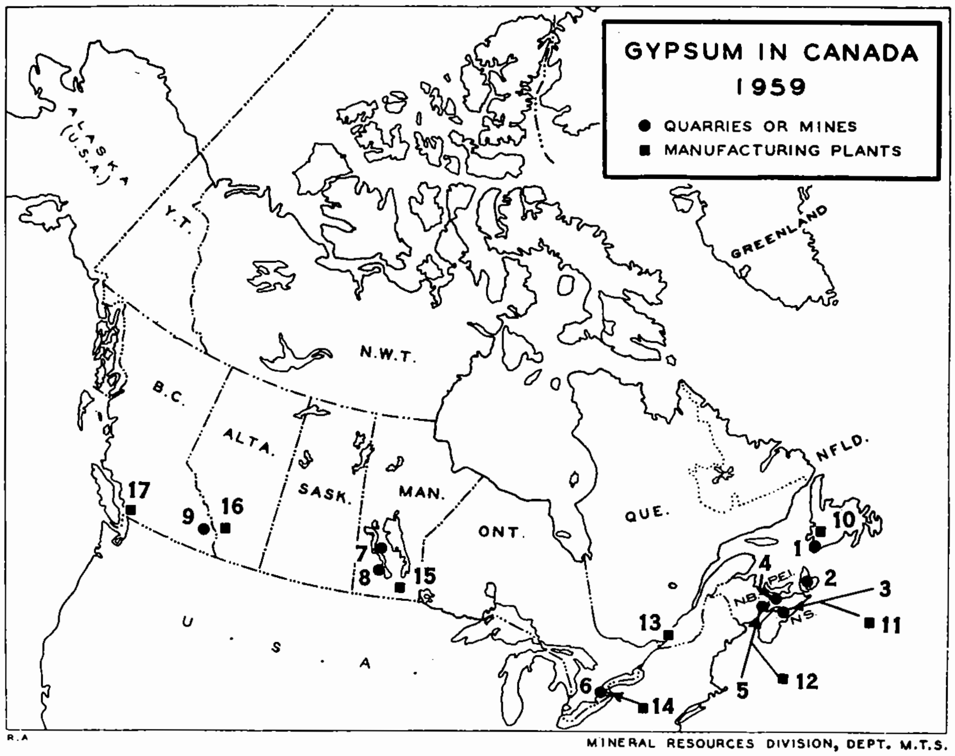
Gypsum, Lime & Alabastine Limited and Canadian Gypsum Company, Limited, operate gypsum-products plants in Montreal East. Crude gypsum from quarries in Nova Scotia is used by these plants in the manufacture of plaster of paris, wallboard and other gypsum products. Atlantic Gypsum Limited manufactures a precast panel for the building-construction industry at a plant in Montreal, using plaster of paris from its Humbermouth, Newfoundland, plant.

Alberta

Gypsum, Lime & Alabastine Limited produces plaster at a plant in Calgary, using raw gypsum from company quarries at Gypsumville, Manitoba. This company's Calgary operation was expanded during the year to include the production of wallboard and lath. Initial production of wallboard and lath is scheduled for early 1960. Western Gypsum Products Limited manufactures plaster and wallboard at a plant in Calgary. Raw gypsum for this plant is obtained from a company-owned quarry at Windermere, British Columbia.

British Columbia

Gypsum, Lime & Alabastine Limited operates a plaster-and-wallboard plant at Port Mann, about 10 miles east of Vancouver. The gypsum requirements of this plant are met by imports from San Marcos Island, Mexico.



Operators or Mines

1. Atlantic Gypsum Limited, Flat Bay Station
2. Little Narrows Gypsum Company Limited, Little Narrows
3. Canadian Gypsum Company Limited, Wentworth and Miller Creek
   National Gypsum (Canada) Limited, Milford and Walton
   Gypsum, Lime & Alabastine Limited, McKay Settlement
4. Gypsum, Lime & Alabastine Limited, Nappan
5. Canadian Gypsum Company Limited, Hillsborough
6. Canadian Gypsum Company Limited, Hagersville
   Gypsum, Lime & Alabastine Limited, Caledonia
7. Gypsum, Lime & Alabastine Limited, Gypsumville
8. Western Gypsum Products Limited, Amaranth
9. Western Gypsum Products Limited, Windermere

Manufacturing Plants

10. Atlantic Gypsum Limited, Humbermouth
11. Gypsum, Lime & Alabastine Limited, Windsor
12. Canadian Gypsum Company Limited, Hillsborough
13. Canadian Gypsum Company Limited, Montreal
    Gypsum, Lime & Alabastine Limited, Montreal
14. Canadian Gypsum Company Limited, Hagersville
    Gypsum, Lime & Alabastine Limited, Caledonia
15. Gypsum, Lime & Alabastine Limited, Winnipeg
    Western Gypsum Products Limited, Winnipeg
16. Gypsum, Lime & Alabastine Limited, Calgary
    Western Gypsum Products Limited, Calgary
17. Gypsum, Lime & Alabastine Limited, Port Mann
    Western Gypsum Products Limited, Vancouver

Uses

Calcined gypsum, or plaster of paris, is the main constituent of gypsum board and lath, gypsum tile, roof tile 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 limited 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 soils, and as a fertilizer for peanuts and other leguminous crops.

Prices

The nominal price of crude gypsum in 1959 was $3 to $5 a ton f.o.b. quarry or mine. Under large contracts with seaboard quarries, however, prices were much lower.

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Gypsum			
Crude	free	free	free
Ground	10%	12 1/2%	15%

United States

Gypsum	
Crude	free
Ground, per long ton	$1.19

ANHYDRITE

The mineral anhydrite, which is anhydrous calcium sulphate, usually occurs in the massive form and is commonly associated with gypsum. It is produced in small amounts at one or two locations in Nova Scotia for export to the United States, where it is used as a fertilizer for peanut crops.

Anhydrite is used to a limited extent as a soil conditioner. Gypsum and anhydrite are potential sources of sulphur compounds. As yet, however, these minerals have not been utilized for this purpose 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.

LIME

J.S. Ross*

The lime industry has completed another year of record production and, with the installation of five new vertical kilns in Ontario, has continued to modernize and expand its facilities. One rotary-kiln plant is under construction in Quebec.

High-calcium and dolomitic quicklime and smaller amounts of the hydrated counterparts were produced. At 1,685,725 tons valued at $21,304,021, production during 1959 reached a new peak. This represents a third successive annual record and an increase of more than 5.6 per cent over the 1958 tonnage. The chief reason for this rise was that Ontario gained 11.9 per cent in output owing partly to the needs of the metallurgical industry. The uranium industry, which requires a large quantity of lime, will use decreasing amounts during the next few years.

Although Canada is generally self-sufficient in lime, some of its needs are filled by imports. The reason is that certain markets are unfavorably situated and that some types of lime - the pressure-hydrated variety, for example - are not produced. In volume, imports are roughly equal to exports; both concern mainly the United States; both are negligible.

Domestic Production

Lime, produced from the calcination of limestone and dolomite, is marketed either in the oxide or in the hydrate. Quicklime may be classified as (1) high-calcium, containing 90 per cent or more calcium oxide and up to 5 per cent magnesia, (2) magnesian, containing 5 to 25 per cent magnesia, and (3) dolomitic, containing 25 to 45 per cent magnesia.

About 3,062,000 tons of limestone were used in Canada in 1959 for the production of lime. Although all provinces except Prince Edward Island have limestone deposits from which lime could be produced, production is lacking not only in Prince Edward Island but also in Newfoundland, Nova Scotia and Saskatchewan. Production is usually obtained from deposits near the larger centres of population.

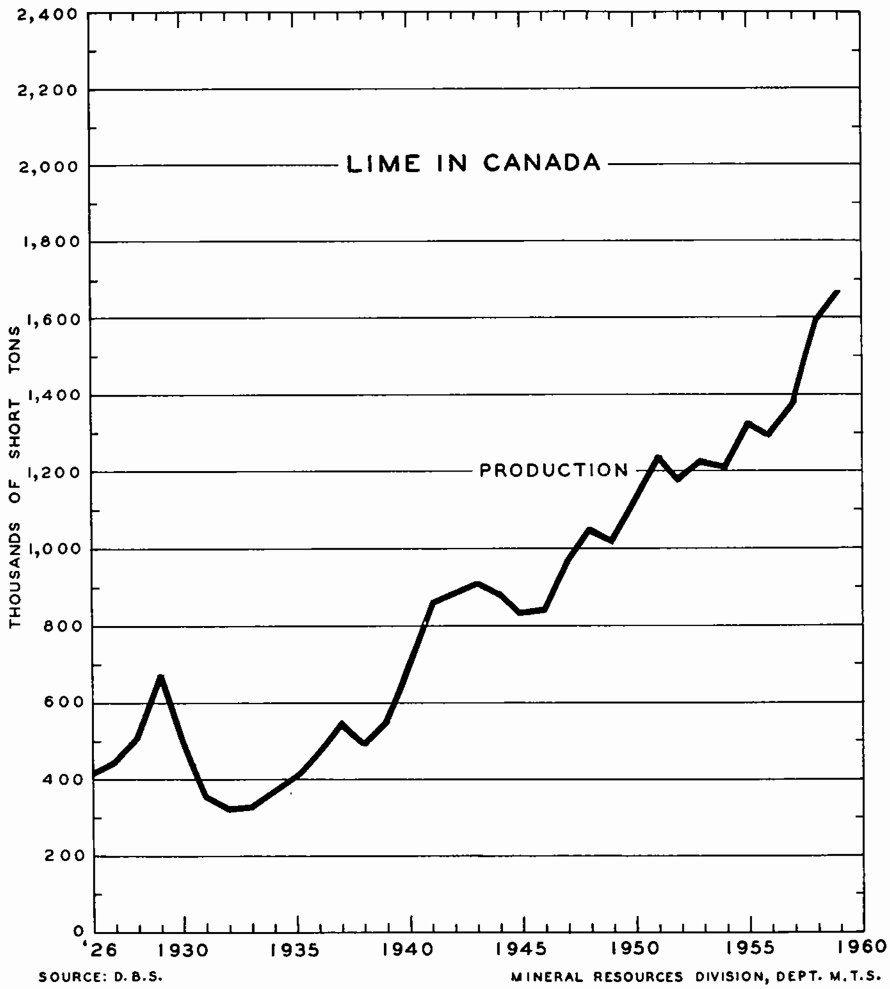
---

*Mineral Processing Division

Lime - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)				
By product				
Quicklime	1,359,666	17,255,903	1,258,089	15,371,452
Hydrated lime	326,059	4,048,118	338,333	4,094,371
Total	1,685,725	21,304,021	1,596,422	19,465,823
By province				
Ontario	1,130,055	14,006,532	1,009,916	12,644,925
Quebec	404,060	4,568,694	421,652	3,985,234
Manitoba	60,503	1,022,953	72,561	1,168,514
Alberta	43,709	741,837	47,112	767,612
British Columbia	29,167	547,190	27,567	505,299
New Brunswick	18,231	416,815	17,614	394,239
Total	1,685,725	21,304,021	1,596,422	19,465,823
Imports				
United States	30,548	379,237	15,395	200,281
United Kingdom	868	8,958	238	3,073
Denmark	7	84	-	-
Total	31,423	388,279	15,633	203,354
Exports				
United States	24,609	428,178	17,222	361,996
Bermuda	25	1,450	-	-
St. Pierre	3	114	3	115
Netherlands Antilles	4	156	-	-
Total	24,641	429,898	17,225	362,111

High-calcium lime is produced in British Columbia, Alberta, Manitoba, Ontario, Quebec and New Brunswick, and dolomitic lime in Manitoba, Ontario, New Brunswick, and from brucitic limestone in Quebec. Ninety per cent is shipped from plants in Ontario and Quebec. Thirty-eight plants containing 130 vertical and 25 rotary kilns and having a total rated output of 7,680 tons of primary quicklime a day, were in operation. In addition, two separate hydrating plants operated. Also, 15 plants containing 16 rotary kilns in British Columbia, Ontario, Quebec and New Brunswick reclaimed captive secondary lime from waste carbonate sludges from the manufacture of pulp and paper. At least one of these latter rotary kilns also produces minor amounts of captive primary lime from stone. Statistics concerning the output of these plants are not available.



During 1959 the rated capacity of Canadian lime plants was increased about 200 tons a day by the construction of three producer-gas-fired vertical kilns at the Beachville, Ontario, plant of Chemical Lime Limited and by the addition of two vertical kilns at the Guelph plant of Canadian Gypsum Company Limited. Standard Lime Company Limited is increasing the capacity of its plant near Joliette, Quebec, by constructing a new rotary-kiln plant with a daily output of 200 tons.

Lime Producers, 1959

Name of Firm	Plant Location	Type of Quicklime	Hydrator
New Brunswick			
Bathurst Power & Paper Company Limited	Bathurst	High-calcium	
Snowflake Lime Limited	Saint John	High-calcium and dolomitic	Hydrator
Quebec			
Aluminum Company of Canada, Limited	Wakefield	Magnesium	Hydrator
Bousquet, Adrien	St. Dominique	High-calcium	
Dominion Lime Limited	Lime Ridge	"	Hydrator
Lamothe, N.	Pont Rouge	"	
Raffinerie de Sucre de Québec	St. Hilaire	"	
Shawinigan Chemicals Limited	Shawinigan	"	
Standard Lime Company Limited	Joliette	"	Hydrator
	St. Marc des Carrières	"	
Trottier, David	St. Marc des Carrières	"	
Ontario			
Bonnechere Lime Limited	Grattan tp.	"	
Brunner Mond Canada, Limited	Anderdon tp.	"	
Canada & Dominion Sugar Co. Ltd.	Chatham	"	
	Wallaceburg	"	
Canadian Gypsum Company Limited	Guelph tp.	Dolomitic	Hydrator
Carleton Lime Products Co.	Carleton Place	High-calcium	
Chemical Lime Limited	Beachville	"	
Cobo Minerals Limited	Coboconk (near Lindsay)	"	
Cyanamid of Canada Limited	Niagara Falls	"	
	Ingersoll	"	
Dominion Magnesium Limited	Haley Station	Dolomitic	
Gypsum, Lime & Alabastine Limited	Hespeler	"	Hydrator
	Beachville	High-calcium	Hydrator
	Milton	Dolomitic	
Rockwood Lime Company, Ltd.	Rockwood	"	
Manitoba			
Building Products and Coal Co. Ltd.	Inwood	"	Hydrator
Manitoba Sugar Company Ltd., The	Fort Garry	High-calcium	
Winnipeg Supply and Fuel Company Limited, The	Spearhill	"	
	Stonewall	Dolomitic	

Name of Firm	Plant Location	Type of Quicklime	Hydrator
Alberta			
Canadian Sugar Factories Limited	Raymond	High-calcium	
	Picture Butte	"	
	Taber	"	
Loder's Lime Co. Ltd.	Kananaskis	"	Hydrator
Summit Lime Works Limited	Crowsnest	"	Hydrator
British Columbia			
Crown Zellerbach Canada Limited	Ocean Falls	"	
Gypsum Lime & Alabastine Limited	Blubber Bay	"	Hydrator
	Granville Island	"	

Consumption and Uses

Lime has numerous uses and, in most industries, is consumed either as a raw material or indirectly. It is relatively low in price and in many applications has no substitute. As shown in the table on page 348 the consumers of lime fall into three main groups.

The largest group, which consumed 88.4 per cent of all the types of lime used in Canada in 1959, comprises the chemical industry and other industrial users. No separate figures are available for the largest category consumed by this group, namely, captive-tonnage lime, which companies produce for their own use. In the table, this category is covered by 'other industries' and includes lime used in the manufacture of calcium carbide and alkali. Other uses of lime in the chemical and industrial category are shown in the table in the order of the amounts consumed. Chemical and industrial processes require lime for neutralization, causticization, coagulation and precipitation.

The Canadian uranium industry is a major consumer of high-calcium lime and uses the commodity mainly to neutralize waste sludges.

In the pulp-and-paper industry, lime is used in the preparation of dissolving liquors for the sulphite, sulphate and soda processes and as a raw material in the manufacture of the bleaching agent, calcium hypochlorite.

In steel plants, high-calcium lime is used extensively as a flux and desulphuring agent. In the manufacture of steel products it has many uses, including the neutralization of waste pickling liquors.

High-calcium lime is used mainly as a flux in the smelting and refining of nonferrous ores.

Consumption of Lime
(producers' shipments by usage)

Uses	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Chemical and other industrial				
Uranium mills	286,738	3,464,612	273,918	3,301,431
Pulp and paper mills	185,524	2,482,283	183,650	2,458,932
Nonferrous smelters	130,054	714,147	139,005	818,953
Iron and steel plants	162,244	1,904,349	124,770	1,470,792
Sugar refineries	34,324	451,419	36,335	433,181
Glass works	21,075	252,719	22,039	264,756
Sand-lime brick	16,070	181,192	12,215	142,796
Cyanide and flotation mills	31,828	370,065	20,335	277,787
Tanneries	4,986	60,351	7,523	94,866
Fertilizer plants	1,754	19,071	4,316	41,545
Insecticides, fungicides	1,202	23,522	827	15,176
Other industries	615,019	7,735,492	573,716	6,467,074
Building-trade				
Mason's lime	78,963	1,283,591	95,562	1,522,567
Finishing lime	94,464	2,066,517	90,985	1,948,287
Agricultural	8,515	86,224	3,538	64,663
Other	12,965	208,467	7,688	143,017
Total	1,685,725	21,304,021	1,596,422	19,465,823

In the refining of beet sugar, high-calcium lime and the by-product carbon dioxide produce insoluble calcium sucrate, from which impurities are filtered.

Lime serves as a depressant in ore-flotation processes and for pH control in the recovery of minerals by the cyanidation process.

Dolomitic or high-calcium lime is one of the three principal raw materials used in the manufacture of glass.

Lime in one form or another is used in the manufacture of calcium, fertilizers, paint pigments, varnish and glue, and for other purposes including the treatment of sewage and municipal water.

High-calcium lime is a main raw material for the manufacture of such chemical compounds as calcium cyanamide, acetylene, soda ash, precipitated calcium carbonate, calcium chloride, calcium hydroxide, sodium bicarbonate, ethylene glycol and other organic and inorganic compounds.

Twelve per cent of the lime consumed in Canada in 1958 went to the building trade, which uses it as a constituent of plaster, stucco, mortar and artificial stone.

The agricultural industry employs lime for the control of soil acidity, as a source of calcium and magnesium, as a soil conditioner and in insecticides and fungicides.

Prices

Quicklime is marketed in Canada in bulk as lump, pebble and pulverized, or in bags as pulverized lime. Hydrated lime is sold in bulk or in bags as a fine granular product. Prices vary according to the type and form of product, the tonnage of sale and the location. During 1959 the average value of lime produced in Ontario was $12.39 a ton at the plants.

LIMESTONE

J.S. Ross*

Shipments of limestone for purposes other than the production of cement and lime increased in 1959, making a substantial advance toward the corresponding total of 1957, the record production year. Some 450 quarries in all provinces except Saskatchewan and Prince Edward Island produced 36.7 million tons of this type valued at $46,038,315. Included was a small amount of marble and marl. It is noteworthy that Quebec's output increased by 4.6 million tons, or one-third, and for the first time since 1950 exceeded production from Ontario. Quebec's increase was brought about mainly by additional demands by the construction industry. Limestone used for all purposes reached 47.9 million tons.

Complete statistics on Canadian trade in limestone are not available, but it is known that in 1959 Canada exported 285,560 tons of this broken,crushed and ground rock valued at $522,486 (U.S.) and imported from the United States 1,066,760 tons of the same material valued at $1,817,673 (U.S.). In recent years the values of these exports and imports have been increasing. Stone is exported from British Columbia coastal ports to the west coast ports of the United States for use in the manufacture of pulp and paper and as metallurgical flux. High-calcium stone is exported from Ontario to the United States for consumption as flux. Crushed stone for construction purposes is shipped from the more southerly parts of Ontario to adjacent areas in the United States. Smaller amounts of building, ornamental and monumental limestone are exported.

During 1959, renovations and expansions were completed at some limestone plants and a few new crushing and screening plants and quarries were put in operation. Major changes included the erection of a modern crushing and screening plant by Queenston Quarries Limited at Niagara Falls, Ontario; expansion of the operations of Niagara Crushed Stone Limited near Port Colborne, Ontario; and new crushing facilities at the Beachville, Ontario, operations of Chemical Lime Limited. Major limestone quarries and crushing and screening plants were put in operation during the year near Colborne and Milton, Ontario, by St. Lawrence Cement Company and Halton Crushed Stone Limited, respectively.

Uses

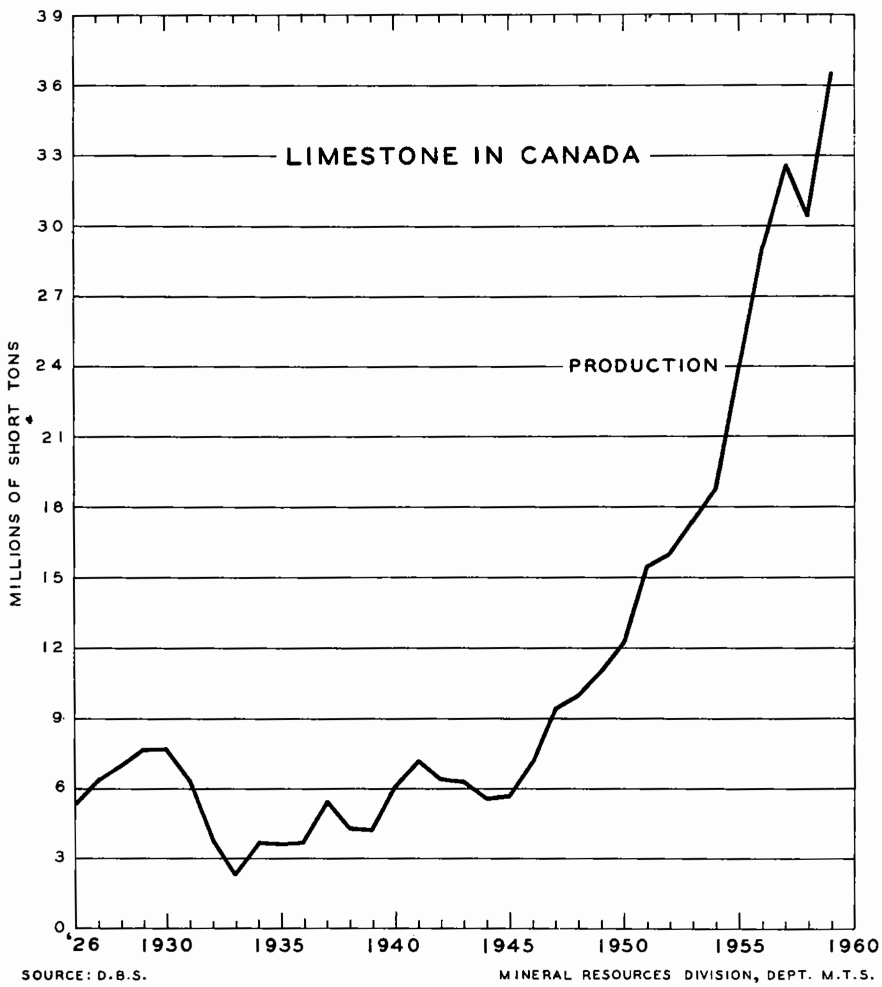
In industry, the term 'limestone' includes rocks that are composed at least 50 per cent of calcite, dolomite or combinations of these minerals. Owing to the numerous possible variations in chemical composition and geological

*Mineral Processing Division

Limestone - Production and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
By province(1)				
Newfoundland	352,127	582,815	222,767	380,415
Nova Scotia........	70,156	187,828	120,898	235,701
New Brunswick	139,180	425,593	199,511	503,278
Quebec............	18,168,512	22,629,885	13,565,133	17,263,107
Ontario	16,373,511	19,691,087	15,178,350	18,844,057
Manitoba	526,679	771,091	540,703	983,463
Alberta	279,584	459,359	39,612	163,436
British Columbia...	782,055	1,290,657	468,030	910,614
Total	36,691,804	46,038,315	30,335,004	39,284,071
	1959		1958	
By uses				
Structural(2).......	91,275	2,131,647	89,477	2,421,309
Metallurgical	1,916,215	2,227,304	1,531,351	1,778,973
Glass-making......	46,582	154,826	32,401	108,214
Sugar-refining	38,756	77,672	20,386	24,603
Pulp and paper.....	375,823	1,169,780	340,750	1,093,517
Other chemical uses	445,397	414,656	416,820	381,341
Pulverized for agricultural and fertilizer uses....	727,142	1,966,332	696,437	1,790,169
Pulverized for other uses	253,986	869,166	174,756	699,408
Rubble and riprap ..	830,201	1,057,125	1,195,072	1,273,786
Concrete aggregate.	7,476,397	8,716,154	6,137,598	7,466,637
Road metal	20,230,873	22,003,778	16,472,736	18,238,796
Railroad ballast....	1,135,524	1,159,421	802,055	938,939
Other uses	3,123,633	4,090,454	2,425,165	3,068,379
Total	36,691,804	46,038,315	30,335,004	39,284,071
	1959*		1958	
Consumption				
In the production of cement	8,175,733		8,473,596	
In the production of lime	3,062,152		2,831,886	
Miscellaneous	36,691,804		30,335,004	
Total	47,929,689		41,640,486	

(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, flagstone and curbstone.
(e) Estimated.



history, this rock may be classified into many categories. Varieties such as brucitic limestone and magnesitic dolomite originate from the partial replacement of a limestone by brucite or magnesite, respectively. In this review, marble is regarded as recrystallized limestone and marl as an unconsolidated form of limestone.

In general, Canada is fortunate in having excellent occurrences of the more necessary types of limestone in the more populated regions. More than 90 per cent of this rock, produced for purposes other than the making of cement and lime, is shipped from quarries in southern Ontario and Quebec.

Limestone, a low-priced commodity, is used extensively in construction and in the chemical and other industries. With the exception of structural stone and rubble and riprap, limestone is consumed in sized, crushed or ground forms ranging in size from approximately 16 inches to minus 325 mesh. The use of a particular limestone depends upon the distance to markets; the accessibility of the rock; the color, texture, hardness and chemical composition of the rock; the thickness and extent of the beds and formation; and other minor local conditions.

Canadian limestone is used mainly for construction purposes - as road metal; in the production of cement; as concrete aggregate, rubble and riprap, structural and ornamental stone, railroad ballast, terrazzo, stucco and artificial stone; as a filler in asphalt; and in the production of lime. Except when limestone is used in the production of cement and lime, the physical properties that make it suitable for construction are its most important characteristics.

High-calcium and dolomitic limestones are the main types consumed by the chemical industry. High-calcium limestones low in impurities have qualities that make them chemically important. They are the source of this industry's lime and serve as fluxes in the smelting of ferrous and nonferrous ores. High-calcium limestone is used by the pulp-and-paper industry in the preparation of calcium bisulphite dissolving liquor. It is also employed as a filler and whiting compound in the manufacture of such materials as rubber, paint and floor tile.

Dolomitic limestones containing low impurities are employed as fluxes in iron and steel production, in the production of lime mainly for construction purposes and in the manufacture of glass.

Ground limestone is used in agriculture to control soil acidity and to supply calcium and magnesium. Increasing amounts of marl are also being used for this purpose in Quebec and British Columbia.

Aluminum Company of Canada Limited recovers magnesia from brucitic limestone quarried near Wakefield, Quebec. Dominion Magnesium Limited quarries dolomite for the production of magnesium near Haley Station, Ontario.

Dolomitic magnesite is mined by Canadian Refractories Limited at Kilmar, Quebec, for use in the production of basic refractory products. Steetly of Canada Limited dead-burns dolomite near Dundas, Ontario, for use as a refractory material in open-hearth furnaces.

Prices and Tariffs

Prices of limestone products vary according to the geographical location, the local supply and quantity of sale of a given product, and the type, quality and degree of preparation of the stone. Transportation costs add greatly to the gross price. Crushed and sized limestone for concrete aggregate may sell for $1.25 a ton or more at the plant.

There is no Canadian tariff on crushed limestone. The United States import duty is 1 1/4 cents per 100 pounds for the crude or crushed variety.

LITHIUM MINERALS

J.E. Reeves*

The Canadian lithium-minerals industry experienced two notable changes during 1959. Quebec Lithium Corporation's shipments were curtailed sharply in August when its main contract, with Lithium Corporation of America Inc., for chemical-grade spodumene concentrate, was abruptly terminated. Chemalloy Minerals Limited (formerly Montgary Explorations Limited) reopened its mine in southeastern Manitoba and initiated a program for the development of concentrations of select lithium minerals and pollucite (a cesium-aluminum silicate). All other properties in Canada are inactive pending considerable market expansion.

Production and Trade

In 1959, Quebec Lithium Corporation shipped spodumene concentrates containing 2,756,280 pounds of lithia (lithium oxide, Li_2O); its 1958 shipments contained 3,853,322 pounds. The value was 30.6 per cent lower than that of 1958, which amounted to $2,047,880. Most of these shipments consisted of chemical-grade spodumene concentrate containing slightly less than 6 per cent Li_2O. This concentrate was sent to Lithium Corporation of America, at Bessemer City, North Carolina. Relatively small shipments of ceramic-grade spodumene concentrate, having nearly 6 1/2 per cent Li_2O and a closely controlled iron content, were begun during the year. This grade is sold under contract to Kimble Glass Division of Owens-Illinois Glass Company, at Columbus, Ohio, for use in glass for television tubes.

On August 24, Lithium Corporation of America Inc. announced the termination of its contract with Quebec Lithium Corporation, about 2 1/2 years before it was due to expire. This resulted in a reappraisal by Quebec Lithium Corporation of its mining and milling schedules and the subsequent temporary suspension of these operations at the end of November, when more than 8,000 tons of spodumene concentrate, including chemical- and ceramic-grade, had been stockpiled. A suit for breach of contract, brought against Lithium Corporation of America by Quebec Lithium Corporation, was settled out of court for $1,900,000 in United States currency, to be paid over a period.

The construction of a lithium-chemical plant by Quebec Lithium Corporation at the mine site was nearly complete by the end of the year. The initial feed will be 50 tons a day of stockpiled chemical-grade spodumene concentrate, from which 12,000 pounds a day of lithium carbonate can be produced. Production is scheduled to commence in July 1960.

---

*Mineral Processing Division

The company also shipped 2,830 tons of glass-grade, by-product feldspar to the Montreal area during the year, but the production of this commodity was discontinued along with that of the chemical-grade spodumene concentrate.

Canada has been importing all its lithium-compound requirements from the United States. On the basis of incomplete information, these imports had an approximate value of $85,000 in 1959 and $68,000 in 1958. The imports consist mainly of lithium carbonate and lithium hydroxide monohydrate, with lesser amounts of lithium bromide, lithium hydroxide and lithium stearate. In addition, sizable quantities of lithium greases are imported from the United States.

Lithium-bearing Minerals

Numerous minerals contain lithium, but only four have had any economic importance. In addition, zinnwaldite and lithiophilite occur as accessory lithium minerals. The lithium content of all these minerals has been replaced to some extent by other alkali metals, with the result that the composition of these minerals is variable. In the following table, the lithium minerals appear in the order of their importance.

Mineral	Simplified Formula	Theoretical Li_2O Percentage	Actual Range Li_2O Percentage
Spodumene	$LiAlSi_2O_6$	8.03	4 to 7
Lepidolite	$KLi_2AlSi_4O_{10}F_2$	7.65	3 " 5
Amblygonite	$LiAlFPO_4$	10.10	8 " 9
Petalite	$LiAlSi_4O_{10}$	4.89	3 " 4
Zinnwaldite	$LiKFeAl_2F_2Si_3O_{10}$	3.40	2 " 3
Lithiophilite-triphylite	$Li(MnFe)PO_4$	9.52	2 " 6

Occurrences in Canada

Quebec

Diamond-drilling on the property of Quebec Lithium Corporation in Lacorne township north of Val d'Or has indicated one of the largest spodumene deposits in the world. The deposit consists of a number of large pegmatite dykes and many associated smaller ones, constituting a family of parallel dykes that extends for several miles. The company has reported reserves in excess of 20 million tons containing 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.

Manitoba

Numerous lithium-bearing pegmatites occur in the Winnipeg River-Cat Lake area, in the southeastern part of the province. The most significant occurrence at present 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. Spodumene is an important constituent, but of more immediate interest are concentrations of amblygonite and lepidolite and the unusual concentration of the cesium mineral, pollucite. The company's most recent estimate of lithium-mineral reserves places them at about 9 million tons with a grade of 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, to a much lesser extent amblygonite, and minor amounts of other lithium minerals have been described. Beryl and columbite-tantalite are also relatively common.

World Resources and Production

The United States is the leading producer of lithium compounds, metal and alloys. During 1959, the producers of these commodities were confronted with several problems, including excess plant capacity, the termination of contracts with the United States Atomic Energy Commission for lithium compounds, and a growing stockpile of lithium hydroxide, which remains after the Atomic Energy Commission has extracted the lithium-6 isotope for its use.

The chief sources of raw material in the United States continued to be the large reserves of spodumene in North Carolina, to a lesser extent spodumene from South Dakota, and the brine of Searles Lake, California, from which by-product dilithium sodium phosphate is obtained. Production was at a lower rate than in 1958.

Another important world source of lithium minerals is Southern Rhodesia. Lepidolite is that country's most common variety, but petalite, spodumene and amblygonite are also abundant. As elsewhere, production has been sharply reduced.

Technology

Lithium is not uncommon as a constituent of the earth's crust, but commercial concentrations occur mainly in certain granitic pegmatites and are restricted to a few areas.

A very large part of the lithium-mineral concentrates is converted, before use, to the carbonate or the hydroxide-monohydrate compounds and, to a lesser extent, to other compounds. Relatively small amounts of mineral concentrates are used directly. There is only a very small production of lithium metal.

Lithium compounds, whose many properties have resulted in the development of a wide range of markets, have a promising future despite current production reversals. Some of the most important of their properties are mentioned in the following section.

Uses and Specifications

Lithium compounds are used chiefly in ceramics and 'multipurpose' lubricating greases.

The carbonate and fluoride compounds have become important ceramic raw materials. Concentrates of spodumene, lepidolite and petalite are also used, but to a much lesser extent. In ceramics, lithium is primarily important as a flux, permitting the development of low-temperature bodies with the attendant benefits of lower refractory and fuel costs and wider color use. Lithium compounds reduce the maturing temperature and increase the fluidity and gloss of glass, glazes and enamels, facilitate the production of glasses of high electrical, chemical and shock resistance, make possible the production of glass transparent to ultraviolet light for use in germicidal lamps, and in various other ways have resulted in improved ceramic products.

Lithium stearate and other lithium soaps, derived from lithium hydroxide monohydrate, allow lubricating greases to be effective over a wide range of temperatures - from -60°F to +320°F - and make them highly insoluble in water.

Other common applications include the use of lithium hydroxide as a constituent of the electrolyte in alkaline storage batteries; of lithium chloride (an extremely hygroscopic compound) and lithium bromide (for gas absorption) in air-conditioning units and refrigeration systems; of lithium chloride or fluoride as a flux in the welding and brazing of aluminum; of lithium fluoride as the analyzing crystal in X-ray spectrographs; of compounds in the control of reactions leading to the formation of alkyd resins for paints; and of compounds in the manufacture of dry-cell batteries that will function at extremely low temperatures where normal cells are inoperative.

Lithium metal has so far had limited application. It seems to have its principal use as a scavenger of impurities in the refining of nonferrous metals and as a grain-refining agent. Only very small amounts are added for these purposes. Lithium alloys of magnesium, aluminum, copper, lead and zinc are in the early stages of development.

Standard specifications for lithium-mineral concentrates have not been established. Specifications for any particular contract have been negotiated between supplier and user.

Prices

Published prices of lithium-mineral concentrates are nominal and roughly vary between \$5 and \$10 per unit of Li_2O (1 short-ton unit equals 20 pounds).

According to the Oil, Paint and Drug Reporter of December 28, 1959, prices of the important lithium compounds, per pound, are as follows:

Lithium carbonate	\$0.67	to \$0.73
Lithium hydroxide	\$0.72	" \$0.73
Lithium chloride	\$0.87	" \$0.89
Lithium bromide	\$2.60	
Lithium fluoride	\$2.15	" \$2.23 1/2
Lithium stearate	\$0.47 1/2	" \$0.53 1/2

E & M J Metal and Mineral Markets of December 31, 1959, gives the selling price of lithium metal, 99.5 per cent, as \$9 to \$11 a pound.

MAGNESITE AND BRUCITE

H.M. Woodrooffe*

Brine bitterns, magnesium salts from sea water, and the minerals magnesite and brucite are the principal sources of magnesia, an oxide of magnesium. In Canada, brucitic limestone and magnesitic dolomite are the only sources of magnesia now being worked. The value of the production of magnesia and dead-burned magnesitic dolomite increased in 1959 by over 20 per cent to $3,050,779 as the output of basic refractories returned to a more normal level. The consumption of basic refractories was affected markedly in 1958 by labor difficulties in the metallurgical industry.

Canada imports dead-burned magnesite from the United States and Yugoslavia for processing into basic refractories. Caustic calcined magnesite in several grades is also imported from the United States for several industrial applications.

The Canadian magnesia-mineral industry is confined to two deposits in western Quebec near the Ottawa River. The product is used principally in basic refractories and for other industrial and chemical requirements.

At Farm Point, near Wakefield, Quebec, 22 miles north of Ottawa, Aluminum Company of Canada, Limited, quarries a deposit of brucitic limestone. In this rock, in a matrix of calcite, spheroid granules of the hydroxide of magnesia (brucite) occur. During processing the rock is crushed, sized and calcined for the removal of combined water and carbon dioxide and is separated into commercial forms of magnesia and lime. The magnesia is used in the manufacture of high-magnesia basic refractories and is prepared in various grades for agricultural, chemical and industrial application. Wakefield magnesia was also formerly shipped to Arvida for processing to magnesium chloride, from which magnesium metal was produced by an electrolytic process. The metal plant was closed in the fall of 1959. The processing of brucite yields quicklime and hydrated lime as coproducts.

At Kilmar, in Argenteuil county, Quebec, about midway between Montreal and Ottawa, Canadian Refractories Limited, a subsidiary of Harbison-Walker Refractories Company, of Pittsburgh, Pennsylvania, is mining, by an underground method, a deposit of magnesitic dolomite that occurs in the Grenville series. The rock, an intimate mixture of magnesite and dolomite, is crushed and beneficiated in a sinkfloat plant so that the

*Mineral Processing Division

Magnesite and Brucite - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production*				
Magnesitic dolomite and brucite		3,050,779		2,529,161
Imports				
Magnesite, dead-burned and sintered				
United States	14,305	1,172,469	6,990	689,119
Yugoslavia	3,306	159,294	6,909	369,443
Other countries	30	1,976	72	5,349
Total	17,641	1,333,739	13,971	1,063,911
Magnesite, caustic calcined				
United States	2,418	165,708	1,306	111,184
India	25	3,943	25	4,025
Netherlands	18	1,041	11	717
Other countries	10	666	35	2,078
Total	2,471	171,358	1,377	118,004
Magnesitic firebrick				
United States		230,319		277,990
West Germany		141,575		19,031
United Kingdom		65,473		30,806
Total		437,367		327,827
Magnesium carbonate and magnesium oxide				
United States	2,043	221,755	1,258	116,721
United Kingdom	359	51,322	462	63,686
Total	2,402	273,077	1,720	180,407
Magnesium salts or compounds				
United States	2,121	286,206	4,796	325,789
United Kingdom	103	49,315	133	41,336
Other countries	11	630	53	3,606
Total	2,235	336,151	4,982	370,731

Magnesite and Brucite - Production and Trade (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Imports (cont'd)				
Magnesium sulphate or Epsom salts				
West Germany	1,797	31,467	1,403	27,034
United States	862	35,566	950	39,200
Other countries	62	3,664	100	4,975
Total....................	2,721	70,697	2,453	71,209
Magnesia pipe covering				
United States		40,953		70,560
United Kingdom		-		26,970
Total....................		40,953		97,530
Exports				
Dolomite and brucite				
United States		64,237		85,677

*Includes the value of brucitic magnesia shipped, dead-burned magnesitic dolomite and a small quantity of serpentine.

silicate minerals, which constitute impurities, may be controlled. The beneficiated rock, on being calcined by dead-burning in a 245-foot rotary kiln, gives a clinker for the manufacture of basic refractories. At Marelan, 10 miles south of Kilmar, the company operates a modern basic-brick plant. The output of both plants includes basic brick of various sizes and shapes, high-temperature refractory cements, ramming mixtures and other specialized refractory products. These products are prepared from dead-burned magnesitic dolomite and brucitic magnesia and other refractory raw materials.

General Refractories Company has established facilities at Smithville, Ontario, for the production of basic refractories from imported dead-burned magnesite clinker.

Other occurrences of brucitic limestone in Canada have been discovered in the vicinity of Wakefield, Bryson and Lake St. John, in Quebec, near Rutherglen, Ontario, and on West Redonda Island, British Columbia.

Magnesite and hydromagnesite deposits have been reported as occurring in British Columbia and Yukon Territory. Generally, they are either not extensive or are remote from transportation, and consequently have not been developed. The most important deposits occur in British Columbia - near Cranbrook, in the vicinity of Marysville. During 1959, development work was undertaken by a Canadian company interested in this material as a source of dead-burned magnesite.

Hydromagnesite deposits occur north of Clinton and near Atlin, both of which are also in British Columbia.

Technology

Magnesite, the carbonate of magnesia, contains theoretically 47.6 per cent MgO (magnesium oxide). It occurs in deposits of varying purity. Iron, lime and silicate minerals are the principal impurities.

Brucite, the hydroxide of magnesia, contains theoretically 69 per cent MgO.

The property both minerals have of dissociating, under increased temperature, to magnesia and a gas constituent is used in the recovery of magnesia from them.

Sea water and natural brines are today important sources of magnesia. Normal sea water contains the equivalent of 0.2 per cent magnesia. In the recovery processes, magnesium hydroxide is precipitated by lime or calcined dolomite. The hydroxide is then calcined for the market.

Two general types of magnesia are prepared commercially. Dead-burned magnesite is obtained by converting a magnesium compound at high temperature to a dense, granular, chemically inactive magnesia. It is the principal raw material for the manufacture of basic refractories. Caustic calcined magnesite, a chemically active product, is magnesia processed at a lower temperature.

Uses

Magnesia finds its greatest use in refractory manufacture. The pulp-and-paper industry now uses it in the preparation of magnesium-bisulphite dissolving liquor for the chemical treatment of wood pulp. In this treatment, magnesia and sulphur are recovered. Magnesia is also used in the production of magnesium metal and the preparation of magnesium oxychloride and oxysulphate cements. In Canada, it is used to control acidity in the processing of uranium ores.

Caustic calcined magnesite is prepared in several different grades for a number of chemical and industrial uses. It enters into the manufacture of rayon and serves as a catalyst and filler in the processing of synthetic rubber. It is consumed in the manufacture of one type of thermal steam-pipe insulation, and is also used in fertilizers and welding-rod coatings, as insulant in heating elements, as a fine abrasive, in the manufacture of magnesium chemicals and pharmaceuticals, and in other ways.

Prices

According to E & M J Metal and Mineral Markets, the United States prices of magnesite in carload lots, f.o.b. Chewelah, Washington, at the end of 1959 were:

Dead-burned grain, in bulk	$ 46
Crude	$ 27.50

MICA

J.E. Reeves*

For the first time since 1932 the annual production of mica was less than 1 million pounds; the volume produced in 1959 was 813,834 pounds, only slightly more than half that of 1958.

Imports of unmanufactured mica were nearly one-third greater. Their value, however, was about 25 per cent lower because of a decline in mica imports from India, which are of relatively high value.

Exports of unmanufactured mica were considerably higher than in the previous year but consisted mostly of rough block and scrap of relatively low unit value. Consequently, their total vorth was about one-third less than in 1958.

Producers

Nearly all the mica produced in 1959 was phlogopite, and most of it was obtained in Quebec's Gatineau Valley within a few miles of Ottawa. Blackburn Brothers Limited mined sheet phlogopite and operated a dry-grinding mill near Cantley, in Hull township. Feed for the mill was scrap phlogopite, mostly from a property near Perkins, a few miles away.

Ontario provided a very minor amount of phlogopite, mostly scrap, shipped from the Perth area, and a small quantity of muscovite sheet, shipped from the Parry Sound district.

World Review

World trade in mica is considerable because many consuming nations either have inadequate resources or lack low-cost, experienced labor. India is prominent, especially as a source of high-quality ruby muscovite. Canada imports ruby muscovite splittings for use in the manufacture of built-up sheet. Madagascar is an important source of high-quality phlogopite.

Technology

The importance of mica in industry is due to its unusual electrical and other physical characteristics. It has consistent and relatively high dielectrical properties, high temperature resistance and low thermal

(text continued on page 367)

*Mineral Processing Division

Mica - Production and Trade

	1959		1958	
	Pounds	$	Pounds	$
Production				
By shipments				
Trimmed	16,336	21,407	29,834	29,992
Sold for mechanical splittings	23,250	6,495	54,717	14,413
Splittings	-	-	-	-
Rough, mine-run or rifted	8,641	601	4,608	573
Ground or powdered	591,356	29,953	1,380,530	44,298
Scrap and unclassified	174,251	4,548	35,244	375
Total	813,834	63,004	1,504,933	89,651
Imports				
Unmanufactured				
United States	1,074,300	67,058	687,800	50,149
India	225,600	90,401	335,900	164,097
United Kingdom	21,600	1,455	12,300	852
Brazil	18,900	2,395	700	556
Other countries	-	-	11,000	1,782
Total	1,340,400	161,309	1,047,700	217,436
Manufactured				
United States		404,772		357,023
United Kingdom		22,610		25,363
Mexico		706		2,054
West Germany		-		56
Total		428,088		384,496
Exports				
Unmanufactured				
Rough				
United States	92,000	1,380	-	-
Japan	15,100	4,613	-	-
Total	107,100	5,993	-	-
Trimmed				
Japan	24,200	23,154	50,900	48,750
United States	-	-	200	850
Other countries	-	-	800	1,735
Total	24,200	23,154	51,900	51,335

Mica - Production and Trade (cont'd)

Exports (cont'd)	1959 Pounds	1959 $	1958 Pounds	1958 $
Scrap				
Belgium	160,000	6,340	-	-
United States	64,200	302	128,000	608
Japan	22,300	6,420	42,200	10,635
Total	246,500	13,062	170,200	11,243
Ground				
United States	46,000	2,760	78,000	4,253
Total unmanufactured	423,800	44,969	300,100	66,831
Manufactured				
Brazil		8,500		-
United States		70		-
Total		8,570		-

Consumption (available data only)	
Paints and wall-joint sealing compounds	2,266,000
Electrical apparatus	312,000
Rubber	516,000
Roofing	200,000
Paper	104,000
Other	224,000
Total	3,622,000

Mica - Production and Trade, 1949-59
(pounds)

	Production(1)	Imports(2)	Exports(2)
1950	3,879,209		1,975,100
1951	4,961,508		2,432,800
1952	2,014,941		1,562,300
1953	2,265,128		1,994,600
1954	1,706,770	232,700	771,200
1955	1,640,708	198,900	362,800
1956	1,843,811	324,900	277,800
1957	1,282,416	501,900	362,200
1958	1,504,933	1,047,700	300,100
1959	813,834	1,340,400	423,800

(1) Producers' shipments. (2) Unmanufactured mica.

conductivity, and its perfect basal cleavage permits it to be readily split into very thin sheets that are flexible, elastic, strong and generally transparent.

High-quality muscovite, which possesses the best dielectric properties of all types of mica, is used extensively for insulation at high frequencies and voltages and in capacitors. Its high strength and transparency make it of minor value for glazing. It may be colorless, ruby-colored, green or brown and is found in granitic pegmatites.

Phlogopite, or amber mica, varies considerably in dielectric strength, hardness, structural strength and other properties, but its thermal resistance, which is higher than muscovite's, gives it a certain limited 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 an almost complete lack of color to a deep brown.

Uses

Mica is marketed in three forms - natural sheet, splittings and ground mica.

Natural-sheet mica is used mainly 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.

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 and the product is baked and pressed into sheets of required size. 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.

Mica, frequently of lower quality, is dry-ground and used principally as a dusting powder for asphalt roofing and in the manufacture of moulded high-frequency insulators. It also finds application in protective coatings, lubricants and joint-sealing compounds and as a dusting agent for rubber tires and tubes. The wet-grinding of high-quality muscovite scrap yields a polished white powder that is used mainly as a pigment extender in paints, a filler in plastics and hard rubber, and a mould lubricant and dusting agent in the manufacture of rubber tires, as well as for its decorative effect in wall-paper.

More recently, a new form of mica insulation has been offered in the United States. It is formed by impregnating ground muscovite scrap with a resin and forming a mica paper. It can replace built-up sheet in many electrical applications.

Specifications

Natural Block Muscovite

Size and quality gradings for block muscovite conform generally to those adopted by the American Society for Testing Materials (Designation D351-57T). For grading size, this classification utilizes the area of minimum rectangle and the minimum dimension of one side; for grading visual quality, it utilizes the degree of staining by included impurities.

Natural Phlogopite Sheet

In Canada, size gradings for phlogopite sheet are expressed in terms of linear dimensions (inches), the following grades being in common use: 1 x 1 and 1 x 2, 2 x 3, 2 x 4, 3 x 5, 4 x 6, 5 x 8, and larger.

No formal quality-grading that applies specifically to phlogopite has been established, but the soft, light-colored varieties are generally regarded as having the best electrical qualities. These grade down to the darker, more brittle varieties.

Ground Mica

Mica is ground to meet the user's requirements, the only formal specification being for mica pigment. For this, a well-delaminated product with a low bulk density is required and A.S.T.M. Designation D607-42 specifies a maximum of 10 pounds per cubic foot.

Dry-ground mica is sold in a wide range of particle sizes, from as coarse as minus 20 mesh for use by some roofing companies to as fine as minus 200 mesh for other purposes. Wet-ground mica is generally at least minus 200 mesh, but there is a trend toward the greater use of finer grades.

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 limited 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	0.30 to 0.70
1 x 2	0.50 " 0.80
1 x 3	0.75 " 0.85

Prices for larger sheet, from 2 x 3 to 5 x 8, may be obtained from the buyer.

Clean scrap phlogopite sells for as much as $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 3, 1959, included:

Punch mica, per lb	$ 0.07 to $ 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

MINERAL PIGMENTS AND FILLERS

H.M. Woodrooffe*

Of the naturally occurring pigments referred to as the mineral-earth group, those composed essentially of oxides of iron find greatest application in industry. They are used as color pigments, generally in yellow and red shades, have stability and good covering power and are opaque to ultraviolet light. They are competing, however, with synthetically produced pigments of a similar chemical composition.

In many industrial processes, such as the manufacture of paper, paint, rubber and plastic products, fine-ground nonmetallic minerals are used to modify in some manner the chemical or physical properties of the product. These pulverized minerals are usually referred to as mineral fillers.

For the purpose of this review, the principal commodities reported on are iron oxide and ground marble (whiting substitute).

Iron Oxide (Ochres)

Canadian production of natural iron-oxide pigments again declined sharply in 1959. It amounted to 1,235 short tons valued at $108,286. The downward trend in production reflects a decrease in consumption due to conversion to natural gas as a domestic fuel. Formerly, purification of manufactured gas in eastern municipalities provided a market for substantial quantities of iron oxide.

Occurrence and Production

Known Canadian deposits of pigment-grade iron oxide are of the bog type believed to have been formed by the precipitation of iron oxide leached from iron-bearing rocks.

The Sherwin-Williams Co. of Canada, Limited, operates a processing plant for the production of iron-oxide pigments at Red Mill, 7 miles east of Three Rivers, Quebec. Production has been almost continuous since 1888, when Canada Paint Company established a plant at this location.

The raw oxide is obtained from deposits nearby in Champlain county. The oxide is removed from the deposits and calcined to develop the desired color. It is then ground and air-classified.

*Mineral Processing Division

Iron Oxides - Production, Trade and Consumption

	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Production (shipments)				
Natural (crude and calcined)..	1,235	108,286	1,632	113,390
Imports				
Ochres, siennas, umbers				
United States	784	75,561	642	54,801
United Kingdom............	29	2,047	27	2,245
Spain	12	964	11	498
Sweden	8	409	-	-
Total	833	78,981	680	57,544
Exports				
Natural and synthetic iron oxides				
United States	2,395	364,201	2,119	322,281
France	129	21,032	87	15,052
Netherlands	62	8,909	132	23,174
Cuba	13	2,131	16	2,745
Peru	10	1,724	12	2,056
Other countries............	15	2,703	35	5,979
Total	2,624	400,700	2,401	371,287
	1958		1957	
Consumption				
Coke and gas industries......	237	2,446	5,999	64,854
Paint industry (calcined and synthetic iron oxide)	1,826	471,356	1,895	427,289
Ochres, siennas and umbers..	158	46,511	263	88,103

Iron Oxides - Production, Trade and Consumption, 1949-59

(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
1949	13,625	1,580	3,406	3,388	8,189	2,049	260
1950	13,696	1,544	4,096	3,934	11,624	2,453	268
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			

Ochre deposits were worked in earlier years in Colchester county, Nova Scotia, and near New Westminster, British Columbia.

Pigment-grade ochre has been reported from Haliburton county, Ontario, from north of Lake Winnipegosis, Manitoba, and in Saskatchewan and British Columbia.

Uses and Specifications

Iron-oxide pigments are widely used in paints, wood and paper stains, oilcloth, linoleum, shade cloth, concrete and mortar, roofing granules, plaster, rubber, plastic, imitation leather, mastic tile and many other pigmental materials.

Permanence of color has been one of the reasons for the wide use of iron-oxide pigments in outside paints to protect large surfaces, such as those of barns, railway buildings and rolling stock. These pigments have proven useful in protecting metal and are used in metal-priming and ship-bottom paints.

Natural iron oxide as a paint pigment should be virtually free of grit (particles above 325-mesh) and water-soluble salts. Pigments of this type are resistant to alkali and consequently are used in coloring portland cement, mortars and artificial stone.

Red iron oxide is also used to color fertilizer.

Other iron-oxide materials that are not of pigment grade are mined, air-dried and used to extract hydrogen sulphide and other undesirable constituents from manufactured gas. A similar use is found in some of the older types of refineries, where natural gas is cleaned by being passed through columns filled with wood chips coated with iron oxides.

Certain grades of iron oxide are processed by grinding and sizing into jeweller's rouge for metal- and glass-polishing. Other grades (e.g., sienna and umbers) are used principally in the preparation of stains for treating wood and paper.

A number of standard tests have been developed with the object of eliminating the human factor in assessing pigments, but they have not been altogether successful. In the final analysis, the appraisal of a pigment is a matter of experience. The most important properties are mass color, tinting strength, particle size, oil-absorption, opacity and hiding power, and chemical composition. Mass color and tinting strength have to do with the comparison of color with a standard and refer to color, respectively, when it is rubbed out with a specified amount of oil and when it is diluted with standard amounts of zinc-oxide oil paste. The physical properties are more important than the chemical composition.

The specifications for air-dried oxide to be used in gas purification are not rigid with respect to iron content, grain size or silica content, but the proportion of clay must be kept to a minimum because it tends to pack and clog the purification chambers.

Prices

No published prices for Canadian ochres are available. Georgia ochre was quoted at the end of 1959 by E & M J Metal and Mineral Markets at $26.50 to $32 a ton bagged, f.o.b. mines.

Other Pigments

Synthetic iron oxides have replaced natural ochres in much of the paint-pigment market. These oxides are also the principal raw material in the growing use of ferrites as magnetic compounds.

Canada has a large producer of synthetic iron-oxide pigments. It is at New Toronto, Ontario, and is operated by Northern Pigment Co., Limited.

At Varennes, Quebec, titanium-dioxide pigments are being produced by Canadian Titanium Pigments Limited from titania slag, a product of Quebec Iron and Titanium Corporation. British Titan Pigments Co. Ltd. is establishing a similar facility at Sorel to convert 15,000 tons of slag a year to pigment.

Whiting Substitute

In industry the term 'whiting' is often applied to a fine white powder of calcium carbonate derived from chalk, marl, limestone or marble or from a precipitate in a chemical process. More specifically, true whiting is prepared by grinding chalk to a suitable particle size. Chalk is a white, friable, fine-grained type of limestone composed of the residue of microscopic marine organisms. 'Whiting substitute' is a term applied to a white powder prepared by fine-grinding marble or limestone. In Canada this material is sometimes termed domestic whiting or marble flour. Marl, when of suitable color and free of organic impurities, is an acceptable source of whiting substitute, but there has been no production in Canada from marl for several years.

The production of whiting substitute decreased slightly in 1959 to 11,633 tons valued at $140,873. The principal source of this commodity is a deposit of white marble near Bedford, Missisquoi county, Quebec. British Columbia recorded a small output.

There is no production of true whiting in Canada. It is imported from the United States, the United Kingdom and France.

Whiting - Production, Imports and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
Stone processed for whiting...	11,633	140,873	11,900	143,977
Imports				
Whiting, gilders' whiting and paris white				
United States	4,524	197,338	4,830	219,604
United Kingdom	3,134	53,840	3,603	56,999
France	2,664	22,520	2,688	17,867
Total	10,322	273,698	11,121	294,470
	1958		1957	
Consumption*				
Ground chalk, whiting and whiting substitute				
Explosives	397		371	
Medicinals and pharmaceuticals	106		95	
Paints and varnishes	15,545		12,686	
Soaps	30		41	
Toilet preparations	17		15	
Electrical apparatus	551		519	
Linoleum and oilcloth	8,162		7,591	
Rubber goods	9,789		8,327	
Tanneries	253		234	
Gypsum products	26		73	
Adhesives	179		120	
Asbestos products	48		45(e)	
Pulp and paper	1,271		421	
Miscellaneous chemicals ...	854		800(e)	
Miscellaneous	40(e)		36	
Total	37,268		31,374	

* Includes some ground limestone.

(e) Estimated.

Whiting - Production, Imports and Consumption, 1949-59
(short tons)

	Production	Imports	Consumption*
1949	15,657	19,361	24,238
1950	17,603	21,336	26,110
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	

* Includes some ground limestone.

Use

True whiting originating in England is referred to commercially as a paris white, gilders' whiting or ground cliffstone.

Whiting is an important raw material in the manufacturing processes of a number of industries. True whiting, which improves opacity, and whiting substitute are used in formulating cold-water paints. In this application whiteness, fine-particle size and freedom from grit are the main characteristics.

In the manufacture of oil paint, both types of whiting are used as extender pigments. They have the bulk density, color, oil-absorption, fineness and chemical composition that are among the important properties required for this use. Whiting is also the principal ingredient in putty.

Whiting is used in large quantities as a filler in rubber products, chemical composition being extremely important in this application. Some whitings are chemically treated to improve dispersibility in the rubber mix. Whiting is used as a filler in linoleum, oilcloth, polishes, paper, cleaning compounds and the moulding of plastics. In these uses color, particle size and shape, and absence of grit are generally of primary importance.

True whiting is used by the ceramic industry in glazing and in the manufacture of whiteware.

Other Mineral Fillers

In various industrial processes in Canada, a number of other non-metallic mineral fillers are used to impart the desired properties to the product. These include pulverized limestone, china clay, diatomite, barite, nepheline syenite, feldspar, talc and soapstone. Information on these minerals will be found in the appropriate reviews in this series. All the foregoing except china clay and diatomite are produced in Canada.

NEPHELINE SYENITE

J.E. Reeves*

Shipments of nepheline syenite in 1959 established a new high increasing by nearly 14 per cent in volume and more than 12 per cent in value over the shipments of 1958. Exports, similarly, were at the highest level in the history of the industry, with increases over those of the previous year of approximately 11 and 12 per cent in tonnage and value, respectively. The United States continued to be the predominant consumer, taking considerably more than in any previous year despite strong competition in some regions from a large feldspar industry. The main domestic consumer is the glass industry of eastern Canada, which has virtually replaced feldspar with nepheline syenite.

Producers

All production comes from the large Blue Mountain deposit in Methuen township, Peterborough county, southeastern Ontario. American Nepheline Limited continued to operate its quarry and 600-ton mill at Nephton in the southwestern part of the deposit. International Minerals & Chemical Corporation (Canada) Limited operated a quarry and mill at the northeastern end of the deposit and during the year increased the capacity of the mill approximately 50 per cent over the previous rate of 300 tons a day.

Other Canadian Occurrences

There are nepheline-bearing rocks in many localities in Canada. In Ontario, other deposits of nepheline syenite occur in the Bancroft and Gooderham areas of the southeast, in Bigwood township northeast of Georgian Bay and at Port Coldwell on the north shore of Lake Superior. Each of these areas has been investigated to some extent as a source of marketable nepheline syenite, and prior to 1942 minor, intermittent production came from some of the deposits near Bancroft and Gooderham. In Quebec, nepheline syenite occurs in the Labelle-L'Annonciation area, and in British Columbia, in the Ice River area south of Field.

In addition, in many places in Quebec and Ontario, there are deposits of complex alkaline rocks in parts of which nepheline is relatively common. These appear to be of no interest as commercial sources of nepheline-rich products.

---

*Mineral Processing Division

Nepheline Syenite - Production, Exports and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)	228,722	2,930,932	201,306	2,613,446
Exports (crude and processed material)				
United States.........	170,094	2,213,938	152,862	1,977,523
United Kingdom	4,788	74,844	4,084	64,274
Puerto Rico	900	13,500	1,650	30,105
Dominican Republic...	775	14,722	392	5,205
Other countries	1,563	28,337	1,093	21,314
Total	178,120	2,345,341	160,081	2,098,421

Consumption(domestic)*	1959 Short tons	1958 Short tons	1957 Short tons
Glass..................	27,573	19,279	15,806
Stone products (mineral wool etc.)		4,886	5,227
Clay products etc.	2,453	2,579	2,345

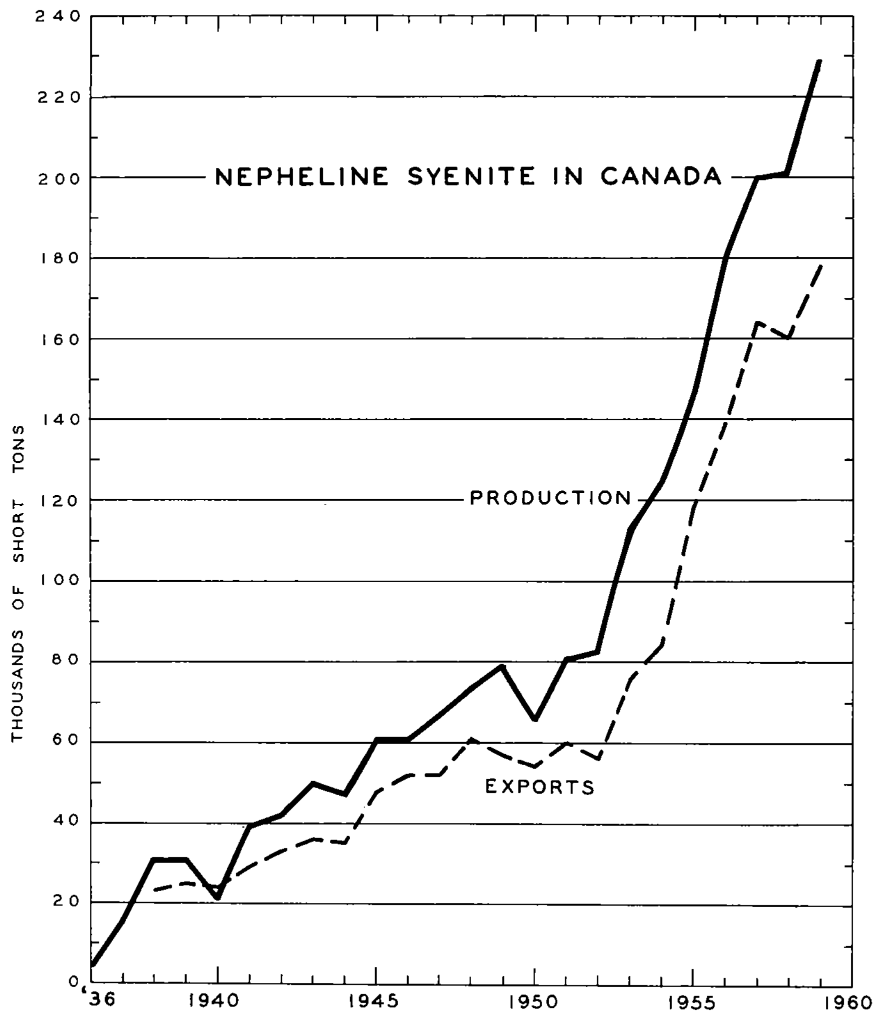
*Available data.

Foreign Occurrences

Deposits of nepheline syenite occur in the United States, particularly in New Jersey and Arkansas. It has not been possible, however, to reduce the iron content of these rocks sufficiently for the production of a ceramic raw material. Nepheline syenite from near Little Rock, Arkansas, is used in the manufacture of roofing granules.

Deposits also occur in Norway, India, Korea and Peru. A deposit in the northern part of Norway, between Alta and Hammerfest, has commercial potential and has been considered as a possible source of marketable nepheline products.

Russia is the only other producer of a ceramic raw material containing abundant nepheline. A huge deposit of apatite-nepheline rock, located near Kirovsk in the Kola peninsula, is being mined on a large scale for apatite, with nepheline as a by-product. This nepheline is used in the ceramics industry and also as a source of aluminum. Other deposits with a high nepheline content are reported to occur in the area west of Lake Baikal in eastern Siberia.



SOURCE: D.B.S.

MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Technology

Nepheline syenite is a quartz-free crystalline rock consisting principally of nepheline (an aluminum silicate with sodium and a minor proportion of potassium), soda feldspar and potash feldspar. It has an industrial application because of a relatively high content of alumina and total alkali (sodium plus potassium) and because of its firing properties. To be of commercial interest, it must be amenable to treatment for the removal of iron-bearing impurities such as magnetite, biotite, and hornblende. In Canada, high-intensity magnetic separation is used to reduce the iron-oxide (Fe_2O_3) content from between 1.5 and 2 per cent in the mill feed to less than 0.1 per cent in the finished product. Dry milling methods are used throughout the processing.

Uses and Specifications

Nepheline syenite finds its major uses in the ceramics industry, the largest proportion being consumed in the manufacture of glass products. In glass batches it provides a higher proportion of alumina than does the same amount of feldspar and it gives a comparatively high alkali content. It is important also for its relatively low melting temperature. A particle size of essentially minus 30 mesh, U.S. standard, with a minimum of fines - not more than 8 per cent minus 200 mesh - is specified. For the most part, a low Fe_2O_3 content is required.

In the whiteware industry (which produces sanitaryware, floor and wall tile, electrical porcelain, semivitreous ware, low-temperature vitreous ware, dental porcelain and similar commodities), it is used in both the body and the glaze. It is more fusible and is a more active flux than potash feldspar, and this permits either a lower firing temperature or the use of a smaller amount of this vitrifying agent. The use of a lower firing temperature can result in savings in refractory and fuel costs. Size specifications call for all material to be minus 200 mesh and a certain proportion (from 95 to 100 per cent, according to the end product) to be minus 325 mesh. For some uses an excess amount of fines is not desirable, and thus control of particle size distribution is important. An Fe_2O_3 content of less than 0.1 per cent is necessary.

In porcelain enamels for sheet steel and cast iron, nepheline syenite gives good results as a frit ingredient, chiefly because of its low fusion temperature. For cover coats, specifications are similar to those for whitewares.

Finely ground material is used as an extender pigment in paints.

Cheaper, lower-grade by-products, which differ only in having a higher iron content, are used in colored glass, ground-coat enamels, structural-clay products and glass fibre, as a body and glaze additive in the manufacture of sewer pipe and in other manufactured products in which the higher iron content is of no importance. Some crude is sold for use in the manufacture of mineral wool for insulation purposes.

Prices

Prices of nepheline syenite, per short ton, in bags, by carload lot, f.o.b. works, according to Canadian Chemical Processing of October 1959, are:

Glass grade	$15.00
Finely ground grades	$21.50 to $28.00
By-product grade	$12.00

PHOSPHATE

J.E. Reeves*

There has been no production of phosphatic raw material in Canada for many years. Ontario and Quebec deposits of apatite, which is essentially calcium phosphate, have been investigated, but no production has resulted. During 1959, additional diamond-drilling by Multi-Minerals Limited on its property near Nemegos, Ontario, resulted in larger estimated reserves of apatite than had been previously calculated for these deposits.

During the year, almost 800,000 short tons of phosphate rock were imported. An all-time maximum for this commodity, these imports were 7 per cent over the corresponding 1958 total. The value was approximately 9 per cent higher. All except about 6,000 tons originated in the United States, Florida supplying eastern Canada, and Montana and Idaho the western part of the country. Montana Phosphate Products Company, a subsidiary of The Consolidated Mining and Smelting Company of Canada Limited, mines sedimentary phosphate rock near Garrison, Montana, and ships it to the parent company's fertilizer plants at Trail and Kimberley, British Columbia.

There is a considerable trade between Canada and other countries in phosphate fertilizers. In 1959, imports into eastern Canada declined slightly compared with those of 1958. Their value, however, increased because they included a large proportion of the higher-priced triple superphosphate. New production facilities at Port Maitland, Ontario, may eventually result in a reduction of these imports. Exports of phosphate fertilizers, which went mainly to the northwestern United States, were slightly higher than in 1958.

Electric Reduction Company of Canada, Limited, produces elemental phosphorus, phosphoric acid and phosphorous compounds from sedimentary phosphate rock imported from Florida. A new plant was under construction in 1959. During the year, more than $1 million worth of phosphoric acid and phosphorous compounds was imported.

Occurrences and Production

Almost all the phosphate mined in Canada has consisted of the mineral apatite. An apatite-mining industry flourished from 1878 to 1892 and then declined sharply as the large sedimentary deposits in Florida were developed. A peak was reached in 1890, when more than 31,000 tons were produced, but since 1894 production has seldom exceeded 1,000 tons. The last shipment was made in 1951.

*Mineral Processing Division

Phosphate - Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Imports				
Phosphate rock				
United States	790,878	7,125,909	740,822	6,672,681
Belgium	5,446	298,152	3,342	181,562
Japan..............	739	44,307	-	-
Total..............	797,063	7,468,368	744,164	6,854,243
Phosphate fertilizers				
Triple superphosphate				
United States	63,828	2,861,567	44,248	2,019,957
Belgium	500	23,741	-	-
Total..............	64,328	2,885,308	44,248	2,019,957
Superphosphate not otherwise provided				
United States	142,143	2,605,896	168,459	3,211,138
Netherlands	-	-	4,998	80,981
Total..............	142,143	2,605,896	173,457	3,292,119
Phosphate fertilizer not otherwise provided				
United States	3,985	273,386	3,325	235,208
Total, phosphate fertilizers	210,456	5,764,590	221,030	5,547,284
Phosphoric acid and phosphorous compounds	5,886	1,181,075	4,576	938,567
Exports				
Phosphate-nitrogen fertilizers				
United States		20,156,947		18,280,570
Colombia		1,561,537		1,257,452
Korea		510,864		655,961
Hawaii		215,248		142,381
Philippines		162,169		471,450
Other countries		287,346		231,591
Total..............		22,894,111		21,039,405

Phosphate - Trade and Consumption (cont'd)

	1958 Short tons	1957 Short tons
Consumption of phosphate rock (available data)		
Fertilizers	583,584	584,216
Chemicals..............................	115,556	114,265
Stock and poultry feed	29,766	24,234
Total	728,906	722,715

Phosphate Rock - Production, Imports and Consumption, 1949-59

(short tons)

	Production	Imports	Consumption
1949	20	620,808	429,528
1950	129	491,026	488,237
1951	6	499,711	519,143
1952	-	470,913	511,757
1953	-	576,500	512,090
1954	-	644,860	628,061
1955	-	588,209	585,326
1956	-	627,648	552,646
1957	-	723,220	772,715
1958	-	744,164	728,906
1959	-	797,063	786,266

Apatite is commonly found, together with phlogopite, in irregular deposits in association with pyroxenites in southeastern Ontario and southwestern Quebec. Quebec has contributed almost 90 per cent of the nearly 350,000 tons of apatite produced in Canada since 1870, when production was first reported. Most of Quebec's production came from deposits in Buckingham and Portland townships in the Lièvre River valley, and from Templeton and other adjacent townships to the west. In Ontario, mines in North Burgess, Loughborough and Bedford townships, in the area between Perth and Kingston, were the main producers.

Apatite is relatively abundant in some of the alkaline rock complexes that occur in parts of Ontario and Quebec. Of particular note is the Nemegos area, about 150 miles northwest of Sudbury in northern Ontario, where extensive zones contain about 20 per cent apatite. It also occurs as an essential constituent in some titaniferous magnetite deposits, which are associated with anorthosite. There is a notable occurrence on the north shore of the Saguenay River near Arvida, Quebec.

Some sedimentary phosphate rock occurs between Banff, Alberta, and the Crowsnest-Fernie area of southeastern British Columbia. From 1927 to 1934, The Consolidated Mining and Smelting Company investigated deposits, especially near Crowsnest, as a source of raw material for fertilizer, but these proved to be of low grade and only about 4,000 tons were shipped.

World Production

Most of the world supply of phosphate rock comes from sedimentary deposits of marine origin, frequently referred to as phosphorites; approximately 12 per cent is derived from deposits of apatite and a minor amount from guano deposits.

World production in 1959 was probably in excess of 36 million long tons, or appreciably above the estimated 34.8 million long tons produced in 1958. The largest producer was the United States, with about 15 1/2 million long tons of sedimentary rock, over 70 per cent of which originated in Florida. Other major sources of sedimentary phosphate rock were North Africa (particularly Morocco and Tunisia), Nauru and other islands in the southern Pacific, and Russia. Deposits in Russia, Chile and India have supplied apatite. Russia's source, unusual deposits of apatite-nepheline rock in the Kola peninsula, provides about two thirds of that country's phosphate output. There is considerable world trade in phosphate.

Technology

Phosphate (either the sedimentary rock or primary apatite) is the source of phosphorus, an essential constituent in plant and animal life. Phosphorus is supplied to plants by the addition of certain fertilizers to the soil. Superphosphate, one of the commonest of these fertilizers, has an 18- to 22-per-cent content of available P_2O_5 (phosphorus pentoxide). It is manufactured by treating phosphate rock with sulphuric acid. Triple superphosphate is produced by acidulating phosphate rock with phosphoric acid. It contains 45 to 48 per cent P_2O_5 and is more important where high transportation costs are concerned. These fertilizers can be used separately or they can be blended with compounds containing nitrogen and potash to produce mixed fertilizers. Ammonium phosphate is manufactured by adding ammonia to phosphoric acid, generally wet-process acid produced by acidulating phosphate rock with sulphuric acid in much the same way as in the manufacture of superphosphate. Ammonium phosphate provides nitrogen as well as phosphorus.

High-purity elemental phosphorus is manufactured by fusing a mixture of phosphate rock, silica and coke in an electric furnace. From this, phosphoric acid and numerous phosphorous compounds are produced.

Canadian apatite would be generally acceptable as a phosphatic raw material if the mineral supplied could be competitive with currently imported phosphate rock and if considerable reserves were available. It is not as amenable to acid treatment as the open-textured sedimentary rock but could be acidulated if ground very fine. In furnace treatment, highly concentrated apatite would permit a smaller feed with lower temperatures and less slag than are possible with sedimentary phosphate rock.

Uses and Specifications

About three quarters 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 compounds and as a feed supplement for livestock and poultry.

Compounds of phosphorus 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. Compounds 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.

Chemical analyses of phosphate rock are 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).

For electric-furnace use, phosphate rock should contain a minimum of about 70 per cent B.P.L. and a maximum of 1 per cent Fe_2O_3, and should be as coarse as possible to facilitate the furnace treatment. For fertilizers, it should contain about 74 to 75 per cent B.P.L. Particle size does not matter because it must be ground fine before further treatment.

Prices and Tariffs

According to E & M J Metal and Mineral Markets of December 3, 1959, 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
	($)	($)
77 to 76	8.21	10.00
75 " 74	7.21	9.00
72 " 70	6.21	8.00
70 " 68	5.56	7.50
68 " 66	5.16	6.85

Phosphate rock enters Canada duty-free.

POTASH

C. M. Bartley*

Potash* production started in Canada during the latter part of 1958, but water problems in the shaft of Potash Company of America, Ltd., near Saskatoon, caused the mining and milling operation to be shut down for several months while the shaft was being repaired.

In spite of the problems encountered by this company and expected by others, there is no doubt that continuing efforts will result in solutions to present difficulties. The Saskatchewan deposits are the largest and richest known potash occurrences in the world. The only other significant North American source, in New Mexico, has been in large-scale production for 30 years and now has only limited reserves of lower-grade ore. World potash consumption has been increasing at about 5 per cent annually and there is every reason to expect that this rate will be maintained and that it will probably increase.

Consequently, the industry expects that by 1961 two plants will be in large-scale production in Saskatchewan and that by 1970 several more will be in operation or under construction there.

Deposits

Potash occurs in several reasonably continuous and consistent layers in the upper part of the Prairie Evaporite formation of Devonian age that underlies southern Saskatchewan and adjacent parts of Manitoba and Alberta. The Prairie Evaporite is a basin structure, largely of salt, which trends northwest-southeast and is tilted gently to the southwest. Portions of the salt and potash deposited in the original structure have been removed by solution, but these sections form only a small part of the basin, the main barren part being at depths of more than 5,000 feet in the southern part of the province.

The shallowest potash occurrences are found along a line that runs approximately through Binscarth, in Manitoba, and Yorkton, Saskatoon and Unity, in Saskatchewan. Going westward, the potash horizon becomes progressively deeper, dropping from 2,500 feet at Binscarth to about 3,500 near

---

*'Potash' is the name used in trade to describe any material containing the element potassium, regardless of its composition. The potash value is expressed as the equivalent of the oxide (K_2O) content.

---

*Mineral Processing Division

Unity in a line that represents the northern edge of the potash zone. Southward, the beds also become progressively deeper, dipping to 7,000 feet at Saskatchewan's southern boundary. The main potash minerals are sylvite (KCl) and carnallite ($KCl.MgCl_2.6H_2O$). Minor amounts of other potash minerals have been noted but are not economically important. In addition to the salt (NaCl) that encloses the potash, varying amounts of gypsum, anhydrite and insoluble clay minerals are found, particularly in the western and central deposits.

Production and Trade

The potash produced by Canada during 1959 was valued at $1,408,462. Part of this production was consumed in eastern Canada and part was exported to Japan and the United States. In each case, it was used in fertilizer.

Potash - Production and Imports

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
K_2O content		1,408,462	-	-
Imports				
Potash fertilizers				
Muriate of potash				
United States	54,790	1,289,437	78,791	1,650,329
France	16,269	382,548	24,934	676,037
West Germany	18,752	482,978	21,465	597,340
U.S.S.R.	5,488	127,091	6,050	164,174
Israel	-	-	65	1,834
Total	95,299	2,282,054	131,305	3,089,714
Sulphate of potash				
United States	14,542	496,779	9,033	319,242
France	6,105	180,598	4,581	170,281
West Germany	4,095	137,634	1,925	66,704
Total	24,742	815,011	15,539	556,227

Potash - Production and Imports (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Sulphate of potash magnesia				
United States	4,451	72,250	2,728	50,393
West Germany	-	-	400	10,725
Total	4,451	72,250	3,128	61,118
Total, potash fertilizers	124,492	3,169,315	149,972	3,707,059
Potash chemicals and compounds				
Potash and pearl ash	456	76,626	365	62,075
Potash, bichromate, crude	132	43,340	137	44,877
Potash, caustic	4,243	428,398	4,419	459,775
Potash, chlorate, ground	43	12,590	41	12,251
Potash, red or yellow prussiate	8	5,884	12	7,169
Potash, nitrate, or saltpetre	741	104,161	680	81,757
Cream of tartar in crystals	190	99,958	149	75,825
Potassium cyanide	89	59,386	67	45,750
Potash chemicals not otherwise provided	4,827	1,000,913	3,301	769,240
Total, potash chemicals and compounds	10,729	1,831,256	9,171	1,558,719

Less potash was imported into Canada than in 1958 because part of the domestic requirements were filled from Saskatchewan production. Imports for use in fertilizers amounted to 124,492 short tons valued at $3,169,315 and imports of potash chemicals and compounds, at 10,729 short tons valued at $1,831,256, were higher than in 1958.

Among potash chemicals, as in previous years, caustic imports were greatest in amount and value. During the year, it was announced that in 1960 Canadian Industries Limited would produce caustic potash at its Cornwall works and that The Consolidated Mining and Smelting Company of Canada Limited planned to produce caustic potash at an alkali-chlorine plant being built at Trail, British Columbia. These two operations will probably supply all Canadian requirements for caustic potash and make imports unnecessary. Numerous other potash chemicals and compounds are imported in small amounts, but their individual consumption is normally too small to make manufacture in Canada profitable.

Potash Operations in Canada

Development work for the recovery of potash from the Saskatchewan deposits has been in progress since 1953, when Western Potash Corporation Limited* started to sink a shaft near Unity, Saskatchewan. Although the deposits are deeper than any others now in production, the depth itself is not a serious problem. The Blairmore formation, however, a 200-foot-thick layer of fine sand and shales with water under high pressure, at depths of 1,200 to 1,700 feet, is a major problem in shaft-sinking and mining. Since potash is highly soluble, and since water consequently cannot be permitted to enter the workings, potash mining in Saskatchewan depends on sinking shafts through the wet Blairmore to the potash horizon without allowing water to reach the potash.

Potash Company of America, Ltd.

After some early investigation of brining methods by Western Potash Corporation Limited,* the first large-scale attempt at mining was initiated by Potash Company of America, Ltd., near Saskatoon in 1957. The 16-foot-diameter, concrete-lined circular shaft sunk through artificially frozen ground to immobilize the water was completed in June 1958. By the following November, underground development was under way and the mill was processing a limited tonnage resulting from this work.

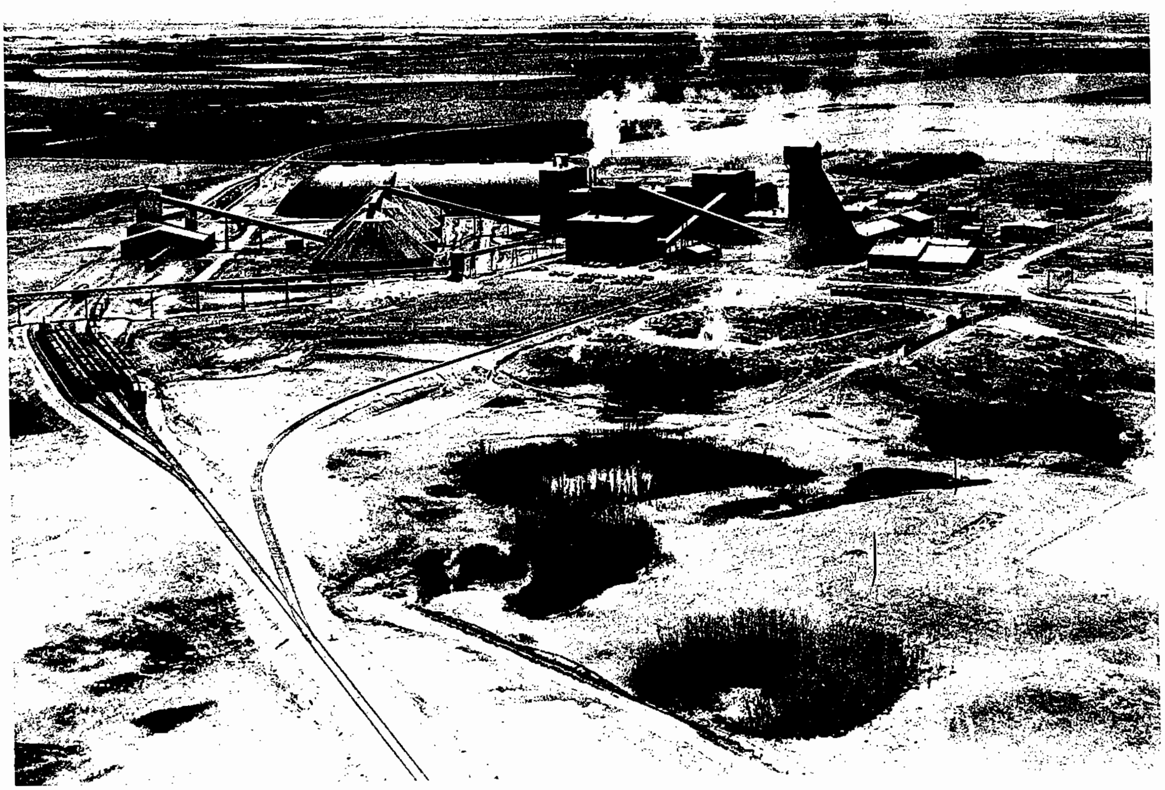
The difficulties presented by the Blairmore formation are unusual in Canadian mining experience and difficult to solve. The development schedule of Potash Company of America, Ltd., has been delayed and additional expenditures have been required to solve these problems, but in spite of the difficulties the company is expected to be the first to reach full-scale production. The experience gained by Potash Company of America, Ltd., in solving these engineering and technical problems will be of considerable value both to this company and to others that undertake potash mining in Saskatchewan.

During the latter part of 1958 and the first 10 months of 1959, potash was mined and processed on a limited basis as the underground development provided ore and as machinery for underground and milling operations was tested and adjusted. Mine production during this period was not sufficient to test the mill at full capacity, but during 1959 potash valued at $840,000 was shipped to consumers in Canada, the United States and Japan.

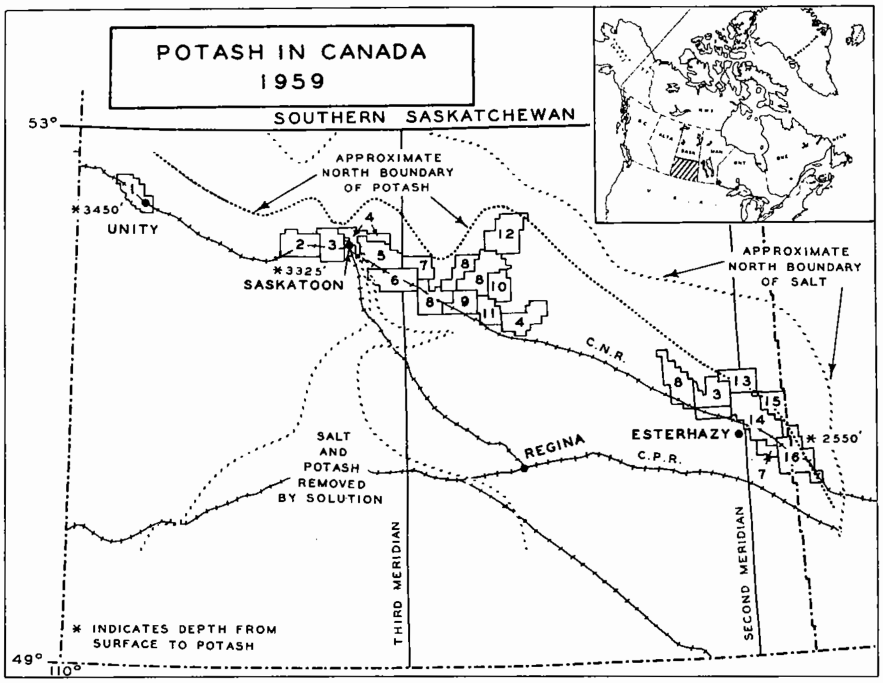
International Minerals & Chemical Corporation (Canada) Limited

This company started exploration in Saskatchewan in 1955 and in 1957 began to sink a shaft and build a large processing plant just east of Esterhazy, near the Saskatchewan-Manitoba boundary. Potash deposits in this area are

*Name changed to Continental Potash Corporation Limited Sept. 16, 1955.



Potash mine and mill, Saskatoon, Saskatchewan.



1. Continental Potash Corporation Limited
2. National Potash Company
3. Duval Sulphur and Potash Company
4. Southwest Potash Corporation
5. Potash Company of America, Ltd.
6. United States Borax and Chemicals Corporation
7. Low and Morrow
8. Alwinsal Potash of Canada Limited
9. Commonwealth Potash and Chemicals Limited
10. Sturgeon Petroleums Ltd.
11. General Petroleums of Canada Limited
12. Honolulu Oil Corporation
13. Canadian Amco Limited
14. International Minerals & Chemical Corporation (Canada) Limited
15. Canberra Oil Company
16. S. A. M. Explorations Ltd.

found at depths of about 3,200 feet and are generally considered attractive since they are of good grade, contain relatively small amounts of insoluble material and are overlain by thicker-than-average rock salt, which is expected to provide a suitable roof for mining.

After an 18-foot-diameter, concrete-lined shaft had been sunk to the top of the Blairmore by standard methods, an attempt was made to immobilize the water-bearing Blairmore sands by using a chemical sealant. This method has several advantages over the freezing technique, but it was not completely satisfactory at Esterhazy and has been abandoned in favor of the slower but more certain freezing method. After observing the problems encountered by Potash Company of America, Ltd., International Minerals & Chemicals Corporation (Canada) Limited slowed its construction schedule to permit the installation of other safeguards.

German potash-mining companies have found that salty and sulphate-bearing waters under pressure have a highly corrosive and deteriorating effect on concrete and that, in extreme cases, no type of concrete is completely satisfactory as a reliable seal against such corrosive action. For these reasons many German mines used cast-iron shaft linings in sections where such waters were encountered. The added cost of these installations has been justified by the protection they afford against leakage and deterioration of the shaft wall.

To guard against shaft problems of this nature, International Minerals & Chemicals Corporation (Canada) Limited announced late in 1959 that it planned to install cast-iron 'tubbing' through the Blairmore formation. These changes will delay the construction schedule. The shaft area is to be frozen to -50°F so that all water will be immobilized, and sinking will then continue. Below the Blairmore a multiplatform sinking stage will be used to speed progress by the simultaneous mucking, hoisting and pouring of concrete walls.

The shaft is expected to be completed by June 1961 and, as mining development opens up ore, milling will begin at 1,200 tons a day and later increase to 6,000 tons a day.

Continental Potash Corporation Limited

This Canadian company has a 12-foot-diameter shaft sunk to the 1,675-foot level on its property just west of Unity, near the Alberta-Saskatchewan boundary. The company, originally named Western Potash Corporation Limited, was reorganized in 1957. By the end of 1959 it was making changes in surface installations and at the top of the shaft and had announced plans to resume sinking during 1960 to the potash horizon at 3,460 feet.

An early core intersection in this area showed about 11 feet of ore with a grade of more than 21 per cent K_2O.

Alwinsal Potash of Canada Limited

A subsidiary of German and French potash interests, Alwinsal holds two permit areas and one withdrawal area and during 1959 drilled 14 holes for potash exploration. With adequate experience in potash mining, processing and marketing, the company is well qualified to conduct underground development and surface milling for a large-scale potash operation.

Continuous exploration carried on over the past three years has provided information on which a decision for the location of an underground mine could be based. It is expected that Alwinsal will be one of the companies to announce underground development plans in the near future.

United States Borax and Chemical Corporation

This company, which operates mines and processes potash in the Carlsbad area of New Mexico, is the only one in the United States that processes mined potash by hot solution rather than flotation. In 1955 it began core-drilling for potash in Saskatchewan and by early 1959 it had completed 17 deep holes. The company has not reported results in detail or announced definite plans for underground development but is believed to have accumulated sufficient information to plan and construct a mining and processing plant in Saskatchewan. Difficulties in sinking through the Blairmore in Saskatchewan and the fact that the company has some reserves of good ore in New Mexico have, however, delayed the decision to start underground development in Saskatchewan. At the end of 1959, it seemed doubtful that United States Borax and Chemical Corporation would start work within a year, although it was expected to undertake active development at a later date.

Other Companies

At the end of 1959, the other companies holding potash land rights in Saskatchewan and having varying amounts of exploration work to their credit were the following: Southwest Potash Corporation and Canadian Amco Limited, both subsidiaries of American Metal Climax Inc.; Duval Sulphur and Potash Company; National Potash Company, owned jointly by Freeport Sulphur Company and Pittsburg Consolidated Coal Company; Canberra Oil Company Ltd.; Tombill Mines Limited, a Canadian company that has optioned the property of S. A. M. Explorations Ltd. on the Saskatchewan-Manitoba boundary; Sturgeon Petroleums Ltd.; Honolulu Oil Corporation; Commonwealth Potash and Chemicals Limited; and Low and Morrow, consulting geologists.

In addition to companies interested in conventional mining, there are companies that continue to show interest in the possibility of recovering potash by brining methods. Development of brining methods that could be applied to the deeper deposits (i.e. those below 5,000 feet and possibly those narrow high-grade layers not considered suitable for mining) would immediately increase the available reserves in Saskatchewan by a very large amount and might result in larger and lower-cost production. Early solution, however, of the problems connected with the sinking of satisfactory shafts through the Blairmore would probably divert attention from this method.

World Review

Production schedules in the Carlsbad area of New Mexico were planned with the expectation that Potash Company of America, Ltd., at Saskatoon, would reach full-scale production during 1959. Because of the delay due to shaft repairs, Saskatchewan production was much lower than expected, and this, in addition to an increase in demand for potash, resulted in intensified activity at Carlsbad. All the United States companies in New Mexico and California have increased production to supply customer requirements.

In the United States in 1959, as in almost every year since 1930, production increased. It totalled 2,383,000 short tons. Exports, at more than 337,000 tons, and imports, at about 234,000 tons, were also higher than in 1958. Two thirds of United States exports went to Japan. Imports were largely from West Germany and France, and there were smaller amounts from Spain, the Union of Soviet Socialist Republics and Canada. East Germany stopped shipping to the United States early in 1959.

West Germany, the second producer, exports large amounts of potash. France, the U.S.S.R., Spain and Israel produce considerable quantities. Minor amounts are produced in such other countries as Chile, Japan and China, and potash reserves are known to exist in many other countries although most are not economically workable at present.

East Germany, the third-ranking producer of potash, has an output of about 2 million tons of K_2O a year and is reported to export 1 million tons a year to 43 countries. It has ceased shipping to the United States in order to serve Communist-bloc and Middle East consumers.

During 1959, Delhi-Taylor Oil Corporation continued development drilling on a reportedly good-grade deposit of potash at a depth of 2,000 feet in eastern Utah. Lack of established transportation, however, and rough topography that may result in differential loading in the mining area have so far delayed development of the deposit.

Core-drilling was also conducted during 1959 on a deep salt-and-potash deposit in Denmark. Two shafts to depths of almost 3,000 feet would be necessary to produce 600,000 tons annually. Recent reports indicate that the economics of the project are not at present certain. The grade of the potash has not been reported.

East Germany is believed to be the leading exporter of potash, selling throughout Europe, Communist countries and the Middle East at prices reported to be lower than those of western European producers.

The U.S.S.R. is known to export considerable amounts of potash. In 1958 it exported more than 430,000 tons, mostly to Free World nations. Two of its potash areas are in Byelorussia, at Soligorsk, and just west of the Ural mountains, at Solikamsk.

Open-pit mining has started at the San Cataldo kainite ($MgSO_4.KCl.3H_2O$) deposit in Sicily. The Montecatini Company will operate two open pits to produce 3,000 tons daily.

China is known to have potash reserves, but they are believed to be small in relation to domestic requirements. It has been estimated that production of potash fertilizers in China during 1959 amounted to about 200,000 tons. In 1958, large deposits of kainite were found in the Charhan Lake area of Tsinghai province, and potash is now being recovered there.

Uses and Specifications

Approximately 95 per cent of the potash consumed is used in agriculture - usually in mixed fertilizers. Such fertilizers are combinations of nitrogen, phosphate and potash with various fillers, and the percentages of the main ingredients, which are always listed alphabetically, are shown by three numbers - for example, 7-7-7. Most fertilizer potash is consumed as potassium chloride of various concentrations, but some crops and some soils require other forms such as potassium sulphate.

The need for chemical fertilizers is increasing as populations grow and living standards rise in the less developed countries. This is particularly true at present, when the economics of agriculture demand larger yields from smaller acreage.

Small amounts of potash are used in the manufacture of potash chemicals for industrial and consumer use. For chemical use, the concentrate supplied by mining companies is refined to high purity and made into potassium hydroxide, chlorate, carbonate, nitrate and other compounds. These are used in the manufacture of soap, glass, textiles, matches, explosives and a variety of consumer products and fine chemicals.

Potash for the manufacture of fertilizer is usually a 96-98 per cent concentrate of potassium chloride. It is marketed in several grain sizes to meet customer requirements. For this material, physical specifications of size and uniformity are important. A concentrate of greater than 99-per-cent purity is produced for chemical purposes by removal of such impurities as iron and magnesium.

Prices

The Oil, Paint and Drug Reporter for December 23, 1959, quoted United States prices for agricultural potash as follows:

	*	**
Potassium, agricultural muriate		
Standard		
Bulk, carload, works, unit-ton	$ 0.32	$ 0.34
Bagged, 60% min. K_2O, same basis, ton	$24.10	$25.30
Granular		
Bulk, carload, works, unit-ton	$ 0.32 1/2	$ 0.34 1/2
Bagged, 60% min. K_2O, same basis, ton	$24.40	$25.60
Potassium sulphate, agricultural, bulk, carload, works, unit-ton	$ 0.64 1/2	$ 0.66 1/2

*Inside prices apply to material contracted for before July 1, 1959.
**Outside prices apply to material contracted for after July 1, 1959, but also for delivery during the current month.

Tariffs

Canada

German potash salts, muriate and sulphate of potash, saltpetre and potash nitrate	free

United States

Crude potash salts, muriate of potash, and potassium sulphate	"

ROOFING GRANULES

F.E. Hanes*

In 1959 the consumption of roofing granules by manufacturers of asphalt roofing and siding amounted to 138,758 short tons valued at $4,182,615. The volume was 2.1 per cent and the value 7.3 per cent less than in 1958.

The value of $4,509,638, reached in 1958, established an all-time high, which was 10.3 per cent greater than the value of the granules consumed in 1955. In volume, however, the record of the latter year, 147,877 short tons, still stands. The establishment of these records in different years can be represented as the difference in the average value per ton (calculated from the annual volume and value). Granules averaged $27.65 a short ton in 1955 and $31.82 in 1958, and the average value per ton increased steadily during this period. A decrease to $30.14 that occurred in the average price per ton in 1959 marked the first significant downward trend in 10 years.

On a month-by-month basis from March to December inclusive, residential construction was consistently lower in 1959 than in 1958. In January and February of 1959, however, as in all months of 1958 and from August to December inclusive in 1957, the record showed monthly increases over the comparable figures of the preceding year. For 1957, 1958 and 1959, residential construction* amounted respectively to $1,813 million, $2,189 million and $2,190 million.

Fluctuations in residential construction are usually reflected in the annual consumption of granules, but the foregoing figures, although they show the high attained in 1958 by residential construction, give no sign of the downward trend that existed in 1959 in granule consumption. In 1957, fewer low-priced granules were marketed than at any other time in the 1953-59 seven-year period.

The estimate of a residential-construction value of $2,153 million for 1960 means that granule consumption for that year will probably be slightly less than in 1959.

---

*As reported in Construction in Canada, 1958-60, a publication of the Dominion Bureau of Statistics.

---

*Mineral Processing Division

Roofing Granules - Consumption and Imports

	1959*		1958**	
	Short Tons	$	Short Tons	$
Consumption				
By kind				
Naturally colored	29,457	613,226	26,812	546,245
Artificially colored........	109,301	3,569,389	114,250	3,941,788
Not classified	-	-	674	21,605
Total	138,758	4,182,615	141,736	4,509,638
By color				
Black and gray-black	41,451	903,277	39,700	883,500
Green	33,172	1,080,867	34,063	1,157,605
Red	14,410	413,908	15,518	458,757
Blue	7,916	306,300	9,224	376,766
White	23,793	923,227	23,655	995,412
Gray	8,450	241,772	8,569	253,191
Buff	1,176	42,282	1,407	51,127
Brown and tan	6,577	202,287	6,709	216,273
Coral, cream and yellow...	1,813	68,695	2,217	95,402
Not classified............	-	-	674	21,605
Total	138,758	4,182,615	141,736	4,509,638
Imports				
United States				
Naturally colored	26,789	570,044	23,757	499,349
Artificially colored........	60,459	2,052,018	77,145	2,800,512
Total	87,248	2,622,062	100,902	3,299,861

*Compiled from figures supplied to the Mines Branch by producers and consumers. The consumption figures reported for 1959 represent returns from 16 of the 17 plants.

**The consumption figures for 1958 have been adjusted to include returns received after the 1958 review was written.

The use of imported granules (all from the United States) has decreased during the past five years. In 1955, their value was 85 per cent that of consumption; in 1959 it dropped to 62.7 per cent. The volume of granules imported during the same period decreased from 81.7 per cent to 62.9 per cent of the volume of consumption. Twenty-two per cent of the value of the granules imported in 1959 was accounted for by a natural black slag, which increased that year in popularity. From 1958 to 1959, the imports of the black granule, a natural slag produced in steam-generating plants, increased from 21,974 to 26,498 short tons, or 20.6 per cent.

Roofing-granule Plants in Canada

Building Products Limited is the principal producer of roofing granules in Canada. The company quarries a fine-grained, dark-colored basalt (trap) rock at Havelock, Ontario. The rock is crushed and graded at the company's plant, east of the town. Further processing for coloring is carried out in a subsidiary unit of the same plant. Base granules are artificially colored by the sodium-silicate process. Building Products Limited also produces some naturally colored rock and slate.

In many localities, graded crushed stone is used sporadically on a limited basis as a roof protection. The crushed stone is spread on from one to several layers of asphalt-saturated felts, usually on roofs ranging from low-sloping to flat. This granule production is not considered in this review. None of these granules are artificially colored by any of the known coloring processes. Paint is sometimes applied, however, as an added protection.

Roofing and Siding Plants in Canada

Shingles and siding manufactured in 1959 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, Quebec Vancouver, British Columbia St. Boniface, Manitoba
Building Products Limited	Montreal, Quebec Hamilton, Ontario Winnipeg, Manitoba Edmonton, Alberta
Canadian Gypsum Company, Limited	Mount Dennis, Ontario
Canadian Johns-Manville Company, Limited	Asbestos, Quebec
IKO Asphalt Roofing Products Limited	Calgary, Alberta Brampton, Ontario
Murray-Brantford Limited Brantford Roofing Company Limited	Brantford, Ontario Saint John, New Brunswick Lachine, Quebec
Philip Carey Company Limited, The	Lennoxville, Quebec
Sidney Roofing and Paper Company Limited	Burnaby, British Columbia Lloydminster, Alberta

Some Properties of a Good Granule

The demand for high-quality granules and producers' competition for markets have resulted in specifications designed to ensure a product that will last for 20 years. Only rocks that have all the qualities expected of them will make an economic deposit.

Granules from suitable rock must be able to withstand all kinds of weather. They must be amenable to a coloring process, with the exception of those granules that, having natural coloring, are suitable for shingle application without color coating. Granules used for coloring must be free from mineral constituents that react chemically with bonding materials in the coloring process or with the asphalt in the finished product.

Granules with good opacity characteristics are of great importance, as ultraviolet rays must not be allowed to penetrate and dry out the asphalt-coated felt. Granules must be tough and highly abrasive-resistant. For the most efficient processing, a source rock should have fracturing qualities that result in equidimensional, nearly cube-shaped granules. Those of a more regular shape do much to impart an even-textured, even-colored appearance to the final product and require a minimum of coloring media. The regular-shaped particle has less surface area and hence less bonding area.

Low porosity is necessary for good granule performance. Porous rocks, if permeable, allow moisture to seep through to the asphalt and cause blistering, cracking and deterioration of the shingle or siding. Porous rocks also increase manufacturing costs owing to the absorption of coloring media into the granule particles.

Finally, the adhesive properties of the granule in both colored and natural types must be such that maximum bonding exists when the granules are in contact with hot asphalt (during the manufacture of the shingle) and cold asphalt (during handling and outdoor exposure).

Technology

Producers of roofing shingles and siding, recognizing the value of high-quality products, employ rigid standards of inspection and testing throughout the manufacturing process.

Initial inspection includes testing and checking for quality, grade and the color constancy shown by the granule before it is applied to the felt. Color constancy is sometimes obtained by mixing different shades of one color. In the processing stage of shingle manufacture, a close watch is kept on the quality, temperature and application of the asphalt, which is occasionally tested for viscosity and variations in type and quality. These tests are most important, as those conducted by the Asphalt Roofing Industry Bureau have indicated a direct relation between durability and asphalt quality. Crude oils from different sources result in different asphalts.

A mineral filler of finely ground rock between 60-mesh and finer than 325-mesh is necessary for body and stability in the asphalt coating. Proper use of the right filler material in an asphalt coating makes the coating resistant to weathering and cold-weather shattering. Fillers also control the viscosity of the asphalt coating. Several rock and mineral types are used. Finely ground minerals are also used to dust and back the felt to prevent its sticking during handling and packaging. The minerals and rocks so used are mica, talc, schist and pyrophyllite.

Canadian Prices

All color groups decreased in price in 1959 compared with 1958. These decreases ranged from 38 cents for buff granules to $5.14 for coral, cream and yellow granules. The values per ton are calculated on the total consumption of granules of each color type. The cost to the consumer depends on the type of granule, the color, the distance from the producing plant and whether the granules are naturally or artificially colored.

For all types of granules, the average prices to roofing manufacturers per short ton in 1959, with 1958 figures in brackets, were: red, $28.72 ($29.56); green, $32.58 ($33.98); black, $21.79 ($22.25); blue, $38.69 ($40.85); white, $38.80 ($42.08); gray, $28.61 ($29.55); buff, $35.95 ($36.33); brown and tan, $30.76 ($32.24); and coral, cream and yellow, $37.89 ($43.03).

The average Canadian prices per short ton for imported, artificially colored granules were: red, $36.20; green, $39.28; black, $26.70; blue, $39.62; white, $42.74; gray, $35.93; buff, $34.42; brown and tan, $37.76; and coral, cream and yellow, $43.99. Because of differences in freight rates and variation in product types, a wide price range is to be expected.

United States Granule Production*

In 1959 roofing-granule production in the United States was 8 per cent higher in tonnage and 4 per cent greater in value than in 1958. The output amounted to 1.9 million tons valued at $38.6 million. Natural granules (24 per cent of production) were valued at $9.56 a short ton, and artificially colored granules at $23.75 a short ton. The general average value was $20.41 a short ton. Granules are produced in some 20 localities, 14 of which are in the East and six in the states bordering the Pacific Ocean.

*U.S. Bureau of Mines, Mineral Market Report (MMS) 3124.

SALT

R.K. Collings*

The annual production of salt in Canada increased at a remarkable rate during the five-year period 1954 to 1959. The 1959 record production of 3,289,976 short tons was more than 38 per cent greater than the output of the previous year and well over three times the amount produced in 1954. The rapid expansion of the Canadian salt industry is attributed to two factors - the opening of a rock-salt mine at Ojibway, Ontario, by The Canadian Rock Salt Company Limited in 1955, and the initiation of a program of brine export by Canadian Brine Limited at Sandwich, Ontario, in 1958. A further increase in salt production can be expected in 1960 as Canada's two new rock-salt mines, one at Pugwash, Nova Scotia, the other at Goderich, Ontario, enter their first full year of production. Both were officially opened on November 4, 1959.

Salt imports increased slightly - from 340,887 short tons in 1958 to 369,967 short tons in 1959. Exports, on the other hand, showed a substantial increase - from an estimated 906,707 short tons in 1958 to 1,274,077 short tons in 1959. Most of the salt exported in 1959 was in the form of brine for use by chemical plants in the United States.

Producers*

Salt is recovered from underground deposits at three locations in Canada by standard room-and-pillar methods and at nine locations by brining followed by evaporation. Salt brine for use in the manufacture of chemicals is produced from underground salt beds at Amherstburg, Sandwich, and Sarnia, Ontario, and at Duvernay, Alberta.

Ontario

Ontario accounted for more than 92 per cent of Canada's production in 1959. The entire production was from salt beds 800 to 1,800 feet below the surface in the area between Amherstburg and Goderich in the southwestern section of the province.

Fine salt, obtained by vacuum-pan evaporation of brine from local wells, is produced by The Canadian Salt Company Limited, at Sandwich, and by Sifto Salt Limited, a subsidiary of Dominion Tar and Chemical Company,

*See map on page 408.

(text continued on page 406)

*Mineral Processing Division

Salt - Production and Trade

	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Production (shipments)				
By type				
Fine vacuum salt......	459,857	8,918,231	438,394	8,700,562
Mined rock salt	1,221,999	7,512,695	787,032	4,910,675
Salt recovered in chemical operations...	17,210	63,675	17,733	59,293
Salt content of brines used and shipped......	1,590,910	1,539,921	1,132,033	1,319,012
Total	3,289,976	18,034,522	2,375,192	14,989,542
By province				
Ontario...............	3,036,230	13,228,977	2,126,483	10,204,472
Nova Scotia...........	120,225	1,897,708	125,872	2,026,551
Alberta	61,198	1,092,331	55,766	983,640
Saskatchewan	48,776	1,189,675	46,511	1,157,729
Manitoba	23,547	625,831	20,560	617,150
Total	3,289,976	18,034,522	2,375,192	14,989,542
Imports (by type)				
Table				
United States..........	175	62,743	41	34,342
Total	175	62,743	41	34,342
For fisheries				
Bahamas	32,029	120,824	25,259	101,959
Spain	26,607	117,504	24,923	110,530
Jamaica	5,032	17,572	5,223	26,720
Portugal	48	449	-	-
St. Pierre............	40	764	-	-
United Kingdom	33	966	22	415
United States..........	-	-	1,550	7,750
Total	63,789	258,079	56,977	247,374
Other in bulk				
United States..........	205,778	911,064	223,789	897,688
Mexico	82,240	97,227	43,635	48,471
French Africa.........	3,360	9,265	-	-
Total	291,378	1,017,556	267,424	946,159

Salt - Production and Trade (cont'd)

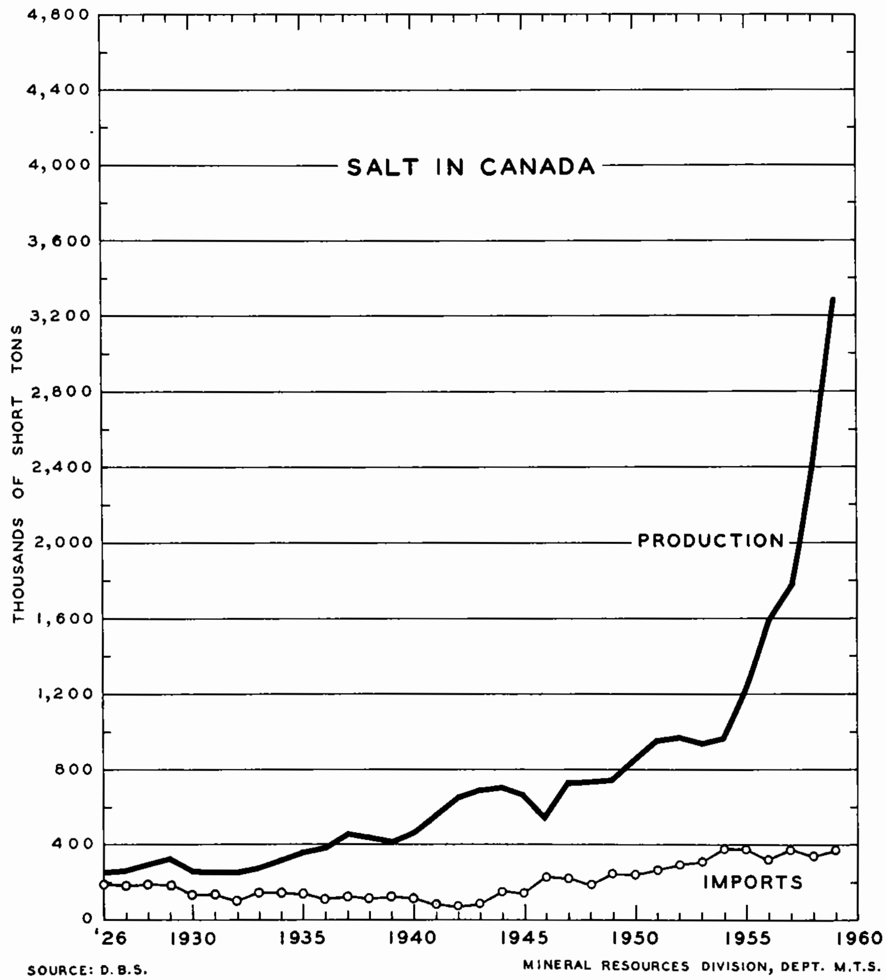
	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Other, in bags, barrels and other covering				
United States..........	13,198	211,818	14,704	237,861
United Kingdom.......	1,427	27,416	1,741	37,262
Total................	14,625	239,234	16,445	275,123
Total imports.........	369,967	1,577,612	340,887	1,502,998
Exports				
United States	1,273,923	4,630,149	406,563*	2,910,426*
Bermuda	131	6,440	141	6,617
Other countries	23	2,933	3	226
Total	1,274,077	4,639,522	406,707	2,917,269

*These figures do not include the salt content or value of brine exported to the United States. The quantity and value relating to brine were included under another classification in Trade of Canada statistics in 1958.

Salt - Production and Trade, 1949-59
(short tons)

	Production(1)	Imports	Exports
1949	749,015	236,688	3,474
1950	858,896	238,239	4,100
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

(1) Producers' shipments.
(2) This figure has been adjusted to include the salt content of brine, estimated at 500,000 tons, exported to the United States during 1959.



Limited, at Goderich and Sarnia. The Canadian Salt Company Limited also operates a fusion plant at Sandwich. Fine salt from the evaporator plant is fused, cooled, crushed and sized to produce coarse salt for special purposes.

Coarse rock salt is produced at Ojibway, near Windsor, by The Canadian Rock Salt Company Limited, a subsidiary of The Canadian Salt Company Limited, and at Goderich, by Sifto Salt Limited. The salt bed mined at Ojibway is at 980 feet; that mined at Goderich is at 1,760 feet.

Brine from company-owned wells is used by Dow Chemical of Canada Limited to produce caustic soda, chlorine and related chemicals at Sarnia. At Amherstburg, Brunner Mond Canada, Limited, produces industrial salt, soda ash, calcium chloride and other chemicals, using brine from local wells.

Canadian Brine Limited, a subsidiary of The Canadian Salt Company Limited, supplies brine from wells at Sandwich to a chemical plant in Detroit. The brine is pumped to Detroit through pipelines running under the Detroit River.

Warwick Salt and Chemicals Limited has resumed operations at Watford, producing coarse evaporated salt for use in agriculture, ice control and water-softening and for salting hides.

Nova Scotia

Fine salt is produced by Sifto Salt Limited at a plant at Nappan, near Amherst. Brine for this operation is obtained from salt beds 1,100 to 1,800 feet below the surface.

Malagash Salt Company Limited, a subsidiary of The Canadian Salt Company Limited, operates a rock-salt mine at Pugwash. The salt,obtained from a bed at 630 feet, is crushed and screened to give a coarse product for use in ice and dust control on highways, for fisheries, and for use by chemical and agricultural industries. Operations at Malagash Salt Company's mine at Malagash were suspended when the Pugwash salt deposit was brought into production on November 4.

Prairie Provinces

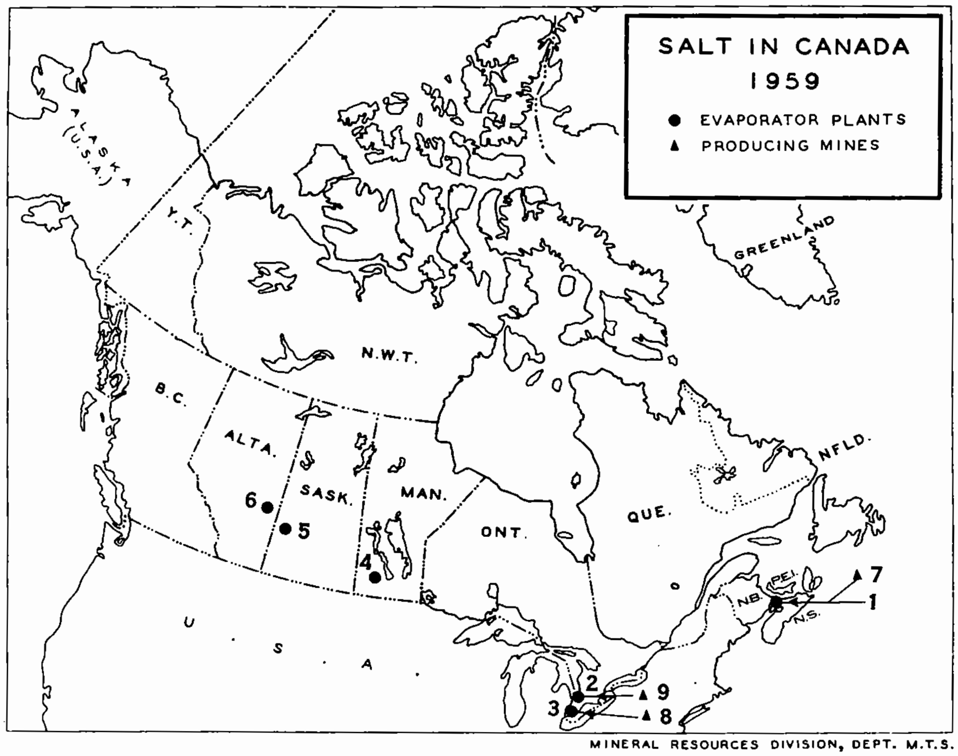
Fine salt, obtained by vacuum-pan evaporation of brine from salt beds 1,000 to 3,500 feet below the surface, is produced by The Canadian Salt Company Limited at Neepawa, Manitoba, and Lindbergh, Alberta, and by Sifto Salt Limited at Unity, Saskatchewan. Part of the Lindbergh output is fused, crushed and screened to give a coarse salt for various uses.

Western Chemicals Limited, of Calgary, Alberta, uses brine obtained from salt beds 3,600 feet below the surface to produce caustic soda, chlorine and hydrochloric acid at its chemical plant 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.

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.



Evaporator Plants

1. Sifto Salt Limited (Nappan)
2. Sifto Salt Limited (Goderich and Sarnia)
   Warwick Salt and Chemicals Limited (Watford)
3. Canadian Salt Company Limited, The (Sandwich)
   Brunner Mond Canada, Limited (Amherstburg)
4. Canadian Salt Company Limited, The (Neepawa)
5. Sifto Salt Limited (Unity)
6. Canadian Salt Company Limited, The (Lindbergh)

Producing Mines

7. Malagash Salt Company Limited (Pugwash)
8. Canadian Rock Salt Company Limited, The (Ojibway)
9. Sifto Salt Limited (Goderich)

Uses

Brine is used extensively in the chemical industry for the manufacture of chlorine, hydrochloric acid, caustic soda and related chemicals. Fine salt produced by vacuum-pan evaporation of brine is also used in the chemical industry and for dairy, household and food purposes.

The coarser grades of salt are used in the curing of fish, for ice and dust control on highways, in dairying, for the regeneration of zeolites in water-softening, as refrigerants and for other purposes. Coarse salt is obtained by the use of open-pan evaporators, by the pressing or fusion of fine salt into blocks or pellets which are then crushed and screened, and by the mining, crushing and screening of rock salt. Coarse salt produced by the open-pan evaporation of brine or by the fusion of fine salt is pure but expensive, and hence is used only where purity is essential, as in the curing of fish or in the dairy industry. Mined rock salt is used extensively for the control of ice and dust conditions on highways and the removal of ice from railways. Rock salt, dissolved in water to form brine, is also used in the chemical-manufacturing industry.

Available Data on Consumption of Salt
in Specified Canadian Industries, 1958*
(short tons)

Industry	Quantity Used
Chemical	991,448
Slaughtering and meat-packing	50,311
Pulp-and-paper mills	44,122
Miscellaneous food preparations	36,309
Fish-processing	21,494
Stock and poultry feed, prepared	25,764
Leather tanneries	7,053
Miscellaneous manufacturing	4,968
Other industries	628,000**

* Latest year for which complete data are available.

** Apparent consumption (1958) less 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	"	3¢ per 100 lb	5¢ per 100 lb
Salt in bags, barrels, etc.	"	3.5¢ per 100 lb	7.5¢ per 100 lb
Table salt	5%	10%	15%

United States

Bulk salt	1.7¢ per 100 lb
Salt in bags, barrels, etc.	3.5¢ per 100 lb

SAND, GRAVEL AND CRUSHED STONE

F.E. Hanes*

Production of all types of crushed stone and natural sand and gravel amounted in 1959 to 224.7 million short tons valued at $151.0 million. The increase in the use of these materials in building and road construction reflects the general growth in construction that has taken place throughout Canada not only in the year under review but during the last few years. The combined volume of all types of aggregate and stone materials produced in 1959 increased 18 per cent. Since 1955 it has increased 50.8 per cent. In 1959, the value of the aggregates produced was 11.1 per cent greater than in 1958 and 54.7 per cent greater than in 1955.

Sand and Gravel

Seventy-four per cent of the 1959 volume of all products was composed of sand and gravel made up of both pit-run and washed material including crushed gravel. Seven per cent was sand produced from deposits of gravel-free materials composed of fine sands suitable for mortars and concrete used in building and road construction. This sand is also classified as pit-run and washed. The remaining 19 per cent of the aggregate produced was crushed stone.

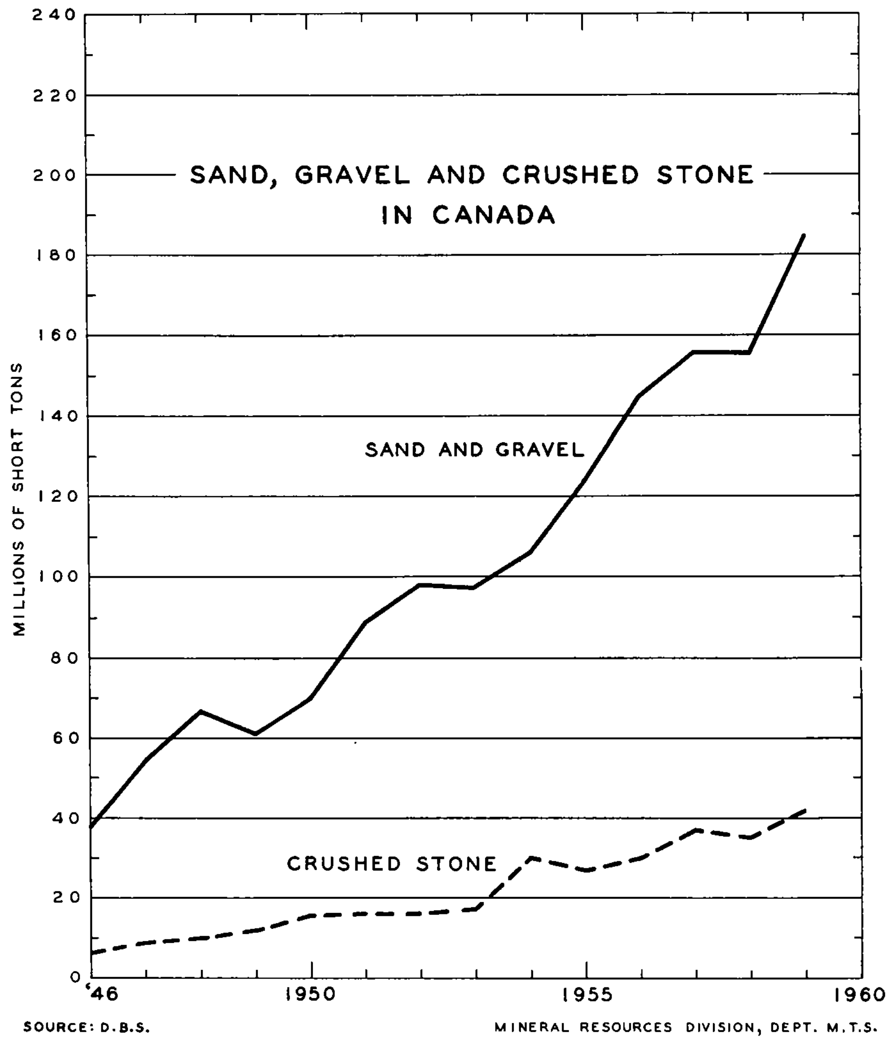
More than 92 per cent of the sand and gravel produced in 1959 for concrete and road-building was composed of pit-run material. This speaks highly for the quality of the natural deposits now being exploited, since the material recovered from them must meet increasingly rigid specifications. Modern methods of processing and equipment designed to produce cleaner gravel are employed when high-quality, premium products are specified. These products are classified as washed. Sand-and-gravel production for 1959 is 146.6 million tons of pit-run and 20.2 million tons of washed material. Sand, on the other hand, is made up of 4.3 million tons of pit-run and 11.2 million tons of washed material.

---

*Mineral Processing Division

PRODUCTION OF SAND, GRAVEL AND CRUSHED STONE

	Sand and Gravel				Crushed Stone				Total Production Sand, Gravel and Crushed Stone			
	1959		1958		1959		1958		1959		1958	
By province	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
Newfoundland	4,825,724	2,306,864	3,924,080	1,456,379	104	604	59,867	156,335	4,825,828	2,307,468	3,983,947	1,612,714
Prince Edward Island	5,244,968	2,859,171	-	-	1,700,000	1,700,000	-	-	6,944,968	4,559,171	-	-
Nova Scotia	8,025,765	5,020,033	2,332,909	2,372,419	1,300,239	1,198,995	335,575	563,814	9,326,004	6,219,028	2,668,484	2,936,233
New Brunswick	5,087,425	2,886,647	4,015,976	1,750,657	2,035,731	1,296,986	2,026,865	1,464,367	7,123,156	4,183,633	6,042,841	3,215,024
Quebec	41,815,299	21,060,512	38,375,529	19,010,360	19,661,753	22,581,351	16,263,456	20,415,088	61,477,052	43,641,863	54,638,985	39,425,448
Ontario	71,860,435	39,029,063	65,465,401	39,455,397	15,404,760	18,199,780	14,096,699	17,047,756	87,265,195	57,228,843	79,562,100	56,503,153
Manitoba	9,258,632	4,683,610	9,985,838	5,962,166	169,365	154,806	170,291	154,448	9,427,997	4,838,416	10,156,129	6,116,614
Saskatchewan	5,888,951	2,889,865	5,358,702	2,821,487	-	-	-	-	5,888,951	2,889,865	5,358,702	2,821,487
Alberta	13,271,695	11,949,099	13,225,048	12,714,750	445,490	396,339	52,504	84,926	13,717,185	12,345,438	13,277,552	12,799,676
British Columbia	17,055,272	11,061,014	12,959,378	8,426,846	1,658,975	1,695,643	1,719,556	2,051,678	18,714,247	12,756,657	14,678,934	10,478,524
Total	182,334,166	103,745,878	155,642,861	93,970,461	42,376,417	47,224,504	34,724,813	41,938,412	224,710,583	150,970,382	190,367,674	135,908,873
By type												
Sand												
Building concrete	15,556,197	13,325,181	13,232,445	11,902,625								
Sand and gravel												
Concrete: road-building	128,056,334	61,874,585	106,229,805	55,362,687								
Railroad ballast	8,303,445	2,836,993	8,373,117	3,624,978								
Crushed gravel	30,418,190	25,709,119	27,807,494	23,080,171								
Crushed stone												
Concrete aggregate					8,450,120	10,448,077	8,364,487	12,493,684				
Railroad ballast					1,958,325	1,923,569	1,496,352	1,633,114				
Road metal					26,371,980	27,904,991	19,290,774	21,240,892				
Rubble and riprap					1,853,803	2,128,901	2,479,319	2,597,157				
Terrazzo, stucco and artificial stone					41,926	459,377	45,303	511,432				
Other uses					3,700,263	4,359,789	3,048,578	3,462,133				
Total	182,334,166	103,745,878	155,642,861	93,970,461	42,376,417	47,224,504	34,724,813	41,938,412				



The sand-and-gravel industry is supported by 2,200 operators who work 8,070 pits. Quebec, with more than half the total number of operators, produced about 23 per cent of all the sand and gravel. Ontario, with 40 per cent of the operators, is the principal producer and accounts for some 39 per cent of Canada's production. The remaining eight provinces, with less than 10 per cent of the operators, account for the remaining 38 per cent of production, about half of which is shared by British Columbia and Alberta, which are the next two producers in importance.

Crushed Stone

For the last five years crushed stone (not to be confused with crushed gravel), compared with the natural products, has averaged approximately 31.3 per cent of the total annual value and 18.9 per cent of the total annual volume.

For 1959, the production of crushed stone amounted to 42.4 million tons valued at $47.2 million.

Four fifths of the total volume and value of this industry's output go to fill road and concrete aggregate commitments. Aggregates produced for road construction amounted in 1959 to 26.4 million tons valued at $27.9 million; those produced for concrete came to 8.4 million tons valued at $10.4 million.

Ontario and Quebec produce about 83 per cent of the crushed stone; Ontario leads in the production of road metal, Quebec in the production of concrete aggregate. Limestone, the principal rock crushed for both road and concrete use, makes up between 80 and 90 per cent of all rock crushed. Some 212 operators produce crushed rock.

Imports and Exports

Imports, at 2.15 million short tons valued at $1.98 million, were more than double their 1958 volume, which was valued at $1.4 million. Natural sand and gravel and crushed stone were equally favored in 1959, whereas in 1958, 78 per cent of the imported stone consisted of crushed rock. In 1959 the price of imported sand and gravel dropped to an average of 52 cents a ton from the 1958 average of $1.05. The cost of crushed stone per short ton dropped to $1.34 in 1959 compared with the 1958 value of $1.40.

In 1959 Canada exported 831,708 short tons of aggregate valued at $1,094,850. This was made up of 242,951 tons of sand and gravel and 588,757 tons of crushed stone. Although the crushed stone accounted for 71 per cent of all the aggregate shipped, its value averaged only 94.7 cents a ton. The sand and gravel, however, rose to $2.21 a ton from the 1958 average of $1.16.

Sand and Gravel and Crushed Stone - Imports and Exports

	1959		1958	
	Short Tons	$	Short Tons	$
Imports				
Sand and gravel	1,096,623	571,109	233,518	246,563
Crushed stone	1,055,712	1,408,686	829,955	1,165,977
Total	2,152,335	1,979,795	1,063,473	1,412,540
Exports				
Sand and gravel	242,951	537,117	353,155	408,648
Crushed stone	588,757	557,733	228,312	275,039
Total	831,708	1,094,850	581,467	683,687

Consumption of Aggregate

A carry-over of large contracts in building construction helped offset the steadily decreasing need for aggregate in housing development. For each month except January and February, contracts for residential construction were consistently lower than in 1958. The 1959 record in the production of aggregate resulted mainly from expansion in construction work on both new and old highways and airports. The Dominion Bureau of Statistics has reported that, compared with 1958, the year showed a 10.8-per-cent increase in road and runway construction. In 1959, projects in these categories had a total value of $789 million (preliminary, subject to revision). The value of $784 million forecast for them for 1960 probably indicates a levelling-off due to the completion of some of the larger contracts.

One of the larger road-building projects well on its way to completion is the Montreal Metropolitan Boulevard, which traverses Montreal Island from Ste. Anne de Bellevue in the west to the eastern limits of Sherbrooke Street in Pointe aux Trembles, a distance of 31.5 miles. This six-lane expressway will have 6 miles of elevated sections in the more congested areas of the city. The cost has been estimated at $125 million.

The prospect of a great increase in vehicular traffic has precipitated road-expansion programs based on 10 to 25 years of planning into the future. Road-building is not restricted to new transcountry arterial routes: many established main highways are being widened for increased traffic. Repair work is constantly going on in all sections of the country on all types of roads and highways. The trend from rural to urban living has increased the concentration of population within comparatively narrow limits, thus making it necessary to develop by-pass routes through and around massed residential and industrialized areas.

Other projects helping to maintain the high level of road construction are the Trans-Canada Highway and the Roads to Resources Program.

The Trans-Canada Highway agreement, due to expire in 1960, has been extended for three years by a House of Commons Bill. Because of this time extension, the $350-million appropriation authorized by the federal government to carry the project to the end of 1960 has been increased by $50 million. A section from Revelstoke to Golden, in British Columbia, and one from Agawa to Marathon, north of Lake Superior, are the two principal gaps. A few short stretches remain unfinished in some of the other provinces. When completed, the Trans-Canada Highway, exclusive of the Quebec provincial-highway section, will run some 4,500 miles from coast to coast.

The Roads to Resources Program, in which provincial and federal departments participate, encompasses, as well, the federally sponsored Northern Development Roads Program. The plans for the provinces and northern territories call for the development of access roads to areas of potential wealth in mineral and other resources. Federal assistance in the form of 50 per cent of a fixed amount is available to each province for use in resource areas that would otherwise remain undeveloped for years. By the end of 1959, nine provinces were actively taking part in this plan. The program, estimated to cost $145.2 million, will result in the construction of more than 4,000 miles of roads within the next 5 to 10 years. Roads constructed to date under this project are additional to the roads and highways built in 1959 under Provincial sponsorship, as already mentioned.

Uses and Markets

Sand, gravel and crushed stone are used in two ways - with or without a binder. They find their most important application in the building industry as aggregate and in all forms of road and pavement construction either as aggregate or as bulk material without a binder.

Future of the Industry

Because of the number of operators, many of whom are small, and the low value of the product, distribution is restricted to local markets. Thus, for the producer, industrialized areas are highly competitive, and the smaller operator works within a very narrow margin. Since the small operator is restricted in the amount of research and improvement he can carry out during the development and exploitation of his deposit, he depends largely on the manufacturer and research testing laboratories for assistance.

The new machinery constantly being introduced is equipped with the latest developments resulting from research conducted by the manufacturer, government testing laboratories and private enterprise. These advances are of benefit at the quarry and at the comminution, screening and classifying, and beneficiation stages of plant operation.

Improvements in classifying and beneficiation processes are particularly notable in jig and separation equipment; and the improvement in aggregate after treatment, especially in aggregate for use in exposed concrete, results in premium products commanding higher prices that often quickly offset the capital investment.

The main and most beneficial effect of these developments is the increase in the volume of quality aggregate and the betterment of concrete construction.

SILICA

R.K. Collings*

Silica is the common name for silicon dioxide, a compound occurring in the free state chiefly as quartz. Quartz is widespread in Canada. It occurs in many forms, but only those in which the silica content is high - namely, vein quartz, silica sand, sandstone and quartzite - are used in industry. Most of the silica produced in Canada is in the form of sand, lump sandstone, quartz or quartzite and is for use in the manufacture of ferrosilicon alloys and as a fluxing agent in metallurgical industries. Part of the Canadian production of lump silica is exported to ferrosilicon producers in the United States.

High-purity silica sand for use in glass, silicon carbide and silica chemicals and for other purposes is produced at two locations only, both in Quebec - at Lachine, from St. Donat quartzite, and at St. Canut, from a local sandstone. Most of the high-purity sand required in Canada is, however, currently obtained from United States producers.

At 2,163,546 short tons, the production of silica minerals in Canada was 48.8 per cent greater in 1959 than in the previous year. This rise is attributed to a gradual recovery of ferrosilicon markets, which decreased in 1958 owing to production curtailments within the steel industry, and to an increase in the production of smelter flux, which was down in 1958 because of a three-month strike by the employees of The International Nickel Company of Canada, Limited, at its Whitefish Falls, Ontario, quartzite quarries.

Exports of quartzite, mostly for ferrosilicon production, rose from 19,599 short tons in 1958 to 147,412 short tons in 1959. Imports of silica sand for use as foundry sand and in the manufacture of glass and silicon carbide totalled 792,129 short tons, 31.3 per cent more than in the previous year.

Producers

Nova Scotia

Dominion Steel and Coal Corporation, Limited, obtains quartzite as required from a deposit at Chegoggin Point, Yarmouth county. Rock from this deposit is used in the manufacture of silica brick at Sydney.

Quebec

Electro Metallurgical Company, Division of Union Carbide Canada Limited, quarries sandstone at Melocheville, Beauharnois county, for the

(text continued on page 421)

*Mineral Processing Division

Silica - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production(1)				
Quartz and silica sand				
By province				
Ontario	1,600,352	1,363,541	922,599	666,275
Quebec	301,706	1,533,206	268,676	1,412,802
Saskatchewan	188,515	114,994	187,360	134,899
British Columbia	65,318	379,890	67,146	286,438
Manitoba	6,504	38,761	7,875	37,736
Nova Scotia	1,151	6,338	-	-
Total	2,163,546	3,436,730	1,453,656	2,538,150
By use				
Flux	1,672,224	1,109,613	1,202,524	1,061,079
Ferrosilicon	235,633	710,042	77,376	230,405
Silicon carbide	98,300	620,738	82,610	610,192
Glass	30,945	206,427	40,116	253,163
Other uses	126,444	789,910	51,030	383,311
Total	2,163,546	3,436,730	1,453,656	2,538,150
	Thousands of Bricks		Thousands of Bricks	
Silica brick	1,926	354,295	2,815	472,346
Imports				
Silica sand for glass and carborundum manufacture and for use in steel foundries, filtration plants and sand-blasting				
United States	791,264	2,487,177	603,287	2,113,949
Belgium	663	36,780	-	-
Australia	198	1,189	-	-
Norway	4	173	56	606
Total	792,129	2,525,319	603,343	2,114,555
Quartz				
Silex, or crystallized quartz, ground or unground(2)	13,815	184,451	12,024	150,960
Piezoelectric quartz(3)	1	72,575	2.6	60,710
Total	13,816	257,026	12,026.6	211,670

Silica - Production and Trade (cont'd)

	1959		1958	
	Short Tons	$	Short Tons	$
Imports (cont'd)				
Flint and ground flint stones				
United States	418	12,692	346	12,687
Denmark	259	10,578	104	4,171
France	109	3,207	72	2,937
Belgium	-	-	20	2,772
Total	786	26,477	542	22,567
Firebrick containing not less than 90% silica				
United States		1,444,320		1,207,828
West Germany		50,088		39,505
United Kingdom		4,619		-
Total		1,499,027		1,247,333
Exports				
Quartzite				
United States	147,412	465,166	19,599	86,037

(1) Producers' shipments, including crude and crushed quartz, crushed sandstone and quartzite, and natural silica sands.
(2) Mostly from the United States.
(3) Mostly from Brazil.

Available Statistics on the Consumption of Silica by Specified Industries
(short tons)

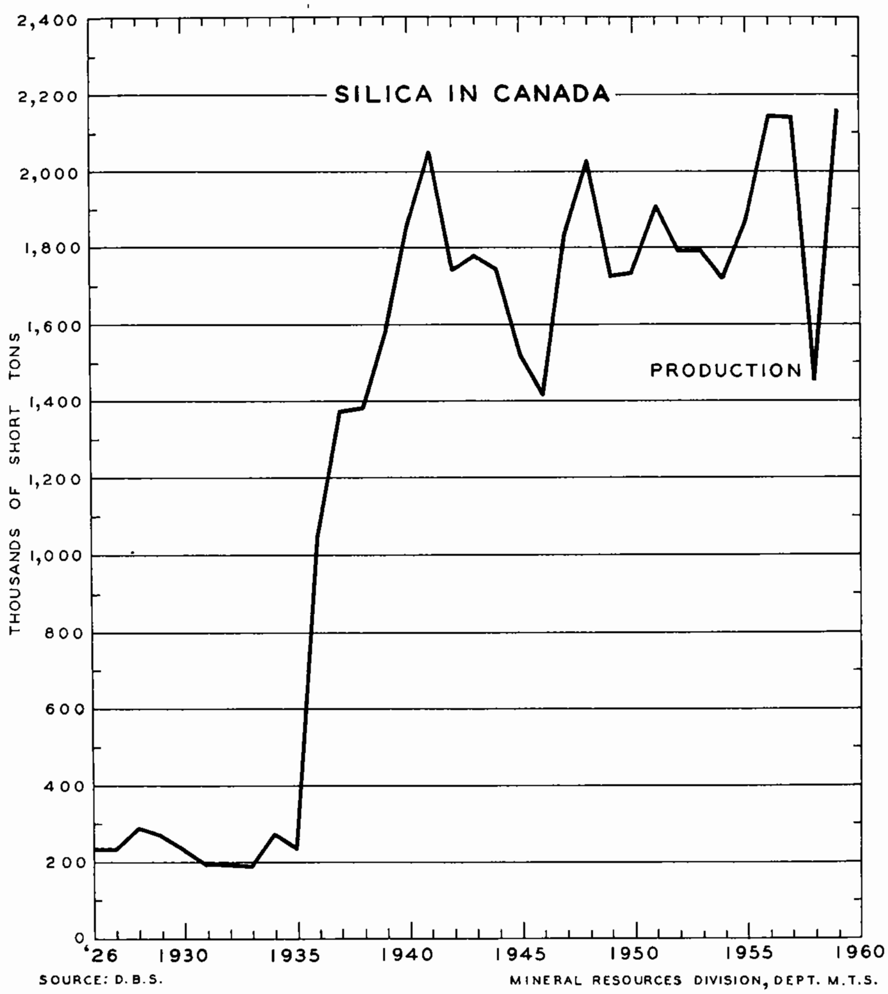
Industry	Consumption 1958	Consumption 1957
Smelter-flux	1,202,500	1,626,900*
Glass-manufacturing	281,400	268,300
Foundry-sand	129,400	170,100
Ferrosilicon	64,700	141,100
Artificial-abrasives	116,900	125,500
Cement-manufacturing	185,500	89,800
Chemical	62,600	26,800
Soap-and-cleanser	16,200	12,300
Clay-products	8,600	7,100

*Includes low-grade sand and gravel as well as crushed quartz.

Silica - Production and Trade, 1949-59

	Production		Imports				Exports
	Quartz and Silica Sand	Silica Brick	Silica Sand	Silex, or Crystallized Quartz	Ground Flint Stone	Ganister	Quartzite
	(short tons)	(thousands of bricks)	(short tons)				(short tons)
1949	1,722,476	3,663	511,116	22,966	602	176	144,302
1950	1,730,695	3,126	573,362	24,757	939	178	195,430
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	*	19,599
1959	2,163,546	1,926	792,129	13,815	786	*	147,412

* Not available separately. Included with miscellaneous stone imports from January 1, 1958.



manufacture of ferrosilicon at Beauharnois. The fines produced during crushing and screening are sized and used in foundry work, in cement manufacture and as a metallurgical flux.

E. Montpetit et Fils Ltée also quarries sandstone in the Melocheville area. This sandstone is used by Electro Reagents (Quebec) Limited for ferrosilicon production at Beauharnois.

Dominion Silica Corporation Limited quarries quartzite at St. Donat, Montcalm county, for use in the manufacture of silica sand and flour at Lachine. The production from the Lachine plant is used in the manufacture of glass and artificial abrasives and for other products requiring high-quality silica.

Canadian Silica Corporation Limited, with head offices in Toronto, produces silica sand and flour at St. Canut, Two Mountains county. The sand is used in the manufacture of glass, silicon carbide and cement and for foundry purposes. The flour is used by steel foundries, as a filler in asbestos-cement products, and as an abrasive ingredient in various cleansers.

Ontario

Canadian Silica Corporation Limited and Electro Metallurgical Company operate quarries in the quartzite formations occurring along the northwest shores of Georgian Bay. Canadian Silica Corporation has quarries at Sheguiandah, on Manitoulin Island; Electro Metallurgical Company's quarries are at Killarney, on the mainland. A large portion of the production from these deposits is exported to the United States; the remainder is used domestically, mostly for ferrosilicon manufacture. A small percentage of the production from Sheguiandah is used for the production of silica flour at Whitby, Ontario.

The Algoma Steel Corporation, Limited, quarries quartzite from a deposit at Bellevue, north of Sault Ste. Marie, for the manufacture of silica brick for furnace linings.

Manitoba

On April 30, 1959, Selkirk Silica Company Limited, of Winnipeg, suspended operations at its Black Island, Lake Winnipeg, sand deposit and at the Selkirk sand-processing plant. Selkirk Silica's assets were recently acquired by The Winnipeg Supply & Fuel Company Limited, which is currently conducting market and cost surveys with a view to reopening the Black Island sand deposit.

British Columbia

Pacific Silica Limited quarries quartz from a deposit 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, Quebec; Sudbury, Ontario; Flin Flon, 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, quartzite and, in some cases, sandstone and sand are used as fluxes in smelting base-metal ores low in silica. The composition of the flux and the amount of silica used depend upon the composition of the ore, but the silica content should be as high as possible. 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 at least 98 per cent, that of iron and alumina less than 1 per cent each and the total iron-and-alumina content less than 1 1/2 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 used 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 of the quartz used 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. The content of 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 at least 99 per cent. The iron and alumina should be less than 0.1 per cent each. Lime, magnesia and phosphorus are objectionable. A coarse-grained sand is preferred for silicon-carbide manufacture, but finer sands are sometimes used. All sand should be plus 100 mesh, with the bulk of it plus 35 mesh in size.

SODIUM SULPHATE

C.M. Bartley*

In 1959 sodium-sulphate production, at 179,535 tons, was 9 per cent higher than in 1958. At year-end the demand for sulphate pulp was increasing and larger amounts of sodium sulphate were being used in its production. Output is derived almost entirely from natural deposits in alkali lake beds in Saskatchewan, where the salts accumulate in closed-drainage basins under conditions of high evaporation. Canadian production has been continuous since 1919 although the demand has fluctuated considerably from year to year. Output increased steadily from the few hundred tons initially produced to a 1951 peak of more than 192,000 tons.

The kraft-paper industry consumes more than 90 per cent of the sodium sulphate produced in Canada, and the requirements of this market largely control its production and sale. Processing improvements made by kraft-paper manufacturers have reduced the salt cake required to produce a ton of paper and have made specifications stricter. For these reasons, the production of finished sodium sulphate is growing at a lower rate than the kraft-paper industry. In recent years, rising rail freight rates have also restricted and, in some cases, eliminated markets formerly served with Saskatchewan salt cake. On both coasts, by-product sodium sulphate from United States or European sources is in a favorable competitive position because of low bulk shipping costs.

Canadian producers are trying to maintain and expand sales by requesting lower rail freight rates, increasing the efficiency of salt collection and processing, developing new markets for improved grades and using sodium sulphate as the basic ingredient in the manufacture of other chemical products.

Production and Trade

The slight increase in production in 1959 and the year-end rise in activity in the pulp-and-paper industry indicated an increased demand for 1960. Several Saskatchewan producers have expanded their capacity by various methods, and all are attempting to increase efficiency, reduce costs and produce a higher-grade product.

Imports of salt cake increased about 5 per cent to 27,157 tons valued at $511,162, and exports increased about 20 per cent to 47,922 tons valued at $752,116. Generally speaking, production fluctuates but is rising consistently, exports are higher than imports, and consumption has risen more than 50 per cent in the past eight years.

*Mineral Processing Division

Sodium Sulphate - Production, Trade and Consumption

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)...	179,535	2,881,861	173,217	2,862,915
Imports				
Crude sodium sulphate, or salt cake				
United States	18,058	311,554	16,663	293,597
United Kingdom.......	9,099	199,608	9,150	184,618
Total	27,157	511,162	25,813	478,215
Glauber's salts				
West Germany........	562	17,373	765	19,240
United States	403	22,224	450	19,298
United Kingdom.......	1	310	2	254
Total	966	39,907	1,217	38,792
Exports				
Crude sodium sulphate				
United States	47,922	752,116	39,763	645,670

	1959	1958
Consumption		
Pulp and paper.........	145,501	164,556
Glass, including glass wool	3,135	2,357
Medicinals	-	52
Soaps	2,733	814
Stone products	460	288
Total	151,829	168,067

The most serious problem facing the industry is the upward trend of rail freight rates, which tends to limit and gradually reduce the market area available to Saskatchewan producers. Late in 1958 and early in 1959 the producers requested the Canadian railways to reduce the rates to their main marketing areas (i.e. to both coasts and to points in the United States). The producers regard freight rates as important at present because favorable rates would not only enlarge their immediate market but would enable them to compete more effectively with by-product sodium sulphate, which may enter the Great Lakes area via the St. Lawrence Seaway from Europe or the United States. The Saskatchewan companies hope to obtain rates that will keep them fully competitive with any imports entering the Great Lakes area by low-cost ocean freight. Briefs presented to the railways point out that the selling price of Canadian sodium sulphate at the producing plants is lower than European and United States plant prices but that imports can compete in coastal and possibly in Great Lakes areas by reason of low ocean shipping rates. The fact that sodium sulphate is produced at four widely separated plants and shipped to more than 20 consuming plants in Canada and the United States makes low rates on multicar rail shipments difficult to obtain.

Salt-cake producers are encouraged by the increasing use of bleached kraft pulp in paper-making. Between 1956 and 1958 bleached-sulphate-pulp production increased by 247,000 tons while bleached-sulphite production decreased by 89,000 tons. The greater strength of sulphate paper, which permits higher machine speeds, is believed to be the reason for this increase.

Sodium Sulphate - Production, Trade and Consumption, 1949-59
(short tons)

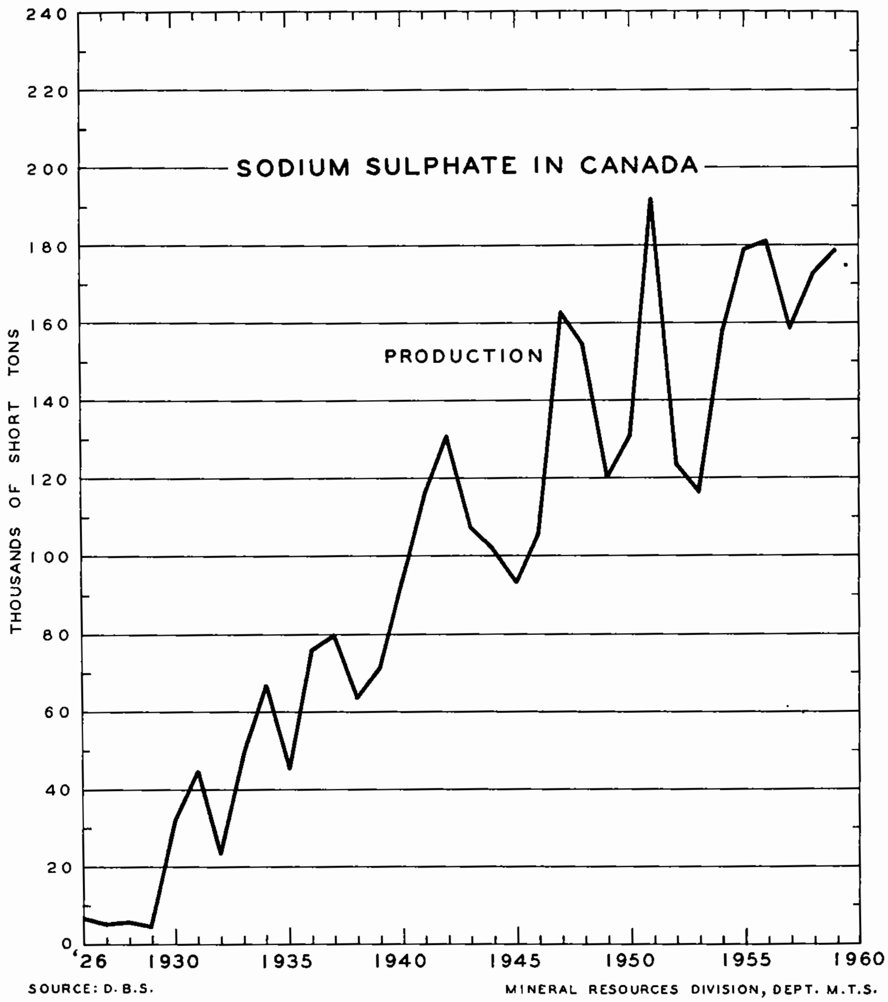
	Production(1)	Imports		Exports(2)	Consumption
		Salt Cake	Glauber's Salt		
1949	120,259	4,294	1,996	21,090	106,257
1950	130,730	15,705	2,256	28,375	115,937
1951	192,371	19,432	3,234	63,179	144,144
1952	122,590	19,576	4,577	27,144	116,786
1953	115,565	32,802	5,493	20,132	129,698
1954	158,417	30,235	5,134	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	151,829

(1) Producers' shipments of crude sodium sulphate.
(2) Exports to the United States from 1949 to 1954 inclusive are taken from United States import statistics.

Producing Companies

Four companies in Saskatchewan produced sodium sulphate in 1959 from the natural deposits of that province, and Courtaulds (Canada) Limited produced a relatively minor amount of by-product sodium sulphate at Cornwall, Ontario.

Midwest Chemicals Limited operates a plant on Whiteshore Lake near Palo in western Saskatchewan. During 1959 the company recovered more than 100,000 tons of raw sodium sulphate and produced finished salt cake for domestic use and export. A large storage bin is planned to insure the quality of shipments during winter.



Ormiston Mining and Smelting Co. Ltd., with a plant on Horseshoe Lake in southern Saskatchewan, produced at a normal rate during 1959. The company operates a floating dredge to excavate crystal from the lake bottom and pump it through a 10-inch pipeline for about half a mile to the plant. This crystal supplements that recovered from brine reservoirs by standard methods.

The raw salt is dehydrated in three rotary kilns, in which local low-grade coal is used as fuel. It is expected that natural gas will be available during the latter part of 1960 and that its use will reduce costs and increase efficiency.

Saskatchewan Minerals, Sodium Sulphate Division, at Chaplin, recovers sodium sulphate from Chaplin Lake. Production during 1959 was maintained at a high level, and sales increased by comparison with those of 1958. About one third of the shipments go to export markets.

Under the company's sponsorship, the Saskatchewan Research Council is attempting to produce other chemicals from sodium sulphate and thereby increase its markets.

Sybouts Sodium Sulphate Company Limited operates a plant near Gladmar, on East Coteau Lake,* in southern Saskatchewan. Sodium sulphate is recovered mechanically and dehydrated in two coal-fired rotary kilns. During 1959 production was maintained at near-capacity levels.

Other Occurrences

Explorative work on the numerous deposits in Saskatchewan has shown that large reserves of sodium sulphate are available. More than 20 lake deposits contain at least 500,000 tons each and 11 are estimated to contain from 100,000 to 500,000 tons each. Reserves in Saskatchewan have been estimated to total more than 200 million tons.

Sodium-sulphate occurrences similar to those in Saskatchewan have been found in Alberta and British Columbia. Production totalling 200 tons has been credited to Alberta. There is no record of production from British Columbia.

Drilling in New Brunswick has indicated a deposit of glauberite, the double sulphate of sodium and calcium, at depths of about 1,300 feet.

Technology

Until very recent years, almost all efforts to improve the technology of sodium sulphate were directed toward improvements in standard procedures. Various methods were used to control the concentration of salt in natural lakes by dams to prevent dilution in wet seasons or the addition of fresh water in dry seasons. Pumping concentrate brines from natural and artificial lakes lowered the amount of the impurities introduced by the mechanical recovery of salts from lake bottoms. Now, however, more efficient dehydration procedures, in which natural gas is used as fuel, and corrosion-resistant equipment have contributed to a higher-grade product and lower unit costs. These and other methods have increased production efficiency and the grade of the salt cake.

During the past two years, attention has been directed toward the production of other materials from sodium sulphate. Saskatchewan Minerals, Sodium Sulphate Division, has sponsored investigations by the Saskatchewan Research Council regarding the production of sodium carbonate from sodium sulphate by gas reduction and carbonation. At year-end, encouraging progress was being made and work to determine the best operating conditions was continuing.

The Saskatchewan Research Council has also investigated the use of potassium chloride and sodium sulphate, or a mixture of magnesium and sodium sulphates, to produce potassium sulphate for fertilizer. The latter method

*Formerly Sybouts East Lake.

would involve the use of the mixed sodium- and magnesium-sulphate brines, which are geographically closer to the potash deposits than are the pure sodium-sulphate brines. In this process, magnesium-potassium sulphate would be produced directly for use in specialty fertilizer, and magnesium chloride would be recoverable as a by-product.

The successful development of these processes will assist both the sodium-sulphate and the potash industries and provide consumers with needed products at lower cost.

Prices

Canada

The Canadian price of sodium sulphate (salt cake), bulk, carload, f.o.b. works, as reported by Canadian Chemical Processing in October 1959, was $16.50 a ton.

United States

According to Oil, Paint and Drug Reporter of December 28, 1959, United States prices of sodium sulphate were as follows:

Anhydrous, technical-grade, bags, car lots, per short ton	$54.00
Detergent, rayon-grade, per short ton	
Bags, car lots, f.o.b. works	$36.00
Bulk, car lots	$32.00
Crystallized, drums, per lb	17 1/2¢ to 18¢

Tariffs

Canada

	British Preferential	Most Favored Nation	General
Sodium, sulphate of, crude, or salt cake, per lb	1/5¢	1/5¢	3/5¢

United States

Sodium sulphate, crude, or crude salt cake	free
Sodium sulphate, anhydrous, per long ton	$1.27
Sodium sulphate, crystallized, or Glauber's salt, per long ton	$1.00

BUILDING AND ORNAMENTAL STONE

F.E. Hanes*

The production of all types of building and ornamental stone for 1959, amounted to 171,672 short tons valued at $6.55 million, was slightly lower in volume and 12.3 per cent less in value than the output of 1958. The lower value may be attributed to lower unit prices.

Although sandstone represented only 16 per cent of the volume of all the stone produced in 1959, its value, at $722,449, was 18 per cent greater than in 1958. Marble, which made up less than half of 1 per cent of the stone produced, gained one and one-half times in volume and was more than double in value. No production of slate and shale was reported for 1959. Quebec is the principal producer of granite; Ontario leads in limestone and sandstone.

Ontario continued as the leading source of stone, shipping 86,353 short tons; Quebec, the second largest source, shipped 63,739 short tons. The two provinces together accounted for 87.4 per cent of Canada's stone production. Quebec led in value with $4.25 million worth; Ontario's output was valued at $1.34 million. Together, the two provinces accounted for 85.3 per cent of the value of the 1959 production.

Newfoundland has dimension-stone deposits of production potential but, because of its location, has no economic output. Prince Edward Island and Saskatchewan cannot compete in Canadian or foreign markets because they lack suitable stone or their dimension-stone deposits are inaccessible.

Imports and Exports

In 1959, imports of stone of all types reached a value of $2,749,390, or 5.2 per cent more than in 1958. Marble made up 42.7 per cent, granite products 25.8 per cent, and other building stones (except slate), principally limestone, 29.2 per cent of the value of all the stone imported. The remaining 2.3 per cent was slate, which decreased to one half its 1958 import value. In 1959 compared with 1958, imports of granite decreased in value while those of marble and limestone increased.

Exports increased in value by 62.8 per cent - from $174,101 in 1958 to $283,356 in 1959. Dressed stone of all types made up 38 per cent of the stone exported.

---

*Mineral Processing Division

ESTIMATED* PRODUCTION OF BUILDING AND ORNAMENTAL STONE, 1959

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$
Building stone												
Rough	14,765	295,014	51,772	520,489	256	8,232	19,906	479,821	-	-	86,699	1,303,556
Dressed	20,619	2,290,643	34,956	1,546,104	525	45,275	1,400	152,840	-	-	57,500	4,034,862
Total	35,384	2,585,657	86,728	2,066,593	781	53,507	21,306	632,661	-	-	144,199	5,338,418
Monumental and ornamental												
Rough	9,923	250,715	-	-	-	-	-	-	-	-	9,923	250,715
Dressed	5,954	831,306	-	-	-	-	4	4,386	-	-	5,958	835,692
Total	15,877	1,082,021	-	-	-	-	4	4,386	-	-	15,881	1,086,407
Flagstone	800	10,000	3,716	11,297	-	-	6,033	75,002	-	-	10,549	96,299
Curbstone	505	17,366	50	250	-	-	-	-	-	-	555	17,616
Paving block	181	1,934	-	-	-	-	307	10,400	-	-	488	12,334
Total	1,486	29,300	3,766	11,547	-	-	6,340	85,402	-	-	11,592	126,249
Grand total	52,747	3,696,978	90,494	2,078,140	781	53,507	27,650	722,449	-	-	171,672	6,551,074

*The estimated figures are based on the final returns filed with the Dominion Bureau of Statistics by 94.8% of the operators for 1959 and the final returns filed by the remaining operators for 1958.

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, 1958

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$
Building stone												
Rough	10,733	205,430	49,091	519,870	8	222	21,554	465,779	-	-	81,386	1,191,301
Dressed	26,884	2,967,288	35,902	1,865,802	300	24,000	757	65,843	-	-	63,843	4,922,933
Total	37,617	3,172,718	84,993	2,385,672	308	24,222	22,311	531,622	-	-	145,229	6,114,234
Monumental and ornamental												
Rough	8,597	257,634	-	-	8	272	-	-	-	-	8,605	257,906
Dressed	7,542	966,626	-	-	-	-	-	-	-	-	7,542	966,626
Total	16,139	1,224,260	-	-	8	272	-	-	-	-	16,147	1,224,532
Flagstone	414	5,175	4,168	11,143	-	-	6,281	80,721	454	32,395	11,317	129,434
Curbstone	70	2,912	-	-	-	-	-	-	-	-	70	2,912
Paving blocks	1	14	-	-	-	-	-	-	-	-	1	14
Total	485	8,101	4,168	11,143	-	-	6,281	80,721	454	32,395	11,388	132,360
Grand total	54,241	4,405,079	89,161	2,396,815	316	24,494	28,592	612,343	454	32,395	172,764	7,471,126

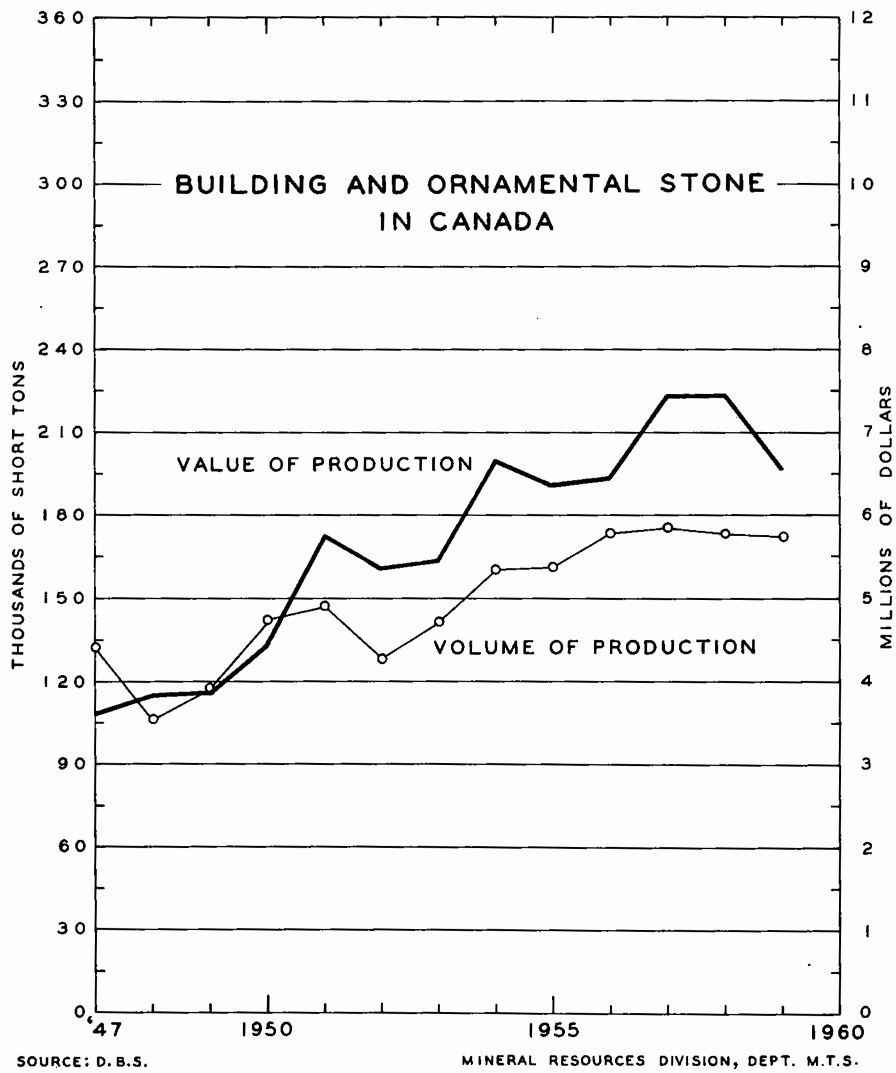
ESTIMATED* PRODUCTION OF BUILDING AND ORNAMENTAL STONE, BY PROVINCE, 1959

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$
Nova Scotia	1,748	246,595	-	-	-	-	1,884	58,477	-	-	3,632	305,072
New Brunswick	2,704	193,864	1,726	8,546	-	-	1,275	125,400	-	-	5,705	327,810
Quebec	41,889	3,138,117	21,069	1,054,729	781	53,507	-	-	-	-	63,739	4,246,353
Ontario	1,989	57,832	60,028	751,490	-	-	24,336	533,922	-	-	86,353	1,343,244
Manitoba	17	170	7,671	263,375	-	-	-	-	-	-	7,688	263,545
Alberta	-	-	-	-	-	-	155	4,650	-	-	155	4,650
British Columbia	4,400	60,400	-	-	-	-	-	-	-	-	4,400	60,400
Total	52,747	3,696,978	90,494	2,078,140	781	53,507	27,650	722,449	-	-	171,672	6,551,074

*The estimated figures are based on the final returns filed with the Dominion Bureau of Statistics by 94.8% of the operators for 1959 and the final returns filed by the remaining operators for 1958.

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, BY PROVINCE, 1958

	Granite		Limestone		Marble		Sandstone		Slate and Shale		Total	
	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$	S. Tons	$
Nova Scotia	1,332	179,805	-	-	-	-	1,497	33,343	-	-	2,829	213,148
New Brunswick	2,210	98,728	882	2,646	-	-	370	42,300	-	-	3,462	143,674
Quebec	46,632	4,022,740	20,381	1,115,338	316	24,494	451	1,446	-	-	67,780	5,164,018
Ontario	2,277	72,306	59,511	818,578	-	-	26,211	534,908	-	-	87,999	1,425,792
Manitoba	-	-	8,387	460,253	-	-	-	-	-	-	8,387	460,253
Alberta	-	-	-	-	-	-	63	346	103	2,560	166	2,906
British Columbia	1,790	31,500	-	-	-	-	-	-	351	29,835	2,141	61,335
Total	54,241	4,405,079	89,161	2,396,815	316	24,494	28,592	612,343	454	32,395	172,764	7,471,126



The first requirement for exploitation of a rock deposit is that it be free from closely spaced joints, cracks and other planes of weakness that would prevent the removal of blocks large enough to satisfy all uses. Many deposits having suitably spaced sheet planes and joint systems may still be difficult to quarry if angles made by natural parting surfaces make the blocks wedge-shaped. As the angle of dip increases, quarrying becomes more difficult and more rock is wasted. The ideal situation is to have well-developed, horizontal sheet planes and two sets of perpendicular joints at right angles to each other. The difficulty of rock-quarrying also varies with the direction of lineation or bedding and with the relation of postdepositional-cleavage structures to the main structures.

Dimensional stone, particularly when required for ornamental and monumental use, must be of uniform composition, even texture and pleasing

Ornamental and Building Stone - Imports and Exports

	1959		1958	
	Quantity	$	Quantity	$
Imports				
Granite				
Rough, not hammered or chiselled		294,151		386,050
Sawn		115,146		81,109
Manufactures		298,816		277,412
Total		708,113		744,571
Marble				
Rough, not hammered or chiselled		58,437		51,438
Sawn or sand-rubbed, not polished		757,749		653,660
Not further manufactured than sawn for manufacture of tombstones		45,737		40,688
Ornamental or decorative		166,948		170,628
All other marble manufactures		144,352		164,349
Total		1,173,223		1,080,763
Slate				
Roofing (squares)	1,185	21,779	783	22,461
Manufactures		43,163		105,316
Total		64,942		127,777
Building stone other than marble or granite (short tons)	32,512	803,112	31,161	660,485
Total, building, ornamental and monumental stone		2,749,390		2,613,596
Exports				
Granite and marble, unwrought (short tons)	8,540	172,127	6,827	108,049
Freestone, limestone and other building stone, unwrought (short tons)	142	3,925	391	14,042
Stone of all kinds, dressed		107,304		52,010
Total		283,356		174,101

color. Iron in certain forms, usually oxides and sulphides, is at all times objectionable. Building stone must be able to withstand weathering, particularly the freezing and thawing extremes of the Canadian climate.

Ornamental and building stone, to be finished to a high polish, must be free from knots, streaking, cracks and iron or other deleterious constituents that would be more noticeable on the polished surface than on a sawn or a rock-faced finish. On stone selected for such a finish there should be a good contrast between the polished and the sandblasted surfaces, particularly when lettering is to be used.

Building and Ornamental Stones, by Types

Granite

The category of rocks designated as 'granite' includes both true granites and such quartz-poor igneous rocks as syenites, diorites and trap (fine-grained rocks of the diabase-gabbro-basalt class). It includes practically all the igneous and many of the metamorphic rocks. Ferromagnesian rocks containing plagioclase feldspar, augite, pyroxene and hornblende are often referred to as 'black granites'. Any one of the foregoing types is to be found within the Canadian Shield, which outcrops over a large part of eastern Canada and the northern parts of the Prairie Provinces. Mountain ranges on the west coast contain few suitable granite deposits, owing primarily to structural weaknesses that developed during the formation of the mountains and subsequent movement.

The decrease in the value of granite production from $4.4 million in 1958 to $3.78 million in 1959 was due mainly to the smaller output of dressed stone.

Nova Scotia

In 1959 Nova Scotia's production of granite was greater in both volume and value than in 1958.

Gray granites are quarried and dressed in the Middleton-Nictaux, Shelburne and Halifax areas. A black diorite is quarried in the Shelburne area.

New Brunswick

New Brunswick's granite production increased in 1959 and almost doubled in value.

A coarse-grained, gray-brown granite is produced near St. Stephen. A light-pink, medium-grained granite comes from the Antinouri Lake district, and gray, pink and blue-gray granites ranging from fine to medium grain are quarried in the Hampstead (Spoon Island) district. A pink-gray granite is quarried near Bathurst, and some black granite is being taken out of the Bocabec River area.

Quebec

Quebec, the leading granite province, produces 79.4 per cent of the volume. Production was down in volume and value in 1959 compared with 1958.

Numerous quarries operating south of the St. Lawrence River produce a fine-to-medium-grained gray granite. These are located in the Stanstead, Stanhope, Scotstown, St. Samuel-St. Sebastien and St. Gerard areas. Dark gray-blue essexite, both fine- and medium-grained, is quarried on Mount St. Gregoire. A coarse-grained, dark-green nordmarkite is quarried in the Lake Megantic mountain area. A fine-grained green granite is also produced in the St. Gerard area.

Quarries north of the St. Lawrence River contain a variety of granite rocks of many colors and textures. Black anorthosite and red and brown granites are characteristic of the Lake St. John district; blue-gray, rose-gray, deeper pink-gray and a black-and-white gneissic granite of the Riviere-a-Pierre district; pink granite of the Guenette area; pink-red granite of the St. Alban area; a banded gneiss of the St. Raymond area; and brown-red to green-brown granites with darker varieties,of the Grenville district.

Ontario

Granite production in Ontario decreased both in volume and in value during 1959.

Monumental stone is quarried from a salmon-pink granite in the Vermilion Bay area, and from a black anorthosite in the River Valley area. Some rough building stone is quarried in the Parry Sound area from a multicolored, gneissic rock.

Manitoba

A small quantity of stone is quarried in the Lac du Bonnet area.

British Columbia

Granite production in British Columbia increased in volume and value in 1959.

Stone, which is used principally on the west coast in construction and monuments, comes from the islands of Nelson and Haddington. A light-gray and blue-gray, even-grained granite is produced on Nelson Island. The fine-grained, bluish-gray and buff andesite quarried on Haddington Island is used for building construction.

Limestone

Limestone suitable for building purposes is quarried in Ontario, Quebec and Manitoba, and to a small extent in New Brunswick. Many other outcrops of limestone occur, but, owing to their location and market access, only a few of these can be considered as of potential value. Those now being operated are ideally situated near large industrial areas and have transportation facilities suited to economic production. Limestones, being softer, are better for dressing, with the result that their costs are lower than those of granite. Some limestones take a good polish and make high-quality decorative products. Limestone is used principally for building (both interior and exterior), being dressed to regular or shaped forms for wall facings, sills, lintels, blocks, columns, etc. Various finishes are obtained by hammering, pebbling, chiselling, sawing and hone-polishing.

New Brunswick

A limited amount of limestone for building construction is produced in the Saint John area. In 1959 the province quarried almost double the amount of limestone it produced in 1958.

Quebec

Production of limestone in Quebec increased by 688 tons in 1959 but was slightly lower in value compared with 1958.

A brownish-gray, fine-to-medium-grained, fossiliferous limestone is quarried from several deposits in the St-Marc-des-Carrieres area. Some limestone for building use is quarried in the Montreal area, particularly on Ile Jesus, north of the city.

Ontario

Ontario, the principal limestone producer, accounts for more than 66 per cent of Canada's output. The 1959 output, although slightly above that of 1958, was lower in value owing to the lower prices prevailing for dressed products.

Most of Ontario's production comes from deposits of a dense, hard, gray-blue limestone located in the Niagara Falls area near St. Davids. A dense, buff-to-buff-gray limestone is quarried on the Bruce peninsula, near Wiarton and Owen Sound, and some dark-gray limestone is quarried in the Ottawa area.

Manitoba

A distinctive, mottled, buff-brown-to-gray-brown dolomitic limestone is produced from several quarries a few miles north of Winnipeg. The Manitoba stone is popular with architects and is to be found in structures in many cities in Canada. It has been used effectively in rough and sawn finishes and takes a high polish for decorative use.

Sandstone

Sandstones are used on interior and exterior walls, and for steps, sills, copings, pillars, columns and panelling. Coarser varieties are more suitable for exterior walls, and finer-grained, less porous stones are favored for interior work. The latter stone lends itself more readily to shaping, but ornamentation is used on both types. Specific applications requiring high resistance to abrasion call for sandstones containing strong bonding properties. Rock finishes range from rock-face ashlar to sawn and honed surfaces. Sandstone has limited application in monuments because of its relatively poor polishing quality.

Nova Scotia

Substantial gains in volume and value were made in the sandstone industry in Nova Scotia during 1959.

Practically all of Nova Scotia's sandstone originates from deposits in the Wallace area. The stone is a drab, olive-buff, massive-textured stone suitable for ornamental dressing and building purposes. Stone originating in the Antigonish area is slightly coarser and darker than the Wallace stone.

New Brunswick

New Brunswick's sandstone industry nearly quadrupled in volume and tripled in value in 1959 compared with 1958.

Stone from the Shediac area is of a coarse-grained, hard, drab, olive-gray variety.

Ontario

Ontario, the principal sandstone producer, accounted for 88.0 per cent of the volume and 73.9 per cent of the value of the 1959 output. Production was down by 1,875 tons in volume and $986 in value during 1959 compared with 1958.

There are many quarries along the Caledon Hills, in the stretch where the Medina formation outcrops along the ridge between Georgetown and Orangeville. Stone from these quarries is varicolored in light-buff, brown and deep brown-red shades, which are partly mottled and sometimes speckled or streaked by darker material. A medium-grained, buff-to-cream-colored stone of the Nepean formation is quarried at Bell's Corners, near Ottawa. Many examples of these two types of stone are found in residential and public buildings in the Toronto and Ottawa areas. Some 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 is quarried in Alberta and is used as flagstone.

Marble

Marble is regarded geologically as a metamorphic rock resulting from the recrystallization of limestone. Commercially, it is considered that any calcareous rock capable of taking a polish can be classed as a marble. Serpentine rocks containing little calcium or magnesium carbonate, if capable of taking a polish, are classed as serpentine marbles. Marbles must be of close texture to ensure good polishing and are usually preferred in a variety of intermixed but pleasing colors.

Quebec

Quebec is the only province that produces marble blocks. When dressed, they are used for interior and exterior construction, for ornamental purposes and as monuments. In 1959 Quebec's production of marble was almost 2.5 times the volume and more than double the value of its 1958 output.

Light and dark-gray varieties with some green-mottled white marbles are quarried in the Philipsburgh area south of Montreal near the United States border. This area has also produced black marble. A white-gray marble is obtained in the western part of the Stukely area.

SULPHUR

C.M. Bartley*

During 1959, the significant factor in the Canadian sulphur industry was the recognition that increasing production of natural gas in western Canada for domestic use and export to the United States would soon result in a very large output of sulphur. Natural gas is in demand for industry and household use in both eastern Canada and the northern and western parts of the United States. The inevitable use of the large supplies available in western Canada will be accompanied by the production of sulphur. Sulphur-recovery plants now operating in western Canada are capable of producing 600,000 short tons of sulphur annually. Plants planned for the time when full-scale gas exports are in progress require the production of at least 2,400,000 short tons by 1962 and possibly 4 million short tons by 1970.

At present, world sulphur supplies are in excess of demand,and production is increasing at a faster rate than consumption. The discovery of sulphur resources in several countries in recent years and technical advances that produce a high-purity product have caused domestic production to serve local markets and reduced the dependence of consumers on the traditional suppliers, the Frasch-process producers of the United States. Sulphur consumption is rising, but at a rate lower than present producing capacity.

Production and Trade

Although there are no known deposits of native elemental sulphur in Canada, sulphur or its equivalent in other forms has been produced in this country from native pyrite and pyrrhotite for 90 years. The manufacture of sulphuric acid from sulphur-dioxide gas derived from these sulphides was the basis of one of Canada's earliest chemical industries.

The large-scale production of low-cost high-purity Frasch sulphur during the 1920's made most pyrite-mining operations uneconomic, and the production of pyrite dropped from 416,600 short tons in 1917 to 15,600 short tons in 1925. In some areas, however, pyrite was able to compete with imported elemental sulphur, and the increasing production of base metals in British Columbia, Ontario and Quebec supplied large amounts of low-cost by-product pyrite and pyrrhotite. An increasing demand for sulphuric acid, particularly for the fertilizer and uranium industries, together with improved processes for recovering both sulphur and iron from these sulphides has encouraged their use. In recent years the output of pyrite and pyrrhotite has

(text continued on page 445)

*Mineral Processing Division

Sulphur - Production and Trade

	1959 Short Tons	1959 $	1958 Short Tons	1958 $
Production				
Pyrite and pyrrhotite(1)				
Gross weight	1,099,564	3,433,095	1,191,731	4,248,668
Sulphur content	465,611		512,427	
Sulphur in smelter gases(2)	277,030	2,716,416	241,055	2,361,252
Elemental sulphur(3)	145,656	2,620,787	94,377	1,872,832
Total sulphur	888,297	8,770,298	847,859	8,482,752
Imports				
Brimstone				
United States	327,614	6,834,195	374,201	8,296,929
Mexico	4,815	90,405	1,130	27,262
United Kingdom	1	338	-	-
Total	332,430	6,924,938	375,331	8,324,191
Exports				
Pyrite				
United States		801,544		1,203,705
United Kingdom		217,064		359,510
Netherlands		-		316,036
Total		1,018,608		1,879,251
Other sulphur				
United States	26,526	504,961	2,299	52,766
Alaska	-	-	5,040	108,600
India	-	-	269	9,600
Total	26,526	504,961	7,608	170,966

(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 iron sinter.

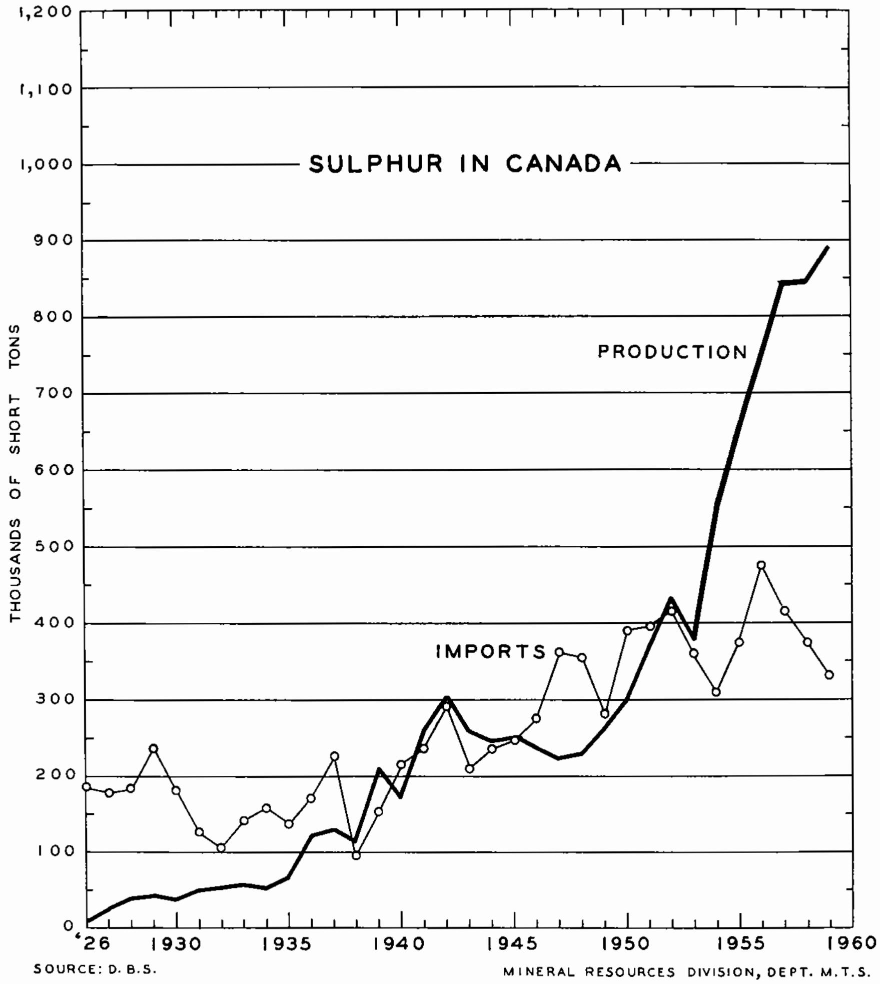
(2) Includes sulphur in acid made from roasting zinc-sulphide concentrates at Arvida, Quebec.

(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.

Sulphur - Production, Trade and Consumption, 1949-59
(short tons)

	Production				Imports	Exports		Consumption
	In Pyrites Shipped (1)	In Smelter Gases (2)	Elemental Sulphur (3)	Total	Brimstone	In Pyrite (4)	Other Sulphur (5)	Elemental Sulphur (6)
1949	117,581	144,290	-	261,871	280,557	90,553	-	328,302
1950	150,487	150,685	-	301,172	390,333	111,652	65	372,347
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	93,338	843,557	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	450,007

(1) Sulphur content of pyrite and pyrrhotite shipped by producers. The figures for 1952-55 include the sulphur content of the acid made by roasting zinc-sulphide concentrate at Arvida, Quebec.
(2) Sulphur in liquid sulphur dioxide and sulphuric acid from the smelting of metal-sulphide ores. The figures for 1956 and the years following include sulphur in acid made from roasting zinc-sulphide concentrate at Arvida.
(3) Elemental sulphur produced from natural gas. The figures for 1952 to 1956 refer to production. From 1957 on, the figures refer to sales. The figures from 1957 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; only the values are published.
(5) Exports of sulphur produced from natural gas and other sources.
(6) Consumption of elemental sulphur by industries. The coverage is incomplete.



been well over 1 million tons annually, and its sulphur content has amounted to half a million tons.

Since the 1920's, international trade in sulphur has been dependent upon and controlled by the Frasch-sulphur production of the United States. However, a sulphur shortage in 1950 and 1951 temporarily increased pyrite usage and at the same time encouraged the search for other sources of sulphur. Largely because of the 1950 shortage, sulphur was found and brought into production in a number of countries that had never produced significant amounts of elemental sulphur before. The new sources consist of both Frasch-type deposits in the United States and Mexico and the elemental sulphur that many countries recover by several different methods from their natural gas, crude oil and sulphide. The sulphur supply now appears to be adequate to all the requirements of the near future, and present production is greater than consumption. Competition has depressed prices, and some redistribution of world markets is taking place because the variation in freight costs from different sources makes appreciable differences in what the consumer must pay.

Sulphur production is increasing in Canada, Mexico and France. The new supplies will probably capture nearby markets formerly supplied with United States Frasch sulphur and then compete for available world markets. Sharing in this readjustment will be Mexican Frasch sulphur, with its low labor costs and freight rates, and Canadian and French sour-gas sulphur, which is a by-product of natural-gas recovery. Under these circumstances, it is unlikely that sulphur prices will increase in the near future.

There is no doubt that the plentiful supplies of pure sulphur will discourage the use of pyrite as a source of sulphur. Frasch companies are reported to offer very attractive prices to users willing to replace pyrite with elemental sulphur. It is unlikely, however, that the major pyrite consumers will change. The reasons for the stability shown by this industry in some areas are complicated, but - to summarize them - low-cost material, location, high processing efficiency and the ready markets for sulphur, iron and other by-products make pyrite competitive with elemental sulphur, particularly in western Europe and Japan.

Pyrite and Pyrrhotite

Pyrite and pyrrhotite are mineral combinations of iron and sulphur. Iron and sulphur are valuable separately, but the difficulty and cost of completely separating them from these minerals has restricted their use. Sulphur-dioxide gas, in dilute concentrations, is readily produced when pyrite or pyrrhotite is heated, but it is technically difficult to recover all the sulphur in this way and produce a sulphur-free iron. Pyrite cannot compete in areas where elemental sulphur is produced but is often a satisfactory source of sulphur (in sulphur-dioxide gas) when the cost of transporting elemental sulphur from producer to consumer is prohibitive. In areas that are not well provided with iron resources, the residue remaining after pyrite is burned has considerable value as iron ore.

The production of pyrite and pyrrhotite in Canada during 1959 amounted to 1,099,564 short tons with a sulphur content of 465,611 short tons. The pyrite and pyrrhotite tonnage is lower by over 92,000 tons than in 1958. The sulphur content is lower than the decrease in sulphide tonnage would indicate because of the consumption of relatively larger amounts of pyrrhotite with a lower sulphur content than pyrite.

During 1959, the companies listed on the next page produced pyrite and pyrrhotite concentrates for their own use or for sale.

Pyrite and pyrrhotite concentrates are consumed in Canada to make sulphur compounds and iron ore, and are exported to other countries for the same purpose.

Large amounts of pyrite and pyrrhotite are produced by base-metal mines in British Columbia, Manitoba, Ontario and Quebec, and additional amounts could be produced from deposits in New Brunswick and Newfoundland.

Producers of Pyrite and Pyrrhotite Concentrates

Company	Location	Use
Consolidated Mining and Smelting Company of Canada Limited, The	Kimberley, B.C.	SO_2 for H_2SO_4
Howe Sound Company*	Britannia Beach, B.C.	Sale
International Nickel Company of Canada, Limited, The	Copper Cliff, Ont.	Iron ore and SO_2 for sulphuric acid
Noranda Mines, Limited*	Noranda, Que.	Iron ore, sulphur, SO_2 and for sale
Waite Amulet Mines, Limited	Noranda, Que.	Iron ore, sulphur, SO_2 and for sale
Quemont Mining Corporation, Limited*	Noranda, Que.	Sale
Normetal Mining Corporation, Limited*	Normetal, Que.	Sale
Weedon Pyrite & Copper Corporation Limited*	Weedon, Que.	Sale

*These companies sell pyrite concentrate to consumers.

Very large amounts are available in known sulphide deposits undeveloped at the present time.

Lorado Uranium Mines Limited produced pyrite during 1958 but closed its pyrite operation and used other sources of sulphur during 1959. In the latter part of 1959, Weedon Pyrite & Copper Corporation Limited, at Weedon, Quebec, closed because of limited ore reserves.

Smelter Gas

Smelter gas, given off during the smelting of sulphide ores, is used at several plants in Canada as a source of sulphur dioxide for the manufacture of sulphuric acid. The Trail plant of The Consolidated Mining and Smelting Company of Canada Limited and the Copper Cliff plant of The International Nickel Company of Canada, Limited, recover sulphur dioxide for acid production. At the latter plant, acid is made by Canadian Industries Limited. At Copper Cliff, concentrated sulphur-dioxide gas from the flash smelting of copper is used by Canadian Industries Limited to produce liquid sulphur dioxide, which is sold to pulp mills.

In 1959, the production of sulphur in smelter gas increased to 277,030 short tons valued at $2,716,416. In 1958, it amounted to 241,055 short tons.

Sherbrooke Metallurgical Company Limited is building a zinc-roasting plant at Port Maitland, Ontario, with an annual sulphur-dioxide capacity of 45,000 tons of sulphur.

Late in 1959, Border Chemical Co. of Winnipeg announced plans for the construction of a 50-ton-a-day sulphuric-acid plant to operate on gas from the roasting of nickel-copper sulphides. Canadian elemental sulphur will be used until roaster gas is available.

Sulphur from Natural Gas

The rapidly increasing production in western Canada of sulphur from natural gas and the building of new plants that are now under construction or are planned for 1960, clearly indicate the development of this new and important Canadian industry. The recommendation that gas should be exported, made in March 1959 by the Alberta Oil and Gas Conservation Board, and the formation of the National Energy Board in October of that year suggest that large-scale gas exports to the United States will be authorized in the near future. The significance of these exports with regard to sulphur is not generally recognized, but provincial-government and private-company officers estimate that by 1965 sulphur production in western Canada will be between 3 million and 4 million short tons a year. When it is noted that producers' shipments in 1959 were about 146,000 short tons, the expected amount of increase is better appreciated. By the end of 1959, the National Energy Board had planned hearings on gas exports for January 1960, and the Conservation Board, in Alberta, had granted increases in the volume of exportable gas, subject to N.E.B. approval.

During 1959, additional discoveries of sour gas were made, notably in Alberta - at Burnt Timber Creek, by Shell Oil Company of Canada, Limited; at Lookout Butte, by The British American Oil Company Limited; and at Wildcat Hills, by Imperial Oil Limited and Western Leaseholds Ltd. It has been noted that as drilling continues in the Foothills area of Alberta and British Columbia, sulphur is being discovered at an accelerated rate. Gas reserves, now estimated to be about 28 trillion* cubic feet, contain sulphur totalling 106 million tons. On the basis of a study of the discovery rate in relation to the number of wells already drilled and the favorable area as yet undrilled, estimates of resources go as high as 75 trillion cubic feet of gas containing 300 million tons of sulphur. These estimates are based on data compiled by the Alberta Oil and Gas Conservation Board. Earlier studies made by the Board were purposely and consistently conservative, and upward revisions may be expected as exploration continues.

The table on page 449 lists sulphur-recovery plants as at the end of 1959 - in operation, under construction, and planned for construction when gas-export contracts are finally approved. The sulphur-production capacity of the first two groups will be more than 800,000 tons a year; for all groups it will be more than 3 million tons a year. It is worth noting that the last group includes four plants larger than the Pincher Creek plant, which at present is one of the

*Trillion = 1 million million.

largest in the world recovering sulphur from gas. The list does not include any plans for the reserves at Panther River, Alberta, whose 87-per-cent content of hydrogen-sulphide gas will probably not be developed until sulphur demand rises and markets are more predictable.

Sulphur Plants

Company	Location	Approximate Percentage H_2S	Capacity (short tons) Daily	Capacity (short tons) Annual*
Producing				
British American Oil Company Limited, The	Pincher Creek, Alta.	10	755	264,000
Jefferson Lake Petrochemicals of Canada Limited	Taylor Flats, B.C.	3	330	115,000
Texas Gulf Sulphur Company	Okotoks, Alta.	35	415	145,000
Shell Oil Company of Canada, Limited	Jumping Pound, Alta.	3	100	35,000
Royalite Oil Company Limited	Turner Valley, Alta.	4	30	10,500
Imperial Oil Limited	Redwater, Alta.	10	10	3,500
Steelman Gas Limited	Steelman, Sask.	1	7	2,450
Standard Oil of California	Nevis, Alta.	6	116	40,000
Total			1,763	615,450
Cumulative total			1,763	615,450
Under construction				
British American Oil Company Limited, The	Homeglen-Rimbey, Alta.	4-8	280	98,000
Canadian Oil Companies, Limited	Innisfail, Alta.	30	123	43,000
British American Oil Company Limited, The	Nevis, Alta.	6	111	39,000
Total			514	180,000
Cumulative total			2,277	795,450

* On basis 350 days' operation a year.

Sulphur Plants (cont'd)

Company	Location	Approximate Percentage H_2S	Capacity (short tons) Daily	Annual*
Plants proposed (not dependent on gas export)				
Imperial Oil Limited	Joffre, Alta.	13	110	38,000
Shell Oil Company of Canada, Limited or Hudson's Bay Oil and Gas Company Limited	Olds, Alta.	10	110	38,000
Mobil Oil Company or British American Oil Company Limited, The	Wimborne, Alta.	30	390	136,000
Total			610	212,000
Cumulative total			2,887	1,007,450
Additional plants necessary for large-scale gas exports				
British American Oil Company of Canada Limited, The, or Shell Oil Company of Canada, Limited	Berland River, Alta.	35	840	292,000
Texaco Exploration Company	Castle River, Alta.	30	560	196,000
?	Central Foothills, Alta.	5	220?	77,000
Jefferson Lake Petrochemicals of Canada Limited	East Calgary, Alta.	35	900	312,000
	Savanna Creek, Alta.	15	670	234,000
Shell Oil Company of Canada Limited	Waterton Park, Alta.	30	1,500?	525,000

* On basis 350 days' operation a year.

Sulphur Plants (cont'd)

Company	Location	Approximate Percentage H_2S	Capacity (short tons) Daily	Annual*
Canadian Fina Oil Co. Limited, Hudson's Bay Oil and Gas Company Limited, Pan American Oil and Gas Company Limited	Whitecourt, Alta.	18	1,500 ?	525,000
Total			6,190	2,161,000
Cumulative total			9,077	3,176,950

*On the basis of 350 days' operation a year.

Consumption of Elemental Sulphur, 1959

	Short Tons
Pulp and paper	252,113
Heavy chemicals	184,352
Rubber goods	2,219
Medicinal uses	8
Adhesives	62
Starch	234
Sugar-refining	157
Petroleum-refining	160
Steel and iron	2,110
Asbestos Products	80
Miscellaneous chemicals	8,127
Miscellaneous non-metallics.............	385
Total	450,007

Sulphur from Sulphide

Sulphur, in its elemental form, is also produced from sulphide materials at two plants in Canada. At Copper Cliff, Ontario, sulphur-dioxide roaster gas from International Nickel's pyrrhotite and iron-ore plant is used to produce elemental sulphur in a pilot plant designed and operated by Texas Gulf Sulphur Company.

Elemental sulphur is recovered by an entirely different process at International Nickel's Port Colborne refinery. High-purity elemental sulphur is produced by the electrolysis of nickel-sulphide matte.

Sulphur from Oil Refineries

During 1959, elemental sulphur was produced by Laurentide Chemicals & Sulphur Ltd. at a plant in Montreal East. The source of this sulphur is hydrogen sulphide recovered from sour crude oils at several refineries in the area. Laurentide sulphur production, which totalled 32,000 tons, was sold to consumers in the Montreal area. It should be noted that sulphur production from this source is not included in Canadian mineral statistics since it is not derived from Canadian materials.

An oil refinery at present under construction by Irving Refining Limited at Saint John, New Brunswick, includes plans for the recovery of elemental sulphur.

Sulphur production in Canada from sources like this is not expected to be large. Foreign crude oils imported into eastern Canada contain sulphur, which is being recovered, but most Canadian and United States crudes are sweet.

World Review

A world-wide review of the sulphur industry shows a continuation and strengthening of the main trends of the past five years. The principal factors are: the addition of several new large-scale sources of high-quality elemental sulphur; an excess of the rate of production over that of consumption, which is expected to continue in the immediate future and is resulting in vigorous competition for markets; a consequent redistribution of sulphur markets on the basis of the relative location of producers and consumers. Sulphur-marketing is further complicated by the fact that two of the new sources are made up of numerous small-volume by-product operations conducted by groups not primarily interested in sulphur. These plants, producing elemental sulphur from oil-refinery waste and sulphide materials, are normally well situated to market their small output locally. Individually, they have only a negligible effect on the major sulphur-producing companies, but their total production, which is considerable, has grown quickly, and there is now a noticeable deterioration of markets in areas once served entirely by the traditional Frasch producers.

During 1959, the established Frasch producers in the United States operated an overseas sales agency, Sulphur Export Corporation, and succeeded in increasing sulphur exports in spite of competition from other sources. This was accomplished by a concerted sales effort aided by low selling prices and the trend toward large shipments (up to 20,000 tons) at low ocean freight rates. Foreign sulphur, for instance, has reached consumers in eastern Canada at shipping rates of less than $3 a ton.

Freeport Sulphur Company completed a 7-mile underwater molten-sulphur pipeline to deliver the production of the offshore Grande Isle mine to shore installations. The mine is expected to be in operation early in 1960 at a rate of up to 5,000 short tons a day. Twelve Frasch sulphur mines operated in the United States during 1959 and produced about 5 million short tons of sulphur. One mine, the Bay Ste. Elaine, closed at the end of 1959.

In Mexico sulphur production by three Frasch producers totalled about 1,540,000 short tons, and exports amounted to 1,140,000, of which the larger part went to the United States. At year-end it was decided to close down one of the Frasch operations, but the other two, controlled by Pan American Sulphur Company and Gulf Sulphur Company, both of the United States, were continuing and other companies were exploring. Mexican sulphur reserves were estimated at more than 51 million short tons.

Elemental-sulphur production capacity at the Lacq sour-gas field in France reached an annual 700,000 tons by mid-1959, and continuing construction will raise this capacity to 1,400,000 tons by the end of 1960. Production in 1959 was 426,000 tons, up from the 128,400-ton output of 1958. The rising French production is expected to find markets in Europe and to displace amounts hitherto imported from the United States and Mexico.

Elsewhere in Europe, sulphur-recovery plants are being built at oil refineries at Hamburg and Cologne. Sulphur plants completed or definitely planned will operate in Australia on smelter gas, in Finland on pyrite, in Italy on gypsum, in Norway on pyrite and in Turkey on smelter gas and gypsum.

A deposit estimated to contain 10 million tons of fine-quality sulphur has been reported found at Pomezia, a few miles southwest of Rome, and development is planned.

In the Communist-bloc countries, sulphur or equivalent sulphur is produced mainly in Russia, Poland and China. In Russia most of the sulphur demand (for sulphuric acid) is satisfied by smelter gas, and it is significant that sulphur is one of the few minerals imported by Russia. Native-sulphur deposits are under development at several places in Russia, and recovery from sour crude oils is planned.

Large, shallow deposits of native sulphur have been found in Poland on the Vistula River and are now in production.

Production in China is apparently greater than consumption, since considerable amounts have been exported to Russia; during 1959, refined sulphur was offered in shipload quantities in Europe and Australia.

The possibility that Communist-bloc sulphur will be offered in amounts and at prices that would affect the international sulphur trade appears to be remote. Word from Communist countries gives no indication of large reserves of Frasch-type or sour-gas sulphur, and it is reported that the rising industrial demand for sulphuric acid is not completely satisfied by domestic sulphur production.

Sulphuric Acid

In 1959, sulphuric-acid production in Canada totalled 1,552,400 short tons, 33,600 less than in 1958. Since 1940, production has increased five-fold from 300,000 tons a year. The decrease in 1959 can be attributed to production cut-backs in the uranium industry. Imports, at 18,489 tons, and exports, at 27,863 tons, show little change from the average of recent years.

The leading consumers of sulphuric acid in Canada are the fertilizer and uranium industries, each of which uses more than 500,000 tons annually. Other important uses are found in iron and steel works, smelting and refining, and the coke and gas industries.

Sulphuric Acid - Production, Trade and Apparent Consumption, 1949-59
(short tons of 100% acid)

	Production	Imports	Exports	Apparent Consumption
1949	707,717	24	17,336	690,405
1950	756,110	332	44,417	712,025
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	29,550	1,261,496
1958	1,586,000	39,345	23,252	1,602,093
1959	1,552,400	18,489	27,863	1,543,026

Consumption of Sulphuric Acid*
(short tons of 100% acid)

	1958	1957
Fertilizers	673,000	668,900
Acids, alkalis and salts	176,300	177,900
Nonferrous smelters and refiners	31,500	29,300
Coke and gas	27,100	28,000
Petroleum-refining	16,300	11,100
Leather-tanning	2,200	2,100
Iron and steel	37,300	31,900
Electrical apparatus	8,600	8,400
Plastics	17,800	16,600
Soap and washing compounds	14,300	13,700
Sugar-refining	300	300
Pulp and paper	15,300	12,400
Vegetable oils	100	100
Adhesives	700	900
Miscellaneous	68,100	85,500
Uranium ore processing	586,700	
Total	1,675,600	1,087,100

*Available data.

Uses

Sulphur is consumed in some form and at some stage in the manufacture of almost everything that is used in an industrial country and is one of the commodities essential to industrial growth. It is usually consumed in sulphuric acid, but in Canada large amounts of elemental sulphur are used by the pulp-and-paper industry. Other consumers are the fertilizer, chemical, uranium and steel industries.

Prices

The Oil, Paint and Drug Reporter of December 28, 1959, quoted the following United States prices per long ton:

Crude, domestic, bright, bulk, f.o.b. mines	$23.50
Crude, export, f.o.b. vessels, Gulf ports	$25.00
U.S. and Canada, f.o.b. vessels, Gulf ports	$25.00
Domestic, dark	$ 1.00 lower
Crude, bulk, imported Mexican, filtered, f.o.b. vessels, Coatzacoalcos	$24.00
Pyrite, Canadian, 48-50% sulphur, f.o.b. mines	$ 5.00 to $6.00

Tariffs

Canada

Sulphur and brimstone, crude or in roll or flour form	free

TALC AND SOAPSTONE; PYROPHYLLITE

J.E. Reeves*

The production of Canadian talc and soapstone in 1959 was 3,218 tons less than in 1958 - an appreciable decline although there was only a minor change in value. The decline was due to a decrease in Quebec output; shipments of Ontario talc were virtually unchanged. Almost twice as much pyrophyllite was shipped from Newfoundland as in 1958.

Imports of ground talc increased more than 11 and 19 per cent in volume and value respectively over those of 1958, thus continuing the fairly steady rise that has been taking place for more than 20 years. They consist mainly of higher-quality grades of ground talc at relatively high unit prices, for use in the paint, ceramic, cosmetic and pharmaceutical industries. A small amount of deeply colored, lower-quality talc is purchased from the United States for use in foundry facings. The 1959 increase was due to an increase in the quantities imported from the United States. A small amount of talc of exceptional quality is imported from Italy for cosmetic and pharmaceutical preparations.

Exports of talc and soapstone showed little change in 1959. Only small quantities have been exported annually in the last 15 years. All pyrophyllite is exported to the United States.

Producing Companies

Quebec

Baker Talc Limited, 215 St. James Street West, Montreal, operates the Van Reet mine near the town of South Bolton in Brome county and produces several lower-priced grades of ground talc at a mill near Highwater, about 10 miles to the south. A program, started in 1956, to enlarge and improve the mill was continued during the year. It included the installation of a rotary dryer to facilitate year-round operations.

Broughton Soapstone and Quarry Company Limited produces some lower-priced grades of ground talc, metalworkers' crayons of soapstone, and a small quantity of refractory soapstone blocks at a mill and plant near Broughton Station in Beauce county. Talc was mined from a deposit about 6 miles northwest of the mill, and soapstone was quarried from a deposit less than 2 miles southwest of it.

---

*Mineral Processing Division

Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production (shipments)				
Quebec (1).............	15,937	185,951	19,226	194,074
Ontario (2)............	8,796	125,903	8,725	125,511
Newfoundland (3)........	14,443	200,275	7,454	109,551
Total..................	39,176	512,129	35,405	429,136
Imports (2)				
United States...........	17,098	639,002	15,179	525,533
Italy	1,403	57,947	1,414	59,133
Total..................	18,501	696,949	16,593	584,666
Exports (5)				
United States...........	1,877	25,654	1,771	22,366
Nicaragua...............	47	634	50	625
Cuba	45	1,050	30	690
Ecuador	32	415	62	807
Other countries	52	2,043	18	225
Total..................	2,053	29,796	1,931	24,713
Consumption(2) available data)	33,563			

(1) Ground talc, soapstone blocks and crayons. (2) Ground talc.
(3) Pyrophyllite. (5) Talc and soapstone only.

Ontario

Canada Talc Industries Limited, at Madoc, Hastings county, operates the Conley and Henderson mines and produces a variety of grades of ground talc. The latter mine yields an especially high-grade white product. Development of the bottom level at the Conley mine was continued.

Newfoundland

Newfoundland Minerals Limited, Box 2043, St. John's, began operations in June 1956 and has continued development of the pyrophyllite deposits near Manuels, about 12 miles southwest of St. John's. The new crushing and screening plant, installed in 1958, was destroyed by fire in September 1959, and for the rest of the year the company shipped crude ore,

Production and Trade, 1949-59
(short tons)

	Production		Imports(2)	Exports(3)
	Talc and Soapstone(1)	Pyrophyllite		
1949	26,922		7,269	4,222
1950	32,604		8,974	4,467
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

(1) Producers' shipments (including minor amounts of pyrophyllite shipped before 1954).
(2) Ground talc.
(3) Talc and soapstone only.

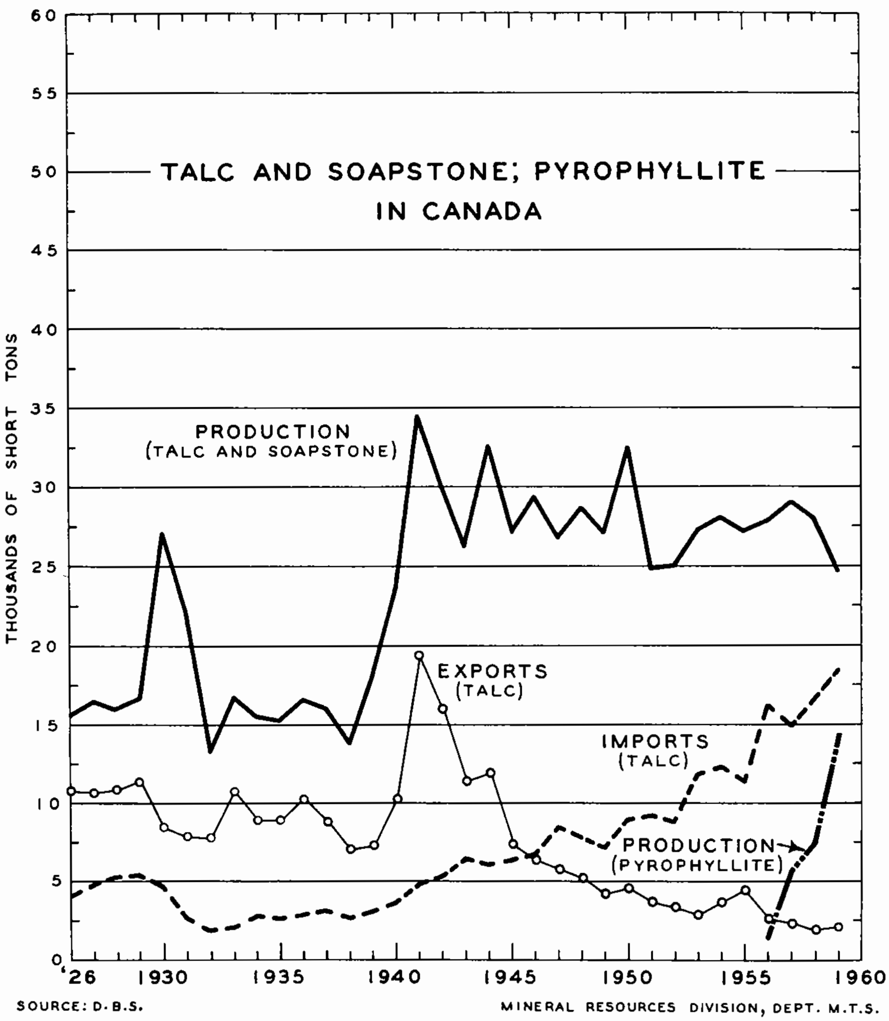
more than 10,000 tons being sent. Production is exported to the parent company, American Encaustic Tiling Company Inc., at Lansdale, Pennsylvania.

Occurrences

Talc and soapstone occur in many localities in Quebec, Ontario and British Columbia.

There are several other deposits of talc in the vicinity of the Van Reet mine in southern Quebec, a number of which were mined extensively for feed for the mill at Highwater before the Van Reet mine became the sole source. In the Thetford Mines area there are numerous deposits from which soapstone was quarried when blocks of it were much more widely used as refractory material.

Deposits of talc occur in many places in southeastern Ontario, and soapstone is not uncommon in the Kenora district. Refractory soapstone blocks were produced in Ontario on a limited basis many years ago, and minor amounts of talc have been obtained from several places, but for a considerable period production in this province has been confined to Madoc.



Many deposits of talc are known to occur in British Columbia and there has been a little mining there, but the smallness of the markets in the West has not encouraged the development of a talc-mining industry.

Pyrophyllite occurs in Newfoundland near Manuels and in British Columbia near Princeton and Semlin in the south-central part of the province and at Kyuquot Sound in the northwestern part of Vancouver Island. The deposits in Newfoundland appear to be the largest and have received intermittent attention for many years.

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 yeilds a white powder on being ground. It is relatively inert chemically and has a low moisture and oil absorption, a high fusion point and low electrical and thermal conductivity.

Most commercial talcs have an appreciable content of other minerals, including serpentine, chlorite, magnesite, tremolite and dolomite. The extent to which these associated minerals should be restricted depends on the particular use. The talc deposits in southern Quebec resulted from the alteration of serpentine rock, contain some unaltered serpentine and iron-bearing minerals such as chlorite, have a variable carbonate (magnesite) content and yield ground products which are somewhat off white. These products are used where color specifications are not exacting. The Madoc deposits represent altered white dolomite and consist principally of talc, tremolite and dolomite in varying proportions. They are low in iron and yield ground products of prime-white color, but because of a variable carbonate (dolomite) content the products are limited in their range of uses.

Soapstone is essentially a massive, 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 a high impurity content.

Pyrophyllite is physically very similar to talc but is a hydrous aluminum silicate. It also is an alteration product, but it has been derived from siliceous rocks and is often accompanied by sericite and quartz. The color is entirely acceptable, but the impurities must be limited.

Uses and Specifications

Talc has a wide range of uses, largely as an industrial filler.

High-quality talcs are used as fillers in the paint, ceramic and paper industries. Color, particle shape, packing index and oil absorption are the principal factors in paint use. The ceramic trade demands prime-white color, and the paper industry talc of high brightness, high retention in the pulp, low abrasiveness and freedom from chemically active substances. Talc of high purity is demanded for the cosmetic and pharmaceutical trades.

Lower-grade talc is used mainly as a dusting agent for asphalt roofing, a filler in joint-sealing compounds and asphalt pipeline enamels, a diluent for dry insecticides and a filler and dusting agent in the manufacture of rubber products. Color and impurity content are generally of little importance, although for asphalt enamels low carbonate is specified to avoid a reaction with soil acids.

Because of its peculiar physical characteristics there are a number of miscellaneous uses for talc, including its use in cleansers plaster, polishes, plastics, foundry facings, linoleum and oilcloth, oil-absorbent preparations and textiles.

Grinding specifications for most uses vary from 95 per cent to 99.8 per cent minus 325 mesh, the trend being toward still finer grinds for some uses. The paint industry demands at least 99.8 per cent minus 325 mesh and in some cases 99.99 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 essentially minus 325 mesh and contain a minimum of quartz and sericite.

Prices

Prices vary considerably according to quality; high purity, fine particle size and a high degree of whiteness command higher prices. There are no published prices for Canadian products; 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¢ per lb
Ground, powdered, pulverized or washed (except toilet preparations)	
Not more than $14 a ton	8 3/4%
More than $14 a ton	15%

COAL AND COKE

COAL

T.E. Tibbetts*

In 1959 the Canadian coal industry continued to suffer from the increasing competition of other fuels. Production dropped by 9.1 per cent to 10,626,722 tons from 11,687,110 tons in 1958. This is the lowest since 1909 and is 44.5 per cent less than the record 19,139,112 tons produced in 1950. Throughout the country, the output of bituminous coal decreased by 10.4 per cent and that of lignite by 13.6 per cent, while the production of subbituminous coal increased by 2.9 per cent.

More than 41 per cent of the coal output was from Nova Scotia, 9.4 per cent from New Brunswick, more than 18 per cent from Saskatchewan, 24 per cent from Alberta and almost 7 per cent from British Columbia and Yukon Territory. Both Alberta and New Brunswick reported an increase in production. In Alberta the decrease in the production of bituminous coal was more than offset by an increase of almost 3 per cent in that of subbituminous. The increase for the province as a whole was 1.2 per cent. The New Brunswick coal industry established a record high of 1,003,387 tons, about 27 per cent more than in 1958.

In Nova Scotia production decreased 16.7 per cent - to 4,391,829 tons in 1959 from 5,269,879 tons in 1958. Saskatchewan and British Columbia reported decreases of 13.6 per cent and 14.0 per cent respectively from their 1958 production.

More than 38 per cent of the coal mined in Canada was from strip mines. Saskatchewan's entire production was from strip mines and accounted for 48.0 per cent of the national strip-mining total. Alberta, where 47.6 per cent of the coal was won by stripping methods, accounted for almost 30 per cent of strip coal production; New Brunswick, where 81.2 per cent of the coal was won by stripping, produced 20.1 per cent. All production in Nova Scotia was from underground mines. Production in British Columbia was mainly from underground mines, only 11.3 per cent coming from strip mines.

---

* Fuels and Mining Practice Division

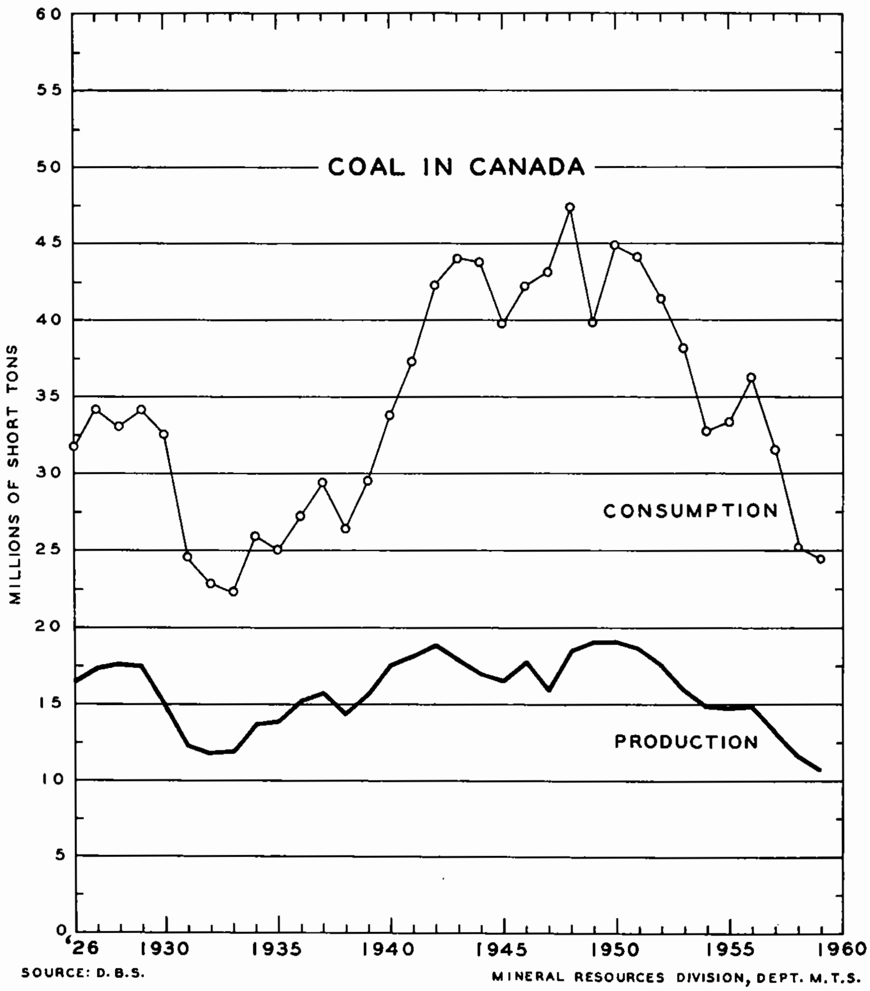
Production of Coal, by Provinces and Territories, 1958 and 1959
(short tons)

		Bituminous*	Subbituminous*	Lignite*	Total
Nova Scotia	1959	4,391,829	-	-	4,391,829
	1958	5,269,879	-	-	5,269,879
New Brunswick	1959	1,003,387	-	-	1,003,387
	1958	790,719	-	-	790,719
Saskatchewan	1959	-	-	1,947,380	1,947,380
	1958	-	-	2,253,176	2,253,176
Alberta	1959	816,275	1,733,883	-	2,550,158
	1958	834,256	1,685,645	-	2,519,901
British Columbia and Yukon Territory	1959	733,968(1)	-	-	733,968
	1958	853,435(2)	-	-	853,435
Total	1959	6,945,459	1,733,883	1,947,380	10,626,722
	1958	7,748,289	1,685,645	2,253,176	11,687,110
Value $	1959	62,448,411	7,681,440	3,746,044	73,875,895
	1958	68,053,797	7,530,049	4,379,481	79,963,327

* Coals classed according to "A.S.T.M. Classification of Coal by Rank - A.S.T.M. Designation D388-38", A.S.T.M. Standards on Coal and Coke.
(1) Includes 3,879 tons from Yukon Territory.
(2) Includes 4,344 tons from Yukon Territory.

Production of Coal, by Type of Mining, 1959

		Short Tons	%
Nova Scotia	Strip mines	-	-
	Underground	4,391,829	100.0
New Brunswick	Strip mines	814,358	81.2
	Underground	189,029	18.8
Saskatchewan	Strip mines	1,947,380	100.0
	Underground	-	-
Alberta	Strip mines	1,214,993	47.6
	Underground	1,335,165	52.4
British Columbia and Yukon Territory	Strip mines	82,765	11.3
	Underground	651,203	88.7
Canada	Strip mines	4,059,496	38.2
	Underground	6,567,226	61.8

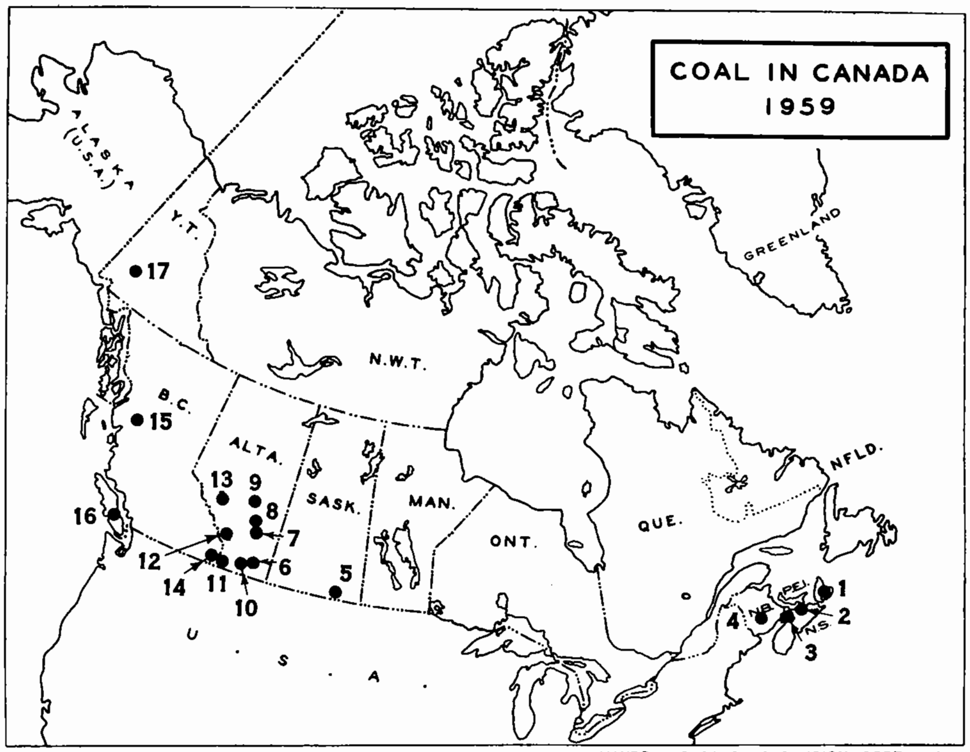


The output per man-day for all mines increased by 0.179 tons to 4.282 tons. This is the highest production average on record. The closing down of low-production mines and increased mechanization in underground mines resulted in a record output average in these mines of 3.003 tons per man-day. A 8.4-per-cent decrease per man-day for strip mines indicated a greater average thickness of cover.

Average Output of Coal per Man-day for Canada, 1958 and 1959
(short tons)

	1959	1958
Strip mines	13.787	15.058
Underground mines	3.003	2.892
All mines	4.282	4.103

(text continued on page 468)



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Coal Areas and Principal Producers
(approximate production in short tons)

Nova Scotia

1. Sydney and Inverness Areas (high-volatile bituminous)

Dominion Coal Co. Ltd.	3,142
Beaver Coal Co. Ltd.	28
Bras d'Or Coal Co. Ltd.	81
Indian Cove Coal Co. Ltd.	44
Old Sydney Collieries Ltd.	676
S.J. Doucet and Sons Ltd.	15
Evans' Coal Mines Ltd.	34

2. Pictou Area (medium- and high-volatile bituminous)

Acadia Coal Co. Ltd.	197
Drummond Coal Co. Ltd.	41
Greenwood Coal Co. Ltd.	19

3. Springhill and Joggins Areas (high volatile bituminous)

Cumberland Fuel and Trading Ltd.	28
Joggins Coal Co. Ltd.	66

New Brunswick

4. Minto Area (high-volatile bituminous)

Lafferty, J.	15
Avon Coal Co. Ltd.	211
Crawford Contractors Ltd.	40
King Mining Co. Ltd.	43
Mills Ltd., D.W. & R.A.	252
Miramichi Lumber Co. Ltd.	234
Newcastle Coal Co. Ltd.	39

New Brunswick (cont'd)

Wasson Ltd., A.W.	27
McMann Ltd., V.C.	63
McEwan Mining Co. Ltd.	19
Norman T. Swift, Ltd.	11
Dufferin Mining Ltd.	35

Saskatchewan

5. Souris Valley Area (lignite)

Manitoba & Saskatchewan Coal Co. Ltd.	571
North West Coal Co. Ltd.	81
Western Dominion Coal Mines Ltd.	859
Old Mac Coal Ltd.	221
Utility Coals Ltd.	215

Alberta

6. Brooks and Taber Areas (subbituminous)

Kleenbirn Collieries Ltd.	12
Alberta Coal Sales Ltd.	40

7. Drumheller, Sheerness and Carbon Areas (subbituminous)

Amalgamated Coals Ltd.	176
Century Coals Ltd.	186
Federated Co-ops Ltd.	51
Midland Coal Mining Co.	22
Murray Collieries Ltd.	21
Red Deer Valley Coal Co. Ltd.	104
Western Dominion Coal Mines Ltd.	167
Subway Coal Co.	11
Nottol Bros.	13

8. Castor, Ardley and Camrose Areas (subbituminous)

Battle River Coal Co. Ltd.	209
Forrestburg Collieries Ltd.	321
Allyn Mann Construction Co.	28
Lynass, John H.	13
Camrose Collieries Ltd.	27

9. Edmonton, Tofield and Pembina Areas (subbituminous)

Black Gem Coal Co. Ltd.	17
Egg Lake Coal Co. Ltd.	27
Star-Key Mines Ltd.	52
White Mud Creek Coal Co. Ltd.	20
Black Nugget Coal Co. Ltd., The	22
Alberta Coal Co. Ltd.	100
Warburg Coal Co. Ltd.	13

10. Lethbridge Area (high-volatile bituminous)

Lethbridge Collieries Ltd.	80

11. Crowsnest Area (medium-volatile bituminous)

Coleman Collieries Ltd.	272
West Canadian Collieries Ltd.	131

12. Cascade Area (low-volatile bituminous and semianthracite)

Canmore Mines Ltd., The	180

13. Coalspur Area (high-volatile bituminous)

Canadian Collieries Resources Ltd.	142

British Columbia

14. East Kootenay (Crowsnest) Area (medium-volatile bituminous)

Crow's Nest Pass Coal Co. Ltd., The	569

15. Northern Area (medium- and high-volatile bituminous)

Bulkley Valley Collieries Ltd.	6

16. Vancouver Island (Comox) Area (high-volatile bituminous)

Canadian Collieries Resources Ltd.	147

Yukon Territory

17. Carmacks Area (high-volatile bituminous) Yukon Coal Co. Ltd. 4

The average value of all Canadian coals increased in 1959 to $6.951 a ton, f.o.b. mines, from $6.842 in 1958. Although the value of New Brunswick bituminous coal dropped slightly, for the country as a whole this type of coal increased in value to $8.990 a ton from the 1958 value of $8.783 a ton. Lignite and subbituminous coals decreased slightly in value.

Comparison of Values of Canadian Coal for 1958 and 1959

		1959		1958	
	Average Btu/lb	Average Value per Short Ton ($)	Average Value per Million Btu (¢)	Average Value per Short Ton ($)	Average Value per Million Btu (¢)
Nova Scotia					
Bituminous	13,180	9.957	37.77	9.554	36.24
New Brunswick					
Bituminous	11,990	8.319	34.69	8.374	35.18
Saskatchewan					
Lignite	7,730	1.924	12.44	1.944	12.66
Alberta					
Bituminous	12,360	6.383	25.77	6.326	25.86
Subbituminous	9,350	4.430	23.69	4.467	23.69
British Columbia					
Bituminous	13,820	6.989	25.29	6.773	24.56
Yukon					
Bituminous	11,450	15.003	65.50	12.979	56.68
Canada					
Bituminous	13,040	8.990	34.47	8.783	33.83
Subbituminous	9,350	4.430	23.69	4.467	23.69
Lignite	7,730	1.924	12.44	1.944	12.66
Average	11,460	6.951	30.33	6.842	29.54

Disposition of Coal*

Nova Scotia and New Brunswick

Nova Scotia produces high- and medium-volatile bituminous coking coals in the Sydney, Cumberland and Pictou areas and some noncoking bituminous coal in the Inverness area. The New Brunswick output, consisting entirely of high-volatile bituminous coking coal mined from one thin seam, comes mainly from the Minto area, a small proportion originating in the Beersville area.

Interprovincial Shipments of Coal, 1959
(short tons)

Destination	Originating Province				
	Nova Scotia	New Brunswick	Saskat-chewan	Alberta	British Columbia
Newfoundland	184,975	-	-	-	-
Prince Edward Island	33,730	-	-	-	-
New Brunswick	282,850	-	-	-	-
Quebec	2,075,798	130,122	-	80	-
Ontario	177,136	498	120,946	52,828	13,618
Manitoba	-	-	997,246	239,503	151,707
Saskatchewan	-	-	-	551,369	3,116
Alberta	-	-	-	-	637
British Columbia	-	-	-	486,613	-
Total	2,754,489	130,620	1,118,192	1,330,393	169,078

A large part of the production from the two provinces is used locally for industrial steam-raising, household and commercial heating and the manufacture of metallurgical coke and as railway locomotive fuel. Of Nova Scotia's total mine production, 62.7 per cent was shipped to other provinces, 81.8 per cent of these shipments going to central Canada. A small amount was exported to the island of St. Pierre. About 13 per cent of New Brunswick's coal production was shipped to central Canada and approximately 7 per cent to the United States.

---

*For detailed information concerning the types and quality of coals mined in Canada, refer to the following publications:

(a) Swartzman, E., Fuels Division. Canadian Coals - Their General Characteristics, Analyses and Classification. Report No. FRL-248. June 1956.

(b) Swartzman, E. Analysis Directory of Canadian Coals. Mines Branch Publication No. 836. 1953.

(c) Swartzman, E. and T.E. Tibbetts. Analysis Directory of Canadian Coals - Supplement No. 1; 1955. Mines Branch Publication No. 850.

Exports of Coal, 1959
(short tons)

Destination	Shipments from Mines(1)						
	From Nova Scotia Mines	From New Brunswick Mines	From Saskat-chewan Mines	From Alberta Mines	From British Columbia Mines	From All Mines	Total Exports(2)
St. Pierre	8,505	-	-	-	-	8,505	9,134
United States	-	70,463	2,564	33,455	40,097	146,579	273,912
Japan	-	-	-	124,719	62,091	186,810	190,722
Total	8,505	70,463	2,564	158,174	102,188	341,894	473,768

(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 particularly to New Brunswick coals going to the United States.

Saskatchewan

Only lignite is produced in Saskatchewan, chiefly from the Bienfait and Roche Percee fields in the Souris area.

About 57 per cent of the output for 1959 was shipped to Manitoba and Ontario for industrial, commercial and household use; the rest, with the exception of a very small amount exported to the United States, was distributed within the province for similar purposes.

Alberta

Practically every type of coal is produced in Alberta. Coking bituminous coals ranging from high- to low-volatile are produced in the Crowsnest and Mountain Park areas. These are mainly industrial steam and railway coals, but commercial and domestic markets are also supplied. Owing to the shrinking market, however, mining has terminated in the Mountain Park area and has been further seriously curtailed in the Crowsnest area. In the Lethbridge, Coalspur and several other areas of the Foothills, lower-rank bituminous noncoking coals are available, but production is at present confined mainly to the Lethbridge and Coalspur areas. The coal in these areas is distributed mainly for household and commercial use, although some is used for industrial steam production. The coal in the Drumheller, Edmonton, Brooks, Camrose, Castor, Carbon, Sheerness, Taber, Pembina and Ardley areas is classed as subbituminous and that in the Tofield, Redcliff and several other areas is on the border between subbituminous and lignitic. These are mainly household and commercial coals, but increasing amounts are being used industrially, especially for thermal-power production. The Cascade area was the only producer of semianthracite, some of which was shipped as far as Quebec, where it competes with imported anthracitic coals.

Approximately 52 per cent of Alberta's coal production was shipped to other provinces. Saskatchewan received 41 per cent of Alberta's coal shipments to other provinces. British Columbia received 37 per cent and Manitoba received 18 per cent. About 2.1 per cent of Alberta's shipments to other provinces went to central Canada. The export of Alberta coking coal to Japan in 1959 increased considerably, some 125,000 tons being supplied to this market.

British Columbia

Bituminous coking coal, ranging from high- to low-volatile, is mined on Vancouver Island and in the East Kootenay (Crowsnest), northern (Telkwa) and Nicola-Princeton areas. Small quantities of subbituminous coal are produced in the Princeton field. In the Crowsnest area, source of about 78 per cent of the province's coal production, medium-temperature (by-product) coke is manufactured, chiefly for industrial consumption in western Canada and the northwestern United States. Mining on Vancouver Island was confined almost entirely to the Comox area in 1959, the coal being used within the province for industrial, commercial and household purposes. Approximately 20.8 per cent of the province's production was shipped to Manitoba and about 1.9 per cent to Ontario. Negligible quantities were shipped to Alberta and Saskatchewan. About 14 per cent was exported to the United States and Japan for blending in the manufacture of metallurgical coke.

Subventions

Assistance was given to marketing Canadian coals by the continuance during 1959 of subvention payments through the Dominion Coal Board. This aid applied to coal exported as well as to interprovincial shipments.

Coal Moved under Subvention, 1958 and 1959
(short tons)

Origin	1959	1958
Nova Scotia	2,154,034	2,370,131
New Brunswick	137,613	120,963
Saskatchewan	111,006	297,892
Alberta and British Columbia	323,813	238,358
Total	2,726,466	3,027,344

Source: Dominion Coal Board.

Imports

There was a decrease of about 2 per cent in the imports of bituminous coal from the United States and an increase of about 3 per cent in all imports of anthracite. The average value of imported bituminous coal decreased to $5.29 a ton from the 1958 value of $5.35, and anthracites decreased to $11.18 a ton from $12.29.

Imports of Coal for Consumption, 1958 and 1959(1)
(short tons)

Country of Origin		Anthracite	Bituminous	Total
United States	1959	1,507,095	12,389,882(2)	13,896,977
	1958	1,490,743	12,640,634(3)	14,131,377
United Kingdom	1959	96,814	-	96,814
	1958	65,275	-	65,275
Total	1959	1,603,909	12,389,882	13,993,791
	1958	1,556,018	12,640,634	14,196,652
Value $	1959	17,934,649	65,524,942	83,459,591
	1958	19,130,513	67,687,832	86,818,345

(1) From Trade of Canada,Dominion Bureau of Statistics; includes briquettes but does not include coal imported and subsequently sold for use on board ships.

(2) Includes lignite (quantities not separately reported) and 24,521 tons of briquettes.

(3) Includes 1,035 tons of lignite and 41,820 tons of briquettes.

Consumption

Consumption of coal decreased by 2.7 per cent in 1959, the use of Canadian coal decreasing by 4.3 per cent and of imported coal by 1.4 per cent from the 1958 total. That these rates of decrease follow the sharp declines of 1957 and 1958 indicates a possible levelling off in consumption.

Continuing to decrease in 1959 under increasing competition from gas and oil,the household and commercial use of coal dropped to 5,611,250 tons from 5,908,913 tons consumed in 1958.

Consumption of Canadian and Imported Coal, 1952-59

	Canadian(1)		Imported(2)		Total
	Short Tons	Percentage of Consumption	Short Tons	Percentage 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

(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.

Consumption of Fuels for Domestic and Building Heating, 1947-59

	Fuel Oil and Distillate(a)	Natural Gas(b)	Manufactured Gas(b)	Coal and Coke(c)
	(barrels)	(M cubic feet)	(M cubic feet)	(short tons)
1947	16,273,423	28,198,903	20,525,540	13,117,157
1948	17,036,106	30,824,172	21,570,466	13,429,436
1949	18,733,890	32,164,544	23,864,281	12,473,258
1950	24,669,930	40,004,435	20,363,572	12,653,394
1951	29,787,032	43,048,025	24,072,327	11,436,717
1952	34,863,926	43,328,304	22,527,092	10,515,475
1953	38,585,104	46,390,654	21,418,959	8,941,428
1954	46,808,256	56,864,148	22,090,283	8,599,993
1955	52,861,644	68,591,360	15,742,947	8,283,432
1956	61,276,831	77,937,257	16,392,636	8,048,673
1957	63,170,085	92,217,497	13,478,976	6,952,821
1958	68,108,400	112,939,734	5,232,899	6,061,924
1959	74,003,859	142,682,865	1,318,286	5,751,361

(a) Consumption of Petroleum Fuels, Dominion Bureau of Statistics.

(b) The Crude Petroleum and Natural Gas Industry, Dominion Bureau of Statistics. Manufactured and natural gas used for household and commercial purposes.

(c) "Sales of Coal and Coke by Retail Fuel Dealers." The Coal Mining Industry. Dominion Bureau of Statistics. Not available prior to 1947.

Consumption of coal by railway locomotives continued to decrease, as it has since 1949, because of dieselization of the railroads. Dieselization gives an increase in apparent efficiency, as indicated by the decrease in fuel consumption from 93 tons in 1949 to 19 tons in 1959 in terms of coal per million gross ton miles of traffic.

Fuel Consumed by Railway Locomotives, 1943-59

	Coal(1)	Fuel and Diesel Oil(1)	Estimated Heat Equivalent of Oil in Terms of Coal(2)	Estimated Heat Equivalent of Oil as Percentage of Total of Coal and Oil
	(thousands of tons)	(millions imp. gal)	(thousands of tons)	
1943	11,987	79.0	538.6	4.3
1944	11,993	80.9	551.6	4.4
1945	12,084	78.3	533.8	4.2
1946	11,632	82.2	560.4	4.6
1947	12,331	86.7	591.1	4.6
1948	12,422	96.3	656.6	5.0
1949	11,444	139.3	949.7	7.7
1950	10,452	217.9	1,485.6	12.4
1951	10,505	260.4	1,775.4	14.5
1952	9,798(3)	291.9	1,990.2	16.9
1953	8,323(3)	308.2	2,101.3	20.2
1954	6,502(3)	326.6	2,226.8	25.5
1955	5,587(3)	384.6	2,622.2	31.9
1956	5,587(3)	444.6	3,031.3	35.2
1957	3,322(3)	419.4	2,859.3	46.3
1958	1,394(3)	390.6	2,662.8	65.6
1959	554	400.2	2,728.6	83.1

(1) Railway Transport, Dominion Bureau of Statistics.

(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 railway briquettes.

Relation of Fuel Consumed by Railway Locomotives to Gross Ton Miles of Traffic(1)

	Traffic in Millions of Gross Ton Miles(2)	Coal and Oil Consumed in Terms of Thousands of Tons of Coal(3)	Fuel Consumed in Terms of Tons of Coal per Million Gross Ton Miles of Traffic	Oil Consumed as Percentage of Total Fuel
1947	138,329.9	12,922	93.4	4.6
1948	136,408.9	13,079	95.9	5.0
1949	133,306.4	12,394	93.0	7.7
1950	133,103.8	11,938	89.7	12.4
1951	148,547.1	12,280	82.7	14.5
1952	156,671.3	11,788	75.2	16.9
1953	151,194.5	10,424	68.9	20.2
1954	162,538.7	8,729	53.7	25.5
1955	178,757.1	8,209	45.9	31.9
1956	203,629.4	8,619	42.3	35.2
1957	184,347.4	6,181	33.5	46.3
1958	162,030.1	4,057	25.0	65.6
1959	173,061.9	3,283	19.0	83.1

(1) Railway Transport, Dominion Bureau of Statistics.

(2) Freight-train cars plus passenger-train cars, exclusive of locomotives and tenders.

(3) Oil has been 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.

Briquettes

Both the production and the consumption of briquettes decreased considerably in 1959. The greatest decline in production was in British Columbia, where the output was 45.2 per cent lower than in 1958. Production in Saskatchewan, from carbonized lignite, decreased by 15.4 per cent. In Alberta 45.5 per cent of production was from the semianthracite of the Cascade area, the remainder from the medium-volatile bituminous coals of the East Kootenay (Crowsnest) area. The province's total production was 22.6 per cent less than in 1958.

About 46 per cent of the briquettes produced in Canada were consumed by the railways. In fact, 93 per cent of British Columbia's production of briquettes went to the railways. Continued dieselization decreased the market for locomotive briquettes by some 36 per cent of 1958 consumption.

Briquettes - Production and Consumption, 1958 and 1959
(short tons)

	1959	1958
Production		
Saskatchewan	34,789	41,142
Alberta	99,499	128,512
British Columbia	18,846	34,396
Total, Canada	153,134	204,050
Consumption		
Briquettes available for consumption (shipments plus imports)	175,008	239,770
Consumption of briquettes by railways	70,609	110,607
Railway consumption as a percentage of the total available	40.3	46.1
Railway consumption as a percentage of all Canadian production	46.1	54.2

Beneficiation

The coal industry continued its efforts to improve the quality of its products by such methods as cleaning, drying, dustproofing, freezeproofing and briquetting. The greatest problem at present is the disposal of fine coal, the proportion of which has risen as mine mechanization has increased. A partial solution has been obtained through modification of mining methods and equipment.

There is a growing need to beneficiate fine coal to give it greater uniformity and a satisfactory ash content for household and industrial use. For this purpose, additional equipment has been installed in some mechanical coal-cleaning plants.

In 1959, at its pilot cyclone plant, where water and heavy-media separations are studied, the Mines Branch continued to investigate coal-cleaning problems. The Branch co-operated with industrial organizations in conducting laboratory and plant-scale coal-cleaning tests, studied the coking properties of coals in relation to their preparation for export markets and their use in prospective steel industries, and continued to investigate methods of briquetting fine coal with and without binders.

COKE

E.J. Burrough*

The pattern of demand and production with respect to coke changed further in 1959. While the plants producing manufactured gas and domestic coke reached the point of near extinction, the capacity for the production of metallurgical coke for the steel and base-metal industries expanded.

The gas industry, which has greatly expanded 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 on liquid petroleum gases is 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 in Canada.

The standard by-product-coke-oven plants are owned and operated by the steel plants, with the exception of a few custom plants built primarily for the production of domestic coke. The increase in blast-furnace capacity in Canadian plants has led to an increase in metallurgical-coke production; a new battery of coke ovens was brought into production during the year at the plant of Dominion Foundries and Steel Limited.

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. An increase in the use of electrical reduction processes 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 Algoma Steel Corporation, Limited, which have reported coke-oven-capacity increases, are considering further expansion. In western Canada proposals have been advanced for the instalment of iron blast furnaces that would require

* Fuels and Mining Practice Division

Coke - Production and Trade

	1959		1958	
	Short Tons	$	Short Tons	$
Production				
From bituminous coal				
Ontario............	3,178,068	49,269,505	2,543,149	36,584,484
Newfoundland, Nova Scotia, New Brunswick and Quebec	777,631	14,089,144	766,036	13,804,373
Manitoba, Alberta and British Columbia.........	134,134	1,789,906	173,920	2,253,102
Total	4,089,833	65,148,555	3,483,105	52,641,959
Of pitch coke	3,463	67,097	8,155	163,278
Of petroleum coke ...	529,580	5,011,026	462,797	5,638,024
Total	4,622,876	70,226,678	3,954,057	58,443,261
Bituminous coal used* to make coke				
Imported	4,824,928	51,105,124	3,984,994	42,665,692
Canadian	812,168	8,860,954	795,021	8,415,402
Total.............	5,637,096	59,966,078	4,780,015	51,081,094
Imports (all types)				
United States	697,220	10,940,563	605,609	9,205,703
United Kingdom......	195	4,521	87	2,900
Total	697,415	10,945,084	605,696	9,208,603
Exports (all types)				
United States	138,858	1,935,040	117,733	1,545,570
United Kingdom......	27,175	1,207,990	23,949	1,097,018
Other countries......	9,987	200,529	3,520	132,596
Total	176,020	3,343,559	145,202	2,775,184

*Includes additional volumes of coke (used as catalytic carbon) not reported prior to 1958.

additional coke-oven capacity. In British Columbia a new electrical reduction plant was installed, and for other western areas new plants of this type were proposed which will require some form of low-volatile fuel such as coke or coke breeze for use as a reduction medium.

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

The manufacture of by-product coke in Canada is usually standardized 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 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.

Pitch coke is produced in Canada only from surplus coal-tar pitch that is not required for such other industrial uses as the production of electrodes or briquettes.

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 coking stoker-type 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 six plants in eastern Canada, namely: Dominion Steel and Coal Corporation, Limited, at Sydney, Nova Scotia, with rated annual capacity of 1,001,900 tons of coal; Quebec Natural Gas Corporation, at Ville La Salle, Quebec, with rated annual capacity of 656,000 tons; Algoma Steel Corporation, Limited, with a metallurgical-coke plant at Sault Ste. Marie, Ontario, which has a rated annual capacity of 2 million tons; Hamilton By-Product Coke Ovens Limited, at Hamilton, Ontario, with a rated annual capacity of 415,000 tons; Dominion Foundries and Steel Limited, at Hamilton, with an annual capacity of 930,000 tons; and The Steel Company of Canada, Limited, at Hamilton, with a rated capacity of 1,470,000 tons of coal a year.

NATURAL GAS

R.L. Borden**

The year 1959 was a period of consolidation for the natural-gas industry. No new major gas pipelines were placed in operation, although additions to established lines exceeded 3,000 miles. The main market areas of eastern Canada were made accessible to western gas in 1957-58, and gas production and sales then rose rapidly. The net production of natural gas, which in 1958 was slightly less than 338 million Mcf,* rose in 1959 to more than 433 million Mcf.

The production of natural gas is shown by provinces in the table on page 481, which in addition to the gross quantity produced, gives waste and net output. Both net and gross production reached record levels. At the same time, gas flared and wasted declined to 60 million Mcf. This is still excessive, but government and the industry have been cooperating in recent years to reduce the waste, which in 1959 was about 24 per cent lower than in 1958.

Alberta accounts for more than 70 per cent of the national output, followed by British Columbia with 16.6 per cent Saskatchewan with 8 per cent and Ontario with 4 per cent. The remainder came from New Brunswick and the Northwest Territories.

The most important producing fields are given by province in the table on page 482.

The value of net production exceeded $39 million, rising more than 23 per cent over that of 1958. The average value per unit, however, increased only slightly, as shown in the table on page 483.

Exploration and Development

Natural-gas discoveries made in western Canada in 1959 are indicated by the numbered stars on the map on page 486. These discoveries are largely removed from established fields and available pipeline facilities, and their development will depend upon market demand.

---

*Mcf = 1,000 cubic feet.

**Mineral Resources Division

Production of Natural Gas

	1959 Mcf[1]	1959 $	1958 Mcf[1]	1958 $
Gross production				
New Brunswick	117,502		123,957	
Ontario	16,839,236		16,147,986	
Saskatchewan	54,073,202		42,568,346	
Alberta	352,733,681[2]		294,398,314[2]	
British Columbia...	69,956,418		64,051,785	
Northwest Territories	67,189		24,100	
Total, Canada	493,787,228		417,314,488	
Field Waste				
Saskatchewan	20,460,236		23,748,551	
Alberta	39,270,198		55,348,723	
British Columbia...	827,710		413,488	
Total, Canada	60,558,144		79,510,762	
Net production				
New Brunswick	117,502	188,394	123,957	197,199
Ontario	16,839,236	6,516,784	16,147,986	5,974,755
Saskatchewan	33,612,966	3,327,684	18,819,795	1,881,980
Alberta	313,463,483	24,995,790	239,049,591	20,080,166
British Columbia...	69,128,708	4,558,023	63,638,297	3,915,239
Northwest Territories	67,189	22,718	24,100	8,197
Total, Canada	433,229,084	39,609,393	337,803,726	32,057,536

* All 1959 figures are subject to revision.
(1) Mcf = 1,000 cubic feet.
(2) Includes withdrawals from storage of 15,894,557.

British Columbia

Natural-gas exploration and development were highlighted by the outlining of a potentially important new gas region in the Fort Nelson area. Two major gas discoveries - the Kotcho Lake(1)** and the Petitot River(2) - together with 'step-out' discoveries at the Clarke Lake field, indicated a large reserve of natural gas in the Devonian Slave Point formation. In addition, important discoveries at Bubbles and Jedney helped to establish two new gas

**The numbers in parentheses refer to the numbers on the map on page 486.

Natural-gas Fields Producing 7.5 Million Mcf or More

	1959	1958
Alberta	(Mcf)	(Mcf)
Pincher Creek	36,806,053	18,589,168
Pembina	34,948,221	34,412,892
Cessford	28,300,309	4,306,600
Turner Valley	25,975,430	24,373,934
Jumping Pound	25,580,262	26,282,574
Provost	15,421,064	11,124,629
Leduc-Woodbend	13,422,872	13,814,401
Alexander	11,998,424	7,536,814
Viking-Kinsella	11,221,766	24,716,158
Pouce Coupe	9,971,383	10,818,305
Gordondale	9,587,780	9,195,784
Medecine Hat	12,978,531	8,485,630
British Columbia		
Fort St. John	16,922,625	26,158,789
Buick Creek West	13,863,729	9,579,318
Fort St. John Southeast	11,020,214	13,714,423
Saskatchewan		
Coleville-Smiley	16,593,758	12,663,937
Steelman	17,085,903	12,418,381

fields, which were placed in production late in 1959. A significant gas discovery in the Mississippian formation was made at Lilly (3).

Alberta

There were three important Mississippian discoveries. The Lookout Butte (4) discovery extended the gas-producing trend along the Foothills to within 6 miles of the United States border. The other significant Mississippian discoveries were the Burnt Timber (5), which is 65 miles northwest of Calgary, and the Brazeau River (6), which is 30 miles southwest of the Pembina oil field. An important Devonian D-3 discovery was made at Worsley (7), in the Peace River district.

Saskatchewan and Manitoba

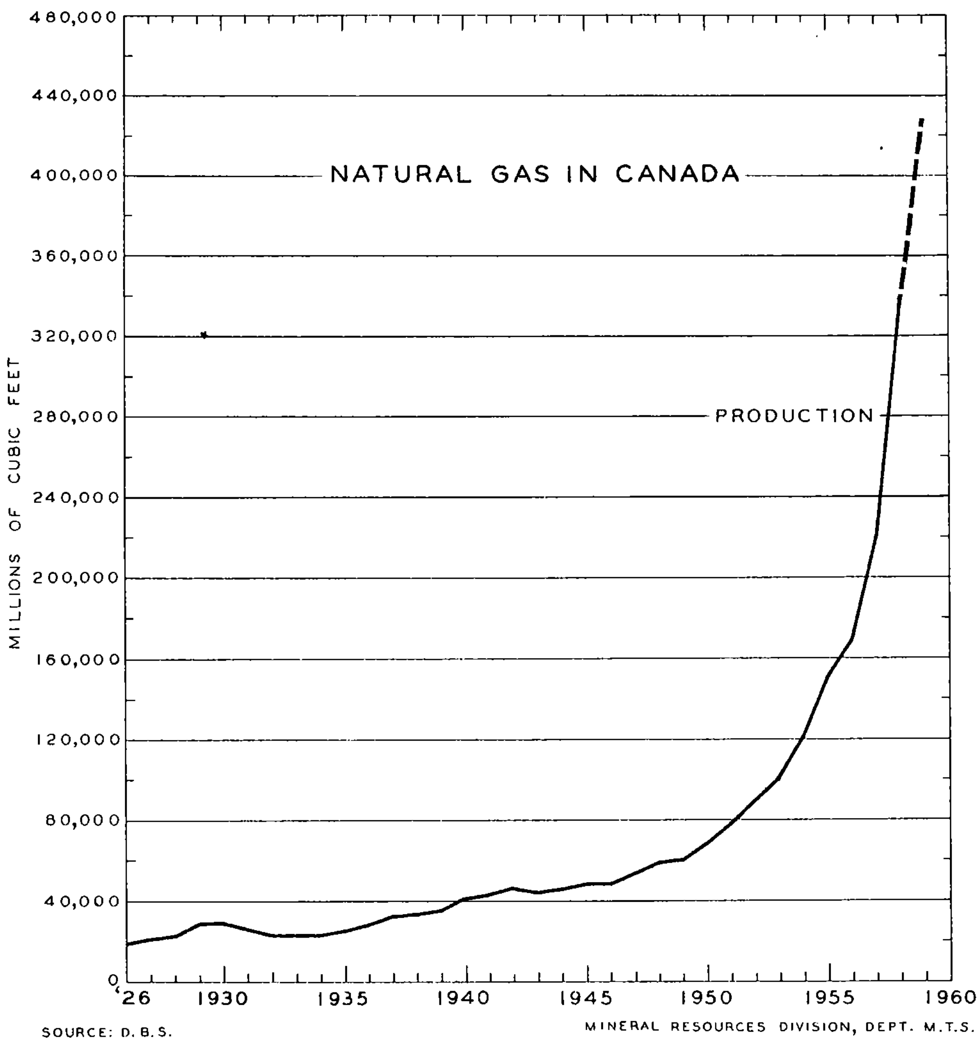
There were no important hydrocarbon-gas discoveries in Saskatchewan and Manitoba. In Saskatchewan, however, natural gas containing significant quantities of helium was made at Wilhelm (8), which is about 10 miles north of Swift Current.

Value of Gas Production

	1956		1957		1958		1959	
	Total Value ($)	Value per Mcf (¢)	Total Value ($)	Value per Mcf (¢)	Total Value ($)	Value per Mcf (¢)	Total Value ($)	Value per Mcf (¢)
Alberta*	10,960,042	7.50	13,735,562	7.5	20,080,166	8.4	26,351,784	8.4
British Columbia	20,193	10.75	366,867	4.4	3,915,239	6.15	4,662,251	6.6
Saskatchewan	980,770	10.0	1,368,647	9.8	1,881,980	10.0	3,025,167	9.9
Northwest Territories	6,938	32.7	6,446	33.5	8,197	34.0	22,844	33.8
Ontario	4,740,298	37.0	5,328,338	37.0	5,974,755	37.0	6,204,225	38.7
New Brunswick	141,315	74.3	156,641	88.8	197,199	159.0	123,377	160.3
Total, Canada	16,849,556	9.96	20,962,501	9.5	32,057,536	9.5	40,389,648	9.3

*These figures include the value of gas withdrawn from storage except in 1959.

Source: Dominion Bureau of Statistics.



Yukon and Northwest Territories

Exploration in this region was encouraged by the oil-and-gas discovery in the Eagle Plains region of Yukon Territory. The discovery was made in a section of more than 100 feet believed to be of Carboniferous age. This is the most northerly oil-and-gas discovery in Canada.

Drilling

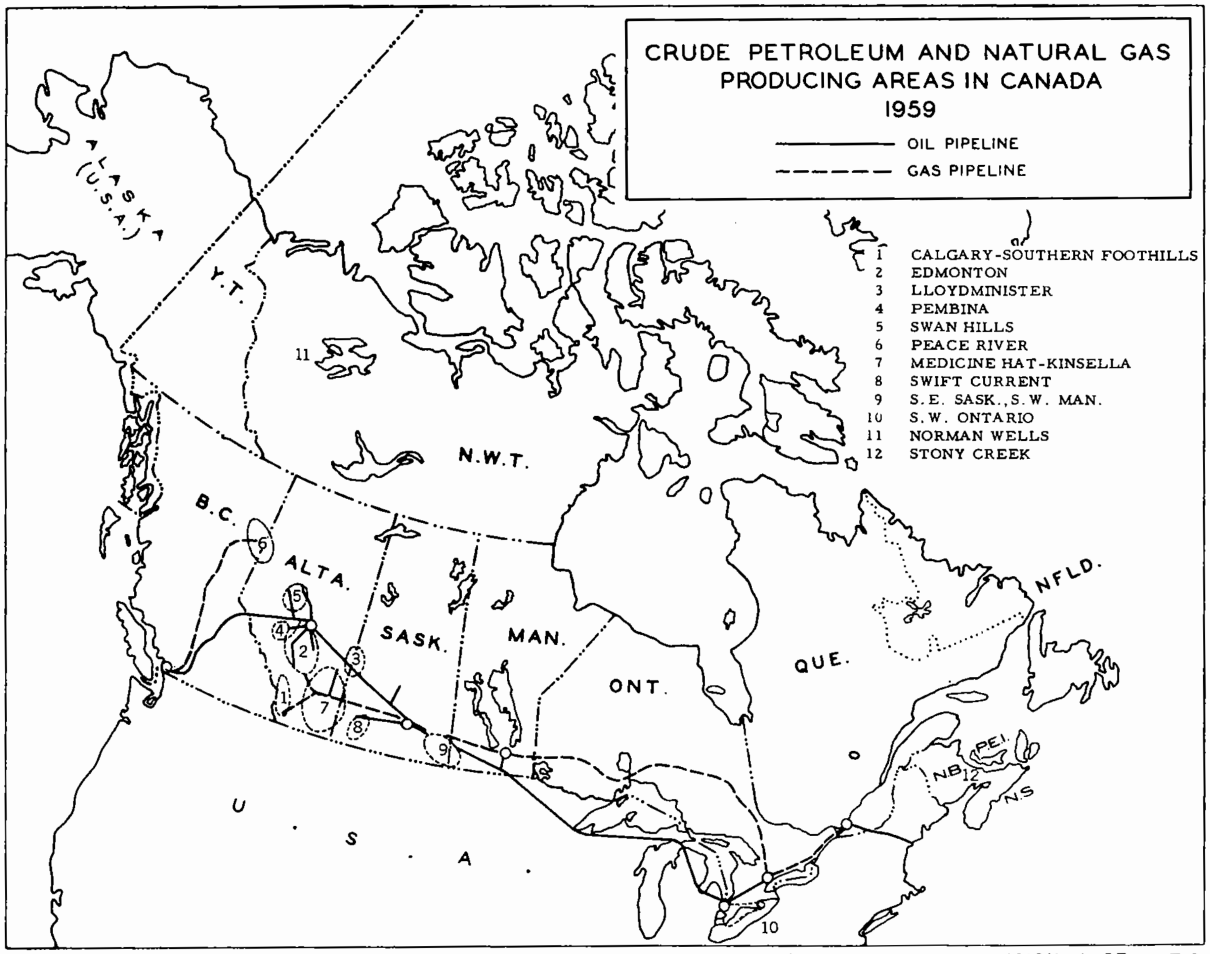
There was a 5-per-cent decline in drilling for the country as a whole, the drop in western Canada amounting to 3 per cent. The following tables show all wells completed in 1959 and 1958 together with the footage drilled.

(text continued on page 487)

Wells Completed in Canada, 1958-59

	Exploratory Wells				Development Wells				Total			
	Oil	Gas	Dry	Total	Oil	Gas	Dry	Total	Oil	Gas	Dry	Total
					1959(1)							
Alberta	86	115	348	549	781	131	90	1,002	867	246	438	1,551
Saskatchewan	44	7	214	265	433	5	74	512	477	12	288	777
British Columbia	3	20	43	66	17	21	11	49	20	41	54	115
Manitoba	3	0	14	17	26	0	2	28	29	0	16	45
Northwest Territories	0	0	8	8	0	0	0	0	0	0	8	8
Total, western Canada	136	142	627	905	1,257	157	177	1,591	1,393	299	804	2,496
Ontario	3	5	108	116	16	95	54	165	19	100	162	281
Quebec	0	0	6	6	0	0	0	0	0	0	6	6
Maritimes	0	0	8	9	0	0	0	0	0	0	8	8
Total, eastern Canada	3	5	122	130	16	95	54	165	19	100	176	295
Total, Canada	139	147	749	1,035	1,273	252	231	1,756	1,412	399	980	2,791
					1958(2)							
Alberta	60	87	336	483	899	149	104	1,152	959	236	440	1,635
Saskatchewan	32	6	184	222	475	12	94	581	507	18	278	803
British Columbia	5	10	40	55	12	12	11	35	17	22	51	90
Manitoba	1	0	15	16	60	0	16	76	61	0	31	92
Northwest Territories	0	0	9	9	0	0	0	0	0	0	9	9
Total, western Canada	98	103	584	785	1,446	173	225	1,844	1,544	276	809	2,629
Ontario	3	7	94	104	19	142	88	249	22	149	182	353
Quebec	0	0	13	13	0	0	0	0	0	0	13	13
Maritimes	0	0	5	5	0	0	0	0	0	0	5	5
Total, eastern Canada	3	7	112	122	19	142	88	249	22	149	200	371
Total, Canada	101	110	696	907	1,465	315	313	2,093	1,566	425	1,009	3,000

(1) American Association of Petroleum Geologists.
(2) Provincial-government departments and agencies.



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Footage Drilled in Canada, by Provinces, 1958-59

	Exploratory	Development	All Wells
	1959		
Alberta	2,697,473	6,112,071	8,809,544
Saskatchewan	1,029,568	2,200,393	3,229,961
British Columbia	391,653	223,208	614,861
Manitoba	42,044	58,600	100,644
Northwest Territories	25,322	0	25,322
Total, western Canada	4,186,060	8,594,272	12,780,332
Ontario	193,735	209,132	402,867
Quebec	12,066	0	12,066
Maritimes	34,381	0	34,381
Total, eastern Canada	240,182	209,132	449,314
Total, Canada	4,426,242	8,803,404	13,229,646
	1958		
Alberta	2,609,738	6,506,974	9,116,712
Saskatchewan	907,164	2,474,906	3,382,070
British Columbia	361,035	123,252	484,287
Manitoba	34,323	163,961	198,284
Northwest Territories	36,493	0	36,493
Total, western Canada	3,948,753	9,269,093	13,217,846
Ontario	178,820	294,298	473,118
Quebec	26,149	0	26,149
Maritimes	30,630	0	30,630
Total, eastern Canada	235,599	294,298	529,897
Total,Canada	4,174,825	9,591,139	13,765,964

Development drilling was done mainly in the Waterton, Carstairs, Wildcat Hills, Pine Creek and Medicine Hat fields in Alberta and in the Jedney and Bubbles fields in British Columbia. This work, along with new discoveries, increased Canada's proven reserves of natural gas by about 3,800 million Mcf.

Reserves

According to a compilation by the Canadian Petroleum Association, a total of 3,808,303,000 Mcf was added to Canada's proven recoverable reserves of natural gas during 1959. Allowing for the year's production, proven recoverable reserves at the end of 1959 totalled 26,605,336,000 Mcf. The reserves are given on a provincial basis in the following table.

Estimated Proven Recoverable Reserves of Natural Gas

	(Mcf)
Alberta	23,300,669,000
British Columbia	1,825,238,000
Saskatchewan	1,235,592,000
Ontario	208,967,000
Northwest Territories	32,063,000
Manitoba	1,959,000
New Brunswick	848,000
Total	26,605,336,000

Transportation

The two main components of Canada's natural-gas pipeline system are Westcoast Transmission Company Limited and Trans-Canada Pipe Lines Limited. Westcoast takes gas gathered in the Peace River district of British Columbia and Alberta and carries it southward through British Columbia to Vancouver and the United States border. It serves distribution companies in the interior of British Columbia and the Vancouver area and, in addition, supplies a line in the United States Pacific Northwest. Trans-Canada takes gas gathered in Alberta by Alberta Gas Trunk Line Company Limited and transports it to distribution companies in Saskatchewan, Manitoba, Ontario and Quebec. By the end of 1958, natural gas was being carried to market by more than 26,000 miles of pipeline of all types.

Preliminary figures show that more than 3,000 miles of transmission and distribution lines were laid in 1959, or about two thirds of the mileage of the same type of pipeline that was installed in 1958. The build-up of pipeline mileage is shown in the table on the next page.

No new major gas pipelines were placed in operation during 1959, but important extensions were made by three companies. Westcoast Transmission extended its gathering facilities in the Peace River area, adding 30 miles in British Columbia to connect the Jedney and Bubbles fields to its system, and 9 miles in Alberta fields to make contact with new wells. Alberta Gas Trunk Line added 256 miles of pipeline to its facilities, connecting the new Carstairs, Makepeace and Medicine Hat fields and extending its system to the Nevis gas-processing plant, which utilizes gas from several fields in the area. The Saskatchewan Power Corporation was the most active builder of pipeline additions, adding 25.6 miles of gathering lines, 334 miles of trunk

Gas-pipeline Mileage in Canada

	1954	1955	1956	1957	1958	1959
Gathering[1]						
New Brunswick	21	21	10	10.6	10.6	10.6
Ontario	2,079	2,166	851	941.2	940.4	955.4
Saskatchewan	188	474	99	91.8	311.3	355.3
Alberta	1,820	1,915	948	972	1,633.8	1,733.3
British Columbia	6	6	6	120.5	212.5	253.2
Total	4,114	4,582	1,914	2,136.1	3,108.6	3,307.8
Transmission[2]						
New Brunswick	-	-	11	11.4	11.4	11.4
Quebec	-	-	-	26.5	26.5	26.5
Ontario	-	-	1,284	2,519.6	3,466.1	3,528.6
Manitoba	-	-	-	354	375	391.3
Saskatchewan	-	-	635	1,093.2	1,395	1,782.9
Alberta	-	-	1,797	2,127.3	2,581	3,096.5
British Columbia	-	-	37	1,101.6	1,101	1,103.5
Total	-	-	3,764	7,233.6	8,957	9,940.7
Distribution						
New Brunswick	65	65	65	65.4	65.4	65.4
Quebec	-	-	-	962.5	971.1	1,027.4
Ontario	3,560	3,778	4,667	5,769.9	8,094.9	9,144.3
Manitoba	-	-	146	433	509.8	690.3
Saskatchewan	80	162	339	879.3	946.7	1,060.0
Alberta	1,506	1,672	1,879	2,075	2,201.9	2,465.5
British Columbia	5	6	925	1,902	2,379.9	2,709.3
Total	5,216	5,683	8,021	12,087	15,169.7	17,162.2

(1) Includes transmission lines for 1954 and 1955.

(2) Does not include 210 miles of Trans-Canada line laid in the Prairie Provinces in 1956.

line and 400 miles of distribution lines. In 1959 the system that serves the more northern areas with gas from the Coleville and Brock areas was joined, by the Corporation, to the southern system, which is connected to larger supplies of natural gas in Saskatchewan and Alberta. All cities in Saskatchewan are now linked to supplies of natural gas.

Processing of Natural Gas

The natural-gas-processing industry has progressed concurrently with the construction of the main gas-transmission pipelines, which have brought natural gas to large consuming areas between Vancouver and Montreal. Processing has developed because much of the gas found in Alberta and British Columbia contains such components as propane, butane, natural gasoline and sulphur, which must be largely removed to make the gas salable. Hence, to meet the gas requirements of pipeline companies, natural-gas-processing has been greatly increased. The following table gives the plants that operated in 1959 and their capacities.

Natural-gas-processing Plants in Canada

Fields Served	Raw-gas Capacity (thousand Mcf/day)	Residue Gas Produced (thousand Mcf/day)
Alberta		
Alexander	55	52
Carstairs	75	66
Cessford	125	120
Provost	90	85
Consort	17	12
Rosedale	6	5
Hussar	37	36
Jumping Pound	110	90
Makepeace	10	9
Leduc-Woodbend	35	31
Morinville	25	24
Nevis	35	24
North Nevis	48	43
Okotoks	30	12
Oyen	3	3
Pembina	91	74
Pembina	8	7
Pigeon Lake	30	27
Pincher Creek	196	145
Princess	22	21
Princess	13	12
Redwater	11	8

(table continued)

Natural-gas-processing Plants in Canada (cont'd)

Fields Served	Raw-gas Capacity (thousand Mcf/day)	Residue Gas Produced (thousand Mcf/day)
Alberta (cont'd)		
Samson	4	3
Turner Valley	100	85
Turner Valley	10	9
Windfall	30	*
Acheson	7	6
Total	1,223	1,009
Saskatchewan		
Coleville	60	56
Alida	9	6
Smiley	3	3
Steelman	33	26
Total	105	91
British Columbia		
All fields	330	300
Total, Canada	1,658	1,400

*This plant is recycling gas and removing condensate, which is sold.

By-products from Natural Gas, Alberta and British Columbia, 1950-59

	Propane (barrels)	Butane(1) (barrels)	Natural Gasoline (barrels)	Condensate (barrels)	Sulphur (short tons)
1950	141,070	33,906	446,384	-	-
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	913,672	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

(1) Includes Propane-butane mix.

Markets and Trade

The general increase in natural-gas production was the result of an increase in domestic sales and the consequent additional fuel requirements of the processing facilities. In spite of a decline in exports, the demand for Canadian gas increased by more than 21 per cent, the average daily requirement being 1.17 million Mcf in 1959 and 0.96 million Mcf in 1958.

The following table gives the make-up of gas supply for 1958 and 1959, as well as a recapitulation of the use of that supply.

Natural Gas - Supply and Demand

(Mcf)

	1959	1958
Supply		
Net new production*	417,334,527	334,464,505
Changes in storage		
Out of storage	27,542,092	7,392,421
Into storage	-30,082,378	-26,055,958
Net changes in storage	- 2,540,286	-18,663,537
Total supply of domestic origin	414,794,241	315,800,968
Imports	11,962,811	34,716,151
Total supply	426,757,052	350,517,119
Demand		
Export	83,251,000	91,705,547
Domestic sales		
Residential	97,937,027	75,137,525
Industrial	141,694,838	93,305,201
Commercial	43,485,254	37,802,209
Miscellaneous	112,970	308,235
Total domestic sales	283,230,089	206,553,170
Line pack	4,593,949	4,204,070
Adjustment for pressure differences	7,419,059	5,877,905
Consumption and metering differences	52,713,326	40,227,028
Gas not accounted for	-4,450,371	1,949,399
Total demand	426,757,052	350,517,119

*Does not include field waste.

An analysis of sales of natural gas in Canada shows that the Ontario market had the largest volume increase, which amounted to 28.6 million Mcf. The increases in other provinces were as follows: Alberta, 23.5 million Mcf; Saskatchewan, 9.4 million; British Columbia, 8.0 million; Manitoba, 4.3 million; and Quebec, 1.8 million. In New Brunswick, consumption declined by 4.4 million cubic feet. The sales of natural gas by province and use are shown in the following table.

Sales of Natural Gas, 1959*

	Mcf	$	$/Mcf	Number of Customers Dec. 31, 1959
New Brunswick				
Residential	93,893	231,447	2.47	3,201
Industrial	-	-	-	-
Commercial	317	1,031	3.25	7
Miscellaneous	-	-	-	-
Total	94,210	232,478	2.47	3,208
Quebec				
Residential	3,114,828	6,334,676	2.03	220,747
Industrial	1,060,673	1,237,292	1.17	1,121
Commercial	945,400	1,691,868	1.79	10,929
Miscellaneous	-	-	-	-
Total	5,120,901	9,263,836	1.81	232,797
Ontario				
Residential	36,981,312	48,586,884	1.31	422,899
Industrial	37,020,128	21,345,965	0.58	3,846
Commercial	9,166,766	10,547,778	1.15	29,508
Miscellaneous	4,245	3,837	0.90	7
Total	83,172,451	80,484,464	0.97	456,260
Manitoba				
Residential	2,960,104	2,503,514	0.85	21,175
Industrial	4,307,857	1,523,180	0.35	177
Commercial	1,302,136	971,098	0.75	1,921
Miscellaneous	9,850	7,271	0.74	4
Total	9,579,947	5,005,063	0.58	23,277

(table continued)

Sales of Natural Gas, 1959 (cont'd)

	Mcf	$	$/Mcf	Number of Customers Dec. 31, 1959
Saskatchewan				
Residential	8,132,140	6,276,696	0.77	47,286
Industrial	16,785,907	3,437,987	0.20	272
Commercial	3,785,281	2,130,156	0.56	4,663
Miscellaneous	35,500	12,447	0.35	16
Total	28,738,828	11,857,286	0.41	52,237
Alberta				
Residential	37,912,970	16,235,021	0.43	171,412
Industrial	74,397,861	10,561,788	0.14	522
Commercial	25,016,352	7,755,106	0.31	17,579
Miscellaneous	61,638	16,388	0.27	84
Total	137,388,821	34,568,303	0.25	189,597
British Columbia				
Residential	8,741,780	11,022,811	1.26	91,654
Industrial	8,122,412	3,334,777	0.41	236
Commercial	3,269,002	4,011,689	1.23	13,699
Miscellaneous	1,737	1,102	0.63	11
Total	20,134,931	18,370,379	0.91	105,600
Canada				
Residential	97,937,027	91,191,049	0.93	978,374
Industrial	141,694,838	41,440,989	0.29	6,174
Commercial	43,485,254	27,108,726	0.62	78,306
Miscellaneous	112,970	41,045	0.36	122
Total	283,230,089	159,781,809	0.56	1,062,976
Previous totals				
1958	206,553,170	115,242,246	0.56	1,035,591
1957	168,783,456	83,163,566	0.49	645,646
1956	143,725,649	64,652,458	0.45	514,162

National Energy Board

An Act to establish a National Energy Board was assented to on July 18, 1959, and came into effect the following October 30. It regulates, among other things, the interprovincial and international movement of gas and the construction of pipelines that cross provincial and national boundaries.

PETROLEUM

R.A. Simpson*

Production of crude petroleum increased in 1959 to the highest level in history. The 184,778,497 barrels of crude oil produced were almost 12 per cent over the 1958 output and about 1.6 per cent over the previous record level, reached in 1957. All producing areas except New Brunswick, Manitoba and the Northwest Territories turned out more than in 1958. Alberta's increase of 16.7 million barrels contrasted strikingly with the 24.2-million-barrel decline that occurred in 1958. Saskatchewan's moderate increase of 2.8 million barrels is also in marked contrast with its 7.7-million-barrel increase of 1958. In 1959, Manitoba's decline amounted to 0.7 million barrels; its 1958 decline to less than 0.3 million. Ontario made an all-time record, exceeding the 829,104 barrels produced in 1894. Production in New Brunswick continued to decline.

Alberta accounted for 70.3 per cent of Canada's production (68.4 per cent in 1958), Saskatchewan for 25.7 per cent (27.0 per cent in 1958), Manitoba for 2.7 per cent (3.5 per cent in 1958) and Ontario, British Columbia, the Northwest Territories and New Brunswick for the remaining 1.3 per cent (1.1 per cent in 1958).

There were 12,522 producing oil wells in western Canada at the end of 1959 - 8,281 in Alberta, 3,445 in Saskatchewan, 730 in Manitoba, 37 in British Columbia and 29 in the Northwest Territories. Over the last two years the number of producing wells in the Northwest Territories has increased, not because new wells have been drilled but because old producers have been reactivated to provide oil for increased runs to stills at the Norman Wells refinery. There were 14,312 wells capable of production - i.e. completed and linked to facilities capable of delivering crude oil to purchasers - but the lack of markets kept 1,765 wells inoperative. In 1958 there were 13,169 wells capable of production, but 1,586 of these were inoperative. At year-end the industry was operating at about half its capacity to produce crude oil.

Reserves

Reserves of crude oil in Canada were increased during 1959 by 514,959,000 barrels, according to a compilation of the Canadian Petroleum Association. Of this quantity, 421,107,000 barrels were added by extensions to established fields and by some revisions. The remaining 93,852,000

---

*Mineral Resources Division

Production of Crude Oil, by Province and Field

	1959		1958	
	Barrels	$	Barrels	$
Alberta				
Pembina	34,520,314		33,093,712	
Redwater	15,112,108		13,074,440	
Leduc-Woodbend	14,598,083		14,910,237	
Joffre	6,326,789		5,367,841	
Fenn-Big Valley	6,199,976		5,571,322	
Bonnie Glen	5,951,008		4,225,487	
Joarcam	3,410,524		3,476,187	
Sturgeon Lake South	3,199,001		2,893,305	
Wizard Lake	2,719,898		1,583,277	
Innisfail	2,259,940		1,244,998	
Keystone	2,214,595		1,466,262	
Acheson	2,056,804		1,693,896	
Harmattan-Elkton	1,845,919		1,980,071	
Stettler	1,818,549		1,658,511	
Golden Spike	1,758,758		870,879	
West Drumheller	1,354,822		1,299,420	
Turner Valley	1,352,518		1,458,753	
Erskine	1,260,449		1,225,780	
Westerose	1,156,804		784,274	
Sundre	1,129,624		1,105,664	
Harmattan East	1,087,607		472,774	
Other fields	18,633,222		13,820,757	
Total	129,967,312	306,917,803	113,277,847	283,262,592
Saskatchewan				
Steelman	11,247,528		11,278,609	
Weyburn	5,763,487		6,034,630	
Dollard	4,095,848		3,121,587	
Coleville-Smiley	2,529,797		2,369,061	
Carnduff	2,505,353		2,999,708	
Nottingham	2,460,672		2,451,278	
Midale	2,312,572		2,464,275	
Fosterton	2,040,618		2,043,201	
Instow	1,618,490		1,045,919	
Success	1,434,348		1,585,149	
Alida	1,380,502		1,022,118	
Alameda	1,142,320		995,843	
Queensdale	1,070,029		604,699	
Other fields	7,840,934		6,610,071	
Total	47,442,498	97,731,546	44,626,148	96,704,863

Production of Crude Oil, by Province and Field (cont'd)

	1959		1958	
	Barrels	$	Barrels	$
Manitoba				
North Virden-Scallion	1,930,505		2,262,643	
Virden-Roselea	1,318,713		1,625,015	
Other fields	1,806,857		1,941,568	
Total	5,056,075	11,619,872	5,829,226	14,415,676
Ontario	1,001,580	3,194,000	778,341	2,623,000
British Columbia	866,234	1,583,129	512,359	1,022,156
Northwest Territories	430,319	1,025,914	457,086	698,266
New Brunswick	14,479	20,271	15,189	21,265
Total, Canada	184,778,497	422,092,535	165,496,196	398,747,818

barrels were added by new field discoveries, including new pools in old fields. Proved reserves of crude oil at the end of 1959 totalled 3,497,124,000 barrels. Of these Alberta had 2,898,878,000 barrels, Saskatchewan 495,787,000 barrels, the Northwest Territories 51,970,000 barrels, Manitoba 23,054,000 barrels, British Columbia 19,401,000 barrels, Ontario 7,971,000 barrels and New Brunswick 63,000 barrels.

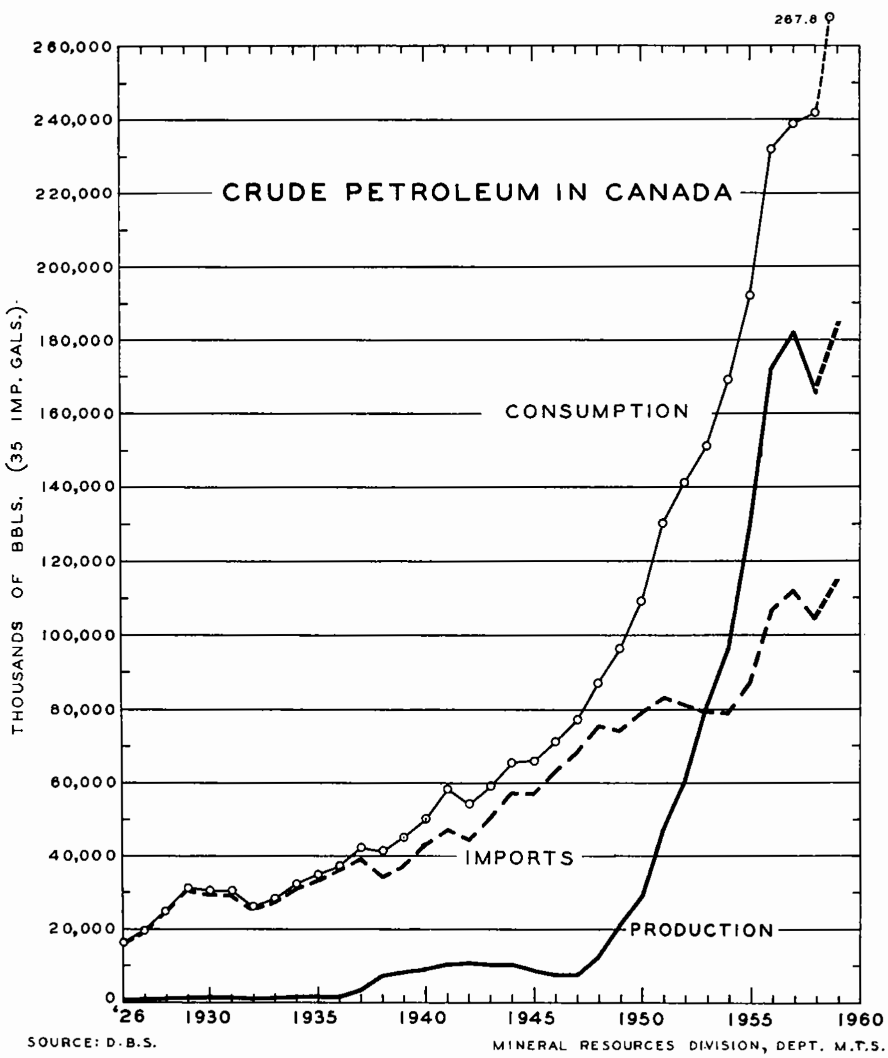
Additions to reserves in Alberta totalled 455,511,000 barrels, or almost 89 per cent of all additions; in Saskatchewan, 45,606,000 barrels, equal to about 9 per cent, were found. A total of 11,261,000 barrels was added to reserves in British Columbia and 1,996,000 barrels were added in Ontario. Only 585,000 barrels were added to reserves in Manitoba, all by extensions and revisions to old fields, which amounted only to about one tenth of the quantity of oil produced. There were no additions to reserves in New Brunswick and the Northwest Territories.

A total of 24,628,000 barrels of natural-gas liquids (condensate, propane, butane and pentanes plus) added to reserves during 1959 brought their total to 502,145,000 barrels. Of this, 463,923,000 barrels were in Alberta, 23,297,000 barrels in British Columbia and 14,925,000 barrels in Saskatchewan. Revisions made during the year reduced the Saskatchewan reserves by 18,503,000 barrels to the foregoing total. In British Columbia, revisions in previous reserves reduced their total by 5,829,000 barrels, but the addition in 1959 of 2,095,000 barrels in new fields gave a net reduction of only 3,734,000 barrels in the reserves of natural-gas liquids. Discoveries of these liquids in Alberta in 1959 amounted to 46,865,000 barrels.

Crude Oil - Production, Trade and Consumption, 1948-59
(barrels)

	Production	Imports	Exports	Consumption(1)		
				Domestic(2)	Imported(3)	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

(1) For 1948-50, inclusive - as reported in Petroleum Products Industry; for 1951-59, inclusive - receipts at refineries as reported by Refined Petroleum Products.
(2) 'Domestic' includes crude naphtha and absorption gasoline to 1950 only.
(3) 'Imported' includes reduced crude for all years.



The reserves of liquid hydrocarbons, including crude oil and natural-gas liquids at the end of 1959 totalled 3,999,269,000 barrels. Canada therefore had about 1.3 per cent of the world's reserves while the United States had 12 per cent, Venezuela 6 per cent and the Middle East 65 per cent.

Exploration and Development

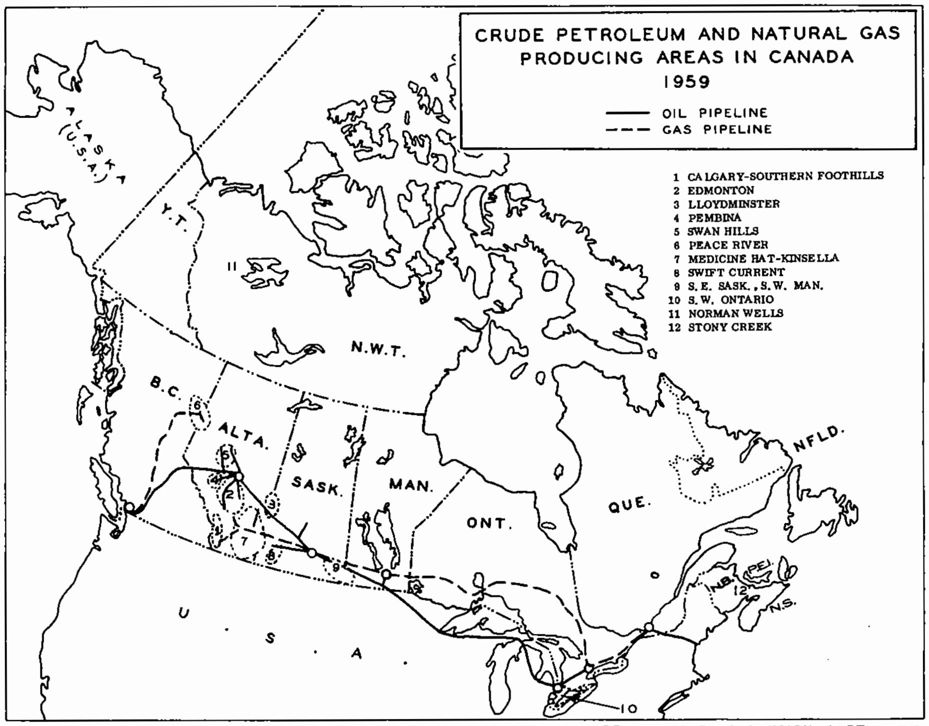
Petroleum and natural-gas land holdings totalled more than 265 million acres at the end of 1959, including 80 million acres held in Alberta, 50 million in British Columbia, 30 million in Saskatchewan, 5 million in Manitoba and more than 99 million in the Northwest Territories proper. In addition, about 130 million acres in the Arctic Islands were being held by applications pending the issuance of new regulations.

Geophysical work of all kinds continued the decline which began in 1953 after the record year of activity experienced in 1952. The seismic method, the one most frequently used, accounted for almost 95 per cent of all geophysical ground work. Most crews were in Alberta, where the decline continued at about the same rate as in the immediately previous years. Work in Saskatchewan dropped sharply and the number of crew months fell by 69 per cent. Interest in the northern areas was shown by the increase in the geophysical work being carried on in the Northwest Territories and northeastern British Columbia, where activity jumped by 60 and 16 per cent respectively.

Exploratory drilling in Canada was up slightly from the seven-year low of 1958 to about the level of the 1952-56 period but was some 13 per cent below the record level of 1957. The exploratory wells drilled in 1959 totalled 1,035 of which 139 found oil, 147 found gas, 749 were dry and abandoned and one was completed as a service well. In western Canada 30.8 per cent of exploratory holes were successful. The average depth of hole in the region was 4,920 feet. In eastern Canada only 6.9 per cent of all exploratory holes were successful and the average depth of hole was 1,821 feet.

Wells of All Types Drilled to Completion - Western Canada

	Oil Wells		Gas Wells		Dry and Abandoned Holes		Total	
	1959	1958	1959	1958	1959	1958	1959	1958
British Columbia	20	16	44	23	46	51	110	90
Alberta	877	959	242	227	456	443	1,575	1,629
Saskatchewan	520	507	9	18	294	278	823	803
Manitoba	29	61	0	0	16	31	45	92
Northwest Territories	0	0	0	0	8	9	8	9
Total	1,446	1,543	295	268	820	812	2,561	2,623



MINERAL RESOURCES DIVISION, DEPT. M.T.S.

Oil Wells - Western Canada
(at year-end)

	Producing Wells			Wells Capable of Production		
	1959	1958	1957	1959	1958	1957
British Columbia	37	29	15	59	39	22
Alberta	8,281	7,811	7,136	9,216	8,536	8,016
Saskatchewan	3,445	2,961	2,652	4,099	3,655	3,226
Manitoba	730	736	735	876	877	846
Northwest Territories	29	22	19	62	62	38
Total	12,522	11,559	10,557	14,312	13,169	12,148

Development by Areas

Eastern Canada

The petroleum-producing industry of eastern Canada has a much longer history than that of western Canada, but the fields that have been discovered are relatively small and until 1959 annual production never exceeded a million barrels. By far the greater part of production has come from Ontario. Production on a per-well basis is small, amounting to about 450 barrels annually. For this reason and because they produce a relatively small part of the Canadian total, the well data are not grouped with those of western Canada in this review.

Exploratory wells drilled in southwestern Ontario totalled 116, of which three found oil, five found gas and 108 were dry and abandoned. Only one of the oil discoveries was significant - a discovery about 25 miles south of Windsor, offshore from Colchester South township, at a point where oil was found in commercial quantities at a depth of 2,100 feet in Trenton formations of Middle Ordovician age. This was the first indication of oil in the Trenton since the discovery of the Dover field in 1917. In addition to exploratory wells, 194 development wells were drilled, 16 of which found oil, 95 found gas, 56 were dry and abandoned and 27 were completed as service wells.

In Quebec six wells were drilled, all of them dry, three to the north-east of Three Rivers and two about 15 miles southwest of it. The sixth well was near the eastern tip of Gaspé.

Eight wells were drilled in New Brunswick, south of Moncton. None was successful. One well was drilled in Nova Scotia in the Port Hood region of Cape Breton Island. The hole was dry.

British Columbia

The greatest increase in exploratory drilling was in British Columbia, where 37 per cent more holes were drilled than in 1958. By far the greater number of discoveries were of natural gas, but two oil discoveries were made, both of which were considered significant. The Sinclair, Peejay D-39-E well discovered Permo-Pennsylvanian oil at a depth of 8,185 feet. This well is just south of the Milligan Creek field. The second oil discovery, also in the Permo-Pennsylvanian, was made when the Triad, Beatton River D-39-K found oil north of the northern limit of the Milligan Creek field.

In addition to these exploratory successes, there was an 80-per-cent jump in development drilling, 49 development wells being drilled. Of these, 17 oil and 21 gas were successes. The oil wells were mostly in the Boundary Lake and Milligan Creek fields.

Pipelines

The construction of oil-pipeline systems in Canada has progressed with the development of producing fields, refining facilities and domestic and export requirements. A good indication of this progress is the increase in crude-oil-pipeline mileage from the completion, in 1950, of the first main trunk line in Canada, the Interprovincial pipeline, to the completion, in 1953, of the Trans Mountain line, and from then to the present. By the end of 1959 the construction of loops, extensions and new feeder systems had increased the length of crude-oil pipelines in Canada to 7,945 miles. The year-to-year figures given in the following tables are exclusive of extensions to the Interprovincial and Trans Mountain systems in the United States, which are used to carry Canadian crude oil exclusively. At the end of 1959 these extensions totalled 1,369 miles.

Crude-oil-pipeline Mileage in Canada

Year-end	Miles	Year-end	Miles
1950	1,423	1955	5,079
1951	1,577	1956	6,051
1952	2,500	1957	6,873
1953	3,794	1958	7,148
1954	4,656	1959	7,945

The crude-oil pipeline laid in 1959 totalled 797.5 miles. Construction in Alberta accounted for 481.5 miles of all types of crude-oil lines, 275 miles being extensions to gathering facilities and 206.6 miles being trunk line including a 40-mile condensate line connecting the natural-gas processing-plant at Windfall with the Trans Mountain pipeline at Edson. As the product from this line is transported via the Trans Mountain pipeline, the line may be considered one of Trans Mountain's feeders. The Federated pipeline, completed in the Fall of 1958, with additions in 1959, connects the relatively new Swan Hills field with Edmonton. Deliveries started in January 1959. Gathering lines built totalled 109.5 miles in Saskatchewan and 3.3 miles in Manitoba. Construction of trunk lines in British Columbia and the Yukon Territory totalled 203.1 miles. The 107 mile line of Alaska-Yukon Pipeline Limited, consisting of part of the 3" Canol line running from Whitehorse to Haines Junction has reversed its flow of line to take products to Whitehorse. Yukon Pipelines Limited constructed 90.5 miles of 4" pipeline from Summit, B.C. , to Whitehorse, Yukon Territory.

Interprovincial Pipe Line Company

The Interprovincial oil pipeline is the longest in the world. It originates in Alberta's Redwater field, but its main receiving station is at Edmonton, where the bulk of crude oil to be shipped is delivered. In addition to oil from Redwater, the line takes oil from 11 other pipelines in the three Prairie Provinces and delivers crude to five pipelines in Canada and three in the United States. The system, either directly or in conjunction with its connecting carriers, transports Canadian crude to refineries situated as follows: Saskatoon, Moose Jaw and Regina, in Saskatchewan; Brandon and Winnipeg, in Manitoba; Sarnia, Clarkson, Port Credit and Trafalgar, in Ontario; St. Paul-Minneapolis and Wrenshall, in Minnesota; Superior, in Wisconsin; and West Branch, Bay City and Midland, in Michigan.

The Interprovincial system consists of two complete lines from Edmonton to Superior, Wisconsin, a single but larger-diameter line from Superior to Sarnia, Ontario, and a smaller-diameter extension from Sarnia to the Toronto area.

Deliveries for the year totalled 122.9 million barrels, 12.2 per cent more than the 109.5 million barrels delivered in 1958. The following table compares 1959 deliveries with those of 1958.

Deliveries of Crude Oil (destination)	Millions of Barrels 1959	1958
Western Canada	32.7	29.5
U.S. Mid-West	20.3	21.3
Superior (for tankers)	0	1.8
Ontario	69.9	56.9
Total	122.9	109.5

Trans Mountain Oil Pipe Line Company

The Trans Mountain pipeline carries oil from Edmonton to Vancouver and has an extension into the United States to refineries at Ferndale and Anacortes, in the State of Washington. At Edmonton it takes deliveries of crude oil from seven feeder lines, and at Edson it receives crude oil from the Peace River pipeline and condensate from the new condensate-carrying line from the Windfall area.

Deliveries can be made to refineries at Kamloops and Vancouver in British Columbia and to the aforementioned refineries in the United States. During 1959 deliveries were 20 per cent greater than in 1958 but were still well below the capacity of the line, which is about 90 million barrels a year. The following table compares the 1959 deliveries with those made in 1958.

Deliveries of Crude Oil (destination)	Millions of Barrels 1959	1958
British Columbia	22.6	20.6
State of Washington	13.3	9.0
Tankers	0	0
Total	35.9	29.6

Other Oil Pipelines

In Alberta five crude-oil pipelines added to their facilities. Britamoil Pipe Line Company Limited added 45 miles of lateral extensions to its gathering facilities. Additional fields served included Hussar, Wayne, Rosebud and Joffre North. Peace River Oil Pipe Lines Co. Ltd. added 2 miles of gathering lines in the Kaybob and Sturgeon Lake South fields. Federated Pipelines Limited added to its system in the Swan Hills-Virginia Hills region by constructing gathering facilities in the Judy Creek, Virginia Hills and Sarah Lake fields and a line from the three fields to its Swan Hills-Edmonton trunk line. Pembina Pipe Line Ltd. added 75.9 miles of gathering line to its facilities in the Pembina field, which now includes the fields formerly known as Keystone, Lobstick and Carnwood. Rangeland Pipe Line Company Limited constructed 3.3 miles of trunk line and added 11.5 miles of gathering line to include the Medicine River and Gabriel Lake fields to its system. Hudson's Bay Oil and Gas Company Limited built the previously mentioned condensate pipeline that connects the natural-gas-processing plant in the Windfall area with the Trans Mountain pipeline.

In Saskatchewan, three companies added to their systems during 1959. South Saskatchewan Pipe Line Company built 1.8 miles of gathering lines in the southwestern region of the province. Trans-Prairie Pipelines Ltd. added 11.3 miles of gathering to its facilities. Westspur Pipe Line Company and Producers Pipelines Ltd. built 75.9 miles of line and added the Queensdale, Parkman and Pinto to its list of fields served.

In Manitoba, Trans-Prairie Pipelines Ltd. increased the mileage of its gathering facilities in the group of fields centred around Virden by 3.3 miles.

Petroleum-refining

At the close of 1959 there were 40 operating refineries in Canada, two fewer than at the end of 1958, but the crude-oil capacity lost by the closure of the two plants was more than made up by additions to other plants. At the end of 1959, crude-oil capacity totalled 853,262 barrels a day, 3 per cent more than at the end of 1958, when it was 827,407 barrels a day.

At the close of 1959, two large new refineries were under construction and scheduled to come on stream in 1960. At Saint John, New Brunswick, a 40,000 barrel-a-day plant was being built for Irving Refining Limited and was expected to begin operating in late March. In Montreal East B.P. Refinery Canada Limited was building its sixth plant, which is to have a capacity of 25,000 barrels a day and is expected to go on stream in May. The addition of these plants will increase the crude-oil capacity of Canada's refineries to more than 900,000 barrels a day.

The refineries that shut down in 1959 are owned by Royalite Oil Company, Limited, and are in Saskatchewan. The 4,750 barrel-a-day Coleville plant was shut down in January, and the 950 barrel-a-day Prince Albert plant stopped refining in April. Both were primarily fuel-oil producers.

The 40 refineries in Canada were operated by 22 companies. Imperial Oil Limited operated nine refineries having an aggregate crude-oil capacity of 38.9 per cent of the national total. The remaining distribution was as follows: The British American Oil Company Limited, six refineries, 17.2 per cent; Shell Oil Company of Canada,Limited, two refineries, 9.4 per cent; Texaco Canada Limited, two refineries, 8.3 per cent; Canadian Oil Companies, Limited, one refinery, 5.6 per cent. Each of the remaining refineries had less than five per cent of crude-oil capacity and are listed in descending order of capacity: Canadian Petrofina Limited, Regent Refining (Canada) Limited, Cities Service Refining (Canada) Limited, Standard Oil Company of British Columbia Limited, Sun Oil Company, Consumers' Co-operative Refineries Limited, North Star Oil Limited, Canadian Husky Oil Ltd., Royalite Hi-Way Ltd., Royalite Oil Company, Limited, Anglo American Exploration Ltd., Wainwright Producers & Refiners Limited, Canadian Kodiak Refineries Ltd., Phillips Petroleum Company, Anglo-Canadian Oils Limited, Northern Petroleum Corporation Limited and New Brunswick Oilfields Limited.

Crude-oil Refining Capacity, by Regions

	1945		1950		1955	
	Bbl/day	%	Bbl/day	%	Bbl/day	%
Maritimes	34,250	14.8	22,300	6.2	18,300	3.0
Quebec	59,000	25.5	143,000	39.9	210,000	34.0
Ontario	75,450	32.6	75,200	21.0	148,800	24.0
Prairies and Northwest Territories	41,515	18.0	89,525	24.9	174,850	28.3
British Columbia	21,000	9.1	28,850	8.0	66,500	10.7
Total, Canada	231,215	100.0	358,875	100.0	618,450	100.0
	1957		**1958**		**1959**	
	Bbl/day	%	Bbl/day	%	Bbl/day	%
Maritimes	44,300	5.8	49,300	6.0	49,300	5.8
Quebec	255,800	33.6	264,800	32.0	265,000	31.0
Ontario	198,510	26.1	228,822	27.6	254,272	29.8
Prairies and Northwest Territories	189,035	24.8	187,735	22.7	189,140	22.2
British Columbia	74,250	9.7	96,750	11.7	95,550	11.2
Total, Canada	761,895	100.0	827,407	100.0	853,262	100.0

Canadian Crude Oil as a Percentage
of Refinery Receipts, by Regions

	1940	1945	1950	1955	1957	1958	1959
Maritimes	0	0	0	0	0	0	0
Quebec	0	0	0	0	0	0	0
Ontario	1.2	0.5	1	78.8	86.1	93.7	96.8
Prairies and Northwest Territories	92.3	58.2	99	100	100	100	100
British Columbia	0	0	0	100	100	100	100
Total, Canada	16.4	11.7	24.4	54.7	53.2	55.6	56.6

National Energy Board

An Act to establish a National Energy Board was assented to on July 18, 1959, and came into effect on October 30. It regulates, among other things, the interprovincial and international movement of gas and the construction of pipelines that cross provincial and national boundaries.

Marketing and Trade

Crude oil delivered from domestic oil fields to domestic refineries totalled 151,507,774 barrels in 1959, about 12.6 per cent above the 1958 total of 134,513,998 barrels. Deliveries of foreign crude oil to refineries within Canada amounted to 116,342,270 barrels, about 8 per cent more than in the preceding year. As in 1958, deliveries to refineries showed a greater increase in Ontario than in any other province. Refinery receipts of crude oil went up by 16 per cent in Ontario, 10 per cent in Quebec, 8 per cent in British Columbia and 5 per cent in the Prairie Provinces. Much that is produced from crude delivered to refineries in Quebec is consumed in Ontario, with the result that Ontario is indirectly accountable for part of the oil delivered to plants in Quebec. In 1959, the net transfers of finished petroleum products from Quebec into Ontario totalled more than 23 million barrels; in 1958 they amounted to 21 million barrels.

In 1959, Venezuela continued as the leading supplier of the crude oil imported into Canada, providing more than 64 per cent of all Canadian imports of that commodity. The crude received at Canadian refineries from Venezuela during the year totalled 73.2 million barrels, or more than 10 per cent of all that country's crude-oil exports. Middle East countries supplied 32.8 per cent, 16.6 million barrels coming from Saudi-Arabia, 15.5 million from Kuwait and 6.1 million from Iran and Iraq combined. Crude oil from Trinidad totalled 3.4 million barrels, and the United States supplied less than a quarter of a million.

Exports of crude oil went entirely to the United States, to the regions served by pipelines from Canada. They were up from the preceding year's 31.7 million barrels to 33.4 million barrels, of which two thirds went to the United States Great Lakes region and one third to refineries in the Puget Sound region of Washington. The Puget Sound exports were considerably greater during the latter half of 1959 than during its first half; those to the mid-continent region were constant throughout the year.

Imports of petroleum products, which totalled 30 million barrels in 1958, amounted to more than 38 million barrels in 1959. Product imports were made up as follows: light fuel oil, more than 37 per cent; heavy fuel oil, 32 per cent; aviation and motor gasolines, in about equal proportions, 14 per cent; all other products, consisting chiefly of Diesel oil, petroleum coke and lubricating oils, 17 per cent.

There is no tariff on crude oil entering Canada. There is a United States import tax of 5 1/4 cents a barrel on Canadian crude oil testing under 25° A.P.I. gravity and 10 1/2 cents a barrel on oil testing at or above that gravity.

Supply and Demand - All Oils
(barrels)

	1959	1958
Supply		
Production		
Crude oil	184,778,497	165,496,196
Natural gasoline and liquid petroleum gases	5,669,178	2,816,962
Total, Canada	190,447,675	168,313,158
Total, Canada, barrels per day	521,774	461,132
Imports		
Crude oil (including natural gasoline)	116,342,270	107,444,741
Refined petroleum products	38,821,689	30,451,414
Total	155,163,959	137,896,155
Change in stock		
Crude oil	+1,090,064	-949,217
Refined petroleum products	-7,810,204	+5,782,519
Total, net	-6,720,140	+4,833,302
Total supply	338,891,494	311,042,615
Demand		
Exports		
Crude oil	33,362,234	31,679,429
Products	1,694,462	960,901
Total	35,056,696	32,640,330
Domestic sales		
Motor gasoline	95,883,318	92,137,073
Middle distillates	104,161,017	94,155,317
Heavy fuel oil	49,808,249	43,247,833
Other products	32,223,652	30,194,206
Total	282,076,236	259,734,429
Uses and losses		
Refinery	20,922,493	18,845,108
Field and pipeline	355,573	-31,114
Total	21,278,066	18,813,994
Total demand	338,410,998	311,188,753
Oils not accounted for	+480,496	-146,138

Regional Consumption of Petroleum Products - Net Sales, 1959
(barrels)

	Motor Gasoline	Kerosene and Stove Oil	Diesel Oil	Light Fuel Oils 2 and 3	Heavy Fuel Oils 4, 5 and 6
Newfoundland	987,452	795,715	911,935	856,876	2,073,163
Maritimes	5,916,765	2,167,536	1,891,261	3,855,514	4,713,148
Quebec	20,108,625	5,492,690	5,274,732	15,629,482	20,000,459
Ontario	36,584,113	4,586,793	5,239,573	28,607,888	11,441,202
Manitoba	5,075,295	322,206	1,341,448	3,100,329	1,900,426
Saskatchewan	7,783,124	348,720	1,932,819	2,652,044	2,126,912
Alberta and Northwest Territories	10,499,648	253,774	3,715,874	1,338,922	1,437,852
British Columbia and Yukon Territory	8,928,296	2,132,614	3,690,472	3,799,300	6,115,087
Total, Canada	95,883,318	16,100,048	23,998,114	59,840,355	49,808,249

Source: Dominion Bureau of Statistics, Refined Petroleum Products, 1959.

Index to Companies