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Canada

The Canadian Mineral Industry 1956

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Mineral Report 1

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CONTENTS

* Geological Survey of Canada
** Corundum, emery, garnet, quartz, grindstones, pumice, grinding pebbles

* Granite, structural limestone, marble, sandstone

FOREWORD

Mineral Report 1, The Canadian Mineral Industry in 1956, has been prepared by the Mineral Resources Division of the Department of Mines and Technical Surveys, in collaboration with the Mines Branch of the Department. Earlier publications of this nature and under the same title appeared as Mines Branch Reports No. 760, 773, 786, 791, 804, 815, 820, 824, 827, 829, 830, 835, 841, 844, 851, 857 and 862, (the first for 1934 and the last for 1955). The catalogues of the Mines Branch and Geological Survey of Canada list even earlier reviews of the mineral industry, under various titles, as far back as 1886.

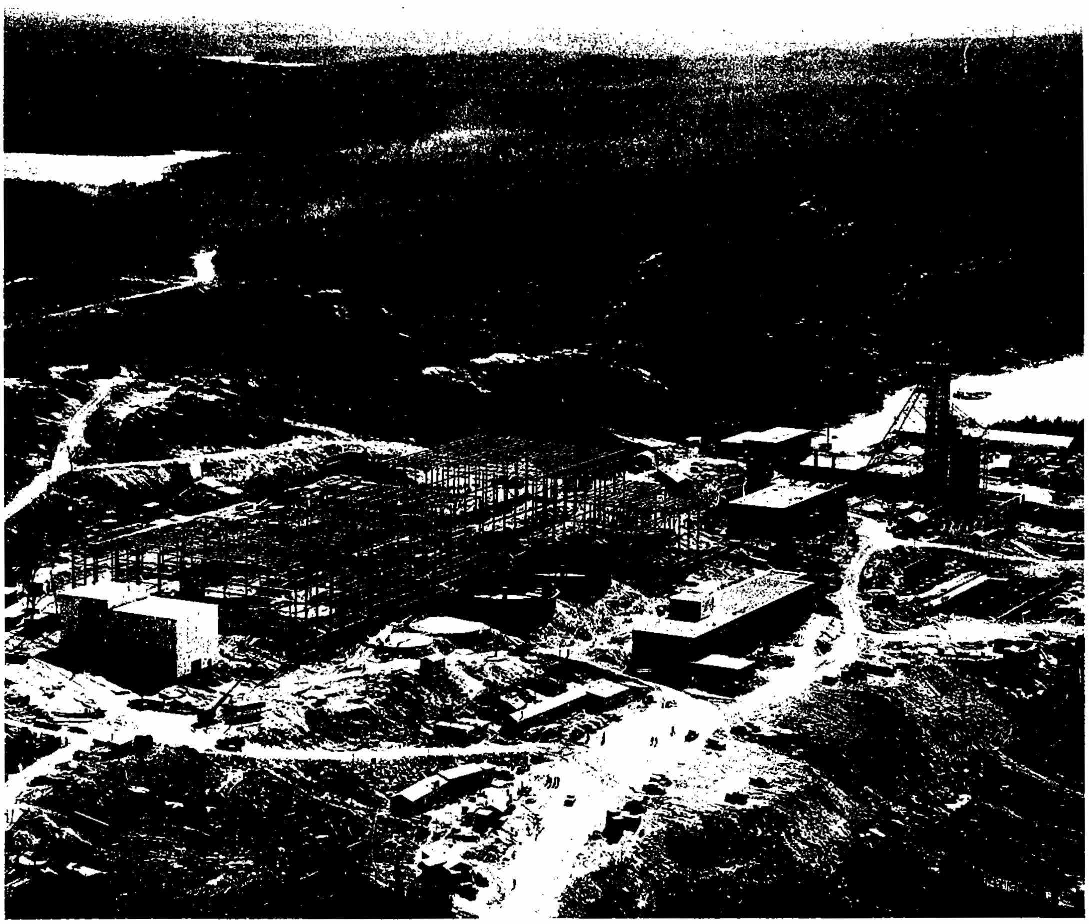
Like the previous issues, the present volume contains reviews of the metallic minerals, industrial minerals and mineral fuels produced or consumed in commercial quantities in Canada during the year concerned. The reviews are the final versions of preliminary papers issued during 1957. Those dealing with industrial minerals and coal were written by officers of the Mines Branch; all others, with the exception of the review on uranium which was prepared in the Geological Survey of Canada, were written in the Mineral Resources Division.

Canada was host to the Sixth Commonwealth Mining and Metallurgical Congress during September and October of 1957. The Congress was last held in this country in 1927, and in honour of this, an effort has been made in the present volume to comment on the growth of the industry during the 30-year intervening period. For the first time, as well, an extensive summary is included in order to relate developments in the Canadian mineral industry with developments in other sectors of the Canadian economy. It is planned to continue this addition to the contents in future issues of the series.

Final Dominion Bureau of Statistics figures are used, except where noted. Market quotations are mainly from standard marketing reports issued in London, Montreal and New York.

The Division is indebted to all those who contributed data for the reviews, and in particular to mining operators and others connected with the mineral industry.

W. Keith Buck,
Chief,
Mineral Resources Division.



The Nordic Mine of Algoma Uranium Mines Limited in the Blind River area of Ontario, under construction in 1956. The mill and mine went into production in January 1957 at a rate of 3,000 tons a day, after a remarkably short development period of three years.

Photo by George Hunter

SUMMARY OF DEVELOPMENTS IN THE CANADIAN MINERAL INDUSTRY

IN 1956

By W. Keith Buck and B. F. Burke
Mineral Resources Division

GENERAL

This summary of the mineral industry in Canada in 1956 is chiefly concerned with the highlights of developments during that year, but considerable attention is paid as well to the growth of the industry in the past thirty years. The reason for this is that between September 8 and October 9, 1957, Canada will play host to the Sixth Commonwealth Mining and Metallurgical Congress. Inasmuch as the Second Congress assembled in Canada in 1927, it is of interest not only to the delegates to the Sixth Congress but also to Canadians in general to review the growth which has taken place in the Canadian mineral industry in the intervening years*. More detail concerning developments in regard to specific minerals may be found in the separate mineral reviews.

The value of Canada's mineral production amounted to $2.1 billion in 1956, the first time that the two billion dollar mark was surpassed. On a per capita basis, the value of 1956 production was $129.65, a figure which ranks very high among the per capita values of the mineral production of other countries. It even exceeds that of the United States where the per capita value in the same year was $103.28.

Since 1926, Canada has experienced a five-fold increase in the per capita value of its mineral output, owing in part, of course, to price increases. However, the great growth in volume of production is demonstrated by comparing the index of physical volume of mineral production for 1956 with that for 1926. Using the average of the years 1935-39 equal to 100, the 1926 index is 54.9 and the 1956 index, 272.5. This five-fold increase in the volume of production does not make allowance for Canada's increasing output of ilmenite (titanium ore) and lithium concentrates, nor does it allow for aluminum ingot which is included in the manufacturing index of physical volume of production. With further immediate and large-scale increases in the production of iron ore, uranium, petroleum and natural gas, the index of physical volume of Canadian mineral output will undoubtedly soon advance considerably beyond the 1956 level.

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* For comparison purposes, 1926 statistics are employed as they were the latest available statistics when the Congress met in Canada in 1927.

Summary

METALS, NON-METALS AND FUELS, A COMPARISON

Table I shows the changes which have taken place in the production of individual minerals since 1926.

TABLE I

Mineral Production of Canada
1956 and 1926

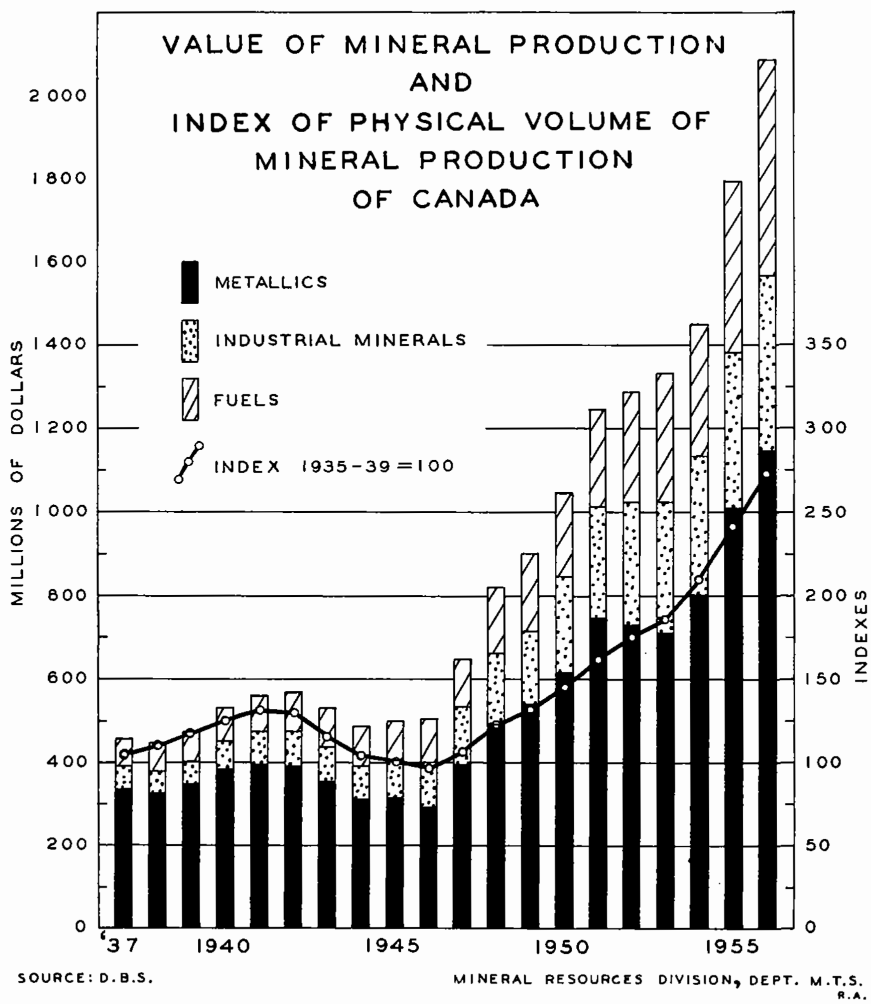
	1956		1926	
	Quantity	$	Quantity	$
Metallics				
Antimony.....lb	2,140,432	687,527	1,596	281
Bismuth .....lb	285,861	544,900	6,440	6,440
Cadmium ....lb	2,339,421	3,977,016	-	-
Cobalt ....lb	3,516,670	9,065,493	664,778	1,136,014
Copper.......s.t.	354,860	292,958,091	66,547	17,490,300
Gold ....oz	4,383,863	151,024,080	1,754,228	36,263,110
Indium ....oz	363,192	795,390	-	-
Iron ore .....l.t.	19,953,820	160,362,118	179	600
Iron ingots ...s.t.	159,874	7,996,897	-	-
Lead ....s.t.	188,854	58,582,651	141,901	19,240,661
Magnesium & calcium		6,595,195	-	-
Manganese ore	...	1,900	-	-
Molybdenite (MoS_2)......s.t.	1,403,772	955,828	10	10,472
Nickel ....s.t.	178,515	222,204,860	32,857	14,374,163
Platinum group metals......oz	163,451	6,681,098	10,024	640,178
Platinum .....oz	151,357	15,725,992	9,521	923,607
Selenium .....lb	330,389	4,460,252	-	-
Silver........oz	28,431,847	25,497,681	22,371,924	13,894,531
Tellurium ....lb	7,867	13,767	-	-
Tin ....l.t.	338	670,441	-	-
Titanium ore .s.t.	2,310	16,561	-	-
Tungsten (WO_3) s.t.	2,271,437	6,362,368	-	-
Uranium .....s.t.	2,281	45,732,145	-	-
Zinc ....s.t.	422,633	125,437,344	74,969	11,110,413
Total metallics		1,146,349,595		115,090,770
Non-metallics				
Arsenious oxide ....lb	1,790,381	77,612	5,074,677	146,811
Actinolite ....s.t.	-	-	80	1,000
Asbestos .....s.t.	1,014,249	99,859,969	279,403	10,099,423
Barite ....s.t.	320,835	3,031,034	100	2,307
Bituminous sands ......s.t.	-	-	528	2,112
Diatomite ....s.t.	2	40	-	-
Feldspar ....s.t.	18,153	364,849	35,951	310,238
Fluorspar....s.t.	140,071	3,407,582	-	-

		1956		1926	
		Quantity	$	Quantity	$
Graphite	s.t.	-	-	2,727	194,860
Grinding pebbles	s.t.	-	-	64	576
Grindstones	s.t.	-	-	2,695	151,227
Gypsum	s.t.	4,895,811	7,260,236	883,728	2,770,813
Iron oxides ...	s.t.	8,803	186,225	6,626	101,843
Lithia (Li_2O) ..	s.t.	2,395	2,643,950	-	-
Magnesitic dolomite & brucite		...	2,783,181	...	137,431
Mica	s.t.	922	95,666	2,545	229,204
Mineral water .	gal	292,526	149,867	215,356	29,721
Nepheline syenite	s.t.	180,006	2,574,140	-	-
Peat moss	s.t.	128,054	4,240,714	-	-
Phosphate	s.t.	-	-	40	800
Quartz	s.t.	2,142,234	3,036,543	232,082	553,161
Salt	s.t.	1,590,804	12,144,476	262,547	1,480,149
Silica brick ...	M	5,799	736,817	2,665	130,702
Sodium carbonate	s.t.	-	-	595	5,370
Sodium sulphate	s.t.	181,053	2,838,186	6,775	13,550
Soapstone & talc	s.t.	29,326	365,226	15,767	217,195
Sulphur (pyrite & smelter) ...	s.t.	709,693	6,862,375	17,845	63,899
Titanium dioxide	s.t.	157,374	7,682,911	-	-
Volcanic dust .	s.t.	-	-	90	630
Total non-metallics ..			160,341,599		16,643,022
Structural Materials					
Clay products .		...	37,784,980	...	10,357,323
Cement	bbl	28,695,331	75,233,321	8,707,021	13,013,283
Lime	s.t.	1,295,699	15,667,598	...	3,781,484
Sand & gravel .	s.t.	148,801,268	81,957,352	17,112,798	4,941,434
Stone	s.t.	33,257,318	48,809,918	6,397,590	7,865,874
Total			259,453,169		39,959,398
Total industrial minerals			419,794,768		56,602,420
Fuels					
Coal	s.t.	14,915,610	95,349,763	16,478,131	59,875,094
Natural gas	M cu. ft.	169,152,586	16,849,556	19,208,209	7,557,174
Crude petroleum	bbl	171,981,413	406,561,872	364,444	1,311,665
Total fuels			518,761,191		68,743,933
GRAND TOTAL			2,084,905,554		240,437,123

... indicates not available - indicates no production

Summary

Emphasis should be given to several facts implicit in the above table. In the period from 1926 to 1956, metal mining increased almost ten-fold in value and 7 per cent in relative importance in the mineral industry as a whole. Larger tonnages and higher prices for the chief base metals -- copper, nickel, lead and zinc -- were mainly responsible for these increases. However, iron ore and uranium, current substantial contributors to the value of metal production, were not produced in 1926. The value of these two metals in 1956 alone exceeded the entire value of metal production of the earlier year. Output of industrial minerals increased



seven-fold in value in the 30-year period, but the relative importance in the industry as a whole declined 3 per cent. The value of asbestos production alone in 1956 was almost double the entire value of industrial mineral output in 1926. Production of mineral fuels -- petroleum, natural gas and coal -- also increased seven-fold, mainly as a result of the increase in output of crude petroleum which, in 1956, was 6 times the total value of fuels produced in 1926.

PROVINCIAL DISTRIBUTION OF MINERAL PRODUCTION

The provincial distribution of Canada's mineral production has changed considerably since 1926. For instance, in 1956, Newfoundland's mineral output accounted for 4 per cent of the Canadian total. However, in 1926, Newfoundland was not a member of Confederation. There was no production from the Northwest Territories in 1926, while in 1956 this region's output was 1.1 per cent of Canada's total and was valued at $22.2 million.

TABLE II

Provincial Distribution of Canadian Mineral Production

	1956		1926	
	Value of Mineral Production	Percentage of Total	Value of Mineral Production	Percentage of Total
	$		$	
Newfoundland	84,349,006	4.0	-	-
Nova Scotia	66,092,274	3.2	28,873,792	12.0
New Brunswick	18,258,302	.9	1,811,104	.8
Quebec	422,464,410	20.3	25,956,193	10.8
Ontario	650,823,362	31.2	84,702,296	35.2
Manitoba	67,909,407	3.3	3,073,528	1.3
Saskatchewan	122,744,698	5.9	1,193,394	.5
Alberta	411,171,898	19.7	26,977,027	11.2
British Columbia	203,277,828	9.7	65,622,976	27.3
Northwest Territories	22,157,935	1.1	-	-
Yukon Territory	15,656,434	.7	2,226,813	.9
CANADA	2,084,905,554	100.0	240,437,123	100.0

CANADA IN RELATION TO THE WORLD

The importance of Canada in the world as a producer of certain important metals and non-metals is shown in Table III. The production statistics for the U.S.S.R. are estimates. Although not noted on the table, Canada in 1956 became the fourth largest producer of iron ore after United States, U.S.S.R. and France.

TABLE III

CANADA'S ROLE IN THE WORLD AS A PRODUCER OF CERTAIN IMPORTANT METALS AND NON-METALS, 1956

	World Production	Rank 1st	2nd	3rd	4th	5th	6th
NICKEL (short tons)	279,800 100%	**CANADA** 178,515 63.8%	U.S.S.R. 50,000 17.9%	New Caledonia 25,500 9.1%	Cuba 16,062 5.7%	United States 6,723 2.4%	Union of S. Africa 2,773 1.0%
ASBESTOS (short tons)	1,705,000 100%	**CANADA** 1,014,249 59.5%	U.S.S.R. 240,000 14.1%	Union of S. Africa 136,520 8.0%	Southern Rhodesia 118,973 7.0%	United States 41,312 2.4%	Italy 36,459 2.1%
ALUMINUM (short tons)	3,617,224 100%	United States 1,678,954 46.4%	**CANADA** 620,321 17.1%	U.S.S.R. 485,000 13.4%	France 165,096 4.6%	W. Germany 162,437 4.5%	Norway 102,172 2.8%
ZINC (short tons)	3,139,079 100%	United States 537,643 17.1%	**CANADA** 422,633 13.5%	U.S.S.R. 336,000 10.7%	Mexico 274,348 8.7%	Australia 261,520 8.3%	Peru 176,584 5.6%
PLATINUM and platinum group metals (fine oz)	975,000 100%	Union of S. Africa 491,270 50.4%	**CANADA** 314,808 32.3%	U.S.S.R. 125,000 12.8%	Colombia 26,215 2.7%	United States 21,398 2.2%	Japan 683 0.1%
GYPSUM (000's short tons)	34,200 100%	United States 10,316 30.2%	**CANADA** 4,896 14.3%	United Kingdom 3,724 10.9%	France 3,300 9.6%	U.S.S.R. 3,300 9.6%	W. Germany 1,046 3.1%
COBALT (short tons)	16,000 100%	Belgian Congo 10,019 62.6%	**CANADA** 1,758 10.9%	N. Rhodesia 1,271 7.9%	United States 1,269 7.9%	Fr. Morocco 710 4.4%	
CADMIUM (M pounds)	19,020 100%	United States 10,414 54.8%	**CANADA** 2,339 12.3%	S.W. Africa 2,327 12.2%	Mexico 1,892 9.9%	Japan 886 4.7%	W. Germany 645 3.4%
GOLD (fine oz)	38,400,000 100%	Union of S. Africa 15,896,693 41.4%	U.S.S.R. 10,000,000 26.0%	**CANADA** 4,383,863 11.4%	United States 1,837,961 4.9%	Australia 1,029,821 2.7%	Ghana 620,194 1.6%
SILVER (fine oz)	222,400,000 100%	Mexico 43,077,046 19.4%	United States 38,157,000 17.2%	**CANADA** 28,431,847 12.8%	U.S.S.R. 25,000,000 11.2%	Peru 22,972,236 10.3%	Australia 14,586,197 6.6%
COPPER (short tons)	3,750,275 100%	United States 1,114,285 29.7%	Chile 539,839 14.4%	N. Rhodesia 445,054 11.9%	U.S.S.R. 417,000 11.1%	**CANADA** 354,860 9.5%	Belgian Congo 275,535 7.3%
Lead (short tons)	2,218,786 100%	United States 348,329 15.7%	Australia 313,364 14.1%	U.S.S.R. 290,000 13.1%	Mexico 220,030 9.9%	**CANADA** 188,854 8.5%	Peru 133,491 6.0%

MINERAL EXPORTS

Canada is the second largest country in the world, with a population of less than 17,000,000. It is necessary to import large quantities of manufactured goods and this is especially true as the Canadian standard of living continues to rise. In order to pay for these imports and maintain the balance of trade, Canada must export large quantities of basic materials - products of the mines, the forests and the farms. Formerly, exports of these products have balanced the very heavy imports of manufactured goods and other materials which are not produced domestically. However, of late years, principally owing to the high level of Canadian prosperity, the value of imports has exceeded that of exports. It is necessary to keep this adverse balance of trade as low as possible and in this respect the mineral industry is playing a very important role.

In 1956 the value of Canada's exports of all kinds amounted to $4,789.7 million. The value of the exports of the three classes of mineral products, namely iron and its products, non-ferrous metals and their products, and non-metallic minerals including fuels and their products, in all stages of production from crude ores and concentrates to completely finished goods, was $1,710.4 million or 35.7 per cent of total exports. In 1926 exports of these products were 14.6 per cent of the total export trade for that year. This indicates the increasing importance of mineral and metal exports in Canada's export trade.

The exports of the three classes of mineral products by main countries of destination are compared for the years 1956 and 1926 in Table IV.

TABLE IV

Exports by Destination, 1926 and 1956
($Millions)

1926

	To United Kingdom	To United States	To Other Countries	Total
Iron and its products ...	6.9	10.2	58.5	75.6
Non-ferrous metals and products	13.9	40.4	27.7	82.0
Non-metallic minerals, fuels and products	1.8	17.5	7.8	27.1
Total	22.6	68.1	94.0	184.7
Grand total all exports ..	459.2	465.2	344.1	1,268.5
	%	%	%	%
Percentage metals, minerals & their products of total exports	4.9	14.6	27.3	14.6

Summary

TABLE IV (Cont'd.)

1956

	To United Kingdom	To United States	To Other Countries	Total
Iron and its products ...	37.7	260.7	160.4	458.8
Non-ferrous metals and products	264.3	535.8	159.4	959.5
Non-metallic minerals, fuels and products	19.2	224.8	48.1	292.1
Total	321.2	1,021.3	367.9	1,710.4
Grand total all exports..	812.7	2,818.7	1,158.4	4,789.7
Percentage metals, minerals & their products of total exports	% 39.5	% 36.2	% 31.8	% 35.7

Table V indicates the value of Canada's exports of metals, minerals and their products in 1956.

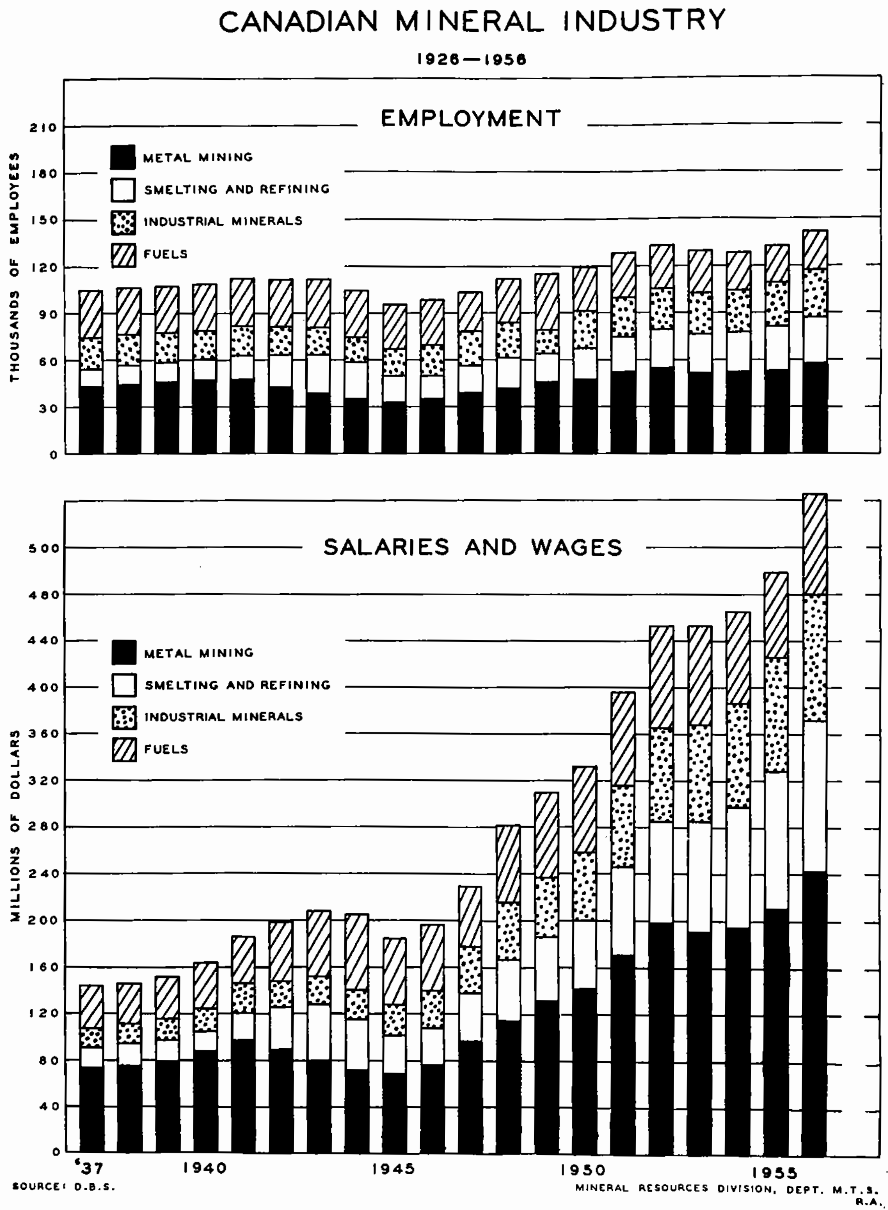
TABLE V

Exports of Metals, Minerals and Their Products, 1956, by Degree of Manufacture ($ Million)

	Raw Material	Partially Manufactured	Fully or Chiefly Manufactured	Total
Iron and its products	144.4	77.6	236.8	458.8
Non-ferrous metals and products	229.4	672.2	57.9	959.5
Non-metallic minerals, fuels and products	157.6	103.0	31.5	292.1
Total.................	531.4	852.8	326.2	1,710.4
Per cent of total	31.0	49.9	19.1	100.0

EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL INDUSTRY

The total number of people employed in the mining industry was 142,560 in 1956. They earned a total of $566.0 million. These figures include employment in non-ferrous smelting and refining which includes the aluminum industry. They do not include, however, the large numbers of people working for oil and gas exploration companies, petroleum refineries and oil and gas pipe line companies. If these activities were included, both the numbers employed and the salaries and wages would be substantially increased.



Summary

Employment in mining stood at 77,931 in 1926 and earnings amounted to $94.2 million. It is interesting to note that while the number of employees increased 83 per cent between 1926 and 1955, salaries and wages rose by over 500 per cent. The growth in volume of mineral output was 396 per cent. This increase in productivity was achieved by technological improvements in all phases of mining and metallurgy, and by improved transportation facilities.

MINERALS AND RAILWAY TRANSPORTATION

Table VI shows the volume of ore and of mineral products transported by Canadian railways in 1956.

TABLE VI

Tonnage of Crude Mineral Products Transported by Canadian Railways during 1956

	Short Tons	% of Total
Metallic ores and concentrates	30,895,963	39.5
Industrial minerals	24,970,993	32.0
Fuels	22,302,546	28.5
Total	78,169,502	100.0

Shipments of ore and mineral products made up 41.2 per cent of the total tonnage of all revenue freight carried by Canadian railways in 1956. This was the largest single group transported, and was followed by manufactured products, which accounted for 28.1 per cent of gross shipments. Agricultural products amounted to 18.3 per cent and forest products 10.0 per cent.

Certain items listed under manufactured products are the primary results of metal or mineral processing. The table below shows the tonnage of railway shipments of these items in 1956.

	Short Tons		Short Tons
Gasoline	4,219,667	Nickel, ingot	61,654
Fuel Oil (incl. bunker & diesel)	3,527,492	Other metals & alloys	730,251
Petroleum & coal products	1,610,189	Cement	2,620,710
Iron & steel (ingot & pig)	1,255,254	Brick & artificial stone	843,200
Scrap & waste metal	1,999,799	Lime and plaster	693,708
Aluminum ingot	613,766	Sewer pipe & drain tile	106,099
Matte (of all kinds)	312,549	Sulphur	227,183
Copper, ingot	524,345	Total	19,345,866

If this tonnage is added to the total in Table VI, metallic ores, industrial minerals, fuels and related primary products accounted for 97,515,368 tons, or 51.4 per cent, of revenue railway freight carried in Canada in 1955. It can be readily seen that the prosperity and growth of Canada's railways are greatly dependent on the mineral industry.

FUELS CONSUMED BY THE MINERAL INDUSTRY

The value of all fuels, namely coal, coke, gasoline, fuel oil, gas and wood consumed by the mineral industry in Canada amounted to $76.9 million in 1956 compared to $17.7 million in 1926.

While the value of fuels used in 1956 by the mineral industry was nearly 4 1/2 times the comparable total of 1926, consumption by the metal mining and non-ferrous smelting and refining branch of the industry in 1955 was over 8 times that of 1926. The following table shows the value of fuel consumption for the three branches of the industry for the years 1926 and 1956.

TABLE VII

Fuel Consumed by the Mineral Industry

Branch of Mineral Industry	Value of Fuel Consumed (Coal, coke, gasoline, fuel oil, gas, etc.) 1956	1926
	$	$
Metals, incl. smelting and refining	41,946,258	5,030,906
Industrial minerals	30,500,916	9,706,535
Fuels (excl. of petroleum refining)	4,507,904	2,988,774
Total	76,955,078	17,726,215

CONSUMPTION OF ELECTRIC POWER IN THE MINERAL INDUSTRY

The increase in the production of metals, minerals and fuels in Canada has resulted in over a twelve-fold increase in the quantity of electric power consumed from 1926 to 1956.

TABLE VIII

Consumption of Electricity in the Mineral Industry

Sector of Industry	1956	1926
	Millions of k.w.h.	Millions of k.w.h.
Metal mining	18,217	1,215
Industrial minerals	1,319	272
Fuels (excl. of petroleum refining)	340	117
Total	19,876	1,604

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Summary

The almost fifteen-fold increase by the metal mining industry is attributable to a great extent to the increase in smelting and refining of metals in Canada, particularly the smelting of aluminum which requires large amounts of electricity. As indicated, the electricity used in the expanding petroleum refining industry is not included in Table VIII.

SOURCES OF FUNDS FOR MINERAL DEVELOPMENT AND EXPANSION

The capital required today for all phases of mineral development from prospecting to production is considerably greater than in 1926 or even a few years ago. This is only partly due to the general increase in all costs that has taken place. The finding of mineral deposits, for example, used to be largely the role of the individual prospector, who looked for orebodies which outcropped at the surface or for oil seeps which told of the presence of oil.

Today's search is directed largely toward finding mineral deposits hidden beneath the surface. These can be located only by detailed geological and geophysical exploration and their existence must be proved by drilling. As the hinterland is pushed back, communications, with all the associated expense, become one of the most acute problems. These factors contribute to the increased cost of nearly every stage of mineral development. Technological advances have made possible improved operating conditions, greater efficiency, larger operations, mining of lower grade ores and lower unit costs. The advances, however, have also brought with them, the need for greater capital outlays before a mine or oil well can be brought into production.

There are many methods of financing mineral development. However, in recent years, the trend has been toward three relatively new means -- debt financing with public and institutional funds; financial assistance by established mining companies and mine finance houses; and government financial aid and participation. Although an important part of the capital required by the mineral industry is still supplied through the sale to the public of shares in mining companies, the funds raised in this manner are largely confined to financing the search for mineral deposits.

In a survey of the methods by which 72 mining companies (exclusive of petroleum, natural gas and coal) raised the funds required to finance new development and major expansion programs from the end of World War II to July 1956, it was found that the total amount of $1,330.5 million was secured in the following manner:

TABLE IX

Source of Funds for Development and Expansion
1945 to 1956

	%	Totals %
Bonds and debentures		
Bonds	36.0	
Debentures	14.0	50.0
Loans		
Parent company or major interest	6.0	
Bank	3.0	9.0
Retained earnings		27.0
Stock sales		
Major mining company	9.0	
Shareholders	1.0	
General public	1.0	
Unclassified	2.0	13.0
Miscellaneous sources		1.0
Total ($1,330.5 million)		100.0

The amount shown as raised by the sale of stock to the public may be somewhat low, but the general order of magnitude is correct.

Much of the element of risk is gone from mineral development today, due mainly to the thoroughness of modern exploration prior to development, the establishment of purchase contracts prior to development and the growing world demand for mineral products.

CHANGES IN MINERAL INDUSTRY, 1926 - 1956

In 1926, and until fairly recently, gold was the greatest single contributor to Canada's mineral output. Most of its production then came from the Porcupine and Kirkland Lake areas in Ontario and gold mines in southern British Columbia. These regions still account for much of the output. Other sources of gold in 1926, as well as in 1956, are placer mining in British Columbia and Yukon; as a by-product of base-metal ores chiefly in the Sudbury area of Ontario, the Noranda district of Quebec and by The Consolidated Mining and Smelting Co. of Canada Limited in British Columbia. By 1956 gold had lost a great deal of its importance among the metals mined in Canada, although actual output was nearly three times that of the earlier year. With a fixed price ($35 U.S. per oz.) and constantly rising costs, gold mining in many cases became unprofitable and emphasis changed to base metals. By 1956, gold had slipped in terms of value to fifth place in

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the list of minerals produced in Canada.

The dwindling reserves of direct-shipping iron ore in the United States brought about intense activity in the development of iron ore resources in Canada immediately following World War II, particularly in the Quebec-Labrador region. With increased production from this area and also greater output from the other producing areas, Canada has become the fourth largest iron ore producer of the world. This growth has all taken place since 1939, there being no production of iron ore in Canada from 1924 to 1938, inclusive. All indications point to the doubling and possibly trebling of Canadian production during the next decade.

The petroleum industry in western Canada has developed very rapidly since 1947 when the Leduc field was brought into production in Alberta. Modern industrial demands for petroleum and its products have spurred intense exploration activity for new sources of petroleum and natural gas. Petroleum production, which was once confined to southwestern Ontario, is now firmly established in Alberta, Saskatchewan, Manitoba and British Columbia, with also minor production in New Brunswick and Northwest Territories. The growing demand for petroleum and natural gas in both Canada and United States has emphasized the importance of the western Canada hydrocarbon reserves, and pipe lines have been and are being constructed to make crude oil and natural gas more readily available to eastern industrial regions.

The development of the use of uranium for military purposes brought about the mining of this metal in Canada during World War II and intensive post war exploration and development throughout Canada. At present, the Blind River area in Ontario promises to be the largest source of uranium ore in the world.

Although Canada has produced copper for many years, the pressing world demand for the metal plus the high prices of the past few years, have been a great impetus to increased exploration and production. In 1956, copper output was five times that of 1926. The production of lead and zinc has also risen steadily over the past quarter century. Zinc production has increased five-fold from 1926-1956, with much of the growth due to the higher zinc to lead ratio of the ore mined and better market conditions.

Better recovery techniques and market conditions have resulted in certain metals, such as cadmium, indium, selenium, tellurium and tin, being recovered and marketed as by-products of the mining of base-metal ores. In 1926, none of these metals, now of considerable value to the Canadian economy, was recovered.

The utilization of the lighter metals -- aluminum, magnesium and calcium -- has rapidly expanded throughout the world, particularly since World War II. Canada, with her abundance of hydro-electric power, has made an outstanding contr ibution to the output of aluminum ingot to meet the increasing world demand for the metal. Magnesium and calcium, which were not produced in Canada thirty years ago and were scarcely known in the world, are being extracted in increasing quantities from domestic ores. Canada stands to be a leading producer of these two metals.

Canada ranks high in the world as a producer of ilmenite (titanium ore). The increasing use of titanium dioxide pigments and of titanium metal has focussed attention on Canada's resources of ilmenite, which are among the world's largest. There was negligible production of titanium-bearing raw materials, in Canada prior to 1950.

Since 1926, there has been a marked increase in the output of many of the industrial minerals in Canada. Notably among these are asbestos, cement and gypsum. The entry of Newfoundland into Confederation in 1949 greatly increased the Canadian output of fluorspar, since practically all of the present production is obtained from that province. The production of lithium concentrates started in 1955 in the province of Quebec. At present, these lithium-bearing concentrates are exported to the United States for treatment, but facilities are being constructed for their treatment in Canada. This will encourage the domestic use of lithium products and will also help to increase the value of export trade.

Although Canada imports nearly half a million tons of sulphur annually, the production of sulphur from smelter gases and in pyrites and also recently from natural gases in western Canada has greatly decreased dependence on imported natural sulphur. In 1926, Canada produced barely 10,000 tons of sulphur, while output in 1956 stood at 710,000 tons. The pulp and paper industry and the heavy chemical industry utilize vast quantities of sulphur both in the elemental state and as sulphur dioxide and sulphuric acid. The Canadian mineral industry has responded to this demand for sulphur by increased production in the form of by-product pyrite and in smelter gases.

Although production of cement has greatly expanded since the 1926 output of 8.7 million barrels, the pace of present-day construction necessitates the importation of nearly 3,000,000 barrels annually. With planned increases in the current Canadian production of 29.7 million barrels, these imports should be considerably diminished.

1956 IN REVIEW

Metals

Copper. Canada's copper production of 354,860 tons was greater than in any preceding year and the value of the output, $292,958,091, exceeded that of any other metal produced in 1956. About 44 per cent of the total came from the nickel-copper ores of the Sudbury district of Ontario and 35 per cent from the copper and copper-zinc ores of Quebec.

Summary

A world shortage of copper accompanied by high prices in 1955 and the first half of 1956 stimulated very extensive exploration in Canada which resulted in the discovery of a number of promising occurrences. Several new copper mines were brought into production and others were developed to a near-production stage. The following were among the more important areas in which exploration and development of copper deposits took place in 1956: Notre Dame Bay area of Newfoundland; Bathurst area of New Brunswick; Chibougamau and Noranda areas of Quebec; Manitouwadge, and various areas of western Ontario; Snow Lake area of Manitoba; southwest British Columbia and the Pacific Coast region.

Expansion projects were initiated at the Noranda copper smelter in Quebec and at the Falconbridge nickel-copper smelter in Ontario. At Montreal East, where one of Canada's two copper refineries is located, the construction of additional refining facilities was commenced. This will increase the plant's capacity by about 20 per cent.

Lead. Canada's production of lead declined in 1956 for the second consecutive year. British Columbia's lead mines, which regularly produce 80 per cent of the national total, reduced output and accounted for much of the decrease. Production from Newfoundland increased and output from the Mayo district of Yukon was about the same as in 1955.

No work was done to bring Canada's major lead reserves at Pine Point on Great Slave Lake in the Northwest Territories into production. These deposits are owned by The Consolidated Mining and Smelting Company of Canada Limited which continued to await improvements in transportation facilities before undertaking full development. Adequate exploration has been completed.

Mine development and surface construction were carried out by Heath Steele Mines Limited in New Brunswick and by Consolidated Sudbury Basin Mines Limited in the Sudbury area of Ontario. Production from both properties is scheduled to begin in 1957, at 1,500 and 1,000 tons per day, respectively.

Nickel. Canada's nickel output continued to climb in 1956. Most of the 178,515 tons produced came from the Sudbury area of Ontario. The International Nickel Company of Canada Limited accounted for 81 per cent of the national production and Falconbridge Nickel Mines Limited 12 per cent. The remaining 7 per cent came largely from Sherritt Gordon Mines Limited at Lynn Lake in Manitoba.

The principal producers and several smaller operators effected expansion projects at their mines and plants which will further increase the output of nickel. At Rankin Inlet on the west coast of Hudson Bay, North Rankin Nickel Mines Limited, commenced the construction of a 250-ton concentrator from which production was expected to begin in 1957.

Exploration for mineral deposits was widespread across Canada with particular attention given to indications or occurrences of nickel. In December, International Nickel announced its plans for a major development program designed to bring very large nickel deposits in north-central Manitoba into production by 1960. This project will include the development of two mines, construction of a smelter, a refinery and about 50 miles of railway, a hydro-electric power plant and the creation of a new town named Thompson, to accommodate about 8,000 people.

Zinc. Canada's zinc production in 1956 was only slightly less than the record set in 1955. Supported by the United States stockpile purchases, the price of zinc remained steady at 13 1/2 cents per pound throughout the year, despite a general oversupply and a decline in world consumption of zinc. Canadian exports to the United States were at an all-time high.

The major development in Canada during the year was the discovery by Hudson Bay Mining and Smelting Company Limited of three important base-metal deposits in the Snow Lake area of north-central Manitoba. Two of these are high-grade zinc deposits, and the third contains predominantly copper values.

Three important deposits were in pre-production states of development during the year: Heath Steele Mines Limited, in New Brunswick; Geco Mines Limited in the Manitouwadge area of central Ontario; and Consolidated Sudbury Basin Mines Limited, in the Sudbury area of Ontario. All three.are scheduled to begin regular production in 1957 and will, when full capacity is attained, add about 5,800 ore tons per day to production totals.

Gold. Continuing rising costs combined with the set price for gold further depressed the gold mining industry in Canada in 1956.

The premium on the Canadian dollar rose during the year in relation to the United States dollar. This resulted in a fall in the price received for fine gold from the Royal Canadian Mint. The price ranged from a high of $34.96 an ounce in the first quarter of 1956 to a low of $33.56 by the year end. The year average was $34.45 compared with $34.52 in 1955.

Most of the gold mines in Canada went on a 44-hour work week during the year and a shortage of skilled miners reduced tonnage milled and tended to raise labour costs.

Ontario was again the leading producer of gold with 57 per cent of the total, followed by Quebec with 24, Northwest Territories 8, British Columbia 5 and Manitoba 3 per cent.

Three gold mines closed in Quebec and one in Ontario. No new mines came into production.

Summary

Gold dropped to fifth place in value in Canadian mineral production being surpassed by crude petroleum, copper, nickel, and iron. In the Free World output, Canada retained second place, following the Union of South Africa.

Iron Ore. During 1956, sizable gains in output were made by each of the principal iron-ore producing provinces - Newfoundland, Quebec and Ontario. Shipments again attained a new record of 19,953,820 long tons, valued at $160,362,118, considerably above the previous record of 14,538,551 long tons in 1955.

At Wabana, Newfoundland, Dominion Wabana Ore Limited completed its large-scale underground and surface modernization and expansion program which was instrumental in increasing production to 2.65 million long tons in 1956. Shipments from the Labrador-New Quebec operations of Iron Ore Company of Canada Limited exceeded 12 million long tons, the major part to United States destinations although a substantial tonnage was exported to the United Kingdom and Western Europe. Also in Quebec, The Hilton Mines, located about 35 miles northwest of Ottawa, continued the development of its low-grade magnetite open-pit mine and its beneficiation plant for initial production in the Fall of 1957.

In Ontario, Noranda Mines Limited and The International Nickel Company of Canada Limited recorded initial production of high-grade iron-oxide sinter and pellets from their respective plants at Port Robinson and Copper Cliff. Algoma Ore Properties Limited in the Michipicoten area developed a new open-pit mine, the Sir James, for initial production in 1957. Lowphos Ore Limited announced its plans for the development of the old Moose Mountain magnetite property north of Sudbury for initial production in 1958. Steep Rock Iron Mines Limited, while increasing production to 3.3 million long tons in 1956, continued its large-scale development and expansion program. This program is expected to increase the company's annual production to 5 1/2 million long tons in 1959. Also in the Steep Rock Lake area, Caland Ore Company continued the large-scale dredging operations necessary for the open-pit mining of "C" orebody in Falls Bay. In addition, Caland made preparations for shaft sinking to permit the underground mining of a section of this orebody.

In British Columbia, Empire Development Company commenced the development of its concentrating grade Elk River magnetite deposit at the northern end of Vancouver Island, for initial production in 1957.

The intense activity which took place in 1956 in the field of iron ore was a continuation of the development activity which commenced during World War II. This activity has been instrumental in increasing the value of iron-ore production until, in 1956, it was the fourth most valuable segment of the Canadian mineral industry. It has also made Canada the world's fourth largest producer of iron ore.

Titanium. Quebec Iron and Titanium Corporation completed, early in 1956, its $7.5 million ore beneficiation and rotary kiln plant at Sorel to up-grade the ilmenite ore from its Allard Lake properties. These facilities enabled the company to improve the grade of feed to its electric smelting furnaces at Sorel. Records were again established by Quebec Iron and Titanium in the shipments of titanium dioxide (TiO_2) slag and 'Sorel metal' from Sorel. Early in 1957, it was announced that the capacity of the smelter would be increased 60 per cent by 1959 with the addition of four furnaces at Sorel, with the first unit expected to be in operation by the end of 1957.

Of particular interest to the production of TiO_2 slag in Canada is the construction of a $15 million titanium-dioxide pigment plant at Varennes, Quebec, that will require about 28,000 tons of slag from Sorel to make a projected 18,000 tons of pigments a year. Canadian Titanium Pigments Limited expects to have this plant in production toward the end of 1957. Also of special interest was the announcement, late in 1956, that Kennecott Copper Corporation and Allied Chemical and Dye Corporation would build a $40 million plant in the United States to make titanium tetrachloride, sponge metal, and billets. As Kennecott has a large interest in Quebec Iron and Titanium it is possible that feed for the new plant will be TiO_2 slag from Sorel.

Uranium. Canada produced uranium valued at $46 million in 1956. The most notable feature of the year was the preparations to bring about 24 mines into production as quickly as possible.

In the Beaverlodge camp in northern Saskatchewan, a custom mill was being completed by Lorado Uranium Mines, Limited which will allow the company to process ore from five other mines as well as from its own by late 1957. The Blind River area in northern Ontario experienced the greatest rate of expansion; in 1956 Pronto Uranium Mines, Limited was in production for the full twelve months. Algom Uranium Mines, Limited reached production at one of its two properties late in the year, and nine more mines were being prepared for operations in 1957. In the Bancroft area in southeastern Ontario, Bicroft Uranium Mines Limited came into production in December, and three more mines were scheduled to commence operations in 1957. In the Marion River area of Northwest Territories, Rayrock Mines Limited was being readied for production, and in southeastern British Columbia Rexspar Uranium and Metals Mining Company Limited was planning production for late 1957.

When all of these mines are in production, the value of uranium output should exceed $300 million annually.

Fuels

Petroleum. The petroleum industry in 1956 continued the rapid expansion which has characterized it since the Leduc oil discovery of 1947. Exploration and oil field activity, as measured by such indicators as expenditures and drilling footage, were 15 to 25 per cent higher than in 1955. Canada's oil pipe-line transportation system was enlarged through the completion of three new pipe lines and the construction of new facilities on several other lines which had reached capacity throughput. The nation's oil pipe-line system moved 32 per cent more oil in 1956 than in 1955. Petroleum refining capacity was increased by 13 per cent as a result of the completion of two new refineries as well as construction work on existing refineries in most provinces across Canada. Large supplies of petroleum products were readily available to meet increasing requirements resulting from population growth and the rising standard of living. There was a 13 per cent increase in the domestic demand for petroleum products in 1956.

Of prime importance to the future growth of the petroleum industry were the significant oil discovery results obtained in 1956 in many areas throughout Alberta and in the southeastern sector of Saskatchewan. In Alberta, the "Granite Wash" exploration in the Red Earth Creek locality, east of the Peace River region, and the evidence of Cardium sand occurrences beyond the bounds of the Pembina oil field were highlights of the year. The continuing success in finding oil in southeastern Saskatchewan and the rapid rate of field development there made this 5,000-square mile area the most active oil region in Canada.

Canada's importance as an oil-producing country became further evident in 1956 when crude oil exports reached 42.9 million barrels, a three-fold increase over 1955. On trade balance, the country's degree of self-sufficiency in crude oil and petroleum products was 65 per cent in 1956, compared with under 10 per cent in 1946 when petroleum needs were less than one-third of current domestic demand.

An appraisal of 1956 achievements indicates therefore that the oil industry is building up a producing potential which should provide an increasing share of domestic oil requirements in the future and at the same time enable Canada to become an important oil exporting country.

Natural Gas. Prior to 1956, the natural gas industry in Canada was confined to Alberta, Saskatchewan, and Ontario, except for minor production in the Northwest Territories and New Brunswick.

During 1956 however, exploration activity was concentrated in British Columbia, and resulted in several sizable discoveries. The transportation developments of 1956 will enable natural gas produced in Alberta and British Columbia to be marketed in all provinces except the Maritimes. In finalizing countrywide transportation plans, which had been under consideration for several years, the natural gas industry in 1956 entered an entirely new phase of growth which will lead to a marked change in the pattern of energy usage in Canada. The year was therefore one of the most important periods in the entire history of the Canadian natural gas industry.

Natural gas production continued to increase at the rapid pace of the past several years and extensive exploration swelled Canada's reserves by the end of 1956 to over 23 trillion cubic feet.

In British Columbia the high success ratio in exploratory drilling of recent years was maintained during 1956. Although many of the 29 exploratory wells were drilled at locations within 65 miles of Fort St. John, appraisals were commenced in several areas farther north in the favourable 30-million acre Peace River area of northeastern British Columbia.

The discovery of natural gas in Alberta dates back to 1883, but it is only in the past ten years that exploration work has uncovered the large reserves in that province. Drilling during 1956 was widespread, with emphasis being given to areas adjacent to the proposed route of the Alberta Gas Trunk pipe line which will deliver Alberta gas to the Trans-Canada pipe line, and to the Peace River region.

Natural gas exploration continued on a more modest scale in Saskatchewan, Ontario and Quebec but with favourable results being obtained in each of these provinces.

In 1956 work began on the 2,294-mile system of Trans-Canada Pipe Lines Limited to eastern Canada following several years of resource development and market planning. Construction work also commenced on the 650-mile Westcoast Transmission Company Limited pipe line from the Peace River region to the Pacific Coast. By the end of 1956, seventy per cent of the line was completed.

Natural gas marketing is on the threshold of large-scale expansion. Sales in 1956 amounted to 143,725 million cubic feet; transportation developments of 1956 will ensure a much greater rate of increase in annual sales than the 20 per cent average annual increase that has taken place during the past four years.

Industrial Minerals

Production of the industrial minerals again attained a new record in 1956, with asbestos, cement, concrete aggregates, lightweight aggregates, nepheline syenite, salt, potash and sulphur deserving special mention. The value of production of the industrial minerals was $419,794,768, this figure including non-metallic minerals and construction materials (cement, clay products, lime, and aggregates).

A major development of interest in 1956 was the decision of National Gypsum (Canada) Limited to enter the asbestos production field. A subsidiary, National Asbestos Mines Limited, has been formed to develop a property east of Thetford Mines, Quebec. A 3,000-ton mill is being erected and is expected to be in production early in 1958. The province of Quebec accounted for about 95 per cent of the output in 1956.

During the year Carey-Canadian Mines Ltd., a subsidiary of Philip Carey Manufacturing Co., completed stripping operations at its new orebody in Broughton township, Quebec, west of Tring Junction. A large body of good-quality, slip fibre-bearing rock has been indicated. A 2,000-ton mill is under construction with initial production planned for mid-1957.

Summary

Outstanding progress was made by Lake Asbestos of Quebec Limited in the draining of Black Lake in Quebec. This project has necessitated construction of a diversion channel for the Becancour River, new drainage courses, relocation of 1 1/2 miles of main highway and removal of 25,000,000 cubic yards of silt. Construction of a 4,000-ton mill is in hand with production anticipated in 1958.

During August, Canadian Johns-Manville Company Limited placed in operation the remaining units of the new mill at the Jeffrey mine in Quebec. The mill, largest in the asbestos industry, has an annual capacity of 625,000 tons of asbestos fibre. One month later, as a result of the strong market for longer fibre grades, the company announced plans for the immediate construction of a $1 million addition to this unit. At the company's Munro mine, near Matheson, Ontario, underground development is progressing to prepare for a change from open-pit mining to block caving.

Cassiar Asbestos Corporation doubled dry-dock storage capacity to 100,000 tons at its property in northern British Columbia. Since mining operations are seasonal, this will permit operation of the mill throughout winter at the current rate of 700 to 750 tons per day. The company also placed in operation a new aerial tram line at a cost of $1 million to transport asbestos rock from the mine at McDame Mountain to the milling plant.

Cement. During 1956 the Canadian cement industry experienced its greatest period of growth. Production of cement rose from 25 million barrels of cement per year at the end of 1955 to almost 29 million barrels at the end of 1956. In addition to breaking production records, the industry as a whole embarked on a $100 million capital expansion program, which, when completed by the end of 1957, will have further increased annual productive capacity to 42 million barrels. With the culmination of this expansion program it can be reasonably assumed that Canada will no longer be plagued with the cement shortage which has existed for so many years.

The capital expansion which took place during 1956, included the construction of four new plants: St. Lawrence Cement Co. Ltd., at Clarkson, Ontario, began production in one kiln of its new plant in the early autumn -- ultimate capacity early in 1957 will be three million barrels; Canada Cement Company Ltd. also started production in the first half of its new 3 million-barrel plant at Zorra Station, near Woodstock, Ontario; the province of Saskatchewan obtained its first cement plant when Saskatchewan Cement Corporation began operations in a dry processing plant of 800,000-barrel capacity; and Inland Cement Company Ltd. at Edmonton started cement production about the middle of the year in a 900,000-barrel capacity plant. In addition to new plants, several companies expanded production by adding new kilns. These include: the Montreal East plant of Canada Cement Company, St. Mary's Cement Company, St. Mary's, Ontario, and British Columbia Cement Company at Bamberton, British Columbia. The latter company also spent $1.5 million on a new supply and distribution depot at Vancouver.

Plans for 1957, many of which were being executed at the end of 1956, will result in: the construction of a new plant at Picton, Ontario - Lake Ontario Portland Cement Company, which will have a 1.8 million-barrel capacity; a further increase in the Fort Whyte plant at Winnipeg by 1.5 million barrels to bring it up to 3 million-barrels annual capacity; the construction of a new plant on Lulu Island near Vancouver by Lafarge Cement Company of North America Limited - capacity of plant 1.3 million barrels; a doubling of the capacity of Inland Cement Company's plant at Edmonton, and a similar increase in the 800,000-barrel plant at Havelock, New Brunswick, of Canada Cement Company's plant. It is also worthy of note that Ideal Cement Company of Denver plans to incorporate a new Canadian company - Ideal Cement Company Ltd. at Vancouver. The purpose of this move, as given by company officials, is to activate the quarry and industrial site acquired by the American company some time ago.

Sand and Gravel. The high level of construction, particularly in the field of engineering, has kept most sand, gravel and quarry operations at peak production schedules. The St. Lawrence Seaway development has been a predominating influence in eastern Ontario and Quebec in aggregate production. Total aggregate to be used by the seaway and hydro construction will amount to about 5 1/2 million tons. The hydro-power development at Beechwood, New Brunswick, also consumed vast quantities of aggregate for concrete.

Lightweight Aggregates. The lightweight aggregate industry, which has made such rapid progress over the past few years in Canada, continued to expand in 1956. Four plants that were under construction in 1955 came into full production during 1956, and two others, one at Winnipeg and the other at New Westminster, British Columbia, were built and producing by the end of the year. Of the 26 plants now operating in Canada to produce lightweight aggregate, nine are expanding clay or shale, two are expanding slag, seven perlite, and seven vermiculite. One plant in the Vancouver area imports pumice from Washington for use as lightweight aggregate. All perlite and vermiculite for commercial production were imported in the raw state and expanded in plants across the country.

Nepheline Syenite. Canada and Russia are the only producers of nepheline syenite. Since 1940 when nepheline syenite started to be used in the ceramic industry, consumption has increased almost continuously. American Nephline Limited at Nephton, Ontario, spent $2.5 million modernizing and increasing the capacity of its mill, which is now 600 tons per day. International Minerals and Chemicals Corporation (Canada) entered the field of nepheline producers with a new plant at Blue Mountain, 20 miles north of Havelock and just a few miles east of Nephton. Present output is 300 tons per day but capacity can be quickly increased to 600 tons if the need arises.

Salt. Salt production increased by about 28 per cent in 1956. The very substantial increase is due to production from the rock salt mine at Ojibway near Windsor, Ontario, owned by Canadian Salt Company Limited. The mine only began production in late 1955 but operated at full production for the whole of 1956. Most of the salt production from this source was exported to the adjacent area of the United States. A subsidiary of this company,

Summary

Malagash Salt Company, has been operating a mine at Malagash, Nova Scotia, since 1919. This mine is now largely exhausted, but the company is sinking on a new property at Pugwash and has completed the construction of a new surface plant. The salt beds are at a depth of 400 feet. The mine was scheduled to start production by late spring of 1957.

Potash. Production of Canada's first potash from the rich but deeply buried potash beds of Saskatchewan has come appreciably closer with the recent announcement contained in a Saskatchewan Government publication that Potash Company of America was to start construction of a $20 million refinery in 1957. The plant is to be located at Patience Lake, 10 miles east of Saskatoon, where the company is sinking a shaft to 3,500 feet, of which 850 feet were completed at the end of the year. November 1958 has been given as the target date for the beginning of production. As of June 1956 the company was reported to have spent $5 million on exploration and development work.

There are now thirteen companies engaged in the exploration and development of Saskatchewan's potash beds which contain estimated reserves of up to 100 billion tons. The Saskatchewan Government has granted permits to explore 3 1/2 million acres for potash. Most of the potash companies from New Mexico are represented, as well as British, German, and Canadian interests. It has been estimated that by 1960 Canada may be producing 500,000 tons of potash salts annually.

Sulphur. Canada's production of equivalent sulphur from Canadian raw materials in 1956 was about in balance with consumption. In the West, two companies have been recovering elemental sulphur from sour natural gas, and four others were in various stages of constructing facilities during 1956 for the same purpose. Near the end of 1956, at Pincher Creek, Alberta, British American Oil Company was on the verge of beginning operations for sulphur recovery in a natural-gas cycling operation from which it plans initially to recover 225 tons daily. Pacific Petroleums Ltd. and associates commenced construction of a natural-gas processing plant near Fort St. John, British Columbia; this plant will have facilities for the initial recovery of 275 tons of sulphur daily. A small recovery plant was built by Imperial Oil Limited in the Redwater field, Alberta, where daily output will total from 10 to 20 tons of sulphur. Near Savanna Creek, 60 miles southwest of Calgary, Phillips Petroleum Company and associates are in the initial planning stages for sulphur recovery. Shell Oil Company and Royalite Oil Company have been recovering sulphur from sour gas since 1952. In the East, Laurentide Chemical and Sulphur Company is building a plant to recover elemental sulphur from oil refinery gases at Montreal East. Annual capacity is to be about 33,000 long tons and the plant is to be completed by mid-summer 1957.

Noranda Mines is starting to double the capacity of its Cutler sulphuric-acid plant in the Blind River area, Ontario. This will bring the productive capacity of the plant up to 1,000 tons of sulphuric acid per day. Raw material is to be by-product pyrite from the Noranda area in Quebec, which will also furnish a high-grade iron-oxide sinter for steel companies.

The acid is used in uranium recovery at the nearby mines of the Blind River camp. It is reported that Canadian Industries Limited is enlarging its sulphuric-acid plant at the smelter of International Nickel Company at Copper Cliff, also to supply acid to the Blind River uranium mines.

CONCLUSION

Mineral resources development in 1956 continued at the rapid rate which has marked its course since the 1940's. Following the depression of the 1930's and World War II, consumer demand for all kinds of durable goods was very great. Both industrial and domestic construction demands were exceptionally high. These demands were present in all countries but probably were greater in war-torn Europe. Accelerated industrial output and expansion were necessary to satisfy this tremendous backlog of demand. Non-ferrous base metals together with iron and steel were required in ever-increasing quantities. At the same time that this pressure was exerting itself, the Free World embarked on a great defensive build-up, entailing the production of modern machines of war. Large quantities of alloying metals were needed for defence purposes, which gave impetus to increased expansion in the mining of nickel, cobalt, molybdenum, tungsten and the smelting of aluminum.

The Korean Emergency also increased the demands for metals for defence purposes. The present stockpiling policies of certain western governments have been withdrawing large quantities of metals, particularly nickel, from industrial use for possible future defence purposes.

All these factors brought about pressing demands for metals and minerals of all kinds, pushing prices upwards, and Canada with her abundant mineral resources experienced unprecedented mineral activity. Canada's great mineral potential became known to the world and funds for exploration, development and expansion flowed into the country. The effects of these large capital outlays in exploration and development are now becoming evident in increased mineral production, and are being felt throughout the entire economy of the country.

ALUMINUM

By H.A. Graves
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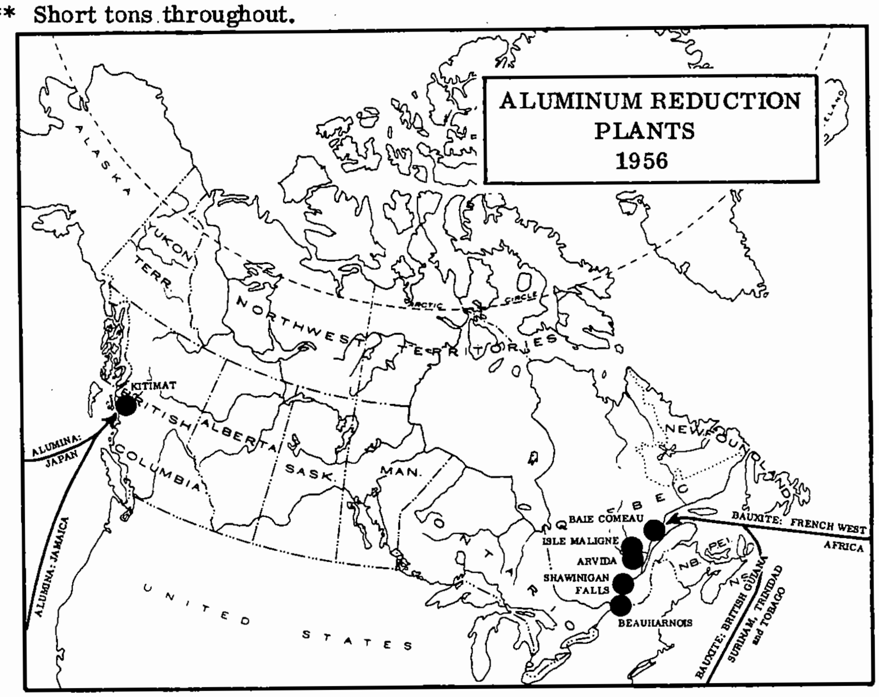
The world-wide demand for aluminum continues to increase at such a rate that, in spite of the phenomenal expansion in production facilities during recent years and of plans for future capacity, no threat of over-production is apparent. During the past 55 years, in the free world, the average annual increase in production has been 10.75 per cent which is equivalent to a 100 per cent increase every seven years. Present expansion plans indicate that output will keep pace with this demand and that the industry, which produced 2,852,000 tons* in 1955, will have a capacity of 4,655,500 tons by 1960.

Canadian output of aluminum during 1956 amounted to 620,321 tons** compared with 1955 production of 612,543 tons, all of the output being from imported ore. A power shortage in the Saguenay River district,

* Submission to the Royal Commission on Canada's Economic Prospects by the Aluminum Company of Canada Ltd.

** Short tons throughout.



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Aluminum - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production				
Ingot	620,321		612,543	
Imports				
Bauxite & Alumina				
British Guiana.....	1,401,594	7,453,380	1,831,011	8,180,032
Surinam	457,061	2,425,586	450,664	2,422,029
French Africa.....	311,974	1,697,010	461,956	2,514,433
Jamaica..........	178,628	11,879,101	127,231	6,410,331
Japan	19,858	1,174,365	21,141	1,285,226
United States	16	5,114	91	4,251
Other countries ...	-	-	-	-
Total	2,369,131	24,634,556	2,892,094	20,816,302
Cryolite				
W. Germany	14,331	3,355,528	1,103	260,000
Denmark	3,856	824,793	2,204	468,270
United States	123	29,713	96	24,317
Total	18,310	4,210,034	3,403	752,587
Aluminum Products				
Semi-manufactured.		11,514,512		3,042,866
Fully-manufactured ...		21,590,071		16,926,626
Total		33,104,583		19,969,492
Exports				
Primary forms				
United Kingdom ...	239,665	107,867,763	259,112	99,040,796
United States......	213,298	93,201,472	193,648	76,129,245
Other countries ...	56,031	26,362,451	57,871	24,023,735
Total	508,994	227,431,686	510,631	199,193,776
Semi-fabricated				
United States	3,079	2,340,905	6,028	3,992,310
India.............	1,120	632,931	2,018	1,051,580
New Zealand	954	604,656	624	314,652
Other countries ...	1,925	1,207,361	4,236	2,256,491
Total	7,078	4,785,853	12,906	7,615,033
Manufactured				
United States		735,461		1,281,127
Colombia		119,018		138,149
Other countries ...		502,622		336,173
Total		1,357,101		1,755,449
Scrap				
United States	4,759	998,377	10,014	3,006,013
W. Germany	1,428	500,457	2,527	958,532
Japan	1,476	594,562	-	-
Other countries ...	1,318	495,456	581	197,942
Total	8,981	2,588,852	13,122	4,162,487
Consumption				
Aluminum ingot ...	91,869		91,522	

Quebec, early in the year, cut production in eastern Canada by nearly one-half in the first quarter of 1956. All of this primary aluminum was produced by the Aluminum Company of Canada Ltd. (Alcan) in Quebec and British Columbia, this company being Canada's only producer at present. Canadian British Aluminum Company Limited, however, is building a smelter at Baie Comeau, Quebec, from which initial production is expected by the end of 1957.

The graph on page 31 illustrates the increase in production, exports and consumption in Canada during the past thirty years, or since 1927 when the Commonwealth Mining and Metallurgical Congress was last held in Canada.

Alcan has a $250 million program underway on the Peribonka River in northern Quebec. It concerns a large new hydro-electric project to develop 1,000,000 h. p. which will support a minimum of 150,000 tons of new aluminum smelting capacity in the Saguenay district.

At Kitimat, British Columbia, the annual ingot capacity at the end of 1956 was 180,000 tons with five potlines in operation. Present expansion plans are to increase this capacity to 330,000 tons by 1959. On August 9, 1956, the second anniversary of Kitimat production, the company announced that it had spent approximately $380 million on the project. An additional $130 million will be required during the next three years to bring the works to the annual production capacity of 330,000 tons. Provision has been made for an ultimate potential of 550,000 tons when required.

At the end of 1956, Alcan's total smelting capacity was 762,000 tons annually, compared with 650,000 tons of capacity at the beginning of 1956. If present plans for expansion in Quebec and British Columbia are completed on schedule, the company's annual capacity by the end of 1959 will have increased to over one million tons.

This great increase in the production of aluminum requires a parallel increase in the mining of bauxite and in ore-refining capacities. Alumina Jamaica Limited, an Alcan subsidiary, is undertaking an extensive program in Jamaica. Designed to provide the alumina for the next planned stage of output at Kitimat - 330,000 tons - the expansion program involves extending the capacity of the present Kirkvine Works to 550,000 tons of alumina a year. In addition, a new plant to cost about $35 million, is to be built at Ewarton with an ultimate capacity of 245,000 tons of alumina a year and with initial production expected by mid-1958. The total planned ultimate Jamaican alumina-producing capacity will be almost 800,000 tons a year.

In British Guiana, work is expected to commence shortly on the construction of a new plant of an annual capacity of 250,000 tons of alumina from the treatment of bauxite from the company's present mining installations in the Demerara River district. The plant will be erected near Mackenzie at an estimated cost of $33 million. First shipments of alumina are expected in 1959, and will be mainly to Canada.

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Aluminum

Canadian British Aluminum Company Limited, a subsidiary of British Aluminum Limited, London, England, commenced construction in May 1956 of a new aluminum smelter at Baie Comeau, Quebec. The smelter as planned will have an ultimate capacity of 180,000 tons. The first units of 45,000 tons capacity are expected to come into operation in November 1957, and another 40,000 tons capacity to be available by March 1959. This will cost $72 million. There is no firm commitment for the contemplated addition of another 90,000 tons capacity which would involve an outlay of $52 million, but the tentative date for its completion is 1965.

In the United States, primary aluminum producers increased their annual capacity by more than 250,000 tons in 1956, so that at year-end their total capacity stood at 1,762,000 tons. An additional 648,000 tons of aluminum ingot capacity is being built or planned. Three of the new reduction plants being built will obtain electric power from coal. This development is regarded as one of great significance to the continued growth of the aluminum industry. The office of Defense Mobilization has announced there will be no stockpile call for aluminum in the first half of 1957 thereby making the entire output available to industry.

The Anaconda Company of America is planning to build a $1 million pilot plant at Anaconda, Montana, to test a new process for the extraction of alumina from low-grade domestic clays.

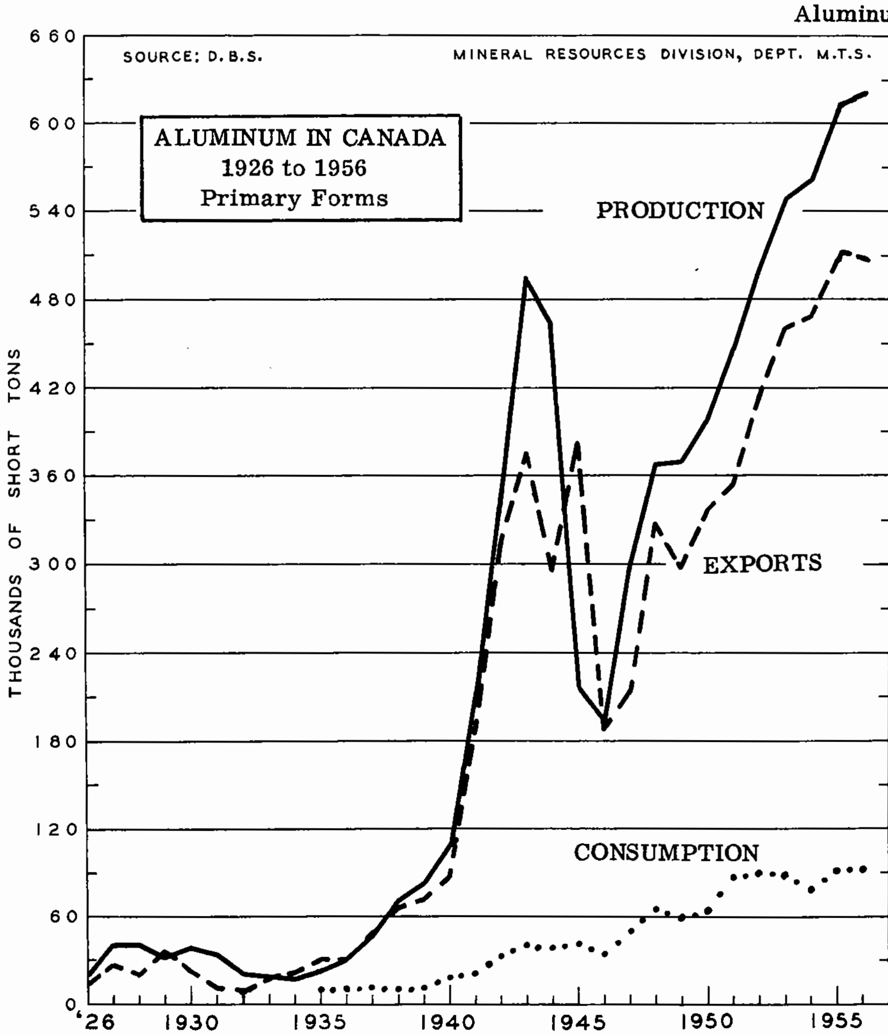
Consumption and Exports

The Canadian market for primary aluminum in recent years has averaged about 15 per cent of the annual production, or approximately 100,000 tons annually. It is estimated by Canadian aluminum producers that consumption in Canada will rise 50 per cent to 145,000 tons by 1960 and to 550,000 tons by 1980. Even with this increase in domestic consumption, the aluminum industry will still be dependent upon export demand. Canada accounts for 75 per cent of the annual tonnage of aluminum exports. Most of Canada's production is exported under government purchase contracts to the United States and the United Kingdom.

In 1956, aluminum replaced nickel as Canada's leading primary metal exported, the value of its exports being $227.4 million, up from $197 million in 1955.

Uses

The continuing growth in the demand for aluminum is due largely to the desirable physical and chemical properties of the metal. It has a high strength to weight ratio, particularly when alloyed with such metals as copper, silicon, manganese and magnesium; good conductivity of heat and electricity; is resistant to corrosion; attractive in appearance; and has low machining and handling costs.



Aluminum is believed to have more than 3,000 uses. Examples of the more important ones are:

Building and Construction. Windows, doors, store fronts, exterior curtain walls, ducts, mouldings and low-cost prefabricated houses.

Transportation. Increasing quantities of aluminum are being used in all types of transportation equipment to take advantage of its light weight.

Electrical Industry. The metal is widely used in the transmission and distribution of electricity and in the manufacture of electrical equipment, motors and appliances.

Canning and Packaging. The use of aluminum foil for packaging is rapidly increasing.

Aluminum

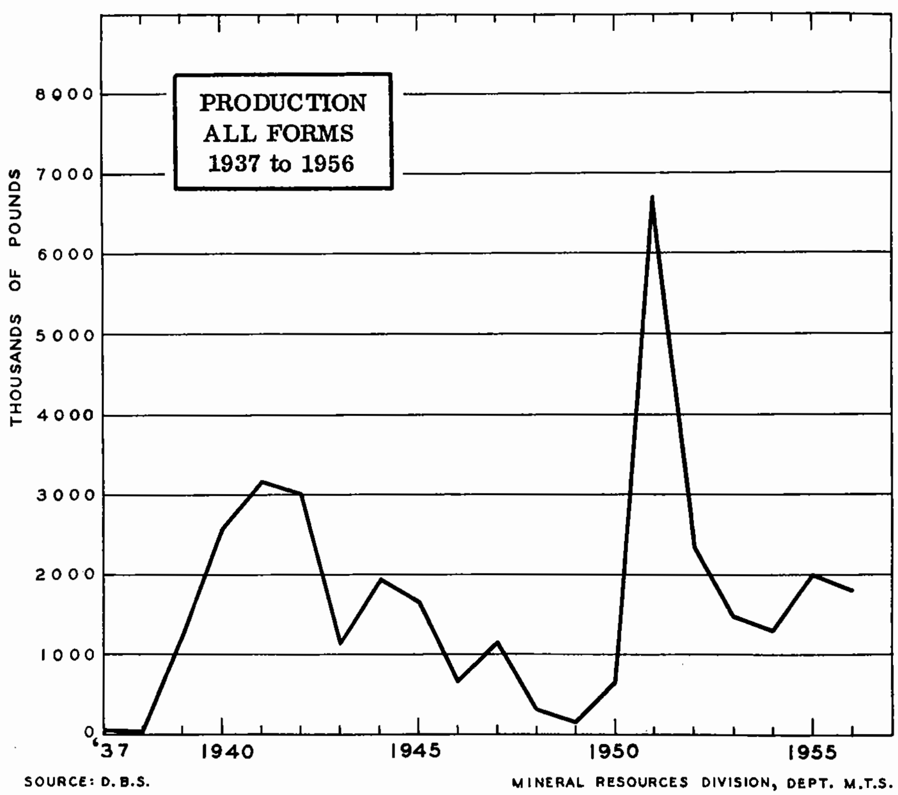
Prices

The Canadian price of aluminum ingot was 21 cents a pound at the beginning of 1956. Early in January it was raised to 22 1/4 cents, on March 31 to 23.5 cents and on August 14 to 24.5 cents a pound, where it remained.

ANTIMONY

By D.B. Fraser
Mineral Resources Division

No metallic antimony has been produced in Canada since 1944, when The Consolidated Mining and Smelting Company of Canada Limited discontinued operation of its antimony refinery at Trail, British Columbia, which had been turning out antimony metal since 1939. Production since 1944 has been in the form of antimonial lead, derived from lead concentrates produced from ores of the company's Sullivan mine at Kimberley, British Columbia, and from lead-silver ores and concentrates containing antimony shipped by other mines to Trail for treatment. Canada's output in the last twenty years is shown in the accompanying line graph. The peak indicated for the year 1951 includes the antimony content of slags and flue dust not reported in previous years.



Antimony - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production				
Antimony content of antimonial lead alloy ...	904		783	
Antimony content of flue dust and dore slag..	166		228	
Total	1,070	687,527	1,011	563,345
Imports				
Antimony metal				
China	509	184,906	53	19,630
United Kingdom......	343	149,680	340	212,543
Czechoslovakia	49	18,691	32	12,350
Other countries......	-	-	255	111,817
Total............	901	353,277	680	356,340
Antimony oxides				
United Kingdom......	99	47,139	65	28,950
United States	28	14,508	45	25,074
Belgium	3	1,587	1	516
Other countries......	-	-	32	13,907
Total............	130	63,234	143	68,447
Antimony Salts				
United States	9	11,374	18	18,627
West Germany.......	1	1,112	1	1,024
Other countries......	-	-	112 lbs	61
Total............	10	12,486	19	19,712
Exports				
Antimony content of antimonial lead alloy....	527		787	

	1956 Short Tons	1955 Short Tons	1954 Short Tons
Consumption of antimony regulus in production of:			
Antimonial lead........	525	495	467
Type metal............	88	56	59
Babbitt	76	121	129
Solder.................	17	25	11
Cable alloys...........	1	2	4
Antimony oxide	1	1	1
Batteries	3	3	5
Other uses	28	91	129
Total	739	794	805

Antimonial lead produced at Trail normally contains about 25 per cent antimony, but grades ranging from 1 to 35 per cent antimony are also produced. Lead bullion produced at the smelter contains about one per cent antimony, and the antimonial lead is recovered from the anode mud formed in the electrolytic refining of lead. In the smelting process, slags and flue dust containing a high percentage of antimony are accumulated, and as they cannot be readily treated at Trail are sold from time to time to foreign smelters.

Canadian production in 1956 was 1,070 tons valued at $687,527, compared with 1,011 tons in 1955 valued at $563,345.

World production of antimony in 1955 was an estimated 50,000 tons. The principal producing countries on a mine basis were: the Union of South Africa (15,640 tons); China (13,000); Bolivia (5,907); Mexico (4,209); Yugoslavia (1,769); and Algeria (1,102). The United States, the principal consumer, used 12,470 tons in 1955, of which only 633 tons were obtained from domestic sources.

Occurrences and Developments

Several occurrences or deposits of the principal antimony mineral stibnite (Sb_2S_3) have been explored and partly developed in Canada, 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, Truax Creek, Bridge River district, Stuart Lake mine, Fort St. James area, and Caroline property, West Kootenay district, British Columbia; Highet Creek deposit, Mayo district, and Wheaton River deposits near Whitehorse, Yukon.

About 2,000 feet of exploratory drilling was done in 1956 on the Lake George property in New Brunswick. No active development on any other Canadian deposit has been reported for several years.

Uses and Consumption

Antimony is used chiefly to impart hardness and mechanical strength to lead. Electric storage batteries for cars and trucks absorb large amounts of antimonial lead with an antimony content ranging from 4 to 12 per cent. Antimony is also an important constituent in lead cable covering, bearing metal, type metal, and solders.

Transistors and rectifiers made of an aluminum-antimony alloy are used in the electronics field. Sulphides of antimony are used as pigments in paint and rubber manufacture. Antimony oxide is employed for the flame-proofing of paints, plastics, and textiles.

Antimony

Prices

The year-end Canadian buying price of imported antimony regulus, at Toronto, duty paid, was:

		Per Pound
99.6%	-	32¢
99.5%	-	31.5¢
99%	-	31¢

The United States price of antimony, 99.50%, boxed, at New York, was 36.470 cents per pound.

BISMUTH

By D. B. Fraser
Mineral Resources Division

Bismuth was produced at Trail, British Columbia, by The Consolidated Mining and Smelting Company of Canada Limited (Cominco), whose entire output was refined metal, and by Molybdenite Corporation of Canada Limited at LaCorne, in western Quebec, which produced semi-refined metal of about 98 per cent purity. About 3 per cent of the total output was recovered by Deloro Smelting and Refining Company Limited, at Deloro, Ontario, from silver-cobalt ores mined in northern Ontario.

In general Canada's annual production of bismuth, illustrated in the graph on page 39, has been quite erratic owing to the small and variable demand for the metal. Since World War II, the price of bismuth has been relatively stable and a steadier production trend has developed. Annual world output is about 4 million pounds with Mexico, Peru, South Korea, Canada and Yugoslavia as the leading primary producers.

Domestic Sources

British Columbia

Bismuth produced at Trail originates for the most part in the lead-zinc-silver ores produced at Cominco's Sullivan mine at Kimberley, but some comes from other mines of the company and from custom ores and manufacturers' residues. The sources of the company's bismuth output are not separately reported.

Lead bullion produced at the Trail lead smelter contains about 0.05 per cent bismuth. The residue resulting from the electrolytic refining of the bullion is treated for the recovery of contained precious metals, bismuth, and antimony. The refined bismuth has a purity exceeding 99.99 per cent.

Quebec

In ores of the LaCorne mine, 23 miles northwest of Val d'Or, both molybdenite and bismuth are of economic importance. A daily average milling rate of 452 tons was maintained during 1956. Ore reserves at year-end were 184,860 tons of measured ore and about 300,000 tons of indicated ore.

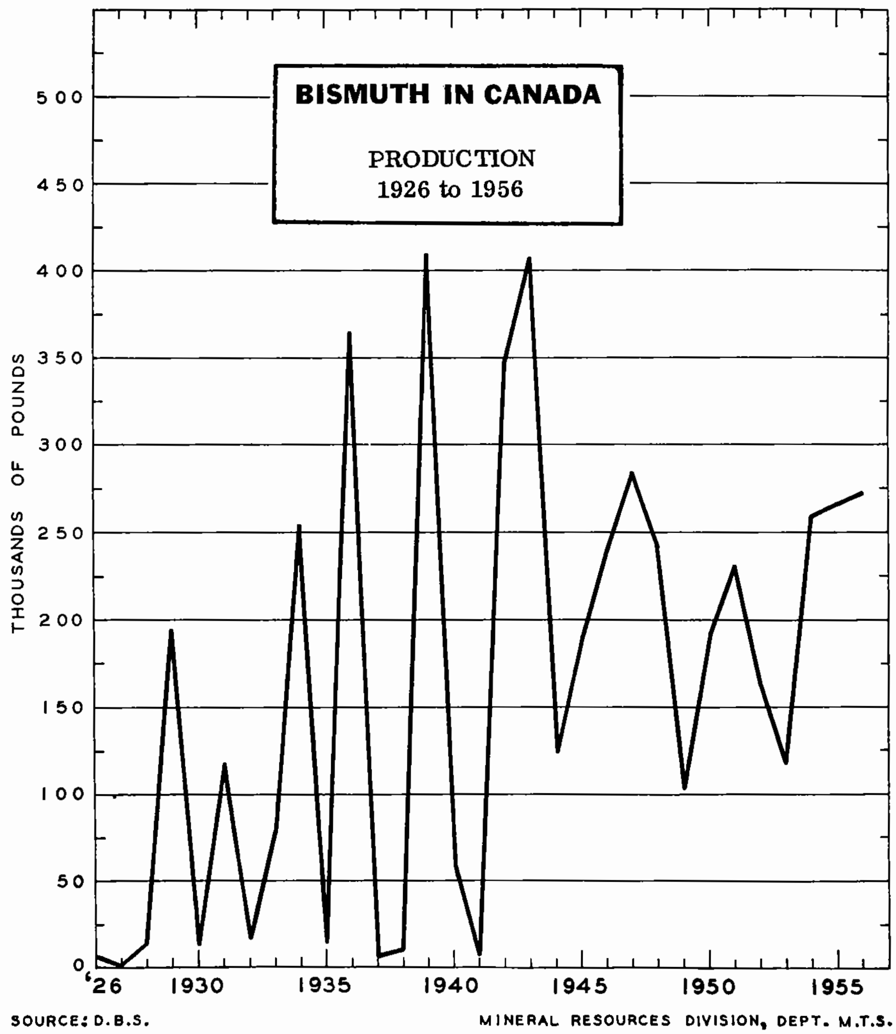
Bismuth - Production, Trade and Consumption

	1956 Pounds	1956 $	1955 Pounds	1955 $
Production[a]				
Quebec	122,128	230,213	105,129	210,636
British Columbia	156,753	304,101	160,767	361,726
Ontario....................	6,980	10,586	-	-
Total	285,861	544,900	265,896	572,362
Production[b], refined metal	156,753		160,766	
Imports				
Bismuth, residues and concentrates				
Peru	21,755	43,988	5,908	11,888
United States	2,270	5,155	-	-
Total......................	24,025	49,143	5,908	11,888
Bismuth salts				
United Kingdom.............		18,093		17,244
United States..............		3,375		4,555
Total......................		21,468		21,799
Exports, metal	134,705		56,142	
	1955		1954	
Consumption of metal by industries				
Medicinals & pharmaceuticals	82,296		41,400	
White metal foundries.......	38,571		35,846	
Miscellaneous	13,000 (e)		12,754	
Total......................	133,867		90,000	
Consumption of bismuth salts in chemicals & allied product industries..................	21,185		17,330	

(a) Refined metal from Canadian ores plus bismuth content of bullion exported.

(b) Production of refined metal from both domestic ores and imported residues and concentrates.

(e) Estimated.



The flotation process produces a concentrate containing 7 per cent bismuth, which is separated by leaching to form bismuth oxychloride. This is smelted in electric arc furnaces to produce crude metal with a bismuth content of 98 per cent or over. In 1956 a total of 138,574 pounds of ingots was produced. It is planned to develop in 1957 a process at LaCorne for refining the crude metal into a chemically pure bismuth metal.

Twenty miles west of LaCorne, Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada has an interest, outlined about one million tons of ore similar to that at the LaCorne mine. Joint consideration is being given to bringing this property into production.

Ontario

Deloro Smelting and Refining Company Limited, at Deloro, in south-eastern Ontario, recovered 8,433 pounds of bismuth in silver-lead-bismuth bullion, from the refining of silver-cobalt ores originating in the Cobalt-

Gowganda district. The bullion so produced contains about 20 per cent bismuth, and 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 this property to alloys it is used in making type-metal.

Permanent magnets of a very high energy potential are made from finely pulverized manganese-bismuth mixtures.

In the field of atomic energy, considerable research has been directed into the possible use as coolants in atomic piles of low-melting-point bismuth alloys having low neutron-capture qualities.

Bismuth salts have a fairly wide application in the preparation of pharmaceutical and cosmetic products; kaolin-base preparations have, to some extent, replaced bismuth compounds for pharmaceutical purposes in recent years.

In the United States, consumption by principal uses in 1956 and 1955 was as follows: (Ref. U.S. Mineral Industry Surveys)

	1956		1955	
	Pounds	Per cent of Total	Pounds	Per cent of Total
Fuse metal	179,600	12	176,000	11
Solder	152,800	10	122,000	8
Other alloys	601,300	40	568,000	37
Selenium rectifiers	13,000	1	26,400	2
Pharmaceuticals	425,200	28	471,000	30
Other uses	141,100	9	184,600	12
Total	1,513,000	100	1,548,000	100

Prices

Canadian prices quoted by The Consolidated Mining and Smelting Company of Canada Limited in 1956 were $2.25 a pound in lots of one ton or larger, and $2.50 a pound in lots of less than one ton. E & M J Metal and Mineral Markets quoted the price of bismuth in ton lots or larger as $2.25 a pound in New York throughout the year.

CADMIUM

By D.B. Fraser
Mineral Resources Division

Cadmium is a minor constituent of most zinc ores and is recovered as a by-product in the refining of zinc at various plants throughout the world. In Canada, The Consolidated Mining and Smelting Company of Canada Limited (Cominco) at Trail, British Columbia, and Hudson Bay Mining and Smelting Company Limited at Flin Flon, Manitoba, produce refined cadmium from the treatment of zinc concentrates from their own and custom ores. The metal is accumulated in cadmium-rich precipitates that result from the purification of the zinc electrolyte used in the electrolytic process for making refined zinc. About 70 per cent of the cadmium in the concentrates is recoverable, and metal of a purity not less than 99.95 per cent is produced in the form of balls, sticks, or slabs. Other amounts of cadmium are produced from zinc concentrates exported to foreign smelters, not all of which are reported.

Canada's cadmium output has increased proportionately with growing zinc production, and, as shown in the graph on page 43 reached an all-time high in 1956. A total of 2,339,421 pounds were produced, compared with 1,919,081 pounds in 1955. Output of refined cadmium was 1,932,887 pounds.

The United States and Mexico are the leading primary producers, followed by Canada, South West Africa, Japan and Germany. In refined output, Canada ranks second to the United States. Most of Canada's production is exported to the United States and the United Kingdom.

Domestic Sources

British Columbia

Much of the output of cadmium came from the zinc concentrate produced at Cominco's Sullivan mine near Kimberley. Other important sources were Cominco's H.B. mine near Salmo, its Bluebell mine on Kootenay Lake, and its northwestern subsidiary, Tulsequah Mines Limited; the Jersey zinc-lead mine of Canadian Exploration Limited near Salmo; Reeves MacDonald Mines Limited near Nelway; Britannia Mining and Smelting Company Limited on Howe Sound; Sheep Creek Mines Limited, Lake Windermere district; Sunshine Lardeau Mines Limited, near Camborne; Violamac Mines Limited, near Sandon; and Silver Standard Mines Limited

Cadmium

Cadmium - Production, Trade and Consumption

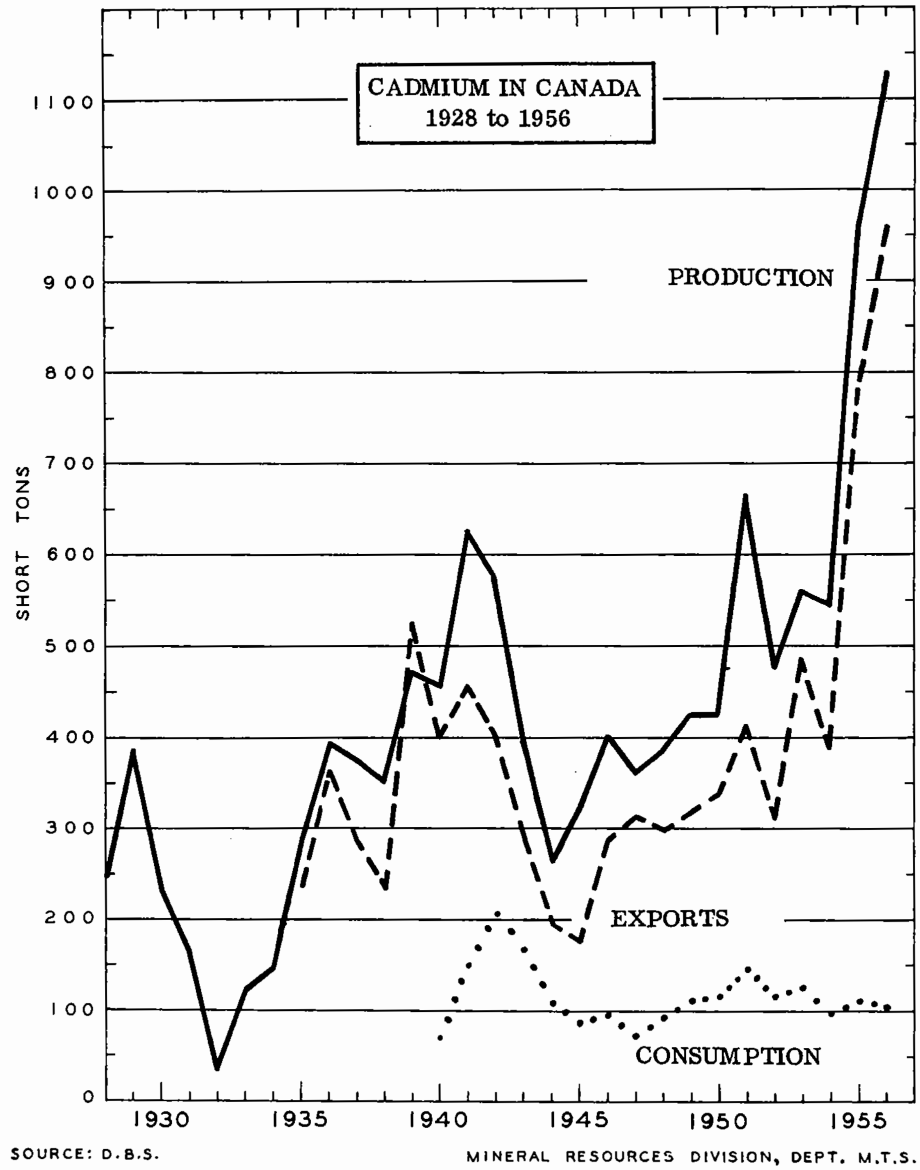
	1956		1955	
	Pounds	$	Pounds	$
Production, all forms				
British Columbia	1,937,807	3,294,272	1,515,582	2,576,490
Yukon	244,628	415,868	211,808	360,074
Saskatchewan and Manitoba	156,986	266,876	191,691	325,875
Total	2,339,421	3,977,016	1,919,081	3,262,439
Production,* refined cadmium	1,932,887		1,714,965	
Exports				
United States............	1,199,964	1,706,649	819,570	1,200,034
United Kingdom	675,162	1,052,519	608,725	902,035
Netherlands.............	36,200	48,768	78,400	102,468
W. Germany	11,200	16,128	33,600	40,830
Chile..................	159	421	-	-
Other countries	-	-	22,042	30,105
Total	1,922,685	2,824,485	1,562,337	2,275,472
Consumption by industries				
Aircraft	8,534		61,011	
Automotive	35,165			
Electrical	46,244		89,364	
Hardware...............	52,582		12,902	
Solders	5,654		4,957	
Miscellaneous...........	58,241		52,652	
Total	206,420		220,886	

* Includes some metal from foreign ores

near Hazelton. Zinc concentrates produced at the Sullivan average about 0.14 per cent cadmium but those from some other mines range up to 0.8 per cent.

Yukon

United Keno Hill Mines Limited was the principal producer. The adjoining Galkeno Mines Limited resumed milling in July after an 8-month shut-down during which ore reserves were built up. Zinc concentrates produced from the Mayo ores average about 0.8 per cent cadmium.



Saskatchewan and Manitoba

The refined cadmium production of Hudson Bay Mining and Smelting Company Limited came from its Flin Flon copper-zinc mine on the provincial boundary and from several small mines operated by the company in the Flin Flon area. Zinc concentrates produced from the Flin Flon ores average about 0.1 per cent cadmium.

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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 the amount recovered reported.

Uses

Cadmium is used chiefly as an electro-deposited protective coating for iron and steel products and, to a lesser extent, for copper-base alloys. Where cost is not of prime significance, cadmium is preferred to zinc as a coating because it can be deposited more uniformly in the recesses of intricately shaped parts; it has a slightly higher resistance to atmospheric corrosion; and it has a higher rate of deposition per unit of electric power.

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

The second largest use is for bearing alloys used in internal combustion engines specially designed for high speeds and temperatures. There are two types of these alloys: the cadmium-nickel alloy composed of about 98.5 per cent cadmium and 1.2 per cent nickel, and the cadmium-silver-copper alloy containing 98.3 per cent or more cadmium, 0.7 per cent silver, and 0.6 per cent copper.

Cadmium is also used in making low-melting-point solders and fusible alloys of the cadmium-tin-lead-bismuth type for automatic sprinkler systems, fire-detection apparatus, and valve seats for high-pressure gas containers. The addition of about one per cent of cadmium considerably strengthens copper wire without seriously reducing its conductivity. In the field of atomic energy, the metal is used for shielding purposes and in devices for reactor control.

Nickel-cadmium storage batteries have a longer life period than the standard lead-acid battery and are relatively much smaller but more expensive. The use of this type of battery is increasing, particularly for military applications and low-temperature conditions.

Cadmium sulphide and cadmium sulphoselenide are used where bright, high-quality, yellow and red colors, respectively, are required for paints, inks, ceramic glazes, paper, rubber, and glass. Cadmium oxide, cadmium hydrage, and cadmium chloride are used in electroplating solutions. Cadmium bromide and iodide are used to make photographic films, and also in photo-engraving and photo-lithography. Cadmium stearate goes into the making of vinyl plastics.

Prices

The average Canadian price of cadmium in 1956, estimated by the Dominion Bureau of Statistics, was $1.70 a pound. The New York price of cadmium in commercial sticks was $1.70 a pound throughout the year.

80486-4—4½

CHROMITE

By R.J. Jones
Mineral Resources Division

Canada has no known deposits of commercial-grade chromite ores. During World War II, some chromite was produced in the area between Quebec City and Sherbrooke in the Eastern Townships of Quebec but no shipments have been made from this source since 1949. The Bird River deposits in the Lac du Bonnet district in southeastern Manitoba are large but low in grade. The material is high in iron, and an economical method of bringing the chrome-iron ratio to within market requirements is needed.

Canadian consumption of chromite, which is mainly used in the production of ferrochrome, reversed the downward trend of the past few years and increased to 69,835 tons compared with 49,270 tons in 1955. This resulted from increased production of stainless steel. Regular grades of ferrochrome and ferrochrome-silicon were produced mainly for the domestic market. Exports continued to decline with the United States continuing to be the major importer. Special grades of low-carbon ferrochrome are imported into Canada, as the demand for them is still not sufficient to warrant manufacture.

Chromite is consumed in Canada by Electro Metallurgical Company (Division of Union Carbide Canada Limited) at Welland, Ontario, where high- and low-carbon chromium alloys are produced in a modern plant using electric furnaces. Exothermic chromium alloys are produced by Chromium Mining and Smelting Corporation, Limited, at Sault Ste. Marie, Ontario, in electric furnaces.

Canadian Refractories Limited produces chrome refractories for furnace linings in its plant at Marelan, about 50 miles west of Montreal.

World Production

World production of chromite in 1956 was estimated at 4,200,000 tons, 10 per cent higher than the 1955 production of about 3,800,000 tons. Turkey was the largest producer. Most of the output from the Union of South Africa is of chemical grade, of which it is the only producer.

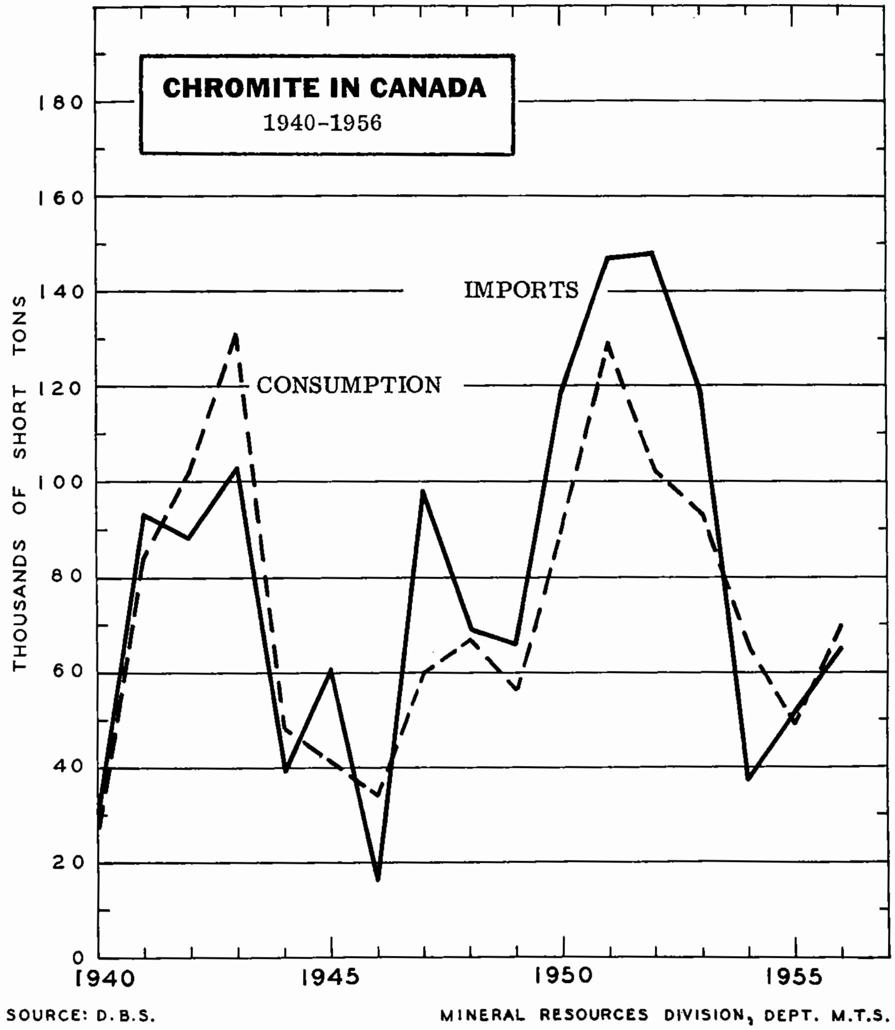
Chromite

Chromite - Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Imports, chromite				
Union of South Africa	18,468	220,466	9,805	112,597
United States	18,142	693,351	5,029	172,257
Philippines	17,344	264,974	14,896	197,505
Rhodesia & Nyasaland ...	6,593	201,667	7,849	179,254
Turkey	2,120	87,805	-	-
Cuba	2,093	56,953	14,165	308,534
Pakistan	205	4,195	-	-
Russia	-	-	110	1,375
Total	64,965	1,529,411	51,854	971,522
Exports, ferrochrome				
United States	9,327	1,887,804	11,695	2,070,342
United Kingdom	246	58,806	453	92,019
Belgium	177	50,016	157	38,015
W. Germany	106	24,867	-	-
Other countries	41	14,221	49	14,778
Total	9,897	2,035,714	12,354	2,215,154
Consumption of chromite ..	69,835		49,270	

The second largest producer was Turkey, where most of the production is a very high (52% chromic oxide, Cr_2O_3) metallurgical-grade ore. Russia was the third largest producer and Southern Rhodesia the fourth. Southern Rhodesia competes with Turkey as a major source of metallurgical-grade ore. The Philippines, with very large reserves of ore of metallurgical and refractory grades, occupied fifth position in world production.

In the Americas, the United States was the leading producer, followed by Cuba. Cuba's output comprises both refractory and metallurgical grades. The United States production is not for current consumption, but for stockpile purposes at high incentive prices. The Domestic Chrome Purchase Program was extended to June 30, 1959. Three quarters of domestic output in the United States was from American Chrome Company's Mouat mine in Montana. This ore which is similar to that of the Bird River deposits is beneficiated to about 38% Cr_2O_3 and sold to the government under a long-term contract calling for 900,000 short tons over an eight-year period. The United States Department of Agriculture bartered surplus farm commodities for chromite and chromium alloys.



Consumption and Uses

World consumption of chromium is about three and one-half times the combined consumption of nickel, tungsten, molybdenum, and cobalt, with the United States consuming about one-third of the total.

Approximately 55 per cent of all chromite consumed is metallurgical grade, 30 per cent is refractory grade, and 15 per cent chemical grade.

Metallurgical-grade Chromite

For metallurgical consumption in the manufacture of ferrochrome, chromite should contain 45 to 50 per cent Cr_2O_3 with a chromium-iron ratio which varies from 2.8 to 1 to 3 to 1. The material should be in lump form, as it is used in electric furnaces, and should contain as little silica as possible.

Chromite

Ferrochrome is mainly consumed as low-carbon or high-carbon ferrochrome, both of which contain from 67 to 71 per cent chromium. Low-carbon ferrochrome is used in stainless and in heat-resistant steels because of its low carbon content. These steels are widely used in the chemical and petrochemical industries. High-carbon ferrochrome is used in the production of other chromium-bearing steels and alloy cast-irons. Chromium in these steels greatly increases corrosion resistance. In cast-iron, chromium increases hardness, strength, and resistance to corrosion.

Chromium metal is used in the production of high-temperature, corrosion-resistant alloys as well as in chromium bronzes, hard-facing alloys, welding-electrode tips, and certain high-strength aluminum alloys. High-temperature alloys contain from 18 to 28 per cent chromium together with varying amounts of cobalt, tungsten, molybdenum, nickel, titanium, and columbium. The main uses of high-temperature alloys are in the jet and gas-turbine engine industry for such parts as nozzle guide vanes and turbine blades. They are also used in heat exchangers, boiler super-heaters, and superchargers.

Chromium plating is extensively used to produce brilliant, non-tarnishing, and durable finishes. Many articles such as dies, gauges, and punches are plated with a thicker layer to improve wearing qualities.

Refractory-grade Chromite

For the manufacture of refractories, specifications call for a 57 per cent minimum of combined chromic oxide and alumina with as little iron and silica as possible, usually around 10 and 5 per cent, respectively. The chromium-iron ratio is of no consequence in this grade but the ore must be hard and lumpy, not under 10-mesh. Fine ore is suitable for the manufacture of brick cement or in the chrome-magnesite brick industry.

Refractory-grade chromite is manufactured into bricks for use as a neutral lining for 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, separating the silica bricks of the roof and the top of the sides from the dolomite or magnesite bricks of the hearth and sides below the slag line. Other chrome refractories are used for patching brickwork and in making ramming mixtures for furnace bottoms.

Chemical-grade Chromite

For chemical consumption, specifications are not as rigid as in the metallurgical and refractory grades. Standard chemical ores contain 44 per cent Cr_2O_3, and iron is not a problem within reasonable limits. The ore should not contain more than 15 per cent alumina (Al_2O_3), 20 per cent FeO, and 3 per cent SiO_2; the sulphur must be low. The chromium-iron ratio is usually about 1.5 to 1. Fines are preferred because the ore is ground in processing to sodium and potassium chromates and bichromates.

Sodium bichromate or its derivatives are widely used in the tanning of leather, as pigments in the paint and dye industries, in the surface treatment of metals, and as a source of electrolytic chromium metal.

Prices

According to E & M J Metal and Mineral Markets of December 27, 1956, United States prices were as follows:

Chrome Ore: per long ton, dry basis, subject to penalties if guarantees are not met, f.o.b. cars N.Y., etc.

Rhodesian	
48% Cr_2O_3, 3 to 1 ratio, lumps	\$55 to \$58.50
48% Cr_2O_3, 2.8 to 1 ratio	52 to 56
48% Cr_2O_3, no ratio	46 to 49.75
all long-term contracts	
South African (Transvaal)	
48% Cr_2O_3, no ratio	\$38 to \$39
44% Cr_2O_3, no ratio	26.50 to 27.50
Turkish	
48% Cr_2O_3, 3 to 1 ratio, lump and concentrates	\$59 to \$61
46% Cr_2O_3, 3 to 1 ratio, lump and concentrates	56 to 58
Pakistan (Baluchistan)	
48% Cr_2O_3, 3 to 1 ratio	\$52 to \$53

Ferrochrome per lb of Cr.

High carbon (4-9% C), 65 to 69% Cr, lumps, carloads, f.o.b. destination continental United States - 27 3/4¢

Low carbon (0.06% C) - 39 1/2¢

Chromium metal

Per lb, 97% grade, 0.5% C - \$1.29

Electrolytic chromium, commercial grade, 99% min., delivered - \$1.29 per lb

Tariffs

Canadian

Chrome ore - free

Chromium metal - in lumps, powder, ingots, blocks, or bars, and scrap alloy metal containing chromium, when imported by manufacturers for use exclusively for alloying purposes in their own factories - free.

Chromite

Ferrochrome

British preferential	- free
Most favoured nation	- 5% ad valorem
General	- 5% ad valorem

United States

Chrome ore - free

Chromium metal - 11 1/2% ad valorem

Ferrochrome

3% or more carbon on Cr. content	- 5/8¢ per lb
Less than 3% carbon on Cr. content	- 11 1/2% ad valorem

COBALT

By R.J. Jones
Mineral Resources Division

Cobalt production, as represented by shipments of metal, oxides, matte and exports of concentrates, derived from ores of Canadian origin, increased to about 3,516,670 pounds from 3,319,000 pounds in 1955. The increase arose from the continued expansion of the nickel industry, which produces cobalt as a by-product. This production represents the highest ever recorded in Canada.

Consumption of cobalt increased to about 436,000 pounds from 288,000 pounds in 1955.

Production

Cobalt-Gowganda Area, Ontario

Cobalt ore shipments made via the Temiskaming Testing Laboratories, Cobalt, amounted to 571,244 pounds of contained cobalt, a large decrease compared with the 1,293,500 pounds in 1955. These shipments were made chiefly to Deloro Smelting and Refining Company Limited, Deloro, Ontario. A small parcel of cobalt ore was exported.

The principal shippers of cobalt ore were Cobalt Consolidated Mining Corporation Limited and Silver Miller Mines Limited, with smaller shipments being made by Silver Crater Mines Limited and Tiara Mines Limited. The main producer, Cobalt Consolidated Mining Corporation Limited, produced cobalt ore from a group of mines which have been rehabilitated in recent years.

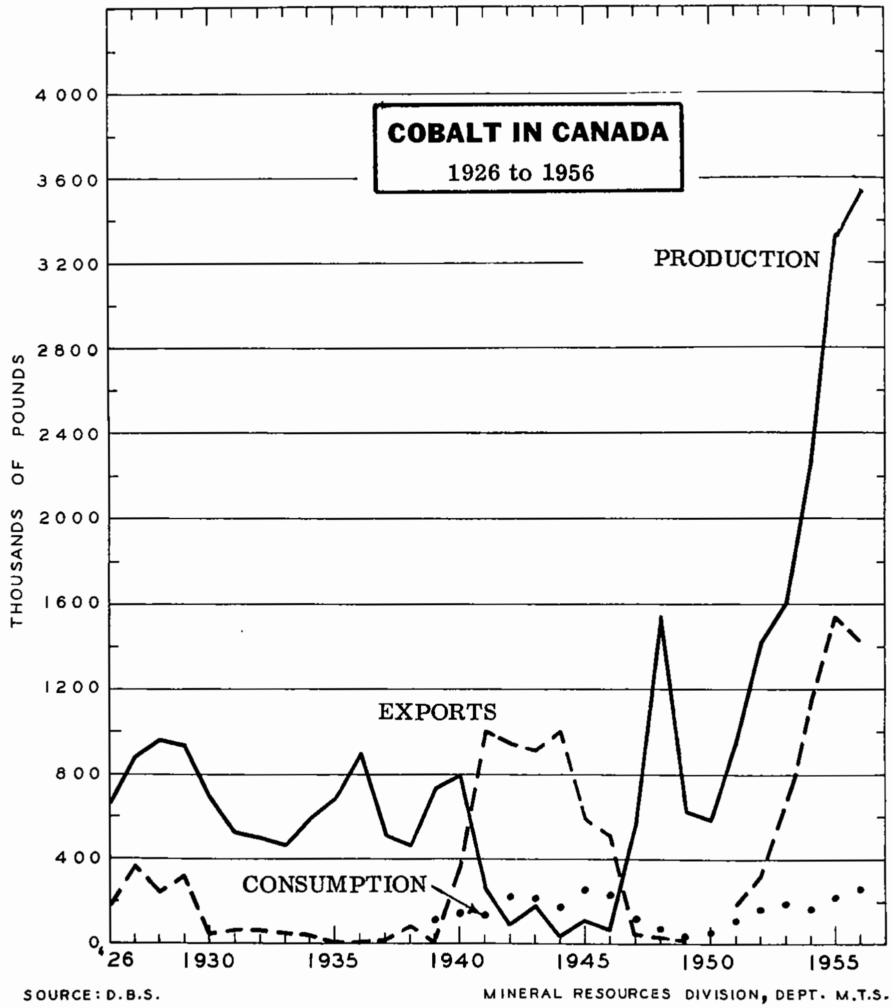
The ores and concentrates were sold under the Canadian Government's premium price plan on behalf of the United States Government. The prices paid for cobalt ores under this plan were as follows, f.o.b. Cobalt, Ontario:

7 - 7.99%	cobalt,	$1.00	per lb of contained cobalt.
8 - 8.99%	"	$1.15	" " " " "
9 - 9.99%	"	$1.30	" " " " "
10 - 10.99%	"	$1.40	" " " " "
11 - 11.99%	"	$1.50	" " " " "
12% plus	"	$1.60	" " " " "

Cobalt - Production, Trade and Consumption

	1956		1955	
	Pounds	$	Pounds	$
Shipments (a) from Canadian ores (contained cobalt in metals, alloys, oxides, salts and in concentrates)	3,516,670	9,065,493	3,318,637	8,563,700
Exports				
Cobalt in ores and concentrates (b)	16,000	15,092	-	-
Cobalt metal				
United States	1,432,884	3,546,025	1,383,088	3,178,553
Cobalt alloys (c)				
United States	5,615	10,905	1,753	5,697
France	5,150	24,717	10,450	48,246
Israel	398	1,751	30	168
Other countries	180	2,713	124	1,987
Total	11,343	40,086	12,357	56,098
Cobalt oxides and salts (c)				
United Kingdom	1,283,745	2,310,741	1,617,445	2,864,130
United States	5,400	4,400	20,525	25,732
Other countries	-	-	2,312	4,522
Total	1,289,145	2,315,141	1,640,282	2,894,384
Imports (c)				
Cobalt concentrates				
United States	1,900	1,031	37,600	10,386
Norway	-	-	200	512
Total	1,900	1,031	37,800	10,898
Oxides				
United States	10,905	26,327	8,000	20,490
United Kingdom	448	798	-	-
Total	11,353	27,125	8,000	20,490
Consumption (d)				
(Contained cobalt)	435,732		287,806	

(a) Excludes cobalt content of nickel matte shipped to the United Kingdom by International Nickel Company but includes the cobalt content of Falconbridge's shipments of nickel copper matte to Norway.
(b) Cobalt-Gowganda area only.
(c) Gross weight.
(d) Producers' shipments of metal, oxide and salts.



These ores and concentrates were refined to metal by the Deloro smelter and shipped to the United States Government. The premium price plan which had been in effect since the start of the Korean Emergency in 1951 terminated at the end of 1956. Thus, production of cobalt ores at commercial prices is likely to be at a lower level in the future.

Silver ore shipments made in 1956, via the Temiskaming Testing Laboratories, were mainly to the Deloro smelter which purchased the cobalt content of these ores for its own account. Shipments amounted to 209,857 pounds of contained cobalt compared with 135,938 pounds in 1955.

Certain lower grade silver concentrates containing copper and cobalt were shipped to the smelter of Noranda Mines Limited at Noranda, Quebec, but the cobalt content was not recovered.

Cobalt

Sudbury Area, Ontario

Cobalt occurs in minor amounts in nickel-copper ores of the Sudbury area and is recovered as cobalt oxide or electrolytic cobalt from residues obtained in the refining of nickel.

The International Nickel Company of Canada Limited recovers cobalt oxide from the electrolyte at its nickel refinery at Port Colborne, Ontario. The cobalt is separated by precipitation and is shipped as an impure cobalt oxide to the Mond Nickel Company Limited at Clydach, Wales, for the production of black and grey oxides and an extensive range of cobalt salts. In October 1954, International Nickel began the first production in Canada of high-purity electrolytic cobalt at its Port Colborne refinery. Recovery of the cobalt content of nickel matte produced by International Nickel began in 1940 at Clydach, but this cobalt has never been included as Canadian production in Canadian Government statistics. Deliveries of cobalt in all forms by International Nickel in 1956 was 1,543,286 pounds compared with 1,637,405 pounds in 1955.

Falconbridge Nickel Mines Limited produces electrolytic cobalt from nickel-copper matte exported to its nickel refinery at Kristiansand, Norway. Deliveries of metal by Falconbridge increased to 543,012 pounds in 1956 from 337,559 in 1955.

Manitoba

Sherritt Gordon Mines Limited operated its copper-nickel mines at Lynn Lake at capacity. The ores have a low cobalt content. Production of refined cobalt was commenced as a by-product in June 1955 at the company's nickel refinery at Fort Saskatchewan, Alberta. Production in 1956 amounted to 107,414 pounds as against 16,330 pounds in 1955.

The nickel-copper deposit at Mystery-Moak Lake, owned by International Nickel, contains minor amounts of cobalt that will no doubt be recovered when the operation reaches the production stage in 1960.

Domestic Refinery Production

Deloro Smelting and Refining Company Limited operated at capacity during the year, treating cobalt and silver ores from the Cobalt Gowganda area in order to meet the domestic requirements for cobalt products, the export market, and its commitment with the United States Government.

The International Nickel Company operated the electrolytic cobalt unit of its Port Colborne refinery to produce high-purity cobalt used mainly for high-temperature alloys and permanent magnets.

The smelter of Cobalt Chemicals Limited, 5 miles south of Cobalt, operated on a research basis during the year.

World Mine Production

According to the American Bureau of Metal Statistics, the main producers of cobalt in 1956 were: Belgian Congo (20,037,609 pounds of contained cobalt), Canada (3,516,670 pounds), United States (3,595,028 pounds), French Morocco (1,419,762 pounds) and Northern Rhodesia (2,410,000 pounds).

Production from the Belgian Congo is derived from the copper ores of of Union Minière du Haut-Katanga.

In Northern Rhodesia, Rhokana Corporation Limited recovers cobalt as a by-product of copper production. In 1956, production of cobalt concentrate was commenced at Chibuluma Mines Limited, a subsidiary of the Rhodesian Selection Trust. The concentrate will be converted to matte at the Ndola smelter and probably exported for refining. Chibuluma will produce about 1,000,000 pounds a year.

United States production of cobalt was higher in 1956, mainly owing to the successful operation of the Calera Mining Company refinery at Garfield, Utah.

Of interest was the formation during 1956 of the Cobalt Development Institute by the world's major cobalt producers with an objective of increasing consumption of cobalt by developing the existing uses of cobalt and fostering new uses. The large increase in world production in recent years would indicate that such a move on the part of the producers would be beneficial in the future.

Kilembe Copper Cobalt Limited in Uganda commenced production in June 1956 and expects to produce eventually 1,500,000 pounds of cobalt annually.

The Cuban American Nickel Company announced that it intends to produce cobalt metal at the rate of 4,400,000 pounds a year from its nickel-cobalt deposits at Moa Bay, Cuba. Production is scheduled for 1959.

Uses and Consumption

Consumption of cobalt in the United States during 1956 was less than the average over the period of 1951 to 1956, chiefly as a result of a decline in use in high-temperature alloys, cemented carbides, and ground-coat frit for porcelain enamel. The United States consumed over one-quarter of the world production.

World consumption has not been keeping pace with the large increase in mine production. Magnet alloys are meeting with increased competition from ferrites and ceramic magnet materials.

Cobalt

About 90 per cent of the total consumption of cobalt is in the form of metal, marketed as rondelles, granules, shot, and powder. The remaining 10 per cent comprises black and grey oxide; inorganic salts such as the acetate, carbonate, sulphate, etc.; and organic compounds such as linoleates, naphthenates, and resinates.

The most important use for 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 also an important constituent of permanent-magnet alloys, cemented carbides, hard-facing rods, and high-speed steel. A radioisotope, Cobalt 60, is widely used for radiographic examinations by industry, and also in the 'Cobalt Bomb' for the treatment of cancer.

The largest use for cobalt oxide is for making ground-coat frit to promote adherence of fired enamel to the metal base to which it is applied. It is also used in ceramics and glass manufacture.

Cobalt organic salts are used as driers in paint, varnish, enamel, ink, etc.; and the use of inorganic salts such as cobalt sulphate is increasing in animal-feed nutrition, especially in mountainous areas where the salt is sprayed by aircraft.

The more important Canadian consumers of cobalt are: Deloro Smelting and Refining Company Limited, Deloro, Ontario; Canadian General Electric Company Limited and Nuodex Products of Canada, Limited (driers), both of Toronto, Ontario; Ferro Enamels (Canada), Limited, Oakville, Ontario; Atlas Steels, Limited, Welland, Ontario; Dominion Glass Company, Limited, Montreal, P.Q.; and Canadian Hanson and Van Winkle Company, Limited (electroplating equipment), Toronto, Ontario.

Prices

The first price reduction in cobalt metal was made on December 1, 1956, when the price was reduced from $2.60 U.S. to $2.35 U.S., after a steady rise in price over a 20-year period. On February 1, 1957 the price was further reduced to $2.00 U.S.

Prices at the end of 1956 according to the E & M J Metal and Mineral Markets were as follows:

Cobalt metal, $2.35 per pound in the form of rondelles or granules in 500 to 600 pound containers, ex docks or store New York or Niagara Falls, N.Y. In 100-pound containers, the price is $2.37 per pound, and in less than 100-pound containers, $2.42 per pound.

Cobalt metal fines, $2.35 per pound of cobalt contained, f.o.b. New York or Niagara Falls, N.Y., standard package of 650 pounds.

Cobalt oxide, ceramic grade, 72 1/2 to 73 1/2 per cent cobalt, $1.78 per pound east of Mississippi and $1.81 per pound west. Quotations are for oxide packed in 350-pound containers.

Tariffs

Canada

Ore - free; cobalt metal: British preferential - free, most favoured nation - 10% ad valoren, general - 10% ad valorem; cobalt oxide: British preferential - free, most favoured nation - 10% ad valorem, general - 10% ad valorem.

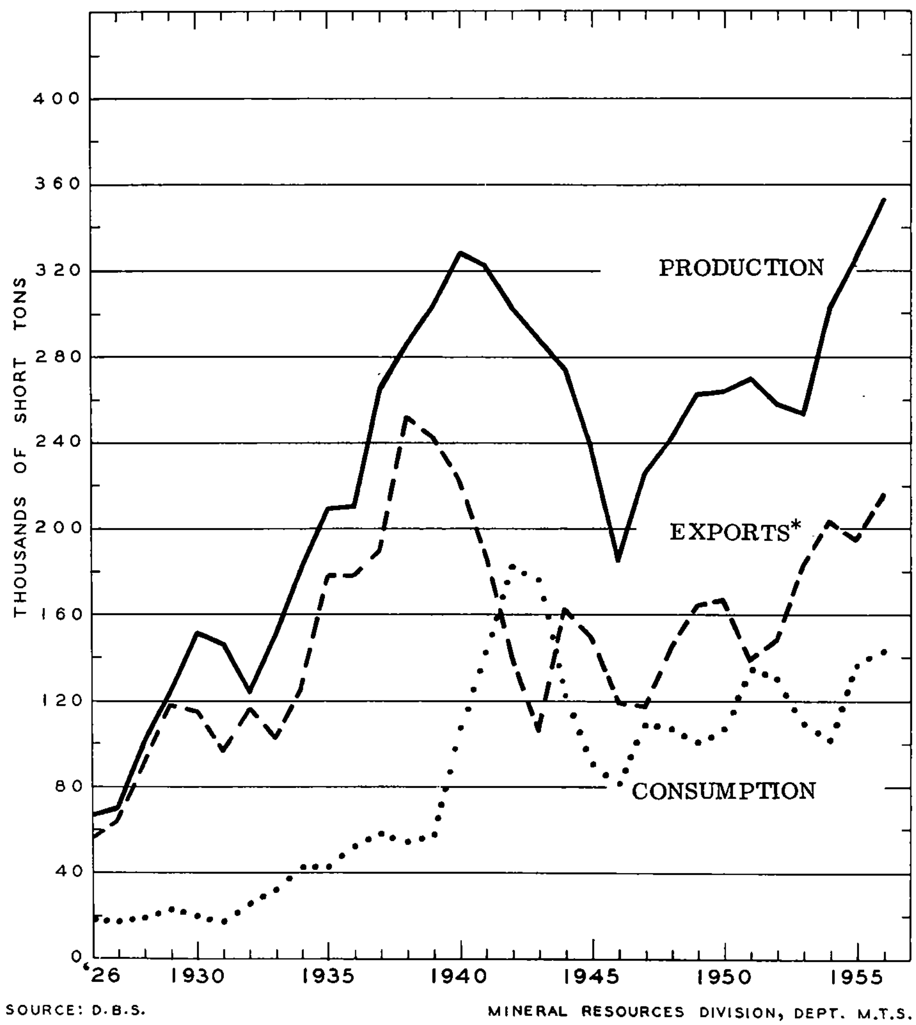
United States

Ore and metal - free; cobalt linoleate - 5¢ per lb ; cobalt oxide - 4 3/4¢ per lb; cobalt sulphate - 2 1/2¢ per lb ; other cobalt compounds and salts - 15% ad valorem.

COPPER

By. R.E. Neelands
Mineral Resources Division

Canada's production of copper in all forms at 354,860 tons was greater than in any preceding year, and the value of the output at $292,958,091 exceeded that of any other metal produced in 1956. About 44 per cent of the total came from the nickel-copper ores of the Sudbury area of Ontario. Quebec produced about 34 per cent and the remainder came in decreasing order from Saskatchewan, British Columbia, Manitoba, Newfoundland, Nova Scotia and New Brunswick.



* Primary forms only

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Copper - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production, all forms				
Ontario	156,271	128,552,450	146,406	107,215,943
Quebec	122,300	101,288,640	101,021	74,502,645
Saskatchewan	33,116	27,426,903	32,945	24,297,063
British Columbia	21,682	17,885,709	22,127	16,267,579
Manitoba	17,973	14,890,139	19,380	14,438,505
Newfoundland	3,108	2,574,274	3,052	2,250,672
Nova Scotia	404	334,704	1,027	757,758
New Brunswick	6	5,272	36	26,290
Total	354,860	292,958,091	325,994	239,756,455
Production - refined	331,176		289,425	
Exports				
In ingots, bars slabs, etc.				
United States	96,746	75,798,864	67,071	48,823,152
United Kingdom	63,990	53,857,357	69,198	48,236,865
France	9,860	8,547,324	8,957	6,904,054
India	3,972	3,336,404	1,724	1,317,693
Brazil	257	206,557	496	342,464
Other countries	19	20,597	5,753	4,025,375
Total	174,844	141,767,103	153,199	109,649,603
In rods, strips, sheets, plates and tubing				
Switzerland	4,570	4,267,453	6,269	4,652,091
United States	2,350	2,691,313	4,321	3,890,384
United Kingdom	1,730	1,692,393	2,432	2,143,851
Cuba	861	1,188,051	693	767,821
New Zealand	483	613,630	1,317	1,376,334
Other countries	1,921	2,232,832	4,130	3,386,910
Total	11,915	12,685,672	19,162	16,217,391

	1956		1955	
	Short Tons	$	Short Tons	$
In ore and matte				
United States.	25,354	19,160,692	26,883	18,547,551
Norway	13,373	10,276,798	11,324	7,654,060
United Kingdom	1,175	898,466	1,130	773,112
West Germany.	692	511,940	1,828	1,279,158
Belgium	398	280,739	400	309,211
Pakistan	1	725	-	-
Total.	40,993	31,129,360	41,565	28,563,092
Scrap, slag & skimmings				
Japan	7,881	6,609,075	74	63,698
West Germany	3,452	2,564,927	7,210	4,761,129
United States	1,333	731,007	8,237	5,571,682
United Kingdom	520	446,743	1,956	1,236,607
Spain	381	314,693	279	160,593
Other countries	1,026	687,261	537	300,592
Total	14,593	11,353,706	18,293	12,094,301
Copper wire and cable, copper screening and copper manufactures				
United States		4,210,549		5,273,809
Venezuela		1,003,499		716,479
Colombia		937,570		597,245
Cuba		439,425		503,106
Phillipines		437,653		206,172
Dominican Republic . .		404,463		274,486
Jamaica		246,319		15,575
Other countries		884,362		938,607
Total		8,563,840		8,525,479
Consumption, refined	145,286		138,559	

Canada's two copper refineries, operated by The International Nickel Company of Canada Limited at Copper Cliff, Ontario, and Canadian Copper Refiners Limited at Montreal East, Quebec, produced 331,176 tons of refined copper which was also a record. An addition to the Montreal East refinery was commenced which, on completion in 1957, will provide for an increase in output of 4,000 tons a month.

A widespread search for copper deposits continued in Canada throughout 1956 and a considerable number of new mines came into production or were developed to a near-production stage.

Copper

World mine production of copper in 1956 was estimated by the American Bureau of Metal Statistics to be 3,747,305 short tons of which United States produced 1,114,285, Chile 539,839, Northern Rhodesia 445,464, Russia 417,000, Canada 354,860 and Belgian Congo 275,535.

In 1956 world production of copper was evidently in excess of consumption requirements. The Canadian price of the metal began to decrease about mid-year, going from 46 cents a pound in June to 34.75 cents a pound at the year end.

Developments At Producing Mines

Newfoundland

Buchans Mining Company Limited in central Newfoundland milled 366,000 tons of zinc-lead-copper ore from which concentrates containing 4,000 tons of copper were produced. The sinking was commenced of a new production shaft designed for a depth of 4,000 feet to mine the new deep-seated MacLean orebody which lies northwest of the older workings.

Nova Scotia

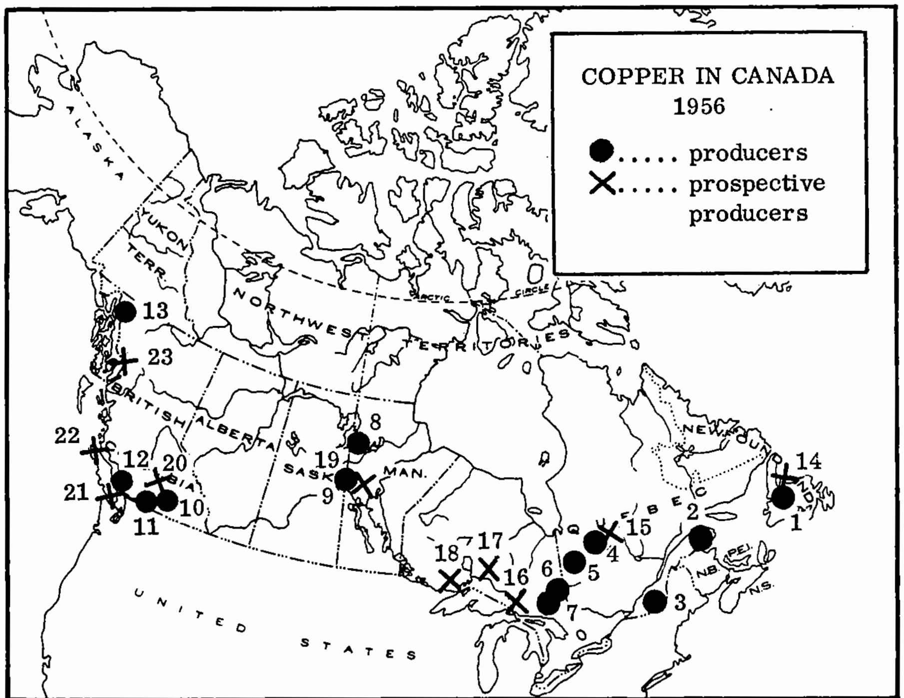
Mindamar Metals Corporation Limited which had been working the Stirling zinc-lead-copper mine in southern Cape Breton Island since mid-1952 ceased operations in April after all known ore had been exhausted. Concentrates containing 404 tons of copper were produced.

New Brunswick

Keymet Mines Limited produced concentrates containing about 16 tons of copper from its zinc-lead property near Bathurst before suspending operations in March.

Quebec

Noranda Mines Limited operated its Horne mine, concentrator and copper smelter at Noranda where the mine output was 1,320,222 tons, 39 per cent of which was direct smelting ore. At the smelter, 1,253,242 tons of ores and concentrates were treated including 585,037 tons of material from other companies. The production of anode copper was 105,950 tons which yielded 101,406 tons of copper, 413,390 ounces of gold and 2,280,400 ounces of silver. Of this total, 26,308 tons of copper, 199,630 ounces of gold and 779,800 ounces of silver were credited to the Horne mine. The anode copper was refined at the electrolytic copper refinery of Noranda's subsidiary Canadian Copper Refiners Limited, Montreal East, where the refined copper and precious metals were recovered. To provide for an anticipated increase in the receipt of custom concentrates, construction of a third reverberatory furnace and various ancillary facilities were commenced at the smelter.



PRODUCERS

1. - Buchans Mining Co. Ltd.
2. - Gaspe Copper Mines Ltd. (Smelter)
3. - Weedon Pyrite and Copper Corp. Ltd.
   Quebec Copper Corp. Ltd.
4. - Opemiska Copper Mines (Quebec) Ltd.
   Campbell Chibougamau Mines Ltd.
   Merrill Island Mining Corp. Ltd.
   Chibougamau Explorers Ltd.
5. - Rainville Mines Ltd.
   Golden Manitou Mines Ltd.
   East Sullivan Mines Ltd.
   Normetal Mining Corp. Ltd.
   Lyndhurst Mining Co. Ltd.
   Noranda Mines Ltd. (Smelter)
   Quemont Mining Corp. Ltd.
   Waite Amulet Mines Ltd.
6. - Temagami Mining Co. Ltd.
7. - The International Nickel Company of Canada Limited.
   (5 mines, 1 refinery, 2 smelters)
   Falconbridge Nickel Mines Ltd.
   (5 mines, 1 smelter)
   Nickel Rim Mines Ltd.
   Nickel Offsets Limited.
8. - Sherritt Gordon Mines Ltd.
9. - Hudson Bay Mining and Smelting Co. Ltd.
   (3 mines, 1 smelter)
10. - Woodgreen Copper Mines Ltd.
11. - The Granby Consolidated Mining, Smelting and Power Co. Ltd.
12. - Brittania Mining and Smelting Co. Ltd.
13. - Tulsequah Mines Ltd.

PROSPECTIVE PRODUCERS

14. - Maritimes Mining Corp. Ltd.
15. - Copper Rand Chibougamau Mines Ltd.
    Chibougamau Jaculet Mines Ltd.
16. - Coppercorp. Ltd.
17. - Geco Mines Ltd.
    Willroy Mines Ltd.
18. - Coldstream Copper Mines Ltd.
19. - Hudson Bay Mining and Smelting Co. Ltd.
    (Chisel Lake)
20. - The Granby Consolidated Mining, Smelting and Power Co. Ltd.
    Bethlehem Copper Corp. Ltd.
21. - Cowichan Copper Co. Ltd.
22. - Noranda Mines Ltd.
    (Yreka mine)
23. - Granduc Mines Ltd.

Copper

Total reserves of copper sulphide ore at the Horne mine were 11,567,000 tons* averaging 2.29 per cent copper and 0.187 ounces per ton gold.

Gaspe Copper Mines Limited, a subsidiary of Noranda Mines Limited, mined 1,333,117 tons and produced 93,487 tons of copper concentrate averaging 27.52 per cent copper. The smelter, located at the mine site in North Gaspé county, treated 101,690 tons of concentrate including 8,465 tons from a stockpile and produced 27,749 tons of anodes containing 27,617 tons of copper, 3,542 ounces of gold and 391,209 ounces of silver. The anodes were shipped to Canadian Copper Refiners, Montreal East. Operations were hampered by a three-month suspension in the supply of hydro-electric power and by a shortage of mine labour. Ore reserves remained at 67,000,000 tons averaging 1.3 per cent copper.

Waite Amulet Mines Limited and Amulet Dufault near Noranda delivered 152,600 tons of copper-zinc ore to the Waite Amulet mill from which concentrate containing 11,357 tons of copper was produced. West Macdonald Mines Limited shipped 353,453 tons of zinc-pyrite ore to the Waite Amulet mill during the year.

Quemont Mining Corporation Limited adjoining Noranda milled 840,942 tons of ore and produced 59,126 tons of copper concentrate containing 10,172 tons of copper. A start was made on the establishment of a permanent rock quarry and crushing plant on the property to provide fill material to replace mined ore. Reserves were estimated at 7,980,000 tons averaging 1.30 per cent copper, 2.69 per cent zinc and 0.156 ounces per ton gold.

Normetal Mining Corporation Limited, 55 miles northwest of Noranda, milled 382,860 tons of ore and produced 34,971 tons of copper concentrate containing 7,396 tons of copper. Ore reserves were reported as 3,731,900 tons averaging 2.47 per cent copper and 7.71 per cent zinc.

Beattie-Duquesne Mines Limited at Duparquet, 20 miles northwest of Noranda, modified its gold mill to produce copper concentrates, and at the end of the year commenced treating copper ore from its Hunter mine 8 miles northeast of Duparquet.

Lyndhurst Mining Company Limited, 24 miles north of Noranda, commenced shipping copper ore to the Beattie-Duquesne mill in July. Concentrates containing about 1,100 tons of copper were produced.

Golden Manitou Mines Limited, 9 miles east of Val d'Or, milled 232,035 tons of copper ore and 188,610 tons of zinc ore and produced concentrates containing 1,877 tons of copper. The mill copper circuit was enlarged from 500 to 800 tons a day. Reserves were reported to be 800,000 tons of copper ore and 645,000 tons of zinc ore.

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* This and following statements of reserves apply to the end of 1956, unless otherwise stated.

East Sullivan Mines Limited, 3 miles east of Val d'Or, milled 895,188 tons to produce copper concentrate containing 8,256 tons of copper. The shaft was deepened from 2,950 feet to 4,000 feet providing for the establishment of seven new levels. Ore reserves were unchanged at 3,435,000 tons averaging about 1.2 per cent copper and 1.0 per cent zinc.

Rainville Mines Limited 16 miles east of Val d'Or came into production in April 1956 and milled 84,354 tons of ore in the remainder of the year to produce concentrates containing 1,274 tons of copper. Reserves of probable ore were 272,900 tons averaging 2.03 per cent copper.

Campbell Chibougamau Mines Limited operated its copper mine on Merrill Island, Dore Lake, Chibougamau area, to produce an average of 1,734 tons of ore a day. A part of the ore output came from the adjoining property of Merrill Island Mining Corporation Limited which is held by Campbell under a lease arrangement. The total copper concentrates produced contained about 15,000 tons of copper. The shaft was deepened about 500 feet to the 2,178-foot horizon and several new levels were established. Ore reserves in October to a depth of 1,450 feet were reported to be 3,534,000 tons averaging 2.24 per cent copper.

Opemiska Copper Mines (Quebec) Limited milled 236,392 tons at its property 25 miles west of Chibougamau and produced concentrates containing 9,265 tons of copper. The main shaft headframe and adjoining crusher house were destroyed by fire on October 30 causing a suspension of production until February 25, 1957. A new 2,350-foot shaft was commenced to develop the Perry zone, 3,000 feet east of No. 1 shaft. Ore reserves were 4,697,480 tons averaging 3.44 per cent copper and an additional 4,000,000 tons of a similar grade was indicated east of the mine workings.

Chibougamau Explorers Limited commenced production at its copper-gold property 26 miles south of Chibougamau in February 1956. During the year 132,713 tons averaging 0.52 per cent copper and 0.226 ounces per ton gold were treated to produce concentrates containing about 400 tons of copper.

Weedon Pyrite and Copper Corporation Limited milled 90,393 tons of copper-zinc-pyrite ore at its property 75 miles south of Quebec City. Concentrates containing 1,611 tons of copper were produced. A production incline shaft was completed in the foot-wall to a vertical depth of 1,100 feet and a new ore zone was discovered on the bottom level at 1,070 feet. Ore reserves were 379,687 tons averaging 2.18 per cent copper and 1.31 per cent zinc.

Quebec Copper Corporation Limited near Eastman, Bolton township, milled 294,960 tons to produce concentrates containing 1,560 tons of copper. In order to mine large amounts of ore remaining in shaft pillars a new shaft was started 800 feet south of the original shaft. Ore reserves were reported to be adequate for 5 or 6 years of operation.

Copper

Ascot Metals Corporation Limited ceased operations at its zinc-lead-copper mine near Sherbrooke in July owing to exhaustion of ore reserves. Concentrates containing about 150 tons of copper were produced.

Ontario

The International Nickel Company of Canada Limited mined 15,510,849 tons of ore from its nickel-copper mines in the Sudbury area. Ninety-two per cent came from underground operations at the Frood-Stobie, Creighton, Murray, Garson and Levack mines and the remainder from the Frood open pit. Deliveries of refined copper produced at the company's Copper Cliff refinery amounted to 135,651 tons. The construction of a 6,000-ton concentrator was commenced at the Levack mine. Ore reserves in the Sudbury area were 264,224,000 tons with a nickel-copper content of 7,948,246 tons, or 3 per cent.

Falconbridge Nickel Mines Limited, also in the Sudbury area, milled 1,850,315 tons of ore from its Falconbridge, Falconbridge East, McKim, Mount Nickel, Hardy and Longvack mines to produce copper-nickel concentrates. The matte produced at the Falconbridge smelter was shipped to the company's refinery at Kristiansand, Norway. Deliveries of copper totalled 13,211 tons. At the Fecunis Lake mine, near Levack, a new 2,000-ton concentrator was almost completed and an addition to the smelter was commenced. The Longvack mine was brought into production in May. Developed and indicated reserves were 45,259,450 tons averaging 1.43 per cent nickel and 0.75 per cent copper.

Nickel Rim Mines Limited, 6 miles north of Falconbridge, milled an average of 760 tons a day and shipped nickel-copper concentrates to the Falconbridge smelter until near the end of the year when a part of the production was shipped to the Sherritt Gordon refinery in Alberta. Mill capacity was increased to 1,500 tons a day. Reserves were reported to be 1,924,000 tons averaging 0.72 per cent nickel and 0.28 per cent copper.

Nickel Offsets Limited about 25 miles northwest of Sudbury milled an average of 160 tons of ore a day and shipped nickel-copper concentrates to Falconbridge. The mine was closed in January 1957 when ore reserves were exhausted.

Temagami Mining Company Limited situated on an island in Temagami Lake resumed shipments of high-grade open-pit ore in June. The ore, containing about 2,150 tons of copper, was shipped to the Noranda smelter instead of the United States as in 1955. A shaft was sunk to about 570 feet and the exploration of several copper-nickel zones on two levels was commenced.

Min-Ore Mines Limited near Matachewan, shipped a small quantity of concentrates containing about 400 tons of copper to Noranda.

Manitoba

Hudson Bay Mining and Smelting Company Limited operated its copper-zinc mine, concentrator, copper smelter and zinc plant at Flin Flon on the Manitoba-Saskatchewan boundary and also three small mines near Flin Flon. Ore milled was 1,653,752 tons of which 84.6 per cent came from the Flin Flon mine, 9.4 per cent from the Schist Lake mine (3 1/2 miles south-east of Flin Flon), 4.1 per cent from the North Star mine (12 miles east of Flin Flon) and 1.9 per cent from the Don Jon mine (1,600 feet east of the North Star). The average grade of the ore milled was 2.87 per cent copper and 4.4 per cent zinc. Copper concentrates produced were 318,389 tons averaging 13.97 per cent copper, 0.241 ounces per ton gold and 3.45 ounces per ton silver. At the copper smelter, 437,903 tons of concentrates, direct-smelting ore, zinc-plant residues and by-products were treated to produce blister copper containing 46,575 tons of copper, 106,448 ounces of gold 1,602,968 ounces of silver and 130,410 pounds of selenium. The blister copper was treated at the electrolytic refinery of Canadian Copper Refiners Limited, Montreal East, Quebec. Ore reserves in the Flin Flon area and near Snow Lake, Manitoba, totalled 20,541,000 tons averaging 2.72 per cent copper and 4.8 per cent zinc.

Sherritt Gordon Mines Limited operated two producing nickel-copper mines and a concentrator at Lynn Lake and a chemical metallurgical refinery for treating nickel concentrates at Fort Saskatchewan, Alberta. The ore output was 752,823 tons of which 749,506 tons were milled to produce 84,727 tons of nickel concentrate and 10,933 tons of copper concentrate. Copper concentrate shipped to a custom smelter yielded 4,503 tons of copper, and from the treatment of nickel concentrate at Fort Saskatchewan 2,931 tons of copper sulphide were recovered. Ore reserves were 13,070,000 tons averaging 1.108 per cent nickel and 0.58 per cent copper.

Saskatchewan

The larger part of Hudson Bay Mining and Smelting Company's Flin Flon orebody lies in Saskatchewan and the output of copper and associated metals credited to the province comes from this source.

British Columbia*

The Granby Consolidated Mining, Smelting and Power Company Limited treated 1,930,037 tons of ore from its Copper Mountain mine from which 9,680 tons of copper were produced. It was announced that the mine which had been in production since 1937 would be closed early in the second quarter of 1957 owing to exhaustion of ore.

* Copper concentrates produced in British Columbia are shipped to the American Smelting and Refining Company at Tacoma, Washington, U.S.A.

Copper

Britannia Mining and Smelting Company Limited milled 834,458 tons of ore and produced 25,223 tons of concentrates containing 7,340 tons of copper. A new plant at Britannia Beach to recover copper from mine water was brought into operation and recoveries from it and from the original mine water plant at the Townsite amounted to 375 tons of copper in precipitates.

Tulsequah Mines Limited, a subsidiary of The Consolidated Mining and Smelting Company of Canada Limited, milled 203,688 tons of copper-zinc-lead ore at its properties in northwestern British Columbia. Concentrates containing about 2,800 tons of copper were produced.

Other Developments

Newfoundland

Maritimes Mining Corporation Limited commenced reactivation of the old Tilt Cove mines in the Notre Dame Bay area. A start was made on the construction of a 2,000-ton concentrator which was expected to be in operation in 1957. The total ore reserves at Tilt Cove were reported in March 1956 to be 3,941,700 tons averaging 2.05 per cent copper.

Gullbridge Mines Limited a subsidiary of Maritimes Mining Corporation sank a 500-foot shaft and commenced lateral exploration at its copper property at Gull Pond.

Several other copper properties in the Notre Dame Bay area were re-examined.

New Brunswick

Heath Steele Mines Limited, subsidiary of American Metal Company and The International Nickel Company of Canada Limited, carried out pre-production development on 4 deposits at its property 35 miles northwest of Newcastle. Two open pits and two underground mines were prepared for production and a 1,500-ton concentrator was almost completed. Ore reserves were reported to be 7,200,000 averaging about 5 per cent zinc, 2 per cent lead and 1.4 per cent copper plus some silver.

Exploration continued in the area west of Bathurst and several large deposits containing zinc, lead and copper were outlined by drilling. As in the case of the two deposits of Brunswick Mining and Smelting Corporation Limited near Bathurst, the treatment of New Brunswick sulphide bodies presents metallurgical difficulties owing to the high content of very fine-grained iron sulphides.

Quebec

Exploration on a large scale was carried out in the Chibougamau district and a number of copper deposits of productive potential were revealed. A branch line of the C. N. R. which will provide more direct transportation for concentrates from Chibougamau to the Noranda smelter neared completion.

Copper Rand Chibougamau Mines Limited sank 3 shafts and carried out considerable underground exploration to verify information from surface drilling on 4 copper zones. Consideration was given to construction of a large concentrator to treat ore from the Copper Rand mines and the adjoining Chibougamau Jaculet Mines Limited where another promising copper deposit was partly outlined.

Campbell Chibougamau Mines Limited commenced sinking a production shaft with an objective of 1,150 feet at its Cedar Bay property where reserves of 1,800,000 tons averaging 1.6 per cent copper were indicated. Campbell Chibougamau together with Yorcan Exploration Limited discovered a new copper zone on their common boundary under Chibougamau Lake.

Merrill Island Mining Corporation Limited carried out underground developments on the unleased portion of its property and made plans for construction of a 750-ton mill.

Other companies active in the Chibougamau area included Bouzan Mines Limited, Quebec Chibougamau Goldfields Limited and Bateman Bay Mining Company.

Ontario

Geco Mines Limited, Manitouwadge area, commenced the construction of a 3,300-ton concentrator and carried out underground developments designed for production in mid-1957. Reserves in 3 zones at the end of 1955 were 15,227,000 tons averaging 1.76 per cent copper and 3.48 per cent zinc.

Willroy Mines Limited, adjoining to the west of Geco, also started construction of a concentrator designed to treat 1,000 tons a day. Ore reserves were increased to 2,160,000 tons averaging 1.09 per cent copper and 6.29 per cent zinc.

Consolidated Sudbury Basin Mines Limited continued exploration on its Vermilion Lake and Errington properties 15 miles northwest of Sudbury. The construction of a 3,000-ton concentrator at the Errington mine was begun. Ore reserves were estimated to be 17.8 million tons averaging 1.1 per cent copper, 3.92 per cent zinc and 1.0 per cent lead.

Copper

The International Nickel Company continued a major exploration program in the Sudbury nickel-copper district. Preproduction development was carried out at the Crean Hill mine, 18 miles west of Sudbury.

Falconbridge Nickel Mines Limited carried out preproduction development at 3 mines in the Levack area 22 miles northwest of Sudbury and obtained very encouraging results at its Strathcona property in the same area.

Coppercorp Limited sank a 550-foot shaft at its property at Mamainse Point, 40 miles northwest of Sault Ste. Marie and carried out exploration on 3 levels, disclosing several new zones. Ore reserves in October were estimated at 2,200,000 tons averaging 2.0 per cent copper.

Coldstream Copper Mines Limited began construction of a 1,000-ton concentrator at its property 90 miles west of Fort William. The shaft was deepened to 625 feet and a considerable amount of new ore was developed. Reserves to the 800-foot horizon were estimated at 2,648,000 tons averaging 2.2 per cent copper.

Eastern Mining and Smelting Corporation Limited continued underground exploration of its copper-nickel deposit at Werner Lake northwest of Kenora.

Manitoba

Hudson Bay Mining and Smelting Company carried out extensive exploration in the Snow Lake area which resulted in the finding of three orebodies. At Chisel Lake, 5 miles southwest of Snow Lake town and 70 miles east of Flin Flon, a deposit was outlined containing 3,832,400 tons averaging 11.0 per cent zinc and 0.42 per cent copper. An 8 1/2-mile road to this property was almost finished, and preparations were made for shaft sinking. At Ghost Lake, 3 1/2 miles east of Chisel Lake, 260,700 tons of ore were outlined averaging 11.6 per cent zinc and 1.42 per cent copper, and at Stall Lake 4 miles southeast of Snow Lake town 783,200 tons were outlined averaging 4.54 per cent copper.

The International Nickel Company made plans to bring its extensive nickel deposits in the Mystery-Moak Lake district into production by 1960. The ore contains low but recoverable amounts of copper.

New Manitoba Gold Mines Limited commenced shaft sinking to test a large low-grade copper-nickel deposit at Cat Lake in the southeast part of the province.

Saskatchewan

Hudson Bay Mining and Smelting Company continued development at its Birch Lake mine 9 1/2 miles southwest of Flin Flon and at its Coronation mine 13 1/2 miles southwest of Flin Flon. The Birch Lake shaft was deepened to 1,647 feet and the Coronation shaft to 1,452 feet with 9 level stations established. A 14-mile railroad to the Coronation mine site neared completion. Ore reserves at the Coronation property remained at 825,000 tons averaging 5 per cent copper and 0.4 per cent zinc.

There were reports of significant copper discoveries near Lac La Ronge and at various other locations in northern Saskatchewan.

British Columbia

Granduc Mines Limited commenced sinking an internal shaft to explore the orebodies at greater depth at its property 25 miles northwest of Stewart. Additional studies were made on the problem of providing transportation to the property which is located in a difficult mountainous region. Reserves remained at 25,600,000 tons averaging 1.62 per cent copper.

Woodgreen Copper Mines Limited constructed a 1,200-ton concentrator at the Motherlode mine, a former copper producer near Greenwood which had been closed for 39 years. Production commenced early in 1957.

Phoenix Copper Company Limited, a subsidiary of Granby Consolidated, reopened Granby's former producing mine near Phoenix and commenced construction of a 700-ton concentrator to treat ore to be mined by an open pit from pillars left in previous operations.

Granisle Copper Limited, also a Granby subsidiary, drilled its property located on an island in Babine Lake and indicated an orebody of 22,000,000 tons averaging 0.56 per cent copper.

American Smelting and Refining Company established by drilling the presence of large medium-grade copper deposits on the property of Bethlehem Copper Corporation Limited in Highland Valley, 20 miles southeast of Ashcroft.

Cowichan Copper Company Limited continued underground exploration of its property on Vancouver Island, 45 miles northwest of Victoria. Reserves of 500,000 tons averaging 2.0 per cent copper were indicated.

Mid-West Copper and Uranium Mines Limited moved the old Whitewater mill to the Velvet mine at Rossland and commenced production of copper-gold concentrates early in 1957.

Consumption and Uses

The greater part of the primary copper consumed in Canada goes to the rolling mills of Canada Wire and Cable Co. Ltd., Montreal East; Phillips Electrical Co. Ltd., Brockville, Ontario; Anaconda American Brass Ltd., New Toronto; and Noranda Copper and Brass Ltd., Montreal East. The last two firms also operate brass mills and foundries. Other smaller consumers are Canadian Arsenals Ltd., the Royal Canadian Mint, Aluminum Co. of Canada Ltd. and several foundries.

Copper

About 50 per cent of the world consumption of copper is used for electrical purposes such as wire, cable, bus bars and other conductors. Increasing quantities of copper tubing, water tanks and fixtures are being used in plumbing. Other uses include brass, bronze, cupro-nickel, nickel-silver, and other copper-alloys and copper salts.

The following table gives a partial distribution by industrial uses of the 143,471 tons of copper consumed in Canada in 1956.

	Copper		
	As Metal Tons	As Component of Brass & Bronze Tons	As Component of Nickel-Silver Tons
Ammunition	26	4,645	
Automotive	3,984	4,334	5
Hardware	3,091	1,019	27
Plumbing and heating	9,987	4,864	-
Sterling silver and plated ware	159	-	599
Screw machine products	53	2,744	2
Wire and cable	78,846	3,898	-
Electrical (exclusive of wire, etc.)	5,891	3,492	23
Industrial equipment	1,195	1,528	63
Other uses	7,960	4,660	376
Total	111,192	31,184	1,095

Prices

The Canadian price of electrolytic copper in Canadian currency was 43 cents a pound from October 1955 until February 1956 when it increased to 46 cents. It remained at this price until the middle of June when it declined to 45.38 cents. It subsequently dropped to 40 cents on July 5, 39.25 cents July 12, 39 cents October 11, 35 cents November 1 and it was 34.75 cents from November 22 to the end of the year. The average price in 1956 was 41.2 cents a pound.

Tariffs

Copper in bars, rods, wire, semi-fabricated forms and fully processed products is subject to varying tariff rates. There is no tariff on copper ores or concentrates imported into Canada.

In the United States, the import tax of 2 cents a pound has been suspended until June 30, 1958, with the provision that it will be restored if the average price for a month is 24 cents a pound or less.

GOLD

By T.W. Verity
Mineral Resources Division

Canadian gold production in 1956 dropped to 4,383,863 ounces valued at $151,024,080, a decrease of 158,099 ounces in quantity and $5,764,448 in value compared to 1955.

Ontario continued to be the principal producer, with 57 per cent of the total production. It was followed by Quebec with 24, Northwest Territories 8, British Columbia 5, and Manitoba 3 per cent. Saskatchewan and Yukon produced under 2 per cent each and only relatively minor quantities were produced by Newfoundland, Nova Scotia and Alberta. About 14 per cent of the gold produced in Canada during 1956 came as a by-product from base metal mines, compared with 13.2 per cent in 1955 and 12.3 per cent in 1954.

Three gold mines in Quebec and one in Ontario closed. No new gold mines came into production.

During the first quarter of the year, the average Mint price for gold was $34.96, up 44 cents an ounce from the 1955 year average. However, the increase in the value of the Canadian dollar in relation to the United States dollar led to a steady decline in the Mint price for gold, and by the year end the price was only $33.57. The year average was $34.44, a decrease of eight cents an ounce.

Gold dropped to fifth place in value among minerals produced in Canada, being surpassed during the year by iron ore. In free world output, Canada retained second place, following the Union of South Africa, whose output rose to 15,900,000 ounces compared with 14,600,000 in 1955.

Assistance to gold mine operators by the Federal Government under the terms of The Emergency Gold Mining Assistance Act was extended to the end of the calendar year 1958 by an amendment to the Act in 1956. The Act was passed in 1948 and was designed to assist Canadian gold mine operators to meet the problem of greatly increasing costs of production of gold without a compensating increase in price.

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Gold

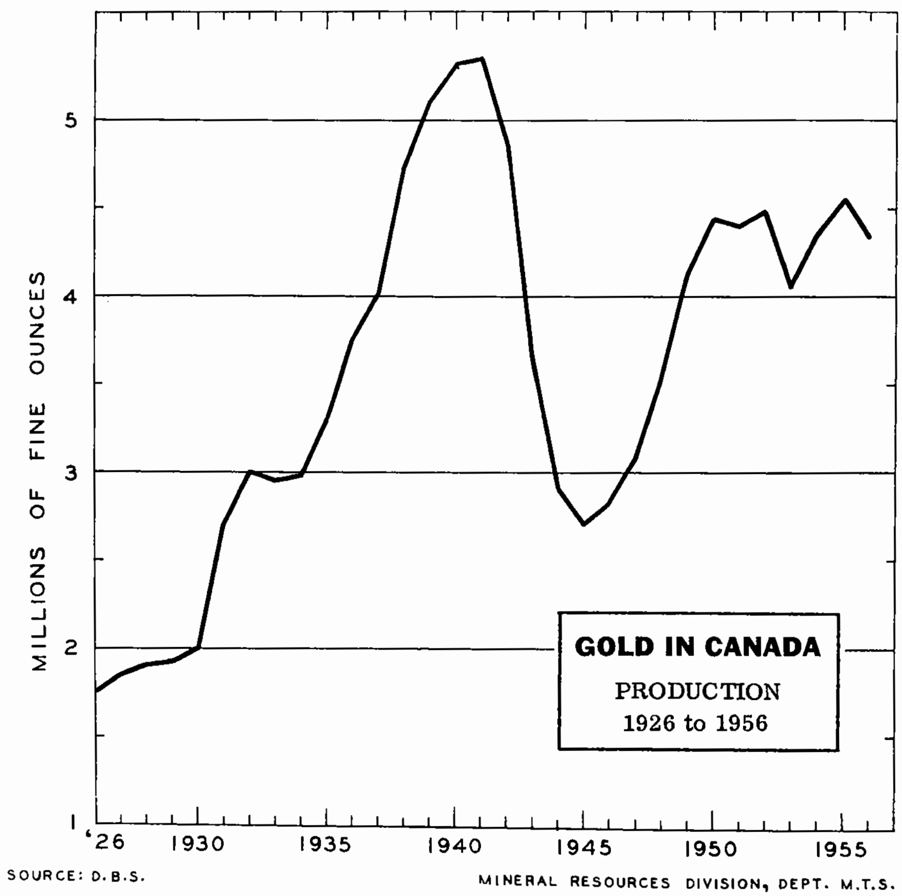
Production of Gold

		1956	1955
		(Fine Ounces)	
Yukon	Placer operations	71,736	72,201
	Base-metal mines	265	--
	Total	72,001	72,201
N.W.T.	Auriferous quartz	352,669*	321,321
B.C.	Auriferous quartz	158,029	199,430
	Placer operations	2,962	6,206
	Base-metal mines	35,701	47,343
	Total	196,692	252,979
Alta.	Placer operations	119	214
Sask.	Placer operations	-	13
	Base-metal mines	82,687	83,567
	Total	82,687	83,580
Man.	Auriferous quartz	97,445	99,366
	Base-metal mines	22,787	24,522
	Total	120,232	123,888
Ont.	Auriferous quartz		
	Porcupine	1,067,735	1,074,916
	Larder Lake	473,235	427,193
	Patricia	419,646	409,820
	Kirkland Lake	369,394	393,294
	Thunder Bay	101,223	102,806
	Sudbury	33,288	38,046
	Matachewan	3,388	29,806
	Miscellaneous	673	--
	Total	2,468,582	2,475,881
	Base-metal mines	45,330	47,159
	Total	2,513,912	2,523,040
Que.	Auriferous quartz		
	Cadillac-Malartic	290,643	329,708
	Bourlamaque	246,175	277,170
	Noranda-Duparquet-Belleterre	91,344	163,038
	Miscellaneous	-	12
	Total	628,162	769,928
	Base-metal mines	407,897	384,594
	Total	1,036,059	1,154,522
N.S.	Auriferous quarts	85	128
	Base-metal mines	1,194	3,752
	Total	1,279	3,880
Nfld.	Base-metal mines	8,213	6,337

* Includes 102 oz placer operations.

		1956	1955
		(Fine Ounces)	
Canada	Auriferous quartz	3,704,870	3,866,124
	Placer operations............	74,919	78,621
	Base-metal mines	604,074	597,217
	Total	4,383,863	4,541,962
Canada	Total value..................	$ 151,024,080	$156,788,528
	Average value per oz.........	34.45	34.52

The chart below shows that in the thirty years of production since 1926 Canada's gold production has increased two and a half times from 1,754,228 to 4,383,863 fine ounces of gold. The present production is, however, nearly one million ounces less than the peak year of production in 1941. Although no records of production of gold from base-metal mines are available prior to the year 1940, it may be noted that in the year 1956 the total of over 600,000 ounces was higher than any previously recorded and the 14 per cent of the total gold production coming from base-metal mines during 1956 was higher than any year except for the war years between 1943-45.



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Operations at Producing Mines

Yukon

Production from placer operations was up down 472 ounces, and a small amount of gold was produced as a by-product from the Galkeno (formerly Mackeno) silver-lead-zinc mine at Mayo. The large dredging companies, Yukon Consolidated Gold Corporation and Yukon Exploration, Limited, had practically the same production as in 1955 but Yukon Gold Placers had a decrease of 860 ounces. Production from small placer mines increased by 1,500 ounces.

Northwest Territories

Production in the Northwest Territories came from lode gold mines, with only a small fraction from placer operations. Since the end of World War II, there has been a steady rise in output, the 1956 preliminary total being a new high. All the gold mines are concentrated in the Yellowknife area. Giant Yellowknife Gold Mines Limited and Consolidated Discovery Yellowknife Mines Limited have been enlarging their mill capacity and mining high-grade gold ore. Consolidated Discovery is the highest grade gold mine in Canada. The Con & Rycon mines of The Consolidated Mining and Smelting Company of Canada Limited also showed a large increase in gold production.

British Columbia

Output in British Columbia was 22 per cent lower in 1956. Only three lode gold mines were operating during the year: Bralorne Mines Limited, Cariboo Gold Quartz Mining Company Limited and Pioneer Gold Mines of B.C. Limited, all of which had about the same output as in the previous year. The closing of Kelowna Mines Hedley Limited in September 1955 caused a considerable drop in the provinces gold production as it produced 38,521 ounces in 1955. The operating lode gold mines have been developing and mining a much higher grade of ore but scarcity of trained miners has reduced milled tonnage.

Placer gold production showed a decrease of some 52 per cent from 6,206 ounces in 1955 to an estimated 2,962 in 1956. The principal producers in the Atlin area, Noland Mines Limited and Enterprises Placers, showed a combined drop of over 2,100 ounces. The Quesnel area showed a small increase with a few new small operations coming into production during 1956.

By-product gold from base-metal mining again dropped sharply chiefly owing to a large drop in gold production by the Tulsequah mine of The Consolidated Mining and Smelting Company of Canada Limited.

Alberta

A small amount of gold was recovered from placer operations on the Saskatchewan River near Edmonton.

Saskatchewan

Gold production continued to come only from that portion of the base-metal orebody of Hudson Bay Mining and Smelting Company, Ltd. lying west of the Manitoba-Saskatchewan boundary. Output was slightly lower than in 1955.

Manitoba

The three lode gold mines in Manitoba continued operations, but total production was down by approximately 1,921 ounces. San Antonio Gold Mines Limited controls the adjoining Forty-Four Mines Limited in the Rice Lake area. Production from San Antonio dropped but a corresponding increase in production by Forty-Four gave a combined total approximately the same as in 1955. The Nor-Acme Mine in the Snow Lake area, now under lease by Britannia Mining and Smelting Company Limited, showed a drop in production of nearly 3,000 ounces.

The production of by-product gold from the Flin Flon mine of Hudson Bay Mining and Smelting Company Limited and from Sherritt Gordon Mines Limited at Lynn Lake, dropped by 1,735 ounces.

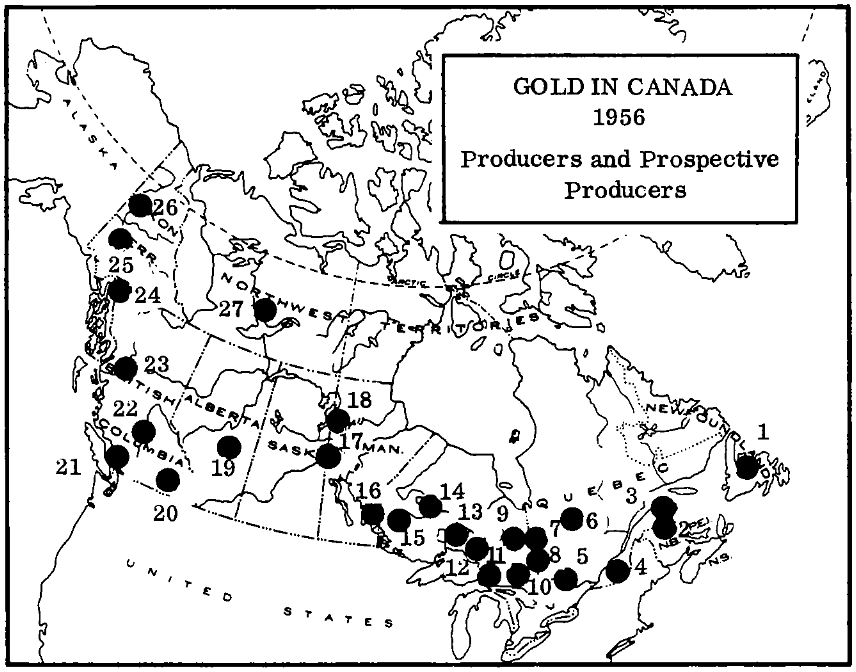
Ontario

There were 32 operating gold mines in Ontario at the end of the year. One mine, the Starratt-Olsen, closed in the Patricia district in July 1956, with all known ore reserves exhausted. The gold mines together with the base-metal mines of the Sudbury area accounted for 57 per cent of the Canadian production during 1956 compared with 55.5 in 1955. The total Ontario production was, however, slightly lower in 1956.

The 13 mines in the Porcupine area showed a drop in production with the exception of Broulan Reef (including Hugh-Pam), Paymaster and Preston East Dome which had small increases. The milled tonnage dropped by some 125,000 tons but the average grade of ore milled increased to 0.245 ounces of gold per ton from 0.239 ounces per ton in 1955. The mines in the district went on a 44-hour work week during 1956, and this has tended to increase labour costs per ton while giving a reduced tonnage of ore mined and milled.

Broulan Reef Mines Limited deepened its shaft in the Reef property by 314 feet as a start in opening three new levels to the 2,500-foot horizon. The adjoining Hugh-Pam Porcupine Mines Limited is being developed under agreement with Broulan Reef and extensive exploration and development work was carried out during the year. Coniaurum Mines Limited carried out exploration work on the adjoining Central Porcupine Mines property from extensions of its 1,000- and 5,500-foot levels. Delnite Gold Mines Limited deepened its No. 3 internal shaft by 451 feet to 4,825 feet preparatory to opening three new levels at 150-foot intervals. Delnite also carried out exploration and development work for Aunor by extension of Delnite workings into Aunor ground on the 3,500- and 4,300-foot levels. Hallnor Mines

(text continued on page 82)



Producers and Prospective Producers

* - base-metal
** - auriferous quartz
*** - placer
( ) - prospective producer

1 - Buchans Mining Co. Ltd. *
2 - Keymet Mines Ltd. *
(Heath Steele Mines Ltd. *)
3 - Gaspe Copper Mines Ltd. *
4 - Quebec Copper Corp. Ltd. *
Weedon Pyrite & Copper Corp. Ltd. *
5 - New Calumet Mines Ltd. *
6 - Campbell Chibougamau Mines Ltd. *
Chibougamau Explorers Ltd. *
Opemiska Copper Mines Ltd. *
(Copper Rand Chibougamau Mines Ltd. *)
7 - Rouyn-Noranda District
Donalda Mines Ltd. **
Elder Mines Ltd. **
Stadacona Mines (1944) Ltd. **
Noranda Mines Ltd. *
Quemont Mining Corp. Ltd. *
Waite-Amulet Mines Ltd. *
(Eldrich Mines Ltd. **)
\- Cadillac-Malartic District
Barnat Mines Ltd. **
Canadian Malartic Gold Mines Ltd. **
East Malartic Gold Mines Ltd. **
Malartic Gold Fields Ltd. **
\- Bourlamaque-Louvicourt District
Bevcon Mines Ltd. **
Lamaque Gold Mines Ltd. **
Sigma Mines (Quebec) Ltd. **
East Sullivan Mines Ltd. *
Golden Manitou Mines Ltd. *
\- Duparquet District
Normetal Mining Corp. Ltd. *
\- Larder Lake District (Ontario)
Kerr-Addison Gold Mines Ltd. **

- Kirkland Lake District (Ontario)
Kirkland Minerals Corp. Ltd. **
Lake Shore Mines Ltd. **
Macassa Mines Ltd. **
Sylvanite Gold Mines Ltd. **
Teck-Hughes Gold Mines Ltd. **
Upper Canada Mines Ltd. **
Wright-Hargraves Mines Ltd. **

8 - Belleterre Quebec Mines Ltd. **
Temagami Mining Co. Ltd. (Ontario)*

9 - Min-Ore Mines Ltd. *
Porcupine District
Aunor Gold Mines Ltd. **
Broulan Reef Mines Ltd. **
Caniaurum Gold Mines Ltd. **
Delnite Gold 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 - International Nickel Co. of Canada Ltd. *
Falconbridge Nickel Mines Ltd. *

11 - Jardun Mines Ltd. *

12 - Renabie Mines Ltd. **

13 - Leitch Gold Mines Ltd. **
MacLeod-Cockshutt Gold Mines Ltd. **

14 - 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. **
(Heath Gold Mines Ltd. **)
(McFinley Red Lake Gold Mines Ltd. **)

16 - San Antonio Gold Mines Ltd. **
Forty-Four Mines Ltd. **

17 - Nor-Acme mine of Britannia Mining & Smelting Co. Ltd. **
Hudson Bay Mining and Smelting Co. Ltd. *

18 - Sherritt-Gordon Mines Ltd. *

19 - Placer operations on Saskatchewan River ***

20 - The Consolidated Mining and Smelting Co. Ltd. (Kimberley)*
Sunshine Lardeau Mines Ltd. (Revelstoke)*
Grandby Consolidated Mining, Smelting and Power Co. Ltd. (Copper Mountain)*

21 - Britannia Mining and Smelting Co. Ltd. *

22 - Pioneer Gold Mines of B. C. Ltd. **
Bralorne Mines Ltd. **
Cariboo Gold Quartz Mining Co. Ltd., The **
Small placer operations***

23 - Silver Standard Mines Ltd. *
Sil-Van Consolidated Mining and Milling Co. Ltd. *

24 - Tulsequah Mines Ltd. *
Noland Mines Ltd. ***
Enterprise Placers, etc. ***

25 - Burwash Mining Co. Ltd. ***
Kluane Dredging Co. Ltd. ***
Other smaller operations***

26 - Yukon Gold Placers Ltd. ***
Galkeno Mines Ltd. *
Yukon Consolidated Gold Corp. ***
Yukon Explorations Ltd. ***
Other smaller operations***

27 - Consolidated Mining and Smelting Co. of Canada Ltd. (Con and Rycon mines**)
Giant Yellowknife Gold Mines Ltd. **
Consolidated Discovery Yellowknife Mines Ltd. **
(Akaitcho Yellowknife Gold Mines Ltd. **)

Limited was opening two new levels during 1956. Paymaster Consolidated Mines Limited deepened No. 6 winze by 106 feet. Preston East Dome Mines was opening three new levels in 1956 and also carried out development work on an adjoining block of ground leased from Dome Mines Limited.

The 7 operating gold mines in the Kirkland Lake area showed a sharp drop in production with only Wright-Hargreaves Mines Limited maintaining its production. There was a drop of some 140,000 tons milled with the average grade increasing from 0.307 to 0.323 ounces of gold per ton. As in the Porcupine area, the mines went on a 44-hour work week during 1956.

Kirkland Lake Gold Mining Company changed its name in April 1956 to Kirkland Minerals Corporation Limited and is now on a salvage basis. Teck-Hughes Gold Mines Limited has been on a salvage basis since 1951. Little Long Lac Gold Mines Limited assumed control of Lake Shore Mines Limited and Wright-Hargreaves Mines Limited, and planned to mill all ore mined by Wright-Hargreaves in the Lake Shore mill commencing in April 1957. Wright-Hargreaves deepened its No. 6 internal shaft by 927 feet in 1956 and acquired a 50-year option on the adjoining Kirkland Townsite Gold Mines and carried out considerable diamond drilling in the property from six levels. Macassa Mines Limited carried out extensive development work and nearly doubled its ore reserves in 1956. Sylvanite Gold Mines Limited did exploration and development work on the adjoining Toburn Gold Mines Limited (now under lease by Arcadia Nickel Corporation Limited) from its 5,550-foot level.

In the Larder Lake area, Canada's leading gold producer, Kerr-Addison Gold Mines Limited, reached an all-time high, increasing production by over 40,000 ounces. This increase was due to an increase in milled grade from 0.260 to 0.286 ounces of gold per ton. Tons milled increased by less than 5,000 tons.

In the Patricia district, 6 gold mines were operating with Starratt Olsen Gold Mines Limited closing down in July 1956. Production rose in the district by 9,826 ounces -- a 2 per cent increase. Milled tons increased by 13,000 tons while grade milled increased from 0.406 to 0.421 ounces of gold per ton. Campbell Red Lake Mines Limited, Cochenour-Willans Gold Mines, and New Dickenson Mines Limited all showed increased production. Aggressive exploration and development programs have been carried out by all the mines in the Red Lake and Pickle Lake areas and the mines are all in a healthy position in spite of the difficulty of high operating costs and a scarcity of skilled miners.

Young-Davidson Mines Limited, in the Matachewan district, closed at the end of 1955 and only a little clean-up ore was produced in 1956.

In the Thunder Bay district Leitch Gold Mines Limited and MacLeod-Cockshutt Gold Mines Limited continued to operate with slightly lower total production. In this camp, tons milled increased by 13,000 tons but average grade dropped from 0.161 to 0.155 ounces of gold per ton. This was due to a drop in grade milled by MacLeod-Cockshutt.

In the Sudbury district, Renabie Mines Limited, in the Missinaibi area, milled 12,000 tons less and the grade dropped from 0.230 to 0.217 ounces of gold per ton resulting in a drop of 4,758 ounces in gold production.

Quebec

Seventeen gold mines were producing in Quebec during 1955 but by the end of 1956 only ten gold mines were still operating, with one new mine, Eldrich Mines Limited, shipping development ore to Noranda to be used as flux ore in the Noranda smelter. During 1956, three gold mines closed and production dropped by over 18 per cent.

In Rouyn-Noranda county, Donalda Mines Limited stopped milling ore in July 1955 to permit underground development, but production was not resumed in 1956 and will not be resumed until economic conditions are more satisfactory. New Senator-Rouyn Limited closed in December 1955 and production during 1956 was from clean-up ore only. Powell-Rouyn Gold Mines Limited closed in November 1955 and the only production in 1956 came from stock-piled ore sent to the Noranda smelter. Elder Mines Limited is financing the development of Eldrich Mines Limited and ore from both mines was sent to the Noranda smelter as flux ore. Stadacona Mines (1944) Limited is the only gold mine now operating in the county with its own mill; production dropped by 4,000 ounces during 1956.

In Abitibi County West, Duparquet district, Beattie-Duquesne Mines Limited stopped milling gold ore in July 1956 and converted its mill for copper ore from its Hunter property and the property of Lyndhurst Mining Company.

In Temiscaming county, Belleterre Quebec Mines Limited decreased production by nearly 4,000 ounces.

In Abitibi County East, Cadillac-Malartic district, O'Brien Gold Mines Limited closed in August 1956, and production from the other operating gold mines in the district -- Barnat Mines Limited, Canadian Malartic Gold Mines Limited, East Malartic Mines Limited and Malartic Gold Fields Limited -- was down by some 39,000 ounces.

In Abitibi County East, Bourlamaque district, Sullivan Consolidated Mines Limited stopped milling ore in July 1956, and has been carrying out sinking in No. 1 shaft, but the mine is not expected to resume production until general economic conditions improve. Of the remaining mines in the district, Sigma Mines (Quebec) Limited and Bevcon Mines Limited showed a slight increase in production but Lamaque Gold Mines, Limited dropped in production by nearly 8,000 ounces.

Base-metal mines in the province contributed a large share of the gold production. Gold production from this source increased by more than 23,000 ounces, owing to increased production from the copper-gold mines in the Chibougamau area. The percentage of total gold production contributed by base-metal mines in the province increased from 33.3 to 39.4 per cent.

Gold

Nova Scotia

In recent years the Mindamar Metals Corporation silver-lead-zinc operation at Stirling in Richmond county has supplied the bulk of the province's gold production. This mine closed in April 1956 and the total gold output of the province dropped by 2,601 ounces.

Newfoundland

Gold production in Newfoundland comes as a by-product from the Buchans Mining Company silver-lead-zinc operation in the Red Indian Lake district. Production increased by about 1,876 ounces in 1956.

Developments at Other Properties

British Columbia

Cariboo Gold Quartz Mining Company Limited has acquired a portion of the old French mine from Kelowna Mines Hedley Limited near Hedley, and has established a new level 125 feet below the former bottom horizon and has developed some ore. A 150-ton mill from the old Island Mountain mine is to be moved to Hedley in the spring of 1957 to mill the ore.

Northwest Territories

Plans are underway to sink a shaft during the summer of 1957 at Taurcanis Mines (formerly Bulldog Yellowknife), 150 miles northeast of Yellowknife, under the management of Consolidated Discovery Yellowknife Mines Limited. From 1948 to 1950, some ore was developed by diamond drilling at the property, and in 1952 buildings were constructed, a head frame erected, and a 3-compartment shaft collared and sunk to 35 feet. Current plans call for deepening the shaft, establishing levels at the 175-foot and 325-foot horizons, and 4,500 feet of lateral work and 8,000 feet of diamond drilling.

Ontario

McFinley Red Lake Gold Mines in the Red Lake area completed sinking a shaft to 420 feet in 1956 and started lateral development work on two levels.

Consolidated Mosher Mines Limited continued exploration and development of its Little Long Lac property to the west of MacLeod-Cockshutt Gold Mines Limited. Ore reserves of 4,000,000 tons, grading 0.155 ounce of gold, were established as the result of extensive development work. The company owns a 600-ton mill on the former Hard Rock property east of MacLeod-Cockshutt and is considering sinking a new production shaft.

Financing was underway during 1956 to resume diamond drilling on the Craibbe-Fletcher Gold Mines Limited property in the Red Lake area.

Quebec

Louvicourt Goldfield Corporation and Standard Gold Mines Ltd. planned to continue exploration work in the Mount Megantic area at the head of the Chaudiere River south of Quebec for lode gold deposits which might have been the source of the rich alluvial (placer) deposits formerly mined in the area. Interesting gold assays were obtained in 1955 in some 12,000 feet of drilling farther down the river valley, but no economic deposits have yet been located.

INDIUM

By D.B. Fraser
Mineral Resources Division

Indium is one of the rarer metals that has become increasingly available in recent years. Considerable research has been carried out to find useful applications for it, and industrial demands have increased substantially.

The metal was first discovered spectrographically in Germany in 1863 but not until about 1927 was it produced in quantities exceeding a few grams. Information on world production is vague but, in addition to Canada, it is produced in United States, Germany, Belgium, Italy, Peru, Japan and probably Russia.

In nature, indium is found only as traces in certain zinc, lead, tin, tungsten, or iron ores, but it has a widespread association with sphalerite, the principal zinc-bearing mineral. Some zinc ores contain as much as 1 per cent indium, but normally indium is present in very much smaller amounts. The metal is produced commercially as a by-product from the smelting and treatment of zinc and lead ores.

Production

In Canada, indium is produced only by The Consolidated Mining and Smelting Company of Canada Limited at Trail, British Columbia. The principal source of the company's ore is the Sullivan lead-zinc-silver mine at Kimberley, British Columbia, from which concentrates are shipped to Trail where the contained lead, zinc, and other metals including indium, are recovered. In addition to concentrates from the Sullivan mine, the company treats ores and concentrates from a number of other mines. The quantity of indium contained in the various ores treated is insignificant.

Certain of the metallurgical operations at Trail result in slag concentrations containing about 2.5 per cent indium. This slag is reduced electrothermally to produce a bullion containing lead, tin, indium and antimony which is treated electrolytically to yield a high indium (20-25 per cent) 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 of indium (99.97 per cent) or a high-purity grade which approximates 99.999 per cent indium.

Indium

Although the presence of indium in zinc concentrate from the Sullivan mine had been known for many years, no serious attempt to recover it separately was made until 1940. The first commercial indium was made at Trail on a laboratory scale in 1942. This production and that made in subsequent years is shown in the following table:

Year	Troy Ounces	Value $
1942	437	4,710
1949	689	1,550
1950	4,952	12,083
1951	582	1,368
1952	404	909
1953	6,752	9,588
1954	477	1,278
1955	104,774	232,598
1956	363,192	795,390

The potential annual production at Trail is approximately one million troy ounces or 35 tons.

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 relatively low melting point of 156°C. and a boiling point of 2,000°C. 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 and a specific gravity of 7.31 at room temperature which is about the same as iron.

Indium is stable at ordinary temperatures in air. It is attacked by some acid solutions but is resistant to alkalis.

The use of indium is undergoing rapid development. One of its chief applications is in antifriction coatings for bearings used in high-speed aviation engines and as an alloy-layer in the outside surface of the bearings themselves. The standard grade indium (99.97 per cent) is satisfactory for this purpose. High-purity indium in many shapes and alloys is finding increasing application in the electronics field for transistors, especially in the United States.

Other uses are the inclusion of indium in low-melting-point alloys, glass-sealing alloys, certain solder alloys and dental alloys.

In the field of nuclear energy, since artificial radioactivity is easily induced in indium by neutrons of low energy, it can be used as an indicator in an atomic pile.

Trade and Consumption

No figures are available on the exports, imports, or domestic consumption of indium. Most of Canada's output is exported to United States and United Kingdom but smaller amounts in 1956 went to Switzerland, France, Germany, Holland and Sweden.

An increasing amount of indium is consumed in Canadian industry.

Prices

The price of indium per troy ounce was quoted at $15 in 1940, in 1941 it had decreased to $12.50, in 1944 to $7.50, and in 1945 to $4.00. Since 1946 the price quoted in E & M J Metal and Mineral Markets has been $2.25 a troy ounce of 99.9+ purity.

IRON ORE

By T. H. Janes
Mineral Resources Division

The modern Canadian iron ore industry had its beginning in 1939 when Algoma Ore Properties brought its Helen mine, in the Michipicoten area of Ontario, back into production after the mine had been closed for about 20 years. In 1956, Canada moved up to fourth place as a producer of iron ore, following the United States, Russia and France.

The annual statistical report of the American Iron and Steel Institute estimates total world production of iron ore in 1956 at about 428 million net tons with the countries listed in the following table contributing the major portion:

	Net Tons
United States	108,311,840
U.S.S.R.	79,365,600
France	58,072,470
Canada	22,348,278
Sweden	21,012,043
West Germany	18,687,200
United Kingdom	18,682,392

The 1956 production (shipments) of iron ore in Canada amounted to 19,953,820 tons*, valued at $160,362,118 compared to 14,538,551 tons valued at $110,435,850 in 1955. This 37.2 per cent increase in tonnage and 45.2 per cent increase in value is attributable mainly to the greatly expanded production by Iron Ore Company of Canada from its open pit mines in Labrador-New Quebec. However, increased shipments from Wabana in Newfoundland, Steep Rock in Ontario, and other producers also contributed to the growth of the Canadian iron ore industry. Over the next few years increased shipments are expected from most of the current producers, and several companies will begin shipping appreciable tonnages from properties being developed. On the basis of known developments, production is expected to reach between 45 and 60 million tons by 1965 and will possibly reach 80 million tons annually by 1980.

* Quantities throughout are expressed in long tons (2,240 lb), unless otherwise noted.

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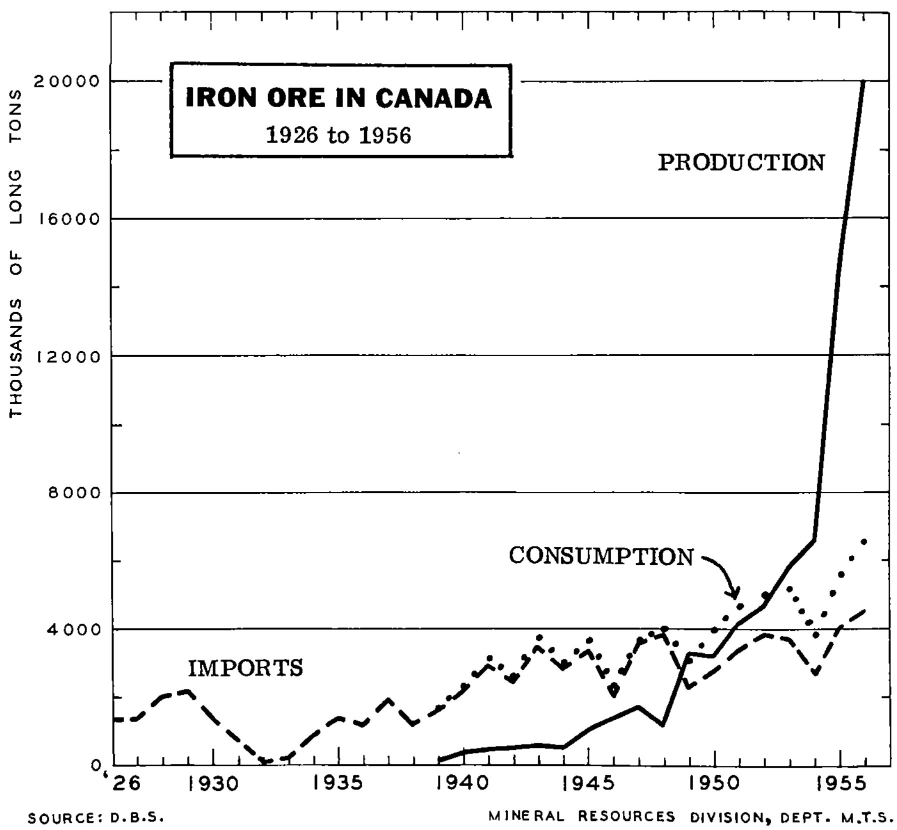
Iron Ore

Most of Canada's iron ore production is exported, chiefly to the United States by reason of geography, company affiliation, high iron content, and good furnace qualities. In recent years, the export of iron ore to the United Kingdom and West European countries by Dominion Wabana Ore Limited and Iron Ore Company of Canada has grown considerably. Ore for blast furnaces in Ontario is, to a large extent, imported from the United States. This is due to The Steel Company of Canada's participation in several iron ore mining companies in the United States, and the need of blending ores from different sources for blast furnace feed. Imports from Brazil and Liberia consist of open-hearth lump ore.

In September 1957, the Sixth Commonwealth Mining and Metallurgical Congress will meet in Canada. The last year Canada played host to the Congress was 1927. No iron ore was produced in Canada then, although during 1886 to 1924 5,878,178 long tons were produced. As noted in the graph below, production recommenced in 1939 and has increased at a rapid rate.



Iron Ore - Production, Trade and Consumption

	1956		1955	
	Long Tons	$	Long Tons	$
Production (shipments)				
Newfoundland	7,556,761	55,620,755	6,434,717	45,701,801
Quebec.	7,104,062	58,373,270	3,663,548	27,164,396
Ontario	4,962,681	44,177,246	3,894,813	34,340,897
British Columbia . .	330,316	2,190,847	545,473	3,228,756
Total	19,953,820	160,362,118	14,538,551	110,435,850
Imports				
United States . . .	4,362,070	36,556,207	3,972,983	30,472,608
Brazil	132,979	1,790,853	60,133	875,730
Liberia.	30,710	374,191	19,365	214,089
United Kingdom . .	9	852	9	934
Total	4,525,768	38,722,103	4,052,490	31,563,361
Exports				
United States	13,737,467	113,516,437	9,983,817	79,713,357
United Kingdom . .	2,504,847	18,506,953	1,342,153	9,013,015
W. Germany	1,088,506	6,858,962	1,035,820	6,337,071
Netherlands	438,290	3,322,051	160,766	1,161,391
Japan	304,470	2,075,500	485,186	3,587,694
Italy	20,411	161,647	-	-
Norway	89	1,000	258	1,578
Total	18,094,080	144,442,550	13,008,000	99,814,106
Indicated Consumption*	6,385,508	54,641,671	5,583,041	42,185,105

*Indicated consumption = Production (shipments) plus imports minus exports.

The shipments of iron ore sinter by Noranda Mines Limited from Port Robinson, of iron ore pellets by The International Nickel Company of Canada Limited from Copper Cliff, both in Ontario, and "remelt iron" by Quebec Iron and Titanium Corporation from its Sorel, Quebec, smelter, are not included in the above table. Shipments for 1955 and 1956, in long tons, from these sources were:-

	1956	1955
Noranda sinter	48,200	-
International Nickel pellets . .	71,000	-
Q.I.T. "remelt iron"**. . . .	143,340	109,095

** Includes 140,221 tons of desulphurized iron and 3,119 tons of high sulphur iron in 1956, and 105,450 tons and 3,645 tons respectively in 1955.

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Iron Ore

Roughly one-quarter of the iron ore production in 1955 and 1956 came from underground operations and the remainder from open pits. Three underground mining methods are being used for ore extraction - room and pillar at Wabana, sub-level stoping at Algoma, and block caving at Steep Rock. In each of these mines ore is brought to surface by conveyor belts. At Algoma's Helen mine in the Michipicoten area of Ontario, it is planned to bring the ore from the lower block of levels, currently under development, to surface by a continuous aerial ropeway on a 22° incline in 3-ton buckets for 5,000 feet, and then on surface for two miles to the sinter plant.

Production and Development

The following table gives details of the companies engaged in iron ore production in Canada or planning such production in the near future.

Companies In Canada Producing Iron Ore, Or With Properties Under Development And Announced Plans of Production

Company	Property Location*	Type of Ore	Product Shipped
In Production			
Dominion Wabana Ore Limited	Wabana, Bell Island, Nfld.	hematite	heavy-media concentrates.
Quebec Iron and Titanium Corporation	Allard Lake, Que. (mine), Sorel, Que. (smelter).	ilmenite-hematite	desulphurized iron
Iron Ore Company of Canada	Labrador-New Quebec, near Schefferville, Que.	goethite and hematite	direct shipping ore
Noranda Mines Limited	Noranda area, Que. (mines); Port Robinson, Ont. (sinter plant)	by-product pyrite flotation concentrate	iron oxide sinter
Marmoraton Mining Co. Ltd. (Bethlehem Steel Co.)	Marmora, Ont.	magnetite	pelletized magnetite concentrate
Clarken Development Ltd.	Lake township, Hastings county, eastern Ont. 16 m. west of Millbridge Stn.	magnetite	magnetic concentrate
Algoma Ore Properties Ltd.	Mines and sinter plant near Jamestown, Ont.	siderite	iron oxide sinter
Steep Rock Iron Mines Limited	Steep Rock Lake, Ont., near Atikokan	goethite	direct shipping ore

* See sketch map on page 97

Company	Property Location	Type of Ore	Product Shipped
The International Nickel Company of Canada, Limited	Mines in the Sudbury area and plant at Copper Cliff, Ont.	pyrrhotite flotation concentrates	iron oxide pellets
Texada Mines Limited	Texada Island, B.C.	magnetite	magnetite concentrate
Argonaut Mine Division of Utah Co. of the Americas	Quinsam Lake near Campbell River, Vancouver Island, B.C.	magnetite	magnetite concentrate
Under Development With Announced Plans of Production			Product to be Shipped
The Cartier Mining Company Limited (1961)	Mt. Reed and Mt. Wright areas, Que., 150 and 210 miles north of Shelter Bay	beneficiating grade specular hematite and magnetite	iron ore concentrates
The Hilton Mines (1957)	Near Bristol, Que., 40 miles northwest of Ottawa	beneficiating grade magnetite	iron oxide pellets
Noranda Mines Limited (1957)	Noranda area, Que. (mines); Cutler, Ont. (sinter plant)	by-product pyrite flotation concentrate	iron oxide sinter
Caland Ore Company Limited (1960)	Steep Rock Lake, Ontario	goethite	direct shipping ore
Lowphos Ore Limited (1958)	Near Sellwood, Ont., 20 miles north of Capreol	beneficiating grade magnetite	iron oxide concentrate or pellets
Canadian Charleson Limited (1958)	Steep Rock Lake Ont.	hematite-bearing gravels	washed and sized hematite
Empire Development Co. Ltd. (formerly Quatsino Copper-Gold Mines Ltd.) (1957)	Elk River deposit near north end of Vancouver Island, B.C.	magnetite	magnetite concentrate

Iron Ore

Iron Ore Production (shipments) in Canada by Company and Property, 1955-56*

Company	Property Location	Material Shipped	1956 Tons	1955 Tons
Dominion Wabana Ore Limited	Wabana, Nfld.	beneficiated hematite	2,654,219	2,369,127
Iron Ore Company of Canada	Schefferville, P. Q.	direct shipping ore	12,023,000	7,721,694
Marmoraton Mining Co. Ltd.	Marmora, Ont.	iron ore pellets from magnetite	283,220	195,776
Noranda Mines Limited	Port Robinson, Ont.	iron sinter from pyrite	48,200	-
The International Nickel Co. of Canada Limited	Sudbury, Ont.	iron ore pellets from pyrrhotite	71,000	-
Algoma Ore Properties Ltd.	Jamestown, Ont.	iron sinter from siderite	1,411,427	1,432,455
Steep Rock Iron Mines Limited	Steep Rock Lake, Ont.	direct shipping ore	3,316,126	2,265,555
Argonaut Mine Division of Utah Co. of the Americas	Vancouver Island, B. C.	magnetite concentrates	183,837	335,903
Texada Mines Limited	Texada Island, B. C.	magnetite concentrate	146,480	236,392

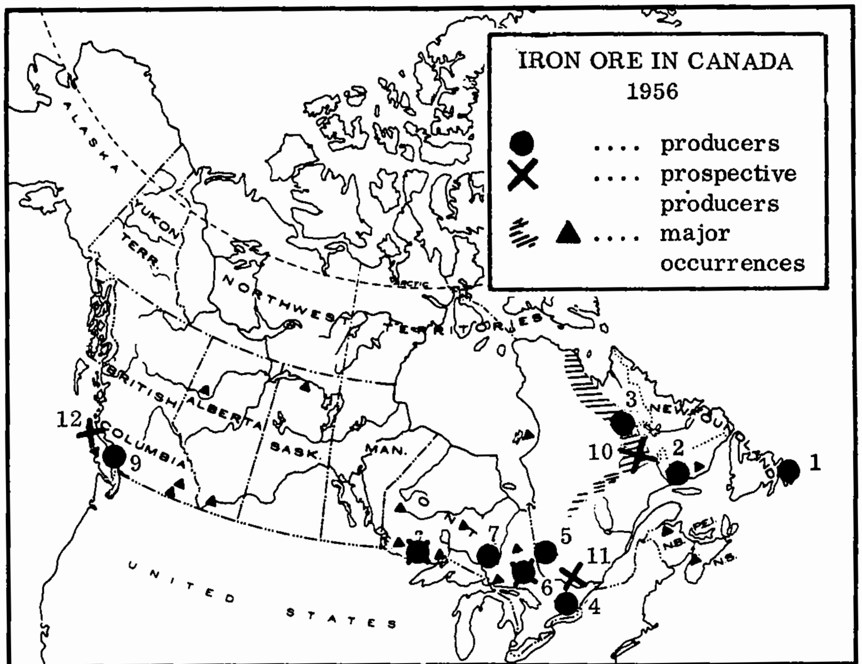
*Shipment figures from company data.

Newfoundland

Dominion Wabana Ore Limited. Shipments of heavy-media hematite concentrates in 1956 from Wabana mines, located off Bell Island under Conception Bay, amounted to 2,654,219 tons, about 12 per cent higher than the 2,369,127 tons shipped in 1955. Destination of shipments from Wabana for the past three years is shown in the following table:-

Country	1956 Tons	1955 Tons	1954 Tons
Canada (Dosco at Sydney, N.S.) . . .	489,886	459,546	555,747
United Kingdom	1,028,620	857,546	897,249
West Germany	1,038,793	976,965	702,735
Netherlands	73,420	62,180	-
France	12,950	-	-
United States	10,555	21,000	-

Average analysis (dry basis) of the ore shipped in 1956 was 50.93 per cent iron, 12.84 per cent silica, 1.61 per cent moisture, and 0.88 per cent phosphorus.



<u>Producers</u>

1. Dominion Wabana Ore Limited.
2. Quebec Iron and Titanium Corporation
3. Iron Ore Company of Canada
4. Marmoraton Mining Company Limited
   Clarken Development Limited
5. Noranda Mines Limited
6. The International Nickel Company of Canada Limited
7. Algoma Ore Properties, Limited
8. Steep Rock Iron Mines Limited
9. Argonaut Mine Division of Utah Co. of the Americas
   Texada Mines Limited

<u>Prospective Producers</u>

6. Lowphos Ore Limited
8. Caland Ore Company, Limited
   Canadian Charleson Limited
10. Canadian Javelin Limited
    The Cartier Mining Company Limited
11. The Hilton Mines
12. Empire Development Company, Limited

Iron Ore

The company reports it has firm commitments for its output of iron ore up to and including 1961. To meet these commitments, the company must produce at least 3,000,000 tons of ore annually, or about 12,500 tons daily. The year under review saw the completion of the extensive expansion and modernization program begun in 1950 that involved the expenditure of some $22,000,000.

Quebec and Labrador - Newfoundland

Quebec Iron and Titanium Corporation. The $7,500,000 ore-beneficiation and rotary-kiln plant at Sorel was completed early in 1956. This resulted in the upgrading of the ilmenite-hematite ore from Allard Lake to about 37 per cent titanium dioxide and 42 per cent iron from 35 and 40 per cent respectively. Concentration of the ore is accomplished by using Dutch State Mines cyclones on the coarse fraction and Humphreys spirals on the fine fraction. Electric smelting of the concentrates yielded a slag analysing about 70.5 per cent TiO_2 and 11 per cent iron and a low phosphorus iron containing about 0.12 per cent sulphur and 2.2 per cent carbon which was ladle-desulphurized to low sulphur content and cast into pigs.

Company operations for the past two years are briefly summarized in the following table:

	1956 Tons	1955 Tons
Ore shipped (Havre Ste. Pierre to Sorel)	560,362	396,134
Ore smelted (at Sorel)	420,308	311,230
TiO_2 slag shipped	190,841	140,516
Desulphurized iron shipped	140,221	105,450
High-sulphur iron shipped	3,119	3,645

Early in 1957, the company announced it will increase by 60 per cent its production of titanium dioxide slag from the Sorel plant by the addition of three electric furnaces and auxiliary equipment at an expenditure of $16,000,000.

Iron Ore Company of Canada. Mining operations at the Labrador - New Quebec concessions of the company during 1956 began on May 1 and continued through a 203-day season until November 19. Production came from four mines - the Gagnon and French mines in Quebec and the Ruth and Gill mines in Labrador - as outlined in the following table:

Quebec		Tons	% Iron
Gagnon Mine	-	4,031,511	52.82
French Mine	-	3,274,017	51.87
Labrador			
Ruth Mine	-	4,021,759	53.17
Gill Mine	-	827,747	48.76

The shipping season out of Sept Iles began on April 8, and 946 cargoes for canal freighters were loaded at Contrecoeur, the transhipment point near Montreal, for passage through the St. Lawrence canal system to Great Lakes ports. A total of 2,757,712 tons was handled through the Contrecoeur transfer dock in 1956. The largest cargo shipped from Sept Iles was 46,000 tons.

Iron Ore Shipped from Sept Iles, 1956

	Quantity Tons	Iron Content %
Quebec		
Bessemer	1,373,577	56.73
Non-Bessemer	5,141,864	52.21
Manganiferous	592,588	47.28 (5.72% Mn)
Total	7,108,029	
Labrador		
Bessemer	196,705	53.67
Non-Bessemer	4,033,175	53.59
Manganiferous	685,132	47.42 (5.94% Mn)
Total	4,915,012	
Grand total	12,023,041	

The destinations of ore shipped from Sept Iles during 1955 and 1956 are given in the following table:

Destination	1956 Tons	1955 Tons
United States	9,447,492	6,728,000
United Kingdom	1,470,060	594,000
Canada	704,045	372,000
Western Europe	391,076	123,000
Lost in transit	10,369	-

During 1956, the Gill mine spur and yards were completed and a railroad spur extending from the French mine to service the Ferriman mine was begun. The Ferriman mine is expected to reach production in 1957, and the total shipment from Sept Iles at that date is expected to exceed 13,000,000 tons.

The Hilton Mines. The Hilton mines, formerly known as the Bristol mines, located about 40 miles northwest of Ottawa in Pontiac county, Quebec, is a concentrating-grade magnetite deposit scheduled to come into production late in 1957. The development and operation of the property will be a joint venture of Stelco Mines Limited and Bristol Quebec Mining Co., each having an equal share in the project. Estimates indicate that the tonnage obtainable by open-pit methods amount to about a 15-year output, based on a contemplated production of 600,000 tons per year of iron ore pellets containing about 66 per cent iron.

Iron Ore

The Cartier Mining Company Limited. This company, a subsidiary of United States Steel Corporation, announced early in 1957 that it will spend an estimated $200,000,000 to bring its holdings in the Mount Reed area of Quebec, about 300 miles northeast of Quebec City, into production. This area lies about 70 miles south of the Mount Wright holdings of the company. Plans call for the construction of a private railway, 150 miles in length, from Shelter Bay on the north shore of the St. Lawrence River, northward to the Mount Wright area. Initial production is expected in 1961 at an annual rate of 3,000,000 tons with expansion to 10,000,000 tons, possibly by 1965. Eventual output from the company's operations in the general area could reach several times this figure. Iron-bearing minerals in several deposits range from coarse-grained specular hematite to relatively fine-grained concentrating-grade magnetite with varying proportions of the two. Overall average grade of the deposits is about 35 per cent iron.

Other Developments in Quebec. In addition to the properties in production and slated for early production there are many properties under geological and geophysical examination and diamond drilling. Favourable iron-bearing formations extend in an almost continuous arc from the most northerly tip of the west coast of Ungava Bay to the Mistassini area of Quebec. Many companies are investigating various sections of this arc with the area lying to the southwest of the northward trending "Labrador - Quebec Trough" receiving the most active investigation in 1956.

Companies with extensive holdings in the latter area, and eastward to the Wabush Lake area, include Jones and Laughlin Steel Corporation, Pickands Mather and Company, Iron Ore Company of Canada, The Steel Company of Canada, and Canadian Javelin Limited.

At the far northern end of the arc, west of Ungava Bay, large reserves of concentrating-grade iron ore have been outlined by reconnaissance diamond drilling and surface examination by several companies. Atlantic Iron Ore Limited and International Iron Ore Company Limited, both controlled by the Cyrus S. Eaton interests of Cleveland, Oceanic Iron Ores of Canada Limited, a subsidiary of Rio Tinto Mining Company of Canada Limited, and Consolidated Fenimore Iron Mines Limited have outlined huge reserves of iron-bearing material consisting of beneficiating-grade magnetite, hematite and siderite at various locations.

Ontario

Steep Rock Iron Mines Limited. Shipments of 3,317,073 gross tons of direct-shipping goethite ore were reported by the company in 1956, compared with the previous high of 2,265,555 tons in 1955. Output from the Hogarth open-pit mine accounted for 3,091,828 tons while 225,245 tons came from the Errington underground mine. The company anticipates a sustained yield of 5,500,000 tons annually, commencing in 1959, from its open pit and underground operations, as detailed in the following production schedule:

Year		Tonnage and Source	
1957		2,750,000	Hogarth pit
		750,000	Errington underground
	Total	3,500,000	
1958		2,500,000	Hogarth pit
		500,000	Errington pit (north)
		1,000,000	" underground
	Total	4,000,000	
1959		2,500,000	Hogarth pit
		1,250,000	"G" pit
		1,500,000	Errington underground
		250,000	Hogarth underground
	Total	5,500,000	
1960		1,500,000	Hogarth pit
		1,500,000	"G" pit
		1,500,000	Errington underground
		1,000,000	Hogarth underground
	Total	5,500,000	

Dredging, stripping and development operations at the various mines located near Atikokan, about 142 miles west of Port Arthur, continued during 1956 in accordance with production schedules. The company was also active in outside exploration, particularly in northwestern Ontario.

Caland Ore Company Limited. This company, a subsidiary of Inland Steel Company of Chicago, continued dredging operations on the "C" ore zone leased from Steep Rock Iron Mines, and prepared a site for a shaft and plant buildings, necessary for the underground mining of the orebody, on the east side of Falls Bay.

Initial production at an annual rate of 750,000 tons is scheduled for 1960 with an ultimate minimum annual output from the "C" zone set at 3,000,000 tons by 1969.

Canadian Charleson Limited. This company, a subsidiary of Charleson Iron Mining Company of Hibbing, Minnesota, holds under lease 19 claims of iron-bearing gravel located south of Steep Rock Lake. It plans on building a beneficiation plant at Atikokan in 1957 to extract typical goethite-hematite from the gravel by washing, screening and jigging. It is expected shipments of ore will begin in 1958 and an annual output of about 200,000 tons is planned.

Steep Rock Lake Area (General). Ultimate annual shipments, already scheduled from operations in the area, call for a minimum of 8,500,000 tons by the mid-1960's and will possibly reach 10,000,000 tons a few years later.

Iron Ore

The ore reserve potential in the area has been estimated at 300,000,000 tons per 1,000 feet of depth. Geological indications support the belief that much greater depths can be anticipated than the 2,100 feet below bedrock where ore has already been proven by deep drilling. In addition, the discovery of new orebodies and the exploration and development of "suspected" orebodies will add substantially to the potential ore reserves already outlined.

Algoma Ore Properties Limited. Production of "Algoma sinter" amounted to 1,411,427 tons in 1956 compared with 1,432,455 tons in 1955. Siderite ore from the Helen and Victoria underground mines in the Michipicoten area, averaging about 35 per cent iron, is sintered in the company's plant at Jamestown to a product averaging about 50.9 per cent iron, 2.8 per cent manganese, and 11.08 per cent silica. About two-thirds of the siderite from the mines is direct sintering and one-third requires beneficiation in the sink-float plant at Jamestown before sintering. Expansion of facilities at Jamestown and increased production from mining operations will increase output capacity of sinter to 2,000,000 tons annually in 1958.

Underground development of the block of three levels below the present first and second levels of the Helen mine were somewhat curtailed during 1956 to concentrate on the development for production of the new Sir James open-pit mine. This new mine, located at Siderite Hill about 3 miles east of the Helen, was officially "opened" by Lady Dunn early in 1956. Drilling to a 3,000-foot depth has indicated about 80,000,000 tons of siderite, of which 7,000,000 tons will be recovered by open-pit methods.

To aid blast furnace operations at the parent company's steelworks at Sault Ste. Marie, shipment of raw siderite ore from Jamestown was begun during 1956 at a rate of 75,000 tons annually. Shipments of sinter by rail to Sault Ste. Marie amounted to 432,846 tons and the balance (978,580 tons) was shipped by lake vessel from Michipicoten harbour to lower lake destinations.

Marmoraton Mining Company Limited. This company, a subsidiary of Bethlehem Steel Company of Bethlehem, Pennsylvania, began shipments of high-grade iron ore pellets from its operations near Marmora in 1955. Ore shipments in 1956 from the Picton dock, 64 miles by rail from the mine site, commenced on April 20 and continued until November 29, during which time 252,875 tons were shipped to the parent company's steel plant at Lackawanna, New York, a distance of 211 miles. In 1955, 195,776 tons were shipped.

The crude ore, containing about 37 per cent iron, is concentrated magnetically and pelletized into a product averaging about 66 per cent iron. Design capacity of the beneficiating and pelletizing plant at Marmora is 500,000 tons of pellets annually.

Noranda Mines Limited. Noranda's sulphur-iron plant at Port Robinson began operations in September 1954. Pyrite flotation concentrate for plant feed is shipped by rail from mines in the Noranda area of Quebec. After pelletizing, it undergoes a two-stage roasting operation on down-draught Dwight-Lloyd sintering machines to produce elemental sulphur, sulphur dioxide gas, and a high-grade iron oxide sinter that is sold to Bethlehem Steel Company for open-hearth and blast-furnace feed in its steel plant at Lackawanna, New York.

In 1956, pyrite concentrate was treated to yield 48,200 tons of iron sinter, 3,700 tons of sulphur, and 30,400 tons of sulphur dioxide gas. The operating rate was somewhat less than half capacity owing to various mechanical difficulties encountered in producing a clean gas. It is expected the Port Robinson plant will be ready for full-scale operation in April 1957.

Noranda is building a second plant at Cutler, Ontario, similar to that at Port Robinson, that is expected to yield, at capacity, 350,000 tons of sulphuric acid for the uranium mills of the Blind River area, and 250,000 tons of iron sinter a year. Operations are expected to begin late in 1957.

The International Nickel Company of Canada Limited. The first shipment of high-grade iron oxide pellets from Inco's new $19,000,000 iron ore recovery plant near Copper Cliff was made in February 1956. At capacity operation, this unit of the iron ore recovery plant will treat 1,000 tons of nickeliferous pyrrhotite a day, corresponding to an output of 250,000 tons of iron ore pellets a year.

Pyrrhotite, carrying low nickel, is recovered from the company's ores in the Copper Cliff concentrator by flotation and transported a short distance to the new plant. The sulphur is removed in roasters, the product is ammonia leached at atmospheric pressure, and the resulting cleaned magnetite is agglomerated into hard one-inch iron ore pellets analysing 68 per cent iron and 1.5 per cent silica. Plans call for the eventual production of 1,000,000 tons of pellets a year but a definite time schedule for the necessary extensions had not been drawn up at the end of 1956.

In 1956, owing to interruptions and the necessity for various changes which are customarily experienced in starting a new plant, the total output for the year was 71,000 tons of iron ore pellets. Shipments, by rail, were made to steel mills in Canada and the United States where it was used successfully in open-hearth steel making and in iron blast furnaces.

Lowphos Ore Limited. This company, a subsidiary of National Steel Corporation of the United States, announced in September that it will proceed with the development of the iron ore property at Moose Mountain, 35 miles north of Sudbury. M.A. Hanna Company will act as operator of the property for Lowphos. The property will be operated by open pit methods to produce 500,000 tons of iron ore concentrates a year. It is expected that construction will begin in time to start operations (shipments) in 1958. Open pit reserves are reported to be sufficient for a 20-year operation at the announced production rate. Concentration of the ore, carrying about 30 per cent iron, will be done magnetically, and the concentrates will be shipped by rail to a port on Georgian Bay and thence by lake carrier to the United States lake ports.

Other Developments in Ontario. In Ontario, there are a number of areas containing iron-bearing occurrences of possible commercial importance that have been under investigation during the past year or two. Jalore Mining Company Limited, a wholly owned subsidiary of Jones and Laughlin Steel Corporation of Pittsburgh, exercised its option to lease an iron property in Boston township, six miles from Kirkland Lake, from Dominion Gulf Company. Mattagami Mining Company was formed by The Steel Company of Canada and Interlake Iron Corporation to acquire an iron property about 35 miles north of Kapuskasing. Iron Bay Mines Limited, holding 90 claims at Bruce Lake south of Red Lake, has outlined a substantial tonnage of concentrating iron ore. Iron-bearing material requiring beneficiation has been under examination and exploration by diamond drilling by a number of companies in eastern Ontario, Temagami, Thunder Bay, Nemegos, Michipicoten, Sioux Lookout, Shebandowan, and Atikokan areas.

British Columbia

Utah Co. of the Americas. The Iron Hill mine of the Argonaut Mine Division of Utah Co. of the Americas is about 17 miles southwest of Campbell River. Operations of the Iron Hill mine in 1956 are summarized in the following table:

	Tons
Crude ore mined	- 113,215
Magnetic concentrate produced	- 83,406
Concentrate from tailings of previous years	- 72,864
Total concentrate shipped	- 183,837 (to Japan)
Stockpiled concentrate	- 54,879

The ore as mined averaged 38.4 per cent iron in 1956 and this was upgraded by magnetic concentration to 56.3 per cent. The Iron Hill mine is now considered to be worked out and was closed on December 21, 1956. Any shipments in 1957 will be from stockpile.

The company has other iron ore possibilities in British Columbia, including the Iron River group of claims, about 11 miles southwest of Campbell River. The material here is similar to that of the Iron Hill mine but is finer grained and carries more sulphur and copper.

Texada Mines Limited. The concentrating-grade magnetite deposits of this company are 4 miles directly south of Vananda, on the west coast of the north part of Texada Island, which lies in the Strait of Georgia about 50 miles northwest of Vancouver, and 2 to 4 miles off the mainland.

Production of crude ore amounted to 252,596 tons during 1956, of which 11 per cent came from the Prescott pit, 30.2 per cent from the Paxton pit, and 58.8 per cent from the Cameron Yellow Kid pit. The mill operated for 8 months of the year. Crude ore milled amounted to 250,196 tons from which 155,823 tons of concentrates were produced. Shipments of concentrates, all to Japan, amounted to 146,480 tons, averaging 56.16 per cent iron, 1.39 per cent sulphur, and 0.17 per cent copper. The grade of ore mined averaged 41.1 per cent iron and 1.44 per cent sulphur.

A new concentrator having a rated capacity of 1,500 tons of concentrate a day was built during the summer. This new mill, employing grinding, flotation, and wet magnetic separation, started operation in October.

Empire Development Co. Ltd. This company, formed in mid-1956, is 40 per cent owned by Quatsino Copper-Gold Mines Limited of Vancouver and 60 per cent by Mannix Ltd. of Calgary, Alberta. Empire Development owns the Elk River magnetite deposit at the north end of Vancouver Island, about 22 miles by road from Port McNeil.

The company estimates that ore reserves, averaging 57 per cent iron, outlined by Quatsino amount to 2,500,000 tons. For its 60 per cent participation, Mannix will spend an estimated $3,000,000 to build an access road, loading facilities at Port McNeil, a concentrator, and to purchase mining equipment. Initial crushing capacity will be about 4,000 tons a day with production expected in 1957.

Contracts for the shipment of 1,380,000 tons of concentrate over a 3-year period have been signed with iron and steel interests of Japan.

Developments in Other Areas

Developments of an exploratory nature have taken place in 1956 at a number of widely scattered locations in Canada, other than those already outlined.

In Nova Scotia, Torbrook Iron Ore Mines investigated the long dormant iron occurrences in the Nictaux-Torbrook district, near Middleton.

In New Brunswick, Strategic Manganese Corporation reports reserves in the order of 200,000,000 tons of 15 to 16 per cent manganese and 18 to 19 per cent iron on its holdings near Woodstock.

In northern Saskatchewan, Triana Explorations, Irex Mining Syndicate, and Yankee Canuck Oil and Mining Corporation Ltd. have investigated iron ore occurrences outlined in an aeromagnetic survey conducted by the Saskatchewan Government.

Iron Ore

In Alberta, West Canadian Collieries Limited has outlined about 35,000,000 tons of titaniferous magnetite north of Burmis, which is 9 miles east of Blairmore. These flat-lying occurrences are reported to average 41 per cent iron and from 4 to 12 per cent titanium dioxide. Deposits of loosely consolidated oolitic goethite with siderite of considerable extent have been investigated in the Clear Hills area of the Peace River District of northern Alberta. They are reported to carry about 34 per cent iron, 24 per cent silica, and to be difficult to concentrate into a marketable grade of material.

In British Columbia, several companies, particularly Frobisher Limited and Utah Co. of the Americas, investigated promising occurrences of beneficiating-grade magnetite by diamond drilling during 1956 on the off-coast islands.

In the Northwest Territories, Belcher Mining Corporation Limited has indicated large reserves of iron-bearing material on Innetalling Island, in the southeast part of the Belcher Archipelago.

Prices

Prices of Canadian iron ores are generally negotiated by contract, with Ontario and Quebec prices being based on the market price of iron ore from the Lake Superior district of the United States. The following quotations from the American Metal Market of December 27, 1956, are considered representative of prices at the close of 1956, but may have been subject to penalties or premiums, according to grade, quality, quantity, commissions, and other factors of negotiation. Where unit price is quoted, one unit is equivalent to 1 per cent, or to each 22.4 pounds, of specified iron content.

Lake Superior Iron Ores, gross ton, 51.50 per cent iron natural, rail of vessel, lower lake ports:

		$
Mesabi non-Bessemer	--	10.85
Mesabi Bessemer	--	11.00
Old Range non-Bessemer	--	11.10
Old Range Bessemer	--	11.25
Open-hearth lump	--	12.10
High phosphorus	--	10.85

Effective January 30, 1957, the prices of iron ore, on the same basis, were raised to:

	$
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 phosphorus	-- 11.45

Swedish Iron Ore, c.i.f. Atlantic ports, 60 to 68 per cent minimum: per unit -- nominal 28.00 cents (Dec. 27, 1956)

Brazilian Iron Ore, f.o.b. Brazilian port, 68 to 69 per cent: per unit -- nominal 25.00 cents (Dec. 27, 1956)

For grades of iron ore, including pellets and sinter, above the Lake Erie base price for 51.5 per cent iron content, 22 to 24 cents per long ton unit of iron content is added, depending upon ore classification. In other words, pellets averaging 65 per cent iron would command about $12.70 plus (65 - 51.5) times 24 cents, or $15.90 per long ton at rail of vessel at Lake Erie ports.

Tariffs

Neither Canada nor the United States maintains tariffs on iron ore. Neither are there import duties on iron ore entering any of the countries to which Canadian producers shipped ore during 1956. These include the United Kingdom, West Germany, Italy, France, the Benelux countries, and Japan.

LEAD

By D. B. Fraser
Mineral Resources Division

Canada ranks fifth among the world's leading primary producers of lead. In 1956 production was 188,854 tons valued at $58,582,651 and equal to about 8 per cent of estimated world output. Total exports of lead were 129,769 tons, compared to 151,494 tons in 1955, 39 per cent going to the United Kingdom, 35 per cent to United States, 10 per cent to Japan, 9 per cent to Belgium and 6 per cent to West Germany.

Canada's lead production declined for the second consecutive year, being about 13,908 tons less than in 1955, and 29,641 tons less than in 1954. The decrease resulted mainly from reduced output from mines in British Columbia which regularly produce about 80 per cent of the national total. Production of refined lead by The Consolidated Mining and Smelting Company of Canada Limited (Cominco) which operates Canada's only lead smelter at Trail, British Columbia, was slightly less than in the previous year. Receipts of domestic and foreign customs ores and concentrates were higher than in 1955.

The graph on page 113 shows the upward trend during the 1920's and 1930's of Canadian production and exports which reached a peak in 1942, fell off sharply in the succeeding two years, and have since tended to level as a result of the general over-supply.

Consumption of primary lead was 65,676 tons, compared to 66,222 tons in 1955. The value of lead and lead products imported was a little higher than in the preceding year, 93 per cent of such imports being tetraethyl lead compounds used in gasoline.

Ethyl Corporation of Canada Limited opened a new plant in Sarnia, Ontario, in September, for the production of antiknock compounds. This is the first plant of its kind to be operated in Canada, and it is so designed that it will have adequate capacity for all Canadian requirements of antiknock compounds now and for many years to come. The estimated consumption of domestic refined lead for antiknock compounds is 7,000 tons per year.

Promising new zinc-lead deposits were outlined in British Columbia and New Brunswick during the year.

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Lead - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production, all forms				
British Columbia	147,701	45,816,877	161,492	46,445,214
Newfoundland	22,788	7,068,813	17,855	5,135,085
Yukon	12,802	3,971,215	13,124	3,774,575
Quebec	2,873	891,145	5,608	1,612,862
Ontario	1,505	466,876	1,927	554,148
Nova Scotia	711	220,521	1,990	572,213
New Brunswick	474	147,204	766	220,403
Total	188,854	58,582,651	202,762	58,314,500
Production, refined	147,865		148,811	
Exports				
In ore & concentrates				
United States	29,997	8,269,305	31,222	8,147,561
Belgium	12,154	3,251,479	16,523	4,529,419
West Germany	7,823	2,027,066	10,418	2,357,518
Total	49,974	13,547,850	58,163	15,034,498
Refined lead, including scrap				
United Kingdom	50,281	13,437,728	56,868	12,946,092
United States	15,963	4,407,302	34,391	8,753,751
Japan	12,541	3,358,770	1,274	310,333
Other countries	1,010	273,620	798	148,936
Total	79,795	21,477,420	93,331	22,159,112
Lead pipe and tubing and lead manufactures				
Columbia		7,296		3,212
Cuba		4,934		5,252
United States		4,821		8,073
Other countries		3,933		7,213
Total		20,984		23,750
Imports				
Lead and lead products				
Tetraethyl compounds		13,348,923		12,707,249
Pigs and blocks		37,790		30,883
Manufactures, n.o.p.		275,020		191,090
Litharge		383,575		364,946
Capsules		79,468		59,935
Miscellaneous		232,875		185,725
Total		14,357,651		13,539,828

	1956		1955	
	Short Tons	$	Short Tons	$
Consumption of refined lead, by uses (primary and secondary)				
Ammunition	4,991		5,289	
Foil and tubes	659		171	
Heat treating	618		610	
Oxides, paints & pigments	7,495		7,764	
Solders	2,665		3,033	
Babbitt	339		207	
Type metal	193		110	
For antimonial lead	3,934		4,827	
Cable covering	15,062		15,397	
Pipes, sheets, straps & bends	4,036		4,012	
Block for caulking	4,117		4,351	
Brass & bronze	722		505	
Batteries	29,145		27,877	
Other uses	1,906		2,198	
Total	75,882		76,351	
Consumption of refined lead by source				
Primary material	65,676		66,222	
Secondary material	10,206		10,129	
Total	75,882		76,351	
Scrap material	9,545		4,013	
Total	85,427		80,364	

Developments at Producing Properties*

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited. The Sullivan zinc-lead-silver mine at Kimberley, owned by Cominco, is Canada's principal source of lead. Since 1910 over 71,000,000 tons of ore have been mined from this deposit. The amount of ore mined in 1956 was 2,769,177 tons compared with 2,836,577 tons in 1955.

At Cominco's H. B. zinc-lead mine near Salmo, 435,305 tons were mined. Production at the company's Bluebell lead-zinc mine at Riondell was 252,523 tons, and at its Tulsequah zinc-copper-lead mine on the northwest coast, 203,688 tons were milled.

All lead concentrates produced at Cominco's four mines were treated at the Trail smelter together with customs concentrates from other mines in British Columbia and Yukon and from foreign shippers. Refined lead production from all sources, was 149,262 tons compared to 149,795 tons in 1955.

Giant Mascot Mines Limited, the second largest producer in the province, produced lead and zinc concentrates from its Silver Giant property and 450-ton mill near Spillimacheen. The orebody was reported to have bottomed at the tenth level. The company holds a 9-mile by 2-mile block of claims at the property, and exploration was directed towards developing new ore deposits and to outlining deep-level extensions of the main deposit.

Canadian Exploration Limited, operating the Jersey lead-zinc mine and two tungsten mines near Salmo, milled approximately 30,000 tons per month of zinc-lead ore with mill heads averaging 1.6 per cent lead and 4.3 per cent zinc. Most of the tonnage was mined by underground trackless methods.

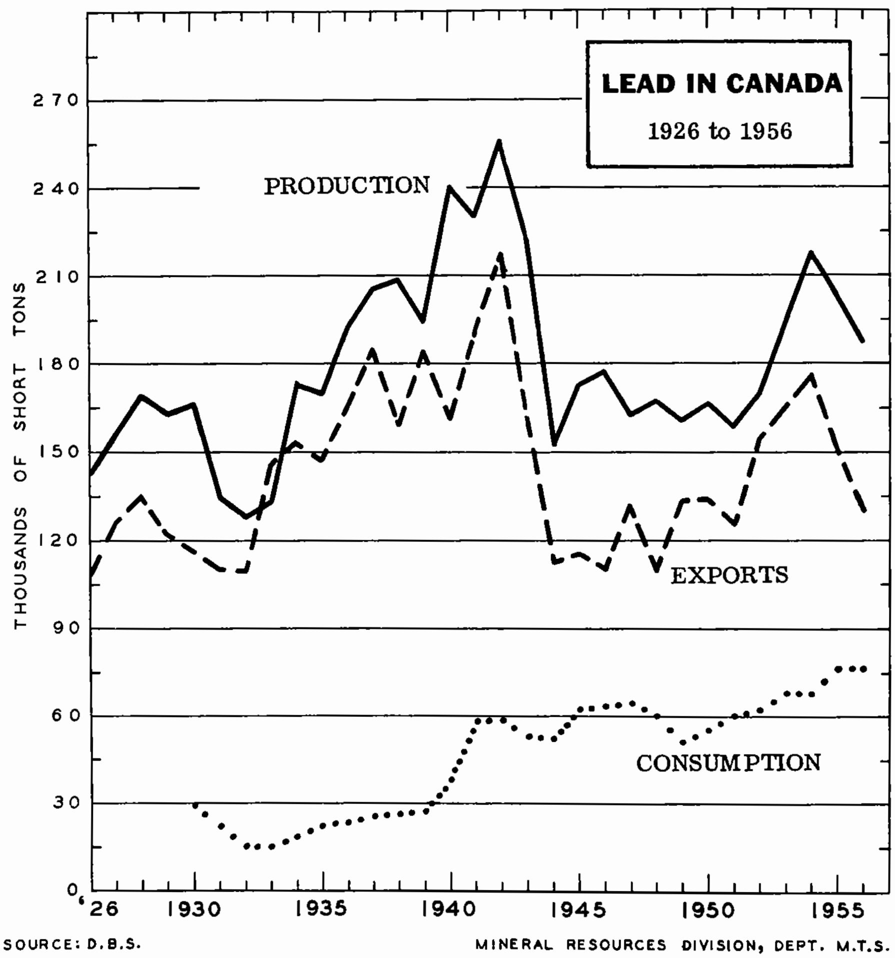
Reeves Macdonald Mines Limited, 12 miles south of Salmo, treated 400,204 tons of zinc-lead ore and produced lead concentrates containing 3,923 tons of lead.

Sheep Creek Mines Limited operated its Mineral King mine and mill, in the Lake Windermere district, at close to its capacity of 500 tons per day. An adit on the seventh level was driven to develop the orebody below the third level.

Silbak Premier Mines Limited resumed production in September at 300 tons per day from its properties in the Portland Canal area of northwestern British Columbia, after a 3-year closure owing to low metal prices. In November the mill burned to the ground. It is planned to rebuild the mill.

Other producers of lead concentrate were Violamac Mines Limited, near Sandon; Yale Lead and Zinc Mines Limited, at Ainsworth; Sunshine Lardeau Mines Limited, near Camborne; Torbrit Silver Mines Limited, near Alice Arm; and Silver Standard Mines Limited, near Hazelton.

* See sketch map, page 115.



Ontario

Jardun Mines Limited continued regular production of lead and zinc concentrates from its zinc-lead-silver property and 300-ton mill 18 miles northeast of Sault Ste. Marie.

Quebec

Lead concentrates were being produced at three mines at the end of 1956, the most important of these being New Calumet Mines Limited, situated on Calumet Island, about 60 miles west of Ottawa. The tonnage milled in the fiscal year ended September 30, 1956, was 161,388 tons, from which 3,463 tons of lead concentrates containing 2,172 tons of lead were produced.

Lead

Golden Manitou Mines Limited, Abitibi East county, produced lead concentrates containing 766 tons of lead from ores mined primarily for their zinc and copper content.

Barvue Mines Limited, in Abitibi East county, primarily a zinc producer, added a lead circuit to the mill during the last half of the year. It was found that when the lead content of the zinc concentrate approached 2 per cent, a low-grade lead concentrate could be economically recovered. A total of 128 tons of lead concentrate were produced.

Ascot Metals Corporation, near Sherbrooke, ceased operations in July when all developed ore had been exhausted.

New Brunswick

Keymet Mines Limited, 18 miles northwest of Bathurst, discontinued operations in March owing to the exhaustion of commercial ore. The mine and 250-ton mill had been in production since early in 1954.

Nova Scotia

Mindamar Metals Corporation shut its 500-ton mill at Stirling, Cape Breton Island, in April, after failing to develop new ore. Production from the property commenced in 1952.

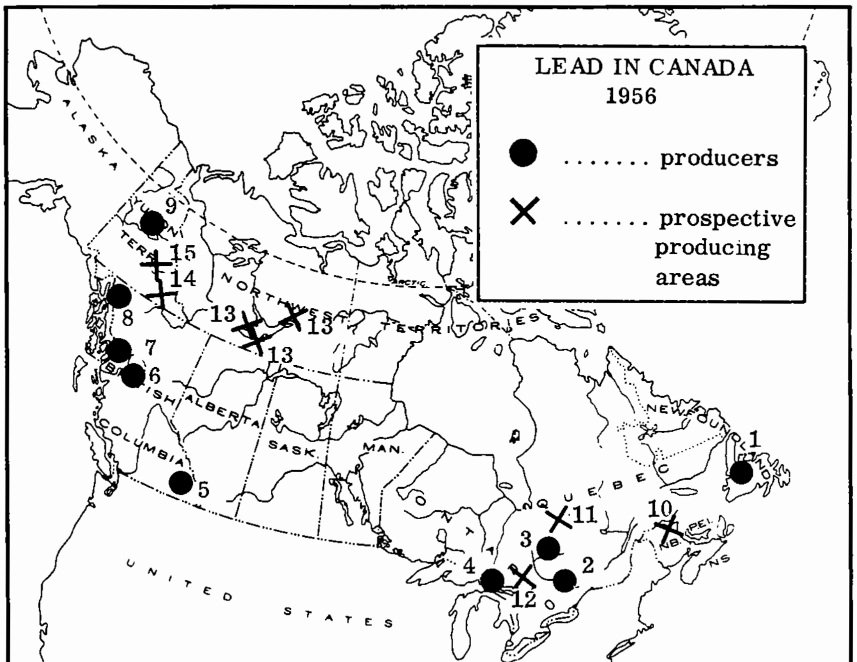
Newfoundland

Buchans Mining Company, Canada's second largest source of lead, produced zinc, lead and copper concentrates, the lead concentrates totalling 39,415 tons. Recoverable lead content of all concentrates was 23,297 tons. Preparations were made to sink the new MacLean shaft, 1 1/2 miles northwest of the Buchans townsite.

Yukon

United Keno Hill Mines Limited, Mayo district, operated at 450 tons per day, and derived about 60 per cent of its mill feed from the Hector mine and about 40 per cent from the Calumet mine which was brought into production in October 1955. Development of the Elsa and Keno mines was continued. Silver-lead and zinc concentrates were shipped to the Trail smelter.

Galkeno Mines Limited (formerly Mackeno Mines Limited), adjoining United Keno's Galena Hill property, resumed production in July after an 8-month shutdown during which ore reserves were built up. Milling rate was 130 tons per day of silver-lead-zinc ore averaging 8 per cent lead.



<u>Producers</u>

1. - Buchans Mining Co. Ltd.
2. - New Calumet Mines Ltd.
3. - Golden Manitou Mines Ltd.
4. - Jardun Mines Ltd.
5. - Reeves MacDonald Mines Ltd.
   Canadian Exploration Ltd.
   The Consolidated Mining and Smelting Co. of Canada Ltd.
   (3 mines, lead smelter and lead refinery)
   Sheep Creek Mines Ltd.
   Giant Mascot Mines Ltd.
   Sunshine Lardeau Mines Ltd.
   Yale Lead and Zinc Mines Ltd.
   Violamac Mines Ltd.
   Slocan Van Roi Mines Ltd.
   Western Exploration Co. Ltd.
   Highland-Bell Ltd.
6. - Cronin Babine Mines Ltd.
   Silver Standard Mines Ltd.
7. - Torbrit Silver Mines Ltd.
   Silbak Premier Mines Ltd.
8. - Tulsequah Mines Ltd.
9. - United Keno Hill Mines Ltd.
   Galkeno Mines Ltd.

<u>Prospective Producing Areas</u>

10. - Bathurst
11. - Bachelor Lake
12. - Sudbury basin
13. - Great Slave Lake
14. - Watson Lake
15. - Pelly River

World Production of Lead

The following table from American Bureau of Metal Statistics gives world production on a mine basis for 1954 and 1955.

	1955	1954
	Short Tons	
United States	333,428	325,427
Australia	309,113	295,056
Russia	255,000	228,500
Mexico	232,381	238,785
Canada	201,583	218,495
Peru	122,902	121,326
Yugoslavia	99,298	92,736
French Morocco	97,664	90,812
South West Africa	80,983	65,308
West Germany	74,396	74,420
Spain	67,096	59,877
Italy	52,500	45,300
Other countries	191,207	235,226
Total	2,117,551	2,091,268

Prices

The Canadian price of lead in 1956 was 15.5 cents per pound throughout the year.

MAGNESIUM

By H.A. Graves
Mineral Resources Division

Successful research in developing new uses for magnesium, and coordinated promotional efforts by the magnesium industry, have resulted in an ever-increasing demand for this metal. Magnesium is now being used in all jet engines produced in Canada. Its value as an alloying agent with other metals, its use in the production of titanium metal, in electrochemistry and in metallurgy promise to make it an even more popular substitute for aluminum, copper, lead and zinc in many industries. The development of new alloying techniques and new alloys with improved physical properties should make it possible for magnesium to achieve a place in the metals industry reflecting its abundance in nature.

Magnesium is available in dolomite, magnesite, brucite and many common minerals of which there is an abundant supply in Canada. It is also obtained from sea water in the United States by the Dow Chemical Co. at plants in Texas. In Canada, magnesium is produced from dolomite and brucite ores mined by open-pit methods. One cubic foot of dolomite contains over twenty pounds of recoverable magnesium, compared to one ounce for each cubic foot of sea water. Most of the problems associated with extraction of magnesium have now been largely overcome; as a result, cost of production has been declining. The capacities of the magnesium foundries and the one extrusion plant in Canada are adequate for present Canadian requirements of castings and extrusions but there are no facilities for rolling and press forging. The present demand for sheet metal and forgings is covered by imports.

Production

Sole magnesium metal producers in Canada are Dominion Magnesium Limited with an annual capacity of 7,500 short tons and Magnesium Company of Canada Limited, a subsidiary of Aluminum Limited, with an annual capacity of 4,500 short tons. In 1956 their combined metal output amounted to 9,606 short tons valued at $6,079,890 of which $5,153,509 worth of metal was exported. During the same period imports of magnesium alloys were valued at $366,837.

Magnesium

The plant of Dominion Magnesium Limited at Haley, Ontario, uses the Pidgeon ferrosilicon process, a batch process developed in Canada. Finely ground calcined dolomite is mixed with finely ground ferrosilicon and fluorspar, and heated to about 1,150°C in horizontal, cylindrical retorts under vacuum. The magnesium metal is driven off as vapour and condenses in crystal form at the cool end of the retort. Dolomite is obtained from a quarry adjacent to the plant, and ferrosilicon from Electro-Reagents (Quebec) Ltd., a subsidiary of Dominion Magnesium, at Beauharnois, Quebec. A very high-purity magnesium metal is produced by this method, and one which can be successfully alloyed to produce many useful types of alloy. For part of the time, the plant is used to produce calcium and thorium. It is reported that the company also will produce lithium in the near future.

Dominion Magnesium has been hampered by high United States tariffs in its desire to market its high-purity (99.98%) magnesium in that country. Consequently, the company is establishing a new company, the Alabama Metallurgical Corporation at Selma, Alabama, owned jointly with Brooks and Perkins Inc. of Detroit. The metal will be made by the same process that is used at Haley, Ontario. Dolomite will be obtained from a large deposit nearby, with low-cost fuel available in the form of natural gas. The $7,000,000 plant will have an annual capacity of 10,000 tons, with production commencing in 1957.

At Arvida, Quebec, the Magnesium Company of Canada Limited produces magnesium by the electrolytic method from granular calcined brucite. The raw material is mined and calcined from brucitic limestone at Wakefield, Quebec. The company operates a magnesium foundry at Etobicoke, Ontario.

The following foundries manufacture magnesium castings of various types: in Quebec - Robert Mitchell Company Ltd., Montreal; in Ontario - Aluminum Company of Canada Ltd. at Etobicoke, Canadian Magnesium Products Ltd. at Preston, Grenville Castings Ltd. at Merrickville, Barber Die Castings at Hamilton, and Light Alloys Ltd., a subsidiary of Dominion Magnesium Ltd. at Haley; and in British Columbia - Western Magnesium Ltd., Vancouver. Magnesium extrusions are produced at Haley, Ontario, by Dominion Magnesium Limited.

MANGANESE

By R. J. Jones
Mineral Resources Division

During 1956 the demand for ferromanganese rose in accordance with the increased level of steel operations in Canada. Canadian steel mills produced a record quantity of steel ingots in 1956 -- 5,180,421 tons, a seventeen per cent increase over 1955 production.

Price levels were increased substantially by conditions in India and the Middle East. Ore prices were increased, export taxes were imposed by India, and higher freight costs resulted from shipping shortages and the closure of the Suez Canal.

Canada produces no manganese ore although small amounts were mined from bog deposits in New Brunswick and British Columbia in past years.

The availability of abundant power has enabled the establishment of a modern ferromanganese plant at Welland, Ontario, in which high- and low-carbon ferromanganese and silicomanganese are manufactured in electric furnaces for domestic consumption and for export. The plant is operated by Electro Metallurgical Company, Division of Union Carbide Canada Limited. Metallurgical-grade ore is also used by Chromium Mining and Smelting Corporation, Limited, at Sault Ste. Marie, Ontario, to make manganese alloys.

Canadian Furnace Company Limited at Port Colborne, Ontario, produces silvery pig iron from low-grade manganiferous ores.

Imports of manganese ore, consumption of ore and exports of ferromanganese increased during the year. Prices for ferromanganese were subject to upward pressure during the year. Influential were shipping costs, together with domestic factors including labour, freight and production charges.

Manganese - Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Imports, manganese ore				
United States*..........	94,019	4,105,351	47,201	1,948,055
Ghana	30,688	1,384,569	56,011	2,296,787
India	26,199	1,090,697	42,199	1,809,801
Belgian Congo..........	26,484	1,262,378	11,951	591,004
Cuba	23,361	988,866	5,355	180,352
Union of South Africa ...	3,350	148,380	8,926	363,452
Other countries	3,876	157,037	3,639	148,818
Total	207,978	9,137,278	175,282	7,338,269
Exports, ferromanganese				
United States	59,355	10,208,367	27,659	4,900,051
Colombia	88	16,446	141	20,183
Mexico	2	301	1	180
Other countries	-	-	1,603	285,280
Total	59,445	10,225,114	29,404	5,206,694
Consumption, ore				
Metallurgical grade	216,475		110,056	
Battery grade	2,666		3,019	
Total	219,141		113,075	

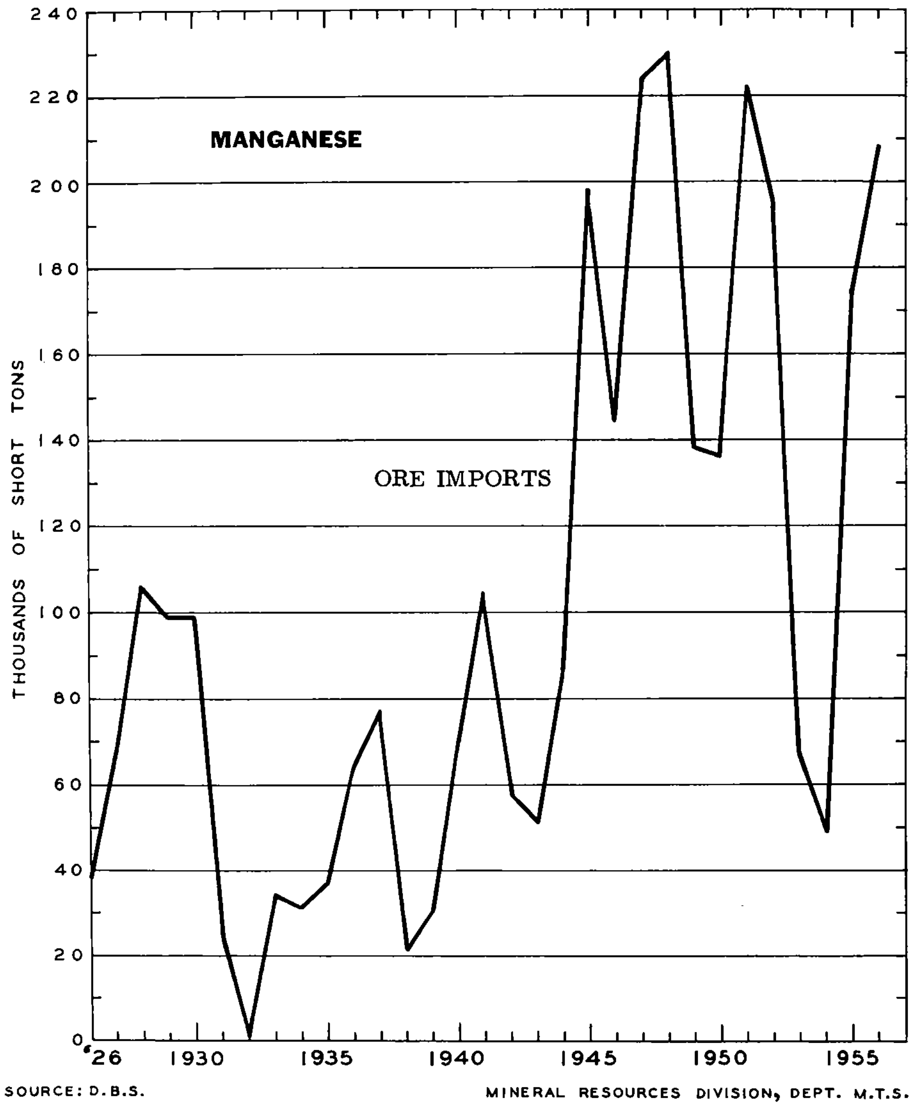
* Country of origin not known.

Canadian Occurrences and Developments

Strategic Materials Corporation

This Corporation through a subsidiary, Stratmat Limited, owns a large low-grade manganese deposit a few miles northeast of Woodstock, New Brunswick. During the year, shipments of concentrates from the company's sink-float plant were made to the pilot plant of Strategic-Udy Metallurgical and Chemical Processes Limited at Niagara Falls, Ontario, and later to a semi-commercial plant.

This plant is the result of test work carried out in 1955 in 50 k.v.a. and 250 k.v.a. electric furnaces at the Mines Branch, Ottawa. The Niagara Falls plant has a capacity of 50 tons of concentrate per day and produces pig iron, ferrosilicon-manganese and ferromanganese. The purpose of the Niagara Falls plant is to check the process on a semi-commercial scale and to obtain data in order to construct an electric smelter in New Brunswick with an initial capacity of 70,000 tons of ferromanganese and 60,000 tons of iron per year. The operating company in New Brunswick is Strategic Manganese Corporation.



<u>Labrador Mining and Exploration Company Ltd.</u>
<u>Iron Ore Company of Canada</u>
<u>Hollinger North Shore Exploration Co. Ltd.</u>

Large reserves of manganiferous iron ore occur in the Labrador and New Quebec area. In Labrador, in eleven deposits, reserves amount to 13,321,000 long tons averaging 49.23 per cent iron and 7.45 per cent manganese. In Quebec, in nineteen deposits, reserves amount to 40,045,000 long tons averaging 50.25 per cent iron and 7.70 per cent manganese. There are sections in the Labrador-New Quebec orebodies where the manganese content is in the vicinity of 20 per cent.

Some test work has already been carried out on this manganiferous iron ore in order to determine the technical feasibility of making either manganese ore or ferromanganese from it.

Manganese

Steep Rock Iron Mines Limited

During mining operations at Steep Rock Lake, 120 miles west of Port Arthur, Ontario, this company must remove considerable quantities of "paint rock" which forms the footwall part of the ore-zone. This waste material averages more than 2 per cent manganese whereas the average manganese content of the ore itself is about 0.18 per cent. Inasmuch as this material must be mined and removed, it constitutes a potential source of manganese.

World Production

Most of the world reserves of high-grade manganese ore are in Russia and satellite countries. The Free World supply comes mainly from India, Union of South Africa, Ghana, Cuba, Belgian Congo and French Morocco. World mine production during 1956 was estimated at 12,145,000 short tons, of which 5,235,000 tons came from Russia.

Indian and Cuban output is generally consigned to United States while North African production is destined for European markets. The output of Ghana, Belgian Congo, and Union of South Africa goes to both markets. Production from Ghana, Union of South Africa, Cuba, and India is mostly metallurgical grade, but Ghana also ships a large amount of battery and chemical grades. Of importance is the growing production in Brazil, Turkey, Mexico, Egypt, and Japan.

During 1956 initial shipments were made from the Amapa deposits in Brazil by way of a new 120-mile railway from the deposit to the ore port at Santana on the Amazon River. This deposit is owned jointly by the Bethlehem Steel Company and Brazilian interests. The ore runs about 45 per cent manganese and, when full production of some 700,000 tons annually is reached, will make Brazil the Free World's third largest producer after India and the Union of South Africa. Other United States steel interests are exploring deposits in Brazil in order to obtain closer sources than is now the case.

The Government of India imposed an export tax effective August 31 which was equivalent to $2.10, $4.20 and $6.30 per ton for 38-40%, 40-44% and 44+% ores, respectively.

To encourage domestic production of manganese ore, the United States Government, in 1951, introduced an incentive price purchase plan for domestic ore based on a price of $2.30 per long ton unit for ore of 48 per cent manganese content. Duration of the plan was changed to January 1, 1961, or until delivery of 28,000,000 long ton units.

The United States Government has also entered into agreements with commercial interests for research and development in upgrading domestic ores, and the recovery of manganese from steel furnace slags. Success in any of these projects would be of utmost importance to the North American continent in an emergency.

Consumption, Uses, and Specifications

Approximately 95 per cent of the world output of manganese ore is used to make manganese alloys for the steel industry. An average of 13 pounds of manganese is needed to produce a ton of steel ingot, this amount being necessary to deoxidize, clean and combine with sulphur so as to produce steel that may be readily rolled and fabricated. As an alloying element, manganese improves the strength and toughness of structural steels and cast-irons. The dry-battery industry accounts for 3 per cent, and the chemical industry for the remainder.

Metallurgical-grade Manganese

Most of the manganese consumed by the steel industry is in the form of high-carbon ferromanganese and the remainder as low- and medium-carbon ferromanganese, silicomanganese, spiegeleisen, manganese metal, and ore in the order given.

Electrolytic manganese metal is used in place of low-carbon ferromanganese to reduce the carbon content in stainless steels, thus eliminating the need of a carbon stabilizer.

General specifications for metallurgical-grade manganese ore are as follows: 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 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.

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.

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Manganese

Canadian Consumers

Consumers of metallurgical-grade ore are Electro Metallurgical Company at Welland, Chromium Mining and Smelting Corporation Limited at Sault Ste. Marie, and Canadian Furnace Company Limited at Port Colborne, all in Ontario.

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.

Electrolytic manganese metal imported from United States is used at Atlas Steels, Limited, Welland, Ontario, in making low-carbon stainless steel. It is also used by the aluminum and magnesium alloy industry.

Prices

The December 27, 1956, issue of E & M J Metal and Mineral Markets quotes the following manganese prices in the United States.

Manganese ore

Indian ore, per long ton unit of Mn, basis 46% to 48% Mn, c.i.f. U.S. ports, import duty extra, export duty included - \$1.64 to \$1.69. Exclusive of export duty - \$1.505 to \$1.555.

Manganese dioxide, 84% MnO_2, long tons, bulk, c.i.f. U.S. ports - \$92 to \$100.

Chemical grade manganese ore per ton, coarse or fine, minimum 84% MnO_2, carload lots, f.o.b. Philadelphia:

	Retail	Wholesale
Paper bags -	\$ 105	\$ 96
Burlap " -	\$ 108.50	\$ 98.50
Drums -	\$ 113.00	\$ 102.50

Ferromanganese

Standard - per lb , carload lots, lump, bulk, f.o.b. shipping point:
74 to 76% Mn - 11.75¢ to 12.75¢.

Medium carbon - per lb contained Mn; carload lots, lump, bulk, f.o.b. U.S.:
80 to 85% Mn, 1 1/4 to 1 1/2% C - 24.15¢ to 25.50¢.

Low carbon - basis as for medium carbon 85 to 90% Mn, max. 0.07% C - 33.75¢ to 35.10¢.

Silico manganese - per lb carload lots, lump, bulk, f.o.b. shipping point:

1.5% C max.	18-20% Si	-	13.80¢
2% C "	15-17 1/2% Si	-	13.60¢
3% C "	12-14 1/2% Si	-	13.40¢

Spiegeleisen - per gross ton, carload lots, lump, bulk, f.o.b. Palmerton, Pa.:

3% Si max.	16-19% Mn	$ 97.50
3% Si "	19-21% Mn	$ 99.50
3% Si "	21-23% Mn	$102.00

Manganese metal - per lb delivered, 95.5% Mn, carloads, bulk - 45¢, packed 45 3/4¢.
Electrolytic, per lb f.o.b. Knoxville, Tenn., with freight allowed east of Mississippi:

Min. 99.9% Mn carloads - 33¢, ton lots - 35¢.

Tariffs

Canada

	British Preferential	Most Favoured Nation	General
Manganese ore	free	free	free
Ferromanganese (on Mn content)	free	1 cent per lb	1 1/4 cents per lb
Silico manganese (on Mn content)	free	1 1/2 cents per lb	1 3/4 cents per lb

Manganese

United States

Manganese ore	-	1/4¢ per lb on Mn. content.
Ferromanganese		
Not over 1% C	-	0.9¢ per lb on Mn content and 7% 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.

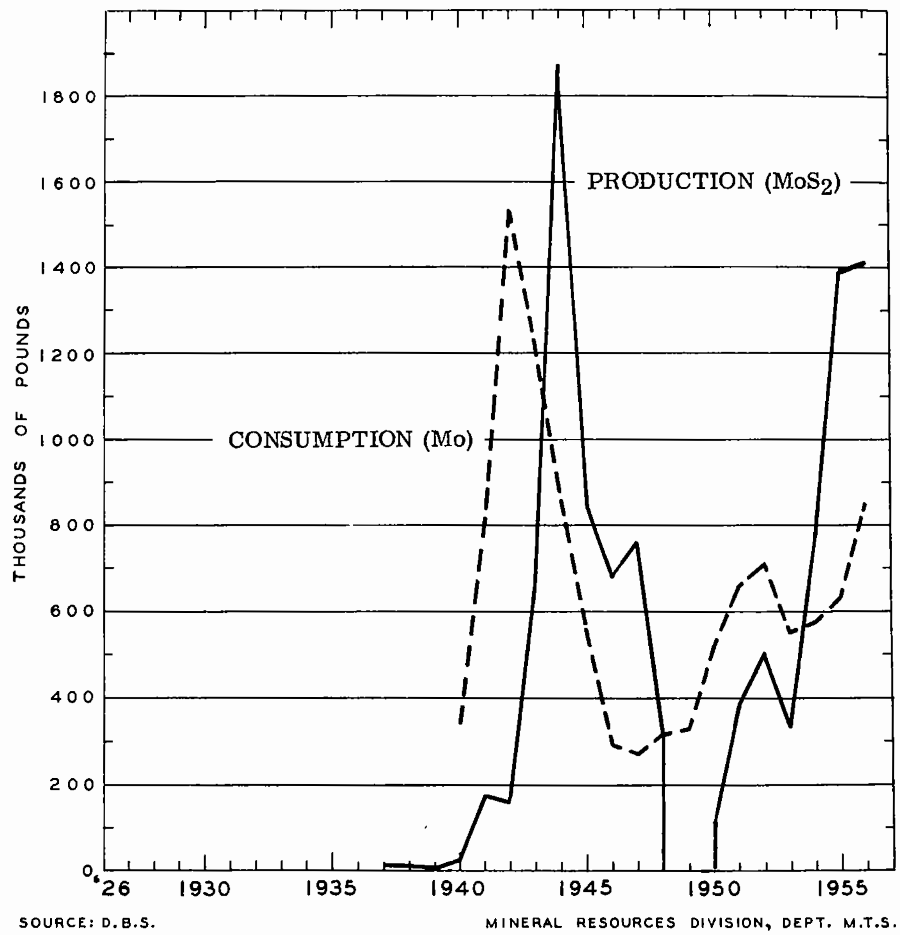
These classes must contain 30% or more Mn.

Spiegeleisen		
Not over 1% C	-	15/16¢ per lb on Mn. content and 7 1/2% ad valorem.
Over 1% C	-	75¢ per ton.
Manganese metal	-	1 7/8 cents per lb on Mn. content and 15% ad valorem.

MOLYBDENUM

By R.J. Jones
Mineral Resources Division

Shipments of molybdenite increased from 1,389,177 pounds in 1955 to 1,403,772 pounds in 1956 to establish the largest annual output on record, with the exception of 1944 when 1,870,132 pounds was produced. The sole producer was the Molybdenite Corporation of Canada Limited at Lacorne about 25 miles northwest of Val d'Or in northwestern Quebec.



Molybdenum

Molybdenum - Production, Imports and Consumption

	1956		1955	
	Pounds	$	Pounds	$
Production (shipments)				
Contained MoS_2	1,403,772	955,828	1,389,177	823,954
Imports				
Molybdic oxide				
United States	955,308	705,400	658,060	545,518
Calcium molybdate (grouped with vanadium oxide and tungsten oxide for alloy steel manufacture)				
United States	322,295	367,194	129,130	174,249
Consumption (Mo content)				
Molybdic oxide	535,546		470,996	
Ferromolybdenum	255,919		125,609	
Calcium molybdate	13,688		5,026	
Sodium molybdate	33,021		22,380	
Molybdenum metal	12,286		7,870	
Molybdenum wire	3,558		2,180	
Miscellaneous	1,450		-	
Total	855,468		634,061	

The Molybdenite Corporation property was operated during World War II by a Crown company, Wartime Metals Corporation, which constructed a 275-ton mill on the site. Production from May 1943 until July 1945 amounted to 2,739,539 pounds of concentrate averaging 87 per cent MoS_2 and containing 1,429,711 pounds of molybdenum. As there were no Canadian plants equipped to convert molybdenite into primary products, the concentrates were shipped to Langeloth, Pennsylvania, for treatment, and returned to Canadian consumers. The property was returned to the present operating company on July 15, 1945, and continued in production until December 1947, when operations were suspended.

The company resumed test milling early in 1951 and succeeded in producing a concentrate relatively free of bismuth and containing over 90 per cent MoS_2. By the end of 1951, it had increased the milling rate to about 280 tons a day. During 1952, underground development on the 270-, 375-, and 500-foot levels, together with diamond drilling, indicated further ore at greater depth and plans to expand production were made.

Operations were suspended at the property during 1953 and early 1954 to permit the opening of two new levels at the 625- and 750-foot horizons and to prepare the mine for production at the rate of 500 tons a day. Milling operations recommenced in March 1954 and have been continuous since that date. The treatment process is essentially one of hand sorting, crushing, grinding, flotation and leaching. The grade of the ore is approximately 0.5 per cent molybdenite and 0.04 per cent bismuth.

During 1955, the mill capacity was increased to 560 tons a day. Production of molybdic oxide was commenced by the company in December 1956 in a roasting plant at the property. This will result in a product that can be consumed by Canadian steel plants, and will thus lead to a decrease in imports of the oxide.

Climax Molybdenum Company acquired an option on a molybdenite prospect on Boss Mountain, British Columbia. Preliminary drilling has indicated a deposit averaging a little under one per cent MoS_2. Drilling will be continued in 1957 to determine the extent of the deposit.

Preissac Molybdenite Mines Limited is examining the molybdenite property that was operated by Indian Molybdenum Limited during World War II about 20 air miles northwest of the Lacorne mine in Preissac township.

World Production

United States production of molybdenum concentrates in 1956 was estimated by the United States Bureau of Mines at 57,464,000 pounds compared to 61,781,000 pounds in 1955. The United States accounts for about 90 per cent of the total world output.

Production from Climax Molybdenum Company at Climax, Colorado, the largest producer, amounted to 37,489,000 pounds from 9,930,000 tons of ore mined and milled. This tonnage represents a record for the company and the largest ever achieved by an underground mine of any kind in North America. The balance of United States production is derived from the molybdenite-bearing copper ores of Utah, New Mexico, Nevada and Arizona; the molybdenite mine of Molybdenum Corporation of America at Questa, New Mexico; and the tungsten mine of the United States Vanadium Corporation at Bishop, California.

In Chile, molybdenite is recovered as a by-product in the milling of copper ores by Braden Copper Company, a subsidiary of the Kennecott Copper Corporation.

Consumption and Uses

About 85 per cent of the total molybdenum used in the United States, by far the world's largest consumer, is used in the form of ferromolybdenum molybdic oxide, and calcium molybdate - about 70 per cent in the making of steels and 15 per cent in cast-iron and malleable castings. The remainder is used in non-ferrous alloys, metallic molybdenum and compounds. In the production of low-molybdenum steels, molybdenum is generally used in the form of molybdic oxide. Ferromolybdenum is used where a higher molybdenum content is required, as in cast-iron and malleable castings.

A large amount of the molybdenum used in alloy steels goes into the making of gears and axles for the automobile, railroad, and ship building industries, shafts for mining and industrial machinery, and castings for pumps and valves. Titanium-base alloys being developed as frame and skin for supersonic aircraft contain from 1 to 6 per cent molybdenum.

Varying amounts of molybdenum are used in high-speed tool steels, high-temperature alloys, and stainless steels. Molybdenum imparts increased strength and hardness and resistance to heat and corrosion.

Molybdenum wire and sheet are used in the electric lamp, radio valve, rectifier, and resistance-wire industries. Molybdenum is used in conjunction with cobalt as a catalyst in hydroforming, desulphurization, and hydrogenation.

Molybdenum salts are used as fertilizers, and in pigments, mordants, and welding-rod coatings. They have a limited use in the chemical field. Molybdenite is finding increasing use as a lubricant, as molybdenum disulphide in greases, oil dispersions, resin-bonded films, or dry-powder lubricants.

Molybdenum orange pigments for automobile finishes are popular.

Among the more important Canadian consumers of molybdenum primary products are Atlas Steels, Limited; Algoma Steel Corporation; The Steel Company of Canada, Limited; Sorel Industries, Limited; Shawinigan Chemicals, Limited; Canada Iron Foundries; Welland Electric & Steel Foundry, Ltd.; Dominion Engineering Works, Ltd.; Dominion Colour Corp. Ltd.; L'Air Liquide; Crane Limited; Eastern Electro-Casting Company Limited; and Dominion Brake Shoe Company, Limited.

Prices

On August 25th, the price of molybdenum contained in concentrate was increased from $1.10 to $1.18 per pound and prices of the majority of molybdenum products were increased an average of 7 per cent.

According to E & M J Metal and Mineral Markets, December 27, 1956, the prices of molybdenum in United States were as follows:

Molybdenum metal,	99% purity - $3.35 lb
Ferromolybdenum,	f.o.b. shipping point per lb of contained Mo: 58-64% Mo, powdered - $1.74 All other sizes - 1.68

NICKEL

By R.E. Neelands
Mineral Resources Division

The production of nickel in Canada continued to increase for the sixth consecutive year. The output in all forms in 1956 amounted to 178,515 tons valued at $222,204,860. The three principal producers were The International Nickel Company of Canada Limited and Falconbridge Nickel Mines Limited in the Sudbury district, Ontario, and Sherritt Gordon Mines Limited at Lynn Lake, Manitoba.

The world production in 1956, exclusive of Soviet countries, is estimated to have been 229,900 tons of refined nickel of which Canada produced 78 per cent, Cuba 7 per cent, New Caledonia 11 per cent, and United States 3 per cent. The remainder came from a number of countries including Japan which refined some of the ore produced in New Caledonia.

Nickel for industrial applications continued to be in short supply owing to very large requirements for defence purposes. In December, International Nickel Company increased its price of refined nickel by 9.5 cents to 74 cents (United States currency) from the level of 64.5 cents a pound which had been in effect since November 1954.

An event of major significance was the decision by International Nickel Company to proceed with the development of its extensive nickel deposits in Manitoba which, when brought into production about 1960, will provide a nickel output second only to that of the Sudbury area.

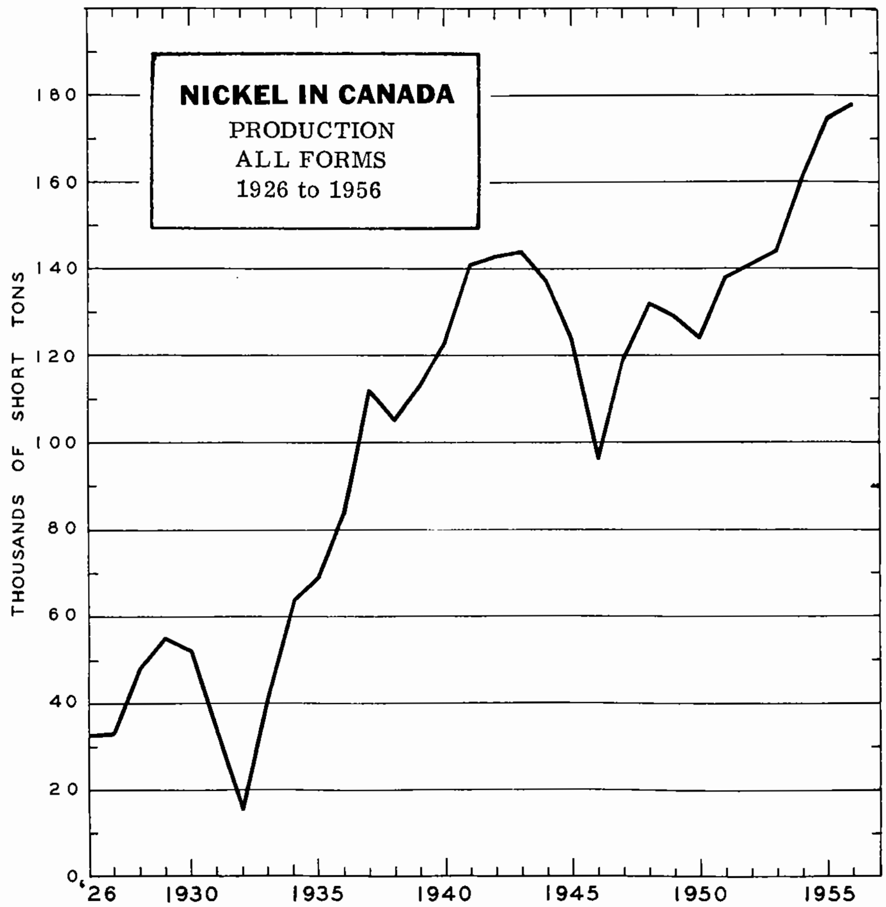
The following graph illustrates the growth of Canada's nickel production since 1926. Most of the output was exported and the domestic consumption, except during wartime periods, has been small.

Producing Mines*

Ontario

The International Nickel Company of Canada Limited (INCO) mined 15,510,849 tons of ore from its mines in the Sudbury area -- the highest tonnage mined in the company's history. Ninety-two per cent of the ore came from underground operations at the Frood-Stobie, Creighton, Murray, Garson, and Levack mines. The remainder was mined in the Frood open pit.

* See map page 137.



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

In addition to its five mines, the company operated two concentrators, two smelters and a copper refinery near Sudbury and a nickel and cobalt refinery at Port Colborne, Ontario. The delivery of nickel in all forms amounted to 143,071 tons. The construction of a new 6,000-ton concentrator was commenced at the Levack mine, and at Port Colborne improved warehousing and shipping facilities were completed. Ore reserves in the Sudbury area at the end of 1956 were 264,223,823 tons with a nickel-copper content of 7,948,246 tons, or 3 per cent.

Falconbridge Nickel Mines Limited treated 1,850,315 tons of ore from its Falconbridge, Falconbridge East, McKim, Mount Nickel, Hardy and Longvack mines near Sudbury; the Longvack mine came into production in May. The company also operated three concentrators and a smelter in the Sudbury area and a refinery at Kristiansand, Norway. Deliveries of refined nickel totalled 21,692 tons. At the Fecunis Lake mine, near Levack, a new 2,000-ton concentrator was almost completed and an addition to the Falconbridge smelter was commenced which, when completed early in 1958, will increase its output of copper-nickel matte. Developed and indicated reserves at the end of the year were reported to be 45,259,450 tons averaging 1.43 per cent nickel and 0.75 per cent copper.

Nickel - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production, all forms				
Ontario	167,576	208,099,454	161,161	198,489,258
Manitoba	10,939	14,105,406	13,767	17,376,749
Total	178,515	222,204,860	174,928	215,866,007
Exports				
Nickel in matte or speiss				
United Kingdom	28,296	34,485,212	27,606	33,103,052
Norway*	23,382	28,474,349	20,721	24,822,876
United States	19,036	23,153,053	17,626	21,119,243
Other countries	1	378	1	240
Total	70,715	86,112,992	65,954	79,045,411
Nickel in oxide				
United States	1,052	1,192,398	761	878,960
United Kingdom	634	439,816	598	350,795
Other countries	81	118,918	94	127,933
Total	1,767	1,751,132	1,453	1,357,688
Refined metal				
United States	92,905	119,166,952	97,775	123,830,389
United Kingdom	5,073	6,616,378	5,706	6,702,887
W. Germany	2,823	4,133,666	585	904,789
Italy	908	1,306,778	557	733,654
Sweden	834	1,174,301	554	811,580
Other countries	1,813	2,646,587	1,296	1,782,511
Total	104,356	135,044,662	106,473	134,765,810

* For refining and re-export

Nickel Rim Mines Limited on the east rim of the Sudbury Basin milled an average of 760 tons a day and shipped concentrates to Falconbridge smelter until near the end of the year when a part of the concentrate production was shipped to the Sherritt Gordon refinery in Alberta. The shaft was deepened to 1,415 feet and four new levels established. Mill capacity was increased to 1,500 tons a day. At the year end reserves were reported to be 1,924,216 tons averaging 0.72 per cent nickel and 0.28 per cent copper.

Nickel

Nickel Offsets Limited in Foy and Bowell townships, about 12 miles north of Chelmsford, milled an average of 161 tons a day and shipped concentrates containing 419 tons of nickel to Falconbridge. The mine was closed in January 1957 when the ore reserves were exhausted.

Manitoba

Sherritt Gordon Mines Limited operated its "A" and "EL" mines and concentrator at Lynn Lake and its nickel refinery at Fort Saskatchewan, Alberta. From 752,823 tons of ore hoisted, 749,506 tons were milled for the production of 84,727 tons of nickel concentrate and 10,933 tons of copper concentrate. Most of the nickel concentrate was shipped to Fort Saskatchewan where 9,619 tons of refined nickel were produced. Nickel concentrate amounting to 13,082 tons was sold to INCO under a contract which ended March 31, 1956. At a point 3,700 feet south of "A" shaft, sinking was commenced of a new shaft (the Farley shaft) which is designed to handle a cage large enough to accommodate trackless diesel equipment. Ore reserves at the end of the year were 13,070,000 tons, averaging 1.108 per cent nickel and 0.58 per cent copper.

Exploration and Development

Quebec

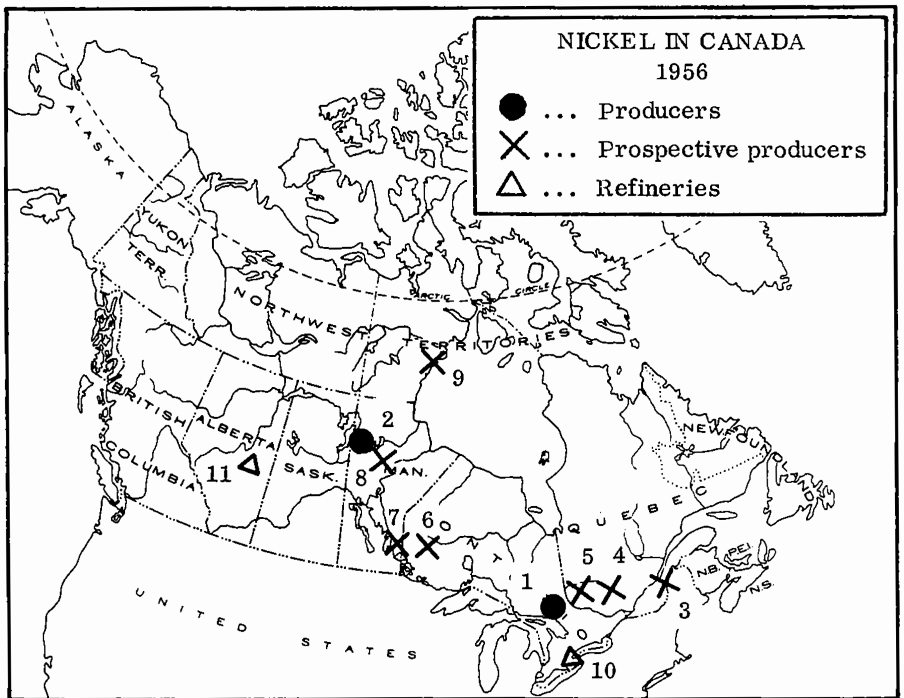
Eastern Metals Corporation Limited deepened the shaft to 1,200 feet at its nickel-copper property in Montmagny county, 65 miles southeast of Quebec. A 500-ton mill was planned for completion in 1957. Reserves included 400,000 tons averaging 0.95 per cent nickel.

Lake Renzy Mines Ltd. (Selco Exploration) discontinued drilling exploration of its property near Delahey Lake after 1,138,000 tons, averaging 0.68 per cent nickel and 0.67 per cent copper had been outlined in a continuous V-shaped deposit.

Consolidated Regcourt Mines Limited drilled a deposit in Blondeau township, 60 miles south of Noranda, where 4,500,000 tons were indicated to a depth of 1,000 feet with a combined nickel-copper content of 1.45 per cent.

LeMoyne Ungava Mines Limited reported the discovery of widespread nickel occurrences in the northern Ungava district in a mineralized belt of rocks between Cape Smith on Hudson Bay and Wakeham Bay on Hudson Strait.

Eastern Mining and Smelting Corporation Limited commenced the installation of a nickel smelter and refinery at Chicoutimi where concentrates from several of the company's mines and affiliated operations are to be treated.



Producers

1 - Sudbury Area
 The International Nickel Company of Canada Limited
 (5 mines; 2 smelters)
 Falconbridge Nickel Mines Limited
 (5 mines; 1 smelter)
 Nickel Rim Mines Limited
 Nickel Offsets Limited

2 - Sherritt Gordon Mines Limited

Prospective Producers

1 - Arcadia Nickel Corp. Limited
3 - Eastern Metals Corp. Limited
4 - Lake Renzy Mines Limited
5 - Consolidated Regcourt Mines Limited
6 - Eastern Mining and Smelting Corp. Ltd.
7 - New Manitoba Gold Mines Ltd.
8 - International Nickel Company of Canada Limited
9 - North Rankin Nickel Mines Ltd.

Refineries

10 - International Nickel Company of Canada Limited
11 - Sherritt Gordon Mines Limited

Nickel

Ontario

The International Nickel Company continued a major exploration program in the Sudbury district. Preproduction development was carried out at the Crean Hill mine, 18 miles west of Sudbury.

Falconbridge Nickel Mines carried out extensive preproduction developments at its Onaping, Boundary and Fecunis Lake mines in the Levack area. Encouraging results were obtained in exploration on the Strathcona property which lies between Longvack and Fecunis Lake. An agreement was made with International Nickel for jointly mining a deposit that is partly within INCO'S Levack mine property and partly in Fecunis Lake property. Each company will treat that portion of the ore deemed to have been mined from its property.

Arcadia Nickel Corporation Limited and Aer Nickel Corporation Limited continued the exploration of nickel-copper deposits on their adjoining properties northeast of Worthington and 25 miles west of Sudbury. Metallurgical test work indicated that satisfactory recoveries of the metals in concentrates could be made.

In the Kenora district Kenbridge Nickel Mines Limited, a subsidiary of Falconbridge, continued to develop a property at Populus Lake where a shaft was deepened to 1,525 feet and exploration was carried out on two levels.

Eastern Mining and Smelting Corporation sank a new 1,100-foot shaft at its Gordon-Werner Lakes nickel-copper property northwest of Kenora, and established four new levels.

Norpax Nickel Limited, adjoining the above property, sank a 350-foot shaft and carried out underground exploration on two copper-nickel zones.

Manitoba

The International Nickel Company announced in December that early in 1957 it would commence a major development program designed to bring into production by 1960 two nickel mines within its Mystery-Moak Lakes property in the north-central part of the province where intensive exploration has been carried out for some years. The project will involve construction of a concentrator, smelter and refinery to treat ore from the Thompson and Moak Lake mines. A 30-mile branch of the C.N.R. was planned from Sipiwesk on the Hudson Bay line northwesterly to a proposed new community at the Thompson mine and from there a 20-mile Company-owned railway is to be built northeasterly to the Moak Lake mine. Power will be provided from a hydro-electric station to be constructed at Grand Rapid on the Nelson River. It was forecast that the completion of this development, together with some expansion at Sudbury, would increase the Company's present nickel output by about 50 per cent to 197,500 tons a year. The indicated ore reserves in Manitoba have not been reported by the company but have been unofficially estimated to exceed 100 million tons averaging 1.5 per cent nickel.

New Manitoba Gold Mines Limited commenced shaft sinking to test a large low-grade copper-nickel-cobalt deposit at Cat Lake in the southeast part of the province.

British Columbia

Canadian Explorers Limited reported the discovery of a large nickel occurrence in the Nahlin River area, northwestern British Columbia.

Yukon

Hudson-Yukon Mining Company, a subsidiary of Hudson Bay Mining and Smelting Company Limited, discontinued development in October at its Wellgreen nickel-copper property near Kluane Lake. Exploration on the lower levels did not materially add to the ore reserves which were 737,600 tons, averaging 2.04 per cent nickel and 1.42 per cent copper when operations were suspended.

Canalask Nickel Mines Limited prepared to commence underground exploration on its property 250 miles northwest of Whitehorse where 550,000 tons, averaging 1.68 per cent nickel, were outlined by drilling.

Northwest Territories

North Rankin Nickel Mines Limited commenced construction of a 250-ton concentrator at its property on Rankin Inlet, 270 miles north of Churchill. Production of nickel concentrates was expected to be commenced in the spring of 1957.

Uses

The steel industry continued during 1956 to be the largest world consumer of nickel principally in the production of stainless steel, engineering alloy steels and jet-engine alloys. The field of non-ferrous castings for many miscellaneous applications also uses important amounts of nickel alloyed with copper, aluminum, silver, magnesium and chromium. The third largest use is in plating, and other outlets include electrical-resistance alloys, catalysts, batteries and ceramics. New nickel alloys developed during 1956 include Incoloy "T" which contains nickel, iron, titanium and chromium and is used in jet aircraft systems where high resistance to heat and stress are essential. Only about 3 per cent of Canada's nickel production is consumed in Canada.

Prices

The Canadian price of refined nickel at Port Colborne, Ontario, was 63 cents a pound from January until the middle of October when it decreased to 62 cents and then 61 cents. On December 6 the price increased to 70 cents a pound where it remained to the end of the year.

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Nickel

In the United States the price of Port Colborne nickel was 64.5 cents a pound until December 6 when it advanced to 74 cents. These prices included the United States import duty of 1 1/4 cents a pound on refined nickel.

NIOBIUM AND TANTALUM

By R.J. Jones
Mineral Resources Division

No commercial production of niobium (columbium) or tantalum ores was recorded in 1956. Production during the previous year was 42 pounds of niobium pentoxide valued at $1,032 and 390 pounds of tantalum pentoxide valued at $9,760 which was produced by Boreal Rare Metals Limited at its refinery at Cap de la Madeleine, Quebec, from concentrates originating in a lithium-tantalum-niobium property 70 miles east of Yellowknife, Northwest Territories. A 100-ton mill at the property was destroyed by fire in 1955 and the company suspended operations shortly after.

Developments and Occurrences

Northwest Territories

In addition to the property of Boreal Rare Metals Limited there are many niobium-tantalum occurrences in the Yellowknife area, north of Great Slave Lake. The presence of columbite-tantalite has been noted in many pegmatite dykes in association with beryl, spodumene and amblygonite. A small quantity of columbite-tantalite was produced in 1947 from the Peg property of Nationwide Minerals Limited near Upper Ross Lake, 45 miles northeast of Yellowknife.

British Columbia

On Bugaboo Creek about 30 miles southeast of Golden, Quebec Metallurgical Industries Limited have developed an extensive niobium-bearing gravel deposit. During 1956, a plant was installed to mine gravel and produce a gravity concentrate. The concentrates were processed to produce high-purity niobium oxide, niobium alloys and niobium sponge in a company pilot plant near Ottawa.

Ontario

The Consolidated Mining and Smelting Company of Canada Limited in 1956 took over the management of Beaucage Mines Limited which has been developing a pyrochlore-uranium deposit located on and around islands in Lake Nipissing about 7 miles southwest of North Bay. A 50-ton test mill has been operated to check the laboratory findings of Battelle Memorial Institute.

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Niobium and Tantalum

Tonnage and grade estimates in a zone to the east of Newman Island, not including any material between the lake bottom and the 300-foot level are as follows:

Tons	o/o U_3O_8	o/o Nb_2O_5
2,695,000	0.042	0.69
1,824,000	0.05	0.88
617,000	0.075	1.06

Multi-Minerals Limited have outlined two pyrochlore-bearing deposits on its Nemegos property about 14 miles from Chapleau. About 50,000,000 tons of material averaging 0.26 per cent Nb_2O_5 have been indicated with local concentration averaging around 1.0 per cent Nb_2O_5.

Dominion Gulf Company have outlined two areas of niobium mineralization in Chewett township, 17 miles north of Chapleau. One area contains 20,000,000 tons of material averaging 0.5 per cent Nb_2O_5 plus a very substantial tonnage averaging down to 0.3 per cent Nb_2O_5. The other area indicates a possible 15,000,000 tons above the 500-foot level.

Quebec

The main companies in the Oka area are Quebec Columbium Limited, jointly owned by Molybdenum Corporation of America and Kennecott Copper Corporation; Columbium Mining Products Limited, owned by Coulee Lead and Zinc Mines Limited and Headway Red Lake Gold Mines Limited; Oka Rare Metals Mining Company Limited and St. Lawrence River Mines Limited.

The Quebec Columbium Limited property is reported to indicate 30,000,000 tons averaging 0.6 per cent Nb_2O_5 in one zone and 25,000,000 tons averaging 0.35 per cent Nb_2O_5 in another.

Columbium Mining Products Limited have outlined some 30,000,000 tons of material averaging 0.35 per cent Nb_2O_5.

World Mine Production

World production of niobium and tantalum concentrates amounted to some 9,640,000 pounds in 1956 according to the United States Bureau of Mines. The main producer of niobium concentrates was Nigeria with a production of 5,866,560 pounds. Other important producers of niobium concentrates were Belgian Congo, Norway, Brazil and U.S.A.

West Germany was the largest producer of tantalum concentrates followed by Brazil and Australia.

Of interest to Canada is the increasing output from West Germany and Norway where the production is derived from pyrochlore deposits.

Consumption and Uses

The most important use of niobium is in the manufacture of stabilized austenitic stainless steels of A. I. S. I. Type 347 where niobium is added in the form of ferroniobium or ferrotantalum-niobium. Niobium is also consumed in the manufacture of certain high-temperature alloys to provide creep resistance at elevated temperatures.

Minor uses for niobium are in the manufacture of certain aluminum casting alloys and in the canning of uranium metal in atomic plants.

Probably the greatest tonnage use of tantalum is in the consumption of ferrotantalum-niobium in the manufacture of stainless steel. Tantalum metal being resistant to most corrosive acids is widely used in hydrochloric acid absorption plants, in plants for the manufacture of pharmaceutical products, spinnerets for extruding rayon fibres and in laboratory equipment such as spatulas and crucibles. Tantalum metal being inert to body acids is used to repair skull injuries and in the repair of bones and in plastic surgery. It is also used in the manufacture of vacuum tubes to remove gases in the tube when in operation.

Tantalum pentoxide is used as a catalyst in the synthesis of butadiene from ethyl alcohol and in the production of certain optical glasses.

The more important Canadian consumers of niobium and tantalum are: Atlas Steels, Limited, Welland, Ontario; Shawinigan Chemicals, Limited, Shawinigan Falls, Quebec; Fahralloy Canada, Limited, Orillia, Ontario. Other consumers are Sheepbridge Engineering (Canada) Limited, Guelph, Ontario; Hayward Tyler of Canada, Limited, Kitchener, Ontario; and Massey-Harris, Ferguson, Limited, Toronto, Ontario. These companies consume about 5 tons of niobium alloys each year.

Prices

Prices of columbium and tantalum according to E & M J Metal and Mineral Markets of December 27, 1956,were as follows:

Columbite, $1.25 - $1.35 per 1b of pentoxide, basis 65% Nb_2O_5 and Ta_2O_5 with a Nb: Ta ratio of 10 : 1

$1.05 - $1.15 per 1b of pentoxide with a ratio of 8 1/2 : 1

Tantalum, $128 per kilo for rods and $100 per kilo for sheet (base price)

Ferroniobium, $6.90 per 1b of contained Nb, ton lots 50-60% Nb, max. 0.40% C, max. 8% Si f.o.b. destination continental U.S.

Niobium and Tantalum

The American Metal Market of January 1, 1957 quoted the following nominal prices:

Niobium powder - $120 per lb
Tantalum powder - $ 49 per lb

Tariffs

Canada

Ferroniobium and ferrotantalum-niobium: British preferential-free, most favoured nation - 5% ad valorem, general - 5% ad valorem.

United States

Ore - free

Ferroniobium - 12 1/2% ad valorem.

Niobium and tantalum metal - 12 1/2% ad valorem.

PLATINUM METALS

By R.E. Neelands
Mineral Resources Division

Canada's production of platinum in 1956 was 151,357 ounces, and of palladium, rhodium, iridium, osmium and ruthenium together 163,451 ounces. These figures are 19,137 ounces and 50,801 ounces respectively less than the comparative 1955 outputs, the decreases being partly accounted for by a reduced demand for the metals in 1956.

In 1956 Canada was the second largest producer of platinum group metals (314,808 oz) following South Africa (491,270 oz). Russia's production was estimated to have been 125,000 oz. Other producers included Colombia (26,215 oz) and United States (21,398 oz).

Output in Canada has varied considerably from year to year because refining is not generally carried out on a uniform basis. An unusually large requirement for platinum metals for use in the production of wartime goods particularly in aircraft manufacture accounted for the high output in 1942 and 1943. (See graph on page 147).

Production

The International Nickel Company of Canada Limited is Canada's principal producer of platinum group metals which it recovers as a by-product from the treatment of its nickel-copper ores mined in the Sudbury district, Ontario. The total platinum group metal content of the ores does not exceed 0.02 ounces per ton but since very large tonnages are mined (15,510,849 tons in 1956) the platinum content is of considerable significance. The company's platinum metals refinery is at Acton, near London, England. Deliveries of platinum metals in 1956 by International Nickel amounted to 371,155 ounces.

The other Canadian producer, Falconbridge Nickel Mines Limited, also operates nickel-copper mines near Sudbury and recovers platinum metals at its refinery at Kristiansand, Norway. In 1956 Falconbridge mined 1,850,315 tons of ore.

Most of the metal refined in England and Norway is returned to Canada for re-export to world markets of which the United States is the largest consumer. The Canadian consumption is relatively small.

Platinum Metals

Platinum and Platinum Metals - Production and Trade

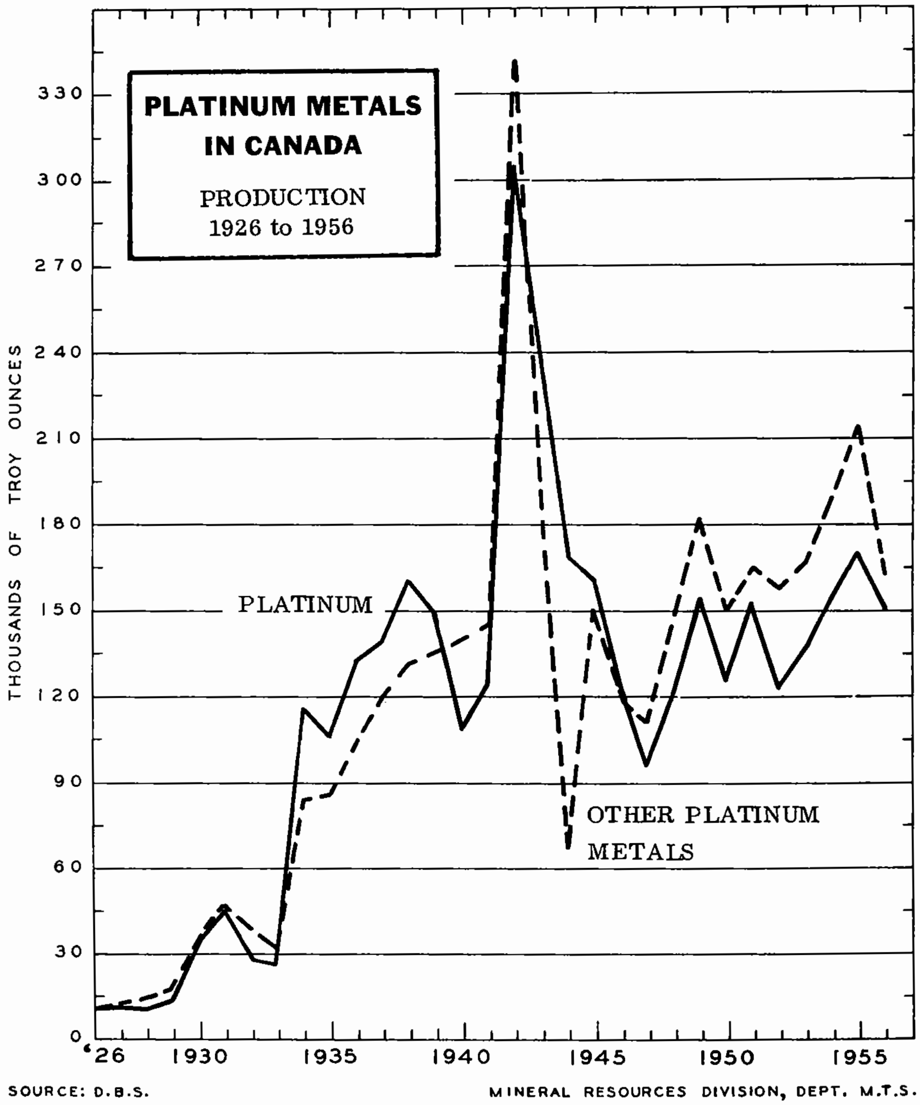
	1956		1955	
	Troy Ounces	$	Troy Ounces	$
Production				
Platinum	151,357	15,725,992	170,494	14,747,732
Palladium, rhodium, ruthenium, iridium, and osmium	163,451	6,681,098	214,252	8,321,633
Total	314,808	22,407,090	384,746	23,069,365
Exports				
Platinum metals in concentrates*......		20,157,210		14,533,193
Platinum metals refined and semi-processed**				
United States		14,814,488		11,697,861
Other countries....		414,413		72,346
Total		15,228,901		11,770,207
Platinum, old and scrap				
United Kingdom ...		45,328		6,956
United States		224,948		4,950
Total		270,276		11,906
Imports				
Platinum and platinum metals, refined, semi-processed, and manufactured				
United Kingdom**..		19,139,549		15,519,547
United States		1,914,056		1,342,379
Other countries ...		293,430		3,257
Total		21,347,035		16,865,183

* To U.K. for refining and processing

** Derived from domestic concentrates refined and processed in U.K.

Developments

Late in 1956 The International Nickel Company announced its decision to proceed with a large-scale development program designed to bring its extensive nickel deposits in north-central Manitoba into production by 1960. In addition to nickel, the ore in these deposits contains recoverable values in platinum and other precious metals.



Exploration of the Gordon Lake-Werner Lake property of Eastern Mining and Smelting Corporation Limited (formerly Quebec Nickel Corporation) was continued with encouraging results. The nickel-copper ore contains appreciable amounts of platinum metals.

North Rankin Nickel Mines Limited reopened its property at Rankin Inlet on the west coast of Hudson Bay, 270 miles north of Churchill, Manitoba, and commenced construction of a concentrator which was expected to be completed in the second quarter of 1957. Ore reserves at the end of 1954 were reported to be 460,000 tons averaging 3.3 per cent nickel, 0.81 per cent copper, 0.03 ounces per ton platinum and 0.06 ounces per ton palladium.

Platinum Metals

The Wellgreen property, Kluane Lake district, 150 miles west of Whitehorse, Yukon, which had been under development for several years by Hudson-Yukon Mining Co. Limited, a subsidiary of Hudson Bay Mining and Smelting Co. Limited, was closed in October 1956. Exploration on the lower mine levels did not result in materially increasing reserves which were 737,600 tons averaging 2.04 per cent nickel, 1.42 per cent copper, 0.038 ounces per ton platinum and 0.027 ounces per ton palladium, when operations were suspended.

Uses

The basic properties of the platinum metals such as their high melting point, catalytic characteristics and exceptionally high resistance to corrosion a count for their industrial applications. Their fine appearance, high density, workability and strength for securely holding diamonds and other stones have been recognized for many years in the jewellery trade. The use of the metals in jewellery and for decorative purposes however is reported to have declined in the last decade.

A major market for platinum in 1956 was the petroleum refining industry where the metal is used as a catalyst in the reforming process for making high-octane gasoline. This increased demand arose from the construction of a number of new petroleum refineries. Since platinum is not consumed in the refining process the future demand for the metal as a petroleum catalyst will depend on the rate of installation of new refineries.

Platinum and palladium are also used extensively as catalyst materials in the production of chemicals such as sulphuric and nitric acids.

Platinum metals are employed in numerous electrical applications owing to their resistance to oxidation, sulphidization, and spark erosion and because of their good mechanical properties. Palladium is used widely in the contacts of telephone relays. Platinum, both pure or alloyed with iridium or ruthenium, is used for contacts in voltage regulators, thermostats and high tension magnetos. Spark plugs with platinum alloy electrodes have an exceptionally long and reliable life. Platinum alloys are employed in numerous electrical instruments and electronic tubes.

In the glass industry platinum and platinum-rhodium alloy are used for melting crucibles, nozzles and weirs for glass handling equipment. They are also used to make "bushings" for the production of glass fibre.

The artificial silk industry depends on platinum-rhodium or gold-platinum spinnerets to form very fine rayon fibre from viscose material.

Other uses are in dentistry for denture plates, pins and anchorages and as electroplate on mirrors and reflectors. Ruthenium and osmium are employed in alloys for fountain pen and phonograph needle points.

Prices

Canadian prices of platinum metals are based on the United States prices in New York published by the E and M J Metal and Mineral Markets. These prices at the end of 1956 were as follows:

		Per Troy Ounce
Platinum	-	\$103 to \$107
Palladium	-	23 to 24
Rhodium	-	118 to 125
Iridium	-	100 to 110
Osmium	-	80 to 100
Ruthenium	-	45 to 55

SELENIUM

By R. E. Neelands
Mineral Resources Division

Canada's production of 330,389 pounds of selenium during 1956 was 23 per cent lower than the 1955 output but its value at $4,460,252 was the highest on record. The metal occurs in small amounts in most copper ores and it is recovered at both of Canada's copper refineries as a by-product from the treatment of the anode mud which accumulates during the electrolytic refining of copper. The increase in Canadian selenium production each year since 1952 probably resulted from a similar increase in the output of refined copper

Canadian Copper Refiners Limited, a subsidiary of Noranda Mines Limited, operates the largest selenium plant in the world adjoining its copper refinery at Montreal East, Quebec. Production of selenium commenced in 1933 and has been continuous since; the plant now has a rated annual capacity of 450,000 pounds of selenium and a wide range of selenium compounds. The feed consists of copper anodes produced at (a) the Noranda smelter from copper ores mined in the Noranda area and other parts of Quebec, (b) the smelter of Gaspe Copper Mines Limited (a subsidiary of Noranda) at Murdochville, North Gaspé county, Quebec, and (c) blister copper produced by Hudson Bay Mining and Smelting Co. Limited from its copper-zinc deposits at Flin Flon on the Manitoba-Saskatchewan boundary. In addition to refined selenium (99.5% Se) and High Purity selenium (99.99% Se), selenium dioxide, sodium selenate, sodium selenite and ferroselenium are produced. For several years, Noranda has been carrying out research to improve the recovery of selenium contained in the various copper and pyrite ores treated.

The International Nickel Company of Canada Limited recovers selenium in the form of a black free-flowing amorphous powder (99.5% Se) at its copper refinery at Copper Cliff, Ontario, from the treatment of nickel-copper ores of the Sudbury area. The plant has a rated capacity of 270,000 pounds of selenium a year. Production began in 1931.

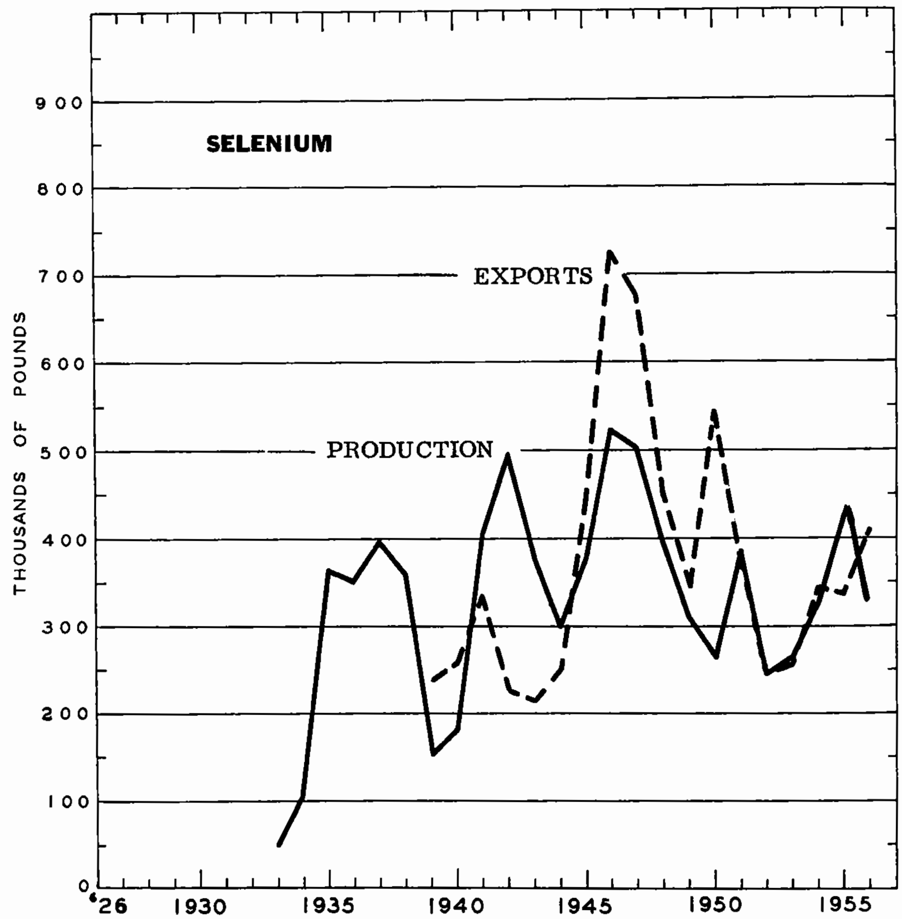
The world shortage of selenium, which began about 1950, continued in 1956, but the demand eased somewhat toward the end of the year owing to increased production and recovery from scrap in some countries.

The United States and Canada are the leading producers followed by Russia, Belgium, Sweden, Japan and Northern Rhodesia, in that order.

Selenium - Production, Trade, and Consumption

	1956		1955	
	Pounds	$	Pounds	$
Production				
Quebec	117,555	1,586,993	236,767	1,775,753
Ontario	109,156	1,473,606	94,465	708,488
Manitoba and Saskatchewan	103,678	1,399,653	95,877	719,078
Total	330,389	4,460,252	427,109	3,203,319
Exports, metal & salts				
United States	228,348	3,395,348	185,266	1,423,376
United Kingdom	169,857	2,573,205	141,521	1,051,431
France	6,435	223,527	-	-
W. Germany............	2,000	71,880	325	5,173
Italy	1,663	52,380	-	-
Other countries	1,426	26,408	7,103	75,709
Total	409,729	6,342,748	334,215	2,555,689
Approximate consumption by industries				
Alloy steel	4,440		13,474	
Rubber.................	4,963		4,981	
Electronics	14,072		9,617	
Glass	8,090		6,725	
Agriculture	104		57	
Total	31,669		34,854	

Canada's annual production of selenium since 1933 and the exports since 1939 are shown on the following graph.



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

Uses

Selenium is used principally in electrical applications, pigments and in metallurgical additives. A number of other uses are of relatively minor importance. In Canada, the largest use is for the manufacture of rectifiers; a small amount goes into the glass industry.

The most important electrical use of selenium requiring High Purity metal is in the manufacture of dry-plate rectifiers for changing alternating to direct current. Applications for rectifiers include radios, television sets, battery chargers, electroplating equipment, magnetic brakes, and circuit breakers. Some of the advantages of selenium rectifiers are their high efficiency, small size and weight, ruggedness and long life. For large, fixed, power applications, germanium rectifiers are being substituted for selenium rectifiers to some extent. Silicon and titanium are also replacing selenium rectifier plates where high-temperature conditions prevail.

Selenium

Selenium photoelectric cells find many important uses in light-sensitive devices such as electric eyes, colorimeters and pyrometers. A fairly new application of the metal is in xerography, a dry print photographic process employing selenium-coated metal disks from which the photographic image is transferred by static electricity.

In the rubber industry, selenium compounds are used as accelerators and vulcanizing agents, to increase resistance to heat, oxidation and abrasion, and to improve the resilience of rubber.

In the glass industry, small amounts of selenium are added to the glass to neutralize undesirable colours. If the proportion of selenium is increased, an amber or ruby glass is produced. About 80 per cent of the selenium used for glass purposes is for decolourizing, especially in the manufacture of milk bottles.

Ferroselenium or iron selenide (about 53% Se) is added to certain stainless steels to improve machineability and to control porosity in castings. Small amounts of selenium also improve the machineability of copper without affecting other properties.

Cadmium sulphoselenide in varying amounts is used in pigments to provide colours ranging from intense orange to dark maroon. The pigments possess good opacity and staining power, stability to sunlight, and resistance to heat and chemical attack. They are used in a wide variety of products such as ceramics, lacquers, inks, enamels and plastics.

Prices

The price of commercial grade selenium was quoted by E & M J Metal and Mineral Markets at $10.00 a pound in January 1956; it was increased to $15.50 a pound on February 1, but was reduced to $12.00 a pound effective January 1, 1957. The price of High Purity selenium was reduced at the beginning of 1957 from $18 to $15 a pound.

SILVER

By D.B. Fraser
Mineral Resources Division

Most of Canada's production of silver in 1956 was derived as a by-product of base-metal mining. Lead-zinc ores were the principal source, supplying 60 per cent of total silver production; copper, copper-zinc and nickel-copper ores provided a further 22 per cent; gold ores accounted for only 2 per cent, and the remaining 16 per cent came from the silver and silver-cobalt ores of northern Ontario.

World production was an estimated 222,400,000 ounces, a decrease of less than 1 per cent from the previous year. Mexico, with 43,077,046 ounces, was again the leading producer, followed by the United States, with 38,157,000 ounces, and Canada, with 28,431,847 ounces.

The graph on page 157 illustrates Canadian silver production, exports, imports, and consumption over the 30-year period since 1926. Complete information on consumption prior to 1942 is not available.

Most of Canada's production is exported, chiefly to the United States. An estimated 19,839,435 ounces was so exported in 1956, plus another 1,426,732 ounces to other countries; domestic consumption amounted to 7,710,925 ounces.

Developments at Producing Mines*

Yukon

Production at the silver-lead-zinc mines of United Keno Hill Mines Limited in the Mayo district, Canada's largest single source of silver, was 5,582,979 ounces in the fiscal year ended September 30, 1956, the average recovery amounting to 35.9 ounces per ton milled. Mill feed was derived mainly from the Hector and Calumet mines. Exploration and development of these mines and the Elsa and Keno properties continued.

* See map, page 159.

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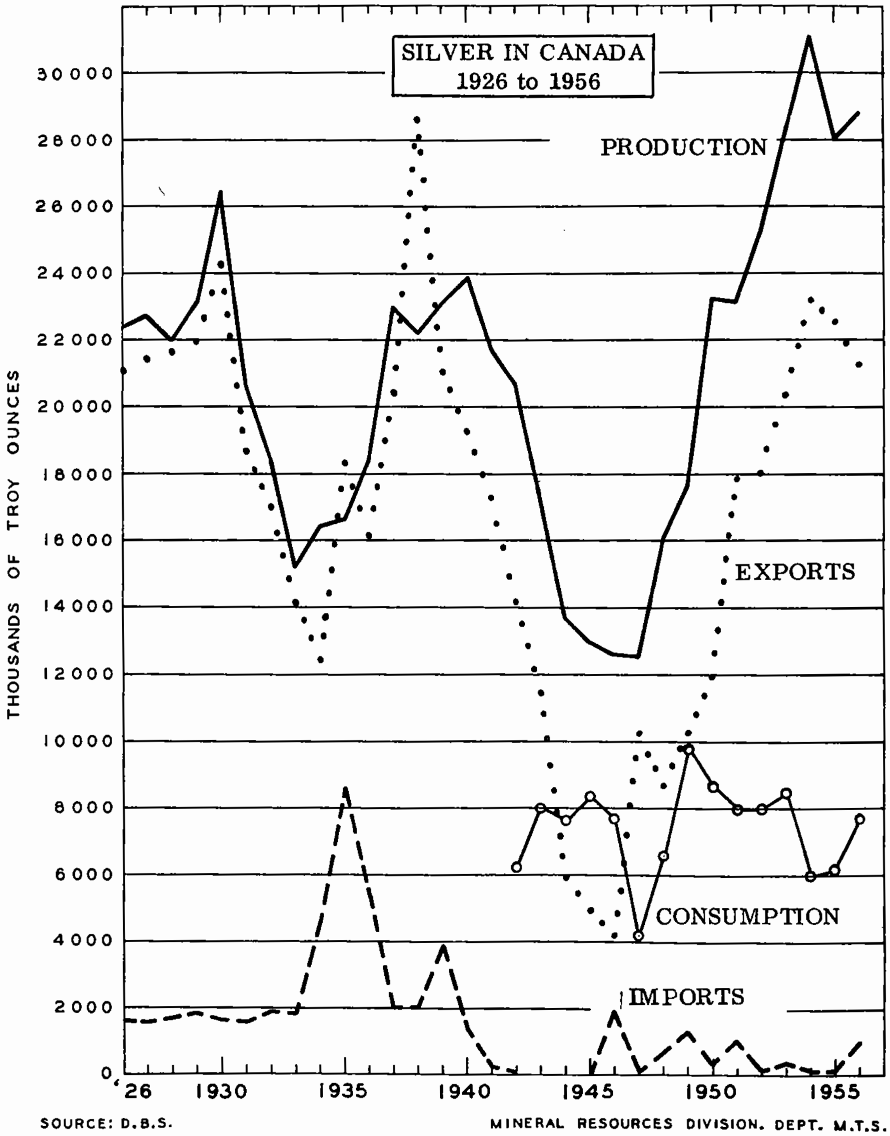
Silver - Production and Trade

	1956		1955	
	Ounces	$	Ounces	$
Production by Provinces				
B.C. & Alta.	8,801,412	7,893,106	8,702,143	7,673,549
Ontario	6,626,447	5,942,597	6,051,017	5,335,787
Yukon	6,192,706	5,553,619	5,712,219	5,037,035
Quebec	4,063,966	3,644,565	4,786,695	4,220,908
Sask. & Man.	1,609,234	1,443,161	1,684,707	1,485,575
Newfoundland	957,125	858,350	701,792	618,840
Nova Scotia	92,859	83,276	262,067	231,091
Northwest Territories	69,916	62,701	58,477	51,565
New Brunswick	18,182	16,306	25,087	22,122
Total	28,431,847	25,497,681	27,984,204	24,676,472
Production by Sources				
Base-metal ores	23,071,468		23,247,898	
Gold ores	623,935		652,554	
Silver-cobalt and silver ores	4,721,556		4,067,751	
Placer gold operations	14,888		16,001	
Total	28,431,847		27,984,204	
Imports				
Unmanufactured				
United States	1,006,590	898,454	87,128	75,345
United Kingdom	3,590	3,236	-	-
Total	1,010,180	901,690	87,128	75,345
Manufactured				
United Kingdom		450,796		433,842
United States		203,930		250,275
Denmark		64,755		30,651
W. Germany		21,378		18,585
Other countries		31,171		30,078
Total		772,030		763,431
Exports				
In ore and conc.				
United States	6,475,439	5,479,732	5,435,110	4,474,212
Belgium	278,862	243,024	269,502	235,387
W. Germany	170,113	148,682	169,261	148,349
Total	6,924,414	5,871,438	5,873,873	4,857,948
Bullion				
United States	13,363,996	11,943,229	15,675,242	13,673,969
W. Germany	827,009	746,360	522,168	472,017
United Kingdom	150,748	131,806	401,167	339,051
Total	14,341,753	12,821,395	16,598,577	14,485,037
Manufactures				
United States		29,921		43,207
Other countries		4,267		11,275
Total		34,188		54,482



Milling at Galkeno Mines Limited, adjoining United Keno Hill's Galena Hill properties, was resumed in July, following an 8-month shutdown during which ore reserves were built up. Production from July to December averaged 130 tons per day of lead-zinc-silver ore grading about 40 ounces per ton of silver.

Northwest Territories

The small production comes mainly from gold mines in the Yellowknife area: the operations of Eldorado Mining and Refining Limited at Great Bear Lake produce a small unspecified amount.

Silver

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited, operating four base metal mines in British Columbia, is the leading silver producer. A total of 11,583,530 ounces of refined silver was produced at the Trail refinery, most of it from lead and zinc customs concentrates. The Sullivan mine at Kimberley was the source of most of the silver produced from company-owned mines.

Torbit Silver Mines Limited, operating a silver-lead mine near Alice Arm, produced 1,562,438 ounces of silver in concentrates and bullion. Exploration failed to disclose new ore, although some encouraging results were obtained. Highland-Bell Limited, at Beaverdell, shipped lead and zinc concentrates containing 636,313 ounces of silver, and discovered and partially developed a downward extension of the orebody. Mill capacity is to be increased from 50 to 75 tons per day.

Other important producers were Silver Standard Mines Limited near Hazelton, which has located new ore; Violamac Mines Limited in the Slocan area; Sunshine Lardeau Mines Limited at Camborne; Giant Mascot Mines Limited near Spillimacheen; Yale Lead and Zinc Mines Limited at Ainsworth; and Sheep Creek Mines Limited near Invermere.

The balance of the output was made up by the two large copper mines, The Granby Consolidated Mining, Smelting and Power Company Limited, near Princeton, and Britannia Mining and Smelting Company Limited, on Howe Sound, and from a number of small base-metal shippers. A minor amount is obtained as a by-product from lode gold operations.

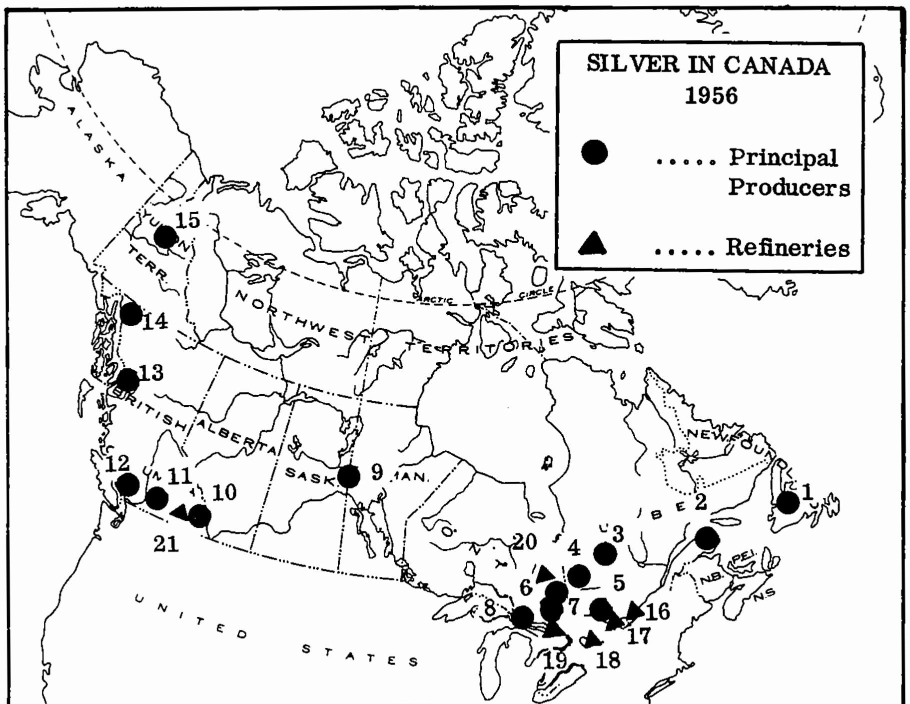
Manitoba and Saskatchewan

Most of the output is derived from the copper-zinc orebody of Hudson Bay Mining and Smelting Company Limited on the provincial boundary, which produced 1,586,939 ounces of silver in 1956. The remainder is a by-product from operations by Sherritt Gordon Mines Limited at Lynn Lake, Nor-Acme Gold Mines Limited at Snow Lake, and San Antonio Mines Limited at Rice Lake, all in Manitoba.

Ontario

The mines of the Cobalt-Gowganda area are the main source of Ontario's silver production, accounting for 70 per cent of the total. The principal producers were Silver Miller Mines Limited; Castle-Trethewey Mines Limited; Siscoe Metals of Ontario Limited; Cobalt Consolidated Mining Corporation Limited; and Nipissing-O'Brien Mines Limited.

The International Nickel Company of Canada Limited recovered 1,292,454 ounces of silver from nickel-copper ores of the Sudbury district.



Producers

1. Buchans Mining Co. Ltd.
2. Gaspe Copper Mines Ltd.
3. Campbell Chibougamau Mines Ltd.
   Opemiska Copper Mines (Quebec) Ltd.
4. Barvue Mines Ltd.
   Golden Manitou Mines Ltd.
   East Sullivan Mines Ltd.
   Noranda Mines Ltd.
   Quemont Mining Corp. Ltd.
   Waite Amulet Mines Ltd.
   Normetal Mining Corp. Ltd.
5. New Calumet Mines Ltd.
6. Silver-Miller Mines Ltd.
   Cobalt Consolidated Mining Corp. Ltd.
   Nipissing-O'Brien Mines Ltd.
   Langis Silver and Cobalt Mining Co. Ltd.
   Castle-Trethewey Mines Ltd.
   Siscoe Metals of Ontario Ltd.
7. The International Nickel Co. of Canada Ltd.
   Falconbridge Nickel Mines Ltd.
8. Jardun Mines Ltd.
9. Hudson Bay Mining and Smelting Co. Ltd.
10. The Consolidated Mining and Smelting Co. of Canada Ltd. (Sullivan & Bluebell Mines)
    Giant Mascot Mines Ltd.
    Sunshine Lardeau Mines Ltd.
    Violamac Mines Ltd.
    Yale Lead and Zinc Mines Ltd.
11. Highland-Bell Ltd.
    The Grandby Consolidated Mining, Smelting & Power Co. Ltd.
12. Britannia Mining and Smelting Co. Ltd.
13. Silver Standard Mines Ltd.
    Torbit Silver Mines Ltd.
14. Tulsequah Mines Ltd.
15. United Keno Hill Mines Ltd.
    Galkeno Mines Ltd.

Refineries

16. Canadian Copper Refineries Ltd.
17. Royal Canadian Mint
18. Deloro Smelting and Refining Co. Ltd.
19. The International Nickel Co. of Canada Ltd.
20. Hollinger Consolidated Gold Mines Ltd.
21. The Consolidated Mining and Smelting Co. Ltd.

Silver

The balance of the production came from Jardun Mines Limited, Falconbridge Nickel Mines Limited, and from numerous lode gold mines.

Quebec

The production from Quebec is entirely by-product, mostly from copper mines. These mines ship their concentrates to Noranda, where they are converted into anode copper along with Noranda ores; the anode copper is refined at Canadian Copper Refiners at Montreal, where the silver is recovered. The following mines shipped to Noranda: Waite Amulet Mines Limited; Normetal Mining Corporation Limited; Quemont Mining Corporation Limited; East Sullivan Mines Limited; Quebec Copper Corporation Limited; Opemiska Copper Mines (Quebec) Limited; Campbell Chibougamau Mines Limited; Weedon Pyrite and Copper Corporation Limited; Golden Manitou Mines Limited; Chibougamau Explorers Limited; Lyndhurst Mining Company, Limited; and Rainville Mines Limited.

The following mines also produced substantial amounts of silver; Barvue Mines Limited; Gaspe Copper Mines Limited; New Calumet Mines Limited; and Ascot Metals Corporation Limited which ceased operations in July 1956.

The lode gold mines of western Quebec added a small amount of by-product silver to the total.

Nova Scotia

Output was entirely from the base-metal operation of Mindamar Metals Corporation Limited, on Cape Breton Island, which closed its mill in April 1956 owing to exhaustion of commercial ore.

New Brunswick

Keymet Mines Limited, the only producer, ceased operations in March 1956.

Newfoundland

Buchans Mining Company Limited produced by-product silver at its base-metal mine in central Newfoundland.

Developments at Other Properties

Manitoba

Hudson Bay Mining and Smelting Company Limited outlined 3,832,400 tons of zinc-lead-copper ore at Chisel Lake, grading 1.96 ounces per ton of silver. Immediate underground development was planned.

Ontario

Geco Mines Limited, in the Manitouwadge area, proceeded with development of its 15-million ton base-metal orebody, grading 1.77 ounces per ton of silver. Production from the 3,300-ton mill is planned for mid-summer of 1957. Willroy Mines Limited, adjoining, expects to begin production at 750 tons per day by the end of 1957.

Consolidated Sudbury Basin Mines Limited, 15 miles northwest of Sudbury, increased its ore reserves to over 17 million tons of zinc-copper-lead ore grading 1.58 ounces per ton of silver. Production is scheduled to begin in August 1957 from a 1,000-ton mill.

Quebec

Coniagas Mines Limited commenced shaft-sinking and lateral development on its Bachelor Lake zinc-silver-lead property.

New Brunswick

The more important base-metal deposits under development in 1956 included: Heath Steele Mines Limited, in the Newcastle area, with reserves of 7,200,000 tons grading 2.7 ounces per ton of silver; Brunswick Mining and Smelting Corporation Limited, in the same area, with over 57 million tons grading 1.8 ounces per ton of silver; Anacon Lead Mines Limited, south of Bathurst; Sturgeon River Mines Limited, northwest of Bathurst; and Nigadoo Mines Limited, north of Bathurst.

Heath Steele Mines Limited planned to begin milling early in 1957, with full production of 1,500 tons per day to be attained by mid-year.

Domestic Refineries

Fine silver is produced by the following: Quebec - Canadian Copper Refiners, Montreal East; Ontario - Royal Canadian Mint, Ottawa, The International Nickel Company of Canada Limited, Copper Cliff, Hollinger Consolidated Gold Mines Limited, Timmins, Deloro Smelting and Refining Company Limited, Deloro; British Columbia - The Consolidated Mining and Smelting Company of Canada Limited, Trail.

Domestic Consumption

Owing to a large increase in the minting of coins, there was a sharp rise in the use of silver in Canada in 1956:

Silver

Consumption of Silver

	1956 (Fine Ounces)	1955 (Fine Ounces)
Coinage	2,505,131	519,453
Silverware	1,972,053	1,577,930
Photography	1,174,427	1,324,464
Plating	1,347,698	1,116,713
Wire and rod	199,079	271,225
Grain silver	-	35,000
Brazing alloys	107,763	75,219
Lead-silver alloys	14,363	9,960
Miscellaneous	390,411	231,481
Total	7,710,925	5,161,445

Prices

The Canadian price of silver was 90.75 cents per ounce at the beginning of 1956, increasing to a high of 91.50 at the end of April. Subsequently the price declined and the year-end price was 88.12 cents per ounce. The average price for the year as computed by the Dominion Bureau of Statistics was 89.71 cents per ounce.

TELLURIUM

By R.E. Neelands
Mineral Resources Division

Tellurium occurs in extremely small amounts in certain copper, gold and lead ores. In Canada, it is recovered as a by-product at electrolytic copper refineries from the treatment of anode slimes that accumulate in the electrolytic refining of copper.

The two Canadian producers of tellurium are The International Nickel Company of Canada Limited, Copper Cliff, Ontario, and Canadian Copper Refiners Limited, a subsidiary of Noranda Mines Limited, Montreal East, Quebec. International Nickel Company's sources of tellurium are the copper-nickel ores of its deposits in the Sudbury area, Ontario. Canadian Copper Refiners obtains most of its tellurium from blister copper produced in the copper smelter of Hudson Bay Mining and Smelting Company Limited, Flin Flon, Manitoba, derived from copper-zinc ores of the Flin Flon mine on the Saskatchewan-Manitoba boundary. Tellurium contained in anodes produced at the Noranda copper smelter from the treatment of Quebec copper ores is also recovered at the Montreal East refinery.

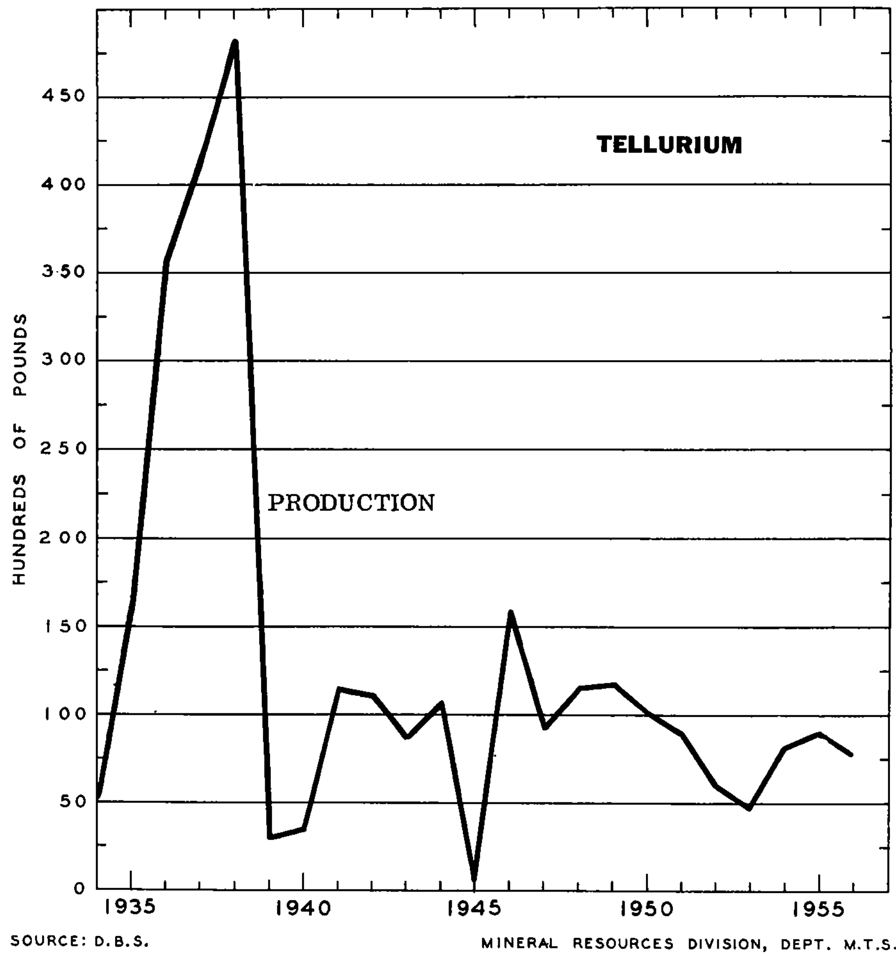
Other world producers of tellurium are United States, Australia, West Germany and Sweden.

Production of Tellurium

	1956		1955	
	Pounds	$	Pounds	$
Manitoba and Saskatchewan	1,562	2,733	2,559	4,478
Ontario	6,305	11,034	6,455	11,296
Total	7,867	13,767	9,014	15,774

As shown in the following graph, marked fluctuations have occurred in the Canadian production of tellurium since it commenced in 1934. The demand is limited and variable and the metal could be produced in much greater quantities if required. Canadian exports to the United Kingdom in 1956 were 8,200 pounds which amounted to 96 per cent of the total tellurium export. Domestic shipments were 8,500 pounds, compared to 6,000 pounds in 1955.

Tellurium



Uses

The principal use of tellurium is as an additive to rubber to increase resistance to abrasion and heat and to improve the aging and mechanical properties of low-sulphur rubber. Tellurium rubber is used in portable rubber-covered cables for dredging, mining, and welding units, and also in special conveyor belts.

Very small amounts of tellurium are added to molten iron to control the depth of chill in castings in order to produce a hard, abrasion-resistant surface. Tellurium is used as an alloying agent with copper, lead and tin to improve the properties of these metals for certain applications.

In the ceramic and glass industries tellurium is used to impart bluish or brownish tints and has served as a base for ultra marine type pigments.

Tellurium chloride, and tellurium dioxide in hydrochloric acid solutions are used to impart a permanent black antique finish to silverware.

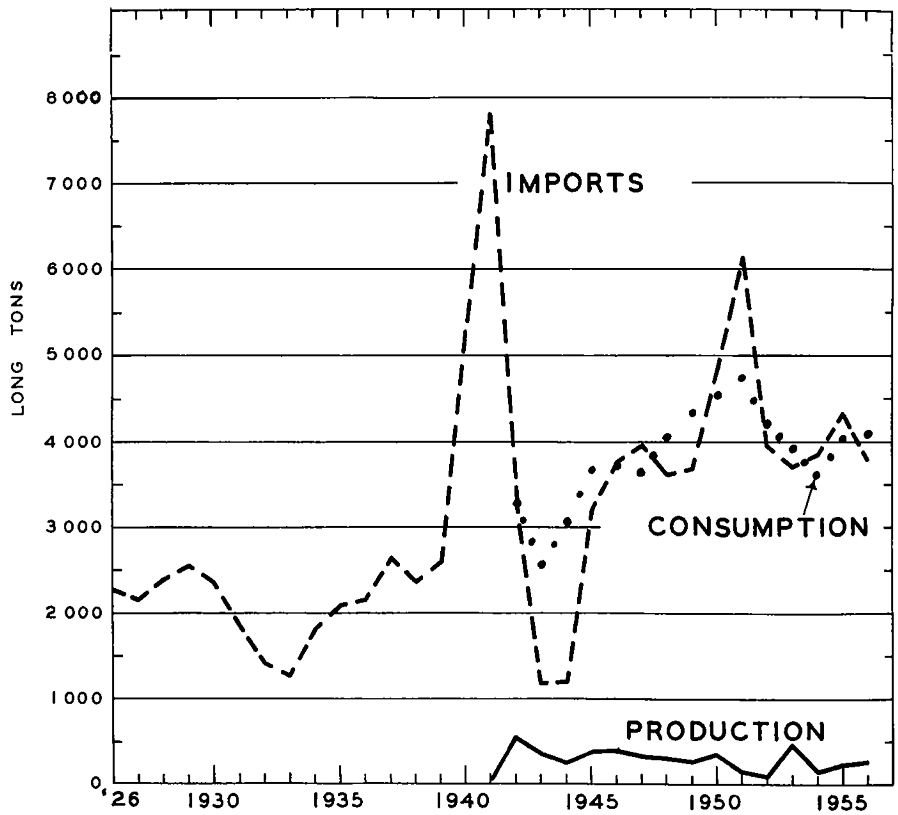
Prices

During 1956, the price of tellurium in the United States was quoted by E & M J Metal and Mineral Markets at $1.50 to $1.75 a pound.

TIN

By H. D. Worden
Mineral Resources Division

There are no mines in Canada producing tin as a primary product, but a small tonnage of tin concentrate is obtained from the treatment of the zinc-lead-silver ores of the Sullivan mine in the Fort Steele Mining Division of southeastern British Columbia. Here, in 1941, the operator, The Consolidated Mining and Smelting Company of Canada Ltd., added metallurgical equipment to its mill flow sheet to recover the tin minerals comprising cassiterite (90%) and tin sulphides (10%). In the following year the company built an electrical reduction plant at Trail to treat the tin concentrates and



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

Production, Trade, Consumption of Tin

	1956		1955	
	Long Tons	$	Long Tons	$
Production				
Tin-in-concentrates....	338	670,441	220	408,030
Imports				
Blocks, pigs, bars				
Malaya	1,410	2,981,229	1,109	2,262,219
Belgium	1,210	2,634,832	1,173	2,384,347
United Kingdom........	424	936,951	596	1,238,199
Netherlands	369	812,941	543	1,104,737
United States	352	806,849	896	1,824,042
Portugal	9	21,565	-	-
Total	3,774	8,194,367	4,317	8,813,544
Tin Plate				
United States	3,106	653,385	9,622	1,496,416
United Kingdom........	311	111,295	293	101,077
Total	3,417	764,680	9,915	1,597,493
	Pounds		Pounds	
Tin Foil				
United States	15,291	17,517	35,057	39,680
United Kingdom........	178	126	1,202	1,085
W. Germany..........	-	-	246	353
Total	15,469	17,643	36,505	41,118
Babbitt Metal				
United States	35,600	29,306	35,900	29,959
United Kingdom........	4,500	2,868	7,100	4,600
Total	40,100	32,174	43,000	34,559
	Long Tons		Long Tons	
Consumption (virgin tin)				
Tin Plate	1,396		1,344	
Tinning	625		586	
Solder	1,428		1,515	
Babbitt	276		264	
Bronze	222		156	
Foil	15		18	
Collapsible tubes	11		13	
Galvanizing	17		45	
Other uses	95		78	
Total	4,085		4,019	

produce metal. The volume of concentrates was only sufficient for intermittent refining operations and the treatment was discontinued in 1952. Since then, the tin concentrates have been exported to the Texas Tin Smelter in the United States for refining, and the metal has been returned to the company for marketing under its registered trade names.

Initial production in 1941 was 29 long tons of tin-in-concentrates, increasing to 553 long tons in 1942. Since then production has been continuous at an annual rate exceeding 200 long tons. In 1955, it was 220 long tons increasing in 1956 to 338 long tons valued at $670,441.

Canadian Occurrences

Cassiterite, the principal ore of tin, has been found in pegmatite dykes in Nova Scotia and in many locations scattered throughout the Canadian Shield, and in the Cordilleran Region of British Columbia and Yukon. Reports state that there are alluvial gravels in the Mayo area of Yukon containing tin and its presence has also been reported in assays of diamond drill core from the Bathurst area of New Brunswick. In addition, Ontario and Manitoba have occurrences of tin in pegmatitic phases of the Precambrian rocks, and several of these have been explored without, however, discovering economic deposits.

World Production and Trade

The International Tin Study Group report world production of tin-in-concentrates in 1956, excluding Russia, to be 175,000 long tons, metal production 177,000 long tons, and consumption 160,500 long tons. The difference between metal produced and metal consumed, 17,500 long tons, is assumed to be stored in industrial and national stockpiles. Comparable quantities were produced annually by the United States Texas Smelter to supply its national stockpile. However, commencing in 1957, this plant will be operated by private interests producing tungsten and tin alloys rather than tin metal; the portents being that its former metal production from Bolivian concentrates will now be handled by European smelters, and an extra 17,500 long tons will be available for world consumption.

Mine production figures are 2,000 long tons less than 1955 figures owing principally to political conflicts in Indonesia and Bolivia. However, since both countries depend on tin sales for prosperity, it is in their interest to improve production. With this in view, Bolivia is currently surveying its mining problems.

The industry established a milestone when the International Tin Council, governing body for the International Tin Agreement, held its inaugural meeting on July 2, 1956. From inception, the Council was pressed by producing countries to revise the Agreement's original price control structure. Producers reasoned that a higher floor price was necessary to compensate for inflated operating costs fostered by labour strikes at the mines, smelters and dockyards. Resultant negotiations, culminated in March 1957, proclaimed a new set of prices which raised the buying level for Buffer Stocks.

Tin Traffic During 1956 in Long Tons*

	Production		Exports	Consumption
	Mines Tin-in-Cons.	Smelters Metal	Tin-in-Conc.	Metal
Malaya	62,295	73,263		
Indonesia	30,053		31,159	
Bolivia	26,842		26,393	
Belgian Congo	14,533	2,964	11,408	
Thailand	12,481	-	12,424	
China (e)	8,400	8,400		
Nigeria	9,067		9,687	
United Kingdom		26,434		
Netherlands		28,197		
Belgium		9,716		
Canada	273	-		
U.S.A.		17,630		4,085
America, N. & S.				70,150
Europe				64,820
Asia**				20,277
Africa				2,310
Oceania				2,895
World**	175,000	177,000	93,500	160,500

* Table compiled from figures published in March 1957 issue of the Statistical Bulletin of the International Tin Study Group. One long ton equals 2,240 pounds.

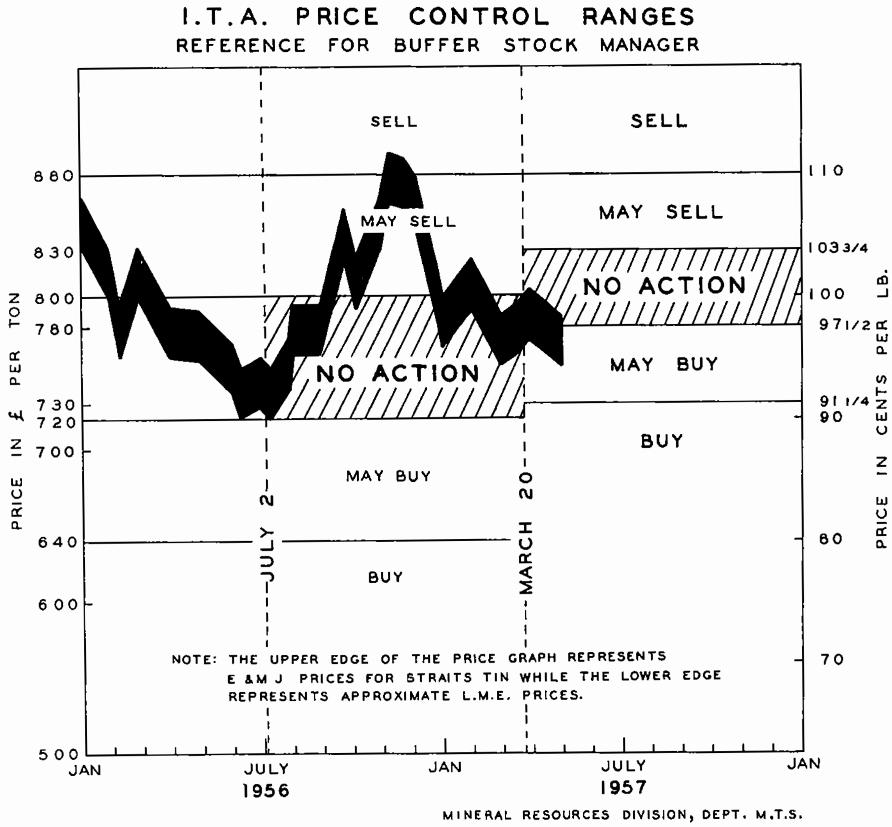
e Estimated.

** Excluding U.S.S.R.

The current fluctuations of tin metal prices, together with the market margins prescribed by the Tin Council (the governing body of the I.T.A.) are illustrated in the accompanying graph, and the buying and selling boundaries define the terms of reference guiding the Buffer Stock Manager in his market actions.

Uses and Consumption

The Canadian tin-plate industry consumed 1,396 long tons of tin in supplying the packaging industries with a wide variety of tin-coated steel. This material owes its popularity to developments in rolling thin steel strip and electrolytic tinning methods. The latter innovation, first introduced to the United States in 1942, made its Canadian debut in 1949. Countries following the trend include Belgium in 1951, United Kingdom in 1952, France in 1954, and Germany, Japan, and Russia in 1955. New techniques developed larger and faster tinning lines, and one notable economy resulted in reduction of tin required to produce a ton of tin plate. The amount dropped from 37.4 pounds during 1935-39 period to 20.8 pounds in 1956. This feature contributed to a drop in world metal consumption of 20,000 tons from 1950 to 1952. Since then however, consumption has increased owing to new applications



and inventions of a variety of container shapes. Food, beverages, drugs, petroleum products, etc., are usually preserved in conventional round cans but the adoption of square food cans aboard the submarine Nautilus, allowing 11.5 per cent more food aboard, demonstrates the versatility of tin-plate packaging.

In manufacturing solders for use in the electrical, electronic, and telephonic industrial fields, 1,428 long tons of tin were consumed. Whole circuits for radios, television and other instruments are line produced by solder dips. Besides these applications, tin-lead solders are extensively used in the plumbing trades and the canning industries.

Babbitt, bronze, and plating alloys consumed about 500 long tons of tin. These materials are in constant demand, and there is universal interest in research for improved alloys to withstand wear and corrosion.

Tin chemicals consume only minor amounts of tin, but their contribution to our way of life is increasing. New uses for organotin chemicals include vinyl plastics, transformer oils, biocidal and fungicidal agents, and veterinary medicines.

Prices

Increased consumption of 6,000 long tons, coupled with labour unrest in the producing areas of Malaya and longshoremen strikes in the United States and United Kingdom, contributed to metal price fluctuations throughout the year, and the Egyptian Government's action in nationalizing the Suez Canal in September followed by military action in November, forced tin prices upward. Prices generally eased in December, following announcement by the Government of the United Kingdom of its intention to dispose of 2,500 tons of metal from the National Stock Pile. Prices firmed however, when the market realized that such disposal required the scrutiny of the International Tin Council and an advance notice of 6 months, under the terms of the International Tin Agreement.

According to E & M J Metal and Mineral Markets, the New York price for Straits tin opened the year at 108.500 cents a pound, dropped to 92.875 cents in July, increased steadily to 113.750 cents in November, and closed the year at 99.875 cents. Canadian prices, with monetary exchange differences applied, approximated these prices.

Tariffs

Tin metal in all forms for use in national manufacturing enters duty free.

TITANIUM

By T.H. Janes
Mineral Resources Division

Even though titanium is estimated to be the ninth most abundant element in the earth's crust, there are only two titanium minerals - ilmenite and rutile - considered to be of commercial importance. Ilmenite ($FeTiO_3$) theoretically contains a maximum of 53 per cent titanium dioxide and rutile (TiO_2) ideally contains 100 per cent TiO_2. Sphene ($CaTiSiO_5$ - also called titanite), containing up to 41 per cent TiO_2, is mined in the Kola Peninsula of Russia.

Rutile has been preferred as the raw material source for the manufacture of titanium metal, but it appears that the production and reserves of rutile will be inadequate to meet the growing demands for metal in the future. Therefore, any major expansion of the industry will probably be dependent upon the use of ilmenite (or titanium slag) of which there are large reserves in Canada and the United States. With this increase in demand for ilmenite, and the growth of titanium pigment manufacture, a major increase in Canadian production may take place during the next decade.

Canada possesses the world's largest known deposits of ilmenite at Allard Lake, 22 miles north of Havre St. Pierre, a port on the north shore of the Gulf of St. Lawrence about 570 miles northeast of Montreal, Quebec. The deposits contain an estimated 150 million tons of ilmenite - hematite averaging 35 per cent TiO_2 and 40 per cent iron, with the largest orebody at Lac Tio containing an indicated 125 million tons. Initial shipments of ore were made in 1950 by Quebec Iron and Titanium Corporation to the company's electric smelter at Sorel, about 40 miles downriver from Montreal.

Several companies, including Hollinger (Quebec) Exploration Company Limited, Canadian Javelin Limited, Laurentian Titanium Mines, Ltd., and Titanium Development Corporation have carried out exploration programs on ilmenite properties in Quebec over the past several years. Titaniferous magnetite deposits are known to occur in many areas of Canada.

In spite of the widespread interest and rapid growth in titanium metal manufacture, about 98 per cent of the total world production of titanium-bearing minerals is used in the titanium dioxide pigment industry.

80486-4—12½

Production, Exports and Imports of Titanium

	1956		1955	
	Short Tons	$	Short Tons	$
Production (shipments)				
Ilmenite				
Allard Lake to Sorel, Que.	627,901		444,235	
St. Urbain area, Que.	2,310	16,561	1,400	9,982
Total	630,211		445,635	
Titanium dioxide slag from Allard Lake ilmenite	218,575		162,784	
Titanium dioxide content of above	157,374	7,682,911	117,042	5,192,810
Exports				
Titanium slag				
United States	184,571	6,547,077	143,351	4,465,691
Japan	11,202	396,078	23,793	770,937
Italy	5,822	187,128	5,673	182,340
Other countries	281	10,512	140	5,028
Total	201,876	7,140,795	172,957	5,423,996
Imports				
Titanium dioxide and pigments containing not less than 14% titanium				
United States	28,035	8,637,934	25,315	6,536,335
United Kingdom	9,715	3,884,323	10,484	3,968,607
Other countries	122	75,776	-	-
Total	37,872	12,598,033	35,799	10,504,942

Production and Development

Quebec Iron and Titanium Corporation

The Allard Lake ilmenite deposits are 22 miles north of Havre St. Pierre, the shipping point on the north shore of the Gulf of St. Lawrence 540 miles downriver from the smelter site at Sorel. They contain one of the largest known reserves of ilmenite in the world. This ilmenite is intergrown with hematite in orebodies consisting of dikes, irregular lenses, or sill-like bodies lying within an anorthosite mass covering 134 acres. Reserves of about 150 million tons of ore, averaging 35 per cent titanium dioxide and 40 per cent iron, have been indicated by diamond drilling. The largest orebody, located at Lac Tio, contains estimated reserves in excess of 125 million tons of ilmenite. These deposits are owned by Quebec Iron and Titanium

Corporation formed in October 1948 with Kennecott Copper Corporation holding a two-thirds interest and New Jersey Zinc Company the remainder.

Following construction of a 28-mile railroad, wharves, terminal and harbour facilities, the first shipments of ore were made from Harve St. Pierre to Sorel in 1950.

At Sorel, the company built docks, unloading facilities and a large electric smelting plant containing 5 electric arc ore treatment furnaces each designed to treat 300 tons of ore per day. The company began test operations with one furnace in 1950 and since then has carried out continuous studies of the process and operation of the furnaces.

In 1955, construction was begun on a $7.5 million ore beneficiation and rotary kiln plant to treat the crude ore before smelting. The ilmenite is intimately associated with hematite so that mechanical means of separation cannot be used although the ore can be upgraded by removal of the anorthosite gangue. Standard practice has been to mix the crushed ore with coal as feed to the electric arc furnaces to produce a high titania slag, containing about 70 per cent TiO_2, and a low-sulphur, low-phosphorus pig iron containing 1.5 to 2.2 per cent carbon.

During 1956, four furnaces were in operation for the first two months and all five furnaces thereafter. Additional furnaces were in the design stage.

For the first four months of the year, ore as mined, analysing about 35% TiO_2 and 40% Fe, was smelted directly. Resulting slag analysed 70.5% TiO_2, 8% Fe. In May the ore, of slightly lower grade than before was crushed and treated in the new beneficiation and rotary kiln plant. The ore was crushed and separated into two sizes, - 1/4" + 14-mesh and -14-mesh. Upgrading of the coarse fraction was accomplished hydraulically in Dutch State Mines cyclones using magnetite as the suspension medium. The fine fraction was concentrated in Humphreys spirals. The combined concentrates, analysing about 37% TiO_2 and 42% Fe, were kiln-treated at high temperature thereby eliminating sulphur. Electric smelting of this ore yielded a slag analysing about 70.5% TiO_2 and 11% Fe and a low phosphorus iron containing about 0.12% S and 2.2% C which was ladle desulphurized to low sulphur content and cast into pigs.

Most of the slag produced was exported to the U.S. for the titanium pigment and welding rod industries. Experimental work on a pilot scale in the use of slag for production of titanium metal was continued by several companies.

Titanium

Production figures for 1955 and 1956 are listed in the following table -

	In Gross Tons	
	1956	1955
Ore blasted	631,637	413,061
Overburden removed	32,433	64,873
Ore crushed	568,440	368,883
Ore shipped	560,362	396,134
Ore smelted	420,308	311,230
TiO_2 slag produced	195,156	145,343
TiO_2 slag shipped	190,841	140,516
TiO_2 content of slag shipped	134,500	99,204
Desulphurized iron produced	142,745	108,314
Desulphurized iron shipped	140,221	105,450
High sulphur iron shipped	3,119	3,645

The company announced, early in 1957, that it will increase by 60 per cent its production of TiO_2 slag at the Sorel plant. The increase will come from three new furnaces and auxiliary equipment at an expenditure of more than $16 million. The expansion is prompted by increased demand for slag for processing into TiO_2 pigment used extensively in paint and paper products and for processing to titanium metal. First of the new furnaces is scheduled to be in operation by the end of 1957 with scheduled expansion to be completed in 1959.

Baie St. Paul Titanic Iron Company Limited

This company shipped, from its holdings in the St. Urbain area of Charlevoix county in Quebec, 2,310 tons of ilmenite ore in 1956, compared with 1,400 tons in 1955. The destination of the shipments is not available. In 1955, it was reported the ilmenite was shipped to a reduction plant in the United States.

Canadian Titanium Pigments Limited

This company, a subsidiary of National Lead Company, Titanium Division, is building Canada's first titanium pigment plant, at Varennes, Quebec. The new plant, involving an expenditure of an estimated $15 million was begun in 1956 and is scheduled for completion in the third quarter of 1957. It is located on a 76-acre tract about 15 miles northeast of Montreal and 40 miles upriver from Sorel. The plant will produce several grades of both anatase and rutile types of titanium dioxide pigments for use in the manufacture of paint, paper, rubber and plastics, linoleum, and ink. Annual capacity is rated at 18,000 tons of TiO_2 pigments. The source of raw material for plant feed will be TiO_2 slag from the Sorel smelter of Quebec Iron and Titanium Corporation.

Canadian Titanium Production and Fabricating Facilities

Titanium research in several fields, including ore beneficiation, smelting, production and fabrication, is conducted at the Mines Branch, Ottawa. Shawinigan Water and Power Company, at Shawinigan Falls, Quebec, operates a pilot plant for the production of titanium sponge. Dominion Magnesium Limited, at Haley, Ontario, also operates a pilot plant for the production of titanium and conducts research in the production of homogeneous titanium alloy powders.

Several firms, including Atlas Titanium Limited at Welland, Vanadium-Alloys Steel Canada Limited at London, Canadian Steel Improvement Limited at Etobicoke, and Thompson Products Limited at St. Catherines, all in Ontario, are active in the titanium metal and alloy fabricating fields.

World Production*

The following tables show the production of rutile and ilmenite concentrates by the major producing countries in 1954 and 1955:

Production of Rutile Concentrates

Country	1955	1954
	Short Tons	Short Tons
Australia	66,766	50,018
United States	8,513	7,411
Other countries	221	71
Total	75,500	57,500

Production of Ilmenite Concentrates

	1955	1954
	Short Tons	Short Tons
United States[1]	583,044	547,711
India	300,661	269,375
Norway	173,981	164,448
Canada[2]	164,185	124,162
Finland	93,668	55,765
Malaya	60,340	50,114
Other countries	42,421	20,825
Total	1,418,300	1,232,400

1 Includes a mixed product containing altered ilmenite, leucoxene, and rutile

2 Consists mainly of TiO_2 slag containing about 70% TiO_2

* Statistics: United States Bureau of Mines, MMS No. 2569, November 27, 1956.

Titanium

The United States is by far the world's leading producer of titanium metal with an estimated output in 1956 of 14,500 tons. Production is expected to reach 20,000 tons in 1957. Japan and the United Kingdom are the only other producers of pure titanium metal, with the former accounting for 1,375 tons in 1955 and the latter considerably less, possibly 100 to 200 tons. In 1955, United States' output amounted to 7,398 tons.

Consumption and Uses

Titanium in Pigments

Canadian imports of titanium dioxide and pigments containing not less than 14 per cent titanium totalled 37,872 short tons valued at $12,598,033 in 1956 compared with 35,799 tons valued at $10,504,942 in 1955. Imports from the United States in those respective years were 28,035 and 25,315 tons, and those from the United Kingdom were 9,715 and 10,484 tons. No titanium pigments have been made in Canada. However, the new plant of Canadian Titanium Pigments under construction at Varennes, Quebec, will enter production late in 1957 with a capacity rate of 18,000 tons a year.

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 paint pigment and in the manufacture of ceramics, cosmetics, food products, paper and rayon.

Titanium Metal

Titanium is a low-density, silver-white metal. It owes its importance to a combination of lightness, strength, and resistance to corrosion. Because of its high strength-weight ratio, titanium metal and alloys have special applications in the aircraft industry, particularly jet aircraft and guided missiles. Owing to high corrosion resistance, it is expected that titanium metal will find increasing acceptance in the food processing and chemical industries. The chief disadvantages are high cost, difficulties of fabrication, and excessive reactivity at high temperatures. Although the melting point of titanium (3,020°F) is very high, it absorbs oxygen, nitrogen and hydrogen and becomes brittle with prolonged atmospheric exposure above 1,000°F.

Titanium in Other Applications

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 rutileis considered to be the most desirable material for this purpose. Of the total consumption of rutile concentrates, amounting to 28,762 tons in 1955, 12,614 tons were consumed for this purpose, along with 1,188 tons of ilmenite concentrate. 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.

Titanium carbide is one of the ingredients of carbide high-speed cutting tools, usually with tungsten carbide. Minor amounts of titanium tetrachloride are used for purifying aluminum alloys.

Consumption of Refined TiO_2, Extended TiO_2 Pigments, and Ferrotitanium in Canada

Material and End-Use	1955	1954	1953
	Short Tons	Short Tons	Short Tons
Refined titanium dioxide (TiO_2)			
Paints........................	11,637	11,479	10,595
Linoleum and oilcloth	2,047	2,016	1,770
Pulp and paper	1,640	1,247	1,161
Rubber goods	728	598	533
Polishes and dressings.........	147	140	113
Misc. non-metallic mineral products(1)..................	301	331	387
Misc. chemical products(2).....	n.a.	n.a.	65
Extended TiO_2 pigments			
Paints........................	13,936	13,155	12,907
Estimated TiO_2 content	4,180	3,946	3,901
Ferrotitanium			
Primary iron and steel.........	156	171	213

n.a. - not available
1. - includes consumption for ceramic purposes
2. - includes plastics and pharmaceutical uses

Consumption* of Titanium Concentrates in the United States in 1955, by Products (Short Tons)

Product	Ilmenite		TiO_2 Slag		Rutile	
	Gross Weight	Estimated TiO_2 Content	Gross Weight	Estimated TiO_2 Content	Gross Weight	Estimated TiO_2 Content
Pigment (mfg. TiO_2)(1)	732.5	396.5	134.3	94.1	-	-
Titanium metal......	(2)	(2)	-	-	10.3	9.8
Welding-rod coatings.	1.1	.7	-	-	12.6	11.8
Alloys and carbide...	7.2	3.6	-	-	2.4	2.3
Ceramics...........	(.02)	(.01)	-	-	.4	.4
Miscellaneous	.4	.3	.6(3)	.4(3)	2.9(4)	2.8(4)
Total..............	741.4	401.1	135.0	94.5	28.8	27.2

* United States Bureau of Mines, MMS No. 2569, November 27, 1956.

(1) Includes a mixed product containing rutile, leucoxene, and altered ilmenite used to make pigments and metal. (2) Included with pigments to prevent discolosure of individual company operations. (3) Includes consumption for welding-rod coatings and research purposes.
(4) Includes consumption for chemicals, fiberglass, and welding flux.

Tariffs and Prices

Neither Canada nor the United States maintained tariffs on titanium ores during 1956.

The E & M J Metal and Mineral Markets of December 20, 1956, quotes the following United States prices for titanium ores:

Ilmenite, per gross ton, 59.5% TiO_2, f.o.b. Atlantic Seaboard - $26.25 & $30.00 (1955 year-end price was $20 nominal)

Rutile, per lb., minimum 94% concentrate - 9 1/2 cents & 11 1/2 cents, depending on time of delivery. (1955 year-end price was 10 to 15 cents)

Sponge Titanium

Further price reductions, effective December 6, 1956, on titanium sponge were announced by E.J. du Pont de Memours & Co., Inc., one of the five U.S. producers, as follows:

			Old Price $	New Price $
Per lb	Grade A - 1 sponge	-	3.00	2.75
	Grade A - 2 sponge	-	2.70	2.50
	A - 2 fines	-	2.30	2.25

Titanium sponge was first produced and marketed by Du Pont in 1948 at $5 per pound.

TUNGSTEN

By R. J. Jones
Mineral Resources Division

The market for tungsten ore in 1956 showed a steady decline, with prices dropping about $6.00 a short-ton unit of WO_3. Some contracts with the United States Stockpile which were negotiated during the Korean Emergency, when prices were more than double present prices, have come to an end. A few countries have been obliged to sell on the open market in competition with supplies from Iron Curtain countries, the Board of Trade's release of its strategic stock, and the surplus from United States producers above the maximum which the United States Government was prepared to purchase. Several mines with high-cost production have been forced to suspend operations under these conditions.

Shipments of tungsten concentrates continued to come from the Salmo, British Columbia, operations of Canadian Exploration Limited. Canadian shipments in 1956 amounted to 2,271,437 pounds of WO_3 compared with 1,942,770 pounds in 1955. Small clean-up shipments were made from a wolframite prospect in New Brunswick.

Production

Canadian Exploration Limited

The tungsten orebody at the Emerald mine was discovered in 1942. A 300-ton mill was erected on the property in 1943 by Wartime Metals Corporation, a Crown company. The property was closed late in 1943 with the easing of tungsten supplies. In 1947, Canadian Exploration Limited, a subsidiary of Placer Development Limited, purchased the property and operated the mill until the end of 1948 when tungsten prices were too low to permit profitable operation. The mill was converted to treat lead-zinc ores from the Jersey mine. Late in 1950, the Canadian Government purchased the remaining ore reserves in the Emerald mine and constructed a new 250-ton mill on the property. In 1951, Canadian Exploration discovered a new orebody on its Dodger property and negotiated a contract with General Services Administration of the United States Government that called for a maximum of 570,000 short-ton units of WO_3 from 1952 to June 30, 1958, at a price grading from $60 to $55 a unit.

Tungsten - Production, Trade, and Consumption

	1956		1955	
	Pounds	$	Pounds	$
Production (shipments)				
WO_3	2,271,437	6,362,368	1,942,770	5,508,437
Imports				
Scheelite (a)				
United States	92,000	126,951	91,800	126,137
Australia	22,900	22,834	-	-
Brazil	8,900	10,770	-	-
Total	123,800	160,555	91,800	126,137
Ferrotungsten (b)				
United Kingdom	194,500	262,864	31,900	64,287
United States	11,000	7,395	39,900	62,625
Portugal	-	-	42,400	80,403
Total	205,500	270,259	114,200	207,315
Exports				
Scheelite (W content)				
United States	1,757,969		1,688,682	
United Kingdom	5,824		22,815	
Other countries	-		-	
Total	1,763,793		1,711,497	
Consumption (W content)				
Scheelite	64,957		48,043	
Ferrotungsten	60,459		83,165	
Tungsten metal and tungsten metal powder ...	42,499		43,700	
Tungsten carbide and carbide powder	103,142		94,271	
Tungsten wire and miscellaneous (c)	13,261		13,499	
Total	284,318		282,678	

(a) WO_3 content not known.
(b) W content not known.
(c) Miscellaneous includes tungsten chemicals.

The company purchased the new mill from the Canadian Government and, effective October 1, 1952, it repurchased the remaining ore reserves at the Emerald mine. The mine and mill have been in continuous operation since then and mill capacity has been gradually increased to 700 tons a day, with the flow-sheet being changed to increase recovery and eliminate the necessity of shipping low-grade flotation concentrates to the United States for up-grading to contract specifications. Present recovery at the mill is about 83 per cent of the average mill head of 0.71 per cent WO_3.

Domestic Refinery Production

A plant operated by a division of Kennametal Incorporated at Port Coquitlam, British Columbia, produces tungsten carbide and tungsten powder directly from low-grade imported tungsten concentrates. No ferrotungsten is made in Canada.

World Mine Production

World production of tungsten ores in 1956 amounted to 81,400 short tons contained in 60 per cent WO_3 concentrates of which China accounted for an estimated 19,800 tons. Other large producing nations were the United States, Russia, Bolivia, Portugal, Korea, Australia and Burma. Production in 1956 in the United States, the largest producer in the free world, is estimated by the United States Bureau of Mines at about 7,381 tons of contained metal compared to the record production of 7,916 tons in 1955. The United States Government's domestic purchase plan for 3,000,000 short-ton units of WO_3 was completed about June 1. A new purchase plan was initiated effective July 20, 1956, for 1,250,000 short-ton units, or until December 31, 1958, whichever occurs first, with a provision that the maximum purchase from any one mine would be 5,000 units per month. Purchases under this new plan were discontinued in December pending the approval of further funds by Congress. Price under the new plan is $55 per unit compared with $63 under the previous plan.

Consumption and Uses

Tungsten is utilized as scheelite, ferrotungsten, pure metal (powder, wire, rod, sheet), and in various chemical compounds such as the metatungstates. The greatest single use of tungsten is in the steel industry, where it is used in the form of scheelite or as ferrotungsten for the production of high-speed steel. The type most widely used, commonly known as the 18-4-1 type, contains 18 per cent tungsten, 4 per cent chromium, and 1 per cent vanadium.

Tungsten carbide is used for tipping tools, such as milling cutters, reamers, punches, and drills; for dies in wire and tube drawing; for wear-resistant parts such as gauges, valve seats, and valve guides; and as cores in armour-piercing shells.

Tungsten

In the non-ferrous or super-alloy field, tungsten is alloyed with cobalt, chromium, nickel, molybdenum, titanium, and columbium in varying amounts to produce a series of hard-facing, heat-resisting, and corrosion-resisting alloys. The main use of the high-temperature alloys is in turbo-jet 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 superchargers.

The pure metal is used in ignition and other contact points in the automotive industry. It is also used for incandescent lamp filaments and in making certain types of bronze.

Stellite, a non-ferrous 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 commercial applications of chemical compounds of tungsten are numerous, some of the more important being: flame-proofing combustible materials, in the dyeing industry, as catalysts and tanning agents, and in making X-ray screens.

The more important consumers of tungsten in Canada are: Atlas Steels Limited; Canadian General Electric Company Limited; Shawinigan Chemicals Limited; A.C. Wickman (Canada) Limited; Kennametal of Canada Limited; Deloro Smelting and Refining Company Limited; Wheel Trueing Tool Company of Canada Limited; Boyles Bros. Drilling Company Limited; J.K. Smit and Sons of Canada Limited; Johnson, Matthey and Mallory Limited; Canadian Westinghouse Company Limited; and Dominion Colour Corporation Limited.

Atlas Steels Limited, by far the largest consumer, uses approximately 80 per cent of the total in the form of ferrotungsten and scheelite.

Prices

According to E & M J Metal and Mineral Markets for December 27, 1956, tungsten prices in the United States were as follows:

Tungsten ore, per short-ton unit of WO_3 concentrates of known good analysis, basis 65%:

Foreign ore, nearby arrival, c.i.f. U.S. ports, duty extra:

Wolfram	- $28 to $28.50
Scheelite	- 28 to 28.50

Domestic ore - $55, f.o.b. mine, subject to penalties.

Tungsten metal, per lb 98.8% min., 1,000-lb lots - $4.20, effective October 30; hydrogen-reduced, 99.9% plus - $5.

Ferrotungsten, per lb of W contained, 70-80% W - $3.45, in lots of 5,000 lb or more, f.o.b. destination continental U.S.

Tariffs

Canada

	British Preferential	Most Favoured Nation	General
Tungsten ore	Free	Free	Free
Tungsten metal	"	"	"
Tungsten oxide	"	"	5% ad valorem
Ferrotungsten	"	5% ad valorem	5% ad valorem
Tungsten rod and wire	"	Free	25% ad valorem
Tungsten carbide	"	"	Free

United States

Tungsten ore and concentrates, on tungsten content - 50¢ per lb

Tungsten metal, tungsten carbide, and combinations containing tungsten carbide or tungsten metal, on tungsten content - 42¢ per lb plus 25% ad valorem.

Ferrotungsten, on tungsten content - 42¢ per lb plus 12 1/2% ad valorem.

Tungsten acid and other compounds, on tungsten content - 42¢ per lb plus 20% ad valorem.

URANIUM

By A. H. Lang
Geological Survey of Canada

Uranium production in Canada was greater in 1956 than in any previous year, amounting to 2, 281 short tons of U_3O_8 valued at $45, 732, 145. The feature of the year, however, was not the actual production but the great preparations for additional production during the next few years. The total value of agreements for delivery of uranium up to 1963 has risen to more than $1, 500, 000, 000 and estimates of the gross annual value of uranium production in Canada by 1959 range from $300, 000, 000 to $400, 000, 000. In 1956 uranium was in eighth place among metals produced in Canada, but by 1959 it is expected to be the leading metal produced, unless there is a large increase in the output of one of the other metals, such as nickel. The present uranium production is derived chiefly from mines in northern Saskatchewan, but large tonnages of ore developed recently in the Blind River region of Ontario indicate that this will soon be the principal uranium district of Canada. Other important events during the year were the beginning of production in the Bancroft area of Ontario and the awarding of contracts for sale of uranium from one mine in Northwest Territories and one in British Columbia.

Canada has been one of the world's leading uranium producers since the beginning of interest in atomic energy and has maintained this position despite greatly increased production in some other countries during the last few years. The recent developments indicate that this country will soon assume a much more prominent place among world producers, and the ore in the Blind River area is now considered to be the largest proved reserve of uranium ore in the world.

Restrictions on publication of figures for production and ore reserves at privately-owned uranium mines were removed. Preliminary steps were taken to establish an international atomic energy authority, expected to facilitate export of Canadian uranium for peaceful purposes.

The great advances in the Canadian uranium industry have caused interest to be taken in it by persons unfamiliar with the general background of the subject. The following notes are, therefore, included as an introduction.

General Information

From 1933 to 1940 important amounts of radium were produced by a private company from concentrates from the Eldorado mine, which was discovered in 1930 at Great Bear Lake, close to the Arctic Circle. This

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mine became second only to the Shinkolobwe mine in Belgian Congo as a producer of radium. The pitchblende from which the radium was extracted contained much larger amounts of uranium but there was then little demand for it. The Eldorado mine was, and still is, a relatively small, high-grade operation serviced by air and by a barge route extending 1,380 miles from a railhead north of Edmonton. The mine was closed in 1940 because of difficulties of wartime operation, but in 1942 it was re-opened as a uranium mine, at the request of the Canadian government. Production was pressed, and improvements were made in the gravity concentrator at the mine and in the refinery that had been erected at Port Hope, Ontario, originally for production of radium.

As the need for security and for increased uranium production became apparent, the Canadian government took steps to ban staking and mining for uranium by private individuals or companies. Extensive prospecting and geological research programs were undertaken by the Eldorado company and by the Geological Survey of the Department of Mines and Technical Surveys, and research on improved methods of treating uranium ores was accelerated by the Mines Branch of this Department. In 1944 the shares of the Eldorado company were bought by the Canadian government and the operation has thereafter been conducted by a Crown company. Prospecting and geological studies were carried on in many parts of the country, the most promising discoveries being in the Beaverlodge region of northern Saskatchewan where one minor pitchblende deposit had been found shortly after the discovery at Great Bear Lake. The best of the Beaverlodge discoveries at that time proved to be the Ace, which was brought to production by the Crown company in 1953, at an original rate of 500 tons a day. It is a medium-size, medium-grade operation with ore averaging considerably less than that at Great Bear Lake, that required much careful exploration and much metallurgical research to perfect a leaching process that would make treatment economic. The Beaverlodge region is served by a 340-mile barge route, and an airport constructed after the importance of the area became apparent.

Early in 1948, as the need for greatest security had passed and as a means of increasing discoveries and production by permitting private participation, the bans on private staking and mining for uranium were removed. Eldorado was made the sole buyer of privately-produced uranium ores or concentrates, and a base price of $2.75 per pound of contained uranium oxide was guaranteed until 1962. This price was later increased to a maximum of $7.25 per pound by the addition of development and milling allowances. Eldorado was also empowered to make special price contracts to meet special circumstances, such as might occur if a company had developed a large tonnage of low-grade material that could not be produced at the published schedule of prices, or if a company proposed to erect a leaching plant that would supply a much higher grade product which would not require such extensive refining after purchase. Apart from these special conditions, it was stated that acceptable ores would normally be expected to contain at least 10 per cent uranium oxide. It is noteworthy that except for small test shipments no private producers have delivered ores under the published price schedule, all significant private production being under some form of special contract. The first private production was from a few relatively small mines in the Beaverlodge region, which did not warrant construction of independent treatment plants, and whose ores did not meet the specification of a content of 10 per cent or more of uranium oxide. The owners made special arrangements with Eldorado for treatment in its Ace plant, and transport of ore by trucks between the mines and this plant began in 1954. The large Gunnar mine, discovered at Beaverlodge in 1952, began production in 1955 after construction of a leaching plant rated at 1,250 tons a day, which is now being enlarged. The upper part of the orebody is being mined by open-pit methods, and mill-heads were recently reported to be averaging about $40 per ton. Also in 1955, production was begun at the Pronto mine in the Blind River region, Ontario. The ores of this region are low grade, averaging about 0.1 per cent U_3O_8, but the accessibility of the region makes mining possible. As in the case of the Gunnar mine, a special price contract was negotiated for the Pronto ore and also for several additional properties where orebodies have since been proved and where plants have been built or are under construction. Orebodies of about the same grade as at Blind River have been proved in the Bancroft region of Ontario, where production was begun at the Bicroft mine late in 1956, and where additional properties are being prepared for production. Special price arrangements have also been announced for the Rayrock mine in Northwest Territories, and the Rexspar mine in British Columbia. The Rayrock is being developed as a relatively small high-grade pitchblende mine with a leaching plant, and the Rexspar is a low-grade deposit at which a leaching plant is planned.

The lifting of the ban on private staking and mining caused much prospecting and exploration, aided by special government publications, facilities for testing samples, and other services, based on earlier experience by Eldorado and the Department of Mines and Technical Surveys. During the years from about 1950 to 1954 more persons were prospecting for uranium than for any other metal in Canada, and more uranium prospects were being explored than those of any other kind. A total of between 8,000 and 10,000 individual radioactive occurrences were found. Although most of these appear to be small and uneconomic, some are, as has already been shown, very important, and others offer possibilities for further testing. Some others are thorium occurrences. In 1955, the government announced that because of the large number of special price contracts negotiated it would not be possible to accept applications for such contracts after March 31st, 1956. This caused much decline in prospecting for uranium and exploration at prospects in early stages, but some prospecting and exploration were continued, either with the hope of proving orebodies before the deadline for special price contracts, or of proving high-grade deposits that would be mineable under the guaranteed schedule of prices, or of proving existence of deposits that might be in demand in the future.

Geological Notes. Canadian uranium deposits are widely distributed and of several distinct types. All the present producers and all but one of those being prepared for production are in the Canadian Shield; these, as well as most of the known uranium occurrences, are distributed around the

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periphery of the Shield. A much smaller number of occurrences has been found in the Cordilleran region of British Columbia and in the Appalachian region, mainly in Gaspé, New Brunswick, and Nova Scotia. The Eldorado mine at Great Bear Lake contains fairly massive pitchblende along with many other metallic minerals. The deposits of the Beaverlodge region consist chiefly of disseminations and stringers of pitchblende, which form orebodies only where fairly large concentrations of stringers or disseminations are present. The Ace orebodies are related to zones of shattered rocks adjacent to a prominent fault. The Gunnar orebody is in a pipe-like body of shattered rock and contains in addition to pitchblende a large amount of the secondary uranium mineral uranophane. The Blind River orebodies are beds of uranium-bearing conglomerate lying at or near the base of the Proterozoic (Late Precambrian) group of strata. The matrix contains pyrite and microscopic grains of brannerite and uraninite. It has not yet been definitely established whether the Blind River ores are of placer or hydro-thermal origin; the prevailing opinion is that they were originally placer deposits, and many geologists believe that they were later modified by hydro-thermal or other means. The Bancroft ores belong to the general pegmatitic class, but are not typical pegmatites; the principal uranium minerals are uraninite and uranothorite. The Rexspar deposit is an unusual type, possibly of replacement or contact metasomatic origin, containing uranothorite, uraninite, bastnaesite, and other minerals.

The above notes provide only the briefest of general information on Canadian uranium deposits and mining. Many references to the extensive literature are contained in a recently published bibliography.*

Production and Sales

The value of Canadian uranium production in 1956 was $45,732,145, an increase of $22,700,541 over the value for 1955, resulting largely from the first full-year of operations at the Gunnar and Pronto mines. The production was divided as follows: Saskatchewan, $27,194,202; Northwest Territories, $9,176,076; and Ontario, $9,361,867. The following mines produced during the year:

Mines Shipping Ore

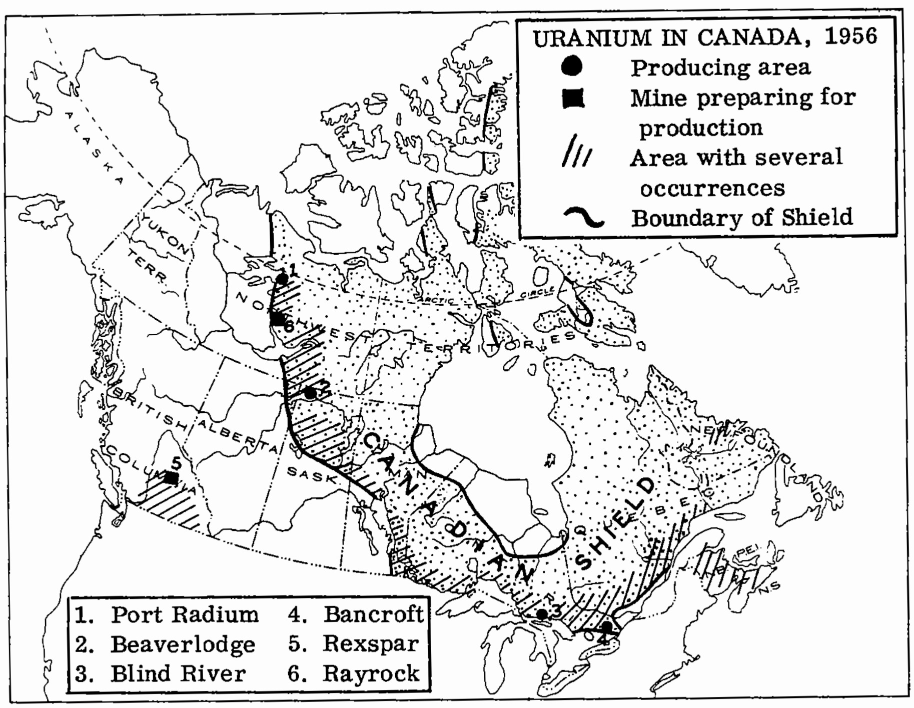
Name	Location	Commencement of production
Rix Athabasca	Beaverlodge	1954
Nesbitt-LaBine	Beaverlodge	1954
Nicholson	Beaverlodge	1954
National Explorations	Beaverlodge	1954

* "A Bibliography on the Occurrence of Uranium in Canada, and Related Subjects"; Geol. Surv. Canada, Paper 56-5 (Price 25 cents).

Mines Producing from Individual Plants

Name	Location	Contract (total to 1962)	Commencement of production	Plant Capacity (tons per day)
Eldorado	Great Bear L.	$ 33,500,000	1933	300
Eldorado	Beaverlodge	168,500,000	1953	700 (being increased to 2000)
Gunnar	Beaverlodge	$ 76,950,000*	1955	1250 (being increased to 1650)
Pronto	Blind River	$ 55,000,000	1955	1500
Algom				
Nordic	Blind River)	$ 206,910,000	1956(Dec.)	3000
Quirke	)		1956(Sept.)	3000
Bicroft	Bancroft	$ 35,805,000	1956(Dec.)	1000

* An additional contract is being completed but details are not yet available.



Uranium

The production at Great Bear Lake is derived partly from current mining and partly from re-treatment of old tailings; treatment is by a combination of gravity concentration and acid leaching. The other plants listed in the preceding table use leaching only, the Eldorado plant at Beaverlodge using a basic process and the others using acid leaching. These plants produce high-grade complex di-uranate or other compounds that are treated further at the Port Hope refinery which has recently been modified for a solvent extraction process that produces 'orange oxide' of high purity. Production to date has been sold entirely to the United States Atomic Energy Commission. Metallic uranium has not been produced in Canada because it was more economic to buy from the United States Atomic Energy Commission the relatively small amounts required for Canadian research reactors. However, construction of a plant at Port Hope for production of fuel elements has been begun and is to be completed in 1957. During 1956 arrangements were concluded by Eldorado for sale of substantial amounts of uranium to the United Kingdom before 1962, as well as for options thereafter. Also, steps were taken to establish through the United Nations an International Agency for Atomic Energy which is expected to facilitate sale of Canadian uranium to other countries for peaceful purposes. Late in 1956 arrangements were made by Eldorado for sale of 10 tons of unprocessed uranium ore to the Japanese atomic energy authority for tests.

Other Agreements

The table below lists the approximate values of additional agreements negotiated with Eldorado Mining and Refining Limited for delivery of uranium at special prices.

Company	Location	Agreement	Proposed Mill Capacity (tons per day)
Can-Met	Blind River	$ 79,352,000	2,500
Cavendish	Bancroft	27,592,000	750
*Cons. Denison	Blind River	201,250,000	5,700
Dyno	Bancroft	34,881,000	900
Faraday	Bancroft	29,754,800	750
Greyhawk	Bancroft	20,350,000	600
Lorado	Beaverlodge	64,380,000	500
Milliken Lake	Blind River	94,525,000	3,000
Northspan	Blind River	275,000,000	9,000**
Rayrock	Northwest Territories	15,792,000	150
Rexspar	British Columbia	21,556,000	650
Stanleigh	Blind River	90,405,625	3,000
Stanrock	Blind River	95,207,700	3,300

* Contract awarded in 1955.

** Three separate plants, of 2,000, 3,000, and 4,000 tons capacities.

It was originally intended that all contracts would terminate on March 31, 1962. However, a slight modification was announced which permits those companies that were unable to arrange contracts in time to construct plants and obtain a full five years' production before March 31, 1962, to continue sales for a full five years, provided that this term does not extend after March 31, 1963. Contracts were reported to contain options for purchase of uranium up to the end of 1966.

A preliminary estimate of the total ore reserves of producing Canadian uranium camps, made by Eldorado officials, was reported recently to total 225,000,000 tons containing 237,000 tons of U_3O_8. This estimate is based on proved reserves and a conservative estimate of inferred ore.

Prospecting, Exploration and Development

The amount of prospecting for uranium and of early-stage exploration of prospects declined sharply in 1956, as it was realized that the metal is no longer in short supply and that only the most promising discoveries are likely to be attractive in the near future. On the other hand, exploration was accelerated at the most advanced prospects, in the hope of proving sufficient ore to permit obtaining contracts, and mine development and plant construction were very active at the properties for which contracts were awarded.

Exploration Permits from the Atomic Energy Control Board in force at the end of 1956 totalled 428, but only 92 of the companies concerned reported any work during the year. These were distributed as follows: Ontario, 49; Saskatchewan, 20; Northwest Territories, 11; Quebec, 9; British Columbia, 3. Apart from producing mines underground work was done at 20 properties, and more than 1,000 feet of diamond drilling (from surface) was done at each of 13 properties.

The greatest amount of construction was done in the Blind River area, where large plants were completed at two mines of Algom Uranium Mines Limited, another was nearing completion at the Consolidated Denison property, and others were begun or in the planning stage. Large increases to existing plants were nearing completion at the Ace and Gunnar mines at Beaverlodge, and a plant was under construction at the Lorado property there, intended to handle ore from the Cayzor, St. Michael, Lake Cinch, National Explorations, and Black Bay properties as well as from the Lorado. In Bancroft area, Ontario, a plant was nearing completion at the Faraday property, and three others were being planned or in early stages of construction. A smaller plant was under construction at the Rayrock mine in Northwest Territories, and a site was prepared for a plant near the Rexspar property in British Columbia.

Preliminary exploration in a relatively new uranium area was undertaken at several pitchblende discoveries in the Makkovik area of Labrador, about 75 miles north of Goose Bay, by British Newfoundland Exploration Limited, and Frobisher Limited.

Uranium

Much interest is taken in the possibilities for uranium production after existing contracts expire in 1962 or 1963. Little definite information can be added at present to the statement on this subject made in 1955 by the President of Atomic Energy of Canada, as follows: "It is impossible to say at this time what the demand for uranium will be after March 31, 1962, the present expiry date of the guaranteed market. The military demand may continue at the present rate or may cease altogether. On the other hand, we may have a situation in which there is still government buying but on a reduced scale. Whatever happens, it can be safely predicted that there will be some requirement for uranium for use in atomic power programmes in the early sixties. It is evident, however, that the demand for uranium in the early stages of a Canadian atomic power programme will take up only a small part of our potential production. Consequently, if the military requirement ceases or is cut back substantially, Canadian producers may have to look to export markets and should expect to meet the same conditions which prevail in the case of other base metals which are not in short supply." The United States Atomic Energy Commission has since extended its domestic procurement policy beyond 1962, and although this does not ensure extended purchases from Canada, it points to continued demand, as does the option for sale of Canadian uranium to the United Kingdom after 1962. The existing contracts with private producers allow full write-offs for plants, and several of these producers have substantial reserves in excess of those covered by contracts; these mines should be in a favourable position to take advantage of the market for uranium after 1962. In addition, there are many partly-explored properties, and there is much territory in Canada favourable in a general way for the occurrence of uranium. These facts, and the experience now possessed by Canadian prospectors and companies, indicate that this country should be able to supply much additional uranium in future if demand is sustained or increased.

ZINC

By D.B. Fraser
Mineral Resources Division

Canada has been an important producer of zinc since 1920 and the second largest producer since 1945. Significant production began with the development by The Consolidated Mining and Smelting Company of Canada Limited (Cominco) of the Sullivan lead-zinc deposit at Kimberley, British Columbia, still the country's leading producer. Additional major sources of zinc were developed in northern Manitoba and Newfoundland in the late 1920's, and in western Quebec in the period since 1930.

The line graph on page 199 shows the striking increases in production and exports made during the past thirty years, expansion being particularly rapid since 1947. In 1956 the output of zinc was 422,633 tons valued at $125,437,344 compared with 433,357 tons valued at $118,306,466 in 1955.

Canada's two zinc refineries operated by Cominco at Trail, British Columbia, and Hudson Bay Mining and Smelting Company Limited at Flin Flon, Manitoba, produced 255,564 tons of refined zinc, compared with 257,008 tons in 1955.

Zinc produced from the provinces east of Manitoba was all exported in concentrates to United States or Europe. Most of the zinc concentrates produced by mines in British Columbia other than Cominco's were exported to the United States. The remainder, and concentrates from United Keno Hill Mines in Yukon were treated at Trail.

The world demand for zinc fell off somewhat in 1956 from the record high of 1955. The United States, which consumes one-third of the world supply, used an estimated 1,008,800 tons of slab zinc, 10 per cent less than in 1955. The Canadian price of Prime Western zinc remained steady at 13.5 cents per pound during the year.

Developments at Producing Mines*

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited (Cominco). Production from the company's four mines totalled 3,660,693 tons of ore. Output from the Sullivan mine at Kimberley was 2,769,177 tons,

(text continued on page 198)

* See map, page 201.

Zinc- Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production, all forms				
British Columbia	224,324	66,579,127	215,886	58,936,877
Quebec	85,973	25,516,714	101,431	27,690,668
Saskatchewan	45,380	13,468,767	48,960	13,366,168
Newfoundland	34,680	10,293,055	28,636	7,817,635
Manitoba	17,904	5,313,968	17,966	4,904,725
Yukon	10,526	3,124,194	10,912	2,978,881
Ontario	1,227	364,218	1,548	422,555
Nova Scotia	2,088	619,841	8,018	2,188,957
New Brunswick	531	157,460	-	-
Total	422,633	125,437,344	433,357	118,306,466
Production, refined	255,564		257,008	
Exports				
Refined metal				
United States	115,895	31,077,002	113,306	26,802,730
United Kingdom	63,838	15,038,273	95,598	19,420,800
Argentina	1,673	372,584	-	-
India	1,120	245,011	3,260	575,567
Philippines	662	149,131	-	-
Other countries	540	131,212	1,673	308,206
Total	183,728	47,013,213	213,837	47,107,303
Zinc contained in concentrates				
United States	173,325	23,501,976	168,069	20,529,375
Norway	8,354	966,098	2,170	239,141
Belgium	7,376	799,285	7,488	819,361
United Kingdom	6,311	752,167	8,245	866,008
France	3,947	465,074	4,613	534,598
Total	199,313	26,484,600	190,585	22,988,483
Zinc Scrap				
Belgium	3,000	246,554	2,292	151,655
Netherlands	1,220	92,082	1,260	89,352
United States	685	101,991	1,208	145,696
W. Germany	236	31,995	546	39,433
Other countries	325	40,232	160	36,078
Total	5,466	512,854	5,466	462,214
Zinc Manufactures				
Netherlands		148,773		27,563
United States		56,198		92,734
Peru		7,752		-
Colombia		6,957		11,874
Other countries		1,761		30,017
Total		221,441		162,188

	1956		1955	
	Short Tons	$	Short Tons	$
Imports of zinc and zinc products				
Blocks, pigs, bars, plates		42,934		27,928
Strips, sheets		765,392		788,994
Dust		154,031		127,357
Zinc mfgrs. n.o.p. ...		2,464,058		2,108,492
Zinc slugs		317,595		346,078
Zinc chloride		52,784		28,299
Zinc sulphate		117,403		143,508
Zinc white		174,792		208,784
Lithopone		348,267		265,224
Total		4,437,256		4,044,664
Consumption, refined zinc (primary & secondary)				
Electro-galvanizing ...	1,130		1,091	
Hot-dip galvanizing ...	32,579		26,955	
Zinc die-cast alloy....	9,354		10,464	
Brass and bronze	7,721		9,350	
Other alloys	692		678	
Rolled & ribbon zinc ..	1,648		1,395	
Zinc oxide	7,497		7,141	
Zinc castings	784		603	
Other uses	784		797	
Total	62,189		58,474	
World zinc production, mine basis*	1955		1954	
United States	542,340		514,671	
Canada	422,633		433,357	
Russia	336,000**		300,000**	
Mexico	274,348		296,959	
Australia	261,620		241,376	
Peru	193,038		188,072	
Poland	143,500		154,500	
Japan	135,198		119,786	
Italy.................	115,534		110,738	
W. Germany	101,897		101,557	
Other countries	649,606		560,713	
Total	3,175,714		3,021,729	

* American Bureau of Metal Statistics.

** Estimated.

bringing its total production since 1910 to over 71,000,000 tons. From the H.B. mine, 22 miles east of Trail, 435,305 tons were mined, and from the Bluebell mine, on the east shore of Kootenay Lake, 252,523 tons. Cominco's northern subsidiary, Tulsequah Mines Limited, produced 203,688 tons of zinc-copper-lead ore.

Zinc concentrates from the company's four mines, together with custom ores and concentrates from British Columbia, Yukon Territory and from foreign shippers, were treated in Cominco's electrolytic zinc refinery at Trail. Output from all sources was 193,041 tons of refined zinc, compared with 190,910 tons in 1955.

Canadian Exploration Limited produced from the Jersey mine near Salmo about 30,000 tons of zinc-lead ore per month, with mill heads averaging 4.3 per cent zinc and 1.6 per cent lead. The major part of the tonnage was mined by underground trackless methods.

Giant Mascot Mines Limited continued regular operations at about 450 tons per day in its lead-zinc mine near Spillimacheen. The main orebody was reported to have bottomed at the 10th level. The company's holdings cover an area 9 miles long and 2 miles wide. Exploration of these claims and deep-level exploration of the main property were continued.

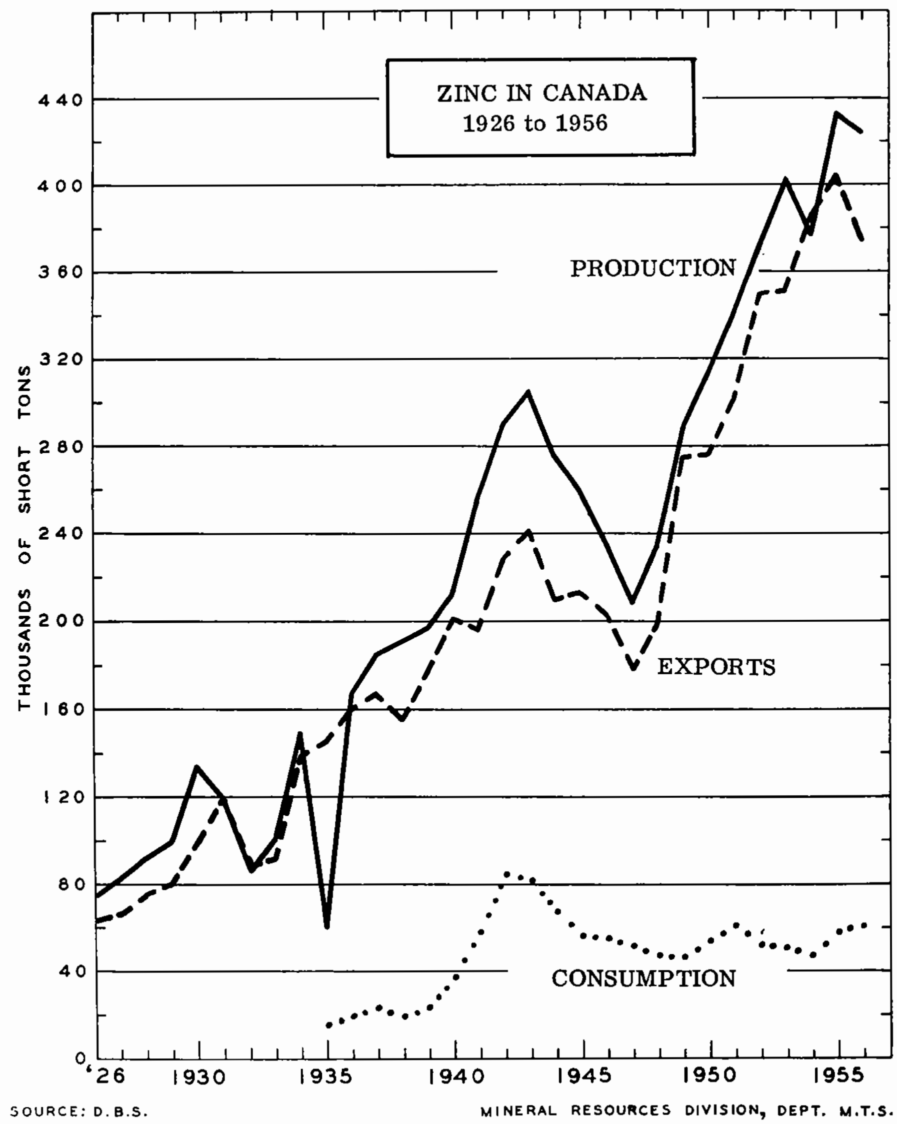
Sheep Creek Mines Limited operated its Mineral King mine and mill in the Lake Windermere district at close to its capacity of 500 tons per day. A 7-level adit was driven to develop the orebody below the 3rd level.

Britannia Mining and Smelting Company Limited milled 834,458 tons of ore from its copper-zinc mine on Howe Sound, from which 7,153 tons of contained zinc were produced.

Reeves Macdonald Mines Limited, 12 miles south of Salmo, treated 400,204 tons of zinc-lead ore and produced zinc concentrates containing 15,178 tons of zinc.

Silbak Premier Mines Limited resumed production in September at 300 tons per day from its properties in the Portland Canal area of northwestern British Columbia, after a 3-year shut-down due to low metal prices. In November the 600-ton mill was destroyed by fire. It is planned to rebuild the mill.

Other producers of zinc concentrate included Sunshine Lardeau Mines Limited, near Camborne; Violamac Mines Limited, near Sandon; Yale Lead and Zinc Mines Limited, Ainsworth, and Silver Standard Mines Limited near Hazelton.



Manitoba and Saskatchewan

Hudson Bay Mining and Smelting Company Limited, Canada's second largest zinc producer, commenced production in 1930 at 3,000 tons per day of copper-zinc ore and increased its output during World War II to 6,000 tons per day. Recent production has averaged 4,500 tons per day.

It mined 1,396,292 tons of ore in 1956 from its main mine at Flin Flon and 154,968 tons from the Schist Lake mine 3 1/2 miles southeast of Flin Flon. At the company's zinc plant 114,296 tons of zinc concentrate and

40,977 tons of fume and stack dust were treated to produce 63,284 tons of slab zinc. There were also produced 46,715 tons of zinc plant residue, most of which was treated in the copper smelter for the subsequent recovery of zinc from zinc oxide fume.

Ontario

Jardun Mines Limited, 18 miles northeast of Sault Ste. Marie, continued regular production of zinc and lead concentrates.

Quebec

Barvue Mines Limited, in Abitibi East county, milled 902,223 tons of zinc ore containing 24,301 tons of zinc, a decrease of 11,411 tons from the 1955 output. The conversion from open pit to underground mining was completed, with underground production scheduled at 3,000 tons per day, compared to 4,000 tons from open pit production. Selective mining is expected to raise the ore grade sufficiently to maintain production of zinc concentrates at approximately the same level as before the changeover.

Quemont Mining Corporation Limited, in Rouyn-Noranda county, milled 840,942 tons of copper-zinc ore, producing 37,912 tons of zinc concentrates containing 19,841 tons of zinc. A start was made in establishing a rock plant and quarry on the property to provide waste material for stope filling.

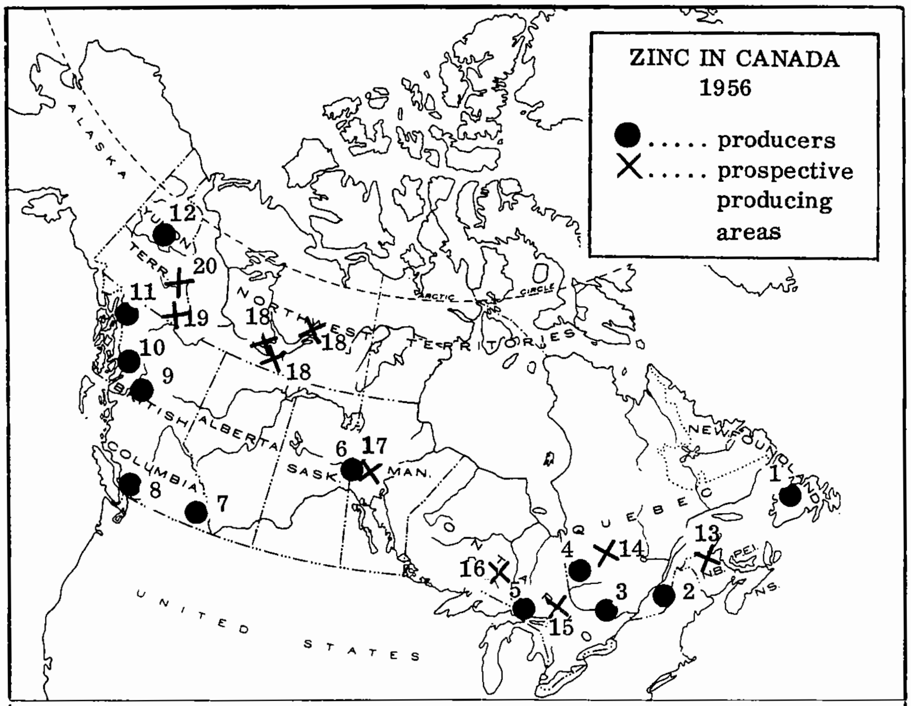
Normetal Mining Corporation Limited, Abitibi West county, treated 382,860 tons of zinc-copper ore and produced 33,506 tons of zinc concentrates containing 17,307 tons of zinc. Ore reserves were substantially increased.

East Sullivan Mines Limited, Abitibi East county, milled 895,118 tons of copper-zinc ore, producing zinc concentrates containing 4,919 tons of zinc. The shaft was deepened to 4,000 feet, preliminary to developing seven new levels below the 2,850-foot level.

Golden Manitou Mines Limited, Abitibi East county, treated 188,610 tons of zinc ore and 232,035 tons of copper ore in a split circuit mill. The zinc content of concentrates was 10,330 tons. The copper circuit operated at 815 tons per day and the zinc circuit at 550 tons per day.

West Macdonald Mines Limited, in Rouyn-Noranda county, commenced production in September 1955, and maintained during 1956 a production rate of about 1,000 tons of zinc ore per day. The ore was transported by a 6-mile aerial tramway to the Waite Amulet mill for treatment.

Waite Amulet Mines Limited, in Rouyn-Noranda county, milled 310,081 tons of copper-zinc ore, producing zinc concentrates from which 8,438 tons of zinc were recovered.



<u>Producers</u>

1 - Buchans Mining Co. Ltd.
2 - Weedon Pyrite and Copper Corp. Ltd.
3 - New Calumet Mines Ltd.
4 - Golden Manitou Mines Ltd.
East Sullivan Mines Ltd.
Barvue Mines Ltd.
Quemont Mining Corp. Ltd.
Waite Amulet Mines Ltd.
West Macdonald Mines Ltd.
Normetal Mining Corp. Ltd.
5 - Jardun Mines Ltd.
6 - Hudson Bay Mining and Smelting Co. Ltd. (also refinery)
7 - Reeves MacDonald Mines Ltd.
Canadian Exploration Ltd.
The Consolidated Mining and Smelting Company of Canada Limited (also refinery)
Sheep Creek Mines Ltd.
Giant Mascot Mines Ltd.
Sunshine Lardeau Mines Ltd.
Violamac Mines Ltd.
Yale Lead and Zinc Mines Ltd.
Slocan Van Roi Mines Ltd.
Western Exploration Co. Ltd.
Highland-Bell Ltd.
8 - Brittania Mining and Smelting Co. Ltd.
9 - Cronin Babine Mines Ltd.
Silver Standard Mines Ltd.
10 - Silbak Premier Mines Ltd.
11 - Tulsequah Mines Ltd.
12 - United Keno Hill Mines Ltd.
Galkeno Mines Ltd.

<u>Prospective Producing Areas</u>

13 - Bathurst
14 - Bachelor Lake
15 - Sudbury Basin
16 - Manitouwadge
17 - Snow Lake
18 - Great Slave Lake
19 - Watson Lake
20 - Hyland River
Pelly River

Zinc

New Calumet Mines Limited, in Pontiac county, milled 161,388 tons of zinc-lead-silver ore in the fiscal year ended September 30, producing 14,000 tons of zinc concentrates and 3,463 tons of lead concentrates. Zinc contained in concentrates amounted to 7,998 tons.

Weedon Pyrite and Copper Corporation Limited, a copper-zinc-pyrite mine in Wolfe county, operated at an average milling rate of 270 tons per day, producing copper, zinc and pyrite concentrates.

Ascot Metals Corporation Limited closed its zinc-lead-copper Suffield mine and 650-ton mill near Sherbrooke in July, owing to exhaustion of commercial ore. The property had been in production since 1950.

New Brunswick

Keymet Mines Limited, 18 miles northwest of Bathurst, discontinued operation of its lead-zinc-silver mine and 250-ton mill in March, owing to exhaustion of commercial ore. Production from the property commenced early in 1954.

Nova Scotia

Mindamar Metals Corporation Limited shut down its 500-ton mill at Stirling, Cape Breton Island, in April, after failing to develop new ore. The mine, a zinc-lead-copper-silver producer, had operated continuously since 1952.

Newfoundland

Buchans Mining Company Limited, operating since 1928, produced zinc, lead and copper concentrates, the zinc concentrates totalling 68,062 tons. Recoverable zinc content of all concentrates was 37,140 tons. Preparations were made to sink the new MacLean shaft, 1 1/2 miles northwest of the Buchans townsite.

Yukon Territory

United Keno Hill Mines Limited, Mayo district, operated at 450 tons per day, and derived about 60 per cent of its mill feed from the Hector mine, and about 40 per cent from the Calumet mine. Development of the Elsa and Keno mines was continued. Zinc and silver-lead concentrates were shipped to the Trail smelter.

Galkeno Mines Limited (formerly Mackeno Mines Limited) adjoining United Keno's Galena Hill property, resumed production in July after an 8-month shut-down during which ore reserves were built up. Milling rate was 130 tons per day of silver-lead-zinc ore.

Other Developments

British Columbia

Development of the Trophy Mountain properties 70 miles north of Kamloops, held by Ormsby Mines and Goldcrest Mines, was suspended owing to the limited tonnage outlined.

A two-year exploration program carried out by Cominco on Western Mines' lead-zinc property near Ainsworth was successful in outlining about 750,000 tons of indicated ore averaging 3.1 per cent lead and 2.2 per cent zinc.

An interesting lead-zinc discovery was made by American Standard Mines in the Revelstoke area. Preliminary estimates of reserves were 2,800,000 tons of indicated zinc-lead ore averaging 5.6 per cent zinc, 5.1 per cent lead, and 1.1 ounces per ton of silver. Further exploration was planned for the summer of 1957.

Manitoba

Hudson Bay Mining and Smelting Company in 1956 discovered three base metal deposits in the Snow Lake area about 70 miles east of Flin Flon. The tonnage and grade based on about 130,000 feet of diamond drilling were reported as follows:

	Average Assays					
	Ore Tons	Au-Oz.	Ag-Oz.	Zn %	Cu %	Pb %
Chisel Lake Mine	3,832,400	0.066	1.96	11.0	0.42	0.91
Ghost Lake Mine	260,700	0.013	1.14	11.6	1.42	0.7
Stall Lake Mine	783,200	0.020	0.27	0.4	4.54	

Preparations for shaft sinking on the Chisel Lake and Stall Lake properties were made, and road and power services to Chisel Lake were nearly completed at year end.

Saskatchewan

Development work at the Hudson Bay Mining and Smelting Company's Coronation mine, 13 1/2 miles southwest of Flin Flon, included 1,300 feet of shaft sinking and station cutting on 9 levels. Ore reserves remained unchanged at 825,000 tons averaging 5.08 per cent copper and 0.4 per cent zinc.

Ontario

Geco Mines continued underground development of its large zinc-copper deposits at Manitouwadge, 40 miles northeast of Heron Bay, Lake Superior. Shaft-sinking was completed, and construction of the 3,300-ton mill and surface plant buildings proceeded, with production scheduled to

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begin in mid-summer of 1957.

Willroy Mines, adjoining Geco to the west, completed the sinking of No. 1 shaft and began sinking a smaller ventilation shaft 700 feet to the south-west. Production is scheduled to commence late in 1957 at 750 tons per day, to be increased later to 1,000 tons per day.

Consolidated Sudbury Basin Mines, 15 miles northwest of Sudbury, continued preparations for production in August 1957 at 1,000 tons per day from its Vermilion mine, to be increased a year later to 3,000 tons per day when the Errington mine, 6 1/2 miles distant, will be ready for production. Railway and road connections into the properties were completed, and construction of a 6 1/2-mile aerial tramway connecting the two mines was started.

Quebec

The Coniagas Mines Limited continued the development of its zinc-lead property at Bachelor Lake, about 100 miles northeast of Barraute. A shaft scheduled for a depth of 850 feet was sunk to 450 feet and lateral development commenced on two levels. The Canadian National branch railway from Barraute to Chibougamau passes through the property.

Ungava Copper Corporation carried out further exploration of copper-zinc deposits near Gerido Lake, 25 miles south of Leaf Bay, Ungava Bay area. In view of the remoteness of the area and the lack of facilities such as docks and townsites, production plans were deferred until the area as a whole is opened up.

New Brunswick

Heath Steele Mines Limited continued the development of its zinc-lead-copper property 32 miles northwest of Newcastle. Four deposits on the property were under development, two for open pit and two for underground production. Construction of the 1,500 ton mill and related facilities was completed and breaking-in milling commenced early in 1957. A 22-mile railway from Bartibog was under construction.

Brunswick Mining and Smelting Corporation Limited continued mineral dressing tests on the complex zinc-lead-pyrite ores of its two deposits 12 miles and 17 miles southwest of Bathurst. Favourable progress was reported. Underground development of the No. 12 orebody continued from the preliminary shaft sunk in 1954-55 and the main or production shaft was collared.

Nigadoo Mines Limited, a subsidiary of The Billiton Company of Holland, began shaft sinking on a lead-zinc property 10 miles north of Bathurst, formerly owned by Anthonian Mining Corporation.

Anacon Lead Mines Limited continued exploratory drilling and underground development of the New Larder "U" Island property 15 miles south of Bathurst.

Sturgeon River Mines Limited completed shaft sinking to 600 feet and began lateral development on three levels at its zinc-lead-silver property 12 miles northwest of Bathurst.

Anaconda Company (Canada) Limited, 30 miles west of Bathurst, and Middle River Mining Company Limited, 12 miles west of the Heath Steele property, each outlined major sulphide orebodies during the year, containing predominantly zinc and lead mineralization with subordinate copper.

Yukon

Prospectors Airways Company Limited continued exploration of its lead-zinc deposits 30 miles west of the Canol Road - Pelly River crossing without adding important tonnage of ore to that already outlined.

American Smelting and Refining Company carried out exploratory drilling of its Hyland River lead-zinc deposit 60 miles northeast of Watson Lake. A large tonnage has been blocked out, but production plans have been deferred until transportation facilities become available.

Northwest Territories

No work was done by Pine Point Mines Limited, a Cominco subsidiary, on its extensive zinc-lead deposit south of Great Slave Lake, previous exploration having outlined adequate reserves. Further development depends on improvements in transportation facilities.

Exploration continued in the Indian Mountain Lake District.

Uses

Zinc has a wide range of industrial uses, the more important being in galvanizing, die-casting and brass products. In 1956 the United States consumed about 998,000 tons and the United Kingdom, the second largest consumer, 253,606 tons.

Zinc is marketed in grades that vary according to the content of impurities such as lead, iron and cadmium. The principal grades produced are "Special High Grade", chiefly used for die-casting; "Regular High Grade", used for making brass and miscellaneous products; and "Prime Western" for galvanizing. In Canada, zinc is refined by the electrolytic process only, by which most "Special" and "Regular" zinc is produced. To meet consumer requirements for "Prime Western", Canadian producers debase the higher grades by adding lead.

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In galvanizing, zinc is applied as a protective coating to iron or steel to prevent rusting. This is done usually by hot-dipping methods, but for some purposes electo-plating is used.

Zinc-base alloys, prepared from "Special High Grade" zinc to which is added 3 to 4 per cent aluminum, up to 1.3 per cent copper, and 0.03 to 0.08 per cent magnesium, are used extensively for die-casting complex shapes, especially automobile parts.

Brass, a copper-zinc alloy containing up to 50 per cent zinc, has many diversified uses in industry and the arts.

Rolled zinc is used principally for making flashlight battery cups, also for articles exposed to corrosion, such as weather-stripping, roofing drains, and gutters, and as anti-corrosion plates for boilers and ships' hulls. Zinc dust is used to make zinc salts and compounds, in purifying fats, in manufacturing dyes, and to precipitate gold and silver from cyanide solutions. Zinc oxide is used in compounding rubber and in making paint, ceramic materials, inks, matches, and many other commodities. 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. In recent years, zinc compounds have been increasingly replaced by titanium dioxide.

Prices

The Canadian price of Prime Western zinc was 13.5 cents per pound throughout the year. Regular and Special High Grades were respectively an additional 1.35 and 1.5 cents a pound. The average price of all grades of Canadian zinc, as calculated by the Dominion Bureau of Statistics, was 14.8 cents a pound.

ABRASIVES

By R. M. Buchanan
Industrial Minerals Division

The term 'natural abrasives' includes all rocks and minerals hard enough to be capable of abrasive action. These occur widely distributed in all countries and are used in a myriad of ways. They are, for convenience, sometimes grouped in order of hardness from diamond, the hardest of all natural substances, to chalk and clay. The 'high grade' abrasives include diamond, corundum, emery and garnet; 'low grade' types are silicates and the various forms of silica -- quartz, quartzite, flint, sandstone, pumice, pumicite and ground feldspar. Other materials used for their polishing and mild abrasive actions include diatomite, the soft silicas (tripoli, micro-crystalline silica and rottenstone), chalk, china clay and bath brick.

Natural abrasives have suffered more severely than most industrial minerals from the competition of artificial materials. No natural abrasives, with the exception of quartz sand from sand blasting and a small quantity of grinding pebbles, have been produced in Canada for several years. On the other hand, artificial abrasives with a value of $46,023,192 were produced in Canada in 1956. The most common artifical abrasive materials are silicon carbide, alumina, ferrosilicon, boron carbide and fused magnesia.

Occurrences of several abrasive materials are known in Canada and some deposits have been worked at various times. It is unlikely that there will be significant production unless commodities assume strategic importance, as corundum did, during the war.

Brief notes are given, in this review, on corundum, emery, garnet, quartz, grindstones, oilstones, pulpstones, pumice, pumicite and grinding pebbles. Trade, production, consumption and price statistics are included in tables because many of the commodities are grouped together in all the available figures.

Corundum (Al_2O_3)

All corundum consumed in Canada, mostly the fine-grained type used for grinding glass, was imported. Although the immediate source was the United States, it is likely that it was produced in the Transvaal, Union of South Africa. This area, along with India, has been the source of most of the world production for the past thirty years. At present, world production is about 10,000 tons a year.

In the first quarter of this century a major portion of the world's supply came from deposits in southeastern Ontario. There are found in this region, three easterly trending belts of subsilicic rocks containing deposits of corundum. The main belt is about 100 miles long and about 6 miles wide. It contains the two most important deposits, the Craig and the Burgess, in Raglan and Carlow townships, respectively, along with a number of lesser ones. The grade of Canadian deposits is about 5 per cent or less whereas that of South African deposits is about 20 per cent.

From 1944 to 1946, some of the tailings from the mill at Craigmont, northeast of Bancroft, Ontario, were treated. They contained about 3 per cent of fine-grained corundum and a recovery of about 44 per cent was obtained.

Uses

Corundum is used chiefly in making grinding wheels. Extreme hardness and the property of fracturing in such a way as to give sharp cutting edges makes it valuable. The coarsest material is used in 'snagging wheels' for the finishing of metal castings. The very finest is used for grinding optical glass.

Emery

Emery is a mixture of corundum and magnetite with, in some cases, varying amounts of other spinels and hematite. The association is so intimate that the constituents cannot be separated effectively by physical means. The magnetite and the other spinels detract from the hardness but increase the polishing action. Also, the shape of the grains is more or less rounded and therefore they polish rather than cut.

The entire world supply of emery, before 1847, was derived from deposits on the island of Naxos in the Greek Archipelago. At that time comparable deposits were found in Turkey. Both these sources are still important.

There is no record of emery production in Canada, but deposits of corundum mixed with variable amounts of magnetite are known in the area east of the Madawaska River in southeastern Ontario. They can be described as coarse-grained emery.

The principal United States deposits are in New York, Virginia and Massachusetts, but production in the last thirty years has come only from Cortland township, N.Y. In these deposits are two types of emery: the 'black' fits the conventional definition, being composed of corundum and magnetite, but the 'grey' is a cordierite-sillimanite or sillimanite-sapphirine rock of variable magnetite content. All the current production is 'grey emery'.

Uses

Most of the American emery is used as a 'nonskid' agent in concrete and asphalt floors, stair treads and pavements. It gives a hard, tough, abrasion-resistant surface. The remainder is used in the manufacture of grinding wheels, abrasive sticks, and coated papers.

Garnet

Members of the garnet group of minerals are essentially aluminum silicates containing variable amounts of iron, magnesium, manganese, calcium and chromium. They are common constituents of many rocks, particularly metamorphic types, and some beach sands. The desirable types of garnet for abrasive use are those which break down into sharp fragments. Many of the numerous Canadian occurrences, however, are not of this sort and are often badly fractured. Some garnet has been produced from the property of Cubar Uranium Mines Limited, formerly owned by the Niagara Garnet Company, Limited, in Dana Township, about 25 miles north of Sturgeon Falls, in northern Ontario. No production was reported in 1956.

Most of the garnet used in Canada is imported from the United States, where the chief producer is Barton Mines Corp., from deposits near North Creek, N.Y.

Uses

The principal use of garnet abrasives is in the manufacture of coated papers. Some is produced for sand blasting and metal spraying, but it is seldom competitive with quartz, the common sand-blasting agent. In coated papers, garnet types are superior to 'flintpapers' containing quartz.

Crushed Quartz, Quartzite and Sandstone

Crushed and sized quartz and quartzite are used in making the cheapest grades of coated papers, the 'flintpapers' or 'sandpapers'. Canadian requirements of graded silica are normally imported from the United States. Quartz sand from sandstone and beach sand deposits is used extensively in sand blasting, metal spraying, and initial grinding or surfacing of plate glass. Most of the sand for these purposes is also imported, but some small foundries make use of local deposits.

Some silica rock is crushed and screened for use in the manufacture of ferrosilicon or further milled to produce sand for silicon carbide.

Grindstones, Oilstones, Pulpstones, etc.

Sandstone deposits suitable for such abrasive stone occur in Nova Scotia, New Brunswick and on the coast of British Columbia. At one time the deposits in the Maritime Provinces were worked extensively, but no production has been reported for many years. Pulpstones of natural sandstone have been largely replaced by much more efficient types made of bonded silicon carbide.

Abrasives

Some natural grindstones were imported from the United States along with whetstones, sticks and files.

Pumice and Pumicite

These commodities are quite similar. Both are ejected from volcanoes and are usually composed of glassy material with the composition of rhyolite. Pumice is in the form of cellular masses of very low density, and pumicite forms a fine dust composed of sharp angular fragments of glass that are characteristically striated.

Widespread deposits of pumicite occur in Saskatchewan, Alberta and British Columbia, but beds are usually thin and far from markets. There has been no significant production. Small operations have been undertaken to supply local requirements, from time to time. Pumice occurs over a large area in the Bridge River district of British Columbia.

Uses

The most important abrasive uses of pumice and pumicite are in scouring compounds, cleansers and hand soaps. They are sometimes used as carriers for insecticides. There are many other non-abrasive uses, e.g. as lightweight aggregate and as an extender in concrete.

Grinding Pebbles

In grinding ores, and minerals such as feldspar, clay, and other ceramic materials, where contamination from steel grinding balls and rods would be detrimental, pebbles of hard, tough flint or quartz are used.

The only production of grinding pebbles, for several years has been by W. May of Elkwater, Alberta, from field deposits in the Cypress Hills area of southern Alberta and Saskatchewan.

Other Natural Abrasives

In the statistical tables that follow there are grouped together in exports from the United States to Canada under "All Other Natural Abrasives" such substances as tripoli, diatomite, lava and calcareous tufa.

Although large imports of diamonds from the United States are shown, the original source is, of course, South America or Africa.

Imports of Natural and Artificial Abrasives*

	1956	1955
	$	$
Artificial abrasives, grains	2,333,133	1,989,035
Diamonds black, bort for borers................	10,369,632	8,091,852
Emery in bulk**............................	242,834	207,659
Grinding wheels, bonded natural and artificial grains	2,148,715	1,957,316
Grinding stones or blocks manufactured by bonding either natural or artificial abrasives	381,823	269,846
Manufactures of emery or of artificial abrasives, n.o.p.	561,663	356,471
Grindstones, not mounted, and not less then 36" in diameter........................	24,620	18,790
Grindstones, n.o.p.	7,544	12,533
Pumice and pumice stone, lava and calcareous tufa, not further manufactured than ground ...	242,656	214,358
Sandpaper, glass, flint and emery paper or emery cloth	1,053,800	1,032,845
Total	17,366,420	14,150,705

* From "Trade of Canada".

** Includes also corundum and garnet, separation not possible.

Exports of Natural and Artificial Abrasives*

	1956	1955
	$	$
Abrasives, natural, n.o.p. in ore or bulk, crushed or ground	17,004	16,606
Abrasives, artificial crude..................	28,388,901	26,941,712
Abrasives, artificial made up into wheels and stones	17,447	11,728
Sandpaper, glass, flint and emery paper and emery cloth	665,764	439,254
Grindstones, manufactured	92,642	45,039
Total	29,181,758	27,454,339

* From "Trade of Canada".

Abrasives

Consumption of Abrasives, Natural and Artificial, in the Production of Artificial Abrasive Products

	1956		1955	
	Short Tons	$	Short Tons	$
Natural Abrasive Grains				
Garnet	307	76,185	269	65,043
Emery	63	10,258	81	13,309
Quartz or flint	299	21,025	287	19,696
Other	n.a.	1,873	n.a.	4,931
Total	669	109,341	637	102,979
Artificial Abrasive Grains for Wheels, Paper, etc.				
Fused alumina	3,202	869,978	3,166	709,388
Silicon carbide	2,610	623,401	1,684	441,573
Total	5,812	1,493,379	4,850	1,150,961
Silica Sand	121,583	1,039,980	97,968	866,373

Artificial Abrasives Made in Canada

	1956		1955	
	Short Tons	$	Short Tons	$
Crude silicon carbide	80,467	10,430,549	74,947	9,681,788
Crude fused alumina	181,830	17,636,382	177,162	16,676,424
Silicon carbide firesand, etc.	304	25,587	409	32,757
Abrasive wheels and segments	n.a.	7,206,636	n.a.	5,666,352
Sharpening stones and files	n.a.	268,886	n.a.	252,519
Ferrosilicon	27,522	1,298,105	32,986	1,468,397
Other products*	n.a.	9,157,047	n.a.	8,741,458
Total		46,023,192		42,519,695

* Includes: abrasive cloth (emery cloth etc.), abrasive paper (sandpaper etc.), abrasive tiles, artificial pulpstones, boron carbide, fused magnesia.

n.a. not available.

The official Canadian trade statistics do not separate natural and artificial abrasives. The natural abrasives imported into Canada from United States are recorded in the United States Export Statistics Report FT. 410 P.T., and are shown below.

Natural Abrasives

	1956		1955	
	Short Tons	$	Short Tons	$
Imports into Canada from United States				
Corundum	194	48,842	100	24,659
Emery powder, grains and grits	1,439	128,601	1,214	108,698
Natural grindstones and pulpstones	371	42,835	314	31,422
Whetstones, sticks, files and blocks etc.	4	9,286	11	19,487
All other natural abrasives	15,111	868,960	13,811	719,277
Total	17,119	1,098,524	15,450	903,543
Diamond grinding wheels, sticks, etc., carats	85,880	429,294	92,516	418,855
Diamond powder carats ...	184,306	540,809	103,098	256,775

Prices

Corundum

E & M J Metal & Mineral Markets, Dec. 13, 1956:
Crude, per ton, c.i.f. U.S. ports-$100 to $120, nominal.

Pumice Stone

E & M J Metal & Mineral Markets, Nov. 29, 1956:
Per lb , f.o.b., New York or Chicago, in barrels,
powdered - 3 to 5 cents
lump - 6 to 8 cents

Alumina, calcined

Oil Paint & Drug Reporter, Jan. 7, 1957, per lb - $00.0455.

Tripoli

E & M J Metal & Mineral Markets No. 29/56:
Per ton, paper bags, min. carload 30 tons, f.o.b. Missouri:

Once ground, through 40-mesh, rose and cream coloured - $50.
Double ground, through 110-mesh, rose and cream - $52; air-floated, through 200-mesh - $55.

Garnet

Not quoted in E & M J since 1951 when price was $93 per ton.

Emery

Not quoted in E & M J since 1951 when price was $12 per ton, domestic, crude.

Diatomite

Not quoted in E & M J since 1951 when price was $25 per ton, 98% minus 100-mesh.

Flint

No quotation published.

LIGHTWEIGHT AGGREGATES

By H.S. Wilson
Industrial Minerals Division

Although the lightweight aggregate industry began in 1927, when the first plant in Canada was built, it is mainly during the past ten years that it has shown marked expansion. Its growth is partly due to the construction boom and partly to the demand for aggregates possessing certain special qualities. The year 1956 saw an over-all increase of 19 per cent over the previous year's production. The perlite expanding companies showed the greatest increase in activity, amounting to 34 per cent. The companies that expanded clay and shale and those expanding slag showed increases of 24 per cent and 23 per cent respectively. Output of pumice declined 6 per cent while that of vermiculite increased 12 per cent. Two plants under construction at the end of 1955 went into production during 1956; one expands clay and the other perlite. They bring to 24 the number of all types of lightweight aggregate plants in Canada.

Production of Lightweight Aggregates

	1956		1955	
From Domestic raw materials	Cu. Yds.	$	Cu. Yds.	$
Clay and shale	215,000	1,190,500	171,000	958,000
Expanded slag	242,000	547,500	201,000	444,000
From imported raw materials	Cu. Ft.		Cu. Ft.	
Perlite	2,317,000	583,600	1,800,000	437,000
Pumice............		110,000		117,000
Vermiculite.........	6,928,070	1,536,000		1,369,000
Total		3,967,600		3,325,000

Types of Lightweight Aggregate

The five lightweight aggregates produced can be classified into two types, namely, those suitable and those unsuitable for load-bearing concretes. The first type includes aggregates processed from pumice, and from expanded clay, shale, and blast furnace slag. These can be used because of their high compressive strengths. The second type includes expanded perlite and vermiculite. Although they do not possess sufficient compressive strength to be used in load-bearing concrete, they can be used where low density and good insulating properties are required.

Raw Materials

Clays and shales are the most widespread of the raw materials consumed in the production of lightweight aggregate. The types used are the common clays and shales such as are used in the production of brick and structural and drain tile. These materials usually contain from 3 to 10 per cent iron as ferric-oxide and have a comparatively low vitrification temperature (1,800 to 2,100° F.). Deposits of suitable material occur in all provinces. The results of test work on materials from all provinces but Newfoundland appear in the following reports, available at a cost of 50 cents a copy from Publications Distribution Section, Mineral Resources Division, Department of Mines and Technical Surveys, Ottawa:

Preliminary Reports on Coated Lightweight Aggregates from Canadian Clays and Shales:

Memorandum Series No.	117 -	Alberta
" " "	120 -	Manitoba and Saskatchewan
" " "	121 -	Ontario
" " "	122 -	New Brunswick, Nova Scotia and Prince Edward Island
" " "	126 -	Quebec
" " "	128 -	British Columbia

A more extensive survey is being carried out to test more raw materials in the provinces listed above. Work was done in Quebec during 1956 and will be continued in Ontario during 1957.

Expanded slag is produced from blast furnace slag in the molten state as it is drawn from the blast furnace. The processing of this lightweight aggregate is undertaken in certain areas in which steel plants are situated, i.e. Hamilton, Ontario, and Sydney, Nova Scotia.

Pumice is a highly vesicular material of volcanic origin. None is produced in Canada as the known deposits are either too small or are uneconomically located. All the pumice used in Canada is imported, mainly from the western United States.

Vermiculite is a type of mica that exfoliates when heated to form a highly cellular material that possesses good insulating qualities. A small production is obtained from deposits near Perth, Ontario, but most of the vermiculite used in Canada is imported from Transvaal, Union of South Africa, and the United States, and expanded for domestic consumption. Main sources of raw vermiculite in the United States are Montana, North and South Carolina, Wyoming, Colorado, and Georgia.

Perlite is a glassy volcanic rock that "pops" when heated, giving a white cellular product of very low density. Deposits occur in central British Columbia, but have not been developed commercially. Raw material is imported from the United States for treatment, mainly from Colorado and New Mexico.

Lightweight Aggregate Plants in Canada

Company	Location	Aggregate
Burtex Industries Ltd.	Calgary, Alta.	Expanded shale
Consolidated Concrete Industries Ltd.	Calgary, Alta.	" "
The Cooksville Co. Ltd.	Cooksville, Ont.	" "
Clayburn Co. Ltd.	Abbotsford, B.C.	" "
Aggregates and Construction Products Ltd.	Regina, Sask.	Expanded clay
Atlas Light Aggregate Ltd.	St. Boniface, Man.	" "
Edmonton Concrete Block Co. Ltd.	Edmonton, Alta.	" "
Light Aggregate (Sask.) Ltd.	Regina, Sask.	" "
Winnipeg Light Aggregate Ltd.	Transcona, Man.	" "
Dominion Iron and Steel Ltd.	Sydney, N.S.	Expanded slag
National Slag Ltd.	Hamilton, Ont.	" "
Canadian Perlite Corp.	Montreal, P.Q.	Perlite
Gypsum Lime and Alabastine (Canada) Ltd.	Caledonia, Ont.	"
Montreal Perlite Industries	Montreal, P.Q.	"
Perlite Industries Reg'd.	Ville St. Pierre, P.Q.	"
Perlite Industries Ltd.	New Westminster, B.C.	"
Perlite Products Ltd.	Winnipeg, Man.	"
Western Perlite Co. Ltd.	Calgary, Alta.	"
F. Hyde and Co. Ltd.	Montreal, P.Q.	Vermiculite
	Toronto, Ont.	"
	St. Thomas, Ont.	"
Insulation Industries (Canada) Ltd.	Vancouver, B.C.	"
	Calgary, Alta.	"
	Winnipeg, Man.	"
Siscoe Vermiculite Mines Ltd.	Cornwall, Ont.	"
	Rexdale, Ont.	"
Vermiculite Insulating Ltd.	St. Laurent, P.Q.	"

Production Methods

Expanded shale and clay aggregates are produced in Canada by the rotary kiln process. Some of the plants using this process size the raw material prior to firing while others do not find it necessary. The product from the kiln in some cases occurs as separate particles, and in others as clinker, which must be crushed to achieve the desired aggregate size. Firing temperatures are within the range of 1,900° to 2,100° F.

The sintering process for the production of lightweight aggregate from clays and shales is not used in Canada. It is used to a considerable degree, however, in the United States. This process has been adapted from the metallics industry where ores are beneficiated or agglomerated by this process. The fuel needed for sintering is mixed with raw material and the mixture is sintered either down-draft or up-draft on a travelling grate sintering machine. In the lightweight aggregate field, usually 5 to 10 per cent fuel is added to the shale or clay and pelletized.

Expanded slag is produced from the slag as it is drawn from the blast furnace. The expanding or foaming is performed in concrete pits or in specially designed machines. In either case controlled amounts of water and air are injected into the molten slag. The steam thus formed causes the slag to foam. On being cooled the hardened slag is crushed to the desired size.

Perlite is a type of volcanic rock composed of small spheroids. It contains 3 to 4 per cent water, and it is this combined water which gives perlite its peculiar "popping" characteristic when heated. On being heated rapidly to the softening point, perlite will expand from 4 to 20 times its original volume. Firing is generally done in horizontal kilns (stationary or rotary) or stationary vertical kilns at temperatures from 1,600° to 2,300° F. The ore is crushed and screened to size at the mine site and is received at the expanding plant ready for the "popping" process.

Vermiculite, which is similar in appearance to mica, contains from 6 to over 20 per cent water. The process of exfoliation is due to the evaporation of this water when the ore is heated rapidly to temperatures between 1,600° and 2,000° F. The expansion, accordion-like, may be as high as 20 times the original volume. Many types of furnaces for expanding vermiculite have been used, but the vertical kiln, containing baffles to retard the descent of the material, is most common. The furnaces are usually gas- or oil-fired. Vermiculite is dealt with separately on page 391.

Properties and Uses

Lightweight aggregates produced from pumice, clay, shale, and slag usually possess sufficient strength to be used in load-bearing concrete. From 70 to 90 per cent of these aggregates are used in the production of concrete block, and about 10 to 20 per cent in other cast shapes. About 10 per cent of clay and shale aggregates are used in ready-mix concrete. Small quantities are used as loose insulation and in refractories.

The principal use of perlite is as an aggregate in plaster. About 70 per cent is used for this purpose owing to its white colour and extreme low density. About 10 per cent is used in insulating concrete blocks. Other uses for small quantities of perlite are stucco admix, underground insulation, as loose insulation, asbestos board, and in oil well drilling.

Vermiculite finds its greatest use as loose insulation where approximately 60 per cent of it is used. It is used in insulating plaster and concrete and as an insecticide carrier, soil conditioner, etc.

Prices

Expanded clay and shale aggregate sell within the price range of $4.50 to $6.50 per cubic yard. Expanded slag sells at $2.00 to $3.25 per cubic yard. Perlite and vermiculite are sold at about 20 cents to 35 cents per cubic foot. They are both marketed in bags holding 4 cubic feet.

80486-4—15

ARSENIC TRIOXIDE

By R. M. Buchanan
Industrial Minerals Division

Arsenic is most commonly marketed in the form of white arsenic (arsenic trioxide or arsenious oxide, As_2O_3).

In Canada, as in most other producing countries, arsenic is obtained as a by-product from the smelting of base and precious metals. In fact, the amount of arsenic released during the treatment of metallic ores far exceeds the consumption. Because of its extremely poisonous nature, the excess must be stored in such a way that it cannot pollute the atmosphere or terrestial water.

Canadian Production

All of the arsenic sold during 1956 was produced by Deloro Smelting and Refining Company Limited at Deloro, Ontario, as a by-product in the treatment of cobalt-silver concentrates from the Cobalt and Gowganda areas of northern Ontario. In these deposits the arsenic occurs in a complex group of arsenides and sulpharsenides of cobalt, nickel and iron, of which the principal ones are cobaltite ($CoAsS$), safflorite ($CoAs_2$), arsenopyrite ($FeAsS$), rammelsbergite ($NiAs_2$), skutterudite ($CoAs_3$), niccolite ($NiAs$), lollingite ($FeAs_2$), smaltite ($CoAs_3$), chloanthite ($NiAs_3$) and gersdorffite ($NiAsS$). The arsenic-bearing minerals occur, along with many other minerals of which the most prominent is native silver, in calcite veins associated with thick diabase sills.

The capacity of the Deloro refinery is about 100 tons of refined white arsenic per month. Production, consumption and export figures are seldom in balance for any one year since shipments are governed by demand and stocks can be stored indefinitely.

The production of white arsenic in Canada during the period 1926-1956 was only a small portion of world output. According to estimates by the United States Bureau of Mines, it was about 5 per cent of the world total in 1942, but was less than 2 per cent in other years.

80486-4—15½

Arsenic Trioxide

Arsenic - Production, Trade and Consumption

	1956		1955	
	Pounds	$	Pounds	$
Production				
(refined As_2O_3)...........	1,790,381	77,612	1,571,787	69,159
Exports(1)				
United States	1,088,400	46,968	858,900	37,198
Other countries...........	79,700	3,514	81,700	3,596
Total	1,168,100	50,482	940,600	40,794
Consumption by industry				
Glass	381,547		356,211	
White metals(2).............	90,454		95,462	
Miscellaneous chemicals(3).	43,135		11,163	
Total	515,136		462,836	

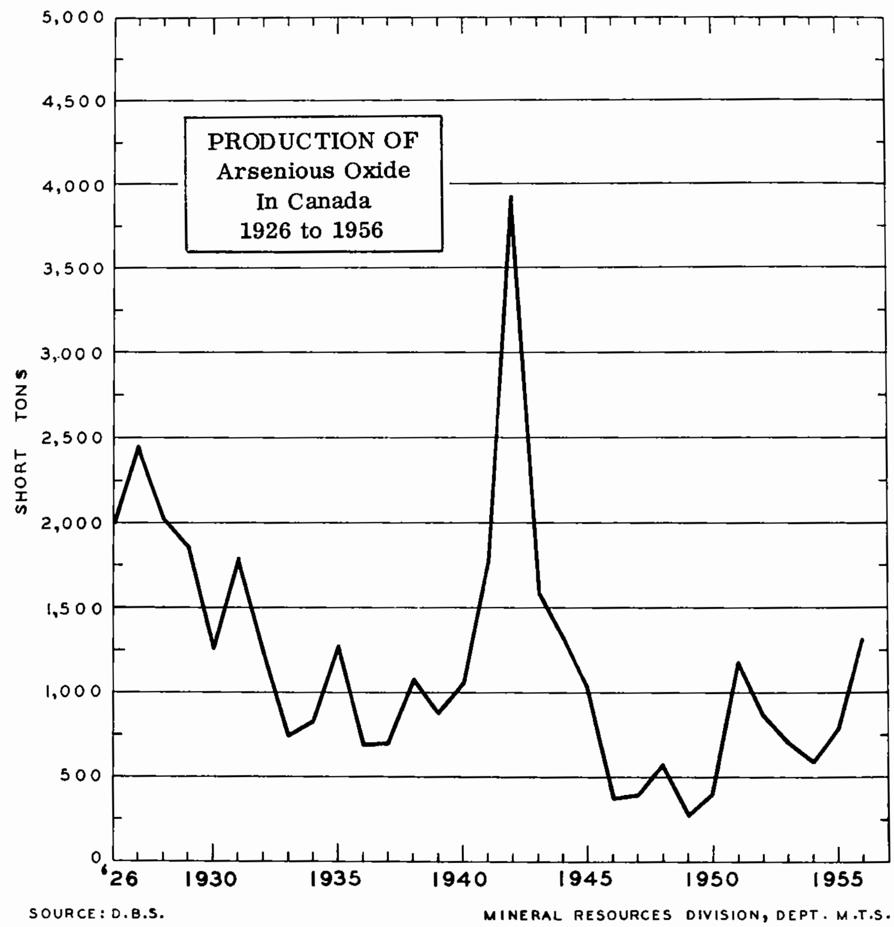
(1) Does not include arsenic content of gold ores exported for refining.
(2) Includes both arsenious oxide and arsenic metal.
(3) In addition to these quantities of refined white arsenic, 455 tons of arsenic pentoxide (As_2O_5) were consumed in making insecticides in 1955 and 188 tons in 1956.

The general downward trend from 1926 until about 1950, with the exception of the years 1941 to 1943, is, chiefly, a response to the decline in the use of arsenical insecticides. The purchases of the British Ministry of Supply accounted for most of the wartime increase. At that time all available crude arsenic was disposed of and therefore entered production figures.

The upward trend since 1950 is likely a reflection of the expansion of the glass industry.

Other Canadian Sources

Some crude white arsenic has been produced and stored on the properties of some of the gold mines in western Quebec. Before the termination of its gold milling operations in July 1956, several millions of pounds of crude white arsenic containing 65 to 70 per cent As_2O_3 had been stored at the property of Beattie-Duquesne Mines, Limited, in Duparquet township. In the company's milling operations it was necessary to roast the arsenical gold ore, and the arsenic recovered in the Cottrell plant was stored in waterproof structures. At the property of O'Brien Gold Mines Limited in Cadillac township, where milling operations were terminated in August 1956, arsenic



had been accumulated from the roasting operation. At both of these properties the arsenic occurred in the form of arsenopyrite.

A similar situation exists in the Yellowknife gold camp on the north side of Great Slave Lake in the Northwest Territories. The crude arsenic recovered from the roasting of gold ores containing arsenopyrite is stored underground in specially excavated stopes well removed from the ore-bearing area. These stopes are in permafrost and are completely isolated from the rest of the mine workings by waterproof stoppings. Since there is no circulation of ground water in the permafrost zone and since the stopes can be reached only through raises to surface, the arsenic is permanently removed from any possible contact with humans, wildlife or vegetation.

Some of the gold mines in British Columbia ship arsenical gold concentrates to a smelter in Tacoma, Washington, for treatment. This arsenic is not counted in Canadian production but it is likely that it contributes in a minor way to production in the United States since this smelter is one of that country's main sources of arsenic.

Arsenic Trioxide

Minor amounts of arsenic are widely distributed in many other gold and base metal deposits, usually in the form of arsenopyrite. There has been a small production from the arsenical gold ores of the Little Long Lac area of northern Ontario, and from arsenical gold ores in Nova Scotia.

World Production

United States

The United States is the largest producer and consumer of white arsenic. The domestic supply is derived as a by-product from copper, lead and zinc smelting operations and forms, usually, about 20-40 per cent of the estimated world total.

Sweden

The importance of Sweden as a source of white arsenic is based on the arsenic content of the copper-gold-silver deposits of Boliden. It has been stated that the Boliden operations could supply the whole world's requirements of arsenic. The excess of production over demand is stored in large concrete structures.

Mexico

The production in Mexico is usually comparable to that of Sweden. It is a by-product from copper-smelting operations and most of it is exported to the United States.

Other Countries

Significant production of white arsenic is reported from France, Belgium, West Germany, Japan, Brazil and Portugal, and smaller amounts from many other countries.

Uses

Arsenic metal has only restricted uses. Small amounts are used for the hardening of lead shot and the formation of certain copper alloys.

Arsenic compounds are widely used in insecticides, rodenticides and other pesticides. The consumption in the United States, for example, varies directly with the severity of the infestation of cotton by the boll weevil in the southern states. Many railways use arsenic compounds for killing weeds on their rights of way. They also are effective in the control of aquatic plant life in ponds and lakes.

Other important uses are: as a decolourizer in glass, as preservatives and depilatories in the tanning of hides; in the chemical debarking of trees; in pyrotechnics; and to a minor extent in paint pigments. Certain preparations containing, usually, sodium arsenate, are useful as wood preservatives.

The large amount of white arsenic produced at Boliden stimulated research into the uses of arsenic in Sweden. One of the developments was discovery of its ability to make concrete waterproof. This property has not been exploited because of the toxicity.

In recent years organic and inorganic substances have been replacing arsenic compounds in several ways. DDT and benzene hexachloride are used in the control of the boll weevil and other insects instead of calcium and lead arsenates. As a weed killer, sodium arsenate is being replaced by 2-4-D. Thallium sulphate is ten times as poisonous as arsenic compounds in rodenticides. Penicillin is replacing arsenic compounds in most medicinal uses. This has resulted in the glass industry becoming the largest consumer in recent years.

Prices

Refined white arsenic was quoted at 5 1/2 cents per lb. (powdered, in barrels, car lots) throughout 1956 according to the Oil, Paint and Drug Reporter. This price has been unchanged since it was reduced from 6 1/2 cents in August 1952.

ASBESTOS

By H. M. Woodrooffe
Industrial Minerals Division

Of the three varieties of asbestos important in commerce - - chrysotile, crocidolite and amosite - - chrysotile only is produced in Canada. Since it was first mined almost 80 years ago, Canada has been the foremost producer.

During 1956, Canadian mines produced 1,014,249 tons of asbestos valued at $99,859,969. Although the tonnage of fibre marketed was slightly below the peak year of 1955, its value increased 4 per cent to establish a record. The increased value resulted from a higher price for Canadian asbestos and a change in demand for the various grades.

Shipments of shingle group fibre were at a record level during the year to supply the demand from the asbestos cement industry. This was accompanied by a decreased demand for the short grades.

Since domestic requirements for chrysotile asbestos are small, most of the Canadian production is exported to world markets. Shipments to the United States in 1956 amounted to 52 per cent of the value of all asbestos exports. During the year, Russian shipments gave considerable competition for longer fibre grades in European markets, and increased competition from Rhodesian chrysotile was felt in the Sterling Area.

As in the previous year the principal developments in the industry took place in Quebec, the major producing area. The program of expansion, involving capital expenditures approaching $100 million since 1950, continued. Canadian Johns-Manville Company's new mill at Asbestos was completed, and a short time later the company announced additional plans to expand production facilities for the longer fibre grades. The ore-body beneath Black Lake is being prepared for production by Lake Asbestos of Quebec Limited and new mills are under construction near East Broughton and Thetford Mines.

Canadian production of asbestos has shown a consistent increase since the depression period, except for 1949 when operations in the industry were curtailed as a result of a labour dispute. Exports followed the production trend during the same period. Production since 1926 is shown in the graph on page 231.

Asbestos - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production (shipments)				
Crude	717	692,677	724	608,052
Milled fibres.........	392,983	69,397,107	395,096	65,462,260
Shorts & refuse	620,549	29,770,185	667,982	30,121,005
Total	1,014,249	99,859,969	1,063,802	96,191,317
Production by Provinces				
Quebec	967,145	90,531,457	1,022,065	88,607,804
Ontario	26,748	3,929,782	24,550	3,317,542
British Columbia	20,356	5,398,730	17,187	4,265,971
Total	1,014,249	99,859,969	1,063,802	96,191,317
Exports				
Crude				
United States.........	210	173,970	250	204,927
United Kingdom	150	180,655	112	104,895
West Germany	65	50,926	89	66,034
Japan	61	53,372	29	22,523
France..............	42	40,005	69	48,719
Other countries	32	27,287	37	33,515
Total	560	526,215	586	480,613
Milled fibres				
United States	157,953	28,430,591	169,107	28,347,582
United Kingdom	35,530	8,155,299	37,698	7,694,097
Japan	26,050	3,857,538	12,801	1,937,314
West Germany........	24,382	4,443,312	24,660	4,270,714
France	22,723	4,668,432	18,709	3,463,594
Belgium	17,360	3,351,391	15,358	2,810,499
Australia	12,235	1,968,017	20,868	3,440,967
Mexico	8,410	1,446,233	6,169	1,005,878
Brazil	6,607	1,099,636	3,511	558,620
Other countries	65,794	11,607,151	57,099	9,905,740
Total	377,044	69,027,600	365,980	63,435,005
Waste, refuse and shorts				
United States	468,493	23,413,004	524,212	24,697,990
United Kingdom	36,290	1,699,008	38,668	1,677,424
West Germany	27,236	1,411,464	24,543	1,347,759
Japan	15,191	1,225,177	7,002	549,645
France..............	8,812	571,743	9,057	527,152
Netherlands	5,219	289,500	189	6,634
Belgium.............	5,016	325,105	7,959	500,256
Other countries	20,060	1,406,031	23,631	1,581,137
Total	586,317	30,341,032	635,261	30,887,997

	1956		1955	
	Short Tons	$	Short Tons	$
Manufactures				
United States		3,093,343		2,281,277
Colombia		217,882		71,010
Mexico		120,680		162,151
Cuba		34,372		23,210
Union of South Africa		22,599		37,336
Venezuela		21,912		10,617
Lebanon		16,943		12,248
Syria		14,712		8,609
Switzerland		12,577		18,891
Greece		11,956		5,935
Belgium		9,700		6,049
Jamaica		6,348		6,687
United Kingdom		1,502		100
Other countries		158,702		258,147
Total		3,743,228		2,902,267
Imports, manufacturers				
Packing		326,295		243,760
Auto brake linings		486,776		395,979
Auto clutch facings		394,673		381,491
Brake linings & clutch, N.O.P.		224,704		160,326
Miscellaneous		3,951,187		2,872,276
Total		5,383,635		4,053,832

Although chrysotile asbestos occurs at several places in Canada, 95 per cent of production is confined to mines in a relatively small area in the province of Quebec. Two other mines, one each in northern Ontario and northern British Columbia, contribute the remainder.

What are believed to be the world's largest deposits of asbestos occur in the Eastern Township region of Quebec, in a narrow band extending from east of the Chaudiere River southwest almost to Sherbrooke, approximately 80 miles east of Montreal. All the producing deposits in the province are in this region. Production in the Eastern Townships has been continuous since 1878. The persistence of the mineral depth, as established by drilling, indicates that reserves will be sufficient for many years.

Chrysotile generally occurs in two forms, a "cross fibre" and a "slip fibre". In the former type the individual fibres lie across the vein in a parallel manner, and the vein width indicates the fibre length. Although fibres as long as five inches occur, most of the production is from fibres one-half inch or less in length. Slip fibre is usually deposited along fault planes and the fibres lie in an overlapping manner. Much of the production from the East Broughton area is of this type.

Asbestos

Fibrous tremolite, actinolite, and anthophyllite occur in various places in Canada. The fibres of these varieties are usually weak and not suited for the manufacture of textiles. There are, however, certain uses for which their chemical natural and physical characteristics are suited. During the war, a small production of tremolite was reported in eastern Ontario. Recently, in the iron-ore region near the Labrador-Quebec boundary occurrences of crocidolite were reported.

The Canadian asbestos companies were actively engaged in an exploration programme for new deposits of chrysotile. Much of the work centered in British Columbia, Newfoundland and Yukon Territory, although limited exploration continued in the province of Quebec and Ontario. Promising occurrences have been indicated near Cry Lake, British Columbia, and on Cassiar Creek, west of Dawson in Yukon Territory, and on the Burlington Peninsula of Newfoundland. These were examined in detail during the year to establish their economic possibilities.

Developments and Production

Newfoundland

Chrysotile occurs in several places in Newfoundland and Labrador. During the year the discovery of an important deposit of asbestos of good quality in the Burlington Peninsula was reported. An extensive development program is being undertaken by Advocate Mines Limited.

Quebec

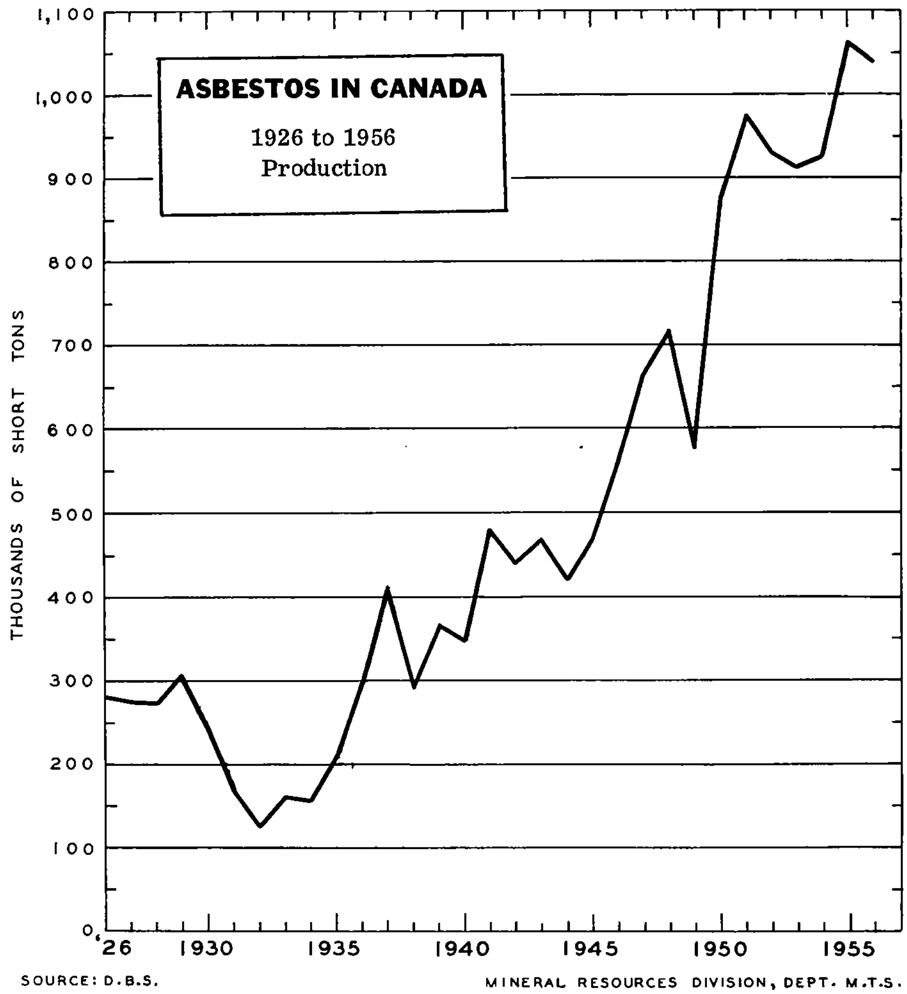
Asbestos is produced in the counties of Richmond,Arthabaska, Megantic and Beauce. Eleven producing mines are located at or near Thetford Mines, Black Lake, East Broughton and Asbestos.

The world's largest asbestos mine, the Jeffrey, is operated by Canadian Johns-Manville Company at Asbestos, Richmond county, 80 miles east of Montreal. Although originally an open pit mine, current production is principally from underground by the block caving method. An extensive construction program by the company resulted in the completion of a new mill in 1956 with an annual capacity of 625,000 tons of fibre. An addition to provide more primary milling circuits was under construction.

Asbestos Corporation Limited operates an underground mine, the King, at Thetford Mines, and three open pit properties, the Normandie in Ireland township, the British Canadian at Black Lake and the Beaver in Thetford Mines.

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 located at Thetford Mines.



Open pits are worked by Flintkote Mines Limited a few miles east of Thetford Mines; by Nicolet Asbestos Mines Limited at St. Remi de Tingwick; and by Quebec Asbestos Corporation Limited at East Broughton. The last-named was developing a major orebody in 1956 east of its present mine; a 2,000-ton mill under construction was expected to be in operation in late 1957. The property will be operated as Carey Canadian Mines Limited.

Lake Asbestos of Quebec Limited is preparing an orebody at Black Lake for production. The removal of silt and draining of the lake was well advanced at the end of the year and construction was in progress on the new 4,000-ton mill. Production was scheduled for the summer of 1958.

National Gypsum (Canada) Limited is developing an asbestos deposit east of Thetford Mines and preparing for production in 1958. A

3,000-ton mill was in course of erection in 1956. The property will be operated by a subsidiary, National Asbestos Mines, Limited.

Ontario

Canadian Johns-Manville operates an open-pit mine in Munro township, east of Matheson in northern Ontario, 160 miles north of North Bay. The fibre is particularly suited to the manufacture of asbestos-cement products. In 1956, the company was developing underground works preparatory to production by block caving.

British Columbia

Cassiar Asbestos Corporation Limited recovers long-fibred asbestos from a deposit on McDame Mountain in northern British Columbia. The fibre is shipped over the Alaska Highway to Whitehorse, on the White Pass and Yukon Railway to Skagway, and then by boat to Vancouver. Construction of an aerial tramway to transport rock from the mine to mill was completed in 1956.

World Review

Of the several countries which produce asbestos, Russia and Southern Rhodesia offer the greatest competition to Canada in world trade. World production for 1956 is estimated at 1,970,000 tons of which Canada contributed 51 per cent.

Russia is known to have extensive deposits of chrysotile in the Ural region and elsewhere. These have been developed to provide domestic needs and permit export of fibre of good quality to several European countries. Recent estimates place current production at 500,000 tons annually.

Union of South Africa, Southern Rhodesia, and Swaziland all produce considerable fibre. Most of the world's crocidolite, is mined in the Transvaal and Cape provinces of South Africa where amosite, a unique variety used in the manufacture of thermal insulation is also produced.

Southern Rhodesia produced 119,000 tons of long-fibre chrysotile in 1956. This fibre is low in iron and finds a ready market for weaving into textiles for electrical insulation.

Uses and Prices

Asbestos is an important raw material for many industrial uses. The longer fibres may be carded and spun in a similar manner to organic fibres. The yarn is woven into textiles for use as heat resistant friction materials, packing, electrical insulation and fire resistant cloth. An important part of current output is consumed by the asbestos-cement industry for the manufacture of pipe, shingle, tile, mill board, siding and other building materials. The durability and corrosion resistance of products of this industry has led to the widespread use of asbestos cement pipe in municipal water and sewerage systems. Asbestos is widely used in the manufacture of thermal insulation and asbestos papers.

The shorter grades are used in a variety of ways. Today the volume of asbestos classified as short fibre far exceeds all other grades combined. It is used in the moulding of plastics, manufacture of floor tiling, in the paint industry in the manufacture of protective coatings, and for other applications requiring a fibrous filler with the physical characteristics of asbestos.

The automobile industry uses a large quantity of asbestos products, including woven and moulded brake linings, clutch facings, and pressure gaskets. Undercoating compounds are an important use for very short grades of fibre.

The price of Quebec asbestos was unchanged during the year. Prices per short ton in U.S. dollars f.o.b. mines at the end of the year were, according to published information:

		$
Crude No. 1	-	1,400
Crude No. 2	-	750
Spinning fibre		
3K	-	480
3R	-	408
3T	-	383
3Z	-	353
Shingle stock	-	172 to 190
Paper stock	-	114 to 135
6D	-	82
Shorts	-	28 to 72

Prices of western asbestos per short ton f.o.b. Vancouver, U.S. funds:

		$
AAA	-	750
3K	-	460
4K	-	205
AC	-	300

BARITE

By V.A. Haw
Industrial Minerals Division

Another record was established in barite production for the year, with total mine shipments amounting to 320,835 tons valued at $3,031,034. Shipments in 1955 amounted to 253,736 tons. The increase, as in past years, was accounted for by requirements of the oil-well drilling industry in the United States, where a greater number of holes of increased depths were being drilled. About 90 per cent of the barite used for drilling muds in the United States is consumed in the Gulf areas of Louisiana and Texas where the principal markets for Canadian barite are located.

The same general pattern of trade was maintained during the year, with over 90 per cent of production being exported, mainly to the United States in the form of crude barite, which is ground in mills at Gulf ports for use in drilling muds. Some ground barite was also exported to South America for direct use. The United States tariff was lowered $0.15 per ton on crude barite, effective June 30, 1956, the first of three such cuts to be made in successive years. The tariff of $6.50 per long ton on ground barite entering the United States remains unchanged.

An upward trend in prices of about $3.00 per ton for all grades was noted in American markets. This places domestic crude in the United States (Georgia and Missouri crude) at from $16.00 to $18.00 per ton. Canadian firms do not quote prices for publication.

Only two companies produced barite in Canada in 1956, namely, Magnet Cove Barium Corporation (Canadian Division), operating one of the world's largest deposits at Walton, Nova Scotia, and Mountain Minerals Limited of Lethbridge, Alberta, which obtains its barite from a property near Brisco, British Columbia.

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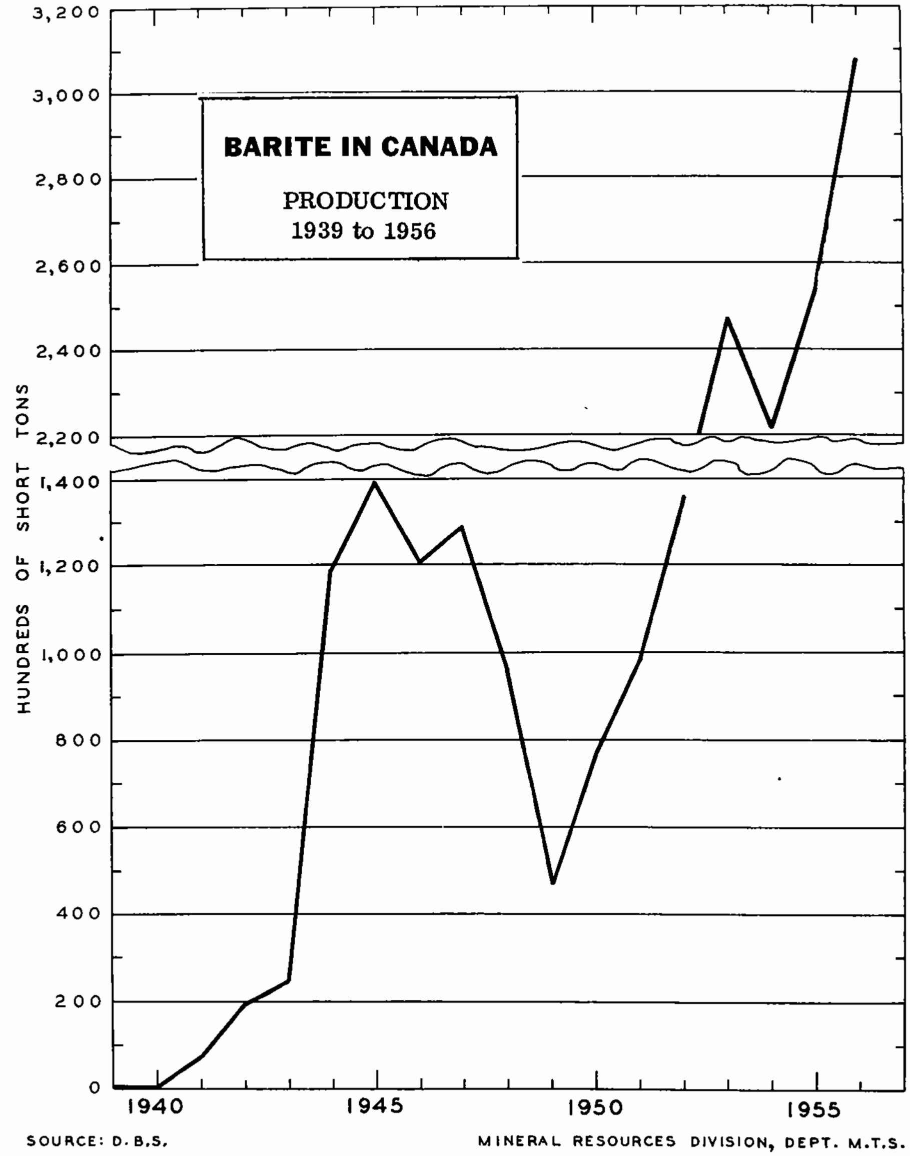
Barite

Barite - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production (Mine Shipments)				
Crude	243,398	1,721,571	182,195	1,182,831
Ground	77,437	1,309,463	71,541	1,094,335
Total............	320,835	3,031,034	253,736	2,277,166
Imports, ground				
United States.....	897	37,053	830	31,787
W. Germany	538	12,514	619	14,230
Italy	40	1,261	-	-
Total............	1,475	50,828	1,449	46,017
Exports[1], crude				
United States	240,650	1,707,597	187,355	1,364,285
Consumption				
Paints	869		963	
Rubber goods	492		537	
Glass	331		287	
Oil well drilling ..	12,000(e)		12,000(e)	
Asbestos products .	64		39	
Miscellaneous chemicals	93		96	
Total.............	13,849		13,922	

(1) Not recorded separately in the official Canadian trade statistics. The figures shown here are reported in the United States import statistics.

(e) = estimated.



Domestic Producers

Nova Scotia

Magnet Cove Barium Corporation operates the barite property near Walton at the head of the Bay of Fundy. The deposit is a massive body of barite, very pure in composition, but stained a reddish brown owing to the presence of iron oxides. Production has hitherto been from an open-pit operation that has reached a depth of over 300 feet. Underground development is well under way and all production will soon be obtained by block-caving methods. A new surface plant will be constructed to beneficiate lower-grade material. All production is shipped from Walton by boat.

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Barite

British Columbia

Mountain Minerals Limited operates a grinding plant at Lethbridge, Alberta, and a quarry at Brisco in the East Kootenay district. The deposit is a massive vein-type occurrence of very pure barite, somewhat discoloured, but by selective quarrying a high-quality white product may be obtained. The plant at Lethbridge produces ground barite mainly for use in well-drilling muds, although minor quantities are marketed for other uses in nearby areas.

Other Occurrences

A witherite (barium carbonate) deposit occurs in northern British Columbia at Liard River Crossing. The deposit is flat-lying at a contact between Devonian shales and limestones. Up to 20 feet in thickness, it is composed of an intimate mixture of witherite, fluorite, quartz, and barite. Two other noteworthy occurrences of barite are located in the Lake Ainslie district of Nova Scotia, and on McKellar Island in Lake Superior 25 miles from Port Arthur. Both have been under development in the past and are now being further investigated. Barite occurs in appreciable quantities near Brookfield, Nova Scotia; in Penharwood and Langmuir townships in Ontario; and near Parson, British Columbia. Many other occurrences have been found in Nova Scotia, New Brunswick, Quebec, Ontario and Manitoba.

World Sources

World production of barite is estimated at 3 million tons for 1956. The United States, by far the largest producer, accounts for about 45 per cent of the output. Other major producers in addition to Canada are: West Germany, Italy, Yugoslavia, France, and Russia.

Uses and Specifications

The principal use of barite is in oil-well drilling muds with bentonite and minor conditioning agents. In the United States, which consumes more than half the total world production of barite, about 75 per cent of the consumption is used in drilling muds. Barite is used also as a pigment and filler in paints, rubber, linoleum, and papers; in the manufacture of barium chemicals; as an additive to glass batches; as an aggregate in concrete where additional weight is required (such as in coatings for underwater pipes), or where shielding is required against radiation such as in X-ray rooms or atomic energy plants.

Specifications vary widely, depending on use and on agreement between producer and consumer.

In drilling muds, which are used to combat high pressure of gas and water in wells and to float drill cuttings, the specific gravity and grain size of the barite are important factors. The usual specifications require a minimum specific gravity of 4. 2, and a grind of 98 per cent minus 325-mesh. A minimum of 90 per cent $BaSO_4$ is also usually demanded. Soluble salts are objectionable because of their flocculating tendencies.

The chemical trade demands a minimum of 95. 0 per cent $BaSO_4$, with the Fe_2O_3 content not in excess of 1. 75 per cent. The material is required in lump form, and colour is not important.

As a filler for paints, rubber, paper, etc., an almost pure white colour is essential, and usually a grind of 200-mesh or finer is required. A minimum of 95 per cent $BaSO_4$ is specified.

For the glass trade, barite serves as a fluxing agent, deoxidizer, and decolourizer. For this purpose a minimum of 98 per cent $BaSO_4$ may be specified, and a very low iron content - about 0. 20 per cent or less. Grain sizes up to 20-mesh are required with a minimum of minus 200-mesh.

Barium Compounds

Barium compounds are used widely in industry. Barium carbonate is used to reduce "dry house" scum on bricks; in pharmaceuticals; as a flux in the enamelling and ceramic trades; and in heat-treatment compounds. The chloride is used as a pigment in lithographic inks; in the purification of salt brine and in water treatment; as a mordant in dyeing textiles; and in many other applications. Other compounds include the hydrate, phosphate, oxide, sulphide, stearate, and chlorate.

Imports and Consumption of Barium Compounds

	1956		1955	
	Short Tons	$	Short Tons	$
Imports of Barium Compounds				
Lithopone				
(70% $BaSO_4$)				
United Kingdom	1,001	159,453	549	69,547
United States	826	126,715	994	150,749
W. Germany	356	49,084	235	32,347
Other Countries	112	13,015	116	12,581
Total	2,295	348,267	1,894	265,224
Blanc fine				
(precipitated $BaSO_4$)				
W. Germany	191	12,497	299	19,473
United States	164	17,687	208	25,440
Belgium	55	4,059	68	5,415
United Kingdom	38	8,519	24	4,559
Total	448	42,762	599	54,887

Barite

	1955	1954
	Short Tons	Short Tons
Consumption of main barium compounds in chemical & allied products industry		
Barium chloride	258	259
Barium nitrate	80	77
Barite	1,058	1,976
Blanc fixe	450	250
Lithopone	1,893	2,707

Prices

Prices quoted in E&MJ Metal and Mineral Markets at the end of 1956 were as follows:

Canada: Crude in bulk, f.o.b. shipping point - $11.00 per long ton.
Ground in bags - $16.50 per short ton.

Georgia: Crude, jig, and lump - $18.00 per net ton.
Beneficiated - $21.00, in bulk, and $23.50 to $25.00 per net ton in bags.

Missouri: Water-ground and floated, bleached - $45.00 per ton.
Crude, min. 94% $BaSO_4$, less than 1% iron - $16.00 per ton.
Crude, oil-well drilling, min. sp. gr. 4.3, bulk - $11.50 per ton.

Tariffs

Canada

Barite	British preferential	- free
	Most favoured nation	- 25% ad. val.
	General	- 25% ad. val.
Blanc Fine	British preferential	- free
	Most favoured nation	- 10% ad. val.
	General	- 10% ad. val.
Lithopone	British preferential	- free
	Most favoured nation	- 12 1/2% ad. val.
	General	- 15% ad. val.

United States

Crude	- $2.85 per ton
Ground or otherwise manufactured	- $6.50 per ton
Precipitated barium sulphate or blanc fine	- 5/8¢ per lb.

BENTONITE

By R. M. Buchanan
Industrial Minerals Division

The term bentonite was originally applied to a clay material, with peculiar properties, found in the Fort Benton formation of Upper Cretaceous age, in Wyoming. It had a slippery feel when wet, swelled greatly in water and formed a colloidal suspension with well-defined thixotropic properties. The material was found to contain, principally, the clay mineral montmorillonite and was considered to be formed by the alteration of volcanic ash. In modern usage the term has been extended to cover any clay material in which the principal constituent is a member of the montmorillonite group of clay minerals. Usually it is found that it can be shown to be derived from volcanic ash but the term is also applied to montmorillonite clay of supposed hydrothermal origin.

There are two types of bentonite,(1) the sodium, or swelling bentonite and (2) the calcium, or non-swelling type. It is likely, however, that there is a continuous gradation between the two extremes and that the distinction is an artificial one.

In some cases certain properties are enhanced by ion exchange, usually of sodium for calcium, or by the treatment with acids (acid activation).

Production in Canada

Figures on the production of bentonite in Canada during 1956 are not available for publication but it is likely that there was a small increase over that of previous years. Although favourable strata occur from Manitoba to British Columbia and deposits of bentonite are numerous, current production comes from only two localities.

In Manitoba, Pembina Mountain Clays Limited, 945 Logan Avenue, Winnipeg, mines a non-swelling (calcium) bentonite near Morden, about 60 miles southwest of Winnipeg. The dried, crushed clay is shipped to the Winnipeg plant where it is ground and activated with sulphuric acid. The dried, ground bentonite possesses good oil decolourizing properties and the activated material compares favourably with the best imported bleaching earths. Most of the company's output is used for mineral oil clarification and the remainder is used for decolourizing vegetable and animal oils. The bentonite horizon from which the raw material is obtained is at the bottom of the Pembina member of the Vermilion River formation of Upper Cretaceous age.

Bentonite

For a number of years, Mr. G. L. Kidd has shipped raw, lump bentonite from the Drumheller area to the Alberta Mud Company, Limited, at Calgary where it is dried, ground and bagged. Most of this material is used as a carrier for the dusting agents in insecticides and other pesticides. A large portion is also used in diamond drilling through overburden, in foundry moulding sand and for sealing irrigation channels.

Canadian Occurrences

As mentioned above, the strata favourable to the occurrence of bentonite, i.e. Cretaceous or younger, are widely distributed in the western provinces. Numerous occurrences are known but types suitable, in their natural state, for some of the more important uses have not been found. No deposits are known east of Manitoba.

Manitoba

The bentonite horizon being exploited at Morden extends from the United States border northward to Miami, a distance of 35 miles. It varies in thickness, purity, and depth of cover but a favourable occurrence has been recorded, in a report of the Manitoba Mines Branch, on Deadhorse Creek (tp. 2, range 6, W. 1st mer). Other occurrences have been noted as far to the northwest as Swan River.

Saskatchewan

Several deposits of bentonite are known in Saskatchewan. Results of diamond drilling on some of them and of mechanical and chemical improvement tests have been published by the Saskatchewan Department of Mineral Resources. It has been shown that, although in the natural state none of the known material is suitable for oil-well drilling mud, improved material, in some cases, performed satisfactorily in drilling tests.

The largest known deposits of non-swelling calcium bentonite occur in the Vermilion River formation (Upper Cretaceous) in the northeastern part of the province, on the Swan River, north of Pelly. When activated, the material is a good oil decolourizer. Similar material is found in the Riding Mountain formation (later Upper Cretaceous) that underlies a large area in the eastern part of the province. Small deposits are known south of Moosomin but they are not considered to be of economic size. Other non-swelling bentonites, of Tertiary age, are found in the Ravenscrag formation west of Rockglen, in the south central part of the province.

A large deposit of 'semi-bentonite' is known at Knollys, along the Frenchman River valley in the Butler formation, of Upper Cretaceous age.

Swelling bentonites are found in the St. Victor-Pickthall area, in the southern part of the province, from Twelve Mile Lake eastward along the Big Muddy Valley. These are also in the Ravenscrag formation.

Alberta

A recent publication of the Alberta Research Council gives the results of an extensive survey of bentonite deposits in the province. In addition to the Kidd deposit from which current production is derived, there are several others in the Drumheller area, in the Edmonton formation (Upper Cretaceous). One of these, a thin parting in a coal seam, has proved to have fairly good drilling mud characteristics when tested. Generally speaking, however, Alberta bentonites, which are usually the swelling type, are not suitable for drilling mud, in the natural state. A five-foot bed of fair quality material is reported near Busby, north of Edmonton. In sediments of the Wapiti formation which closely resemble those of the Edmonton formation, a 4-foot bed of bentonite is found about 12 miles northeast of Grande Prairie. This deposit is considered to merit further investigation.

British Columbia

Tertiary formations favourable to the occurrence of bentonite are widely distributed in the interior plateau of British Columbia. The thickest known deposits occur near Princeton on the Copper Mountain branch of the C. P. R.; about 5 miles from Princeton on the same railway; and at Quilchena, 15 miles east of Merritt. Occurrences have also been reported at the mouth of Gorge Creek in the Deadman River valley, northwest of Kamloops; at 17 Mile House on the Cariboo Highway and in the banks of the Nechako River west of Prince George.

Uses

The non-swelling types of bentonite are used, in both the natural and activated conditions, almost exclusively for the filtering and decolourizing of mineral, animal and vegetable oils. Smaller amounts are used for the clarification of food products such as wine, vinegar, corn syrup and sugar.

The principal uses of the swelling types are in oil-well drilling fluids and in the moulding sand used in foundries. In drilling fluids, the bentonite serves to control the viscosity and to form an impervious cake on the wall of the hole, to prevent loss of the fluid to porous formations.

In addition to its major uses, swelling bentonites have a great variety of less important applications. They are used in the bonding and plasticizing of ceramic and refractory bodies; as the fillers 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 toiletries and medicinal preparations. The grouting of dams and irrigation channels and the prevention of seepage around the foundations of buildings are other significant uses. Treated bentonite is used as a desicant to prevent atmospheric moisture from entering packaged goods, and to coat small seeds to increase their bulk.

An application that will likely increase in future years is in the binder used in the pelletizing of iron ore concentrates. Usually, about 0.5 per cent of bentonite is added to the concentrate.

Consumption and Trade

The following table gives the latest available figures for bentonite consumption and imports. The statistics for consumption are not complete in that some of the smaller industrial users are not included and some of those included may not be completely covered. Estimates of the real consumption range as high as 50,000 tons per year.

Bentonite - Tràde and Consumption

	1956	1955
	$	$
Imports		
Activated clays for oil refining*		
United States	1,477,604	1,246,976
W. Germany	6,520	379
Total	1,484,124	1,247,355
Consumption	Short Tons	Short Tons
Steel foundries	6,701	4,786
Miscellaneous non-metallic mineral products	976	958
Soaps and cleaning compounds	876	622
Pulp and paper	188	346
Petroleum-refining	5,111	5,806
Oil-well drilling	11,271	12,216
Vegetable-oil mills	292	302
Polishes and dressings	1	4
Miscellaneous chemicals	199	1,103
Iron castings	2,019	934
Gypsum products	-	64
Asbestos products	528	480
Total	28,162	27,621

* Includes also kaolin used in petroleum refining.

Production and Consumption in United States

The latest statistics available for the bentonite industry of the United States are those published in a Mineral Industry Survey of the U. S. Bureau of Mines for the year 1956.

The amount of bentonite produced in the United States in 1956 amounted to 1, 570, 610 pounds valued at $18, 414, 807, an increase of 6 per cent in quantity and 7 per cent in value over 1955. Of the 14 states which contributed to this production, the 4 principal ones were: Wyoming (54% of total); Mississippi (14% of total); Texas (10% of total); and Arizona (8% of total).

Prices

The prices of bentonite vary within wide limits depending upon the grade and the amount of processing required. In the United States the price of domestic bentonite, according to the Oil, Paint and Drug Reporter, remained unchanged at $14. 00 per ton (minus 200 mesh, bagged, carload lots, at mines).

The prices of Alberta bentonite remained unchanged at $40. 00 per ton (90% minus 200 mesh, f. o. b. Calgary) and activated bentonite delivered to points in Ontario and Quebec sold at prices from $60. 00 to $80. 00, in carload lots.

BUILDING AND ORNAMENTAL STONE

By V. H. Haw
Industrial Minerals Division

The value of production of building and ornamental stone at $6.4 million was about the same as in 1955. Output of granite, limestone, marble and sandstone showed little change. No slate was produced in 1956, requirements being filled by imports.

Most of the output of granite, limestone and marble comes from the province of Quebec, whereas most of the sandstone for building purposes is produced in Ontario and Nova Scotia.

The value of imports of stone for building and ornamental use was about the same as in 1955. Imports of marble again came mainly from Italy which supplied about 70 per cent, and the balance from the United States. Essentially all imports of limestone consist of the well known "Indiana" variety. Imports of granite come from the United States, Sweden, and Finland, in the form of "rough", sawn, and manufactured products.

Production of Canadian granites for building purposes is fairly well established, and the many granite buildings in Canada bear witness to the excellent quality of material available. The granites quarried in many parts of Canada compare favourably with those produced elsewhere, and no difficulty should be encountered by architects or contractors in obtaining suitable material of almost any colour desired. Canada also produces a wide variety of monumental stone - the equal in quality of many of the imported stones - and this branch of the industry is growing steadily in spite of competition from the better-known, lower-priced imports.

In the stone industry, the term 'granite' covers all compact igneous rocks, as well as metamorphic rocks of igneous origin, adaptable to commercial use; thus, anorthosites, syenites, diorites, andesites, gneisses, and other related rocks are known to the trade under the general name 'granite'. 'Black granite' is merely a trade name employed to distinguish the darker-coloured commercial stones of igneous origin. These

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, 1955

	GRANITE		LIMESTONE		MARBLE		SANDSTONE		SLATE		TOTAL	
	S.Tons	$	S.Tons	$	S.Tons	$	S.Tons	$	S.Tons	$	S.Tons	$
Building Stone												
Rough......................	9,939	124,552	46,234	416,954	183	16,852	19,733	195,455	-	-	76,089	753,813
Dressed....................	17,389	1,754,058	41,968	2,368,569	420	96,600	1,798	130,772	-	-	61,575	4,349,999
Total......................	27,328	1,878,610	88,202	2,785,523	603	113,452	21,531	326,227	-	-	137,664	5,103,812
Monumental & Ornamental												
Rough......................	9,154	214,513	-	-	244	12,417	6,127	63,531	-	-	15,525	290,461
Dressed....................	5,491	925,358	-	-	-	-	-	-	-	-	5,491	925,358
Total......................	14,645	1,139,871	-	-	244	12,417	6,127	63,531	-	-	21,016	1,215,819
Flagstone	450	5,265	1,308	10,422	-	-	-	-	185	11,100	1,943	26,787
Curbstone	200	5,547	15	299	-	-	-	-	-	-	215	5,846
Paving blocks	202	1,474	-	-	-	-	-	-	-	-	202	1,474
Total......................	852	12,286	1,323	10,721	-	-	-	-	185	11,100	2,360	34,107
Grand total	42,825	3,030,767	89,525	2,796,244	847	125,869	27,658	389,758	185	11,100	161,040	6,353,738

PRODUCTION OF BUILDING AND ORNAMENTAL STONE, 1956

	GRANITE		LIMESTONE		MARBLE		SANDSTONE		SLATE		TOTAL	
	S.Tons	$	S.Tons	$	S.Tons	$	S.Tons	$	S.Tons	$	S.Tons	$
Building Stone												
Rough......................	6,781	129,458	41,612	416,007	76	608	29,481	231,223	-	-	77,950	777,296
Dressed....................	21,461	1,732,260	38,085	2,245,736	854	80,319	1,092	92,994	-	-	61,492	4,151,309
Total......................	28,242	1,861,718	79,697	2,661,743	930	80,927	30,573	324,217	-	-	139,442	4,928,605
Monumental & Ornamental												
Rough......................	8,988	224,699	-	-	8	800	-	-	-	-	8,996	225,499
Dressed....................	5,841	869,882	12	170	170	60,000	-	-	-	-	6,023	930,052
Total......................	14,829	1,094,581	12	170	178	60,800	-	-	-	-	15,019	1,155,551
Flagstone...................	425	5,000	3,495	33,339	-	-	8,291	149,383	-	-	12,211	187,722
Curbstone	5,767	167,785	4	76	-	-	-	-	-	-	5,771	167,861
Paving blocks	-	-	-	-	-	-	253	8,875	-	-	253	8,875
Total......................	6,192	172,785	3,499	33,415	-	-	8,544	158,258	-	-	18,235	364,458
Grand Total	49,263	3,129,084	83,208	2,695,328	1,108	141,727	39,117	482,475	-	-	172,696	6,448,614

IMPORTS & EXPORTS OF BUILDING, ORNAMENTAL AND MONUMENTAL STONE

	1956		1955	
	Quantity	$	Quantity	$
Imports				
Granite				
Rough, not hammered or chiselled	...	253,344	...	237,713
Sawn	...	102,812	...	84,140
Manufactures	...	299,395	...	339,935
Total		655,551		661,788
Marble				
Rough, not hammered or chiselled	...	129,910	...	122,108
Sawn or sand rubbed, not polished	...	384,001	...	366,860
Not further manufacutred than sawn, for the manufacture of tombstones	...	41,836	...	44,440
Ornamental or decorative	...	76,000	...	123,213
All other marble manufactures	...	114,000	...	69,727
Total		745,747		726,348
Slate				
Roofing (squares)	1,967	41,552	1,468	46,585
Manufactures	...	57,021	...	31,691
Total		98,573		78,276
Building stone other than marble and granite (short tons)	27,302	596,343	34,671	639,183
Total building, ornamental and monumental stone		2,096,214		2,105,595
Exports				
Granite and marble, unwrought (short tons)	10,544	217,196	6,019	92,796
Freestone, limestone, and other building stone, unwrought (short tons)	475	16,404	279	9,420
Stone of all kinds, dressed	...	112,599	...	21,161
Total	...	346,199	...	123,377

... means not available

rocks are rarely true granites in the petrographic sense. Stones so designated are not necessarily black, but may be of varying shades of dark grey or dark green.

In present day construction, structural or, as it is sometimes referred to, "dimension" limestone is used chiefly in larger buildings for exterior facing, window sills, lintels, entrances, etc. Mill blocks of limestone are quarried and prepared in slabs and other shapes cut to accurate dimensions to enable the stone to be set in place without further dressing.

Marble for dressing and use as ornamental stone in building construction is quarried at three centres in Quebec, the largest quarry being at Phillipsburg on Lake Champlain.

In dressing marble, the stone is sawn into slabs, matched, shaped and polished. Canadian production of such marble is only a small part of the country's requirements and the market is mainly supplied by imports from Italy and the United States in the form of mill blocks or sawn slabs which are finished in Canadian marble-dressing plants.

Sandstone used for building stone is quarried principally in the Maritime Provinces and Ontario, although a few small operations elsewhere furnish stone for local consumption.

General Requirements

In prospecting for raw materials, the first requirement is that blocks of sufficiently large size must be obtainable. In sedimentary rocks (limestones, sandstones and marbles) the beds must be thick, i.e., at least 18 inches for marble and two feet for building stone, and be free from other structural features so as to allow for the removal of sound durable blocks of 5 feet or more in length. In granites, the spacing of joints is likely to be critical, and here again other planes of weakness or disfiguring features must be widely enough spaced to obtain the required size of mill block.

For building purposes all types of stone must have an even texture, be of uniform composition, and have a pleasing and lasting colour. Iron is at all times an objectionable constituent because it may cause disfiguring stains. For massive structures a coarse-textured stone may be used with pleasing effect, although the finer-textured stones are also used. Building stone must be durable to withstand weathering conditions -- particularly the freezing and thawing conditions of Canadian climates. This is particularly true of the more porous limestones and sandstones.

For ornamental stone used in polished form in base courses of buildings, pillars, and monuments, specifications as to texture, colour, and freedom from flaws are more rigid. All cracks, knots, hair lines, and iron spots should be absent. The stone must be capable of taking and retaining a high polish, and there must be a good contrast between the polished and hammered or sandblasted surfaces.

Producing Areas

Nova Scotia

Granite - The granites are mainly grey and are medium to coarse in texture. Black diorite is also available. Grey granite is produced in the Nictaux and Shelburne areas, and black from near Shelburne. Most of the production is for the monumental trade.

Sandstone - The oldest and perhaps the best known sandstone quarry in Canada is near Wallace on the north coast. The stone is an olive drab to buff and occurs in beds up to 22 feet in thickness. It is widely used as building stone and as armour stone for breakwaters. Some fine-grained dark-brown sandstone is produced near North Grant in Antigonish county.

New Brunswick

Granite - Granite suitable for quarrying occurs in a number of places and a wide variety of textures and colours are available. At present, operations are confined to the Hampstead district where a pinkish-grey granite is being quarried, and to the Autinauri Lake district which produces a pink variety. The Hampstead granite is used mainly for monumental work, and the Autinauri Lake granite entirely for building stone.

Sandstone - A small production of sandstone was reported from the Shediac and Quarryville districts in 1956. The stone is olive green to greenish and is fine to medium grained. It is used for building and as rip-rap for causeways.

Quebec

Granite - Quebec has been the leading producer of granite in Canada for many years. Most of the production comes from the Eastern Townships south of the St. Lawrence River where a highly developed industry is based on the production of a light grey granite. North of the river, the resources of granite are more varied but the industry is less developed.

In the Eastern Townships light grey granites of Devonian age are produced from the Stanstead, Stanhope, Scotstown, St. Gerard, St. Samuel, and St. Sebastien areas. At Mount Johnson, a darker, bluish-grey granite of medium to coarse texture is produced. North of the St. Lawrence a much wider variety of granites is available, namely: blacks, pinks, reds and browns of the Lake St. John region; the reds, greens and greys of the Rivière-à-Pierre district; the pinks of Guenette; the bonded gneisses of St. Raymond; the pinks and blacks of Rouyn, and the reds and greens of the Grenville area.

Limestone - At St. Marc des Carrier in Portneuf county three companies are producing dimension stone from the Trenton formation of Ordovician age. It is a brownish-grey, medium-grained, high-calcium limestone which finds wide application in building construction. All companies operate dressing plants at the quarry locations just west of the village. Several small quarries are operated in the Montreal area for production of hand-trimmed stone used in residential construction.

Marble - Most of the production from the aforementioned quarry near Phillipsburgh consists of a grey variety although shades of green and black are also produced. The operating company dresses imported marbles and other stone in addition to its own material. Two other companies also produce marble; one, just southwest of the village of North Stukely, is quarrying a mottled white marble, and the other a green and red type from a quarry north of Mount Orford in Shefford county.

Ontario

Granite - In recent years the only production has come from River Valley, about 45 miles northwest of North Bay, where a black granite is produced; from near Lyndhurst in eastern Ontario where small quantities of red granite have been quarried; and from the Vermilion Bay area in the Kenora region which produces a pink variety.

Sandstone - Sandstone has been quarried for many years for use as building stone near Ottawa and in southern Ontario. Near Ottawa, the Nepean sandstone is medium-grained, buff to cream coloured, and occurs in rather thin beds. Most of it is used in residential construction. The Medina sandstone which is quarried in Halton and Peel counties in southern Ontario is also used almost wholly for residential construction. It is a fine- to medium-grained stone which occurs in colours ranging from red to grey to white.

Limestone - One of the best known building stones in Canada is the Queenston dolomite of the Lockport formation which is quarried near Queenston in the Niagara area. It is a silver-grey and variegated buff and grey medium-grained stone, widely used in eastern Canada for building construction.

Marble - A black marble is produced near St. Albert, southeast of Ottawa, in the form of mill blocks. It has been used as ornamental building stone but has been produced mainly for use as terrazzo chips.

Manitoba

Granite - Only a very small production of grey and black granite has taken place from near West Hawk Lake, about 100 miles east of Winnipeg.

Limestone - Three companies operate quarries at Tyndall, Manitoba, where a very popular and distinctive stone of mottled buff and grey is produced. It is used in exterior and interior finishes as it takes a most pleasing polish.

British Columbia

Granite - The predominant types being quarried are grey granites of varying shades, but in a few localities stone of other colour has been worked in a small way. At Nelson Island, a high-quality light-grey granite is produced, and at Haddington Island an andesite is quarried which is quite popular on the West Coast. In the interior, stone production is small and intermittent and confined to areas near Nelson and Sirdar.

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CEMENT

By V.A. Haw
Industrial Minerals Division

During the year the Canadian cement industry experienced the greatest period of growth in its history. Production rose from about 25 million barrels a year at the end of 1955 to almost 29 million at the end of 1956, while value of production increased from about $66 million to more than $75 million. In addition to breaking production records, the industry embarked on a $100 million capital expansion program which when completed near the end of 1957 will have increased annual production capacity to about 42 million barrels. With the culmination of this expansion program, it can be reasonably assumed that Canada will no longer be plagued by the perennial cement shortage which has existed for so many years.

The increased production came from four new plants brought into operation during the year - one each at Clarkson and Woodstock in Ontario, Regina in Saskatchewan, and Edmonton in Alberta. In addition, plants at Montreal in Quebec, and St. Mary's in Ontario, were enlarged. In the past decade the industry has trebled its production facilities in the attempt to meet increasing demand. In 1957 -- with construction underway at the end of 1956 -- new plants will be completed at Picton, Ontario, and Lulu Island, British Columbia, and a further five plants will increase capacity.

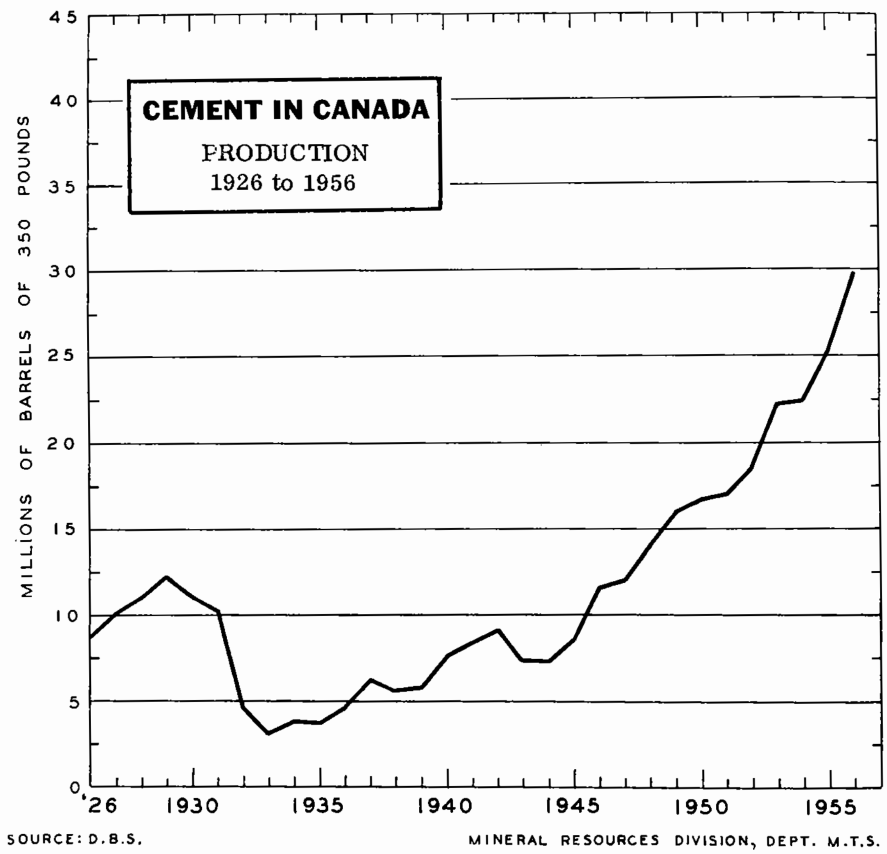
It was still necessary to import cement during the year, and the amount remained about the same as for 1955 -- between 3 and 3 1/2 million barrels valued at slightly over $8 million. In addition, clinker valued at over a million dollars was imported for grinding, which included 14,943 tons for the production of white cement. Exports of cement amounted to 711,775 barrels valued at $1,984,908, which represents a drop of about 26 per cent from the previous year.

Consumption

Cement requirements follow closely the general level of construction. With increases in 1956 in all sections of the construction industry consumption of cement jumped to 31,409,981 barrels from 27,162,649 in 1955. Industrial, commercial, and engineering construction accounted for most of the increase. Residential housing suffered a set-back in the last six months although it was still able to show a small increase over the whole year. Figures now available for 1957 show a further increase of 10.4 per cent in value of total construction over 1956. The resulting increase in demand for cement was largely satisfied by the expanded capacity of Canadian cement plants.

Cement - Production, Trade and Consumption

	1956		1955	
	Barrels of 350 lb	$	Barrels of 350 lb	$
Production	28,695,331	75,233,321	25,168,464	65,650,025
Exports				
Portland cement				
United States	711,017	1,982,298	964,885	3,138,343
Other countries	758	2,610	300	1,155
Total	711,775	1,984,908	965,185	3,139,498
Cement N.O.P and cement manufactures				
United States		62,917		46,577
India		19,302		8,848
Other countries		53,885		84,744
Total		136,104		140,169
Imports				
Portland cement				
Czechoslovakia	705,546	836,437	-	-
Poland	613,921	1,091,289	-	-
United States	584,791	2,343,702	696,349	2,735,975
United Kingdom	483,019	1,240,183	867,956	2,081,167
W. Germany	430,903	1,107,794	1,076,917	2,700,906
Sweden	378,091	892,723	111,148	236,911
Other countries	230,154	566,206	207,000	688,456
Total	3,426,425	8,078,334	2,959,370	8,443,415
Clinker				
Belgium	445,670	714,878	-	-
United States	85,466	295,733	78,928	254,624
Total	531,136	1,010,611	78,928	254,624
Cement manufactures				
United States		239,705		159,018
Other countries		14,308		76,879
Total		254,013		235,897
Apparent Consumption (Exclusive of clinker)	31,409;981		27,162,649	



In addition to the cement being used directly in engineering and building construction, increasingly larger amounts are being used in the concretes products industry - concrete block, brick, pipe, ready mix concrete, and other miscellaneous items. Gross selling value of these products amounts to $155,369,190 compared to $133,826,687 in 1955. Ready mix concrete accounted for the major portion of the increase. Value of the cement used in 1956 for the manufacture of concrete products amounted to $38,155,502, slightly more than half the total cement produced.

Cement

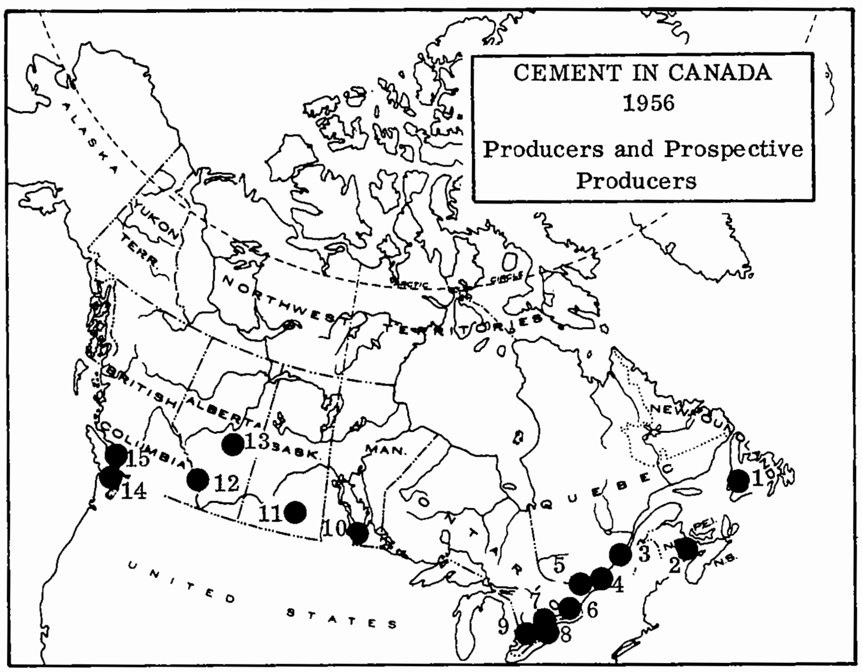
The following table details the expansion program undertaken by the industry.

Company	Plant Capacities Total End of 1956	 Planned for 1957	 Projected Total End of 1957
	bbl	bbl	bbl
Canada Cement Company			
(2)* Havelock, N.B.	800,000	800,000	1,600,000
(4) Montreal, Que.	6,000,000 plus 1,500,000**		7,500,000
(5) Hull, Que.	1,100,000		1,100,000
(6) Belleville, Ont.	4,000,000		4,000,000
(8) Port Colborne, Ont.	1,200,000		1,200,000
(9) Woodstock, Ont.	1,500,000**	1,500,000	3,000,000
(10) Fort Whyte, Man.	3,000,000		3,000,000
(12) Exshaw, Alta.	3,000,000		3,000,000
North Star Cement Limited			
(1) Cornerbrook, Nfld.	600,000		600,000
Le Ciment Quebec			
(3) St. Basile, Que.	700,000		700,000
St. Lawrence Cement Company, Ltd.			
(3) Villeneuve, Que.	1,500,000		1,500,000
(9) Clarkson, Ont.	1,500,000**	1,500,000	3,000,000
St. Mary's Cement Company Limited			
(9) St. Mary's, Ont.	2,300,000 plus 700,000**		3,000,000
Saskatchewan Cement Corp. Limited			
(11) Regina, Sask.	800,000**		800,000
Inland Cement Company Limited.			
(13) Edmonton, Alta.	900,000**	900,000	1,800,000
British Columbia Cement Co. Limited			
(14) Bamburton, B.C.	2,200,000	800,000	3,000,000

* Numbers in brackets refer to map locations.

** Installed 1956.

Company	Plant Capacities		
	Total End of 1956	Planned for 1957	Projected Total End of 1957
	bbl	bbl	bbl.
Lake Ontario Portland Cement Co. Limited			
(6) Picton, Ont.		1,800,000	1,800,000
Lafarge Cement Company Limited.			
(15) Lulu Islands, B.C.		1,300,000	1,300,000
Totals	33,300,000	8,600,000	41,900,000



Specifications and Prices

The great bulk of cement manufactured in Canada is of Type I which is that used in general construction. High early strength (Type III) and sulphate-resisting cement (Type V) are also produced and are readily available, as is also masonry and air-entraining cement. When particular projects, such as large dams, require moderate to low heat-of-hydration cement, plants normally have to make special runs. These types and varieties of cement are sold under the trade names of various companies.

Prices are reported to have remained essentially unchanged during the year, except for some slight regional variations. Value per barrel (350 lb) based on production statistics is $2.62.

CLAYS AND CLAY PRODUCTS

By S. Matthews
Industrial Minerals Division

During 1956 the output of clay products from domestic and imported clays increased by approximately $5 million over that of 1955. This is attributed mainly to the brisk demand for ceramic products used in construction, such as building brick, structural tile, sanitary ware, sewer pipe, floor and wall tile, flue liners, etc. The demand for refractories, particularly high-temperature types, has also shown a marked increase. Production of high-tension electrical insulators continues at a high level.

The expanding state of the clay products industries is indicated by the number of new plants in operation or being built. Construction was completed on a plant for production of basic refractories in Ontario and on two structural clay products plants, one in Nova Scotia and the other in Quebec. In Ontario, a fully modern plant for the manufacture of building brick commenced production in 1956. Construction was started on a new sewer pipe plant in Saskatchewan and on a sanitary ware plant in British Columbia. Several well-established plants in the structural clay products and refractories industries plan to improve their equipment and increase production.

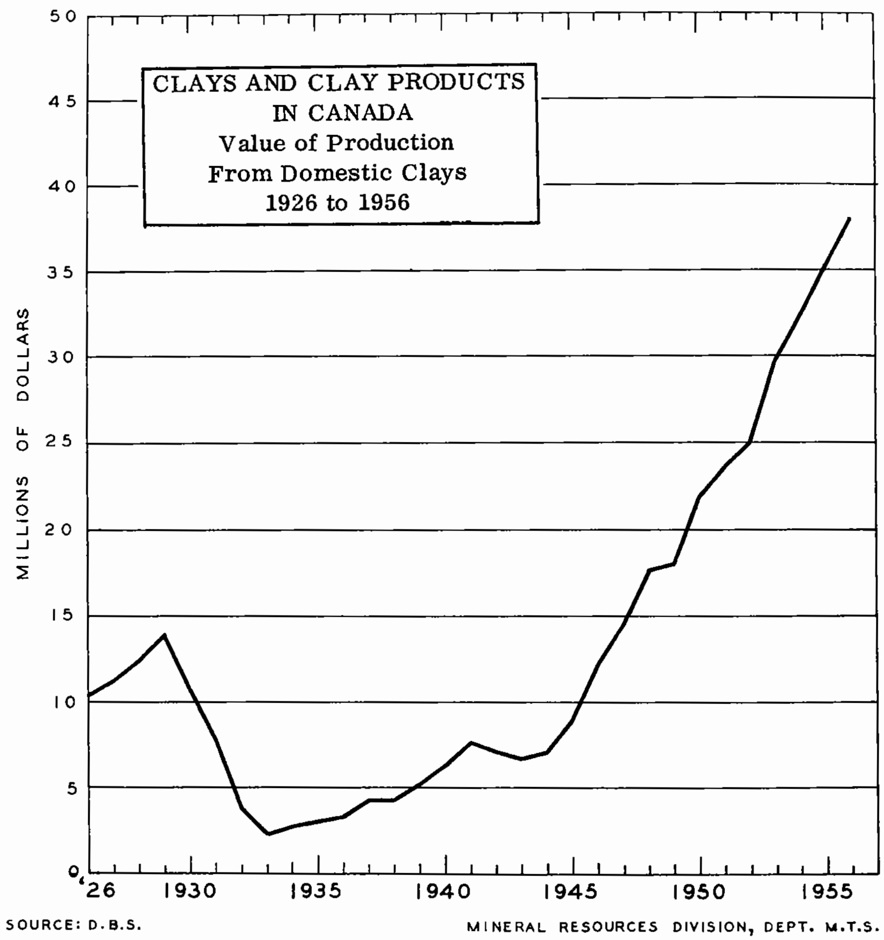
Imports of clays and clay products, particularly the latter, show a substantial increase over 1955. A portion of these imports includes special types of refractories not made in Canada, chiefly because suitable raw materials from domestic sources are not available. Producers of fireclay refractories in Ontario and Quebec import their raw materials. China clay is imported for use in whiteware, which includes tableware, sanitary ware, electrical porcelain, floor and wall tile, etc. China clay is also used in the paper and rubber industries. Large quantities of ball clay for use in whiteware bodies, particularly in Eastern Canada, are also imported. Quantities of bleaching clays and bentonites are imported for use in oil refineries and as drilling muds.

Common Clays and Shales

Clays or shales suitable for the production of good quality building brick and tile occur in all provinces and adjacent to the thickly populated areas. Raw materials of this type cannot be transported economically for long distances, as the cost would be prohibitive. The better grades of clays are not plentiful, but new sources are continually being sought, as indicated by the large number of samples submitted to the Mines Branch for investigation.

Clay and Clay Products - Production and Trade

	1956	1955
	$	$
Production from domestic clays		
Clays including bentonite	457,638	521,919
Clay products		
From: Common clays	31,001,923	28,913,159
Stoneware clays	4,553,847	4,731,121
Fireclays	902,005	820,817
Other products	869,567	272,754
Total	37,784,980	35,259,770
Production from imported clays		
From: Stoneware clays	919,697	884,997
Fireclays	3,131,137	2,783,536
China clay	16,899,680	14,725,857
Total	20,950,514	18,394,390
Grand total	58,735,494	53,654,160
Imports		
Clay		
Fireclay	542,167	421,205
China clay	2,002,154	1,902,470
All other, including activated, filtering, and bleaching clays	2,081,060	1,726,341
Total	4,625,381	4,050,016
Clay products		
United States	28,801,890	23,040,013
United Kingdom	15,263,875	13,878,775
Other countries	3,693,882	2,893,679
Total	47,759,647	39,812,467
Exports		
Clay		
United States	146,736	93,681
Other countries	2,025	1,004
Total	148,761	94,685
Clay products		
United States	2,158,175	1,654,546
W. Germany	221,178	95,601
Union of South Africa	148,939	72,244
Belgium	145,391	96,990
Brazil	67,949	75,255
New Zealand	46,778	71,958
Other countries	403,761	492,416
Total	3,192,171	2,559,010



Investigations on Canadian clays or shales for making lightweight aggregate were continued in the Mines Branch. In 1956 nine plants were in operation, most of them in Western Canada. Production of lightweight aggregate during the year was valued at $1,190,500.

Stoneware Clays

Southern Saskatchewan is the main Canadian source of stoneware clay. The clay is selectively mined and is shipped to Medicine Hat, Alberta, for making sewer pipe, brick, crockery, etc. Quantities are also shipped to Regina, Saskatchewan, for making sewer pipe.

The stoneware clays or semi-fireclays that are associated with the fireclays in the Sumas Mountain, near Vancouver, British Columbia, are utilized on a large scale for making sewer pipe, flue liners, and other stoneware products. This type of clay is also found in British Columbia near Williams Lake and Chimney Creek Bridge. Deposits of clay suitable for making stoneware products, sewer pipe, and buff face brick occur in Manitoba near Swan River and Pine River. Ontario and Quebec import their requirements of stoneware clay.

The stoneware clays that occur near Shubenacadie and Musquodoboit, Nova Scotia, have been used over the past years on a limited scale for the production of pottery, certain stoneware products, and low-temperature refractories. The recent opening of the Shubenacadie deposit on a large scale made available a source of material that is being used in the manufacture of buff face brick.

Fireclays

Two large plants, one in British Columbia and the other in Saskatchewan, manufacture refractory products from domestic fireclays. The plant in British Columbia is about 50 miles southeast of Vancouver and obtains its raw material from the clay beds in the Sumas Mountain by underground mining. Several smaller plants in the Vancouver area derive all or part of their raw materials from the same source. Some of this material is exported to the United States for use in making refractories. The plant in Saskatchewan is at Claybank, about 40 miles southeast of Moose Jaw, and utilizes the highly plastic refractory clays from the Whitemud beds in that area by selective open-pit mining.

The clay found at Musquodoboit, Nova Scotia, is suitable for the production of stove linings and for certain foundry purposes. Several seams in the recently opened deposit at Shubenacadie have been found suitable for the manufacture of moderately high-temperature refractories.

The relatively extensive deposits that occur in the James Bay basin on the Mattagami, Missanabi, Moose, and Abitibi rivers in northern Ontario have not been developed commercially owing to their remoteness and to difficulties in extracting uniform, high-quality material.

A deposit of kyanite near Sudbury, Ontario, has proved to be a very valuable material for the production of superduty and high-alumina refractories. Further research on the kyanite concentrate was carried out in the Mines Branch, and continued interest was shown in its development.

Producers of fireclay refractories in Ontario and Quebec import their raw materials. Fireclays imported from the United States enter Canada duty free if not processed further than grinding.

China and Ball Clay

China clay is an essential raw material in making such ceramic products as electrical insulators, sanitary ware, tableware, and floor and wall tile. Large quantities are also used by the paper industry for coating and filling. The only production of china clay in Canada on a commercial scale was at St. Remi d'Amherst, Papineau county, Quebec, several years ago, but this project was abandoned because of the mining and operational difficulties. Several other deposits of kaolinized material occur in Quebec, one being near Point Comfort, Thirty-one Mile Lake, and the others near Brebeuf, Lac Labelle, and Chateau Richer. Exploratory work, however, indicates that none of these are of sufficient size and uniformity to warrant development.

About 25 miles north of Prince George, British Columbia, are deposits containing rather high-grade clay of the china clay type. The beds are variable in quality, however, and the extent and uniformity of the high-grade material present has not been definitely established.

The Saskatchewan Government has carried out an extensive program of exploration of its ball-clay resources in the southern part of the province. A considerable amount of work was also carried out on the recovery of kaolin from kaolinized sand in the Whitemud formation. These projects were designed to expand the markets for Saskatchewan clay.

DIATOMITE

By E.G. De Wolfe
Industrial Minerals Division

Although diatomite has been produced in Canada since 1896, production has been very small. In fact, the total output since that date is equivalent to little more than the current annual consumption. In 1956, 2 tons of diatomite were mined from a deposit near Quesnel, British Columbia.

Domestic requirements are met mainly by imports, largely from the United States, with minor amounts from other countries, mainly Denmark. The gradual rise in imports during the past several years is largely attributable to the steadily expanding Canadian economy.

Diatomite - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production (sales)	2	40	16	352
Imports				
United States..........	21,047	887,454	22,133	787,651
Denmark	30	636	24	852
Total	21,077	888,090	22,157	788,503
Consumption*				
Fertilizer dusting	10,000		9,652	
Filtration............	9,000		8,726	
Fillers...............	3,000		2,626	
Insulation	175		169	
Miscellaneous	100		90	
Total	22,275		21,263	

* Estimated from information supplied to the Mines Branch by distributors and consumers.

80486-4—18

Diatomite

Canadian Occurrences

The largest known deposits of diatomite are in the Quesnel area of British Columbia, along the banks of, and adjacent to, the Fraser River. They are of freshwater origin, Tertiary age, and occur in compact beds up to 40 feet thick. The diatomite is white to cream in colour, practically free from grit and vegetable matter, and composed mainly of the skeletal remains of small barrel-shaped diatoms. Minor amounts of this diatomite, from time to time, have been used for insulation and concrete admixture purposes, in the Vancouver area. The dried, ground material appears suitable for fertilizer dusting, insulation, and filler purposes, but transportation difficulties have hindered development of the deposits. The diatomite does not appear to be suitable for good grade filtration material.

There are several hundred known small occurrences of bog diatomite in Canada. These consist of grey, to brown, to black, mud, or peat, in bogs, or on the bottoms of ponds in Nova Scotia, New Brunswick, Quebec, Ontario, and British Columbia. The deposits are of Recent origin, and are forming at the present time. Deposits of this type cannot be operated economically on a large scale, but with treatment, usually calcining, marketable grades of diatomite are produced. Production has been quite small and limited mainly to Nova Scotia, which has accounted for over 90 per cent of the Canadian output.

Production in Nova Scotia has been from various small lakes, but is now confined to a 20-foot thick deposit on Digby Neck, which is worked only sporadically. During recent years shipments have been made from a stock-pile of calcined material on the property.

World Production

World production runs at about 650,000 tons, of which over half comes from the United States. California is the leading producer, followed by Oregon, Nevada and Washington. United States reserves of diatomite for all uses appear adequate for many years. Among the many other producing countries are: Denmark, Algeria, West Germany, France, Great Britain, and Australia.

Uses and Specifications

Diatomite, also known as diatomaceous earth and keiselguhr, consists of microscopically small, opaline silica, skeletal remains of organisms known as diatoms. The purest varieties of diatomite are chalklike in appearance, free from grit, porous, and friable and have an apparent specific gravity under one when dry.

It is the physical properties of porosity and chemical inertness that account for most of the uses of diatomite. The principal uses are as a filtering medium, filler, and as an insulator against heat, cold and sound. Diatomite is important in many industries, such as sugar refining, liquor distilling, dry cleaning and water purification. For filtration the important considerations are size and shape of principal diatoms present, purity, and density of the consolidated material.

Diatomite is used as a filler in rubber, paper, asphalt products, plastics, explosives, insecticides, paints, and many other products. It is used as a concrete admixture and as the mild abrasive in metal polishes and dentrifices. Important properties of diatomite to be considered for such uses include: color, freedom from grit, low density, inertness, and particle size. Diatomite imparts bulk with little increase in weight, along with certain desirable physical properties to the end products.

It is being used successfully as insulation in a wide variety of applications, some of these being: boilers, kilns, furnaces, retorts, ovens, fire-resistant safes, chill rooms, ice cellars, cold storage, and building walls. The important properties when used as insulation are porosity and structure and freedom from solid impurities.

Acceptance of diatomite by consumers depends mainly upon the physical properties of the mineral in relation to its intended use. Microscopic examination can determine, in a general way, to what uses any particular material may be put.

The major Canadian use is in the manufacture of fertilizer, where it is used to coat pellets to prevent caking and sticking. The diatomite should be uncalcined, 95 per cent minus 325-mesh, with less than 5 per cent moisture content. The next major use is in filtration in sugar and brewing industries.

Prices

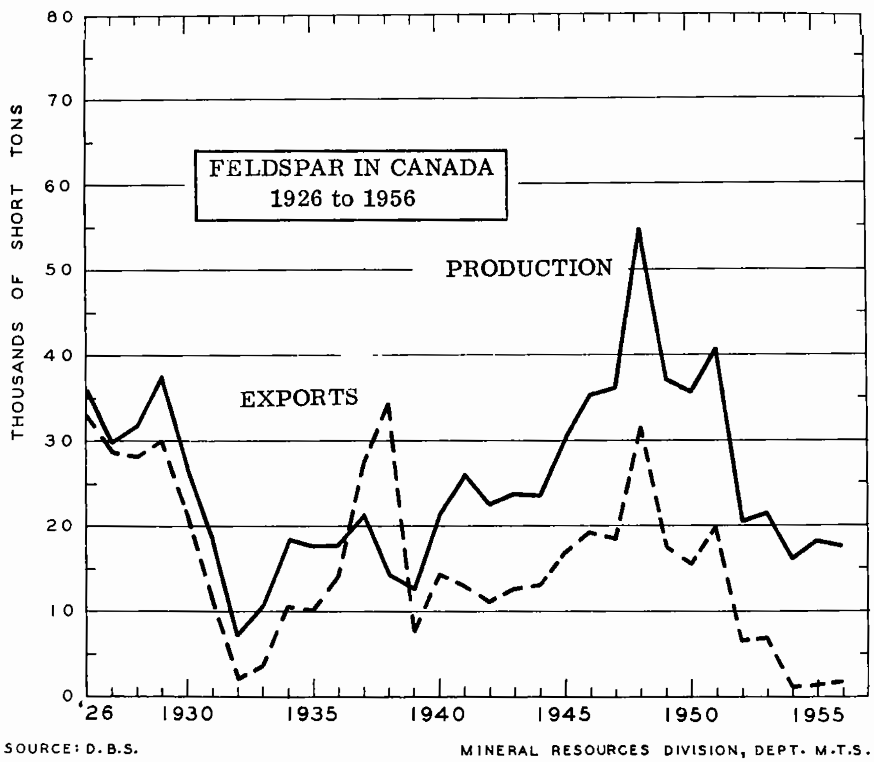
Prices for diatomite vary widely according to type and grade and the quantities purchased, and they range from $40 to $175 per ton, depending upon quality, quantity, and point of sale. They have shown little fluctuation for several years.

80486-4—18½

FELDSPAR

By J. E. Reeves
Industrial Minerals Division

The volume of Canadian feldspar production in 1956, all from the province of Quebec, was essentially the same as in 1955, although the value increased by a small amount.



Exports in 1956, although somewhat higher than in 1955, were only a small fraction of those of most years between 1926 and 1951. Almost all the exports go to the United States, which obtains most of its imports of feldspar from Canada. Canadian exports are largely a high-quality feldspar with a unit value appreciably higher than the average value of the large United States production. The increased use since 1951 of flotation in that

Feldspar - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production				
Quebec	18,153	364,849	18,152	355,879
Imports				
Ground				
United States	196	4,530	137	3,106
Crude				
United Kingdom	5	228	-	-
Total	201	4,758	137	3,106
Exports				
United States	1,771	45,464	1,419	37,553
W. Germany	33	2,904	7	572
Total	1,804	48,368	1,426	38,125
	1955		1954	
Consumption				
Glass	4,993		4,612	
Cleansers	1,385		1,399	
Abrasives	13		11	
Clay products	6,356		5,839	
Enamelling	941		874	
Heating & cooking apparatus	*		166	
Iron castings	*		22	
Electrical apparatus	744		767	
Total	14,432		13,690	

* not reported

country for beneficiating low-grade deposits, has reduced the amount of high quality material imported from Canada. Also, the markedly increased use of nepheline syenite, especially in glass making in the United States, has cut deeply into the use of feldspar for that purpose.

Producers

Canadian Flint and Spar Department of International Minerals and Chemical Corporation (Canada) Limited was again the largest single producer of high-grade crude feldspar, and operated its grinding mill at Buckingham, Quebec, about 20 miles northeast of Ottawa. The ground spar is produced mainly for the domestic pottery, glass, enamelling and cleanser trades. Mill feed was drawn from the company's own and several smaller mines in Derry, Buckingham and Portland West townships, all within a few miles of the mill.

Bon Ami Limited, Montreal, purchased crude feldspar and produced ground material for its own use.

Spar-Mica Corporation Limited, Montreal, is planning production from a pegmatite deposit on the north shore of the St. Lawrence River, at Baie Johan Beetz opposite Anticosti Island. A mill, with a capacity of about 300 tons per day of glass-grade feldspar, is under construction and is scheduled for production in mid-1957. The company plans to export by water to the eastern United States and Europe.

In the production of the lithium mineral spodumene from pegmatite deposits, a large amount of associated feldspar is encountered. The possibility of making a marketable material was realized, and during the latter part of 1956, Quebec Lithium Corporation announced its intention to produce first-quality feldspar as a flotation by-product at its plant near Barraute, Quebec, about 275 miles northwest of Montreal.

Uses and Specifications

Feldspar is used chiefly by the ceramic industry in the manufacture of glass, pottery, and enamelware and by the cleanser trade in making scouring soaps and powders. Some select material is used in the manufacture of artificial teeth.

For ceramics, feldspar is classified as potash spar or soda spar and is graded in either category as No. 1 Ceramic or No. 2 Ceramic according to purity. To qualify as No. 1 Ceramic, feldspar should contain less than 0.06 per cent iron or other colouring oxides and under 5 per cent quartz. For No. 2 Ceramic, the iron content must be low but more latitude is permitted with respect to quartz. Colour is of no importance in either grade.

For cleansers, the material should be grit-free and approach a good white colour. Either potash or soda spar is acceptable.

Dental spar is potash spar of high purity, selected by the trade according to its firing characteristics. Up to 0.10 per cent iron oxides is tolerated but there must be a complete absence of tourmaline, biotite, and any other dark mineral that will leave specks in the product.

Markets and Prices

International Minerals and Chemical Corporation (Canada) Limited, 77 Metcalfe St., Ottawa, is the principal purchaser of crude feldspar of all grades in Canada. Bon Ami Limited, 13719 Notre Dame St. E., Montreal, purchases white spar for cleanser use.

Buyers of dental-grade spar include: Myerson Tooth Corporation, Cambridge, Massachusetts; Dentists' Supply Company, 220 W. 42nd St., New York, N.Y.; and Universal Dental Company, Brown at 48th St., Philadelphia, Pa.

Prices for ceramic grade crude spar are about $10.00 per short ton for No. 1 and $7.00 for No. 2, f.o.b. rail.

United States prices at the end of 1956, according to E. & M. J. Metal and Mineral Markets, were:

200-mesh $18.50 per ton, f.o.b. point of shipment, North Carolina.
325-mesh $22.50 per ton
Glass, No. 18 grade $12.50 per ton
Semi-granular $11.75 per ton.

FLUORSPAR

By E.G. DeWolf
Industrial Minerals Division

Canada was, until 1949, a very minor producer of fluorspar. Many deposits were known to exist, but because of remoteness from markets or low grade it was not economical to operate them extensively except in cases of national emergency. However, with the accession of Newfoundland to the Canadian Confederation in 1949, Canada became an important source, and in 1956 was in fourth position as a world producer. The graph on page 277 indicates the output since 1929.

Fluorspar - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production (shipments)				
Newfoundland	139,801	3,395,061	127,384	2,678,641
Ontario	270	12,521	730	29,796
Total	140,071	3,407,582	128,114	2,708,437
Imports				
Mexico	26,523	644,741	9,690	233,703
United States	1,566	43,431	2,825	92,350
United Kingdom	59	2,607	289	11,889
Spain	-	-	5,815	111,053
Union of South Africa	-	-	3,155	60,007
Total	28,148	690,779	21,774	518,002
Exports				
United States	78,380	1,941,500	58,390	1,460,844
	1955		1954	
Consumption				
Heavy chemicals	76,452		68,592	
Steel furnaces	18,979		18,610	
Glass	669		592	
Enamelling and glazing	100(e)		97	
White metal alloys	26		36	
Total	96,226		87,927	

e = estimated

Fluorspar

Fluorspar is a non-metallic mineral, calcium fluoride, containing 51.1 per cent calcium and 48.9 per cent fluorine. In itself it has only moderate value, and represents a negligible portion of the value of most finished products in whose production it is used. Nonetheless it has a great industrial importance, and is essential to a great many industrial processes.

Fluorspar is produced in many countries and, because of its widespread occurrence, transportation to markets is the major factor influencing its production.

Canadian Occurrences

Fluorspar is found in six of the Canadian provinces and in the Northwest Territories, and well over 100 deposits are known. Some of these are in remote areas and most of the rest are either too low-grade or too small to be mined. However, during both World Wars, several smaller deposits were operated.

Newfoundland

The principal occurrences in Newfoundland are at St. Lawrence on the Burin Peninsula. Nearly all of the commercial fluorspar veins occur as fissure fillings in a granite intrusive believed to be of Devonian age.

Although no close estimate of Newfoundland's reserves of fluorspar has been made, they are very large, and may be classed as among the most important in the world.

Nova Scotia

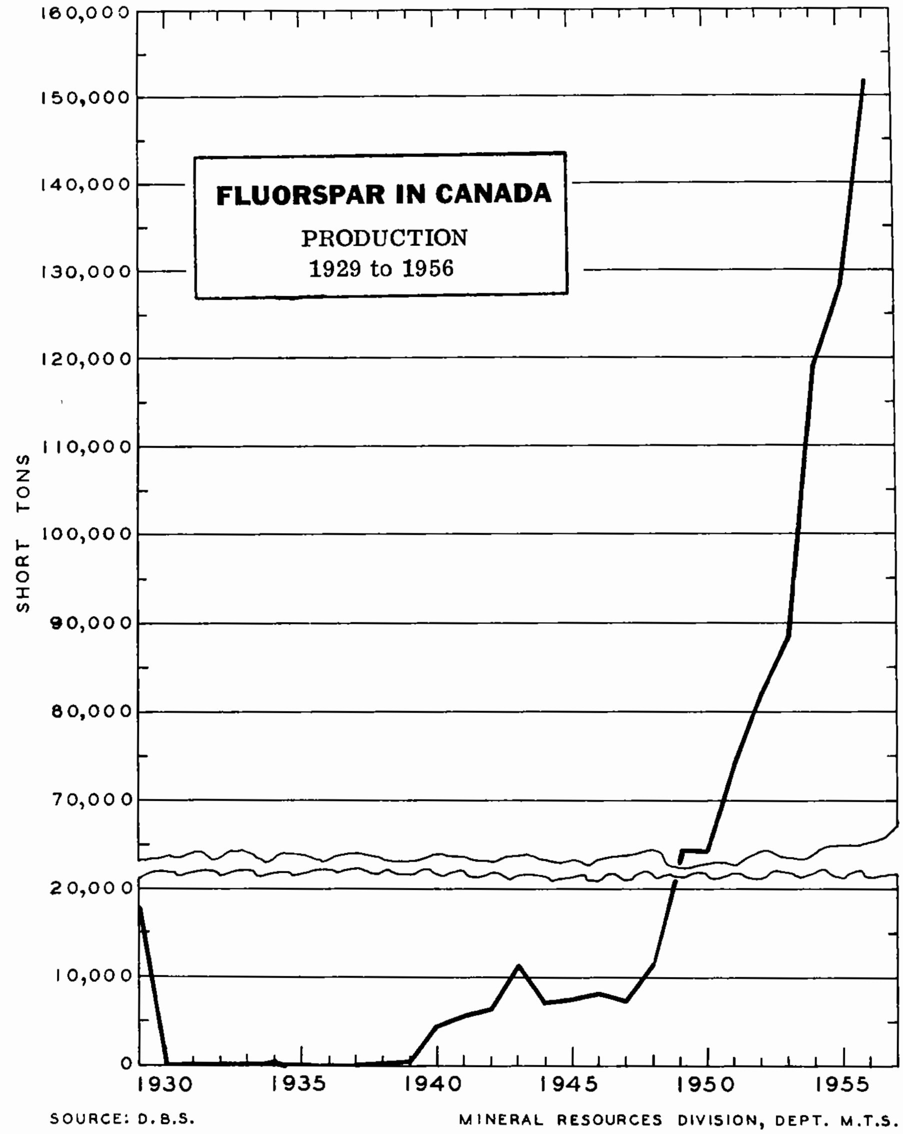
There are several deposits of fluorspar on Cape Breton Island, in which, however, the fluorspar is an accessory material in baryte. The baryte occurs as a vein deposit.

Ontario

Ontario has deposits of fluorspar in rocks of Precambrian age stretching, roughly in a crescent, from near Ottawa, in the east, to Fort William - Port Arthur in the west. Most of these deposits are not of commercial interest, as they are usually small and the fluorspar is normally a minor accessory material with silver, barite, and others. The principal deposits are those of the Madoc district, Hastings county, where the fluorspar occurs as a vein deposit, thought to be of ground-water origin, in association with barite and filling fissures in limestone.

British Columbia

The deposits of fluorspar are mostly in the extreme southern part of the province, but an occurrence in association with barite and quartz, reported to be extensive, was located at Lower Liard River Crossing in northwestern British Columbia.



The principal deposit is just north of Grand Forks and is a replacement vein deposit covering a fairly large area and over 200 feet in depth. Canada's main production came from this mine for some years. However, production was discontinued in 1929 owing to high tariffs hampering the export and the replacement of fluorspar used in that area by by-product fluorine materials.

Other Occurrences

Deposits of fluorspar occur in Pontiac county, Quebec; on the Dubawnt River, Northwest Territories; and in many other localities in the provinces named above.

Fluorspar

Producers

Huntingdon Fluorspar Mines operated the Kilpatrick mine in the Madoc area, in Ontario. However, production in the past few years has been small.

There are two producers in Newfoundland, St. Lawrence Corporation of Newfoundland, Limited, and Newfoundland Fluorspar Limited, a subsidiary of Aluminum Company of Canada, Limited.

Fluorspar claims were first staked in the St. Lawrence region in 1910, but the district did not come into production until 1932, when the St. Lawrence Corporation of Newfoundland Limited began surface-mining for shipment to the Dominion Steel and Coal Corporation Limited at Sydney, Nova Scotia. Production of the Corporation has increased more or less steadily since then. Newfoundland Fluorspar Limited first entered the field in 1940 and began to make shipments in the spring of 1942.

In 1956, St. Lawrence Corporation recovered as heavy media concentrates 73,393 tons from 111,062 tons mined. Of the concentrate recovered, 72,718 tons was shipped to Wilmington, Delaware, to St. Lawrence Fluorspar Incorporated, a subsidiary company. Newfoundland Fluorspar recovered 76,049 tons as heavy media concentrate from 118,154 tons mined. Shipments were 68,083 tons to the parent company at Arvida, Quebec.

World Production

Complete statistics for world production of fluorspar are not available, but a reasonable estimate would be 1,500,000 tons per year at the present time. Fluorspar is produced in every continent, the chief producing countries being United States, Germany, Mexico, Canada, Russia, United Kingdom, and France.

Uses in Canada

Fluorspar is used in Canada chiefly in making artificial cryolite and aluminum fluoride for the aluminum industry. The fluoride is added directly to the pots as a make-up to the electrolyte. Fluorspar is also used as a fluxing agent in the steel industry, where about 6 pounds are required per ton of steel made in the open hearth, and about 20 pounds per ton for that made in the electric furnace; in the manufacture of heavy chemicals; and in the ceramic industry as a fluxing and opacifying ingredient in glass and enamels. It is used in small amounts in numerous other metallurgical industries, including foundries and various metal-refining plants. Uranium hexafluoride is used for the gaseous diffusion separation of the uranium isotopes U_{235} and U_{238} in the development of atomic energy.

According to a recent announcement, a plant is to be erected at Valleyfield by Nichols Chemical Company, Limited for the production of hydrofluoric acid.

Specifications

Standard fluxing gravel, or lump grade, for metallurgical use is usually sold on a specification of a minumum 85 per cent CaF_2, and maximum of 5 per cent silica and 0.3 per cent sulphur. Fines should not exceed 15 per cent.

Ceramic grade for the glass and enamel trades calls for not less than 95 per cent CaF_2, with maxima of 2 1/2 to 3 per cent SiO_2 and 0.12 per cent Fe_2O_3.

Acid grade has the most rigid specifications, a minimum of 97 per cent CaF_2 and not over one per cent silica. As in the ceramic trade, it is used mainly in powder form.

Prices

Canadian prices as quoted in the Northern Miner of January 10, 1957, by Aluminum Company of Canada per net ton, f.o.b. Arvida, Quebec, were as follows:

Ceramic Grade - coarse

In bulk: minimum carload or truck load - $57.75

Ceramic Grade - fine

In bulk: minimum carload or truck load - $59.75

Specifications: CaF_2 minimum 94 per cent; $CaCO_3$ maximum 3.5 per cent; SiO_2 maximum 3 per cent; and Fe_2O_3 maximum 0.1 per cent.

United States year-end prices, as quoted in E & M J Metal and Mineral Markets Bulletins, represented an increase over the previous year and were as follows:

Metallurgical grade

From 60 per cent to 72 1/2 per cent effective units

CaF_2 - $28 to $41 f. o. b. shipping point

Acid Grade

Concentrates - $52.50 to $55.00 f.o.b. Rosiclaire, Illinois

Ceramic Grade

Containing 95 per cent CaF_2 - $41 to $43 f. o. b. Rosiclaire Illinois

Fluorspar

Mexican fluorspar prices, f.o.b. border were:

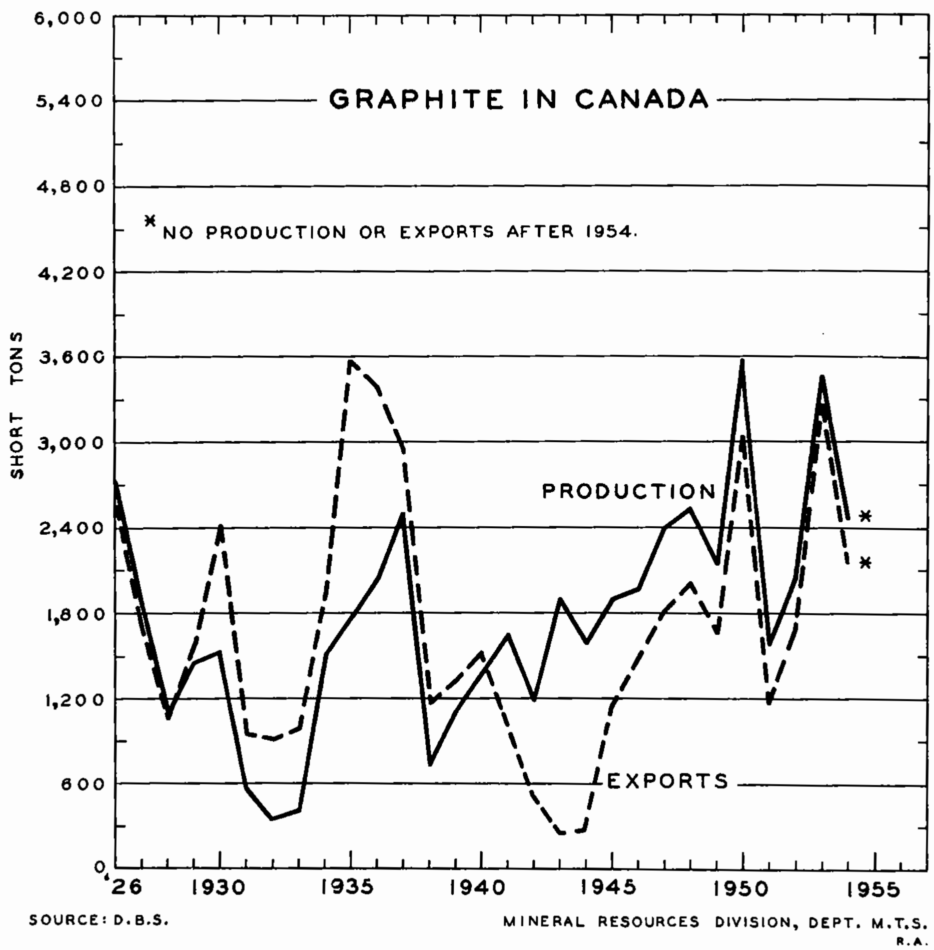
Metallurgical grade, all rail, duty paid - $27 to $27.50 per ton.

Metallurgical grade, barge to Brownsville, Texas - $29 to $30.

GRAPHITE

By J. E. Reeves
Industrial Minerals Division

Since the closing of the Black Donald mine in 1954 there has been no graphite production in Canada. The mine is near Calabogie, Ontario, about 65 miles southwest of Ottawa, and was the most important Canadian producer.



Graphite

Graphite - Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
No production or shipments 1955 and 1956				
Exports, crude and refined				
United States			6	501
Australia			1	260
Total	-	-	7	761
Imports				
Unmanufactured				
United States		42,248		29,413
Mexico		22,449		21,030
Ceylon		11,498		-
Norway		10,389		13,697
Other countries		1,342		658
Total		87,926		64,798
Ground and manufactured				
United States		730,741		518,497
United Kingdom		39,699		17,642
W. Germany		36,946		20,360
Other countries		7,998		4,895
Total		815,384		561,394
Crucibles				
United States		140,245		101,524
United Kingdom		119,755		101,340
Total		260,000		202,864
Total imports		1,163,310		829,056

During the last few years several companies have undertaken the exploration of properties containing deposits of graphite in southern Ontario or southern Quebec, relatively near to the principal markets, but no production has resulted.

	1956 Short tons	1955 Short tons
Consumption		
Polishes and dressings	10	11
Paints	87	55
Brass and copper products	23	20
Electrical apparatus	308	685
Heavy chemicals	377	344
Boilers and platework	8	4
Steel ingots and castings	1,108	808
Farm implements	-	5
Railway rolling stock	128	39
Machinery	39	89
Iron castings	507	402
Cooking and heating equipment	3	15
Ferro-alloys	250(e)	250(e)
Asbestos products	17	14
Explosives	2	1
Miscellaneous non-metallics	244	210
Clay products	125	100
Miscellaneous iron and steel	89	27
Miscellaneous non-ferrous	-	1
Petroleum refining	-	31
Machine tools	3	28
Total	3,328	3,139

(e) estimated

Artificial graphite is produced by Electro Metallurgical Company of Canada Limited, Welland, Ontario, by the electric furnace treatment of petroleum coke.

Previous production in Canada was mostly of the small flake and amorphous grades, derived from relatively small and widely separated deposits in the crystalline limestones and gneisses of southeastern Ontario and southwestern Quebec.

The earliest mining is reported to have been in 1846 in Grenville township, Argenteuil county, Quebec, about 60 miles east of Ottawa. In later years a number of properties came into production in Quebec, many of them in the vicinity of Buckingham, about 20 miles east of Ottawa, but production was small and sporadic, and had ceased completely by 1936.

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Graphite

Graphite mining in Ontario commenced in 1870 in North Elmsley township, Lanark county, about 50 miles southwest of Ottawa. Other relatively small producers were in Cardiff township, Haliburton county, and Monteagle township, Hastings county, about 100 to 120 miles west of Ottawa. In 1897 the first shipments were made from the famous Black Donald mine, Canada's largest and, for many years, its only graphite producer. The ore consisted of fine- to coarse-grained, disseminated to massive graphite in strongly folded, silicated crystalline limestone, and yielded various grades from low quality amorphous material to high quality lubricating flake. Whereas deposits in Quebec are associated with crystalline limestone and gneiss, the Ontario deposits were all in crystalline limestone.

In the latter part of the nineteenth century some amorphous grade material was produced from impure graphite shales and slates near Saint John, New Brunswick.

World Situation

Principal world sources are Mexico for amorphous (very fine grained) graphite, Ceylon, especially for the coarsely crystalline variety (sometimes referred to as plumbago because it occurs in massive form in veins), and Madagascar for large flake. There is a considerable amount of world trade, particularly in high-quality graphite. Most industrial nations are not able to compete with the above countries because of higher production costs, relatively low-grade deposits, and inferior flake, compared with that from Madagascar. It is expected, however, that technological advances in the use of lower grades may lessen the dependence on these foreign sources for high-quality material.

Uses and Specifications

Natural graphite is used mainly in the iron and steel industries, the largest users, in the form of crucibles, foundry facings, and other refractories, and in the paint industry as a pigment and anti-corrosive element in protective coatings. Graphite is used widely as a lubricant particularly under high-temperature and corrosive conditions, in lead pencils, in corrision-resistant pipes and fittings for the chemical industry, for impregnating wood and metal surfaces in oiless bearings, in the manufacture of stove and other polishes, and as a polishing agent for lead shot, explosives, and fertilizers.

Artificial graphite is used in the manufacture of electrodes, brushes, and other special shapes and more recently as a moderator in some atomic reactors. In powdered form it competes only to a very limited extent with natural graphite.

Carbon content, mesh size, and type are the principal factors which govern the selection of graphite for its various uses. The different types of graphite are interchangeable to some extent and are frequently blended according to recipes developed and protected by the manufacturers.

No universal code of specifications is recognized, but those for No. 1 crucible flake usually require 85 per cent or 90 per cent carbon, through 20-mesh on 50-mesh. For lubricants, the requirement is usually a minimum of 95 per cent carbon. In general, the demand is for material containing at least 70 per cent carbon, although lower-grade material is potentially saleable.

Markets

Buyers of crude and finished graphite in the United States include Joseph Dixon Crucible Company, Jersey City, New Jersey; Charles Pettinos, 1 East 42nd Street, New York, N.Y.; and George F. Pettinos Inc., 1206 Locust Street, Philadelphia 7, Pa.

Prices

United States prices of graphite according to E & M J Metal and Mineral Markets of December 13, 1956 were:

Per lb., carload lots, f.o.b. shipping point:

Crystalline flake, natural,

85-88% C, crucible grade	- 13¢
96% C, special and dry usage	- 22¢
94% C, normal and wire drawing	- 19¢
98% C, special for brushes, etc.	- 26 1/2¢

Amorphous, natural, for foundry facings, etc.,

Up to 85% C	- 9¢

Madagascar, c.i.f. New York,
"Standard grades 85 to 87% C" - $235 per ton
Special mesh - $260
Special grade 99% C - nominal

Amorphous graphite, Mexican, f.o.b. point of shipment (Mex.),

Per metric tons - $9 to $18, depending on grade.

80486-4-19½

GYPSUM AND ANHYDRITE

By R. K. Collings
Industrial Minerals Division

Gypsum is a hydrous calcium sulphate. It is one of the most useful of the non-metallic minerals and large amounts are produced annually at numerous locations throughout Canada. In 1956 Canadian production of crude gypsum increased about 5 per cent over 1955.

Exports of gypsum and gypsum products represented approximately 78 per cent of the total output. Most of the exports were shipped as crude gypsum to the United States. Approximately 75 per cent of the imports was crude gypsum for use in Western Canada, the remainder being manufactured plaster and plaster products.

Canadian production increased nearly sixfold in the 30-year period 1926 to 1956, as indicated in the graph on page 289. In 1926 883,728 short tons of gypsum were produced. Production dropped during the depression years but gradually rose again reaching a peak of 1,593,406 short tons in 1941. A second slump occurred during World War II when production dropped to 466,848 short tons (1943). Following World War II the demand for gypsum for use in the manufacture of plaster and plaster products increased greatly, resulting in a remarkable expansion of the Canadian gypsum industry. This expansion has continued to the present.

In 1956 Canada ranked next to the United States as a producer of gypsum in the free world. Conservative estimates indicate that Russia accounted for 10 per cent of world production in 1956: the United States produced 30 per cent, and Canada 14 per cent.

Occurrences

Canada has many gypsum deposits. Some of these are impure, others are too far from markets to be of economic importance. However, many deposits are very pure and are well situated with respect to centres of population and transportation facilities.

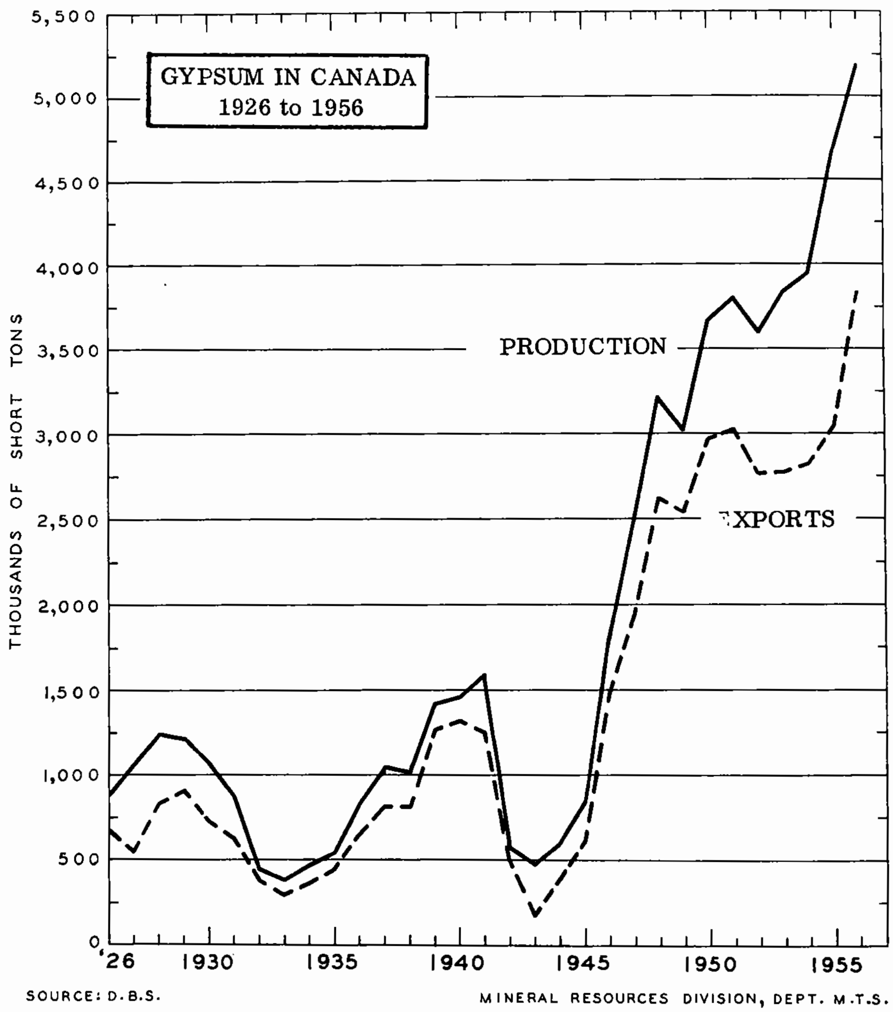
Deposits of gypsum suitable for use in the gypsum products industry occur in all provinces with the exceptions of Prince Edward Island and Saskatchewan. The largest deposits, occurring in the Maritime Provinces, are flat-lying and generally are covered by 10 to 15 feet of overburden. The deposits in Nova Scotia occur throughout the central and northern portion of the mainland and on Cape Breton Island. In New Brunswick, the chief deposits are in the southeastern section in the vicinity of Hillsborough. The Newfoundland deposits are confined to the Bay St. George area in the southwestern section of the Island.

Gypsum - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production, crude gypsum				
Nova Scotia	4,144,147	5,250,883	3,838,847	6,061,922
Ontario	366,956	840,829	366,416	808,424
Manitoba..............	185,986	365,840	176,005	291,708
British Columbia	75,618	391,919	150,078	383,934
New Brunswick	86,104	224,038	90,096	315,336
Newfoundland.........	37,000	186,727	46,459	175,829
Total	4,895,811	7,260,236	4,667,901	8,037,153
Exports				
Crude Gypsum				
United States	3,840,521	6,987,225	3,039,192	4,930,626
New Zealand	200	312	-	-
Plaster of paris, wall plaster				
United States	133	4,748	85	3,083
New Zealand	14	297	10	213
Bermuda.............	2	52	2	45
Total	3,840,870	6,992,634	3,039,289	4,933,967
Imports				
Crude Gypsum				
Mexico	61,001	211,668	5,890	51,309
United States	9,386	89,311	10,174	71,206
Other countries	49	1,660	40	1,341
Plaster of paris, wall plaster				
United States	22,358	552,141	25,676	591,543
United Kingdom.......	424	8,331	260	3,989
Sweden	11	1,874	-	-
West Germany........	1	144	-	-
Total	93,230	865,129	42,040	719,388

The only known occurrences of gypsum in Quebec are on the Magdalen Islands in the Gulf of St. Lawrence. The deposits outcrop over wide areas and are quite thick, measuring 50 feet or more in places.

Gypsum is found in a number of localities in Ontario, chief of which are the Moose and Grand River areas. The deposits in the Moose River area in northeastern Ontario are 15 to 20 feet or more in thickness and are covered by 10 to 30 feet of overburden. In the Grand River area in southern Ontario, gypsum occurs as narrow underground seams at depths up to 200 feet.



Large gypsum deposits occur in Manitoba and Alberta. In Manitoba, the main occurrences are at Gypsumville, where thick beds of undetermined size occur at shallow depths, and at Amaranth, where a 40-foot seam is found at a depth of 100 feet. In Alberta, the chief occurrences are in the northern part of the province in the McMurray and Peace River districts. At McMurray, 130 feet of gypsum occurs at depth of 500 feet while 10- to 15-foot seams are found at shallow depths along the banks of the Peace River north of Peace River town.

The main deposits of British Columbia occur at Windermere, Mayook, and Canal Flats near Cranbrook, and at Falkland, near Kamloops.

Producers

Nova Scotia

This province produced over 84 per cent of the Canadian output of crude gypsum in 1956. Most of the gypsum quarried is exported to the United States; the remainder is used in the manufacture of plaster and wallboard at plants in Montreal, and for the manufacture of plaster at a plant in Windsor, Nova Scotia.

Gypsum is quarried at Wentworth, near Windsor, for export to the United States by Canadian Gypsum Company Limited, the largest producer in Canada. This company recently started development work on a deposit at Miller's Creek, about 2 miles from Wentworth. The Miller's Creek quarry is expected to reach full production towards the latter part of 1957.

National Gypsum (Canada) Limited, is Canada's second largest producer. It operates quarries at Walton in Hants county and at Milford Station, about 30 miles north of Halifax. Most of the gypsum from these quarries is exported to the United States.

Little Narrows Gypsum Company Limited, with head offices in Toronto, operates a quarry at Little Narrows on Cape Breton Island. Output is shipped to the United States and to Montreal for use in the manufacture of plaster and plaster products.

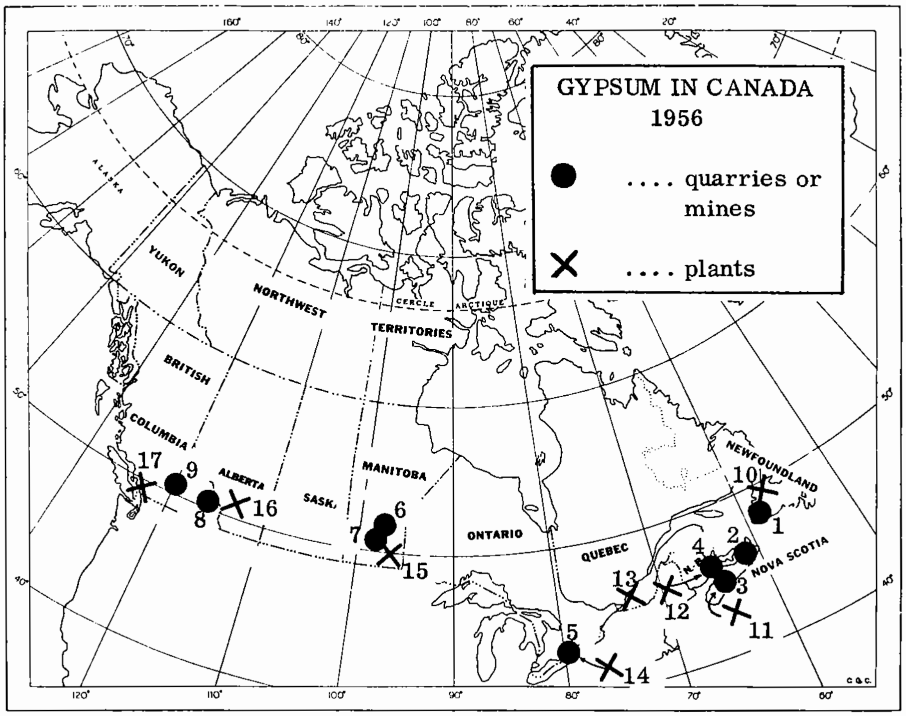
Gypsum, Lime and Alabastine, Canada, Limited, with head offices in Toronto, operates the only calcining mill in Nova Scotia. This mill, at Windsor, was formerly owned and operated by the Windsor Plaster Company Limited. Gypsum from quarries at Brooklyn, near Windsor, is calcined at the Windsor plant and shipped to consumers in Nova Scotia and eastern Quebec and Ontario.

The Bestwall Gypsum Company (Canada) Limited, with head offices at Thorold, Ontario, has undertaken preliminary investigation of a number of deposits in the southern portion of Cape Breton Island. The company plans to develop one or a number of these deposits.

Ontario

Gypsum is mined at Hagersville and Caledonia in southwestern Ontario. In 1956, Ontario produced about 7 per cent of the total Canadian output.

Canadian Gypsum Company Limited operates the mine at Hagersville where the output is used in the manufacture of plaster and wallboard.



Quarries or Mines

1. Atlantic Gypsum Ltd. (Flat Bay Station)
2. Little Narrows Gypsum Co. Ltd. (Little Narrows)
3. National Gypsum (Canada) Ltd. (Milford Station and Walton)
   Canadian Gypsum Co. Ltd. (Wentworth)
   Gypsum, Lime & Alabastine, Canada, Ltd. (Windsor)
4. Canadian Gypsum Co. Ltd. (Hillsborough)
5. Gypsum, Lime & Alabastine, Canada, Ltd. (Caledonia)
   Canadian Gypsum Co. Ltd. (Hagersville)
6. Gypsum, Lime and Alabastine, Canada, Ltd. (Gypsumville)
7. Western Gypsum Products Ltd. (Amaranth)
8. Columbia Gypsum Co. Ltd. (Windermere)
9. Gypsum, Lime and Alabastine, Canada, Ltd. (Falkland)

Plants

10. Atlantic Gypsum Ltd. (Humbermouth)
11. Gypsum, Lime and Alabastine, Canada, Ltd. (Windsor)
12. Canadian Gypsum Co. Ltd. (Hillsborough)
13. Canadian Gypsum Co. Ltd. (Montreal)
    Gypsum, Lime and Alabastine, Canada, Ltd. (Montreal)
14. Gypsum, Lime and Alabastine, Canada, Ltd. (Caledonia)
    Canadian Gypsum Co. Ltd. (Hagersville)
15. Gypsum, Lime & Alabastine, Canada, Ltd. (Winnipeg)
    Western Gypsum Products Ltd. (Calgary)
16. Gypsum, Lime & Alabastine, Canada, Ltd. (Calgary)
    Western Gypsum Products Ltd. (Calgary)
17. Gypsum, Lime & Alabastine, Canada, Ltd. (Port Mann)

Gypsum

Gypsum, Lime and Alabastine, Canada, Limited obtains gypsum from a mine at Caledonia for use in the manufacture of plaster and wallboard at a nearby plant.

Manitoba

Gypsum is mined from an underground deposit at Amaranth by Western Gypsum Products Limited and is shipped to Winnipeg, and Calgary, where it is used in the manufacture of plaster and wallboard in company-owned plants.

Gypsum is quarried at Gypsumville, Manitoba, by Gypsum Lime and Alabastine, Canada, Limited for use in the manufacture of plaster and wallboard at its Winnipeg and Calgary plants.

British Columbia

Columbia Gypsum Company Limited, with head offices in Vancouver, operates a quarry at Windermere in the southeastern section of the province. Crude gypsum from this quarry is used in the manufacture of cement at plants in British Columbia, Alberta and the State of Washington, and is shipped also to Spokane, Washington, where it is processed at a company-owned plant and sold for agricultural purposes.

New Brunswick

Gypsum is quarried at Hillsborough by Canadian Gypsum Company, Limited for use in the manufacture of plaster and wallboard at a company-owned plant in Hillsborough.

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 its 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 and Alabastine, Canada, Limited and Canadian Gypsum Company, Limited both operate gypsum-product 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.

Alberta

Gypsum, Lime and Alabastine, Canada, Limited produces plaster at its plant in Calgary, using raw gypsum from company quarries at Gypsumville, Manitoba.

British Plaster Board (Holdings) Limited, through its subsidiary Western Gypsum Products, Limited, manufactures plaster and wallboard at a plant in Calgary. Raw gypsum for this plant is obtained from the company's mine at Amaranth, Manitoba.

British Columbia

Gypsum, Lime and Alabastine, Canada, Limited, operates a plaster and wallboard plant at Port Mann, about 10 miles east of Vancouver Gypsum was formerly obtained from a company quarry at Falkland, British Columbia, but this quarry was closed in 1956. The gypsum requirements are now met by imports from San Marcos, Mexico.

Western Gypsum Products Limited has announced plans for the construction of a products plant at Vancouver, construction to start in 1957, with initial production scheduled for 1958. Crude gypsum will be imported from San Marcos, Mexico.

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, expanded perlite, or vermiculite) and applied over wood, metal or gypsum lath to form a wall finish in buildings. 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 added to portland cement during its manufacture. The gypsum, acting as a retarder, is used to control the set of the cement. Crude gypsum, reduced to 40-mesh or finer is used as a filler in paint and paper. Powdered gypsum also finds a use as a soil conditioner to offset the effect of black alkali, to restore impervious, dispersed soils, and as a fertilizer for peanuts and other leguminous crops.

Prices

The nominal price of crude gypsum in 1956 was $3.00 to $5.00 per ton f.o.b. quarry or mine. However, large contracts with seaboard quarries were at much lower prices.

ANHYDRITE

The mineral anhydrite is anhydrous calcium sulphate. It usually occurs in the massive form and is commonly associated with gypsum and limestone. Deposits of anhydrite occur associated with gypsum in Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba, Alberta, and British Columbia. However, the production of this mineral in Canada is limited to quarries where its removal is essential to the continued production of gypsum. Anhydrite is used to a limited extent as a soil conditioner.

Gypsum and anhydrite are potential sources of sulphur compounds. In Europe gypsum or anhydrite is calcined at 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. To date in Canada, gypsum and anhydrite have not been considered of economic interest as sources of sulphur and sulphur dioxide.

INDUSTRIAL WATERS

By J. F. J. Thomas
Industrial Minerals Division

Water is the most used and important industrial mineral in Canada, and since 1947 a comprehensive survey of the chemical quality of this resource from the standpoint of both domestic and industrial use has been under way. A knowledge of the quality as well as the quantity of water in Canada is essential for its efficient utilization in the expanding growth and development of the country.

Industrial users require waters of many different types; some, indeed, must get rid of all impurities for satisfactory use. Larger industries such as the textile, pulp and paper, chemical, and steel use enormous quantities of a wide range of quality and must therefore depend on the larger surface water supplies. High contents of heavy metals, iron, manganese, or colouring matter may adversely affect the final product of an industry and expensive treatment is often required to adapt the water for use. Even the users of large quantities of water for cooling, transportation, and development of power may be seriously affected if the waters are excessively scale- or slime-forming, or are corrosive.

Most of Canada has a plentiful supply of surface waters low in dissolved minerals and soft to medium hard in character. The waters of the streams and lakes of that major portion of Canada included in the Canadian Shield and Cordilleran and Appalachian Regions are of this type, the principal impurities being the bicarbonate salts of calcium and magnesium - non-carbonate hardness. In the Cordilleran Region, waters are often more mineralized and harder than in the Shield because many rise in the calcareous mountains. Some, like the Fraser River, also carry much sediment and turbidity and as a result are not fit for most industrial uses. Coastal waters in British Columbia and the Atlantic provinces are very soft, carrying very little dissolved matter.

In all these more rugged areas of Canada are small areas such as the clay belts of northern Ontario and Quebec and certain valleys in the interior of British Columbia where local geological and climatic conditions give rise to more mineralized and turbid waters. Most of the waters of the Shield and Cordilleran and Appalachian Regions have a corrosive tendency and rather high colour, necessitating treatment for many uses. Seasonal variation in most of these waters is not great and turbidity is troublesome only during the short period of spring run-off.

The other large geological region of Canada, the Interior Plains, does not have either the quantity or quality of waters available in the more rugged regions. However, the major river systems, North and South Saskatchewan, Churchill, and Mackenzie, whose headwaters are either in the Cordilleran Region or the Canadian Shield do supply a considerable part of the Plains with satisfactory waters. These, although generally classed as hard to very hard, are still not excessively mineralized. They show somewhat greater seasonal variations, particularly in turbidity, than waters of the Shield. Many of the small rivers of these systems have a relatively high proportion of non-carbonate hardness and alkali salts because of the variable inflow from small local drainage basins and sloughs in semi-arid alkali regions. The remainder of the Plains Region, particularly the southern portions of Alberta, Saskatchewan, and Manitoba, is drained by rivers rising within it, such as the Assiniboine, Milk, Souris, and Red. Their waters are highly mineralized, very hard, and often high in alkali salts; turbidity may be excessive and flow at times inadequate. The wide seasonal variation in quality and flow and the large proportion of sulphate and chloride salts make treatment of many of these waters uneconomical for most uses.

The remainder of Canada, the St. Lawrence Lowlands of Ontario and Quebec, which are heavily populated and industrialized, is to a large extent supplied with water from the huge St. Lawrence River system. Waters of this system are at first soft and very similar to waters of the Canadian Shield but increase continually in hardness and total mineralization down to Lake Ontario. Thereafter, inflow of softer tributary waters from both the Shield and Appalachian Regions maintains the river as a clear, medium-hard, very satisfactory water for most industrial uses. However, in some of these lowland areas, particularly southwestern Ontario, the tributary streams are heavily contaminated with sediment and run-off from cultivated lands, very hard, highly mineralized, and generally unsatisfactory. In some cases, contamination from industrial and municipal wastes has seriously affected water quality. The rapid run-off and excessive demand have resulted in shortages in some areas.

Ground waters vary widely across Canada and within geological regions. In the productive areas of the St. Lawrence Lowlands and Interior Plains, these waters are generally very hard or, if soft, have a high content of alkali salts, and are seldom satisfactory for industrial use without extensive treatment. In other regions, ground waters may be satisfactory or may be high in salt or sulphur compounds. Many smaller municipalities and industries do, at present, use ground waters, but for many major users such waters require excessive treatment or are in short supply.

It is evident that, except for the presently productive and industrialized lowlands and plains regions, water quantity and quality is generally satisfactory. In these areas, careful conservation, efficient use, and adequate future planning are required if larger problems of deteriorating water resources and quality are not to occur. Such planning involves the decision as to whether land and water resources may more economically be applied to industry or to agriculture, and whether transportation of more suitable supplies from the Shield and other regions to the more populated and productive areas, or the location of industries in these areas of plentiful water, is not desirable.

Study of seasonal and long-term variations in quantity and quality, present and possible future use and misuse, etc. is essential to such planning if efficient use of this great resource is to be achieved.

The following reports on the industrial water resources of Canada are available from the Mines Branch, Department of Mines and Technical Surveys, or from the Queen's Printer, Ottawa:

Water Survey Report No. 1; Scope, Procedure and Interpretation of Survey Studies, by J. F. J. Thomas, Mines Branch No. 833. 75 cents

Water Survey Report No. 2; Ottawa River Drainage Basin, 1947-48, by J. F. J. Thomas, Mines Branch No. 834. 75 cents

Water Survey Report No. 3; Upper St. Lawrence River-Central Great Lakes Drainage Basin in Canada, by J. F. J. Thomas, Mines Branch No. 837. $1.50

Water Survey Report No. 4; Columbia River Drainage Basin in Canada, 1949-50, by J. F. J. Thomas, Mines Branch No. 838. 75 cents

Water Survey Report No. 5; Skeena River Drainage Basin, Vancouver Island, and Coastal Area of British Columbia, 1949-51, by J. F. J. Thomas, Mines Branch No. 839. 75 cents

Water Survey Report No. 6; Fraser River Drainage Basin, 1950-51, by J. F. J. Thomas, Mines Branch No. 842. 75 cents

Water Survey Report No. 7; Saskatchewan River Drainage Basin, 1951-52, by J. F. J. Thomas, Mines Branch No. 849. 75 cents

Interim Report, Hardness of Major Canadian Water Supplies, by J. F. J. Thomas, Memorandum Series No. 132. 1956. 25 cents

IRON OXIDE

R. M. Buchanan
Industrial Minerals Division

Natural iron oxide, probably the first pigment used by man, has been receiving competition from manufactured types of pigments since the early part of this century. Although the uses of pigments have been expanding, particularly in the paint and concrete products industries, natural pigments form a progressively smaller portion of the total production of the iron oxide types.

Although natural iron oxide pigments are widely distributed, have a comparatively low cost of production, and are characterized by permanence and chemical stability, artificial pigments in comparison, have the advantage of uniform particle size, a friable structure that makes for easy grinding, high covering power, colour permanence, good protection of paint film against ultraviolet light, and resistance to water, acids, and alkalis. As a rule manufactured pigments are the more expensive but have a higher tinting power.

Known Canadian deposits of iron oxides, of pigment grade, are all of the bog-iron type. Although there are many deposits of hematite, it has never been shown that there are materials of pigment grade associated with them. The types of residual deposits that form the source of much of the pigments produced in the eastern United States, for example, are absent, likely because of glacial action and the absence of tropical or sub-tropical weathering conditions.

The iron in the bog-iron type of deposits is considered to have been dissolved out of iron-bearing rocks and carried in streams in the form of the soluble bicarbonate. In lakes, swamps, and sluggish streams the iron is oxidized and precipitated as oxides or hydrated oxides. The action of bacteria and other organic material in the precipitation is not fully understood but appears to be significant. A certain amount of clay, sand, and organic matter is usually deposited with the oxides.

Production

The production of iron oxide pigments in Canada has been a minor industry and has not varied much in volume from year to year. Most of the deposits for which production has been recorded in the last thirty years are

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Iron Oxide

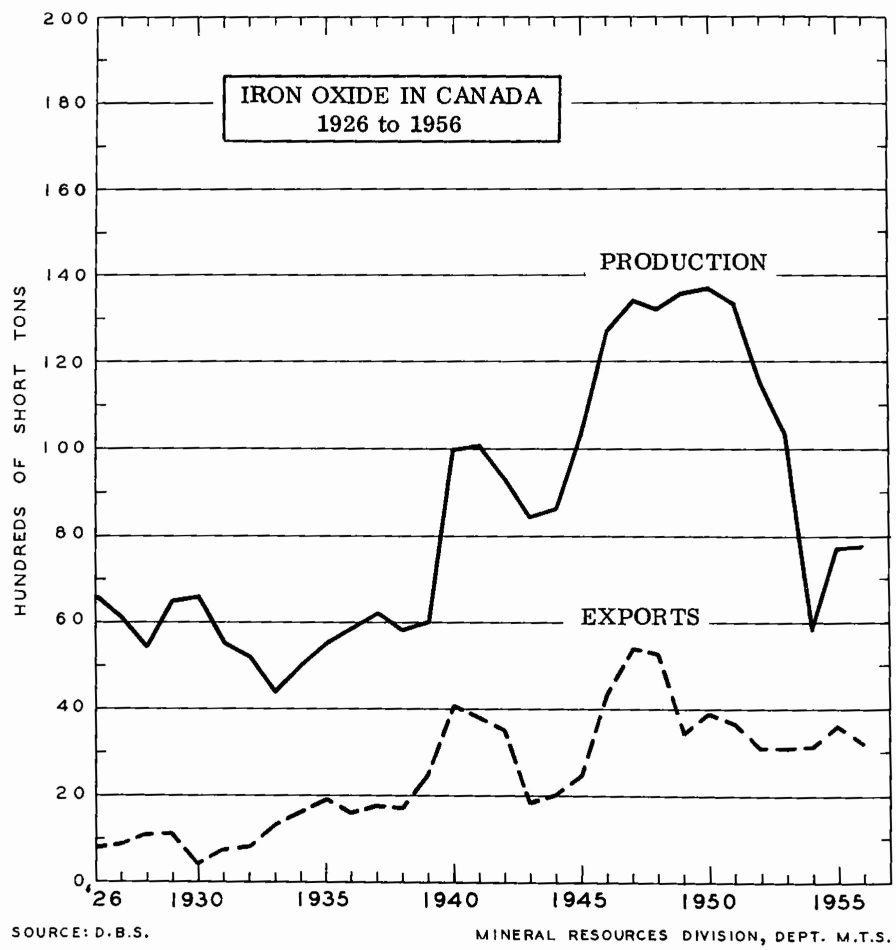
Iron Oxides - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production (sales)				
Natural (crude & calcined) .	8,803	186,225	7,702	162,512
Imports				
Ochres, siennas, umbers				
United States	1,095	86,853	880	60,837
United Kingdom	46	2,854	86	4,182
Spain	11	455	-	-
Sweden	10	571	-	-
France	-	-	20	988
Total	1,162	90,733	986	66,007
Exports				
Natural and synthetic iron oxides				
United States	2,974	409,191	3,439	418,384
France	123	21,537	100	16,702
Belgium	29	4,677	36	5,462
Cuba	19	3,305	10	1,568
Peru	16	2 825	8	1,275
Colombia	14	2,313	4	722
Other countries	28	4,584	26	4,250
Total	3,203	448,432	3,623	448,363
Consumption				
Coke and gas industry	8,745	89,107	6,835	70,675
Paint industry, calcined & synthetic iron oxide	2,166	430,797	2,298	407,762
Ochres, siennas, and umbers	220	52,053	221	55,745

within a radius of a few miles of Three Rivers, Quebec, on the north shore of the St. Lawrence River.

Natural Iron Oxide Pigments

Output of natural iron oxide pigments in 1956 came from the plant of Sherwin Williams Company of Canada, Limited, at Red Mill, Quebec, about seven miles east of Three Rivers. A plant was erected at this location by the Canada Paint Company in 1888, and it has been in almost continuous operation since then.



The raw material, quarried from two deposits of the bog-iron type, which are reported to range in thickness from two to eight feet, is trucked to the plant for stock-piling. Some of the oxides are used in the raw or uncalcined state and are prepared for use by washing, drying, and grinding. Others are calcined to burn off the associated organic matter and to drive off part or all of the combined water of the hydrated oxides to give the required colour. The calcination process, carried out at high temperatures (1200° to 1400° F), is a delicate operation and it seems that the physical changes taking place are more important than the chemical ones. After calcining, the pigments are ground in a buhr mill in closed circuit with an air-classifier and ball mill. The ground material, about 99.5% minus 300-mesh, is packed for shipment in 400-pound barrels and 100-pound paper bags. Calcined iron oxide exported to the United States is not ground.

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Iron Oxide

Synthetic Iron Oxide Pigments

All synthetic iron oxide pigments produced in Canada in 1956 came from the New Toronto, Ontario, plant of Northern Pigment Company, Limited, one of the largest producers of manufactured iron oxide pigments by the ferrite process in the world. Scrap iron, usually barrel cuttings, is digested in acid. Ferrous sulphate or chloride is precipitated from the resulting solution by alkali (lime, soda ash, sodium hydroxide, etc.) and oxidized with air to the hydrated ferric oxide stage. The resulting colloidal gel is allowed to crystallize into a yellow hydroxide. The changes taking place in the gel during crystallization are extremely complicated and depend on surface phenomena, internal structure, and chemical composition. The colour depends on the crystal size and passes through a series of successive stages — blue, green, yellowish-brown and finally yellow to yellow-orange. The crystals are filtered off at the proper stage and then calcined or blended to give the full range of colours.

In the other process that is important in pigment manufacture, the "copperas process", the calcination of copperas (ferrous sulphate) a by-product from some steel-making operations), gives the required shade of oxide.

Crude Oxide for Gas Purification

The entire Canadian output of crude, air-dried iron oxide for gas purification in 1956 was produced by Charles Girardin of Yamachiche, Quebec, from a deposit in Champlain county, about five miles north of Three Rivers.

In past years there have been a number of small-scale operations for crude iron oxides in this area.

A small annual production of oxides for gas purification was recorded in British Columbia during the period 1923 to 1949. The deposit at Alta Lake near New Westminster has been worked out.

Other Occurrences

Quebec

Extensive deposits occur on the south shore of the St. Lawrence River, but most of them are relatively thin and do not show much economic promise. In Lynch township, Labelle county, near Annonciation, there are deposits reported to be more than 12 feet thick in places and to cover 25 or 30 acres. A small production was recorded in this locality many years ago. There are smaller occurrences in Portneuf and Drummond counties and in Montmorency county near Ste. Anne de Beaupré, where a small amount of iron oxide has been produced.

Atlantic Provinces

Minor deposits of pigment grade occur in Nova Scotia and New Brunswick, and a small amount has been produced in Colchester county, Nova Scotia.

Ontario

Small, thin deposits have been reported to occur on the east bank of the Abitibi River, in Kennedy township, near Cochrane in northern Ontario and in Monmouth township, Haliburton county.

Western Canada

Iron oxide deposits of significant size occur near Grand Rapids and Cedar Lake, north of Lake Winnipegosis, Manitoba, and at Loon Lake, about 32 miles from Walburg, Saskatchewan. Several occurrences are known in British Columbia and material that might be suitable for gas purification is found in the Peace River area of northern 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, plastics, imitation leather, mastic tile and many other pigmentable materials.

The permanence of the colours has long made iron oxide pigments important in paint for use on barns, railway structures and rolling stock. They are used as rust inhibitors, in metal priming, and in ship-bottom paints.

A time-honoured use of ground natural or synthetic hematite is in jeweller's rouge for polishing metal and glass.

Ground hematite that may be of pigment grade is used in compounding certain stock and poultry feeds and as a weighting agent in drilling muds.

Siennas and umbers are used chiefly in wood and paper stains.

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 passing it through columns filled with wood chips coated with iron oxides.

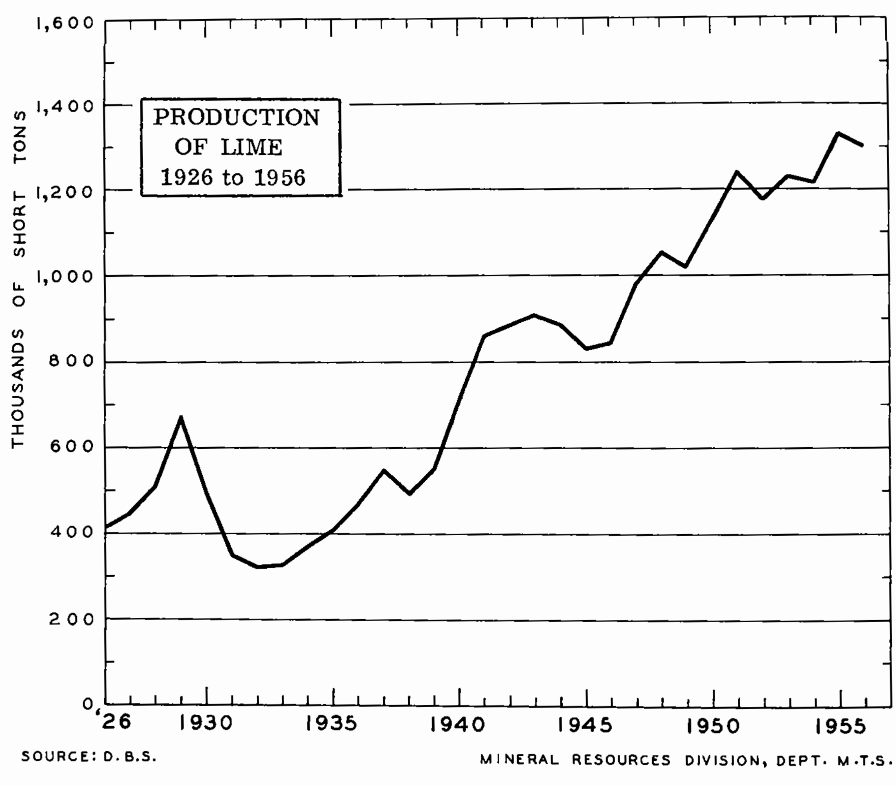
A number of standard tests have been developed with the object of eliminating the human factor in assessing pigments, but they have not been completely successful. In the final analysis, the appraisal of a

LIME

By H. M. Woodrooffe
Industrial Minerals Division

Lime is an important raw material in the economy of an industrial nation. Canada's industrial growth has been reflected in a steadily increasing production of this commodity. Except for the depression period, output has increased steadily during the past thirty years, with current production 300 per cent above 1926. Production in 1956 was down slightly from the peak year of 1955.

To supply the growing demand, facilities for the production of chemical lime are being expanded. An important new use has developed recently in the treatment of uranium ores in the Blind River and Bancroft areas of Ontario for which purpose substantial quantities are required.



Lime - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production (Shipments)				
Quicklime	947,316	11,852,860	995,639	12,221,541
Hydrated lime	348,383	3,814,738	335,479	3,589,363
Total	1,295,699	15,667,598	1,331,118	15,810,904
Production (Shipments) by Provinces				
New Brunswick	18,432	408,338	18,861	385,979
Quebec	452,779	4,506,430	461,805	4,448,525
Ontario	673,357	8,258,857	698,245	8,420,382
Manitoba	64,286	1,066,704	57,510	886,901
Alberta	41,309	624,060	38,335	553,526
British Columbia	45,536	803,209	56,362	1,115,591
Total	1,295,699	15,667,598	1,331,118	15,810,904
Imports				
United States	46,893	545,655	24,697	278,766
United Kingdom	385	4,987	311	4,410
Total	47,278	550,642	25,008	283,176
Exports				
United States	31,897	622,713	29,031	537,647
Other countries	10	316	5	149
Total	31,907	623,029	29,036	537,796

Consumption of Lime

	1956		1955	
	Short Tons	$	Short Tons	$
Producers' Shipments by usage				
Building Trades				
Finishing lime..........	97,328	1,951,027	89,769	1,760,307
Mason's lime	101,962	1,535,247	108,095	1,678,044
Industrial uses				
Non-ferrous smelters...	157,695	796,523	171,220	852,994
Iron and steel plants	113,605	1,364,700	99,950	1,146,498
Cyanide & flotation mills	17,929	215,345	24,138	336,383
Pulp and paper mills....	222,752	2,825,484	249,309	3,134,588
Glass works	15,723	174,295	19,068	219,110
Sugar refineries........	25,931	337,442	28,940	361,076
Tanneries	5,905	69,994	6,011	74,637
Sand-lime brick	13,973	162,393	16,033	190,518
Insecticides, fungicides .	77	689	141	966
Fertilizer plants........	4,752	48,605	2,781	28,381
Other industries........	491,891	5,878,152	500,810	5,806,945
Agricultural	6,251	77,476	5,420	84,074
Other uses.............	19,925	230,226	9,433	136,383
Total	1,295,699	15,667,598	1,331,118	15,810,904

Limestone suitable for production of lime occurs in all provinces except Prince Edward Island. The concentration of industry in Ontario, Quebec, and on the coast of British Columbia has encouraged development of large kilns and efficient plants for lime burning in those areas.

British Columbia, Alberta, and Quebec are sources of high calcium lime, and Ontario, Manitoba and New Brunswick produce the dolomite variety as well. Currently in production in Canada are 40 plants with 145 kilns installed. These range from small shaft kilns to rotary units. There are 22 of the latter type.

Certain industrial plants burn lime for their own use as intermediate stages in a manufacturing process; examples are the production of cyanamide and calcium carbide, and the refining of sugar.

Although limestone deposits are plentiful in Canada, few are suitable for the economic production of a lime sufficiently high in calcium, low in impurity, and of white colour, for chemical uses.

Lime

Since it is a relatively low-priced commodity, lime is not generally an item of international trade. However, local economic conditions favour export of lime to the United States on the West Coast and imports from that country on the East Coast. A small quantity is also imported to Ontario for use by the iron and steel industry.

Producers

New Brunswick

Bathurst Power and Paper Company Limited burns lime at Bathurst for use in the processing of wood pulp. Stone for this operation is quarried in Quebec. Snowflake Lime Limited operates kilns at Saint John for the production of quick and hydrated lime for building and industrial use.

Quebec

Shawinigan Chemicals Limited operates a lime plant at Shawinigan Falls as part of its process for manufacturing calcium carbide. Stone for this operation is quarried near Bedford, Missisquoi county.

Standard Lime Company Limited produces high calcium lime at St. Marc des Carrières, Portneuf county, and at Joliette. Most of the production is used industrially, principally in the pulp and paper industry. At the latter plant, mason's lime and hydrate for the building industry are also produced.

Dominion Lime Limited, Lime Ridge, in Wolfe county, produces quick and hydrated lime from high calcium stone for industrial and building use.

During the recovery of magnesia from brucitic limestone, Aluminum Company of Canada Limited produces both quick and hydrated lime near Wakefield, Quebec.

Five small lime-burning plants are also in production, supplying local markets.

Ontario

Gypsum, Lime and Alabastine, Canada, Limited produces dolomitic and high calcium quick and hydrated lime from its plants near Beachville, Hespeler and Milton. The company supplies industrial, chemical and building lime. At its Beachville plant installation of a second rotary kiln was begun.

North American Cyanamid Limited operates lime kilns at its Niagara Falls, Ontario, plant in conjunction with the manufacture of cyanamide. Stone is quarried by the company at Beachville. The company has under construction a new lime plant at the quarry for the production of commercial lime.

A high calcium limestone near Amherstburg is being burned for lime by Brunner-Mond Canada Limited during the manufacture of alkali.

Chemical Lime Limited produces lime near Beachville, chiefly for use in the metallurgy of iron and steel.

In Wellington county, near Guelph, Canadian Gypsum Company Limited produces a hydrated dolomitic lime for the building trades.

Six independent lime plants were in production during 1956.

Manitoba

Two plants are operated by Winnipeg Supply and Fuel Company Limited; at Moosehorn, a high calcium lime is produced mainly for industrial use, and at Stonewall, dolomitic lime is produced for the building industry.

Building Products and Coal Co. produces dolomitic lime at Inwood.

The Manitoba Sugar Company Limited operates kilns at Fort Garry in conjunction with the refining of sugar.

Alberta

High calcium quick and hydrated lime is produced by Loder's Lime Company Limited at Kananaskis and by Summit Lime Works Limited near Crowsnest, British Columbia.

Lime kilns are also located at the Picture Butte, Taber and Raymond refineries of Canada Sugar Factories Limited.

British Columbia

Gypsum, Lime and Alabastine, Canada, Limited produces high calcium lime and hydrate at Granville Island, Vancouver, and at Blubber Bay, Texada Island.

Crown Zellerbach, Canada, Limited burns lime at Ocean Falls for use in the manufacture of paper.

Uses and Marketing

Apart from its role in building, lime is a widely used raw material with a broad industrial application. Because of its low cost and availability, it is commonly used as a causticizing agent and a base in acidity control. Its use is also important in the production of calcium compounds.

Lime

The high calcium variety is a basic raw material in the manufacture of calcium carbide and cyanamide, soda ash, ethylene glycol, citric acid, pharmaceuticals and fine chemicals. In the metallurgical industry lime is used in the open hearth process for desulphuring and as a flux in steel production. Non-ferrous applications include additions of lime during flotation of several minerals and for acidity control in the recovery of precious metals from their ores by the cyanidation process. It is used to some extent in the preparation of alumina from bauxite by the Bayer process. A recent application has been in acidity control during the processing of uranium ores.

It is of importance to the pulp and paper industry both as a causticizer in the sulphate and soda processes and in preparing calcium bisulphite dissolving liquor. It is used in the manufacture of glass, in tanning of leather, and in treatment of municipal waters. In the last case it is useful in overcoming temporary hardness and turbidity. It is used to neutralize acidic industrial and municipal wastes to reduce stream pollution.

The use of lime as plaster, stucco and mortar by the building industry is well known. It is also a raw material in the production of lime-sand building bricks, cold-water paints and some forms of insulation.

Agricultural uses of lime include its direct addition to soil to adjust acidity and to overcome calcium deficiency. It is used in the preparation of some insecticides.

In Canada lime is marketed both as calcium oxide and calcium hydrate, usually referred to as quicklime and hydrated lime respectively.

The former type is shipped in bulk in lump form or as crushed lime in bulk or containers; a minor production is pulverized and bagged before shipment. Hydrated lime is a dry, slaked form and is marketed as a fine powder (e.g. 95% passing a 325-mesh screen) in containers, usually multi-wall paper bags.

Prices

Market prices in the Montreal area during 1956 for carload lots were in the range \$15.00 to \$19.00 per ton.

LIMESTONE

By H. M. Woodrooffe
Industrial Minerals Division

Canadian production of limestone during 1956 established a new peak and increased more than 20 per cent over 1955. The production figures (see table) do not include stone quarried for the production of lime and portland cement.

Apart from a small output of dimension stone for building, Canadian limestone is marketed in crushed form in several sizes for a variety of uses. It is the most widely quarried of all native rocks and is used in large quantities as concrete aggregate, road building material, and railway ballast. The availability of deposits and ease of quarrying are the principal factors responsible for its wide use. Limestone is also an important raw material in several industrial processes. Although there are active quarries in all provinces except Prince Edward Island and Saskatchewan, the industry is largely concentrated in southern Ontario and Quebec, which together account for almost 90 per cent of current production.

Limestone occurs in this country in two forms; in bedded formations, which yield most of the production, and in massive metamorphosed deposits. Its chemical composition varies from high calcium through magnesian to dolomite. Deposits of siliceous and argillaceous varieties occur, as well as brucitic limestone and magnesitic dolomite. Deposits of the last two varieties are being worked. High-calcium limestone sufficiently pure to provide industry with an important raw material for use in certain chemical and metallurgical processes is available in only a few areas.

Limestone is widespread in its occurrence and is generally a low-cost commodity. Consequently there is little international trade. In Canada, however, it is exported from the Pacific Coast of British Columbia to the adjacent area of the United States for use in the manufacture of pulp and paper and as a metallurgical flux.

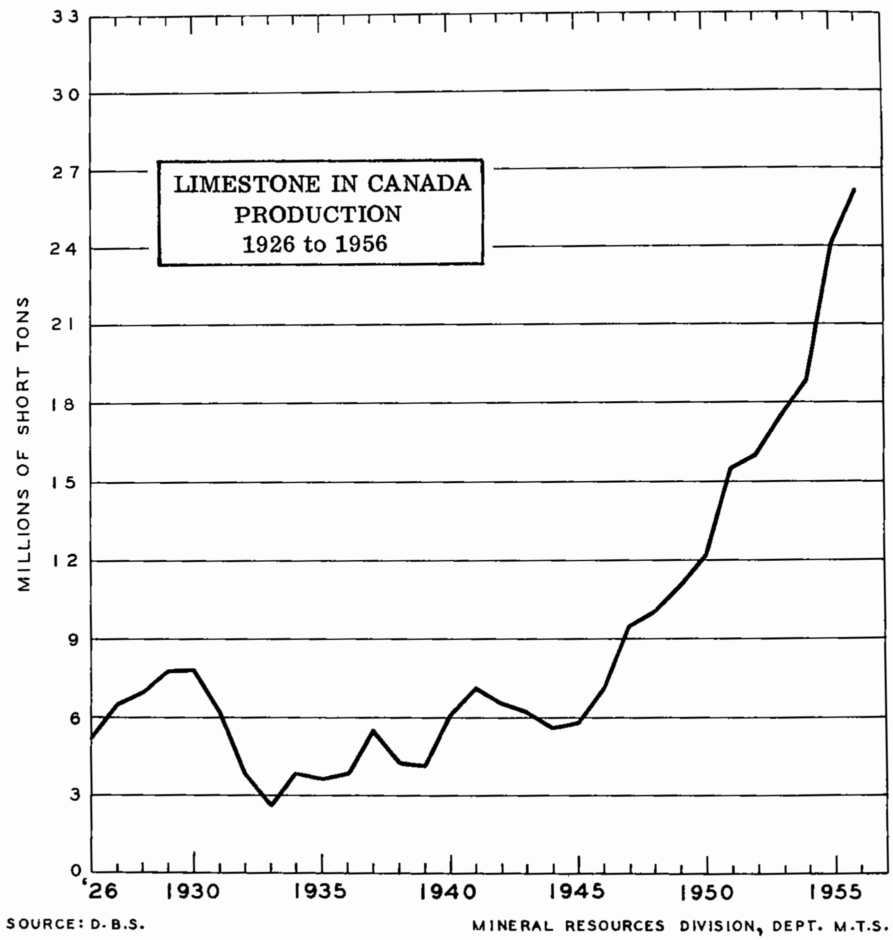
The period since World War II has marked a substantial steady growth in the limestone industry. Production has increased by 300 per cent to supply markets for concrete aggregate and road material during the intensive program of construction this country has experienced. During the period, these used have increased more rapidly than other uses for limestone.

Limestone

Limestone - Production and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production by Provinces				
Newfoundland	319,261	573,304	333,354	590,945
Nova Scotia	109,142	211,765	102,648	209,981
New Brunswick	502,232	633,575	423,619	609,226
Quebec	10,448,278	14,793,410	8,975,721	12,623,593
Ontario	15,207,534	18,941,565	12,233,730	14,765,784
Manitoba	262,557	956,708	227,297	1,112,276
Alberta	30,863	111,165	23,577	91,831
British Columbia	2,226,110	3,084,323	1,787,625	2,318,677
Total	29,105,977	39,305,815	24,107,571	32,322,313
Production by Uses				
Structural*	83,208	2,699,658	89,525	2,796,244
Metallurgical	1,944,444	2,415,247	1,893,266	2,202,833
Glass making	17,098	45,454	17,662	43,840
Sugar refining	4,400	8,627	8,905	11,093
Pulp and paper	421,652	1,224,996	439,730	1,344,352
Other chemical uses	66,476	74,582	63,371	65,910
Pulverized for agricultural & fertilizer uses	474,903	1,229,300	424,028	1,027,161
Pulverized for other uses	171,287	620,538	140,499	656,768
Rubble & riprap	606,755	596,090	410,457	402,322
Concrete aggregate	10,081,389	12,628,014	8,203,448	9,834,144
Road metal	13,835,618	16,233,750	11,548,279	12,953,661
Rail ballast	809,078	793,586	753,412	756,524
Other uses	589,669	735,973	114,989	227,461
Total	29,105,977	39,305,815	24,107,571	32,322,313
Limestone used in manufacture of cement	7,152,693		6,033,619	
Limestone used in manufacture of lime	2,276,836		2,274,211	
Limestone miscellaneous	29,105,977		24,107,571	
Total	38,535,506		32,415,401	

* Includes building, monumental, and ornamental stone, flagstone and curbstone.



Uses

In Canada, limestone is used mainly in road construction and as an aggregate in concrete. In 1955, more than 82 per cent of all stone quarried was crushed and marketed for these uses.

Limestone is of importance to the metallurgical industry. It is used as a slag-making constituent in smelting processes. In the blast furnace reduction of iron ore, it is added to flux siliceous impurities. In most metallurgical operations, stone high in calcium and low in silica is used.

Limestone also finds application in the pulp and paper industry in the preparation of calcium bisulphite dissolving liquor. High-calcium varieties with little insoluble impurity are preferred for this use. It is used in the manufacture of glass and in sugar refining and is marketed in ground form for use as a mineral filler in several industrial processes.

Limestone

There has been a growing use for limestone in conditioning agricultural soils. Ground limestone, commonly referred to as "Agstone", is added to the land to overcome calcium deficiency and to correct acidity. In 1955, sales of "Agstone" in Canada exceeded $1,000,000. Marl, an unconsolidated form of calcium carbonate, is also used for this purpose.

Certain varieties of limestone supply raw material for the production of calcium and magnesium metals. The latter is produced by the thermal ferrosilicon process from a dolomite of high purity quarried near Haley, Ontario. In Canada, magnesium is also made by the electrolytic process from magnesia obtained from brucitic limestone quarried near Wakefield, Quebec.

Dolomite is quarried and dead-burned at Dundas, Ontario, by Steetly of Canada Limited for use as a refractory material in basic open-hearth steel furnaces.

At Kilmar in Quebec, magnesitic dolomite (a magnesium-rich dolomite) is mined by Canadian Refractories Limited for use in the manufacture of basic refractories. The latter are also made from magnesia recovered from brucitic limestone quarried near Wakefield.

Other important uses for limestone are as a raw material in the production of lime and the manufacture of portland cement.

Geographical location, quality and preparation for the market effect the price of limestone. When sold as commercial stone for concrete aggregate, the quarry price is as low as $1.50 per ton in some localities.

LITHIUM MINERALS

By V.A. Haw
Industrial Minerals Division

Canada became a major producer of lithium minerals during the year, as the mine and plant of Quebec Lithium Corporation completed its first full year of operation. The company produces spodumene concentrates from vast deposits of spodumene-bearing pegmatite in LaCorne township in the Val d'Or district of western Quebec. Interest in lithium minerals remained at a high level as a result of speculation on the application of lithium derivatives in the field of high-energy fuels for rockets, jet aircraft, and guided missiles, as well as in the development of nuclear energy.

Several occurrences of spodumene in Ontario and Manitoba were developed to the point where large reserves were blocked out, and even some underground work was completed. However, markets for these new prospects have been slow in developing, and production plans have been retarded. Although the lithium industry generally (mainly in the United States) has made tremendous strides since 1950, the point has now been reached when production facilities are more than adequate to meet present requirements, according to recent published information. However, research on product development for lithium and its compounds is continuing at a fast pace and this, together with its potential military applications, would appear to assure lithium a promising future.

Production and Trade

Quebec Lithium Corporation remained the only producer of lithium concentrates, and reported a production of 4,789,360 pounds of lithia in the form of spodumene, according to figures released by the Dominion Bureau of Statistics. All production was exported to Lithium Corporation of America at Bessemer City in North Carolina under a five-year contract. The company is now, however, reported to be studying the possibility of erecting a Canadian plant to produce lithium chemicals from raw materials in excess of contract commitments.

The mine and plant operated on a restricted basis during the break-in period for the first half of the year, but in the second half mine production was maintained at designed capacity of 1,000-1,200 tons per day. The spodumene is concentrated by froth flotation to a grade of 5 per cent lithia or slightly better. In addition to the spodumene, the company is also producing feldspar as a by-product.

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Lithium Minerals

Consumption of lithium products in Canada is not large. Estimated imports from the United States in the form of lithium carbonate and lithium hydroxide amount to $30,000 annually.

Occurrences of Lithium Minerals In Canada

Quebec

Exploration drilling on the property of Quebec Lithium Corporation in the north portion of LaCorne township has indicated one of the largest spodumene deposits in the world. The main dyke has been traced for about two miles and, together with closely associated groups of parallel dykes, constitutes an orebody with reported indicated reserves of 15 million tons down to the 500-foot level. Average lithia content has been calculated to be 1.2 to 1.3 per cent.

Other lithium-bearing dykes in the same general area are located in LaCorne, Figuery, and Landrienne townships. In most of the occurrences spodumene is the only lithium mineral present, although lepidolite has been reported occurring in some of the smaller dykes and lithiophilite has also been recognized as a minor constituent in at least one dyke. These dykes are associated with the contact of a large granitic intrusive known as the LaCorne batholith. They occur both within the intrusive near the contact and in the enclosing metamorphic rocks. The spodumene has a uniform distribution in some of the larger dykes; in others it is locally segregated into bands and patches. Beryl and tantalite-columbite are common accessory minerals.

Ontario

There are now three districts in which large reserves of spodumene are indicated. The one that has received the most attention is in the Beardmore area south of Lake Nipigon. Many occurrences of spodumene pegmatite have been discovered, and exploration drilling by a number of companies has outlined in excess of an estimated 6 million tons of reserves running from 1.1 to 1.4 per cent lithia. The district is serviced by road and railway transportation, as well as being close to boat transport on Lake Superior; hydro power facilities are also readily available. The other two districts are located near Root Lake, 50 miles north of Sioux Lookout, and near Falcon Lake, 14 miles north of the Canadian National Railways between Nakina and Armstrong. Little is known of the last two except that the occurrences are reported to be extensive.

Manitoba

In southeastern Manitoba, numerous lithia-bearing dykes occur in the Winnipeg River-Cat Lake area. As elsewhere in Canada, the principal lithium mineral is spodumene. However, in one dyke near Lamprey Falls on the Winnipeg River the lithium mica, lepidolite, is a prominent constituent, and east of Bernic Lake amblygonite occurs in a dyke. In neither case has it been suggested that there is enough present to be economically important.

Companies have been active in the area and in properties east of Bernic Lake and northwest of Cat Lake tonnages of spodumene reserves in excess of 8 million have been indicated by diamond drilling.

Spodumene-bearing pegmatite dykes also occur near East Braintree, 84 miles east of Winnipeg, and in the Herb Lake area of northern Manitoba. The Herb Lake property has been drilled, and indicated reserves in excess of 5 million tons containing 1.20 per cent lithia have been reported.

Northwest Territories

In the area lying northeast of Yellowknife for about 50 miles, and eastward along the north shore of Great Slave Lake as far as Hearne Channel, pegmatite dykes containing rare-element minerals are common. All the lithium minerals of commercial interest, as well as beryl and columbite-tantalite, have been reported as occurring in many of these dykes. Officers of the Geological Survey of Canada have particularly mentioned occurrences in the areas of Buckham Lake, Sproule Lake, and to the north of Hearne Channel, as having a high content of spodumene. Appreciable quantities of amblygonite have also been observed, in addition to minor occurrences of lithiophilite, lepidolite, and petalite.

World Survey of Resources and Production

Four principal companies produce lithium chemicals, metals, and alloys in the United States. Raw material for this production is imported from Canada, Southwest Africa, Southern Rhodesia, Brazil, and Mozambique, and some is obtained from domestic sources. Large reserves of spodumene in North Carolina are being mined by two companies. The Black Hills of South Dakota have been a source of spodumene for many years and are still being mined on a small scale. The salt brine of Searles Lake, California, is a source of dilithium phosphate, obtained as a by-product of salt production: present output in terms of lithium carbonate is estimated to be close to 2 million pounds, about one-fifth of American requirements for 1955.

Lithium mineral production in Africa consists mainly of lepidolite (lithium potassium aluminum silicate), petalite (lithium aluminum silicate), and amblygonite. Very large reserves of lepidolite and petalite exist in Southern Rhodesia and Southwest Africa and make up the great bulk of production, although amblygonite is produced on a relatively small scale. A new $6,500,000 chemical processing plant recently constructed in Texas uses lepidolite from Southern Rhodesia as raw material. These African sources supply lithium concentrate requirements of the United Kingdom and European countries also. Other countries too numerous to mention are also known to contain lithium mineral occurrences that have not yet been developed. Very large deposits of spodumene have been reported as occurring in the Belgian Congo.

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Uses and Specifications

Lithium compounds find their most important applications in the ceramic industry and in the manufacture of lubricating greases. Practically all lithium concentrates are converted chemically to lithium carbonate or hydroxide, the usual basic compounds used in industry. For chemical processing, the only specification available is for the spodumene that Quebec Lithium Corporation is exporting. Four and a half per cent lithia is required as a minimum in the concentrate. However, practically all producers of lithium compounds either own or have a share in mining properties from which they obtain concentrates; standard specifications have therefore not been established, and grades are a matter of individual negotiation.

Lithium greases, first evolved in 1943, came to play an important role in lubrication wherever operational extremes of temperature were experienced, as they maintain their lubricating qualities between -60° F and +320° F, and moreover, have excellent water insolubility characteristics. In wartime, lithium greases were invaluable for aircraft engines. Since the war, their industrial use has grown rapidly, as their unique properties make possible the production of multi-purpose greases, simplifying both manufacture and application.

In ceramics, lithium serves primarily as a flux, permitting the development of low-temperature ceramic bodies with the attendant benefits of refractoriness, fuel economies, and wider colour use. It also makes possible the production of glass transparent to ultraviolet light for use in germicidal lamps.. Lithium compounds reduce the maturing temperature and increase the fluidity and gloss of glass, glazes, and enamels; facilitate production of certain glasses of high electrical resistance; and have many other desirable effects that render them of great benefit in the field of ceramics.

Other common applications include the use of lithium hydroxide as a constituent of the electrolyte in alkaline storage batteries; lithium chloride and bromide in air conditioning units, and in refrigeration systems; lithium fluoride as a flux in the welding and brazing of aluminum; and for such other miscellaneous uses as for the production of single-crystal optical units; in the control of reactions leading to the formation of alkyd resins for use in paints, and in the manufacture of dry-cell batteries which will function at extremely low temperatures where normal cells are inoperative.

The use of lithium as a metal has so far had limited applications. Its principal use appears to be as a scavenger of impurities in refining non-ferrous metals, and as a grain-refining agent. Only very small amounts are added for this purpose. Lithium alloys of magnesium, aluminum, copper, lead, and zinc are under development and have promise.

The use of lithium in nuclear energy production and as a source of fuel for rockets and guided missiles has received much publicity, and speculation as to its exact function has been widespread. Little information is available in either case, but from scientific publications it has become generally known that tritium, a reported constituent of the hydrogen bomb, is obtained by bombarding the lithium isotope Li^6 with neutrons. The association of lithium with solid fuels is in the form of lithium hydride. The chemical compound furnishes a readily available source of hydrogen, which is a high-energy fuel.

Prices and Tariffs

Lithium concentrates are not traded in the open market and prices published in trade journals are therefore purely nominal. The one exception is the price of spodumene concentrate established in the contract between Quebec Lithium Corporation and Lithium Corporation of America of $11.00 per unit of lithia (Li_2O).

Nominally quoted prices for lithium concentrates published in trade journals:

Spodumene	-	$11.00/unit Li_2O
Lepidolite	-	"
Petalite	-	"
Amblygonite	-	$75.00/short ton

Prices of lithium chemicals from "Chemical and Engineering News, Quarterly Report on Current Prices" are:

		Per lb *	
Lithium metal, 1 lb cans	-	$13.00	- $20.00
" bromide	-	$ 1.80	
" chloride	-	$ 1.45	
" carbonate	-	$ 0.85	- $ 1.13 1/2
" hydroxide monohydrate	-	$ 0.80	- $ 0.81 1/2
" stearate	-	$ 0.49	- $ 0.50
" fluoride	-	$ 2.17 1/2	- $ 2.40

* For quantities normally involved in commercial transactions.

There is no tariff on mineral concentrates entering the Unites States. A duty is imposed on the metal and alloys of 25 per cent ad valorem and on chemicals of 12 1/2 per cent.

MAGNESITE AND BRUCITE

By H. M. Woodrooffe
Industrial Minerals Division

In Canada the primary production of magnesia is in the form of calcined brucitic granules and magnesitic dolomite. Production in 1956 amounted to $2,783,181, a substantial increase over the $2,151,820 reported in 1955.

At present, the only deposits being worked as a source of magnesia are in Quebec Province north of the Ottawa River at Kilmar, Argenteuil county, midway between Ottawa and Montreal, and at Farm Point near Wakefield, 22 miles north of Ottawa.

At the former location, Canadian Refractories Limited works a deposit of magnesitic dolomite, a rock composed of an intimate mixture of magnesite and dolomite. Underground mining is practised. Impurities are controlled by beneficiation and the milled product is calcined in a rotary kiln to a dead-burned clinker. From the latter a number of basic refractory products are manufactured. At Marelon, 10 miles south of Kilmar, the company operates a modern basic-brick manufacturing plant. Products from both plants include basic brick in various sizes and shapes, high-temperature refractory cements, ramming mixtures, and other specialized refractory products.

At Farm Point, Aluminum Company of Canada Limited quarries a brucitic limestone. In this rock granules of brucite, a hydroxide of magnesium, occur in a matrix of calcite. The rock is crushed, sized, calcined, and separated into marketable forms of magnesia and lime. Part of the magnesia is used by the Company at Arvida in the production of magnesium metal. The remainder is used in the manufacture of high-magnesia refractories, as a soil additive, and in other industrial applications. Both quick and hydrated lime are recovered in the process.

The other known occurrences of brucitic limestone in Canada are in the vicinities of Wakefield, Bryson, and Lake St. John, Quebec; at Rutherglen, Ontario; and on West Redonda Island, British Columbia.

Although magnesite and hydromagnesite deposits occur at several locations in Western Canada, mostly in British Columbia and Yukon, they are generally not extensive or are remote from transportation and are

Magnesite and Brucite.

Magnesite and Brucite - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production				
Magnesitic dolomite and brucite		2,783,181		2,151,820
Imports				
Dead-burned and caustic calcined magnesite				
Yugoslavia	15,133	731,148	7,514	356,049
United States	6,507	727,223	6,349	488,478
West Germany	2,240	116,000	-	-
Other countries	180	15,654	74	9,625
Total	24,060	1,590,025	13,937	854,152
Magnesite fire-brick				
United States		676,416		528,284
West Germany		3,937		9,375
United Kingdom		-		16,412
Total		680,353		554,071
Magnesium salts or compounds				
United States	7,052	324,282	5,187	224,416
United Kingdom	165	104,763	90	42,586
Other countries	39	9,701	-	-
Total	7,256	438,746	5,277	267,002
Magnesium sulphate				
West Germany	1,605	29,085	1,379	26,281
United States	837	35,608	868	37,527
Other countries	172	4,824	129	5,201
Total	2,614	69,517	2,376	69,009
Magnesia pipe covering				
United States		128,947		53,846
United Kingdom		29,627		38,551
Total		158,574		92,397
Magnesium carbonate & magnesium oxide				
United States	5,704	540,589	5,035	465,984
United Kingdom	671	98,713	462	67,878
Total	6,375	639,302	5,497	533,862

	1956		1955	
	Short Tons	$	Short Tons	$
Exports				
Basic refractory materials, dead burned				
United States	10,256	715,179	1,105	67,676
United Kingdom	2,106	97,987	213	13,191
Brazil	1,354	94,633	1,880	112,437
Other countries	1,110	55,809	57	2,467
Total..................	14,826	963,608	3,255	195,771

not worked. The more important of these are at Marysville, near Cranbrook, British Columbia, and are owned by The Consolidated Mining and Smelting Company of Canada, Limited.

Hydromagnesite occurrences near Atlin and Clinton, British Columbia, have been worked intermittently.

Uses

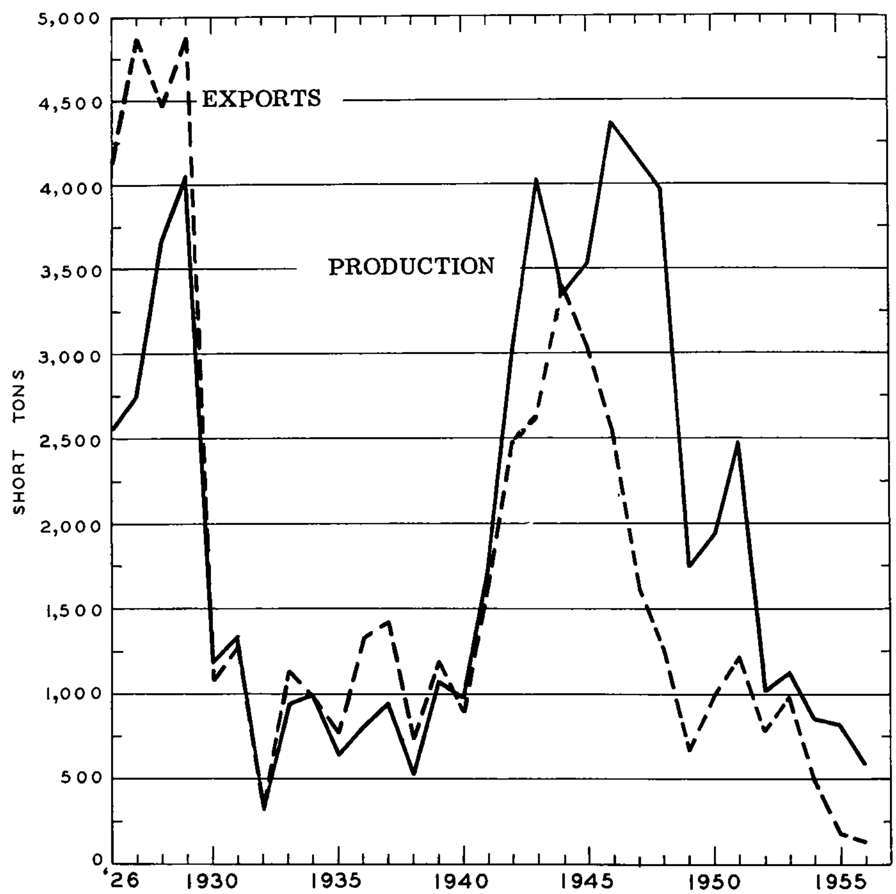
Magnesia is a raw material used for the production of magnesium metal and basic refractories and for the preparation of oxysulphate and oxychloride cements. The last is a durable cement used principally as a floor covering, and is obtained by the reaction of active magnesia with a solution of magnesium chloride. Magnesia is used in the pulp and paper industry in the preparation of magnesium bisulphite dissolving liquor for chemical treatment of wood pulp. In this process it is possible to recover much of the magnesia and sulphur for re-use. It is used in processes for recovering uranium from its ores.

Other uses for magnesia are in the preparation of a number of magnesium chemicals and compounds for use in the pharmaceutical trade, in industry, in soil additives, and to control acidity. An example of the last is its use in neutralizing sulphuric acid solutions where it forms a compound more soluble than that obtained with lime.

MICA

By J. E. Reeves
Industrial Minerals Division

In 1956, Canadian Mica production markedly increased over that of 1955. This is reflected particularly in the exports of untrimmed sheet phlogopite to Japan, and ground phlogopite to the United States, and in the greater consumption of mica in certain domestic industries. This production is still but a small fraction of the high figures attained during most years from 1941 to 1951 when World War II, the immediate post-war period and the Korean emergency stimulated a large demand for trimmed mica.



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

Mica - Production, Trade and Consumption

	1956		1955	
	Pounds	$	Pounds	$
Production (primary sales)				
Trimmed	22,355	26,641	24,317	26,019
For mechanical splittings	16,000	4,160	8,000	2,080
Splittings	2,000	3,480	-	-
Rough, mine-run or rifted	40,826	841	25,275	2,272
Ground or powdered	1,493,410	58,083	943,158	42,857
Scrap and unclassified	269,220	2,461	639,958	4,313
Total	1,843,811	95,666	1,640,708	77,541
Production by provinces				
Quebec	1,617,276	93,761	1,095,034	73,734
British Columbia	180,000	1,260	504,300	2,861
Ontario	46,535	645	41,374	946
Total	1,843,811	95,666	1,640,708	77,541
Imports				
Unmanufactured				
India	275,700	151,642	103,300	54,111
United States	27,000	38,377	80,300	42,234
Argentina	16,500	7,760	-	-
Other countries	5,700	3,000	15,300	9,465
Total	324,900	200,779	198,900	105,810
Manufactured				
United States		505,501		462,424
United Kingdom		32,726		17,937
Brazil		-		2,492
Total		538,227		482,853
Exports, unmanufactured				
Rough				
Japan	20,200	5,526	-	-
United States	4,000	500	2,000	195
Sweden	300	33	-	-
Total	24,500	6,059	2,000	195
Trimmed				
Japan	40,800	37,412	45,500	34,858
United Kingdom	500	1,338	400	1,140
United States	500	1,231	1,000	5,320
Total	41,800	39,981	46,900	41,318
Scrap				
Belgium	80,000	2,400	20,400	612
United States	39,500	836	272,200	2,836
Netherlands	-	-	20,400	612
Total	119,500	3,236	313,000	4,060

	1956		1955	
	Pounds	$	Pounds	$
Ground				
United States	92,000	5,520	900	45
Total	277,800	54,796	362,800	45,618
Exports, manufactured				
Brazil		1,880		-
Jamaica		39		42
Total		1,919		42
Consumption				
Asbestos products	16,800		26,157	
Paints	1,652,031		1,721,152	
Electrical apparatus	515,960		492,589	
Rubber goods	543,940		484,985	
Roofing	1,220,000		480,000	
Paper goods	494,000		38,000	
Non-metallic mineral product	79,719		101,219	
Miscellaneous	-		4,702	
Miscellaneous chemicals	2,360		8,100	
Total	4,524,810		3,356,904	

Exports have always played a very important part in Canada's mica industry. Until recently the United States was a major consumer of Canadian mica, and the loss of much of this market has been the prime reason for the industry's decline in Canada. This particularly applies to high-quality trimmed mica, for which there is a large market in the United States. Under present conditions, Canada finds it difficult to compete with foreign supplies, especially Indian muscovite and Madagascar phlogopite.

Production of mica in Canada consists mainly of phlogopite from southeastern Ontario and southwestern Quebec, in the region of Ottawa. A small amount of mica, derived from schist, was produced in Vancouver, but this business has declined. In Ontario, a small amount of muscovite was produced during the year from the former Purdy property near Eau Claire.

Quebec

Production in 1956, all phlogopite, came from several small, scattered deposits in the Gatineau-Lievre area north of Ottawa.

Mica

Mining operations have been conducted in Hull, Wakefield, Buckingham, Portland, and Amherst townships during the past few years. Most of the production in 1956 came from Hull, Wakefield, and Portland West townships, with Blackburn Bros. Ltd. and R. J. Holt, Cantley; Cameron and Sons, Buckingham; and Edgar Lavigne of Wilsons Corners being major contributors.

Ontario

Phlogopite production comes from the Stanleyville area, North Burgess township, about 50 miles southwest of Ottawa near Perth. Peter Farrel of Stanleyville was the chief contributor in 1956. In previous years considerable phlogopite was mined in the area between Perth and Kingston, but present production is small.

Mid-Bay Mica Syndicate commenced production in January from the famous Purdy property at Eau Claire, 30 miles east of North Bay, and during the year produced some muscovite sheet.

British Columbia

For a number of years Geo. W. Richmond Co. Limited and Fairey and Co. Limited, both of Vancouver, have been grinding mica schist mined near Albreda, about 290 miles northeast of Vancouver, or near Kamloops about half-way between the two. It is used in the manufacture of local roofing, to dust the backs of asphalt shingles and siding to prevent sticking. More recently this production had declined, and by the end of the year had ceased.

Uses and Properties

Mica is used in three principal forms, namely, natural sheet, splittings, and ground mica.

Natural Sheet

Sheet mica is used chiefly for electrical insulation in a wide variety of electrical machines, instruments, lighting and power fixtures, and industrial and household appliances; in electronic equipment such as radio, television, and sound-recording equipment; as the dielectric in capacitors; and for glazing compass dials, boiler gauges, furnace observation holes, and lamps.

Sheet mica is sold commercially according to variety, size, and quality and is selected by the manufacturer according to its intended application.

Muscovite (potassium mica) of superior quality possesses the best dielectric properties of all the micas and is used extensively for insulation at high frequencies and high voltages and for capacitors. Because of its high mechanical strength and transparency, it is favoured for glazing also.

Phlogopite (magnesium or amber mica) varies considerably as regards dielectric strength, hardness, structural strength, and other properties, but its electrical properties are such that it is used widely as an insulator in a variety of electrical installations at normal industrial and domestic frequencies and voltages. Its high thermal resistance makes it suitable for use under high-temperature conditions, as in heaters, toasters, flat-irons, etc., and its softness, as compared to muscovite, makes it particularly suitable for flush commutators in which the copper and mica segments are required to wear at the same rate.

Biotite (iron or black mica) has comparatively low dielectric strength and is somewhat brittle. However, it finds limited application as insulation in low-powered fixtures and appliances.

Splittings

Mica splittings are used in the manufacture of built-up sheet in which the mica is bonded with natural or synthetic resins of suitable dielectric properties, baked, and pressed into sheets of any required size. Either muscovite or phlogopite may be employed, according to end use. Splittings are used similarly in the manufacture of mica tape, cloth, and paper, and are cut or moulded into washers, tubes and many other forms.

Built-up mica sheet is used, within the limits of its dielectric characteristics, in place of natural sheet, particularly in cases where large size would make the use of natural sheet uneconomical.

Ground Mica

Mica may be ground wet or dry according to use. Dry-ground mica is usually lower-grade, off-colour material, mainly muscovite and phlogopite but to some extent biotite, and is used principally in the roofing trade as a backing for asphalt tile and tar paper. It is also used for moulded high-frequency insulation in which the mica is bonded with ceramic binders to form a compound that may be pressed into any desired shape. Other uses are in protective coatings and to a limited extent in grease lubricants.

Wet-ground mica is prepared mainly from good quality muscovite scrap, chiefly for the paint, rubber, and wallpaper trades. White products are preferred. In paint, wet-ground mica serves as a pigment and extender; in rubber, as a dusting agent and lubricant on tire walls, and as a filler in hard rubber; in wallpaper, it is used to produce decorative effects. Wet-ground biotite is used as a lubricant in rubber tire manufacture.

A new form of mica insulation is now being prepared in the United States from muscovite scrap treated by a chemical process. The resulting pulp is formed into a continuous sheet by methods similar to those used in the manufacture of paper.

Specifications

Natural Block Muscovite

Size and quality gradings for block muscovite in general use in Canada and United States conform generally to those adopted by the American Society for Testing Materials (Designation D351-53T). Grade sizes are shown in the following table:

A. S. T. M. Grade Sizes	Area of Minimum Rectangle		Minimum Dimension of One Side	
	Sq. In.	Equivalent, sq. cm.	In.	Equivalent cm.
OOEE Special	100	650	4	10
OEE Special	80	520	4	10
EE Special	60	390	4	10
E Special	48	310	4	10
A-1 (Special)	36	235	3 1/2	8.8
No. 1	24	155	3	7.6
No. 2	15	97	2	5.0
No. 3	10	65	2	5.0
No. 4	6	40	1 1/2	3.8
No. 5	3	20	1	2.5
No. 5 1/2	2 1/4	15	7/8	2.2
No. 6	1	6.5	3/4	1.9

O = Over E = Extra

The grading of the visual quality makes use of the following eleven categories:

A. S. T. M. Visual Quality	Commercial Designation
V-1	Clear
V-2	Clear and Slightly Stained
V-3	Fair Stained
V-4	Good Stained
V-5 *	Stained A Quality
V-6 *	Stained B Quality
V-7	Heavy Stained
V-8	Black Dotted
V-9	Black Spotted
V-10	Black Stained
V-11	Densely Stained

* A case of mixed V-5 & V-6 must contain not less than 30 per cent V-5 and not more than 70 per cent V-6.

In all categories except the last two, the mica must be hard and free from cracks and foreign inclusions; category V-10 is essentially similar to V-9 except that it may be soft; in category V-11 mica is soft and may contain heavy stains, inclusions, cracks, etc.

Natural Phlogopite Sheet

In Canada, size gradings for phlogopite sheet generally follow those applying to muscovite, but are expressed in terms of linear dimensions (in 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, in general, the soft, light-coloured varieties are regarded as having the best electrical qualities; these grade down to the darker, more brittle varieties in the lower grades. The terms "light amber", "medium amber", and "dark amber" are commonly used in reference to quality.

Ground Mica

Mica is ground to meet the user's requirements, and, except for A. S. T. M. Designation D607-42 which specifies the requirements for mica pigment, there are no fixed specifications.

Dry-ground mica is sold for roofing purposes in sizes ranging from 8-mesh to under 200-mesh according to individual requirements.

Wet-ground mica (which has not been produced in Canada) is sold in the United States and Canada at minus 160-mesh for rubber and minus 200-mesh for paint and wallpaper. In general, wet-ground muscovite must be white or nearly so.

Since covering power is one of the dominant properties of finely divided mica, a well delaminated product having a low bulk density is usually specified. For dry-ground roofing mica a bulk density of about 17 pounds per cubic foot may be specified. A. S. T. M. Designation D607-42 specifies 10 pounds per cubic foot for mica pigment.

Markets

Mica purchasers in Canada and the United States include the following:

Canada

All grades

Blackburn Bros., Limited, 85 Sparks St., Ottawa, Ont.
Walter C. Cross & Co., 209 Eddy St., Hull, P. Q.

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Mica

Block

Canadian Wilbur B. Driver Co. Limited, 85 King St. East., Toronto 1, Ontario.
Mica Company of Canada Ltd., 4 Lois St., Hull, P.Q.

United States

All grades

Hal Delphin & Co., 880 Bergen Ave., Jersey City 7, N.J.
F.D. Pitts Company, 85 Chestnut Hill Rd., Newton 67, Mass.

Block

American Mica Insulation Co., 235 Parker Avenue, Manasquan, N.J.
Asheville Mica Company, Box 318, Newport News, Va.
Blanchard Mica, Inc., 2315 Broadway, New York 24, N.Y.
Farnam Manufacturing Co., Inc., Sweeten Creek Rd., Asheville, N.C.
Ford Radio & Mica Corp., 536 63rd St., Brooklyn 20, N.Y.
Gillespie-Rogers-Pyatt Co., Inc., 75 West St., New York 6, N.Y.
Industrial Mica Corporation, 223 South Van Brunt St., Eaglewood, N.J.
Manchard Trading Corp., 2315 Broadway, New York 24, N.Y.
Micacraft Products In., 710 McCarter Highway, Newark 5, N.J.
Minerals & Insulation Co., 53 Central Ave., Rochelle Park, N.Y.
Reliance Mica Co., 341 39th St., Brooklyn 32, N.Y.
Spruce Pine Mica Company, Spruce Pine, N.C.

Splittings

Continental-Diamond Fibre Co., Valparaiso, Ind.
The Macallen Company, Bay Road, Newmarket, N.H.
New England Mica Company, Inc., 66 Woerd Avenue, Waltham, Mass.

Scrap

Hayden Mica Company, Wilmington, Mass.
U.S. Mica Company, Inc., Jordan & VanDyke Streets, East Rutherford, N.J.

Prices

Prices offered by Canadian purchasers for sheet phlogopite vary with the quality and with the degree of trimming and grading. In 1956, for well-graded good quality sheet, they were approximately as follows:

Size Inches	$ Per Pound
1 x 1	0.30 to 0.55
1 x 2	0.50 to 0.70
1 x 3	0.75 to 0.85
2 x 3	1.30 to 1.40
2 x 4	1.60 to 1.70
3 x 5	2.15 to 2.50
4 x 6	2.50 to 2.75
5 x 8	3.00 to 3.50

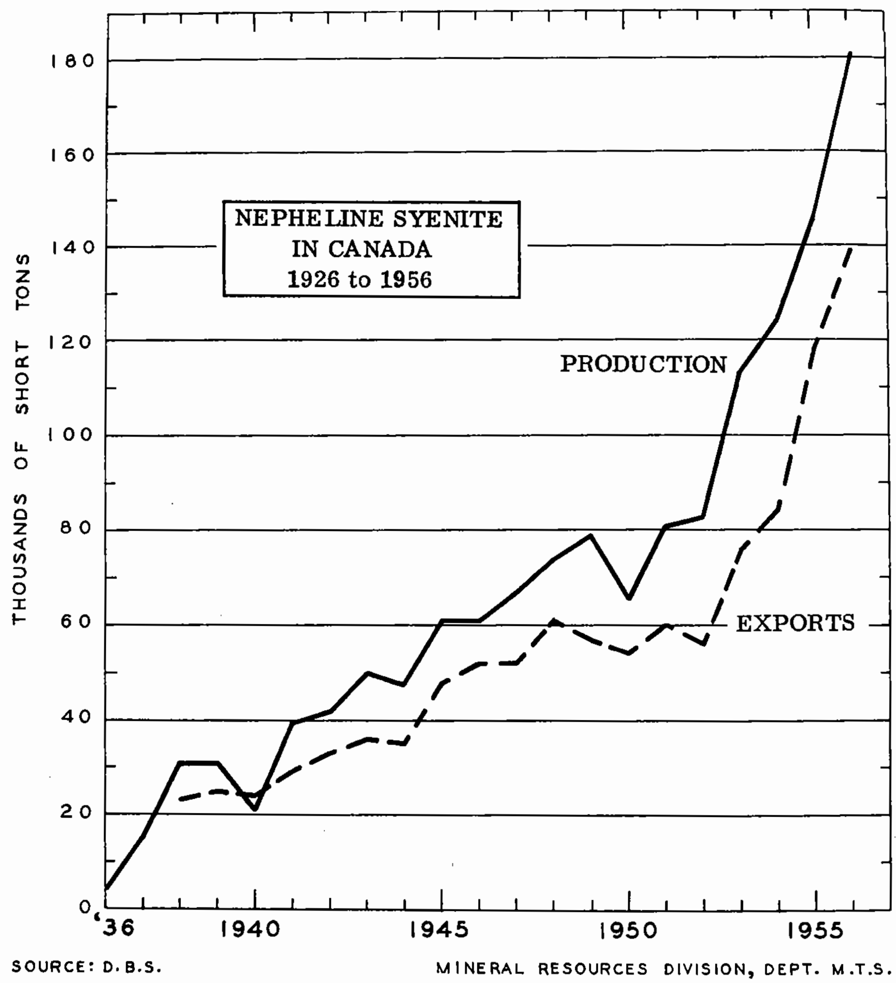
Clean scrap phlogopite sold up to about $25 per ton delivered at the plant. Scrap muscovite sells for slightly more f.o.b. shipping point, when available.

80486-4—22½

NEPHELINE SYENITE

By J. E. Reeves
Industrial Minerals Division

The year 1956 marked a continuation of the steady growth of the nepheline syenite industry, with 233,011 short tons of ore being mined. Shipments totalled 180,006 short tons valued at $2,574,140, an increase of about 23 per cent in both tonnage and value. Canada is the sole producer of nepheline syenite outside of Russia.



Nepheline Syenite

Nepheline Syenite - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production, crude (crude ore mined)	233,011		194,205	
Shipments				
Ground				
Glass grade			99,651	
Pottery grade			33,551	
Miscellaneous			10,694	
Total	177,599		143,896	
Crude	2,407		2,172	
Total shipments	180,006	2,574,140	146,068	2,099,512
Exports, crude and processed material				
United States	130,318	1,773,706	114,297	1,682,372
Netherlands	4,272	76,896	1,832	32,960
United Kingdom	1,951	34,704	848	14,669
Puerto Rico	1,230	21,175	720	12,480
Other countries	1,534	28,834	578	10,636
Total	139,305	1,935,315	118,275	1,753,117
Consumption				
Glass and glass wool....	23,009		17,176	
Clay products	2,008		1,520	
Total	25,017		18,696	

Nepheline syenite was first produced in Canada in 1936 and was originally used almost entirely in the manufacture of glass. Many other uses have been developed in the ceramic industry and have resulted in a more diversified and steadily increasing market. With a uniform supply assured for many years from extensive deposits in Blue Mountain, Methuen township, Peterborough county, about 30 miles northeast of Peterborough, Ontario, a continuing growth in demand and production is anticipated.

The year 1956 was one of significant expansion. American Nepheline Limited, previously the sole producer, completed a new 600-ton milling plant at Nephton, Ontario, at the southwestern end of Blue Mountain. This effected the centralization of mining, milling and shipping facilities and, as a result, an improvement in operating efficiency. A second operation commenced about mid-year when the Canadian Flint and Spar Department of International Minerals and Chemical Corporation (Canada) Limited opened a 300-ton plant at the northeastern end of Blue Mountain, to market glass- and ceramic-grade products.

Other Occurrences and Production

In addition to the Blue Mountain deposits, other deposits of nepheline syenite occur in Ontario near Bancroft, Hastings county; Gooderham, Haliburton county, in the French River area, Georgian Bay district; and at Port Coldwell, Thunder Bay district. In Quebec, nepheline syenite occurs in the Labelle-Annonciation and other areas, and in British Columbia in the Ice River district near Field.

Russia is the only other producer of nepheline syenite but production data are lacking. In Russia, large tonnages of nepheline-apatite rock are mined for the recovery of apatite, with nepheline as a co-product. Material of glass-grade quality, unsuitable for pottery grade, is recovered. Canada is the sole source of high-grade ceramic material.

Occurrences of nepheline syenite have been reported in California, New Jersey, Arkansas, and other localities in the United States. Deposits also occur in India and Finland but no production has been reported; apparently the material does not occur in sufficient tonnage, or the iron content is too high and difficult to reduce, in order to make it acceptable for ceramic purposes.

Specifications

Nepheline syenite is a quartz-free crystalline rock consisting principally of nepheline (a silicate of alumina, soda and potash), albite (a soda feldspar), and microcline (a potash feldspar). To be of commercial interest it must be amenable to treatment for the removal of iron-bearing impurities such as magnetite, biotite, hornblende, and tourmaline, so that the iron-oxide (Fe_2O_3) content can be reduced to about 0.08 per cent. Finely divided iron impurities frequently cannot be removed by dry milling methods, and render otherwise promising deposits of nepheline syenite useless for commercial operation.

Specifications for glass-grade nepheline syenite call for all material minus 30-mesh, U.S. standard, and for pottery grade all through 200-mesh or finer. High-intensity magnetic separation reduces the iron-oxide content from about 1.5 to 2.0 per cent in the feed to about 0.08 per cent in the finished product. Dry milling methods are used throughout the processing.

Nepheline Syenite

Uses

Nepheline syenite finds wide use in the ceramic industry where it replaces feldspar as a source of alumina and the alkalis in making glass, pottery, floor and wall tile, refractory cements, whiteware and porcelain products, enamels, and varied ceramic products. The lower fusibility and greater fluxing action of nepheline syenite as compared with that of the traditional vitrifying agents enables a manufacturer to either fire the ware at lower temperature or use a reduced amount of vitrifying agent and still attain the desired properties. In glass batches, the low iron content of nepheline syenite, combined with its high alumina and alkali content, make it a desirable means of introducing alumina, especially where low iron is important.

Finely ground material is used as an extender pigment for paint, as a filler for plastics and rubber, and as an inert carrier for insecticides.

Lower grade materials are also marketed. They can be drawn off at various stages during the milling and differ only in the Fe_2O_3 content, which is up to 0.5 per cent and higher. One use is as a vitrifying agent in some types of structural clay products. Recently a minus 200-mesh product containing about 3.0 per cent Fe_2O_3 was introduced for use as a body and glaze addition in the sewer pipe industry.

Principal markets are not domestic, the industry having been developed to supply markets in the United States. More than 70 per cent of the production is still being exported to the United States where the glass making industry is the major user. Five per cent is shipped overseas and the remainder is used in Canada. Consumption in Canada has been increasing, and in 1956 was 34 per cent higher than in 1955 and about 14 per cent of the total production.

Prices

Recent prices have been approximately as follows:

In bulk, carload lots, f.o.b. shipping point, per short ton:

			$
Glass grade,	minus 30-mesh	-	14.50
Pottery grade,	minus 200-mesh	-	18.50
Pottery grade,	minus 270-mesh	-	19.00
Pottery grade,	minus 325-mesh	-	24.00
Lower grade,	minus 100-mesh	-	10.00

An additional charge is levied for shipment in bags.

PHOSPHATE

By J. E. Reeves
Industrial Minerals Division

There was no production of phosphate in Canada in 1956. All requirements were met by imports, chiefly from the United States.

Canadian phosphate mining flourished during the years 1878 to 1892 and then declined sharply with the development of the large sedimentary deposits in Florida. A peak was reached in 1890 when more than 31,000 tons were produced, but since 1894 production has seldom exceeded 1,000 tons, and in the last 5 years no shipments have been made.

For a number of years Multi-Minerals Limited, Toronto, has been conducting an investigation of a large magnetite-apatite deposit near Nemegos, Ontario, about 135 miles northwest of Sudbury. During 1956 some test work was done on milling methods.

Imports of phosphate rock in 1956 amounted to 627,648 short tons, valued at $5,185,597, compared with the all-time high of 644,860 tons in 1954. Industries in eastern Canada import from Florida and in the West from the western United States. The Consolidated Mining and Smelting Company of Canada Limited obtains phosphate rock for its large fertilizer operations at Trail and Kimberley, British Columbia, from near Garrison, Montana, about 300 miles southeast of Trail. Here a subsidiary, Montana Phosphate Products Company, operates four mines, removing high-grade sedimentary phosphate rock by underground mining methods.

Occurrences in Canada

Almost all of the phosphate mined in Canada has consisted of the mineral apatite, essentially a calcium phosphate. It is commonly found, together with phlogopite, in association with pyroxenites in southeastern Ontario and southwestern Quebec. Quebec contributed almost 90 per cent of the nearly 350,000 tons of apatite that have been produced in Canada.

Most of Quebec's production came from deposits in Buckingham and Portland townships in the Lièvre River valley, and from Templeton and 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. Some sedimentary phosphate rock occurs between

Phosphate - Imports and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Imports				
Phosphate rock				
United States	616,613	4,863,774	577,026	4,232,914
Netherlands Antilles	5,603	155,302	11,155	275,811
French Africa	3,425	60,575	-	-
Belgium	2,007	105,946	-	-
Other countries	-	-	28	4,108
Total	627,648	5,185,597	588,209	4,512,833
Phosphate fertilizers				
Triple superphosphate				
United States	38,487	1,741,268	35,324	1,606,817
Superphosphate N. O. P.				
United States	183,991	3,420,818	175,944	3,263,012
Phosphate fertilizers N. O. P.				
United States	1,663	133,407	1,830	90,224
Belgium	101	5,277	66	4,213
Other countries	-	-	758	65,166
Total	1,764	138,684	2,654	159,603
Total phosphate fertilizers	224,242	5,300,770	213,922	5,029,432
Phosphoric acid				
United States	244	41,732	222	45,302
Consumption of phosphate rock				
Fertilizers	417,910		465,129	
Chemicals	109,524		97,716	
Steel and iron	276		128	
Stock & poultry feeds	24,596		21,919	
Miscellaneous	340		434	
Total	552,646		585,326	

Banff, Alberta, and the Crowsnest-Fernie area of southeastern British Columbia. In the years 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 comes from secondary deposits called phosphorites. These are, for the most part, limestones that have been altered by solutions containing phosphoric acid derived from the leaching of igneous rocks containing apatite or from bone or guano deposits.

In 1956 world production amounted to 34 million long tons, more than 15 million being mined in the United States from sedimentary deposits. Other major producers of sedimentary phosphate rock are: Morocco, Tunisia, Algeria and Egypt in North Africa; the Ocean, Nauru and Makatea Islands in the Pacific; Christmas Island in the Indian Ocean; and Russia. Russia, Sweden and Brazil mine apatite deposits.

Uses

About 80 per cent of the phosphate rock imported into Canada is used in the manufacture of commercial fertilizers, chiefly superphosphate. Ordinary superphosphate is made by treating the phosphate rock with sulphuric acid, and contains 16 to 20 per cent available P_2O_5. The phosphate is thus rendered largely water soluble, and the phosphorus is readily available to plant life. Triple superphosphate is produced by acidulating the phosphate rock with phosphoric acid. It contains 42 to 50 per cent P_2O_5, and is growing in importance, especially where higher freight costs are concerned.

Phosphate rock is the chief source of elemental phosphorus. A high purity product is obtained by treating the phosphate rock in electric furnaces, and compounds of this phosphorus are widely used by food, chemical and drug industries, in the manufacture of detergents, flame retardants, water softeners, pigments, opacifiers, food preservatives, pharmaceutical preparations, livestock feed supplements, leavening agents, flotation reagents, rodent poisons, fireworks, matches, and many other products.

Ferro phosphorus is used in the manufacture of iron castings to increase fluidity in the melt and in the manufacture of structural steel to increase strength. Phosphorus is used as a deoxidizer and hardening agent in copper alloys.

Phosphate

Specifications

Chemical analyses of phosphate rock are reported as CaO and P_2O_5, or as tri-calcium phosphate, $Ca_3(PO_4)_2$. The latter is commonly referred to as bone phosphate of lime and signified by B. P. L. The relationship is: 1.0 B. P. L. = 0.458 P_2O_5.

Because of its open texture, sedimentary phosphate rock is preferred for acid treatment to compact, crystalline apatite. The B. P. L. content should approach 80 per cent.

For furnace treatment apatite should contain a minimum of 70 per cent B. P. L. Size specifications call for a minimum of 80 per cent on 10-mesh.

Apatite for furnace treatment has at times been purchased by Electric Reduction Company, Limited, Buckingham, Quebec.

Prices

According to E & M J Metal and Mineral Markets of November 29, 1956, prices of phosphate rock in the United States were as follows:

Per long ton f.o.b. mines, Florida land-pebble phosphate rock:

% B. P. L.		$
77 to 76	-	7.00
75 to 74	-	6.00
72 to 70	-	5.00
70 to 68	-	4.35
68 to 66	-	3.95

There is no import duty on phosphate rock entering Canada.

POTASH

By M.F. Goudge
Industrial Minerals Division

Exploratory core-drilling carried on since 1943, when the potash mineral sylvite was first recognized by Imperial Oil Limited in the core from one of the oil wells drilled near Radville in southern Saskatchewan, has shown the potash* deposits of Western Canada to be among the largest and richest in the world. They are considered to be of Middle Devonian age. Associated with rock salt, they underlie much of southern Saskatchewan as well as a small part of southwestern Manitoba.

The potash occurs at depths of from 2,550 to 7,000 feet at or near the top of a vast salt bed up to 600 feet thick. This bed dips to the south at a relatively constant angle. It is 2,500 to 2,900 feet beneath the surface along its northern limit in Saskatchewan, and is well over 7,000 feet beneath the surface along the International Boundary in the eastern half of the province. In the west-central half of the province no salt, and consequently no potash, is found within a large triangular area with its base on the International Boundary and its apex reaching nearly to Saskatoon. Evidence points to the salt having been removed by solution from this area.

The northern limit of the salt basin extends northwesterly from the Manitoba-Saskatchewan boundary in the neighbourhood of Churchbridge, Saskatchewan, north of Yorkton, the Quill Lakes, Saskatoon, and North Battleford, into Alberta.

The potash deposits are found 5 to 20 miles south of the northern rim of the salt and are nearest the surface in a belt 35 to 50 miles wide and 400 miles long that extends diagonally across the entire width of the province. The deposits are nearly continuous but are richer and thicker in some areas than in others. Particularly rich areas occur in the vicinities of Saskatoon and Esterhazy. There are several potash beds. The potash minerals so far identified are sylvite (potassium chloride), and carnallite (the hydrous chloride of potassium and magnesium). Both are always mixed with varying proportions of rock salt (halite). Sylvite is the predominant potash mineral

* Potash is the oxide of potassium (K_2O). It is the name applied generally to various compounds of potassium used in agriculture and industry. It is not a natural compound but the term is used as a basis of comparison for all potash minerals and artificial salts.

in most areas, but in the east-central part of the province some beds of carnallite over 30 feet thick have been found.

Sylvite, which when pure contains the equivalent of 63.1 per cent of K_2O (potash), is the sought-after mineral. Beds of intermixed sylvite and rock salt (referred to as sylvinite) over 10 feet thick and containing the equivalent of over 25 per cent of K_2O are common, and some beds 3 1/2 feet thick and containing the equivalent of between 35 and 40 per cent of K_2O are reported.

At the end of 1956, fourteen companies financed by capital from Canada, the United States, Germany, and France were operating under the potash regulations of the Saskatchewan Government. The first company to attempt production was the Canadian company, Western Potash Corporation Limited (now Continental Potash Limited). This company, after trying unsuccessfully to recover the potash by dissolving it underground and pumping it to the surface, sank a shaft to a depth of over 1,100 feet on its property near Unity. Operations are at present suspended.

Potash Company of America which operates a potash mine at Carlsbad, New Mexico, after extensive exploratory drilling, formed a Canadian subsidiary - Potash Company of America Limited - which has begun the sinking of a shaft at Patience Lake, 14 miles east of Saskatoon. The company froze the ground surrounding the shaft from the surface to a depth of 3,000 feet prior to commencing shaft sinking. Good progress is being made in the sinking of the shaft and preparations are being made to build a plant for the treatment of the potash.

International Minerals and Chemical Corporation which also operates a potash mine at Carlsbad formed a Canadian subsidiary which, after detailed exploratory drilling, has announced its intentions of sinking a shaft and building a plant for the treatment of potash at Esterhazy near the Manitoba boundary.

Other companies holding land in Saskatchewan and engaged in exploration programs are: United States Borax and Chemical Corporation (formerly United States Potash), Duval Sulphur and Potash Company, Southwest Potash Corporation, and National Potash Company, all of Carlsbad, New Mexico; the two Canadian companies, Campana Limited, and General Petroleums of Canada Limited; Dominion Potash Limited, financed by French capital; and Winsal of Canada, Limited, financed by German capital. In addition, a number of smaller companies hold "withdrawals".

A Canadian company - - S. A. M. Explorations Limited - - at the end of the year completed the drilling of a well in Manitoba on the extension of the potash beds into that province and encountered a thickness of over 5 feet of very high-grade potash at a depth of 2,548 feet, the shallowest depth at which the potash has yet been found in Canada.

Potash Licensing System

Under Order in Council 1544/56 the Saskatchewan Government issued regulations under the Mineral Resources Act for the disposal of subsurface mineral rights, the property of the Crown. These regulations became effective on July 20, 1956, and replace former ones. They apply to many natural mineral salts, including those of potassium, occuring more than 200 feet below the surface of the land. A summary of the regulations follows:

Withdrawals

Any person may submit application for the withdrawal from disposal under these regulations of a certain specific area or areas for the purpose of wildcat drilling with a view to the discovery of recoverable deposits of subsurface minerals. The maximum area of a withdrawal shall be 100,000 acres, but a person may apply for withdrawal of any number of areas. The term of a withdrawal is one year with two possible six-month extensions. The rental, payable in advance, is three cents per acre for one year, and five cents per acre for each six-month extension granted.

Prospecting Permits

Each prospecting permit shall be for less than 100,000 acres, with a maximum of four different permits and with a maximum of 200,000 acres for the four permits. The term of the prospecting permit is three years. The rental, payable in advance, is five cents per acre per year, plus a $20,000.00 deposit as a guarantee that required expenditures will be made, followed by a second and third $20,000.00 deposit within 60 days of the commencement of the second and third years of the term of the permit. The permittee shall expend the sum of $60,000.00 during the first year of the term of the permit, and the sum of $80,000.00 during each of the second and third years of the permit, for exploration.

Leases

The holder of a permit in good standing may be granted a lease on not less than 640 acres and not more than 12,500 acres of the area described in the permit. A $25,000.00 deposit, payable in advance, is required and a lease application must be accompanied by an estimate of the costs of plant and facilities, and the proposed development area must be designated. A lease shall run for 21 years, renewable for further successive terms of 21 years. The annual rental for a lease is one dollar per acre per year payable yearly in advance. The lessee shall also expend not less than $3,000,000.00 within the first three years of the term of the lease. This time is subject to extension under certain circumstances.

Potash

Royalty

The lessee shall pay to the Crown a percentage of the net selling price of mine-run salts as determined by the average grade of potash ore mined in each month. This royalty shall be paid monthly. The rate of royalty runs from 4.25 per cent of the net selling price for mine-run ore under 21 per cent K_2O, to 9 per cent of the net selling price of ore containing 45 per cent K_2O and over.

Uses

The main use for potash is in fertilizers. It is one of the three essential fertilizer materials, nitrogen and phosphate being the other two. The chemical uses of potash are relatively unimportant volumewise.

Since 1930, world consumption of potash has more than trebled and consumption is rising at an accelerated rate, particularly on this continent. Potassium chloride (sylvite) is the most widely used form of potash by the fertilizer industry. Next come potassium sulphate and sulphate of potash magnesia.

Imports of Potash for Fertilizers

	1956		1955	
	Short Tons	$	Short Tons	$
Potash, muriate of				
United States	79,650	1,823,775	69,887	1,618,542
West Germany.....	34,161	861,932	36,737	876,262
France...........	11,971	382,532	29,668	683,083
East Germany	5,511	170,522	-	-
Netherlands	-	-	2,200	52,677
Total............	131,293	3,238,761	138,492	3,230,564
Potash, sulphate of				
United States	10,581	350,545	10,330	341,499
France...........	4,006	180,696	2,044	64,898
West Germany	1,565	52,882	1,582	52,286
Total	16,152	584,123	13,956	458,683
Sulphate of potash magnesia				
United States	1,838	26,610	1,986	28,255
West Germany	500	10,553	-	-
Total	2,338	37,163	1,986	28,255
Other potash fertilizers				
United States	21	2,275	-	-
Total	149,804	3,862,322	154,434	3,717,502

Imports of Potash Chemicals

	1956		1955	
	Short Tons	$	Short Tons	$
Potash and pearl ash	259	44,331	237	40,384
Potass. bicarbonate	9	2,145	6	1,514
Potass. bichromate	171	54,855	128	38,546
Potash, caustic	2,942	331,520	2,470	274,830
Potass. chlorate, ground	63	16,970	66	18,656
Potass., red or yellow prussiate	17	10,131	14	8,648
Potass. nitrate or saltpetre	546	61,171	620	81,253
Potass. compounds N. O. P.	2,097	588,521	1,623	485,963
Total	6,104	1,109,644	5,164	949,794

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ROOFING GRANULES

By F. E. Hanes
Industrial Minerals Division

Total consumption of roofing granules in 1956 by manufacturers of asphalt roofing and siding in Canada was 133,691 tons valued at $3,884,963 according to figures supplied to the Mines Branch. These figures represent a drop in consumption and value of 14,186 short tons and $202,705 compared with 1955 and reflect the decline shown in residential construction during the same period. Although the total consumption shows a decrease for the year, consumption of Canadian produced granules has increased by 6.7 per cent over 1955 (tonnage).

Eighty-two per cent of the total imports (see table) was made up of artificially coloured granules composed of 92 per cent (76,239 tons) igneous rock and eight per cent (6,337 tons) slate granules. The remaining 17,748 tons of imports were granules of natural colour, composed of 81.5 per cent (14,444 tons) almost entirely black slag and 18.5 per cent (3,304 tons) slate. The average price, c.i.f. consuming plant, for all granules in 1956 was $29.06 per short ton compared with $27.65 per short ton in 1955.

Roofing Granule Plants in Canada

Ontario

Building Products Limited, the largest producer of roofing granules in Canada, operates a basalt quarry and roofing granule processing plant near Havelock. It obtains pink rhyolite from a quarry northwest of Madoc for processing granules requiring a light-coloured base. The plant at Havelock crushes both the basalt and rhyolite rock for granules and markets the oversize basalt for highway construction. A full range of coloured granules is produced by the sodium-silicate process and distributed to the company's roofing and siding plants at Montreal and Hamilton and for sale to other manufacturers.

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Roofing Granules

Consumption and Trade * of Roofing Granules

	1956		1955	
	Short Tons	$	Short Tons	$
Consumption by kind				
Natural colour	20,760	386,437	24,173	430,013
Artificially coloured .	112,931	3,498,526	123,704	3,657,655
Total	133,691	3,884,963	147,877	4,087,668
Consumption by colour				
Black and grey-black **	33,207	701,649	37,751	731,952
Green	35,611	1,074,697	43,700	1,248,033
Red	16,966	439,759	20,821	534,319
Blue................	10,868	415,814	15,285	564,137
White...............	19,170	746,394	16,332	610,702
Grey................	9,564	232,867	8,923	240,456
Buff	1,407	45,401	2,087	72,358
Brown and tan	4,832	145,232	2,978	85,711
Coral, cream and yellow	2,066	83,150	***	
Total	133,691	3,884,963	147,877	4,087,668
Imports				
United States				
Natural colour.......	17,748	337,325	16,366	299,642
Artificially coloured .	82,576	2,723,332	104,391	3,174,512
Total	100,324	3,060,657	120,757	3,474,154

* Compiled from figures supplied to the Mines Branch, by the consumer.

** Includes natural granules used as undercoat granules.

*** Minor tonnages of cream and coral granules included under white for 1955.

British Columbia

Geo. W. Richmond supplies natural granules from a crushing and screening plant in Vancouver to West Coast roofing manufacturers. Sources of material are a dark grey slate at McNab Creek, Howe Sound and a green siliceous rock at Bridal Falls near Chilliwack.

Roofing and Siding Plants in Canada

In 1956 granule-coated roofing and siding was manufactured by 9 companies in 16 plants across Canada, as follows:

Company	Location of Plant
Bishop Asphalt Papers Limited	Portneuf Station, Quebec and London, Ontario
The Brantford Roofing Company Limited	Brantford, Ontario
Brantford Roofing (Maritimes) Limited	St. John, New Brunswick
Canadian Gypsum Company, Limited	Mount Dennis, Ontario
The Philip Carey Company, Limited	Lennoxville, Quebec
Building Products Limited	Montreal, Quebec; Hamilton, Ontario; Winnipeg, Manitoba; and Edmonton, Alberta
Sidney Roofing and Paper Company, Limited	Victoria, British Columbia; and Lloydminster, Alberta
Canada Roof Products Limited	Vancouver, British Columbia
The Barrett Company, Limited	Montreal, Quebec; and Vancouver, British Columbia
Canadian Johns-Manville Company, Limited	Asbestos, Quebec

Specifications and Colouring

Specifications for rock types suitable for making roofing granules are very rigid; few rocks possess all the qualities required. The rock should break well with a not too sharp fracture and yield, on crushing, a high percentage in the granule size range (-10 + 35-mesh for coarse, and minor amounts of -28 + 48-mesh for fines). Granules should be blocky rather than splintery. No stone source should be considered unless it contains many years' supply of rock having uniform characteristics chemically, physically, and mineralogically, and unless it lies within economical hauling distance of roofing plants.

Any stone source for roofing granules should contain a minimum of acid-reactive materials such as carbonates, sulphides, sulphates, or high-alkali materials. Pyrites by themselves in small quantities do no harm, but pyrites in conjunction with carbonates inevitably lead to poor weathering. Rocks should be hard and tough enough to withstand breakage and dusting through handling with mechanical equipment. The stone should be fine-grained with low porosity so that it withstands weathering effects from freezing and thawing and so that a minimum of pigment will cover the granules.

A granule should have 'tooth', or adhesive properties in relation to asphalt and the ability to 'wet' well with that material. For instance, granules made from quartz, feldspar, and some rhyolites do not have this latter property because, on crushing, they fracture with a glassy smooth surface. There is no rule by which to determine the ability of a granule to take colour but, in general, for a full range of colours a light-shade base granule is preferred to a dark-shade base in that it requires less pigment to hide the original colour of the rock.

Opacity of rock granules appears to be a very important property by which to determine the acceptability of a base-rock material. If the ultra-violet light of the sun's rays passes through the granules, the resultant deterioration of the asphalt underneath causes a loss of adhesion, with ultimate loss of the granules from the roofing. Some manufacturers and consumers of granules claim that the infra-red (heat) rays of the sun have a more direct influence on the durability of roofings than ultra-violet rays. The type of asphalt used and the filler used in the asphalt are also believed to have a bearing on the loss of granules. Major producers maintain tests stations in warm humid climates where panels of roofing and siding can be exposed to accelerated weathering over a period of years. The results of this test are taken as the final criterion of the durability of the roofing and quality of the granule. Quick laboratory tests of the quality of a granule and the stability of the colour coat that check with actual weathering conditions have been devised.

Processes for colouring granules are covered by many patents. The two most widely used processes are (1) the sodium silicate process, in which the granules are thoroughly coated with sodium silicate, clay, the required pigment, and a little titanium dioxide, and heated to the required temperature in a rotary kiln; and (2) the phosphoric acid process, in which the granules are mixed thoroughly with zinc oxide, clay, liquid phosphoric acid, and the required pigment, and then heated.

The colour of granules is usually heightened by oiling after colouring with a paraffin-base oil but this effect tends to wear off in use. Oiling also improves the adhesiveness of the granules. A good granule shingle has a life expectancy of twenty years or more.

Canadian Prices

Prices paid for roofing granules, c.i.f. consumer's plants, depend upon the type of granule, the colour, distance from producing plant, and whether the colour is natural or artificial. Imported natural granules in 1956 averaged $19.01 per short ton compared with $18.31 per short ton in 1955, c.i.f. Canadian roofing plants. The average prices of all artificially coloured granules per short ton in 1956, with 1955 figures in brackets, were: red - $25.96 ($25.66); green - $30.26 ($28.64); black - $23.49 ($22.21); blue - $38.26 ($36.91); white - $38.94 ($37.38); grey - $27.99 ($26.95); buff - $32.27 ($34.67); brown - $30.06 ($28.10); and coral, cream, and yellow - $40.25.

The average value of all types of granules per short ton c.i.f. consumer's plants was $29.06 in 1956 compared with $27.65 in 1955.

SALT

By R.K. Collings
Industrial Minerals Division

Common salt is a compound composed of two elements, sodium and chlorine. It occurs naturally in solution as brine, also as a solid, rock-like material commonly known as rock salt. Brine springs and salt seepages occur at many locations throughout Canada. However, salt deposits of economic importance occur in only five of the ten provinces, namely, Nova Scotia, Ontario, Manitoba, Saskatchewan, and Alberta. Salt recovery operations are carried on in each of these provinces.

The increases in the production and export of salt in 1956, shown in the table on page 356 were due to increased production of rock salt in Ontario. The rock salt mine at Ojibway, established in 1955, had its first full year of production in 1956.

The production of salt in Canada showed a sixfold increase in the 30-year period from 1926 to 1956 as indicated in the graph on page 357. Production increased gradually during the first portion of this period, from 262,547 short tons in 1926 to 695,217 short tons in 1944. Salt production fell off during the latter years of World War II and a low of 537,985 was reached in 1946; however, since 1946 production has increased rapidly, the production in 1956 reaching an all-time high.

Imports of salt into Canada increased from 188,402 short tons in 1926 to 319,124 short tons in 1956. The imports in 1926 represented 42 per cent of the domestic consumption for the year, whereas in 1956, although the amount imported was almost double that of 1926, they represented only about 20 per cent of the Canadian consumption.

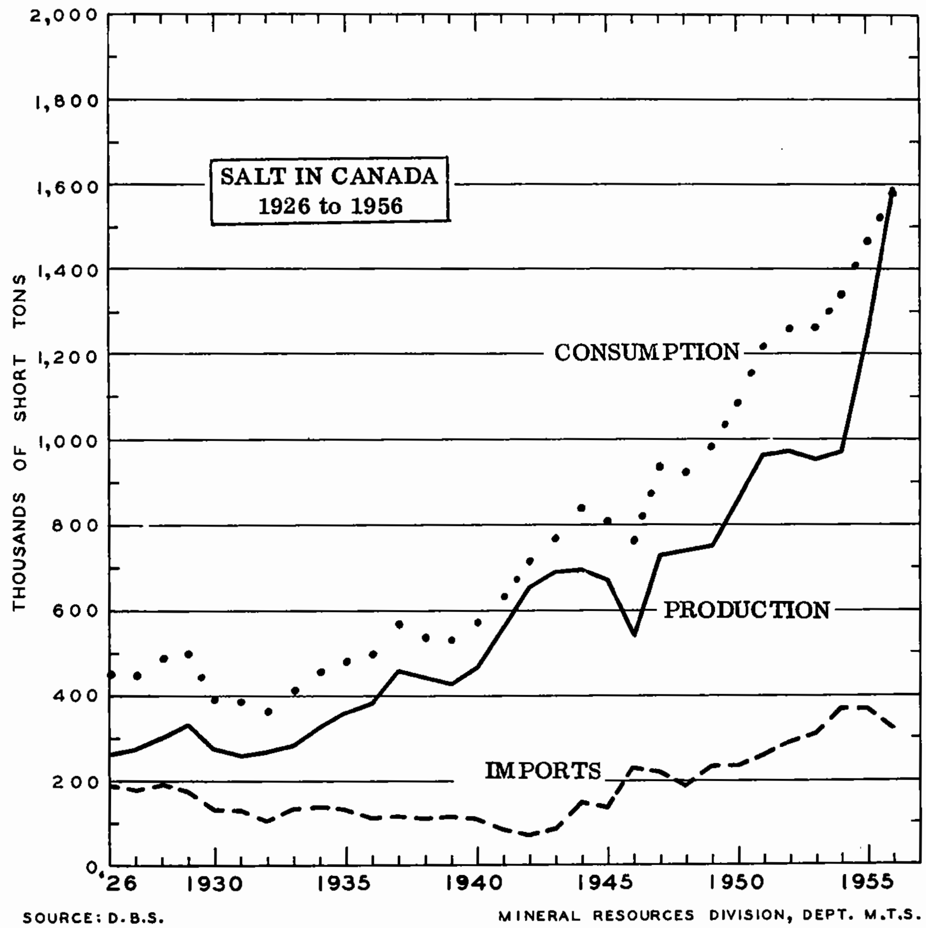
Many countries produce salt, the chief producer being the United States, which accounted for 34 per cent of the total in 1956. Russia was second with 10 per cent, while Canada accounted for 2 per cent.

All of the salt produced in Canada is obtained from underground deposits of salt or brine by standard mining or evaporation methods. A large part of the production is in the form of rock salt, most of which is exported to the United States. In 1956, 40 per cent of the salt produced was rock salt, 27 per cent fine evaporated salt, while 33 per cent was used in the form of brine by the chemical industry. No coarse salt is being produced

Salt - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production (shipments) by types				
Fine vacuum salt ...	428,956	7,061,233	430,327	7,223,928
Coarse grainer salt ..	32	594	1,142	21,300
Mined rock salt	640,027	4,066,249	267,984	1,874,472
Salt, chemical*	521,789	1,016,400	545,308	1,002,599
Total	1,590,804	12,144,476	1,244,761	10,122,299
Production (shipments) by provinces				
Ontario	1,347,729	7,932,294	998,789	5,845,340
Nova Scotia	132,539	1,652,839	144,862	1,808,302
Saskatchewan.......	42,814	882,988	40,748	976,298
Alberta	46,654	1,162,982	41,408	1,014,745
Manitoba...........	21,068	513,373	18,954	477,614
Total	1,590,804	12,144,476	1,244,761	10,122,299
Exports				
United States	333,763	2,279,882	146,159	988,489
Bermuda...........	136	6,027	132	5,839
Other countries.....	36	921	181	6,173
Total	333,935	2,286,830	146,472	1,000,501
Imports				
United States	259,004	1,244,033	311,118	1,484,893
Spain	41,564	263,548	30,119	204,530
Bahamas...........	12,264	42,326	10,888	59,132
Jamaica	4,147	14,522	5,702	28,569
Other countries.....	2,145	41,317	7,428	106,726
Total	319,124	1,605,746	365,255	1,883,850
Apparent Consumption	1,575,993	11,463,392	1,463,544	11,005,648

* Mainly in brine and used by the producers in the manufacture of chemicals.



by evaporation methods in Canada. The last producer, Warwick Pure Salt Company, with head offices at Watford, Ontario, suspended operations early in 1956.

The production of coarse rock salt will probably continue to increase at a fairly rapid rate as new markets are developed and new deposits exploited. Dominion Rock Salt Company Limited, a subsidiary of Dominion Tar and Chemical Company, Limited, is proceeding with plans to develop a rock salt mine at Goderich, while Midrim Mining Company Limited of Toronto is investigating an occurrence of rock salt near Strathroy. Work on the rock salt mine being developed at Pugwash, Nova Scotia, by Malagash Salt Company Limited, a subsidiary of The Canadian Salt Company Limited, is proceeding satisfactorily. Construction of the surface plant is nearing completion and it is expected that the mine will be brought into production during 1957.

Producers

Ontario

Ontario accounted for 85 per cent of Canadian production in 1956. The salt comes from beds 800 to 1,500 feet below the surface in the south-western section of the province.

Fine salt, obtained by vacuum-pan evaporation of brine from local wells, was produced by The Canadian Salt Company Limited at Sandwich and by Sifto Salt Limited, a subsidiary of Dominion Tar & Chemical Company, Limited, with plants at Goderich and Sarnia.

Coarse rock salt is produced at Ojibway, near Windsor, by The Canadian Rock Salt Company Limited, a subsidiary of The Canadian Salt Company Limited. The salt is obtained from a deposit some 1,000 feet beneath the surface by the standard room and pillar method of mining.

Brine from company-owned wells is used by Dow Chemical of Canada Limited to produce caustic soda, chlorine, and other related chemicals at Sarnia. At Amherstburg, Brunner Mond Canada, Limited produced industrial salt, soda ash, calcium chloride, and other chemicals, using brine from local wells.

Nova Scotia

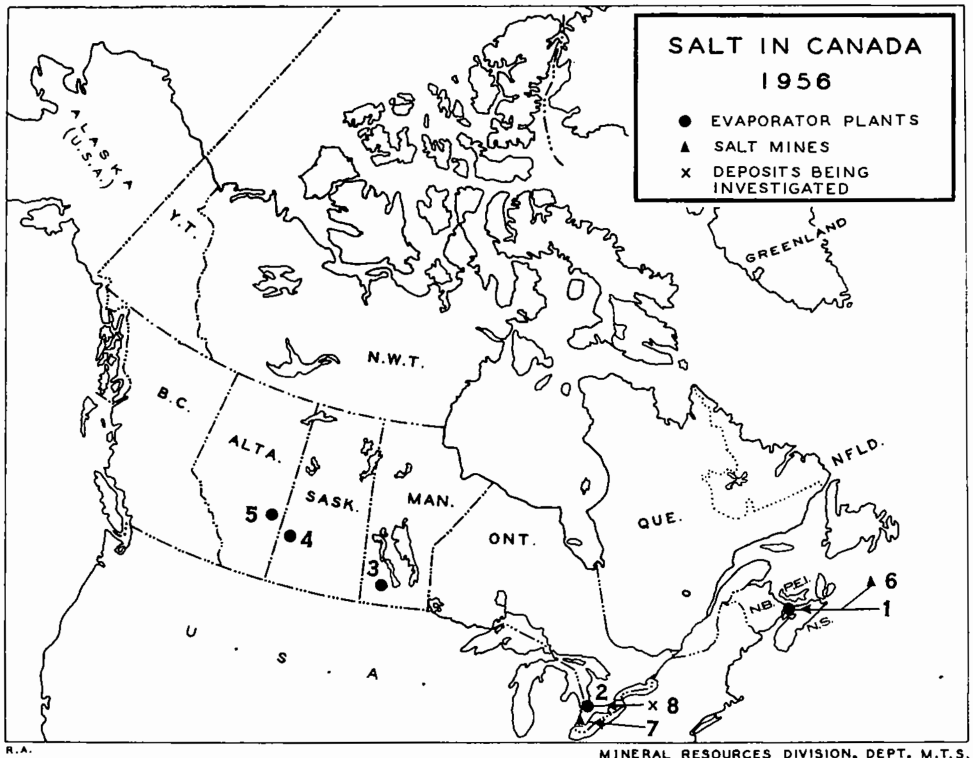
Fine salt is produced by Sifto Salt Limited at a plant near Amherst. Brine for this operation is obtained from wells that are 1,100 to 1,800 feet in depth.

Malagash Salt Company Limited, a subsidiary of The Canadian Salt Company Limited, operates a rock salt mine at Malagash. The salt is crushed and screened to give a coarse salt for use in ice and dust control on highways and for ice removal from railways. Small amounts of salt from Malagash are used locally for curing hay and as a fish preservative.

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 use in tanning and in refrigerator cars, water softeners, etc.

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.



Evaporator Plants

1. Sifto Salt Ltd. (Nappan)
2. Sifto Salt Ltd. (Goderich and Sarnia)
   Warwick Pure Salt Co. (Warwick)
   The Canadian Salt Co. Ltd.
   Brunner Mond Canada Ltd. (Amherstburg)
3. The Canadian Salt Co. Ltd. (Neepawa)
4. Sifto Salt Ltd. (Unity)
5. The Canadian Salt Co. Ltd. (Lindbergh)

Salt Mines

6. Malagash Salt Co. Ltd. (Malagash)
   The Canadian Salt Co. Ltd. (Pugwash)
7. The Canadian Rock Salt Co. Ltd. (Ojibway)

Deposits Being Investigated

8. Sifto Salt Ltd. (Goderich)
   Midrim Mining Corp. Ltd. (Strathroy)

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 400 feet or more in thickness underlie large areas of the Prairie Provinces. The beds occur in a huge southwesterly-dipping basin that extends from northeastern Alberta southeasterly through central Saskatchewan and thence into southwestern Manitoba. These beds vary from less than 400 feet below the surface in northern Alberta to 6,000 feet or more in southern Saskatchewan.

Uses

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, for dairy uses, for the regeneration of zeolites in water softening, as refrigerants, etc. 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 very pure but expensive, and hence is used only where purity is essential, as in the curing of fish or in the dairy industry. Mined salt is generally rather impure and finds its greatest use in the control of ice and dust conditions on highways and the removal of ice on railways.

SAND, GRAVEL AND CRUSHED STONE

By F.E. Hanes
Industrial Minerals Division

Production of aggregate from all sources in 1956 amounted to 175,076,537 short tons valued at $116,787,064, compared with 149,044,706 short tons valued at $97,559,234 in 1955.

The St. Lawrence Seaway development was a predominating influence in eastern Ontario and Quebec in aggregate production for 1956. Large and complex crushing and grinding plants have been constructed at new quarry sites to provide aggregate for use in the lock and dam structures. Total aggregate to be used by the seaway and hydro construction will amount to about 5 1/2 million tons. The hydro-power development at Beechwood, New Brunswick, also consumed large quantities of aggregate for concrete. These industrial developments, together with record road building construction in all provinces and new housing, resulted in a total value of sand, gravel, and crushed stone production of close to $117 million, a new high and an increase of about 20 per cent over 1955.

In addition to the large strides made in production within the aggregate industry, great technical progress has also been noted. Owing to depletion of suitable sand and gravel sources within easy reach of markets, it has been necessary to manufacture coarse aggregate and sand from quarried stone and also to beneficiate gravel from available deposits, using methods hitherto confined to mineral dressing. Plants of 400 tons per hour crushing capacity are located in the St. Lawrence Seaway area. For sand manufacture, the peripheral discharge rod mill with a capacity of 80 tons an hour or more has become popular.

Techniques of wet and dry classification to bring the crushed and natural sand to specified gradings are now common. The practice of removing deleterious constituents from natural gravel by heavy media separation is also gaining favour. This method was first used at Rivers, Manitoba, in 1948 by the Royal Canadian Air Force. Several plants in the United States are now using it, and it was recently used in Canada at the Beechwood project of the New Brunswick Hydro-Power Commission.

Production figures are supplied by the Dominion Bureau of Statistics in part from the sand and gravel industry and stone industry statistical reports.

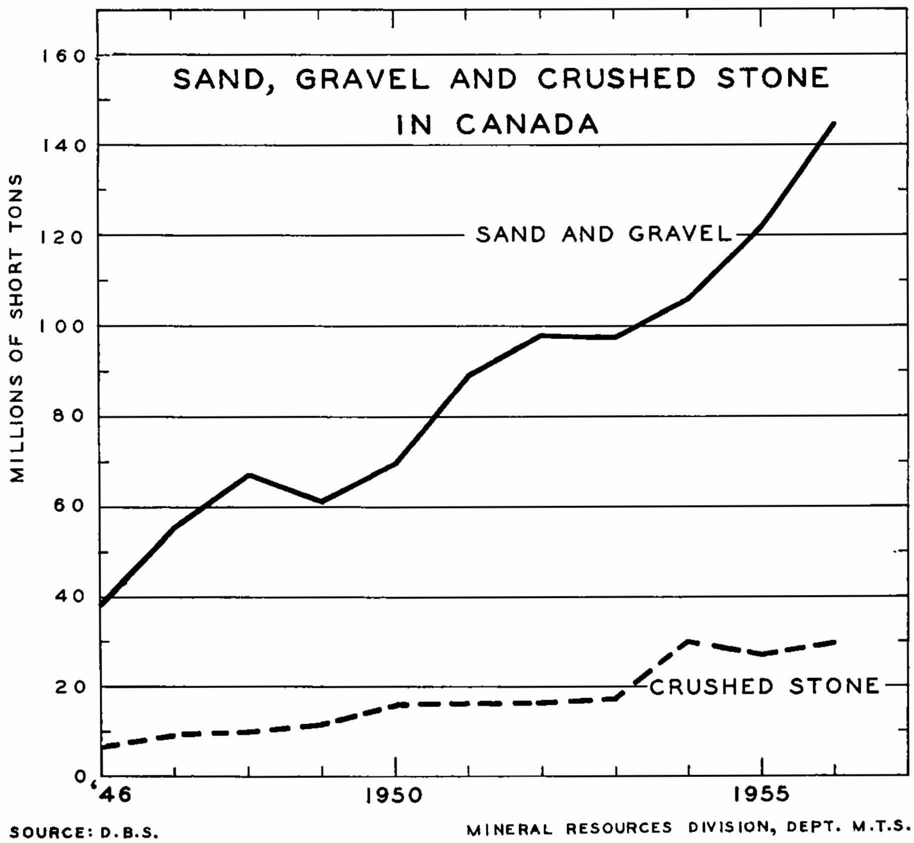
PRODUCTION OF SAND, GRAVEL AND CRUSHED STONE

BY PROVINCE

	Newfoundland	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Sand and Gravel										
1956										
Short Tons	2,439,615	1,674,284	6,140,029	36,641,317	58,922,642	6,875,732	6,184,900	10,522,429	15,873,130	145,274,078
$	1,673,579	1,659,034	3,152,911	16,150,499	33,476,144	2,286,177	3,105,804	8,877,758	10,286,344	80,668,250
1955										
Short Tons	3,118,502	1,156,147	5,729,756	36,013,191	47,727,871	5,263,762	4,301,533	7,819,852	10,700,867	121,831,481
$	1,655,413	1,145,527	2,942,522	15,105,950	28,842,595	1,564,113	2,037,172	5,894,101	6,856,820	66,044,213
Crushed Stone										
1956										
Short Tons	9,021	318,847	2,074,407	10,581,666	13,879,351	230,892	-	36,257	2,672,018	29,802,459
$	32,106	599,661	1,709,724	13,074,302	17,101,690	342,496	-	232,051	3,026,784	36,118,814
1955										
Short Tons	1,632	282,577	1,010,785	12,127,769	11,033,916	193,057	-	22,313	2,541,176	27,213,225
$	7,943	550,574	914,945	13,681,249	12,954,586	257,628	-	149,743	2,998,353	31,515,021
Total Production Sand, Gravel and Crushed Stone										
1956										
Short Tons	2,448,636	1,993,131	8,214,436	47,222,983	72,801,993	7,106,624	6,184,900	10,558,686	18,545,148	175,076,537
$	1,705,685	2,258,695	4,862,635	29,224,801	50,577,834	2,628,673	3,105,804	9,109,809	13,313,128	116,787,064
1955										
Short Tons	3,120,134	1,438,724	6,740,541	48,140,960	58,761,787	5,456,819	4,301,533	7,842,165	13,242,043	149,044,706
$	1,663,356	1,696,101	3,857,467	28,787,199	41,797,181	1,821,741	2,037,172	6,043,844	9,855,173	97,559,234

BY TYPE

	Sand	Sand and Gravel			Crushed Stone					
	Building Concrete	Concrete Road-building	Railroad Ballast	Crushed Gravel	Concrete Aggregate	Railroad Ballast	Road Metal	Rubble and Riprap	Terrazzo Stucco and Artificial Stone	Other Uses
1956										
Short Tons	11,902,438	102,177,661	7,124,461	24,069,518	10,421,209	1,309,156	15,627,912	1,338,988	55,548	1,049,646
$	9,219,153	51,832,543	2,493,086	17,123,468	13,280,234	1,262,783	18,442,792	1,383,843	435,400	1,313,762
1955										
Short Tons	12,341,052	83,941,517	5,129,714	20,419,198	6,537,923	849,905	12,561,077	2,116,646	44,707	5,102,967
$	9,879,011	40,245,390	1,711,776	14,208,036	8,408,081	850,181	14,430,025	2,628,355	406,267	4,792,112



Consumption

Standards for grading and quality are becoming more rigid for aggregate used in government work and also for residential construction as governed by municipal by-laws. As a result of this, more crushed stone and beneficiated gravel is being used to meet these specifications. While the cost of producing crushed stone aggregate is higher than for sand and gravel, process methods are continually being improved, with reduction of relative costs. The trend is toward increased production of crushed stone aggregate.

Comparing production (tonnage) figures of sand and gravel with crushed stone aggregate from 1953 to 1956, crushed stone aggregate was 15 per cent of the total aggregate produced in 1953, 16 per cent of the total in 1954*, 18 per cent of the total in 1955, and 17 per cent of the total in 1956.

Limestone was the principal rock crushed for aggregate in 1956 being 87 per cent of the total. Granite was second in importance with 7.6 per cent of the total, while the remaining 5.5 per cent was made up of sandstone, shale, and marble.

* Nova Scotia produced a very large tonnage of crushed stone in 1954 for construction of the causeway linking the mainland with Cape Breton Island. An average production figure was allowed in this instance for compiling crushed stone increment percentages.

80486-4—24

SILICA

By R.K. Collings
Industrial Minerals Division

Silica is the common name for silicon dioxide. This compound occurs in the free state chiefly as quartz. The mineral quartz is widespread in Canada and occurs in many forms. However, only those forms in which the silica content is quite high, namely vein quartz, silica sand and gravel, sandstone, and quartzite, are utilized for industrial purposes.

Canada produced 2,142,234 short tons of silica minerals in 1956, an increase of 15 per cent over 1955 and an all-time high. The 49 per cent increase in value in 1956 to $3,036,543 was the result of increased production of high-priced silica.

The production of silica minerals in Canada showed a ninefold increase in the 30-year period from 1926 to 1956, as shown in the graph on page 3. There was little change in the annual production during the first 9 years of this period, however a sharp increase in the demand for silica for use in the manufacture of ferrosilicon resulted in a remarkable increase in the Canadian output in 1936. Following this, silica production increased steadily and reached a high of 2,052,878 short tons in 1941. Production declined towards the latter part of World War II to a low of 1,413,378 short tons in 1946. Since 1946 it has shown a gradual increase.

Silica, being rather low-priced and fairly widespread in occurrence, does not enter into world trade to any great extent. Most of the Canadian production of quartz, quartzite, and silica sand is used domestically in the manufacture of silicon and ferrosilicon alloys, as a fluxing material in the metallurgical industries, and for other purposes such as in the manufacture of silica brick, as an ingredient in portland cement, for foundry purposes, etc. Part of the Canadian output of lump silica is exported to the United States where it is used in the manufacture of silicon and ferrosilicon alloys. In 1956 Canada exported 181,196 short tons of quartzite, about 8 1/2 per cent of the total production for the year.

The silica requirements of the glass, chemical and other industries using high-purity silica are supplied, for the most part, by imports from the United States, Belgium and other countries. A small amount of high-purity silica sand is produced in Canada. However, at present this probably is less than 10 per cent of the total annual consumption of this type of silica.

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Silica Minerals - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production				
Quartz and silica sand*.	2,142,234	3,036,543	1,869,913	2,039,575
	Thousands of brick		Thousands of brick	
Silica brick	5,799	736,817	4,763	602,625
Imports	Short Tons		Short Tons	
Silica sand				
United States	840,314	2,594,932	711,432	2,113,042
Belgium	60	2,370	23,828	32,453
United Kingdom	-	-	198	593
Total	840,374	2,597,302	735,458	2,146,088
Silex or crystallized quartz				
United States	26,865	318,709	24,495	246,167
Other countries	27	7,911	22	6,070
Total	26,892	326,620	24,517	252,237
Exports				
Quartzite				
United States	181,196	564,173	87,622	265,374

* Include both crude and crushed quartz, crushed sandstone and quartzite, and natural sands.

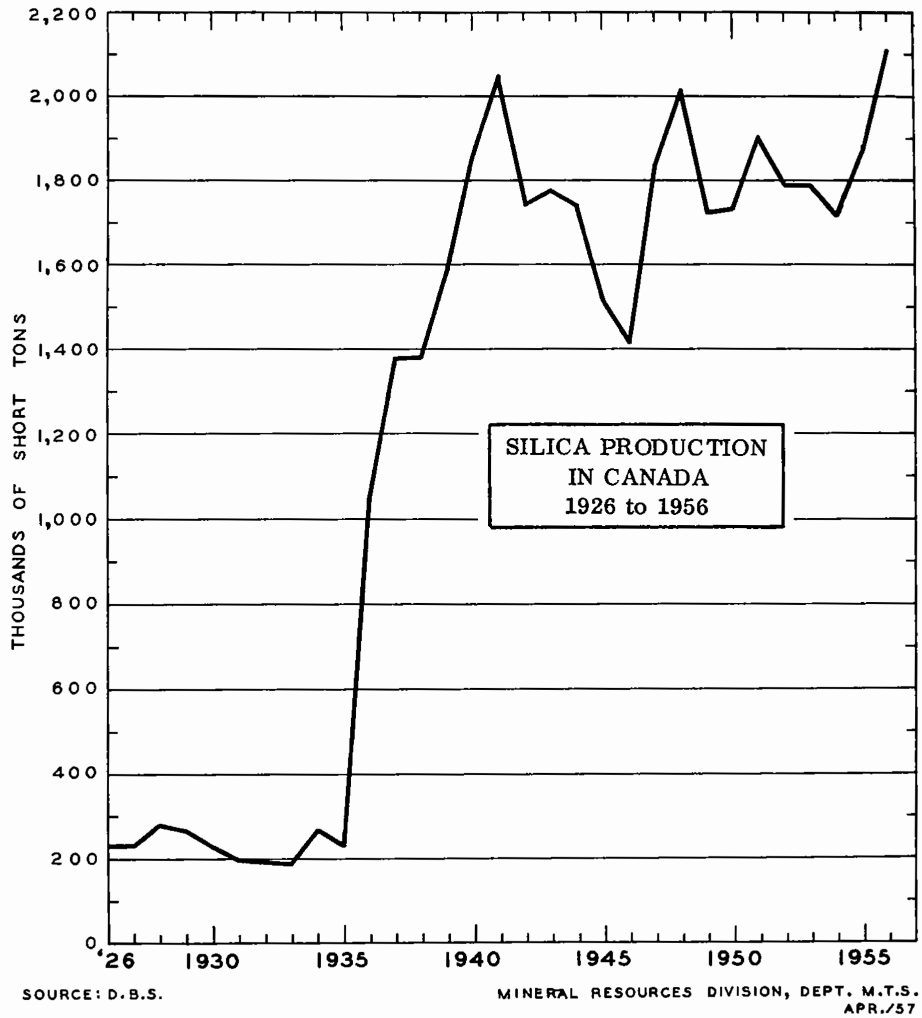
Producers

Nova Scotia

Dominion Steel and Coal Corporation, Limited, quarries 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, a division of Union Carbide Canada Limited, quarries sandstone at Melocheville, Beauharnois county, for use in the manufacture of ferrosilicon at a plant in nearby Beauharnois. Fine sand resulting from the breakdown of this sandstone during milling operations is used as a foundry sand and in cement manufacture.



Dominion Silica Corporation Limited obtains quartzite from a deposit at St. Donat, Montcalm county, for use in the manufacture of silica sand at a plant in Lachine. Glass sand, sand for use in the abrasives industry, and other high-quality silica products are produced at the Lachine plant.

Radius Exploration Limited of Montreal operates a sandstone deposit near Ste. Clothilde, Chateauguay county, Quebec. Sized sand from this deposit is shipped to Delson, Quebec, where it is used in the manufacture of lightweight concrete.

Canadian Silica Corporation Limited, with head offices in Toronto, produces silica sand and flour at a silica milling plant recently completed at St. Canut. The silica sand is used in the manufacture of silicon carbide and cement and for foundry purposes. The flour is used by steel foundries and as a filler and abrasive ingredient in various products.

Silica

Ontario

Lorrain quartzite is quarried by the Electro Metallurgical Company of Canada, Limited, at Killarney, Georgian Bay, and by Canadian Silica Corporation Limited at Sheguiandah, Manitoulin Island. A large part of the production from these deposits is exported to the United States. The Canadian consumption of quartzite from this area is mainly for the manufacture of silicon and ferrosilicon. A small percentage of the production from Sheguiandah is used for the production of silica flour at Canadian Silica's grinding plant at Whitby, Ontario.

Algoma Steel Corporation Limited quarries quartzite from a deposit at Bellevue, north of Sault Ste. Marie, for use in the manufacture of silica brick for furnace linings.

Manitoba

The Winnipeg Selkirk Sand Company Limited of Winnipeg produced a small amount of sand from a deposit on Black Island in Lake Winnipeg in 1956. This sand was used for industrial purposes in the Winnipeg area. A sand-processing plant under construction at Selkirk, Manitoba, will be used to upgrade Black Island sand.

Alberta

Peace River Glass Company Limited of Edmonton produced a small quantity of foundry sand from its silica sand deposit at Peace River during 1956. This company is planning to construct a glass melting plant at Fort Saskatchewan which, when completed, will use sand from Peace River for the production of glass for use in the manufacture of glass fibre products.

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 quartzites exist in all provinces, but most of them are too impure or too far from markets to warrant present development.

Specifications and Uses of Silica

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 and amount of silica used is dependent upon the composition of the ore being fluxed; however, the silica content should be as high as possible. Small amounts of impurities such as iron and alumina are not objectionable. Silica used for flux is generally all - 1, + 5/16 inch in size.

Silicon Alloys. Lump quartz, quartzite and well-cemented sandstone are used in the manufacture of silicon, ferrosilicon, and other alloys of silicon. The silica content should be 98 per cent while the iron and alumina contents should each be less than 1 per cent, and the total iron and alumina less than 1 1/2 per cent. Lime and magnesia should each be less than 0.20 per cent. Phosphorous 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 use in the construction of high-temperature refractory furnace linings. The silica content of the quartz used should be 97 per cent. The iron and alumina contents should each be less than 1 per cent and other impurities such as lime and magnesia should be low.

Other Uses. Lump quartz and quartzite, shaped to proper size are used as linings in ball and tube mills, and as a lining and packing for acid towers. Naturally occurring flint pebbles are used as a grinding media for the reduction of various non-metallic 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 silica-ware. The silica content should be over 99 per cent and the iron content should be uniform and less than 0.04 per cent; other impurities such as alumina, lime and magnesia should be low. Uniformity of grain size is very important; glass sand should be between 20- and 100-mesh in size with a minimum of coarse or fines.

Silicon Carbide. Sand used for silicon carbide manufacture should have a silica content of 99 per cent. The iron and alumina contents should each be under 0.10 per cent. Lime, magnesia and phosphorous are objectionable. A coarse-grained sand is preferred for silicon carbide manufacture; however, finer sands are sometimes used. All sand should be +100-mesh and the bulk of the sand should be +35-mesh in size.

Hydraulic Fracturing. Silica sand is used in the hydraulic fracturing of oil-bearing formations. The amount of sand used varies greatly but is generally from 5,000 to 15,000 pounds per treatment. Sand used in the hydraulic fracturing of oil-bearing formations must be clean and dry and have a high compressive strength. It should have a high silica content and must be free of all acid-consuming constituents. The grain size of the sand must be closely controlled; all sand should be between 20- and 35-mesh. The grains should be well rounded to facilitate placement and to provide maximum permeability.

Silica

Foundry Use. Naturally occurring sand and sand produced by the reduction of sandstone to grain size are used extensively in the foundry industry for moulding purposes. Silica sands for foundry use vary greatly in screen size and chemical composition. The purity and size of the sand used depends upon the type of casting to be produced and the foundry practice followed. Grain size is usually between 20- and 200-mesh in closely sized ranges. A sand with a rounded grain is preferred for the foundry industry.

Sodium Silicate and other Chemicals. Sand used in the manufacture of sodium silicate and other chemicals should be very pure. For sodium silicate the silica content should be 99 per cent. The alumina content should be less than 1 per cent, the combined lime and magnesia less than 0.5 per cent, and the iron less than 0.1 per cent. All sand should be between 20- and 100-mesh.

Other Uses. Coarsely ground, closely sized quartz, quartzite, sandstone and sand are used as an abrasive grit for sand-blasting purposes and for the manufacture of sandpapers.

Various grades of closely sized sand are used in water-filtration plants as a filtering medium.

Silica sand is used by the cement industry as an ingredient in the manufacture of portland cement.

Silica Flour

Silica flour, formed by grinding quartz, quartzite, sandstone, and sand to a very fine powder is used in the ceramic industry for enamel frits and pottery flint. It is also used as an inert filler in rubber and asbestos-cement products, as an extender for paint, and as an abrasive ingredient in soaps and scouring powders.

Quartz Crystals

Quartz crystals, possessing the necessary piezo-electric properties, are used in radio-frequency control apparatus, radar, and other electronic devices. Crystals used for this purpose must be water clear, perfectly transparent, and free from all visible impurities or flaws. The individual crystals should weigh 100 grams or more and should measure at least 2 inches in length by an inch or more in diameter.

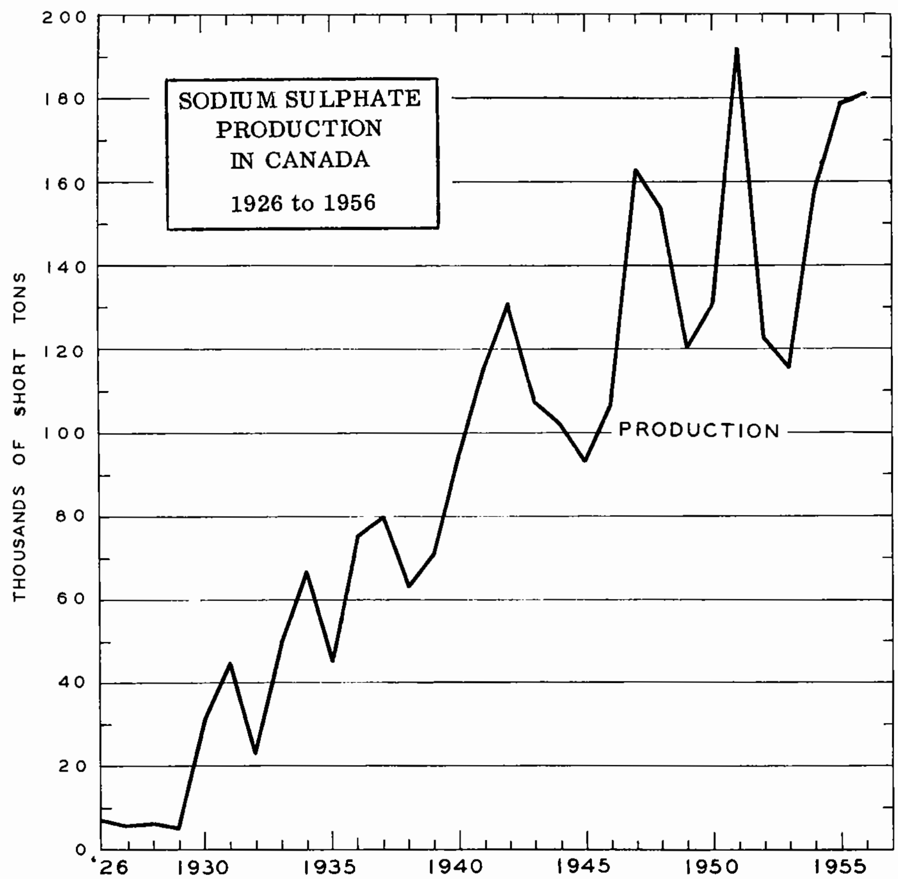
Prices

The price of silica varies greatly depending upon the location of deposits, the purity of the product, and the purpose for which it is required. High-quality silica sand from Ottawa, Illinois, in carload lots f.o.b. Montreal, costs from $8 to $10 per ton.

SODIUM SULPHATE

By E.G. DeWolf
Industrial Minerals Division

Production of natural sodium sulphate has been carried on in Canada since 1918 when 811 tons were produced. Average annual production since then has shown a fairly steady increase, accompanied by some marked production peaks, notably 1951 when 192,371 tons were produced, an all-time record.



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

Sodium Sulphate

Production, Imports and Trade of Sodium Sulphate

	1956		1955	
	Short Tons	$	Short Tons	$
Production (shipments)...	181,053	2,838,186	178,888	2,799,715
Imports(1)				
United States	20,576	369,897	18,871	345,708
United Kingdom........	9,743	188,759	11,056	228,732
Total	30,319	558,656	29,927	574,440
Exports(1)				
United States	60,579	985,801	76,894	1,263,911

	1956	1955
Consumption		
Pulp and paper	156,698	137,575
Glass, including glass wool	2,922	2,722
Soaps.................	1,335	1,555
Medicinals	54	37
Total	161,009	141,889

(1) Trade of Canada

The production of natural sodium sulphate is closely allied to that of kraft pulp and rayon. The kraft pulp industry accounts for over 95 per cent of sodium sulphate consumption, while the rayon industry produces large quantities as a by-product. Therefore as expansion in the kraft pulp industry continues and as rayon is supplanted by nylon, an increasing use of natural sodium sulphate may be expected.

One producer was closed for six months by strike action in 1956 and this was accompanied by a drop in exports to the United States. Value of production, however, reached a new high.

All shipments from Canadian producers are in the form of anhydrous sodium sulphate (salt cake) except for a small quantity shipped each year as glauber's salt.

Occurrences

Sodium sulphate occurs in three main forms in Canada:

As brine, in alkali lakes
As an intermittent crystal
As a salt bed

There are many occurrences of sodium sulphate in Canada, but the principal deposits are in Saskatchewan, the only producer.

In general, the larger deposits are made up of a permanent bed of varying thickness and composition, covered by a thin layer of mud, on top of which brine forms in the spring. During the period of high evaporation the brine becomes more concentrated and crystals precipitate. This cycle is repeated each year with gradual accumulation of a thick deposit. In some occurrences the brine does not become sufficiently concentrated to form crystal and there may or may not in such cases be a permanent bed. However, the brine may contain large tonnages in solution.

The sodium sulphate deposits occur in undrained basins. One theory of their origin is that they were formed by ion exchange between calcium salts in meteoric waters and alkali silicates in bentonitic clays, releasing soluble sulphates which were concentrated in drainage basins.

The reserves in Saskatchewan have been variously estimated at between 60 and 200 million tons. Over 2,800,000 tons have been produced since 1926 with no noticeable depletion of deposits. More than 20 lakes each containing in excess of 500,000 tons are known and there are numerous other lakes containing smaller amounts.

Several lakes of the above type occur in Alberta and British Columbia. However, the sodium sulphate content compared with Saskatchewan is small and there has been only minor production.

A deposit at depth is reported by the Geological Survey of Canada in New Brunswick. A bed of sodium sulphate 60 to 100 feet thick covers a bed of rock salt. The extent of the deposit is not known.

Production

There were four producers of natural sodium sulphate in 1956, with operations at seven lakes and five dehydrating plants. They were: Midwest Chemicals Limited, at Palo; Ormiston Mining and Smelting Company Limited, at Ormiston; Saskatchewan Minerals, Sodium Sulphate Division, at Chaplin and Bishopric; and Sybouts Sodium Sulphate Company Limited, at Gladmar. The combined drying capacity of these five plants is 312,000 tons per year.

Sodium Sulphate

Production methods, for finished salt cake, vary but generally the practice is to produce a white product of high purity. In some operations the sodium sulphate is obtained by mining the permanent crystal bed, but in most the salt is obtained by solar evaporation of brine. In late summer, the brine is usually almost saturated and is then pumped from the lake into evaporating or crystallizing ponds. After further evaporation, and the effect of cooler weather, the sodium sulphate crystallizes out as glauber's salt and excess brine is returned to the lake. The salt is collected and stockpiled. As salt is required for shipping, it is taken from the stockpile and put through the dehydrating plant to remove the water of crystallization, which amounts to over 50 per cent of the weight of the crystals.

The dehydrating plant usually consists of a simple rotary kiln, a crushing plant and a screening plant. However, to increase operating efficiency and capacity the trend is toward the use of natural gas fired evaporators.

Salt from the Saskatchewan plants is exported to the United States and also is used from coast to coast in Canada. With the proposed construction of several new pulp mills in the West, the demand for sodium sulphate is likely to increase, and most producers have or plan to increase production and efficiency. This will enable them to adequately supply the growing home market and put them in better competitive position for distant markets.

Uses

In Canada, sodium sulphate is used chiefly in the sulphate process for making kraft pulp, which in turn is used mainly in making brown wrapping paper, paper bags and corrugated paper board boxes in which a high degree of strength is required. Sodium sulphate, as such, does not enter into the actual digestion of the wood, but into the preparation of the digester solution, and is used as a make-up to compensate mainly for dust losses.

Consumption of salt cake per ton of pulp produced has been steadily decreasing, and newer plants probably use 100 pounds per ton of pulp rather than the 200 pounds formerly required. However, there has been a steady increase in kraft pulp production with an overall increase in salt cake consumption.

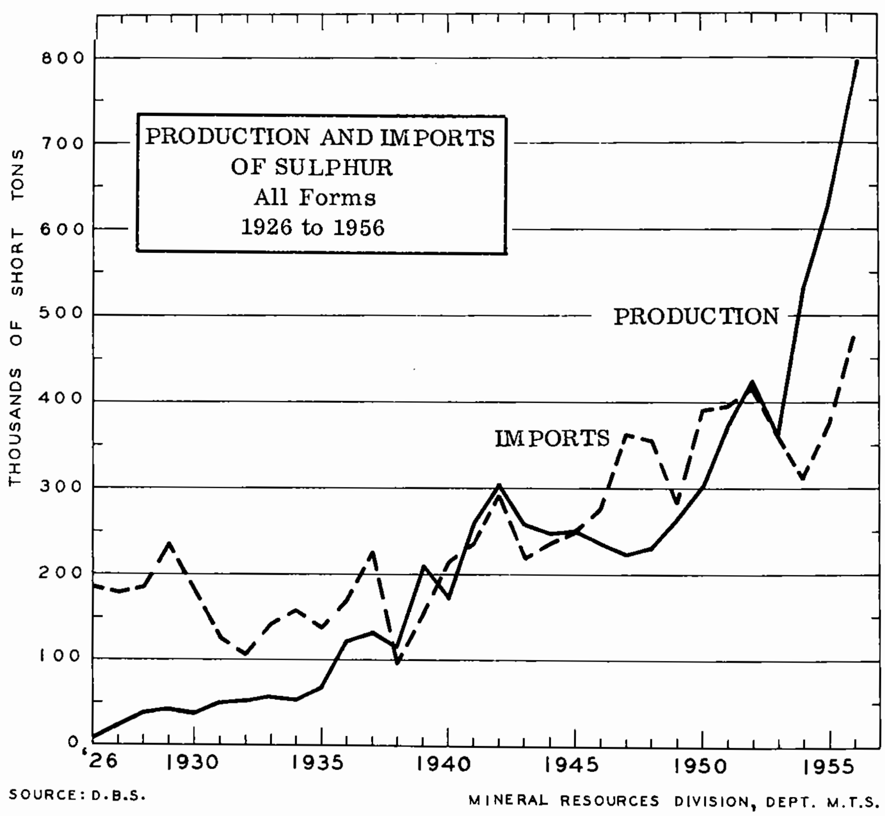
Sodium sulphate is used as a diluent in synthetic detergents, in the manufacture of heavy chemicals, and in the glass, dye, and textile industries. Small amounts, mostly as glauber's salt, are used for medicinal purposes.

Prices vary considerably and are usually by agreement between supplier and consumer.

SULPHUR AND PYRITES

By M. F. Goudge
Industrial Minerals Division

The year 1956 was notable in the history of sulphur production in Canada. Not only did it witness a record production of 743,157 short tons of sulphur in various forms - an increase of 188,738 tons over 1955 - but it also marked the beginning of a rapid expansion in production of sulphur and sulphur compounds from natural gas and from pyrites that, within a few years, should place Canada second among the sulphur-producing and sulphur-exporting countries of the world. This country is already the fourth largest producer of sulphur, its production being exceeded only by that of the United States, Japan, and Spain. The Canadian industry is based on domestic resources of pyrites and pyrrhotite, sour natural gas, and smelter gases. There are no known deposits of native sulphur.



Sulphur - Production, Imports and Exports

	1956		1955	
	Short Tons	$	Short Tons	$
Production (sulphur content)				
By-product pyrites and pyrrhotite shipped*	473,605	4,538,785	403,986	3,740,383
Smelter gases	236,088	2,323,590	224,457	2,244,570
Total	709,693	6,862,375	628,443	5,984,953
Elemental sulphur from natural gas (shipments)	33,464		25,976	
Total all sulphur	743,157		654,419	
Imports, brimstone				
United States	472,976	11,831,667	373,373	9,386,983
Other countries	1,141	25,889	-	-
Total	474,117	11,857,556	373,373	9,386,983
Exports**				
Sulphur content of by-product pyrites				
United States		1,370,419		1,293,373
United Kingdom		568,970		458,202
Netherlands		422,970		210,000
France		286,990		40,000
Total		2,649,349		2,001,575
Other sulphur				
India	4,130	123,022	2,720	83,338
United States	146	3,444	282	6,311
Indonesia	55	1,650	-	-
Other countries	-	-	49	4,492
Total	4,331	128,116	3,051	94,141

* Includes also sulphur content of sulphur dioxide gas obtained from roasting zinc concentrates.

** From 1955 onwards only dollar values are given in the official export statistics of pyrites.

Consumption of Elemental Sulphur

	1956 Short Tons	1955 Short Tons
Pulp and paper	313,851	300,899
Heavy chemicals	108,300	82,947
Rubber goods	2,905	2,783
Medicinal and pharmaceutical	126	27
Adhesives	41	29
Starch	27	340
Fruit and vegetable preparations	7	6
Sugar refining	140	168
Petroleum refining	225	255
Steel and iron	86	65
Miscellaneous chemicals	5,473	5,591
Asbestos products	10	8
Miscellaneous non-metallics	11	30
Total	431,202	393,148

Sour Natural Gas

The building of pipe lines to transport natural gas from Alberta and British Columbia to Eastern Canada and the United States has paved the way for the utilization of the enormous sulphur resources of the sour natural gas fields of these provinces. Sour natural gas is so called because it contains hydrogen sulphide (H_2S). This compound, which is very corrosive, must be removed from the gas before it is fed to the pipe lines. In the removal process it is a relatively simple matter to recover the sulphur in elemental form and at a cost that is comparable with that of obtaining sulphur by the Frasch process. The sulphur so obtained is bright and of a purity exceeding 99.8 per cent. The content of H_2S in the major sour gas fields of Western Canada ranges from 2 to 37 per cent.

Prior to 1956 there were only two small sulphur recovery plants operating on sour gas in Western Canada. The plant of Shell Oil Company of Canada at Jumping Pound, Alberta, now producing 80 long tons of sulphur daily, commenced operations in May 1951, and the plant of the Royalite Oil Company at Turner Valley, Alberta, producing 30 long tons daily, began operations in 1952. In 1956, with the maturing of plans for the distribution of natural gas on a large scale, the construction of several sulphur recovery plants was undertaken and sulphur production is becoming a major industry.

Imperial Oil Limited in 1956 constructed a plant at the Redwater oilfield north of Edmonton to recover sulphur from 9 million cubic feet of gas daily. This plant produces 20 long tons of sulphur per day.

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Sulphur

The British American Oil Company Limited in 1956 built the first large sulphur recovery plant at Pincher Creek near Lethbridge, Alta. This plant, which came into operation on January 31, 1957, has a daily production capacity of 225 long tons of sulphur.

In 1956 Jefferson Lake Sulphur Company of New Orleans, La., the third largest sulphur producer in the United States, concluded agreements with Pacific Petroleums Limited to process hydrogen sulphide gas from the latter's gas wells at Fort St. John, British Columbia,into elemental sulphur. This sulphur plant, which is sheduled to be in production by November 1957, is to have a capacity of 425 long tons of sulphur per day, which will be increased to 800 long tons in 1959.

Jefferson Lake Sulphur Company has also entered into an agreement with Mobil Oil Company of Canada to drill on the latter company's property east of Calgary, and on development of sufficient reserves of sour gas to build a sulphur recovery plant there with a capacity of 425 long tons per day.

Contingent upon agreement being reached between several producers and others, another large sulphur plant with a capacity of 300 long tons daily will be built in the Calgary area.

The largest sulphur plant of all - one with a daily capacity of 500 long tons of sulphur--is proposed for the Savanna Creek gas field west of Calgary. This gas has a sulphur content of about five long tons per million cubic feet.

As the quantity of gas marketed by the pipe line companies increases so will the amount of recovered sulphur, because the hydrogen sulphide gas has to be removed before the gas enters the main gas lines. Sulphur plants already in operation, under construction, or planned for completion in 1958, have a combined rated annual capacity of about 800,000 long tons of sulphur. By the end of 1960 or shortly thereafter it is possible that 1,000,000 tons of sulphur a year will be available from natural gas in Western Canada. This quantity greatly exceeds Western Canada's needs, and as transportation costs will restrict the shipping of the sulphur to Eastern Canada where the present major markets for sulphur exist, a large portion of the output will be available for export.

Oil Refinery Gas

Laurentide Chemicals and Sulphur Limited, Montreal,is building a plant in Montreal East for the recovery of sulphur from hydrogen sulphide gas obtained from the five oil refineries and a chemical plant operating in the vicinity. The process is similar to that used in recovering sulphur from sour natural gas. The plant is expected to begin operations in October, 1957, and is designed to produce 100 long tons of bright sulphur daily. The product is to be marketed chiefly with pulp and paper companies and with companies making sulphuric acid.

Pyrites and Pyrrhotite

The utilization of pyrites and pyrrhotite as sources of sulphur increased considerably in 1956, the sulphur content of the shipments amounting to 473,605 short tons compared to 403,986 short tons in 1955. A large part of this increase was due to an increase in exports of pyrites but some was due to an increase in domestic utilization of pyrites for the making of sulphuric acid and wood pulp. A factor in the increase was the plant operated by Noranda Mines Limited at Port Robinson near Welland, Ontario, where pyrites is used for the production of sulphur dioxide (for making acid), elemental sulphur, and iron sinter. This plant is designed to utilize from 250 to 350 tons of pyrites daily, and when working at capacity can produce 50 to 60 tons of elemental sulphur per day.

The same process as is used at Port Robinson is being used by Noranda Mines Limited in a new plant at Cutler, Ontario, to provide sulphuric acid for the leaching of uranium ore in the mills of the uranium producers at Blind River, Ontario. The plant at Cutler when completed will have a daily capacity of 900 to 1,000 tons of 100 per cent sulphuric acid, 140 tons of elemental sulphur and 700 tons of iron sinter. It will require 450 tons of pyrites and 550 tons of pyrrhotite daily, which will be supplied from Noranda's operations in Quebec. The first 500-ton unit of the acid plant came into production in July 1956 and the complete plant is expected to be in operation in July 1957. Because of the immediate need for sulphuric acid, the acid plant was started by using imported elemental sulphur as feed. The switch from sulphur to sulphur dioxide gas from pyrites and phyrrhotite will be made as soon as the iron-sulphur units are in operation. This will be in 1957 for the first unit, and in 1958 for the second unit.

Deposits of pyrites and pyrrhotite are abundant in Eastern Canada and in British Columbia. The entire quantity utilized for sulphur, however, is obtained as by-product material from the concentrators of mining companies engaged in the production of copper, lead, and zinc. The pyrites is sold by contract and the price is sufficiently low that it does not pay to mine and concentrate the mineral as a primary product.

During the sulphur shortage of a few years ago a number of Canadian pulp mills, which are large users of sulphur, fearing that they would not be able to obtain their required supplies of sulphur from the United States, installed equipment to use pyrites. At present eight pulp mills in various parts of Canada are so equipped, but only five were using pyrites in place of sulphur in 1956.

Mining companies marketing pyrites in 1956 were: Buchans Mining Company Limited, Buchans, Newfoundland; Noranda Mines Limited, Noranda, Que.; Waite Amulet Mines Limited, Noranda, Que.; West Macdonald Mines Limited, Noranda, Que.; Quemont Mining Corporation Limited, Noranda, Que.; Normetal Mining Corporation Limited, Normetal, Que.; East Sullivan Mines Limited, Val d'Or, Que.; Weedon Pyrite and Copper Corporation Limited, Weedon, Que.; and Britannia Mining and

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Smelting Company Limited, Britannia Beach, B.C. In addition, The Consolidated Mining and Smelting Company of Canada Limited utilizes pyrrhotite from its Sullivan mine at Kimberley, B.C., for making sulphuric acid for fertilizer manufacture.

Smelter Gases

The equivalent of 236,088 short tons of sulphur was recovered from smelter gases during 1956. The recovery of sulphur values is made at two smelters - that of The Consolidated Mining and Smelting Company of Canada Limited at Trail, British Columbia, and that of The International Nickel Company of Canada Limited at Copper Cliff, Ontario. The first-mentioned company was the pioneer in developing a process for the production of sulphur and sulphuric acid from smelter gases, and for a time both elemental sulphur and sulphuric acid were produced. In recent years, however, the requirements of sulphuric acid for the production of fertilizers in the company's plants have been so large that all the sulphur dioxide recovered from the smelter gases has been made into sulphuric acid. Additional sulphuric acid is made by this company from the roasting of pyrrhotite obtained as a by-product in the concentration of lead-zinc ore from the Sullivan mine.

At the smelter of The International Nickel Company of Canada Limited at Copper Cliff, both liquid sulphur dioxide and sulphuric acid are produced by Canadian Industries Limited from the stack gases. Liquid sulphur dioxide is obtained from the gases resulting from the flash smelting of copper ore, which gases contain 70 per cent or more of sulphur dioxide. The liquid sulphur dioxide plant has a rated capacity of 90,000 tons per year, which is the equivalent of 45,000 tons of sulphur. The production is sold to the pulp mills of northern Ontario.

The International Nickel Company and the Texas Gulf Sulphur Company are jointly investigating the economics of producing elemental sulphur from the gases from International Nickel Company's new iron ore recovery plant which came into operation in 1956. These investigations may extend over several years.

It is also proposed to recover sulphur values from the gases of the smelter of Eastern Mining and Smelting Corporation Limited now under construction at Chicoutimi, Quebec. This copper-nickel smelter will use a flash smelting process and the gases will be rich in sulphur dioxide.

Athabasca Tar Sands

Royalite Oil Company Limited of Calgary announced at the beginning of 1957 that it proposes to build a 20,000-barrel-per-day processing plant on its leased tar sand property at Mildred Lake, Alberta, in the valley of the Athabasca River about 350 miles north of Edmonton. The process used is to be the Coulson centrifuge process perfected jointly by Royalite Oil Company and Can-Amera Oil Sands Development Company of Calgary. It is expected that 140 long tons of sulphur will be recovered per day from the initial unit.

Uses

Sulphur has innumerable industrial uses and is one of the most important of the industrial minerals. Generally it is converted into sulphuric acid for industrial use. In the United States about 75 per cent of the sulphur used is in the form of acid, but in Canada the percentage is less because of the importance of pulp and paper industry in this country. This industry accounts for about half of the amount of sulphur consumed in Canada. It uses it in the forms of elemental sulphur, pyrites, and liquid sulphur dioxide.

Production, Imports, Exports and Apparent Consumption of Sulphuric Acid in Canada

(short tons of 100% acid)

Year	Production	Imports	Exports	Apparent Consumption
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

Consumption of Sulphuric Acid by Industries

(short tons of 100% acid)

	1956	1955
Fertilizers	563,400	577,100
Heavy chemicals	188,700	139,700
Non-ferrous smelters & refiners	25,600	24,500
Coke and gas	35,600	37,900
Petroleum refining	11,000	6,500
Leather tanning	2,300	2,300
Iron and steel	39,000	35,300
Electrical apparatus	6,800	8,100
Plastics	17,000	15,000
Soaps and washing compounds	12,200	11,300
Sugar refining	300	300
Pulp and paper	9,000	8,700
Vegetable oils	100	100
Adhesives	400	200
Miscellaneous	83,400	70,800
Total	994,800	937,800

Sulphur

World Situation and Prices

The world situation as regards sulphur supplies has changed very considerably since 1952 when sulphur was in short supply. Production of elemental sulphur in the United States is at a new high, and Mexico has also become an important producer. France is planning a large production from sour natural gas, and with the greatly increased volume of sulphur to become available from Canada in the near future it is to be expected that world supplies will continue to expand faster than demand, which will bring about changes in the marketing situation.

Prices of elemental sulphur and of pyrites remained stable in the past year. Bulk United States sulphur f.o.b. vessels at Gulf of Mexico ports was sold at $28.00 per long ton to all customers, the export differential of $3.00 formerly charged on foreign shipments being dropped early in the year. Prices for Mexican brimstone ranged from $24.00 to $26.50 per long ton. Prices of Canadian sulphur and pyrites are not published, because all sales are by contract. However, sulphur from the United States generally costs about $35.00 per long ton in Eastern Canada, depending on the consuming plant's location and on ocean freight rates. Prices of Canadian pyrite ranged from $4.00 to $5.00 per long ton of material having a minimum content of 48 per cent sulphur.

TALC AND SOAPSTONE

By J. E. Reeves
Industrial Minerals Division

Production in 1956 increased about 8 per cent over the 1955 level to 29,326 short tons, and, for the first time in a number of years, included a small amount of pyrophyllite.

Imports, consisting mainly of special grades for the paint, ceramic and cosmetic trades, principally from the United States and Italy, increased almost 43 per cent to 16,268 tons. This is the highest figure for imports on record and is a continuation of the increasing trend that has taken place since 1938. A small tonnage was exported, chiefly to the United States.

Production since 1926 has been relatively steady, as shown in the graph on page 387, with the exception of a low period during and after the depression years and of the high production due to the stimulus of World War II and the Korean emergency. In the past few years a slight upward trend has developed.

Canadian consumption, in recent years, has increased and has regularly exceeded production. The increase in imports has been accompanied by a decrease in exports.

Although the mineral talc is a hydrous silicate of magnesium, most commercial talcs contain appreciable amounts of other minerals such as serpentine, chlorite, tremolite, magnesite, dolomite and calcite. Soapstone is essentially a talcose rock of massive nature, from which blocks and crayons are derived, but ground soapstone is also an important source of low-carbonate material.

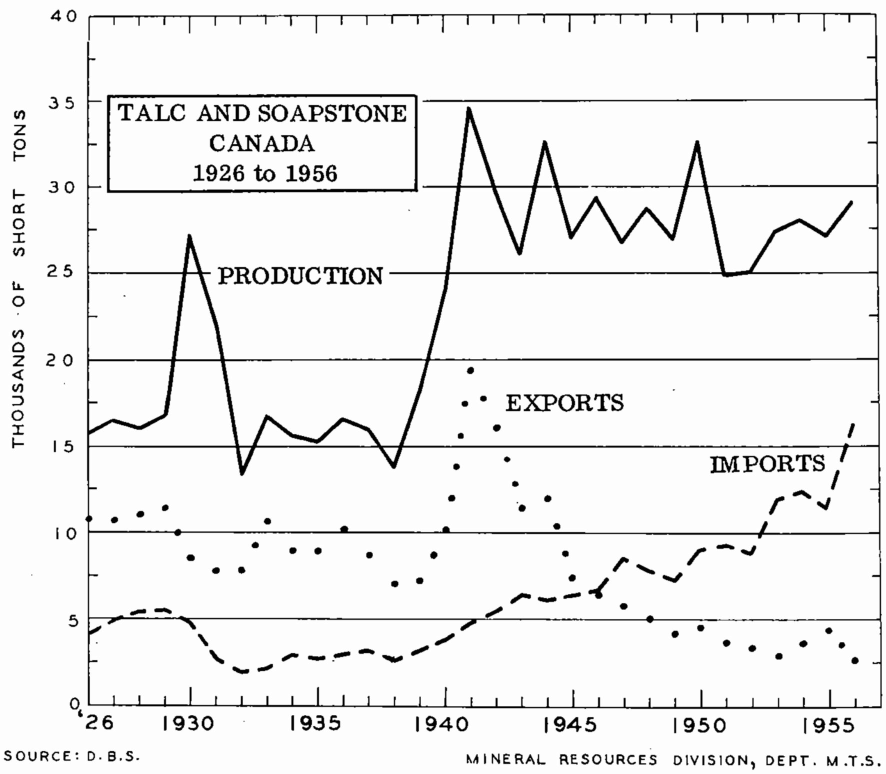
Occurrences

Talc and soapstone occur in numerous localities in Quebec, Ontario and British Columbia, deposits in the first two provinces having contributed most of Canada's production.

In Quebec, important deposits occur just north of the Vermont State border about 60 miles southeast of Montreal, and in the Thetford Mines district. Each of these areas contains a producer. The deposits were formed by the alteration of serpentine rock, and are high in iron, have a variable carbonate content, and are somewhat off-colour. The products are used where colour specifications are not exacting and low carbonate material can be selected for use where low loss on ignition is important.

Talc and Soapstone - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production (sales)				
Ground	29,201	340,880	27,079	320,110
Sawn soapstone blocks and talc crayons...........	125	24,346	81	18,857
Total	29,326	365,226	27,160	338,967
Imports				
United States........	14,703	433,677	10,312	330,219
Italy	1,528	61,405	1,059	47,343
France	37	919	11	465
Total...............	16,268	496,001	11,382	378,027
Exports				
United States	2,476	31,873	4,175	60,433
Ecuador	62	789	67	886
Cuba	15	262	95	1,702
Other countries	60	1,484	91	1,953
Total...............	2,613	34,408	4,428	64,974
Consumption				
Paints.............	7,436		7,872	
Roofing	9,091		9,414	
Pulp and paper......	900		687	
Rubber	1,742		1,392	
Toilet preparations..	716		540	
Electrical apparatus.	791		311	
Clay products	4,157		3,302	
Soaps & cleaning preparations.......	117		64	
Insecticides and miscellaneous chemicals.........	3,785		5,503	
Polishes and dressings	7		8	
Miscellaneous non-metallic mineral products	75		83	
Tanneries	3		6	
Asbestos products...	-		9	
Coal tar distillation..	2,385		783	
Medicinal preparations.......	246		408	
Other products......	28		975	
Total	31,479		31,357	



There are deposits in Ontario, in the northwestern part, especially in the Kenora district, and in the southeast. The only production comes from southeastern Ontario near Madoc, about 110 miles southwest of Ottawa. The talc in this locality resulting from the alteration of white and grey dolomite, is low in iron and relatively high in carbonate, and is used to a large extent where prime white colour is important.

There are several talc deposits in British Columbia and a small production was reported from 1916 to 1936. Most of it came from two small mines, one in the southern part of Vancouver Island and the other on the mainland about 100 miles northeast of Vancouver. They produced low-grade talc for the roofing industry. At present this industry is using sand and, to some extent, ground mica. Massive talc, yielding a good white powder, occurs near the Alberta border west of Banff. Present needs for high-grade white talc are being met by material from California.

Pyrophyllite is very similar to talc but contains alumina instead of magnesia. It also is an alteration product, but it has been derived from siliceous rocks rather than from dolomites or serpentine rocks, and is often accompanied by sericite and quartz. It occurs at Kyuquot Sound in the northwestern part of Vancouver Island and near Manuels, Newfoundland, about 12 miles southwest of St. John's. The latter deposits are larger and are now undergoing development.

Producers

Quebec

Broughton Soapstone and Quarry Company Limited, Broughton Station, produces commercial grades of ground talc, and soapstone blocks and crayons.

Baker Talc Limited, 302-215 St. James St. West, Montreal, with grinding mill near Highwater, produces talc derived from the Van Reet mine 10 miles to the north. During 1956 equipment was installed to increase production.

Ontario

Canada Talc Industries Limited, Madoc, operates the Conley and Henderson mines for the production of ground talc. The latter mine yields an especially high-grade, white product.

Newfoundland

Newfoundland Minerals Limited, Box 2043, St. John's, commenced operations in June 1956, and planned increased development of the pyrophyllite deposits in 1957. It is expected that production will be exported to the United States.

History

The first production recorded in Canada was soapstone from Bolton township, Quebec, in the vicinity of the property of Baker Talc Limited, in 1871. However, it was not until 1922 when production of sawn soapstone commenced in the Thetford Mines district that the industry became firmly established. The Broughton Soapstone and Quarry Company started production in 1923. Baker Talc erected its grinding mill in 1938 and has been in production since that time.

Mining of talc in the Madoc area commenced around 1900, and a grinding mill was erected in 1906.

Some mining was undertaken on the pyrophyllite deposits near Manuels, Newfoundland, in the early part of this century and again between 1938 and 1947. A crushing plant was built in 1942 but shipments were small.

The deposits in British Columbia were mined in a minor way for about 20 years.

World Situation

The United States in the largest producer and consumer. However, because of the need for special grades an appreciable amount of world trade takes place. India and Sardinia provide a high-quality steatite for ceramic insulators, and France and Italy produce a prime white talc for cosmetic, pharmaceutical and ceramic use. Most of Canada's trade is with the United States, and to a slight extent with Italy for white talc.

Uses and Specifications

The roofing, paint, insecticide and rubber industries account for much of Canadian consumption. More recently the use of low-carbonate talc as an asphalt filler in pipe-line enamels has become important.

Lower grade talc is used as a surfacing material and dusting agent for asphalt paper roofing, as a filler and dusting agent in rubber products, and as a polishing agent for wire nails, rice, peanuts, and other commodities. For paint use, colour, particle shape, packing index, and oil absorption are the principal factors. The ceramic trade demands prime white colour and the paper industry talc of high brightness, high retention in the pulp, low abrasiveness, and freedom from chemically active substances. For lubricants, talc must be soft, free from grit, and have high slip. Talc of high purity is demanded for the cosmetic and pharmaceutical trades. For asphaltic compounds low ignition loss is of first importance.

Grinding specifications for cosmetic, ceramics, and filler grades vary from 95% to 99.8% minus 325-mesh; for roofing grades there are various specifications in the minus 80- plus 200-mesh range. Prices vary considerably owing to quality, colour, loss on ignition, and fineness of grind.

Miscellaneous uses for talc include cleaners, plaster, polishes, plastics, foundry facings, linoleum and oilcloth, oil-absorbent preparations, textiles.

Massive, compact talc, often referred to as steatite, is used in making ceramic electrical insulators.

Prices

Canadian prices quoted in The Northern Miner at the end of 1956 were as follows:

Ground talc, prices by Canada Talc Industries Ltd., per short ton, in bags, f.o.b. Madoc, Ontario:

	$
Filler grade, 50-lb. bags	- 11.50 - 15.00
Cosmetic grade, 50-lb. bags	- 26.00 - 50.00
Ceramic grade, 50-lb. bags	- 17.50 - 26.00
Roofing grade, 70-lb. bags	- 10.00 - 13.75

According to E & M J Metal and Mineral Markets Bulletin of December 20, 1956, prices in the United States were as follows:

Per short ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey

Mineral pulp, ground - $10.50 to $12.50, bags extra.

New York

Double air-floated, short fibre, 325-mesh - $18.00 to $20.00.

Vermont

100% through 200-mesh, extra white, bulk basis - $12.50; 99 1/2% through 200-mesh, medium white - $11.50 to $12.50; packed in paper bags - $1.75 per ton extra.

Virginia

200-mesh - $10.00 to $12.00; 325-mesh - $12.00 to $14.00; crude - $5.50.

VERMICULITE

By H. S. Wilson
Industrial Minerals Division

The vermiculite industry, which in Canada began in 1938, has shown a continuous increase through the years. From its inception, the industry has relied on foreign sources for raw material. During 1956, however, limited production was commenced from domestic vermiculite by Northern Vermiculite Limited utilizing a deposit near Perth, Ontario. A plant was built to expand the material. Production figures are not available.

All other companies expanding vermiculite import raw material mainly either from the United States or from the Union of South Africa.

Vermiculite - Trade and Consumption

	1956	1955
	$	$
Imports, crude		
United States	291,198	284,152
Union of South Africa	82,609	71,259
United Kingdom	109	-
Total	373,916	355,411
Products produced (particulars not available)	1,535,844	1,369,316

Description, Properties and Uses

Vermiculite is a type of hydrous mica that when heated exfoliates to form a highly cellular material which possesses good insulating qualities. There are several forms of vermiculite which are commonly associated with such rocks as serpentines, peridotites and pyroxenites. Vermiculite is thought to be the hydrothermal product of the parent rock. The colours can vary from black to golden yellow. Exfoliation can be as high as 25 times the original volume.

Vermiculite

The Canadian deposit of vermiculite being worked is near Stanleyville, about 8 miles southwest of Perth, Lanark county, Ontario. There are several occurrences in this district in the Grenville series of metamorphosed sediments of Precambrian age.

Vermiculite finds its greatest use as loose insulation. Approximately 60 per cent is consumed in this field. It is also used in plaster for insulation purposes, in lightweight concrete, as a soil conditioner, as an insecticide carrier, etc.

Plants Expanding Vermiculite

Company	Plant Location
Northern Vermiculite Limited	Perth, Ont.
F. Hyde and Company, Limited	Montreal, Que.
	St. Thomas, Ont.
	Toronto, Ont.
Insulation Industries (Canada) Ltd.	Vancouver, B.C.
	Winnipeg, Man.
	Calgary, Alta.
Siscoe Vermiculite Mines Limited	Cornwall, Ont.
	Toronto, Ont.
Vermiculite Insulating Limited	Montreal, Que.

Prices

Prices were quoted in E & M J Metal and Mineral Markets of November 29, 1956, as:

	$ Per ton
Montana, f.o.b. mines	- 9.50 - 18.00
South African, c.i.f. Atlantic ports	- 30.00 - 32.00
Georgia, 98% through 200-mesh,	
grey	- 10.50 - 11.00
white	- 12.50 - 15.00

WHITING

By H. M. Woodrooffe
Industrial Minerals Division

Production in Canada of whiting substitute increased slightly during 1956. The output of grinding plants was 17,448 tons valued at $174,120 compared with 16,007 tons at $162,731 in 1955.

True whiting is prepared by fine grinding to the appropriate particle size chalk, a fine-grained light-coloured calcareous stone composed of the residue of microscopic marine organisms. Whiting substitute is a term applied to a finely ground white product prepared from marble or limestone. The latter material is sometimes referred to in this country as domestic whiting or marble flour. It is produced in Quebec and British Columbia. Marl of good colour, free of organic impurities is a potential source of whiting substitute. Although formerly processed in Canada, there has been no production from this source for several years.

Precipitated calcium carbonate, a by-product obtained during the manufacture of caustic soda is also a source of a whiting. None is produced in Canada.

Industrial Fillers Limited of Montreal quarries a white marble near St. Armand, Missisquoi county, Quebec. This is ground at its plant in Montreal for the production of whiting substitutes used in various industries. Beale Quarries Limited and Donald and Alex McKay Company produce whiting substitute by grinding limestone in British Columbia. The former company operates a quarry at Vananda, Texada Island, while the latter company's quarry is near Victoria, British Columbia.

Uses

True whiting originating from England is generally referred to commercially as a Paris White, Gilders' Whiting, or ground Cliffstone.

Whiting is an important raw material for a number of industries in their manufacturing processes. In formulating cold water paints, true whiting and whiting substitute are used. The former imparts improved opacity. White colour, fine particle size and freedom of grit are important characteristics in this application.

Whiting - Production, Trade and Consumption

	1956		1955	
	Short Tons	$	Short Tons	$
Production				
Stone processed for whiting	17,448	174,120	16,007	162,731
Imports				
Whiting, gilders' whiting and Paris white				
United States	5,543	208,040	5,785	224,303
United Kingdom	3,176	51,407	3,413	52,368
Other countries	2,637	16,467	2,707	21,208
Total	11,356	275,914	11,905	297,879
Chalk, Prepared				
United States		5,829		4,024
Miscellaneous Chalk, China, Cornwall or Cliffstone (ground or unground), and mica schist				
United States		6,368		2,430
W. Germany		2,643		-
Other countries		-		421
Total		9,011		2,851
Consumption, ground chalk, whiting and whiting substitute				
Explosives	341		321	
Medicinals and pharmaceuticals	240		40	
Paints	14,108		13,066	
Soaps	41		51	
Toilet preparations	14		17	
Electrical apparatus	547		352	
Linoleum	7,223		7,009	
Rubber goods	9,502		8,755	
Tanneries	242		218	
Gypsum products	260		347	
Polishes and dressings	-		2	
Adhesives	124		162	
Asbestos products	57		672	
Pulp and paper	466		563	
Miscellaneous chemicals	1,015		1,476	
Miscellaneous products	30		120	
Total	34,210		33,171	

In the manufacture of oil paint, both types of whiting are used as extender pigments. Bulk density, colour, oil absorption, fineness and chemical composition are important characteristics. Whiting is also a principal ingredient in the manufacture of putty.

Large quantities of whiting are used as a filler in the manufacture of rubber products. Chemical composition is extremely important in this application. Some whitings are chemically treated to improve dispersability in the rubber mix. Whiting is used as a filler in the manufacture of linoleum, oil cloth, moulding of plastics, polishes, paper and cleaning compounds. Generally, for these applications, colour, particle size and shape, and absence of grit are of primary importance.

True whiting is used by the ceramic industry in glazing and in the manufacture of whiteware.

Prices

During 1956 the price of whiting substitute per ton, bagged, ranged between $15.00 and $20.00 per ton f.o.b. plants.

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COAL AND COKE

COAL

By E. Swartzman
Fuels Division

Production

Although the Canadian coal industry has suffered from the effect of increasing competition from oil and gas, the stabilizing trend which appeared in 1955 has continued. Production at 14,915,610 tons was 0.7 per

Production of Coal by Provinces and Territories*, 1955 and 1956
(Short Tons)

		Bituminous	Sub-Bituminous	Lignitic	Total
Nova Scotia	1956	5,775,025	-	-	5,775,025
	1955	5,731,026	-	-	5,731,026
New Brunswick	1956	988,266	-	-	988,266
	1955	877,838	-	-	877,838
Saskatchewan	1956	-	-	2,341,641	2,341,641
	1955	-	-	2,293,816	2,293,816
Alberta	1956	2,064,405**	2,264,382	-	4,328,787
	1955	2,115,072**	2,340,207	-	4,455,279
British Columbia and Yukon	1956	1,481,891	-	-	1,481,891
	1955	1,460,921	-	-	1,460,921
Total	1956	10,309,587	2,264,382	2,341,641	14,915,610
	1955	10,184,857	2,340,207	2,293,816	14,818,880
Value $	1956	80,284,374	10,745,222	4,398,031	95,349,763
	1955	78,191,725	11,078,583	4,309,163	93,579,471

* Coals classed according to A.S.T.M. Classification of coal by Rank - A.S.T.M. Designation D388-38.

** Includes a small amount of semi-anthracite from the Cascade area.

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cent higher than in 1955 but still 22.1 per cent below the record of 19,139,112 tons in 1950, Nova Scotia contributed about 39 per cent of the total, Alberta 29, Saskatchewan almost 16, British Columbia and Yukon 10, and New Brunswick just under 7. Nova Scotia, New Brunswick, Saskatchewan British Columbia and Yukon showed, collectively, an increase of 2.2 per cent over 1955, whereas Alberta's output again decreased by 2.8 per cent, bituminous coal accounting for about 40 per cent of the Alberta decrease. New Brunswick showed the greatest gain with an increase of over 12 per cent from the 877,838 ton output of 1955. For the country as a whole production of bituminous coal increased by about 1.2 per cent and lignite by 2.1 per cent, whereas subbituminous production decreased by about 3.2 per cent.

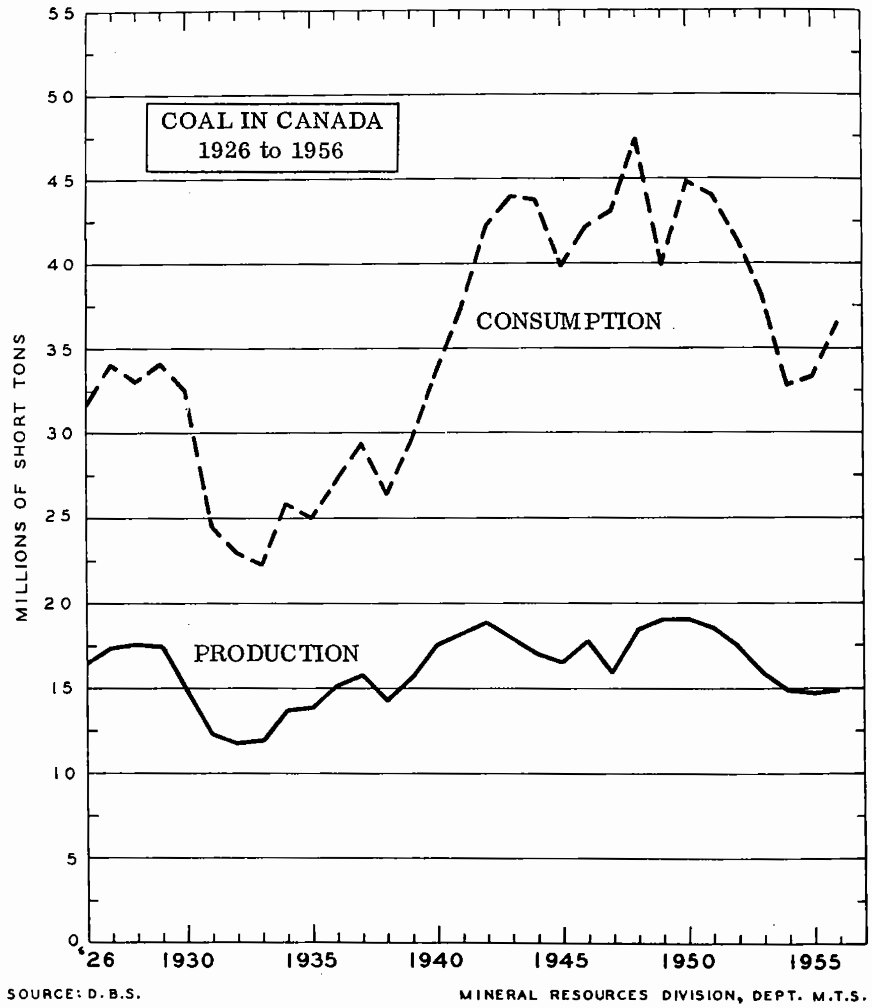
The proportion of coal produced in Canada by strip mining showed a very slight increase, 37 per cent of the output in 1956 being produced in this manner compared to 36 per cent in 1955.

Production of Coal by Type of Mining, 1956

			Short Tons	%
Nova Scotia	-	Strip mines	-	-
		Underground	5,775,025	100.0
New Brunswick	-	Strip mines	805,329	81.5
		Underground	182,937	18.5
Saskatchewan	-	Strip mines	2,339,053	99.9
		Underground	2,588	.1
Alberta	-	Strip mines	2,004,170	46.3
		Underground	2,324,617	53.7
British Columbia	-	Strip mines	374,059	25.2
and Yukon		Underground	1,107,832	74.8
Canada	-	Strip mines	5,522,611	37.0
		Underground	9,392,999	63.0

Output Per Man-day

The output per man-day in strip mining varies from about 5 to 23 short tons, depending upon thickness and type of cover and the ratio of thickness of coal seam to that of the cover, but in all cases it is far greater than for underground mining. There was a slight increase in output per man-day from 1955, strip mining showing an increase of about 0.2 per cent and underground mining 2.2 per cent. Underground mining has shown a steady increase in productivity per man-day during the last few years, which reflects the influence of increasing and improved mechanization.



Average Output of Coal per Man-day for Canada, 1955 and 1956
(Short Tons)

	1956	1955
Strip mines	13.340	13.309
Underground	2.780	2.719
All mines	3.932	3.826

Consumption

Apparent consumption showed a further increase in 1956, the increased requirements being met mainly by bituminous coal from the United States. This greater demand may be accounted for by continued industrial expansion accompanied by increased thermal power production. The increase, however, was not commensurate with the industrial expansion owing to competition from liquid and gaseous fuels.

Consumption of Canadian and Imported Coal, 1952-1956

	Canadian Coal(a)		Imported Coal(b)		
	Short Tons	% of Consumption	Short Tons	% of Consumption	Total
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	19,323,332	57.9	33,383,371
1956	14,115,095	38.9	22,198,049	61.1	36,313,144

(a) 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.

(b) Deductions have been made to take into account foreign coal re-exported from Canada and bituminous coal ex-warehoused for ships' stores. Imports of briquettes are not included.

Imports of Coal for Consumption[a], 1955 and 1956
(Short Tons)

Country of Origin		Anthracite	Bituminous	Total
United States (d)	1956	2,392,378	19,779,831(b)	22,172,209
	1955	2,379,465	16,798,185(c)	19,177,650
United Kingdom	1956	153,249	155	153,404
	1955	267,038	2,860	269,398
Total	1956	2,545,627	19,779,986	22,325,613
	1955	2,646,503	16,801,045	19,447,548
Value $	1956	30,060,480	98,107,953	128,168,433
	1955	30,190,088	75,997,671	106,187,759

(a) From Trade of Canada. Includes briquettes but does not include coal imported and subsequently sold for use on board ships.

(b) Includes 1,940 tons of lignite and 126,724 tons of briquettes.

(c) Includes 1,548 tons of lignite and 124,216 tons of briquettes.

(d) Includes a small quantity from Alaska.

Exports of Coal, 1955 and 1956
(Short Tons)

Destination	1956	1955
United States*	339,893	337,153
United Kingdom	240,137	233,770
West Germany	4,050	11,203
St. Pierre and Miquelon	10,086	10,656
Total	594,166	592,782
Value $	4,710,030	4,870,598

* Includes a small quantity to Alaska.

Consumption of Fuels for Domestic and Building Heating, 1947-1956

Year	Fuel Oil and Distillate(a)	Natural Gas(b)	Manufactured Gas(b)	Coal & Coke(c)
	Bbl	M cu ft	M cu ft	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	8,084,673

(a) The Petroleum Products Industry, Dominion Bureau of Statistics.
(b) The Crude Petroleum & Natural Gas Industry, Dominion Bureau of Statistics. Manufactured and natural gas used for household and commercial purpose.
(c) The Coal Mining Industry "Sales of Coal & Coke by Retail Fuel Dealers", Dominion Bureau of Statistics. Not available prior to 1947.

Relation of Fuel Consumed by Railway Locomotives to Gross Ton Miles of Traffic(a), 1946-1956

Year	Traffic in Millions of Gross Ton Miles (b)	Coal and Oil Consumed in Terms of Coal(c)	Fuel Consumed in Terms of Tons Coal per Million Gross Ton Miles Traffic	Oil Consumed As Percentage of Total Fuel
		Thousands of Tons		%
1946	128,311.9	12,192	95.0	4.6
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

(a) Railway Transport, Dominion Bureau of Statistics.
(b) Freight train cars plus passenger train cars, exclusive of locomotives and tenders.
(c) Oil has been estimated in terms of coal at 13,000 Btu/lb, taking oil at 9.33 lb/gal with a calorific value of 19,000 Btu/lb.

Fuel Consumed by Railway Locomotives, 1943-1955

Year	Coal(a)	Fuel and Diesel Oil(a)	Estimated Heat Equivalent of Oil in Terms of Coal(b)	Estimated Heat Equivalent of Oil as a Percentage of Total Coal & Oil
	Thousands of tons	Millions of 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*	291.9	1,990.2	16.9
1953	8,323*	308.2	2,101.3	20.2
1954	6,502*	326.6	2,226.8	25.5
1955	5,587*	384.6	2,622.2	31.9
1956	5,587*	444.6	3,031.3	35.2

(a) Railway Transport, Dominion Bureau of Statistics. (b) Estimated in terms of coal at 13,000 Btu/lb, taking oil at 9.33 lb/gal with a calorific value of 19,000 Btu/lb. * Inclusive of railway briquettes.

Consumption of Briquettes

Briquettes available for consumption increased from 777,808 tons in 1955 to 879,208 tons in 1956. About 70 per cent of the amount marketed in Canada (that is, about 82 per cent of the Canadian output) was used by the railways in Western Canada mainly as locomotive fuel. Although dieselization of the railways continued, the market for locomotive briquettes remained constant at almost 620,000 tons. However, a former large producer in the Mountain Park area ceased operations. The Saskatchewan output of almost 39,000 tons of briquettes, used almost entirely for household and commercial purposes, is made from carbonized lignite. Of the 525,202 tons manufactured in Alberta, about 17.1 per cent was prepared from semi-anthracite coal in the Cascade area, the remainder being made from medium volatile bituminous coals in the Crowsnest area. In British Columbia 188,355 tons of railway briquettes were prepared from medium volatile bituminous coals in the East Kootenay (Crowsnest) area.

Imports of briquettes from the United States in 1956 amounted to 126,724 tons, an increase of 2,508 tons from 1955. These briquettes, used almost entirely for household and commercial purposes, are made from low volatile bituminous coals and from anthracite, alone or mixed with bituminous coking coal.

Value of Canadian Coals

The average value of Canadian coal f.o.b. mines after showing a decrease in 1955 for the first time in several years to $6.31 per ton, increased in 1956 to about $6.40. Imported coal also showed a trend reversal in value by increasing from $5.46 per ton in 1955 to $5.74 in 1956. This increase in the value of both Canadian and imported coal is probably part of the general trend in the rising level of prices of most commodities and services, and tends to counteract the previous decrease in costs resulting from more intensive and improved mechanical mining and preparation.

A much more equitable manner of comparing the value of coals, because of the wide variation in their calorific values, is on the basis of their value per million Btu, as shown below.

Comparative Value of Canadian Coals in 1956

	Average Btu/lb*	Average value per ton**	Av. value per million Btu
		$	¢
Nova Scotia			
Bituminous	13,200	8.819	33.41
New Brunswick			
Bituminous	11,980	8.085	33.74
Saskatchewan			
Lignite	7,920	1.845	11.65
Alberta			
Bituminous	12,110	6.069	25.08
Subbituminous	9,125	4.745	25.99
British Columbia			
Bituminous	13,700	5.924	21.62
Yukon			
Bituminous	11,400	11.855	51.81
Canada			
Bituminous	12,930	7.787	30.11
Subbituminous	9,130	4.745	25.96
Lignite	7,920	1.845	11.65
Average	11,500	6.393	27.80

* These values are calculated on the basis of the 1956 production from the various mines.

** This data obtained from Dominion Bureau of Statistics, "The Coal Mining Industry - 1956".

Further to the value of coals on the Canadian market, it is of importance to note that whereas United States bituminous coal imported into Canada was valued at $4.96 per ton in 1956, Canadian bituminous coal was valued at $7.66.

Coal Producing Areas(1)*

Nova Scotia and New Brunswick

Nova Scotia produces high- and medium-volatile bituminous coking coals in the Sydney, Cumberland and Pictou areas, and some non-coking bituminous coal from the Inverness area. The New Brunswick output, consisting entirely of high-volatile bituminous coking coal mined from one thin seam, came mainly from the Minto area, a small proportion originating in the Beersville area.

A large part of the production from the two provinces is used locally for industrial steam raising, manufacture of metallurgical coke, as railway locomotive fuel and for household and commercial heating. In 1956, 2,267,903 tons, approximately 36 per cent of the output, was shipped to central Canada for commercial and railway use, compared to 2,380,944 tons in 1955. Of this 99 per cent originated in Nova Scotia.

Saskatchewan

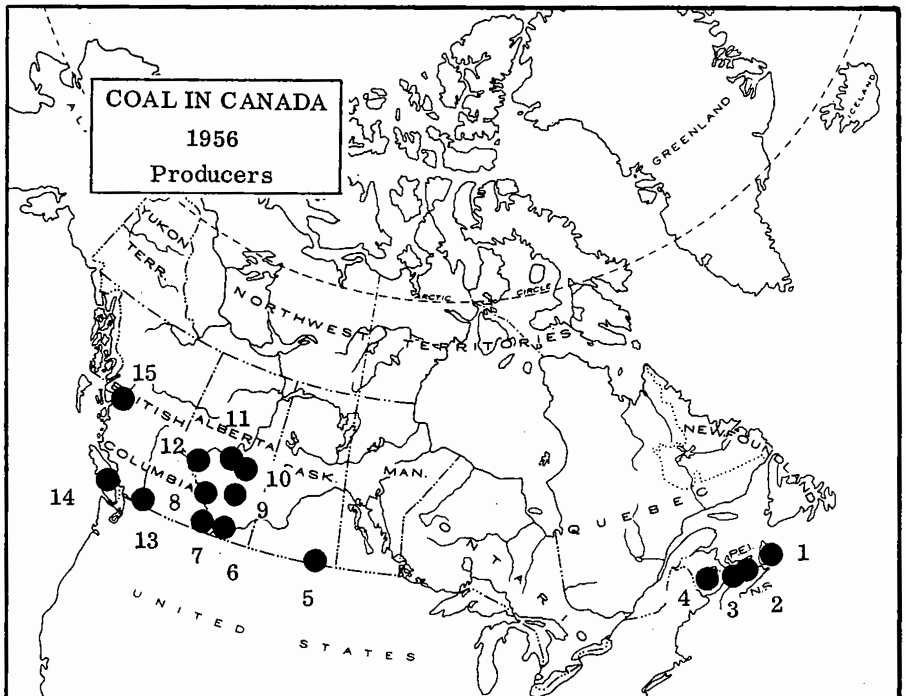
Only lignite is produced, chiefly from the Bienfait and Roche Percee fields in the Souris area. Approximately 52 per cent of the 2,341,641 tons produced in 1956 was shipped to Manitoba and about 11 per cent to Ontario for industrial, commercial and household use, the rest being distributed within Saskatchewan for similar purposes. With the extensive developments in progress for the production of thermal power in Saskatchewan and Manitoba it is expected that Saskatchewan lignite production will increase sharply during the next two years.

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 railway and industrial steam coals, but commercial and domestic markets are also supplied. However, owing to the shrinking market, mining in the Mountain Park area terminated, whereas in the Crowsnest area it was seriously curtailed during the year. In the Lethbridge, Coalspur and several other areas of the foothills, lower rank bituminous non-coking coals are available, but production is presently confined mainly to the Lethbridge and Coalspur areas. The coals in these areas are distributed mainly for household and

(1) For detailed information concerning the types and quality of coals mined in Canada refer to the following publications: (a) "Canadian Coals - Their General Characteristics, Analyses and Classification" - E. Swartzman - Fuels Division. Report No. FRL-248 (June, 1956); (b) "Analysis Directory of Canadian Coals" - E. Swartzman - Mines Branch Publication No. 836 (1953), (c) "Analysis Directory of Canadian Coals - Supplement No. 1: 1955" - E. Swartzman and T.E. Tibbetts, Mines Branch Publication No. 850.

* See map on page 404.



COAL AREAS AND PRINCIPAL MINES.

Nova Scotia

1. - Sydney & Inverness Areas
   - Dominion Coal Co. Ltd.
   - Beaver Coal Co. Ltd.
   - Bras d'Or Coal Co. Ltd.
   - Four Star Collieries Ltd.
   - Indian Cove Coal Co. Ltd.
   - Old Sydney Collieries Ltd.
   - S.J. Doucet & Sons Ltd.
   - Evans' Coal Mines Ltd.
   - Margaree Steamship Co. Ltd.
2. - Pictou Area
   - Acadia Coal Co. Ltd.
   - Drummond Coal Ltd.
3. - Springhill & Joggins Areas
   - Cumberland Railway and Coal Co.
   - Joggins Coal Co. Ltd.

New Brunswick

4. - Minto Area
   - Avon Coal Co. Ltd.
   - Crawford Contractors Ltd.
   - King Mining Co. Ltd.
   - Mills Ltd., D.W. & R.A.
   - Miramichi Lumber Co. Ltd.
   - Newcastle Coal Co. Ltd.
   - Wasson Ltd., A.W.

Saskatchewan

5. - Souris Valley Areas
   - Manitoba & Saskatchewan Coal Co. Ltd.
   - North West Coal Co. Ltd.
   - Western Dominion Coal Mines Ltd.

Alberta

6. - <u>Lethbridge, Brooks,* Taber Areas**</u>
Lethbridge Collieries Ltd.
*Kleenbirn Collieries Ltd.
**Alberta Coal Sales Ltd.

7. - <u>Crowsnest Area</u>
Coleman Collieries Ltd.
West Canadian Collieries Ltd.

8. - <u>Cascade Area</u>
The Canmore Mines Ltd.

9. - <u>Drumheller , Sheerness *, Carbon ** Areas</u>
Amalgamated Coals Ltd.
Brilliant Coal Co. Ltd.
Century Coals Ltd.
Federated Co-ops Ltd.
Midland Coal Mining Co.
Murray Collieries Ltd.
Red Deer Valley Coal Co. Ltd.
*Star Coal Mine Ltd.
*Western Dominion Coal Mines Ltd.
**McArthur, A.A.

10. - <u>Castor, Ardley,* Camrose ** Areas</u>
Battle River Coal Co. Ltd.
Forestburg Collieries Ltd.
*Mills & Sons, J.J.
*Allyn Mann Construction Co.
**Camrose Collieries Ltd.

11. - <u>Edmonton, Tofield,* Pembina** Areas</u>
Egg Lake Coal Co. Ltd.
White Mud Creek Coal Co. Ltd.
Starky Co. Ltd., J.B.
Sundance Mines Ltd.
*The Black Nugget Coal Co. Ltd.
**Alberta Coal Co. Ltd.

12. - <u>Coalspur Area</u>
Canadian Collieries Resources Ltd.

British Columbia

7. - <u>Crowsnest Area</u>
Coleman Collieries Ltd.
The Crow's Nest Pass Coal Co. Ltd.

13. - <u>Nicola - Princeton Area</u>
Mullin's Strip Mine Ltd.

14. - <u>Vancouver Island Area</u>
Canadian Collieries Resources Ltd.

15. - <u>Northern Area</u>
Bulkley Valley Collieries Ltd.

commercial use, although a proportion 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 of subbituminous and lignite. These are mainly household and commercial coals, but increasing proportions are being used industrially, especially for thermal power production. The Cascade area was the only field that produced semi-anthracite, some of this coal being shipped as far as Quebec where it competes with imported anthracitic coals.

Alberta's output of bituminous coal as a proportion of the total did not change materially from 1955 remaining at about 48 per cent. Of the total production of all the coals mined only about 1.7 per cent (a substantial decrease from 1955) was shipped to central Canada mainly for commercial use. However, about 7 per cent, consisting to a large extent of subbituminous coal was shipped to Manitoba, 20 per cent to Saskatchewan and 20 per cent to British Columbia, for both industrial steam raising and household use.

British Columbia

Bituminous coking coal, ranging from high- to low-volatile, is mined on Vancouver Island and in the East Kootenay (Crowsnest), Telkwa and Nicola (Merritt) areas. Small quantities of subbituminous coal are produced in the Princeton field. In the Crowsnest area, where about 80 per cent of the provincial coal production originates, medium-temperature (by-product) coke is manufactured chiefly for industrial consumption both in Western Canada and northwestern United States. In addition, coal is exported to southwestern United States for blending in the manufacture of metallurgical coke. A briquetting plant that started operating in 1953 produced almost 190,000 tons of railway briquettes in 1956. Mining on Vancouver Island was confined almost entirely to the Comox area - the coal being used within the province for industrial, commercial and household purposes. Of the total production over 16 per cent was shipped to Manitoba and about 4 per cent to Ontario.

Beneficiation

The competition of liquid and gaseous fuels and the necessity for increased mechanization to reduce costs continue to give impetus to efforts to improve the quality of the coal produced by the use of modern methods of beneficiation such as cleaning, drying, dust- and freeze-proofing and briquetting.

As a result of the success, from a technical and coal marketing viewpoint, of the first mechanical coal-cleaning plant for washing 2 x 0 inch slack established in 1955 in the Minto area of New Brunswick, a second coal cleaning plant to clean 6 x 1/4 inch coal was near completion by the end of 1956. These two plants will allow for the cleaning of over 34 per cent of the total output of New Brunswick. Both plants are equipped with modern mechanical and thermal drying machines. In Nova Scotia, plans were completed for the establishment of a large central mechanical cleaning plant to process coals from the mines of the largest operator in the Sydney area. When this is completed it will be possible to clean over 80 per cent of the coal mined in the province. One of the smaller operating companies has continued to conduct experiments, aided by the Mines Branch, with a view to determining the system of mechanical cleaning most suited to their conditions, especially in relation to the grade of coal produced by continuous mechanical mining. In this regard, it should be noted that the "Dosco Miner", a continuous mechanical miner of the ripper type, was being increasingly introduced in the mines of the Sydney area, a move which practically necessitates the parallel introduction of mechanical coal cleaning.

A major problem continued to be the beneficiation of fines with a view to preparing a product with a uniform and satisfactory ash content that will find greater acceptance in the household and industrial markets. In this regard additional equipment is being installed at certain Western collieries for the cleaning and drying of fines.

During the year the Mines Branch, with a view to aiding the industry in various beneficiation problems, has cooperated with industrial organizations in conducting laboratory- and plant-scale tests in regard to coal cleaning and the use of fine coal in compounded agglomerates as a reductant in the smelting of minerals. Studies were also conducted on the effects of continuous mechanical mining on the size distribution and cleaning characteristics of Nova Scotia coals with a view to aiding the coal industry in its mining and beneficiation problems.

COKE

By E.S. Burrough

The production of coke in Canada is confined almost exclusively to the manufacture of metallurgical coke in standard slot-type coke ovens of the Koppers design. The coke is used in the operation of iron blast furnaces or in the production of non-ferrous base metals. The operation of gas retorts, which in Great Britain represents about half the total carbonization load, has no counterpart in Canada. In the early part of the previous century, small gas plants were installed in towns on the St. Lawrence River and gradually most of the larger urban centres in Canada were served with manufactured gas from retort plants. At the end of the First World War the popularity of these plants declined and with competition from electricity and other methods of producing domestic gases the retort plants were gradually superceded. At a few of the larger centres by-product coke ovens were installed to produce manufactured gas for city distribution and by-product coke for domestic fuel. Of greater significance than these gradual changes in the domestic fuels and the manufacture of coke and by-products of the past century will no doubt be the advent of the distribution of Western natural gas in the industrial centres of Ontario and Quebec.

The modern coke oven unit used in the production of metallurgical coke has been more or less standardized on units of 17 inches in oven width and capacities approaching 20 tons per unit charge and the batteries are

Coke - Production and Trade

	1956		1955	
	Short Tons	$	Short Tons	$
Production from bituminous coal				
Ontario	3,088,678		2,853,569	
Nova Scotia, New Brunswick, Quebec and Newfoundland ...	931,114		882,538	
Manitoba, Saskatchewan Alberta and British Columbia	300,824		292,821	
Total	4,320,616		4,028,928	
Production of pitch coke	8,089		3,029	
Production of petroleum coke	270,905		269,900	
Total	4,599,610		4,301,857	
Bituminous coal used to make coke				
Imported	4,813,850		4,415,143	
Canadian	1,114,648		1,060,275	
Total	5,928,498		5,475,418	
Imports, all types				
United States	943,312	13,200,283	760,503	11,406,689
United Kingdom.......	27	956	111	3,280
Others	-	-	-	-
Total	943,339	13,201,239	760,614	11,409,969
Exports, all types				
United States	134,479	1,529,132	147,271	1,556,967
United Kingdom.......	14,633	571,205	13,045	506,717
Other countries.......	10,555	378,541	11,432	400,897
Total	159,667	2,478,878	171,748	2,464,581

constructed of pure silica brick shapes. The plants are operated for maximum throughput, carbonizing times are at rates of one inch of oven width per hour, or better.

Increased activity in construction of plant has been shown in the past five years with the installation of new plant and the replacement of obsolete batteries at existing plants.

The trade and production figures for 1956 have shown consistent increases over previous years.

The production of coke from bituminous coal was 4,320,616 tons, 7.2 per cent above 1955, and followed an upward trend evident for several years. Imports at 943,339 tons were up 24.0 per cent, and exports at 159,667 tons were down 7.0 per cent. This increased activity was mainly owing to recovery from the temporary drop in steel production that took place in 1954.

Coal processed for the manufacture of coke was 5,928,498 tons, of which approximately 81 per cent was from the United States and the remainder from domestic sources.

Most of the coke produced in Canada is obtained from standard by-product coke ovens that process coal in large tonnages for use in processing steel and non-ferrous metals. A limited market for solid fuels in domestic heating also consumes prepared by-product coke. The production of retort coke, a by-product of the gas industry, continues to decline with the change in methods of production of manufactured gas for domestic use.

The principal use for petroleum coke in Canada is in the production of electrodes which are required in appreciable quantities in the aluminum industry. The Soderberg process for the manufacture of electrodes is the one generally used in this industry.

The production of pitch coke in Canada is confined to the disposal of surplus coal-tar pitch not required for other industrial uses such as the production of electrodes or briquettes.

Other than the standard by-product coke ovens which are used almost exclusively in the coking industry, there exist in Canada a Curran Knowles carbonization plant located at the Crow's Nest Pass collieries in Michel, British Columbia; a distinctive coking stoker-type of plant designed and operated by the Shawinigan Chemicals Company, Shawinigan Falls, Quebec; and two small plants operating gas retorts.

About 80 per cent of the coal used in the production of coke in Canada is processed at 6 plants in eastern Canada, namely, Dominion Steel and Coal Corporation at Sydney, Nova Scotia, with rated annual capacity of 1,001,900 tons of coal; Montreal Coke and Manufacturing Company at Ville La Salle, Quebec, with rated annual capacity of 656,000 tons of coal (the

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company normally produces domestic coke and also supplies Montreal with gas); Algoma Steel Corporation Limited with a metallurgical coke plant at Sault Ste. Marie, Ontario, which has a rated annual capacity of 2,000,000 tons of coal; Hamilton By-Product Coke Ovens Limited at Hamilton, Ontario, with a rated annual capacity of 415,000 tons of coal; Dominion Steel Foundries Limited, with an annual capacity of 540,000 tons; and Steel Company of Canada Limited at Hamilton, with a rated capacity of 1,470,000 tons of coal a year.

NATURAL GAS

By R.B. Toombs and R.A. Simpson
Mineral Resources Division

The year 1956 was a period of major achievement in the natural gas industry. As a result of the year's developments a change in the pattern of fuel usage will begin to take place in Canada, and beneficial effects will be felt in many other sectors of the Canadian economy. Chemically based industries in particular should benefit from large supplies of natural gas.

Developments related principally to commencement of construction of a country-wide gas pipe-line transportation system. The 2294-mile system of Trans-Canada Pipe Lines Limited for transporting Alberta natural gas eastwards and the 650-mile Westcoast Transmission Company line from the Peace River area of British Columbia and Alberta to Vancouver and to the United States boundary will provide outlets for the large natural gas resources which have been developed in the past ten years. Reserves in excess of 23,000 billion cu. ft. provide more than adequate support for these and related transportation systems.

The natural gas industry in Canada has a long history but, as shown in the chart on page 415 which covers marketed production for the period from 1926 to 1956, annual increases have been small until recent years. Output in 1956 of 169,542,504 M cu. ft., after field waste, represented a 12 per cent increase over the previous year. Production value of $17,367,106 is still a relatively small portion of the total value of output of the Canadian mineral industry. It can be expected that natural gas production will register at least a three-fold increase by 1960.

Development and Production by Provinces

British Columbia

Although exploration for natural gas in northeastern British Columbia was carried out in the early 1920's and in the early 1940's, it was not till 1948 that a large-scale program got underway. In 1952 the highly successful Pacific Fort St. John No. 4 well found large quantities of gas in the Lower Cretaceous (Cadomin), in three Triassic zones, and in the Permo-Pennsylvanian, and confirmed the Peace River district as an important natural gas region. Stratigraphic and structural conditions in thick sedimentary sequences throughout the 30-million acre basin lying east of

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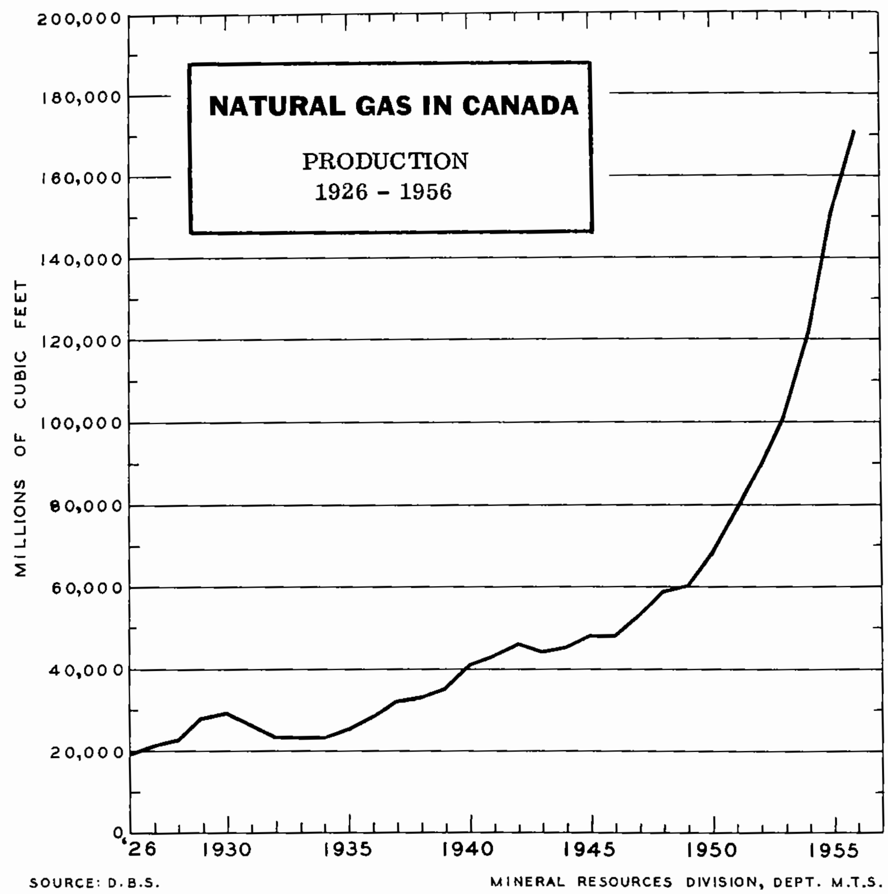
Natural Gas

Production of Natural Gas[a]

	1956		1955	
	M. cu. ft.	$	M cu. ft.	$
Alberta[b]				
Turner Valley.....	29,789,073		28,748,262	
Jumping Pound....	17,128,767		14,890,662	
Leduc-Woodbend..	13,691,054		12,250,318	
Pakowki Lake.....	11,123,716		11,523,280	
Bonnie Glen	7,619,444		5,762,144	
Acheson	1,223,923		1,193,124	
Other fields and areas	65,557,736		58,639,703	
Total	146,133,713	10,959,983	133,007,493	9,975,562
Ontario	13,203,671	5,281,468	10,852,857	4,341,143
Saskatchewan				
Coleville	8,495,896		5,068,758	
Success	1,579,823		546,862	
Brock............	1,187,170		1,488,936	
Lloydminster	953,220		936,145	
Unity.............	778,853		928,330	
Other fields and areas	6,680,689		2,283,939	
Total	19,675,651		11,252,970	
Waste	9,867,954		4,546,227	
Net production	9,807,697	956,250	6,706,743	637,140
British Columbia ...	187,726	20,143		
New Brunswick Stony Creek	189,234	141,925	186,549	138,450
Northwest Territories Norman Wells	20,963	7,337	18,670	6,213
Canada Total.......	169,542,504	17,367,106	150,772,312	15,098,508

(a) 1956 figures are preliminary. Production figures for Alberta and Saskatchewan were taken from Provincial Government reports. Production figures and valuations for Ontario, New Brunswick and Northwest Territories are from Dominion Bureau of Statistics reports.

(b) Production figures represent the total production, less field waste.



the Rocky Mountains give much promise of major gas reserves which, in 1956, were reported by industry to be in excess of four trillion cubic feet. Zones in sedimentary beds of all ages down to and including those of Devonian age have been indicated as potential gas sources. The Fort St. John gas field has the largest reserves in British Columbia. Other fields developed to date are within 50 miles of Fort St. John. Exploration is now reaching farther afield, although much of the potentially favourable area of northeastern British Columbia awaits preliminary exploratory drilling. At the end of 1956, exploration companies held 27,750,864 acres of land in British Columbia, over 96 per cent of this being in the Peace River District.

During 1956, twenty-nine exploratory wells were drilled of which 12 were successful new-field wildcat wells and one was a successful deeper-pool test. Most of the successful exploratory wells were within a north-westerly arc of 65 miles radius from Fort St. John, with, however, two wells being 135 miles and 160 miles in a north-northwesterly direction from that town. Included in the results of the year's exploratory drilling was an extension of the Blueberry gas area, 55 miles northwest of Fort St. John on the Alaska highway route and the discovery of a large gas source a few miles south of the Blueberry area. A well drilled at a location 160 miles north-northwest of Fort St. John tested favourably from a mid-Devonian formation and a well located a few miles south of Fort St. John was indicated as an equally good producer from a formation of Upper Devonian age. These two wells found production in zones which hitherto had not been established as producers.

Development drilling in the Fort St. John field during 1956 continued successfully with 25 wells being completed in the Cadomin (Lower Cretaceous), the Triassic "A", "B" and "D" zones, and in the Permo-Pennsylvanian. Of these, 23 were gas wells and two were oil wells. Five wells were completed in the Boundary Lake field, all being oil wells.

Survey party work by geophysical crews amounted to 192 crew-months of seismic operations and 3 crew-months of gravity work while surface geological mapping involved 76 crew-months of field activity. One-fifth of the seismic crews working in western Canada at the end of the year were in British Columbia. Nineteen drilling rigs were in operation at the year-end, being 9 per cent of all rigs in use in western Canada.

Natural gas production was officially recorded for the first time in 1956 although there has been minor production since 1954. The total of 187,726 M cu. ft. recovered in 1956 is the equivalent of considerably less than the daily average expected shortly after the Westcoast Transmission pipe line commences operations late in 1957.

Alberta

The history of natural gas discovery in Alberta dates from 1883 when gas was encountered in water-well drilling during construction of the Canadian Pacific Railway. Drilling commenced in the Medicine Hat area in 1890 and by 1912 the availability of large supplies of natural gas was attracting industry to that town. In the same year a 174-mile gas line was built from the nearby Bow Island gas field to Calgary; this was one of the earliest long-distance gas transmission lines in North America. The Turner Valley field discovery of 1914 was the next major event, to be followed in 1924 by the bringing in of the famous Royalite No. 4 naphtha producer in that field. In the Edmonton area natural gas was first discovered in 1914 near the town of Viking, 75 miles southeast of the city, and in 1923 gas supply to Edmonton was established. From these early discoveries and small pipe-line systems a province-wide distribution has grown up. Alberta's natural gas resources now being more than adequate to meet provincial demands for the foreseeable future will shortly supply a transmission and distribution system reaching as far east as Montreal.

Alberta's recovered production of natural gas in 1956 was 146,133,713 M cu. ft. representing a 20 per cent increase during the year and almost a three-fold increase over the production of 1950, which in turn was only double the 1940 output. These production figures illustrate the fast build-up in provincial marketing of recent years which is due in large part to an even greater rate of gas reserve growth.

As of September 30, 1956, established disposable reserves of natural gas stood at 18,300 billion cu. ft. compared with 15,600 billion cu. ft. in June 1955, according to studies of The Petroleum and Natural Gas Conservation Board of Alberta. Approximately 75 per cent of the province's reserves occurs in formations of Devonian, Mississippian, and Lower Cretaceous (Viking) ages - close to 25 per cent in each - and the remainder is largely accounted for by reserves in Lower Cretaceous formations, other than Viking, and in formations of Upper Cretaceous age.

Initial gas well completions remained at a high level, as indicated in the following tabulation of well completions for the past three years. Exploratory drilling in Alberta showed a 16 per cent increase in 1956 but this is more apparent in the results of oil well drilling.

	1956	1955	1954
Successful exploratory gas wells	61	68	55
Successful outpost gas wells	19	9	15
Successful development gas wells	54	61	70
	134	138	140

At the end of 1956, Alberta had 523 gas wells capable of production and 712 capped gas wells. Many of the 7,390 oil wells also yield gas and in 1956 they produced 67 per cent of Alberta's natural gas. In 1955, gas wells available for immediate production totalled 486 and there were 609 capped gas wells. The mounting number of shut-in wells and the increase in gas reserves of 2,000 to 3,000 billion cu. ft. annually point to the importance of the progress made in natural gas marketing in 1956. As the market is expanded emphasis on supply will be placed on primary gas areas rather than on oil field gas.

The successful exploratory wells drilled during the year in further preparation for large markets in the near future were widely distributed throughout the province. One well was completed in the extreme southeast corner of the province close to the Canadian-Montana gas export pipe line. At least seven exploratory wells were drilled in areas adjacent to the route of the Alberta Gas Trunk Line which will supply the Trans-Canada line. Four more were completed close to the Viking-Kinsella to Edmonton line of Northwestern Utilities Limited and six were within short distances of the system of Canadian Western Natural Gas Limited which supplies Calgary and southern Alberta towns. Two wells found production in proximity to the route of a proposed gas line from Red Deer westward to Rocky Mountain House, and two others helped to fill in the gap between the Leduc-Woodbend and Pembina fields. Most of the remaining successful exploratory gas wells were spud-in at locations throughout the large region stretching northwest from Edmonton to the Peace River country, 18 of these being within the Peace River district and another 13 in the general region of the Athabasca River between Hinton and the Whitecourt area.

The greatest number of discoveries were made in formations of Lower Cretaceous age but there was good representation of Devonian, Triassic and Mississippian formations and a small number in formations of Jurassic, Upper Cretaceous, and Permo-Pennsylvanian ages.

Natural Gas

A well completed 40 miles south of the Rimbey gas field constituted an important discovery on the southward extension of the Leduc-Rimbey reef trend. Significant exploratory successes also included two wells drilled in the vicinity of the Windfall gas condensate discovery of 1955 in the Whitecourt area, about 110 miles northwest of Edmonton. A major gas field is indicated in this area. A major gas field is also indicated at the 1955 Savanna Creek discovery, 65 miles southwest of Calgary. Of the total number of exploratory successes, 12 wells indicated immediate reserves of 10 billion cu. ft. or greater.

The year's exploratory program thus illustrates the widespread geographical and geological distribution of natural gas occurrences. The areas of deep sediments in the western and northwestern parts of Alberta attracted the largest proportion of exploratory effort in 1956 and the results obtained give great promise of very large utlimate reserves. In the plains region of the eastern half of the province more shallow drilling has also developed large reserves. In the past, exploration in the foothills and the adjacent deep Alberta basin has resulted in the discovery of the Pincher Creek, Savanna Creek, Jumping Pound, Sarcee, Harmatton-Elkton, Homeglen-Rimbey, Windfall, Chinook Ridge and other fields; on the east side, the Princess, Bindloss, Cessford, Provost, Drumheller and Nevis fields have been the more important finds. Some of these last fields will serve as initial sources for the Trans-Canada pipe line, with the foothills fields being linked to the system as markets grow.

Development drilling in 1956 further extended many of these gas fields and others throughout the province. A total of 54 successful development wells were completed with considerable emphasis being given to fields on the east side of the province. Many of the 19 successful outpost wells were also completed on this side of the province within reach of the Trans-Canada system.

At the end of the year Alberta had almost 60 per cent of all drilling rigs which were active in western Canada. Survey work during the year consisted of 952 crew-months of seismic exploration and 53 crew-months of gravity work, while geological surface parties worked 127 crew-months. At the end of the year 65 per cent of all seismic crews in Western Canada were in Alberta.

Saskatchewan

The first natural gas discovery of significance in Saskatchewan was made in the Lloydminster field in 1934 when production was obtained from a Lower Cretaceous sand. The fields which now contain the bulk of Saskatchewan's natural gas reserves were not, however, discovered until the 1950's. The Coleville field has the largest reserves; this field, the Hatton and the Hoosier fields contained 77 per cent of Saskatchewan's 537 billion cu. ft. of natural gas reserves at the end of 1956. Gas-bearing formations are predominantly Cretaceous in age.

All gas fields are on the west side of the province although the recent prolific oil-field discoveries of the southeast sector will shortly constitute important gas sources. There was a 75 per cent increase in production in Saskatchewan in 1956 owing largely to increase in output from the Coleville field near Kindersley, which is the main source of supply for Saskatoon and Prince Albert. Important too, was the production increase in the Success field near Swift Current. Deliveries were commenced from this field to Swift Current and Moose Jaw. Rising output in the new oil fields in the southeast area also contributed considerably to gross provincial output.

Six natural gas discoveries were made in Saskatchewan during 1956, four of these being within ten miles of the Alberta boundary at locations 25 to 35 miles northwest of Kindersley. The other two exploratory successes were drilled at locations about 20 miles west of Swift Current. Well depths were in the range of 2,345 to 3,100 feet.

Development drilling resulted in 7 successful completions, 6 of these being close to the Coleville field and one being on the east side of the province. Although Saskatchewan had 153 gas wells at the end of 1956, only 61 were in operation. The rapid progress being made in construction of a province-wide gas distribution system will shortly result in a greater utilization of provincial reserves. Gas exploration results to date, however, indicate that Saskatchewan will, over the long term, depend to a considerable degree on gas supplies from Alberta.

At the end of the year Saskatchewan had almost 30 per cent of all drilling rigs in western Canada and 12 per cent of the seismic crews. The emphasis in this province is primarily on oil exploration and the relatively high percentage of drilling rigs is due to extensive oil field development in the southeastern sector, within the Williston basin.

Manitoba

Oil is being produced from 12 fields and several individual well areas but there is no recovery of gas. About 85 per cent of the oil production comes from the North Virden, Virden-Roselea and Daly fields in the vicinity of the town of Virden near the Saskatchewan border. Manitoba's oil fields do not have associated gas caps and the gas saturation is relatively low. The small amount of gas released at the well-head is flared.

Manitoba will rely completely on Alberta natural gas for the Winnipeg, Brandon and other town distribution systems which were being set up in 1956.

Northwest Territories and Yukon

The only natural gas production in the Territories is that derived from the Norman Wells oil field which was discovered in 1920. This field is on the Mackenzie River, 90 miles south of the Arctic Circle. Natural gas production never exceeded 1,500 M cu. ft. annually until 1948 when it increased. It has, however, remained in the general range of 20,000 to 30,000 M cu. ft.

80486-4—28

Natural Gas

There were no gas discoveries in 1956. Some development work was done in the Norman Wells field but the four successful wells were classified as oil wells. There were 3 abandonments.

One drilling rig operated at intervals throughout 1956 in the Northwest Territories. At the end of the year 4 seismic crews were active and during the summer as many as 9 surface geological parties were in the field. The total crew-months worked by all types of geophysical and geological parties during 1956 constituted only 4 per cent of the western Canada total. Exploratory work in the Territories in 1956 was considerably less than that of the previous several years.

Ontario

Natural gas production has been recorded in Ontario since 1890. It reached a peak of 16 billion cu. ft. in 1917, declined to the 7 to 10 billion cu. ft. range during the inter-war years, rose to a second peak of 13 billion cu. ft. in 1940, dropped to as low as 7 billion in the mid-1940's from which it has steadily climbed to the 1956 level of over 13 billion cu. ft. The production increases of recent years reflect the continuing success of exploratory and development programs being carried out in the relatively restricted area of southwestern Ontario. Moreover, the local producing industry shows signs of continuing its gradual upward trend for some time to come. Production in 1956 was, however, only about one-half of provincial demand which will rise rapidly as Alberta natural gas becomes available.

During 1956 drilling activity was at a high level with the number of well completions and the total footage setting an all-time record for Ontario. Nine successful exploratory gas wells were drilled. As in recent years, exploratory work was concentrated in Kent, Lambton and Huron counties. In Kent county there was considerable offshore drilling near Port Alma, Erieau and Morpeth. One well in Huron county measured 8 million cu. ft. daily on test but open-flow potentials for most wells were generally much smaller. The average depth of all exploratory wells was 1,654 feet.

Development drilling programs resulted in 148 successful gas wells, principally in Haldimand, Kent, Welland and Norfolk counties. The most important development drilling was that carried out in Norfolk field. The Tilbury field in Kent county was extended into Lake Ontario off Port Alma to a distance of 4 1/2 miles where water depths are about 65 feet. The average depth of all development wells drilled in 1956 was 985 feet.

Quebec

Although there has been no recorded natural gas production in Quebec, exploratory activities date from 1865 when drilling was initiated in the Gaspé Peninsula. Early drilling was also carried out in the St. Lawrence Valley, and since the early 1880's small gas flows from a number of shallow wells have been used by Lowlands farmers.

In recent years, a systematic exploratory program has been carried out in the 10,000 square miles of the St. Lawrence Lowlands between Montreal and Quebec. In 1956 drilling operations were conducted by 15 companies at 46 localities in Gaspé Peninsula and several localities in the Lowlands. One gas well was completed near L'Assomption at a depth of 1,235 feet.

The proximity to large markets and the ease of access in exploration are incentives to continuing the exploration programs which have recently been considerably accelerated.

New Brunswick

History of the oil and gas industry in New Brunswick dates back to the year 1859 when interest was first aroused in an area east of the Petitcodiac River. Over the years sporadic drilling proved unsuccessful and it was not until 1910 that the Stony Creek field was discovered on the west side of the Petitcodiac River. By 1912 natural gas was being delivered to Moncton by pipe line. For many years gas production was about 650 million cu. ft. annually but in recent years it has gradually dropped to about 185 million cu. ft. This is the only locality of oil or gas production in Canada east of Ontario and the records for this small oil and gas field show that about 85 per cent of the value of its output has been derived from natural gas sales.

During 1956, two small gas wells were drilled in the Stony Creek field. At the end of the year there were 65 producing wells in this field, 46 being classified as gas wells and 19 as oil wells.

There were small amounts of exploratory activity in Nova Scotia, Prince Edward Island and Newfoundland in 1956 but no gas discoveries were made.

Pipe-Line Transportation

Trans-Canada Pipe Lines Limited

Completion of arrangements in 1956 for the transportation of natural gas from Alberta to eastern Canada represented the final phase of resource development and marketing negotiations which had been underway as early as 1950. In that year the two predecessors of Trans-Canada Pipe Lines Limited placed applications before The Petroleum and Natural Gas Conservation Board of Alberta for permission to remove natural gas from the province. Late in 1953 the Government of Alberta declared a surplus of gas for use outside the province. In January 1954 the two principal contenders combined to form Trans-Canada Pipe Lines Limited and attempts to obtain adequate supply and marketing contracts and financial backing were actively commenced by the new company. However it was not until June 1956 that financing arrangements were sufficiently completed to permit a start on construction of the $370 million pipe line to Ontario and Quebec.

80486-4—28½

Natural Gas

Steps which led to final approval of the project included an agreement reached in November 1955 in which the Federal and Ontario governments undertook to construct at a cost of $120 million a 675-mile section in northern Ontario from the Manitoba border to Kapuskasing. For this purpose a Crown company, the Northern Ontario Pipe Line Crown Corporation, was organized. Inasmuch as this assistance did not enable Trans-Canada to complete its financing, provision was made for a short-term federal loan in June 1956 to permit commencement of construction on the western section. All government permit requirements, together with gas purchase contracts and principal Canadian sales contracts, had been finalized in April. Construction commenced in July and at the end of the year 230 miles of the 586-mile, 34-inch western section from Alberta to Winnipeg had been completed.

The line is scheduled to reach Winnipeg by September 1957, Fort William by November 1957, and to be completed by December 1958. It will then consist of the western 586-mile section, a 1251-mile central section from Winnipeg to Toronto of 30-inch pipe, and an eastern section of 20-inch pipe running 308 miles eastward from Toronto to a point just west of Montreal. Construction work in eastern Canada will also include a 33-mile link with the present line being used to deliver United States gas to Toronto, and a 40-mile extension to Ottawa. Construction of a 24-inch lateral line from Winnipeg to Emerson will await United States government approval of Canadian gas imports.

Initial capacity of the line will be 300 million cu. ft. a day. Additional compressors will be installed during the first four years of operation to raise the daily capacity to 570 million cu. ft. and provision is being made for an ultimate capacity of 780 million cu. ft. daily.

Trans-Canada will initially pay 10 cents per M cu. ft. for gas in the field and, based on a 75 per cent load factor, average general service prices to distributors would be 28.3 cents per M cu. ft. in Manitoba, 49.3 cents in southern Ontario and 52.1 cents in eastern Ontario and Montreal.

Westcoast Transmission Company Limited

Construction of the Westcoast Transmission Company Limited 650-mile, 30-inch gas pipe line from the Peace River area to a point near Vancouver commenced in April and by the end of the year over 70 per cent of the line had been completed. The company was incorporated in 1949 but it was not until November 1955 that supply and market contracts were finalized and Canadian and United States government approval obtained for this international project. Initial financing was completed in April 1956 and construction of the $152-million project was immediately commenced. Further financing for early expansion of the project was arranged later in the year. Plans for increasing the initial capacity of 400 million cu. ft. daily to 660 million were subsequently announced.

When operation of the line commences in the latter part of 1957 deliveries will be made to British Columbia Electric Company Limited for distribution in Vancouver and the lower Fraser Valley, to Inland Natural Gas Company for distribution in the interior of British Columbia, and to Pacific Northwest Pipeline Corporation for deliveries in states of the Pacific Northwest. These companies carried out large-scale distribution preparations during 1956.

Westcoast's basic price to producers in the Peace River area for the first 5 years is 10 cents per M cu. ft. and, after the initial build-up period, the sales price to B.C. Electric and Inland Natural Gas at 100 per cent load factor will be 30 1/2 cents per M cu. ft. Sales to Pacific Northwest Pipeline, when the volume reaches 400 million cu. ft. daily, will be at the rate of 22 cents per M cu. ft. under terms of an initial contract and 25 cents, at 90 per cent load factor, under a second contract which provides for additional deliveries by 1959. Initial deliveries to B.C. Electric and Inland Natural Gas will be 21 million and 28 million cu. ft. daily rising to at least 50 million and 43 million cu. ft. daily by 1960.

Alberta Gas Pipe Lines

In 1956 North Canadian Oils Limited completed a $5 million, 136-mile, 10-inch pipe line in northwestern Alberta from the Wabamun gas line terminal to Hinton, site of a large pulp mill. Communities along the route and a Trans Mountain Oil Pipe Line Company pumping station will also be served by the line. South Alberta Pipe Line Limited completed a 46-mile, 10-inch pipe line from the Etzikom gas field to Medicine Hat primarily to serve a new chemical plant. Canadian Western Natural Gas Company extended the company's system by 111 miles to include 11 more communities, 4 in the Lethbridge area and 7 in the Calgary area.

Alberta Gas Trunk Line Limited constructed 18 miles of 34-inch main line and 16 miles of 18-inch line to join the Bindloss gas field to the Trans-Canada Pipe Lines Limited terminal on the Alberta-Saskatchewan border.

Saskatchewan Gas Pipe Lines

The Saskatchewan Power Corporation constructed a transmission line from the Swift Current area to Moose Jaw and commenced natural gas service in that city and in Swift Current. It also extended its northern distribution system to North Battleford and to Humboldt and introduced gas service in these centres and in several other towns en route.

The Corporation constructed 437 miles of pipe line during 1956.

Ontario

In southwestern Ontario, The Consumers' Natural Gas Company of Toronto, Union Gas Company of Canada Limited, Dominion Natural Gas Company and several smaller utilities extended their systems during 1956 in preparation for more adequate supplies of natural gas when the Trans-Canada pipe line from Alberta is completed. A total of 436 miles of gathering, transmission and distribution lines were constructed in Ontario during 1956 and placed in operation.

Natural Gas Pipe-line Mileage

Natural gas pipe-line mileage, by provinces, at the end of each year from 1952 to 1956 is shown in the following table:

	Gathering and Transmission				
	1952	1953	1954	1955	1956
New Brunswick	20	20	20	20	20
Ontario	2,303	2,326	1,959	2,046	2,081
Saskatchewan	36	115	188	474	735
Alberta	1,262	1,466	1,672	1,727	2,363
British Columbia	-	-	6	60	77
	3,621	3,927	3,845	4,327	5,276
	Distribution				
	1952	1953	1954	1955	1956
New Brunswick	65	65	65	65	65
Ontario	2,068	2,118	3,420	3,638	4,039
Saskatchewan	24	31	80	162	338
Alberta	1,349	1,503	1,506	1,672	1,841
British Columbia	-	-	5	6	971
	3,506	3,717	5,076	5,543	7,254
Total Canada all lines	7,127	7,644	8,921	9,870	12,530

Pipe-line Expenditures

Natural gas pipe-line expenditures in 1956 totalled $130,800,000, an increase over the 1955 investment of $17,700,000.

Natural Gas Processing

In 1956 three new natural gasoline plants commenced production, another small plant shut down, and at the end of the year the ten plants in operation had a capacity of 401,500 M cu. ft. of natural gas. A cycling and sulphur recovery plant in the Pincher Creek gas field was nearing completion; in 1957 this plant will add 60,000 M cu. ft. to Alberta's processing capacity. All plants constructed to date are in Alberta, but a 300,000 M cu. ft. plant under construction at Taylor, in the Peace River region of British Columbia, will be ready for operation late in 1957.

Production from Alberta natural gasoline plants since 1950 is shown in the following tabulation:

	Natural Gasoline	Propane	Butane	Sulphur
	bbl.	bbl.	bbl.	Short Tons
1956	913,572	925,716	591,638	33,464
1955	868,416	796,482	492,051	29,093
1954	682,378	529,117	245,189	22,320
1953	602,368	433,083	198,401	18,298 c
1952	579,873	337,678	140,228	8,931 c
1951	515,027	248,554	84,527	-
1950	431,362	141,070	33,906	-

c - corrected

Natural gasoline plant expenditure in 1956 amounted to $12,800,000 compared with $3,200,000 in 1955.

Markets for Natural Gas

Natural gas sales in 1956 to domestic, commercial and industrial customers are summarized in the following table. Three-quarters of the 1956 natural gas sales increase resulted from growing markets in Alberta and Saskatchewan. Natural gas distribution in the Vancouver area commenced in November; previously British Columbia natural gas sales had been restricted to minor quantities marketed in the Peace River area. In eastern Canada all natural gas marketing took place in Ontario except for the New Brunswick consumption of 189,234 M cu. ft.

Natural gas distribution investment, other than in pipe lines, totalled $19,600,000 in 1956 compared with $11,500,000 in 1955.

Sales of Natural Gas in 1956

	Volume	Value	Number of Customers As of Dec. 31, 1956
	M cu. ft.	$	
Eastern Canada			
Domestic	17,953,146	25,615,526	314,704
Commercial	3,546,671	4,984,051	19,284
Industrial...........	5,085,960	5,266,170	2,902
Miscellaneous	84,400	81,925	447
Total...............	26,670,177	35,947,672	337,337
Western Canada			
Domestic	34,086,325	13,876,704	159,575
Commercial	22,351,115	6,461,003	16,595
Industrial...........	60,545,273	8,349,187	596
Miscellaneous.......	72,759	17,892	59
Total...............	117,055,472	28,704,786	176,825
Canada total 1956	143,725,649	64,652,458	514,162
Canada total 1955	117,800,311	55,181,479	484,306
Canada total 1952	66,005,785	27,101,680	263,268

Natural Gas

The preceding tabulation represents gas utility sales whereas the production figures tabulated on page 2 are gross withdrawals from fields, less field waste. The difference in the totals of the two tables is accounted for by the storage in Alberta fields of 8,944,931 M cu. ft. and by field use and natural gas processing plant use and loss, also in Alberta. Domestic supply was further augmented to the extent to which imports exceeded exports.

Exports and Imports

Canadian natural gas exports in 1956 amounted to 9,642,449 M cu. ft. valued at $1,118,215. Canadian-Montana Pipe Line Company was the only exporter, its natural gas being sold in the State of Montana.

Natural gas imports totalled 15,695,359 M cu. ft. with a value of $3,479,610. Imports into British Columbia commenced in November with supplies for the Vancouver area coming from New Mexico via the Pacific Northwest Pipeline Corporation's system. Late in 1957 the flow will be reversed on completion of the Westcoast Transmission Company Limited line from the Peace River area. Minor imports were received at an Alberta town on the United States Boundary. Ontario was the principal importer. Natural gas entered at Niagara and Windsor, with the Niagara imports accounting for almost two-thirds of the provincial total.

The Canadian import duty on gas used for heating and cooking is 3 cents per M cu. ft. There is no export duty.

PEAT

By A. A. Swinnerton
Fuels Division

Peat moss is widely distributed in Canada, and commercial production is from plants in British Columbia, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia. Over eighty per cent of the 128,054 tons produced in 1956 came from the delta of the Fraser River in British Columbia and the Rivière-du-Loup area of Quebec.

The peat moss industry in Canada is still expanding, production in 1956 being about 9 per cent greater than that in 1955. Canadian peat moss continues to be in demand in the United States and it is sometimes difficult to fill export orders. As a result, some of the larger operators are opening new deposits and some United States importers are interested in developing peat bogs in Canada in order to have a dependable source of supply.

Practically all of the Canadian output is exported to the United States where it is in competition with peat moss from Germany, but the superior packaging of the Canadian peat makes it more attractive to the consumer.

Peat moss is the dead, slightly humified, fibrous moss found in peat bogs. When dried and shredded it has a high absorptive capacity, for which reason it finds wide use in horticulture as a packing material, a means of introducing humus into the soil, and in stables and poultry runs as litter.

Generally speaking considerable manual labour is still required for digging. Mechanical excavators have been tried but they have been unsatisfactory for dealing with peat containing roots. However, the harvesting of the peat moss has been largely mechanized.

One operation in British Columbia is almost completely mechanized. The peat is excavated by hydraulic jets and pumped to the plant, where it is dried by steam heat in a modified paper-making machine.

In eastern Canada, generally, there is little mechanization, except for one bog in Quebec, one in Ontario and one in Nova Scotia which operate a "milling" process. In this process, the peat is lightly harrowed to a depth of one or two inches, after which it dries rapidly, under favourable weather conditions. It is then gathered by large-scale "vacuum cleaners" mounted on caterpillar treads, and when the containers are full

Production and Trade of Peat

	1956		1955	
	Short Tons	$	Short Tons	$
Production (Shipments)				
British Columbia	63,812	2,393,571	65,436	2,289,846
Quebec	40,268	951,644	32,383	638,696
New Brunswick.........	13,421	520,224	8,743	234,599
Manitoba	6,145	236,254	6,146	190,381
Ontario................	3,267	97,091	4,284	123,862
Nova Scotia	1,141	41,930	587	7,903
Total..................	128,054	4,240,714	117,579	3,485,287
Production (by uses)				
For horticulture	112,001	3,775,567	110,431	3,255,814
For poultry & stable litter................	15,993	458,368	7,091	225,294
For other uses	60	6,779	57	4,179
Total..................	128,054	4,240,714	117,579	3,485,287
Exports				
United States	113,300	6,066,393	102,948	5,385,671
Other countries	46	2,452	49	2,691
Total..................	113,346	6,068,845	102,997	5,388,362

	1956		1955	
	No. of firms or producers	No. of bogs	No. of firms or producers	No. of bogs
Nova Scotia	1	1	1	1
New Brunswick	3	4	3	4
Quebec	15	17	15	17
Ontario	2	2	2	2
Manitoba	1	1	1	1
British Columbia	12	12	13	13
Total..................	34	37	35	38

they are dumped into field railway cars or transported directly to the mill for baling and shipment.

Peat Fuel

Small quantities of peat fuel have been produced in recent years from a bog at Gads Hill Station near Stratford, Ontario, but no production was reported for 1956.

On the Burin peninsula in Newfoundland small quantities of peat fuel have been dug for local use.

Producers

British Columbia

The peat operations in the Fraser River delta near New Westminster are the largest in Canada. Four bogs are being worked, namely: Pitt Meadows, Byrne Road, Lulu Island, and Delta (or Burns), and from this small area 12 companies in 1956 produced 63,812 tons, approximately half of the Canadian production. The largest producers are Industrial Peat Limited, Atkins and Durbrow Limited.

Manitoba

Western Peat Company Limited, the only producer, operates the Julius, or Shelley, bog about 50 miles east of Winnipeg.

Ontario

Two companies are in operation at present. Most of the output in 1956 was produced by Atkins and Durbrow (Erie) Limited at its plant near Port Colborne which operates a milling process as described above. The other producer, Humar Corporation Ltd., processes and sells humus from a bog near Dundas.

Quebec

The peat moss deposits being worked are mainly in the lower St. Lawrence region. Fifteen companies contributed to the output in 1956 but most of the production came from three, namely: Premier Peat Moss Corporation with operations at Rivière-du-Loup, Isle Verte, and Cacouna; Tourbières Rivière-Ouelle in the Rivière-du-Loup area; and Quebec Peat Moss Company, St. Guillaume.

New Brunswick

The most important peat moss deposits are in Northumberland and Gloucester counties on both shores of Miramichi Bay, and on Miscou and Shippigan Islands. Three companies produced peat moss in 1956, namely: Fafard Peat Moss Company at Pokemouche; and Atlantic Peat Moss Company, Limited at Shippigan and on Shippigan Island and Bog Trotters Ltd. at Centreville.

Nova Scotia

Annapolis Peat Moss Company, Limited, the only producer of peat moss, operated the Caribou bog near Berwick in 1956 employing the milling process already described.

Other Occurrences

Newfoundland

Peat moss is not produced in Newfoundland. The deposits are close to the coast and their development would possibly be handicapped by the same poor drying weather that is sometimes experienced in northern New Brunswick. In 1954, the Provincial Department of Mines started a survey of its peat resources and a detailed report of bogs in the Avalon and Burin Peninsulas was issued in 1955.

Prices

The price of peat moss in 1956 varied from approximately $20 to $40 a ton, according to location.

CRUDE PETROLEUM

By R.B. Toombs and R.A. Simpson
Mineral Resources Division

During 1956 the Canadian petroleum industry continued the rapid growth that was initiated by the Leduc, Alberta, oil discovery of 1947. Prior to the drilling of the Imperial Leduc No. 1 well there were only 400 wells in western Canada and average daily production was 19,000 bbl. At the end of 1956 there were 10,587 wells and the year's average daily production had reached 470,000 bbl. During the intervening period, liquid hydrocarbon reserves grew from 72 million to 3,129 million bbl. The increasingly large supplies of crude oil being made available in western Canada have enabled Canada to improve its oil self-sufficiency from less than one-tenth in 1946 to almost two-thirds in 1956, in spite of a three-fold increase in domestic demand for petroleum fuels.

The chart on page 435, showing crude oil production since 1926, emphasizes the importance of the post-1947 growth period.

Crude petroleum production in 1956 amounted to 172,005,206 bbl. valued at $408,367,230. Production increased 27 per cént over the previous year, and for the fourth consecutive year the value of crude petroleum production exceeded that of any other mineral. Alberta accounted for 83.7 per cent of the total compared with 87.3 and 91.3 per cent in 1955 and 1954, respectively. Saskatchewan almost doubled its production in 1956. This raised the province's share in total production to 12.2 per cent, compared with 8.8 per cent in 1955 and 5.6 per cent in 1954. Manitoba at 3.4 per cent showed little change from the previous two years. The other crude oil producing areas - Ontario, Northwest Territories and New Brunswick - continued to account for less than one per cent of total output. A small output was recorded for British Columbia in its first year as a crude-oil producer.

As in 1955, the most important oil field developments took place in the huge Pembina field of Alberta and in the highly successful oil discovery area of southeastern Saskatchewan. There was a 23 1/2 per cent increase in total footage drilled in Canada in 1956, owing largely to the high level of oil activity in these two regions. Exploratory drilling increased somewhat while geophysical activity registered a slight decline.

(Text continued on page 434)

Petroleum

Crude Petroleum Production

	1956 *		1955	
	Bbls.	$	Bbls.	$
(1) Alberta				
Pembina	33,701,302		14,850,341	
Redwater	28,182,265		28,506,532	
Leduc-Woodbend	21,097,718		20,421,285	
Bonnie Glen	10,279,168		7,826,622	
Fenn Big Valley	8,028,779		7,546,666	
Wizard Lake	4,823,992		3,720,011	
Joarcam	4,540,276		4,792,878	
Golden Spike	3,941,614		3,400,517	
Joffre	3,331,075		1,692,739	
Acheson	2,579,503		2,698,527	
Westerose	2,317,544		1,742,259	
Stettler	2,119,498		1,832,836	
Sturgeon Lake S.	1,962,933		680,566	
Turner Valley	1,776,393		2,056,439	
West Drumheller	1,397,044		1,227,687	
Lloydminster	1,091,536		1,221,505	
Excelsior	1,004,637		1,084,643	
Erskine	997,773		567,184	
Sundre	796,336		207,654	
Harmattan Elkton	796,039		-	
Malmo	754,407		739,720	
Wainwright	678,671		207,517	
Duhamel	636,091		599,574	
Fairydell Bon Accord	572,089		555,028	
Homeglen-Rimbey	487,040		417,763	
Glen Park	421,973		468,426	
Sturgeon Lake	403,598		-	
New Norway	389,616		360,910	
Drumheller	293,301		272,370	
Clive	283,392		227,920	
Westward Ho	278,507		124,312	
Bentley	260,900		-	
Cessford	197,826		233,007	
Bellshill Lake	183,750		-	
Chauvin	171,584		163,721	
Jumping Pound	156,925		164,238	
Alhambra	154,698		-	
Battle South	135,104		173,705	
St. Albert	130,072		-	
Hamilton Lake	123,621		128,104	
Taber	120,527		110,519	
Battle	108,406		116,642	
Conrad	-		104,290	
Other fields	2,202,118		1,784,883	
Total	143,909,641	355,173,842	113,035,046	274,901,232

* Preliminary (1) Petroleum and Natural Gas Conservation Board, Alberta

	1956		1955	
	Bbls.	$	Bbls.	$
(2) Saskatchewan				
Coleville-Smiley	3,633,832		3,439,005	
Fosterton	1,866,736		1,353,259	
Steelman	1,849,390		197,457	
Success	1,728,871		1,154,977	
Midale	1,430,098		478,586	
Nottingham	1,365,847		265,069	
Cantuar	1,357,160		639,630	
Dollard	1,302,192		322,533	
Lloydminster	883,993		945,815	
Battrum	842,681		-	
Alida	648,967		247,357	
Lone Rock	634,562		727,846	
Kingsford	555,396		-	
Gull Lake	532,286		547,524	
Weyburn	386,795		66,765	
Frobisher	320,822		237,290	
Wapella	264,141		266,695	
Hastings	255,882		-	
Bone Creek	246,431		77,164	
Instow	217,633		-	
Carnduff	120,754		-	
Other fields	632,902		350,196	
Total	21,077,371	36,130,930	11,317,168	18,317,968
(3) Manitoba				
North Virden	2,183,000		876,910	
Virden-Roselea	1,782,675		1,346,146	
Daly	1,215,136		1,416,066	
Woodnorth	202,879		187,976	
Other fields	402,850		318,658	
Total	5,786,540	13,417,267	4,145,756	9,618,154
(4) Ontario	603,900	1,984,000	525,510	1,599,335
(5) British Columbia	148,454	290,000	-	-
Northwest (4) Territories	457,000	1,340,000	404,219	1,185,780
(4) New Brunswick	22,300	31,200	12,548	17,567
CANADA	172,005,206	408,367,230	129,440,247	305,640,036

(2) Dept. of Mineral Resources, Sask.
(3) Dept. of Mines and Natural Resources, Man.
(4) Dominion Bureau of Statistics.
(5) Dept. of Mines, B. C.

Petroleum

Marked expansion took place in other sectors of the petroleum industry. Oil pipe line mileage increased from 5,079 in 1955 to 5,807 miles in 1956. Petroleum refinery capacity rose from 618,300 to 700,050 bbl. a day. Demand for all oils reached 719,697 bbl. per day compared with 640,416 bbl. a day in 1955. The most important change in Canada's oil trade position was the increase in daily average crude-oil exports from 40,641 to 117,235 bbl. The growth in exports and the 13 per cent increase in domestic demand for all oils did much to improve the market outlook for Canadian crude oil. However, at the end of 1956, actual production was little more than 50 per cent of total production potential.

Exploration, Development and Production

Geophysical, Geological and Land Activity

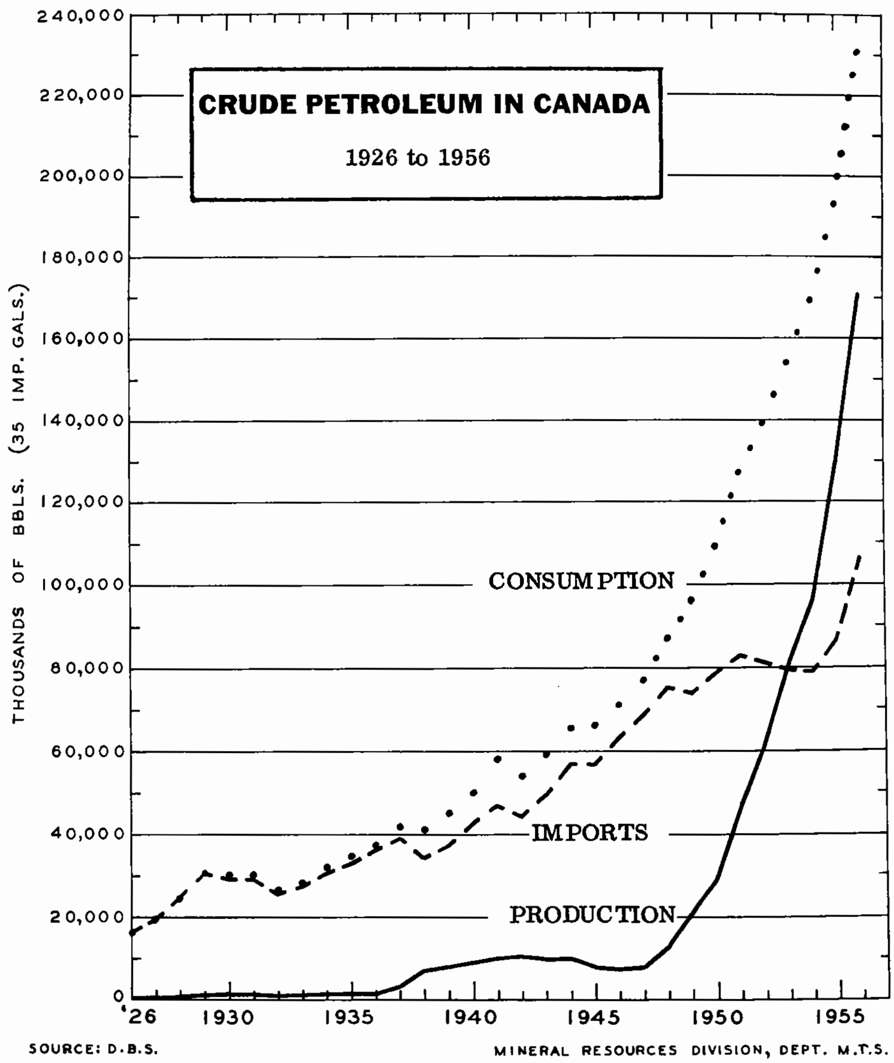
Geophysical activity in western Canada reached a peak of over 2,000 crew-months in 1952 and has since declined to the 1956 total of 1,484 crew-months. Seismic surveys in 1956 accounted for 94 per cent of all geophysical work, the remainder being gravity surveys. Alberta accounted for 70 per cent of all seismic work done during the past two years and Saskatchewan 20 per cent. Most of the remainder was carried out in British Columbia although minor activity continued in Manitoba and Northwest Territories. Gravity work was largely concentrated in Alberta with, however, somewhat more emphasis placed on such surveys in Saskatchewan in 1956 than in former years.

Fifty-eight surface geological parties were in the field in western Canada during the summer of 1956.

Total land holdings in western Canada amounted to 200,811,298 acres at the end of 1956. Of this, 100,261,700 acres were in Alberta, 46,338,906 acres were in Saskatchewan, 27,822,127 in British Columbia, 18,559,793 in Northwest Territories and 7,828,772 in Manitoba. These totals include all types of land titles, including freehold lands.

Drilling Activity

Total well completions amounted to 3,359 in 1956, a 14 per cent increase over 1955. Exploratory well completions were only slightly above the 1955 level, the year's total drilling increase being due largely to increased activity in development drilling. Exploratory wells were 31 per cent successful compared with 28 per cent in 1955. Drilling activity, as measured by total footage drilled, registered a 23 1/2 per cent increase in 1956. The average well depth was 4,689 feet compared with 4,326 feet in 1955; hence the percentage increase in footage was not matched by as great an increase in well completions.



Wells Drilled to Completion - Western Canada

	Oil Wells		Gas Wells		Dry Holes		Total	
	1956	1955	1956	1955	1956	1955	1956	1955
British Columbia	7	1	34	12	16	25	57	38
Alberta	1368	1145	138	138	392	344	1898	1627
Saskatchewan	803	564	16	12	311	333	1135	909
Manitoba	202	279	-	-	60	80	262	359
N. W. T.	4	-	-	1	3	28	7	29
Total	2389	1989	188	163	782	810	3359	2962

Petroleum

Total Footage Drilled and Drilling Rigs in Use - Western Canada

	1956		1955	
	Footage	Rigs in Use at Year-end	Footage	Rigs in Use at Year-end
British Columbia	334,729	19	231,768	9
Alberta	10,093,579	126	8,444,578	171
Saskatchewan	4,705,234	61	3,245,666	45
Manitoba	603,919	15	841,580	18
N. W. T.	12,488	-	28,612	-
Total	15,749,949	221	12,792,204	243

Exploratory Drilling in 1956 - Western Canada

	Oil Wells	Gas Wells	Dry Holes	Total	Footage
British Columbia	-	11	16	27	184,649
Alberta	92	80	306	478	2,625,285
Saskatchewan	91	5	251	347	1,465,017
Manitoba	4	-	40	44	124,618
N. W. T.	-	-	3	3	6,038
Total	187	96	616	899	4,405,607

Liquid Hydrocarbon Reserves

The annual reserve study of crude oil and natural gas liquids made by the Canadian Petroleum Association indicated an increase in proved reserves, after deducting 1956 production of 372,685,000 bbl. The year-end total for Canada for crude oil and natural gas liquids was raised to 3,129,304,000 bbl. Alberta and British Columbia had 2,391,778,000 bbl. of the total crude oil reserves of 2,849,370,000 bbl. and all of the 279,934,000 bbl. of natural gas liquid reserves. Saskatchewan crude oil reserves of 358,693,000 bbl. represented a 48 per cent gain over the previous year. Saskatchewan's net increase was responsible for 32.7 per cent of the net Canada change, compared with 4.3 per cent in 1955.

There is a growing diversification of reserve development as indicated by the fact that crude oil production in 1956 was derived from formations of the following geological ages: Upper Cretaceous - 20.1 per cent, Lower Cretaceous - 10.3 per cent, Jurassic - 2.8 per cent, Triassic - 0.1 per cent, Permo-Pennsylvanian - a trace, Mississippian - 10.6 per cent, and Devonian - 56.1 per cent. Several years ago practically all oil was derived from formations of Devonian age.

Numbers of Oil Wells and Fields

The size of the oil industry in western Canada may be further assessed in terms of the numbers of oil fields and wells.

Crude Oil Wells and Oil Fields - Western Canada*

	Oil Fields		Producing Wells		Wells Capable of Production	
	1956	1955	1956	1955	1956	1955
British Columbia	1	-	9	-	9	1
Alberta	86	74	6,743	5,511	7,390	6,138
Saskatchewan	46	37	2,047	1,251	2,414	1,655
Manitoba	12	11	646	486	736	554
N. W. T.	1	1	31	27	38	34
Total	146	123	9,476	7,275	10,587	8,382

* At end of year.

In eastern Canada, Ontario had 1,504 oil wells and New Brunswick 19 at the end of 1956. These wells have a much smaller producing potential than western Canada oil wells.

Developments by Areas

British Columbia

During 1956 British Columbia's first oil field was being developed following the initial discovery late in 1955. The Boundary Lake field produces 34° A.P.I. gravity crude oil from a Triassic formation at a depth of 4,300 feet. At the end of the year, an average daily rate of production of 240 bbl. was being maintained from each of 6 producing wells.

A second oil source was developed in the Fort St. John gas field. During 1956 one gas well was reworked as an oil producer and 3 new oil wells were drilled. One of the new wells produces from a formation of Permo-Pennsylvanian age; the other 3 wells are Triassic "C" zone producers.

As a result of the favourable oil indications obtained during 1956, further oil activity appears imminent in this province. However, the principal activity will continue to relate to natural gas development.

Alberta

During 1956 the Pembina field became Alberta's largest oil producer. The three leading fields - - Pembina, Redwater, and Leduc-Woodbend - - accounted for 58 per cent of provincial output, with the remainder coming from 83 other fields.

Development drilling was again concentrated in the Pembina field and at the end of the year this field had 1,680 oil wells compared with 808 wells at the end of 1955. The number of oil wells in the Peace River South Sturgeon Lake field was increased from 41 to 89 as a result of the year's development drilling. Other active areas included the Joffre, Bentley, Harmattan and Wainwright fields which had 283, 39, 39 and 124 oil wells

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at the end of 1956 compared with 186, 0, 1 and 66 oil wells, respectively, at the end of 1955.

Notwithstanding the development work done in these and other fields, the Pembina field accounted for two-thirds of Alberta's development drilling and by the end of the year the commercially productive area of the field had reached almost 275,000 acres. The total productive area is expected ultimately to be 380,000 acres. Important secondary recovery measures were instituted during the year to ensure maximum oil recovery from the Pembina field which produces from the Cardium formation of Upper Cretaceous age.

Exploratory drilling resulted in 92 oil discoveries compared with 78 in 1954. About 25 per cent of all successful exploratory oil wells constituted extensions of the Pembina field. Another 15 per cent of successful drilling was done in the Pembina-Leduc-Edmonton region, and 40 per cent in a wide zone between Calgary and Edmonton. The areas south of Calgary and along the eastern edge of Alberta accounted for 5 and 10 per cent, respectively. The remaining 5 per cent of the successful exploratory drilling was done in the Peace River region.

Twenty-four of the total exploratory successes were indicated as new field discoveries. Among the more important was the Union Red Earth 12-17 well, 85 miles east-northeast of Peace River town. This discovery resulted in widespread exploration activity across northern Alberta and into northern Saskatchewan in search of further "Granite Wash" oil pools in sediments overlying the Precambrian basement rocks. Important Cardium sand discoveries were made in the southern part of the Peace River area, 175 miles northwest of Pembina, and at Crossfield, 18 miles north of Calgary. A discovery in the Red Deer area led to a 40-well development program in the Bentley field which is in the Lower Cretaceous Viking sand trend established by the Joffre field. In the east-central part of Alberta, another important discovery was followed by a 17-well program in the newly-defined Bellshill Lake field. These and other new field discoveries ensured a continuation of the rapid growth in oil reserves which has occurred in Alberta during the past ten years.

The Athabasca bituminous sands of northern Alberta were under active development during 1956. Royalite Oil Company completed its pilot-plant studies of a centrifugal technique for removing bitumen from the sands and made plans for opening up its Mildred Lake property mid-way between McMurray and Bitumount.

Saskatchewan

Saskatchewan's production growth in 1956 was due largely to the successful oil resource development in the southeastern corner of the province. The new fields there produce from formations of Mississippian age within the Williston Basin. During 1956, 551 wells were drilled within the boundaries of 16 fields and a considerable amount of exploratory drilling was also done. One-third of all drilling rigs in western Canada were located in this part of the province to make the 5,000 square mile area the most active in Canada's 1956 oil field program. Production from these new fields accounted for over 35 per cent of Saskatchewan's total output compared with less than 15 per cent in 1955. The trend towards a greater percentage output from southeastern Saskatchewan will continue as the field wells now being rapidly drilled are brought into production. The principal fields being developed in 1956 were Steelman, with 166 new oil wells, and the Midale, Kingsford, Weyburn and Nottingham fields with 97, 59, 53 and 44 new wells, respectively.

The Coleville-Smiley, Fosterton, Success, Cantuar and Dollard fields of western Saskatchewan are major producers in this province, but, except for a 70-well program in the Coleville field, well completions were relatively few. The second most active drilling program in western Saskatchewan was carried out in the new Bone Creek field where 23 wells were completed. Like other fields in the Swift Current region it is a medium gravity field. The Coleville and Lloydminster areas produce heavy gravity crude oil for the most part. This medium and heavy gravity oil production is being balanced by light gravity crude from southeastern Saskatchewan. The province is thus gaining a diversified output and a considerably improved provincial average well-head price, which in 1956 was $1.71 a bbl.

Successful exploratory oil wells increased from 53 in 1955 to 91 in 1956 with 33 of these being classified as new field discoveries and the remainder as field outpost wells. Twenty-six of the new field wells were completed in southeastern Saskatchewan which indicates continuing favourable prospects for further oil reserve increases in the future in this part of the province.

Manitoba

The principal oil fields of Manitoba are grouped around the town of Virden, 23 miles east of the Saskatchewan border. The years 1954 and 1955 were the most active oil industry periods in Manitoba; the 1956 level of activity being somewhat lower. However, production increased by 25 per cent in 1956, and favourable field development drilling was continued in the Virden-Roselea and North Virden fields where 116 and 51 oil wells were completed in these two leading producers. Of the total of 736 oil wells in Manitoba at the end of 1956, 86 per cent were in the Virden-Roselea, North Virden and Daly fields.

Production in Manitoba comes from formations of Mississippian age. During 1956 a program was commenced to explore the production possibilities in areas east of the pinch-out of Mississippian formations. The objective is to test formations of Devonian age and older.

Manitoba crude oil is light gravity, in the range of 32.4° to 35.5° A.P.I. The average well-head price in 1956 was $2.32 a bbl. compared with the Alberta average of $2.47. The difference is due largely to the somewhat higher sulphur content of Manitoba crude oil. The closer proximity of Manitoba to eastern markets is, however, a compensating factor in the marketing of its oil.

Northwest Territories

The small production of the Northwest Territories comes from the Norman Wells field which is located on the Mackenzie River, 90 miles south of the Arctic Circle.

During 1955 and 1956 land holdings were reduced and there were no significant exploratory results. A 53-test hole program was carried out in the region west of the southwest end of Great Slave Lake as part of a continuing exploratory program in the region. Four oil wells were successfully completed in the Norman Wells field in the first field development drilling since 1945.

Ontario

In Ontario a total of 431 wells were drilled in 1956 resulting in 57 oil wells, 157 gas wells and 217 dry holes. Drilling amounted to 513,917 feet, or an average of 1,192 feet per well. No significant exploratory wells were drilled, but oil field development drilling added considerably to Ontario's oil potential. The county of Elgin accounted for 38 of the province's 52 successful development wells. The Rodney field in this county is now Ontario's most important oil field.

The gravity of crude oil produced is in the range of 36° to 40° A.P.I. Production finds a ready market in the nearby Sarnia refineries with field producers receiving $3.28 a bbl.

In spite of its long production history, current output is now close to the all-time high of 795,030 bbl. which was reached in 1890. Until 1920 Ontario was Canada's only important oil source and although present production is less than one-half per cent of total Canadian output, recent field progress will ensure a continuing industry for a number of years. Inasmuch as the record of earliest oil drilling activity dates from the year 1858, Ontario's oil industry will soon enter its second century.

Quebec

Quebec also has had a long history of oil industry activity, dating from 1865. There has been no recorded oil production from this province but exploration programs have been carried on from time to time and in 1956 a total of 13 wells were drilled. In addition, 22 structure test holes were put down as part of an extensive exploratory program in the region between Montreal and Quebec City. Quebec is now undergoing the most thorough oil and gas search in the history of the industry in this province.

New Brunswick

The Stony Creek field, 9 miles south of Moncton, remains the only oil producing field east of Ontario. Production, dating from 1910, declined steadily from the 1941 high of 31,359 bbl. to the 1955 output of 12,548 bbl. Output, however, was almost doubled in 1956, and minor development work was continued in the Stony Creek field.

Transportation

The industry continued to expand facilities for transporting crude oil and petroleum products and made capital expenditures in excess of $45 million in 1956 compared with $32.7 million in 1955. Operating pipe line mileage increased to 5,807(1) miles from 5,079 in the previous year, an increase of over 14 per cent. Deliveries of crude oil and petroleum products in 1956 reflect this expansion, and during the year net deliveries totalled 274,940,340 bbl. compared with 224,274,768 bbl. in 1955. The largest transporters are Interprovincial Pipe Line Company Limited, Montreal Pipe Line Company Limited, Imperial Pipe Line Company, Trans Mountain Oil Pipe Line Company and Pembina Pipeline Limited in order of decreasing gross deliveries.

There was no change in the mileage of extensions of pipelines into the United States which carry Canadian oil exclusively. This figure remains at 1,514 miles.

Oil Pipe Line Mileage in Canada

Year-End	Miles
1950	1,423
1951	1,577
1952	2,500
1953	3,794
1954	4,656
1955	5,079
1956	5,807

The pipe line tariffs, per bbl. of oil, from Edmonton, Alberta, to Sarnia, Ontario, is 64 cents; from Edmonton to Vancouver, British Columbia, 45 cents; and from Cromer, Manitoba, to Sarnia, 48 cents. The rates, including field gathering charges from Pembina, Leduc, Redwater and Big Valley fields to Edmonton are 12, 7, 6 and 18.5 cents, respectively.

Interprovincial Pipe Line Company

During the year 67 miles of 24-inch loop west from Somerset, Manitoba, and 52 miles of 26-inch loop from Gretna into North Dakota

(1) Pipe line mileage does not include the miles of pipe making up the loops on many of the systems.

and Minnesota were laid. Completion of this program provided a two-line system between Regina, Saskatchewan, and Clearbrook, Minnesota, with a capacity of 193,000 bbl. per day.

Deliveries for the year totalled 97,116,072 bbl., an increase of over 20 per cent from the 80,701,123 bbl. delivered in 1955. Refineries in western Canada took deliveries of 33,700,000 bbl. while those in the United States and Ontario accepted deliveries of 16,900,000 and 40,500,000 bbl., respectively. An additional 5,600,000 bbl. were delivered to tankers at Superior and 400,000 bbl. went into storage.

Trans Mountain Oil Pipe Line Company

Construction commenced on permanent pumping stations at Gainford and Jasper, Alberta, and because of increased demand two temporary pumping stations were also installed which raised the capacity of the line to 185,000 bbl. per day. The temporary unit at Jasper was destroyed by fire and the capacity of the line was reduced during the latter part of the year. However, the permanent station was scheduled for completion early in 1957. Late in the year the company announced that the capacity of the line would be increased to 240,000 bbl. per day by August 1957.

Total deliveries for the year were 47,251,641 bbl., averaging 129,103 bbl. a day, an increase of 54 per cent over the 1955 deliveries. Of this total, 46.1 per cent was delivered to Canadian refineries, 40.7 per cent delivered to Washington refineries and 13.2 per cent constituted offshore shipments. This was the first year crude oil was taken from Trans Mountain by tankers, and during the year 53 tankers were loaded at Vancouver.

Pembina Pipe Line Company Limited

During the year 153 miles of field gathering lines were installed, construction of the main pump station completed, and at the end of the year a throughput capacity of 123,000 bbl. per day had been reached. Throughput was approximately 32,120,000 bbl. representing an average of 88,000 bbl. per day. By November 30, 1956, 230 batteries were connected to the system.

Peace River Oil Pipe Line Co. Ltd.

This line was completed early in 1956 from the Sturgeon Lake area to theTrans Mountain line at Edson, Alberta. It consists of 107 miles of trunk and 37 miles of gathering lines. Deliveries to Trans Mountain began in March and throughput totalled 1,824,000 bbl. in 1956.

Cremona Pipeline Limited

This 65-mile, trunk line system was constructed in 1956 to serve Sundre, Westward Ho and Harmattan fields northwest of Calgary. Capacity of the line is 18,000 bbl. per day.

Westspur Pipe Line Company

The Westspur line which was started in 1955 was completed in 1956 and commenced deliveries in July 1956. The line serves the fields in south-eastern Saskatchewan carrying crude to the Interprovincial line at Cromer, Manitoba.

Other Crude Oil Pipe Lines

In Alberta, the British American Oil Company Limited acquired the Canadian Gulf Pipe Line Company, renamed it Britamoil Pipe Line Company and extended the system south 35 miles to the West Drumheller field. Rangeland Pipe Line Company constructed a 50-mile gathering system and a 10-mile trunk line connecting the Gilbey, Bentley and West Joffre fields to the pipe line of Texaco Exploration Company at Rimbey. Later in the year the company received permission to build a 50-mile trunk line to the Sundre field from its newly completed line, thus allowing crude from the expanding Sundre field to be taken either to Edmonton or, via the Cremona system, to Calgary.

The South Saskatchewan Pipe Line Company laid 59 miles of pipe line to connect the Dollard, Leon Lake, Instow, Bone Creek, Gull Lake and North Premier fields with the company's existing line from Cantuar to Moose Jaw and Regina. In December Trans-Prairie Pipelines Limited completed a 25-mile pipe line which connects with the Westspur line and serves the fields of Weyburn and Halbrite.

Petroleum Processing

At the end of 1956 there were 43 operating petroleum refineries in Canada with a total daily crude oil throughput capacity of 700,050 bbl. and a daily cracking capacity of 361,490 bbl. Crude capacity increased by 81,600 bbl. per day during the year. Two new refineries went on stream, one replacing a former plant built in 1918 at Halifax, Nova Scotia, and one at Grande Prairie in Alberta.

Since the beginning of 1946, $623.6 million have been spent in the petroleum refining industry on new plants and on maintenance. Canada now has one of the largest and most modern petroleum refining industries in the world. In 1956 alone, $112.9 million were invested in the refining industry.

Imperial Oil Limited operates 9 refineries having a daily crude-oil capacity equivalent to 41.2 per cent of the national total. Refineries of The British American Oil Company Limited have 13.1 per cent; Shell Oil Company of Canada Limited, 10.5 per cent; McColl-Frontenac Oil Company Limited, 9.9 per cent and the remaining 25.2 per cent is divided among the 20 remaining companies.

Petroleum Refining Throughput Capacity by Regions

Region	1939 Capacity Bbl./day	1939 %	1945 Capacity Bbl./day	1945 %	1950 Capacity Bbl./day	1950 %
Maritimes	32,750	16.4	34,250	14.8	22,300	6.2
Quebec	64,500	32.2	59,000	25.5	143,000	39.9
Ontario	44,500	22.2	75,450	32.6	75,200	21.0
Prairies & N.W.T.	35,570	17.8	41,515	18.0	89,525	24.9
British Columbia	22,700	11.4	21,000	9.1	28,850	8.0
Total	200,020	100	231,215	100	358,875	100

Region	1955 Capacity Bbl./day	1955 %	1956 Capacity Bbl./day	1956 %
Maritimes	18,300	3.0	42,300	6.1
Quebec	210,000	34.0	247,000	35.3
Ontario	148,800	24.0	159,700	22.8
Prairies & N.W.T.	174,850	28.3	180,800	25.8
British Columbia	66,500	10.7	70,250	10.0
Total	618,450	100	700,050	100

Canadian Crude Oil as a Percentage of Refinery Receipts

Region	1936	1939	1940	1945	1950	1955	1956
Maritimes	0	0	0	0	0	0	0
Quebec	0	0	0	0	0	0	0.3
Ontario	1.6	0.4	1.2	0.5	1	78.8	84.5
Prairies & N.W.T.	23.5	37.0	92.3	58.2	99	100	100
British Columbia	0	0	0	0	0	100	100
Canada	3.5	17.0	16.4	11.7	24.4	54.7	54.1

Marketing

Crude oil delivered from domestic oil fields to refineries within Canada totalled 125,592,074 bbl. in 1956 compared with 105,050,563 bbl. in 1955, representing a 19.3 per cent increase. A greater share in the Ontario refinery market accounted for a greater domestic market growth than that which occurred in 1955 when the growth rate was 13.8 per cent. Of even more importance was the expansion of Canada's crude oil export market from the 1955 level of 14,833,971 bbl. to 42,908,085 bbl. in 1956. The increase in exports was equivalent to 66 per cent of the total increase in oil field production. Total supply of crude oil, on a daily average basis, amounted to 633,630 bbl. of which 342,914 bbl. daily came from domestic fields and 290,716 bbl. a day were imported. Crude oil exports averaged 117,235 bbl.

a day.

Degree of Petroleum Self-sufficiency

Canada's petroleum refining industry took delivery of 232 million bbl. of crude oil - - domestic and foreign - - and manufactured the equivalent of 89 per cent of the country's petroleum product requirements. Although crude oil production was the equivalent of 74 per cent of refinery runs, allowance for imports, exports and stock changes resulted in a petroleum self-sufficiency, on trade balance, of 65 per cent in 1956.

Trade

Canada's crude oil exports totalled 42,908,085 bbl. valued at $103,923,155, three times the amount exported in 1955. Product exports more than doubled, being 2,729,842 bbl. with a value of $12,150,967. Crude oil imports of 106,470,015 with a value of $270,882,104 represented a 23 per cent volume increase. Product imports of 37,633,519 bbl. valued at $157,369,635 showed little change from 1955.

Venezuela supplied 74.3 per cent of total crude oil imports, Middle East countries 17.4 per cent, United States 5.1 per cent, and Trinidad and Colombia 3.2 per cent. Except for small shipments to Japan and France, crude oil exports went to United States. A new crude oil market was opened in California, and the existing Washington and Mid-west markets were enlarged. The State of Washington took 45 per cent of Canada's exported crude oil; California received 14 per cent; and 41 per cent went to Minnesota, Wisconsin and Michigan. Petroleum products trade is largely with United States but Canada has developed small petroleum product markets in several European and South American countries.

There is no Canadian tariff on crude oil imports testing 42° A.P.I. gravity or less. The United States tariff on Canadian crude oil exports is 5 1/4 cents per bbl. on oil testing under 25° A.P.I. gravity, and 10 1/2 cents per bbl. on oil testing at or above that gravity.

Regional Consumption of Petroleum Products

The regional share of total crude oil and product demand in 1956 was as follows: British Columbia - 11 per cent, Prairie Provinces - 20 per cent, Ontario - 34 per cent, Quebec - 25 per cent, and Atlantic Provinces - 10 per cent. British Columbia derives almost three-quarters of its total energy supply from petroleum fuels; the Prairies, Ontario and the Atlantic Provinces, more than two-fifths; and Quebec, approximately 60 per cent. British Columbia's petroleum consumption is characterized by a relatively large usage of heavy fuel oil and diesel oil. Motor gasoline consumption on the Prairies is comparatively high. Both the gasoline and the heating fuel oil markets in Ontario are exceptionally large. Quebec is a large consumer of heavy and light fuel oils but uses less gasoline than Ontario and the Prairie Provinces. The pattern of petroleum fuels consumption in the Atlantic Provinces is characterized by a relatively high percentage of aviation fuels.

Supply and Demand of all Oils

	1956	1955
	bbl.	
New Supply		
Production		
Crude petroleum	172,005,206	129,440,247
Natural gasoline.................	913,572	868,416
Total	172,918,778	130,308,663
Imports		
Crude petroleum	106,470,015	86,678,253
Petroleum tops	171,342	114,210
Natural gasoline	201,770	237,943
Refined petroleum products........	37,260,407	37,428,092
Total	144,103,534	124,458,498
Total new supply	317,022,312	254,767,161
Daily average	866,337	697,992
Demand		
Domestic..........................	263,409,059	233,751,969
Average daily domestic demand....	719,697	640,416
Exports		
Crude petroleum	42,908,085	14,833,971
Refined products	2,729,842	1,170,714
Total	45,637,927	16,004,685
Total demand	309,046,986	249,756,654
Daily average	844,391	684,264
Change in Stocks	+7,975,326	+5,010,507

Prices

The average field prices of crude oil in Alberta, Saskatchewan and Manitoba in 1956 were $2.47, $1.71 and $2.32 per bbl., respectively. The Canadian average was $2.37 a bbl. compared with $2.36 in 1955. Early in 1957, most field prices in western Canada increased by 18 cents per bbl.