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THE CANADIAN MINERAL INDUSTRY IN 1946

Reviews by the Staff of the Bureau of Mines

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PREFACE

Mimeographed separates of all the metals and minerals reviewed in this report were issued in 1947. In these separates, preliminary figures for production as supplied by the Dominion Bureau of Statistics were used, whereas in the present report, with the few exceptions noted, final figures are used.

Doubtless, because of the increasingly important rôle the mineral industry has been playing in the economy of the country, Canadians have been showing a widening interest in matters concerned with the development of their mineral resources, an interest that is reflected in a growing number of requests reaching the Bureau of Mines for specific or general information on domestic sources of mineral supply, trade in minerals and their products, uses, developments in the industry, etc. A primary purpose of these annual reviews is to provide such information. The Bureau is indebted to all those who contributed data for use in the reviews, particularly to operators of mines and quarries and to officers of the Dominion Bureau of Statistics.

C. S. PARSONS,
Chief, Bureau of Mines.

OTTAWA, December 1947.

I. METALS

ALUMINIUM

Although there is no bauxite (the ore of aluminium) in Canada, the Canadian aluminium industry is exceeded in size only by that of the United States. The principal factor favouring the establishment of the industry in Canada is abundant and low-cost hydro-electric power at points where necessary raw materials can be cheaply and conveniently assembled.

Production is entirely by Aluminum Company of Canada, Limited, which has its alumina plant at Arvida and reduction plants at Arvida, Ile Maligne, Shawinigan Falls, La Tuque, and Beauharnois, all in the province of Quebec. These reduction plants have a total rated capacity of about 550,000 tons of aluminium a year, or over 20 per cent of the estimated productive capacity of the world. In 1946, operations were concentrated at Arvida and Ile Maligne.

Fabricating plants are located at Kingston, Toronto, and Etobicoke in Ontario, and at Shawinigan Falls in Quebec. These plants consume only a small part of the company's production, and Aluminum Company of Canada is primarily a producer and exporter of aluminium ingot.

The demand for aluminium was good in 1946. Increased facilities for the production of aluminium sheet and foil were installed. In pre-war years Germany controlled the greater part of the trade in foil, but Canada is now taking a large part of that market.

Principal Canadian Sources of Supply

The principal imported raw materials used in the Canadian aluminium industry are bauxite from British Guiana, coal and coke from the United States, fluorspar from Newfoundland, and cryolite from Greenland and the United States.

Although no bauxite occurs in Canada, potential ores of aluminium such as clay, shale, nepheline syenite, and anorthosite, containing from 20 to 30 per cent alumina, are found in many parts of the country. The utilization of these low-grade raw materials has been the object of much research, and various processes have been developed. Three of these that have been tried out on a commercial scale in the United States are:

(1) The lime-sinter-soda leach process of Ancor Corporation, Harleyville, South Carolina, which uses clay and marl as its basic raw materials and has a Portland cement material as a marketable by-product.

(2) The lime-soda-sinter process of Monolith Portland Cement Company, Laramie, Wyoming, which uses anorthosite and limestone as the basic raw materials, and also has a Portland cement material as a marketable by-product.

(3) The ammonium sulphate digestion process of Columbia Metals Corporation, Salem, Oregon, using clay as the basic raw material, and having no marketable by-product.

In Europe, other processes have been developed to produce alumina from clay, colliery waste, low-grade bauxite, and various other materials.

The economic success of any of these processes will depend in large part upon local conditions, but it has yet to be proved that any of them can compete on an even basis with the Bayer process, the standard process for producing alumina, and which utilizes bauxite containing less than 7 per cent silica and from 55 to 60 per cent alumina. This process involves the digesting of bauxite in caustic soda solution under pressure and at elevated temperature, to put the alumina into solution as sodium aluminate, leaving the impurities undissolved. The impurities, principally iron oxides and silica, are separated off and run to waste. The alumina is precipitated from the sodium aluminate solution in the form of aluminium hydrate, which, after being filtered and washed, is calcined to produce alumina for the electrolytic reduction process. The liquor from which the aluminium hydrate is precipitated contains the caustic soda and some dissolved alumina and is used again in the process for digesting more bauxite.

Production and Trade

Information on production is not available for publication. Exports of aluminium and products in 1946 were valued at $56,030,039, of which ingots, bars, blocks, and blooms comprised $49,146,887; the corresponding figures for 1945 being $133,566,994 and $121,778,512, respectively.

Imports of aluminium and products in 1946 were valued at $5,618,798, compared with $1,823,460 in 1945. In addition, 2,836 tons of cryolite valued at $430,349 and 1,283,176 tons of bauxite valued at $8,524,873 were imported in 1946 for the production of aluminium.

Uses and Prices

Aluminium metal, being only one-third as heavy as steel, untarnishable, and a good conductor of electricity, is finding an increasingly wide field of usefulness. It is available from fabricating plants in many forms such as sheets, foil, castings, forgings, rolled and extruded shapes, tubes, rods, wire, powder, and paste. Because of its light weight and strength when alloyed, it is widely used in the making of aircraft and for many other purposes where lightness of the structural metal is particularly desirable. Large tonnages are used for making cable for transmission of electricity, and for making cooking utensils and containers for food and beverages. It is finding increasing use in architecture and in construction of transportation equipment such as railway cars, automobiles, and boats.

The price of aluminium ingot early in 1946 was reduced from 15 cents to 13¼ cents per pound f.o.b. plant and has since remained at the latter figure.

ANTIMONY

Antimony continued in short world supply in 1946, largely due to the decline in production from Bolivia. Output from China, which prior to the war was the chief producer, was not fully resumed, although at the close of the year shipments of Chinese antimony said to be from current production were being offered. As a result of the shortage antimony remained under government control both as to price and use.

No metallic antimony has been produced in Canada since 1944, in which year The Consolidated Mining and Smelting Company of Canada, Limited discontinued the production of electrolytic antimony. However, the company continued the production of an antimonial lead (25 per cent antimony) from antimonial fume residues that are a by-product of its lead-zinc smelting operations at Trail, British Columbia.

Occurrences in Canada

Certain occurrences of antimony in Canada have been explored and developed to some extent, but results generally have not been favourable to prolonged mining operations. The following is a summary of the more important known occurrences of antimony.

In Nova Scotia, the deposit at West Gore, in Hants county, is the best known. For many years prior to 1917, some antimony was produced in the form of a concentrate containing gold.

In New Brunswick, stibnite occurs in quartz veins at Lake George in a deposit that appears to have some promise. Mining operations had been carried on intermittently over a number of years, the latest production being in the period 1929-31 when high-grade ore was shipped. Ore dumps on the property are understood to contain a substantial amount of antimony and the various quartz veins have not been thoroughly explored. At the end of 1946, negotiations were under way with a Canadian metals firm to exploit this deposit.

In Quebec, antimony ore was mined at the Fallow property in Bonaventure county many years ago. Information on the extent of these deposits is scarce. Prior to 1917 small amounts of ore were shipped from a deposit in Wolfe county.

In Ontario, antimony occurs in several of the gold mines, but no attempt has been made to recover it.

In British Columbia, there are several occurrences, a few of which have been developed to some degree. Test shipments were made from the Bridge River area in 1941; and from the Fort St. James area in 1940 after the sinking of a test shaft. The occurrences in the former area are considered to be worthy of attention.

Yukon contains several occurrences of antimony ores, none of which has been developed to any great extent.

Production, Supply, and Trade

Production by years is given in the table that follows:

Year	Production of antimony in all forms		Production of refined metal	Imports of refined antimony and regulus	
	Pounds	Value	Pounds	Pounds	Value
		$			$
1940	2,594,492	396,468	2,549,792	236,071	21,521
1941	3,185,077	445,911	3,169 785	2,240	423
1942	3,041,108	516,988	3,041,030	100	21
1943	1,114,166	189,408	1,114,166	240,700	38,755
1944	1,937,933	281,000	1,937,933	1,558,198	237,334
1945	1,667,951	290,557	....	1,034,792	172,253
1946	642,145	96,322	....	1,861,962	374,066

The principal sources of antimony in normal trade are China, Mexico, Bolivia, Czechoslovakia, and Yugoslavia. The United States is the chief consumer. Production of antimony in the United States in 1946 was about 50 per cent of the 1945 production. The Laredo, Texas, plant of Texas Mining and Smelting Company is the largest producer of refined antimony metal.

Uses of Antimony

Antimony is used chiefly in the manufacture of hard lead for storage batteries, and cable covering. It is alloyed with tin in the manufacture of babbitt bearings, and with lead and tin in solders and type metal. Its property of expansion on cooling when alloyed makes it particularly useful in the manufacture of type metal. During the war it was used to harden the lead used in bullets and to flameproof canvas goods used by the Armed Forces.

Sulphides of antimony are used as a pigment in paint manufacture, and in the making of india-rubber. The oxides of antimony are used in the ceramic enamel trade as an opacifier. Compounds of the metal are used in the medicinal trade.

Consumers in Canada

Canada Metal Company, Limited, Toronto, is Canada's largest consumer. Other important purchasers are A. C. Leslie and Company of Montreal and Winnipeg; Hart Battery Company, St. Johns, Quebec; Monarch Batteries, Limited, Kingston, Ontario; Mount Royal Metal Company, Montreal, Quebec, and Steel Company of Canada, Limited, Montreal, Quebec.

Consumption in Canada

Uses of Antimony in Canada in 1945
(1946 figures not available)

	Pounds
Foil	51,278
Batteries	1,739,083
Solders	25,516
Babbitt metal	483,245
Cable sheathing	69,539
Ammunition	104,364
Type metal	257,188
Miscellaneous	109,577
Total	2,839,790

Prices

Administrator's Order No. A-2245, which came into force on January 22, 1947, set the maximum prices of antimony according to the Wartime Prices and Trade Board.

The maximum price at which antimony of Chinese grade or higher grade may be sold or purchased by any person shall according to the quantity be sold as follows:

Quantity	Montreal, Toronto, and Hamilton (cents per pound)
10,000 lbs. and over	29·50
2,000 lbs. and less than 10,000 lbs.	30·25
1,000 lbs. and less than 2,000 lbs.	32·35
less than 1,000 lbs.	32·75

The said maximum prices are exclusive of sales tax.

Engineering and Mining Journal's "Metal and Mineral Market's" average price for domestic antimony at New York was 17·306 cents in 1946, compared with 15·839 cents in 1945.

ARSENIC

Arsenic was produced at a number of mines and refineries during 1946. O'Brien Gold Mines, Limited, in Quebec, continued to ship crude arsenic to the Deloro Smelting and Refining Company, Limited, Deloro, Ontario. Beattie Consolidated Gold Mines, Limited, in Quebec, continued to obtain crude arsenic from its roasting plant. The Deloro smelter shipped arsenic to the United States and also to domestic consumers.

Occurrences in Canada

Newcor Mining and Refining, Limited states that it proposes to begin, in 1947, the production of refined arsenic from the gold arsenical ore of its Douglas Lake property in Saskatchewan, 5 miles southwest of Flin Flon, Manitoba. Crude arsenic will be recovered from a baghouse and then refined.

The Bralorne, Hedley, Kelowna, and other mines in British Columbia shipped a gold arsenic concentrate to the Tacoma smelter in the United States, but under their smelter contract no payment for the arsenic content is received, and no figures are available as to the quantity shipped.

In Nova Scotia and in the Little Long Lac area of Ontario, arsenopyrite is associated with certain gold ores, but no attempt is made to recover it.

Production, Supply, and Trade

Production of Arsenic (As_2O_3) in Canada

Year	Tons	Value
1940	1,047	$ 62,798
1941	1,769	153,195
1942	7,484	652,041
1943	1,577	254,009
1944	1,313	180,866
1945	1,023	130,909
1946	373	38,264

Exports of Arsenic (Crude and Refined)

Year	Tons	Value
1940	564	$ 33,362
1941	1,969	126,616
1942	4,193	226,018
1943	3,309	353,484
1944	2,999	306,891
1945	3,035	282,718
1946	859	74,252

The world output of arsenic is practically all obtained as a by-product from the treatment of gold, silver, copper, lead, zinc, cobalt, tungsten, and tin ores.

The larger producing countries of arsenic are Sweden, Italy, United States, Mexico, Peru, Australia, Japan, France, and Belgium.

Uses of Arsenic

The use of arsenic in insecticides accounts for the greater part of the consumption. Its use as a clearing agent in the manufacture of glass is also important. Other uses are in the preservation of wood, the manufacture of pigments in metal finishing, and bearing metals. A small amount is used in lead cable sheathing to increase resistance to soil corrosion. It is also used in the medicinal trade.

Consumers in Canada

The more important consumers are: Niagara Brand Spray Company, Limited, Burlington, Ontario; The Steel Company of Canada, Hamilton, Ontario; Mount Royal Metal Company, Montreal, Quebec; Sherwin-Williams Company of Canada, Limited, Montreal, Quebec; Dominion Glass Company, Montreal, Quebec; Consumers Glass Company, Montreal, Quebec; International Fibre Board, Gatineau, Quebec; Brandram-Henderson, Limited, Montreal, Quebec; and Canada Metal Company, Toronto, Ontario.

Consumption in Canada

Consumption of Arsenious Oxide in 1945
(1946 figures not available)

	Pounds
Glass industry	303,246
Insecticides	340,000
White metal alloys	62,000
Miscellaneous	8,000
Total	713,246

Prices

Engineering and Mining Journal's "Metal and Mineral Markets" prices for white refined arsenious oxide (99 per cent) varied in 1946 from 4 cents to 6 cents a pound, in barrels, delivered in carload lots. The price at the end of the year was 5 cents a pound, and 6 cents a pound for 1947 contracts.

BISMUTH

Bismuth is produced in Canada by The Consolidated Mining and Smelting Company of Canada, Limited, at Trail, B.C., from the residues resulting from the electrolytic refining of lead bullion. The plant has been operated intermittently since 1928. The capacity is 60 tons a year.

A recent producer is the La Corne mine, Quebec, operated by the Molybdenite Corporation of Canada, which commenced the production of a 30 per cent bismuth concentrate in May, 1946. Prior to 1946 molybdenum concentrate produced by the La Corne mine contained undesirable amounts of bismuth and copper. During the war the concentrate was refined solely for its molybdenum content. A process was worked out in the Bureau of Mines Laboratory, Ottawa, early in 1946, whereby the bismuth could be removed and sold at a relatively high price, and which improved the saleability of the molybdenite concentrate. The mine produced about 45 tons of bismuth concentrate by the end of the year.

Occurrences in Canada

The known deposits or occurrences of bismuth ore in Canada are few. It is possible, however, that the metal occurs with other molybdenite deposits of Canada, as in the case of the La Corne mine.

Production, Supply, and Trade

Production of Bismuth in Canada, all forms

Year	Pounds	Value
1940	58,529	$ 81,004
1941	7,511	10,396
1942	347,556	479,627
1943	407,597	562,484
1944	123,875	154,844
1945	189,815	260,047
1946	240,504	336,706

Production of Refined Metal

Year	Pounds	
1940	40,700	....
1941	......	....
1942	318,888	....
1943	407,596	....
1944	123,876	....
1945	189,815	....
1946	240,504	....

Imports of Refined Bismuth

Year	Pounds	Value
1940	5	$ 11
1941	100	149
1942	5	11
1943	..	..
1944	..	..
1945	5	11
1946	6	13

Exports of Bismuth

Year	Tons	
1940	..	....
1941	..	....
1942	..	....
1943	112	....
1944	50	....
1945	41	....
1946	95	....

The world production of bismuth comes principally from the United States, Peru, Mexico, Bolivia, and Canada. Deposits, however, are known in South Australia, Spain, Southern China, Rhodesia, and India.

A large proportion of the bismuth manufactured in the United States is derived from anode slimes obtained in the Betts process for desilverizing lead, and is separated from the gold and silver by an electrolytic process.

The following are the principal producers of refined bismuth in the United States: American Smelting and Refining Company of Omaha, Nebraska; International Smelting and Refining Company of East Chicago, Indiana; United States Smelting, Refining and Mining Company of East Chicago, Indiana; and Bunker Hill and Sullivan Mining and Concentrating Company of Kellogg, Idaho.

Uses of Bismuth

The greatest use of bismuth is in medicinal and cosmetic preparations. Bismuth is too brittle to be used alone, but its alloys find many uses in industry. Alloys are used in the manufacture of sprinkler plugs and other fire-protection devices, electrical fuses, low-melting solders, dental amalgams, and tempering baths for small tools. As does antimony, bismuth expands on solidification and retains this property in a number of alloys, and is used in type-metal. Salts of bismuth are used in the X-ray examination of the digestive tract, due to the absorptive powers of bismuth for X-rays. A certain amount is used in optical glass manufacture.

Consumers in Canada

The more important consumers of bismuth in Canada are: The Canada Metal Company, Limited, Toronto, Ontario; Mallinckrodt Chemical Works, Limited, Ville Lasalle, Quebec; Merck and Company, Montreal, Quebec; and Mount Royal Metal Company, Montreal, Quebec.

Consumption in Canada

Consumption of Bismuth in 1945 by Canadian Industry
(1946 consumption not available)

	Pounds
Pharmaceuticals	30,591
Non-ferrous smelters	5,000
White metal alloys	33,920
Total	69,511

Prices

Engineering and Mining Journal's "Metal and Mineral Markets" price for bismuth during 1946 was $1.60 per pound, in ton lots, until December 2, when the price was raised to $1.80, to effect December, 1946, and later shipments.

CADMIUM

Cadmium occurs as a minor constituent in most zinc ores and in some lead ores. In Canada its production is limited to the by-product recovery from the manufacture of electrolytic zinc. Some important uses have been developed during the past fifteen years and indications are that a strong demand will continue for the metal.

Canadian Sources of Supply

Cadmium metal is produced by The Consolidated Mining and Smelting Company of Canada, Limited, at Trail, British Columbia, and by Hudson Bay Mining and Smelting Company, Limited, at Flin Flon, Manitoba. The cadmium produced at Trail originates largely in the silver-lead-zinc ores of the Sullivan mine at Kimberley, B.C. A small amount is contained in zinc concentrate shipped to Trail from Zincton Mines, Limited, in the Slocan district. At Flin Flon it is contained in the copper-gold-zinc ores of the Flin Flon deposit on the Saskatchewan-Manitoba boundary. At Trail and Flin Flon cadmium is recovered from the residue resulting from the refining of zinc.

Production and Trade

Canada produced 802,648 pounds of cadmium valued at $979,230 in 1946, compared with 646,064 pounds valued at $639,603 in 1945. About 80 per cent of the production came from British Columbia. Exports were 573,368 pounds valued at $694,254, compared with 350,744 pounds valued at $385,369 in 1945. Ninety-two per cent of the exports went to the United Kingdom.

Canadian consumption amounted to about 192,000 pounds and was used mainly in the white metal alloys industry.

The world production of cadmium approximates 5,000 tons a year; United States, Canada, and Tasmania being the principal producers.

Uses

The chief use for cadmium is in electroplating, where the metal is applied as a thin protective coating to other metals, principally steel. A very thin coating of cadmium gives lasting protection from corrosion, without seriously increasing the original dimensions. The metal is used in the manufacture of hard alloys for use as bearings in high-speed internal combustion engines. It is a constituent of certain types of solder where the cadmium content adds strength to the solder alloy. A recent use has been developed in the manufacture of "cerrobend", an alloy employed as a filler to bend thin wall tubing. Cadmium sulphide and cadmium sulphoselenide are standard agents for imparting bright resistant yellow and red colours, respectively, to paints, ceramic materials, inks, rubber, leather, and other products. Cadmium nitrate is used in white fluorescent lamp coatings, and the oxide, hydrate, and chloride are used in electroplating solution. Sixty per cent of the consumption is estimated to be used for electroplating, 10 per cent for bearing alloys, and 10 per cent in chemical compounds.

Cadmium is marketed in metallic form, 99·5 per cent pure or better, and as a sulphide. The principal compounds are cadmium lithopone, and cadmium selenide.

Prices

The Canadian price of cadmium averaged $1.22 a pound, compared with 99 cents a pound in 1945. In the United States the controlled price was raised from 90 cents to $1.25 a pound in July, and when price controls on metals ended in November the price became $1.35 a pound and further increased to $1.50 a pound at the end of the year. In the United Kingdom the price of cadmium increased during the year from 5 shillings 4 pence to 10 shillings a pound. Higher prices prevailed in European countries.

CHROMITE

Union Carbide Company, which obtains its chromite from the "Montreal" pit in the Black Lake district, Quebec, operated for the company by Orel Paré, continued in steady production and supplied close to 99 per cent of the Canadian output in 1946. Chrome Association supplied the remainder. There was continued improvement in the world supply of chromite.

Pure chromite (FeO, Cr_2O_3) contains 68 per cent chromic oxide, but in nature it always contains, besides iron, varying amounts of magnesia and alumina. It is a heavy, almost black, lustrous and brittle mineral, and the ore usually occurs in dunite bands in serpentine rocks. Fresh dunite is a fine-grained, dark grey-green olivine rock. Chromite is distinguished in the field from other black minerals of similar appearance by its chocolate-brown powder or streak when struck or scratched with a hammer.

Principal Canadian Sources of Supply

Most of the deposits from which production has been obtained are between Quebec City and Sherbrooke in the Eastern Townships of Quebec. Chromite, Limited, which was in production during part of the war, obtained its output from the old Sterrett mine in Cleveland township. The ore, which averaged 18 per cent Cr_2O_3, was treated in a 150-ton mill. The Chromeraine mine in the same area was in production in 1943 and part of 1944. The ore averaged 8·0 per cent Cr_2O_3, with a small amount of massive mineral.

The old Montreal pit was operated over 50 years ago and was reopened by Union Carbide Company in 1941. Since then, production has been continuous. About 70 car lots of ore were shipped to Welland from this property in 1946. Chrome Association, which has been prospecting for the past two or three years in the Black Lake area, Coleraine township, shipped a car lot to Welland from the old Greenshields mine in that township.

There are large deposits of chromite in the Bird River area of south-eastern Manitoba, but the chromite is high in iron and an economical method of bringing the chrome-iron ratio to within market requirements has not been devised.

Production and Trade

Shipments amounted to 3,110 short tons of lump ore valued at $61,123, compared with 5,755 tons of ore and concentrate valued at $160,752 in 1945.

Canadian users reported total receipts, including the aforementioned shipments, of 36,895 short tons of chrome ore in 1946, of which about 32,000 tons was for metallurgical use and the remainder for refractory use. Stocks on hand at the end of 1946 were 22,240 tons, an increase of about 3,000 tons over 1945. Production of ferrochrome and of chrome alloys (Chrome X) was 6,443 tons, about 60 per cent of that of 1945; and consumption was 2,842 tons. Stocks at the end of the year were nearly 2,000 tons.

Imports of chrome ore amounted to 15,836 tons valued at $269,248 in 1946, nearly 70 per cent of which came from Africa, and the remainder from the United States, Turkey, and Cuba. In 1945 imports were 60,691 tons valued at $1,154,985.

Exports of ferrochrome and chrome alloys amounted to 4,762 tons and were mainly to the United States.

The world annual production of chromite just prior to the war was about 1,300,000 metric tons. Russia, Turkey, Union of South Africa, the Philippines, and Southern Rhodesia were each producing 100,000 tons or more a year, and Cuba, Yugoslavia, Greece, New Caledonia, and India, 50,000 tons or more each. Estimated production in 1942, the peak year, was over 2 million tons, of which Russia, Southern Rhodesia, and Union of South Africa each produced over 300,000 metric tons.

Russia is probably the leading world producer of chromite, but no official production figures have been published.

In Turkey, production from nearly all privately owned mines ceased after British and American Government purchases ended on January 1, 1945. Large stocks have accumulated owing to the lack of transportation. Production since then has been about 70,000 tons a year of high-grade (49 per cent Cr_2O_3) ore from the Guleman mine; most of which was exported to the United States, and some to Canada.

Southern Rhodesia and Union of South Africa were among the leading chrome producers during the war. Output in the former country reached a peak of 348,314 metric tons in 1942. It was 186,318 tons in 1945, and considerably less in 1946. South Africa produced about 210,000 tons in 1946, which was almost double the 1945 output. The principal sources of supply are in the Lydenburg and Rustenburg districts, where the ores are associated with pyroxenite.

In the Philippine Islands there was apparently no production in 1946. Just before the Japanese occupation many of the mines were flooded and much of the machinery was destroyed by American engineers. An output of 50,000 to 70,000 tons a year was estimated during the occupation, mainly from the Zanbala mine. A few of the mines were reported to have been left in good condition.

Cuba was one of the major producers toward the end of the war. Most of the ore is refractory grade, and the remainder metallurgical.

United States production of about 1,200 metric tons in 1946 was only one-tenth that of 1945, and compares with a peak of 145,260 metric tons in 1943. The drastic drop in production was due to the available supplies of higher grade and lower iron content foreign ores. In an emergency, substantial production of chrome can be obtained from the Montana and other United States ores after beneficiation.

Consumption in the United States and imports in 1946 were considerably lower than in 1945, when consumption was 808,120 metric tons of ore averaging 43·8 per cent Cr_2O_3, and imports, 915,000 tons, which came mainly from Cuba, Southern Rhodesia, Russia, and South Africa. Imports of metallurgical ore in 1946 were substantially below requirements, however, due to transportation difficulties in Southern Rhodesia between the mines and ports, and also to the diversion of New Caledonia's metallurgical ore to France.

In India, production has declined appreciably during the past three years. Most of the ore is exported. The principal deposits are in the Kistna and Salem districts of Madras Presidency.

In New Caledonia, the most important chromite deposits in the north have been worked extensively, but smaller deposits occur near Noumea in the southern part of the island. Prior to 1946 most of the output, which amounted to 40,826 tons in 1945, was exported to the United States, but in 1946 nearly all of it went to France.

Uses and Specifications

The uses of chromite are divided into three groups, namely metallurgical (by far the most important), refractory, and chemical.

In the metallurgical field, chromium is one of the principal alloying elements in a great variety of steels, chief of which in the amount of chromium used are the stainless and the corrosion-resistant steels. During the war, chromium was the vital ingredient, with nickel and molybdenum, in making armour plate, and armour-piercing projectiles. It is used in high-speed tool steels, and as a hard, toughening element in vehicle axles and frames, and in areoplane parts. Chromium in high-temperature alloys is being used extensively for gas turbines, jet-propulsion units, and gas engine superchargers. For metallurgical uses chromite should contain a minimum of 48 per cent Cr_2O_3 with a chrome-iron ratio of 3 to 1 or higher, and the ore should be hard and lumpy.

Chrome ore is used for making refractory bricks or materials used in basic open-hearth furnaces, in arches of furnaces, in parts of combustion chambers of high-pressure steam boilers, etc. It is used with magnesia to make chrome-magnesia refractories, an important use in Canada being in the manufacture of brucite magnesia bricks that contain up to 30 per cent Cr_2O_3. Refractory chromite should be fairly high in Cr_2O_3 and alumina, and as low as possible in silica and iron. The ore should be hard and lumpy and not under 10-mesh size, and the chromite should be present in an evenly and finely distributed form, not as coarse grains mixed with blobs of silicate. The Cr_2O_3 content is usually over 40 per cent.

In the chemical industry, chromite is used mainly in fundamental salts such as sodium and potassium bichromates that are used in electroplating, tanning, dyeing, glassmaking, pigments, photography, bleaching, safety matches, antiseptics, some aniline dyes used in printing, etc. Finely powdered chrome oxide is used as a buffing compound for polishing stainless steels. Chemical grade ore should contain a relatively high percentage of Cr_2O_3 and be low in silica.

Beneficiation

Although high-grade lump ore is preferred, it is sometimes necessary to treat lower grade ore or fines by ordinary gravity concentration. For use in an emergency, the large available tonnage of low-grade and high-iron complex ores of many parts of the United States and in some sections of Canada would have to undergo special beneficiation processes. The Montana low-grade chrome ores were successfully treated by roasting and leaching. The ore was heated with carbon in a rotary kiln to reduce the iron in the ore to a semi-metallic form. The iron then becomes soluble in dilute sulphuric acid and most of it can be removed.

Prices

The principal Canadian buyers of chromite for metallurgical use are: Chromium Mining and Smelting Corporation, Sault Ste. Marie, Ontario, and Electro-Metallurgical Company of Canada, Welland, Ontario. The only important purchaser of refractory ore is Canadian Refractories, Limited, Canada Cement Building, Montreal.

At the end of 1946, the United States price of domestic and imported ores of 48 per cent Cr_2O_3 and 3 to 1 ratio was $39; ores of lower grade and ratio vary down to a minimum of $27 a long, dry ton at seaboard. Canadian prices of 47 to 48 per cent Cr_2O_3 concentrates are $25 to $40, and crude ore $15 to $20 a long ton, f.o.b. mines, depending upon the chrome-iron ratio and upon the percentages of certain impurities.

COBALT

No cobalt metal or oxide of domestic origin has been produced in Canada since the summer of 1940, and shipments of hand-picked ore and of concentrates, all of which originate in the Cobalt and the neighbouring Gowganda areas of Ontario, amount to only a few hundred tons a year. In 1946, properties that were operated by Silanco Mining and Smelting Company were the source of more than 95 per cent of the cobalt content of these shipments. The company had intended to treat its accumulated stocks of ore and concentrate in a 10-ton smelter and refinery it was erecting, 5 miles south of Cobalt, but the erection of the plant was postponed indefinitely and the company temporarily ceased all operations except shipments from stock. In 1946, this company and the other operators in the area shipped all their concentrate and hand-picked cobalt ore to Shepherd Chemical Company, Cincinnati, Ohio, where it is converted mainly into cobalt oxide. No payment is received for the silver content. Part of the silver ore and concentrate was shipped to Deloro Smelting and Refining Company, Limited, Deloro, Ontario, and the remainder to Noranda Mines, Limited, Noranda, Quebec, for the recovery of silver. At Deloro, the cobalt content of this material is contained in a speiss, large stocks of which have accumulated for future treatment for the recovery of the cobalt. The shipments to Noranda contain very little cobalt and this is not recoverable. Shipments from the Cobalt region have shown a marked decline since February, 1944, when the United States Government ceased buying Canadian ores and concentrates for stockpiling at Deloro, where the stocks remain untreated.

From the summer of 1940 until May, 1946, the refinery at Deloro treated cobalt residues, a by-product from copper mines in Northern Rhodesia, for Rhokana Corporation. The grade of these residues is much higher than the Canadian material and their treatment was comparatively simple, and during the war they were the chief source of cobalt for the United Kingdom. Since May, 1946, however, all the residues have been shipped to the refinery at Hoboken in Belgium.

Activities in Cobalt Camp in 1946

Silanco Mining and Smelting Company operated the Agaunico mine for cobalt ore and the Beaver and Temiskaming mines for silver ore. The ores were treated in the company's Colonial and O'Brien mills. Ausic Mining and Reduction Company operated the Genesee and Silver Cliff mines and treated some of the ore in the company's mill on the northeast side of Cross Lake. Silver Miller Mines, Limited operated the Rochester and Lunsden silver properties, but made no shipments until early in 1947. Silver Arrow Mines, Limited mined some silver-cobalt ore from the Van Tassel property. Other companies were engaged in prospecting and drilling in the Cobalt-South Lorrain area.

In the Gowganda area, construction of a 100-ton gravity flotation mill on the Miller Lake O'Brien property was completed in December and milling was started in January, 1947. The property is operated by Siscoe Metals, Limited, a subsidiary of Siscoe Gold Mines, Limited.

Production and Trade

The 329 tons of cobalt ore and concentrate shipped in 1946 had a cobalt content of 73,900 pounds valued at $70,215. No payment was received for the 6 tons of cobalt contained in the 129 tons of silver ore and concentrate shipped. About 1,700 tons of 12 per cent cobalt concentrate was on hand at Cobalt at the end of 1946. At Deloro, stocks of Canadian concentrate being held for the United States Government, on hand at the end of 1946, contained 323 tons of cobalt, and accumulated speiss and residues contained about 470 tons.

Annual world production of cobalt is estimated at 4,000 metric tons, the principal producing countries being Belgian Congo and Northern Rhodesia.

Uses

Seventy-five per cent or more of the world production of cobalt is used in the metallurgical industry and most of the remainder in the ceramic industry. Prior to 1946 the largest use was for stellite alloys which contain 40 to 45 per cent cobalt, 30 to 37 per cent chromium, and 12 to 17 per cent tungsten. Stellite is used mainly for cutting metals at high speed, for making magnets, and for the manufacture of valves for airoplane engines. Cobalt is a major constituent in one type of alloy used for the rotor blades of turbines in jet propulsion motors. It is used in carbide type alloys, for welding rods, and for tipping tools. Cobalt is used in electroplating; as a catalyst; and with other chemicals in nickel-plating solutions as an undercoating for chromium plating. Cobalt oxide has fine colouring properties and is used chiefly in the ceramic industry. Cobalt sulphate is used in the paint industry. Other compounds of cobalt are used as driers in paints and varnishes.

Prices

The price per pound of contained cobalt in ore or concentrate, f.o.b. Cobalt, Ontario, ranged from 70 to 85 cents for 9 to 12 per cent concentrate in 1946. The New York price for cobalt metal in 550-pound barrels remained constant at $1.50 per pound, and for black oxide 70 to 71 per cent grade for metallurgical use, $1.06, and for the ceramic industry $1.16 per pound. The British price for black oxide was reduced from $1.90 to $1.20 per pound.

COPPER

Canada's output of copper declined in 1946, mainly on account of the necessary curtailment of nickel production with which it is associated in the Sudbury mines, and partly the result of the strike of workmen at Noranda, and of the continuing shortage of miners. This recession was in line with the trend in the other principal copper-producing countries.

With the restoration of a free international market for copper in March, 1946, the price commenced to rise, and this continued until the end of the year. The ceiling price to Canadian consumers was retained at the war-time level of $11\frac{1}{2}$ cents a pound throughout the year, but was raised in January, 1947, to $16\frac{5}{8}$ cents a pound, about midway towards the price in the free market.

The supply of ore for Canadian copper smelters is adequate for many years to come. Development of the Quemont mine in Quebec has increased the tonnage of proven ore substantially. Several large deposits have been indicated by drilling in the Lynn Lake area of northern Manitoba, where the ore contains about one-half as much copper as nickel. No other large copper deposit was found during the year.

The expansion of manufacturing facilities in Canada during the war has enlarged considerably the home market for copper. The conversion, now

(April, 1947) under way, of the brass strip mill in Montreal East from munitions to industrial forms of brass and copper will provide the largest single, new domestic outlet for the metal for peace-time use.

Principal Canadian Sources of Supply

Copper is produced from the smelters at Noranda in Quebec, Copper Cliff and Falconbridge in Ontario, and Flin Flon in Manitoba. Concentrate from the two large copper mines in British Columbia (Copper Mountain and Britannia) continues to be exported.

Ontario

International Nickel. The International Nickel Company of Canada, Limited produced about 40 per cent of the total Canadian output of copper in 1946. The company's smelter at Copper Cliff was operated at about half capacity until the end of June, following which it was gradually increased to 75 per cent of the maximum war-time rate by the end of the year. Its copper refinery at Copper Cliff also treated blister from Sherritt Gordon mine in Manitoba. The improved method of separating the copper and nickel was in use on a small scale and the whole of the new plant is expected to be in operation some time in 1947.

Mine development, held in abeyance during the war, was actively resumed, and ore reserves at the end of 1946 were estimated at 217,142,000 tons containing a total of 6,861,000 tons of copper and nickel. A survey of some of the company's mineral lands by airborne magnetometer was planned for 1947 in an endeavour to acquire information that would indicate the presence or otherwise of ore deposits.

Sales of refined copper in 1946 were 74,888 tons, compared with 107,862 tons in 1945. There was also a moderate production of copper in combination with nickel as Monel metal, and a production of copper sulphate.

Falconbridge. Falconbridge Nickel Mines, Limited treated 486,516 tons of ore from which 12,780 tons of matte was produced in its smelter at Falconbridge, Ontario. Its refinery in Christiansand, Norway, produced 2,845 tons of refined copper, and is expected to reach its rated capacity during 1947. Development during 1946 in the lower levels of the Falconbridge mine to a depth of 2,800 feet has increased the ore reserves in that area by 830,000 tons of a grade substantially above mine average.

The ore reserves at the end of the year were:

—	Tons	Per cent nickel	Per cent copper
Falconbridge mine	8,296,500	1·63	0·85
Outside holdings in Sudbury district	5,909,000	1·88	1·02
	14,205,500	1·73	0·92

Quebec

Noranda. The smelter of Noranda Mines, Limited, at Noranda Quebec, treated ore and concentrate from its Horne mine and from its subsidiai Waite

Amulet. It also smelted custom ore from Normetal mine and a small amount from Mic Mac mine. A substantial tonnage of brass shell cases was treated in the open-hearth furnace to recover the contained copper.

In 1946, to November 21 when a strike caused the closing of the plant, the smelter treated 752,518 tons of ore, concentrate, slag, and shell cases, from which 37,033 tons of anodes were produced. The material treated included 250,226 tons from other companies and was handled on a custom basis. The anodes were shipped to Canadian Copper Refiners in Montreal East for refining. An estimated 35,189 tons of copper was recovered, with which were associated 198,660 ounces of gold and 823,171 ounces of silver. Selenium metal and copper sulphate were also produced at the refinery.

The Horne mine produced 358,768 tons of direct smelting ore averaging 1·383 per cent copper; 33,959 tons of siliceous fluxing ore with 0·297 per cent copper; and 560,710 tons of concentrating ore averaging 1·870 per cent copper. The concentrator produced 107,252 tons of copper-gold concentrate. The recovery from Horne ore was 13,763 tons of copper, 155,197 ounces of gold, and 317,997 ounces of silver. Pyrite concentrate was also produced. Ore reserves of the Horne mine at the end of 1946 were:

—	Tons	Per cent copper	Oz./ton gold
Over 4 per cent copper	4,960,000	7·14	0·159
Under 4 per cent copper	14,692,000	0·67	0·196
Siliceous fluxing ore	838,000	0·11	0·108

Waite-Amulet-Dufault. Waite Amulet Mines, Limited milled 427,400 tons of ore averaging 4·56 per cent copper, 5·37 per cent zinc, 0·046 ounce gold, and 1·17 ounces silver per ton. This included 346,695 tons from the subsidiary, Amulet-Dufault. During the labour strike at Noranda the copper concentrate was stockpiled. The estimated recovery from copper concentrate was:

Copper	18,243 tons
Gold	13,748 ounces
Silver	319,466 ounces

Pyrite and zinc concentrates were also produced. Ore reserves at the end of 1946 were:

—	Tons	Per cent copper	Per cent zinc	Oz./ ton gold	Oz./ ton silver
Waite copper ore	40,000	4·5	....	0·04	0·5
Waite zinc ore	5,000	....	9·5	....	....
"F" Shaft	30,000	3·2	9·9	0·01	1·01
'C" Shaft	24,000	2·0	9·07	0·02	4·0
Dufault Lower "A"	1,865,739	6·0	4·01	0·045	1·5
Dufault Upper "A"	132,000	2·0	6·5	0·07	1·6

Normetal. Normetal Mining Corporation, Limited, 60 miles north of Noranda, produced 186,634 tons of ore averaging 3·24 per cent copper, 7·04 per cent zinc, 0·031 ounce gold and 2·16 ounces silver per ton. From this was obtained 25,337 tons of copper concentrate averaging 22·36 per cent copper, 5·89 per cent zinc, 0·156 ounce gold and 12·93 ounces silver, which was shipped to Noranda until November 21, after which it was stockpiled at the mine. Estimated metal recovery from the copper concentrate is 5,665 tons of copper, 3,955 ounces of gold, and 327,621 ounces of silver. Operations were kept considerably below capacity by the shortage of miners. By the end of 1946 the underground crew was built up almost to full strength, largely with inexperienced men.

The mine is developed to a depth of 3,050 feet. Ore reserves at the end of the year were 1,716,000 tons averaging 3·68 per cent copper, 7·28 per cent zinc, 0·033 ounce gold, and 2·66 ounces silver. Diamond drilling below the 3,200-foot level gave inconclusive results.

Golden Manitou, at Val d'Or, Quebec, is essentially a zinc mine, but it produced a small amount of lead-copper concentrate that was exported to the United States.

Quemont. Quemont Mining Corporation, Limited continued exploration and development work in preparation for production. It did 83,000 feet of diamond drilling on its property which adjoins the Noranda mine on the north, and extended development on the 200-foot and 900-foot levels. On May 15, 1946, the company announced that over 6,000,000 tons of ore was indicated, averaging 1·58 per cent copper, 3·2 per cent zinc, 0·181 ounce gold, and 1 ounce silver. This tonnage has been increased substantially since then. Drill intersections have shown ore to a depth of 1,952 feet below the surface. An operating shaft was being sunk. The company is controlled by Mining Corporation of Canada, Limited.

East Sullivan. East Sullivan Mines, Limited sank a shaft to a depth of 500 feet on its large body of mixed sulphides near Val d'Or, Quebec, and was opening levels to that depth. The deposit contains copper, zinc, and gold and the underground development is designed to determine the average values.

Other Quebec Properties. Two other large deposits in the Rouyn copper area were further developed during 1946. Joliet-Quebec Mines, Limited, whose property adjoins Noranda on the northwest, extended a shaft to a depth of 628 feet and did 1,500 feet of lateral work on the 300-foot and 600-foot levels. This showed a large body of low-grade copper-bearing material. Macdonald Mines, Limited, 5 miles northeast of Noranda, sank a shaft to 900 feet and was driving levels into the large deposit of mixed sulphides to determine its content of copper, zinc, and gold.

Manitoba

Hudson Bay. Hudson Bay Mining and Smelting Company, Limited, at Flin Flon, Manitoba, treated in its smelter ore and concentrate from its Flin Flon mine and from Sherritt Gordon mine, 40 miles northeast. The company's blister copper is shipped to Canadian Copper Refiners in Montreal East for refining. The copper smelter treated 434,194 tons of ore and concentrate averaging 11·11 per cent copper, 0·336 ounce gold, and 4·54 ounces silver. The 387,477 tons of ore and concentrate from Flin Flon mine yielded 39,995 tons of copper, 121,729 pounds of selenium, 143,282 ounces of gold, and 1,839,426 ounces of silver, which is slightly less than in 1945 except for gold which increased slightly. The company is also a leading producer of refined zinc and cadmium.

Its Flin Flon orebody lies astride the Manitoba-Saskatchewan boundary and most of the output now comes from the Saskatchewan side. During the year 1,846,601 tons of ore was mined, averaging 2·44 per cent copper, 5·0 per cent zinc, 0·093 ounce gold, and 1·32 ounces silver. The mill produced 366,956 tons of copper concentrate averaging 11·02 per cent copper, 0·342 ounce gold, and 4·63 ounces silver. The flotation tailing was cyanided, and the precipitate contained 73,126 pounds of copper, 17,180 ounces of gold, and 183,484 ounces of silver. This precipitate was added to the smelter feed and the metals extracted were thus included in the blister copper reported above. The scope of underground development was increased and preparations were made to establish levels down to 4,000 feet. No estimate of ore reserves has been announced since the end of 1945, when they were reported at 26,000,000 tons averaging 2·99 per cent copper, 4.24 per cent zinc, 0·089 ounce gold, and 1·25 ounces silver, down to the 3,250-foot level.

The company completed a shaft to a depth of 615 feet on the Cuprus property 88 miles east of Flin Flon, which it controls.

Sherritt Gordon. Sherritt Gordon Mines, Limited ships its copper concentrate to the smelter at Flin Flon, and its portion of the blister copper goes to the copper refinery of International Nickel Company at Copper Cliff. During the year 558,836 tons of ore was milled, giving 45,632 tons of copper concentrate. This yielded 10,774 tons of copper, 6,185 ounces of gold, and 196,545 ounces of silver. A zinc concentrate was also made. No new ore was found. The ore reserves at the end of 1946, all in the West mine, were estimated at 1,368,000 tons averaging 2·60 per cent copper, 2·12 per cent zinc, 0·021 ounce gold, and 0·61 ounce silver. This is expected to supply 500,000 tons a year for the next two years, and a diminishing supply for a period thereafter. The mine equipment of the East mine, now completely worked out, is available for use at Lynn Lake, and part of it has been shipped there.

The company is developing nickel-copper deposits at Lynn Lake, 120 miles north, where drilling has indicated important tonnages of ore in several deposits. The deposits do not outcrop and were found by means of magnetometric surveys. Magnetic anomalies have been found throughout a wide area. Drilling in the area by other companies has disclosed low values in nickel and copper. The company reports that the ore in the Sherritt Gordon deposits is amenable to a simple and inexpensive method of treatment.

British Columbia

Granby Consolidated. The mine of Granby Consolidated Mining, Smelting and Power Company, Limited is at Copper Mountain, British Columbia, and the concentrator is at Allenby, 6 miles north. As a result of a labour strike the mine was closed from July 3 until early in November, and milling was resumed January 2, 1947. More miners became available in 1946 and mine production was raised to an average of 3,881 tons a day for the half-year, compared with an average of 2,584 tons daily in 1945. The mill treated 597,678 tons of ore averaging 1·103 per cent copper. From this ore was produced 20,007 tons of concentrate containing 5,314 tons of copper, 2,487 ounces of gold, and 76,116 ounces of silver. The smelter at Tacoma, Washington, to which this concentrate was sold, was closed by a strike early in 1946, so shipments were delayed and a considerably higher price was thus obtained owing to the rise meantime in the United States price of copper.

Ore reserves at the end of 1946 were reported at 9,982,000 tons averaging between 1·2 per cent and 1·3 per cent copper.

Howe Sound (Britannia Mine). Howe Sound Company's Britannia mine is 20 miles north of Vancouver. Like other mines in British Columbia, it was closed by a strike on July 3. Production was resumed on November 5, and by the end of the year had reached 3,000 tons a day. Ore milled during the period of operation was 435,982 tons. A copper-gold concentrate is made, copper precipitate is obtained from the copper-bearing minewater, and a pyrite concentrate is produced. In 1945, zinc production was commenced as a by-product from the new No. 8 orebody, but no zinc concentrate was shipped in 1946. The copper concentrate and precipitate made in 1946 was shipped to Tacoma for smelting and contained 4,761 tons of copper, 6,107 ounces of gold, and 38,099 ounces of silver. There was a good supply of labour at the end of 1946.

Production and Trade

Total copper production (including refined copper and the copper content of shipments for treatment) of Canada in 1946 was 183,968 tons valued at $46,632,093. The output by provinces was:

Copper Production

—	1945	1946
	(tons)	(tons)
Quebec	51,342	34,899
Ontario	119,726	89,712
Manitoba	20,563	19,251
Saskatchewan	32,950	31,356
British Columbia	12,876	8,750
TOTAL CANADA	237,457	183,968

Canada's two copper refineries located at Copper Cliff and at Montreal East produced 167,221 tons of refined copper, compared with 228,861 tons in 1945.

Exports of primary copper were:

—	1945		1946	
	Tons	Value	Tons	Value
Copper contained in ore, matte, etc.	19,295	$ 2,701,244	17,628	$ 2,467,906
Copper in ingots, bars, cakes, slabs and billets	129,349	32,098,264	101,415	27,463,366
Copper in rods, strips, sheets and tubing	7,281	1,956,339	15,918	4,940,721
	155,925	$36,755,847	134,961	$34,871,993

A substantial amount of copper was also exported as wire, screen, and in manufactured goods.

The export markets for primary copper are restored to something approaching their normal geographical distribution, as indicated in the following tables.

Exports of Copper in 1946 Contained in Ore, Matte, etc.

—	Tons	Value
United Kingdom	244	$ 34,181
Norway	4,899	685,783
United States	12,485	1,747,942
	17,628	$2,467,906

The above exports to the United Kingdom and Norway were composed of nickel-copper matte for refining. The exports to the United States were concentrate, mainly from the Copper Mountain and Britannia mines in British Columbia, and partly in nickel-copper matte shipped to Bayonne, New Jersey.

Exports of Copper in 1946 as Ingots, Bars, Cakes, Slabs, Billets, Rods, Strips, Sheets, and Tubes

—	Tons	Value
United Kingdom	70,637	$19,602,328
British India	2,642	862,027
British West Africa	119	58,466
British Guiana	....	85
Bermuda	4	2,006
Trinidad	3	1,509
Newfoundland	27	11,565
New Zealand	442	209,216
Australia	23	13,089
British Empire	73,897	$20,760,291
Argentina	2	$ 620
Brazil	2,254	607,647
China	1,008	335,169
Colombia	1	363
Cuba	3	1,355
Ecuador	....	16
France	9,257	2,470,419
French Africa	....	241
St. Pierre	....	5
Guatemala	....	12
Mexico	13	5,531
Netherlands	4,854	1,302,860
Norway	198	62,029
Persia	110	49,115
Peru	....	150
Sweden	431	111,512
Switzerland	6,601	1,859,477
	24,732	$6,806,521
United States	18,704	$4,837,275
GRAND TOTAL	117,333	$32,404,087

Canada used an estimated 80,500 tons of copper in 1946, divided roughly as follows:

Copper Used in Canada in 1946

	Tons
Products from wire rods	63,500
In brass and bronze	15,000
Miscellaneous uses	2,000
TOTAL	80,500

As noted above, much of the copper thus used was contained in manufactured products exported.

Uses and Prices

Electrical manufactures such as generators, motors, switchboards, and light bulbs provide the largest single market for copper. Next in importance comes copper wire installed in buildings, railway cars, ships, tramways, and similar uses. The automotive industry is another important outlet. A substantial part of the total is used as brass and bronze in many industrial and household forms.

Restrictions on the prices paid for export copper were removed in March, 1946. The world market prices ranged from 11·7 cents in January to 19·5 cents at the end of 1946. Import quotas and similar trade restrictions remained in force in the principal trading countries.

GOLD

Gold continued to be the chief single contributor to the value of Canada's mineral output, although the value of output of the metal in 1946 was only about half that of 1941, the peak year. Ontario, Quebec, British Columbia, and Saskatchewan, in the order named, were again the chief producers. Gold-quartz mines contributed 83 per cent of the output; gold-bearing base-metal mines, 15 per cent; and placer operations, 2 per cent. The industry employed 19,000 workers and paid $38,000,000 in salaries and wages in 1946.

Production of gold and the value of the output were slightly greater than in 1945. The value would have shown a greater increase, however, except for the restoration of the Canadian dollar to parity in July, which action reduced the price of gold from $38.50 an ounce to $35.00 an ounce in Canadian funds. The reduced price, together with the shortage of experienced labour, rising costs of equipment and supplies, increased wages, absenteeism, strikes, and strike threats, handicapped operations, though to a lesser degree in a number of camps than in 1945. Nevertheless, very satisfactory headway was made in preproduction development work on several properties.

Sources of Output and Developments

Ontario

In Ontario, the gold-quartz mines of the Porcupine and Kirkland Lake areas supplied 73 per cent of the total output of the province; the other gold-quartz mines, headed by those in the Patricia area, and followed in order by those in the Larder Lake, Thunder Bay, and Matachewan areas, 25 per cent; and the copper-nickel mines of the Sudbury area, the remainder. The total output was 11·6 per cent greater than in 1945, and the value was also higher. In Porcupine area, the Hollinger, McIntyre, Dome, Aunor, and Hallnor mines were the chief contributors; in Kirkland Lake area, the Lake Shore, Wright-Hargreaves, and Sylvanite mines; in Patricia area, the Pickle Crow, Central

Patricia, Madsen Red Lake, Cochenour-Willans, and McKenzie Red Lake mines; in Larder Lake area, the Kerr-Addison, Chesterville, and Omega mines; in Thunder Bay area, the MacLeod-Cockshutt, Leitch, and Little Long Lac mines; and in Matachewan area, the Matachewan Consolidated and Young-Davidson mines. In the Porcupine area the Hoyle mine, closed since July, 1943, owing to a fire, resumed shipments of ore in March to the mill of Pamour Porcupine Mines, Limited. In the Patricia area, the Jason mine at Casummit Lake was reopened in September. Hasaga Gold Mines, Limited discontinued milling early in November to confine attention to ore development, and resumed operations in March, 1947. Berens River Mines, Limited discontinued milling in December to work on a new orebody. In the Thunder Bay district, milling was resumed at the Magnet and MacLeod-Cockshutt properties, and production was commenced at the Maylac mine, its output in December being 419 ounces.

Production from the principal areas in Ontario in 1946 is given on page 27.

Seldom was diamond drilling in Ontario more active than in 1946, nor was the search for new sources of gold. Thousands of claims were staked as a result of this search, those recorded with the Ontario Department of Mines in the Larder Lake and the Red Lake areas, for example, being 3,563 and 3,476, respectively.

In western Ontario, exploratory work was most active in the Red Lake area, particularly in Dome and Balmer townships where a number of prominent and strongly financed companies had prospecting parties. The 83-mile road that was commenced and completed in 1946 by the Provincial Government makes Red Lake accessible from Quibell on the Canadian National Railway and is serving to intensify mining development in and around the area. Among the properties which were not producing in 1946, but where underground work was begun, renewed, or extended, were: Starratt Olsen Gold Mines, Limited, and McMarmac Red Lake Mines, Limited, both of which will resume production in 1947, Campbell Red Lake Mines, Limited, Dickenson Red Lake Mines, Limited, Orlac Red Lake Mines, Limited, Marcus Gold Mines, Limited, and Bayview Red Lake Gold Mines, Limited. Crowshore Patricia Gold Mines, Limited did underground development on its claims adjoining Pickle Crow mine, as did Lingman Lake Gold Mines, Limited, at Lingman Lake; Kenwest Mines, Limited in Upper Manitou Lake area; Wampum Gold Mines, Limited, near Flint Lake, about 50 miles southeast of Kenora; and Undersill Gold Mining Company, Limited, near Beardmore. In Echo township, some 25 miles southwest of Sioux Lookout, Lunward Gold Mines, Limited disclosed, mainly by drilling, low-grade deposits of a substantial size. The O'Sullivan Lake area, 45 miles northwest of Geraldton, also attracted attention owing to the success that attended drilling by Osulake Mines, Limited.

In eastern Ontario, among the properties in an advanced stage of development are: Amalgamated Larder Mines, Limited, and Laguerre Gold Mines, Limited, in Larder Lake area; Renabie Mines, Limited, in Missinaibi area; Golden Arrow Mines, Limited, in the Ramore area; and Golden Gate Mining Company, Limited (formerly a producer) and Queenston Gold Mines, Limited, in Kirkland Lake area.

Among the discoveries of gold in Ontario during 1946, those in the Groundhog Lake and Lightning River areas are noteworthy. Activity in the former area resulted from Joe Burke's find and drilling by Joburke Gold Mines, Limited. In the Lightning River area, into which a road from Matheson was being constructed by the Provincial Government, some encouraging results also attended drilling, principally by Dome Mines, Limited, Wright-Hargreaves Mines, Limited, and Kelwren Gold Mines, Limited. Recent finds elsewhere in

Ontario include those near Fort Hope, which lies some 30 miles east of Miminiska Lake on the Albany River, and on a small lake about 6 miles west of King Bay on Sturgeon Lake.

Quebec

In Quebec, approximately 70 per cent of the production of gold in 1946 came from nineteen gold-quartz mines, of which the more important in order of output were: Sigma, Belleterre, East Malartic, Lamaque, Malartic Goldfields, Canadian Malartic, Sullivan, and Mic-Mac. These are in western Quebec, most of them in the Rouyn-Harricanaw belt that bears roughly east-northwest from the Kirkland Lake mines in Ontario. West Malartic, one of the nineteen mines, discontinued operations in January, 1946. The remainder of the output came from five base-metal mines, namely, Noranda, Waite Amulet, Golden Manitou, Normetal, and New Calumet, all of which are in the same general area as the gold-quartz mines except the last, which is on Calumet Island in Ottawa River. The Noranda copper-gold mine is the greatest single producer of gold in the province, being credited in 1946 with about 25 per cent of the total output of 618,339 ounces. There were two additions to the list of producing gold mines in 1946, namely, Consolidated Beattie, which resumed production in July and yielded 7,739 ounces, and Elder, which, during development work, shipped some ore to the Noranda smelter for treatment. The output of gold from gold-quartz and from base-metal mines was less, however, than that in 1945.

Diamond drilling and, in most cases, shaft sinking and underground work featured activity at a number of prospects, including: in the Rouyn area, Lake Wasa, Quemont, Macdonald (gold-copper-zinc), New Marlon Rouyn, Anglo-Rouyn (gold-copper), Donalda, Eldona, Joliet-Quebec (gold-copper), Rouyn Merger, Hosco, and Elder properties; in the Cadillac-Malartic area, Heva, Sullivan Consolidated, Shawkey, and Consolidated Central Cadillac; in the Bourlamaque-Louvicourt-Pershing area, East Sullivan (gold-copper-zinc), Louvicourt, Regcourt, Bevcourt, Buffadison, Chimo, Lapaska, Mylamaque, Aumaque, Formaque, and Croinor-Pershing and in Gaspe Peninsula, the lead-silver-gold-zinc prospect of Candego Mines, Limited. At the Quemont property several million tons of ore have already been indicated. The Louvicourt mine entered into production in April, 1947, and Consolidated Central Cadillac was expected to later in the year. Developments of interest were under way or in prospect on properties in Guillet township; in Apawica Lake, Bachelor Lake, and other sections of the Chibougamau district, into which a road from St. Felicien was under construction by the Quebec Department of Mines; and in Ligneris, Duverny, and Barraute townships. Thus, the outlook appears favourable for an appreciable expansion of the province's gold-mining industry.

British Columbia

In British Columbia, the output of gold was the lowest since 1896, a consequence of a shortage of labour and of a labour strike that lasted from July 3 to November 8. During that period production was virtually at a standstill, but by the end of 1946 most of the mines had resumed operations, the chief exceptions being Hedley Mascot, Nickel Plate, Pioneer, and Bayonne. Most of these, however, were milling ore again in 1947. At Hedley Mascot, mine equipment was being installed to treat the concentrate and so obviate the need of shipping it to the Tacoma smelter.

Of the provinces's total output of 136,242 ounces, about 70 per cent was derived from lode-gold mines, the more important among which in descending order of output were: Bralorne in the Bridge River area; Nickel Plate and Hedley Mascot, near Hedley; Cariboo Gold Quartz and Island Mountain in the Cariboo district; and Sheep Creek in the Kootenay district. Production of lode gold was resumed at Polaris Taku mine in the Atlin district and at Zeballos mine on Vancouver Island. Operations at the Privateer mine, however, were limited to 2 to 3 months because of the destruction of the power-house in May and the subsequent 5-month labour strike. In December the company was developing an ore shoot as rich as any ever worked in the mine, with assays ranging from 1 to 28 ounces a ton.

The remainder of the output in British Columbia was derived mostly from placer gold operations and from the Britannia and Copper Mountain copper-gold-silver mines of Howe Sound Exploration Company, Limited, and the Granby Consolidated Mining, Smelting and Power Company, Limited, respectively. The output of approximately 16,000 ounces of placer gold was 50 per cent greater than in 1945, a result, in no small measure, of increased individual operations on Hyland, Dease, Kechika (Muddy), and Liard Rivers in the Cassiar district. The output is likely to be further increased in 1947 with the expected greater activity in the Similkameen and Tulameen Valleys, where it is proposed to use dredging equipment; on Quesnel River in Cariboo district; and on Manson Creek in Omineca district.

Though production of gold was generally restricted, exploration and development were active and the staking of claims was on the greatest scale in a long time. Encouraging results were obtained from work based upon new geological interpretations. For example, Noranda Mines, Limited, associated with Quebec Gold Mining Corporation (N.P.L.), proved that on the Bridge River property of Pacific (Eastern) Gold Mines, Limited, the rock formations were identical to those in which the orebodies of Bralorne and Pioneer mines occur, and discoveries (silver-lead mainly, with some gold) were made in the Hedley camp.

Progress towards production, or the resumption of production, after a lapse of some years was recorded by: Duthie Mines (1946), Limited, on its gold-silver-lead-zinc claims near Smithers in the Omineca district; Metalsmith Mines, Limited, on its Alpine group of claims near Nelson; Morris Summit Gold Mines, Limited, on its property acquired from Salmon Gold Mines in the Portland Canal mining division; Surf Inlet Consolidated Gold Mines, Limited, on Princess Royal Island; Kenville Gold Mines, Limited, near Nelson; Dentonia Mines, Limited, and Brooklyn Stemwinder Gold Mines, Limited (gold-copper), near Greenwood; the Twin "J" Mines, Limited, on its zinc-copper-silver-gold property on Vancouver Island; Spud Valley Gold Mines, Limited, near Zeballos, Vancouver Island; Vananda Mining Company, Limited (gold-copper), on Texada Island; Cangold Mining and Exploration Company, Limited, on Vancouver Island, 36 miles northwest of Port Alberni; Congress Gold Mines, Limited, and other companies in the Bridge River area; and by Williams Creek Gold Quartz Mining Company, Limited (financed by Quebec Gold Mining Corporation and Nornada Mines), and other companies in the Cariboo area.

The year 1946 was noteworthy for the gratifying results of work in new areas, particularly in Taseko Lake area by Pellaire Mines, Limited (controlled by Quebec Gold Mining Corporation and Noranda Mines), and in Tranquil

Creek area, Clayoquot district, Vancouver Island, by Privateer Mine, Limited. A gold strike was reported to have been made about 100 miles northeast of Hazelton in territory tributary to the Sustut River in the upper reaches of Skeena River, where some 500 claims were rcorded.

Saskatchewan

Aside from a trifling amount of placer gold, Saskatchwan's output of gold for the past several years has come from that part of the copper-zinc-gold mine of Hudson Bay Mining and Smelting Company, Limited, at Flin Flon that lies within the province.

Newcor Mining and Refining, Limited (successors to Flin Flon Gold Mines, Limited, and Douglas Lake Mines, Limited) expects to have the necessary plants installed in 1947 for the production of gold and arsenic at its property 3½ miles west of Flin Flon. The outlook for production from other sources in the near future appears to depend largely upon the success that may attend the continuation of efforts undertaken in 1946 in the Rottenstone mining division by The Consolidated Mining and Smelting Company of Canada, Limited, in Joe-Jay and Star Lake areas, and by Hudson Bay Mining and Smelting Company in Nistoassini Lake area; and upon the success of efforts at Sulphide Lake north of Lac la Ronge; at Phantom, Schist, and Barrier Lakes in the Flin Flon area; at Amisk Lake and Kettle Falls in the Churchill mining division; and at Lake Athabaska. Geophysical surveys were made at each of the last three localities.

Manitoba

Of Manitoba's output of 79,402 ounces, about 54 per cent came from the San Antonio gold-quartz mine in the Rice Lake area and the remainder from the copper-zinc-gold ores of Hudson Bay Mining and Smelting Company's mine at Flin Flon, and of the Sherritt Gordon mine 40 miles northeast of Flin Flon. Though production was 11 per cent greater than in 1945, shortage of labour prevented capacity operations. Sherritt Gordon's output during the last half of 1946 was lower than it has been for many years. The ore at the company's east mine is now practically exhausted.

Prospecting and development work were exceptionally active. The outstanding development is that on the Nor-Acme property of Howe Sound Exploration Company, Limited, at Snow Lake, west of Herb Lake, where preparatory and construction work in the opening up of the large medium-grade gold property was maintained throughout the year. Ore reserves, as of May, 1945, were officially estimated at 4,860,900 tons averaging 0·1363 ounce of gold per ton. A 5-compartment shaft will be sunk to 1,000 feet in 1947, and the machinery for a 2,000-ton mill will be brought in over the road being built by the Manitoba Government from Herb Lake, which is already connected by road with the Hudson Bay Railway. Electric power from the Churchill River plant will be available in 1947 and production at the property is expected to commence in 1948.

Squall Lake Gold Mines, Limited did considerable drilling with encouraging results on its property 5 miles northeast of the Nor-Acme deposit. Wekusko Consolidated, Limited resumed underground exploration at its Ferro property, 4 miles northeast of Herb Lake settlement, as did Century Mining Corporation, Limited, on the Elbow Lake property it acquired from Golden West Mines, Limited, which it controlled. This property was in production for a few months in 1941 and 1942. Much farther north, in the Lynn Lake-Barrington Lake area beyond Granville Lake, it is reported that a number of gold showings were found, on one of which drilling has indicated 140,000 tons averaging 0·21 ounce of gold over a mean width of 4·2 feet to a depth of 350 feet.

In the Rice Lake area San Antonio Gold Mines, Limited plans underground work in 1947 on a rich outcrop, 10 miles northeast of its mine, that was disclosed by drilling. The work will be done by Jeep Gold Mine, Limited, a subsidiary that was organized for the purpose. Ogama-Rockland Gold Mines, Limited, developing a property to the southeast from which gold ore was formerly shipped, intends to continue underground work in 1947, as does Kiwago Gold Mines, Limited, on an adjoining property. Gold Pan Mines (1945), Limited, which commenced surface exploration in 1946 on claims 6 miles southeast of San Antonio mine, is considering underground exploration where previous operators had sunk a shaft, and, nearer San Antonio mine, where Sannorm Mines, Limited did extensive drilling.

Yukon

The Yukon Consolidated Gold Corporation, Limited accounted for 85 per cent of the gold output in Yukon, which was 43 per cent greater than in 1945. Practically all of the output came from placer deposits mainly in the Klondike district, where large-scale dredging operations are conducted from May to late in October. The labour situation did not improve as much as the company had expected.

There is an increasing tendency toward prospecting with modern equipment on many old placer creeks that had been worked to only a limited extent in the past. Large companies are leasing great stretches of creeks, with the result that individual operations are decreasing yearly. In 1944, for example, Numalake Mines, Limited acquired 100 miles of prospecting leases, and Clear Creek Placers, Limited added to its holdings by obtaining considerable acreage on Matson, Thistle, Barker, and Rosebute Creeks. The latter company installed a dredge on Henderson Creek in 1946 and will have one on Thistle Creek in 1947. Yukon Explorations, Limited took over the holdings of Sunshine Mining Company on creeks in the Sixtymile River area and is planning for large-scale operations in 1947 on 7·5 miles of already explored dredging ground. The unexplored ground comprises 8 miles on Glacier Creek.

There has been a renewal of activity in southern Yukon especially on Shorty, Bullion, Duke, Gladstone, Livingstone, and Tatshenshini Creeks.

A noteworthy event of the year was the encouraging results obtained from the surface examination and drilling by Brown-McDade Mines, Limited, of its lode gold-silver deposit discovered near Victoria Creek in the Carmacks area. Exploration for lode gold and silver deposits was undertaken by Transcontinental Resources, Limited, in the Windy Arm area, which lies south of Carcross, where some work was also done on Big Thing and other old mines to determine whether they can be mined economically. The Hudson Bay Mining and Smelting Company is developing a lode gold property on Log Jam Creek, a tributary of Teslin Lake.

Northwest Territories

The production of 23,420 ounces credited to Northwest Territories came from the Negus and Con mines near Yellowknife on the north shore of Great Slave Lake. Production at the Con mine was resumed in August after a lapse of nearly three years. Two formerly producing properties, namely, Thompson-Lundmark, and the gold base-metal mine on Outpost Island, Great Slave Lake, which is now owned by Philmore Yellowknife Gold Mines, Limited, are expected to resume production in 1947.

Exploration, staking, and development were again on a pronounced scale, mining interest in the Yellowknife area being intensified by work under way by the Dominion Government. This comprises development of hydro-electric power on Snare River; topographical, geological, and hydrographic surveys; townsite surveys and improvements; and betterment of highway, air, and water transportation facilities, including, under arrangement with the Alberta Government, the construction of an all-weather 378-mile road to link Great Slave Lake to Grimshaw, which is near the head of the railroad passing through Peace River, Alberta.

Headway was made by Giant Yellowknife Gold Mines, Limited, in the development of its property, by far the most outstanding in the whole area and one of the greatest gold discoveries in Canada in recent years. Construction of the first mill unit of 500 tons daily capacity will be undertaken in 1947, but production at that rate will not be attained until power from the Snare River development becomes available, presumably late in 1948. Progress was also made in work at other properties. These include Beaulieu, where a 35-ton mill will be installed in 1947 to treat high-grade material; Crestaurum, at which a shaft was put down 410 feet; and Discovery, Diversified, Indin Lake, Akaitcho (adjoins Giant Yellowknife on the north), Spinet, Salmita, Sunset, and Cassidy.

The most promising discovery of the year was that made by prospectors employed by Tom Payne, who found rich gold ore in a shear zone in the Courageous Lake—Mackay Lake area. Prospectors for Don Cameron Exploration Company, Limited (in the financing of which Frobisher Exploration Company, Limited, and Ventures, Limited, were main factors) located, north of 64 degrees latitude, a gold belt of promise on the shore of Regan Lake in the upper Back River area.

Nova Scotia

Nova Scotia's output came from Queens Mines, Limited, operating in the Malaga gold field, Queens county, and The Consolidated Mining and Smelting Company of Canada, Limited, operating at Caribou, Halifax county. The output in 1946 (*See* page 27) compares with 29,943 ounces in 1939, and with a peak of 30,348 ounces in 1902. The renewed interest in prospecting, which is aided through use of the drilling equipment of the Provincial Department of Mines, supports the view that, despite the costliness of operating the narrow veins characteristic of the province's many small gold fields, new or formerly producing properties will be developed as soon as equipment is available and labour is more plentiful.

Canadian Production by Regions; World Production; Prices

The following table compares the Canadian output in 1946 with that in the preceding year, and with 1941, the year of peak production:—

Region	1946	1946*	1945	1941
	oz.	oz.	oz.	oz.
Ontario—				
Gold Areas—Porcupine	901,953			
Kirkland Lake	402,693			
Larder Lake	145,208			
Matachewan	41,833			
Sudbury				
Algoma				
Thunder Bay	104,621			
Patricia	154,979			
Other Mines	84,600			
Totals, Ontario		1,813,333	1,625,368	3,194,308
Quebec—				
Gold mines	406,734			
Base-metal mines	179,497			
Totals, Quebec		618,339	661,608	1,089,339
British Columbia—				
Gold mines (lode)	93,693			
Gold mines (placer)	15,266			
Other mines	14,389			
Totals, British Columbia		136,242	186,854	608,203
Saskatchewan—				
Gold mines				
Other mines	112,000			
Totals, Saskatchewan		112,101	108,568	138,015
Manitoba—				
Gold mines	42,732			
Other mines	36,000			
Totals, Manitoba		79,402	70,655	150,553
Yukon (chiefly placer)		45,286	31,721	70,959
Northwest Territories— Gold mines		23,420	8,655	74,417
Nova Scotia		4,321	3,291	19,170
Alberta (placer)		110	7	215
Canada—Output		2,832,554	2,696,727	5,345,179
Value		$104,096,359	$103,823,990	$205,789,392

* The totals for 1946 are finally revised figures. The other figures for 1946 are preliminary.

World gold production (excluding Russia) totalled 31,500,000 ounces in 1945, compared with 37,100,000 ounces in 1940, the peak year. The corresponding figure for 1946, based on less complete data, is given by Engineering and Mining Journal (February, 1947) as 22,500,000 ounces. In each of the years referred to, Canada was second to the Union of South Africa, the outstanding leader, which produced over 53 per cent of the world output in 1946.

This compares with 13 per cent for Canada and 7 per cent for the United States. The price per ounce of gold paid by the Dominion Government in 1946 to Canadian producers was virtually the same as the equivalent in Canadian currency of the United States price, which has been $35 for some years now. In the first half of the year the Canadian equivalent was $38.50, but in the latter half only $35 owing to the restoration of parity on July 5.

IRON ORE

Production of iron ore in Canada continued to expand moderately in 1946, shipments being 1,440,640 long tons, compared with 1,013,221 tons in 1945. All of it came from mines in Ontario. Of the 1946 shipments, 389,113 tons was used in Canada and the remainder was exported. Of the 2,426,325 long tons of ore used in Canadian furnaces, only 16 per cent was from Canadian mines. It is likely that this preponderance of imported ore over domestic ore will continue for some years to come, though possibly in lesser degree as the supply of Canadian ore becomes more abundant. The imported ore, though of lower grade, is relatively cheap and the Canadian ore brings premium prices in the United States. Thus, the international exchange of ores is of benefit to both countries.

Shipments of Canadian Iron Ore, 1946

	Long tons
Michipicoten	
Helen and Victoria mines (including fines from Josephine mine)	552,056
Josephine (lump ore)	58,103
Steep Rock Mine	830,481
Total Canadian shipments	1,440,640

The output from Michipicoten has reached a maximum for the present facilities. Steps were taken to increase the Steep Rock tonnage moderately in 1947, and to bring a second large orebody into production in three or four years. Development of the large deposits in the Labrador-Quebec boundary area proceeded satisfactorily, but there will be no production for some years to come.

Principal Canadian Sources of Supply

Only two of the many known iron-bearing districts in Canada produced ore in 1946, namely: Michipicoten, northeast of Lake Superior; and Steep Rock, 150 miles west of Port Arthur. No work was done on the magnetite deposits of eastern Ontario. Plans for the use of the magnetite ore of the Pacific coast did not mature.

Algoma Ore Properties, Limited—Helen Mine. The large body of siderite at the Helen mine extends several thousand feet eastward from the original hematite deposit from which 2,520,865 long tons of ore was shipped between 1900 and 1918. The siderite has been drilled beneath the former hematite deposit and eastward beneath the siderite outcrop, to outline 100,000,000 tons of siderite ore.

During 1946 ore was extracted from two open-pits, the New Helen pit adjacent on the east to the former hematite deposit, and the Victoria pit, about ¾ mile east of the New Helen pit. The crude ore from the Victoria pit was treated by the sink-and-float process to reduce the silica content.

The New Helen and Victoria pits furnished 843,420 long tons of siderite to the sintering plant on the Algoma Central Railway at Wawa. The Josephine mine, 8 miles northeast of the Helen mine, shipped 97,480 long tons of hematite concentrate to Wawa. From this siderite and hematite there was made 552,056 long tons of sinter. Somewhat more than half this sinter was used in the furnaces of Algoma Steel Corporation at Sault Ste. Marie, Ontario, owners of the mine, and the remainder was exported to the United States. Algoma Ore Properties is the sales agent.

The typical analysis of siderite and sinter, and the guaranteed grade for 1946 are:

Michipicoten Siderite and Sinter

—	Siderite, per cent	Sinter, per cent	Guarantee, 1946: Dried at 212°F, per cent	Guarantee, 1946: Natural, per cent
Iron	35·00	51·50	51·84	*51·00
Phosphorus	0·014	0·02	0·018	0·018
Sulphur	1·76	0·04	0·064	0·063
Manganese	2·04	3·00	3·05	3·00
Silica	6·46	9·50	9·97	9·81
Lime	2·45	3·60	3·84	3·78
Magnesia	5·41	7·96	7·48	7·36
Alumina	1·60	2·35	1·84	1·81
Loss on ignition	32·00	....	....	1·61

*54·00 per cent iron plus manganese.

Preparations were under way to develop an underground mine beneath the Helen open-pit. To augment the production of the Victoria pit, if necessary while the mine is being developed, the Bartlett deposit of siderite which adjoins the Algoma Central Railway 9 miles northeast of the Helen was being prepared for production. Drilling indicated that the grade of ore is at least equal to that of the Helen and the tonnage available from an open-cut will last for several years.

Michipicoten Iron Mines, Limited—Josephine Mine. During 1946 the Josephine mine yielded 165,085 long tons of crude ore, which was treated by screening, washing, and jigging to produce 27,588 tons of open-hearth lump ore and 97,480 tons of concentrate. The lump ore was marketed by Algoma Ore Properties and the concentrate was mixed with siderite from the Helen mine to make sinter.

On September 15, 1946, caving commenced above one of the stopes and continued through to surface, which is the bottom of a small lake that had been drained to facilitate mining. This let into the mine an estimated 80,000 cubic yards of mud and slime that flooded the lower levels. As the mine had been operated at a loss up to this time, Sherritt Gordon Mines, Limited (which controls Michipicoten Iron Mines, Limited) decided not to pump it out.

Steep Rock Iron Mines, Limited—Steep Rock Mine. The 1946 shipments of Steep Rock ores were 830,481 long tons, compared with 504,772 long tons in 1945, an increase of 64 per cent. Production for the year, all from the "B" orebody, was 993,798 tons, of which 167,654 tons was stockpiled at the mine after the end of the shipping season. The company expects to attain a similar increase in the output for 1947. There is substantial evidence that the open-pit on "B" orebody can produce approximately 1,000,000 tons annually for some years to come.

Preparations were commenced to open the "A" orebody, 1½ miles north of "B". This involves some preliminary drilling, pumping out the remainder of the Middle Bay of Steep Rock Lake, and removing the overburden. The surface of "B" orebody lies 170 feet, and "A", 333 feet below the former surface of the lake. From the preliminary drilling, it appears that "A" orebody will be capable of providing an annual output about double that from "B", after it has been fully prepared for mining. It is estimated that three or four years will be required to complete the preparations, though a limited output may be obtained in the meantime.

Steep Rock crude ore is separated by screening into three shipping grades, the expected analyses for 1947 being as follows:

Steep Rock Hematite

—	"B" orebody	Shipping Grades: Steep Rock Lump, 1½" to 9"	Shipping Grades: Seine River, Minus 1½"	Shipping Grades: Rainy Lake, Minus 1½"
	per cent	per cent	per cent	per cent
Iron (natural)	56·54	57·60	51·70	50·50
Phosphorus	0·016	0·024	0·022	0·022
Sulphur	0·036	0·029	0·029	0·029
Manganese	0·18	0·14	0·18	0·18
Silica	3·18	4·32	5·81	8·05
Lime	....	0·31	0·29	0·29
Magnesia	....	0·26	0·24	0·24
Alumina	0·67	0·96	1·34	1·57
Loss on ignition	....	7·20	7·61	7·61
Moisture	7·00	4·00	10·55	10·50
Iron (dry basis)	60·80	60·00	57·80	56·43

Shipments in 1946 were all made through the ore dock of Canadian National Railways at Port Arthur. Most of the ore was sold in the United States, Cleveland-Cliffs Iron Company being the sales agent.

Labrador and Quebec. Prospecting of this extensive iron range, astride the Labrador-Quebec boundary in the central part of the Ungava Peninsula, has indicated high-grade hematite deposits for a length of 100 miles. The width of the iron-bearing formation varies from 20 to 40 miles. It has been impossible up to the present to cover the whole of this large area of 3,000 square miles or more of favourable ground with more than rather cursory and wide-spaced traverses. Work has been concentrated on the central section, about 50 miles in length and 5 miles in width, within which are located most of the large high-grade deposits so far discovered. Within and beyond this central area, large deposits of medium-grade ore (40 to 50 per cent iron in the outcrops) have been found, as well as very large areas of the siliceous iron formation. On none of these deposits had enough work been done by the end of 1946 to determine the full dimensions. Hollinger North Shore Exploration Company, a subsidiary of Hollinger Consolidated Gold Mines, Limited, holds the concession on the Quebec side of the border, and Labrador Mining and Exploration Company, Limited, controlled by Hollinger Consolidated, the concession on the Labrador side. M. A. Hanna Company of Cleveland has a minority interest.

Development work during the brief field season of 1946 consisted mainly of drilling on some of the larger outcrops in the central section astride the height-of-land which constitutes the Quebec-Labrador boundary. This drilling showed that, in some deposits at least, the hard, dense hematite of the surface outcrops constitutes a covering or crust on top of the softer ore that resembles fairly closely the characteristic high-grade ore of the Mesabi range in Minnesota. Several of the outcrops are thousands of feet in length and hundreds of feet in width. A satisfactory depth has been determined in several places. There is thus some definite evidence that large open-pit operations can be established in due course.

No details as to the grade of the ore disclosed by drilling in 1946 have been made public, but there is no reason to believe it is different from the outcrops.

Preparations were made during the winter of 1946-47 for a longer field season in 1947. A landing strip for large transport planes was being constructed. A permanent base camp was established and motor roads were being cleared to connect with the airport and with the main iron ore deposits, throughout a length of 35 miles. The drilling and test-pitting to be conducted in 1947 and 1948 will, it is hoped, prove enough ore to warrant the heavy financial commitment required for the next stage of the development.

During 1945 and 1946 preliminary reconnaissance for a railway route was made. In 1947 a preliminary location is to be made, approximately along the Moisie River in the vicinity of the port of Seven Islands on the Gulf of St. Lawrence, directly northward to the central deposits, a distance of 350 miles. The Dominion Government has granted a railway charter.

Production and Trade

Only during the 18th and 19th centuries did Canada produce enough iron ore to feed its own furnaces. The small plants of those times were supplied from deposits close at hand. Only the Helen mine in Michipicoten, Ontario, and the Magpie mine nearby were operated commercially during the first quarter of the present century. From 1923 to 1939 there was no production of iron ore in Canada. The table below indicates how rapidly the output has increased since 1939. In 1946 an amount of ore equal to over half the tonnage required for Canadian furnaces was produced in Canada. It seems probable that in 1947 the production in Canada will be about equal to the consumption of the furnaces in Ontario, those in Nova Scotia being supplied with ore from the Wabana mines in Newfoundland. The fact that most of the Canadian ore is exported to the United States and the required balance is imported is to the advantage of Canadian trade.

Shipments of Canadian Iron Ore

(Thousands of long tons)

—	Helen sinter	Josephine lump ore	Steep Rock hematite	Total Canada
1939	109	....	....	109
1940	358	....	....	358
1941	456	....	....	456
1942	482	....	....	482
1943	440	....	....	440
1944	474	....	16	490
1945	462	1	485	948
1946	552	58	830	1,440

An outline of the trade in iron ore is given in the following table:

Canadian Iron Ore Production, Imports, and Exports

(Long tons)

—	Canadian ore		Imports			Total ore used in Canada
	Used in Canada	Exported to United States	From United States	*From New-foundland	From other countries	
1938	....	187	563,420	541,987	57,477	1,162,884
1939	100,945	9,411	1,076,126	468,615	31,012	1,676,698
1940	123,280	224,666	1,434,621	639,569	84,951	2,282,421
1941	208,901	251,846	1,975,390	859,160	71,392	3,114,843
1942	222,630	264,250	1,816,037	545,421	51,014	2,635,102
1943	238,051	334,533	2,659,275	813,795	14,810	3,725,931
1944	218,598	275,377	2,233,694	557,938	20	3,010,250
1945	324,387	688,835	2,668,289	657,737	13,125	3,663,538
1946	360,953	1,022,550	1,505,568	463,005	68,638	2,398,164

* All from Wabana Mines of Dominion Steel and Coal Corporation, Sydney, Nova Scotia.

As such a large part of the ore supply for Canadian furnaces is obtained from the Lake Superior district of the United States, it is of interest to notice the trend of the average grade of shipments, part of which represents Canadian imports.

Lake Superior Shipments

(Average of all grades)

Year	Long tons	Natural iron	Dry silica	Moisture
		per cent	per cent	per cent
1904	21,436,000	55·02	6·12	9·36
1924	43,276,000	51·72	8·45	10·75
1944	81,039,000	51·72	8·42	11·02
1945	75,207,000	51·69	8·52	10·96

The rate of decline in grade has been reduced markedly during recent years by the installation of washing plants to remove siliceous gangue from the raw ore.

The part played by the Canadian mines in the total (United States plus Canada) Lake Superior production is illustrated in the following table:

Lake Superior Shipments in 1946

——	Long tons	Per cent of total Lake Superior shipments	
Mesabi Range	46,326,240	75·91	....
Total U.S. Ranges	59,587,730	....	97·64
Michipicoten	610,159	1·00	....
Steep Rock	830,481	1·36	....
Total Canadian	1,440,640	....	2·36
Total Lake Superior	61,028,370	....	100·00

The Wabana iron mines in Newfoundland are capable of producing a much larger annual tonnage of ore than at present, and the cost of mining and transportation is low.

The ore is high in silica, which increases the cost of smelting it. The high phosphorus content restricts its more general use on this continent.

Wabana Hematite

Typical Analysis

	Per cent
Iron	52·5
Phosphorus	0·85
Sulphur	0·018
Silica	12·0
Lime	2·0

Some details of iron ore imports from overseas (excluding Newfoundland) are shown in the following table:

Canadian Iron Ore Imports from Overseas

(Long tons)

—	Great Britain	Sweden	Brazil	Others
1938	13,096	....	31,289	13,090 (Norway, 6,090: Philippines, 7,000)
1939	....	12,738	18,218	....
1940	....	13,535	71,416	....
1941	....	....	65,018	6,348 (Br. South Africa)
1942	....	....	47,722	3,292 (Mexico)
1943	....	....	14,800	....
1944	....	....	....	....
1945	....	13,126	....	....
1946	....	38,339	30,300	....

The above shipments comprised mainly open-hearth lump ore for use of Dominion Steel and Coal Corporation at Sydney, Nova Scotia. When the Swedish supply was cut off in 1941, mines in Brazil furnished an adequate amount until 1943, when shipments ceased. To meet the emergency at Sydney, carloads of lump ore were sent by rail from Steep Rock mine in Ontario as fast as the ore was produced. This situation was relieved only with the arrival of the first shipments of magnetite from Sweden after the end of the war in 1945.

It seems likely that there will be available for export an ample supply of Swedish ore for several years. Before the war, over 60 per cent of the Swedish ore went to Germany, where little will be required for some time. This will probably give an adequate supply for the Brititsh furnaces, which formerly used about 20 per cent of the Swedish output, and for other customers. The bulk of the Swedish ore is natural magnetite from the Kiruna deposits in Lapland.

Kiruna Iron Ore

Typical Analysis of Magnetite Concentrate

	Bessemer Grade per cent	Non-Bessemer per cent
Iron	69·5	67·7
Phosphorus	0·019	0·258
Sulphur	0·02	0·017
Silica	1·69	2·07

The principal iron ore in Brazil at present available for export is from Itabira in the province of Minas Geraes. These deposits are 350 miles westward from the port of Victoria and are served at present by a narrow-gauge railway. This railway, the loading facilities at Victoria, and the mine equipment at Itabira were considerably improved during the war by means of an Anglo-American loan; but the cost of transport still is high and is likely to remain so. There are three types of ore, a hard surface layer of almost pure hematite; a type called "canga" which consists of fragments of hematite, cemented with iron oxides; and soft ore beneath the hematite that has been found only by means of tunnels and bore-holes. Average analyses of these are stated to be:

Average Analyses of Itabira (Brazil) Hematite

—	Hard hematite	"Canga"	Soft ore
	per cent	per cent	per cent
Iron	68·8	61·9	68·2
Phosphorus	0·01	0·06	0·02
Sulphur	0·02	0·04	0·02
Insoluble	1·32	0·35	2·17

LEAD

Canada's lead production was slightly higher than in 1945, and due to a strong demand for the metal and a marked increase in the price of lead abroad the value of the lead produced was the highest on record. Domestic consumption continued at about twice the pre-war level and was about 45 per cent of the pig lead production.

Principal Canadian Sources of Supply

In British Columbia, The Consolidated Mining and Smelting Company of Canada, Limited, one of the world's greatest producers of lead and zinc, continued to supply more than 95 per cent of the Canadian output of lead. The company operates the Sullivan mine and the concentrator of 8,600 tons daily capacity, both located near Kimberley. The concentrates are shipped 205 miles by rail to the company's smelter and refineries at Trail, where 165,744 tons of refined lead was produced in 1946. Tonnage of ore mined was slightly lower than in 1945; but a great deal of underground development work was done, much of it in connection with changes in the stoping system designed to simplify the mining of the lower portions of the orebody. No. 1 incline shaft was deepened 500 feet. Work was commenced on a new haulage level consisting of over 2 miles of tunnel from the mine workings to the concentrator site. When this project is completed it will eliminate the present system whereby the crushed ore is transported 3 miles by railway. A sink-float plant will be erected near the concentrator to eliminate coarse waste material by gravity selection before concentration. No serious labour difficulties or shortage of labour at Kimberley or Trail was experienced in 1946.

Other lead production in British Columbia came from a number of smaller operations most of which were more or less adversely affected by labour troubles. Base Metals Mining Corporation at Field and Western Exploration Company, Limited at Silverton, which have been steady producers of lead and zinc concentrates in recent years, were shut down in July due to labour strikes, but production is expected to be resumed in 1947. Ainsmore Consolidated Mines, Limited at Ainsworth operated continuously in 1946, shipping lead and zinc concentrates to the United States. At Zincton Mines, Limited, near Slocan Lake, a silver-lead orebody was developed above the present zinc ore workings. A road was constructed to this deposit and a lead recovery circuit was being added to the concentrator. The increased price of silver brought renewed interest in many of the dormant silver-lead-zinc mines throughout the province and a number of these were reopened and worked in a small way. Some twenty-six lessees and other operators in the southeastern part of the province shipped small lots of ores or concentrates to the Trail smelter.

Development and further exploration on a substantial scale of silver-lead deposits was commenced, notably: north of Alice Arm, where The Mining Corporation of Canada, Limited acquired control of the Torric mine; near Stewart, where Big Four Mines, Limited was reopening several former producing mines in the vicinity of Beaverdell; and in the Taku River area, where The Consolidated Mining and Smelting Company was developing the Tulsequah Chief property. There was renewed activity also in Yukon, particularly in the Mayo district where some of the rich silver-lead mines were reopened by Keno Hill Mining Company, Limited. About 160 tons of silver-lead ore was shipped from Mayo in 1946.

In Ontario, Berens River Mines, Limited exported a small amount of concentrate containing lead to the United States.

In Quebec, New Calumet Mines, Limited, on Calumet Island in the Ottawa River, produced concentrate for export containing about 3,600 tons of lead. The mill treated an average of about 570 tons a day. Considerable underground development was done, principally in opening up several orebodies. Golden Manitou Mines, Limited, in Bourlamaque township, produced about 1,600 tons of lead concentrate containing 850 tons of lead.

A discovery of lead-bearing ore was made northeast of Mistassini Lake. Other developments on known lead deposits include those of Candego Mines, Limited, in the central part of Gaspe peninsula, and of the Gulf Lead Mines, Limited, at Richmond Gulf on the east coast of Hudson Bay, where a limited amount of exploratory work was done.

Production and Trade

Canada produced 176,987 tons of lead valued at $23,893,230, compared with 173,497 tons valued at $17,349,723 in 1945. British Columbia contributed 98 per cent of the output.

Exports of pig lead amounted to 104,109 tons valued at $15,977,709, compared with 107,292 tons valued at $8,603,049 in 1945. Forty-eight per cent of the pig lead exported went to United Kingdom, 25 per cent to European countries, and 20 per cent to the United States. Lead exported in ores and concentrates amounted to 6,006 tons valued at $736,933, compared with 7,834 tons valued at $573,690 in 1945. The export of lead concentrate to Belgium, which trade was disrupted during the war, was resumed in December, and amounted to 1,107 tons. The rest was shipped to smelters in United States.

Imports of lead and lead products were valued at $4,531,051, of which the value of tetraethyl compounds imported from the United States amounted to $4,075,721. In 1945 imports of lead and lead compounds were valued at $4,756,005.

Consumption of lead in Canada was estimated to be about 63,000 tons in 1945, of which 30 per cent was used in storage batteries, 27 per cent in solders, babbitts, etc., 19 per cent in paints and pigments, 14 per cent in cable coverings and 10 per cent for ammunition and other uses.

World consumption of lead has increased considerably compared to the pre-war period, particularly in the United States which has been using about one million tons annually. In Europe lead has always been used in large quantities for plumbing, cable covering, and roofing, and the need is now especially great for reconstruction. World production in 1939 (complete figures for the war or post-war years are not available) on a smelter basis, as published by American Bureau of Metal Statistics was 1,890,362 short tons, the principal producing countries in order of importance being: United States, Australia, Mexico, Germany, Canada, Belgium, and Russia. Although world output increased during the war there was a decline in 1945 and 1946, particularly in the United States, Mexico, and Australia, and stocks in various countries were largely consumed. Indications are that for the next few years production will not meet world requirements although this situation will be partly offset by the re-use of scrap lead which has been a very important source of the metal. In Rhodesia one new producer came into production at a rate of about 1,000 tons of metal a month, and several discoveries of lead deposits that appear to be large were reported in 1946, particularly in Morocco, Tanganyika, and Mexico. It is not likely, however, that mines in these areas can be developed sufficiently to make any material contribution toward relieving the scarcity of the metal for several years.

Uses

Lead has many uses and the demand for it is more steady than for most non-ferrous metals. In peace time, the principal uses of lead in order of importance are for storage batteries, cable coverings, white lead, red lead, litharge, ammunition, and lead tetraethyl. Other uses include lead for collapsible tubes, sheet, solder, babbitt, type metal, caulking lead, and bronze. In North America about 25 per cent of the lead is used in storage batteries, from which it can be recovered and re-used. In other countries where fewer automobiles are operated the production from secondary lead is less important. Lead is completely dissipated in certain uses such as in paints, ammunition, and tetraethyl compound. The last, which is used for tempering gasoline, contains 45 to 60 per cent lead and has an increasingly large outlet. The development of atomic power may eventually create an important new use for lead, as large tonnages will probably be required for protection of personnel against radiation.

Prices

In Canada, the controlled price ceiling of 5 cents a pound prevailed throughout 1946, but was increased to 10·625 cents a pound on January 22, 1947. Producers of refined lead were obliged to satisfy domestic requirements before exporting the surplus. The average price (based on exports plus domestic consumption) was 6·75 cents a pound. In the United States, the controlled price of 6·5 cents a pound, which had been constant since 1942, was raised in June, 1946, to 8·25 cents a pound. When price controls on metals ended on November 11, 1946 the price of lead became 10·5 cents, equivalent to the price paid at New York for foreign lead. At the end of 1946 it had increased to 12·5 cents and was continuing to rise early in 1947. The average price of pig lead in New York was 8·109 cents a pound. In the United Kingdom the price increased during the year from £30 to £55 a long ton.

MAGNESIUM

Production of magnesium in Canada in 1946 was confined to a small tonnage made in a pilot plant operated by Aluminum Company of Canada at Arvida, Quebec. Based on data obtained from this work the company was building an electrolytic magnesium plant having an initial rated capacity of 1,000 tons a year. The raw material will be magnesia obtained from brucitic limestone at the company's plant at Wakefield, Quebec.

Dominion Magnesium, Limited, Haley, Ontario, shipped a considerable tonnage of magnesium from stock and also made and shipped various magnesium alloys, but there was no production of the metal.

Progress was made in developing and furthering the use of magnesium and its alloys, and prospects are good for the greater utilization of this light metal in the near future.

Light Alloys, Limited, Renfrew, Ontario, enlarged the capacity of its magnesium foundry and installed die-casting equipment. Magnesium foundries were also operated by Robert Mitchell Company, Limited, Montreal, and by Western Magnesium, Limited, Vancouver.

Principal Canadian Sources of Supply

Sources, actual and potential, of magnesium in Canada are brucite, dolomite, magnesite, serpentine, and sea-water.

Brucite, the hydroxide of magnesium, containing 41·6 per cent magnesium, is available in the form of granules 1 to 4 mm. in diameter thickly disseminated throughout certain deposits of crystalline limestone in Quebec, Ontario, and British Columbia. The Canadian deposits of this mineral are the largest known. The brucite is being recovered in the form of magnesia granules at a plant operated by Aluminum Company of Canada, Limited, at Wakefield, Quebec, and is being used for the production of magnesium as well as for the manufacture of basic refractories, and for fertilizer.

Magnesite, the carbonate of magnesium, containing 28·7 per cent magnesium, and hydromagnesite containing 26·5 per cent magnesium are available in British Columbia, Deposits of magnesitic dolomite consisting of an intimate mixture of magnesite and dolomite occur in Argenteuil county, Quebec, where they are being worked for the production of basic refractories. The magnesite deposits in British Columbia are undeveloped, but magnesium has been made from them on an experimental scale. Magnesitic dolomite possesses no advantages over dolomite or magnesite as a source of magnesium.

Serpentine, the silicate of magnesium, contains 25·8 per cent magnesium, and occurs in many deposits throughout Canada. It is also available in huge waste dumps, aggregating probably 100,000,000 tons, in the asbestos-producing region of Quebec. The average magnesium content of these dumps is about 23 per cent. A process has been worked out for the recovery of magnesium from serpentine.

Sea-water, although it contains only 0·13 per cent magnesium, is a source of the metal in England and the United States. Dolomitic lime is used to precipitate the magnesia from the sea-water in the form of hydroxide, and the magnesia from both is recovered in the process.

Underground brines containing magnesium chloride ($MgCl_2$), and residual brines from salt-making operations, containing $MgCl_2$, are used in the United

States as sources of magnesia, but brines containing sufficient $MgCl_2$ to render them of value are not available in Canada.

Processes for the production of the metal from the various raw materials may be divided into two groups, namely, electrolytic and thermal. The electrolytic process provides practically all of the magnesium made. The three thermal reduction processes that have been developed to the commercial stage involve: reduction of magnesia with carbon; reduction of magnesia with calcium carbide; and reduction of calcined dolomite with ferrosilicon.

Production and Trade

The field of usefulness for magnesium is steadily expanding. It was formerly used almost exclusively in pyrotechnics, but it is now an important structural material, being used alloyed with various proportions of other metals in the form of castings, extruded shapes, forgings, and sheets. Other uses, such as for the cathodic protection of underground pipelines and of domestic hot-water tanks from corrosion, have been developed. It is also used as a minor constituent of many aluminium-base alloys.

The price quoted by *Engineering and Mining Journal* during 1946 for 99·8 per cent magnesium in ingot form in carload lots was 20½ cents per pound, U.S. currency, f.o.b. New York.

MANGANESE

All manganese properties in Canada have been inactive since 1943. The small Canadian production of manganese ore in the past came mainly from deposits in the Maritime Provinces. This output ranged from a peak of only 957 tons in 1916 to a low of 48 tons in 1943. Known deposits of high-grade manganese ore in Canada are small and are almost exhausted. Adequate supplies of high-quality ore can now be obtained from foreign deposits.

About 97 per cent of the imports of manganese ore in 1946, totalling 144,023 tons, came from Africa, mainly from the Gold Coast. In 1945 imports were 193,322 tons, also mainly from the Gold Coast. Consumption in 1946 was 139,200 tons, 70 per cent above that of 1944. Stocks of ore at the end of 1946 were 50,465 tons, compared with about 7,000 tons a year previously. About 4,500 tons of the Canadian consumption in 1946 was used in the manufacture of dry batteries and the remainder for use in the metallurgical industries.

Canadian production of manganese ferro-alloys, of which 53 per cent was ferro-manganese, and 34 per cent silico-manganese, totalled 41,735 short tons, 37 per cent below that of 1945. Exports of ferro-manganese amounted to 32,486 tons, and of spiegeleisen to 887 tons. Stocks of manganese alloys at the end of 1946 were about 1,800 short tons.

World production of manganese ore is estimated to be between 5 and 6 million tons annually, the leading producing countries being Russia, British India, Gold Coast, Union of South Africa, Brazil, Cuba, and United States. Prior to the last war Russia was the source of nearly half of the world production, the principal deposits being in the Republics of Georgia and Ukraine. Its estimated output for 1945 (1946 not available) was about 2¼ million tons. India and Gold Coast are each producing about half a million tons a year, and South Africa, Brazil, and Cuba, about ¼ million tons. Output of 153,000 tons in the United States in 1946 was 16 per cent below that of 1945.

MERCURY

In contrast with the shortages of most other metals, mercury was in abundant world supply in 1946, and prices for the metal continued to decline appreciably. Chief contributing factor to this decline was the excess of supplies in Europe, the principal source of output, in relation to the demand. Other factors of importance was the discovery of large stockpiles of mercury in the American zone of Germany and in Japan. Operation of the Mercurio Europeo cartel also had a depressing effect on the market. During the latter part of 1946 this Italo-Spanish combine appointed London and Scandinavian Metallurgical Company as the agent for the United States, and Elder, Smith and Company for the British Empire.

All of the Canadian production has come from the Pinchi mine of The Consolidated Mining and Smelting Company of Canada, Limited, and from the Takla property of Bralorne Mines, Limited, both of which mines are in Omineca mining division, British Columbia. The Pinchi mine was the largest single producer of mercury in the Western Hemisphere. Canadian production of mercury ceased in September, 1944, and since then shipments have been made from producers' stocks. Ore reserves in the Pinchi and other deposits in British Columbia are sufficient to permit operation at the record rate of 1943 for years should this become necessary.

Production and Trade

During the time the two aforementioned mines were in operation, Canada produced a total of 56,641 flasks of mercury, which at 76 pounds to a flask amounts to 2,076 tons. Exports in 1946 were 750 flasks valued at $100,665, of which 98 per cent went to India, and the remainder to British Guiana and Newfoundland. Imports were 2,009 flasks valued at $165,431, of which 64 per cent came from United States, 21 per cent from Italy, and the remainder from Mexico, Spain, and Chile. In 1945 exports amounted to 3,473 flasks, and imports, which came mainly from Mexico, to 360 flasks. Consumption in 1946 was 1,345 flasks, almost the same as in 1945. Producers and consumers' stocks at the end of 1946 were 3,300 flasks compared with 3,728 flasks at the end of 1945.

Italy is the leading producer of mercury and is followed in order by Spain, United States, and Mexico. Output in Italy reached a peak of 94,000 flasks in 1941, but during 1944 and 1945 the output in that country was exceeded by that of Spain. War-damaged mines and plants were being repaired, however, and in the latter part of 1946 production was at a rate of 6,000 flasks a month, compared with a rate of 4,500 flasks in Spain.

Over half of the Italian output comes from Amiata mine, and most of the remainder from the Siele mine, 7 miles to the south. These mines are in Tuscany. The Idria mine in Gorizia province is in the disputed region, but operations were resumed recently by the Yugoslavs, and at the end of 1946 production was in excess of 600 flasks monthly. The average grade of the Tuscany ore is about 1·3 per cent mercury, and of the Idria ore, 0·6 per cent.

Production in Spain reached a peak of 86,500 flasks in 1941 and declined to 69,100 flasks in 1944, and to 40,100 flasks in 1945. The world-famous Almaden mine, believed to have been first worked in 400 B.C., has a continuous recorded production of over 6,500,000 flasks since the year 1500. The ore was very high grade, and even at present averages 6 per cent mercury.

In the United States, almost 80 per cent of the output in 1946 came from California, and about one-third of it from the New Idria mine. It and the New Almaden mine were the only two that were being operated at capacity at the end of 1946. During the early years of the war, production was maintained from nearly 200 properties and in 1943 output amounted to 55,000 flasks. A few large high-grade deposits were discovered during the latter part of the war and although these have enabled the maintenance of production, the profit margin is small at present prices of mercury.

In 1946, the United States imported 23,000 flasks of mercury, which was less than one-third the amount imported in 1945. Consumption of 31,000 flasks was slightly less than half that of 1945. Exports amounted to 907 flasks, close to 90 per cent of which went to Canada.

In Mexico, production reached a peak of 32,443 flasks in 1942, but declined to half that amount in 1945, which, however, is 2½ times the pre-war level. Most of the output is exported to the United States and some to Canada.

No production statistics are available from Russia since 1938, when 8,700 flasks were reported.

The output from free China reached a peak of 6,527 flasks in 1941 and it was estimated to have been less than half this amount in 1945. The pre-war output from Chile was only about 45 flasks a year. It rose to 2,563 flasks in 1943 and dropped to 1,175 flasks in 1944. Czechoslovakia produced between 2,000 and 3,000 flasks a year just prior to and early in the war, but there are apparently no records since 1940. Union of South Africa started to produce from Monarch Kop in 1940 and the output rose to 1,184 flasks in 1943. It dropped to 852 flasks in 1945, and was slightly less in 1946.

World production just prior to the war was estimated at about 6,000 tons a year. It reached a peak of nearly 11,000 tons in 1941. Producers of more than 1,000 tons a year during the war were: Italy, Spain, United States, Mexico, Russia, China, Canada, Czechoslovakia, Chile, and the Union of South Africa.

Uses

Canadian consumption has been decreasing and now amounts to about 1,500 flasks annually. Most of it is used for medicinal and pharmaceutical purposes and in the heavy chemical industries. Between 5 and 10 per cent is used for the recovery of gold by amalgamation.

In the United States, the development, for military use, of the small mercury cell or "tropical dry battery" accounted for a substantial increase in the consumption of mercury late in the war. Production of the cells for several types of military batteries and for hearing-aid use is under way. Work has been concentrated on the development of new designs and on more economical manufacture. The battery is not being made in Canada.

A comparatively recent development is the use of a mercury clutch for fire-engine pumps, helicopters, for the electric motors of refrigerator equipment, washing machines, etc. A water-repellent mercury fungicide is said to afford efficient protection against mildew and to destroy microbes that attack a large variety of articles such as textiles, paints, wood, and leather. In Germany, a considerable amount of mercury was consumed in a small cathode cell for the electrolytic production of chlorine and caustic soda. This cell has been introduced with considerable advantage in a number of alkali-chlorine plants in the United States.

Prices

The average United States quotation at the beginning of 1946 was $105 a flask, but prices dropped to $88 in December, the year's average being $98.24, compared with nearly $135 in 1945. Late in 1946 the price of £30, pegged by the British Government, was lowered to £25 per flask, but in private hands the price was £20. In January, 1947, the Mercurio Europeo cartel was asking $67.50 in bond New York or $86.50 with the U.S. import duty of $19 per flask.

MOLYBDENUM

Molybdenite Corporation of Canada, Limited, the only Canadian producer of molybdenum ore in 1946, has maintained a continuous output from the LaCorne mine in LaCorne township, Quebec, since July, 1945, when it took over the property from Wartime Metals Corporation. As there are no plants in Canada to convert the concentrate into addition agents, there is no sale for the concentrate in Canada. Sales to the United States are barred because of tariffs and the large productive capacity in that country, consequently all shipments go to Europe. The LaCorne ore contains bismuth, which until recently was a disadvantage as it remained in the concentrate and a concentrate containing more than 0·5 per cent bismuth is not acceptable. During 1946, however, a process was developed by the Bureau of Mines, Ottawa, which not only freed the concentrate of this metal, but also raised the molybdenum content of the concentrate and this content is probably higher than that of any other concentrate produced in the world. The bismuth is saved as a by-product, for which purpose a unit was installed.

Molybdenite, the chief ore of molybdenum, is a soft and shiny steel blue-grey sulphide containing 60 per cent of the metal. In eastern Canada it is usually found in pegmatite dykes or along the contacts of limestone and gneiss, commonly associated with greenish grey pyroxenites in which other metallic minerals such as pyrite and pyrrhotite often occur. In northern and western Ontario, Quebec, and in British Columbia, molybdenite usually occurs in quartz or in quartz veins, along the contacts of, or intruded into granites, or diorites. It generally occurs in the form of soft, pliable flakes or leaves, but is sometimes semi-amorphous, filling cracks and smearing the rock surface. It can be readily distinguished in the field by the olive-grey-green smear it leaves when rubbed on glazed white porcelain or enamel. Graphite, for which it is often mistaken, leaves a grey-black smear.

Principal Canadian Sources of Supply and Occurrences

At least 400 molybdenite deposits and occurrences are known in Canada, distributed in all provinces except Alberta. Present indications, however, are that the Abitibi area in Quebec will continue to be the principal source of production as it is probably one of the most favourable areas for the discovery of other workable deposits. The area is about 100 miles from the Ontario boundary, and, in general, extends from Rouyn to Val d'Or.

The LaCorne mine, only source of the output in 1946, was being developed to a depth of 500 feet on four levels. Two distinct types of ore occur. The east-west veins, which were first worked, are quartz veins; the north-south veins, which are richer and wider, are characterized by the presence of red feldspar. About 235 tons of ore was treated daily, of which nearly 80 per cent came from the north-south veins and averaged 0·77 per cent MoS_2, and the rest from the east-west veins averaging 0·44 per cent MoS_2. New ore-bearing veins were located in the 2,500 feet of drilling done during 1946. The Indian Peninsular mine in the same area was closed in 1944.

Hedley Monarch Gold Mining Company prospected the Golconda property near Olalla, British Columbia. The molybdenite ore contains copper.

Production and Trade

From a total of 84,600 tons of 0·58 per cent molybdenite ore treated, 518 tons of 85 per cent concentrate (440 tons of MoS_2) was produced. However, as this contained about 3·0 per cent bismuth, 466 tons of it was re-treated by the new process, which gave 419 tons containing 94·44 per cent MoS_2 and 0·44 per cent bismuth. The copper content was reduced from 0·4 to less than

0·1 per cent. Shipments amounted to 368 tons of concentrate containing 338 tons of MoS_2 (203 tons of molybdenum), about 80 per cent of which was the new high-grade concentrate. The value of shipments was about $295,640. In 1945, shipments were 489 tons of concentrates valued at $411,613 and containing 251 tons of molybdenum. Shipments in 1946 went to England, France, Sweden, and Belgium. Stocks at the LaCorne mine at the end of 1946 were about 260 tons of MoS_2 (contained in concentrates).

Thirty-eight tons of bismuth concentrate containing 27 per cent bismuth and 13 per cent MoS_2 was produced as a by-product, and nearly 9 tons of the concentrate was shipped for sale in England.

Canada imports all the molybdenum addition agents it uses from the United States through Climax Molybdenum Company, the distributors for Canada being Railway and Power Engineering Company, Toronto. Imports amounted to 56·6 tons of contained molybdenum, of which about 51 per cent was in the form of ferromolybdenum; 38 per cent as molybdenum trioxide and briquettes; 8 per cent as calcium molybdate; and 3 per cent as sodium molybdate. Imports in 1945 were 102 tons of contained molybdenum in the same addition agents.

Consumption of molybdenum closely follows that of alloy steel production. In 1946 it amounted to 125 tons of contained molybdenum, of which 74 per cent was in the form of ferromolybdenum, 21 per cent as the trioxide, and 5 per cent as calcium molybdate. Consumption of molybdenum in 1945 was 397 tons. The metal is used by about ten Canadian iron and steel manufacturers, but most of it is consumed by Atlas Steels, Limited, and Steel Company of Canada.

Just prior to the war, 90 per cent of the world production, estimated at about 16,000 metric tons of metallic molybdenum annually, came from the United States. Climax Molybdenum Company, Climax, Colorado, the world's largest producer, operated throughout 1946 on a 5-day-a-week basis and treated about 5,700 tons of ore daily, or a little over one-third of the maximum rate, the grade being about 0·6 per cent MoS_2. The company contributes about 72 per cent of the estimated total United States output of 7,500 short tons of contained molybdenum. This total compares with 15,400 tons in 1945 and with 30,833 tons in 1943, the peak year. The remainder of the 1946 output was obtained mainly as a by-product from the operation of some of the large copper producers.

About 12 per cent of the sales of Climax Molybdenum Company were exported in 1946, compared with 77 per cent in the years just prior to the war.

Chile and Mexico are the next largest producers. Mexico has been producing for many years and was second largest producer until 1944 when the output from Chile was 1,058 metric tons, compared with 717 tons from Mexico. The principal operator in Mexico is Cananea Consolidated Copper Company at Cananea, Sonora county. The Chilean output is a by-product of Braden Copper Company's (Kennecott Copper) el Tiente mine at Braden. In Norway, production from the Knaben mine just prior to the war was about 430 metric tons a year, but the output has been considerably reduced. In Peru, molybdenite has been produced by Peru Molebdeno S.A. for a number of years and output reached a peak of 154 tons of molybdenum in concentrate in 1942. It dropped to 30 tons in 1945 when operations ceased owing to the depletion of the mineable ore.

Uses; Specifications

Molybdenite concentrate is converted into an addition agent that is introduced into steel as molybdenum trioxide, ferromolybdenum, or to a small extent as calcium molybdate. The oxide is usually moulded into briquettes which weigh 5 pounds each, and contain 2½ pounds of molybdenum.

Molybdenum has a widening range of uses, but by far the greater part of the output is used in steel to intensify the effect of other alloying metals, particularly nickel, chromium, and vanadium. These steels usually contain from 0·15 to 0·4 per cent molybdenum, but in some instances the percentage is considerably higher. For high-speed tool-steels as much as 9 per cent is added.

Molybdenum alloys are used widely for the hard-wearing and other important parts of aeroplanes. They are used in the automobile industry; in high-grade structural die and stainless steels; in heat and corrosion resistant alloys; and to some extent in high-speed tool-steels. Molybdenum is used in cast iron and in permanent magnets. Much molybdenum wire and sheet is used in the radio industry; and new alloys suitable for electrical resistance and contacts and for heating elements contain molybdenum.

The chemical uses continue to increase, and the salts are used in pigments, in vitreous enamels for coating steels and sheet iron, in welding rod coatings, lithographing and printing inks, and for analytical work. The addition of about 3 per cent molybdenum trioxide to the glaze used on graphite crucibles considerably reduces the surface tension of the glaze so that it flows easily over the surface of the crucible. It also improves the properties of ceramic bonded grinding wheels.

United States specifications for concentrate dried at 212°F. are: MoS_2, minimum 85 per cent; copper, maximum 0·6 per cent; iron, maximum 3·0 per cent; combined phosphorus, antimony, and tin, maximum 0·2 per cent.

Prices

There is no Canadian market for concentrates as there are no conversion plants, and since July, 1945, the only shipments have been to Europe. The present price of these shipments is 41½ cents per pound of MoS_2 in high-grade concentrate.

The price per pound of contained molybdenum, f.o.b. Toronto, in Canadian funds, for the following imported compounds is approximately: calcium molybdate (42 per cent Mo), 90 cents; ferromolybdenum (60 per cent Mo), $1.13; and molybdic oxide (52 per cent Mo), 90 cents. Calcium molybdate is sold in bags of about 12½ pounds containing exactly 5 pounds of molybdenum.

Tariff

Canadian ore and concentrate when shipped to the United States is subject to a duty of 17½ cents a pound of contained molybdenum.

NICKEL

Canada's nickel output still comes almost entirely from mines of the Sudbury district in Ontario. Production was curtailed drastically shortly after the end of the war, as it was anticipated that the change from munitions to industrial production would result in a considerably smaller market for the metal. The demand increased rapidly, however, in the middle of 1946, and by the end of the year exports were above the level of 1945 and only 20 per cent below those of the two preceding years.

Important improvements were commenced in the metallurgical treatment at Copper Cliff. Exploration in the new nickel-copper field at Lynn Lake in northern Manitoba gave good results. The former diversified overseas market for Canadian nickel was largely restored, with the notable exceptions of Germany and Japan. No major source of nickel outside Canada has been found yet, unless one has been developed in Russia.

Principal Canadian Sources of Supply

The production of nickel in 1946, at 96,062 tons, was substantially below that of any of the war years, and the smallest since 1936. It came from the mines of the two companies in the Sudbury area, with the exception of a small amount derived from the cobalt-silver ore of the Cobalt district.

International Nickel. The five mines of The International Nickel Company of Canada, Limited, the Frood, Garson, Murray, Creighton, and Levack, operated throughout the year. The smelter at Copper Cliff operated at about one-half its war-time capacity until the end of June, when the rate was raised gradually, and reached three-quarters capacity by the end of the year. This was in response to an increased demand, mainly from the United States. Ore mined in 1946 was 7,736,334 tons, compared with an average of 11,453,154 tons for the three preceding years, and 5,321,634 tons average for the three years 1936-38. The smelter at Coniston operated throughout the year, as did the central concentrating plant for ore at Copper Cliff.

The plant at Copper Cliff for the separation of nickel and copper by the new and improved method was under construction, but progress was delayed by shortage of materials. This method gives a clean separation and good recoveries. From the nickel portion there will be produced a new marketable product, nickel oxide sinter, which is expected in due course to be used largely in place of refined nickel. This sinter will also be treated in the nickel refinery at Port Colborne to give pure electrolytic nickel. The plant for the separation process and for production of nickel oxide sinter is expected to be completed in 1947.

A part of the nickel-copper matte made at the smelters is sent to the plant at Clydach in Wales to be refined by the Mond process. Nickel-copper matte is also sent for treatment to the company's plant at Huntington, Virginia. Most of the nickel matte is treated in the nickel refinery at Port Colborne, Ontario.

The company's sales of nickel during 1946 totalled 100,552 tons. This was in a variety of forms such as refined metal to be used in alloys, Monel metal, rolled and cast nickel, special alloys made by the company, and nickel salts and chemicals. The company also produced refined copper, platinum metals, gold, silver, selenium, and tellurium.

Development of ore in the five operating mines of International Nickel had reached a normal position by the end of 1946. The ore reserve was then 217,142,000 tons containing 6,861,000 tons of nickel-copper. This compares with a reserve in 1938 of 212,368,000 tons containing 6,806,000 tons of nickel-copper.

Falconbridge. Falconbridge Nickel Mines, Limited operated its mine and smelter at Falconbridge, Ontario, at about half the war-time capacity. At the end of the year this was increased to three-quarters of the war-time maximum in accordance with progress in rehabilitation of the refinery at Christiansand, Norway. Experimental work is under way to improve the methods of smelting and refining. The Falconbridge mine produced 488,117 tons of ore, and the smelter output was 12,780 tons of matte which was shipped to Norway for treatment. The refinery output was 5,018 tons of nickel, and 2,845 tons of copper. The mine is opened to the 2,800-foot level. Development of the lower levels added 830,000 tons of ore that is well above mine average in grade. Ore reserves at the end of 1946 were:

—	Tons	Per cent nickel	Per cent copper
Falconbridge mine	8,296,500	1·63	0·85
Outside holdings	5,909,000	1·88	1·02
	14,205,500	1·73	0·92

Lynn Lake (Sherritt Gordon). The Lynn Lake area, 120 miles north of Sherridon in northern Manitoba, shows promise of becoming an important source of nickel, with copper as a by-product. Development was carried on in 1946 mainly by Sherritt Gordon Mines, Limited, the pioneer in this area, but other companies commenced exploration. By means of magnetometric surveys followed by drilling, Sherritt Gordon located a number of separate deposits of ore or of near-ore grade. Drill cores from one of these indicate a pipe-like deposit 200 feet or more in diameter that varies from 2 to 4 per cent nickel. Cores from other deposits, 2 to 3 miles to the north, show about half this amount of nickel. With the nickel there is about one-third the amount of copper. Sherritt Gordon reports an aggregate of 5,000,000 tons in these orebodies, averaging 1·18 per cent nickel and 0·60 per cent copper up to the end of 1946. This is exclusive of the higher grade deposit discovered in January, 1947. Preparations were made to sink a shaft during 1947 on the most promising of these deposits.

Other Nickel Prospects. The deposits of nickel at Shebandowan Lake, 75 miles west of Port Arthur, Ontario, at Rankin Inlet on the west coast of Hudson Bay, and near Hope, British Columbia, have remained unworked during recent years.

Production and Trade

The fact that the quantity of nickel used in time of peace is already approaching that required in time of war for munitions is illustrated by the following table of production and exports. Present indications are that the peace-time consumption will surpass that of the war years in due course.

Production and Exports of Nickel

—	Production		Exports	
	Tons	Value	Tons	Value
		$		$
1939	113,053	50,920,305	117,391	57,933,511
1940	122,779	59,822,591	124,516	61,163,197
1941	141,129	68,656,795	137,795	67,679,708
1942	142,606	69,988,427	138,795	68,407,207
1943	144,009	71,675,322	135,547	68,346,346
1944	137,299	69,204,152	132,599	68,400,634
1945	122,565	61,982,133	108,221	54,778,226
1946	96,062	45,385,155	111,939	55,204,632

Exports of Nickel in Various Forms

—	In matte or speiss		In oxide		Refined nickel	
	Tons	Value	Tons	Value	Tons	Value
		$		$		$
1939.......	47,051	16,940,142	2,425	1,410,909	67,914	39,582,460
1940.......	38,484	13,854,142	3,864	1,795,905	82,168	45,513,150
1941.......	42,616	15,331,760	7,240	3,345,776	87,739	49,002,172
1942.......	41,263	14,854,626	9,224	4,258,050	88,308	49,294,531
1943.......	36,415	13,109,436	3,892	1,798,607	95,240	53,438,303
1944.......	33,848	12,185,370	1,242	574,857	97,509	55,640,407
1945.......	28,295	10,186,290	1,758	808,715	78,168	43,783,221
1946.......	30,625	11,026,910	517	228,562	80,797	43,949,160

In the above table, the small amount of nickel produced from the silver-cobalt ore of the Cobalt district is included in the speiss shipments. The exports of matte are mainly to the refineries of the Canadian companies in Wales, Norway, and Virginia. The exports of refined nickel have a wide distribution, as indicated in the following table:

Nickel Exports in 1946

Destinations	Tons	Value
		$
Great Britain..	13,888	5,625,406
Norway...	9,248	3,311,244
United States..	82,203	41,458,782
British India..	67	26,930
Argentina..	139	94,939
Belgium..	473	337,219
Brazil...	96	69,060
Chile..	96	65,270
France...	3,305	2,473,571
Italy..	1,173	877,116
Mexico...	51	34,295
Netherlands..	83	56,440
Sweden...	1,050	730,828
Total Exports.............................	111,872	55,161,100

There was no export of Canadian nickel to Russia in 1946, in contrast to the substantial amounts sent there during recent years. This seems to indicate that the Petsamo mine, formerly in Finland, and formerly belonging to International Nickel, is now in production, in addition to other nickel mines in Russia. No information is available on current nickel developments in Russia.

Shipments of nickel from New Caledonia to France, interrupted during the war, were resumed. Thus, it is likely that the amount provided for French industries from Canada in 1947 will be much lower than in 1946.

The Nicaro plant in Cuba, which supplied an appreciable part of the demand for nickel (largely in the form of oxide) in the United States during the latter years of the war, continued to operate in 1946. It was closed early in 1947, and future plans for its reopening have not been disclosed.

Discoveries of nickel have been reported in Tanganyika and Venezuela, but there is no evidence that they are of economic interest.

Uses and Prices

No data are available on the various uses of nickel in Canada, and the amount for each use. The United States Bureau of Mines has published such statistical data, and the percentage figures are possibly about the same for Canada.

Uses of Nickel in United States in 1945

Use	Pounds of nickel	Per cent
Ferrous:—		
Steel (including heat and corrosion resisting alloys and high-iron alloys)	111,114,967	57·7
Cast iron	6,025,564	3·2
Non-ferrous:—		
(Copper-nickel alloys, nickel silvers, brass, bronze, and aluminium alloys, Monel, Inconel, and malleable nickel)	52,802,013	27·4
High temperature and electrical resistance alloys	7,902,392	4·1
Electroplating (anodes and solutions)	12,736,349	6·6
Catalysts	890,253	0·5
Ceramic	43,042	0·02
Other	990,168	0·5
	192,504,748	100·0

The variety of forms in which nickel is used is indicated in the 1946 report of International Nickel and in the President's address to shareholders.

Uses of Nickel, Illustrated by INCO Sales of Nickel in 1946

	Tons
Nickel in refinery products (Port Colborne, Clydach, Huntington refineries)	71,208
Nickel in rolling mill and foundry products (Birmingham, Glasgow, Huntington, Bayonne mills and foundries)	27,553
Nickel in salts and chemicals (Copper Cliff, Clydach refineries)	1,791
	100,552

The use of nickel in cast irons for abrasion resistance and for corrosion resistance increased in 1946. The volume of stainless steels containing 8 per cent or more nickel reached 550,000 tons in the United States in 1946, requiring 20,000 tons of refined nickel. This is five times the volume of 1936. Other nickel-bearing alloys with remarkable resistance to heat have been developed for use in jet engines and gas turbines. In electroplating, the nickel is used mainly as a base under a chromium finish.

For twenty years prior to November 25, 1946, the contract price for electrolytic nickel in the United States was 31½ cents a pound. On that date International Nickel changed its contract price to 35 cents a pound, inclusive of the import duty of 2½ cents a pound. This brings the United States price in line with the world price. The prices in Canada remain at 35 cents a pound.

PLATINUM GROUP METALS

The platinum metals are by-products from the nickel-copper ore of the Sudbury district, Ontario, and thus production in 1946 was reduced in accord with the lessened demand for nickel at the end of the war. The volume of sales was much lower than in 1945, but the value was much higher, resulting from the lifting of price control in April, 1946.

Though no information is available on platinum production in Russia, Canada is apparently still the principal source of supply, followed by Russia and South Africa, and with smaller amounts from Colombia and the United States. The United States is still by far the largest consumer of the platinum metals.

Principal Canadian Sources of Supply

The five mines of The International Nickel Company of Canada, Limited, and the mine of Falconbridge Nickel Mines, Limited, all in the Sudbury district, furnished the ore from which the Canadian output of the platinum metals was produced in 1946. The ores of these mines differ considerably in their content of the precious metals. Ore from certain mines with a low content of these metals is smelted separately to make matte for the production of Monel metal, as this natural alloy of nickel and copper does not go through the refining process from which the precious metal concentrates are derived, and the minute amounts of precious metals in the ore thus remain in the Monel metal. By far the larger part of the Sudbury ores, however, is converted into crude nickel and copper which is refined in the electrolytic refineries at Port Colborne and Copper Cliff respectively. By this means the platinum metals, along with gold, silver, selenium and tellurium, are recovered as anode residues and are treated in a separate refinery at Acton, near London, in Great Britain. In the same refinery is treated a precious metals residue from the plant of International Nickel at Clydach, Wales, which employs the Mond process of refining nickel. The nickel-copper matte from Falconbridge is treated by the company's own process at Christiansand in Norway, and the precious metals are recovered similarly from the anode residues. There is no published record of the recovery of the platinum metals in Falconbridge's refinery in Norway. During the three years 1944-46, International Nickel smelted approximately 30 million tons of ore and its sales of platinum metals during this period were about a million ounces. Thus the ore contained about 0·033 ounce of platinum metals to the ton. This minute amount in a ton of ore can be extracted profitably, of course, only because it is concentrated automatically and without extra cost in the refinery sludges.

There has been no production of platinum during recent years from the placers of the Tulameen River in British Columbia, and the nickel-copper-platinum deposits near Hope have remained undeveloped. Nor have the nickel-copper deposits at Shebandowan Lake, 75 miles west of Port Arthur, Ontario, which contain palladium and platinum, been exploited.

Metals of the Platinum Group

Canadian Production*

—	Platinum		Palladium, rhodium ruthenium, iridium, and osmium	
	Ounces	Value	Ounces	Value
		$		$
1939	148,877	5,221,712	135,402	4,199,622
1940	108,464	4,239,424	91,522	3,520,746
1941	124,257	4,747,860	97,432	3,396,304
1942	285,188	10,897,033	222,573	8,279,221
1943	219,706	8,458,681	126,004	5,233,068
1944	157,523	6,064,635	42,929	1,960,085
1945	208,234	8,017,010	458,674	18,671,074
1946	121,771	7,672,791	117,566	5,162,801

* For 1945 and 1946 the figures represent the metal content of concentrates produced from nickel-copper ores, and the adjustment of previous figures to this basis for the years 1938 to 1944 inclusive is added to 1945.

Exports in 1946 of platinum metals in all forms except scrap were valued at $15,409,281, compared with $13,297,660 in 1945. Imports were valued at $8,718,524, of which metals to the value of $8,046,251 were from Great Britain and the remainder from the United States. Most of the imports are re-exported to the United States and to other American countries.

The trend in sales of the platinum metals is indicated in the table that follows:

Sales of Platinum Group Metals by International Nickel

	Ounces
1938	193,195
1939	240,778
1943	376,604
1944	303,394
1945	381,741
1946	320,794

An idea of the relative amounts of these metals used annually can be gained from the figures published by the United States Bureau of Mines for the output of platinum refineries in the United States. The amounts for 1945 were:

	Ounces	Per cent
Platinum	162,032	79·4
Palladium	28,649	13·9
Iridium	5,783	2·8
Rhodium	4,731	2·3
Ruthenium	2,466	1·2
Osmium	845	0·4
	204,506	100·0

By industries the amounts in ounces sold in the United States in 1945 were:

Industry	Platinum	Palladium	Others	Total	Per cent
Electrical	107,260	69,300	5,572	182,132	33·1
Jewellery and decorative	81,305	56,578	10,026	147,909	26·9
Chemical	115,816	8,988	6,182	130,986	23·8
Dental and medical	30,871	42,259	900	74,030	13·5
Miscellaneous	1,599	8,107	5,282	14,988	2·7
	336,851 61%	185,232 34%	27,962 5%	550,045 100%	100·0

Uses

The six platinum metals fall naturally into two categories. Platinum, osmium, and iridium have atomic weights around 190, and specific gravities of 21 to 22. Palladium, rhodium, and ruthenium have atomic weights of about 100 and specific gravities of 11 to 12. The particular qualities that make them useful may be stated as follows:

High Melting Point. Ranges from 1554°C for palladium to 2700°C for osmium.

Corrosion Resistance. The resistance of platinum to common reagents except chlorine is well known. The metals and their alloys are mostly resistant to tarnishing. Silver is electroplated with an extremely thin coating of rhodium to make it non-tarnishing. A reflector of rhodium in optical instruments can be used at high temperatures.

Ductility. Used mainly in wrought forms. Platinum and palladium are extremely ductile. Rhodium and iridium are worked with difficulty, ruthenium with still more difficulty, and osmium is almost completely non-ductile.

Alloys. The metals are used mainly as alloys. Rhodium, iridium, ruthenium, palladium, copper, gold, and nickel are the elements most commonly added to platinum, seldom over 25 per cent and often 10 per cent or less. Iridium and ruthenium increase the strength and hardness of platinum at room temperatures. Rhodium gives alloys resistance to oxidation at high temperatures.

Catalysts. Platinum in particular is a useful catalyst. Eighty-mesh gauze of 10 per cent platinum-rhodium alloy is used commonly for nitrogen fixation. A unit containing 90 troy ounces of gauze, operating at about 1000°C, can give 40 tons of nitric acid in 24 hours with a conversion efficiency of 96 per cent.

The uses of the platinum metals, either as pure metals, clad, or alloyed with other metals, are summarized in a special issue of "Canadian Mining Journal", May, 1946, thus:

Jewellery: Platinum with 5 per cent to 10 per cent iridium or 5 per cent ruthenium, and palladium with 5 per cent ruthenium.

Decoration: for glassware and porcelain (platinum); book stamping, window signs, embossing, statuary, furniture, picture frames, moulding, and lighting fixtures (platinum or palladium, as leaf); plating glassware, and silverware (rhodium); medals or awards (platinum or palladium).

Chemical Industry: for lining of processing and reaction vessels (platinum or platinum-clad), as catalyst to produce sulphuric acid and nitric acid (platinum or platinum alloyed with 10 per cent rhodium); hydrogenation of organic compounds (palladium or platinum); rayon spinnerets (platinum alloyed with 10 per cent rhodium or a 30 per cent platinum-gold alloy); nozzles for the production of glass fibre and glass insulators for electric light bulbs (platinum alloyed with rhodium or other metals); tubing, valves, syphons, and safety disks for the handling of corrosive liquids and gases (platinum or platinum-clad); anodes for the production of "per" salts, gas analysis cells, crucibles, and laboratory equipment (platinum).

Electrical Industry: for thermocouples and high-temperature furnace windings (platinum and rhodium-platinum); precision resistance thermometers (pure platinum); spark plug electrodes (4 per cent tungsten-platinum and palladium-ruthenium-platinum alloy); magneto contacts (platinum alloyed with ruthenium or iridium); electrical contacts, relays, thermostats, automobile voltage regulators, and direction indicators, switches for potentiometric recorders (platinum or palladium alloys); reflectors for searchlights and projectors (rhodium plated); vibrating contacts, pivots, fountain pen points, and long-life phonograph needles (ruthenium, osmium, platinum, and rhodium).

Dentistry: for inlays, full and partial dentures and orthodentic appliances (palladium 3 per cent to 24 per cent, platinum 1 per cent to 17 per cent, balance gold and other metals); bases for porcelain restorations (platinum and 5 per cent to 15 per cent iridium); pins for artificial teeth (palladium or platinum alloys generally clad on nickel).

Prices

Until April 29, 1946, ceiling prices of $35 an ounce for platinum and ruthenium, $24 for palladium, $50 for osmium, $125 for rhodium, and $165 for iridium, were in force. Following the lifting of the ceiling prices, the price of platinum rose rapidly, and reached $90 to $93 in September, when it declined, and was $60 to $65 at the end of the year. The average price for 1946 was $57. Palladium remained at $24 throughout the year. Iridium was $90 to $100 at the beginning of the year, reached $125 in September, and was at $110 at the end of 1946. Rhodium was quoted at $125 an ounce throughout the year. Ruthenium prices paralleled those of platinum, reaching $93 in September and receding to $56 at the end of 1946. Quotations for osmium remained nominal. The price reached $75 in May and $100 by September, where it remained to the end of the year.

SELENIUM

Selenium is widely distributed throughout the world, but is nowhere sufficiently concentrated to recover profitably except as a by-product in the recovery of other metals. In Canada it is usually associated with copper-sulphide and gold ores. Although new uses are steadily being found for selenium, relatively small amounts are involved and thus production is restricted to current industrial demands. Most of the selenium produced in Canada is exported.

Principal Canadian Sources of Supply

The only Canadian plants producing refined selenium and selenium products are the copper refineries of The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario, and Canadian Copper Refiners, Limited, at Montreal East, Quebec. The Copper Cliff product is derived from the treatment of the copper-nickel ores of the Sudbury area, Ontario. At Montreal East, selenium is obtained from the treatment of copper anodes prepared from the copper-gold ores of Noranda, Quebec, and from blister copper from the copper-zinc ores of the Flon Flon mine of Hudson Bay Mining and Smelting Company, Limited, on the Saskatchewan-Manitoba boundary. The Montreal East plant is capable of the largest individual production of selenium in the world, and, in addition to the chemically pure product selenium dioxide, sodium selenate and sodium selenite are manufactured.

Production and Trade

Canadian production of selenium in 1946 reached a peak of 521,867 pounds valued at $949,798, compared with 379,187 pounds valued at $728,039 in 1945. Quebec was the source of about 21 per cent of the total output, Ontario 52 per cent, and Manitoba and Saskatchewan 27 per cent. Present production could be increased very considerably from current levels to meet a greater demand.

Exports of selenium and of selenium salts were 723,490 pounds valued at $1,261,205, compared with 442,084 pounds valued at $843,404 in 1945. Sixty-seven per cent of the exports was shipped to the United States and 25 per cent to the United Kingdom.

World production of selenium is estimated to be 700 tons a year, Canada and the United States being the principal producers.

Uses and Prices

Selenium is generally marketed as a black to steel-grey amorphous powder, but cakes and sticks are also obtainable. Among other selenium products marketed are ferroselenium, sodium selenite, selenious acid, and selenium dioxide. No figures are available to show the relative consumption of selenium by uses. Prior to World War II, the most important uses were in the glass, rubber, and paint industries, and although these outlets continue to be important, many new uses have been developed as a result of research during the war.

Selenium is used in the manufacture of glass to neutralize the green colour caused by iron impurities. When sufficient selenium is added it causes glass to turn a ruby colour highly suitable for signal lenses. In the manufacture of rubber the addition of selenium promotes resistance to heat, oxidation, and abrasion. It is also used as an accelerator in the vulcanization of synthetic rubber. Cadmium sulphoselenite pigments are used where a durable outdoor paint is required, with a colour ranging from orange to maroon. A recent important development is the use of selenium in electrical dry plate rectifiers for radar equipment and aircraft generators. Due to its ability to carry high overloads without loss in efficiency, and certain other characteristics, its use in the manufacture of rectifiers has created a lasting outlet for the metal.

A unique characteristic of selenium is that its resistance to electricity decreases on exposure to light. This property is made use of in photo-electric cells and in various devices and controls, though the amount of selenium used is small.

Selenium is used to improve the machineability of metals; for fat hardening; as a catalyst in the petroleum industry; in the hydrogenation of coal; in certain printing inks; mineral and vegetable oils; in therapeutic preparations for skin diseases; for flotation agents; and moth repellants. Sodium selenate is used chiefly in the preparation of an insecticide in floriculture.

Since August, 1938, the nominal price for black powdered selenium, 99·5 per cent pure, at New York, has been $1.75 per pound. The average Canadian price in 1946 was estimated by the Dominion Bureau of Statistics to be $1.82 a pound.

SILVER

The abandonment by the Government at the end of January, 1946, of the domestic ceiling price of 40 cents an ounce for silver, which had been in effect since January, 1943, coupled with the raising of the price of silver in the United States for domestically mined silver to 90·5 cents an ounce at the end of July, 1946, and a rise in the world price resulted in a considerable increase in activities in several of the old silver camps in Canada, particularly in British Columbia and Yukon. The average price of the metal in Canada rose from 47 cents an ounce in 1945 to 83·65 cents in 1946 and although the output was about 400,000 ounces lower than in 1945 its value was more than $4,000,000 higher. About 90 per cent of the Canadian output of silver is obtained as a by-product from the treatment of base-metal ores and most of the remainder from the treatment of gold-quartz ores. British Columbia provides about 48 per cent of the output, and the Sullivan mine near Kimberley in that province is the source of about 44 per cent of the production. During the period of the price ceiling Canadian producers were required to meet domestic requirements before exports at higher prices were permitted.

Canadian Sources of Supply—Developments

In British Columbia, the concentrate produced in the 8,600-ton concentrator at the Sullivan mine of The Consolidated Mining and Smelting Company of Canada, Limited is shipped to the company's smelting and refining plants at Trail for the recovery of the lead, zinc, silver, and other metals it contains. The other base-metal properties that contributed to the province's silver output were: the copper mine of The Granby Consolidated Mining, Smelting, and Power Company, Limited, at Allenby; the copper-zinc mine of Britannia Mining and Smelting Company, Limited, at Britannia Beach; and the Monarch and Kicking Horse mines of Base Metals Mining Corporation, Limited, at Field.

Nearly all the remainder of the output came from gold-silver mines; the Highland Bell mine at Beaverdell, which is one of the few straight silver producers in the Dominion; and silver-lead-zinc mines, mostly small, in the Slocan-Lardeau area. Their total output was much smaller than in 1945 owing to the labour strike, which lasted from July 3 to November 8.

Development and related work was more active in the southern part of the province than elsewhere. At Beaverdell, Highland Bell, Limited produced 412,646 ounces of silver, compared with 266,968 ounces in 1945. Drilling and underground development work disclosed several good sections of ore. The company's camp was completed by finishing existing buildings and by adding new ones. Other companies have been organized to develop claims in the area. In the Slocan area, more developments were under way or planned than for many years past. Sheep Creek Gold Mines, Limited was probing a rich silver-lead deposit on its producing Zincton property; Santiago Mines, Limited was shipping high-grade silver ore to Trail from the old Boston mine; Utica Mines (1937), Limited was preparing for mill construction; Western Exploration Company, Limited was doing development work on its property at Silverton preparatory to mining and milling; and Silver Ridge Mining Company, Limited was developing a deposit near Sandon. The Granby Consolidated Mining, Smelting, and Power Company, Limited, Cansil Consolidated Mines, Limited, and Kelowna Exploration Company, Limited were also active in the area.

A number of long-dormant properties in the province received attention. At the old Toric mine at Alice Arm, Torbrit Silver Mines, Limited (subsidiary of The Mining Corporation of Canada, Limited) is erecting a 300-ton mill which is expected to be in operation early in 1948. In the same district, Big Four

Silver Mines, Limited was considering the erection of a mill following the encouraging results of an examination of its group of silver-lead-zinc claims.

Duthie Mines (1946), Limited diamond drilled a property from the surface near Smithers that was last worked in 1930, and early in 1947 started to drill from underground prior to resuming underground development work. Another old mine, the Silver Standard, not far distant, from which silver-lead-zinc ore to the value of $400,000 was shipped about twenty-five years ago, was being prepared for production.

Discoveries of ore rich in silver were reported to have been made on Stemwinder Mountain near Hedley and on Boulder Creek in the Manson Creek area.

The Twin "J" Mines, Limited disclosed additional zinc-copper ore at its property on Mount Sicker, Vancouver Island, and resumed milling in February, 1947. The ore contained appreciable quantities of silver and gold.

In Ontario, most of the silver output, which accounted for 20 per cent of the total for Canada, came from the nickel-copper mines of The International Nickel Company of Canada, Limited and of Falconbridge Nickel Mines, Limited in the Sudbury area, and most of the remainder from the silver-bearing gold ores mined in Porcupine, Kirkland Lake, Larder Lake, Red Lake, and other areas.

In the Cobalt-Gowganda area, 129 tons of silver ore and concentrate shipped came from the underground workings and dumps of old properties. About 68 tons of this ore and concentrate were shipped to Deloro Smelting and Refining Company, Limited, Deloro, Ontario, and the remainder to Noranda Mines, Limited, Noranda, Quebec, for recovery of the silver, which amounted to 399,316 ounces. No payment was received for the silver content of the cobalt concentrate, all of which was shipped to the United States. Though the rise in the price of silver served to enliven interest in the area, the finding of new ore zones of importance does not seem likely, as the possibilities of the camp were rather thoroughly determined in the early years of the properties. Silanco Mining and Refining Company, Silco Mines, Limited, Ausic Mining and Reduction Company, Limited, Silver-Miller Mines, Limited, and Siscoe Gold Mines, Limited (operating the Miller Lake-O'Brien property) were among the more active companies in the area in 1946.

In Quebec, the production of silver was 11 per cent less than in 1945. Noranda Mines, Limited was the chief source of the output; the other sources being the lead-zinc mine of New Calumet Mines, Limited, on Calumet Island; the copper-zinc ores of Golden Manitou Mines, Limited; Waite Amulet Mines, Limited; Normetal Mining Corporation, Limited; and the gold mines in western Quebec.

In Saskatchewan, practically all of the silver output came from the Flin Flon copper-zinc-gold deposits of Hudson Bay Mining and Smelting Company, Limited, that straddle the Saskatchewan-Manitoba boundary near The Pas, Manitoba. These deposits were also the source of a large part of Manitoba's output, the remainder of which came mainly from the zinc ore of the Sherritt Gordon mine at Sherridon and the gold ore of the San Antonio mine in the Rice Lake district.

In Yukon, production was 24 per cent higher than in 1945, and was obtained chiefly from placer gold dredged out of creeks in the Klondike area, mainly by The Yukon Consolidated Gold Corporation, Limited. It comprised also the silver content of high-grade silver-lead ore shipped out in small amounts by individual operators in the Mayo area. Until the withdrawal of Treadwell Yukon Corporation, Limited, in 1941, this area was the principal contributor to Yukon's silver output. The properties and plant of Treadwell

Yukon Corporation were acquired in 1946 by Keno Hill Mining Company, Limited, which plans operations on a wide scale with the intention of beginning production in 1947. Yukon Northwest Explorations, Limited uncovered what is thought to be the extension of a vein on an adjoining property that was a former producer of lead-silver ore. Among other companies that have acquired properties are Noranda Mines, Limited, and Ventures, Limited.

In the Northwest Territories, the Eldorado mine on Great Bear Lake, and the Negus, Con, and Rycon gold mines in the Yellowknife area were the sources of nearly all the silver output. Production of silver in the Northwest Territories reached a peak of 581,902 ounces in 1938.

Production and Trade; World Production; Prices

Canadian Silver Production

1. By provinces, 1945 and 1946:

Province	1945		1946	
	Output (oz.)	Value	Output (oz.)	Value
		$		$
Nova Scotia	112	53	146	122
Quebec	2,149,570	1,010,298	1,916,453	1,603,113
Ontario	3,185,369	1,497,123	2,485,215	2,078,882
Manitoba	533,883	250,925	528,017	441,686
Saskatchewan	1,426,457	670,435	1,498,496	1,253,492
Alberta	....	....	12	10
British Columbia	5,620,323	2,641,552	6,078,419	5,084,597
Northwest Territories	2,033	956	6,112	5,113
Yukon	25,158	11,824	31,230	26,124
TOTALS	12,942,906	6,083,166	12,544,100	10,493,139

2. By ore sources, 1946:

	Ounces
From base-metal ores	11,144,470
From gold ores	956,445
From silver-cobalt	428,560
From placer-gold operations	11,800
From other sources	2,825
TOTAL	12,544,100

Canada's production of silver reached a peak of 32,869,264 ounces valued at $17,580,455 in 1910, over 30,000,000 of which came from the Cobalt area of Ontario, and a peak value of $20,693,704 in 1918, when 21,383,979 ounces was produced. The highest average price was 111·122 cents an ounce in 1919.

In recent years, production of silver in Canada has declined while consumption has increased, with the result that exports of silver bullion declined from 22,682,687 ounces in 1938 to 2,316,689 ounces in 1946. These figures do not include the silver recovered from ores, concentrate, and matte exported, which in 1946 amounted to 1,863,817 ounces. France and the United States were the main destinations of the bullion in 1946; and the United States, chiefly, and Belgium, the silver in ore, concentrate, and matte. Exports of Canadian silver manufactures were valued at $691,812 in 1946, compared with $284,639 in 1945; the corresponding imports having values of $508,828 and $61,850 respectively. The estimated consumption of silver in Canadian arts and industries was 6,142,000 ounces, a little less than in 1945, the peak year.

According to the American Bureau of Metal Statistics, five-sixths of the world production of silver comes from Mexico, United States, Peru, Canada, and Australia, which led in that order in 1945, when output totalled 126,000,000 ounces. Of this, Mexico contributed 60,000,000 ounces.

On the abolition of the domestic ceiling price on silver bullion and of the rationing of supplies to the domestic trade, the price of silver in Canada immediately advanced from 40 cents an ounce to slightly in excess of 78 cents, the equivalent in Canadian funds of the 71·11 cents paid at that time by the United States treasury for newly mined domestic silver. Six months later, when the United States price was raised to 90·91 cents, the price in Canada advanced to approximately that level, but not beyond it because on July 5 the Canadian Government had set exchange at par with the United States dollar. For slightly over two months 90⅝ cents was the price offered for foreign silver on the New York market, but in view of subsequent excess offerings and the anticipated effect of the decision of the Government of India to replace the silver in the half- and quarter-rupee coins with nickel, and the announcement in October by the United Kingdom to substitute copper-nickel coins for all silver coins, the price declined to 70·75 cents by the end of the year. This was still well above the average in Canada during any of the preceding twenty-five years. The price of silver in Bombay rose in May, 1946, to the equivalent of $1.69 in Canadian funds, but was appreciably lower than that peak by the end of the year.

The purpose of the new coinage arrangements by India and Britain were to aid repayment to the United States of 226,000,000 ounces of silver lend-leased to India, 88,000,000 ounces to United Kingdom, and 11,800,000 ounces to Australia. Including the quantities to other countries, the total amount of silver lend-leased by the United States during the war was 410,814,344 ounces.

TELLURIUM

The occurrence of tellurium in small amounts is fairly widespread and its presence in the form of tellurides is common in copper-sulphide and gold ores. The potential production as a by-product in the treatment of copper ores is great, but recovery is restricted to meet current demands, which are limited as industrial uses consume relatively minor quantities of the metal.

Tellurium is recovered from the slimes formed in the process of electrolytic refining of copper at Copper Cliff, Ontario, by The International Nickel Company of Canada, Limited, and at Montreal East by Canadian Copper Refiners, Limited. At the former plant the metal originates in the Sudbury copper-nickel ores, and at Montreal East it is recovered from unrefined copper derived from the copper-gold ores of Noranda, Quebec, and from the copper-zinc-gold ores of the Flin Flon deposit of Hudson Bay Mining and Smelting Company, Limited, on the Manitoba-Saskatchewan boundary.

Production and Trade

Canada produced 15,848 pounds of tellurium in 1946 valued at $24,405, compared with 484 pounds valued at $929 in 1945. Exports of tellurium are not recorded separately, but it is believed that most of the metal produced in Canada is exported. Domestic consumption is confined to small amounts used in the white metal and steel foundries.

The world production is estimated to be about 150 tons a year, Canada and United States being the principal producers.

Uses and Prices

Tellurium has no great application in industry, but a number of outlets on a limited scale have been developed for the metal in recent years. One of its more important uses is in the rubber industry, where it has much the same effect as selenium in contributing to heat-resistance qualities; it is more favoured than selenium where extremely abrasive conditions occur.

In the metallurgical field small quantities are used to improve the physical properties of lead alloys, copper and copper-rich alloys, magnesium alloys, stainless steel, cast iron, and tin where high strength and resistance to corrosion properties are desired. Chilled castings containing about 0·01 per cent tellurium are used as railway car wheels, gears, cam shafts, etc. Tellurium is used in the production of certain glasses and glazes, in petroleum processing, and to remove cobalt in the purification of electrolyte in zinc refining.

The price of tellurium is quoted at $1.75 a pound in New York, and the average Canadian price in 1946 was estimated by the Dominion Bureau of Statistics at $1.54 a pound.

TIN

Canadian Occurrences and Production

Tin ore, of which cassiterite (SnO_2) is the most important mineral, has, so far, not been found in Canada in deposits of economic importance. In many of the placer creeks of Yukon, especially in the Mayo district, some crystalline cassiterite is found. Similar small occurrences have been reported from the gold-bearing placers of British Columbia. Considerable prospecting was done during the war, and although no deposits of economic values were disclosed, the geological conditions in these areas warrant further investigation.

A very small cassiterite content is found in the lead-zinc-silver ore of the Sullivan mine of The Consolidated Mining and Smelting Company of Canada, Limited, at Kimberley, British Columbia. In view of the acute shortage of tin which developed in the early stages of the war, consideration was given to its recovery from this source. On March 1, 1941, a concentration plant treating the tailings from the zinc flotation commenced operations, and in April, 1942, the commercial production of refined tin by electric smelting was commenced.

The recovery of tin from the Sullivan ore constitutes a particularly interesting metallurgical operation. The tailings from the zinc flotation cells, amounting to around 6,000 tons per day, contain about 1·2 pounds of tin per ton. The first operation consists in removing the iron sulphides by flotation. The tailings, containing the tin, are then treated in a series of gravity concentrations which finally result in a concentrate carrying from 63 to 68 per cent tin. This product, representing slightly over 50 per cent of the original tin in the feed, is smelted in a three-phase 400 kilowatt electric furnace of 5 tons capacity to yield high-grade refined tin. Three months' operation of the smelter is sufficient to handle the year's accumulation of tin concentrate. To the end of 1946 some 1,899 long tons of tin was produced. In 1946, production was 390 long tons valued at $480,700, compared with 379 long tons valued at $484,500 in 1945. This represents about 10·5 per cent of the current Canadian consumption, which in 1946 was approximately 3,708 long tons.

Market Conditions and World Production

World supply of tin continued critical during 1946, but by the combined efforts of industry and Government considerable progress was made in rehabilitating the industry in Malaya and the Netherlands East Indies. The indications are that production in the Far Eastern tinfields will have reached the pre-war level, by gradual stages, by 1949, or early in 1950.

At the end of September, 1946, the number of mines operating in Malaya was 181, as against 75 at the beginning of the year. No dredges were operating during January and February, but, by the end of September, 14 were in operation and 24 were being rehabilitated, and 66 dredges were still closed.

The supply situation in Canada was somewhat better in 1946 than in previous years, but the outlook for 1947 was still uncertain.

The Combined Tin Committee, comprising representatives of the United States, the United Kingdom, the Netherlands, France, and Belgium, continued to function in the allocation of the world supply of tin. Canada's allocation for 1946 was 3,770 long tons. Early in 1947 this Committee was enlarged to include representatives of Canada and India.

Early in the war the Canadian Government authorized the Metals Controller to purchase tin with the object of building up a stockpile to ensure that a reasonable supply would be available to meet any emergency. This stock continues to be drawn from to supplement the shipments received under the allocation or other sources, such as reclaimed tin and the small domestic production. All sales were made by the Control until the latter part of 1945 when this function was transferred to the Commodity Prices Stabilization Corporation, Limited. This Crown company during 1946 handled all sales of tin in Canada subject to approval of the Wartime Prices and Trade Board.

During 1946, regulations governing the use and sale of tin remained in force. The Tin Order, A-1774, required that a permit be obtained for all purchases in excess of 15 pounds. Purchases of 15 pounds or less could be made directly from a dealer provided the buyer submitted an affidavit certifying the use for which the metal was required. The order also prohibited or restricted the use of tin in a large number of its commercial applications.

The International Tin Research and Development Council, The Hague, estimates the world production of tin for 1946 at 94,000 long tons. This is some 81,500 long tons short of the world smelter production in 1939. The estimated production by countries for 1946, in long tons, is as follows: Burma, 300; China, 2,000; Malaya, 9,000; Netherlands East Indies, 7,000; Siam, 1,700; South America, 41,500; Africa, 26,500; other countries, 6,000. The bulk of the African production is from the Belgian Congo and Nigeria.

In reviewing the supply position of tin for 1947, the Council estimated that production in the Far East will not exceed 70,000 tons. Bolivian production is expected to continue at around the same level as in 1946, but the production from Nigeria will be substantially less than during the war years owing to depletion of ore. Concentrates from the Belgian Congo are being smelted in Africa and Belgium.

The rate of production is improving so slowly that the forecasts indicate a continued shortage in world supply during 1947.

By far the largest amount of refined tin was produced, prior to the entry of Japan into the war, in the smelters of Malaya and of the Netherlands East Indies. There were seven tin plants in the United Kingdom, but their combined capacity was not large. In 1941 the United States undertook the erection of a tin smelter at Texas City, Texas, and in April, 1942, the Longhorn smelter of the Tin Processing Corporation poured its first ingots. This plant is designed to treat all grades of tin ores and concentrates and handles a great part of the Bolivian production. It had also handled a large tonnage of concentrates from the Congo.

Uses, Trade, and Price

The principal uses of tin are: in the manufacture of tin plate and terne plate; as an alloying element in the making of solder, babbitt, and bronze; in tinning; as foil and collapsible tubes; chemicals; and as an addition agent to the bath in hot zinc galvanizing.

The consumption of primary tin in Canada by principal industrial uses during 1946 was:

	Pounds
Tin plate and terne plate	4,235,183
Solder	2,037,938
Babbitt	686,621
Bronze	743,709
Tinning	402,621
Foil	114,836
Tubes	17,919
Miscellaneous	64,969
TOTAL	8,303,796

Imports of tin (blocks, pigs, or bars) during 1946 were 3,751 long tons. Tin plate imported was 43,495 long tons with a tin content of approximately 544 long tons. Since 1940 Canada has established a tin plate industry that supplies the most of its requirements. A small amount of tin foil (5,918 pounds) was imported in 1946. Imports of babbitt metal amounted to 59,000 pounds, representing an approximate tin content of 24,000 pounds.

Exports of tin are not large and are limited to a few manufactured products such as solder, babbitt, and brass valves. No figures of the actual tin contained in these items are available. The export trade in the above items is largely with Newfoundland and the British West Indies. When tin is more readily available the exports in these items should rise appreciably.

The price of tin in New York was fixed in the last half of 1946 at 70 cents a pound. The Canadian price for imported tin of 99·7 per cent grade or better is 71 cents a pound carload lots f.o.b. government warehouses. The price of domestic refined tin is 70¼ cents a pound.

Future Trends

The shortage in the supply of tin during the past five years has resulted in very appreciable restrictions in its use, and the substitution of more abundant metals has been adopted wherever possible. In the case of tin plate, the tin content has been reduced from 1·50 pounds to 1·25 pounds an average 100-pound base box. The development of electro-deposition methods has permitted the use of much thinner tin coatings. The tin content of solder, babbitt, and bronze has been substantially reduced. Aluminium foil has been substituted for tin foil in a wide variety of uses. In a number of brasses and bronzes other metals have been used in replacing tin in whole or in part. The continued use of these substitutes will depend largely upon their satisfactory metallurgical performance and comparative metal prices.

Indications are that the demand for tin in Canada will considerably exceed the pre-war figures. As previously mentioned, Canada now has a tin plate industry and this alone will account for over 2,000 long tons of tin. In addition, the enormous expansion in manufacturing capacity developed during the war, much of which has been, or is in process of being reconverted to commercial production, will provide an increased demand for solders and babbitts. It is reasonable to assume that this increased demand will far exceed any reduction occasioned by the use of lowered tin-content babbitts and solders.

It is estimated that the unrestricted requirements of tin for 1947 will exceed the actual consumption figures for 1946 by almost 100 per cent.

TITANIUM

Canada has large deposits of titanium-bearing ores, but has no plants for making titanium products. Production of ore during 1946, all for export, remained small.

Titanium-bearing ores in Canada are of two classes. Ilmenite containing 30 to 40 per cent TiO_2 occurs in three localities in Quebec. In one of these, St. Urbain, on the St. Lawrence, 60 miles below Quebec city, a part of the ore contains free TiO_2 as rutile mixed with the ilmenite, and its content of TiO_2 reaches 50 per cent and more. The other two localities are at Ivry, 65 miles north of Montreal, and Allard Lake, 20 miles north of Havre St. Pierre on the Gulf of St. Lawrence. The latter deposits, which are very large, were discovered in 1946. Titaniferous magnetite, the second class, is composed of ilmenite and magnetite, mixed intimately in varying proportions, with a content of 5 per cent or more TiO_2. This ore occurs more widely in Canada than does ilmenite, but is not used in this country at present as a source of titanium. Large deposits occur at Mine Centre in northwestern Ontario, and smaller deposits occur north of Belleville, in the southern part of Hastings county, Ontario; at Desgrosbois, 65 miles north of Montreal, and on the Saguenay River, near Arvida, Quebec.

Deposits of magnetic beach sands containing titanium occur at a number of places on the north shore of the Gulf of St. Lawrence. A bed of such sand that has been consolidated into solid ore occurs at Burmis, Alberta, just east of Crowsnest Pass.

Principal Canadian Sources of Supply

Small shipments of ilmenite were made formerly from the Ivry deposit, but during recent years the only production has been from the St. Urbain deposits.

The largest potential source of ilmenite is the recently discovered Allard Lake ilmenite deposits from which only experimental shipments have been made. During 1946 additional ore was found, one deposit being of unusually large dimensions. As only preliminary work has been done on these deposits, their full extent is not known. The ore as exposed on hills and ridges contains many millions of tons above ground-level. It averages about 35 per cent titanium dioxide, 37 per cent iron, and 3 per cent silica, but there are large areas higher in titanium and lower in silica than this. Its convenient location near an ocean port will permit large-scale development when there are sufficient market outlets.

Production and Trade

During recent years there has been a small annual production of ilmenite from St. Urbain for export to the United States. No ilmenite has been used in Canada.

Exports of Ilmenite from Canada

—	Short Tons	Value	—	Short Tons	Value
		$			$
1939	3,694	21,267	1943	69,437	308,290
1940	4,535	24,510	1944	33,973	165,195
1941	12,651	49,110	1945	14,147	67,575
1942	10,031	50,906	1946	1,352	6,830

During 1946, preliminary steps were taken to construct a plant to make titanium white at Trois Rivières, Quebec, but work was suspended at an early stage.

Uses and Specifications

The substantial amount of titanium white used in Canada is imported, largely for use in the paint industry. Prior to 1939 much of it came from Great Britain, but during the war and at present almost all is from the United States.

Titanium White Imported for Use in Canadian Paint Industry

Year	Titanium dioxide, pounds	Extended titanium dioxide pigments, pounds
1939	1,855,288	5,088,234
1940	2,297,248	6,138,760
1941	3,076,490	8,971,865
1942	4,168,097	7,034,376
1943	4,436,382	9,558,617
1944	4,600,654	13,176,631
1945	6,306,213	12,120,296

Titanium white has many other uses, such as: to make paper opaque; to make rubber white; in ceramic glazes; for printing inks; in linoleum; in cosmetics; and to de-lustre artificial silk. Thus the annual imports are much larger than is recorded in the table above.

Titanium is used in many other forms. Ferrotitanium and ferrocarbontitanium are used under special circumstances to purify steel. It is all imported from the United States.

Ferrotitanium Used in Canadian Steel Industry

—	Short tons	—	Short tons
1939	118	1943	614
1940	118	1944	786
1941	181	1945	656
1942	439		

Recently it has been shown that steel containing a small proportion of titanium can be enamelled with one application of white glaze, without the evolution of gas that formerly made more than one application necessary. Titanium carbide is used as the hard ingredient of the "carbide" high-speed cutting-tools, usually mixed with tungsten carbide. Titanium dioxide, made artificially or in the natural form of rutile, is used commonly as a coating for welding rods.

Titanium tetrachloride was used extensively during the war for smoke screens. A small amount used for purifying alloys of aluminium and an increasing amount is being used for the production of metallic titanium.

The United States Bureau of Mines has been producing about 100 pounds a week of metallic titanium from its experimental plant at Boulder City, Nevada. The metal is reduced from titanium tetrachloride by metallic magnesium, the product being a powder which is made into the ductile metal by compressing it and working the small slabs thus produced. The metal melts at 1800° C., can be rolled and drawn, has a specific gravity of 4·5 (iron is 7·8) and scratches quartz. It has excellent corrosion resistance, except for certain acids, and shows no tarnish after 30 days' exposure to salt spray. The tensile strength of the annealed metal is 82,000 pounds per square inch. Cold-worked to 50 per cent reduction, the tensile strength is 126,000 pounds per square inch. These properties suggest numerous important uses for the metal when the cost of producing it has been reduced sufficiently.

The United States obtains only a small part of its present supply of ilmenite from Canada. Until 1940, Travancore sand from India provided most of the ore treated in the United States. This contains rutile in addition to ilmenite, and the content of TiO_2 is about 60 per cent. The shortage of shipping during the war induced the development of the large McIntyre deposit of titaniferous magnetite in New York State. At the end of the war shipments of Travancore sand were resumed; but in the middle of 1946 they ceased again on account of the industrial policy adopted by the Travancore State Government.

In 1946 at the McIntyre property, 1,848,000 short tons was mined. From this were made 212,800 tons of ilmenite concentrate and 504,000 tons of magnetite concentrate. From the latter, 78,400 tons of sinter was made which contained 10 per cent TiO_2.

Total production of ilmenite in the United States in 1946 was 278,000 short tons, and of rutile 7,000 tons. Imports of ilmenite were 224,524 short tons, of which 93 per cent was Travancore sand. Consumption of ilmenite in 1946 was 400,000 short tons of ilmenite and 7,000 tons of rutile.

The beach sands of Travancore, on the southwest coast of India, contain zircon, sillimanite, and monazite, in addition to ilmenite and rutile. During recent years four mining companies have treated the sands and shipped the separate concentrates abroad. In 1942 the Travancore Government notified the companies of their intention to have a part at least of the metallurgical processes conducted in India. Recently an agreement was announced whereby British Titan Products Company, Ltd. will collaborate with the Travancore Government in establishing a plant in Travancore for the manufacture of titanium pigments.

The amount of titanium oxide used throughout the world is increasing rapidly. When the production of metallic titanium becomes established commercially, the outlet for high-grade ores of titanium will be increased materially. The large deposits of high-grade ilmenite at Allard Lake, Quebec, should be in an advantageous position to supply a substantial part of the titanium ore required in the future.

Prices

Prices f.o.b. Atlantic ports were:

Ilmenite, 60 per cent TiO_2	January	\$28-\$30
57 to 60 per cent TiO_2	June	\$24-\$26
	November	\$22-\$24
Rutile, 94 per cent TiO_2	nominally 8-10 cents per pound (probably averaged around 6 cents).	

TUNGSTEN

Stimulated by a critical shortage during the war up to the autumn of 1943, Canada produced tungsten concentrates from a number of deposits throughout the Dominion, but production ceased in November, 1943, owing to excess of supplies. Stocks in hand at mines have all been shipped. Late in 1946 the Emerald mine near Salmo in southern British Columbia was taken over by Canadian Explorations, Limited, and production of concentrate in the 300-ton mill was expected to start late in the spring of 1947. Canada's requirements can be adequately supplied by this mine.

Wolframite, (Fe, Mn)WO_4, is the principal ore of tungsten, the next in importance being scheelite ($CaWO_4$), a calcium tungstate. The former is a dark brown to black, heavy mineral, which contains 76·4 per cent WO_3 (tungstic oxide) when pure, and is not common in Canada. Scheelite, the chief Canadian ore of tungsten, is a heavy, fairly soft, usually buff, but sometimes white mineral with a dull lustre, which contains 80·6 per cent WO_3 when pure. It is commonly associated with quartz and frequently occurs in gold-bearing veins and in certain contact metamorphic deposits. It can be detected readily in the dark by its brilliant, pale bluish-white fluorescence under ultra-violet light and purple filter.

Principal Canadian Sources of Supply; Occurrences

During 1941 and 1942 scheelite was obtained from many deposits throughout Canada, most of them small. The three largest producers were: the Red Rose mine south of Hazelton in northern British Columbia; the Emerald mine, and Hollinger Consolidated Gold Mines, Limited, Timmins, Ontario. The mill on the Emerald property was operated for a brief period during the war. Estimates of reserves in the main contact metamorphic deposit on the property are about 250,000 tons of 1·25 per cent WO_3 ore, apart from the ore in several minor bodies.

Production and Trade

There was no production in 1946. Shipments of scheelite from government stocks to the United States contained about 89 tons of tungsten.

No ferrotungsten is made in Canada. Tungsten steels are made in two plants. Atlas Steels, Limited, Welland, Ontario, the principal producer, uses ferrotungsten as well as high-grade scheelite concentrate. The latter is added directly to the steel bath, because of the comparative ease with which calcium forms as slag. Quality Steels (Canada), Limited, London, Ontario, (formerly Federal Foundries and Steel Company, Limited), uses scheelite and ferrotungsten in the production of tool and other alloy steels.

Canada in 1946 imported ferrotungsten from the United States, which contained 23 tons of tungsten; and 1 ton of scheelite from Brazil, which contained 1,144 pounds of tungsten. These imports were valued at $55,804.

World production just prior to the war was estimated at 40,000 tons of 60 per cent WO_3 ore and concentrate, those that produced over 500 tons in 1939 being: China, Burma, United States, Portugal, Korea, Bolivia, Argentina, Australia, and South Africa. Information during the war years is very incomplete, but in 1944 it is known that the output from Korea greatly increased, and Brazil and Spain became important producers.

Although China has virtually no modern equipment and employs haphazard methods of mining and ore concentration, it could supply the world's requirements at a very low price. Production (exports) reached a peak of 17,895 metric tons in 1937, but has since declined to about half this amount due to unsettled conditions in the country. The principal deposits are in Kiangsi Province and were developed by the Government during the war. Mining by mechanized methods is planned. The ore is wolfram, and usually contains some tin.

In Burma the Mawchi mine, 170 miles northeast of Rangoon, is the principal producer. It is controlled by a British company and the output goes mainly to England. Prior to Japanese occupation Burma produced about 8,000 tons of 60 per cent WO_3 annually.

In the United States, production, imports, and consumption continued downward throughout 1946. Production of 3,854 short tons of concentrate was 32 per cent below that of 1945, and compares with a peak of 12,700 tons in 1943. Most of the output was obtained from the treatment of war-accumulated material at the Salt Lake City plant of Metals Reserve Company, but this plant ceased operating in September, 1946. The Pine Creek mine, near Bishop, California, resumed operations in April, 1946. Nevada-Massachusetts Company operated some of its properties and plants at reduced capacity. The United States imported 7,160 tons of tungsten concentrates in 1946, about 60 per cent of which came from South America.

Production from Portugal reached a peak of about 7,500 metric tons of 60 per cent WO_3 in 1943. The prohibition on wolfram mining was lifted in December, 1945, and activities in the principal mines at Panasqueira (British) and Boratha (French) were resumed.

Korea was probably Japan's chief source of tungsten during the war. Estimates of the 1945 output range between 5,000 and 10,000 metric tons. Reserves in the Joto mine are estimated to be 50,000 tons of tungsten to a depth of 250 feet.

In South America, Bolivia continued to be the largest tungsten producer. Exports reached a peak of nearly 8,000 metric tons of 60 per cent concentrate in 1944, but owing to the low price offered in 1946 production was appreciably less than the 4,000 tons exported in 1945. To stimulate production, Banco Minero, in July, 1946, undertook to buy all concentrates offered and waived all tungsten export taxes. Production from Argentina has declined sharply from the peak of nearly 2,500 metric tons of concentrate in 1944. The principal deposits are in San Luis and Cordoba Provinces. Brazil increased its production from 9 tons of concentrates in 1942 to 2,242 tons in 1945, though output declined in 1946, to about 1,400 tons, nearly all of which was exported to the United States. The principal deposits, which contain scheelite, are in the northeastern states of Paraiba and Rio Grande do Norte. Peru maintained a steady production of a few hundred tons of concentrate annually throughout the war. A 30-ton concentrator near Callao was operated by the Government.

The contract between the United Kingdom and Australia for the purchase of the concentrates produced at the King Island scheelite deposit in Tasmania was terminated in February, 1946. Milling was started at the end of 1944 and 800 tons of concentrates were produced in 1945. Reserves are estimated at over 2,000,000 tons of 0·65 per cent WO_3 ore and nearly 500,000 tons of 1·21 per cent in the top orebody.

Union of South Africa produced about 150 metric tons of concentrate in 1946, and a peak of 660 tons in 1944. Southern Rhodesia produced about 60 tons in 1946.

Sweden produces a few hundred tons a year.

Canadian consumption amounted to 160 tons of tungsten metal contained in ferrotungsten and scheelite, a decrease of nearly 35 per cent compared with that of 1945. In 1942, the peak year, nearly 1,000 tons of tungsten was consumed. The United States used 6,503 tons of 60 per cent WO_3, a decline of 56 per cent from that of 1945.

Uses

As an alloying metal in steel, tungsten (usually as ferrotungsten, but sometimes as calcium tungstate or scheelite concentrate) is used essentially to impart hardness and toughness, which are maintained even when the steel is heated to a high temperature. Almost 80 per cent of the consumption of tungsten in the United States is used for the production of high-speed steels for cutting-tools, in which the tungsten content is 15 to 20 per cent. Alloy steels containing tungsten have been used extensively in making armour plate, armour-piercing projectiles, and other military equipment. The use of tungsten in hard facing compounds is increasing. Fused powdered tungsten is used for the diamond set bits for rock drilling. Minor amounts of tungsten are used in steels for dies, valves, and valve seats for internal combustion engines, and for permanent magnets. Stellite, the best known non-ferrous alloy, contains 10 to 15 per cent tungsten with higher percentages of chromium and cobalt. Tungsten carbide is widely used as an extra hard cutting-tool. Pure tungsten is used in lamp filaments, in radio tubes, contact points, etc. In the United States there has been an increase in the consumption of tungsten as metal powder, in chemicals, and in high-porosity alloys in gas turbines and other high-temperature uses.

Prices

Until production ceased late in 1943, all sales of Canadian concentrate were made through the Metals Controller, Ottawa, at a price of $26.50 a short unit (20 pounds) of WO_3 for scheelite concentrate containing 70 per cent WO_3 (within specifications), delivered at Welland, Ontario. Since then prices have fluctuated downward, but for the past year there have been no Canadian-made concentrates for sale. Foreign ores entering United States in 1946 were $21 to $25 per short ton unit (20 pounds) of contained WO_3, duty paid. Domestic ore was $25 in car lots delivered to plants. Ferrotungsten of 75 to 80 per cent tungsten was $1.90 per pound of contained tungsten.

ZINC

Production of zinc in Canada was 9 per cent lower than in 1945, but owing to slightly higher average prices a record was set in the value of output, which amounted to $36,755,450. British Columbia produced 58 per cent of the output; Manitoba and Saskatchewan, 22 per cent; and Quebec, about 19 per cent. About one quarter of the production was zinc contained in concentrate that was exported to the United States; the remainder was refined electrolytic zinc produced at Trail, British Columbia, and at Flin Flon, Manitoba. About 87 per cent of the total production was exported.

Principal Canadian Sources of Supply

The Sullivan silver-lead-zinc mine of The Consolidated Mining and Smelting Company of Canada, Limited, at Kimberley, British Columbia, has long been Canada's principal source of zinc. Concentrate produced in the 8,600-ton concentrator near the mine is shipped 205 miles by rail to the company's smelter and refinery at Trail. A total of 2,307,532 tons of ore was mined in 1946, from which were produced 135,274 tons of zinc, 165,849 tons of lead, and 6,008,092 ounces of silver. Good progress was made in underground development projects that had been allowed to lag during the war. Ore reserves at the mine are estimated to be sufficient for over 20 years' operation at the present rate of production.

In British Columbia, in addition to The Consolidated Mining and Smelting Company, a number of properties produced small amounts of zinc contained in ores or concentrate that were shipped to the zinc plant at Trail or to smelters in United States. Among the more important of these were Zincton Mines, Limited, and Western Exploration Company, Limited, both located in the Slocan area, Base Metals Mining Corporation, Limited, at Field, and Ainsmore Consolidated Mines, Limited, at Ainsworth. The substantial increase in the price of silver in mid-1946, together with higher world prices of base metals, caused considerable activity and renewed interest in the silver-lead-zinc deposits throughout British Columbia. Strikes and labour shortages hampered operations, but preparations were made for a resumption of production at many former producers.

Canada's second largest producer of refined zinc is Hudson Bay Mining and Smelting Company, Limited, which operates the Flin Flon copper-zinc-gold-silver mine on the Saskatchewan-Manitoba boundary. A total of 1,846,601 tons of ore was mined in 1946, most of which passed through the concentrator, which treated an average of 5,034 tons a day. The company's zinc plant, also located at Flin Flon, treated 147,189 tons of zinc concentrate from which 51,328 tons of slab zinc was produced. The supply of labour at the property was adequate for the first time in several years, so that considerable underground development and some additional plant construction were undertaken without curtailing production.

Cuprus Mines, Limited (subsidiary of Hudson Bay Mining and Smelting Company, Limited) sunk an exploration shaft 615 feet on its copper-zinc deposit 8 miles southeast of Flin Flon. Underground development of four levels was commenced.

Sherritt Gordon Mines, Limited, at Sherridon, Manitoba, again operated at a reduced rate due to labour shortage. A total of 558,836 tons of copper-zinc ore was milled and 17,291 tons of zinc concentrate containing 8,719 tons of zinc was produced. About one-third of the zinc concentrate was exported to United States and the rest was sent to Hudson Bay Mining and Smelting Company's zinc plant at Flin Flon.

In Quebec, four mines that have been steady zinc producers in recent years continued to ship zinc concentrate to smelters in the United States. An outline of operations at the four properties follows.

Normetal Mining Corporation, Limited, in Abitibi county, 60 miles northwest of Noranda, operated its 780-ton concentrator below capacity due to an intermittent shortage of power and of underground workmen. A total of 186,634 tons of ore was milled with an average grade of 7 per cent zinc and 3·24 per cent copper. A total of 20,508 tons of zinc concentrate was produced containing 10,844 tons of zinc. Arrangements were being made to obtain power from the Quebec Hydro-Electric Commission, which will necessitate construction of a transmission line from Noranda to Normetal.

Waite Amulet Mines, Limited, near Noranda, operated its 1,800-ton concentrator at about 1,100 tons a day. Labour shortage necessitated a curtailment of underground operations, particularly in sections of the orebodies containing higher zinc values. A total of 427,400 tons of ore was milled, with an average grade of 5·37 per cent zinc and 4·56 per cent copper, and 18,733 tons of zinc was recovered from the concentrate.

New Calumet Mines, Limited, on Calumet Island in the Ottawa River, milled 199,236 tons of ore in its 600-ton-a-day concentrator. Zinc concentrate amounting to 24,597 tons containing 12,613 tons of zinc, and 6,040 tons of lead concentrate containing 3,600 tons of lead, plus gold and silver, were exported. Considerable underground development was carried out on the several orebodies.

Golden Manitou Mines, Limited, near Val d'Or in Bourlamaque township, was greatly handicapped by shortage of labour. Its concentrator of

1,000 tons daily capacity was operated at an average of 620 tons a day, and a total of 224,550 tons was milled; 17,466 tons of zinc concentrate containing 10,600 tons of zinc was produced.

Exploration and preproduction development were under way in northwestern Quebec on three copper-zinc-gold properties from which a substantial zinc output may result in coming years. At Quemont Mining Corporation, Limited, which adjoins the Noranda deposits on the north, large tonnages of ore have been disclosed by drilling. A production shaft adequate to handle 2,000 tons of ore a day was commenced in 1946. Macdonald Mines, Limited, 5 miles northeast of Noranda, sank a 950-foot shaft from which an extensive sulphide zone containing gold, copper, zinc, and silver is to be developed. East Sullivan Mines, Limited, near Val d'Or, has outlined two large orebodies containing copper, zinc, and gold, by drilling. A 5-compartment shaft, with an initial objective of 500 feet, and lateral development of the west orebody on three levels, was commenced.

Indications of a sizable zinc-deposit adjoining the large hematite deposits on the Quebec-Labrador boundary have been reported. Major development in this area, however, will probably be deferred until rail transport is available.

Production and Trade

Canada produced 235,310 tons of zinc valued at $36,755,450, compared with 258,607 tons valued at $33,308,556 in 1945. The production, which includes the zinc content of concentrates, by provinces was: British Columbia 137,135 tons; Manitoba and Saskatchewan 53,329 tons; and Quebec 44,825 tons.

Exports of zinc amounted to 206,844 tons valued at $27,659,450, compared with 220,656 tons valued at $20,240,769 in 1945. The details of exports, including articles manufactured largely from zinc, for 1945 and 1946 are shown in the following table:

Exports	1945		1946	
	Tons	Value	Tons	Value
		$		$
Zinc contained in ores and concentrate	91,779	5,540,384	58,200	3,181,120
Metallic zinc	121,960	14,122,706	144,896	24,174,704
Zinc scrap, dross, and ashes	6,886	577,679	3,747	303,626
Zinc manufactures	....	132,405	....	109,721

Fifty-eight per cent of the metallic zinc exported went to the United States, 22 per cent to the United Kingdom, and 14 per cent to France. All of the zinc concentrate exported went to the United States.

Imports of zinc and zinc products of all kinds, including oxide and chemicals, were valued at $2,870,128, compared with $2,257,745 in 1945. Practically all of the imported zinc products originated in the United States, with the exception of lithopone, about half of which with a value of $432,824 was imported from the United Kingdom. Prior to World War II, Canada used an average of 20,000 tons of zinc a year. Owing to war-time requirements, particularly for brass, domestic consumption increased to 80,000 tons in 1943, but had dropped to 46,300 tons in 1946.

The estimated world production of zinc in 1939 on a smelter basis amounted to 1,851,070 short tons according to the American Bureau of Metal Statistics. The principal producing countries in order of importance were: United States, Germany, Belgium, Canada, Poland, and Russia. Belgian and, to a large extent, German production was derived from imported ore. The pre-war capacity of zinc smelters throughout the world was more than sufficient to meet world consumption. Owing to war damage and general industrial upheaval, however, production from European smelters is not likely to attain pre-war levels for several years. In the meantime, large quantities of zinc will be required for reconstruction purposes. In the United States, zinc is not expected to be in as short supply as are copper and lead, but considerable amounts will have to be imported. Most of the zinc imported into the United States comes from Canada and Mexico. A steady domestic and outside demand during the next few years for Canadian zinc seems assured.

Uses

Zinc, one of the most important of the non-ferrous metals, has a wide range of industrial uses. About 39 per cent of the Canadian consumption in 1945 was used for galvanizing, 30 per cent to manufacture zinc oxide and other zinc chemicals, 13 per cent for brass, 15 per cent in die-casting, and 3 per cent for miscellaneous uses. In the United States, galvanizing absorbed about 40 per cent, die-casting 26 per cent, brass manufacture 18 per cent, and rolled zinc 12 per cent. In the United Kingdom, a proportionately larger percentage was used in brass manufacture, which is normally the chief outlet in that country. In galvanizing, as a protection against rust, a thin zinc coating is applied to iron or steel fabrications either by electro-plating or by hot dipping. Die-casting is becoming increasingly favoured as a process for manufacturing complex shapes, especially for automobile bodies and household appliances. High-purity zinc is the most suitable metal for die-casting and comprises 96 per cent of the metal used for this purpose. Brass, the most important of the zinc alloys, contains about two-thirds copper and one-third zinc, and has many diversified uses in industry and the arts. From rolled zinc sheets are made weather stripping, fruit jar sealer rings, printing plates, dry-cell cups, and various electrical appliances. The metal is used for boiler and hull plates, in wire for brake linings, for desilverization of lead, and in the form of zinc dust, for precipitation of gold.

Zinc oxide is used in compounding rubber; and in the manufacture of paint, ceramic materials, linoleum, inks, and many other commodities. A considerable number of other chemical compounds that have many important applications contain zinc, notably lithopone, zinc chloride, and zinc sulphate.

Prices

In Canada a controlled domestic price of 5·75 cents a pound remained in effect throughout 1946, but was increased to 10·25 cents on January 22, 1947. Refined zinc, surplus to domestic requirements, was sold in the export market at an average of 8·4 cents a pound, and zinc contained in concentrate exported to the United States had a value of slightly more than 3 cents a pound. The average price received for Canadian zinc in 1946 is estimated to be 7·81 cents a pound. In the United States, under price control, prime western zinc sold for 8·25 cents a pound, which was increased to 9·25 cents in October. When price control on metals in the United States ended on November 11, the price of prime western at St. Louis became 10·50 cents a pound; high-grade electrolytic zinc costs an additional half cent a pound. In Great Britain the price of refined zinc in December was £55-0-0 a long ton, or 12·5 cents a pound.

II. INDUSTRIAL MINERALS

ABRASIVES (NATURAL)

Brief reviews only are given below of garnet, pulpstones, grindstones, scythestones, and volcanic dust, as the production of natural abrasives in Canada has been small for many years. Corundum is reviewed separately.

Garnet

Niagara Garnet Company was the only garnet producer in Canada in 1946. About 60 tons of garnet ore was mined from the deposit near River Valley in Dana township, Ontario, and was shipped 25 miles southeast to the mill at Sturgeon Falls. The garnet ore is crushed and concentrated to about 95 per cent garnet grain and is then finally pulverized into flour grades for use in the grinding of lenses and in the optical trade. About 1½ tons of flour grade was shipped to plants in the United States. About a ton of flour was on hand at the end of 1946 and nearly 100 tons of broken ore at mine and mill.

Over 85 per cent of the world output of garnet comes from North Creek, New York, and the product is regarded as the world standard garnet. Production in the United States in 1946 was about 7,700 tons, compared with 6,306 tons in 1945. The largest producer in the United States uses the "Sink-float" process in preliminary stages to eliminate the coarse tails, and uses a heat-treatment process to improve the grain in the final concentrate.

Garnet, crushed and suitably graded as to size, is used for making abrasive-coated papers and cloth, which in turn are used mainly in the wood-working (hard woods), and to a lesser extent in the shoe-leather industries. The specifications for garnet for this use are somewhat exacting. Few, if any, of the hundred or more garnet deposits so far examined in Canada fulfil all the requirements. Garnet is used to a minor extent for sandblasting, and for surfacing plate glass. Garnet superfine (flour) grades are used as a partial substitute for corundum flour, which is used for polishing optical lenses. For this purpose, several hundred tons of garnet was probably used in the United States in 1946.

Canadian consumption of garnet grain suitable for the manufacture of sandpaper is about 500 tons a year, the two Canadian manufacturers of sandpapers being Canadian Durex Abrasives, Limited, Brantford, and Canada Sandpapers, Limited, Preston, both in Ontario. Competition from the artificial abrasives, silicon carbide and oxide of alumina, is a serious factor in the marketing of garnet.

Prices of ungraded concentrate suitable for sandpaper range from $60 to $85 a ton, and flours from 6 cents a pound for 275 mesh, to 65 cents a pound for 5 and 10 micron.

Grindstones, Pulpstones, and Scythestones

Material suitable for these stones occurs in certain sandstone beds in Nova Scotia, New Brunswick, and on the coast of British Columbia. Many years ago the output was considerable, but most of the known beds have been depleted and the demand for natural stones has decreased.

A total of 295 tons of grindstones valued at $17,450 was shipped by two operators, by far the larger of which is Read Stone Company, Sackville, from

Stonehaven, New Brunswick, which obtains its material in that province; the other being Bay of Chaleur Company, which obtains its material from along the Bay of Chaleur at low tide near Grande Anse, New Brunswick. There were no exports. In 1945, shipments were 215 tons valued at $10,270.

Pulpstones were last produced in Canada in 1937 by J. A. and C. H. McDonald Company from Gabriola Island, near Nanaimo on Vancouver Island. Good pulpstones are in demand, particularly for use in the large magazine grinders, but known Canadian deposits containing thick beds of sandstone of the proper quality appear to have been worked out. There is increasing competition from Canadian-made artificial segmental pulpstones, mainly of silicon carbide grit, and 703 of these stones are in use and in stock in the various Canadian pulp mills. Most of these are made by Norton Company of Canada, Hamilton, Ontario, but those supplied by Carborundum Company are made in its plant in the United States.

The imported natural pulpstones come mainly from West Virginia.

Volcanic Dust

Volcanic dust (pumicite or pumice dust) is a natural glass or silicate, atomized by volcanic explosions and thrown into the air in great clouds which ultimately settle, forming beds of varying thickness, often hundreds of miles from its source. In many instances the dust has been washed down from higher levels and redeposited by the agency of waters, in which case the beds are stratified and mixed with foreign substances. It consists of aluminium silicate (80 to 90 per cent), and of oxides and silicates of iron, sodium, magnesium, calcium, etc.

Deposits of volcanic dust occur in Saskatchewan, Alberta, and British Columbia. There was no production in 1945 and 1946, but test shipments were made in 1946 by T. Spagrud from a deposit near Rockglen, Saskatchewan. Volcanic Ash Manufacturing Company recently started to make hand cleansers from a pale buff-coloured volcanic dust deposit near Nanton, Alberta.

Imports are grouped with a number of similar products (pumice, pumice stone, lava, and calcareous tufa), the value of which totalled $71,607 in 1946. Most of the pumice dust was used in scouring powders.

ASBESTOS

Production of asbestos in 1946 far exceeded that of any previous year and the demand was still greater than the supply. A new producer, Flintkote Mines, Limited, operating in the Thetford Mines district, came into production, bringing the number of producers to seven.

The continuing outlook for the industry is good. Development of new asbestos products has been rapid in recent years, particularly developments in asbestos-cement products utilizing the short grades of fibre that formerly were difficult to market. Several plants to make asbestos cement products were under construction in Canada at the close of the year.

Principal Canadian Sources of Supply

The asbestos produced in Canada is practically all of the chrysotile variety and comes almost entirely from areas of serpentinized rock in the Eastern Townships of Quebec, where the producing centres are Thetford Mines, Black Lake, East Broughton, Vimy Ridge, Asbestos, and St. Rémi de Tingwick. The Canadian deposits are the largest known anywhere and the great open pit at Asbestos is the largest asbestos quarry in operation.

Small deposits of chrysotile asbestos are known in other parts of Quebec, in Ontario, and in British Columbia, and several of them have been worked from time to time. The asbestos from some of these deposits has a very low content of iron and is entirely free from magnetite, and therefore is particularly suitable for making insulation for electrical machinery.

No amosite or crocidolite has been found in Canada, but there are deposits of fibrous tremolite, actinolite, and anthophyllite. These varieties are commercially termed amphibole asbestos. Their fibres are harsher and weaker than those of chrysotile and cannot be spun, but they have a higher resistance to acids than has the chrysotile fibre, and are usually used in preference to the latter for filtering acid materials. Fibre from certain of the tremolite deposits in Ontario and Quebec has proved to be suitable for this use, and small shipments were made in 1946 and during the war from a property near Calabogie, Ontario, and from another near Val d'Or, Quebec. A number of years ago fibrous actinolite was quarried near the village of Actinolite, Hastings county, Ontario, for use in coating roofing materials. Asbestos deposits reported as discovered in recent years in Manitoba, British Columbia, and in northern and western Ontario are of the amphibole varieties.

In 1946 there were seven producing companies: Asbestos Corporation, Limited, worked two properties at Thetford Mines, and one each at Black Lake and Vimy Ridge; Johnson's Company operated at Thetford Mines and at Black Lake; Bell Asbestos Mines, Limited operated at Thetford Mines; Quebec Asbestos Corporation, Limited, at East Broughton; Canadian Johns-Manville Company, Limited, at Asbestos; Nicolet Asbestos Mines, Limited, at St. Rémi de Tingwick; and Flintkote Mines, Limited, 2½ miles east of Thetford Mines.

Production has been continuous from the Thetford area since 1878 and reserves of asbestos-bearing rock are huge. Core drilling to depths greater than 1,700 feet has revealed the presence of fibre comparable in quantity and quality with that in the present workings. Most of the output consists of vein fibre obtained from veins ¼ to ½ inch in width, though veins exceeding 5 inches in width occur. The fibres run crosswise of the vein and thus the width of the vein determines the length of fibre. Slip fibre, occurring in fault planes, is obtained largely in the East Broughton area.

The asbestos-bearing rock is mined in open pits and underground. The block-caving method of underground mining is coming into general use in the Thetford Mines district, and Canadian Johns-Manville Company is preparing to use the method at Asbestos.

During the late war the Germans produced amphibole asbestos synthetically from mixtures of precipitated silica, calcium fluoride, magnesium fluoride, and ammonium fluoride. The resultant fibres were very short and the product cost several times as much as natural asbestos.

Production and Trade

Production of asbestos in 1946 amounted to 558,181 tons valued at $25,240,562, compared with 466,897 tons valued at $22,805,197 in 1945.

Exports of asbestos in 1946 were: crude asbestos, 639 tons valued at $293,901, compared with 863 tons valued at $366,563 in 1945; milled fibres, 215,233 tons valued at $16,215,579, compared with 209,765 tons valued at $15,857,555 in 1945; asbestos waste, refuse or shorts, 304,312 tons valued at $7,329,708, compared with 229,929 tons valued at $5,618,124 in 1945; asbestos manufactures, n.o.p., including asbestos brake linings and clutch facings, and packing, valued at $641,432, compared with exports valued at $341,648 in 1945. As is seen, most of the Canadian production of asbestos is exported in the unmanufactured state, i.e. either in the crude condition (long-fibre material only), in a partly opened state (crudy fibre), or completely fluffed out and ready for manufacture. The great bulk of the exports goes to the United States, but large quantities are exported to the United Kingdom and Australia, and substantial shipments were made to Europe in 1946.

Imports in 1946 consisted of 225,997 pounds of asbestos packing valued at $124,146; brake linings for automobiles, etc., valued at $444,409; asbestos brake linings, clutch facings (auto) and clutch facings, n.o.p., valued at $226,776; asbestos in any form other than crude, and all manufactures of, not otherwise provided for, $1,434,680. The last classification included some asbestos from South Africa of a kind not produced in Canada and required for certain manufactures. Comparative data for 1945 are: 215,000 pounds of packing valued at $101,615; clutch facings for automobiles valued at $316,461; brake linings for automobiles valued at $379,038, and brake linings and clutch facings, n.o.p., $32,005; asbestos in any form other than crude and all manufactures n.o.p. $1,385,224.

Canada continues to be the principal asbestos producer. Other countries producing relatively large quantities are Russia, Rhodesia, Union of South Africa, Swaziland, the United States, and Cyprus. Small shipments are made from Australia (crocidolite), Boliva (crocidolite), China (chrysotile), India (chrysotile), and Venezuela (chrysotile). The world's largest market for asbestos is in the United States, and Canada's proximity to this market is a great advantage to the Canadian industry.

Uses; Prices

Asbestos is used for a great variety of purposes, the principal products being: cloth, brake linings, clutch facings, packings, insulation, mill-board, siding, shingles, roofing, tile, and pipes.

Prices throughout 1946 remained the same as in 1945; but a 10 per cent increase on some grades was announced shortly after the close of the year. F.o.b. Quebec mines, in United States funds, tax and bags included, 1946 prices were as follows: No. 1 crude, $650 to $750 per ton; No. 2 crude, $165 to $385; spinning fibres, $124 to $233; magnesia insulation and compressed sheet fibres, $124 to $146.50; shingle fibres, $62.50 to $85; paper fibres, $44 to $49; cement stock, $28.50 to $33; floats, $19.50 to $21; shorts, $14.50 to $26.50 per ton.

BARITE

Mine shipments of barite, including crude and ground, in 1946 declined nearly 14 per cent in quantity and 17 per cent in value from the peak record of 1945. Nova Scotia produced 98 per cent of the total, with a tonnage increase of 8·5 per cent over 1945. Shipments in British Columbia dropped to only about 9 per cent of the 1945 tonnage owing to cancellation of contracts for crude barite for use as permanent ballast in maintenance ships on the Pacific coast. Ontario was a producer for the first time since 1940, but no shipments were reported.

Domestic requirements are relatively small and over 97 per cent of the shipments in 1946 was exported. Important outlets have developed in the past few years for ground material for use in oil-well drilling in the West Indies and in South America, and for crude ore for barium chemicals, lithopone, and general manufacturing purposes in the United States and Europe.

Principal Canadian Sources of Supply

In Nova Scotia, Canadian Industrial Minerals, Limited, the only shipper in eastern Canada in 1946, continued to expand its important operation at

Walton, Hants county. Production came entirely from open-cast mining, but preparations for underground operations were made by the sinking of a 3-compartment shaft to a depth of 400 feet, from which it is expected that some ore will be raised in 1947. A large program of plant expansion was completed, including the erection of a new power-house, headframe, ore bin building, roll crusher house, and of housing for employees. Bleaching and beneficiation tests by the Bureau of Mines, Ottawa, in 1946, on ore from the Walton property, showed that material heavily stained by iron can be bleached at a 325-mesh grind to yield a good white colour.

In British Columbia, Mountain Minerals, Limited shipped 2,495 tons from its property at Parson, 25 miles south of Golden, to Pulverized Products, Limited, Montreal, for grinding, and the remaining 193 tons to the plant of Summit Lime Works, Crow's Nest, where it was ground for use in western glass-works and in drilling mud. There was no production from the company's property near Brisco, in the Windermere Valley section, about 25 miles south of Parson, from which most of the barite shipped for ballast purposes in 1945 was taken.

In Ontario, Woodhall Mines, Limited resumed development work on the old Premier Langmuir property on Nighthawk River, Langmuir township, Porcupine area, under lease from Canada Baryte Mines. Considerable stripping, trenching, and test-pitting was reported to have been done on two veins, and 1,200 tons of crude ore was stockpiled. No shipments were made.

Production and Trade

Barite shipments by primary producers in 1946 totalled 120,419 short tons valued at $1,006,473, compared with 139,589 tons valued at $1,211,403 in 1945. Of the 1946 total, 88,327 tons valued at $567,145 was crude ore, and 32,092 tons valued at $439,328 was ground material milled at the source. Nova Scotia supplied 117,691 tons, and British Columbia, 2,728 tons.

Pulverized Products, Limited, Montreal, reported sales of 2,573 tons of ground British Columbia barite in 1946 valued at $84,909 f.o.b. plant, of which about 1,000 tons was exported to Europe.

Exports of barite not shown separately in trade statistics approximated 118,168 short tons, of which 72 per cent was crude and 28 per cent ground material. These figures compare with 107,000 tons exported in 1945, of which 43 per cent was crude and 57 per cent ground barite. Of the crude exports in 1946, 52 per cent was consigned to the United States for use in the manufacture of lithopone and barium chemicals, and 48 per cent went to the United Kingdom and other European markets. Of the exports of ground barite, 95 per cent was sold for oil-well drilling use in the West Indies and South America, and 5 per cent went to European buyers.

Imports of ground barite, all from the United States, totalled 1,547 short tons valued at $42,904.

Pre-war world output of barite approximated one million tons annually, of which Germany supplied about 50 per cent and the United States 30 per cent. The remainder came chiefly from the United Kingdom, Italy, Greece, France, and India. Largely due to increasingly strong demand for barite for use in weighting rotary oil drilling muds, United States production has shown a marked increase in recent years and in 1946 reached a peak of 723,919 short tons, 5 per cent more than in 1945. Arkansas produced 40 per cent of the total, and Missouri 38 per cent. Georgia, Tennessee, California, Nevada, and North Carolina supplied the remainder.

Uses; Specifications

Estimated Canadian consumption of barite in 1946 was 3,836 short tons, of which 3,717 tons comprised ground material and 119 tons, crude. Consumption of ground barite in Canada in 1945 (figures for 1946 not available) as reported to the Dominion Bureau of Statistics by users was 3,328 short tons. This amount does not include materials used in oil-well drilling muds. Distribution by industries was as follows: paint, 1,749 tons; rubber, 478 tons; glass, 879 tons; wallpaper, 22 tons; miscellaneous, 200 tons. Distribution of the 688,883 short tons of primary barite consumed in 1946 in the United States was as follows: well drilling, 54 per cent; lithopone, 21 per cent; chemicals, 13 per cent; fillers, 7 per cent; glass, 4 per cent; miscellaneous, 1 per cent.

Crude lump barite is used in the manufacture of lithopone, an important white pigment and filler material, and in a wide range of barium chemicals. For these trades, barite is required to contain 95 to 96 per cent $BaSO_4$, and not more than 3 per cent SiO_2 and 1 per cent Fe_2O_3. The ore should be furnished crushed to 1½-inch size. There is no manufacture of the above products in Canada, but they are produced on a large scale in the United States, where, in 1946, 34 per cent of the total barite used was for such purposes.

For most other industrial purposes barite is used in finely ground form, 325 mesh being the general specification. The material should be of good white colour, the best grades being obtained by wet grinding, bleaching with acid, and water floating. Some off-colour material is used for less exacting purposes. Content of $BaSO_4$ is usually required to be not less than 95 per cent. Chief uses for ground barite are as a heavy, inert filler or loader in rubber, asbestos products, paper, linoleum and oilcloth, textiles, leather, and plastics. It is one of the leading pigments and extenders in paints, and has become of increasing importance as a heavy weighting medium in oil-well drilling muds to overcome gas pressures. About 5 tons of barite is used for each 1,000 feet of hole drilled. The requirements are a minimum specific gravity of 4·25 (corresponding to a $BaSO_4$ content of 93 per cent) and absence of soluble salts. Considerable barite is used in the glass industry as a batch fluxing ingredient for moulded flint glass, for which purpose it should contain not less than 96 per cent $BaSO_4$, under 3 per cent moisture, and not more than 0·4 per cent iron oxide (Fe_2O_3), with a fineness range of 20 to 100 mesh.

At the Walton deposits, Nova Scotia, washing to remove quarry dirt suffices to ensure a high-grade marketable product for use in oil-well drilling and for the manufacture of lithopone and barium chemicals. Most of the ore is considerably stained by iron and is thus not suitable for general pigment and filler use without bleaching.

Barium carbonate is the principal intermediate salt used in the manufacture of other barium chemicals. It is also used to prevent the unsightly white efflorescence (scumming) in bricks and other heavy clay products, and for case-hardening of steel. Blanc fixe, or precipitated barium sulphate, is used in white paints, rubber, linoleum, and oilcloth. Barium chloride is used to purify salt brines for the manufacture of chlorine and sodium hydroxide; in making coatings for photographic paper; as a flux in the production of magnesium alloys; as an extender in titanium pigments; in colour lakes; in finishing white leather; and in the purification of beet sugar. Barium hydroxide is used in the refining of sugar and of animal or vegetable oils; and the peroxide, in making hydrogen peroxide. Barium titanate, a new compound developed in Russia, is claimed to possess very high electrical insulating properties and to be specially adapted for use in radio equipment. Porous barium oxide is produced commercially in the United States for use as a desiccating agent for laboratory work.

Barium metal has only limited industrial applications. It is used as a wire coating to remove traces of gas in radio, vacuum, and thermionic tubes, and to coat steel balls in the rotating anodes of X-ray tubes. Alloys of barium with lead and calcium ("Frary" metal) are used for bearings; and nickel-barium alloys for corrosion resistant spark-plug electrodes. Nickel coated with barium oxide can replace tungsten to advantage for the cathodes of the smaller types of electron tubes, giving a high yield of electrons per watt of heating energy. Small-scale production of barium metal was commenced in Canada in 1946 at the magnesium plant of Dominion Magnesium, Limited, at Haley, near Renfrew, Ontario.

The Laprairie Company, of Montreal, an important brick manufacturer, employs the intermediate compound, barium sulphide or "black ash", made by roasting barite with coal, as a substitute for barium carbonate to prevent scumming in its products. The black ash is introduced into the pugging water in solution, and is stated to be three times as effective as the same weight of carbonate.

Prices and Tariffs

The average unit price of domestic crude barite sold by primary producers in 1946 was $6.40 to $7.30 per short ton f.o.b. mine. Ground, off-colour barite exported for oil-well drilling was sold for $13.70 per ton f.o.b Atlantic ports, and ground white for the pigment and filler trade averaged $33 per ton f.o.b. mill.

In the United States, Georgia crude was quoted at $8.50 to $9.00 per long ton, f.o.b. mines, and Missouri crude at $8.25 to $8.50. Missouri prime white, water-ground, floated and bleached sold for $22.85 per ton, f.o.b. works.

In the American market, crude barite is usually sold on a penalty-premium basis, a content of 94 per cent $BaSO_4$ and less than 1 per cent iron (Fe_2O_3) being considered standard. A premium or penalty of 25 cents a ton is set for each per cent of barium sulphate above or below 94 per cent, and a similar premium or penalty for each 0·1 per cent of Fe_2O_3 below or above 1 per cent.

The United States imposes a duty of $4 a ton on crude barite, and $7.50 a ton on ground or otherwise manufactured material. Canadian imports are free of duty under the British preferential tariff, and there is no duty on barite used in drilling mud, or in the manufacture thereof. Otherwise, imports from countries other than the United Kingdom are subject to a duty of 25 per cent.

Witherite

Witherite (natural barium carbonate) is the only other barium mineral of commerce. Commercial deposits are rare and most of the world supply is obtained from mines in the north of England. The material is marketed in various sizes, from lump to 300-mesh powder, the $BaCO_3$ content of which ranges from 90 to 95 per cent.

BENTONITE

The known occurrences of bentonite of commercial importance in Canada are in the Prairie Provinces and British Columbia. Manitoba and Alberta have furnished most of the production. Most Canadian bentonites are of the highly colloidal, swelling type, suitable for foundry use and in controlling the viscosity of oil-well drilling muds. Manitoba, however, has deposits of non-swelling material of value for bleaching purposes in the natural state. It is also amenable to activation, and meets certain foundry requirements.

The first discovery of bentonite in eastern Canada was made in 1946 at the most easterly point of Gaspe Peninsula, Quebec. It is interbedded with Lower Devonian limestone and shales, and a preliminary investigation disclosed about twelve individual bentonite beds distributed through a considerable thickness of calcareous formation. Most of the beds are less than 1 foot thick, the thickest, near the base of the formation, being over 4 feet. The outcrops occur in a steep cliff face on the coast and are difficult of access. Laboratory tests of samples taken from three of the thickest beds showed the material to be rather impure, with only 35 to 42 per cent of clay (bentonite), the remainder being sandy.

Principal Canadian Sources of Supply

The Morden area in Manitoba is the chief source, with about 78 per cent of the total reported sales in 1946. After drying, most of the clay is shipped to Pembina Mountain Clays, Limited, Winnipeg, for activation. This company has installed a grinding unit at Morden for the production of foundry clay and of bleaching grades not requiring activation. To the end of 1946, output of bentonite in Manitoba had totalled about 15,000 tons.

In Alberta, production is centred in the Drumheller area, north of Calgary, where Gordon L. Kidd, at Drumheller, and Aetna Coal Company at East Coulée, are the chief producers. Sovereign Coal Mining Company at Wayne shipped a small tonnage in 1946. To the end of 1946, output from the Drumheller field amounted to about 8,600 tons.

In British Columbia, bentonite beds occur at Princeton and near Merritt. Intermittent small shipments have been made from the Princeton deposit by Francis Glover, 969 Jarvis Street, Vancouver, most of which went to Vancouver for local use. No production was reported in 1946.

Production and Trade

The Canadian production of bentonite in 1946 amounted to 5,183 tons, of which 1,118 tons came from Alberta and 4,065 tons from Manitoba. The value of products, including natural crude clay shipped by primary producers and activated material, was $201,742. These figures compare with 4,400 tons valued at $171,780 in 1945.

Imports, all from the United States, of activated clay in 1946 were valued at $267,519, compared with $347,823 in 1945. Considerable amounts (tonnage and value not shown in trade returns) of natural ground bentonite are imported from the United States, mainly for foundry use.

The United States is the chief world producer and user of bentonite and exports substantial amounts of ground natural clay and activated material. Its production in 1945 reached a record peak of 573,998 short tons valued at $3,770,625. Almost 66 per cent of the total came from the Wyoming-South Dakota area, the remainder being supplied by Arizona, California, Colorado, Mississippi, Montana, Texas, and Utah.

Uses

Bentonite is used chiefly as a bonding ingredient in foundry sands; for the bleaching, or decolorizing and filtering of mineral and vegetable oils and of packing-house products; and to control the viscosity of oil-well drilling muds. The colloidal, or swelling type of bentonite has a wide range of minor uses, including fillers, concrete admixture, and for preventing seepage around dams, irrigation ditches, reservoirs, and structural foundations.

Most of the output of Pembina Mountain Clays, Limited, Winnipeg, is used in bleaching petroleum products, though sales are also made to linseed oil plants, packing houses, and to firms engaged in reclaiming crankcase oil. The material from the Drumheller field is mostly shipped to Alberta Mud Company, 502 Lancaster Building, Calgary, and to Western Clay and Chemical Supply Company, 320 First Avenue West, Calgary, for processing use in oil-well drilling in Turner Valley. Alberta bentonite has been used in diamond drilling through heavy overburden in Ontario and Quebec, providing a casing for deep holes where the use of piping proved impractical. Sales for such use in 1946 amounted to about 140 tons. A small tonnage was also used in drilling water wells, and in exploratory drilling in the Athabaska bituminous sand area.

As reported by the Dominion Bureau of Statistics, Canada in 1945 (1946 not available) used a total of about 16,200 tons of domestic and imported natural and activated bentonite, consumption by industries being: bleaching of lubricating oils and gasoline, 55 per cent; foundries, 33 per cent; oil-well drilling, 9 per cent; miscellaneous, 3 per cent. In the United States, about 28 per cent of the sales in 1945 was used in drilling, the same amount in foundries, and 25 per cent for oil filtering and bleaching. Wyoming and South Dakota furnished most of the highly colloidal bentonite used for drilling and in foundries; California and Mississippi supplied most of the non-swelling type for activation use.

Prices

The price of bentonite varies within wide limits, depending upon the nature of the material and the degree of processing it has been given. Alberta crude clay sold in 1946 for $4.50 to $5 per short ton, f.o.b. mines; the material processed for oil-drilling use was priced at $35 per ton, bagged, f.o.b. plant. Activated bentonite for bleaching use cost from $57 to $63 per ton in bulk, carload lots, delivered eastern Canadian points. The average consumer price for Wyoming standard 200-mesh bentonite in 1946 was about $9.50 per ton, bagged, in carload lots, f.o.b. plant, as compared with $8.20 in 1945. Special grades were quoted at $12 to $80.

BITUMINOUS SAND

Deposits of bituminous sand occur along the Athabaska River in Alberta between the twenty-third and twenty-sixth base lines. Intermittent exposures can be seen along both sides of the river and along certain of its tributaries. Investigations subsequent to 1913 indicated that the bituminous sand in certain areas might be suitable for commercial development, but that the true value of individual areas could be determined only after detailed exploration by core-drilling equipment. In 1942, as part of a war program for investigation of petroleum resources in Canada, exploratory core-drilling was undertaken by the Mines and Geology Branch, Department of Mines and Resources, at the request of the Oil Controller for Canada. In 1942, 1943, 1944, and 1945, 212 holes were drilled in the Wheeler Island area, the Steepbank River area, Muskeg River area, and the Horse River Reserve near Fort McMurray. Drilling was continued in 1946 under the supervision of engineers of the Mines and Geology Branch. As a result, 61 holes were drilled in the Ruth-Mildred Lakes area, aggregating 14,274 feet, and 8 holes were drilled in the Muskeg River area, aggregating 1,689 feet.

Production

It has been estimated that approximately 65,000 tons of bituminous sand was mined for all purposes during the 30-year period prior to the end of 1945. Some of this material was for experimental work, but the greater part of it was treated to remove the bitumen, which in turn was processed into gasoline, diesel fuel oil, and residual fuel oils.

As a result of the fire in June, 1945, which destroyed the separation plant, warehouse, and machine shops of Abasand Oils, Limited, no bituminous sand was processed during 1946.

In November, the Dominion Government returned to Abasand Oils, Limited, the properties and leases that the company had transferred to the Government during the war, and an agreement was signed settling the question of payments.

Under an arrangement with Oils Sands, Limited, another separation plant is being erected under the auspices of the Alberta Government at Bitumont, about 50 miles down the Athabaska River from Fort McMurray, but it is not yet in operation.

CEMENT

The Canadian cement industry experienced one of its best years in 1946 and the output was the highest on record, with the exception of 1929. This was occasioned by great activity in the construction industry, the dollar value of building contracts awarded being higher than in any previous year. Prospects are favourable for a still greater increase in the demand for Portland cement in 1947. To keep abreast of the expanding demand, Canada Cement Company and St. Mary's Cement Company were increasing their production facilities, and British Columbia Cement Company was building a new plant at Horne Lake on the east coast of Vancouver Island.

All of the Canadian plants now operate on the wet process of cement manufacture and remarkable uniformity in chemical and physical properties of the standard variety of cement is obtained throughout the Dominion.

Principal Canadian Source of Supply

Raw materials for the making of cement, namely, limestone and clay, are widely distributed in Canada, and cement is manufactured in Quebec, Ontario, Manitoba, Alberta, and British Columbia. In addition to the standard or ordinary variety of Portland cement, several other varieties, including high-early-strength, alkali-resistant, and white cement are made. The white cement, however, is made from imported clinker.

Four companies constitute the Canadian cement industry. These are:

Canada Cement Company, Limited, which has manufacturing plants at Hull and Montreal East in Quebec; at Port Colborne and Belleville in Ontario; at Fort Whyte, Manitoba; and at Exshaw, Alberta. This company also operates grinding plants at Chatham, New Brunswick, and at Halifax, Nova Scotia, where cement is made from clinker brought from Montreal East.

St. Mary's Cement Company, Limited, which operates a plant at St. Mary's, Ontario.

Medusa Products Company of Canada, Limited, which has a grinding plant at Paris, Ontario, where white cement and cement paints are prepared from clinker imported from the United States.

British Columbia Cement Company, which operates a plant at Bamberton, British Columbia. This company is building a new plant at Horne Lake on Vancouver Island.

The present total rated daily capacity of all plants is about 37,000 barrels (a barrel of cement weighs 350 pounds net), but this will be increased when new production units currently being installed are in operation.

Production and Trade

Production of cement was 11,560,483 barrels valued at $20,122,503, compared with 8,471,679 barrels valued at $14,246,480 in 1945.

Exports of Portland cement decreased to 400,295 cwt. valued at $236,276 from 986,803 cwt. valued at $535,012 in 1945. Most of the exports went to Newfoundland, Trinidad, Jamaica, and other British West Indies islands.

Imports of Portland cement rose to 1,225,199 cwt. valued at $1,098,532 from 114,286 cwt. valued at $141,539 in 1945. These imports in 1946 were from the United States, Belgium, and the United Kingdom. In addition to the finished cement, 50,037 cwt. of white Portland cement clinker valued at $30,147 was imported from the United States for grinding in Canada, compared with 54,549 cwt. valued at $35,023 in 1945.

Cement is one of the most important of the structural materials and is used in all construction work, such as bridges, canals, dams, highways, foundations, or buildings. The cement products industry making building blocks, bricks, pipe, artificial stone, garden furniture, etc., uses cement as its principal raw material.

Prices

The average selling prices of cement per barrel f.o.b. plant in the several producing provinces during the period 1938 to 1946 were:

—	1938	1939	1940	1941	1942	1943	1944	1945	1946
Quebec	$1·35	$1·35	$1·41	$1·43	$1·46	$1·44	$1·46	$1·54	$1·57
Ontario	1·40	1·43	1·40	1·40	1·43	1·46	1·46	1·55	1·64
Manitoba	2·28	2·25	2·23	2·21	2·10	1·89	1·96	2·11	2·24
Alberta	2·01	1·97	2·01	2·00	1·96	1·94	1·96	2·01	2·02
British Columbia	1·87	1·91	1·94	1·97	2·07	2·14	2·12	2·12	2·25

CLAY AND CLAY PRODUCTS

The industrial clays of Canada may be classified as common clays, stoneware clays, fireclays, china clays, and ball clays The domestic clays are used for the manufacture of building brick, structural tile, drain tile, roofing tile, stoneware, sewer pipe, pottery, and refractories. From imported clays are made electrical porcelain, sanitary ware, sewer pipe, tableware, pottery, ceramic floor and wall tile, and various kinds of fireclay refractories.

Throughtout 1946, the industry operated at full capacity of the available manpower and was hampered to some extent by the high labour and other costs. Progress was made in the modernization of plant equipment and in the quality control of products.

The products manufactured from Canadian clays, including the sales of domestic clays, were valued at $12,207,367 in 1946, compared with $8,913,092 in 1945, and with a peak value of approximately $14,000,000 in 1929. Imports of clay and manufactures of, reached a value of $17,825,283 in 1946, and exports a value of $1,051,590. The imports consisted principally of china clay, firebrick, china tableware, porcelain, and earthenware.

Common Clays

The largest production of building brick and tile is centred in southern Ontario. Common clays suitable for the production of building brick and tile are found in all the provinces of Canada. There are 112 brick and tile plants in Canada, which are in production or plan to operate in the near future and the capacities of which range from 600 tons to 125,000 tons a year.

Stoneware Clays

The largest production in Canada of stoneware clay or semi-fireclays comes from the Eastend and Willows area, Saskatchewan. Large quantities of the clays from the area are selectively mined and are shipped to Medicine Hat, Alberta, where, owing to the availability of cheap gas fuel, they are used extensively in the manufacture of stoneware, sewer pipe, pottery, tableware, etc.

Stoneware clays and moderately refractory fireclays occur near Shubenacadie and Musquodoboit, Nova Scotia. Some of the Musquodoboit clay is used for the production of pottery, but it has not been extensively developed for ceramic use.

Stoneware clays, or low-grade fireclays, occur near Williams Lake and Chimney Creek Bridge in British Columbia; in the Cypress Hills of Alberta; and near Swan River, Manitoba; but they are difficult of access and have not been developed.

Stoneware articles (sewer pipe, pottery, etc.) are manufactured in thirty-nine plants in Canada, including seven plants that manufacture sewer pipe. Included are a number of small operators engaged in the manufacture of pottery.

Fireclays

Two large plants and a few small plants manufacture fireclay refractories from domestic clay. At one plant about 50 miles south of Vancouver, firebrick and other refractory materials are manufactured from a high-grade, moderately plastic, fireclay that is extracted by underground mining from the clay beds in Sumas Mountain. Another plant at Claybank, Saskatchewan, utilizes the highly plastic refractory clays obtained by selective mining of the "Whitemud" beds in the southern part of the province.

Some of the refractory clays from Shubenacadie are mined and used by the steel plant at Sydney, Nova Scotia.

China Clay, Ball Clay, etc.

China clay (kaolin) has been produced commercially in Canada only from the vicinity of St. Rémi d'Amherst, Papineau county, Quebec. A limited amount is shipped in tank cars to the paper plants as a slurry for use as a paper filler.

Other deposits in Quebec are at Thirtyonemile Lake, near Point Comfort, Hull county; near Brébeuf; at Lake Labelle; and at Chateau Richer. These are not being developed, however, to any appreciable extent. Efforts to develop deposits on the Matagami, Abitibi, and Missinaibi Rivers in northern Ontario have been handicapped owing to the distance of the deposits from industrial centres and railways.

China clay and ball clay from England and the United States is used in the manufacture of porcelain, sanitary ware, dinner ware, ceramic floor and wall tile, etc.

CORUNDUM

With completion of the treatment of tailings at the Craigmont property, Renfrew county, Ontario, at the end of October, 1946, corundum operations in Canada have come to an end for an indefinite period, and the machinery and equipment at the property have been sold. Treatment of the tailing was undertaken at the request of the United States Government as an emergency measure in October, 1944, arising from the difficulty of obtaining supplies of flour corundum from the Transvaal in South Africa. This type of corundum was then urgently needed for use in polishing high-precision lenses for military optical instruments, and a 200-ton gravity mill was erected by Wartime Metals Corporation to treat the tailing. Shipments of concentrate were made to American Abrasive Company's plant at Westfield, Massachusetts, for grinding and for the preparation of fine powders. During the 25-month period of operation a total of 139,323 tons of tailing averaging 2·56 per cent corundum was treated, and 2,588 tons of concentrate containing 1,726 tons of corundum, having a nominal value of $234,820, was shipped to Westfield. Since November, 1945, the Craigmont operations have been handled by the Department of Reconstruction and Supply, Ottawa.

Some corundum is still available in the known deposits, but, except in an emergency, production costs would be excessive. The Canadian consumption of corundum is small and supplies are obtained from foreign sources without difficulty.

Corundum (Al_2O_3), the oxide of aluminium, usually occurs as bronze-coloured barrel-shaped crystals. It is fairly heavy, and has a hardness (Mohs' scale) of 9, being the hardest known mineral next to diamond (hardness 10).

Principal Canadian Sources of Supply

The corundum-bearing nepheline syenite belts of southern and eastern Ontario have been described in Bureau of Mines Report No. 820 "The Canadian Mineral Industry, 1945". No other commercial sources have as yet been discovered.

Production and Trade

During the 10 months of operation in 1946 nearly 64,500 tons of tailing was treated at the Craigmont property, and 1,138 tons of concentrate containing 742 tons of corundum having a nominal value of $102,340 was shipped to Westfield for conversion into flour grades.

A small quantity of flour corundum was imported into Canada in 1946.

Most of the world production of the mineral during the past thirty years has come from the Transvaal, from which production in 1946 was about 2,022 tons, 58 per cent below that of 1945, the decline being largely due to shortage of labour. Until 1946 most of the output was crystal, but in that year the tonnage of concentrate, first produced in 1944, was three times that of crystal. The Transvaal ores vary from 20 to 50 per cent corundum.

As the United States is dependent upon the corundum from South Africa, the Foreign Economics Administration sent representatives to Africa during the war in an effort to stimulate production. The results of this investigation were recently published.[1]

In an emergency about 200 tons a month of eluvial or crystal corundum could be obtained for a short period, but in normal times not more than 100 tons of crystal and 50 tons of reef can be expected monthly. Concentrates must, therefore, be substituted progressively for the decreasing crystal supply.

Some corundum was produced in Southern Rhodesia during the war. It is estimated that an output of 25 tons a month could be maintained. There has been no production from Mozambique since the end of the war. Nyasaland probably has the best prospects for increased production of crystal, although the quality is not so good as the Transvaal corundum.

(1) Metcalfe, R. W., "Corundum in Southern Africa", U.S. Dept. Interior Mineral Trade Notes, Special Supplement No. 12, Feb. 20, 1947.

During the latter war years Madagascar produced 70 to 80 tons annually. A small output is maintained by India, the recorded production between 1941 and 1944 being 60 to 150 tons annually.

Uses

Prior to the war corundum was used chiefly for the abrasive grit in grinding wheels required for special types of work, but during the war most of it was used as flour for the polishing of lenses, and the coarse grain, for snagging wheels. In the United States, which is by far the leading consumer, a start was made shortly after the end of the war to revert to the use of corundum for the manufacture of precision grinding wheels.

The price of Canadian concentrate was Government-controlled at about $90 a ton. The prices of corundum and other ores imported into the United States were frozen as of August 20, 1943. South African "crystal" corundum was $107 and "boulder" was $74 a short ton delivered to the Westfield plant. United States prices of prepared grain and flour corundum vary considerably according to mesh size. These prices are 8¾ cents a pound for 6 to 60 mesh and 9¾ cents for 70 to 275 mesh. Flours range from 30 cents for 850 mesh to 70 cents for 2600 mesh.

DIATOMITE

The Canadian consumption of diatomite as a fertilizer dusting agent has increased annually by 1,000 tons a year since 1943, when it was first used for that purpose, and consumption for all uses reached a record in 1946. Almost all the Canadian requirements are imported, as production is still insignificant. Tests by the companies concerned to determine the suitability of Canadian material for this new use continued and some success was achieved with diatomite from British Columbia.

Diatomite consists of the microscopically small remains of siliceous shells of diatoms, a form of algæ that at one time lived under water. The material of Recent (geologically) fresh-water origin, which is the most common in Canada, usually occurs as a grey or brown mud or peat, whereas the diatomite of Tertiary age is in dry and compact beds, and is very light in weight, and white to cream in colour.

Principal Canadian Sources of Supply: Occurrences

There are more than 400 known deposits of diatomite in Canada. They are in the swamps and in the lake bottoms of northern Nova Scotia; in southern New Brunswick; in the Muskoka district, Ontario; and in various parts of British Columbia. The Tertiary fresh-water deposits near Quesnel in the Cariboo district, British Columbia, are by far the largest known in Canada. They extend for many miles along the Fraser River, are compact and are up to 40 feet thick. At Digby Neck, Nova Scotia, is the largest known Recent fresh-water (swamp) deposit in Canada.

All the Canadian production of diatomite since 1939 has come from the aforementioned areas. The present producers are: G. Wightman, who operates the deposit at Digby Neck; L. T. Fairey, of Vancouver, who has been obtaining his output from Lot 1122 on the west bank of the Fraser River, north of Quesnel; and Cariboo Diatomite Company, which produces small quantities from a deposit near Alexandria, a few miles south of Quesnel, for use in fertilizer dusting.

The Nova Scotia Department of Mines in 1946 investigated some of the deposits of the province, particularly those along Digby Neck. The Resources

Development Board, Fredericton, New Brunswick, examined a number of diatomite deposits in the vicinity of Saint John and intends to submit bulk samples to consumers. Tests were continued on the suitability of diatomite in the vicinity of Quesnel, British Columbia, for fertilizer use and for insulation.

Production and Trade

Production in 1946 was about 155 tons, and sales, 90 tons valued at $2,532, compared with sales of 46 tons valued at $1,238 in 1945.

Imports were 17,063 tons valued at $469,968, all of which came from the states of California and Washington. This is a tonnage increase of 29 per cent over the former peak of 13,217 tons in 1945 valued at $362,882.

Prior to the war diatomite was produced in about thirty countries, with the United States in the lead, followed by Denmark and Germany, the other important producers being Japan, Algeria, Russia, and France. In the United States the estimated output of the ten operators in 1946 was in excess of 180,000 tons. Most of the output is, however, by two companies, namely, Johns-Manville Corporation (Celite Division) from deposits at Lompoc, California, and The Dicalite Company from deposits at Walteria, California, and at Terrebonne, Oregon, and also from deposits acquired in 1945 at Basalt, Nevada, and at Kittitas, Washington. Most of the diatomite exported to Canada for fertilizer use comes from Kittitas, and some from Lompoc. Denmark, prior to the war, had an output of about 100,000 tons a year of a clay-diatomite, known as "Moler" from Jutland. Germany produced from 20,000 to 50,000 tons of "Kieselguhr" annually, the principal deposits being at Luneberger Heath. In Northern Ireland, Australia, England, and Brazil, production has been increasing and in 1946 each of these countries produced 3,000 tons or more.

Uses; Specifications

Canada consumed approximately 16,000 tons of diatomite in 1946, of which about 8,200 tons was used as a fertilizer dusting agent, 5,000 tons for filtration, and the remainder mainly as insulation and as a filler. Prior to 1944 from 70 to 80 per cent of the diatomite consumed in Canada was used in the form of filter aids, mainly in the refining of cane sugar. The ammonium nitrate fertilizers in which diatomite is used as a dusting agent are made in Canada by The Consolidated Mining and Smelting Company of Canada, Limited, in its plant in Trail, British Columbia, and in another in Calgary, and by North American Cyanamid, Limited, in its plant near Welland, Ontario. The diatomite thus used is highly porous and when added to the nitrate it absorbs moisture, which prevents the nitrate from caking and ensures even spreading. Specifications call for uncalcined material of 325 mesh and less than 5 per cent moisture. The remainder of the diatomite was used chiefly as a filler in the paint, chemical, paper, rubber, soap, and textile industries; also in silver polish bases, and as an admixture in concrete. A small amount of lime-diatomite insulation bricks is made by a company in Toronto, which uses diatomite from Nova Scotia. Diatomite is being used in pressure filters in industrial plants in place of sand filters for the removal of disease-producing organisms.

Indications are that not more than 25 per cent of the calcined material produced from the best-quality Canadian deposit so far discovered can be made into an efficient filter aid that can compete with the imported product. Future production thus depends largely upon the success with which the Canadian product can be employed as a dusting agent in ammonium nitrate fertilizer, much of the output of which is being exported to Europe.

Prices

The price of diatomite used in Canada for insulation varies from $23 to $40 a ton; for filtration from $26 to $75 a ton; and fertilizer grades, $28 to $42 a ton. For material suitable for polishes the price for small lots ranged up to $200 a ton in 1946. Imported insulation bricks vary in price from $85 to $140 per 1,000, according to grade and density.

FELDSPAR

Quebec and Ontario continued to supply all of the feldspar mined in Canada in 1946. Production increased 16·5 per cent over that in 1945. Quebec produced 85 per cent of the total compared with 88 per cent in 1945. In both provinces a few new operations contributed moderate tonnages.

Principal Canadian Sources of Supply

Feldspar mining in Canada has been confined almost exclusively to the Ottawa region in adjacent sections of western Quebec and eastern Ontario. A few thousand tons was produced in the Winnipeg River area, southeastern Manitoba, between 1933 and 1939, but no further shipments have been reported.

In Quebec, most of the production in 1946 came from four mines operated by Canadian Flint and Spar Company in Derry, Buckingham, West Portland, and Templeton townships, Papineau county. Bon Ami, Limited undertook development on two of its properties in the Liévre River area, from one of which a few hundred tons was shipped, and also reopened its old mine in Aylwin township, Gatineau county. A few other operators, including Buckingham Mining Corporation, and Buckingham Feldspar, Inc., produced a few hundred tons, from properties in the Buckingham area. Certain mines in this section produce small amounts of high-grade dental feldspar, in addition to standard ceramic and cleanser grades.

In Ontario, Bathurst Feldspar Mines, Limited, operating in Bathurst township, Lanark county, continued to be the largest producer and increased its output substantially. Opeongo Mining Company operated a property at Prince's Lake, in Sabine township, Nipissing district, for a few months and later moved to a mine in Conger township, Parry Sound district, which was worked earlier in the year by Conger Feldspar Mining Company. Bancroft Feldspar Mines, Limited continued production from its property in Monteagle township, near Maynooth, Hastings county, in which operations were started late in 1945. In Bedford township, Frontenac county, the large open pit at the long-idle Richardson mine was unwatered and preparations were made by Canadian Flint and Spar Company to resume operations.

Production and Trade

Mine shipments of crude feldspar in 1946 totalled 35,243 short tons valued at $384,677, compared with 30,246 tons valued at $282,656 in 1945. Quebec supplied 29,758 tons, and Ontario 5,485 tons, compared with 26,389 tons and 3,857 tons, respectively, in 1945.

Exports, which comprised mainly ceramic grades of crude, but included a small amount of ground feldspar and high-value crude dental spar, totalled 19,239 short tons valued at $140,403, compared with 16,888 tons valued at $125,028 in 1945. The quantity was 55 per cent of the total crude production. Most of the material was consigned to grinding plants in the United States, the chief importers being Consolidated Feldspar Corporation, and Genesee Feldspar Company, both at Rochester, N.Y., and Shenango Pottery Company, New Castle, Pa.

Imports of ground feldspar, all from the United States, were 705 tons valued at $13,622, compared with 826 tons valued at $15,052 in 1945.

Canadian production has always greatly exceeded domestic consumption. Canadian spar has a high reputation for quality with the pottery trade in the United States. This market continues to expand owing to the progressive depletion of reserves in the eastern and southern states.

No complete statistics on world production of feldspar have been available since 1937. In 1945, production of crude spar in the United States, the leading producer, reached a peak of 373,054 long tons, an increase of 14 per cent over 1944, and sales of ground feldspar reached a peak of 381,728 short tons, 11 per cent more than in 1944. The leading producing states were North Carolina (40 per cent of the total crude sold), South Dakota (18 per cent), New Hampshire, Virginia (8 per cent), Colorado (7 per cent), Wyoming (5 per cent), and Connecticut (3 per cent).

Uses; Specifications

As reported by the Dominion Bureau of Statistics, consumption of feldspar in Canada in 1945 (1946 not available) totalled 12,944 short tons, compared with 11,173 tons in 1944. Distribution by industries in 1945 was: cleansers, 4,847 tons; glass, 2,740 tons; enamelling, 2,884 tons; pottery products, 2,347 tons; abrasives, 60 tons; miscellaneous, 266 tons. Enamelling use showed the largest increase, the amount being nearly double that used in 1944. Quebec used about 53 per cent of the total consumption, Ontario 45 per cent, and Alberta, 3 per cent.

All of the feldspar used in industry is ground, either in mills run in conjunction with mining operations, or in merchant mills. Some manufacturers of ceramic products mine or buy crude spar and grind it for their own use. Feldspar for domestic use is ground in mills operated by Canadian Flint and Spar Company, Buckingham, Quebec, and by Bon Ami, Limited, 13,719 Notre Dame Street East, Montreal. The former company produces ground spar for ceramic and cleanser use, and Bon Ami uses its product in making cleanser compounds. Frontenac Floor and Wall Tile Company's mill at Kingston, Ontario, did not operate in 1946.

By far the greater part of the production of feldspar (nearly 90 per cent in the United States in 1945) is used in the pottery, glass, enamelware, and other ceramic trades, and the remainder mainly in scouring soaps and cleansers and for bonding of fired abrasive wheels and other shapes. Some coarsely crushed spar, usually made from impure waste or quarry fines, is sold for stucco dash, artificial stone, chicken grit, etc. Small tonnages of specially selected crude ("dental spar") are used in the manufacture of artificial teeth, and such material commands a large premium.

Most of the feldspar used is of the high-potash type, though some high-soda spar is used for blending purposes and in low-fired enamels and glazes. Practically all colours are equally acceptable for ceramic uses, but for cleanser purposes, pale shades of white to buff are demanded. Nepheline syenite and aplite (an impure feldspathic rock) are competitive with feldspar for ceramic uses, notably in the glass trade.

Until recently, all the feldspar supplied to grinding mills consisted of crude lump produced by picking and cobbing methods. As a result of threatened shortages in the eastern and southern United States, however, attention in that country has been given in the past few years to the milling and concentrating by flotation of sub-grade rock to fill grinders' requirements. One such mill already is in operation in North Carolina, and a second plant was reported to be under construction in 1946.

Prices and Tariffs

The average price quoted by Canadian producers for standard grades of crude ceramic and cleanser feldspar during the first half of 1946 was $6.50 to $7 a long ton, f.o.b. rail, for export or shipment to domestic mills. Prices in the second half of the year rose to $7.50 and $8, and special, high-quality ceramic crude sold up to $12. The average declared unit value of all crude feldspar exported to the United States in 1946 was $6.90 a short ton. The declared value of selected dental spar exports to the United States and Mediterranean countries ranged from $35 to $128 a ton, with the average $73. Domestic ground feldspar was quoted at $12.50 a ton for granular glass grade, and $18.50 to $22 for 200-mesh pottery grades, all in carload lots, f.o.b. mill.

The import duty on crude feldspar entering the United States is 25 cents a long ton. The duty on ground spar is 15 per cent ad valorem.

FLUORSPAR

There were no noteworthy changes in the fluorspar industry in 1946. The Madoc area in Hastings county, Ontario, continued to supply all of the production, which remained at substantially the same level as in 1944 and 1945.

Production of fluorspar in Canada was commenced in 1905, and to the end of 1946 output totalled 112,206 tons valued at approximately $2,438,000. Ontario furnished 61 per cent of the shipments by quantity and 68 per cent by value; British Columbia supplied 38 per cent by quantity and 31 per cent by value; and the remainder came mainly from Nova Scotia. For most of the above period, output in Ontario was small, but it rose substantially during the two world wars and reached a peak of 10,385 tons in 1943. The 42,000 tons recorded for British Columbia was produced from the Rock Candy mine of The Consolidated Mining and Smelting Company of Canada, Limited, near Grand Forks, between 1919 and 1929, with the maximum output of 17,800 tons in 1929. The small tonnage produced in Nova Scotia was mined in the three years 1941-1943. In 1944, a few tons of hand-picked high-grade fluorspar was shipped from a deposit in Pontiac county, Quebec.

Canadian Sources of Production

In 1946, all the production came from the Bailey (Millwood Fluorspar Mines, Limited), Rogers (Reliance Fluorspar Mining Syndicate, Limited), Blakely (Charles Stoklosar), and Johnson (Fluoroc Mines, Limited) mines in the Madoc area, the first two of which accounted for 86 per cent of the total shipments. Millwood Fluorspar Mines drilled its main vein in the winter of 1945-46 and reported a substantial additional tonnage of ore indicated below the present 100-foot limit of mining. Reliance Fluorspar Mining Syndicate increased its picking-belt capacity and stepped-up shipping grade materially. Fluoroc Mines, Limited collared a 3-compartment shaft and erected a headframe on its Johnson property, and stockpiled about 500 tons of ore, of which 150 tons was shipped late in the year.

Beneficiation of Madoc fluorspar is confined to screening out of fines from mine-run ore, followed by crushing and wet picking of coarse lump. Screened fines commonly run from 60 to 70 per cent CaF_2 and are sweetened with high-grade lump to make a shipping product of 70 to 80 per cent grade. Special bonus-grade material runs as high as 90 per cent. Calcite and barite are the chief gangue minerals.

Fluorspar, associated with calcite and apatite, occurs as the filling of veins and pockets in pegmatite bodies in the Wilberforce-Harcourt district, about 50 miles north of Madoc, and occasional small development operations have been conducted in recent years. Most of the ore averaged only 25 to 30 per cent CaF_2, and would require milling. In 1946, Fission Mines, Limited took over the former Ontario Radium Corporation and Richardson holdings near Wilberforce and mined and stockpiled a small tonnage. No shipments were made from the area.

There were no further developments on the occurrence near Cobden in Ross township, Ontario, where Dominion Magnesium, Limited did some exploration work in 1944-45 in the hope of providing a local source of fluorspar for its nearby plant at Haley. The ore is similar to that of the Wilberforce area and would require concentrating.

The Lake Ainslie ore in Nova Scotia contains considerable barite, and mill tests by the Bureau of Mines, Ottawa, have shown that it can be concentrated to yield commercial grades of fluorspar and barite.

Production and Trade

Shipments of fluorspar totalled 8,042 short tons in 1946 valued at $237,491. This compares with 7,369 tons valued at $233,708 in 1945.

Imports were 31,813 short tons valued at $737,094, compared with 20,512 tons valued at $530,670 in 1945. Newfoundland supplied 88 per cent of the imports, the United States 8·5 per cent, and Mexico 3·5 per cent.

World production of fluorspar prior to the war averaged about 500,000 short tons annually, of which the United States and Germany supplied about 75 per cent. Mine shipments in the United States reached a record of 413,781 short tons in 1944, well over double the 1939 figure. In 1945 they declined to 325,200 tons, and in 1946 to about 275,000 tons.

Uses; Specifications

Consumption of fluorspar in Canada in 1945 (breakdown for 1946 not available) is estimated at 37,300 short tons compared with 57,632 tons in 1944, and with a peak of 64,922 tons in 1943. Fifty-two per cent of the total in 1945 was used in the steel trade; 35 per cent by smelters of non-ferrous metals; 10 per cent in the heavy chemicals industry; and the remainder in enamels and glazes, ferro-alloys, white metal alloys, glass, etc. Ontario was the largest (43 per cent) consumer and was followed by Quebec (36 per cent), and Nova Scotia (20 per cent). Consumption in the United States in 1945 totalled 356,000 short tons, of which 56 per cent was used in the steel trade, 31 per cent in the manufacture of acid, and 9 per cent in the glass industry. In 1946, the figures for these industries were 54 per cent, 28 per cent, and 13 per cent, respectively.

Fluorspar is used chiefly as a fluxing agent in the steel industry, and in smaller amounts in numerous other metallurgical industries. The next largest market is for the manufacture of hydrofluoric acid, which is used mainly in making artificial cryolite and aluminium fluoride for the aluminium industry. The fluorspar imported from Newfoundland is used for this purpose at Arvida, Quebec. The ceramic industry is the third largest consumer, and uses fluorspar as a fluxing opacifying ingredient in glass and enamels. Uranium hexafluoride is used for the gaseous diffusion separation of the uranium isotopes U_{235} and U_{238} in the development of atomic energy.

Of considerable interest are the possible uses of elemental fluorine in the development of new industrial products and processes A field of use is envisaged for fluorine in the chemical industry comparable to that of its closely related element chlorine. Only recently available on a commercial scale, compressed fluorine gas is being offered in small, half-pound steel cylinders by a company in

Philadelphia. The fluorine is produced in a specially designed electrolytic cell, using an electrolyte of anhydrous hydrofluoric acid and fused potassium bifluoride. Fluorine gas is evolved at the anode and hydrogen at the cathode. The fluorine is purified from associated small amounts of HF either by absorption of the latter in sodium fluoride or by chilling. Among the new compounds expected to be made available by the use of fluorine are: a liquid, fluorinated non-inflammable and non-toxic hydrocarbon that can be used in place of mercury in the present mercury vapour boiler; sulphur hexafluoride gas of high insulating value for high voltages used in X-ray and nuclear physics work; and an extremely stable synthetic lubricating oil capable of withstanding high pressures and friction. Other suggested fluorine compounds include: insecticides, fungicides, germicides, fumigants, anæsthetics, fire extinguishers, and for proofing media, resins, and plastics.

At present, fluorspar is the only source of fluorine, but means may be found for recovering the 2 to 3 per cent of fluorine present in the huge quantities of phosphate rock used in the fertilizer industry and that now goes to waste. It is reported that a system to recover the gaseous fluorine discharged from the reduction pots was installed recently in a Pacific Coast aluminium plant in the United States.

Standard fluxing gravel of lump grade for metallurgical use is usually sold on a specification of a minimum of 85 per cent CaF_2, and not over 5 per cent silica or 0·3 per cent sulphur. Fines should not exceed 15 per cent. Canadian shipments have averaged much below this standard, and in some cases consumers sweeten the material with higher grade imported spar.

Glass and enamel grades call for not less than 95 per cent CaF_2, with a maximum of 2½ to 3 per cent SiO_2 and 0·12 per cent Fe_2O_3. The material must be in mesh sizes ranging from coarse to extra fine.

Acid-grade spar has the most rigid specifications, namely a minimum of 98 per cent CaF_2 and not over 1 per cent SiO_2. It must be in powder form. Most of the material supplied to the acid and ceramic trades is a flotation concentrate.

Prices

Canadian trade journal quotations for metallurgical gravel, 85 per cent grade fluorspar in 1946 remained at $40 per ton, f.o.b. Toronto, and for ground, 97 per cent grade, $66 to $69.

In the United States, under OPA ruling of August, 1943, the maximum price for metallurgical grade spar f.o.b. at consumer's plant was based on the effective CaF_2 content, plus either (*a*) rail freight from shipping point to consumer's plant, or (*b*) rail freight from Rosiclare, Illinois, to such plant, whichever is the lower. The base price was set as follows: 70 per cent or more effective units, $33 per short ton; 65 to 70 per cent, $32; 60 to 65 per cent, $31; under 60 per cent, $30. "Effective units" are computed as the CaF_2 content less 2½ times the percentage of contained silica. This price ruling remained in effect through 1946. Acid grade, 97·5 per cent CaF_2, was quoted at $37 a ton, plus freight. United States fluorspar had an average unit value of $28 a ton and probably included a substantial proportion of acid and ceramic grades, neither of which is produced in Canada. Mexican material had an average unit value of $16 a ton and is assumed to have been all of metallurgical grade.

Tariff

The duty on metallurgical grade fluorspar entering the United States is $5·625 a ton, and on acid and ceramic grades $3.75 a ton. Fluorspar enters Canada duty free.

GRANITE

(*Building, Ornamental, and Crushed*)

Large areas in Canada are underlain by granite and other related crystalline igneous rocks, and in a number of localities quarries in such rocks have been opened up for the production of building stone, monumental stock, riprap, etc. More than 90 per cent of the Canadian output of granite in 1946 was supplied by Quebec and Ontario, and the remainder came from Nova Scotia, New Brunswick, Manitoba, and British Columbia.

Prior to the war most of the Canadian production of granite was used for riprap and crushed stone and in the construction of public and semi-public buildings, and smaller quantities for monumental stock, but during the war there was little demand for dimensioned stone for building so that many of the quarries producing only this type of stone were forced to close. There was sufficient demand, however, for monumental stock for the domestic market and for export to enable a number of the firms to keep their dressing sheds in operation on a small scale, and some of the larger quarries favourably situated were able to supply any demand for riprap that arose. In 1946 the chief production was for monumental stone, but with the prospects of extensive building construction, these companies can turn again to the production of building stone with little loss of time.

Many of the Canadian granites are suitable for monumental use, and prior to the war much of this material was used within a limited radius of the various quarries, but appreciable quantities of special monumental stock such as the 'reds' and 'black granites' were imported from the Scandinavian countries, notably Finland and Sweden. When shipments were cut off, Canada and the United States had to depend upon their own quarries. In Canada a number of quarries produce granite of pleasing characteristics for monumental use, and in the past few years there has been a small but steady increase in the domestic demand for such stone. Moreover, numerous requests from the United States for samples have been received by Canadian firms and exports to that country have shown an appreciable increase.

Principal Canadian Sources of Supply

Quebec continued to furnish most of the granite used for building, road, foundation, and other heavy construction, the leading producing areas being Stanstead, Stanstead county; St. Samuel, Frontenac county; Rivière-à-Pierre, Portneuf county; Lake St. John district; Grenville, Grenville county; Guenette, Labelle county. Granite for monumental use is produced in the Maritime Provinces, and in Quebec, Ontario, Manitoba, and British Columbia. 'Black granite' is produced mainly in the vicinty of Lake St. John and from quarries along the north shore of Lake Superior. Other deposits of 'black granite' in the Maritime Provinces, Quebec, Ontario, and Manitoba show promise of yielding stone of good quality.

In Nova Scotia and New Brunswick the industry was again comparatively quiet. Production in Nova Scotia was limited to a small quantity of monumental stone, 'grey' and 'black' granite from the Shelburne district, and 'grey' granite from the Nictaux West area.

In New Brunswick, the granite quarry at Hampstead was in production, and two firms at St. George produced for the monumental trade. A few tons of 'black granite' was produced from the quarry at Lake Digdequash.

In Quebec, grey granite comprises over half of the total output of the province and is quarried mainly in the Stanstead district, St. Samuel, and St. Gérard. At St. Gédéon and St. Joseph d'Alma in the Lake St. John district, three companies produce 'black' granite and one company produces red granite, all of which finds a ready market for monumental use and for building trim. Brodies, Limited, Montreal, had its new cutting-shed at Iberville, erected to replace the shed destroyed by fire, in full operation. The company obtains its granite from Graniteville, Stanstead county; from Guenette, Labelle county; and from Mount Johnson, near Iberville, Stanstead Granite Quarries Company of Beebe obtained its grey granite stock from quarries at Graniteville; its rough monumental stock was purchased from various other localities. Silver Granite Company is the chief producer of 'grey' granite in the St. Samuel district. Prospecting for some of the coloured granites that are in demand for monumental use was active in the province. Granite of deep red colour and pleasing texture was being developed in several districts, notably near Grenville, in Grenville county, and in the vicinity of Donnacona, Portneuf county.

In Ontario, the Ontario Rock Company, Toronto, quarried a trap rock at Havelock, Peterborough county, which is used mainly for road foundations, railroad ballast, and concrete aggregate. At the east end of Stony Lake, near Lakefield, F. S. Coyle and R. Kilburn produced a small quantity of 'red' granite for building and monumental purposes from a low granite ridge. Large blocks can be obtained from this location.

In Manitoba, small operations were carried on near the Manitoba-Ontario boundary from which several varieties of red, grey, and black granite for the Winnipeg trade were produced.

In British Columbia, granite was produced from several well established properties. A large proportion of the stone production of this province was andesite produced from Heddington Island for the building trade.

Production and Trade

Canada produced an estimated total of 319,354 tons of granite valued at $2,006,297 in 1946, compared with 221,630 tons valued at $1,284,748 in 1945.

Exports of granite and marble (granite is not recorded separately), unwrought, in 1946 was 5,277 tons valued at $82,008, compared with 3,855 tons valued at $46,606 in 1945. The export possibilities of monumental stock are worthy of careful study by Canadian producers especially for the black and red varieties, and in view of the aforementioned interest being shown by American consumers. Many Canadian granites are suitable for all purposes for which granite is used.

Imports of granite in 1946 were valued at $219,546, compared with $75,783 in 1945. Small amounts of granite were imported from the United States mainly for monumental use.

GRAPHITE

The long established Black Donald property near Calabogie in Renfrew county, Ontario, operated since 1943 by Black Donald Graphite, Limited, was again the only producer of graphite in Canada in 1946. It produces a variety of grades of mill products for different industrial uses. Sales remained at about the same level as in 1945. The company is a subsidiary of Frobisher Exploration Company.

Principal Canadian Sources of Supply

Flake graphite is found in many parts of the Canadian Shield, chiefly in gneisses and crystalline limestone. Occurrences of flake graphite are known also in Manitoba and British Columbia, but have attracted little interest.

Bodies of amorphous graphite near Saint John, New Brunswick, were worked on a small scale many years ago. Otherwise, production has been confined to adjacent sections of western Quebec and eastern Ontario, in the general Ottawa region, where about twelve mines and mills were operated at various times in the early years of the industry.

Production from the Black Donald property continued to come mainly from the re-treatment of old mill tailings recovered from the lake alongside the workings by pumping or power shovel, the remainder being mill feed provided by lump ore salvaged from old surface dumps. Preparations for renewal of underground mining from the old Ross shaft were started early in 1946 and a stoping drift was opened on the 290-foot level to develop an orebody discovered some years ago by drilling. This body is 150 feet long and 6 to 8 feet wide, and contains 25 to 30 per cent graphite. Mining and stockpiling of new ore was commenced in August, and by November about 1,500 tons had been raised. Proven ore reserves at the end of 1946 were reported as 7,500 tons, and possible reserves at 10,000 tons. Old tailings reserves, which henceforth will be drawn on only during the summer, are estimated at 10,000 tons. The mill runs three 8-hour shifts, 7 days a week, and has treated up to 50 tons a day of salvaged ore and tailings. The expected rate on newly mined ore is 35 tons a day. Recovery of finished products comprising natural flake, powdered flake, and amorphous in 1946 was about 5 tons a day. Total labour force employed was 22 men, 12 in mining, and 10 in the mill. The mill treated about 13,500 tons, with a recovery of 11·7 per cent carbon per ton.

Production and Trade

Sales of finished products by Black Donald Graphite, Limited, in 1946 totalled 1,975 short tons valued at $180,405, compared with 1,910 tons valued at $179,001 in 1945.

Seventy-three per cent of the shipments in 1946 was exported, almost all to the United States. Exports of milled and finished graphite concentrates were 1,489 tons valued at $142,974, compared with 1,142 tons valued at $124,295 in 1945.

Imports of unmanufactured graphite were valued at $98,847, compared with $66,869 in 1945. By value, 67 per cent of the imports in 1946 was Mexican amorphous, the remainder being credited to the United States. The latter, however, was probably wholly or largely of Ceylon and/or Madagascar origin. Manufactures of graphite imported, exclusive of crucibles, were valued at $360,777, compared with $277,242 in 1945. The United States supplied 94 per cent of such imports by value, the same proportions as in 1945. Imports of graphite crucibles, including lids, stoppers, stirrers, etc., were valued at $142,053, compared with $115,256 in 1945; by value, 50 per cent came from the United States and 50 per cent from the United Kingdom.

Artificial graphite is made in Canada by Electro-Metallurgical Company of Canada, Welland, Ontario, and by Exolon Company, Thorold, Ontario, which export part of their production to the United States.

Prior to the war world production of natural graphite of all types, and including flake, crystalline (plumbago), and amorphous, averaged about 140,000 short tons a year. Madagascar, Germany, Austria, and Czechoslovakia were the principal sources of flake; Ceylon, of plumbago; and Mexico and Korea, of amorphous.

Canada and the United States possess important graphite reserves, but are deficient in the types of graphite required for the most exacting uses, notably for crucible manufacture. Deposits are comparatively low grade for the most part and production costs are high. Consequently, the United States depends for most of its requirements of high-grade graphite upon imports of flake from Madagascar and of plumbago from Ceylon. Production of all types and grades of natural graphite in the United States in 1945 totalled 4,888 short tons, compared with 5,408 tons in 1944 and with 9,939 tons in 1943. Production in 1946 is reported to have shown a further considerable drop. Texas and Alabama have furnished most of the recent supply.

Uses; Specifications

Graphite has many uses, but is employed principally in foundry facings, lubricants, crucibles, retorts and stoppers, packings, pencils and crayons, paints, and stove polish. Important quantities, mostly amorphous or artificial, are used in dry batteries, electrodes, and commutator brushes. Flake from the Black Donald deposit is too small for crucible use and finished products consist mainly of amorphous foundry grades, but include high-grade fine flake and dust sold for use in lubricants, packings, and polishes. Prepared facings for the domestic foundry trade are made also.

In Canada, graphite is used chiefly in the foundry, dry battery, packings, lubricants, and paint trades. Foundry needs are met in part by domestic production, and in part by plumbago from Ceylon. The battery trade uses mainly Mexican amorphous, and paint requirements are filled largely by low-grade amorphous and flake. American imports of Canadian graphite are used chiefly in foundry facings, lubricants, and pencils.

Considerable quantities of specially refined graphite are used in the construction of "atomic piles" for the production of atomic energy. The graphite serves as a moderator to promote the capture of neutrons released by nuclear fission of uranium, which, in the form of slugs or rods, is inserted as a lattice within a large mass of graphite blocks. Graphite is used also as a shield surrounding the piles and reflects escaping neutrons back into the piles.

Mexican amorphous graphite in the form of 4-pound briquettes has recently appeared on the market for use by grey iron foundries in stabilizing carbon content in melts made from high-percentage scrap charges in periods of pig iron shortages.

Prices; Tariffs

Trade journal quotations for flake graphite in the United States in 1946 ranged from 16 cents a pound for best quality, down to 3 cents a pound for the lowest grade. Crude Ceylon lump, chip, and dust ranged from 12 cents to 5 cents a pound, according to carbon content. Madagascar crucible flake sold for 10 to 11 cents a pound, nominal. Mexican crude amorphous was quoted at $14 to $30 a ton, f.o.b. New York, according to grade.

The duty on graphite entering the United States under the general tariff is 5 per cent ad valorem on natural amorphous and artificial grades, and 15 per cent on crystalline lump, chip, and dust grades. The Canadian tariff is as follows: graphite, not ground or otherwise manufactured, British, free; intermediate (including the United States), 7½ per cent ad valorem; general, 10 per cent; on ground and manufactures of, including foundry facings, but not crucibles, British, 15 per cent; intermediate, 22½ per cent; general, 25 per cent. Graphite crucibles enter Canada free under the British preferential tariff; under other tariffs the duty is 15 per cent ad valorem.

GYPSUM

The materials produced are the hydrous calcium sulphate commonly known as gypsum; the partly dehydrated material known as plaster of Paris or wall plaster; and the anhydrous calcium sulphate known as anhydrite. Nova Scotia is the chief producer of gypsum in Canada and is followed by Ontario, New Brunswick, Manitoba, and British Columbia. Gypsum is found in every province, except Prince Edward Island. The crude rock, crushed to a size convenient for handling, is produced mainly for export, and the processed material for domestic sale.

Gypsum for export dropped rapidly during the war due to lack of shipping, and in 1943 exports amounted to only 43 per cent of the total Canadian production, the lowest recorded. Exports increased to 82 per cent in 1946, which compares favourably with pre-war figures.

Associated with many of the Canadian gypsum deposits are extensive beds of anhydrite, the anhydrous calcium sulphate ($CaSO_4$), that are favourably situated for commercial development, and the material from which has been proved by the Bureau of Mines, Ottawa, to be of excellent grade. A small annual tonnage of this material is exported to the United States for use as a soil conditioner for the peanut crop. The use of Canadian anhydrite for the manufacture of sulphuric acid and cement has long been advocated, and the possibility of the establishment of a plant for this purpose is being considered.

Principal Canadian Sources of Supply

In Nova Scotia, most of the material quarried is shipped by boat in the crude state to the ports on the north Atlantic seaboard of the United States. Prior to the war an appreciable tonnage was shipped to the United Kingdom, but these shipments have not been resumed owing to the shortage of dollar exchange. Canadian Gypsum Company, Limited, operating at Wentworth, Hants county, about 2 miles from Windsor, is the largest producer. During the summer it ships part of the crushed stone by steamer to the United States and part by rail to its large storage plant at Deep Brook, Digby county. In the winter, when Wentworth is closed to navigation, the crushed stone from the storage plant is shipped by steamer to the United States. The company is building a storage plant and shipping pier at Hantsport which will enable the loading of larger steamers practically throughout the year. National Gypsum (Canada) Company continued its operations at Dingwell, and Walton, and with its enlarged shipping facilities expects to materially increase its shipments. Windsor Plaster Company quarried rock for use in its calcining mill at Windsor; Connecticut Adamant Plaster Company mined and shipped crude gypsum to the United States; and Gypsum, Lime, and Alabastine, Canada, Limited, at Baddeck was idle. Victoria Gypsum Company at Little Narrows, under the management of Guysborough Mines, Limited, has gradually obtained new quarry equipment and makes shipments to the United States Atlantic seaboard, West Indies, and South America.

In New Brunswick, Canadian Gypsum Company at Hillsborough produced all grades of plaster and wallboards for the markets of eastern Canada. Increased activity was noticed in the province in 1946 with the scouting for favourable deposits, on several of which preliminary steps were made for exploration.

In Quebec, Gypsum, Lime and Alabastine, Canada, Limited announced that improvements to its plant at Montreal will cost about $400,000 and will provide increased storage room, an additional calcining kettle, and a dryer.

In Ontario, Gypsum, Lime and Alabastine, Canada, Limited, with quarries at Caledonia, and Canadian Gypsum Company, Limited, with quarries at Hagersville, both in Haldimand county, manufacture all grades of plaster and plaster products for markets in Ontario and Quebec. Cayuga Gypsum Company also operated on a small scale producing plaster products.

The extensive deposits of gypsum in northern Ontario have not been developed.

In Manitoba, Gypsum, Lime and Alabastine, Canada, Limited and Western Gypsum Products, Limited operated their quarries at Gypsumville and Amaranth, respectively, and their plants at Winnipeg throughout the year.

Western Gypsum Products, Limited opened in March a new gypsum plant in Calgary for the manufacture of various types of wall board, and sheeting, from gypsum rock obtained from Mayook in the Crow's Nest district in British Columbia. This new mill was destroyed by fire late in the year, but plans were being made for another mill.

In British Columbia, Gypsum, Lime and Alabastine, Canada, Limited continued production from its deposits at Falkland to supply its plants at Port Mann, near New Westminster, and at Calgary. The new plant at Port Mann was working at capacity, supplying the British Columbia markets, and will be able to export to markets served through Pacific ports. Several other deposits are known to occur in British Columbia.

Production and Trade

Canada produced 1,810,937 tons of gypsum valued at $3,671,503 in 1946, compared with 839,781 tons valued at $1,783,290 in 1945, and with the previous record output of 1,593,406 tons valued at $2,248,428 in 1941.

Exports of gypsum, plaster of Paris, and ground and prepared wall plaster were 1,489,679 tons valued $1,622,162, compared with 559,073 tons valued at $590,683 in 1945. Imports of gypsum and plaster of Paris were 3,731 tons valued at $22,674, compared with 3,772 tons valued at $11,327 in 1945.

World production under normal conditions is estimated at 8,000,000 tons annually. Canada is probably in third place.

Uses and Prices

Gypsum is marketed in the crude lump form; ground, as "land plaster" and "Terra alba"; or ground and calcined, as plaster of Paris or wall plaster. An increasing portion of the calcined material is used in the manufacture of wallboard, gypsum blocks, insulating material, acoustic plaster, etc. Considerable quantities of gypsum are used in the manufacture of Portland cement.

The use of gypsum products in the building trades has made rapid progress because of their lightness, durability, fire-resisting, insulating, and acoustic properties; and tiles, wallboards, blocks, and special insulating and acoustic plasters have been developed.

Crude gypsum is a low-priced commodity, and its selling price f.o.b. quarry is dependent largely upon the quantity produced and the production facilities available. For export, contracts are generally made with the producer for the year's requirements of the purchaser, and are usually made early each year. The nominal price of crude gypsum, as quoted by Canadian Chemical and Process Industries, remained at $2.50 to $3.50 per ton f.o.b. quarry or mine. However, large contracts with seaboard quarries were at prices as much as 25 per cent below these figures.

IRON OXIDES (MINERAL PIGMENTS)

Ochreous iron oxide, which is sold uncalcined and is used chiefly in the purification of illuminating gas, comprises the bulk of the minerals produced under this category. The Canadian output is small and shows no substantial change from year to year. Production from deposits near Trois Rivières, Quebec, and to a much lesser extent from deposits in British Columbia, has met requirements of the domestic pigment trade for the cheaper grades for many years. There are other deposits in different parts of Canada, however, that could be operated were the demand sufficient to warrant doing so.

Principal Canadian Sources of Supply

In Quebec, Sherwin Williams Company of Canada, Limited produces most of the Canadian iron oxide and is the only Canadian producer of calcined iron oxides, as the others market only air-dried products. It operated its deposits and plant at Red Mill, Champlain county, a few miles east of Trois Rivières, at capacity throughout 1946. Its calcined and air-floated mineral products are produced to rigid specifications. The crude ochre came from deposits at Pointe-du-Lac, Marchand, and Les Vieilles Forges, St. Maurice county; and from Almaville, St. Louis de France, and St. Adolphe, Champlain county, the producers being T. H. Argall, Charles D. Geraudin, and the Maurice Oxide Company, the same as in 1945.

In British Columbia, there has been a small production of iron oxide from Alta Lake, New Westminster district, since 1923, and from oxide beds in the Windermere district. The oxide is used chiefly for gas purification.

In Alberta and Saskatchewan, the several known deposits of ochre are difficult of access and for this reason, and because the market is limited, they have received little active attention, the principal deposit in Saskatchewan of possible economic interest being at Loon Lake, 32 miles from St. Walburg on the Canadian National Railway, and 77 miles northwest of North Battleford. In northern Manitoba, large deposits near Grand Rapids and Cedar Lake remain undeveloped for similar reasons.

In Nova Scotia, beds of ochre and umber were operated on a small scale many years ago.

Production and Trade

The records of Canadian production of ochres include in a single item all grades of material, from the low-priced raw material, to the high-priced calcined products. Sales of ochreous iron oxide in Canada in 1946 totalled 12,695 tons valued at $152,268, compared with 10,314 tons valued at $172,053 in 1945. The 1946 production was made up of 12,268 tons from Quebec and 427 tons from British Columbia.

Exports of iron oxides in 1946 were 4,366 tons valued at $199,619, compared with 2,447 tons valued at $96,490 in 1945. Exports of mineral pigments, n.o.p., (mostly zinc oxide), were 6,754 tons valued at $1,394,354, compared with 6,078 tons valued at $1,012,524 in 1945.

Imports of all kinds of ochres, siennas, and umbers totalled 1,437 tons valued at $81,929, compared with 1,900 tons valued at $97,164 in 1945.

Uses and Prices

The calcined form of ochreous iron oxide is used in the manufacture of paints. A smaller quantity of natural iron oxides associated with clay-like materials in the form of umbers and siennas is produced in the raw and in the calcined state for use as pigments in paints.

The Canadian consumption of iron oxide by the illuminating gas industry in 1945 (figures for 1946 not available) was 7,357 tons, valued at $75,441. The amounts consumed in the paint industry were 2,799 tons of iron oxide valued at $310,434 and 671 tons of ochre, siennas, and umbers valued at $71,231. Iron oxide pigments are used also as colouring agents and fillers in the manufacture of imitation leather, shade cloth, shingle stain, paper, and cardboard. Siennas and umbers are used in wood stains and wood fillers. Ochre is used as a pigment for linoleum and oilcloth; as a pigment in wood stains and wood fillers; and in colouring cement, stuccos, and mortar.

The Canadian price of red iron oxide, f.o.b. Toronto or Montreal, as given by Canadian Chemistry and Process Industries, remained at 2 to 7 cents a pound throughout 1946, and yellow, brown, and black iron oxides remained between 5 and 12 cents a pound.

LIME

Production of lime showed a moderate increase over that of 1945, but it did not equal that of the record year, 1943, when 907,768 tons was produced, although the demand continued strong throughout the year. The lower output, compared with 1943, was caused largely by shortages of fuel, labour, and materials. The demand is likely to continue strong for a number of years because of new lime-using industries coming into production.

Dead-burned dolomite for use in the steel industry was produced for the first time in Canada in 1946 by Dolomite Refractories, Limited, in a new plant at Dundas, Ontario. The plant consists of a vertical mixed-feed kiln having a rated capacity of 40 tons a day.

Principal Canadian Sources of Supply

Limestone suitable for lime manufacture is available in every province except Prince Edward Island. Production, however, in Nova Scotia and Saskatchewan is intermittent and small. Approximately 85 per cent of the Canadian lime production originates in Ontario and Quebec.

Until recently both dolomitic and high-calcium limes were made in Nova Scotia, but no production was reported from there in 1946.

In New Brunswick, Ontario, and Manitoba, high-calcium and dolomitic limes are produced.

In Quebec, Alberta, and British Columbia, only high-calcium lime is produced.

There are many prospective lime-producing localities in Canada, as limestone is abundant throughout the country; but in the more highly industrialized areas, particularly in Quebec and Ontario, unworked, easily accessible deposits of pure high-calcium limestone that will yield a white lime suitable for chemical requirements are becoming scarce.

Production and Trade

Total production of lime in 1946 amounted to 840,799 tons valued at $7,074,940, compared with 832,253 tons valued at $6,525,038 in 1945. Of the 1946 total, 684,674 tons valued at $5,778,243 was quicklime and 156,125 tons valued at $1,296,697 was hydrated lime. This compares with the 1945 production of 708,173 tons of quicklime valued at $5,579,868 and 124,080 tons of hydrated lime valued at $945,170. The values do not include the cost of the containers. About 52 per cent of the quicklime and 2 per cent of the hydrated lime produced in 1945 was used by companies producing lime primarily for their own consumption.

Exports of lime in 1946 amounted to 24,921 tons valued at $284,327, compared with 21,001 tons valued at $237,456 in 1945. Most of these exports went to the United States, but exports were also made to Newfoundland, Jamaica, St. Pierre and Miquelon, British Guiana, and Nicaragua.

Imports of quicklime in 1946 amounted to 7,617 tons valued at $50,093, compared with 6,354 tons valued at $35,766 in 1945. Imports of hydrated lime are recorded with other products.

Quicklime is marketed in the lump, pebble, crushed, and pulverized forms. The lump and pebble lime is sold either in bulk or packed in air-tight, multiwall paper bags.

Hydrated lime, a specially prepared dry slaked lime in the form of a powder of such fineness that usually over 95 per cent will pass a 325-mesh sieve, is marketed in 50-pound, multi-wall paper bags. Both production and value of hydrated lime produced in 1946 was the highest on record and reflects the trend toward the industrial use of lime in this form rather than as quicklime.

Uses and Prices

Lime is one of the great basic raw materials of the modern chemical industry and over 90 per cent of the present Canadian production is used for chemical and metallurgical purposes. Hydrated lime finds wide use in agriculture as the principal ingredient of certain spray mixtures and dusting powders and for the sweetening of acid farmland. Hydrated lime and quicklime are important materials in the construction industry.

Prices of the various lime products vary over a wide range depending upon the geographical location of the plants and upon differences in the quality of the lime. The average price of quicklime f.o.b. plants, but exclusive of containers, is $8.44 a ton, and that of hydrated lime on the same basis, $8.31 a ton. The latter figure includes considerable by-product material sold below the ordinary market price. Exclusive of this the average price obtained for hydrated lime without including the value of containers is $10.75 a ton.

LIMESTONE (GENERAL)

Limestone is the most widely used of all rocks because of the great variety and importance of its industrial uses and because of its widespread occurrence. It is quarried in all the provinces of Canada except Prince Edward Island and Saskatchewan, but by far the greater part of the production comes from Ontario and Quebec. The present production of limestone for all purposes, including the manufacture of lime and cement, constitutes about 90 per cent of the total production of Canadian stone.

Limestone is available in great bedded formations and in massive, highly metamorphosed deposits, the former being much more common and yielding most of the production. In chemical composition the deposits range from those consisting almost entirely of calcium carbonate, through magnesian limestone, to those consisting of dolomite, the double carbonate of calcium and magnesium. Siliceous and argillaceous varieties of the above types also occur, as well as large deposits of the rare brucitic limestone, and magnesitic dolomite, both of which latter types are being worked.

Abundant as is limestone in Canada, easily accessible unworked deposits of the pure high-calcium variety so largely used by chemical and metallurgical industries are becoming scarce within economic shipping range of the more highly industrialized areas, and recourse will have to be had in the future either to underground mining, or to beneficiation of surface deposits in order to remove undesirable impurities. Several Portland cement plants in various parts of the world are beneficiating impure limestone by means of flotation.

Production and Trade

The production of limestone in 1946 for general use, exclusive of that used for lime and cement, was 7,217,600 tons valued at $8,178,513, compared with 5,677,192 tons valued at $6,284,379 in 1945. The production for all purposes in 1946 was 11,230,366 tons.

Limestone being widely distributed and a low-cost commodity is, as a rule, not transported for long distances and rarely figures in international trade, but for certain consuming centres in Canada it is obtained from the United States and Newfoundland. The stone so obtained is used for blast-furnace flux, road metal, and for the manufacture of pulp. Comparatively small tonnages are exported to the United States for use in agriculture and in sugar refineries. No separate record is maintained of the trade in limestone.

Uses

For industrial use limestone is marketed in a variety of forms ranging from huge squared blocks of dimension stone used in construction, to extremely fine dust used chiefly as a mineral filler. For certain uses (in the wood pulp industry, for example) the limestone as quarried requires little or no processing, but most of the output is crushed and screened for use as road metal, concrete aggregate, railroad ballast, and as flux in metallurgical plants. Large quantities are used in the manufacture of Portland cement, lime, and various chemical products. Most of the limestone used in chemical and metallurgical industries is of the high-calcium variety, but dolomite is rapidly increasing in importance as an industrial raw material.

Argillaceous dolomite is used for the manufacture of rock wool, a widely used insulating material. The value of rock wool and slag wool produced in 1946 by ten Canadian plants is estimated at $4,100,538, compared with $1,839,122 in 1945. Imports from the United States were valued at $464,880 in 1946.

Pure dolomite has become an important source of magnesia, and during the latter years of World War II, was an important source of magnesium metal. Magnesia and basic magnesium carbonate are made from calcined dolomite by the Pattinson process.

Magnesium can be recovered directly from calcined dolomite by reduction with ferrosilicon, and indirectly by reacting calcined dolomite with sea-water or with magnesium chloride brine, thereby forming magnesium hydroxide, which in turn is converted into chloride, from which, after dehydration, magnesium is recovered by electrolysis. High-calcium lime can be used in place of dolomitic lime for precipitating magnesium hydroxide from sea-water and brine, but where the dolomite lime is used the yield of magnesia is increased by the magnesia content of the latter.

Dead-burned dolomite is widely used as a refractory material in basic open-hearth furnaces in the steel industry. The first Canadian plant to produce dead-burned dolomite was built at Dundas, Ontario, in 1945.

Magnesitic dolomite is processed at Kilmar, Quebec, for the production of refractory products. Brucitic limestone is processed at Wakefield, Quebec, for the production of magnesia, magnesium fertilizer materials, and hydrated lime.

The use of limestone in agriculture is capable of very extensive development. Though the necessity for applying limestone or lime to agricultural land to remedy deficiencies of calcium and magnesium, to neutralize soil acidity, and to maintain or increase soil fertility has been emphasized for many years, the quantity so used in Canada is still relatively small, whereas the agricultural use of limestone could well constitute one of its most important uses both from the economic and tonnage viewpoints.

LIMESTONE (STRUCTURAL)

With the large volume of building construction and with restrictions removed on the construction of the ornamental type of building, the quarrying of structural limestone was more active in 1946 than for many years. The large producers reported a busy season and a great many small operators reopened quarries that had long been idle, in order to supply local demands for cut stone and building rubble. Difficulties were experienced, however, in obtaining experienced stonecutters to work in the quarries and stone-dressing plants, because in the fifteen years or so that have elapsed since the cut-stone industry was similarly active very few men have learned the trade.

Quarries for the production of limestone for building purposes are worked in Quebec, Ontario, and Manitoba. Modern requirements of the building-stone industry call for blocks of stone of large dimensions from which are sawn slabs and blocks of the exact size required for constructing the building. Although limestone is abundant in Canada, the heavily bedded variety of desirable texture, free from cracks and other defects, and capable of being carved and otherwise worked, is not plentiful.

In Quebec, the quarries yielding heavily bedded building stone are at St. Marc des Carrières in Portneuf county, and in the vicinity of Montreal. At both localities a grey limestone is obtained.

In Ontario, heavily bedded silver-grey limestone is quarried from extensive deposits near Queenston in the Niagara Peninsula, and smaller quantities of buff, and of variegated buff and grey limestone are also obtained. At Longford Mills, near Orillia, buff, silver-grey, and brown limestone suitable for use as building stone and as marble is available.

In Manitoba the quarries are near Tyndall. They yield mottled buff, mottled grey, and mottled variegated limestone suitable for exteriors of buildings and for use as interior decorative stone.

In addition to the large quarries, the products of which normally have a wide shipping range, a number of small quarries producing rough building stone for local use are worked intermittently near Quebec City, Montreal, and Hull, in Quebec; and at Ottawa, Kingston, and Wiarton, in Ontario. Rubble is the chief product.

Production and Trade

The production of limestone for structural purposes in 1946 was 53,596 tons valued at $985,011, compared with 48,487 tons valued at $512,341 in 1945. This production was almost entirely from quarries in Ontario and Quebec. The value refers only to stone marketed in mill blocks or in the finished condition by the quarry companies and does not include the value of the work done on the stone by cut-stone contractors.

There is little trade in building stone at present between Canada and other countries. Exports of limestone for building purposes are small and are not separately recorded, but exports of all varieties of building stone, except marble and granite had a value of $435 in 1946 and of $7,331 in 1945. Imports of all varieties of building stone, except marble and granite, in 1946 had a value of $144,722, compared with $48,997 in 1945.

Prices

Prices of limestone in the mill block, f.o.b. quarry, range from 50 cents to $1 a cubic foot, depending upon the size of block and grade of stone.

MAGNESITE AND BRUCITE

Magnesitic dolomite, a rock composed of an intimate mixture of magnesite and dolomite, is quarried at Kilmar, Argenteuil county, Quebec, by Canadian Refractories, Limited, and is processed for use as refractory products and to a minor extent as fertilizer material.

Brucitic limestone, a rock composed of granules of the mineral brucite (magnesium hydroxide) thickly distributed throughout a matrix of calcite, is quarried near Wakefield, Quebec, by Aluminum Company of Canada, Limited, and is processed for the recovery of magnesia and lime. The magnesia is used for making magnesium metal, basic refractories, and fertilizer.

The value of refractory products made from magnesitic dolomite and brucitic limestone reached a new peak in 1946. Canadian Refractories, Limited, the principal producer of these materials, was carrying out an extensive program of enlargement and modernization of its production facilities at Kilmar. This includes the installation of a sink-float plant and a 245-foot rotary kiln.

Dolomite Refractories, Limited, a subsidiary of Canadian Refractories, Limited, began the operation of a large mixed-feed kiln at Dundas, Ontario, that produces dead-burned dolomite for use as refractory material in open-hearth furnaces at steel plants.

Magnesite deposits occur in British Columbia and in Yukon. The most important of these, at Marysville, British Columbia, between Cranbrook and Kimberley, is owned by The Consolidated Mining and Smelting Company of Canada, Limited. Considerable silica and alumina occur as impurities in this magnesite. The company, however, has devised a flotation method to remove the greater part of these impurities, but there has been no commercial production. Other magnesite deposits in British Columbia and Yukon are of limited extent or are too far from transportation to be of economic interest at present. Some deposits of earthy hydromagnesite near Atlin and Clinton in British Columbia have been worked at various times on a small scale, but there has been no production in recent years.

There are also large deposits of brucitic limestone at Bryson, Quebec, and at Rutherglen, Ontario, and there is a small deposit on West Redonda Island in British Columbia.

Production and Trade

The value of the products made from magnesitic dolomite and brucite magnesia in 1946 was $1,225,593, compared with $1,278,596 in 1945, the peak year.

Exports of basic refractory materials made from magnesite and brucite amounted to 2,502 tons valued at $102,602, compared with 1,550 tons valued at $82,483 in 1945. A considerable tonnage of magnesia is also exported.

Imports of magnesia products had a value of $1,260,545, compared with $938,227 in 1945. The items were: dead-burned and caustic-calcined magnesite valued at $385,573, compared with $279,910 in 1945; magnesite brick valued at $433,327, compared with $305,141 in 1945; magnesia alba and levis, $80,893, compared with $57,056 in 1945; magnesia pipe covering, $187,416, compared with $155,504 in 1945; magnesium carbonate, $40,994, compared with $38,921 in 1945; magnesium sulphate, $132,342, compared with $101,695 in 1945.

Uses

Products at present made from magnesitic dolomite include dead-burned or grain material; bricks and shapes (burned and unburned); caustic-calcined magnesitic dolomite; and finely ground refractory cements.

Products made from brucitic limestone include granular magnesia of high quality for use, after dead-burning, in making refractory products; lower grade magnesia for fertilizer use; and hydrated lime. The granular magnesia has been ground and marketed for the making of magnesium bisulphite liquor used for making special grades of paper. Experiments have shown that, with or without further processing, it can be used for oxychloride cement and oxysulphate and for various other purposes for which magnesia made from magnesite can be used.

MARBLE

The marble industry was considerably more active in 1946 than for many years and the total production was valued at $201,817. Foreign marble, which has always largely dominated the Canadian market is again available, but at considerably higher prices than formerly. Thus the outlook is good for increased production of domestic marble in the near future.

Principal Canadian Sources of Supply

Canada is well supplied with deposits of marble, and quarries are operated in Quebec, Ontario, Manitoba, and British Columbia. The products in recent years have been mostly terrazzo chips, stucco dash, poultry grit, marble flour, whiting substitute, rubble, and material for making artificial stone, but in 1946 there was a greater production of squared blocks for sawing into slabs for interior decorative use than for many years.

In Quebec, clouded grey marbles and a black marble are obtained in the quarries of Missisquoi Stone and Marble Company, Limited, at Philipsburg near the foot of Lake Champlain. Brown marble for counters and wainscoting is obtained from the building-stone quarries in the Trenton limestone at St. Marc des Carrières, Portneuf county. Red marble for use as terrazzo is quarried by MAB, Ltée at St. Joseph de Beauce. Orford Marble Company, Limited produced red, green, and grey serpentinous marble near North Stukely, Shefford county. The product at present is terrazzo, but it is intended to produce block marble at this quarry in the near future. White dolomite is quarried and crushed by Canadian Dolomite Company, Limited, at Portage du Fort, Pontiac county, for terrazzo chips, stucco dash, artificial stone, and various other products.

In Ontario, black marble in blocks up to 40 inches thick is produced by Silvertone Black Marble Quarries, Limited, Ottawa, at St. Albert, 30 miles southeast of Ottawa. Buff, red, white, green, and black marbles are quarried north of Madoc by Karl Stocklosar, and by Connolly Marble, Mosaic and Tile Company, Limited, Toronto, for use as terrazzo. Bolender's, Limited (White Star mine) produces white terrazzo and poultry grit at Marmora.

In Manitoba, a number of highly coloured marbles are available along the Flin Flon and Hudson Bay railroads, and also at Fisher Branch and other places. Winnitoba Marble Company quarried buff and purple marble at Fisher Branch for use as terrazzo.

In British Columbia, there are many deposits of marble, but there is only a small production of white by Marble and Associated Products from a quarry near Victoria and by Beale Limestone Quarries on Texada Island.

Production and Trade

Production of marble in 1946 was 21,796 tons valued at $201,817, compared with 13,388 tons valued at $113,337 in 1945.

Exports of marble are recorded with exports of granite, and the exports of both in 1946 amounted to 5,277 tons valued at $82,008, compared with 3,835 tons valued at $48,606 in 1945.

Imports of marble in 1946 had a value of $194,048, compared with $122,994 in 1945. Imports are largely in the form of unpolished slabs and sawn stock, the finishing being done in marble mills throughout Canada. In addition, mosaic flooring materials consisting in large part of marble were imported to the value of $110,140 in 1946, compared with imports of similar materials valued at $63,006 in 1945.

Prices

There is a wide range in the price of marble depending upon the quality and rareness of colouring.

MICA

Production of mica of all classes in Canada in 1946 was 24 per cent higher than in 1945, but the value of output was about 15 per cent lower. About 82 per cent of the output in 1946 was amber (phlogopite) mica, and the remainder, muscovite. Ontario, Quebec, and British Columbia, in that order, provided the production. Figures of mica production in Canada include a large proportion of low-value scrap and waste recovered from old mine dumps and sold for the production of fine flake and powder. In 1946, about 89 per cent of the total production comprised scrap and ground mica, the proportion in 1945 being 83 per cent.

Military requirements occasioned a sharp rise in Canadian production during the war, and as a result, the output in 1943 rose to 8,050,692 pounds, an amount only slightly smaller than that attained in 1924, the peak year. Though the production in 1944 was 17 per cent lower than in 1943, the value reached an all-time record of $841,026, compared with $553,856 in 1943. These high values were due to the production in 1943-44 of a considerable amount of high unit value muscovite, a type of mica not usually produced in Canada to any extent, and which came from newly discovered deposits in the Mattawa area, Ontario. Production from this source was short-lived, however, and ceased in 1945, when the bulk of the Canadian output again comprised phlogopite, or amber mica. Canada is one of the two leading world sources of phlogopite; Madagascar being the other.

Principal Canadian Sources of Supply

Main source of phlogopite production is the general Ottawa region, both in Ontario and Quebec. Production of muscovite has been small and intermittent, and only rarely, as in the 1942-44 period, has mining for this type of mica been undertaken on an important scale. Most of the output is handled and prepared for market by producers and dealers having trimming establishments in or near Ottawa. A few operators make direct mine shipments of semi-rough mica to the United States for the production there of punched shapes. The making of thin splittings, now done on a very much smaller scale than formerly, is mostly farmed out in small rural communities in the Ottawa district. Scrap mica still continues to be recoverable on a considerable scale from old mine dumps, and these furnish most of the scrap sold for grinding, as well as considerable amounts of screened untrimmed mica shipped to the United States for the making of mechanical splittings.

In Quebec, in 1946, the Nellis mine, near Cantley, in Hull township, operated by Blackburn Bros., Blackburn Bldg., Ottawa, continued to be the leading producer. This company prepares its output in a shop at Ottawa, and also operates a grinding plant at its mine. The plant continued to be the leading Canadian producer of ground phlogopite mica. The remainder of the Quebec output came mainly from a number of small, scattered operations in the general Gatineau-Lièvre River section, most of the material being rough mica sold to dealers, or scrap salvaged from old mine dumps.

New Calumet Mines, Limited, which operates a zinc-lead mine on Calumet Island, Pontiac county, Quebec, investigated further the possibility of recovering a commercial grade of flake mica (mainly phlogopite) from its mill tailings, for the production of ground mica. A small trial unit was installed, from which good results were reported, but it was decided that the cost of a full-scale treatment plant was not warranted and the project was dropped for the present.

Suzorite Company, Limited, a subsidiary of Siscoe Metals, Limited, proceeded with plans to develop production of flake and powdered phlogopite from a large body of "suzorite" rock in Suzor township, Laviolette county, Quebec. Several thousand tons of crude rock were mined and shipped to a plant installed by the company at Shawinigan Falls, Quebec, and some of the material was processed, mainly for the recovery of roofing grades of mica and of rock granules. Early in 1947, milling problems in connection with processing crude suzorite for the recovery of maximum amounts of coarse flake were under study in the Bureau of Mines laboratories, at Ottawa.

In Ontario, Sydenham Mining Company, Limited, operating the old Lacey mine, near Sydenham, in Loughborough township, Frontenac county, was the only important producer. This company ships its product in rough-trimmed form to its affiliate, Lacey Mica Company of New Brighton, Staten Island, N.Y. Loughborough Mining Company (General Electric Company) continued recovery of scrap mica from old waste dumps at the Lacey mine, and was the leading shipper in 1946 of this class of product. The remaining small sales of sheet mica in the province came chiefly from properties in the Perth area, Lanark county.

In British Columbia, ground muscovite mica, made from schist rock, is produced by Fairey and Company, 661 Taylor Street, Vancouver, and by Geo. W. Richmond and Company, 4190 Blenheim Street, Vancouver, for sale to the local roofing trade. The crude rock is procured from the Albreda region.

Production and Trade

Canada produced a total of 8,720,669 pounds of mica valued at $199,039 in 1946, compared with 7,044,221 pounds valued at $233,270 in 1945. Output from Ontario in 1946 amounted to 4,707,381 pounds valued at $66,952, compared with 2,903,363 pounds valued at $95,123 in 1945. Output from Quebec amounted to 2,397,788 pounds valued at $108,667, compared with 2,856,858 pounds valued at $121,011 in 1945; and output from British Columbia was 1,615,500 pounds valued at $23,420, compared with 1,284,000 pounds valued at $17,136 in 1945.

Output of mica in Canada by classes in 1946 was as follows:

Muscovite	Pounds	Value
Rough mine-run	381,930	$ 3,377
Ground	1,234,000	20.083
Total	1,615,930	23,460

Amber or Phlogopite	Pounds	Value
Rough mine-run	310,409	$ 32,004
Sold for mechanical splitting	254,363	42,523
Splittings	13,050	10,725
Ground	1,423,230	31,063
Shop and mine scrap sold for grinding	5,073,092	38,216
Trimmed	30,595	21,048
Total phlogopite	7,104,739	$175,579
Total muscovite and phlogopite	8,720,669	199,039

Except for ground mica, a large part of which is used in Canada, most of the Canadian output of mica is exported to the United States. Exports of scrap mica, all to the United States, and consigned to grinding plants of United States Mica Manufacturing Company at East Rutherford, New Jersey, and Forest Park, Chicago, totalled 3,899,400 pounds valued at $33,601. These figures compare with 4,853,600 pounds valued at $33,200 in 1945. Scrap exports in 1946 had an average unit value of $17.25 a ton, or nearly $4 a ton higher than in 1945. Ninety per cent of the total came from Ontario and the remainder from Quebec.

Untrimmed small sheet, mostly recovered from old waste dumps and exported to the United States for mechanical splitting use, totalled about 320,000 pounds and had an average unit value of 18 cents a pound, an increase of 3 cents a pound over 1945. Almost all of this class of mica came from Quebec.

Exports of ground mica were 451,000 pounds valued at $17,808, compared with 352,000 pounds valued at $11,055 in 1945.

Total unmanufactured mica, imports of all classes were 5,060,500 pounds valued at $204,875, of which only 25,800 pounds valued at $47,494 was trimmed sheet and 8,400 pounds valued at $6,913 was splittings. Prepared sheet mica, therefore, represented less than 1 per cent of the total exports by quantity and 26·5 per cent by value.

Imports of mica and manufactures of, in 1946, were valued at $280,142, compared with $236,597 in 1945. Imports of unmanufactured mica consist largely of muscovite splittings from India for the manufacture of mica plate, and muscovite sheet or block for capacitor films, domestic heater elements, and stoves. There were substantial imports, also, of wet-ground muscovite for use in the manufacture of wallpaper, paints, etc.

Canada and Madagascar are the two chief sources of phlogopite, but small amounts are obtained from Ceylon, Korea, Mexico, Tanganyika, Portuguese East Africa, and the Northern Territory of Australia. Many countries produce muscovite mica, though India has long been the chief source. Indian "ruby" muscovite, obtained from Bihar Province, is the world standard for exacting electrical uses, particularly for magneto and radio condenser films. India also supplies green muscovite, produced in Madras. Brazil is next to India as a source of "ruby" muscovite. The United States is third, the chief producing states being North Carolina, South Dakota, New Hampshire, and Connecticut. Argentina is an important producer and exporter of muscovite, but a large part of the output is green, spotted mica.

Markets and Uses

Mica is outstanding as an insulating material in all forms of electrical equipment and appliances, and almost all the production of sheet muscovite and phlogopite is used in the electrical industry. Some clear mica, mostly muscovite, is used as stove windows and in lighting equipment, and there is a limited demand for special large-sized, flawless sheet for use in marine compass dials, boiler gauges, and in the iconoscopes of television transmitters. The recent development of the ceramic type of spark-plug has greatly reduced the use of mica for aviation spark-plugs.

Large quantities of muscovite are used in the form of thin sheets for radio and magneto condenser films, and for the bridges and supports in radio tubes. Heavily spotted and stained muscovite ("electric" mica) is used mainly in domestic heater appliances. Fine flake or powdered mica, made mainly from muscovite, but also from phlogopite and even biotite, is used mostly in the roofing and rubber trades, and also in paints, wallpaper, moulded electrical insulation, lubricating greases, foundry core and mould washes, fire-resistant wallboard, and in oil-well drilling.

Prices

With the removal of price ceilings, dealers' quotations in 1946 for certain trade sizes of Canadian phlogopite rose from 25 to 30 per cent over levels maintained during the war and were approximately as shown below for best quality, as based on colour, softness, and splitting properties:

Size (Inches)	*Knife-trimmed Block or Sheet* Per pound
1 x 1 and 1 x 2	$ 0.50
1 x 3	0.85
2 x 3	1.15
2 x 4	1.65
3 x 5	2.50
4 x 6	3.50
5 x 8	5.00

	Splittings Per pound
1 x 1	$ 0.75 (unchanged)
1 x 2	0.85

(Splittings prices in U.S. funds)

Ground phlogopite also advanced sharply in price, and sold as follows, according to fineness: 20 mesh, $50; 60 mesh, $65; 150 mesh, $80; all prices f.o.b. Ottawa, in ton lots, bags extra. Scrap phlogopite for consumer use sold for about $17 a short ton, an increase of nearly 30 per cent over 1945.

NEPHELINE SYENITE

Nepheline syenite is a quartz-free rock consisting essentially of nephelite and albite and microcline feldspars. It usually contains small amounts of iron-bearing impurities, chiefly magnetite, hematite, and biotite mica, as well as such minor accessory minerals as sodalite, cancrinite, corundum, zircon, muscovite mica, calcite, scapolite, etc. In the developed Canadian deposits, iron-bearing impurities are of coarse size and can be readily removed from the crude rock by magnetic means. Other objectionable minerals, notably corundum and muscovite, can be extracted by flotation methods, with the recovery of commercial grades of such products. Nepheline syenite is relatively high in alumina (24 per cent in average Canadian commercial rock) compared with straight feldspar (17 to 20 per cent), and for this reason it is used as a feldspar substitute in a number of ceramic industries, more especially in the glass trade.

Canada and Russia are the only important producers. Practically all of the Canadian production is used in the ceramic industry, most of it in the glass trade. The Russian output is obtained as a by-product from the concentration of phosphate (apatite). It is not known what uses are made of the material, but it possibly serves as a raw material for the production of aluminium. Extensive occurrences of nepheline syenite are known in several areas in the United States and in India, where investigations have been made in an attempt to develop industrial uses. It was found, however, that in most cases the rock contains too much finely divided and unremovable iron-bearing impurities to permit of its use in ceramic products, except possibly dark bottle glass. It was announced in 1946 that development was to be undertaken of a deposit near Little Rock, in Arkansas, the material from which would be used for the manufacture of ceramic-coated roofing granules.

Principal Canadian Sources of Supply

The large operation of American Nepheline, Limited, at Blue Mountain, 26 miles northeast of Lakefield, in Peterborough county, Ontario, has accounted for most of the output and has been the only producer since 1942. Prior to that year small tonnages were produced intermittently from deposits near Bancroft in Hastings county, and near Gooderham in Haliburton county, Ontario, and the material was shipped in the crude state to feldspar grinding mills in the United States. The Blue Mountain deposit is massive and medium-textured, whereas most of the production from the Bancroft and Gooderham areas consisted of coarse pegmatitic material. The other known occurrences in Ontario are in the French River area, Georgian Bay district, and at Port Coldwell, Thunder Bay district, on the north shore of Lake Superior. In Quebec, nephelite is a constituent of syenites in the Montreal, Labelle-Annonciation, and other areas. In British Columbia, there are extensive bodies in the Ice River district, near Field.

Prior to 1946, the Blue Mountain deposit had been developed as a large side-hill quarry operation extending for a length of some 2,000 feet and with a face of 60 feet, which was taken down in three lifts. At maximum (summer) capacity, about 500 tons of rock a day was broken with a force of 30 to 35 men.

Quarried rock is loaded by power shovel and trucked to the crusher plant, where it is reduced to about 6 inches, the shipping size. In summer, the rock is trucked 5 miles to a loading dock at the east end of Stony Lake, where it is dumped direct into 300-ton scows for transport to railhead at Lakefield. A large storage pile is maintained at the Lakefield dock from which winter rail loadings are made. Rock for the Lakefield mill, which has a daily capacity of 40 tons of finished product, is trucked the 26 miles from the quarry.

In 1946, American Nepheline, Limited undertook an important expansion program at its Blue Mountain mine site. It abandoned the side-hill method of mining and moved open-quarry operations to the top of the ridge at a point east of the former openings. At the same time an inclined adit was driven 325 feet into the side of the ridge at a point about 125 feet below the crest, and a raise was carried to surface. From the end of the adit a development drift was run a further 100 feet and lateral drifts were opened from which stoping will proceed. These operations were conducted in order to combine open-cast quarrying with underground mining, and to draw mill feed from a new low-corundum area proved by drilling. Reserves in this section are estimated at about one million tons. Rock shipped in 1946 was obtained from the new upper quarry opening and from underground development workings.

Concurrently, work progressed in a plan to move the company's processing operations, hitherto conducted at its Rochester, N.Y., and Lakefield plants, to the mine site. A large mill building and a new primary crusher unit were erected at the adit portal, to which rock is raised by inclined skipway, with conveyer belt feed to the mill. Later, it is planned to move the primary crusher underground. A survey for a new, improved mine road was undertaken, and consideration was being given to the construction of a branch railway to connect the mine with the Canadian Pacific Railway at Havelock. The new mill installation and the 15-mile power line that connects with the Ontario Hydro system at Havelock were completed early in 1947. The mill installation comprises heavy primary jaw crusher, Symons cone crusher, Ruggles-Cole direct-fired dryer, secondary Symons crushers, screens, and Dings magnetic separators. Capacity will be 325 tons of mill feed daily, with recovery of 250 tons of cleaned product. For the present, processing will be confined to dry, magnetic treatment of low-corundum rock, following previous practice; but later, a second mill unit may be installed to provide for flotation treatment of rock containing a higher percentage of corundum.

Fine-grinding equipment is to be installed at the company's Lakefield plant for the production of 200-mesh pottery grade material from cleaned rock for the Canadian and overseas markets. Fine grinding for the American trade will continue to be done at Rochester, N.Y.

The above changes and developments are expected to substantially reduce operating costs and eliminate truck and rail freight charges on the 30 per cent of waste removed in processing.

In 1946, Port Coldwell Mines and Metals, Limited did some 2,000 feet of drilling on its undeveloped Card property in Dungannon township, near Bancroft, where surface trenching has exposed a body of schistose nepheline rock traversed by narrow bands of coarser pegmatitic type.

Production and Trade

Production of crude nepheline syenite in Canada in 1946 totalled 52,000 tons, of which 12,000 tons was processed at Lakefield, Ontario, with the production of 8,000 tons of finished material. Exports of crude rock, all to the Rochester, N.Y., mill of American Nepheline, Limited, were 51,839 tons, part of which was mined in previous years and taken from stockpile. Finished products made at the Rochester plant comprised 20,000 tons of granular glass grade and 14,000 tons of pottery grade. The production and exports of crude rock compare with 61,345 tons mined and 48,351 tons exported in 1945.

Uses

Nepheline syenite is used chiefly for the manufacture of container glass, and for this purpose is marketed in the form of a granular 28-mesh product, replacing granular glass-spar (feldspar). Most Canadian glass companies and a number of large American plants have been using the material for several years. In the glass batch, 3 tons of syenite will replace 4 tons of feldspar on the basis of relative alumina content. The higher content of alkalis reduces the melting temperature with resultant fuel economy and longer tank life. Use of syenite has been expanding in other branches of ceramics, and ground to 200 mesh, it is used in a variety of products. Demand in 1946 exceeded supply, particularly in the field of low-temperature vitreous bodies. Nepheline syenite is claimed to be superior to feldspar for the manufacture of artificial teeth. The Rochester and Lakefield plants produce small tonnages of by-product, low-grade powder that is recovered in the cleaning process and is sold as a pumice substitute and for cleansers, enamels, and heavy clay products use.

For ceramic use the crude rock must be freed of its iron-bearing impurities. Iron (Fe_2O_3) content of the Canadian finished product cleaned by magnetic separation averages about 0·08 per cent. Flotation treatment of the rock to remove corundum and mica was instituted at the Rochester plant of American Nepheline, Limited, several years ago.

Prices and Tariffs

Granular glass-grade nepheline syenite produced in Canada in 1946 was quoted at $11.75 a ton in carload lots f.o.b. mill; that made at Rochester, N.Y., sold for $12 during the first nine months, with an advance to $13 in the last quarter. Ground 200-mesh ceramic grade was priced at $15.50 until September 1, and at $16.50 thereafter. B-grade dust sold at $10 l.c.l. Average declared value of crude exported from Canada in 1946 was about $3.25 a ton.

Crude nepheline syenite enters the United States free of duty. Finished products, including granular glass grade, paid 15 per cent ad valorem prior to 1942 when a revision in the classification gave this last item free entry.

PHOSPHATE

Production of phosphate (which consisted entirely of apatite) in Canada in 1946 amounted to only 57 tons valued at $869, the lowest since 1934, and only occasionally during the past fifty years has the annual production exceeded 1,000 tons. All of the output in 1946 came from the province of Quebec. For many years Electric Reduction Company, Buckingham, Quebec, has purchased most of the output for use in the production of elemental phosphorus and of various phosphorus compounds. The company obtains most of its requirements, however, from Florida. Over 98 per cent of the Canadian imports of rock phosphate come from Florida and Montana and the remainder from North Africa and from Curaçâo, Netherlands West Indies. The Curaçao material is low in fluorine and is used in stock feeds.

In Canada, the apatite is frequently associated with the productive phlogopite mica deposits of the general Ottawa region in Ontario and Quebec. In certain areas of Precambrian pyroxenite, the host rock of the phlogopite are substantial bodies of apatite that contain little or no mica. These, in the past, were mined for straight phosphate and have accounted for the greater part of the recorded production. In more recent years, the small tonnages of apatite sold have been by-product material taken out in the course of mica-mining operations. During the war some renewed interest was taken in a few of the larger and richer apatite properties that were worked in the peak years (1878-1894) of the phosphate industry, and this accounted for the slight rise in production in the 1941-1943 period.

Rock phosphate of Permo-Triassic age occurs along the Rocky Mountain Divide, notably in the vicinity of Crow's Nest, B.C., where a few thousand tons was mined about 1930 by the Consolidated Mining and Smelting Company of Canada, Limited. The material proved to be too low-grade to be of present economic interest and rock for the company's fertilizer plant at Trail, B.C., is obtained from richer deposits in Montana.

Principal Canadian Sources of Supply

In Quebec, most of the small production in recent years came from deposits in the Lièvre River section, Papineau county, and minor amounts were obtained from Templeton and adjacent townships west of that area. In the five years 1942-1946, total output from these sources was about 1,200 tons.

In Ontario, which produced about 850 tons in the same period, most of the output came from the old MacLaren mine in Bedford township, Rideau Lakes area. This property was reopened in 1942 by Canadian Phosphate Mining Company and has since been operated intermittently by its successors, Ontario Phosphate Company, and Ontario Phosphate Industries, Limited. These companies, during the period of operation, did considerable drilling, sank a 3-compartment shaft to a depth of 150 feet, and did about 500 feet of crosscutting and drifting. No shipments were made in 1945 and 1946.

Production and Trade

The aforementioned production of apatite in 1946 compares with 299 tons valued at $4,356 in 1945. Grade of material in 1946 ranged from 74 to 80 per cent B.P.L.

Imports of rock phosphate, used mainly by the fertilizer trade for the manufacture of superphosphate in 1946 totalled 373,677 short tons valued at $2,164,841, compared with 317,695 tons valued at $1,450,580 in 1945.

Most of the world production of phosphate comes from rock phosphate, of which enormous reserves exist. Few countries produce apatite, and Russia supplies by far the largest amount. Estimated world production of phosphate in 1940 (no later figures available) was nearly 10 million metric tons, of which the United States furnished over 4 million tons. Production in the United States was approximately 3,336,000 metric tons in the first six months of 1946.

Uses

Phosphate is used chiefly for the manufacture of fertilizer. Ordinary superphosphate, made by treatment of rock phosphate with sulphuric acid, is the chief product made, but triple superphosphate, ammonium phosphate, and other compounds of higher P_2O_5 content are produced on an important scale. In the United States, production of phosphoric acid by furnace treatment of rock has been increasing steadily, and permits the use of low-grade material that it would be uneconomic to acidulate. Thermal defluorination of phosphate rock and of superphosphate has also shown a marked increase in order to meet deficiencies of bone-meal and other fluorine-free phosphatic materials for stock-feed use. Rock phosphate is the sole commercial source of phosphorus.

Consumption of rock phosphate in Canada in 1945 (1946 not available), as reported by users, was 394,048 tons, of which 93 per cent went to the fertilizer trade, and 6·8 per cent into the production of phosphorus and phosphorus compounds. Consumption by provinces was: British Columbia, 59 per cent; Quebec, 24 per cent; and Ontario, 17 per cent. All of the material for fertilizer is used in three superphosphate plants of Canadian Industries, Limited, at Belœil, Quebec, Hamilton, Ontario, and New Westminster, British Columbia; and in the plant of The Consolidated Mining and Smelting Company of Canada, Limited, Trail, British Columbia. Eastern plants use mainly rock from Florida and North Africa.

Prices

Overall average f.o.b. price of the United States production in the first half of 1946 was $4.24 per long ton. The price paid in 1946 for Canadian apatite delivered at plant continued to be $16 per short ton for material of 80 per cent B.P.L. grade, with a penalty or premium of 20 cents per unit below or above that figure.

PYRITES AND SULPHUR

No pyrites has been produced in Canada as a primary mineral for a number of years as it would have been unprofitable to do so in competition with operations in the Gulf States of the United States, where enormous deposits of sulphur occur. Thus the output of pyrites in Canada is obtained as a by-product from the concentration of base-metal sulphide ores, the producers of pyrites in 1946 being the Waite-Amulet and Noranda mines in Quebec, and the Britannia mine in British Columbia.

Principal Canadian Sources of Supply; Occurrences

In Quebec, Noranda Mines, Limited, Noranda, recovered the pyrites from the cyanide mill tailings and sold it to pulp and paper mills at Trois Rivières and at Hull, Quebec, and to chemical plants in Canada and the United States. Waite-Amulet Mines, Limited has been producing a pyrites concentrate since March, 1944, and in 1946 shipped to National Lead Company and Bethlehem Steel Company in the United States, and to Canadian paper mills and chemical companies.

In British Columbia, most of the large output of pyrites from the Britannia Mining and Smelting Company, Limited at Britannia Beach was sold to acid plants and to the paper mills in British Columbia. Some pyrites was exported.

A large reserve of pyrites occurs at the property of Northern Pyrites, Limited, at Ecstall River, about 60 miles south of Prince Rupert, British Columbia. This property has been idle for many years.

In Ontario, 7 miles west of the town of Sioux Lookout, Kenora district, is a large deposit that was worked for a time a number of years ago. Several deposits occur in the Algoma district.

In Quebec, there are deposits at the Aldermac property in the Rouyn area, and at the Eustis mine in Sherbrooke county, but both properties have been idle for several years.

Deposits of native sulphur of commercial grade have not been found in Canada, but sulphur occurs in combination with copper, nickel, lead, zinc, and iron (pyrites) in many sulphide deposits in various parts of the country. In the smelting of the sulphide ores sulphur dioxide gas is freed, but prior to 1925 no facilities were available in Canada for the recovery from it of sulphur compounds and thus the sulphur dioxide gas was wasted. This gas can be used directly for the manufacture of liquid sulphur dioxide or for the production of elemental sulphur. At Trail, British Columbia, The Consolidated Mining and Smelting Company of Canada, Limited salvages the smelter gases to make sulphuric acid by the contact process, and uses the acid in the manufacture of fertilizers. Likewise, Canadian Industries, Limited uses the contact process in the manufacture of sulphuric acid at Copper Cliff, Ontario, from converter gas that is withdrawn from the flues by arrangement with International Nickel Company of Canada, Limited.

Production and Trade

Production of Sulphur in Pyrites and in Smelter Gases

Year	Tons	Value
1940	170,630	$1,298,018
1941	260,023	1,702,786
1942	303,714	1,994,891
1943	257,515	1,753,425
1944	248,088	1,755,739
1945	250,114	1,881,321
1946	234,771	1,784,666

Imports of Sulphur (Sulphur Content)

Year	Tons	Value
1940	215,597	$3,628,348
1941	235,271	3,920,184
1942	290,121	4,680,672
1943	218,527	3,524,006
1944	235,955	3,875,649
1945	248,846	4,063,324
1946	273,502	4,271,081

Exports of Sulphur in Pyrites

Year	Tons	Value
1940	40,380	$ 230,981
1941	129,629	585,258
1942	166,451	700,918
1943	104,509	409,597
1944	90,836	353,441
1945	75,479	315,232
1946	68,045	286,254

The exports of pyrites in 1946 was as follows: 66,017 tons valued at $278,350 to the United States, and 2,028 tons valued at $7,904 to Mexico.

The United States is the chief world source of sulphur, its production coming mainly from the Gulf States. Other large producing countries are Spain, Japan, Italy, Norway, and Russia.

Uses of Sulphur

Sulphur is used in the manufacture of a long list of commodities. Its principal uses are in wood pulp, paints, pigments, plate glass, textiles, rayons, clarification of fruit juices, precipitation of sugar, in the manufacture of rubber and fertilizers, in the refining of petroleum products, and in the manufacture of acids, heavy chemicals, explosives, glucose, and dyestuffs.

Consumers of Pyrites in Canada

St. Lawrence Pulp and Paper Co., Ltd., Trois Rivières, Que.
E. B. Eddy, Limited, Hull, Que.
Nichols Chemicals Co., Ltd., Valleyfield, Que.
Nichols Chemical Co., Barnet, B.C.

Consumption in Canada

Consumption of Sulphur in 1945 by Industries

(1946 figures not available)	Tons
Wood pulp	203,522
Explosives	1,131
Insecticides	1,244
Rubber	1,496
Adhesives	75
Heavy chemicals	53,689
Starch	253
Fruits and vegetables preservative	123
Sugar refining	130
Petroleum refining	51
Matches	89
Miscellaneous	600
Total	262,403

Prices

Engineering and Mining Journal Metal and Mineral Markets prices for Spanish pyrites in 1946 were nominal at 12 cents per long ton unit of sulphur guaranteed 48 per cent sulphur, c.i.f. (cost, insurance, and freight) U.S. ports. The average price of pyrites in eastern Canada in 1946 was slightly under $2 a ton, f.o.b Noranda, Quebec.

ROOFING GRANULES

There has been a marked expansion in the granule roofing industry in Canada during the past twelve years and particularly during the past three years. About 64 per cent of the granules used are imported, however, though some of the leading manufacturers of granule roofings, as well as individuals, have been searching certain areas in Canada for rocks suitable for making the best type of granules. Apart from slates, there appears to be few such rocks in areas where they can be economically mined, crushed, and shipped to producing plants. Present production comes from three deposits in Ontario and four in British Columbia. In 1946, Canadian consumption of granules used for roofing showed a 39·5 per cent increase over that of 1945, and a further increase is expected in 1947.

The granules consist of small broken particles of rock or slate in their natural state or artificially coloured, that are affixed to asphalt sheeting. The underside of the sheeting is coated with a film of talc or fine mica and is then cut into shapes for roofing shingles and for sidings (resembling rows of bricks separated by mortar). The exposed part of the improved shingle has an innercoating, usually of natural granules, upon which another coating of the required coloured granules is spread.

Principal Canadian Sources of Supply

In Ontario, three deposits were being quarried for granules in the vicinity of Madoc, Hastings county, namely: a grey rhyolite deposit, 5 miles northeast of Madoc; a black amphibole rhyolite, 4 miles northwest of Madoc; and a greenish grey basalt, 20 miles west of Madoc, near Havelock. Building Products Company, the leading Canadian manufacturer of roofing granules, crushes and screens the rock from the first two quarries at a mill near Madoc, and from the other quarry, at a plant in Havelock. At this plant the granules from the three quarries are artificially coloured. It is the only granule-colouring plant in Canada.

In British Columbia, G. W. Richmond quarried a dark grey slate at McNab Creek, Howe Sound, and a greenish siliceous rock at Bridal Falls, near Chilliwack. At Kapoor on southern Vancouver Island, O. M. Brown mined a grey-black slate, and from an adjacent deposit, hard greenish rock. These two operators have crushing and screening plants in Vancouver and Victoria respectively, where natural granules are produced and sold to roofing companies in the two cities. G. W. Richmond, also, produced a small amount of black slag and burnt brick granules.

Many years ago red and green slates from the dumps of the old slate quarries near Granby and Richmond in the Eastern Townships of Quebec were used to a small extent and there has been a renewal of interest in these slates. Tests which were made recently on a hard slate that occurs near Kentville, Nova Scotia, indicated a good granule, but transportation costs to granule plants would be excessive.

In 1946, as in the previous four years, granule-coated roofings and sidings were manufactured by ten companies which have fourteen plants located at: Saint John in New Brunswick; Asbestos, Montreal, and Lennoxville in Quebec; Toronto, Hamilton, Brantford, and London in Ontario; Winnipeg in Manitoba; and Vancouver and Victoria in British Columbia.

Processes for colouring granules are covered by many patents. A few of the methods employed consist of: heating, which darkens the colour; adding oxides of iron and chromium and then burning; addition of sodium silicate, clay, and the required pigment; addition of zinc oxide, clay, and liquid phosphoric acid, heating and then adding the pigment. Many combinations are employed and generally the formulæ used by individual companies are closely-guarded secrets.

Consumption and Trade

Consumption of roofing granules in Canada in 1946 amounted to 108,297 tons valued at $2,276,198. In 1934, the first year in which a detailed survey of the industry was made, only 18,115 tons valued at $288,644 was consumed. About 47 per cent of the total consumption in 1946 was comprised of naturally coloured granules. The distribution of naturally and artificially coloured granules of all types was: greys and blacks, 34·1 per cent; greens, 29·7 per cent; reds, 27·5 per cent; blues, 3·4 per cent; buffs and browns, 2·6 per cent; white and grey-white, 2·7 per cent. About 38 per cent of the material used was slate (21 per cent naturally, and 17 per cent artificially coloured).

Imports of all types and colours amounted to 69,458 tons valued at $1,522,-109, or 64 per cent of the total tonnage consumed. Imports in 1946 came from four leading producers in the United States. Quarries and plants producing slate granules used in Canada are located at Delta, Pennsylvania; Whitsford, Maryland; Fairmont, Georgia; Granville, New York; and Poultney, Vermont. Natural blue-black granules are obtained from Delta and Whitsford; natural green from Fairmont; natural red from Granville; and natural green and red as well as all artificial colours from Poultney. Rock bases come from Charmian near Gladhill, (basaltic greenstone and purple rhyolite) and from Watsontown (buff shale), Pennsylvania; Copley, Ohio, (artificially coloured quartzite) and Pacific, Missouri (natural buff quartz gravel). Artificially coloured trap rocks come from Wausau and Kremlin, Wisconsin, and from Bound Brook, New Jersey. A small amount of ceramic (red brick and white porcelain) granules comes from Danville, Illinois.

The United States is the leading consumer of granule roofings and in 1945 produced 1,045,280 tons of granules valued at $12,700,580, an increase of 5·5 per cent over the 1944 output. About 60 per cent of the total tonnage was artificially coloured granules and about 36 per cent was slate granules.

Specifications

Samples must pass severe tests. The present trend is toward more solid angular fragments, and the use of true slate is decreasing. Rocks suitable for granules should be fairly hard, of low porosity, fine-grained, opaque, possess a high melting point, and break well. They should be composed mainly of silica or silicates and should be free from metallic minerals, flaky minerals, minerals with fibrous partings, and the carbonates. They should withstand weathering action over long periods, and prevent "blistering" of the underlying asphalt caused by a combination of the penetration of water and actinic rays of the sun. Coloured rocks are generally preferred, and the colours (reds and greens) are often intensified artificially, but the granules must have the physical properties that will enable them to maintain the colour permanently. Slates suitable for granules should be hard, and they should be as dark (blue-black) as possible, or else greens and reds. All granules are oiled to improve adhesion to the asphalt and to intensify the colour, but the latter effect is not permanent. Two mesh grades of granules are used, namely "coarse" (10 to 28 mesh), and to a much smaller extent "fine" (28 to 35 mesh).

Prices

Prices vary considerably depending upon the type of granule and upon whether the colour is natural or artificial. Imported granules average $17 a ton, f.o.b. eastern Canadian plants for natural rocks and slates; $21.15 for artificially coloured reds; $23.40 for greens and browns; and $33.15 for blues.

SALT

In Canada salt occurs in the form of brine springs, or in bedded deposits, in every province except Quebec.

Salt is obtained by the following three main methods, only the last two of which are used in Canada: by the evaporation of sea-water by solar heat; by the artificial evaporation of brines obtained from brine springs or of brines formed by allowing fresh water to come into contact with salt deposits at depth; and by actual mining of rock salt deposits. The first method is used in warm countries where there is continuous sunshine over long periods and little rainfall.

The large and flaky crystals produced by this slow method admirably meets the requirements of some of the salt-consuming industries, but it is altogether unsuitable for others.

With the exception of Malagash Salt Company, Malagash, N.S., which mines salt, all the salt produced in Canada is obtained by artificial evaporation, as nearly all the deposits occur at great depths, and, therefore, most of the Canadian production is of the finer grades; and the present producing plants are mostly in Ontario and in the central western provinces. The fishing industries, which prefer a coarse salt, are mainly on the Atlantic and Pacific sea-boards, and a large part of their requirements has in the past been supplied by solar salt from the West Indies and California.

Thus, the geographical distribution of Canadian deposits, together with the necessity of using artificial evaporation methods of recovery, prevents any one company from producing grades to suit all consumers. Accordingly, the importation of the coarser grades not now produced in Canada will have to continue until methods are developed to produce these grades by evaporation or other processes.

Principal Canadian Sources of Supply; Occurrences

Over 80 per cent of the production in 1946 came from Ontario, and Nova Scotia, Manitoba, and Alberta each produced about equal amounts of the remaining 20 per cent.

In Nova Scotia, Malagash Salt Company has been in steady production since 1918. A 25-ton pilot plant for the purification of salt by means of flotation and fusion was erected by the Federal Government in conjunction with the Nova Scotia Department of Mines and the company. By the end of April, 1947, the plant had been running for several months and the salt was being tested by some of the large fishery companies with decidedly promising results. To bring about a lowering of costs, tests were made at the Bureau of Mines, Ottawa, and at the plant on a rotary type of furnace, as compared with the reverberatory type formerly used. The rotary furnace proved unsatisfactory and modifications were made on the former reverberatory furnace with encouraging results.

The salt beds at Malagash occur in strata of the Windsor series. The top of the salt formation was encountered 85 feet below the surface and operations have extended to a vertical depth of 1,128 feet. They reach out horizontally for 1,300 feet north and south and 1,400 feet east and west. In addition to the three main seams of white salt, there are parallel zones of discoloured salt from which the salt can be recovered only by leaching.

At Nappan, near Amherst, Cumberland county, Maritimes Industries, Limited, a subsidiary of Standard Chemical Company, Limited, erected a plant with a capacity of 170 tons of high-grade salt a day, suitable for meat packing, fish packing, table, dairy, and other uses. Production from this plant was commenced early in 1947.

In Ontario, the six plants were in operation, the centres of production being Amherstburg, Sandwich, Sarnia, and Goderich. The caustic-soda-chlorine plants of Canadian Industries, Limited, at Cornwall, Ontario, and at Shawinigan Falls, Quebec, obtain their salt from Sandwich. Brunner, Mond, Canada, Limited, at Amherstburg, manufactures soda ash from saturated brine and recovers calcium chloride from its process as a by-product.

In Manitoba, Neepawa Salt Company (subsidiary of Canadian Industries, Limited), Neepawa, was in continuous operation. This plant, erected in 1941, utilizes vacuum pan evaporation and produces all grades of evaporated salt. The brine is obtained from wells 1,500 feet deep.

In Alberta, Industrial Minerals, Limited, Waterways, operated continuously. The company is in a position to place all grades of evaporated salt on the market.

In the past three or four years much drilling was done in the search for oil over large parts of Alberta and Saskatchewan. In many of these holes salt beds were intersected at depths varying from 2,700 feet in east central Alberta to about 7,600 feet in southern Saskatchewan, and the thickness of beds varies from a few feet to over 600 feet. From the evidence obtained from these wells it can be safely assumed there are vast reserves of salt underlying the provinces of Alberta and Saskatchewan. In December, 1946, it was announced that Prairie Salt Company, a subsidiary of Dominion Tar and Chemical Company, was to erect a salt plant near Unity, Saskatchewan, as the result of the discovery of salt beds in that area. The contract calls for a minimum capacity of 25 tons a day by the summer of 1948.

Production and Trade

The production (sales) of salt in 1946 was 537,985 tons valued at $3,626,165, compared with 673,076 tons valued at $4,054,720 in 1945. The decline was accounted for by the shutdown of plants due to strikes at Amherstburg and Sandwich, Ontario.

Exports were 5,863 tons valued at $116,483, compared with 5,314 tons valued at $105,494 in 1945. Imports were 228,299 tons valued at $1,367,345, compared with 137,167 tons valued at $805,002 in 1945. The apparent Canadian consumption was 752,686 tons valued at $4,621,373, compared with 804,929 tons valued at $4,754,228 in 1945.

No statistics of world consumption have been available since 1938.

World production of salt in 1938, the last year for which complete data are available, was computed at 32,000,000 long tons by the Imperial Institute, London. Of this quantity, the British Empire accounted for 5,200,000 long tons or 16·2 per cent, the order of output of the largest producers being the United Kingdom, India, and Canada. The leading producers among the foreign countries were: the United States, Russia, China, Germany, France, Italy, Poland, Rumania, and Manchuria.

Prices

According to Canadian Chemistry and Process Industries, the quoted prices on various grades of salt remained unchanged throughout 1946 as follows:

Specially purified salt 99·9 per cent f.o.b. plant..	100 lb.	$0.94
Fine industrial salt, bulk carlots f.o.b. plant..	ton	$6.20-6.53
Coarse industrial salt, bulk carlots f.o.b. plant..	ton	$10.12-10.63

SAND AND GRAVEL

Deposits of gravel and sand are numerous throughout eastern Canada, with the exception of Prince Edward Island where gravels are scarce. Owing to the widespread occurrence of gravels and sands and to their bulk in relation to value, local needs for these materials are usually supplied from the nearest deposits, as their cost to the consumer is governed largely by the length of haul; hence the large number of small pits and the small number of large plants. However, grades of sand particularly suitable for certain uses are much less common and so command a higher price than ordinary sand.

The total production of sand and gravel for 1946 amounted to 39,949,994 tons valued at $15,529,700, compared with 29,750,703 tons valued at $10,568,363 for 1945.

Following are the output and value by provinces for the two years:

Province	1945		1946	
	Quantity, tons	Value	Quantity, tons	Value
		$		$
Nova Scotia	1,308,848	555,809	1,105,980	484,585
New Brunswick	1,627,371	686,267	2,203,646	807,045
Quebec	8,971,960	2,279,537	12,374,125	3,313,103
Ontario	10,466,891	4,466,862	14,881,918	6,738,595
Manitoba	1,497,062	516,380	1,333,890	416,431
Saskatchewan	1,237,595	563,276	1,732,731	910,661
Alberta	919,736	433,436	1,812,468	1,060,703
British Columbia	3,721,240	1,066,796	4,505,236	1,798,577
Totals	29,750,703	10,568,363	39,949,994	15,529,700

Road improvement, concrete works, and railway ballast absorb by far the greater part of the gravel and sand used. Gravel in particular has proved a good material for building all-weather roads at low cost and also for bases under paved rural highways, and its use has steadily increased with the growth of motor traffic. On main railway lines there has been for some years a tendency to replace gravel with crushed stone, and this tendency has been intensified since the late war.

A considerable tonnage of sand and gravel is also used in the mines for refilling underground workings. Some mines use several thousand tons a day.

Most of the gravel used for road work comes from pits worked for that purpose. Usually a portable or semi-portable plant is used to extract enough gravel to supply the immediate need, and then a sufficient reserve is built up in the form of stockpiles for two years' requirements. Road pits may remain idle for two years or more. The amount of gravel produced from year to year thus fluctuates, depending upon the program of road construction and improvement. Intermittent operation also applies to railway pits, which may remain idle for several years.

Part of the gravel used is crushed, screened and in some cases even washed, and the proportion thus processed is increasing steadily. Some provincial Highway Departments have used crushed instead of pit-run gravel on their main highways for a number of years. Most of the large commercial plants are equipped for producing crushed, screened, and washed gravel, a product that can well compete with crushed stone.

The amount of sand consumed follows the trend of building activity, as most of it is used in the building industry for concrete work, cement and lime mortar, or wall plaster. The sand must be clean, that is, free from dust, loam, organic matter, or clay, and contain but little silt, and is usually obtainable from local deposits.

Other important uses of sand are for moulding in foundries, filtering of water supply, and glassmaking, all of which require special grades of sand. Moulding sands are generally prepared by blending materials obtained from several deposits, since it is rare to find a deposit yielding sands suitable for all types of metal castings.

Prices

Prices of sand, gravel and crushed stone in the four largest cities in Canada were as follows, at the end of 1945 and 1946. Prices per ton or cubic yard, as indicated below, are for carlots, f.o.b. cars:

	1945	1946
Sand		
Montreal, per ton	$1.20	$1.28
Toronto, per ton	1.00	1.02
Winnipeg, per cubic yard	1.00	1.00
Vancouver, per cubic yard	1.00	1.01
Gravel		
Montreal, per ton	$1.10	$1.10
Toronto, per ton	1.58	1.55
Winnipeg, per cubic yard	1.00	1.00
Vancouver, per cubic yard	1.00	1.01
Crushed Stone		
Montreal, per ton	$0.97	$0.97
Toronto, per ton	1.70	1.67
Winnipeg, per cubic yard	—	—
Vancouver, per cubic yard	1.10	1.11

SILICA

The silica materials produced in Canada are quartz, quartzite, sandstone, and silica sand.

Quartz usually occurs in massive form without crystal faces. In the crystal form, most of the commercial supply for the world is obtained from Brazil. When flawless, transparent, and possessing the necessary piezoelectric properties, quartz crystals are of great strategic importance. They are also cut and ground for lenses, prisms, etc.

Quartzite is a firm, compact, metamorphosed sandstone, made up chiefly of grains of quartz sand united by a siliceous cement.

Sandstone must be of a high purity when the silica content is the prime essential for its employment in industry.

Silica sand is disintegrated quartz, and for commercial use much of it is obtained by the mechanical disintegration of pure grades of sandstone, and in special cases of quartz, after which the crushed material is washed and screened into grades suitable for the several industries.

Principal Canadian Sources of Supply

Quartz is mined in Quebec and Ontario; quartzite is quarried in Nova Scotia, Quebec, Ontario, Manitoba, and British Columbia; sandstone is quarried in Quebec and Ontario; and silica sand (natural) is obtained from Nova Scotia, Quebec, and Manitoba.

In Nova Scotia, quartzite has been quarried regularly for a number of years from a deposit at Leitches Creek, about 25 miles from Sydney for use in the manufacture of silica brick. A deposit of high-grade silica rock in Yarmouth county at Chegoggin has been tested with satisfactory results for this use and in 1946 some 2,000 tons was obtained to supplement the supply from Leitches Creek. Preparations were being made for Dominion Steel and Coal Company to obtain its full year's requirements from the Chegoggin deposit, as the grade is considerably higher than that at present being quarried at Leitches Creek.

In Quebec, a number of silica plants were in operation and several deposits were actively prospected. Canada China Clay and Silica Company, Limited, with a plant near St. Rémi d'Amherst, obtained its silica sand from a nearby quarry in Amherst township, Papineau county. The grinding plant has a capacity of 250 tons a day and the product is sold to manufacturers of glass, ferrosilicon, and silicon carbide, and for use as moulding sand and sand-blasting. It finds a ready market in the Montreal district.

Canadian Carborundum Company produced silica sand at St. Canut, Two Mountain county, for use in the manufacture of carborundum at its plant at Shawinigan Falls. The fines were shipped to Canada Cement Company, Montreal.

Consumers Industrial Minerals, Limited, a new company formed to produce silica sand from a quartz vein near St. Julienne, was building a crushing and screening plant.

St. Lawrence Alloys and Metals, Limited, of Beauharnois, erected a modern crushing and screening plant in Melochville and opened up a new quarry near the plant. This plant produces silica in a large number of screen sizes to suit various industries. The company ships silica to Niagara Falls area of Canada and to United States points. The plant in Beauharnois produces silicon and ferrosilicon and other ferro-alloys which are marketed in Canada and abroad. J. Montpetit produces sandstone at Melocheville for use in the cement industry.

Near Buckingham there was a small production of quartzite for manufacture into grinding pebbles. Canadian Flint and Spar Company, which has a quarry and grinding plant at Buckingham, produced small quantities of high-grade silica sands for special uses and prepared silica flour for use in the pottery industry. Crude quartz produced in this area is used as flux in the electro-chemical plant of Electric Reduction Company, Buckingham.

From Rigaud, an appreciable tonnage of quartzite pebbles was shipped to Lac Remi for use as grinding pebbles.

In Ontario, Kingston Silica Mines, Limited produces silica from a deposit of sandstone near Joyceville, 11 miles north of Kingston, partly to supply silica for the manufacture of cement, but mostly in the washed form for use in steel foundries as a moulding sand.

Dominion Mines and Quarries, Limited shipped crushed quartzite to producers of ferro-alloys at Welland, Ontario; Niagara Falls, New York; and to Toledo, Ohio, from its quarry at Killarney on the north shore of Georgian Bay, which was operated during part of the year. Manitoulin Quartzite Division, a subsidiary of Lapa Cadillac Gold Mines, Limited, produced quartzite for export to the United States from its quarry at Sheguindah, Manitoulin Island. Production from this quarry has expanded steadily during the past three years.

The International Nickel Company of Canada, Limited produced large tonnages of quartzite and low-grade silica sand from a quartzite deposit at Whitefish Falls for use as flux in its operations. Falconbridge Nickel Company, Ltd. also produced a small quantity of quartzite and silica for fluxing purposes.

Verona Rock Products Company, Verona, produced a small tonnage of crushed quartz for use in the manufacture of grit for sandpapers.

Wright Company shipped quartzite to Algoma Steel Company, Sault Ste. Marie, Ontario, from a quarry on the Algoma Central Railway.

Buffalo Ankerite Gold Mines, Limited, in the Porcupine area, produced a small quantity of grinding pebbles for use in the mill of Dome Mines, Limited.

Preliminary tests by the Bureau of Mines, Ottawa, on silica sand obtained from the vicinity of Hudson Bay Junction by the Department of Natural Resources, Saskatchewan, indicated that commercial sands might be obtained economically.

In British Columbia the Consolidated Mining and Smelting Company of Canada, Limited produced a few tons of silica for fluxing purposes.

Production and Trade

Canada produced 1,413,378 tons of quartz and silica sand valued at $1,554,798 in 1946, compared with 1,513,628 tons valued at $1,535,458 in 1945. It produced 2,902 M silica brick valued at $197,804, compared with 4,208 M valued at $317,263 in 1945.

Imports of the various grades of silica in 1946 compared with 1945 were:

—	1945		1946	
	Tons	$	Tons	$
Ganister	426	3,384	518	3,367
Silex or crystallized quartz ground or unground	7,250	247,393	10,640	114,450
Flint and ground flint stones	711	20,550	823	34,449
Silica sand	410,427	926,648	390,014	914,456
		1,197,975		1,066,722

Exports consisted of 200,316 tons of quartzite valued at $441,976, compared with 121,435 tons valued at $282,578 in 1945.

Uses; Specifications

The demand of high-grade silica sand was steady and large quantities are still imported, especially for use in the manufacture of glass and silicate of soda, which call for a high degree of purity and uniformity. Canadian producers must adhere rigidly to specifications and must be in a position to guarantee regularity of shipments in order to take advantage of these markets. The use of Canadian sands for sandblasting and for steel moulding sand is increasing.

Silica sand is generally prepared from a friable sandstone by crushing, washing, drying, and screening to recover different grades of material according to the use for which it is required. In the manufacture of glass, for instance, the material should range between 20 to 100 mesh and the iron content should be around 0·025 per cent. Silica sand may also be obtained from naturally occurring sands, the required grade being recovered by screening.

Silica, known as "potters' flint" for use in the ceramic industry must be 150 mesh or finer, whereas in the paint industry, air-floated material 250 mesh or finer is required.

In the use of silica as a flux, smelter operators endeavour to obtain their material from the nearest possible source, and in many cases use a siliceous ore containing recoverable amounts of the precious or base metals.

Sandstone in run-of-mine size is used by the cement companies to increase the silica ratio of their original mix.

Quartz, quartzite, or sandstone, in sizes from ½ inch to 6 inches, is used in the manufacture of ferrosilicon and metallic silicon; for silica brick, quartzite is crushed to about 8 mesh.

Prices

The price per ton of the several grades of silica varies greatly, depending upon its purity and the purpose for which it is to be used. Silica generally is a low-priced commodity, and, therefore, the location of a deposit with respect to markets is of great importance. The largest markets for silica are in Quebec and Ontario and new deposits to be of interest to these markets should be within economic reach of either Toronto or Montreal. In western Canada the main markets are in Alberta and Manitoba. West of Winnipeg the silica needs are met almost entirely by imported material.

According to Canadian Chemical and Process Industries the following nominal quotations held throughout 1946.

Silica Sand

Various grades, Toronto		Silica, quartz, 99% 110-220 grade	Silica, soft, decomposed, 325 mesh
Carload lots, per ton	L.C.L., per ton	Carload lots, per ton	Carload lots, per ton
\$9.00 - \$9.50	\$13.50 - \$14.50	\$14.00 - \$20.00	\$30.00 - \$35.00

SODIUM CARBONATE (NATURAL)

Deposits of natural sodium carbonate in the form of "Natron" (sodium carbonate with 10 molecules of water) and of brine occur in a number of small "lakes" throughout the central part of British Columbia, chiefly in the Clinton mining division and in the neighbourhood of Kamloops. As the deposits are far from the main eastern Canadian markets, production is restricted to the requirements of consumers within economical rail haul. For the seven years 1940 to 1946 total production amounted to only 1,623 tons valued at \$15,867 and it was all used in Vancouver in making soap. Output in 1946 amounted to 210 tons valued at \$2,310.

Imports of sodium carbonate (soda ash) in 1946 were 5,346 tons valued at \$182,614, compared with 2,229 tons valued at \$91,655 in 1945.

Sodium carbonate has many industrial uses, notably in the manufacture of glass and soap; in the purification of oils; in the production of aluminium; in the flotation of minerals; in the refining of metals; and in the production of caustic soda.

SODIUM SULPHATE (NATURAL)

Sodium sulphate occurs as crystals or in the form of highly concentrated brines in many lakes and deposits throughout western Canada. From these, hydrated sodium sulphate, known as Glauber's salt, and anhydrous sodium sulphate, known to the trade as 'salt cake', are produced in Canada.

Investigations of the sodium sulphate deposits in western Canada were made by the Mines Branch, predecessor organization of the Bureau of Mines, Ottawa, in 1921, and over 120,000,000 tons of hydrous salts were proved in the few deposits examined in detail. The records of present producers indicate, however, that probably not more than 75 per cent of this tonnage is recoverable. The material is in the form of the hydrous salt (mirabilite or Glauber's salt) which contains 55·9 per cent of water of crystallization that is removed before marketing. For the small amount of the hydrous product marketed as such, clean crystals are harvested and stockpiled, after which they are screened to various sizes, bagged, and shipped.

Anhydrous sodium sulphate is also obtained as a by-product from the manufacture of muriatic acid and from the viscose industry. Production of the anhydrous material from the muriatic acid industry is rapidly decreasing, however, as a new process for its manufacture is being more widely used. This should result in the increased use of the natural sodium sulphate.

Principal Canadian Sources of Supply

The production of natural sodium sulphate in 1946 came from Saskatchewan, where the principal producers are: Natural Sodium Products, Limited, with plant at Bishopric; Horseshoe Lake Mining Company, Ormiston; Midwest Chemical Company, Palo; and Sybouts Sodium Sulphate Company, Gladmar. The last named company plans to double the capacity of its plant, construction to start in 1947. There was considerable activity throughout the year at a number of other deposits in Saskatchewan and construction work was commenced at Chaplin Lake, 40 miles west of Moose Jaw, on a plant for the Saskatchewan Government, known as Saskatchewan Minerals Sodium Sulphate Division. It is expected this plant will be in operation in 1948.

Production and Trade

Canada produced 105,919 tons of anhydrous sodium sulphate valued at $1,117,683 in 1946, compared with 93,068 tons valued at $884,322 in 1945. The operating plants in Saskatchewan were producing to capacity in 1946 and there was some difficulty in supplying the full demand. The material is shipped to the pulp mills on the Pacific Coast of Canada and to those in eastern Canada; and to a number of plants in the United States. It is also shipped to glass plants in western and eastern Canada. The erection of several new sulphate pulp plants and the changing over of some pulp mills from the soda process has materially increased the demand for sodium sulphate in Canada.

Export figures for 1946 are not available. Shipments to the United States showed a marked increase during the war, and these continued at a high level in 1946.

Imports of sodium sulphate, including Glauber's salt and salt cake, for 1946 were 22,139 tons valued at $277,753, compared with 14,556 tons valued at $150,434 in 1945.

Uses and Prices

Glauber's salt is used widely in the chemical industries and the demand is increasing. Sodium sulphate is used chiefly in the sulphate process for the manufacture of kraft pulp. It is used in the glass, dye, and textile industries, and to a smaller extent for medicinal purposes, and for tanning.

The price of natural sodium sulphate from the deposits in western Canada in 1946 averaged about $10 a short ton in carload lots f.o.b. plant. The delivered price at pulp mills, which are mostly distant from producing centres, is considerably higher, being over $20 a ton in the Maritime Provinces.

TALC AND SOAPSTONE

Talc and soapstone production in Canada comprises powdered material made from both these raw materials, sawn soapstone furnace blocks and bricks, and talc crayons. For a number of years there has been a steady production of these three classes of material centred in the Eastern Townships, Quebec, and of ground talc in the Madoc area, Hastings county, Ontario. The average output in the period 1941-1946, inclusive, remained steady at about 30,000 tons a year. Very little talc has been produced elsewhere in Canada. The ground talc produced in Quebec consists of grey, slightly off-colour material, classed for statistical purposes as soapstone; that from Ontario is of prime white grade. Production is about equally divided between the two provinces.

Canada has a considerable surplus of most of the grades of ground talc available for export. It produces most of its requirements of sawn dimension soapstone and talc crayons, but imports, mainly from the United States, certain special qualities of ground talc demanded by the ceramic, paint, and cosmetic trades.

Principal Canadian Sources of Supply

In Ontario, output of prime white foliated talc products from the Madoc area during the forty years since operations were commenced is estimated at about 445,000 tons. Since 1937, Canada Talc, Limited, which operates the adjoining Conley and Henderson mines (now combined into a single operation), has been the only important producer. The company's new grinding mill, with a capacity of about 5 tons an hour of finished products, came into operation early in 1945. About 75 per cent of the mill feed is from the Conley workings and 25 per cent from the Henderson property. Coarse rejects are screened and de-dusted for the production of granular roofing grades.

The Madoc talc occurs in a series of closely spaced veins traversing white Grenville crystalline dolomite limestone and varies from coarsely foliated to massive, compact material. Tests by the Bureau of Mines, Ottawa, several years ago, showed that the carbonate content can be reduced by flotation to below the tolerance demanded for even the most exacting uses, but no commercial use of beneficiation has been made.

In Quebec, Broughton Soapstone and Quarry Company, with mines, mill, and sawing plant near Leeds station in Broughton township, is the principal operator, and produces ground talc, sawn soapstone blocks and bricks, and talc crayons. Similar products are made by L. C. Pharo Company of Thetford Mines, at Pontbriand and at Kinnear's Mills in Thetford and Leeds townships respectively. Soapstone blocks are produced by Charles Fortin of Robertsonville, Thetford township. Some of the sawing dust from these operations is sold to domestic roofing firms, and a considerable tonnage of quarry and sawing waste is shipped to the grinding plant of Pulverized Products, Limited, 4820 Fourth Ave., Rosemount, Montreal. Baker Mining and Milling Company operates a mine and a grinding plant near Highwater, Brome county.

The Quebec talc and soapstone bodies occur in highly metamorphosed basic rocks, mainly serpentine and pyroxenite. The talcose material is rather high in iron due to the presence of residual chlorite, and there is often considerable carbonate present. It yields a slightly off-colour, grey powder.

In British Columbia, some ground soapstone for local roofing and building use is produced in Vancouver by Geo. M. Richmond and Company, 4190 Blenheim street, from waste imported from the state of Washington.

Production and Trade

Total production of talc and soapstone in Canada in 1946 was 29,353 short tons valued at $303,684, compared with 27,088 tons valued at $294,888 in 1945. The 1946 figures cover ground material sold by primary producers and by one company grinding purchased domestic waste; sawn soapstone blocks and bricks; and crayons. An additional 150 tons of ground soapstone was made from imported waste. Of the 1946 total, 28,006 tons, or 95 per cent, valued at $355,342 comprised ground products of various grades, and 1,444 tons valued at $43,296 was sawn soapstone blocks and talc crayons. These compare with 24,531 tons of ground material valued at $232,711 and 1,385 tons of soapstone blocks and crayons valued at $64,224 in 1945. Ontario supplied 51 per cent of the ground material and Quebec, 49 per cent. All of the cut soapstone and talc crayons were produced in Quebec.

Exports of talc and soapstone, comprising mainly ground material, but including a small amount of sawn soapstone blocks and talc crayons, totalled 6,402 short tons valued at $74,991, compared with 7,363 tons valued at $100,114 in 1945. Of the total, 88 per cent went to the United States, 8 per cent to the United Kingdom, and the remainder chiefly to other European countries. Soapstone blocks to the value of $1,350 were exported to Australia.

Imports of talc in 1946 were 6,737 short tons valued at $150,972, compared with 6,388 tons valued at $131,863 in 1945. Slightly over 95 per cent of the quantity was ground material from the United States, mainly fibrous tremolitic talc from the Governeur region, New York, and possibly some ceramic and cosmetic-grade material from California. The remainder was obtained from Italy (220 tons), India (90 tons), and Norway (5 tons).

Prior to the war the world production of talc, including ground material, cut soapstone, steatite and pyrophyllite, amounted to about 500,000 tons a year, more than half of which was produced in the United States. Manchuria, with an output of about 100,000 tons, was the next largest producer and was followed by France and Italy, each with about 50,000 tons, Norway, British India, Canada, and Germany (including Austria).

In 1945, production of the above classes of products (excluding sawn dimension soapstone) in the United States had risen to 401,080 short tons valued at $4,956,901. Of this total, 77,594 tons valued at $651,200 was pyrophyllite, which for statistical purposes is included with talc. Average unit value of products was $12.36 a ton. New York continued to be the leading producing state, followed by North Carolina, California, Vermont, Georgia, and Maryland. Smaller amounts were supplied by Nevada, Washington, New Mexico, Pennsylvania, Texas, and Virginia. The New York talc is mainly of the fibrous, tremolitic variety, which is favoured for paint and paper use. California supplies high-grade white talc for ceramic, cosmetic, and general filler and loader purposes, and, with Nevada and Montana, produces most of the domestic talc suitable for the manufacture of steatite insulators. Most of the North Carolina output is pyrophyllite. Vermont and Georgia furnish mainly off-colour, grey talc for the rubber, roofing, and paper trades. Part of the Maryland output is massive steatite, used for the production of sawn electrical insulator shapes. The Washington production is mainly sawn soapstone, and that of Virginia is largely ground soapstone made from the waste from the large sawing industry in that state.

Uses

Ground talc is used chiefly in the paint, roofing, paper, rubber, and ceramic industries. It is used also in foundry facings, bleaching fillers for textiles, cosmetics and pharmaceuticals, soaps and cleansers, insecticides, polishes, plastics, and for rice polishing.

Canada used 21,587 tons of ground talc and soapstone in 1945 (figures for 1946 not available), distribution by industries being: paints, 27 per cent; pulp and paper, 11 per cent; roofing products, 28 per cent; rubber, 12 per cent; cosmetics and pharmaceutical preparations, 6 per cent; insecticides, 4 per cent; soaps and cleansers, 3 per cent; miscellaneous, 9 per cent. Consumption by provinces was: Ontario, 50 per cent; Quebec, 38 per cent; Manitoba, 7 per cent; and British Columbia, 3 per cent.

Steatite is the mineralogical name given to compact, massive talc having no visible grain, that can be sawn, turned, drilled, and otherwise machined into any desired form. Such material is used for the production of fired shapes, which in turn are used mainly as electrical insulators. It is used to an important extent for burner tips. Because of the small amount of natural steatite available, its high cost, and excessive machining and firing losses, the aforementioned articles are now made largely from high talc ceramic bodies. Suitable talc for the purpose must be high-grade material, low in lime and iron, and such talc is commonly termed steatite, or steatitic talc, irrespective of its texture. There is still a limited demand, however, for sawn steatite shapes, and suitable crude is relatively scarce, the chief sources being India, Sardinia, Maryland, Montana, and California.

Soapstone is used extensively in the form of sawn blocks and bricks for lining the alkali-recovery furnaces and kilns of kraft pulp and paper mills. It is used for brick and slab liners for fireboxes, stoves, and ovens, and for switchboard panels, laboratory benches, etc. Considerable quantities of soapstone quarry and sawing waste are ground and used as low-grade talc in the rubber, roofing, foundry, and other trades.

Compact, massive talc, sawn into square pencils and slices, is an important material for steelmakers' crayons. Recent shortages of suitable raw material have led to the introduction of extruded crayons compounded of ground talc with a suitable binder.

Prices

The market value of ground talc varies widely and is dependent upon purity (determined by freedom from lime and gritty or iron-bearing substances, slip, and colour), particle shape, and fineness of grinding, the specifications for which vary in the different consuming industries. Roofing and foundry talcs are the cheapest grades, the users being satisfied with coarser, grey or off-colour material, often soapstone powder or sawing dust, which sells at about $6 to $7 a ton f.o.b. rail. Domestic grey talc suitable for roofing, rubber, and paper use, sold in 1946 for $7.50 to $10 a short ton, according to fineness; similar talc from Vermont was quoted at $9.50 to $11 in bulk. White talc from Madoc, Ontario, was quoted at $9.50 for the coarser grades, $10.50 to $17.50 for finer mesh sizes, and $44 for minus 400-mesh material, output of the last material being only a small part of the total. New York fibrous talc, 325 mesh, sold for $12 to $15. Imported European cosmetic talcs cost as high as $80 per ton, delivered.

Average value of the ground talc produced in Ontario in 1946 was $10.65 a ton, and of the ground material (comprising both talc and soapstone) supplied by Quebec, $7.50 a ton. Average value of sawn soapstone furnace blocks was $27.50 a ton, or $2.40 a cubic foot, and of talc crayons about $275 a ton, or $1.17 a gross. Soapstone waste for grinding sold for $2 a ton, f.o.b. mine. Average declared unit value of all exports of talc was $11.70 a ton.

Tariffs

Canadian ground talc or soapstone exported to the United States is dutiable at 17½ per cent ad valorem on material valued at not over $14 a long ton, and at 35 per cent on material valued at over $14 a ton. The duty on crude material is ¼ cent a pound, whereas cut soapstone or talc in the form of bricks, crayons, blanks, etc., is dutiable at 1 cent a pound. Talc, ground or unground, enters Canada under the British preferential tariff at 25 per cent; imports from the United States are dutiable at 20 per cent.

Pyrophyllite

Pyrophyllite is a soft white mineral closely resembling talc in appearance and general characteristics, but contains alumina instead of magnesia. It can substitute for talc for many of the trade uses and for this reason it is often recorded with talc in production statistics.

The leading world source of pyrophyllite is North Carolina. Small amounts are derived also from Newfoundland, which in 1945 reported exports of 233 tons valued at $6,488. However, according to recent reports of the occupation authorities on the mineral resources of Japan and Korea, a large part of the important tonnage of "talc" produced in those countries, and in Manchuria (93,772 metric tons in 1939), is pyrophyllite. The same sources credit Korea with an output of 41,211 metric tons of pyrophyllite in 1944, and Japan proper with 42,177 metric tons in 1938.

In Canada, some rather low-grade, sericitic pyrophyllite occurs at Kyuquot Sound on the west coast of Vancouver Island. A small quantity was shipped from these deposits about thirty years ago for use in refractories and cleanser products, but there has been no further development.

Pyrophyllite sells for about the same price as talc. Quotations for North Carolina material in 1946 were $9.50 to $11.50 a ton for 200-mesh product, bulk, f.o.b. mines, and $11.50 to $13.90 for 325 mesh.

WHITING SUBSTITUTE

Whiting substitute, also referred to as domestic whiting, and as marble flour, is finely pulverized white limestone, white marble, calcite, or marl. For several years marl was processed for whiting substitute at two plants in Ontario, but no production of marl for this purpose was reported in 1946. Whiting substitute may also be made from lime or from the waste calcium carbonate sludge resulting from the manufacture of caustic soda.

White marble, calcite, and white limestone, when used for whiting substitute, are pulverized to degrees of finess ranging from 200 to 400 mesh. Only materials containing very little magnesium carbonate are used at present for making whiting substitute, though in the past a product from dolomite was used successfully in making putty.

By-product precipitated chalk, made from waste sludge resulting from the manufacture of caustic soda from soda ash and lime, is classed as a whiting substitute, but its usefulness is restricted as it almost invariably contains a small amount of free alkali. It is not made in Canada.

Production and Trade

There is no separate record of production, but the industry has shown a steady growth in recent years because improvements in grinding equipment and the maintenance of close technical control have enabled products to be marketed that are very consistent in chemical and physical properties. Many manufacturers now use the domestic products with entire satisfaction in place of imported whiting, though there are some uses for which chalk whiting is necessary and other materials cannot be substituted. Now that European whiting is again becoming readily available more competition from this source can be expected.

Producers of whiting substitute are: Pulverized Products, Limited, Montreal; Claxton Manufacturing Company, Toronto; Marlhill Mines, Limited, Thorold, Ontario; Gypsum, Lime, and Alabastine, Canada, Limited, Winnipeg; and Beale Quarries, Limited, Van Anda, Texada Island, British Columbia.

Little or no whiting substitute is exported. Imports of whiting, crude chalk, and prepared chalk were valued at $423,783 in 1946, compared with $330,593 in 1945.

Uses, Specifications, and Prices

Whiting substitute made in Canada is used mostly in the manufacture of oilcloth, linoleum, in certain kinds of rubber products, in putty, in explosives, and as a filler in newsprint, book, and magazine paper. In lesser quantities it is used in the manufacture of moulded articles, cleaning compounds and polishes, as a ceramic glaze, and for a number of other purposes. The output of one of the aforementioned plants in Ontario is used entirely as a filler in newsprint.

Marl to be of value for making whiting substitute should be white or nearly so, nearly free from grit and clayey material, and have a very low content of organic matter. It is this last material, present to some extent in all marls, that renders most of them unsuitable for use as a filler in products such as putty and paint where it will come in contact with oils. The oil-absorptive capacity of whiting substitute made from marl is usually greater than that of chalk whiting, but otherwise the physical properties are much the same.

Prices per ton, bagged, and in carload lots range from $10 to $15 f.o.b plants.

III. FUELS

COAL

The production of coal in Canada is confined to the western and eastern provinces. Ontario and Quebec have no commercial coal mines and the previous small production of lignite in Manitoba ceased in 1943. Approximately 31 per cent of the coal produced in Canada in 1946 was mined in Nova Scotia, and almost 50 per cent came from Alberta.

Principal Canadian Sources of Supply

In Nova Scotia, medium and high volatile coking bituminous coals are produced in the Sydney, Cumberland, and Pictou areas, and some non-coking bituminous coal is mined in the Inverness area. Production was 6·6 per cent higher than in 1945, but was almost 20 per cent lower than the 1934-43 average.

In New Brunswick, about 2 per cent of the total Canadian production of bituminous coking coal is mined in the Minto field. Production in 1946 was practically the same as in 1945, but was about 10·5 per cent lower than the 1934-43 average.

In Ontario, lignite of a lower grade than that found in Saskatchewan is available in the Onakawana area, but there has been no commercial production. Operations of the Ontario Department of Mines at Onakawana were confined to further stripping an area capable of producing up to 25,000 tons of raw lignite during the winter of 1946-47. Two carloads of run-of-mine raw lignite were shipped towards the end of 1946.

In Saskatchewan, only lignite is produced, the main producing fields being the Bienfait, Estevan, and Roche Percée divisions of the Souris area, with the major production coming from the Bienfait division. Production amounted to about 8·5 per cent of the total Canadian output and was only slightly lower than in 1945. It was about 35 per cent higher than the 1934-43 ten-year average.

Alberta produces almost all ranks of coal, including a small tonnage of semi-anthracite. Coking bituminous coal ranging from high to low volatile is produced in the Crowsnest, Nordegg, and Mountain Park fields. In the Lethbridge, Coalspur, Saunders, and several other areas of the foothills a lower rank bituminous coal that is practically non-coking is produced. The coal in the Drumheller, Edmonton, Brooks, Camrose, Castor, and Carbon areas is lower in rank and is classed as sub-bituminous; that mined in the Pakowki area is lignite; and that in the Tofield, Redcliff, and several other areas is on the border of sub-bituminous and lignite. The Cascade area was the only field that produced semi-anthracite in 1946. Of the total production in Alberta about 61 per cent was bituminous, and 39 per cent sub-bituminous and lignite, but mainly the former. The total production was 45 per cent higher than the 1934-43 average.

In British Columbia, bituminous coking coal ranging from high to low volatile is mined on Vancouver Island, and in the Crowsnest, Telkwa, and Nicola areas on the mainland. Lesser quantities of sub-bituminous coal are produced mainly in the Princeton field. Total production, which amounted to about 9 per cent of the total Canadian output, was almost 4 per cent lower than in 1945, and about 4·5 per cent lower than the 1934-43 average.

Production and Trade

Canada produced 17,806,450 tons of coal valued at $75,361,481 in 1946, compared with 16,506,713 tons valued at $67,588,402 in 1945. The minimum output during the past sixteen years was 11,738,913 tons in 1932, and the maximum, 18,865,030 tons in 1942.

Production of Coal by Provinces

Province	1945	1946
	tons	tons
Nova Scotia	5,112,675	5,452,898
New Brunswick	365,184	366,735
Manitoba	....	....
Saskatchewan	1,532,095	1,523,786
Alberta	7,800,151	8,826,239
British Columbia	1,699,768	1,636,792
Canada	16,506,713	17,806,450

*Production of Coal in Canada by Kinds**

—	1945	1946**
	tons	tons
Bituminous	11,773,942	12,842,293
Sub-bituminous	3,199,383	3,432,978
Lignite	1,532,803	1,522,207

* Coals classed according to A.S.T.M. Classification of coal by Rank—A.S.T.M. Designation: D388-38.
** 1946 figures subject to revision.

Total imports of coal into Canada amounted to 26,822,853 tons, compared with 24,731,137 tons in 1945. Imports of anthracite amounted to 4,639,348 tons, compared with 3,411,424 tons in 1945. Imports of British anthracite increased from 28,382 tons in 1945, to 101,496 tons in 1946, of which 67,970 tons was mainly buckwheat size. Imports of bituminous coal, all of which came from the United States, amounted to 22,000,398 tons, compared with 21,176,811 tons in 1945.

Exports of coal from Canada amounted to 862,489 tons (853,922 tons bituminous, and 8,568 tons lignite), compared with 840,708 tons in 1945.

The apparent Canadian consumption of coal in 1946, including briquettes, was 43,757,842 tons, compared with 40,350,000 tons in 1945 and 29,400,000 tons in 1939.

Markets and Uses

The coal production from Nova Scotia and New Brunswick was used mainly to supply the requirements of the railways of the area, the steel industry, and the local domestic market.

In New Brunswick, the operators and the Provincial Government, with the aid of other agencies, continued an extensive investigation on their coal resources, methods of mining and beneficiation, and markets, with a view to the installation of a central washery to allow for the preparation of improved products as a means of maintaining the industry on an economic basis. No practical steps, however, have been taken to date.

Because of serious fuel shortages the market in Ontario for Alberta coal was reopened in October, 1944, and continued to expand in 1946, during which year a total of 345,406 tons of Alberta coal, in comparison with 235,227 tons in 1945, was marketed in Ontario. This consisted of 147,723 tons of bituminous coal and 197,683 tons of sub-bituminous coal, the latter being entirely for domestic use. A large part of the sub-bituminous coal came from one or more of the five stripping operations in the Brooks, Castor, Camrose, and Taber areas, initiated and financed by the Emergency Coal Production Board in 1943. Although the Board did not function in 1946, the strip operations continued under private ownership and produced 432,671 tons of coal, in comparison with 534,819 tons in 1945.

Owing to the shortage of various fuels, briquettes continued to find an increasing market in Canada. During 1946 a total of 509,673 tons of briquettes was consumed, compared with 304,175 tons in 1945. These consisted of 54,056 tons made from carbonized Saskatchewan lignite, 272,682 tons made from low volatile coals from the Cascade and Nordegg areas in Alberta, and 182,935 tons imported from the United States and prepared from low volatile bituminous coals and anthracite, alone and mixed.

Use of the process developed in the Bureau of Mines for the improvement of blower coal by chemical treatment was continued in Quebec and Ontario. Widespread installation of domestic oil burners and difficulty of obtaining suitable anthracite for treatment apparently affected the use of blower coals.

COKE

Most of the coke produced in Canada, together with that imported, is obtained from standard by-product coke oven plants which process large tonnages for use in the production of steel and non-ferrous metals. The domestic coke market is also supplied with by-product coke which is prepared and sized according to the market requirements.

The retort coke produced by the gas industry is approximately 10 per cent of the total coke production and is used almost exclusively for the production of carburetted water-gas by the industry, leaving only about 20,000 tons a year for sale as domestic coke.

The adaptation of by-product coke oven plants for the production of domestic coke and city gas has largely superseded the original continuous vertical retort plants of the type in use extensively in Great Britain for the production of manufactured gas.

Principal Canadian Sources of Supply

Coke was produced from the several types of carbonization equipment in use throughout the Dominion. These include seven by-product coke oven plants, two beehive plants, three Curran-Knowles installations, seven continuous vertical retort plants, and eight installations of horizontal "D" retorts.

Approximately 80 per cent of the coal used in the production of coke in Canada is processed in the five principal plants in Ontario and eastern Canada. These include: Dominion Steel and Coal Corporation's plant, Sydney, Nova Scotia, which has an annual rated capacity of 950,000 tons of coal; Montreal Coke and Manufacturing Company's plant at Ville La Salle in the province of Quebec, which normally produces domestic coke and also supplies Montreal with gas, and has an annual rated capacity of 565,000 tons of coal; Algoma Steel Corporation's metallurgical coke plant at Sault Ste. Marie, Ontario, which has an annual rated capacity of 1,780,000 tons of coal; Hamilton By-Product Coke Ovens, Limited, which, together with its subsidiary operations, Ontario Coke Ovens Division, has a rated capacity of 795,000 tons of coal a year; and the coke ovens of Steel Company of Canada, Hamilton, Ontario, which have a rated capacity of 641,000 tons of coal a year.

The manufacture of beehive coke was continued in two plants in western Canada, this production being approximately 4 per cent of the coke marketed in Canada.

Production and Trade

Total production of coke from bituminous coal in 1946 was 3,312,909 tons, compared with 3,862,451 tons in 1945. Production by provinces was reported as follows:

Provinces	1945	1946
	tons	tons
Eastern provinces	1,069,586	950,658
Ontario	2,529,347	2,079,953
Western provinces	263,518	282,298
	3,862,451	3,312,909

Coal processed for the manufacture of coke amounted to 4,462,308 tons, of which 1,254,464 tons was of Canadian origin and 3,207,844 tons was imported from the United States. Petroleum coke produced at the refineries amounted to 69,408 tons, compared with 67,889 tons in 1945.

Imports of coke were 909,111 tons, compared with 1,250,548 tons in 1945. Exports were 47,434 tons, compared with 38,588 tons in 1945.

NATURAL GAS

Natural gas is produced commercially in Alberta, Ontario, New Brunswick, and Saskatchewan. A few shallow wells in Manitoba and Quebec produce small quantities for individual owner consumption. Production in Canada in 1946 amounted to approximately 47,900,484 M cubic feet compared with 48,411,585 M cubic feet in 1945. The value was also slightly lower. Alberta produced about 84 per cent of the total.

Principal Canadian Sources of Supply: Occurrences

The principal Canadian sources of natural gas are in rocks of Palæozoic age, the chief sources of supply being the Turner Valley field in Alberta; fields in Kent and Haldimand counties in Ontario; and the Stony Creek field in New Brunswick. Natural gas is also produced in Alberta and Saskatchewan in considerable quantities from Cretaceous sandstones.

Alberta

Turner Valley has estimated reserves of about 343 million M cubic feet of natural gas. Production has been decreasing, however, consequent to the steady decline in the production of crude petroleum from the field. In the

Viking-Kinsella field, which covers an area of 250,000 acres, gas reserves established to the end of 1946 are estimated at 1,000,000,000 M cubic feet, which places this field in the lead. Of this total, Imperial Oil, Limited has reserves of 400 to 600 million M cubic feet. Total reserves of Medicine Hat and Redcliff fields are estimated at 150 million M cubic feet and those of the Princess-Steveville field at from 40 million to a maximum of 100 million M cubic feet. In addition to these are the reserves of the semi-proven Jumping Pound and Pakowki Lake fields in southern Alberta, and of Peace River and Pouce Coupé fields in the north. In the Pakowki Lake field, near the Montana border, ten exploratory wells were drilled in 1946, jointly by McColl Frontenac Oil Company, Limited, and Union Oil of California, which resulted in four commercially productive gas wells. An active drilling program was contemplated for 1947. The potential gas recovery established by drilling was placed at around 100,000 M cubic feet a day. One of the wells had an open-flow potential of 46,000 M cubic feet a day.

Forty gas wells were completed in 1946, some of which are producing, and the others are capable of production when a market is available. One of the four wells completed in the Provost area had an estimated open flow of 13,000 M cubic feet a day. Three were completed at Elk Point, two at Medicine Hat, and one each in the Brazeau, Jumping Pound, Brooks, Tilley, Lloydminster, Moose Dome, Empress, Irvine, and Youngstown areas.

Northwestern Utilities, Limited extended its pipeline from the Viking field to serve the communities of Camrose, Wetaskiwin, Ponoka, Lacombe, and Red Deer. In line with this expansion, it drilled five wells in the area between its Viking and Kinsella fields, all of which were completed as gas producers. The company added a further length of 16-inch pipeline to connect with the existing transmission lines to Edmonton. Repressuring of excess gas from the Turner Valley field was continued by British American Oil Company, Limited, and Madison Natural Gas Company, Limited. The gas is stored under pressure in the depleted sands through certain selected in-put wells.

Saskatchewan

Four of the fifty-three wells drilled in Saskatchewan were completed as gas wells. Potentially important gas fields have been developed in the Lloydminster-Lone Rock oil and gas area and in the Vera-Unity gas area. This latter field has a developed open-flow reserve of over 100,000 M cubic feet daily from above the Devonian limestone. The Lloydminster field has been producing gas in commercial quantity since 1934, and the town of Lloydminster was the first in Saskatchewan to enjoy the benefits of a gas system. Further gas zones at deeper horizons than those now serving Lloydminster have been discovered in drilling for oil. They have not been tested for pressure and volume, but can be utilized when required. Less than 1 per cent of the population of Saskatchewan is served by natural gas, hence a wide search continues.

Ontario

In Ontario, natural gas production for 1946 is estimated as 7,233,723 M cubic feet. The search for gas resulted in the discovery of a gas field in Sombra township, Lambton county, and in the disclosure of gas in several wells in Malden township, Essex county. Approval by the United States Federal Power Commission of Washington was given to export 5,500,000 M cubic feet per year for twenty years from Texas to Ontario. The application was granted to the Union Gas Company of Canada, Limited, the leading producer and distributor in southwestern Ontario, who plans to store it in off-peak months in the partly depleted sands of the Dawn field in Lambton county. The gas will be piped under the river from Detroit to Windsor, from where a pipeline will be constructed, and deliveries are expected to be taken in the spring or summer of 1947.

New Brunswick

In New Brunswick, the principal producer, New Brunswick Gas and Oil Fields, Limited, operating in the Stony Creek field, accounted for most of the output. Total new production, measured in terms of initial production, amounted to 2,168 M cubic feet a day. This field supplies Moncton and Hillsborough and certain localities in Albert and Westmorland counties.

Production and Trade

Production of natural gas in Canada by provinces in 1945 and 1946 was:—

Province	1945		1946	
	M cu. ft.	Value	M cu. ft.	Value
		$		$
New Brunswick	653,230	317,568	541,010	262,441
Ontario	7,199,970	4,837,586	7,051,309	4,656,528
Saskatchewan	163,824	58,165	209,569	61,740
Alberta	40,393,061	7,095,910	40,097,096	7,184,006
Northwest Territories	1,500	335	1,500	335
CANADA	48,411,585	12,309,564	47,900,484	12,165,050

Markets

Alberta has most of the natural gas reserves in Canada and most of the communities are relatively close to a source of supply. Whereas Alberta is building up huge reserves of natural gas, those in Ontario are dwindling, and the demand from domestic and industrial consumers is increasing. The problem of finding a market in the West for its large reserves of natural gas was being investigated by several of the major producers in Alberta and Saskatchewan. Much study has been given to the matter of establishing a gas synthesis industry for Alberta and the erection of a plant or plants for turning natural gas into petroleum and chemical products. However, this would not be feasible in the event that adequate supplies of crude oil are disclosed. Otherwise, with the steady increase in petroleum consumption, and with the Prairie Provinces being forced to rely in growing measure on imports from oil fields as far distant as Texas, it might be desirable to establish a gas synthesis industry in Alberta.

In the United States, natural gas is used to an increasing extent in the manufacture of liquid gas, a mixture of pentane and butane. This gas is bottled under pressure and is used for general heating and for cooking in areas not served by natural gas. It has a high thermal value.

PEAT

Peat is the material produced by the incomplete decomposition of vegetable matter either in water or in the presence of water under such conditions that atmospheric oxygen is excluded. The character of the peat depends upon the conditions under which it was formed and upon the nature of the vegetation that contributed to its formation. Many species of plants are found in peat bogs, the most abundant being: mosses, such as sphagnum and hypnum; marsh and heath plants; grasses, rushes, etc.; marine plants; and sometimes trunks, roots, and leaves of trees. Peat occurs in every province of Canada, generally in two distinct forms, namely, unhumified, or moss peat, and humified, or fuel peat.

Peat Moss

Peat moss is the dead moss of the sphagnum plant. Its chief value lies in its ability to absorb and hold up to twenty-five times its own weight of liquids and gases. It is used as a bedding litter for animals, for horticultural purposes, and as a filler for fertilizers. Because of its elasticity and low-heat conductivity, it is used for insulating and sound-proofing and as a packing material.

Principal Canadian Sources of Supply

Prior to 1939, peat moss was obtained from bogs in Quebec, Ontario, Alberta, and British Columbia, but the annual production was only a few thousand tons. When supplies from Europe to this country and the United States were cut off as a result of the war, active attention was given to the development of deposits in Canada.

Production and Trade

In 1946, the thirty-seven plants in operation produced 96,839 tons of peat moss valued at $2,395,649. In 1945, production was 83,963 tons valued at $2,011,139.

In British Columbia, fourteen companies produced 49,263 tons valued at $1,546,149, the largest producers being: Western Peat Company, Limited; B.C. Peat Company, Limited; and Industrial Peat, Limited.

In Ontario, three companies produced 17,176 tons valued at $228,496, the largest producer being Erie Peat Company, Welland.

In Quebec, fifteen companies produced 26,382 tons valued at $501,073, the largest producers being: Premier Peat Company, Limited, Isle Verte; and Maple Leaf Peat Company and Perfect Peat Company, Rivière du Loup.

In New Brunswick, the main production was from Fafard Peat Moss Company, Pokemouche.

In Manitoba, the main production came from the property near Whitemouth, operated by Winnipeg Supply and Fuel, Limited. A small quantity was produced by McCabe Bros.

The Canadian production of peat moss is practically all exported to the United States for use as horticultural moss, and as poultry and stable litter.

Large quantities of peat were produced in Denmark, Sweden, Holland, Germany, and Russia prior to the war, but no recent production figures are available. It was reported that a small amount of Dutch peat arrived in New York in 1946.

Price

Price of peat moss varies from $19.50 to $42.50 a ton according to location, the average price for the Canadian production in 1945 being about $29 a ton.

Peat Fuel

Small amounts of peat fuel have been produced intermittently in Ontario and Quebec. In 1946, there was a small output at Gads Hill near Stratford, Ontario.

CRUDE PETROLEUM

Crude petroleum is produced commercially in Canada from wells in Alberta, the Northwest Territories, Saskatchewan, Ontario, and New Brunswick. Alberta, however, contributed nearly 94 per cent of the Canadian production in 1946, 83 per cent of which came from Turner Valley. Production in 1946 declined 9 per cent in quantity compared with 1945, but the value was 10 per cent higher. The daily production in 1946 averaged 21,000 barrels as against the daily consumption of approximately 190,000 barrels. Thus, Canada depends upon outside sources to supply close to 90 per cent of the requirements of crude petroleum. Production from Alberta continued to decline, the newer fields failing to offset the 14 per cent decline in Turner Valley. This is the oldest field in Alberta, and has been producing oil for thirty-two years, but production has been decreasing since 1942, the peak year.

For many years Turner Valley has been the main source of petroleum supply for the Prairie Provinces, but the steady decline in production since 1942 has necessitated a steady increase in the quantity of oil imported to meet the requirements. In 1942, for example, no crude oil was imported into Alberta, but Saskatchewan received 1,149,257 barrels from Montana, and 313,395 barrels were imported into Manitoba. In 1945, Saskatchewan imported more than 5,000,000 barrels, less than 1,000,000 barrels of which came from Montana, more than 2,000,000 barrels came from Oklahoma, more than 1,000,000 barrels from Texas, and about 500,000 barrels from Kansas. In fact, the supply from Turner Valley has not been meeting the requirements of Alberta refineries, and in 1946 a total of 421,491 barrels of crude oil was imported into Alberta, all from Montana.

Production from the other fields in Alberta increased a total of 209,235 barrels over 1945, the largest increases being in the Conrad, Taber, and Lloydminster fields. Output from the Vermilion, Wainwright, and Del Bonita fields in that province was lower than in 1945.

Production in the Northwest Territories continued to decline. The Canol pipeline and the refinery at Whitehorse were being dismantled and many of the wells were being closed. The remaining wells supply the needs of mining and of transportation in the Northwest Territories.

Principal Canadian Sources of Supply and Prospective Producing Areas

In the search for oil in the West, the most active area was the Lloydminster oil and gas field, which straddles the Alberta-Saskatchewan border. Though output is relatively small, this field became the second largest oil-producing area in Canada in 1946. Forty-nine oil wells were drilled, twelve on the Alberta side, and thirty-seven on the Saskatchewan side. By the end of the year twenty-two of these wells were in production, twenty-four were waiting to be serviced and put into production, and the remainder have thin oil sands and may make producers, or were dry holes. Production is obtained from the Sparky Sand of Lower Cretaceous formation at an average depth of 2,850 feet. Average well production is 30 to 35 barrels of "net oil" per day of 14° to 15° A.P.I. gravity. Forty-six wells were in production on both sides of the border at the end of 1946, compared with seventeen at the beginning of the year. Oil is pumped from the wells and is sent by truck to the local treating plant. The field has been extended by drilling over a length of approximately 23 miles in a northwest-southeast direction, from near Blackfoot in Alberta to Lone Rock in Saskatchewan. The width is possibly 8 miles across the prospective area.

In Alberta, eleven wells were completed in Turner Valley, twelve in the Lloydminster (Alberta) field, two each in the Princess and West Taber fields, and one each in the Provost and Baxter Lake fields. Fifty-six wells in the province were abandoned as dry or non-commercial, eight of which are in the foothills, twenty in the southern plains, and twenty-eight in the central plains. The footage drilled decreased from 543,437 feet in 1945 to 487,846 feet in 1946. New areas in the foothills and in the central and southern plains received chief exploratory attention.

In the nine years 1938 to 1946 inclusive, about $140,000,000 was spent in the search for oil in Alberta, the principal drilling and exploratory work being by Imperial Oil, Limited. In the ten years 1937 to 1946, this company drilled 114 wildcat wells in the West (exclusive of Northwest Territories) for a total footage of 510,000 feet. Other major companies active in exploratory work in Alberta in 1946 were: The California Standard Company, Shell Oil Company of Canada, Limited, Sun Oil Company, Gulf Research and Development Company, Socony-Vacuum Exploration Company, McColl-Frontenac Oil Company, Limited, and Union Oil Company. The principal independent companies in Alberta, namely, Anglo-Canadian Oil Company, Limited, Home Oil Company, Limited, and Calgary and Edmonton Corporation, Limited, combined in an exploratory program covering large reservations in central and northwestern Alberta. One of these reservations is at Elk Point where salt beds were discovered in drilling in 1946.

Five of the major operators have combined to test a reservation in the Little Smoky River area, 100 miles north of Jasper, Alberta, where seismic work has indicated the presence of a very favourable geological structure.

A road 70 miles long from Entrance, Alberta, is being built to the site of the project, and production, if obtained, will be from the Madison limestone at a depth of about 10,000 feet. Imperial Oil, Limited spent $1,000,000 jointly with Shell Oil Company in drilling the Imperial-Shell-Stolberg No. 1 well in the Brazeau area in the foothills in 1946 to a depth of 13,747 feet, where it was abandoned. This well is the deepest drilled to date in western Canada. At the end of 1946 Shell Oil Company was starting to drill its fifth test well in the Jumping Pound field, west of Calgary. A well drilled in this field by the company, in 1946, to 10,578 feet got gas in the upper porous formation, and an initial production of 4 barrels a day of oil, accompanied by water, in the lower formation. The oil is a light crude of 47° A.P.I. gravity, whereas most of the other oil fields in Alberta, outside of Turner Valley, produce a heavy crude ranging between 14° and 35° A.P.I.

Toward the end of the year, Home No. 24 in township 20, north end of Turner Valley, was brought in as a large crude producer. It is about a half mile from Home No. 2, Turner Valley's largest producer, which has been producing since January, 1939. In October, South Princess No. 3 well in the Madison limestone was completed at 3,326 feet and is a large producer of 27° A.P.I. gravity oil.

On January 1, 1946, the well-head price of Turner Valley crude of 40°-40·9° A.P.I. was increased 45 cents per barrel to $2.11 with an increase of 2 cents per degree up to 64°. Below 40°, the price decreases by the same amount (2 cents) per degree A.P.I.

In Saskatchewan, the Lloydminster field has been proved at a number of localities over a wide area. It now appears that the field will develop a number of oil "pools" that in size and volume of production will greatly exceed the Vermilion field. The oil is at a depth of less than 2,000 feet and is of the same heavy grade as at Vermilion. Until large reserves are proved so that suitable refinery facilities will be warranted, its uses will be for fuel oil and asphalt, for which it is of excellent quality. A dehydrating plant of 1,000 barrels daily capacity to treat the crude from the combined Alberta-Saskatchewan field was operating $1\frac{1}{2}$ miles northwest of Lloydminster, and an asphalt plant that will have an initial daily capacity of 2,500 barrels was being erected on the Alberta side of the field. The principal consumer of oil from this field in 1946 was the Canadian National Railway, whose requirements were about 70,000 barrels a month. The leading independent operator in the field was Community Services Syndicate, who drilled twenty-six wells with a footage of 52,000 feet.

In Ontario, the Petrolia, Oil Springs, Bothwell and Thamesville, and Mosa fields accounted for about 90 per cent of the total production of 123,082 barrels in 1946. Owing to the increasing demand for fuel oil and petroleum products, Imperial Oil, Limited increased its pipeline deliveries of crude to its refinery at Sarnia from 30,000 barrels a day to 42,000 barrels. Some of the oil comes from South America by tanker to New Jersey and thence by pipeline networks to Sarnia. The remainder comes from the United States fields.

In New Brunswick the principal producer, New Brunswick Gas and Oilfields, Limited obtains its oil from wells in the Stony Creek field near Moncton, and operates a topping plant at Weldon, producing gasoline and fuel oil. The company reported production of 22 barrels a day from new wells in 1946. Four wells were drilled and five existing wells were deepened. There was no wildcat drilling, but geophysical surveys were continued in parts of Albert county.

In Nova Scotia, Nova Scotia Oil and Gas Company, Limited discontinued drilling near Kennetcook, Hants county, with the intention of resuming in 1947. Sun Oil Company continued to drill its second test well near Nappan, 5 miles south of Amherst; and Pictou Petroleum Company carried out geophysical surveys and drilled its holdings in Pictou and Cape Breton counties to determine structures and their possibilities.

In Quebec, Gaspe Oil Ventures, Limited obtained showings of oil and gas at about 1,500 feet near Gaspe Harbour. Continental Petroleums, Limited encountered a heavy showing of gas at about 2,000 feet in its No. 1 well in Gaspe Peninsula, and the casing was cemented towards the close of the year. In view of the increasing demand for their products several companies have been or are planning to expand their refining facilities. Imperial Oil, Limited announced a program of new construction and additions to its plant at Montreal East that will consist of an addition of an 11,000-barrel-a-day fluid catalyst cracking plant, a new light-end recovery unit, and a 4,200-barrel-a-day, non-selective catalytic polymerization plant.

The company announced in 1946 that preparations were being made for the distribution of liquid propane gas, a liquefied petroleum gas, to be bottled under pressure and distributed in 100-pound metal cylinders by truck. Centres of distribution are planned for Ontario, in the central, west, and eastern regions, at Maple, Stratford, and Carleton Place.

British American Oil Company, Limited, over the next few years, plans to increase its total refining capacity almost 50 per cent, and plans to install to produce high-octane gasoline and other new fuels and lubricants. The company in 1946 was installing additional equipment at its Moose Jaw and Calgary refineries to enable the manufacture of a wider range of asphalt products and to utilize the heavy gravity crudes produced in western Canada. Shell Oil Company of British Columbia, Limited opened an extension to its refinery at Shelburne, British Columbia, which contained cracking and polymerization units. McColl-Frontenac Oil Company, Limited erected further crude storage tanks at Barnet, B.C., for its ship service terminal.

Petroleum provides 16 per cent of Canada's industrial energy, as against 51 per cent by coal, 30 per cent by water power, and 3 per cent by natural gas.

However, the increasing use of fuel oil for the increasing number of fuel oil furnace installations, both domestic and industrial, may change these figures of requirements in the near future.

Production and Trade

The table below shows the production of crude petroleum in Canada in 1945 and 1946:

—	1945		1946	
	Barrels	Value	Barrels	Value
Alberta—				
Turner Valley	7,422,061	....	6,371,572	....
Conrad	143,696	....	212,645	....
Taber	135,000	....	206,925	....
Princess	63,377	....	64,953	....
Wainwright	16,472	....	15,114	....
Vermilion	238,358	....	183,946	....
Lloydminster	28,321	....	76,187	....
Other fields	8,155	....	7,190	....
		$		$
Total Alberta	8,055,440	13,169,692	7,138,532	14,347,933
Northwest Territories	345,171	136,303	177,282	173,392
Saskatchewan	14,374	15,362	118,686	135,990
Ontario	113,325	268,478	123,082	291,719
New Brunswick	30,140	42,413	28,584	40,018
TOTALS	8,558,450	13,632,248	7,586,166	14,989,052

NOTE: For Alberta, the production figures are as given by the Petroleum and Natural Gas Conservation Board, Calgary. These are slightly lower than the Dominion Bureau of Statistics figures. The value of production is that given by the Dominion Bureau of Statistics.

Total production in 1946 from the Lloydminster field was 211,888 barrels of "net oil", which is the oil after extraction of basic sediment and water, and delivered to the refinery. It does not include oil in storage pits.

Canada imported 63,400,000 barrels of crude petroleum for refining in 1946 valued at $89,471,000, compared with 56,806,232 barrels valued at $72,320,674 in 1945. Sixty per cent of the imports in 1946 came from the United States, 33 per cent from Venezuela, and the remainder from Colombia and Trinidad.

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