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DEPARTMENT OF MINES AND RESOURCES

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BUREAU OF MINES

THE CANADIAN MINERAL INDUSTRY IN 1947

Reviews by the Staff of the Bureau of Mines

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CONTENTS

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PREFACE

Practically all of the metals and minerals produced in Canada in commercial quantities are reviewed in this report, with emphasis in each case on the principal developments during 1947.

The contents of the reviews indicate the increasing importance of mining in the national economy. The developments in the Leduc oil field in Alberta, in the Quebec-Labrador area where large deposits of hematite are being developed toward production, and at Allard Lake in Quebec where large deposits of titanium ore were discovered recently, provide tangible evidence of the industry's growth. The marked expansion in Canadian industry as a whole in recent years arises largely from the availability within the Dominion of large supplies of most of the minerals and, in fact, many of the hopes and plans for future expansion are linked with potential mineral developments.

Reviews of all the metals and minerals covered in this report were issued by the Bureau as mimeographed separates during 1948. 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, 1948.

I. METALS

ALUMINIUM

Increase in world demand for aluminium brought Canadian production up sharply from 1946 totals to almost 300,000 tons for 1947, and the demand is still increasing because of the rapid development of new uses.

Production in Canada 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 1947, operations were concentrated at Arvida and Ile Maligne, but preparations were made early in 1948 to reopen one of the reduction plants at Shawinigan Falls.

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

In addition to the above plants operated by the producing company, other plants throughout the country produce aluminium products.

Principal Canadian Sources of Supply

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.

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 devoid of bauxite, Canada has in many areas low-grade potential ores of aluminium such as clay, shale, nepheline syenite, and anorthosite containing from 20 to 30 per cent alumina. The utilization of these low-grade raw materials has been the object of much research in different parts of the world, and various processes have been developed. Three 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 while 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

Production of aluminium ingot in 1947 amounted to 299,066 short tons, compared with 194,117 tons in 1946.

Exports of aluminium and products in 1947 were valued at $63,955,574, of which ingots, bars, blocks, and blooms comprised $52,610,741, the corresponding figures for 1946 being $56,030,039 and $49,146,887, respectively.

Imports of aluminium and products in 1947 were valued at $7,422,603, compared with $5,618,798 in 1946. In addition, 7,258 tons of cryolite valued at $1,133,192 and 1,392,693 tons of bauxite valued at $8,565,875 were imported in 1947 for the production of aluminium.

Uses and Prices

Aluminium 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 an increasing number of architectural uses, being employed for window frames, screens, garage doors, heating and ventilating ducts, Venetian blinds, and ornamental spandrels on buildings. Small dwelling houses are also being built of aluminium. These uses have increased so rapidly in the past few years that they now constitute the principal use of aluminium, in so far as tonnage is concerned.

In the transportation industry, aluminium is used in frames and wheels of cars, trucks, and buses, and for the making of pistons. A new development in this field is the use of aluminium tubing for oil, gasoline, and water lines. Aluminium is also used to an increasing extent in the construction of railway equipment, in the fittings of ships, and for the construction of canoes and small boats. An aluminium highway bridge weighing 200 tons is being built across the Saguenay River at Arvida.

Aluminium is being made into nails and into barbed wire. There has been a very large increase in the use of aluminium foil for wrapping food products, particularly frozen foods, and although in pre-war years Germany controlled the greater part of the trade in foil, Canada is now supplying a large part of that market.

The price of aluminium ingot remained at 13¼ cents a pound throughout the year. Effective January 1, 1948, the United States import tariff on aluminium metal and alloys was reduced from 3 cents to 2 cents per pound.

ANTIMONY

A firm demand for antimony continued and supplies, though sufficient to meet Canadian demands, were met almost entirely from stocks or imports. The antimony situation will remain serious until China, formerly the major world producer, is able to resume shipments from current production. Supplies from the Far East have been smaller than anticipated and at the end of 1947 future demands appeared to be in excess of supplies.

No metallic antimony has been produced in Canada since 1944, in which year The Consolidated Mining and Smelting Company of Canada, Limited discontinued the use of its antimony metal refinery at Trail, British Columbia. Since that time the company has been intermittently producing antimonial lead containing 25 per cent antimony. It produced 2,285 short tons of this alloy, most of it in the first seven months of the year. Future production of antimonial lead will depend upon the demand. This demand at present is being largely met by scrap, battery plates, etc.

The important steps in the process used at Trail to recover the antimonial content of antimonial lead is briefly as follows:

1. Melting of the anode mud from lead refining to metal and some slag.
2. Elimination from the metal of the arsenic and antimony as fume.
3. Mixing of drosses from the fire refining of cathode lead and the fume from step 2.
4. Reduction of this mixture with coal to produce a crude antimonial lead.
5. Removal of the arsenic content by fire treatment, and the casting of the antimonial lead into bars for market.

Occurrences in Canada

A number of 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 some years prior to 1917, 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 1947, negotiations were under way with a Canadian metals firm to exploit this deposit.

In Quebec, prior to 1917, small amounts of ore were shipped from a deposit in South Ham township, Wolfe county, near Garthby. It is understood that this property will be examined in 1948 with a view to exploitation.

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 in Canada of antimony in all forms in 1947 amounted to 1,150,463 pounds valued at $384,255, compared with 642,145 pounds valued at $96,322 in 1946.

Imports of refined antimony and regulus in 1947 amounted to 2,880,513 pounds valued at $807,307, compared with 1,861,962 pounds valued at $374,066 in 1946.

The principal sources of antimony in normal times are China, Mexico, Bolivia, Czechoslovakia, and Yugoslavia. The United States is the chief consumer. Production of primary antimony in the United States in 1947 amounted to about 25 per cent of consumption. The Laredo, Texas, plant of Texas Mining and Smelting Company is the largest producer of refined antimony metal from foreign ores, nearly all of which was derived from Mexico and Bolivia.

In 1947, China exported about 8,000 tons of antimony regulus to the United States and Europe, and about 1,000 tons to Canada. These exports were drawn partly from old stocks and partly from current production. Chinese antimony was still under government control and all export sales were made through the Foreign Trade Office of the Natural Resources Commission in Shanghai, or through the New York Branch of this Commission. Over one-half of the Canadian imports of antimony from China during 1947 was contracted for by the Commodity Prices Stabilization Corporation with the Natural Resources Commission of the Chinese Government. In April 1947 antimony was removed from the list of products under government control and the government stocks were taken over by the consuming industries. Antimony was still under control in the United States.

In the United States the principal domestic source is in Idaho, where the antimony is a by-product in the mining of tungsten and gold. Other mines produce primary antimony only when the price is high.

Most, if not all, of the Mexican antimony concentrates was apparently sold to the United States, whereas Bolivian ore was chiefly exported to the United States.

The Star Metal Refinery of Bombay, India, treated ores obtained from its mines in Chitral State, now part of Pakistan.

Uses

The greatest single use for antimony is as an alloying element with lead, to which it adds hardness and mechanical strength, such as in the manufacture of storage batteries and cable covering. It is alloyed with tin in the manufacture of babbitt bearings, and with lead and tin in solders, foil, collapsible tubes, and type metal. Its property of expansion on cooling when alloyed makes it particularly useful in the manufacture of type metal.

Sulphides of antimony are used as a pigment in paint manufacture, and in making india rubber. The oxides are used in the ceramic enamel trade as an opacifier. Compounds of the metal are used in the medicinal trade. The chemical, and pulp and paper industries are consumers of antimonial lead for sheet, pipe, etc.

Substitutes

Due to the scarcity of antimony, the trade has looked for substitutes; possible substitutes being calcium, bismuth, and tin. Calcium is beginning, to a small extent, to replace antimony in some hard-lead alloys. Bismuth may be substituted for battery use, but its relatively high price precludes any substantial replacement. Tin oxide is often preferred to antimony compounds in the ceramic trade. In the manufacture of some pigments, antimony, cadmium, and titanium are competitive. Cadmium has become of increasing importance in bearing metals as a substitute for antimony.

Consumers in Canada

Canada Metal Company, Limited, Toronto, is Canada's largest consumer. Other important purchasers are 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

By Specified Industries, 1946

(1947 not available)

	Pounds
White metal alloys	1,485,292
Electrical apparatus and supplies including batteries, cable sheathing.	155,926
Brass and copper products	41,500

Prices

The Canadian Government Control Order setting the maximum price for antimony was rescinded early in 1947. The Canadian price for antimony was 35 cents per pound at the end of the year. The price of domestic antimony in the United States in 1947 was as follows: according to *Engineering and Mining Journal* Metal and Mineral Markets:

	Sept.	Oct.	Nov.	Dec.
Antimony, bulk, Laredo	33·0	33·0	33·0	33·0
Antimony, in cases, Laredo	33·5	33·5	33·5	33·5
Antimony, f.o.b. New York, packed in cases (224 lbs.) in lots of 5 tons or more, but less than a carload (95·5 per cent grade)	35·94	35·995	36·030	36·030

Yearly Average Prices (E. & M. J.)

Domestic at New York

	Cents per pound
1943	15·928
1944	15·839
1945	15·839
1946	17·306
1947	34·852

ARSENIC

Production of arsenic in Canada amounted to only 394 tons in 1947, the sources of output being O'Brien Gold Mines, Limited, and Consolidated Beattie Mines, Limited, in Cadillac and Duparquet townships, respectively, in Quebec, and Newcor Mining and Refining, Limited, Douglas Lake, Saskatchewan.

O'Brien recovers crude arsenic as a by-product in the treatment of its gold ore. It ships the arsenic to Deloro Smelting and Refining Company, Limited, Deloro, Ontario, where it is refined into white arsenic of commerce. These shipments in the fiscal year ended September 30, 1947, amounted to 285 tons. The process used at O'Brien is briefly as follows:

1. Concentrate is roasted in a modified type of Edward's furnace.
2. Gases of the roasting operation are exhausted by a fan into a bag house.
3. Crude arsenic is caught in the woollen bags and falls into a hopper, while the air and sulphur gas pass through the bags and to atmosphere through a stack.

4. Crude arsenic is conveyed to a packing bin from where it is packed in 45-gallon, used oak barrels which hold 500 pounds. The crude arsenic contains 0·25 ounce of gold per ton and runs 80 per cent As_2O_3. The gold-bearing residue from the refining of the crude arsenic is returned to the mine for treatment.

Consolidated Beattie Mines, Limited, at Duparquet, continued to recover crude arsenic by the Cottrell system in its roasting plant, with an approximate analysis of:

	Per cent
As_2O_3	77·0
Fe_2O_3	3·5
CaO	Trace to 1·0
SiO_2	5·0 to 8·0
SO_3	5·0 to 8·0

During 1947, the company made a 25-ton shipment of crude arsenic to a glass manufacturer in the United States. With the rehabilitation of its mine, production will be increased in 1948. Depending upon market conditions, the company was considering the operation of its refinery in 1948; the white arsenic produced in its refinery during the war contained 99·5 per cent As_2O_3.

Newcor Mining and Refining, Limited commenced the production of white arsenic at Douglas Lake, Saskatchewan, towards the end of 1947, but made no shipments. The process at Newcor is briefly as follows:

1. Massive arsenopyrite and mill concentrates are treated in a blast furnace.
2. The arsenic fumes from the blast furnace are cooled in "U" tubes, and crude arsenic is precipitated and caught in bag filters.
3. Crude arsenic is sublimed in a reverberatory furnace and As_2O_3 ranging around 99·2 to 99·6 per cent purity is recovered in precipitating units.

The Bralorne, Hedley, and other mines in British Columbia shipped a gold arsenic concentrate to American Smelting and Refining Company's smelter at Tacoma, Washington, but under their smelter contract no payment is received for the arsenic content.

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

Production and Trade

The production of arsenic (As_2O_3) in Canada in 1947 amounted to 394 tons valued at $49,348, compared with 373 tons valued at $38,264 in 1946.

Exports of arsenic, crude and refined, for which payment was received, amounted to 65 tons valued at $6,505 in 1947, compared with 293 tons valued at $28,968 in 1946.

Imports of white arsenic and arsenic sulphide in 1947 amounted to a total of 246,379 pounds valued at $24,150, compared with 500 pounds valued at $140 in 1946.

The world production 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 leading producing countries being: Sweden, United States, Mexico, Peru, Australia, Italy, France, Japan, Germany, and Belgium.

Uses

Most of the world production of arsenic is used in insecticides, and as a weed killer particularly on railroad rights-of-way. In Canada it is used chiefly as a clearing agent in the manufacture of glass.

Its use in the medicinal trade has declined rapidly with the advent of penicillin in the treatment of venereal diseases. A small amount is used in lead cable sheathing to increase its resistance to soil corrosion. Other uses of arsenic are: in the preservation of wood; in the manufacture of pigments for metal finishing; and in the manufacture of dyestuffs, cattle dip, and in bearing metals.

Consumers

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

Consumption of Arsenious Oxide in Canada in 1946 and 1947

	1946 *Pounds*	1947 *Pounds*
Glass industry	336,507	432,449
Insecticides	55,808	117,051
White metal alloys	27,501	37,454
Miscellaneous	8,000	9,000
Total	427,816	595,954

Prices

The price of arsenious oxide, refined, white, minimum 99 per cent, remained at 6 cents per pound, in barrels, carload lots, delivered, until December 19, 1947 when the price was advanced $\frac{1}{4}$ cent per pound, effective on contract business on January 1, 1948, according to *Engineering and Mining Journal* Metal and Mineral Markets.

BISMUTH

Metallic bismuth was produced in Canada in 1947 by The Consolidated Mining and Smelting Company of Canada, Limited, at Trail, B.C., and by Molybdenite Corporation of Canada, Limited, at its LaCorne mine, LaCorne township, Quebec. Consolidated Smelters obtains its bismuth from the residues resulting from the electrolytic refining of lead bullion; and has been producing the metal intermittently since 1928. Molybdenite Corporation had been shipping a 30 per cent bismuth concentrate since May 1946, but early in 1947 it installed a furnace to smelt the concentrate into metallic bismuth. The LaCorne mine was closed at the end of 1947.

The important steps in the recovery process used at Trail are, briefly:

1. Melting of the anode mud from lead refining to metal and some slag.
2. Elimination from the metal of the arsenic and antimony as fume.
3. Cupellation of the metal from step 2 to a gold-silver alloy.
4. Reduction of the cupellation slag to a lead-bismuth metal, plus some slag.
5. The lead-bismuth metal is drossed and the precious metals are removed by the Parkes process.
6. The residual metal is refined electrolytically, and the anode mud from this operation is melted and refined to bismuth.

At the LaCorne mine the bismuth concentrates were obtained by cleaning the rougher molybdenite concentrates. Metallic bismuth was obtained by smelting the concentrate in a bullion furnace with soda ash, borax, silica, and fluorspar as fluxes, and with an excess of scrap iron. The bismuth was cast into 100-pound bars and sold mainly in the United Kingdom.

Canadian Occurrences

There are few known occurrences of bismuth ore in Canada. It is possible, however, that the metal occurs with other Canadian molybdenite deposits, as in the case of the LaCorne mine.

Some bismuth ore was removed several years ago from the Glacier Gulch Group near Smithers, B.C., on the Canadian National railway. The bismuth, associated with a gold ore, was shipped to the smelter at Tacoma, Washington.

Production, Supply, and Trade

Canadian production of bismuth in all forms amounted to 284,372 pounds valued at $560,213 in 1947, compared with 240,504 pounds valued at $336,706 in 1946. Production of refined metal amounted to 284,357 pounds in 1947, compared with 234,020 pounds in 1946. Exports of bismuth in 1947 amounted to 122,000 pounds, compared with 192,000 pounds in 1946.

The world output of bismuth comes chiefly from the United States, Peru, Mexico, Argentina, Bolivia, and Canada. The Bolinden Mining Company of Sweden resumed the production of bismuth a few years ago.

Consumption and Uses of Bismuth

The domestic consumption of bismuth in 1947 was approximately 71 tons, compared with 40 tons in 1946. About half of this consumption is by pharmaceutical plants and most of the remainder by white metal foundries.

Bismuth is too brittle to be used alone, but its alloys have many uses such as in the manufacture of sprinkler plugs and other fire-protection devices, electrical fuses, low-melting solders, dental amalgams, and tempering baths for small tools. Like antimony, bismuth expands on solidification and retains this property in a number of alloys, and is used in type metal. This group of bismuth-lead-tin-cadmium alloys is used by the aeroplane and automotive industries to prepare spotting fixtures, to make moulds for electroforming, to fill thin-walled tubing during bending, and to spray-coat wooden patterns and core boxes in foundries.

Some bismuth is used in the manufacture of optical glass.

Salts of bismuth are used in the X-ray examination of the digestive tract due to the absorptive powers of bismuth for X-rays. Other uses are for the treatment of syphilis, for indigestion, and in cosmetic powders

Consumers in Canada

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

Prices

Engineering and Mining Journal Metal and Mineral Market price for bismuth during 1947 was $1.80 per pound in ton lots until February 20, when the price was raised to $2.

CADMIUM

Cadmium is produced in Canada by The Consolidated Mining and Smelting Company of Canada, Limited, Trail, British Columbia, and Hudson Bay Mining and Smelting Company, Limited, Flin Flon, Manitoba. The former company's

Sullivan lead-zinc-silver orebody at Kimberley, British Columbia, is the source of about 80 per cent of the Canadian output. The lead and zinc concentrates are shipped from Kimberley to the company's smelter and refineries at Trail, where the lead, zinc, and other contained metals are recovered. The zinc concentrate, which contains about 0·18 per cent cadmium, is roasted and leached and the cadmium is recovered from the residues that result from the purification of the zinc electrolyte. A very high-grade product (99·99 per cent cadmium) is obtained. The cadmium plant has an annual rated capacity of 700 tons of refined metal.

A number of smaller lead-zinc mines in southern British Columbia ship zinc concentrate containing cadmium to the Trail plant for treatment.

The cadmium contained in Hudson Bay Mining and Smelting Company's copper-zinc ore is recovered in much the same way as that produced at Trail. The capacity of the Flin Flon cadmium plant is rated at 180 tons a year.

Production and Trade

Canada produced 718,534 pounds of cadmium valued at $1,235,879 in 1947, compared with 802,648 pounds valued at $979,230 in 1946. Exports of cadmium metal amounted to 622,891 pounds valued at $1,370,233, compared with 573,368 pounds valued at $694,254 in 1946. Eighty per cent of the exports went to United Kingdom and 18 per cent to France. Canada used about 142,000 pounds in 1947, mainly in the white metal alloys industry.

World production of cadmium amounts to above 5,000 tons annually. The United States is the leading producer, the other principal producers being Canada, Australia, and Mexico.

Uses

The uses for cadmium have expanded rapidly since the pure metal became available as a result of the development of the electrolytic process for refining zinc. Its chief use is in electroplating where it is applied as a thin protective coating to other metals, principally steel. Because of its relatively high cost this use is limited generally to indoor articles where a uniform attractive colour is desired. Most of the remainder is used in bearing alloys where cadmium forms an important constituent, especially where a hard, heat-resisting bearing alloy is required, as in high-speed internal combustion engines. Cadmium is used in some types of solder. The addition of 0·7 to 1·0 per cent cadmium considerably strengthens copper without seriously reducing its electrical conductivity. For this purpose it is used chiefly in overhead power transmission and trolley wires.

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 of cadmium are used in electroplating solution.

In the United States, an estimated 70 per cent of the consumption of cadmium is in electroplating, and most of the remainder for bearing alloys.

Cadmium is marketed in metallic form as slabs or sticks with an impurity content not greater than 0·5 per cent. The principal compounds used are cadmium lithopone and cadmium sulphoselenide.

Prices

The average Canadian price of cadmium in 1947 was $1.72 a pound, compared with $1.22 a pound in 1946. At the beginning of 1947 the New York price was $1.50 a pound for commercial sticks and $1.55 a pound for patented anode shapes. On February 17, 1947, these prices advanced respectively to $1.75 and $1.80, where they remained for the rest of the year.

CHROMITE

Union Carbide Company was the only Canadian producer in 1947. It obtains its chromite from the "Montreal" pit in the Black Lake district, Quebec, which continued to be operated for the company by Orel Paré.

Early in 1947 chrome ore of metallurgical grade was in short supply, but because of increased shipments by Russia and Union of South Africa the import rate into the United States by the end of the year was nearly double consumption, and supplies on hand were adequate. Canadian consumption was about double that of 1946.

Most of the deposits from which production has been obtained are between Quebec City and Sherbrooke in the Eastern Townships of Quebec. During the war the main sources of supply were the Sterrett mine in Cleveland township and the Reed-Belanger property in the Black Lake district, both of which ceased operations in 1944.

The Montreal pit was operated over 50 years ago. It was reopened by Union Carbide Company in 1941 and since then production has been continuous.

The largest known deposits of chromite in Canada occur in the Bird River area of southeastern Manitoba, but because of the high-iron and low-chromium content they are not of present economic interest.

Production and Trade

Shipments, all of which were to Welland, Ontario, amounted to 2,162 short tons of lump ore valued at $42,159, compared with 3,110 tons of ore valued at $61,123 in 1946.

Imports were 98,322 tons, compared with 15,836 tons in 1946. Sixty-nine per cent of the imports were received via the United States, 25 per cent direct from Africa, and 6 per cent direct from other countries.

Domestic consumption was about 66,400 tons, all except 4,000 tons of which was for metallurgical use, the remainder being for refractory use. Stocks on hand at the end of 1947 were 37,000 tons, an increase of 66 per cent over those at the end of 1946.

Production of ferrochrome and of chrome alloys and Chrome X was 29,896 tons, about four and a half times that of 1946, and consumption was 3,837 tons. Stocks at the end of the year were 2,261 tons.

Exports of ferrochrome and chrome alloys amounted to 18,130 tons, about four times those of 1946, and were mainly to the United Kingdom and to the United States.

Figures for world annual production of chromite for recent years are incomplete, but just prior to the war the output was about 1,300,000 metric tons. Russia, Turkey, Union of South Africa, the Philippines, Southern Rhodesia, Cuba, Yugoslavia, Greece, New Caledonia, and India were the chief producers, with 50,000 metric tons or more each.

The output from South Africa in 1947 was about 411,268 short tons, a 76 per cent increase over 1946. Probably the largest chrome ore reserves in the world occur in the Lydenburg and Rustenburg districts in the Transvaal. Grades of shipping ore range from 54 per cent concentrate to lump ore of 44 to 48 per cent Cr_2O_3.

Southern Rhodesia's output comes mainly from the Gwelo and Salisbury districts.

In Cuba the output in 1947 was about 180,000 short tons, nearly all of which was exported to the United States. Most of the ore is refractory grade, and the remainder metallurgical.

In Turkey, production from nearly all privately owned mines ceased after British and American Government purchases ended on January 1, 1945.

In the Philippines, most of the ore is refractory. It is exported to the United States.

In India, production is about 30,000 tons a year and most of the ore is exported. The principal deposits are in the Kistna and Salem districts of Madras Presidency.

In the United States, production in 1947 was about 1,300 short tons compared with 160,000 tons in 1943, the peak year. Imports were nearly 1,000,000 tons, and consumption, about 800,000 tons.

Uses and Specifications

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

Chromium is a principal alloying element in a great variety of steels, chief of which in the amount of chromium used are the stainless and the corrosion-resistant steels. It is used in high-speed tool steels, and as a hard, toughening element in vehicle axles and frames, and in aeroplane parts. Chromium in high-temperature alloys is used 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 to make refractory bricks or materials used in basic open-hearth furnaces, in arches of furnaces, and 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. Chromite for refractory use 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 plus 10-mesh, 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 be relatively high in Cr_2O_3 and low in silica.

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.

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. At the end of 1947 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.

COBALT

The demand for cobalt continued to increase in 1947. The main cause of the increase was the greater use of the metal in cast cobalt-chromium-tungsten type alloys and in new types of alloys containing cobalt; and of the oxide in ground-coat frit for porcelain enamel.

All Canadian shipments of ore and concentrates were from the Cobalt area, Ontario. Ninety-five per cent of the total tonnage shipped to Deloro, Ontario, and to the United States, was from the stockpile of Silanco Mining and Refining Company, Limited, whose various properties were the sources of about the same percentage of the shipments in the past few years. The company did no mining or milling in 1947. The remainder was mainly hand-picked ore from various small properties in the area, all of which was shipped to the United States. The total shipments of ore and concentrate was about three times higher than in 1946.

Considerably more than half the total output of cobalt and cobalt products in Canada in 1947 was of Canadian origin. This is in contrast with the period 1940 to 1946, inclusive, when practically all of the cobalt and cobalt products produced in Canada was derived from the treatment of cobalt residues from African copper ores by Deloro Smelting and Refining Company, Limited, Deloro. Importation of these residues ceased in May 1946, but a substantial amount of cobalt products made from the residues on hand was shipped from Deloro in 1947.

Much the greater part of the output of cobalt and its products of Canadian origin produced in Canada in 1947 was derived from material stockpiled at Delora. The remainder, in the form of cobalt oxide, was produced by The International Nickel Company of Canada, Limited, at its plant in Port Colborne, Ontario, which was brought into operation in June 1947, for the recovery of the small cobalt content of the company's nickel-copper ores in the Sudbury area.

Production and Trade; Developments

Total shipments of cobalt of Canadian origin in 1947 were 286 tons valued at $875,644, compared with 37 tons (metal content of ore and concentrate exported) valued at $70,215 in 1946. The shipments in 1947 include: the cobalt content of Canadian concentrate exported; cobalt metal, oxide, and salts made at Deloro from Canadian ores; and oxides made at Port Colborne. Shipments of cobalt metal and compounds derived from foreign ores amounted to nearly 140 tons of contained cobalt.

Canadian consumption of cobalt was between 50 and 60 tons in 1947.

Exports of Cobalt Ore, Metal, and Compounds, 1946 and 1947
(Cobalt Content)

—	1946		1947	
	Tons	$	Tons	$
Ore and concentrate	37	70,215	44	68,271
Metal	221	854,282	20	72,095
Oxides, salts, and alloys	124	953,779	306	1,151,990
Total	382	1,878,276	370	1,292,356

Much the greater part of the oxides, salts, and alloys exported in 1947 went to Great Britain, and about half of the metal to Austria.

Imports of cobalt oxide from the United States amounted to 740 pounds in 1947, valued at $753. About 1½ tons of cobalt contained in scrap metal was imported.

Deloro Smelting and Refining Company produces cobalt metal, black and grey oxides, and amorphous cobalt sulphate. At Deloro, the stockpile of Canadian concentrate produced early in the war and purchased by the United States Government has not yet been treated nor changed ownership. It contains about 323 tons of cobalt.

All the output from International Nickel Company's plant at Port Colborne in 1947 was shipped to Great Britain. Production at the plant early in 1948 was at a rate of about 15 tons of cobalt metal in oxide per month.

Silanco Mining and Refining Company shipped a total of nearly 900 tons of concentrate in 1947, of which about 500 tons went to Deloro, and the remainder to Shepherd Chemical Company, Cincinnati, Ohio, where it was converted mainly into cobalt oxide. Shipments of ore or concentrate to Deloro are not included in statistics until shipped as metal or compounds.

J. H. Price, operating the Kerr Lake lease; Silver Arrow Mines, Limited, operating the Van Tassel property; Silco Mines, Limited, on the west side of Giroux Lake; Windsor Cobalt Silvers, Limited, operating a property in Bucke township; and others, shipped a total of about 44 tons of 10 per cent cobalt ore, mainly hand-picked, to the United States.

Silver Miller Mines, Limited opened a rich cobalt-silver vein on the 325-foot level at its Lumsden property, about 4 miles southeast of Cobalt.

The Cross Lake lease was operated from the old O'Brien No. 1 shaft and high-grade cobalt and silver ores were stockpiled.

Siscoe Metals, Limited brought its new 100-ton concentrator on the Miller Lake O'Brien property in Nicol township into production in January, but milling operations ceased in July. However, mining and diamond drilling were continued.

At the end of 1947 about 800 tons of 11 to 12 per cent cobalt concentrate was in stock in the Cobalt area.

World Production

The world production of cobalt in 1947 is estimated at about 6,000 short tons. The principal world sources of supply are the copper-cobalt-iron sulphide ores of Belgian Congo and Northern Rhodesia, mainly the former. The largest producer, Union Minière du Haut Katanga, substantially increased its output recently. The Congo output in 1947 was 3,924 short tons of cobalt content, which was 75 per cent of the world total. In Northern Rhodesia, the main source of supply is Rhokana Corporation's Nkana mine. The complex copper-cobalt ore averages about 0·15 per cent cobalt. The output in 1947 was 470 tons of contained cobalt. French Morocco is the third largest producer with 370 tons, followed by Canada. The output of the United States in 1947 is not available. Bethlehem Steel Company, the only producer in 1947, increased its output from the deposit of cobalt-bearing magnetite at Cornwall, Pa. The concentrate containing about 1·5 per cent cobalt is shipped to The Pyrites Company, Wilmington, Delaware, for processing.

The United States is the leading consumer of cobalt and in 1947 used about 2,000 tons of contained metal.

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.

The principal application is for stellite alloys which contain 40 to 50 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 aeroplane engines. One of the largest single uses in 1947 was for permanent magnet alloys. Cobalt is a major constituent in some types of high-temperature alloys used for the rotor blades of turbines in jet aircraft engines, and turbosuperchargers. 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. The use of cobalt in ground-coat frit for enamels increased substantially in 1947. 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, was 77 to 78 cents for 10 to 11 per cent concentrate shipped to the United States in 1947. Deloro buys cobalt concentrate at a basic price, with bonuses for cobalt in excess of 10 per cent and for silver in excess of 150 ounces per ton. The New York price for cobalt metal in 550-pound barrels remained constant at $1.65 per pound. For black oxide 70 to 71 per cent grade for metallurgical use the price increased from $1.06 to $1.65 per pound of cobalt; and for ceramic industry it was $1.27 to $1.30 per pound at the end of the year.

COPPER

Canada's output of copper in 1947 was 225,862 tons, compared with 183,968 tons in 1946, and 327,797 tons in 1940, the peak tonnage output year. The increase compared with 1946 was due mainly to the greater demand for nickel, which permitted more production from the mines of the Sudbury area. Operations in the copper mines of Quebec and British Columbia were still hampered by a shortage of miners. The Flin Flon smelter in Manitoba operated at capacity.

The domestic ceiling price of copper was raised in January 1947, from 11½ cents a pound to 16⅝ cents. Control was removed in June and the price rose rapidly to 21½ cents, where it remained during the second half of the year. With this high average price, the value of Canada's production of copper in 1947 reached a peak of $91,541,888, compared with $46,632,093 in 1946, and $65,773,061 in 1940.

No deposits of copper ore were discovered, but preparations were taken to bring several known deposits into production. Ore reserves at the principal producing mines remain sufficient for many years of operation. Steps were taken to expand the copper refinery at Montreal East and the adjoining wire bar mill.

Principal Canadian Sources of Supply

The mines of The International Nickel Company of Canada, Limited in the Sudbury area, Ontario, were the source of 49 per cent of the tonnage output of copper in Canada in 1947, the two other chief sources being the Noranda mine in Quebec, and the Flin Flon mine on the Manitoba-Saskatchewan boundary.

Quebec

Noranda. The smelter of Noranda Mines, Limited, at Noranda, Quebec, treated ore and concentrate from its own mine, concentrate from its subsidiary, Waite-Amulet Mines, Limited, and custom concentrate from Normetal Mining

Corporation, Limited. It treated a substantial tonnage of brass shell cases for recovery of the contained copper. All the blister copper thus obtained was shipped to its subsidiary, Canadian Copper Refiners, Limited, at Montreal East, where blister copper from the Flin Flon smelter also was refined. Much of the refined copper was made into wire bars in Montreal East and then converted into a great variety of wire products at the associated plant of Canada Wire and Cable, Limited, at Leaside, near Toronto. An additional substantial tonnage was used in the plant of the new subsidiary, Noranda Copper and Brass, Limited, at Montreal East to make copper, brass, bronze, and other alloys in the form of strip, sheet, rod, wire, and tubing.

Noranda produced 516,704 tons of ore from its own mine, made up of 317,748 tons of direct smelting ore, 196,258 tons of concentrating ore, and 2,698 tons of fluxing ore. Its concentrator treated 194,601 tons of ore from which was obtained 41,399 tons of copper-gold concentrate and 46,327 tons of pyrite concentrate. The smelter was closed by a strike during the early part of 1947, but resumed operations on March 1. It treated 648,753 tons of ore, concentrate, refinery slag, and scrap brass to produce 49,760 tons of anodes. Of the tonnage treated, 289,123 tons was on a toll basis. Total ore reserve of the Noranda mine at the end of 1947 was 20,118,125 tons.

The Waite Amulet and the adjoining Dufault mine produced 393,950 tons of ore. Ore reserve at the end of 1947 was 1,765,000 tons.

Normetal. Normetal Mining Corporation, Limited treated in its mill 209,310 tons of ore averaging 3·37 per cent copper, 6·70 per cent zinc, 0·032 ounce gold, and 2·32 ounces silver. It shipped 21,599 tons of zinc concentrate to the United States. Stoping in the mine was conducted on levels from 1,500 to 2,900 feet in depth. The ore reserve is 1,760,000 tons averaging 3·64 per cent copper and 7·63 per cent zinc.

So far, Normetal has been dependent for power upon a small local hydro-electric plant and its own Diesel-electric generators. However, the Quebec Hydro-electric Commission has under way a transmission line to the mine from the Rouyn-Noranda area.

Quemont. Quemont Mining Corporation, Limited continued to develop its mine, adjoining Noranda on the north, and commenced construction of a 2,000-ton mill. Ore reserve at the end of 1947 as reported by the company was 9,431,000 tons, averaging 1·49 per cent copper, 2·69 per cent zinc, 0·174 ounce gold, and 0·943 ounce silver. A new shaft, No. 2, was sunk to 1,142 feet and is to be continued to 2,140 feet or more during 1948. Seven levels have been established and preparations were under way for making stopes ready for production. As a part of the sheet-like orebody reaches the bottom of Osisko Lake, surveys have been made with a view to damming off the bay under which the ore occurs and pumping out the water and mud. Where the the tabular deposit bends on the westward side to a position approaching the vertical, it has been found in drill-holes to a depth of over 3,000 feet.

The flow-sheet has been devised from bulk tests made in the test mill of the Quebec Department of Mines at Val d'Or. Concentrates of copper, zinc, and pyrite will be made; the last to be cyanided after regrinding, to recover gold and silver, and then sold as sulphur ore.

East Sullivan. East Sullivan Mines, Limited developed three levels down to 450 feet during 1947, thus giving an ore reserve of 3,541,000 tons averaging 2·21 per cent copper, 1·26 per cent zinc, 0·025 ounce gold, and 0·46 ounce silver. The shaft was continued to 1,150 feet and it is expected to develop four more levels down to 1,050 feet during 1948. The primary crushing station was established at 960 feet.

A mill of 2,000 tons daily capacity was under construction and is expected to be in operation late in 1948. Provision has been made for expansion to 5,000 tons. An agreement was made with Noranda Mines, Limited to smelt the copper concentrate and to refine and market the metals.

MacDonald Mines. MacDonald Mines, Limited continued exploration of its large deposit of massive sulphides. Development on levels at 300- and 900-foot depths has shown an appreciable amount of zinc and low average values in copper, gold, and silver. Underground work was continued.

Other Quebec Properties. No further work was done on the large low-grade copper deposit of Joliet-Quebec Mines, Limited, adjoining Noranda on the northwest.

The York River copper deposits in Gaspe, held by Noranda, were examined further by drilling. They are extensive and of low grade.

No further move was made to exploit the copper deposits of Opemiska and Chibougamau, approximately 200 miles northeast of Noranda.

Ontario

International Nickel. The smelters of The International Nickel Company of Canada, Limited, at Copper Cliff and Coniston, were operated at about three-quarters of their maximum war-time capacity. Completion of the new process plant at Copper Cliff for separating nickel and copper was further delayed by material shortages, but should be in full operation some time in 1948.

Ore reserve at the end of 1947 totalled 221,843,000 tons containing 7,171,000 tons of nickel-copper, a slight increase compared with 1946. All the company's mines, namely, Frood, Creighton, Levack, Murray, and Garson, were in operation throughout the year, and produced 10,406,644 tons of ore. Underground development totalled 54,790 feet. Airborne magnetometer surveys were made of the Sudbury basin and of two other fields.

The copper refinery at Copper Cliff treated the company's blister copper and also that from the Sherritt Gordon mine, in Manitoba, which was smelted at the Flin Flon smelter.

The company's sales of refined copper in 1947 were 110,336 tons, compared with 74,889 tons in 1946. 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 increased the output of its smelter in the Sudbury district by 45 per cent, compared with 1946. The mill and smelter treated 731,925 tons of ore, the larger of the two blast furnaces being in use throughout the year. The resulting matte was shipped to the company's refinery in Norway.

At the Falconbridge mine, stoping was under way on levels down to 1,925 feet. Development was done on five new levels below this to 2,800 feet. Some drifting was done on the lowest level of the mine, at 3,150 feet. An internal shaft was collared at 2,450 feet to serve the deeper levels.

At the new McKim mine, McKim township, the shaft was at a depth of 477 feet by the end of 1947. It is expected the mine will furnish 500 tons a day in 1949.

Ore reserve of the Falconbridge mine and of the company's outside holdings at the end of 1947 was 14,188,000 tons, averaging 1·75 per cent nickel and 0·92 per cent copper.

Tests have shown the economy of changing the present refinery method using sulphate solution, to another method using chloride solution. The change, intended to be made during 1948, will greatly increase the capacity of the plant.

Manitoba and Saskatchewan

Hudson Bay. Hudson Bay Mining and Smelting Company, Limited treated in its smelter at Flin Flon, Manitoba, ore and concentrate from its Flin Flon mine, and copper concentrate (30,621 tons in 1947) from Sherritt Gordon mine 40 miles northeast. Blister copper from the Flin Flon ore is shipped to Canadian Copper Refiners in Montreal East for refining, and that from Sherritt Gordon concentrate to International Nickel at Copper Cliff, Ontario, for refining.

The Flin Flon mine, lying astride the Manitoba-Saskatchewan boundary, produced 1,855,035 tons of ore averaging 2·60 per cent copper, 4·4 per cent zinc, 0·083 ounce gold, and 1·17 ounces silver. Development of the 3,750-foot level was completed. There was an unusually large proportion of talc in the ore milled, which interfered with recovery in the concentrates. The ore reserve is 22,700,000 tons averaging 3·0 per cent copper, 4·3 per cent zinc, 0·084 ounce gold, and 1·20 ounces silver.

The company was sinking a shaft to develop its Schist Lake orebody that lies beneath the water of Schist Lake, 3½ miles southeast of Flin Flon; and at its Cuprus mine, 8½ miles southeast of Flin Flon, it was erecting a 300-ton mill.

Hudson Bay's power plant at Island Falls on the Churchill River in Saskatchewan was being extended by installation of a sixth generating unit, to give a total capacity of 110,000 horsepower. This plant supplies power to all the mines in the district, the Nor-Acme gold mine having been connected up early in 1948. To service its various properties and to aid in its prospecting and exploration, Hudson Bay maintains an airport at Flin Flon and operates three aeroplanes.

Sherritt Gordon. All of the company's production in 1947 came from its West mine at Sherridon, as its East mine is worked out. The 30,621 tons of copper concentrate produced yielded 7,342 tons of refined copper, 3,681 ounces of gold, and 121,342 ounces of silver. Mining equipment from the East mine is being transferred to Lynn Lake, 150 miles north of Sherridon, as required. At Lynn Lake, the company has outlined, by drilling, 8,300,000 tons of nickel-copper ore, averaging 1·514 per cent nickel and 0·687 per cent copper. There is also a copper-zinc deposit with an indicated 153,000 tons, averaging 1·13 per cent copper, 2·491 per cent zinc, and 0·016 ounce gold. A shaft was started to serve the "A", "C", and "E" deposits, not far from the northeast shore of Lynn Lake. Preparations were under way for a second shaft to serve the "EL" deposit, 2 miles to the south. Tests in a pilot plant at Sherridon have shown that the copper and nickel minerals can be recovered readily in separate concentrates by flotation. The pilot mill is being transferred to Lynn Lake.

British Columbia

Copper Mountain. The mine of Granby Consolidated Mining, Smelting and Power Company, Limited is at Copper Mountain, and the concentrator is at Allenby, 6 miles north. At the end of 1947 the ore reserve was 9,042,000 tons, averaging between 1·2 and 1·3 per cent copper. By the end of the year the supply of miners became adequate, permitting continuous operation of the mill at its rated capacity. Shipments from the mine in 1947 totalled 1,333,777 tons, much of it from areas previously considered of non-payable grade.

The concentrator at Allenby treated 1,333,474 tons averaging 0·987 per cent copper. The concentrate was shipped to the smelter at Tacoma, Washington, and yielded 10,662 tons of copper, 5,141 ounces of gold, and 149,497 ounces of silver.

Britannia. The Britannia mine of Howe Sound Company is 20 miles north of Vancouver. The labour supply was still inadequate. Underground development was improved to some extent and the mill tonnage was increased, but remained below capacity. Mine production averaged 3,000 tons a day, and 794,974 tons was milled in 1947. The mill products are copper gold concentrate, copper precipitate (made from mine water), zinc concentrate, and pyrite concentrate. The copper concentrate and precipitate, shipped to American Smelting and Refining Company at Tacoma, contained 8,547 tons of copper, 9,612 ounces of gold, and 66,905 ounces of silver. During recent years a large stockpile of pyrite concentrate has accumulated, and much of this, in addition to the current output, was sold in 1947.

Twin "J" Mines, Limited operated its mine at Mount Sicker on Vancouver Island for a part of 1947 and shipped several carloads of copper concentrate to Tacoma.

Coast Copper Company, Limited, a subsidiary of Consolidated Mining and Smelting Company of Canada, Limited, did not work its property in 1947. It holds seventy-six mining claims in Quatsino mining division of Vancouver Island.

Production and Trade

Production of copper in Canada in 1947, including refined copper and the copper content of concentrate and matte exported for treatment, was 225,862 tons valued at $91,541,888. The output by provinces was:

Copper Production, 1946 and 1947

—	1946	1947
	Tons	Tons
Quebec	34,899	42,561
Ontario	89,713	113,934
Manitoba	19,250	15,316
Saskatchewan	31,356	33,151
British Columbia	8,750	20,900
Total, Canada	183,968	225,862

The copper refinery at Copper Cliff and that at Montreal East produced a total of 202,427 short tons of refined copper, compared with 167,221 tons in 1946.

Exports of copper in crude and semi-manufactured form were:

—	1946		1947	
	Tons	Value	Tons	Value
Copper contained in ore, matte, etc.	17,628	$ 2,467,906	29,094	$ 9,310,000
Copper in ingots, bars, cakes, slabs, and billets	101,415	$27,463,366	87,478	$33,485,810
Copper in rods, strips, sheets, and tubing	15,918	$ 4,940,721	20,484	$ 8,851,207
	134,961	$34,871,993	137,056	$51,647,017

An estimated 109,210 tons of ingot copper was processed in Canada during 1947. Of this amount, 80,715 tons was rolled into wire rods, a part of which was exported and the remainder re-rolled into a great variety of wire products. Much of the wire products was exported. Approximately 28,000 tons was used to make brass and bronze, and for miscellaneous uses.

The American Bureau of Metal Statistics issued the following estimate of world copper production in 1947. The figures do not include copper exported or imported for smelting, but they represent over 80 per cent of the world total.

Copper Output of Smelters and Refineries in 1947, compared with 1946 and 1943

(Short tons)

—	1947	1946	1943
United States	871,391	603,868	114,149
Canada	201,715	167,858	251,494
Chile	448,153	395,283	538,509
Peru	19,462	21,520	31,183
Mexico	61,189	56,377	44,442
Rhodesia	218,222	204,922	276,955
Australia	15,040	20,494	29,500

Uses

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.

GOLD

Canada is exceeded only by the Union of South Africa in gold production. Canada produced 3,070,221 ounces of gold valued at $107,457,735 in 1947, compared with 2,832,554 ounces valued at $104,096,359 in 1946, and with 5,345,179 ounces valued at $205,789,392 in 1941, the peak year. Labour shortages and rising costs continued to adversely affect production, prospecting, and exploratory work. Towards the end of 1947 more labour was becoming available by the release of men from lumber operations, and by the entry of displaced persons from Europe. At the end of the year a shortage of power, which continued into 1948, forced the mines of Porcupine and Kirkland-Larder Lakes areas to reduce operations.

The production value of gold in 1947 was based on $35.00 an ounce, while that of 1946 was based on $38.50 an ounce for the first six months of that year, and on $35.00 an ounce for the remaining six months.

Legislation and Taxation

The Minister of Finance on March 4, 1947, announced certain tax concessions applicable to gold mines, defining gold mines as those mines where the value of output was to the extent of 70 per cent or more from gold. These concessions are briefly as follows:

1. The depletion allowance for gold mines was increased from 33⅓ per cent to 40 per cent of the net profits. This allowance was made applicable as from January 1, 1947.

Where the depletion allowances on gold mines as calculated on the percentage-of-net-profits basis amounted to less than $4.00 per ounce of gold produced in fiscal periods ending after June 30, 1946, it was provided that the depletion allowance would be at the rate of $4.00 per ounce of gold produced, and that the amount so calculated would be recognized as an expense for all purposes of the Income War Tax Act.

2. In the case of new gold mines exempt for three years from income taxation under Section 4(x), Income War Tax Act, provision was made that depreciation need not be written off during the period of exemption, but may, during or following that period, be written off at a rate not exceeding 25 per cent per year. Provision was also made that pre-production expenses need not be written off during the exempt period, but shall be written off in the four years following such exempt period at a rate not in excess of 25 per cent per year.

On December 11, 1947, the Minister of Finance announced that a proposal would be placed before Parliament whereby the Government, through the Department of Mines and Resources, would undertake to make payments to gold mines to assist in defraying part of the increased costs of production on production after December 1, 1947, (later changed to January 1, 1948), for a term of three years. This payment would be determined by taking half of the amount by which the mine's cost of gold production per fine ounce exceeds $18.00 and applying this to the amount by which production in the assistance-year exceeds two-thirds of the production in the base year, that is, the twelve months ended June 30, 1947. In the case of new mines, the payment as described above would be made on the entire production in the first year, and in the two succeeding years, on the amount by which the current production exceeds two-thirds of the first year's production.

Recurring rumours persisted in Canada, the United Kingdom, and the United States to the effect that the United States Treasury was considering changing its price or bid for an ounce of gold. These were emphatically denied by the Treasury Department who pointed out that the Bretton Woods Agreement makes it impossible for the United States or any other member nation to alter its currency in terms of gold without consultation with, and consent of, the International Monetary Fund.

All the gold produced in Canada must be sold to the Royal Canadian Mint on the basis of $35 per troy ounce of fine gold, and all the gold produced in the United States must be sold to the Treasury at the fixed price.

United States smelters and refiners that treat gold concentrates from foreign sources were permitted for a time to re-export the recovered gold in the free market. According to market authorities, American smelters obtained the equivalent of $39 to $42 an ounce from the gold derived from the refining of concentrates of gold mines in British Columbia. However, amendments to the gold regulations issued under the Gold Reserve Act of 1934 were adopted at the request of the International Monetary Fund, and came into effect on November 24, 1947. The amended regulations permit the export of gold refined from imported gold-bearing ores or concentrates only when the refiners in the United States do not participate in the sale of the refined gold. Foreign gold in ores or concentrates may be imported into the United States for refining and the refined gold re-exported where ownership remains with the foreign producer.

Canadian Gold Production

Production in 1947, compared with 1946, and with 1941, the peak year

—		1947	1946	1941
Ontario—		oz.	oz.	oz.
Porcupine—in gold bullion	937,415			
Kirkland Lake—in gold bullion	627,094			
Other gold mines—in gold bullion	331,260			
In converter copper from nickel-copper ores	36,722			
In ore, matte, etc., exported	12,328			
		1,944,819	1,813,333	3,194,308

Production in 1947, compared with 1946, and with 1941, the peak year—Conc.

		1947	1946	1941
		oz.	oz.	oz.
Quebec—				
In gold bullion.......	465,177			
In anode copper................	125,858			
In ores, etc., exported...........	7,092			
		598,127	618,339	1,089,339
British Columbia—				
In alluvial gold.................	5,732			
In gold bullion..................	126,109			
In base bullion..................	4,712			
In ores, etc., exported...........	112,458			
		249,011	136,242	608,203
Saskatchewan—				
In alluvial gold.................	4			
In blister copper................	93,743			
		93,747	112,101	138,015
Manitoba—				
In gold bullion..................	42,325			
In blister copper................	30,581			
		72,906	79,402	150,553
Yukon—				
In alluvial gold.................	47,679			
In ores exported................	66			
		47,745	45,286	70,959
Northwest Territories—				
In ores, etc., shipped............	26			
In gold bullion produced.........	62,491			
		62,517	23,420	74,417
Nova Scotia—				
In gold bullion..................	....	1,271	4,321	19,170
Alberta—				
In alluvial gold.................	....	78	110	215
Canada Total..............	....	3,070,221	2,832,554	5,345,179
Value..............	....	$107,457,735	$104,096,359	$205,789,392

British Columbia

In British Columbia the output of gold continued to come chiefly from lode gold mines. The remainder came from placers and from two base-metal mines, namely; Britannia Mining and Smelting Company, Limited (Howe Sound Company), at Britannia Beach, and Granby Consolidated Mining, Smelting and Power Company, Limited, at Copper Mountain. The lode gold came from Bralorne and Pioneer mines in the Bridge River area; Cariboo Gold Quartz, and Island Mountain mines in the Cariboo area; Hedley Mascot and Kelowna Exploration mines in Osoyoos area; the Polaris-Taku mine in the Atlin area; Silbak Premier mine in the Portland Canal area; and Privateer mine in the Zeballos River area, Vancouver Island. Polaris-Taku reported the first full year of operation since 1942. Kenville Gold Mines, Limited in the Nelson area, and Dentonia Mines, Limited in the Greenwood area, entered production near the close of 1947.

The value of output of placer gold was less than half that of 1946. Preparations were being made, however, for new placer operations. Interest in dragline dredging resulted in the testing of several areas in the Cariboo, Manson Creek, and McDame Creek regions. Construction of a road was begun to connect McDame Creek with the Alaska Highway.

Saskatchewan

The gold output came from that part of the copper-zinc-gold mine of Hudson Bay Mining and Smelting Company of Canada, Limited, at Flin Flon, that lies within Saskatchewan. A few ounces were recorded from placer operations.

Manitoba

San Antonio mine in the Rice Lake area, the only active gold-quartz mine in the province, was the principal producer of gold in 1947. Because of labour shortage the company's milling rate was reduced to 300 tons a day in the latter half of 1947, which is little more than half the capacity rate. The remainder of the gold output came from the copper-zinc mine of Hudson Bay Mining and Smelting Company, Limited, at Flin Flon, and from the Sherritt Gordon copper-zinc mine at Sherridon.

Ontario

The lode gold mines of the Porcupine, Kirkland Lake, and Larder Lake areas supply most of the output; other important contributors being the lode gold mines of the Patricia, Thunder Bay, and Matachewan areas, and the nickel-copper mines of the Sudbury area.

In the Porcupine area, the producing mines were: Aunor, Bonetal, Broulan, Buffalo Ankerite, Coniaurum, Delnite, Dome, Goldhawk, Hallnor, Hollinger, Hoyle, McIntyre, Pamour, Paymaster, Porcupine Reef, Preston East Dome, and Ross, the principal producers being Hollinger, McIntyre, Dome, and Aunor. Small initial shipments were commenced by Goldhawk to the Broulan mill.

In the Kirkland Lake and Larder Lake areas the producing mines were Bidgood, Chesterville, Kerr-Addison, Kirkland Golden Gate, Kirkland Lake Gold, Lake Shore, Macassa, Omega, Sylvanite, Teck-Hughes, Toburn, Upper Canada, and Wright-Hargreaves. The Omega mine ceased operations in April 1947, because of its ore position and the rising costs of production. The Kirkland Golden Gate mine resumed milling operations early in 1947 after a shut-down of several years. Kerr-Addison announced that its mill capacity is being increased and that the mill will operate at 4,000 tons per day by about the end of 1948. With this increase the mine will become Canada's largest producer of gold.

In the Patricia area the producing mines were Berens River, Central Patricia, Cochenour-Willans, Hasaga, Jason, McKenzie Red Lake, McMarmac Red Lake, Madsen Red Lake, and Pickle Crow; the main producers being Pickle Crow, Madsen Red Lake, and Cochenour-Willans. The Jason mine, which was reopened in September 1946, was closed in June 1947; and the Hasaga mill, which was closed in November 1946, was in operation again in March 1947. The McMarmac mine resumed milling operations in August at a rate of 70 tons per day.

In the Thunder Bay area the producing mines were Hard Rock, Jellicoe, Leitch, Little Long Lac, MacLeod-Cockshutt, Magnet, Maylac, and Talmora; the chief producers being MacLeod-Cockshutt, Leitch, and Hard Rock. Jellicoe made some small shipments to the Magnet mill. Maylac was closed in January 1947.

Other mines that produced gold in Ontario were Matachewan Consolidated and Young-Davidson in the Matachewan area, Renabie in Missanabie area, and Van Houten in Kenora area. Renabie commenced milling in July 1947.

Quebec

The Rouyn-Harricanaw belt of northwestern Quebec was the source of Quebec's gold, except for a small quantity recovered by New Calumet in its zinc and lead concentrates that were shipped to the United States and elsewhere for treatment. The New Calumet mine is on Calumet Island in the Ottawa River. The lode gold mines that accounted for the production, roughly in the order of their output, were: Sigma, Lamaque, Belleterre, Malartic Gold Fields, East Malartic, Canadian Malartic, Consolidated Beattie, Sullivan, O'Brien, Siscoe, Stadacona, Sladen Malartic, Perron, Senator-Rouyn, Mic-Mac, Powell-Rouyn, Elder, Louvicourt, Consolidated Central Cadillac, New Marlon, and Francoeur. The remainder of the output came from four base-metal mines, namely, in order of quantity: Noranda, Waite Amulet, Golden Manitou, and Normetal.

Elder and Powell-Rouyn mines continued to ship their siliceous gold ores to the smelter of Noranda Mines, Limited, under contract that provides for payment of the silica content of this ore for use as smelter flux. The Louvicourt mine commenced milling in the first half of 1947 and the first brick was poured on June 7, 1947. New Marlon commenced to truck ore to the Francoeur mill, in June, which it purchased after the Francoeur mine was closed. Consolidated Central Cadillac began milling in June 1947.

Some mines in Quebec were increasing their mill capacities and others were making plans to do so, to reduce unit operating costs. Canadian Malartic was expanding its mill capacity to 1,200 tons a day and expected to operate at this capacity before the close of 1948. Malartic Gold Fields was building a new mill unit in order to bring over-all capacity to 1,500 tons. Senator-Rouyn was planning to double the mill capacity to 600 tons by the end of 1948.

Nova Scotia

Gold production of Nova Scotia was less than one-third that of 1946, and at the close of 1947 there were no gold mines in production. Output came from the K-V mine in Queens county, the Sara F Silver mine in Guysborough county, the Aulenback mine in Lunenburg county, and from the Consolidated Mining and Smelting Company's property in Halifax county.

Yukon

Gold production came from Klondike, Mayo, and Whitehorse areas, in order of importance as named. The season of 1947 was one of the driest in many years and this adversely affected placer activities. There was an improvement, however, in the supply of labour. Nine dredges were in operation, some of them for only part of the season. Yukon Consolidated Gold Corporation, Limited, the principal producer of placer gold, operated six dredges, all in the Klondike area. Clear Creek Placers, Limited operated a dredge on Clear Creek and was constructing a dredge on Thistle Creek. Yukon Gold Placers, Limited completed the installation of a dredge on Henderson Creek. Yukon Explorations, Limited commenced operating a new dredge in the Sixtymile area. Burwash Mining Company, Limited and Kluane Dredging Company, Limited carried out operations in the Whitehorse area. Development work was done on Ballaret, Britannia, and Canadian Creeks. Small placer operations were carried out in the Mayo area on Dublin and Haggart Creeks.

Smaller operations in the Whitehorse area were carried out on Shorty and Bullion Creeks.

Prospecting and development work was done by various companies, the main being Brown-McDade Mines, Limited, on its property in the Whitehorse area, and Conwest Exploration Company, Limited, Bralorne Mines, Limited, Noranda Mines, Limited, and Hudson Bay Exploration and Development Company, Limited, in various sections of Yukon.

Northwest Territories

Production of gold was almost three times greater in 1947 than in 1946. It came from the Con, Rycon, Negus, and Thompson-Lundmark mines near Yellowknife on the north shore of Great Slave Lake. Thompson-Lundmark resumed production during the latter part of the year with the pouring of a brick on September 20 after a shut-down since September 1943.

Notes on Development Work

British Columbia

United Mining and Dredging Company of California did drilling and test work in the valley of Willow River, Cariboo district. Silver Standard Mines, Limited, in the Omineca mining district, was planning to build a 75-ton mill. Major development work was done by: Privateer Mines, Limited, in the Zeballos area, Vancouver Island; Moccasin Mines, Limited, on placer ground on McDame Creek, in Cassiar district; Morris Summit Gold Mines, Limited, on Princess Royal Island; Spud Valley Gold Mines, Limited, near Zeballos, Vancouver Island, and Cangold Mining and Exploration Company, Limited, on Vancouver Island.

Manitoba

Chief interest in 1947 was centred in developments of Howe Sound Exploration Company's Nor-Acme property at Snow Lake in the Herb Lake mining division. Construction of most of its mine buildings was completed and much of the equipment was installed. A 2,000-ton daily capacity mill was in course of erection.

Wekusko Consolidated, Limited was doing underground exploration work on the Ferro property on the east side of Herb Lake. The Jeep mine, 10 miles northwest of the San Antonio property, was being prepared for production by San Antonio Gold Mines, Limited.

Ogama-Rockland Gold Mines, Limited sunk a shaft to a depth of 775 feet on its property at Long Lake in southeastern Manitoba.

Northwest Territories

Plans for bringing the property of Giant Yellowknife Gold Mines into initial production in 1948 were well advanced. Full-scale production awaited completion of the Dominion Government's hydro-electric plant on Snare River, which was scheduled for October 1948. The crushing plant will have a capacity sufficient for a 1,500- to 2,000-tons per day milling operation, which is aimed at eventually. The Snare River development will supply the power to other mines in the Yellowknife area and will have an initial capacity of 8,000 horsepower.

Drilling done by Akaitcho Yellowknife Gold Mines, Limited, on its property that adjoins Giant Yellowknife on the north, outlined an orebody of sufficient size to warrant proceeding with underground development.

Discovery Yellowknife, in the Quyta-Giauque Lake area, was planning to build a mill with an initial rate of 100 tons a day.

The Indin Lake area was active.

Exploratory work was under way on the various properties in the Gordon Lake area.

Ontario

Naybob (1945) Gold Mines, Limited, in the Porcupine area, was preparing to resume milling in the near future at the rate of 100 tons daily after being closed for 4 years.

In the Groundhog River area, Sudbury district, Joburke mine completed a shaft to a depth of 400 feet and planned to do development work on two levels.

Central Porcupine mine, adjoining the Coniaurum mine, was exploring its property as a result of information made available by Coniaurum.

Campbell Red Lake Mines, Balmer township, Red Lake area, made financial arrangements with Dome Mines, Limited, for a mill and for plant expansion.

Dickenson Red Lake mine, Balmer township, outlined several sizeable orebodies in an effort to develop sufficient ore to warrant a mill.

The Starratt Olsen mine, which adjoins the Madsen Red Lake mine in the Red Lake area, was nearing production.

Activity in the entire Red Lake camp was stimulated with the opening of the Red Lake road which connects the area to the Trans-Canada Highway.

Quebec

Diamond drilling and in most cases, shaft sinking and underground work, was under way at a number of prospects and prospective producers in the Rouyn area, among these being Lake Wasa, Quemont, Macdonald, Anglo-Rouyn, Donalda, Eldona, Joliet-Quebec, Rouyn Merger, and Hosco properties. In the Bourlamaque area extensive development work was done on the Bevcourt, Buffadison, Aumaque, Formaque, Croinor Pershing, Regcourt, and Lapaska properties.

In the Opawica-Bachelor Lake area, Dome Exploration (Quebec), Limited and O'Brien Gold Mines, Limited were exploring recently discovered zinc-silver occurrences containing values in gold.

IRON ORE

Production of iron ore again expanded in 1947. Shipments from the two operating mines, Helen and Steep Rock, in Ontario, totalled 1,713,720 long tons, a gain of 24 per cent over 1946. About 10 per cent of this was used in Canadian furnaces and the rest was exported to the United States. Since the Canadian ores, as shipped, are all high in grade and thus high in price, it is more profitable for the Canadian blast-furnace operators to use only a proportion of the Canadian ores and to purchase ores of lower grade from the United States which, mixed with the Canadian ores, give the most advantageous furnace burden. As high-grade iron ore is much in demand in the United States, this exchange of ores across the border is of advantage to both countries.

Shipments of Canadian Iron Ore, 1947

	Long tons
Michipicoten-Helen mine	507,472
Steep Rock mine	1,206,248
Total Canadian shipments	1,713,720

Output from the Helen mine is capable of a moderate increase, and there are other deposits of siderite in Michipicoten that might be put into production.

Steep Rock has a potential capacity of 3,000,000 tons a year some years from now, if the "A" deposit is put into full production.

Drilling of the iron ore field in the Labrador-Quebec boundary area has now proved a very large tonnage of hematite and it is planned to continue the development vigorously. Thus, the Canadian output of high-grade iron ore can be expected to expand considerably during the next few years.

Principal Canadian Sources of Supply

Until the Ungava-Labrador field commences shipments, the production of iron ore in Canada is likely to be confined to the two Ontario districts, namely, Michipicoten, northeast of Lake Superior, and Steep Rock, 150 miles west of Port Arthur. No work was done during 1947 on the magnetic deposits in British Columbia or in southeastern Ontario, except for a survey by airborne magnetometer south of Renfrew in the latter area.

Algoma Ore Properties, Limited. This company is a wholly-owned subsidiary of Algoma Steel Corporation, Limited. During 1947 the Victoria open pit of the Helen mine provided all the siderite mined. A part of this was sent direct to the sintering plant at Wawa, 3 miles distant. The larger part was treated in the sink-float plant at the mine to reduce the silica content. A total of 507,472 long tons of sinter was shipped to Canadian and United States furnaces.

By the end of 1947 preparations for underground mining of the Helen orebody were well advanced. Two levels are being developed at depths of 300 feet and 600 feet, respectively, beneath the bottom of the open pits. This section of the Helen deposit is expected to furnish 10,000,000 tons of ore, which is sufficient to feed the sinter plant for 10 years. The shaft from which the development is being done will be used only for servicing the mine. The ore, after passing through a primary crusher below the lower level, will be brought to surface at the present secondary crushing plant by a series of belt conveyers of 3,000 feet combined length. Below and beyond the two levels now under development there is a further large tonnage of ore proven by diamond drilling, the total indicated being over 100,000,000 tons.

The steel plant of Algoma Steel Corporation, Limited at Sault Ste. Marie formerly obtained its supply of lump ore for the open-hearth furnaces from the Josephine mine of Michipicoten Iron Mines, Limited. Production from this mine ceased when it was flooded by caving in September 1946, and no steps have been taken as yet to reopen it. Meantime, Algoma Ore Properties, Limited has made at its plant at Wawa a heavy sinter that is being used successfully in place of natural lump ore. This sinter is made from a mixture of Josephine hematite fines and mill scale.

Typical analyses of Helen siderite and sinter (the latter representing the 1946 shipments) are as follows:

Algoma Siderite and Sinter

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

* 54·00 per cent iron plus manganese.

Other Deposits. Additional drilling of the Bartlett siderite deposit, of Algoma Ore Properties, 9 miles northeast of the Helen mine, has shown that its grade is higher in both iron and manganese than the Helen ore; that this grade persists for a length of 4,000 feet; and that the ore becomes wider with depth. A drill-hole that intersects the ore at 2,400 feet depth has shown the same good grade and a width about double the width at surface. It is, therefore, possible that the Bartlett deposit will in due course augment substantially the supply of siderite from the Helen mine.

There is a somewhat similar deposit of siderite, also held by Algoma Ore Properties, on the Johnson Location, east of the Helen, which at present is undeveloped.

The Goulais magnetite deposits of Algoma Ore Properties, 60 miles northeast of Sault Ste. Marie, were not developed further during 1947. Over 100,000,000 tons of concentrating ore averaging 30 per cent iron has been outlined by drilling.

Two other large deposits of siderite are known, both held at present by Frobisher, Limited and Sherritt Gordon Mines, Limited, and under option to Jones and Laughlin Steel Corporation. These are on the Ruth and the Lucy properties, between the Helen mine and the Bartlett. A substantial tonnage of ore has been outlined by drilling on the Ruth deposit, and the Lucy deposit was being drilled during the latter part of 1947.

Steep Rock Iron Mines, Limited—Steep Rock Mine. The 1947 shipments of Steep Rock ores, 1,206,248 long tons, showed an increase of 45 per cent over the 1946 shipments of 830,481 tons. It is expected that the "B" open pit, from which all the present production is obtained, will maintain an annual output of a million tons or more for about 10 years to come. The "B" open pit has been confined so far to a length of 1,600 feet, which is to be extended during 1948 to 2,000 feet. The known length of this deposit is over 4,000 feet, open at both ends.

The "B" ore deposit stands near the vertical, and has been proved by drilling to a considerable depth. It is intended to prepare it for underground mining well before the open pit ore is exhausted, so that the annual output of 1,000,000 tons or more may be maintained throughout.

Further development drilling on "A" orebody, 1½ miles north of "B", was done during 1947 and more of the lake water overlying it was pumped out. There remains a cover of silt and clay above the ore, which will require about 2 years to remove. "A" orebody is expected to provide at least 2,000,000 tons a year of ore somewhat higher in grade than that from "B" when the open pit is in full operation, and there is evidence that the proportion of lump ore will be greater than from "B" pit.

Initial drilling of the 6,000 feet of ground between the "A" and "B" deposits, as noted above, indicates that a substantial quantity of ore will be developed there.

Steep Rock ore is separated by screening and blending into three grades, as illustrated in the following table:

Steep Rock Shipments, 1947

	Long tons	Iron	Phos-phorus	Silica	Manga-nese	Alu-mina	Sulphur	Moisture	Natural iron
From Dock									
Steep Rock	56,671	59·09	0·026	6·02	0·16	1·04	0·026	5·95	55·574
Seine River	788,570	57·77	0·028	6·97	0·19	1·52	0·039	10·40	51·762
Rainy Lake	356,566	56·27	0·028	9·04	0·21	1·75	0·047	10·40	50·418
Total	1,201,807	57·39	0·028	7·54	0·19	1·57	0·041	10·19	51·542
All-Rail									
Steep Rock	4,384	60·26	0·028	4·98	0·14	0·91	0·022	5·46	56·970
Seine River	Nil	....	....	....	....	....	....	....	....
Rainy Lake	57	56·98	0·025	6·71	0·21	1·44	0·092	7·60	52·649
Total Shipped	1,206,248	57·40	0·028	7·53	0·19	1·57	0·041	10·17	51·562

A small part only of the Steep Rock ores is used by Canadian furnaces, the larger part being exported to the United States. The Cleveland-Cliffs Iron Company is sales agent.

Labrador and New Quebec

Two subsidiaries of Hollinger Consolidated Gold Mines, Limited, namely, Labrador Mining and Exploration Company, Limited and Hollinger North Shore Exploration, Limited, hold concessions in Labrador and Quebec, respectively. These concessions cover part of an iron-bearing formation 300 miles or more in length. On the concessions is a continuous iron range of 200 miles known length. Within this range twenty or more separate deposits of hematite have been found so far, all of considerable size and some of very large size.

During 1947, an airport was established, and 100 miles or more of roads were constructed. Drilling, which was concentrated in the central 50 miles of the range astride the boundary, has now proved approximately half the 300,000,000 tons of high-grade ore required to warrant railway construction. Two adits and a winze totalling several hundred feet were opened in two of the larger orebodies, to determine definitely the physical nature of the ore.

The underground openings, in conjunction with material obtained from drill-holes, show that the Labrador-New Quebec ores are essentially similar in nature to those of the Mesabi range in Minnesota. This implies that the ore can be loaded directly into railway cars by power-shovels. Probably a little drilling and blasting will be required to loosen the ore.

Ore proven at the end of 1947 was as follows (dry analysis):

Labrador:

Long tons	Class	% Fe	% Mn	% P	% SiO_2
13,964,000	Bessemer	62·7	0·21	0·030	8·11
20,996,000	Non-Bessemer	59·5	0·66	0·145	4·92
6,166,000	Manganiferous	50·4	8·14	0·174	5·61
41,126,000					

Quebec:

Long tons	Class	% Fe	% Mn	% P	% SiO_2
47,117,000	Bessemer	61·9	0·44	0·030	6·85
40,464,000	Non-Bessemer	57·6	0·59	0·106	7·80
11,111,000	Manganiferous	52·1	6·85	0·121	6·23
98,692,000					

A railway 350 miles in length and a port on the Gulf of St. Lawrence will be required to exploit this iron ore field. A satisfactory route was located for the larger part of this distance during the summer of 1947; and a railway charter has been granted by the Dominion Government. Surveys of possible port sites were made. Shipments during most of the winter are assured, and it is hoped that a site can be chosen that will permit vessels to be loaded the year round.

Both companies conducting this development are controlled by Hollinger Consolidated Gold Mines, Limited. The M.A. Hanna Company of Cleveland, Ohio, has a minority interest.

Production and Trade

During the eighteenth and nineteenth centuries the primitive iron furnaces scattered across Eastern Canada supplied much of the local needs. These were fed with ore from small deposits close at hand and used charcoal as fuel. With the establishment of blast furnaces and steel plants on the modern scale, early in the present century, only the Helen and Magpie mines in Michipicoten, Ontario, were found suitable to meet the changing need. From 1923 to 1938 there was no production of iron ore in Canada. The following table indicates how rapidly the output has increased since 1939.

Shipments of Canadian Iron Ore, 1939-1947

(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
1947	508	....	1,206	1,714

The output from the mines in Ontario is now not far below the tonnage required for the furnaces in the province, though, as mentioned above, most of it is exchanged for ores from the United States. This comparative equilibrium is likely to remain until the second open pit at Steep Rock mine comes into production, or until additional sintering capacity is installed in Michipicoten to treat siderite. It is possible that within a few years the Ontario mines will have a substantial surplus of iron ore for export, above the tonnage required for the Canadian furnaces in their territory.

Dominion Steel and Coal Corporation's steel plant at Sydney, Nova Scotia, is served mainly from the company's own iron ore mines at Wabana, Newfoundland. As the Wabana ore is rather high in silica, high-grade ore is brought from overseas for use as lump ore in the open-hearths. No doubt, Labrador hematite will be used to advantage in Sydney when it becomes available.

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

Canadian Iron Ore Production, Exports and Imports

(Long tons)

Canadian ore			Imports			
—	Used in Canada	Exported to United States	From United States	From Newfoundland	From other countries	Total ore used in Canada
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
1945	324,954	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	2,426,325
1947	151,241	1,562,479	2,791,345	674,654	55,921	3,673,161

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 from that region.

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
1946	58,975,000	51·32	8·83	11·22

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 plants now being established at the east end of the Mesabi range to treat taconite for the production of sinter will also help to keep up the average grade.

The Wabana iron ore mines in Newfoundland are capable of producing a much larger annual tonnage than at present, and the cost of mining and transportation is low. The ore is rather high in silica, however, and the high phosphorus content restricts its more general use on this Continent.

Wabana Hematite
Typical Analysis

	Per cent
Iron (dry)	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. This ore is used at Sydney, Nova Scotia.

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 (British South Africa)
1942	....	....	47,722	3,292 (Mexico)
1943	....	....	14,800	....
1944	....	....	....	....
1945	....	13,126	....	....
1946	....	38,339	30,300	....
1947	....	....	55,904	

Swedish ore is again available in considerable amounts for overseas shipment. Formerly, over 60 per cent went to Germany, where little will be required for some time. This will probably ensure an adequate supply for the British furnaces, which formerly used about 20 per cent of the Swedish output, and for other customers, and will provide competition in Europe for the ore of Labrador when it becomes available. The bulk of the Swedish ore is magnetite from the Kiruna deposits in Lapland.

Kiruna Iron Ore

Typical Analyses of Magnetite Concentrates

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

The principal Brazilian iron ore at present available for export is from Itabira in the province of Minas Geraes. The deposits are 350 miles westward from the port of Victoria and are served at present by a narrow-gauge railway, the cost of transport being high. 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 exposed so far 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

Canadian Plants Using Iron Ores

Almost all the iron ore used in Canada goes through the blast furnaces and open-hearth furnaces of the four companies listed below.

Blast Furnace Plants in Canada

(Net tons)

—	Blast furnaces		Open-hearths	
	Number	Annual capacity	Number	Annual capacity
Dominion Steel & Coal Corp., Sydney, Nova Scotia	4	730,000	15	745,000
Algoma Steel Corporation, Sault Ste. Marie, Ont.	5	1,035,000	12	610,000
Canadian Furnace, Ltd., Port Colborne, Ont.	2	221,760	....	....
Steel Company of Canada, Hamilton, Ont.	3	757,000	13	1,145,000
Totals	14	2,743,760	40	2,500,000

A small tonnage of lump ore is required by several other steel companies that make steel from scrap in small open-hearth furnaces.

During the year the scarcity of scrap induced St. Lawrence Metals and Alloys, Ltd., at Beauharnois, Quebec, to use iron ore as a substitute for scrap in the manufacture of ferrosilicon.

LEAD

Canada's production of 161,668 tons of lead was lower than in 1946, but the value was almost double and was the highest on record. The Consolidated Mining and Smelting Company of Canada, Limited, one of the world's largest producers of lead and zinc, continued to supply more than 95 per cent of the Canadian output. A strong demand for lead in Canada and abroad continued throughout the year. The increased prices of metals stimulated a revival of base-metal mining and several former producing mines were reopened, and operations were expanded at others.

Principal Canadian Sources of Supply

Consolidated Smelters owns and operates the Sullivan mine and concentrator of 8,600-ton a day capacity, both located near Kimberley, British Columbia, and extensive smelting and refining works at Trail in that province. At the Sullivan mine, production was slightly less than in 1946, but much development was done on projects designed to simplify future mining operations and to enable lower grade portions of the orebody to be worked profitably. A new 4-mile haulage way, including 2 miles of tunnel, will connect the mine directly to the concentrator and eliminate the present system whereby the crushed ore is transported by railway. A sink-float plant was being installed at the concentrator to eliminate coarse waste material which will be returned to the mine for use as back fill. The completion of these projects, together with the adoption of a more efficient stoping system on the lower levels, and the installation of an underground crushing unit, should enable production to be increased from the present rate of 8,600 tons to 11,000 tons a day. The grade of the ore at the Sullivan mine is about 7 per cent lead and 6 per cent zinc, with recoverable values in silver, gold, antimony, bismuth, cadmium, tin, and other metals. Ore reserve is estimated to be sufficient to maintain the 1947 production rate for at least 20 years.

Other lead production in British Columbia came from a number of smaller silver-lead-zinc operations, most of which shipped ore or concentrate to the Trail smelter. Among the more important of these were Ainsmore Consolidated Mines, Limited, operating the Kootenay Florence mine at Ainsworth, Western Exploration Company, Limited, operating the Standard and Enterprise mines in the Slocan district; Santiago Mines, Limited, which reopened its Bosun mine in the Slocan area; and Highland Bell, Limited, which produced some lead from its high-grade silver mine at Beaverdell. Silver Giant Mines, Limited shipped lead ore that had been stockpiled at its mine near Golden, and acquired equipment to commence production from the mine in 1948. Base Metal Mining Corporation, which had been inactive since July 1946, resumed production of zinc concentrate from its Kicking Horse mine in September, and lead concentrate from its Monarch mine in November, both properties being at Field. Silbak Premier Mines, Limited produced some lead from its gold-silver-lead property in the Portland Canal district.

Reeves MacDonald Mines, Limited, near Trail, disclosed a large zinc-lead deposit by underground development and drilling. Production at the rate of 1,000 tons a day is planned.

In Ontario, some lead was contained in concentrate exported by Berens River Mines, Limited from its gold-silver-lead mine near Favourable Lake in the northwestern part of the province.

In Quebec, lead concentrate was produced from the silver-zinc-lead deposits of New Calumet Mines, Limited on Calumet Island in the Ottawa River, and of Golden Manitou Mines, Limited near Val d'Or. Candego Mines, Limited erected a 50-ton mill on its property in Gaspé peninsula and was planning to commence production of zinc and lead concentrates early in 1948. Dome Exploration (Quebec), Limited made a discovery of high-grade silver-zinc ore containing some lead and gold during the summer in the Bachelor Lake area, about 100 miles northeast of Senneterre. Exploration of this deposit by drilling was proceeding. The lead discovery made by Mistassini Explorations, Limited near Mistassini Lake in 1946 was drilled, but results were reported as inconclusive. Gulf Lead Mines, Limited transported a large quantity of equipment, including diamond drills, to its lead property at Richmond Gulf on the east coast of Hudson Bay in preparation for extensive exploration in 1948.

In Yukon, lead production came from the rich silver-lead ores of the Mayo area, where Keno Hill Mining Company reopened the properties formerly operated by Treadwell Yukon Company. Low water in the Stewart River during the summer prevented the shipment of a considerable part of the concentrate produced. In the same area a small production resulted from development work carried out by Mayo Mines, Limited. In the Wheaton River area exploration of a rich silver-lead-zinc discovery was reported.

Production and Trade

Canada produced 161,668 short tons of lead valued at $44,200,124 in 1947, compared with 176,986 tons valued at $23,893,230 in 1946. British Columbia contributed 97 per cent of the output.

Exports of pig lead amounted to 124,965 tons valued at $29,098,727, compared with 104,109 tons valued at 15,977,709 in 1946. Forty-seven per cent of the tonnage of pig lead exported went to the United States, 35 per cent to the United Kingdom, and 12 per cent to European countries. Lead exported in ores and concentrate amounted to 6,726 tons valued at $1,601,583, compared with 6,006 tons valued at $736,933 in 1946. About one-half of the lead concentrate exported went to Belgium and the remainder to smelters in the United States.

Imports of lead and lead products were valued at $4,650,451, of which the value of tetraethyl compounds imported from the United States amounted to $4,302,110. In 1946 the value of imported lead and lead products was $4,531,051.

Consumption of pig lead in Canada in the principal uses in 1946 and 1947 are shown in the following table:

—	1946	1947
	Tons	Tons
Solders and alloys	27,329	25,806
Storage batteries	8,472	8,489
Ammunition	262	349
Wire coating and cable covering	9,267	12,624
Hot dipping and annealing	2,034	1,921
Paints and pigments	12,183	10,369
Foil and collapsible tubes	1,708	813
Miscellaneous	1,529	995
Total	62,784	61,366

Prior to World War II Canada used about 26,000 tons of refined lead annually. The increase in post-war consumption has chiefly been in the white metal alloys field, although marked increases have also taken place in other uses.

In the United States, lead consumption in 1947 reached a peak estimated at 1,172,000 tons, almost one-third of which went into storage batteries. In the United Kingdom, where cable covering is the largest outlet, total consumption amounted to 317,000 tons.

Complete figures on the post-war world production of lead are not available, but output continues to be short of the requirements. Production from known sources in 1947 was about 1,251,300 tons. In 1939, world production was estimated to be 1,890,000 tons, the principal producing countries in order of importance being: United States, Australia, Mexico, Germany, Canada, and Russia. United States production of new lead in 1947 is estimated to have been about 375,267 tons, and 504,000 tons were produced for lead scrap. To meet its requirements the United States imported 226,199 tons, 70 per cent of which was refined lead.

There were no reports of major discoveries in 1947, but in the United States and in several African countries deposits were being developed that may yield substantial new production in coming years.

Uses

Few, if any, metals have a wider variety of uses than has lead. A large part of all lead used goes into the manufacture of the many chemical products of which lead is an essential component. The more important of these products are white lead, red lead, litharge and tetraethyl lead. The last named, which is added to gasoline as an anti-knock compound, contains 45 to 60 per cent lead and has become an increasingly large outlet. In recent years the use of lead in storage batteries has become a principal outlet and accounts for about 25 per cent of all lead consumed. Owing to its resistance to corrosion, lead is used extensively for roofing, cable sheathing, lining acid tanks in electrolytic refining, and for lining apparatus in the chemical industry. Other uses include ammunition, plumbing, caulking, foil for packaging, and as a constituent of bearing metals, solder, leaded bronze, and type metal. The development of atomic energy may create an important new use for lead, as large tonnages will probably be required for protection of personnel against radiation.

Lead is completely dissipated in such uses as in paints, ammunition, and tetraethyl compound. However, large tonnages of secondary lead are recovered from batteries, cable covering, sheets, etc.

Prices

In Canada, the controlled price of 5 cents a pound, which had been in effect during the war, was increased on January 22, 1947, to 10·625 cents. When price controls on copper, lead, and zinc were discontinued on June 9, 1947, the price of lead increased to 14·25 cents, where it remained the rest of the year. The average Canadian price, including the value of lead exported in concentrates, was 13·67 cents a pound.

In the United States the quoted price increased from 12·55 cents in January to 15·00 cents in March, where it remained the rest of the year. In the United Kingdom the price of lead in December was £90 a long ton or 16·20 cents a pound at the official rate of exchange.

MAGNESIUM

The only producer of magnesium in Canada in 1947 was Aluminum Company of Canada, Limited, at Arvida, Quebec. This company announced the opening of its electrolytic magnesium plant which has a rated capacity of 1,000 tons of metal per year. The raw material is magnesia obtained from brucitic limestone at its plant at Wakefield, Quebec. Dominion Magnesium, Limited, Haley, Ontario, shipped magnesium from stock and also made and shipped various magnesium alloys, but produced no magnesium metal during 1947. Magnesium foundries operating during 1947 were: Light Alloys, Limited, Renfrew, Ontario; Robert Mitchell Company, Limited, Montreal; and Western Magnesium, Limited, Vancouver. The large magnesium foundry of Aluminum Company of Canada, Limited, at Etobicoke, Ontario, was not in operation in 1947. A new company, Canadian Magnesium Products, Limited, proposes to operate a foundry at Preston, Ontario.

Interesting developments in new alloys, in fabrication, and in protecting the metal from corrosion are steadily improving the prospects for a greater use of magnesium in the near future. Among these is the development of a zirconium-zinc-magnesium alloy in England that has higher compressive and tensile strength and is easier to fabricate than other alloys made to date. It is claimed that this alloy can be rolled, extruded, and forged in equipment used for the fabrication of steel. Lithium-magnesium alloys with excellent properties are also being developed, and Dow Chemical Company has evolved a process of plating magnesium with chrome to prevent corrosion.

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 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 of 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 sillicate of magnesium, contains 25·8 per cent of 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, Trade, and Uses

Data on production, exports, and imports are not available for publication.

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 have been developed such as for the cathodic protection of underground pipelines and also of domestic hot-water tanks from corrosion. It is also used as a minor constituent of many aluminium-base alloys.

The price during most of 1947 for 99·8 per cent magnesium in ingot form in carload lots was 20½ cents per pound, United States currency, f.o.b. New York, but from December 1, 1947 the metal has been priced f.o.b. the point of manufacture at Freeport, Texas.

MANGANESE

Known deposits of high-grade manganese ore in Canada are small and are almost depleted. Thus the Dominion is almost entirely dependent upon imports to meet its requirements. Except for a small output of bog manganese from New Brunswick in 1947, all manganese properties in Canada have been inactive since 1943. This output of bog ore was excavated by Seaboard Chemical Company from the Singleton, Close, and Donovan deposits near Renous, Northumberland county. The company, formed by New Brunswick Resources Development Board, Fredericton, shipped about 500 tons of bog manganese to its plant at St. Stephen, which was in operation by the end of the year and where some manganese sulphate and other manganese chemicals were produced.

In Quebec, Quebec Manganese Mines, Limited, Montreal, is reported to have done some stripping, drilling, and open-cut work on a deposit on Grindstone Island in the Magdalen Islands, and to have mined some ore. No shipments were made except for test purposes.

Canada imported 223,503 tons of manganese ore in 1947; of which 109,903 tons came from Gold Coast, Africa; 100,889 tons from the United States, most of which was originally imported from other countries; and the remainder from India. Imports of manganese ore in 1946 amounted to 144,023 tons, all from Gold Coast.

The Canadian consumption of metallurgical grade ore in 1947 is estimated at 219,000 tons, compared with 139,200 tons in 1946. From this grade of ore Canada produces manganese alloys, including, ferromanganese, spiegeleisen, silico-spiegel, silicomanganese, and silicomanganese briquettes. This production reached 108,041 tons in 1947, the three producers being: Electro Metallurgical Company of Canada, Limited, Welland, Ontario; St. Lawrence Alloys and Metals, Limited, Beauharnois, Quebec; and Canadian Furnace, Limited, Port Colborne, Ontario. Production of these alloys in 1946 amounted to 64,886 tons. Exports of ferromanganese in 1947 amounted to 73,421 tons, of which 95 per cent went to United States; and of spiegeleisen to 837 tons, of which 67 per cent went to the United Kingdom. In 1946, the exports of ferromanganese amounted to 32,486 tons, and of spiegeleisen to 887 tons. Export figures for the other manganese alloys for 1947 are not available.

The Canadian consumption of battery-grade ore as reported by consumers was about 3,237 tons, compared with 4,823 tons in 1946.

Figures for world production of manganese ore for recent years are incomplete. In 1945, according to the available figures, Russia was far in the lead with an estimated output of 2,251,000 metric tons; Gold Coast was second with 460,000 tons (721,400 tons in 1946) and was followed by Brazil with 244,600 tons (export); Cuba with 198,000 tons (50,400 tons in 1947); continental United States with 165,400 tons (shipments); and British India with 213,600 metric tons.

Output in the United States in 1947 was 131,627 tons. It came mainly from the nodulizing plant of Anaconda Copper Company, Anaconda, Montana.

Uses

The most important use of high-grade manganese ore is in the manufacture of ferro-manganese which is essential for the deoxidizing and desulphurizing of steel. Large quantities are used to make dry batteries. After conversion into various chemical compounds, manganese finds use in the glass, enamel, paint, pigment, and rubber industries. It is used in medicinal preparations; in the compounding of certain kinds of fertilizers; in leather processing; and in purifying illuminating gas.

MERCURY

No mercury has been produced in Canada since September 1944, and all shipments since then have been from producers' stocks. Most of the Canadian production in the past came from the Pinchi mine of The Consolidated Mining and Smelting Company of Canada, Limited, and the remainder from the Takla mine of Bralorne Mines, Limited. Both mines are in Omineca mining division, British Columbia. The mines have remained idle because world prices have been too low to enable profitable operation. The world surplus of the metal caused a further weakness in the price of mercury in 1947, the average being 15 per cent lower than in 1946. The Pinchi mine was the largest single source of mercury in the Western Hemisphere and its reserves and those of the other deposits in British Columbia are sufficient for many years of operation at the peak rate of Canadian production in 1943, should this become necessary.

There was a marked increase in imports of mercury in 1947, this being the result of the installation of mercury cells for use in a new plant erected for the manufacture of caustic soda. Only about 100 flasks of mercury a year will be needed, however, to compensate for mercury losses in the cells.

Production and Trade

Exports were 225 flasks valued at $22,205, most of which went to Czechoslovakia, and the remainder to Yugoslavia and British Guiana. In 1946 exports amounted to 750 flasks.

Imports in 1947 were 5,430 flasks valued at $400,156, the bulk of which came from the United States and the remainder from Italy and Mexico. Imports in 1946 were 2,010 flasks.

Italy is the chief producer of mercury and is followed in order by Spain, the United States, and Mexico. Varying smaller amounts are produced in China, Chile, Russia, Czechoslovakia, South Africa, and Japan. In Italy, the principal mines are in Tuscany, and most of the output comes from the Amiata mine. In Spain, 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. One recent estimate gives reserves at the Almaden mine as being sufficient for a production of 80,000 flasks annually for the next 200 years. In the United States, the New Idria mine, California, continued to be the largest producer, with about 40 per cent of the total output. In Mexico, most of the output is exported to the United States, and some to Canada.

Uses

Quite apart from the aforementioned large quantity of mercury used in the caustic soda plant, Canadian consumption in 1947 was almost double that of 1946 and amounted to 2,646 flasks. 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, one of the most important outlets for mercury is in the mercury dry cell, developed during the war. According to the United States Bureau of Mines, no other known uses hold equal promise for large-scale gains in consumption of the metal in that country, the low price for the metal being a stimulant in this direction. The battery is not made in Canada.

A comparatively recent development is the reported use of a mercury clutch for fire-engine pumps, helicopters, and for the electric motors of refrigerator equipment, washing machines, etc.

In Germany, a considerable amount of mercury was used 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, and, as noted elsewhere, a large plant of this type was installed in Canada in 1947. The erection of units in other caustic soda plants is contemplated.

Prices

Prices fell during 1947 from $88 to $79 a flask. Mercurio Europeo dropped the cartel price in August 1947, to $60 a flask at Spanish and Italian ports, and London prices were similarly reduced.

MOLYBDENUM

The LaCorne mine of Molybdenite Corporation of Canada, Limited, in LaCorne township, Quebec, was again the only Canadian producer of molybdenite. The company, however, suspended mining operations on December 1, 1947. As there are no plants in Canada to convert the concentrate into addition agents, all shipments went to Europe.

The LaCorne mine has been developed to a depth of 550 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. The ore contains bismuth and in 1946 a process was developed by the Bureau of Mines, Ottawa, that not only freed the concentrate of this metal, but also raised the molybdenum content of the concentrate, and this content was probably higher than that of any other concentrate produced in the world. The bismuth was saved as a by-product, for which purpose a unit was installed. Ore reserve at the end of 1947 was estimated at 130,000 tons of about 0·5 per cent MoS_2.

The Indian Peninsular mine in the same area was closed in 1944.

Production and Trade

Molybdenite Corporation treated 83,665 tons of molybdenite ore from which it obtained 399 tons of concentrate averaging 93·86 per cent MoS_2 and 0·5 per cent bismuth. Shipments amounted to 396 dry tons of concentrate containing 380 tons of MoS_2. The value of shipments was $309,048. In 1946 the shipments contained 368 tons of MoS_2 and were valued at $295,640.

Canada imports all the molybdenum addition agents it uses from the United States through Climax Molybdenum Company, the distributor for Canada being Railway and Power Engineering Company, Toronto. Imports of these addition agents in 1947 had a molybdenum content of 90 tons, of which 59 per cent was in molybdenum trioxide, 36 per cent in ferromolybdenum, 3 per cent in calcium molybdate, and 2 per cent in sodium molybdate.

Consumption of ferromolybdenum, molybdenum trioxide, and calcium molybdate in Canadian steel furnaces in 1947 reached a total of 168 tons, compared with 220 tons in 1946. These compounds are used by about ten Canadian iron and steel manufacturers, but most of the tonnage is consumed by Atlas Steels, Limited, Welland, Ontario, and Steel Company of Canada, Hamilton, Ontario.

The United States is by far the leading producer of molybdenum, Mexico and Chile being the next largest producers from which statistics are available. Climax Molybdenum Company, Climax, Colorada, was for 23 years ended 1946 the world's largest producer, but in 1947 was exceeded by Kennecott Copper Corporation. Since 1936 this company has recovered the molybdenite as a by-product of copper at its Arthur and Magna concentrators in Utah. Molybdenite is also recovered as a by-product of other copper producers in Arizona, Nevada, and New Mexico. Climax, and Molybdenum Corporation at Questa, New Mexico, operate solely for molybdenite; at the United States Vanadium Corporation Mine at Bishop, California, it is recovered as a by-product of tungsten production.

In 1947 the United States produced 12,268 metric tons of molybdenum contained in concentrates, a 48 per cent increase over that of 1946.

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 that 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 incandescent lamp and in the radio industries; and new alloys suitable for electrical resistance and contacts and for heating elements contain molybdenum. An appreciable amount of molybdenum is used in the glass industry in which heavy sheets of the metal act as electrodes to conduct the current through the molten glass in the electric furnaces.

In the past, molybdenum products were limited because commercial ingots were only up to ¼ inch square and 10 inches long and weighing 4 pounds maximum. By improved methods and technique, ingots of 250 pounds are now being produced so that equipment parts, 7 inches in diameter and 30 inches long, and also sheets 20 by 30 inches can now be made.

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; in 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, maxima 0·2 per cent.

Prices

There is no Canadian market for concentrate as there are no conversion plants, and since July 1945, the only shipments have been to Europe. The price of these shipments in 1947 was 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 was 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 continues to furnish much the larger part of the world's supply of nickel from the mines of the Sudbury district in Ontario. Deposits of nickel-copper ore in northern Manitoba are being developed rapidly and may augment the Sudbury supply in due course. The peace-time market for nickel in the United States and Canada maintained the high level of 1946, which was 50 per cent above that of the best pre-war year. Total production of the Canadian smelters increased 23 per cent above that of 1946. New Caledonia and Petsamo (formerly in Finland, now in Russia) are now the only important commercial sources of nickel outside Canada, unless there are new deposits in the interior of Russia of which there is no public knowledge.

Principal Canadian Sources of Supply

The production of nickel in all forms in 1947 was 118,626 tons, compared with 96,063 tons in 1946. It came, as in previous years, from the five mines of International Nickel and a single mine of Falconbridge Nickel in the Sudbury area, with the exception of a small amount contributed by the smelter at Deloro. Ontario, from ore of the Cobalt district.

International Nickel. The International Nickel Company of Canada, Limited operated the Frood, Garson, Murray, Creighton, and Levack mines throughout the year. The larger part of the ore from these mines was treated in the central concentrator at Copper Cliff. The two concentrates, one containing principally copper and the other mainly nickel, were smelted in the reverberatories of the Copper Cliff smelter and, after further treatment, the crude copper and nickel products were sent to the respective refineries at Copper Cliff and Port Colborne for the production of refined copper and refined nickel.

The new plant at Copper Cliff for separation of nickel and copper by the improved method was in partial operation during 1947. This method gives a clean separation and good recoveries. From the nickel portion there is produced the new commercial form of nickel, namely, nickel oxide sinter, which is expected in due course to be used largely in place of refined nickel for certain important uses. The sinter will also be treated in the refinery at Port Colborne to give pure electrolytic nickel.

The smaller smelter at Coniston also operated throughout the year, using mainly lump ore which is suited to its blast furnaces.

Part of the nickel-copper matte made at the smelters is sent to the refining plant at Clydach, Wales, to be treated by the Mond process, and part is sent for treatment to the company's plant at Huntington, West Virginia. Most of the nickel matte is sent to the nickel refinery at Port Colborne, Ontario.

Development of ore in the five operating mines of International Nickel remains at a normal level. The reserves were 217,142,000 tons containing 6,861,000 tons of nickel-copper at the beginning of 1947, or over 50 years' supply at the present rate. None of the five mines shows signs of exhaustion.

Falconbridge. Falconbridge Nickel Mines, Limited attained its objective for the year, namely, to bring its refinery at Kristiansand in Norway back to its pre-war level of 9,000 tons of nickel and 4,500 tons of copper a year.

The Falconbridge mine and smelter were expanded to produce, during the war years, the maximum possible nickel and copper, which were separated and refined by International Nickel during the German occupation of Norway. The Falconbridge mine output thus reached 12,000 tons of nickel and 6,380 tons of copper in 1944. This was probably in excess of what the mine could be expected to provide over a long term of years.

In order to ensure a full supply of ore for the smelter and of matte for the refinery in the future, the company has commenced to develop new deep levels in the Falconbridge mine and a new mine at the McKim property, adjoining on the east the Murray mine of International Nickel. The company's ore deposit in Levack township remains in reserve.

The present lowest levels of the Falconbridge mine down to 2,800 feet have ore of better than average grade, and there is reason to believe that the new levels below 2,800 feet will continue this good grade. Drilling of the McKim property has indicated an average grade somewhat better than the average of Falconbridge ore. There are thus good grounds for the expectation that the Falconbridge operation will continue on its present profitable basis for many years to come.

Ore reserves at the beginning of 1947 were:

	Tons	Nickel, per cent	Copper, per cent
Falconbridge mine	8,296,500	1·63	0·85
Outside holdings	5,909,000	1·88	1·02
	14,205,500	1·73	0·02

Progress was made during the year in researches and tests with a view to improved smelter and refinery practices.

Lynn Lake (Sherritt Gordon). Development of the new Lynn Lake field, 120 miles north of Sherridon in northern Manitoba, was continued. Sherritt Gordon Mines, Limited made the original discoveries, in ground almost completely covered with soil and muskeg, by means of magnetometric surveys followed by diamond drilling. Up to the present the principal deposits that promise to make mines are on claims staked by Sherritt Gordon. A number of other companies have drilled magnetic anomalies found on their properties around the Sherritt Gordon holdings, but without any marked success so far. International Nickel conducted a survey of the region by airborne magnetometer and has staked an area at some distance from Lynn Lake.

There are now three separate deposits of nickel-copper ore on the Sherritt Gordon ground partly outlined by drilling. At the annual meeting in 1947, the company reported 5,000,000 tons of ore, averaging 1·18 per cent nickel and 0·60 per cent copper. This was principally in "A" orebody, on which a shaft was commenced in 1947, using surplus equipment brought from the Sherritt Gordon copper-zinc mine at Sherridon. During 1947 the "EL" deposit, 2 miles south of "A", was drilled to outline 1,827,000 tons of ore averaging 3·28 per cent nickel and 1·16 per cent copper. Toward the end of the year drilling of the "C" deposit, 600 feet northwest of "A", showed a new orebody, of grade similar to "A", but apparently of somewhat smaller size. Additional deposits have been partly drilled whose content of nickel and copper is below ore grade. One of the low-grade deposits contains copper, zinc, and erratic high gold values.

Permanent camp buildings have been erected. Roads have been constructed connecting the townsite on Lynn Lake with the various deposits. The new camp is served by water-based aeroplanes. Heavy equipment and supplies are brought in during the winter by tractor trains from the railhead at Sherridon.

A 50-ton pilot plant at Sherridon has indicated that separation of the nickel and copper minerals and refining of the two metals will be comparatively simple. It is expected that electrothermic processes will be used, as plenty of potential power is available at Granville Falls on Churchill River, which has been leased to the company by the Manitoba Government.

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.

Surveys by airborne magnetometer were made of the Sudbury district and of some other areas suspected of being nickeliferous.

Production and Trade

The increased production of nickel in 1947 was absorbed mainly in the United States and Canada, though considerably more matte was sent to the refineries in Wales and Norway than during previous years.

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	137,595	67,679,708
1942	142,606	69,998,427	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	96,063	45,385,155	111,939	55,204,632
1947	118,626	70,650,764	117,057	60,442,762

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
1947	39,767	18,292,728	6,535	3,075,068	70,756	39,074,966

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 nickel have a wide distribution, as indicated in the following table.

Nickel Exports

Destinations	1946		1947	
	Tons	Value	Tons	Value
Great Britain	13,886	$5,625,406	26,844	$12,954,143
Norway	9,248	3,311,244	10,402	4,784,874
United States	82,203	41,458,782	74,062	38,808,145
British India	67	26,930	44	32,914
Australia	20	10,414	249	147,657
Austria	....	....	224	153,149
Argentina	139	94,939	104	71,743
Belgium	473	337,219	266	182,839
Brazil	96	69,060	41	27,021
Chile	96	65,270	65	42,716
Czechoslovakia	9	6,596	392	266,561
France	3,305	2,473,571	2,802	1,904,507
Italy	1,173	877,116	30	20,810
Mexico	51	34,295	96	57,884
Netherlands	83	56,440	160	111,402
Sweden	1,050	730,828	1,237	842,340
Others	40	26,522	39	34,057
Total exports	111,939	$55,204,632	117,057	$60,442,762

The Nicaro nickel plant in Cuba was closed early in the year, as it was found uneconomical to operate it under private management.

Shipments of nickel matte from New Caledonia to the refinery at La Havre, France, continued during 1947. Production appears to be still on a small scale, judging by the continued shipments of Canadian nickel to France.

Deposits in Venezuela have been examined by International Nickel, which is making metallurgical tests of the ore.

Discovery of nickel deposits in Celebes Island has been reported.

Uses and Prices

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

Uses of Nickel in United States in 1946

—	Pounds of nickel	Per cent
Ferrous:		
Stainless steels	35,986,164	22·4
Other steels	31,193,998	19·5
Cast irons	5,973,919	3·7
Non-ferrous (comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium, magnesium and aluminium alloys, and Monel, Inconel, and malleable nickel)	51,819,728	32·4
High-temperature and electrical resistance alloys	13,596,601	8·5
Electroplating:		
Anodes	17,059,306	10·7
Solutions	1,542,750	1·0
Catalysts	544,093	·3
Ceramics	387,655	·2
Others	2,106,560	1·3
	160,210,774	100·0

The variety of forms in which nickel is used throughout the world is indicated in the 1946 report of International Nickel.

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

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

In his year-end review of the nickel industry at the end of 1947, the President of International Nickel gave a summary of the present uses. The steel industry remains the largest consumer, mainly accounted for by nickel-chromium stainless steels, the uses of which are expanding rapidly. Nickel-chromium-molybdenum steels for the automotive, construction, railway, tractor and machine tool industries provided the largest single class of alloy steels for those industries. Low alloy, high-strength steels, particularly those containing nickel, continued to gain in favour where a reduction of weight at slight cost is desired.

The use of Monel, Inconel, and other nickel alloys, as well as rolled nickel, continued to expand. Inconel, Nimonic, and other heat-resistant nickel alloys have proved particularly interesting for use in jet engines. Nickel-chromium resistance alloys for heating elements are consuming an increasing tonnage of the metal.

Nickel cast steels, and cast-irons, such as Ni-Resist and Ni-Hard, are growing rapidly in favour. Nickel plating is being used to build up worn parts, and its decorative and protective use continues undiminished.

Nickel prices in Canada, the United States, and Great Britain remained unchanged throughout 1947, having been substantially the same for over 20 years. The price in the United States includes the import duty, and as the recent Geneva trade agreements arranged for a reduction of 1¼ cents a pound in the duty on refined nickel International Nickel announced a like reduction in its prices in the United States, effective on January 1, 1948. The price in Canada remains at 35 cents a pound.

PLATINUM GROUP METALS

Production of platinum group metals in Canada in 1947 declined 14 per cent to 204,902 ounces, compared with 239,337 ounces in 1946. With the exception of a very small amount of platinum from gold placers in Yukon and British Columbia, the production came as a by-product from the nickel-copper mines of the Sudbury area in Ontario. The prices of platinum and ruthenium varied considerably during the year, that of iridium declined, and prices of palladium, osmium, and rhodium were unchanged.

Though no information is available on the production in Russia, the shipments to the United States suggest a substantial output, second in volume only to Canada. South Africa comes third, with smaller amounts from Colombia and the United States. The United States remains 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 1947. The ores of these mines differ considerably in their content of these 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. 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 are recovered as 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 Kristiansand 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 sale of platinum metals during this period was about a million ounces. Thus the ore yielded 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 was no production of platinum during recent years from the placers of the Tulameen River in British Columbia, the nickel-copper-platinum deposits near Hope, nor from the nickel-copper deposits at Shebandowan Lake, 75 miles west of Port Arthur, Ontario, which contain palladium and platinum.

Production and Trade

Though the output of nickel in 1947 was 23 per cent above that of 1946, the by-product platinum metals showed a decline of like dimension. This apparent anomaly is illustrated throughout the accompanying table of annual production. The precious metals accumulate as residues in the electrolytic cells of the nickel and copper refineries. These residues are collected and shipped to the precious metals refineries at infrequent and irregular intervals, thus the official record of output does not reflect precisely the current accumulation in the cells.

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
1947	94,570	5,582,467	110,332	4,387,740

* For 1946 and 1947 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 1947 of platinum metals in all forms except scrap were valued at $11,658,824, compared with $15,409,281 in 1946. Imports in 1947 were valued at $7,565,842, comprising metals valued at $7,406,337 from Great Britain and the remainder mainly from the United States.

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 and imports of refined metals.

Output of United States Refineries in 1946

	Ounces	Per cent
Platinum	92,947	91·0
Palladium	3,858	4·0
Iridium	2,995	3·0
Rhodium	1,396	1·4
Ruthenium	107	0·1
Osmium	475	0·5
	101,778	100·0

Platinum Metals Imported into the United States in 1946

	Ounces	Per cent
Platinum	119,853	36·0
Palladium	187,555	57·0
Iridium	12,402	3·7
Rhodium	525	0·2
Ruthenium	8,894	2·6
Osmium	1,969	0·5
	331,198	100·0

By industries, the amounts in ounces sold in the United States in 1947 (January-September) were:

Industry	Platinum	Palladium	Others	Per cent
Chemical	54,414	3,489	3,738	22
Electrical	20,573	67,742	2,315	33
Dental and medical	5,112	11,891	44	6
Jewellery and decorative	75,580	16,951	8,416	37
Miscellaneous	2,199	59	3,159	2
	157,878	100,132	17,672	100

As an indication of the respective proportions of the platinum group metals supplied to world trade by the British Empire (mainly Canada) and Russia, the following figures from the quarterly reports of the United States Bureau of Mines may be significant. Canadian metals from Norway are included in the British Empire figures.

Imports of Refined Metals into the United States
January-September, 1947

—	British Empire		Russia		All imports
	Fine ounces	Per cent of total	Fine ounces	Per cent of total	Ounces
Platinum	52,043	59	32,667	37	88,869
Palladium	63,764	63	36,664	36	101,063
Iridium	791	22	2,725	78	3,516
Rhodium	785	100	....	....	785
Ruthenium	3,593	100	....	....	3,593
Osmium	506	26	1,412	74	1,918
	121,482	....	73,468	....	199,744

Besides the refined metals noted above, there were 38,924 ounces of unrefined metals imported during the nine months, the larger part of it from Colombia.

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 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 orthodontic appliances (palladium 3 to 24 per cent, platinum 1 to 17 per cent, balance gold and other metals); bases for porcelain restorations (platinum and 5 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 then declined, as did the price of ruthenium. The trend of prices during 1947 is illustrated by the following table, from "Metal and Mineral Markets" at the end of each quarter:

New York Prices, 1947

($ per troy ounce)

—	Jan. 2	Apr. 3	July 3	Oct. 2	Jan. 1, 1948
Platinum	53–56	58–61	53–56	59–62	66–69
Palladium	24	24	24	24	24
Iridium	110	110	80–90	85–90	80–85
Rhodium	125	125	125	125	125
Ruthenium	56	61	56	59–62	66–69
Osmium (nominal)	100	100	100	100	100

A brisk demand for platinum in the world market, and particularly in the United States, stiffened the price towards the end of the year, and seemed likely to continue for at least a part of 1948.

SELENIUM

In Canada a production of selenium is obtained from the refineries of The International Nickel Company of Canada, Limited, Copper Cliff, Ontario, and Canadian Copper Refiners, Limited, Montreal East, Quebec. At Copper Cliff, the metal is derived from International Nickel's copper-nickel ores. The plant has a demonstrated capacity of 270,000 pounds of selenium a year and is probably capable of a larger production. At Montreal East, selenium is recovered from the treatment of copper anodes made from the copper-gold ores of Noranda, Quebec, and from blister copper from the copper-zinc ores of Hudson Bay Mining and Smelting Company, Limited, on the Manitoba-Saskatchewan boundary. The Montreal East plant has an annual rated capacity of 450,000 pounds of selenium, which is larger than any other selenium plant in the world. This plant also produces selenium dioxide, sodium selenate, and sodium selenite.

Production and Trade

Canadian production of selenium in 1947 was 501,090 pounds valued at $937,038, compared with 521,867 pounds valued at $949,798 in 1946. Quebec was the source of 36 per cent of the total output, Ontario 29 per cent, and Manitoba and Saskatchewan 35 per cent. Present production could be increased very considerably to meet a greater demand.

Exports of selenium and selenium salts were 673,588 pounds valued at $1,131,013, compared with 723,490 pounds valued at $1,261,205 in 1946. Seventy-seven per cent of the exported material was shipped to the United States and 19 per cent to the United Kingdom.

United States and Canada produce most of the world's estimated production of 600 to 700 tons a year. Small quantities are also produced in Russia, Rhodesia, and Mexico.

Uses

Selenium is generally marketed as amorphous powder, but cakes and sticks are also obtainable. Other selenium products marketed are ferroselenium, sodium selenate, sodium selenite, selenious acid, and selenium dioxide. The chief uses of selenium are in the glass, rubber, and paint industries, but many new uses have been developed as a result of research during the war. Among the more interesting of the latter is the use of selenium in electrical dry plate rectifiers for radar equipment and aircraft generators. Its use in rectifiers for numerous electronic devices, battery charging, electroplating, and welding has been increasing.

In the manufacture of glass selenium is used to neutralize the green colour caused by iron impurities. When sufficient selenium is added the glass turns a ruby colour highly suitable for signal lenses. In the manufacture of rubber the addition of selenium in concentrations of from 0·1 to 2·0 per cent promotes resistance to heat, oxidation, and abrasion. It is also used as an accelerator in the vulcanization of synthetic rubber.

Cadmium sulpho-selenite pigments are used where a durable outdoor paint is required with a colour ranging from orange to maroon.

The conductivity of electricity of selenium increases on exposure to light. This unique property is made use of in selenium photo-electric cells which can be arranged to operate various devices and controls for lighting lamps and buoys, ringing alarms, in wireless, photography and telephony, and in television and sound film.

Selenium is used to improve the machineability of metals without impairing their resistance to corrosion; as an antioxidant in lubricating oil; for fat harden-ing; as a catalyst in the petroleum industry; in the hydrogenation of coal; in certain printing inks; in therapeutic preparations for treating skin diseases; in flotation reagents; and in moth repellants.

Sodium selenate is used chiefly in the preparation of an insecticide for floriculture; sodium selenosulphate, to produce brown tones in photographic toning baths; selenium dioxide, to produce "Selenac", a rubber accelerator; and selenium oxychloride, as a solvent.

Prices

In June 1947, the nominal price of black powdered selenium, 99·5 per cent pure, at New York increased from $1.75 a pound to $2 a pound, where it remained for the rest of the year. The average Canadian price in 1947 was estimated by the Dominion Bureau of Statistics to be $1.87 a pound.

SILVER

About half of the production of silver in Canada in 1947 came from mines in British Columbia, by far the largest producer being the Sullivan mine of The Consolidated Mining and Smelting Company of Canada, Limited, at Kimberley. Although production of silver has declined steadily since 1940, increased prices have stimulated considerable activity on base-metal deposits that contain silver, and recovery of the metal is making an important contribution to the profitable operation of a number of such mines, most of which are in British Columbia and Yukon. There was much fluctuation in the world price of silver in the first half of 1947, mainly because of unsteady international demand. Its requirements for industry and the arts, however, continued to be strong and the market was firm at the end of the year.

Production

Canada's silver production in 1947 was 12,504,018 ounces valued at $9,002,893. In 1946, 12,544,100 ounces valued at $10,493,139 were produced. British Columbia supplied 47 per cent of the production in 1947, Ontario 19 per cent, Quebec 17 per cent, and Saskatchewan and Manitoba 14 per cent. The remainder came chiefly from the Northwest Territories and Yukon. Production by ore sources for 1946 and 1947 is shown in the following table.

	1946 Ounces	1947 Ounces
From base-metal ores	11,085,524	11,411,080
From gold ores	1,018,216	751,824
From silver, cobalt, and other ores	428,560	330,623
From placer gold operations	11,800	10,491
Total	12,544,100	12,504,018

Canada's production of silver reached a peak of 32,869,264 ounces in 1910, more than 30,000,000 ounces of which came from the Cobalt area of Ontario, and a peak value of $20,693,704 in 1918, when 21,383,979 ounces were produced.

In British Columbia, the lead and zinc concentrates produced near Kimberley in the Sullivan concentrator of 8,600-tons a day capacity are shipped to Consolidated's smelter and refineries at Trail, where the contained metals are recovered. Silver bullion produced at Trail in 1947 amounted to 5,634,975 ounces. A number of other mining companies in southern British Columbia operating silver-lead-zinc orebodies shipped ores or concentrates to the Trail smelter for treatment. Most of the silver contained in these shipments came from the

Highland Bell mine at Beaverdell which produced 605,705 ounces. Other silver-lead-zinc mines of varying importance that shipped to Trail were: Santiago Mines, Limited, from its Bosun mine near Silverton; Western Exploration Company, Limited, from its Standard and Enterprise mines in the Slocan area; Zincton Mines, Limited, which operates the Lucky Jim mine at Zincton; Base Metals Mining Corporation's Monarch mine at Field and Retallack Mines, Limited, operating the Whitewater mine near Kaslo.

The copper ores of Britannia Mining and Smelting Company, Limited, on Howe Sound, of Granby Consolidated Mining, Smelting and Power Company, Limited, at Copper Mountain and of Twin "J" Mines, Limited (which operated from March to September), on Vancouver Island, contain silver that is exported in copper concentrates to the Tacoma smelter in the state of Washington.

Production of silver from the twelve gold mines in operation in British Columbia in 1947 was small but was 45 per cent higher than in 1946.

Preparations were made to reopen a number of silver-lead-zinc mines that were producers in the past. These include: Silver Standard Mines, Limited, near New Hazelton, which plans to mill 50 tons of ore a day; Silver Giant Mines, Limited near Spillimacheen, about 50 miles southeast of Golden, which was assembling a mining plant to resume production of silver-lead ore; and Utica Mines, Limited, which was planning to erect a 100-ton mill at the old Utica mine in the Slocan district.

Reeves MacDonald Mines, Limited, on the Pend-d'Oreille River south of Salmo, has developed a large zinc-lead orebody containing silver, and plans to bring it into production at a rate of 1,000 tons a day.

Torbrit Silver Mines, Limited (a subsidiary of The Mining Corporation of Canada, Limited), continued to prepare the Toric mine, a former silver producer on the West Coast, north of Alice Arm, for production. The roadbed of an 18-mile abandoned railway connecting the mine to tidewater was converted into a truck road and equipment was assembled to erect a 300-ton mill.

In Yukon, production came largely from the silver-lead ores of the Mayo area, where Keno Hill Mining Company, Limited reopened the properties formerly operated by Treadwell Yukon Company. Low water in the Stewart River prevented the shipment of a considerable part of the concentrates produced from ore mined up to the end of the open season. The concentrate had a total silver content of 680,461 ounces. A small production resulted.

In Saskatchewan, practically all of the silver came from that part of the copper-zinc deposits of Hudson Bay Mining and Smelting Company, Limited that is within the province.

The deposits at Flin Flon also supplied a large part of Manitoba's production. The remainder came mainly from the copper-zinc ore of Sherritt Gordon Mines, Limited at Sherridon, and from San Antonio Gold Mines, Limited in the Rice Lake district.

In Ontario, most of the silver output came from the nickel-copper mines of The International Nickel Company of Canada, Limited, and of Falconbridge Nickel Mines, Limited, in the Sudbury area. In the Cobalt-Gowganda area, the most active company in 1947 was Silver Miller Mines, Limited, which reopened several old mines southeast of Cobalt at Brady Lake. Some rich silver ore was discovered and mined at one of these properties. Silanco Mining and Smelting Company, Limited, which has the largest number of silver properties in the Cobalt area, was inactive most of the year. However, it made plans to complete the erection of its smelter south of Cobalt, which has been designed to treat 15 tons of cobalt-silver ore a day. In Gowganda, Siscoe Gold Mines, Limited operated the former Miller Lake O'Brien property where a 100-ton a day gravity flotation mill was brought into production in January. The mill was closed in June and further operations were confined to development work.

The gold deposits of Ontario and of western Quebec contain an average of about 1 ounce of silver to 5 ounces of gold. The fifty-one gold mines in Ontario produced 338,779 ounces of silver and 1,908,403 ounces of gold in 1947.

In Quebec, the copper-gold mine of Noranda Mines, Limited at Noranda is the principal source of silver. The company also treats copper concentrates containing precious metals from Normetal Mining Corporation, Limited and Waite Amulet Mines, Limited, also in western Quebec. New Calumet Mines, Limited, on the Ottawa River, 58 miles northwest of Ottawa, produced concentrate containing 504,615 ounces of silver from its zinc-lead-silver deposit on Calumet Island; and Golden Manitou Mines, Limited produced concentrate containing 646,744 ounces of silver from its silver-zinc orebody near Val d'Or. Other silver production came mainly from the nineteen gold mines in operation in western Quebec.

The copper-gold-zinc orebodies of Quemont Mining Corporation, Limited, near Noranda, and of East Sullivan Mines, Limited, near Val d'Or, contain silver, and at both of these mines preproduction development preparatory to large-scale operations proceeded during 1947. Candego Mines, Limited erected a plant and 50-ton mill and commenced production at its silver-lead zinc mine in Gaspe Peninsula in February 1948. In the Bachelor Lake area, northeast of Senneterre, Quebec, Dome Exploration (Quebec), Limited made a discovery of high-grade silver and zinc ore in the autumn of 1947 and on which it has been doing exploratory drilling.

In the Northwest Territories, some silver is recovered from the pitchblende-silver ores of the Great Bear Lake area and from the four gold mines of the Yellowknife district.

The world production of silver comes chiefly from American countries, Australia being the only other important source. According to Handy and Harman, silver production in the American countries in 1946 and 1947 was:

	1946 Million ounces	1947 Million ounces
United States	21·7	33·5
Canada	13·7	12·7
Mexico	48·3	48·0
Peru	13·0	12·0
Bolivia	6·4	7·0
Other South and Central American countries	7·7	7·0
Total	110·8	120·2

Figures of production from other countries in 1947 are not available. Australian production in 1946 was 7,000,000 ounces, and the Belgian Congo, 2,000,000 ounces.

Trade

Exports of silver bullion was 7,514,373 ounces valued at $5,429,335, compared with 2,316,689 ounces valued at $2,061,338 in 1946. Fifty-eight per cent of the bullion exported went to the United States, 24 per cent to the United Kingdom, and 17½ per cent to France. Exports of silver in ores and concentrates amounted to 2,722,261 ounces valued at $1,998,463, compared with 1,863,817 ounces valued at $1,429,083 in 1946. Eighty per cent went to United States and twenty per cent to Belgium. The export value of silver manufactures was $647,220.

The more than threefold increase in exports of silver bullion compared with 1946 was due in part to a marked decrease in home consumption, which was only 55 per cent of that used in 1946. This reduction was chiefly in the manufacture of sterling silver and coinage. In March 1947, a ban was placed on the importation of silver into India, which has always been a heavy buyer. This caused a recession in world prices which was halted when the Bank of Mexico commenced buying substantial amounts of silver in July for coinage purposes. These Mexican purchases, plus increased industrial demand in the United States during the latter part of 1947, had a stabilizing influence on the market.

Imports of silver toilet articles into Canada were valued at $22,797, compared with $23,841 in 1946, and the value of other silver manufactures was $681,955, compared with $484,757 in 1946.

Uses

The best known use of silver is for the manufacture of silver coins. The silver content of coins varies in different countries, and generally nickel and copper are alloyed with silver to increase the hardness. Another long established outlet is for ornaments, jewellery, and tableware. The electroplating industry is a leading consumer.

Silver, either in pure or alloyed form, is used in electrical contacts where a very low resistance conductor is required. Metals with which silver is alloyed for this purpose include copper, nickel, cadmium, and magnesium. Silver alloys are also used in certain types of bearings, brazing solders, and in dentistry.

A high percentage of silver goes into the manufacture of silver nitrate which is used chiefly in the preparation of light-sensitive photographic emulsions for use on photographic film. Silver nitrate is also used for making mirrors, reflectors, special inks, pharmaceuticals, and conductive coatings on ceramics and glass.

In Canada, consumption of silver by principal uses in 1946 and 1947 was:

	1946 Ounces	1947 Ounces
Sterling	3,282,236	1,285,906
Brazing alloys	28,053	32,601
Lead-silver alloys	40,558	36,715
Wire and shot	180,425	65,124
Anodes	1,301,405	1,155,920
Coinage	1,526,100	499,335
Silver nitrate	936,823	874,465
Miscellaneous*	412,143	252,605
	7,707,743	4,202,671

* (Includes jewellery, and dental and surgical supplies.)

Consumption in the United States in 1947 is estimated to have been about 125,552,000 ounces, 16 per cent less than that in 1946. About half of the amount used in 1947 went into sterling and plated silverware.

Prices

No price controls on silver were in effect in Canada in 1947, but licences were required to export or import silver and silver products. The price in Canada followed the fluctuations in the United States, since commercial transactions between the two countries were carried out at a rate of exchange fixed at par throughout the year. The top price in New York was $86\frac{1}{2}$ cents an ounce in March, and the lowest price 60 cents an ounce in June. During the last two months of 1947 the price of $74\frac{7}{8}$ cents an ounce remained unchanged and continued into 1948. The average Canadian price was 72 cents an ounce in 1947, compared with $83\frac{1}{2}$ cents an ounce in 1946. The price quoted in December in the United Kingdom was 45 pence an ounce.

TELLURIUM

Tellurium is recovered commercially in Canada at the Copper Cliff, Ontario, plant of The International Nickel Company of Canada, Limited, and at the Montreal East refinery of Canadian Copper Refiners, Limited. At Copper Cliff it is recovered from the slimes formed in the process of refining copper produced from the Sudbury nickel-copper ores. At Montreal East it is obtained from the refining of copper anodes made from copper ores at Noranda, Quebec, and from blister copper originating from the copper-zinc ores of Hudson Bay Mining and Smelting Company, Limited at Flin Flon on the Manitoba-Saskatchewan boundary.

Canada produced 9,194 pounds of tellurium valued at $16,090 in 1947, compared with 15,848 pounds valued at $24,405 in 1946. Most of the metal produced in Canada is exported. The small domestic consumption is in the white metals industry and in steel foundries.

World production is estimated to be about 150 tons of refined tellurium a year, Canada and United States being the principal producers.

Uses

A number of additional uses have been found 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-resistant qualities. It is more favoured than selenium for rubber to be subjected to extremely abrasive conditions. The addition of about 0·1 per cent tellurium to lead makes the lead tougher, stronger, and more resistant to corrosion. Quantities of about 0·01 per cent increase the depth of chill in cast iron for such uses as railway car wheels, gears, camshafts, or wherever a casting with a very hard, wear-and-abrasion-resistant surface is required. It is used to remove cobalt from the electrolyte in the refining of zinc. In the ceramic and glass industries tellurium is used to impart blue and brownish effects in the products.

Uses have also been developed for tellurium dioxide, metallic tellurides, and tellurium iodides.

Prices

The price of tellurium was quoted at $1.75 a pound in New York throughout 1947, and this was the average Canadian price.

TIN

Canadian Occurrences and Production

No economic deposits of tin have been found in Canada up to the present. Minor occurrences, principally of cassiterite (SnO_2), the most important tin mineral, are found in the New Ross area, Lunenburg county, Nova Scotia; in the Sudbury mining division of Ontario; in the Lac du Bonnet district of southeastern Manitoba; in southern British Columbia; in the Mayo district, Yukon; and in the Yellowknife area, Northwest Territories. Those in Nova Scotia, Ontario, Manitoba, and the Northwest Territories are found largely in pegmatite dykes. In Yukon, crystalline cassiterite is found in placer gravels along numerous creeks and in one small lode deposit. In British Columbia, tin is found associated with base-metal sulphide ores. The last-mentioned type of occurrence is the only one that has been exploited, and is the source of the small Canadian production. The lead-zinc-silver orebody of the Sullivan mine, Kimberley, B.C., contains a very small percentage of tin. Since 1941, The

Consolidated Mining and Smelting Company of Canada, Limited has been recovering a part of this tin as a by-product from the concentration of its lead-zinc ore. The method of recovery is briefly described in the review of tin[1] in 1946. Up to the end of 1947, a total of 2,246 long tons of refined tin had been produced. In 1947 production was 319 long tons valued at $517,794, compared with 390 long tons valued at $507,028 in 1946.

Market Conditions and World Production

The almost complete dependence of Canada upon outside sources of tin makes world production and supply a matter of prime importance. The hopes for a definite improvement in the supply of tin for 1947 did not materialize and the world position continued weak throughout the year. There was a gradual rehabilitation of the industry in Malaya and the Netherlands East Indies, but labour difficulties in Malaya and slow deliveries of essential equipment combined to keep production down below the levels that had been anticipated. Considerable progress was made, however, and by the end of 1947 the number of dredges operating was fifty-six, as against twenty at the beginning of the year.

World smelter production of tin in 1947 was 123,500 long tons, an increase of 26,500 long tons over 1946. In spite of this increase world demands continued to exceed available supplies. The Combined Tin Committee continued to allocate the world supply. Canada's allocation for 1947 was 3,080 long tons.

Early in the autumn of 1947, the Government stockpile of tin was disposed of and bulk purchasing by the Government was discontinued. Trading in tin reverted to normal commercial channels and was subject to the overall allocation assigned to Canada under an import control on a quota basis. Regulations governing the use and domestic sale of tin remained in force. Wartime Prices and Trade Board Order No. A-1774 was effective until August 5, 1947, when it was replaced by No. A-2417. This was later revised on September 24 and replaced by No. A-2440. A further revision, dealing with price, was issued as Order No. A-2469 January 28, 1948.

The supply of tin in Canada during 1947 remained at about the same level as in 1946, but the outlook for the last half of 1948 should improve if the output from producing countries reaches anticipated levels and political conditions in these countries remain stable.

Uses, Trade, and Price

Tin is used chiefly in the manufacture of tin plate and terne plate; in the production of solder, babbitt, and bronze; in tinning; as foil and collapsible tubes; chemicals; and as an addition agent to the molten bath in hot zinc galvanizing.

The consumption of primary tin in Canada by principal industrial uses during 1947 was:

	Long tons
Tin plate, terne plate and tinning	2,096
Solder	949
Babbitt	211
Brass and bronze	274
Tin foil and collapsible tubes	53
Miscellaneous	45
Total	3,628

Imports of tin (blocks, pigs, or bars) during 1947 were 3,961 long tons valued at $6,677,436. This included 206 long tons of tin reclaimed from scrap tin plate shipped to United States de-tinning plants for recovery of the metal, and 1,200 long tons which was allocated in 1946 but was not received until

[1] Bureau of Mines No. 824: Canadian Mineral Industry in 1946, p. 57.

1947. Tin plate imported amounted to 62,594 long tons valued at $8,001,627; 9,744 pounds of tinfoil, and 74,400 pounds of babbitt metal were imported, having a combined value of $40,764.

The average price of tin in New York in 1947 was 77·949 cents per pound. On December 19, 1947, the price was raised to 94·000 cents. The Canadian price, f.o.b. Montreal or Toronto, during the latter part of 1947 was 80·000 cents per pound. This price was increased to 96·000 cents early in 1948.

Future Trends

The indications are that in 1950, if not sooner, world production will reach a level sufficient to balance world requirements of tin for commercial purposes. The consumption of tin plate, essential in the manufacture of food containers, continues to expand. No satisfactory substitute has yet been developed to offset the demand for tin cans as food containers. This use constitutes the major consumption of tin, the next largest being in solder and babbitt. Both of these uses are highly essential in this mechanized age.

TITANIUM

During 1947 there was little change in Canada's position as regards titanium-bearing ores and titanium products. The ore is conveniently available in large amounts and in considerable variety. However, little is mined and none is used in this country. The imports of titanium dioxide, titanium-bearing pigments, and minor titanium products in 1947 rose about 20 per cent to a value of over $3,000,000.

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. 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 in the southern part of Hastings county, north of Belleville, 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 deposits, but during recent years the only production has been from the St. Urbain deposits, which are scattered through a small area about 9 miles north of Baie St. Paul. They are worked intermittently to supply the present small annual demand for export. During the war, when the interruption of supplies of titanium ore from India put the pigment plants in the United States in short supply, and concentrate from the McIntyre deposits in the Adirondacks was not yet available, there was a substantial production from St. Urbain.

The largest potential source of ilmenite is the recently discovered Allard Lake deposits from which only experimental shipments have been made. One of the deposits, discovered in 1946, is 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 carries about 35 per cent titanium dioxide, 42 per cent iron, and 1 to 2 per cent silica, and areas that contain a small proportion of silicate can be concentrated to this grade. Its convenient location near an ocean port will permit large-scale development when a treatment plant is available.

Production and Trade

During recent years there has been a small annual production of ilmenite from St. Urbain for export to the United States.

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
			1947	1,250	6,775

All titanium products used in Canada are imported, mainly from the United States during recent years.

*Imports of Titanium Dioxide and of Pigments Containing Not Less than 14 per cent Titanium**

—	Tons	Value
		$
1939	4,502	803,198
1940	4,385	782,957
1941	6,610	1,321,367
1942	7,321	1,423,042
1943	8,445	1,533,462
1944	10,087	1,871,434
1945	10,680	2,045,889
1946	11,965	2,193,685
1947	13,656	2,965,826

* Includes antimony oxide.

Titanium dioxide is in short supply in the United States, but increased production facilities being installed by three makers of titanium dioxide will be effective in 1948.

Uses

Titanium White Used in Canadian Paint Industry

	Tons		Tons
1939	928	1943	2,218
1940	1,149	1944	2,300
1941	1,538	1945	3,153
1942	2,084	1946	3,416

The paint industry uses, in addition to titanium white, a considerably larger amount of mixed pigments containing titanium, also imported from the United States.

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 several other forms. Ferrotitanium and ferrocarbon-titanium are used under special circumstances to purify steel. It is all imported from the United States.

Ferrotitanium Used in Canadian Steel Industry

	Tons		Tons
1939	132	1943	614
1940	132	1944	786
1941	181	1945	656
1942	439	1946	416

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 is 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 on a small scale, but an ample supply is not now available 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 was made 212,800 tons of ilmenite concentrate and 504,000 tons of magnetite concentrate. A small part of the latter was sintered for use in the iron blast furnace.

Prices (nominal) f.o.b. Atlantic ports at the end of 1947 were:

Ilmenite, 57 to 60 per cent TiO_2, \$19 to \$20 per gross ton.
Rutile, 94 per cent TiO_2, 8 to 10 cents per pound.

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.

TUNGSTEN

The outstanding development was the resumption of the production of tungsten concentrates from the Emerald mine of Canadian Explorations, Limited, near Salmo in southern British Columbia. The mill was in production for a brief period during the war, and the property was taken over by the aforementioned company in January 1947. The mine was the only Canadian producer of tungsten ore in 1947. Part of the high-grade concentrate was used to meet Canadian requirements of scheelite and the remainder was shipped to England and Europe.

World demand for tungsten increased appreciably in 1947, and, due to lack of sufficient production of high-quality material, prices advanced. However, by the end of the year, United States prices were lowered because of increased output and imports.

Canadian Sources of Supply, Developments

Tungsten concentrates were obtained from a number of sources throughout the Dominion during the early part of the war, but production ceased in November 1943. The three chief producers were Hollinger Consolidated Gold Mines Limited, Timmins, Ontario; the Red Rose mine south of Hazelton in northern British Columbia; and the Emerald mine. The ore at the Emerald mine, where production was resumed in 1947, occurs in several contact metamorphic zones, mainly between granite and argillite and is finely disseminated, usually in impure limestone with garnetite. The main contact metamorphic deposit contains about 200,000 tons of 1·00 per cent WO_3 ore. Treatment in the mill is a combination of wet gravity and flotation.

Production and Trade

The scheelite concentrates produced in the Emerald mill in 1947 had a total WO_3 content of about 288 tons valued at $791,205. The high-grade concentrate, which was about 80 per cent of the total, contained from 73 to 75 per cent WO_3, and the low-grade, about 20 per cent.

No ferrotungsten is made in Canada. Tungsten steels are made by Atlas Steels, Limited, Welland, Ontario, which 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.

Canada in 1947 imported 342 tons of ferrotungsten from the United States and United Kingdom valued at $872,652. Consumption was about 330 tons of the metal contained in ferrotungsten and scheelite, which is nearly three times the 1946 consumption.

Figures for world production of tungsten are incomplete, but in so far as statistics are available, the estimate for 1946, according to the United States Bureau of Mines, is 19,000 metric tons of concentrates containing 60 per cent WO_3. China, Brazil, Argentina, Bolivia, Peru, Australia, Portugal, Spain, Burma, and the United States are leading producers of tungsten.

In the United States, the chief producers in 1947 were Nevada-Massachusetts Company, and U.S. Vanadium Corporation (Riley mine) in Nevada, and Tungsten Mining Corporation from the Hamme mine in Vance county, North Carolina.

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. An important use is for the production of high-speed steels for cutting-tools in which the tungsten content is 15 to 20 per cent. The use of tungsten in hard-facing compounds continues to increase. 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 nonferrous 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 and is now being used as inserts into detachable bits for rock drilling. 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

The price of concentrate is an arbitrary arrangement between the Canadian producer and the buyers. United States prices of imported and domestic ores fluctuated from $22 early in the year, to $32 by midsummer, but by the end of the year, due to excessive imports, dropped to $29 per short ton unit of WO_3. Ferrotungsten of 75 to 80 per cent tungsten was $2.25 to $2.35 per pound of contained tungsten.

ZINC

Production of zinc in Canada was 12 per cent lower in tonnage than in 1946, but a record was set in the value of the output, which amounted to $46,686,010. About 86 per cent of the production was high-grade electrolytic zinc refined at Trail, British Columbia, and at Flin Flon, Manitoba. The remainder came from Quebec and was contained in concentrate which was exported to the United States.

Principal Canadian Sources of Supply

The Consolidated Mining and Smelting Company of Canada, Limited and the Hudson Bay Mining and Smelting Company, Limited are the two Canadian producers of refined zinc. The Sullivan silver-lead-zinc mine of Consolidated Smelters, at Kimberley, British Columbia, is Canada's principal source of zinc. Lead and zinc concentrates produced in the 8,600-ton Sullivan concentrator near the mine are shipped about 200 miles by rail to the company's smelting and refining plants at Trail. At the Sullivan mine the tonnage and grade of ore mined were slightly lower than in 1946, which resulted in a reduced metal output. Good progress was made in the large-scale mine development projects that were begun in 1946. The main shaft was completed to a vertical depth of 850 feet below the main haulage level and a new hoist installation was placed in operation. A 10,500-foot haulageway was commenced, which in conjunction with the installation of an underground crushing plant will enable crushed ore to be hauled directly from the mine to the concentrator, thus eliminating the surface crushing plant and railway haulage now in use. The erection of a sink-float plant at the concentrator was started. Development work on the Sullivan orebody resulted in a substantial increase in the ore reserves, and higher metal prices permitted lower grade portions of the ore to be mined profitably.

At Trail, construction of a second slag-fuming furnace in the lead smelter was commenced. This unit will make possible the treatment of a large stockpile of zinc plant residues. A total of 126,589 tons of refined zinc was produced at Trail in 1947, compared with 135,274 tons in 1946.

A number of silver-lead-zinc and copper-zinc mines in British Columbia ship zinc concentrate to Consolidated Smelters' Trail plant for treatment. Among the more important of these producers in 1947 were: the silver-lead-zinc mines in the Slocan-Ainsworth district operated by Zincton Mines, Limited, Western Exploration Company, Limited, and Ainsmore Consolidated Mines, Limited; Base Metals Mining Corporation, which resumed production at its Monarch and Kicking Horse lead-zinc mines at Field; the copper-zinc mine of Britannia Mining and Smelting Company, Limited, at Howe Sound, and Twin "J" Mines, Limited, which operated its copper-zinc property on Vancouver Island from March until September. In 1947 the total shipments of custom ore to Trail included about 16,000 tons of zinc concentrates containing about 9,200 tons of zinc.

Hudson Bay Mining and Smelting Company, Limited operates the Flin Flon copper-zinc-gold-silver mine on the Saskatchewan-Manitoba boundary, this mine being Canada's second largest source of zinc. The company milled 1,855,035 tons of ore, which was slightly greater than in 1946; and 154,193 tons of zinc concentrate averaging 46 per cent zinc was treated in its zinc plant, from which 52,897 tons of refined zinc was produced. Research in a pilot plant resulted in the development of an economic method to recover some of the zinc and precious metals contained in the zinc plant residues, which now amount to over 700,000 tons, averaging 26 per cent zinc.

Sherritt Gordon Mines, Limited, at Sherridon, Manitoba, was handicapped by a labour strike of three months' duration, which ended November 19, 1947. The company milled 359,031 tons of copper-zinc ore and produced 8,217 tons of zinc concentrate containing 50 per cent zinc. This concentrate was sold to Hudson Bay Mining and Smelting Company and treated in that company's zinc plant at Flin Flon. The mine is being operated largely on a salvage basis with a life expectancy of about 2½ years at the present rate of production.

In Quebec, the Waite Amulet, Normetal, New Calumet, and Golden Manitou mines shipped zinc concentrate to smelters in the United States.

Waite Amulet Mines, Limited milled 393,950 tons of ore from its copper-zinc mines near Noranda. Production was largely from ore containing relatively more copper and less zinc than that normally mined. The zinc concentrate contained 9,547 tons of zinc, compared with 18,733 tons in 1946. The ore at the Waite mine is almost exhausted and it is planned to abandon these workings and resume production at "C" and "F" orebodies on the Amulet property in 1948.

Normetal Mining Corporation, Limited, Desmeloizes township, Abitibi county, was adversely affected by a shortage of power during a part of the year. It milled 209,310 tons of copper-zinc ore from which 21,599 tons of zinc concentrate containing 11,257 tons of zinc was produced. Erection of a power-line to the mine is expected to be completed in 1948. The power will be supplied by the Quebec Hydro-Electric Commission.

New Calumet Mines, Limited, on Calumet Island, Pontiac county, operated its silver-zinc-lead mine at a slightly reduced average tonnage due to an intermittent shortage of labour. Its No. 2 shaft was completed to a depth of 585 feet and development work was well advanced. The company milled 182,020 tons of ore, from which 20,637 tons of zinc concentrate containing 10,733 tons of zinc was produced.

Golden Manitou Mines, Limited, near Val d'Or, milled 254,810 tons of zinc-lead-silver ore, from which 15,508 tons of zinc concentrate containing 9,349 tons of zinc was produced. A shortage of labour reduced production to about two-thirds of the mill capacity.

Developments

Increased prices have stimulated considerable activity in the field of exploration for base metals in Canada and a renewed interest has been shown in some former producing properties. The more significant developments on deposits containing zinc, including new mines being equipped for early production, are as follows:

In British Columbia, Reeves MacDonald Mines, Limited reopened its mine on the Pend-d'Oreille River east of Trail. Initial work was carried out on the construction of a mill and plant to bring the mine into production at a rate of 1,000 tons a day. Previous development on seven ore zones had indicated reserves of more than 2,500,000 tons averaging 6 per cent zinc and 1 per cent lead.

Silver Standard Mines, Limited reopened its silver-zinc-lead mine near New Hazelton and made preparations to install a 50-ton mill; 40,000 tons of ore of a good grade are indicated.

Hollinger Consolidated Gold Mines, Limited and Conwest Exploration Company, Limited conducted extensive geophysical surveys north and southwest of the Sullivan mine. Exploration in this area by the two companies was proceeding.

In Manitoba, development by Cuprus Mines, Limited, a subsidiary of Hudson Bay Mining and Smelting Company, Limited, continued throughout the year. The mine is 8 miles southeast of Flin Flon and is connected by road. Foundations were laid for a 300-ton mill and production was expected to commence in the autumn of 1948.

Hudson Bay also commenced developing a copper-zinc orebody, located by drilling under Schist Lake about 3 miles southeast of Flin Flon. Sinking of a three-compartment shaft was started on the property to permit underground exploration.

Sherritt Gordon Mines, Limited located an orebody of about 150,000 tons containing zinc and copper on its property at Lynn Lake where nickel-copper deposits are being developed. Production from this field will depend upon the establishment of sufficient ore reserves to justify the building of about 140 miles of railway.

In Quebec, Quemont Mining Corporation, Limited reached an advanced stage in the preproduction development of its property near Noranda, as did East Sullivan Mines, Limited near Val d'Or. At Quemont, No. 2 shaft was deepened to 1,142 feet and seven level stations were established. Development of the orebody increased the estimated reserve of ore to over 9,400,000 tons with an average grade of 0·174 ounce of gold, and 0·943 ounce of silver per ton, and 2·97 per cent zinc, and 1·49 per cent copper. The 2,000-ton concentrator is not expected to be completed until the spring of 1949 because of delay in the delivery of materials.

At East Sullivan, underground work has established an ore reserve of 3,500,000 tons averaging 1·26 per cent zinc and 2·21 per cent copper, with low values in gold and silver. The erection of a 2,000-ton concentrator was commenced.

Macdonald Mines, Limited, about 5 miles northeast of Noranda, has outlined a sulphide orebody estimated at 4,482,000 tons containing about 5·25 per cent zinc. It plans to carry out open-pit mining on a scale of 1,500 tons a day and to produce zinc concentrate for export. Development on the 925-foot level indicated another sizeable sulphide zone containing somewhat higher zinc values.

Donalda Mines, Limited, close to Quemont on the east, located a sulphide zone on the surface containing zinc and copper.

Eldona Gold Mines, Limited, whose property adjoins Donalda on the east, completed a shaft to a depth of 500 feet. Drilling from this level disclosed an ore zone containing high values in zinc, gold, and silver. The shaft will be deepened to 1,000 feet to enable further underground exploration.

Candego Mines, Limited, Gaspe Peninsula, erected a 50-ton mill on its lead-zinc property and commenced production of zinc and lead concentrates in the winter of 1947-48.

Dome Exploration (Quebec), Limited made a discovery of high-grade silver-zinc-lead ore in the Bachelor Lake area, northeast of Senneterre on which it did some shallow drilling and had plans for intensive exploration in 1948.

Production and Trade

Canada produced 207,863 tons of zinc valued at about $46,686,010 in 1947, compared with 235,310 tons valued at $36,755,450 in 1946. Production by provinces, including the recoverable zinc in concentrates exported, was: British Columbia 126,859 tons, Manitoba and Saskatchewan 46,628 tons, and Quebec 34,732 tons.

Exports of zinc amounted to 182,522 tons valued at $30,020,177, compared with 206,844 tons valued at $27,659,450 in 1946.

Exports of	1946		1947	
	Tons	Value	Tons	Value
		$		$
Zinc contained in concentrates....	58,200	3,181,120	40,575	2,916,649
Metallic zinc....................	144,896	24,174,704	137,228	26,661,360
Zinc scrap, dross, and ashes.......	3,748	303,626	4,720	442,168
Zinc manufactures...............	....	109,721	....	172,465

Forty-one per cent of the tonnage of metallic zinc exported went to the United Kingdom, 40 per cent to the United States, and 17 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, lithopone, and chemicals, were valued at $4,531,423, compared with $2,870,128 in 1946. The 58 per cent increase was largely due to the increase in the world price of zinc. The largest single item, most of which came from the United States, was lithopone which amounted to 12,736 tons valued at $1,795,269.

Consumption of refined zinc in Canada in 1947 was over two and a half times the amount used in 1938. Consumption of refined new zinc by principal industrial uses in 1946 and 1947 is shown in the following table.

	1946	1947
	Tons	Tons
Galvanizing	17,821	21,506
Zinc oxides and zinc dust	14,070	15,338
Brass and copper products	3,347	4,653
Die-casting alloys	3,268	3,653
Dry batteries	2,048	1,564
Miscellaneous	5,687	4,358
	46,241	51,072

In the United States, which is the chief consumer of zinc, consumption was about 780,700 tons, compared with 801,300 tons in 1946. A decrease in the quantity used for brass manufacture was largely offset by an increase in that used for galvanizing.

In the United Kingdom, consumption of new zinc was about 250,000 tons, about half of which went into manufacture of brass products.

World Production of Zinc on a Smelter Basis as Reported by American Bureau of Metal Statistics

—	1947	1946	1938
	Tons	Tons	Tons
United States	862,200	772,778	477,954
Canada	178,167	185,692	171,656
Belgium	146,618	89,231	231,924
Poland	79,005	62,767	122,119
Australia	77,752	85,474	78,198
Great Britain	76,490	73,199	61,938
Mexico	53,030	53,311	39,552
France	49,828	32,764	68,532
Germany (British Zone)	22,958	18,264	212,173*
Other countries[1]	141,197	107,731	298,931
Total	1,687,245	1,481,211	1,762,977

* Total German production including Czechoslovakia.
[1] Russia, mainly, and some other countries not included in totals for 1947 and 1946.

Uses

Zinc has a wide range of industrial uses. In the United States about 45 per cent of the consumption in 1947 was used in galvanizing; 27 per cent in zinc base alloys; 14 per cent in the manufacture of brass; and 9 per cent in rolled zinc fabrications. In the United Kingdom, a larger percentage was used in brass manufacture than in galvanizing.

The metal is refined and marketed to industry in six grades, varying according to their respective content of lead, iron, cadmium, and other impurities. In North America, the principal grades are "Special High Grade" (used chiefly for die-casting); "Regular High Grade" (used for brass manufacture and rolled zinc fabrications); and "Prime Western" (used for galvanizing).

In Canada, zinc is refined only by the electrolytic process by which the special and regular high-grade zinc products are produced.

In galvanizing, zinc is applied to iron or steel as a thin coating to prevent rust from atmospheric corrosion. Zinc has a strong affinity for iron and the coating is usually applied by hot dipping. In some fabrications such as wire screening the zinc coating is applied by electroplating. Zinc base alloys prepared from high-grade electrolytic zinc to which is added 3 to 4 per cent aluminium, 0 to 3·5 per cent copper, and 0·02 to 0·1 per cent magnesium, are used extensively for die-casting of complex shapes, especially for automobile accessories and household appliances. Brass, an alloy of copper and zinc, containing up to 50 per cent zinc, has many diversified uses in industry and the arts. Rolled zinc is used extensively for fabrications exposed to corrosion such as weather stripping, fruit jar sealer rings, dry cell battery cups, boiler and hull plates, and brake linings. Zinc dust is used to make zinc salts and compounds; in the purification of fats; in the manufacture of dyes; and for precipitation of gold and silver from cyanide solution. Zinc oxide is used in compounding rubber and in the manufacture of paint, ceramic materials, inks, matches, and many other commodities. Among the more important of the zinc products and compounds are lithopone, zinc carbonate, zinc chloride, zinc stearate, zinc sulphate, and zinc sulphide.

Prices

In Canada, the ceiling price of electrolytic zinc was increased late in January 1947 to 10·25 cents a pound from 5·75 cents. When ceiling prices of zinc, copper, and lead were abolished on June 9, 1947, the price of electrolytic zinc increased to 11·00 cents a pound, where it remained for the rest of the year. The net value received for zinc contained in concentrates exported to the United States averaged 3·6 cents a pound after deduction of freight and treatment charges, both of which increased substantially in 1947.

In the United States zinc prices were unchanged throughout 1947. At East St. Louis prime western zinc sold for 10·50 cents a pound; high-grade electrolytic for 11·50 cents; and special high-grade electrolytic for 11·75 cents.

In the United Kingdom the price of ordinary zinc in December 1947 was £70 a long ton or 12·6 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 operator in 1947. About 50 of the 80 tons of garnet ore mined in 1946 from the company's deposit near River Valley in Dana township, Ontario, was shipped 25 miles southeast to its mill at Sturgeon Falls. About 30 tons of the ore was crushed and concentrated to 8 tons of 95 per cent garnet content and then pulverized into flour grades for use in the grinding of lenses and in the optical trade. About one ton of flour grade powder was shipped to the United States.

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.

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. 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.

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 silicon carbide, and oxide of alumina, is a serious factor in the marketing of garnet. Little, if any, garnet is used for other purposes in Canada.

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. Garnet for surfacing plate glass is $100 a ton and for sandblasting, $90 a ton.

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 335 tons of grindstones valued at $21,475 was shipped by the two operators in 1947, all for domestic use. This compares with shipments of 295 tons of grindstones valued at $17,450 in 1946. Read Stone Company, Sackville, New Brunswick, by far the larger operator, obtains its material in New Brunswick and ships from Stonehaven in that province. Bay of Chaleur Company obtains its material from along the Bay of Chaleur at low tide near Grande Anse, New Brunswick.

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 be almost worked out and there has been no production for several years. There is increasing competition from Canadian-made artificial segmental pulpstones, mainly of silicon carbide grit, and 759 of these stones were in use and 150 in stock at the end of 1947 in 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

Deposits of volcanic dust occur in Saskatchewan, Alberta, and British Columbia. There has been no production in recent years, but in 1947 test shipments were made from a deposit near Nanton, Alberta.

In the United States production of pumice and volcanic dust reached a peak of nearly 320,000 tons in 1946. About 77 per cent of the output was used for concrete admixture and aggregate; 16 per cent for cleaning compounds and other abrasive uses; and the remainder for acoustic plaster, insecticide, insulation, brick manufacture, filtration, plastics, paint filler, absorbents, etc.

Imports into Canada are grouped with a number of similar products (pumice, pumice stone, lava, and calcareous tufa), the value of which totalled $62,063 in 1947. Most of the pumice dust was used in scouring powders.

ASBESTOS

Production of asbestos in Canada in 1947 broke all previous records, yet the demand for fibre of all kinds, particularly for shingle grades, was well in excess of the supply. Large expenditures were made by the industry on plant expansion and improvements, but developments in the utilization of asbestos are so rapid that a market will likely be found for all fibre produced for some time to come.

These developments largely centre around the utilization of the medium and short grades of fibre, the former in the manufacture of asbestos-cement products such as siding shingles, pipes, etc., and the latter in the manufacture of plastics and of asphalt tile. An important feature of the expansion in the asbestos industry is the accompanying increase in the quantity and variety of asbestos products being manufactured in Canada. When the additions to present asbestos manufacturing plants are completed and the new plants under construction in or near Montreal, Toronto, and Calgary are in operation, Canada will have become an important source of finished asbestos products as well as of raw fibre.

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. Remi 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 is very low in iron and entirely free from magnetite, and is thus particularly suitable for making insulation for electrical machinery.

No amosite or crocidolite has been found in Canada, but there are numerous 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 the filtering of 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 during the war and in 1946 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 granules. Asbestos deposits reported as discovered in recent years in Manitoba, British Columbia, and in northern and western Ontario are of the amphibole varieties.

Search for new deposits was active, particularly in the Thetford Mines area, and several companies were incorporated during 1947 to develop new properties.

Production and Trade

Production of asbestos in 1947 amounted to 661,821 tons valued at $33,005,748, compared with 558,181 tons valued at $25,240,562 in 1946.

In 1947 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. Remi 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 less than ½ inch in width, though in rare instances veins exceeding 5 inches in width are found. The fibres run crosswise of the vein and thus the width of the vein determines the length of fibre. Slip fibre, occurring in fault veins, 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 will shortly be employed by Canadian Johns-Manville Company at Asbestos.

During the second world 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, however, and the product cost several times as much as natural asbestos.

Exports of asbestos in 1947 were: crude asbestos, 953 tons valued at $445,150, compared with 639 tons valued at $293,901 in 1946; milled fibres, 223,693 tons valued at $20,275,533, compared with 215,233 tons valued at $16,215,579 in 1946; asbestos waste, refuse or shorts, 412,250 tons valued at $11,570,606, compared with 304,312 tons valued at $7,329,708 in 1946; asbestos manufactures, n.o.p., including asbestos brake linings and clutch facings, and packing valued at $677,974, compared with exports valued at $641,432 in 1946. Although, as previously mentioned, larger facilities for the manufacture of asbestos products are being built in Canada most of the Canadian production of asbestos is still exported in the unmanufactured state, either in the crude condition (long-fibred 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 substantial shipments were made to Europe and South America in 1947.

Imports in 1947 consisted of 248,289 pounds of asbestos packing valued at $137,295; brake linings for automobiles, etc., valued at $584,530; clutch facings for automobiles valued at $244,205; and brake linings and clutch facings, n.o.p., $93,929; asbestos in any form other than crude, and all manufactures, n.o.p., $2,620,342. The last classification included asbestos valued at $10,679 from South Africa of a kind not produced in Canada and required for certain manufactures. Comparative data for 1946 are: 225,997 pounds of packing valued at $124,146; clutch facings for automobiles valued at $179,480; brake linings for automobiles valued at $444,409, and brake linings and clutch facings, n.o.p., $47,296; asbestos in any form other than crude and all manufactures, n.o.p., $1,434,680.

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), Bolivia (crocidolite), China (chrysotile), India (chrysotile), and Venezuela (chrysotile). Russia, formerly a large supplier of asbestos, has exported very little since the war. The world's largest market for asbestos is 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. Short fibre is also finding important new applications in the plastics industry.

Prices of fibre advanced during 1947, and according to *Engineering and Mining Journal* Metal and Mineral Markets, year-end quotations in United States funds for fibre f.o.b. Quebec mines, tax and bags included, were as follows: No. 1 crude, $800 per ton; No. 2 crude, $302.50 to $410; spinning fibres, $170.50 to $231; magnesia insulation and compressed sheet fibres $170.50 to $197; shingle fibres, $82.50 to $109.50; paper fibres, $43 to $65; cement stock, $21.50 to $36.50; floats, $26.50; shorts, $20.50 to $38.50 per ton.

BARITE

Mine shipments of barite, comprising both crude and ground, in 1947 increased nearly 7 per cent in quantity and 37 per cent in value over those of 1946. Nova Scotia produced 98 per cent of the total, with a tonnage increase of nearly 7 per cent over 1946. Production in British Columbia rose 5 per cent. Total shipments declined nearly 8 per cent from the record attained in 1945.

Principal Canadian Sources of Supply

Canadian Industrial Minerals, Limited, with mine and mill at Walton, Hants county, Nova Scotia, is now firmly established as a major world producer of barite. Its reserves, estimated at more than 2,000,000 short tons, are sufficient for many years of operation. The barite is off-colour and is thus not suitable for the general pigment and filler trades, but the ore is high in barium sulphate and meets drilling mud and chemical specifications without need for concentration. It is amenable to bleaching at a 325-mesh grind and yields a product of good white colour. About 75 per cent of the production in 1947 was from open-cut mining and the remainder from underground operations. Further stripping of overburden was done on the east part of the deposit. Underground development work comprised 1,216 feet of drifting, raises, and crosscuts on the 270- and 350-foot levels.

In Ontario, Woodhall Mines, Limited was proceeding with plans to bring the old Premier Langmuir mine, on Nighthawk River, in Langmuir township, Porcupine area, into production, and a trial shipment of 40 tons of crude ore was made for concentrating and grinding tests.

In British Columbia, Mountain Minerals, Limited shipped 2,875 tons of crude barite from its Parson and Brisco properties, southeast of Golden. Of this total, 2,348 tons was sent to Industrial Fillers, Limited (formerly Pulverized Products, Limited), Montreal, for grinding, and the remainder to the plant of Summit Lime Works, Crow's Nest, Alberta, where it was ground for local use in drilling mud.

Production and Trade

Barite shipments by Canadian Industrial Minerals, Limited and by Mountain Minerals, Limited totalled 128,635 short tons valued at $1,380,355, compared with 120,419 tons valued at $1,006,473 in 1946. Of the 1947 primary mine shipments, 70,540 tons was crude ore and 58,095 tons, ground material. Nova Scotia supplied 125,760 tons, and British Columbia, 2,875 tons. The domestic market took 2,279 tons of the 1947 production, mostly in the ground form.

Industrial Fillers, Limited, Montreal, reported sales of 1,907 tons of ground British Columbia barite in 1947 valued at $73,309, of which 1,139 tons was sold for domestic use and 768 tons was exported to European countries.

Exports of barite (not shown separately in trade statistics) approximated 137,000 short tons valued at $1,525,204, of which 55 per cent was crude and 45 per cent ground material. These figures compare with 106,533 tons exported in 1946 valued at $998,177, of which 72 per cent was crude and 28 per cent ground barite. Of the exports of crude in 1947, totalling 74,696 tons, 75 per cent was consigned to the United States for use in the manufacture of lithopone and barium chemicals, and 25 per cent to the United Kingdom and other European markets. Of the exports of ground barite, totalling 62,288 tons, 90 per cent was sold for oil-well drilling use in the West Indies and South America, and 10 per cent went to European buyers.

Imports of ground barite, all from the United States, totalled 1,737 short tons valued at $51,060 in 1947.

Pre-war world output of barite was approximately 1,000,000 tons a year, 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 because of 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 725,223 short tons, 5 per cent more than in 1945. Arkansas produced 40 per cent of the total, almost all of which was used for oil drilling, and Missouri, 38 per cent. Georgia, Tennessee, California, Nevada, and Arizona supplied the remainder.

Uses, Specifications

Estimated Canadian consumption of barite in 1947 was 4,057 short tons, of which 4,017 tons was ground material and 40 tons, crude. Consumption of ground barite in Canada in 1946, as reported to the Dominion Bureau of Statistics by users, was 2,838 short tons. This does not include material used in oil-well drilling muds. Distribution by industries was as follows: paint, 1,711 tons; rubber, 461 tons; glass, 266 tons; miscellaneous, 400 tons. Eighty-one per cent of the total was divided about equally between users in Ontario and Quebec.

Crude lump barite is used to make lithopone, an important white pigment and filler material, and in many barium chemicals. For these uses, barite must 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. The above products are not made in Canada, but they are produced on a large scale in the United States.

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 $BaSO_4$ must usually be not less than 95 per cent. Ground barite is used chiefly as a heavy, inert filler or loader in rubber, asbestos products, paper, linoleum and oilcloth, textiles, leather, and plastics. It is an important pigment and extender in paints, and is 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. Much barite is used as a batch fluxing ingredient for moulded flint glass, for which use 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.

Barium carbonate is the principal intermediate salt used in making other barium chemicals. It is used to prevent the unsightly white efflorescence (scumming) in bricks and other heavy clay products, and to case-harden 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 nitrate has important military uses for flares and tracers. Barium titanate has high electrical insulating properties and is specially adapted for use in radio equipment. Porous barium oxide is produced in the United States for use as a dessicating agent for laboratory work.

Barium metal has only limited industrial uses. 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 begun in Canada in 1946 at the magnesium plant of Dominion Magnesium, Limited, at Haley, near Renfrew, Ontario.

Prices and Tariffs

The average unit price of domestic crude barite of white, pigment grade in 1947 was $8 per short ton f.o.b. mine. Ground, off-colour barite exported for oil-well drilling use averaged $15.30 per ton f.o.b. Atlantic ports, and off-colour crude, $7.30 per ton. Ground white for pigment and filler use averaged $38.50 per ton f.o.b. mill.

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 per 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 duty of $4 per ton on crude barite was reduced to $3.50 as from January 1, 1948, but the duty of $7.50 per ton on ground or otherwise manufactured material remains unchanged. 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 sold in various sizes, from lump to 300-mesh powder, the $BaCO_3$ content of which ranges from 90 to 95 per cent. United States quotations on 300-mesh witherite in 1947 were $65 per ton, in carload lots, and on air-floated material, $65 per ton.

BENTONITE

All of the production of bentonite in Canada in 1947 continued to come from Manitoba and Alberta. Sales of processed clay in Manitoba, most of which was activated material for the decolorizing of petroleum products, increased nearly 11 per cent over 1946. Mine shipments of crude bentonite in Alberta showed a rise of 84 per cent in quantity and 96 per cent in value. Most of the Alberta clay, after processing by drying and grinding, is sold for local oil-well drilling use.

Alberta bentonite is of the highly colloidal, swelling type, suitable for controlling the viscosity of oil-drilling muds and for foundry use, while the Manitoba clay is of non-swelling character. The latter possesses bleaching properties in the crude state, but these are enhanced by activation (treatment with sulphuric acid). The material also meets certain foundry requirements. The Alberta and the Manitoba bentonite are of Cretaceous age, and occur in beds intercalated with clay, shale, and sometimes coal seams.

In 1946, discovery was made of bentonite beds of Devonian age in the Gaspe Peninsula, Quebec. Most of the beds are thin and the material is rather impure, only about 40 per cent of it being bentonitic. For this reason, and since the deposits outcrop in a steep cliff-face on the seacoast and are difficult of access, it is doubtful if they are of much economic interest.

Principal Canadian Sources of Supply

In Manitoba, production comes from the Morden-Thornhill area in the southern part of the province, where initial small-scale development was commenced in 1934. Production in recent years has been confined to operations by Pembina Mountain Clays, Limited, 915 Paris Bldg., Winnipeg, which ships the dried, ground clay to its plant at Winnipeg for activation. To the end of 1947, output of crude bentonite in the province is estimated at approximately 26,000 tons. In 1947, the Provincial Mines Branch reported the discovery of further deposits south of Thornhill.

In southern Saskatchewan there are a number of scattered occurrences of bentonite, some of which are associated with deposits of volcanic ash. There has been no production in recent years, but occasional small shipments were made in the past from certain of these deposits.

In Alberta, production is derived from several sources in the Drumheller area, Red Deer Valley, North of Calgary. In 1947, the following reported shipments of crude bentonite: Gordon L. Kidd, and Aetna Coal Company, Drumheller; Sovereign Coal Mines, Wayne; and Western Gem and Jewel Collieries, Limited, Cambria.

In British Columbia, bentonite beds up to 9 feet thick occur at Princeton and near Merritt, south of Kamloops. There has been no production from the area for several years, but intermittent small shipments were made in the past from the Princeton deposit by Francis Glover, 969 Jarvis Street, Vancouver, most of which went to Vancouver for grinding and local use.

Production and Trade

As reported to the Bureau of Mines, mine shipments of crude bentonite in Canada in 1947 totalled 13,060 tons, of which 11,000 tons came from Manitoba and 2,060 tons from Alberta. Alberta shipments were valued at $10,388 f.o.b. rail and compare with 1,118 tons valued at $5,306 in 1946.

Sales of activated bentonite from Manitoba in 1947 approximated 4,500 tons compared with 4,065 tons in 1946. Total quantity of processed products sold, including clay used mainly for oil drilling and activated material for bleaching use, is estimated at approximately 6,000 tons valued at $306,882 f.o.b. Calgary and Winnipeg, respectively.

Imports of activated clay, all from the United States, in 1947 were valued at $242,483, compared with $267,519 in 1946. 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 1946 reached a record of 601,428 short tons valued at $4,361,414. Almost 66 per cent of the total came from the Wyoming-South Dakota region, and the remainder from Arizona, California, Colorado, Mississippi, Montana, Texas, Utah, Nevada, and Oklahoma.

Bentonite occurrences are known in a number of countries, in some of which a substantial bentonite industry has been developed. Production was reported to have commenced in 1942 in French Morocco and Algeria, where output is stated to be about 20,000 tons a year. Most of the material is sold in France and the United Kingdom where, owing to the post-war exchange situation, it has displaced a certain tonnage of United States clay. In Germany (Bavaria), non-swelling bentonite resembling that produced in Mississippi has been mined for many years. Prior to 1940, output was about 70,000 tons a year. All of the crude material is activated or otherwise processed, and under the trade names, Tonsil, Granosil, and Tixoton, is used for bleaching purposes. Italy and New Zealand also have produced small quantities of bentonite. Bentonite also occurs in India, Japan, China, Russia, Turkey, Poland, Rumania, France, Czechoslovakia, Mexico, and Peru.

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. For the last use its thixotropic properties (inversion of clay-water suspensions from the gel to sol state on agitation) and low filter-rate make it indispensable for thickening the mud used in rotary drilling, suspending and bringing to surface the drill chips, and building up a wall around the hole. The colloidal, or swelling type of bentonite has a wide range of minor uses, including the bonding and plasticizing of ceramic and refractory bodies, thermal and acoustical insulation, ore briquettes for smelting operations, and other mineral aggregates; as a detergent in laundering, and as a carrier in horticultural sprays and insecticides; as a filler in paper, rubber, and other products; and as a coagulant for clarifying wines, sugar liquors, turbid water, and industrial waste affluents. It is used in wet-mash poultry and stock feeds, polishes, water paints, adhesives, and asphalt emulsions; as a concrete admixture; in mortars; and for preventing water seepage around dams, irrigation ditches, reservoirs, and structural foundations. Newer applications include the use of acid-washed and baked clay as a desiccant to prevent atmospheric moisture from attacking stored machines and entering packaged goods; and for coating small seeds in order to increase their bulk and facilitate sowing.

For most industrial uses, natural bentonite is sold ground to 200-mesh powder, weighing 55 to 60 pounds per cubic foot. Standard procedure consists in drying the crude clay in rotary dryers fired with oil or natural gas, followed by grinding in air-swept, Raymond-type roller mills combined with air separators.

Activated bentonite for bleaching of petroleum products, animal and vegetable oils and fats, etc., is made by leaching a bentonite-water slurry with sulphuric or hydrochloric acid in closed vats into which live steam is fed, the contents being kept under agitation. Batches contain up to 10 to 12 tons of slurry and are maintained at boiling temperature for about one hour. Total processing, including the cooling-off period, requires about 10 hours. The leached slurry is pumped to filter-presses where it undergoes washing until neutral. Part drying of the filter-cake may be effected by blowing compressed air through the presses, followed by final drying in a rotary or other type of dryer, and pulverizing.

Most of the output from Manitoba undergoes activation and is used in bleaching petroleum products, though sales have also been made to linseed oil plants, packing houses, and to firms engaged in reclaiming crankcase oil. The material from Alberta is shipped to Alberta Mud Company, 502 Lancaster Building, and to Western Clay and Chemical Supply Company, 201 Lancaster Building, both at Calgary, for drying and grinding for use mainly in oil-well drilling in the province. Alberta bentonite has also 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 sands area.

As reported by the Dominion Bureau of Statistics, Canada in 1947 used 16,358 tons, compared with 15,000 tons of domestic and imported natural and activated bentonite in 1946. Consumption by industries in 1947 was: steel furnaces, 3,095 tons; iron foundries, 1,800 tons[1]; petroleum refining, 8,252 tons; oil-well drilling, 2,000 tons[1]; soaps, 794 tons; pulp and paper, 220 tons; miscellaneous, 197 tons.

In the United States, about 38 per cent of the 600,000 tons sold in 1946 was used for oil drilling, 27 per cent by foundries, and 24 per cent for oil filtering and bleaching. Wyoming and South Dakota furnished most of the highly colloidal bentonite used for drilling and by foundries. California and Mississippi supplied most of the non-swelling type for activation use.

Prices and Tariffs

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 1947 for \$4.50 to \$5.50 per short ton, f.o.b. mines; material processed for oil-drilling use was priced at \$35 per ton, bagged, f.o.b. plant. Activated bentonite for bleaching use cost about \$63 per ton in bulk carload lots, delivered eastern Canadian points.

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[1] Partly estimated.

The average consumer price for Wyoming standard 200-mesh bentonite in 1947 was $11 per ton, bagged, in carload lots, f.o.b. plant, as compared with $9.50 in 1946. Special grades were quoted at $18 and up. Dried, unground $\frac{1}{4}$-inch to 20-mesh material sold at $8.50 to $9 per ton, bulk, in carload lots. Mississippi bentonite, natural, ground, 200-mesh material, was priced at $13.25, in carload lots, f.o.b. plant.

The duty on unmanufactured bentonite entering the United States is 75 cents per ton, and on manufactured, $1,625 per ton. Bentonite, not further manufactured than ground, enters Canada free. Activated bentonite, for oil-refining use, imported into Canada, pays 10 per cent ad valorem.

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 Department of Mines and Resources, Ottawa, at the request of the Oil Controller for Canada. From 1942 to 1946, inclusive, two hundred and seventy-three holes were drilled in the Wheeler Island area, the Horse River Reserve near McMurray, the Steepbank area, the Muskeg River area, and the Mildred-Ruth Lakes area. Drilling was continued until March 1947, and in the three months ended March of that year, eleven holes were drilled with a total footage of 2,190 feet. This completed the drilling in the Mildred-Ruth Lakes area, which comprised seventy-two holes aggregating 16,464 feet. Based on the assays of these drill-cores it has been estimated that this area contains at least 350 million barrels of bitumen[1]. An interesting result of this drilling was the discovery of beds of bitumen with a relatively low sand content, interstratified with the bituminous sand.

Production

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

A fire in June 1945 destroyed the separation plant, warehouse, and machine shops of Abasand Oils, Limited, and no bituminous sand has been processed since.

In November 1946, the Dominion Government returned to Abasand Oils, Limited the properties and leases that the company had transferred to the Government during the war.

Under an arrangement with Oil Sands, Limited, a pilot-scale separation plant was being erected in 1947 under the auspices of the Alberta Government at Bitumont, about 50 miles down the Athabaska River from Fort McMurray.

[1] "Results and Significance of Drilling Operations in the Athabaska Bituminous Sands"; G. S. Hume; Can. Inst. of Min. and Met., Trans. 1947, pp. 298-333.

CEMENT

The Canadian cement industry experienced one of its best years in 1947. The value of production was the highest ever attained and the volume was exceeded only in 1929 when the production was 12,284,081 barrels. During part of the year the demand for cement was much greater than the domestic supply and could be satisfied only in part by imports. This demand was occasioned by record activity in the construction industry where the value of construction exceeded that of any previous year. An even greater demand for cement is expected in the future and the industry is preparing for this by a program of expansion that is already under way. A new kiln with a capacity of 1,100,000 barrels annually was put into operation at Montreal in 1947; a kiln with a capacity of 700,000 barrels a year is scheduled to start production at Exshaw, Alberta, early in 1948; another with a capacity of 1,200,000 barrels a year is expected to be ready at Belleville, Ontario, in 1949; and a kiln with an annual capacity of 900,000 barrels will be operating at St. Mary's, Ontario, in 1948 or 1949. British Columbia Cement Company, Limited has announced that it intends to build a new plant of 700,000 barrels annual capacity at Deep Bay on the east coast of Vancouver Island, opposite Denman Island.

Principal Canadian Sources 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.

Production, Trade, and Uses

Production of cement in 1947 was 11,936,245 barrels valued at $21,968,909, compared with 11,560,483 barrels valued at $20,122,503 in 1946.

Exports of Portland cement decreased to 308,105 cwt. valued at $198,354 from 400,296 cwt. valued at $236,276 in 1946. Most of the exports went to Newfoundland, and to Trinidad, Jamaica, and other British West Indies islands.

Imports of Portland cement rose to 4,370,189 cwt. valued at $3,843,652 from 1,225,199 cwt. valued at $1,098,532 in 1946. These imports in 1947 were from the United States, Belgium, and United Kingdom. In addition to the finished cement, 99,619 cwt. of white Portland cement clinker valued at $64,054 was imported from the United States for grinding in Canada, compared with 50,037 cwt. valued at $30,147 in 1946.

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, Limited, which operates a plant at Bamberton, British Columbia.

The present total rated daily capacity of all plants is about 40,000 barrels (a barrel of cement weighs 350 pounds net), but this will be substantially increased when new production units commence operation.

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, and 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 1947 were as follows:

—	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
Quebec	$1·35	$1·35	$1·41	$1·43	$1·46	$1·44	$1·46	$1·54	$1·57	$1·70
Ontario	1·40	1·43	1·40	1·40	1·43	1·46	1·46	1·55	1·64	1·74
Manitoba	2·28	2·25	2·23	2·21	2·10	1·89	1·96	2·11	2·24	2·21
Alberta	2·01	1·97	2·01	2·00	1·96	1·94	1·96	2·01	2·02	1·98
British Columbia	1·87	1·91	1·94	1·97	2·07	2·14	2·12	2·12	2·25	2·10

CLAY AND CLAY PRODUCTS

Production continued to lag far behind demand in 1947, chiefly because of the increase in demand, since the war, for such products as structural and architectural clay units, electrical porcelain, refractories, ceramic bathroom and kitchen equipment, and ceramic household ware. Other factors were the shortage of labour, and difficulty in obtaining suitable raw materials and capital equipment.

The products from domestic clays comprise building brick, structural tile, drain tile, roofing tile, sewer pipe, stoneware, pottery, and refractories. Those from imported clays comprise electrical porcelain, sanitary ware, sewer pipe, tableware, pottery, ceramic floor and wall tile, thermal insulating materials, and various kinds of refractories. The value of clay products made from Canadian clays, including sales of domestic clays, was $14,486,189 in 1947, compared with $12,207,367 in 1946. The value of clay products made from imported clays in 1947 is not available. In 1946 it was $7,073,371.

Large quantities of clays and various kinds of clay products are imported. Imports of clays, including bleaching clays, in 1947 were valued at $2,026,941, and imports of clay products at $22,032,331. The corresponding figures in 1946 were $1,553,845 and $16,271,438.

Exports of clay and clay products in 1947 were valued at $1,182,900.

Common Clays

Common clays suitable for building brick and tile occur in all the provinces of Canada, but clays or shales suitable for high-quality brick and other clay products are not plentiful. This has made it difficult to establish new plants in the Dominion. However, good brick clays or shales occur near Toronto, Hamilton, Montreal, and in the eastern and western coastal areas, and there is a large production of good-quality brick and structural tile. Good-quality structural clay products are also produced in the Prairie Provinces. There has been a great demand for light-weight concrete aggregate. "Haydite" (shale bloated by heat treatment) is produced regularly in a large plant near Toronto, but the demand far exceeds the supply of material suitable for making light-weight structural units.

Developments in production methods include: the use of continuous tunnel kilns instead of periodic kilns to increase production and to save fuel and labour; the increased use of mechanical lifting, conveying, and loading equipment; and better control over raw materials used and processing methods, thereby reducing losses and increasing the percentage of first-quality products.

The value of structural clay products made from domestic clays (including drain tile, roofing tile, and quarry tile) was $10,781,525 in 1947, compared with $8,813,107 in 1946.

Stoneware Clays

The largest production in Canada of stoneware clays is in the vicinity of East End in southern Saskatchewan. The clay is selectively mined and shipped to Medicine Hat, Alberta, where, because of cheap natural gas, it is used extensively to make a wide variety of stoneware and caneware articles, sewer pipe, pottery, etc. Semi-porcelain type tableware is made in Medicine Hat from china clay imported from southern United States. Efforts are being made by the operating companies to develop a suitable semi-porcelain body using Saskatchewan ball clays in conjunction with nepheline syenite and certain other ingredients.

Modernization of plants was continued in the Medicine Hat area. Tunnel kilns and improved drying systems have been installed, forming practices have been improved, and efforts have been made to improve efficiency and control of production generally. Because of the low cost of fuel it is possible that certain classes of clay products made in the Medicine Hat area can be marketed as far east as the Atlantic seaboard.

The stoneware clays or semi-fireclays that occur associated with the fireclays in the Sumas Mountain, south of Vancouver, are utilized on a large scale to make sewer pipe, flue liners, and certain other stoneware products.

Stoneware clays and moderately refractory fireclays that occur near Shubenacadie and Musquodoboit, Nova Scotia, have been used for the production of pottery, certain stoneware products, and low-grade refractories, but have not been extensively developed for ceramic use. Stoneware clays or semi-fireclays also occur near Williams Lake and Chimney Creek Bridge in British Columbia, and near Swan River, Manitoba, but have not been developed as they are difficult of access.

Throughout Ontario and Quebec, stoneware clays where needed must be imported.

The value of stoneware articles (sewer pipe, pottery, etc.) produced in Canada from domestic clays was $2,381,018 in 1947, compared with $2,550,317 in 1946.

Fireclays

Two large plants and a few small plants make fireclay refractories from domestic clay. At a plant about 50 miles south of Vancouver, firebrick and other refractory materials are made on a large scale from the high-grade, moderately plastic fireclay extracted by underground mining from the clay beds in the Sumas Mountain. Other smaller enterprises established in recent years in this area make refractories or allied products from the Sumas Mountain material. Some of this material is exported to the northwestern states of the United States for refractory use. A plant at Claybank, Saskatchewan, uses the highly plastic refractory clays obtained by selective mining of the "Whitemud" beds in the southern part of the province.

The steel plant at Sydney, Nova Scotia, has used a small amount of the most refractory clays in the deposits near Shubenacadie for refractory purposes.

Some of the Musquodoboit clay has been used for the production of stove linings. Other production of fireclay refractories (firebrick, high-temperature cements, plastic refractories, etc.), particularly in Eastern Canada, is from imported clays. Extensive deposits of what may be termed plastic fireclays occur in the Mattagami, Missinaibi, and Abitibi Rivers in northern Ontario, but their remoteness and certain difficulties attending efforts to extract uniform high-quality material have seriously handicapped their development. There is a definite lack of fireclays in Eastern Canada. However, they can be imported, duty free, from the United States if not further processed than ground, and this has a decisive bearing on the development of Canadian deposits distant from consuming centres. Deposits of such alumina, or alumina-silica, minerals as bauxite, sillimanite, kyanite, and andalusite, valuable in making super-duty refractories, have either not been found in commercial quantities, or suitable methods of mining and recovering them have not been applied.

The value of refractories produced in Canada from domestic clays in 1947 was $559,358, compared with $458,886 in 1946. The value of refractories made from imported clays is not available. The value in 1946 was $1,097,151.

China Clay and Ball Clay

China clay (kaolin) has been produced commercially in Canada only in the vicinity of St. Remi d'Amherst, Papineau county, Quebec, where a large plant was established several years ago to extract the kaolinized material by underground mining methods, refine it into high-grade china clay, and to recover washed silica sand as a by-product. Production of china clay on a large scale was abandoned because of mining and operation difficulties, but silica sand suitable for the glass and other ceramic industries has been produced regularly since the plant came into operation.

Several smaller deposits of kaolin have been discovered in Quebec, one near Point Comfort, Thirty-one Mile Lake, Hull county, others near Brébeuf, Lake Labelle, and Chateau Richer; but none of these has been developed.

The clay deposits in northern Ontario, mentioned under fireclays, also contain material that may be classified as crude china clay. In British Columbia, along the Fraser River, about 25 miles above Prince George, parts of the extensive clay deposits yield high-grade kaolin. However, they are distant from industrial centres and have not been developed.

High-grade ball clays are associated with the extensive clay deposits of southern Saskatchewan, and are being used by the potteries in the Medicine Hat area. There has also been a limited demand for these highly plastic ball clays in the United States.

China clay imported from England and the United States is used to make electrical and other porcelains, sanitary ware, tableware, ceramic floor, and wall tile, etc. Because of the few plants in Canada making these products, output figures are not given. Large quantities of china clay are imported for use in the paper and rubber industries. The value of imports of china clay in 1947 was $1,197,977.

Industrial Developments

In addition to the foregoing developments the following may be briefly noted:

Production of steatite electrical insulators for high-frequency and other purposes was resumed on a small scale.

Porcelain-enamelled, heavy gauge sheet-steel sanitary ware (bathtubs, sinks, etc.) is being made in Canada. Formerly, only light gauge porcelain-enamelled sheet-steel products of this type were produced. However, the pressed special steel shapes required for such heavy gauge enamelled ware are imported from the United States.

Several new art potteries have been established, some of which make novelty ware for the tourist trade. Others, founded on the experience of Old Country craftsmen, have aimed at the production of the finer grades of ceramic artware, such as had been produced in Europe. However, the market for art pottery fell off sharply in 1947 because of an influx of European ware.

CORUNDUM

No corundum has been produced in Canada since October 1946, when treatment of the old tailings at the Craigmont property, Renfrew county, Ontario, for the recovery of corundum was completed. This operation was undertaken during the war at the request of the United States Government. During the two years of operation about 2,600 tons of concentrate was shipped from the property to American Abrasive Company, Westfield, Massachusetts, the only handler of corundum on the Continent.

Shipments from the Transvaal to the United States did not improve and in the summer of 1947 American Abrasives Company asked for the co-operation of the Canadian Department of Mines and Resources, and engaged the services of an engineer to thoroughly investigate the possibility of supplying the deficiency from Canadian deposits. Results of preliminary examinations of several deposits and of tests on bulk samples sent to the Bureau of Mines, Ottawa, were encouraging.

The main zone and the only one from which production has been obtained is in a belt 100 miles long and 6 miles wide in Haliburton, Hastings, and Renfrew counties in Ontario. Several of the numerous deposits examined recently contain fair amounts of corundum, the most promising being an extensive deposit in Monteagle township on the east side of the York River, about 10 miles northeast of Bancroft. (For a description of corundum-bearing nepheline syenite belts of south and eastern Ontario, *see* Report No. 820 "The Canadian Mineral Industry in 1945", page 53, issued by the Bureau of Mines, Ottawa). It is doubtful, however, if the production of corundum alone would be economic and, consequently, marketable by-products would be necessary. Present indications are that a large tonnage of good-quality nepheline feldspar product suitable for the glass trade, as well as fine mica for fillers and for backing, can be extracted from the Monteagle deposit, in addition to high-quality, fine-grained corundum.

Production and Trade; Uses

Canada imported about 50 tons of coarse-grained corundum for use in the manufacture of snagging grinding wheels, and also a small quantity of flour corundum.

Most of the world production of corundum during the past 30 years has come from the Transvaal, from which production in 1947 was 2,500 tons. Prior to 1946 most of the output was crystal, but the tonnage of concentrate, first produced in 1944, is now nearly three times that of crystal. The ores of the Transvaal vary from 20 to 50 per cent corundum.

The United States is by far the leading consumer of corundum and uses from 4,000 to 6,000 tons annually. Most of it is used as a flour to polish lenses, and the remainder as coarse grain for snagging wheels. For these purposes it is more suitable than artificial abrasives for certain types of work.

United States prices of South African crystal and concentrate were $100 and $110 per ton in 1947. Prices of prepared grain and flour corundum vary considerably according to mesh size, and were 8¾ cents per 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

Production of diatomite in Canada in 1947 amounted to only 115 tons, the peak year being 1933, when about 1,800 tons was produced. Thus, practically all of the Canadian requirements are imported, the sources of these imports in 1947 being the states of California, Oregon, and Washington. In Canada, diatomite is used chiefly as a fertilizer dusting agent. Tests by various companies to determine the suitability of Canadian material for this use were continued with some further success in 1947.

Principal Canadian Sources of Supply

All of the Canadian production of diatomite since 1939 has come from deposits in the swamps and lake bottoms of northern Nova Scotia; in southern British Columbia; in the Muskoka area, Ontario; and in various parts of British Columbia. Production in 1947 came from two deposits, one at Digby Neck, Nova Scotia, operated by G. Wightman, and the other on Lot 1122 on the west bank of the Fraser River, north of Quesnel, British Columbia, operated by L. T. Fairey of Vancouver. The Tertiary fresh-water deposits near Quesnel in the Cariboo area 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.

The Nova Scotia Department of Mines completed its investigation that was started in 1946 of some of the diatomite deposits of the province, particularly those along Digby Neck.

In New Brunswick, deposits of diatomite in the vicinity of Saint John that were examined by the Resources Development Board, Fredericton, in 1946, were being prospected by a Boston group. The deposits are owned by Murray Campbell of Saint John.

Production and Trade

Production of diatomite in 1947 was about 115 tons, and sales, 103 tons valued at $2,677, compared with sales of 90 tons valued at $2,532 in 1946. Imports were 15,074 tons valued at $431,125, compared with 17,063 tons valued at $469,968 in 1946.

The United States is the leading producer and most of the output is by two companies, namely, Johns-Manville Corporation (Celite Division) from deposits at Lompoc, California, and 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. About half of the diatomite exported to Canada for fertilizer use comes from Kittitas, and the remainder from California and Oregon.

Uses, Specifications

Canada used approximately 15,000 tons of diatomite in 1947, of which 7,452 tons was used as a fertilizer dusting agent; 6,000 tons for filtration; and the remainder mainly as a filler in the paint, chemical, paper, rubber, soap, and textile industries. Small amounts are used 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.

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 plants at Trail, British Columbia, and in Calgary, Alberta, 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 and coats the small grains or nitraprills, which prevents caking and ensures even spreading. Specifications call for uncalcined material of 325 mesh and less than 5 per cent moisture. Much of the output of these fertilizers is exported to Europe.

Prices

The price of diatomite used in Canada for fertilizer grades varies from $38 to $42 a ton; for filtration from $33 to $75 per ton; and for insulation from $23 to $40 a ton. For material suitable for polishes the price for small lots ranged up to $200 a ton in 1947. Imported insulation bricks vary in price from $85 to $140 per 1,000, according to grade and density.

FELDSPAR

Feldspar production in Canada in 1947 showed little change from 1946. It all came from Quebec and Ontario. Ontario, with increased shipments from two reopened old mines, accounted for 19 per cent of the tonnage, as against 15 per cent in 1946. About 43 per cent of the total Canadian output was ground feldspar for domestic uses. The remainder was exported in the crude form to grinding mills in the United States.

Principal Canadian Sources of Supply

Feldspar mining in Canada has been confined almost entirely to adjacent sections of western Quebec and eastern Ontario. Most of the Quebec production has come from the Buckingham area, Papineau county. In Ontario, chief centres of production have been the Perth area, Lanark county; the Verona area, Frontenac county; Hybla, Hastings county; Mattawa and Madawaska, district of Nippissing; and the Georgian Bay area. districts of Sudbury and Parry Sound. In Manitoba, a few thousand tons was mined in the Winnipeg River area between 1933 and 1939.

In Quebec, Canadian Flint and Spar Company, with mines in Derry, Buckingham, West Portland, and Templeton townships, Papineau county, accounted for the great bulk of the output. Bon Ami, Limited, and a few other small operators also made shipments from properties in the same general area. Certain mines in the section have produced small tonnages of selected high-grade dental spar, shipments of such material reported in 1947 being 5 tons.

In Ontario, the leading producers were: Opeongo Mining Company, operating the old McQuire mine in Conger township, Parry Sound district; Bathurst Feldspar Mines, Limited, in Bathurst township, Lanark county; and Canadian Flint and Spar Company, operating the old Richardson mine in Bedford township, Frontenac county. Late in 1947, Opeongo Mining Company moved its operations to the old Cameron (Five-Mile) property in Dickens township, near Aylen Lake, Nipissing district, worked in 1945 by Conger Mines, Limited.

In December, the McQuire mine was taken over for operation by E. Shaw, who continued shipment under contract to Canadian Flint and Spar Company. Earlier in the year the same operator shipped a few tons from a deposit on the Albert Burger property near Eganville, in Renfrew county. Canadian Flint and Spar Company commenced development of a deposit in Hawley township, south of Markstay, in Sudbury district, but made no shipments. In Bathurst township, Lanark county, T. H. Craig shipped one carload from a newly opened extension of the deposit on the old Charles (Card) property. In the same township, Laurentian Feldspar Company did about 3,000 feet of diamond drilling on two of its properties, most of it on the Foster farm, but made no shipments.

Production and Trade

Production of feldspar in 1947, including both crude and ground material, totalled 36,104 short tons valued at $381,360, compared with 35,243 tons valued at $384,677 in 1946. Quebec supplied 29,146 tons (81 per cent of the total) and Ontario, 6,958 tons. In 1946 Quebec supplied 29,758 tons (85 per cent) and Ontario, 5,485 tons.

Production of ground feldspar, comprising ceramic and cleanser grades, was valued at $244,560. Not included in this figure is cleanser grade material ground for its own use by Bon Ami, Limited, Montreal.

Exports, which comprised mainly ceramic grades of crude, but included also some ground feldspar and a few tons of high-value crude dental spar, totalled 18,311 short tons valued at $120,998, compared with 19,239 tons valued at $140,403 in 1946. The quantity was about 52 per cent of the 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 316 short tons valued at $7,821, compared with 705 tons valued at $13,622 in 1946.

Statistics on world production of feldspar are incomplete. The United States Bureau of Mines gives an estimate of 650,000 metric tons in 1946, but points out that this total does not include the output of several countries (Brazil, China, Czechoslovakia, and Russia) for which little data are available. The United States is by far the largest producer, and in 1946 accounted for approximately 75 per cent of the estimated world output. North Carolina is the leading producing state, with 45 per cent of the 1946 output, followed by South Dakota, Colorado, Virginia, Wyoming, Maine, Connecticut, and New York. Sweden, Norway, Canada, Italy, Germany, and Australia are the other leading world producers.

Uses, Specifications

As reported by the Dominion Bureau of Statistics, consumption of feldspar in Canada in 1946 (figures for 1947 not available) totalled 13,114 short tons, compared with 12,994 tons in 1945. Distribution by industries was: clay products, including pottery, tile, insulators, etc., 4,800 tons; cleansers, 4,099 tons; glass, 2,701 tons; enamelling, 1,499 tons; and abrasives, 15 tons. Clay products showed the largest increase, the amount being nearly double that used in 1945. Quebec used about 53 per cent of the total consumption, Ontario, 45 per cent, and Alberta, the remainder.

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, while Bon Ami uses its product in making cleanser compounds.

By far the greater part of the world production of feldspar (nearly 99 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.

All of the feldspar hitherto supplied to grinding mills has 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. Five such mills were in operation or under construction in 1947.

Prices and Tariffs

The average price quoted by Canadian producers for standard grades of crude ceramic and cleanser feldspar during 1947 was $7.50 to $8.50 a short ton, f.o.b. rail, for export or shipment to domestic mills. Special, high-quality ceramic crude sold up to $13. The average declared unit value of all crude feldspar exported to the United States in 1947 was $6.50 a short ton. The declared value of selected dental spar exports was $118 a ton. Domestic ground feldspar was quoted at $12.50 a short ton for granular glass grade, and $18.50 to $22 for 200-mesh pottery grades, all in carload lots, f.o.b. mill.

Under the new Multilateral Trade Agreement, effective January 1, 1948, the import duty on crude feldspar entering the United States remains unchanged at 25 cents per long ton; on ground feldspar, the former duty of 15 per cent ad valorem is reduced to 10 per cent.

FLUORSPAR

The entire production of fluorspar in Canada in 1947 continued to be derived from the long-established source in the Madoc area, Hastings county, Ontario, where four mines were in operation. Total shipments showed a decrease of about 11 per cent in quantity and value from the figures for 1946. Total production from the inception of mining in 1905 to the end of 1947 is estimated at nearly 120,000 short tons valued at $2,620,000. Canada is deficient in fluorspar and depends largely upon imports to fill domestic requirements.

Canadian Sources of Production

The Madoc deposits furnished about 63 per cent of the total Canadian production from 1905 to the end of 1947. Peak production was in 1943, when 10,385 tons was shipped. In 1947, the following producers made shipments: Reliance Fluorspar Mining Syndicate, Limited, operating the Rogers mine; Millwood Fluorspar Mines, Limited, (Bailey mine); Charles Stoklosar, (Blakely mine); and Fluoroc Mines, Limited, (Johnson mine). The first two companies accounted for nearly 90 per cent of total sales. During the year, Reliance Fluorspar Mining Syndicate sank a 3-compartment shaft at the northwest end of its former workings, preparatory to opening two new levels at 175 and 225 feet. Millwood Fluorspar Mines also sank a further 70 feet and opened a new level.

Beneficiation of Madoc fluorspar is confined to screening out of fines from mine-run ore, followed by crushing and picking of washed 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 averaging 70 to 80 per cent grade. Calcite and barite are the chief gangue impurities.

Fluorspar, associated with calcite and apatite occurs as the filling of veins and pockets in bodies of pegmatite rock in Wilberforce-Harcourt district, Cardiff township, Haliburton county, about 50 miles north of Madoc, and various attempts at development of certain of these deposits have been made. In 1946, Fission Mines, Limited took over the former Ontario Radium Corporation and Richardson holdings east of Wilberforce and proceeded with a program of exploration of the fluorspar showings on these properties. This work was continued through 1947, when some 12,000 feet of drilling was done. Some ore has been stockpiled, but no shipments have been made. In the same area, Cardiff Fluorite Mines, Limited, in the past few years, has done considerable exploratory work by trenching, tunneling, drifting, and drilling on its holdings southwest of Wilberforce. Further work of this nature was continued during 1947, some ore was stockpiled, and the company reported that it was considering plans for a mill to treat its anticipated production. The ore of the Wilberforce area, where numerous surface showings exist, has a general average content of about 25 to 30 per cent CaF_2, and 5 to 10 per cent apatite, the remainder being calcite.

Near Cobden, in Ross township, Renfrew county, Ontario, there are several occurrences of fluorspar ore essentially similar in character to that of the Wilberforce area. Some of these were explored in 1944-45 by Dominion Magnesium, Limited, which was considering drawing on the deposits as a local source of fluorspar for the company's nearby plant at Haley, but so far this project has not been undertaken.

In Quebec, fluorspar ore similar to that of the Wilberforce area occurs in Huddersfield township, Pontiac county, and a few years ago some small-tonnage shipments of high-grade picked lump were made from one of the deposits.

In Nova Scotia, veins of fluorspar associated with barite and calcite occur in the Lake Ainslie district, Cape Breton Island, and during the war two of the deposits were worked and about 1,500 tons of run-of-mine metallurgical grade spar was shipped.

In British Columbia, the Rock Candy mine of The Consolidated Mining and Smelting Company of Canada, Limited, near Grand Forks, produced about 42,000 tons of fluorspar concentrate between 1919 and 1929, but has not been operated since. Near Birch Island, North Thompson River, drilling exploration was done some years ago on a deposit consisting of a fine-grained, intimate mixture of fluorspar, celestite, and feldspar, with considerable pyrite. Mill tests on a trial shipment of this ore by the Bureau of Mines, Ottawa, indicated that it is amenable to flotation concentration.

Production and Trade

Mine shipments of fluorspar in 1947 totalled 7,186 tons valued at $209,886, compared with 8,042 tons valued at $237,491 in 1946. All of it was of metallurgical grade, averaging 75 per cent to 85 per cent CaF_2, and was consigned mainly to domestic steel plants.

Imports of all classes and grades were 32,001 tons valued at $702,419 compared with 31,813 tons valued at $737,094 in 1946. Newfoundland supplied 84·6 per cent of the total, Mexico 12·3 per cent, and the United States 3·1 per cent.

Production in the United States in 1947 amounted to 329,484 short tons valued at $10,954,875, as compared with 252,000 tons in 1946.

Uses, Specifications

Consumption of fluorspar in Canada in 1947, as estimated by the Dominion Bureau of Statistics, was 41,279 short tons, compared with 29,995 short tons in 1946, and with a peak of 64,922 tons in 1943. Consumption by industries in 1947 was: steel furnaces, 18,768 short tons; non-ferrous smelters, 18,037 short tons; heavy chemicals, 3,534 short tons; glass, 752 short tons; enamelling, 244 short tons; white metal alloys, 44 short tons.

Consumption in the United States in 1946 totalled 303,000 short tons, of which 53 per cent was used in the steel trade, 28 per cent in the manufacture of acid, and 13 per cent in the glass industry.

Fluorspar is used chiefly as a powerful fluxing agent in basic open-hearth steel furnaces, and also in small 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 ranks third, and uses fluorspar as a fluxing and opacifying ingredient in glass and enamels. Uranium hexafluoride is used for the gaseous diffusion separation of the uranium isotopes U235 and U238 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 now being offered in small steel cylinders. 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 that is now only a waste material in the fertilizer industry. It is reported that a system to recover the gaseous fluorine discharged from the reduction pots has been installed 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.

Glass and enamel grades call for not less than 95 per cent CaF_2, with a maximum of $2\frac{1}{2}$ 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 97 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 1947 remained at $40 per ton, f.o.b. Toronto, and for ground, 97 per cent grade, $66 to $69. Madoc fluorspar, under individual contract, sold for $25.50 per ton for 70 per cent grade and $29.75 for 80 per cent, with a premium of 50 cents per ton for each unit of CaF_2 above 80 per cent. Average unit value of Madoc shipments was $29 per ton. Average declared unit value of fluorspar imports from Mexico was $18 per ton; from Newfoundland, $22; and from the United States, $34. The last probably included a proportion of acid and ceramic grades, neither of which is produced in Canada.

Tariff

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

GRANITE

(Building, Ornamental, and Crushed)

The granite industry in 1947 had not yet fully recovered from the economic effects of the war, but with some evidence of a return to construction of public and semi-public (banks, churches, etc.) building, the outlook was improving. During the past few years the demand for monumental stone has been the mainstay of the granite industry. This demand arises from the backlog of orders carried over from the war, and from markets that have developed in the United States for Canadian red and black granites. Canada produces many varieties of monumental stone fully the equal of some of that imported, but over the years the imported material, through extensive advertising and by rigid inspection as to soundness and freedom from blemishes has gained wide favour in the Canadian trade.

"Granite" as applied to commercial stone includes practically all igneous rocks as well as metamorphic rocks of igneous origin, which may be quarried for use as building, monumental, or crushed stone. Every province, with the exception of Prince Edward Island, has exposures of igneous rocks, and probably 30 per cent of the area of Canada is underlain by such rocks. In only a small percentage of this area, however, are the rocks economically suitable for the production of granite, considering such factors as qualities of the stone, nearness to transportation, and markets. Most of the production comes from Quebec, which has been the leading producer of granite for many years.

Granite is usually quarried in Canada for use as building stone or monumental stone. In both cases there is a large amount of waste in the quarries. Some of the large irregular blocks are used as riprap for breakwaters and causeways where there is heavy wash or currents to contend with, and some of the smaller pieces are crushed for concrete aggregate, or are used as poultry grit, paving blocks, or curbstones. However, these uses for granite waste are extremely limited compared to the amount of granite produced and consequently all quarries have large waste dumps.

Prior to the war, granite as a building stone was used chiefly as an ornamental stone in public and semi-public buildings. Since the war, however, there has been little construction of public buildings and only moderate activity in the construction of semi-public buildings. In the latter, alternative materials are used to a considerable extent rather than the expensive granite.

Principal Canadian Sources of Supply

Granite of all colours for monumental use is produced in the Maritime Provinces, and in Quebec, Ontario, Manitoba, and British Columbia. 'Black granite' is produced mainly in the vicinity of Lake St. John, Quebec, 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 British Columbia, granite was produced from several well-established properties, mainly in the Pacific Coast, Vernon, and Nelson areas, a large part of the output being andesite from Haddington Island for the building trade. Granites in the province are widely distributed and varied in character. Especially on the Pacific Coast, the industry is well developed and stone from some of the localities is marketed in all the western provinces. The grades being marketed are adequate and excellent in their class, but colour variation is somewhat lacking. Grey granite of varying shades are the predominant type being quarried, but stone of other colour is being worked on a small scale.

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

In Ontario, the Ontario Rock Company quarried trap rock at Havelock, Peterborough county, which is used mainly for road foundations, railroad ballast, and concrete aggregate. The granite industry in the province has been quiet for several years and most operations have been confined to the cutting of small bases and dies and to occasional local building contracts. None of the operations can handle large blocks without extra equipment. The formations in many districts contain rock of a quality that will stand the cost of long rail haul, and there appears to be good opportunity for development of local deposits for domestic use and for export.

In Quebec, grey granite comprises over half of the total output and is quarried mainly in the Stanstead, St. Samuel, and St. Gerard districts. 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 find a ready market for monumental use and for building trim. The National Granite Company, one of the large companies producing granite in this area had its cutting-shed destroyed by fire late in 1947. Brodies, Limited, Montreal, has a new cutting-shed at Iberville in full operation. The company obtains its grey granite from Graniteville, Stanstead county, its red granite from Guenette, Labelle county, and its dark grey granite 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. Scotstown Granite Company with a cutting-shed at Cap St. Martin, near Montreal, was very active in the production of Canadian granites. The types of granite quarried and finished by this company included red from Grenville and grey from Scotstown and Rivière à Pierre.

Prospecting for some of the coloured granites in demand for monumental use was active in the Laurentian uplands of the Canadian Shield, north of the St. Lawrence. There are good opportunities in these areas for the opening of quarries that can produce high-class monumental stock of such colours as jet black, deep red, green, and very light grey. If found in large and massive quarriable deposits there would be a good demand throughout Canada for such granite, and possibly also an export market. The suitability for commercial use of the numerous masses of granite in the aforementioned region has been determined only in a few localities.

In New Brunswick, a grey granite quarry at Hampstead was in production in 1947 and two firms at St. George produced some red granite for the monumental trade. Granite was quarried at Bathurst for building purposes. New Brunswick is well supplied with deposits of granite suitable for all uses. The industry is comparatively small at present, however, but from the economic viewpoint, the rough stock could be feasibly marketed throughout Canada and in the eastern United States.

In Nova Scotia, there was considerable activity in granite quarrying, and monumental stone was produced from the grey granite quarries in the Nictaux West area, and black granite from the Shelburne area. In both areas new equipment was added to existing plants and prospecting for new quarries was under way.

The granites in Nova Scotia, for the most part, are grey in colour and medium to coarse in texture. There is a small but steady market for the monumental trade within the province for the grey granite and for limited amounts of black granite.

Production and Trade

Canada produced 551,527 tons of granite valued at $3,175,364 in 1947, compared with 319,354 tons valued at $2,006,297 in 1946.

Imports of granite in 1947 were valued at $234,656 compared with $219,536 in 1946. Granite was imported from the United States, Sweden, Norway, and Finland mainly for monumental use.

Exports of granite and marble (granite is not recorded separately), unwrought, in 1947 was 4,500 tons valued at $65,447 compared with 5,277 tons valued at $82,008 in 1946. 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.

GRAPHITE

Production of natural graphite in Canada in 1947 continued to be confined to the single operator, Black Donald Graphite, Limited, with property near Calabogie, Renfrew county, Ontario. The company, a subsidiary of Frobisher Exploration Company, Limited, took over the former Black Donald Graphite Company's holdings in 1943, and has since continued to produce a variety of grades of mill products for different industrial uses. Sales of finished products in 1947 were 21 per cent higher by quantity and 15 per cent by value than in 1946.

Artificial graphite is made in Canada by Electro Metallurgical Company of Canada, Welland, Ontario.

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.

A large proportion of the Black Donald output in recent years was derived from the re-treatment of old mill tailings recovered by pumping or power-shovel from Whitefish Lake alongside the workings, but in 1947 this procedure was discontinued and the entire production came from crude ore, newly mined, or salvaged from old surface waste piles. Underground development comprised 161 feet of crosscuts, 178 feet of drifts, and 243 feet of raises, together with 1,500 feet of diamond drilling. This work was done on new orebodies located by earlier exploration, and resulted in the production of 7,764 tons of milling ore. A total of 13,952 tons of ore was milled, of which 7,701 tons was obtained from the aforementioned orebodies and 6,237 tons was salvaged on surface. Average carbon content of mill heads was 14 per cent, and carbon recovery, 77·4 per cent.

Plant additions during 1947 included a new crusher house of 150 tons daily capacity, and a primary grinding unit of 100 tons capacity. Ore reserves at the year end were estimated at 15,000 tons proven, with an additional 25,000 tons possible. Remaining tailings reserves were estimated at 5,000 tons. Number of employees totalled 88.

Production and Trade

Sales of finished products by Black Donald Graphite, Limited, in 1947 totalled 2,398 short tons valued at $207,364, compared with 1,976 tons valued at $180,405 in 1946. Of the total, 2,163 tons comprised amorphous and dust foundry grades, and 235 tons, fine lubricating flake. Of the sales in 1947, 1,930 tons (80 per cent) valued at $170,138 was exported, mainly to the United States, and 468 tons valued at $37,226 went to the domestic market.

Imports of unmanufactured graphite were valued at $69,348, compared with $98,847 in 1946. By value, 69 per cent of such imports was Mexican amorphous. The remainder was credited to the United States, but was probably wholly or largely of Ceylon, Madagascar, and/or Mexican origin. Imports of ground and manufactured graphite, exclusive of crucibles, were valued at $385,857, compared with $360,777 in 1946. The United States supplied 94 per cent by value, the same as in 1946, but the material was probably largely re-exported Ceylon, Madagascar, and/or Mexican graphite. Imports of graphite crucibles, including lids, stoppers, stirrers, etc., were valued at $135,894, compared with $142,053 in 1946. By value, 54 per cent came from the United Kingdom and 46 per cent from the United States.

Prior to the war world production of natural graphite of all types, and including flake, crystalline (plumbago), and amorphous, averaged about 200,000 short tons a year. Madagascar, Germany, Austria, and Czechoslovakia were the principal sources of flake; Ceylon, of plumbago; and Mexico and Korea, of amorphous. In 1943, world production was reported as about 300,000 tons.

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. Most of the deposits are comparatively low grade and production costs are high. The United States depends for most of its requirements of high-grade graphite upon imports of flake from Madagascar and of plumbago from Ceylon. Flake graphite of crucible grade is of high strategic importance, and is included in the United States Government list of minerals required to be stockpiled for national defence. The chief world source of such graphite is Madagascar, where, owing to labour troubles, currency fluctuations, and a landslide at one of the larger mines, production declined greatly in 1946, and in 1947 a revolution among the natives caused a further serious reduction in output. As a result, supply and stocks of crucible flake at the close of 1947 were extremely low.

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 of 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 also are made.

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.

Mexican amorphous graphite in the form of 4-pound briquettes 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.

Considerable quantities of specially refined artificial 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.

Prices; Tariffs

Trade journal quotations for flake graphite in the United States in 1947 ranged from 9 to 15 cents per pound, nominal, according to grade. Crude Ceylon lump, chip, and dust ranged from 12 cents to 5 cents per pound, according to carbon content. Madagascar crucible flake sold for 9 to 15 cents per pound, nominal, Mexican crude amorphous was quoted at $16 to $35 per ton, f.o.b. New York, according to grade.

Under the new Multilateral Trade Agreement, in effect from January 1, 1948, the duty on natural amorphous and artificial graphite entering the United States remains at 5 per cent ad valorem. On crystalline lump, chip, and dust grades, the former duty of 15 per cent is reduced to 7½ per cent, and on crystalline flake, from 30 per cent to 15 per cent. It is further specified that the duty on the last-named shall not be less than 0·4125 cent per pound nor more than 0·825 cent. On manufactures of graphite, including electrodes, the former duty of 30 per cent ad valorem is reduced to 15 per cent.

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 AND ANHYDRITE

Production of gypsum in Canada in 1947 was 38 per cent greater in tonnage and 29 per cent greater in value than in 1946, the previous peak year. A record was set also in the tonnage of gypsum exported, which consisted chiefly of crude gypsum from Nova Scotia.

Deposits of gypsum occur in seven of the provinces of Canada and the mineral is produced in five of them.

Production and Trade

Canada produced a record total of 2,496,984 tons of gypsum valued at $4,734,853 in 1947, compared with 1,810,937 tons valued at $3,671,503 in 1946, the previous peak tonnage year.

Exports of gypsum, plaster of Paris, and ground and prepared wall plaster were 1,938,413 tons valued at $2,072,419, compared with 1,489,679 tons valued at $1,622,162 in 1946. Imports of gypsum and plaster of Paris were 18,946 tons valued at $249,618, compared with 11,364 tons valued at $188,537 in 1946.

Principal Canadian Sources of Supply

In Nova Scotia, the leading Canadian producer of gypsum, large deposits occur in widespread areas, the chief producing areas being Hants county on the mainland, and Victoria county, Cape Breton Island. Most of the material quarried is shipped by boat in the crude state to ports on the Atlantic seaboard of the United States. Prior to the war a sizeable tonnage was shipped to Great Britain, but these shipments have not been resumed owing to the shortage of dollar exchange in that country.

Canada Gypsum Company, Limited operates large quarries at Wentworth, Hants county, about 2 miles from Windsor, this being the largest gypsum operation in Canada. Gypsum and anhydrite are quarried and crushed to shipping size. The crushed material is hauled to Hantsport by the Dominion Atlantic Railway and is stored in a large storage-shed. Conveyer belt loading is so arranged that a 12,000-ton ship can be loaded from the shed in two hours, thus enabling a ship to come in, load, and be out, on the same tide. These year-round storage and shipping facilities were completed early in 1947 and will ultimately replace facilities at the winter port of Deep Brook, N.S., and the summer port of Wentworth. All gypsum shipped from the company's quarries at Wentworth goes to plants of United States Gypsum Company on the United States Atlantic seaboard. The anhydrite goes to southern states of the United States for use on peanut crops.

National Gypsum (Canada) Company operates a large quarry at Dingwall at the northern tip of Cape Breton Island. The gypsum is crushed, washed, and then shipped from a dock about a mile from the quarry operation. It is sent to the parent company's plants in the eastern United States and to cement companies in Canada. National Gypsum also operates a property at Walton, Hants county, the gypsum from which is sent to American plants.

Victoria Gypsum Company at Little Narrows, Victoria county, Cape Breton Island, under the management of Guysborough Mines, Limited, made shipments of high-grade gypsum to cement plants in the United States, West Indies, and South America.

Windsor Plaster Company quarries gypsum about 12 miles east of Windsor and calcines it in a small mill in Windsor where hardwall and finishing plasters are made.

Connecticut Adamant Plaster Company mined a small quantity of gypsum from Cheverie, Hants county, and shipped it to the company's finishing plant in New Haven, Conn.

In New Brunswick, Canadian Gypsum Company at Hillsborough produces all grades of plaster and wallboards for the markets of Eastern Canada.

In Quebec, though no gypsum is quarried, Gypsum Lime and Alabastine, Canada, Limited operates a large gypsum products plant at Montreal to which it added new storage and calcining facilities. The company obtains raw gypsum for the plant from Dingwall, Nova Scotia, and calcined gypsum from its plant in Caledonia, Ontario.

In Ontario, this company, 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. Cayuga Gypsum Company, Limited, at Cayuga, operated on a small scale in 1947 and supplied raw gypsum for export.

No development has been undertaken on the extensive deposits of gypsum in northern Ontario.

In Manitoba, Gypsum, Lime and Alabastine, Canada, Limited and Western Gypsum Products, Limited operated gypsum products plants in Winnipeg throughout the year. The former company's output comes from its quarries at Gypsumville, 170 miles north of Winnipeg, and that of the latter from its mine at Amaranth, about 110 miles northwest of Winnipeg.

In Alberta, Western Gypsum Products, Limited rebuilt its wallboard plant in Calgary that was destroyed by fire late in 1946. This plant obtains gypsum from deposits at Mayook in the Crowsnest Pass district of British Columbia and from its Manitoba mine. Gypsum, Lime and Alabastine, Canada, Limited operates a small plaster mill in Calgary obtaining raw gypsum from Falkland, British Columbia.

In British Columbia, Gypsum Lime and Alabastine, Canada, Limited operates a large new plant at Port Mann, near New Westminster, where all grades of plaster and wallboard are produced. The raw gypsum is obtained from the company's quarry at Falkland.

A discovery of gypsum in the Tegart Pass area in the Windermere district of British Columbia was reported during 1947.

Uses

Gypsum. Gypsum has the unusual property that, when heated at a low temperature, three-quarters of the water in the hydrous calcium sulphate is given off. The residue is known as plaster of Paris, which will quickly set to a hard porous mass when water is added. Plaster of Paris as such has only limited uses; for example, in moulding work where quick setting is required, or in ceramic work where its porous properties are essential. To make plasters and wallboards, which are the chief uses of gypsum, certain materials are added to the plaster of Paris as retarders and fillers. This gives the final products a longer period of set and greater strength than the original plaster of Paris. Special products are also made from calcined gypsum such as acoustic boards, partition tile, fire-resisting walls, insulating tile, etc. Because of their lightness and durability gypsum products are being used to an increasing extent in the building industry. Gypsum is also added to Portland cement in small quantities where it acts as a retardant in the time of set of the cement.

Gypsum in the ground form was formerly used in large quantities as a fertilizer on many types of soil. This use, however, now appears to be limited mainly to black alkali soils.

Anhydrite. Anhydrite has few uses, compared with gypsum. Production is usually from gypsum quarried where the removal of anhydrite beds is essential to the further operation of the quarry as a gypsum producer. The material is used on peanut crops in the United States where the added anhydrite acts as a soil conditioner. The use of Canadian anhydrite for the manufacture of sulphuric acid and cement has long been advocated. Such plants are operated successfully in France and England. Another potential use for anhydrite is as a filler in the making of some papers.

Prices

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 (OCHRES)

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 has ranged from a peak of 19,128 tons in 1920 to a low, since then, of 4,357 tons in 1933, the output in 1947 being 13,418 tons. Production from deposits near Trois Rivières, Quebec, and to a much lesser extent from deposits in British Columbia, has been meeting domestic requirements for many years.

Production

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 1947 totalled 13,418 tons valued at $258,322, compared with 12,695 tons valued at $152,268 in 1946. The 1947 production was made up of 13,360 tons from Quebec and 58 tons from British Columbia.

Sherwin-Williams Company of Canada, Limited is the only Canadian producer of calcined iron oxides. It operated its deposits and plant at Red Mill, Champlain county, Quebec, a few miles east of Trois Rivières, throughout 1947. Crude ochre was mined from deposits at Pointe-du-Lac, St. Maurice county; at Almaville, Champlain county; and at Grande Mère, Laviolette county.

In British Columbia, there is a small production of iron oxide from the Morning Star mine of B.C. Electric Company at Alta Lake, New Westminster district. The oxide is used chiefly for the purification of illuminating gas. Elsewhere in Canada, the several known deposits of ochre have received little active attention. The principal deposit in Saskatchewan of possible economic interest is 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 are known, but have not been developed for lack of markets.

Trade

Exports of iron oxides in 1947 were 5,387 tons valued at $313,017, compared with 4,366 tons valued at $199,619 in 1946. Exports of mineral pigments n.o.p. (mostly zinc oxide) were 9,918 tons valued at $2,652,810, compared with 6,754 tons valued at $1,394,354 in 1946.

Imports of all kinds of ochres, siennas, and umbers totalled 1,236 tons valued at $68,426, compared with 1,437 tons valued at $81,929 in 1946.

Uses and Prices

The ochreous iron oxide used in the manufacture of paints is largely in the calcined form. However, a small quantity of natural iron oxides associated with clay-like materials in the form of umbers and siennas is also used as pigments in paints, both in the raw and calcined state.

The Canadian consumption of iron oxide by the illuminating gas industry in 1946 (figures for 1947 not available) was 9,385 tons. The paint industry consumed 2,564 tons of calcined iron oxide valued at $288,190 and 543 tons of ochre, siennas, and umbers valued at $75,769.

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. The natural 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 8 cents a pound throughout 1947, while yellow, brown, and black iron oxides remained between 5 and 12 cents a pound.

LIME

Lime production reached a peak in 1947 when 977,413 tons was marketed, and the demand was still greater than the supply. The increase in requirements for lime came partly from the construction industry, but mostly from the chemical and metallurgical industries where lime is an essential raw material fulfilling many diverse functions. The chemical industry in particular is expanding rapidly and prospects are good for the continuance of the strong demand for lime.

Principal Canadian Sources of Supply

Limestone suitable for lime manufacture is available in every province except Prince Edward Island. In recent years, however, the industry has become largely concentrated in Ontario and Quebec where large concentrated and steady markets for lime permit the use of kilns having a large output and low production cost. Over 85 per cent of the present lime production originates in Ontario and Quebec.

Dolomitic and high-calcium limes were made until recently in Nova Scotia, but no production was reported from there in 1947, however, these limes are produced in New Brunswick, Ontario, and Manitoba. Only high-calcium lime is produced in Quebec, Alberta, and British Columbia.

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 1947 amounted to 977,413 tons valued at $8,542,507, compared with 840,799 tons valued at $7,074,940 in 1946. Of the 1947 total, 801,886 tons valued at $7,021,199 was quicklime and 175,527 tons valued at $1,521,308 was hydrated lime. This compares with the 1946 production of 684,674 tons of quicklime valued at $5,778,243 and 156,125 tons of hydrated lime valued at $1,296,697. The values do not include the cost of containers. About 54 per cent of the quicklime and 2 per cent of the hydrated lime produced in 1947 was used by companies that produce lime primarily for their own use.

Exports of lime in 1947 amounted to 28,615 tons valued at $297,578, compared with 24,921 tons valued at $284,327 in 1946. Most of the exports in 1947 went to the United States, but also to Newfoundland, Jamaica, and St. Pierre and Miquelon.

Imports of quicklime in 1947 amounted to 13,044 tons valued at $115,199, compared with 7,618 tons valued at $50,093 in 1946. 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, multi-wall 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. Production and value of hydrated lime produced in 1947 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 is used in agriculture as the principal ingredient of certain spray mixtures and dusting powders and for the sweetening of acid farmland. The construction industry, which for centuries provided the main outlet for lime, still consumes important quantities of quicklime and of hydrated lime, but the old concept of lime as being primarily a construction material is no longer true.

Prices of the various lime products vary over a wide range depending upon the geographical position 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 $8.76 per ton, and that of hydrated lime on the same basis, $8.67 per ton. The latter figure includes considerable by-product material sold below the ordinary market price.

LIMESTONE (GENERAL)

Production of limestone in 1947 was by far the largest on record. Because of the great variety and importance of its industrial uses and of its widespread occurrence it is the most widely used rock. It is quarried in all provinces of Canada except Prince Edward Island and Saskatchewan, and by far the greater part of the production is from Ontario and Quebec. The present production of limestone for all purposes, including the manufacture of lime and cement, constitutes about 92 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, which are both being worked.

Although limestone is abundant in Canada in the more highly industrialized areas, easily accessible unworked deposits of the pure high-calcium variety, so largely used by chemical and metallurgical industries, are becoming scarce. Consequently, recourse will have to be had in the future either to underground mining, or to beneficiation of surface deposits 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 1947 for general use, exclusive of that used for lime and cement, was 9,497,754 tons valued at $11,966,520, compared with 7,217,600 tons valued at $8,178,513 in 1946. The production for all purposes in 1947 was 14,286,248 tons.

As limestone is widely distributed and a low-cost commodity, it is not as a rule transported for long distances and rarely figures in international trade. However, for certain consuming centres in Canada it is obtained from the United States and Newfoundland for use as blast-furnace flux, road metal, and to make 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 sold in 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 for use as a road metal, concrete aggregate, railroad ballast, and as flux in metallurgical plants, most of the output is crushed and screened. 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 production in Canada in 1947 was approximately $4,561,000, as compared with the 1946 value of $4,098,099. Imports from the United States were valued at $417,450 in 1947, compared with $464,880 in 1946. In addition, glass wool to the value of $520,786 was imported.

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 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)

Production of limestone for building purposes in 1947 was larger than for many years and prospects for the continuance of the increased demand for dimension stone throughout 1948 were excellent. Throughout the country a number of small quarries were opened to supply local demands for cut stone and rubble. Difficulties were experienced, however, in obtaining sufficient experienced stone cutters for the hand-dressing of stone in the quarries and stone-dressing plants because in the past 15 years very few men have learned the trade.

Limestone for building purposes is produced in Quebec, Ontario, and Manitoba. Modern requirements of the building-stone industry are 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 building 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 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

Production of limestone for structural purposes in 1947 amounted to 65,549 tons valued at $1,381,601, compared with 53,596 tons valued at $985,011 in 1946. Production is 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 $959 in 1947 and of $435 in 1946. Imports of all varieties of building stone except marble and granite in 1947 had a value of $193,744, compared with $144,722 in 1946.

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

The value of refractory products made from magnesitic dolomite and brucitic limestone reached a new peak in 1947, but the value of all products from these rocks was slightly under the peak value of $1,278,596 in 1945.

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. Good progress was made by the company in the extensive program of enlargement and modernization of its production facilities at Kilmar, begun in 1946, but slow delivery of some essential materials prevented the new 245-foot rotary coming into operation until early in 1948. The sink-float plant is also expected to be in operation in 1948.

Dolomite Refractories, Limited, a subsidiary of Canadian Refractories, Limited, produces a dead-burned dolomite at Dundas, Ontario, for use as refractory material in open-hearth furnaces at steel plants.

Brucitic limestone, a rock composed of granules of the mineral brucite (magnesium hydroxide) thickly distributed throughout a matrix of calcite, is quarried from large deposits near Wakefield, Quebec, by Aluminum Company of Canada, Limited, and is processed for the recovery of magnesia and lime. The magnesia is used in part by the company for making magnesium metal at Arvida, Quebec, but the major part of the output is sold for the manufacture of basic refractories and for use as fertilizer. Hydrated lime, the co-product, is produced in the process of recovering the magnesia, and is sold for the various purposes for which lime is used.

Brucitic limestone deposits occur also at Bryson, Quebec; at Rutherglen, Ontario, and on West Redonda Island in British Columbia. There are small deposits at a number of other places in Ontario and Quebec.

Magnesite deposits occur in British Columbia and in the 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.

Production and Trade

The value of the products made from magnesitic dolomite and brucite magnesia in 1947 was approximately $1,185,000, compared with $1,225,593 in 1946.

Exports of basic refractory materials made from magnesite and brucite amounted to 4,867 tons in 1947 valued at $81,686, compared with 2,502 tons valued at $102,602 in 1946. A considerable tonnage of magnesia is also exported.

Imports of magnesia products in 1947 had a value of $1,585,646, compared with $1,260,545 in 1946. The items were: dead-burned and caustic-calcined magnesite valued at $662,750, compared with $385,573 in 1946; magnesite brick valued at $465,041, compared with $433,327 in 1946; magnesia alba and levis, $75,823, compared with $80,893 in 1946; magnesia pipe covering, $201,391, compared with $187,416 in 1946; magnesium carbonate, $71,801, compared with $40,994 in 1946; and magnesium sulphate, $108,840, compared with $132,342 in 1946.

Uses

Magnesitic dolomite is being entirely utilized for the production of basic refractory products. These include dead-burned grain material; bricks and shapes (burned and unburned); and finely ground refractory cements.

Brucitic limestone yields magnesia for the making of basic refractory products (burned and unburned); magnesium metal; fertilizers; magnesium oxysulphate products; and several minor uses. Hydrated lime is an important co-product, obtained in the processing of brucite limestone. The magnesia has been satisfactorily used for the making of magnesium bisulphite liquor needed in the manufacture of special grades of paper, and, on an experimental scale, for magnesium oxychloride cement.

MARBLE

Renewed activity in the marble industry noted in 1946 continued throughout 1947 and output was more than double that of 1946. Foreign marble is again available, but at a considerable higher price than before World War II.

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 1947 there was a greater production of squared blocks for sawing into slabs for interior decorative use than for many years.

Production and Trade

Production in 1947 amounted to 45,574 tons valued at $326,605, compared with 21,796 tons valued at $201,817 in 1946.

Exports of marble are recorded with those of granite, and the exports of both in 1947 amounted to 4,500 tons valued at $65,447, compared with 5,277 tons valued at $82,008 in 1946.

Imports of marble in 1947 had a value of $319,232, compared with $194,048 in 1946. 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 $168,649 in 1947, compared with imports of similar materials valued at $110,140 in 1946.

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. Orford Marble Company, Limited produces red, green, and grey serpentinous marble near North Stukely, Shefford county. The product is mainly terrazzo, but several blocks have been quarried to test the soundness and beauty of colouring, and if results are satisfactory it is intended to produce block marble at this quarry. 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. Verona Rock Products, Limited, Verona, produces poultry grit and stucco dash from a white limestone. 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 quarries small quantities of 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.

Prices

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

MICA

Production (sales) of all classes of mica in Canada in 1947 decreased 5 per cent by quantity and increased 1 per cent by value, compared with 1946. Sheet mica sold in block or splittings form constituted only a small part of the total, and, as usual, the great bulk of sales was scrap phlogopite largely salvaged from old waste dumps; similarly recovered, small untrimmed sheet sold for mechanical splittings, and ground mica made both from natural small flakes and scrap. Only four mines producing sheet mica (all phlogopite) were in operation, two in Quebec and two in Ontario. Muscovite mica schist continued to be mined in British Columbia for the production of ground mica, but there were no recorded sales of sheet mica of this type. In Quebec, production of ground mica was augmented by a new operation designed to recover natural flake phlogopite for processing.

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 of sheet phlogopite is handled and prepared for market by producers and dealers having trimming establishments in or near Ottawa. A few operators have made 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 much smaller scale than formerly, is mostly farmed out in small rural communities in the Ottawa district. Scrap mica still continues to be recovered 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 small mica shipped to the United States for making mechanical splittings.

In Quebec, the Nellis mine near Cantley in Hull township, operated by Blackburn Bros., Blackburn Bldg., Ottawa, continued to be the leading producer of sheet mica. This company prepares its output in a shop at Ottawa and operates a grinding plant at its mine. J. B. Gauthier of Buckingham reopened an old mine in Denholm township and produced a few thousand pounds. 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.

Suzorite Company, Limited, a subsidiary of Siscoe Metals, Limited, proceeded further with plans to develop recovery of flake phlogopite from a large body of "suzorite" rock in Suzor township, Laviolette county, Quebec. The deposit is 6 miles north of the main line of the Canadian National Railway, and 15 miles northeast of Parent. A well-surfaced road was built to the property during 1947, and about 8,000 tons of crude rock was mined and shipped to a plant installed by the company at Shawinigan Falls, Quebec. Nearly 5,000 tons of this was processed for the production of various grades of flake and powdered mica and of rock granules.

In Ontario, Sydenham Mining Company, Limited continued to operate the old Lacey mine near Sydenham, in Loughborough township, Frontenac county, until April when the mine was closed. This company shipped 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 to recover scrap mica from old waste dumps at the Lacey mine, and was the leading shipper of this class of product. In Faraday township, Hastings county, Bancroft Mica and Stone Products Mining Syndicate, Limited, undertook further development of a deposit of dark-coloured phlogopite (or lepidomelane) west of Bancroft. This occurrence is remarkable for the quantity of mica in sight and for the large size of the crystals. However, much of the material has poor splitting properties and, thus far, recovery of sound sheet from run-of-mine mica has been low. The dark colour, also, and the high iron content make it unsuitable for general electrical insulation purposes. It serves, however, for less exacting uses, as in low-voltage domestic heater appliances and washers, for which most of the production has been employed. Trimming is done in the company's shop at Bancroft.

Late in 1947, F. Lemieux of Godfrey unwatered the old Orser mine at Thirty-Island Lake in Bedford township, Frontenac county, and began to ship early in 1948. This mica has high heat resistance and was in demand during the early war years for aviation spark plug use. The remaining small sales of sheet mica in Ontario came chiefly from properties in the Perth area, Lanark county.

In British Columbia, ground muscovite mica made from schist rock mined in the Albreda region by George Campbell continued to be produced by Fairey and Company, 661 Taylor Street, Vancouver, and by George W. Richmond and Company, 4190 Blenheim Street, Vancouver, for sale to the local roofing trade. Crude rock purchased by the first-named company was reported at 822 tons.

Production and Trade

Production of mica of all classes in Canada in 1947 totalled 8,318,755 pounds valued at $200,903. This compares with 8,720,669 pounds valued at $199,039 in 1946. Breakdown by classes is shown below with figures for 1946 for comparison.

—	1946		1947	
	Pounds	Value	Pounds	Value
		$		$
Rough cobbed	692,339	35,381	246,947	30,504
Trimmed	30,595	21,048	24,100	18,662
Small untrimmed sold for mechanical splitting	254,363	42,523	291,549	54,357
Splittings	13,050	10,725	10	3
Fine flake and ground	2,657,230	51,146	4,177,251	66,596
Scrap (exports)	3,785,100	31,578	2,560,048	21,706
Total	7,432,677	192,401	7,299,905	191,828
Scrap sold for grinding in Canada	(*b*)1,287,992	(*b*)6,638	(*a*)1,018,850	(*a*)9,075
Grand total	8,720,669	199,039	8,318,755	200,903

(*a*) Actual sales; (*b*) Estimate.

Exports of mica of all classes in 1947 totalled 3,220,300 pounds valued at $127,344, compared with 5,061,000 pounds valued at $204,857 in 1946.

Except for the ground product, the bulk of which is used in Canada, most of the Canadian output of mica is exported to the United States. Exports of scrap mica are consigned to grinding plants of U.S. Mica Company (N.J.) at East Rutherford, New Jersey, and of U.S. Mica Manufacturing Company, Forest Part, Chicago. Scrap exports had an average declared unit value of $17 a ton, almost the same as in 1946. Ninety per cent of the total was shipped from Ontario mines and the remainder from Quebec.

Exports of untrimmed small sheet, mostly recovered from old waste dumps and shipped to the United States for mechanical splitting use, increased 27·5 per cent in quantity and 39 per cent in value over 1946, and had an average unit value of 18 cents a pound, unchanged from 1946. Almost all of this class of mica originated in Quebec. Purchasers are New England Mica Company, Waltham, Mass., and Bay State Mica Company, Woburn, Mass.

Exports of ground mica were 180,000 pounds valued at $6,940, compared with 451,000 pounds valued at $17,808 in 1946.

Exports of prepared sheet, including splittings, were 48,400 pounds valued at $25,866, compared with 21,000 pounds valued at $23,775 in 1946. This class of mica, therefore, represented only 1·5 per cent of total exports in 1947 by quantity, and 20·3 per cent by value.

Imports and manufactures of mica in 1947 were valued at $571,638, compared with $280,142 in 1946. Of the total, $307,196 covered imports from India, $249,480 from the United States, $9,631 from Argentina, and $2,197 from Brazil.

Although Canada exports the greater part of its mica production, substantial imports of muscovite splittings are needed for the manufacture of built-up mica plate, as well as of block muscovite for capacitor films, domestic heater elements, stoves, etc. Imports also include wet-ground muscovite for use in the manufacture of wallpaper and paints.

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. Exports of Madagascar phlogopite totalled 1,574,097 pounds in 1946 and 471,759 pounds in the first half of 1947. Of the last figure, 68 per cent was splittings and the remainder block mica.

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 produces mainly 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 virtually eliminated the use of mica for aviation spark-plugs.

Large quantities of muscovite are used in the form of thin sheets for radio and magneto capacitor 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 biotite, is used chiefly in the roofing and paint trades. It is also used in rubber manufacture, wallpaper, plastics, moulded electrical insulation, lubricating greases, foundry core and mould washes, fire-resistant wallboard, pipeline enamel, Christmas tree "snow", and for oil-well drilling, and annealing. The better grades are made by wet-grinding methods from clean shop waste, and the lower grades from dry-ground mine-scrap and schist rock.

In the United States, ground mica production in 1946 rose to a record high of 62,113 short tons, of which 53,908 tons was dry-ground mica and 8,205 tons wet-ground. Forty-eight per cent of the sales was used by the roofing trade, 23 per cent in paints, 8 per cent in rubber manufactures, and 5 per cent for wallpaper.

Prices and Tariffs

Dealers' quotations for Canadian phlogopite in 1947 remained at the same levels established in 1946, following the removal of war-time price ceilings, when prices were advanced from 25 to 50 per cent. Prices vary according to quality, as based on colour, softness, and splitting properties, and were as follows:

Knife-trimmed Block or Sheet

Size (inches)	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
1 x 2	0.85

Ground phlogopite 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 grinding use sold for $17 to $19 per short ton, according to quality.

Under the new Multilateral Trade Agreement, effective from January 1, 1948, the United States duty on small sizes of untrimmed phlogopite mica (mainly material used for mechanical splitting) was reduced from 10 per cent to 5 per cent, ad valorem. On other classes of mica, including rough-cobbed, trimmed sheet and splittings, scrap, and ground, the various rates of duty in effect hitherto remain unchanged.

NEPHELINE SYENITE

Production of nepheline syenite in Canada in 1947 continued to be confined to the large operation of American Nepheline, Limited, at Blue Mountain, in Methuen township, Peterborough county, Ontario. As reported to the Bureau of Mines, Ottawa, tonnage of crude rock mined by this company increased nearly 39 per cent over 1946, exports of crude for processing in the United States rose 4 per cent, and crude processed in Canada increased 58 per cent. Sales of processed material made in Canada rose 49 per cent by quantity.

The crude rock of the Blue Mountain deposit contains small amounts of iron-bearing impurities, chiefly magnetite, as well as a variety of minor accessory minerals, including corundum, and flake muscovite mica. The iron minerals are of relatively coarse size and can be removed readily at a 28-mesh grind by magnetic means. Methods of recovering the corundum and flake muscovite content as saleable by-products have been under study and show promise.

Nepheline syenite is relatively high in alumina (24 per cent in the Blue Mountain rock) compared with straight feldspar (17 to 20 per cent), and for this reason it has found favour as a feldspar substitute in a number of ceramic industries, more especially in the glass trade.

Canada and Russia are the only important producers of nepheline syenite, Canada being the sole source of high-grade ceramic material. The Russian output is derived as a by-product from the concentration of nepheline-apatite rock, and has been reported as used for the production of aluminium. Extensive deposits are known in several areas in the United States, and in India, but in most cases the rock contains too much finely divided and unremovable iron-bearing impurities to permit of its use in high-grade ceramic products. In 1947, development was undertaken of an occurrence near Little Rock, Arkansas, the material from which will 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, has accounted for most of the output to date 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, 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.

Developed as a large, side-hill quarry operation from the inception of mining in 1936 until 1946, the Blue Mountain deposit since then has also been worked by underground mining. Work has proceeded from an inclined adit crosscut driven 550 feet into the side of the ridge at a point 170 feet below the crest and to the east of the side-hill openings, which have been abandoned. Purpose of the adit was to open up bands of low-corundum rock located by diamond drilling, and these will be worked by stoping from lateral drifts. Reserves of such rock in this section are estimated at over one million tons. Concurrently, mill-rock has continued to be obtained on surface from an open pit located on the top of the ridge and a few hundred feet northeast of the adit. Rock broken at this point is dumped down a raise, carried to the surface from the adit at 280 feet from the portal, and together with that from underground work, is raised by skip to the primary crusher building located at the portal. In 1947, about 65 per cent of the rock produced was taken from surface and 35 per cent from underground development workings.

With completion of a power-line to the property early in 1947, the new mill installed at the mine in 1946 came into operation, supplanting the former mill at Lakefield, which was closed at mid-year. Like the latter, the new mill carries processing of crude to the stage of removal of iron-bearing impurities at 28-mesh size, delivering a clean granular product for the glass trade. Briefly, the mill circuit is as follows: primary crushing to 4-inch size; picking to remove waste; magnetic removal of tramp iron; screening on ½-inch, with throughs to dryer, and overs to Symons cone crusher that reduces to ¾-inch; rotary dryer; screening on ⅛-inch, with overs to second cone crusher that feeds to 28-mesh Hummer screen; throughs to a magnetic drum to remove free magnetite, followed by cleaning on six magnetic separators. Throughs from the ⅛-inch screen pass to rolls in closed circuit with the Hummer screen, overs from which also are returned to the rolls. Three of the magnetic separators are of Stearns type, and three Dings, all being 3-roll machines, with a combined feed capacity of 6 tons per hour. Splits are taken off at various stages in the circuit to provide material for shipment to the company's processing plant at Rochester, N.Y. Cyclone collectors remove dust from all machines, and this constitutes a B-grade product for which limited sale has been found. Rejects from the magnetic separators form a C-grade material, some of which has been tried out for the manufacture of fibreglass. Crushing capacity for ¾-inch rock is 300 tons per day, and output capacity of cleaned glass-grade product, 80 tons per day. Loss in cleaning runs about 30 per cent of the mill-feed.

Crushed rock for shipment to Rochester is moved mainly during the summer and is trucked to the loading dock at the east end of Stoney Lake. From there it is transported by scow to railhead at Lakefield, where large storage-piles are maintained for shipment as required.

In 1947, American Nepheline, Limited completed installation of a fine-grinding plant at Lakefield for the production of 200-mesh pottery-grade material for the Canadian and overseas markets. Equipment consists of an air-swept Hardinge mill, with electric ear feed and air separator, and having a capacity of 1 ton per hour of finished product.

Production and Trade

As reported to the Bureau of Mines, production of crude nepheline syenite in Canada in 1947 totalled 72,000 tons compared with 52,000 tons in 1946. Shipments of crushed crude, all to the Rochester, N.Y., mill of American Nepheline, Limited, were 53,000 tons, compared with 52,000 tons in 1946. Sales of processed material totalled 14,000 tons valued at $167,700, of which 12,700 tons valued at $148,000 comprised granular glass-grade product, 1,200 tons valued at $19,000, ground pottery grade, and 45 tons valued at $600, B-grade dust. These quantities compare with a total of 9,543 tons of processed material in 1946, of which 9,505 tons was glass-grade material, and 38 tons B-grade dust. Of the 1947 sales of processed material, 78 per cent went to the domestic market and 22 per cent was exported.

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 glasspar (feldspar). In the glass batch, 3 tons of syenite will replace 4 tons of feldspar on the basis of relative alumina content, and 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 now used in a wide variety of products. Nepheline syenite is claimed to be superior to feldspar for the manufacture of artificial teeth. The by-product, low-grade dust made in the cleaning process finds a market as a pumice substitute and for use in cleansers, enamels, and heavy clay products.

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 0·8 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, and other methods of improving grade are being studied.

According to returns furnished by users to the Dominion Bureau of Statistics, consumption of nepheline syenite in Canada in 1946 totalled 5,803 short tons, of which 5,584 tons was used in the manufacture of glass and 219 tons for pottery. Distribution of consumption, by provinces, was: Ontario 69 per cent, Quebec 20 per cent, and Alberta 11 per cent. No consumption statistics are available for 1947.

Prices and Tariffs

Granular glass-grade nepheline syenite produced in Canada in 1947 was quoted at $12 per ton in carload lots f.o.b. rail; that made at Rochester, N.Y., sold for $14.25. Ground 200-mesh pottery grade was priced at $16 f.o.b. Lakefield mill, and $18.25 f.o.b. Rochester. B-grade dust sold at $13 l.c.l., f.o.b. both points. Average declared value of crude exported from Canada in 1947 was about $3 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, but in that year a revision in the classification gave this last item also free entry.

PHOSPHATE

Production of phosphate in Canada has consisted almost wholly of the mineral apatite, frequently found associated with the phlogopite mica deposits of the general Ottawa region, in Ontario and Quebec. Mined on a fairly substantial scale prior to 1895, annual production during the past 50 years has only occasionally exceeded 1,000 tons. In 1946, production fell to only 57 tons, the lowest since 1930, and in 1947 there were no recorded shipments. Total recorded production of apatite in Canada to the end of 1947 was 344,898 tons, of which Quebec supplied 90 per cent and Ontario 10 per cent.

For many years, Electric Reduction Company, Buckingham, Quebec, has purchased most of the small output for use in the production of elemental phosphorus and various phosphorus compounds. The company, however, obtains most of its phosphate rock requirements from Florida. That state and Montana supply the great bulk of the phosphate rock which Canada imports for the manufacture of fertilizer, occasional shipments being obtained also from North Africa. Rock low in fluorine is obtained from Curaçao, Netherlands West Indies, for use in stock feeds.

In 1947, some interest developed in the possibility of recovering apatite from a body of ilmenite-magnetite-apatite on the St. Charles property in the Saguenay region, Quebec, in the event that the deposit comes into operation as a simultaneous source of titanium and iron.

Rock phosphate of Permo-Triassic age occurs along the Rocky Mountain Divide, notably in the vicinity of Crowsnest, B.C., where a few thousand tons was mined about 1930 by The Consolidated Mining and Smelting Company of Canada, Limited. The material is 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 1942-46, 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 was later 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 three-compartment shaft to a depth of 150 feet, and did about 500 feet of crosscutting and drifting. No shipments have been made since 1945.

Production and Trade

There was no recorded production of phosphate in Canada in 1947.

Imports of rock phosphate in 1947 totalled 485,391 short tons valued at $2,857.522, compared with 373,177 tons valued at $2,164,841 in 1946. Of the

1947 total, 474,958 tons was supplied by the United States, and 10,434 tons by Curaçao. By uses, 90 per cent went to the fertilizer trade, 8 per cent into the manufacture of phosphorus and phosphorus compounds, and 2 per cent into stock feeds.

According to estimates by the United States Bureau of Mines, total world production of phosphate in 1946 was 11,885,000 metric tons, exclusive of output in a number of countries for which no data were available. The United States supplied nearly 59 per cent (6,970,827 tons) of the total, and of that country's output, Florida furnished 73 per cent, and Tennessee, Idaho, Utah, and Montana, the remainder. The other leading producers are Tunisia, Morocco, Algeria, and Egypt in North Africa; and Nauru, Ocean, and Christmas Islands in the Pacific. Total output in the United States in 1947 amounted to 9,087,199 long tons.

Most of the world production of phosphate consists of sedimentary rock, of which huge reserves exist. Apatite is produced in relatively few countries, Russia being by far the most important.

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 Tennessee, production of phosphoric acid, calcium metaphosphate, and fused tricalcium phosphate, by furnace treatment of rock has been increasing steadily, and permits the use of low-grade material that 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. Production of fertilizer made from fused phosphate rock and olivine or serpentine was commenced in 1946 on the United States Pacific Coast.

Rock phosphate is the sole commercial source of phosphorus.

According to estimates by the Dominion Bureau of Statistics, consumption of rock phosphate in Canada in 1946 (figures for 1947 not available) as reported by users was 400,017 short tons, of which 93 per cent went to the fertilizer trade, 4·5 per cent into the production of phosphorus and phosphorus compounds, 0·5 per cent to the steel trade, and the remaining 2 per cent to miscellaneous minor uses. Consumption by provinces was: British Columbia, 61 per cent; Quebec, 21 per cent; and Ontario, 18 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.

Prices

Overall average f.o.b. value of United States phosphate rock in the first half of 1947 was $5.17 per long ton, compared with $4.24 per ton reported for the corresponding period in 1946. Laid-down cost of Florida rock at eastern Canadian points in 1947 varied between $14.50 and $17.35 per long ton, according to grade and whether shipped all-rail or by water and rail.

The price paid in recent years for Canadian apatite delivered at plant was $15 per short ton for material of 80 per cent B.P.L. (bone phosphate of lime) content, with a penalty or premium of 20 cents per unit below or above that figure.

PYRITES AND SULPHUR

Pyrites is obtained in Canada as a by-product from the concentration of base-metal sulphide ores, the producers in 1947 being Waite-Amulet and Noranda mines in Quebec, and Britannia mine in Brtish Columbia.

Principal Sources of Supply, Occurrences

In Quebec, Noranda Mines, Limited, Noranda, recovered the pyrites with a sulphur content of 48 per cent from its cyanide mill tailings. This was sold to chemical plants in Ontario, Quebec, and the United States for use in the manufacture of sulphuric acid. Waite-Amulet Mines, Limited has been producing a pyrites concentrate since March 1944, and in 1947 produced 51,023 long tons containing 47 per cent sulphur. This was shipped to chemical plants in Ontario, Quebec, and the United States, and to a paper mill at Trois Rivières, Quebec. About 60 per cent of the production was exported to the United States. Operations at the Aldermac property in the Rouyn area, and at the Eustis mine in Sherbrooke county, where pyrites was recovered as a by-product in the production of copper, were abandoned several years ago.

In Ontario, there is a large deposit 7 miles west of the town of Sioux Lookout, Kenora district, which was worked for a time a number of years ago. Several deposits occur in the Algoma district.

In British Columbia, Britannia Mining and Smelting Company, Limited at Britannia Beach produced pyrites containing 50 per cent sulphur and sold most of it to Nichols Chemical Company at Barnet, British Columbia. Some of it was exported to the United States. Northern Pyrites, Limited has a large reserve of pyrites at its property at Ecstall River, about 60 miles south of Prince Rupert. This property has been idle for many years.

No native sulphur is produced in Canada. At Trail, British Columbia, The Consolidated Mining and Smelting Company of Canada, Limited recovers the gases from the smelting of its lead-zinc ore for use in making sulphuric acid by the contact process. The acid is used in the manufacture of fertilizers. At Copper Cliff, Ontario, Canadian Industries, Limited uses the contact process in the manufacture of sulphuric acid from converter gas that is withdrawn from the flues by arrangement with The International Nickel Company of Canada, Limited. After many years of research, International Nickel and Canadian Industries, Limited have developed a method of producing liquefied sulphur dioxide gas on a commercial scale from the smelter gases at Copper Cliff. The liquefied gas is being used in an Ontario sulphite paper mill.

Noranda Mines, Limited installed a pilot-plant late in 1947 for experimental work on the processing of large tonnages of pyrites for recovery of sulphur and iron.

Production and Trade

Production of sulphur in pyrites and in smelter gases amounted to 221,781 tons valued at $1,822,867 in 1947, compared with 234,771 tons valued at $1,784,666 in 1946.

Imports of sulphur (sulphur content) amounted to 361,424 tons valued at $5,466,201 in 1947, compared with 273,502 tons valued at $4,271,081 in 1946.

Exports of sulphur in pyrites amounted to 56,337 tons valued at $281,880 in 1947, compared with 68,045 tons valued at $286,254 in 1946.

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 elemental form in the manufacture of a long list of commodities, including rubber and insecticides. Large tonnages are oxidized for use in paper making. Most of the sulphur from all sources, however, is converted into sulphuric acid which is used in a great variety of industries, including the fertilizer, petroleum refining, explosives, metallurgical, chemical, and textile industries.

Consumers of Pyrites in Canada

St. Lawrence Pulp and Paper Co., Ltd., Trois Rivières, Que.
Nichols Chemical Co., Ltd., Valleyfield, Que.
Nichols Chemical Co., Ltd., Barnet, B.C.
Nichols Chemical Co., Ltd., Sulphide, Ontario.

Consumption in Canada

Consumption of Sulphur in 1946 by Industries
(1947 figures not available)

	Tons
Wood pulp	226,296
Explosives	1,461
Insecticides	1,297
Rubber	1,448
Adhesives	64
Heavy chemicals	183,579*
Starch	208
Fruits and vegetables preservative	120
Sugar refining	128
Petroleum refining	68
Matches	83

* This includes a total sulphur content of 138,233 tons in the sulphuric acid produced at Trail, B.C., and at Copper Cliff, Ontario.

Prices

The price for Spanish pyrites at United States east ports was nominal at 12 cents per long ton unit of sulphur, c.i.f. (cost, insurance, and freight), guaranteed 48 per cent sulphur. The United States domestic market price was $16 to $18 per long ton, f.o.b. Texas mines.

ROOFING GRANULES

Owing to the continued increase in building construction, the roofing granule industry in Canada has expanded considerably in recent years, and in 1947 Canadian consumption of granules used for roofing showed a 14 per cent increase over that of 1946. About 66 per cent of the tonnage of granules used in Canada in 1947 was imported, however, though some of the leading manufacturers of granule roofings, as well as individuals, continued to search 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. Production in 1947 came from three deposits in Ontario, one in Quebec, and four in British Columbia, the tonnage output from Ontario being over 90 per cent of the total. A further increase is expected in 1948. As in the previous 5 years, granule-coated roofings and sidings were manufactured by ten companies which have a total of 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.

Principal Canadian Sources of Supply

In Quebec, granules were made by Suzorite Company, Limited, from a deposit near McCarthy in Suzor township, 160 miles east of Senneterre. The suzorite rock, which contains pyroxenite, feldspar, apatite, and mica, is treated at the company's plant at Shawinigan Falls where the mica is removed and the remaining material, crushed to granule size, is shipped to Canadian consumers. Large deposits of dark grey and small deposits of red and green slates occur near Granby and Richmond in the Eastern Townships, Quebec.

In Ontario, three deposits in the vicinity of Madoc, Hastings county, are quarried for granules. They are: 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, Limited, 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 the latter 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.

Consumption and Trade

Consumption of roofing granules in Canada in 1947 amounted to 123,538 tons valued at $2,732,939, compared with 108,298 tons valued at $2,276,195 in 1946. About 42 per cent of the total consumption in 1947 was comprised of natural coloured granules. The consumption of naturally and artificially coloured granules of all types was: grey and black, 33·5 per cent; green, 28·3 per cent; red, 28·0 per cent; blue, 3·8 per cent; buff and brown, 3·2 per cent; white and grey-white, 3·2 per cent. About 38 per cent of the material used was slate (20 per cent natural, and 18 per cent artificially coloured).

Imports of all types and colours in 1947 amounted to 81,095 tons valued at $1,856,380. They came from four leading producers in the United States. Quarries and plants producing slate granules that are used in Canada are located at Delta, Pennsylvania; Whiteford, Maryland; Fairmont, Georgia; Granville, New York; and Poultney, Vermont. Natural blue-black granules are obtained from Delta and Whiteford; 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, Pennsylvania (buff shale); 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. In 1947 it produced 1,695,420 short tons of granules valued at $23,071,143, compared with 1,380,560 short tons valued at $17,276,097 in 1946. About 67 per cent of the total tonnage was artificially coloured.

Specifications

Samples must pass rigid tests. The trend is toward more solid angular fragments and the use of true slate is decreasing slightly. 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 the grey slates 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 35 mesh), and to a much smaller extent "fine" (28 to 60 mesh).

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.

Prices

Prices vary considerably depending upon the type of granule and upon whether the colour is natural or artificial. Imported granules average $17.45 a ton, f.o.b. eastern Canadian plants for natural rocks and slates, $22.80 for artificially coloured reds, $24.04 for greens and browns, and $34.20 for blues.

SALT (SODIUM CHLORIDE)

Production of salt in Canada in 1947 was 33 per cent higher than in 1946 and the value of output was 22 per cent higher. Most of the output came from six plants in Ontario, and the remainder from two plants in Nova Scotia, one in Manitoba, and one in Alberta.

In Canada, practically all the output of salt is obtained from bedded deposits. It is all obtained by solution methods with the exception of that from Malagash, Nova Scotia, which is mined.

Principal Canadian Sources of Supply, Developments

In Ontario, the production of common salt comes from two plants in Goderich and one each in Sandwich, Amherstburg, Sarnia, and Warwick. At Sandwich, Canadian Industries, Limited produces nearly all types of commercial salt and also supplies brine for its large caustic soda-chlorine plant in that centre, and salt for its caustic soda-chlorine plants, at Cornwall, Ontario, and Shawinigan Falls, Quebec. At Amherstburg, L. Brunner Mond, Canada, Limited manufactures soda ash from saturated brine and recovers calcium chloride as a by-product. A large expansion of this plant was commenced in 1947 and will be completed early in 1948. At Sarnia, the salt plant is operated by Dominion Salt Company, a subsidiary of Dominion Tar and Chemical Company. It was announced during 1947 that another subsidiary, Dominion Alkali and Chemical Company, is to erect a caustic soda-chlorine plant at Beauharnois, Quebec, which will probably require large quantities of salt from the Sarnia plant.

In Nova Scotia, the salt mine at Malagash was operated most of 1947. The rock salt is crushed, screened, and sold as fishery, refrigerator, hay, and dairy salts; for ice removal on highways and railways; and for dust-laying. A process to purify the impure mined rock salt and produce a pure coarse salt that would be more suitable for the needs of the fishing industry on the Atlantic Coast has been developed by the company's staff and the Bureau of Mines, Ottawa, and the salt so produced in a pilot-plant has been under test by the Department of Fisheries, Ottawa. The mine has been in continuous operation since 1918, but mining has gone only slightly below 1,000 feet vertical depth from the surface.

At Nappan, near Amherst, Cumberland county, Nova Scotia, Maritime Industries Limited, a subsidiary of Standard Chemical Company, Limited, erected a vacuum pan evaporation plant with a capacity of 150 tons a day of high-grade salt suitable for table, dairy, meat-packing, some fish curing, and other uses. First production was obtained in February 1947. The brine is obtained from two drill-holes near the plant which penetrated the salt beds just over 800 feet below the surface.

In Manitoba, Canadian Industries, Limited operated its plant at Neepawa throughout 1947. This plant was erected in 1941 and utilizes vacuum-pan evaporation to produce all grades of evaporated salt. Brine is obtained from wells over 1,000 feet deep. It is a nearly saturated natural brine occurring in porous sedimentary rocks, and there are no proved bedded deposits of rock salt in this area.

In Alberta, Industrial Minerals, Limited, Waterways, obtains brine from a bed of very pure rock salt 200 feet thick about 700 feet below the surface. All grades of evaporated salt are produced for household and dairy uses.

Many of the holes drilled for oil and gas over large parts of Alberta and Saskatchewan in the past five years intersected salt beds at depths varying from 2,700 feet in east central Alberta to about 7,600 feet in southern Saskatchewan. The thickness of the beds varies from a few feet to over 600 feet. Natural gas is available cheaply over most of this area. During 1947, Prairie Salt Company, a subsidiary of Dominion Tar and Chemical Company, drilled production wells near Unity and commenced preliminary construction work on a salt plant. Its contract with the Saskatchewan Government calls for a minimum capacity of 25 tons of salt a day by the summer of 1948. In Alberta, Alberta Salt Company was formed by the oil companies responsible for drilling the wells that encountered rock salt at Elk Point, namely, Anglo Canadian Oil Company, Limited, Home Oil Company, Limited, and Calgary and Edmonton Corporation. The newly formed company commenced the construction of a salt plant at Lindbergh, on the North Saskatchewan River, 150 miles east of Edmonton, and it is expected that this plant will be in operation early in 1948.

Production and Trade

The production (sales) of salt in 1947 was 728,545 tons valued at $4,436,930, compared with 537,985 tons valued at $3,626,165 in 1946. Exports were 11,212 tons valued at $243,663, compared with 5,863 tons valued at $116,483 in 1946. Imports were 219,879 tons valued at $1,246,551, compared with 228,300 tons valued at $1,367,445 in 1946. Apparent Canadian consumption was 937,211 tons valued at $5,439,818, compared with 760,421 tons valued at $4,877,027 in 1946.

Canada's imports of salt are chiefly of grain sizes and of purities not obtainable in the Dominion. The salt obtained from direct mining of rock salt beds usually contains many of the impurities of the original beds, and although all grain sizes required can be obtained by this method, the purity may not be sufficiently high to satisfy all uses. The salt from vacuum-pan evaporation is of high purity, but only fine grain sizes are produced. Geographical location of deposits in relation to markets also has a bearing on imports. British Columbia, for instance, will need to continue to import salt from California, as the long rail haul from the nearest domestic sources of supply would prohibit competition under present circumstances with ocean transportation.

Uses

The importance of salt to the economy of the country is evident from some of the more important uses. These include: household uses, such as table and refrigerator salt; agricultural uses, such as dairy salt, hay curing, stock licks, meat curing, and tanning; fish curing; transportation uses, such as de-icing of roads and railways, refrigeration, and dust-laying; and chemical industry uses, mainly in the production of caustic soda and chlorine, which are important raw materials for many manufacturing or processing industries such as rayon, paper, soap, insecticides, plastics, water supply, etc.

The demand for salt for use in the production of caustic soda and chlorine is increasing rapidly as a result of expansion of the paper and rayon industries. The bleaching of sulphate papers is another field which may eventually require quantities of these chemicals derived from salt.

Prices

According to Canadian Chemistry and Process Industries, the price of salt increased gradually from the quotations in the latter part of 1946 as shown in the table given below:

	Price	
	Nov. 1946	Nov. 1947
Specially purified salt per 100 lb. 99·9 per cent f.o.b. plant	$0.94	$1.10
Fine industrial salt per ton bulk carlots f.o.b. plant	$ 6.20- 6.53	$ 6.00- 7.80
Coarse industrial salt per ton bulk carlots f.o.b. plant	$10.12-10.63	$13.00-14.80

SAND AND GRAVEL

Production of sand and gravel in 1947 amounted to 56,789,569 tons valued at $23,134,431, compared with 39,949,994 tons valued at $15,529,700 in 1946. Output and value by provinces for these two years follow:

Province	1946		1947	
	Quantity, tons	Value	Quantity, tons	Value
		$		$
Nova Scotia	1,105,980	484,585	2,966,680	1,363,363
New Brunswick	2,203,646	807,045	3,464,347	1,278,376
Quebec	12,374,125	3,313,103	16,537,303	4,877,339
Ontario	14,881,918	6,738,595	20,230,499	9,034,131
Manitoba	1,333,890	416,431	1,765,976	569,640
Saskatchewan	1,732,731	910,661	2,131,705	1,137,609
Alberta	1,812,468	1,060,703	2,058,142	1,170,883
British Columbia	4,505,236	1,798,577	7,634,917	3,703,090
Totals	39,949,994	$15,529,700	56,789,569	$23,134,431

Road construction and improvement, concrete works, railway ballast, and airport runways account for by far the greater part of the gravel and much of the sand used. Gravel in particular is a good material for low cost, all-weather road surfaces and for pavement bases on rural highways, and its use has steadily increased with the growth of motor traffic. On main railway lines gravel ballast is being gradually replaced by crushed stone ballast. The large increase in rail traffic during the late war greatly intensified the work of replacement. Large tonnages of sand and gravel are used to refill mine stopes.

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 several years' requirements.

Part of the gravel used is crushed, screened, and in some cases 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 gravel, a product that can compete with crushed stone.

Most of the sand is used in the building industry, such as concrete work, cement and lime mortar, and wall plaster. For these purposes it must be free from dust, loam, organic matter, and clay, but the specifications are otherwise fairly broad, and the sand can usually be obtained from local deposits. Special grades of sand are required for moulding in foundries; filtering of water supply; and glassmaking.

Prices of sand, gravel, and crushed stone in the four largest cities in Canada, as given by the Dominion Bureau of Statistics, were as follows at the end of 1947 and 1946. Prices per ton or cubic yard, as indicated below, are for carlots, f.o.b. cars:

Prices

	1946	1947
Sand		
Montreal, per ton	$1.28	$1.38
Toronto, " "	1.02	1.24
Winnipeg, per cu. yd.	1.00	1.00
Vancouver, " " "	1.01	1.25
Gravel		
Montreal, per ton	$1.10	$1.10
Toronto, " "	1.55	1.64
Winnipeg, per cu. yd.	1.00	1.00
Vancouver, " " "	1.01	1.25
Crushed Stone		
Montreal, per ton	$ .97	$1.16
Toronto, " "	1.67	1.76
Winnipeg, per cu. yd.	....	....
Vancouver " " "	1.13	1.35

SILICA MINERALS

Production of quartz and silica sand was 29 per cent higher in tonnage and 13 per cent higher in value in 1947 than in 1946.

Canada produces quartz, quartzite, silica sand, and sandstone; the provinces that produce one or more of these minerals being Nova Scotia, Quebec, Ontario, and British Columbia. Despite the widespread production of silica in Canada, large quantities of high-purity silica sands are imported yearly, as no deposits of these sands have been developed near certain of the principal markets.

Production and Trade

Canada produced 1,836,428 tons of quartz and silica sand valued at $1,796,612 in 1947, compared with 1,413,378 tons valued at $1,554,798 in 1946. It produced 3,094 M silica brick valued at $193,998, compared with 2,902 M valued at $197,804 in 1946.

Imports of the various grades of silica in 1947 compared with 1946 were:

—	1946		1947	
	Tons	$	Tons	$
Ganister	518	3,367	400	3,211
Silex or crystallized quartz, ground or unground	10,640	114,450	15,004	164,826
Flint and ground flint stones	823	34,449	335	12,739
Silica sand	390,014	914,456	533,456	1,148,397
		1,066,722		1,329,173

The imports of silica sand are for use chiefly in the glass and sodium silicate industries, where silica of high purity and uniformity is demanded.

Exports consisted of 223,240 tons of quartzite valued at $489,129, compared with 200,316 tons valued at $441,976 in 1946.

Principal Canadian Sources of Supply

In British Columbia, silica is produced by The Consolidated Mining and Smelting Company of Canada, Limited, for use as flux in its metallurgical plants at Trail.

In the Prairie Provinces, no high-grade silica sand is produced, but several deposits of silica have been investigated in Manitoba and Saskatchewan. Most of these are distant from transportation and so far the markets for silica sand have been too small to justify development. Among the deposits on which preliminary work has given interesting results are: Black and Punk Islands in Lake Winnipeg, and Red Deer River, northeast of Hudson Bay Junction, Saskatchewan.

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 the steel foundries as moulding sands.

Dominion Mines and Quarries, Limited shipped crushed quartzite to producers of ferro-alloys at Welland, Ontario, Niagara Falls, N.Y., and Toledo, Ohio, from its quarry at Killarney on the north shore of Georgian Bay, which was operated during part of 1947.

Manitoulin Quartzite Division (a subsidiary of Lapa Cadillac Gold Mines, Limited), produces quartzite for export to the United States from its quarry at Sheguindah, Manitoulin Island.

The International Nickel Company of Canada, Limited produced large tonnages of quartzite from a deposit near Whitefish Falls for use as a flux in its smelting operations. Falconbridge Nickel Company, Limited also produced a small quantity of quartzite and silica for fluxing purposes.

Verona Rock Products, Limited, Verona, produced a small tonnage of crushed quartz for use in the manufacture of grit for sandpapers.

Wright and Company shipped quartzite to Algoma Steel Company, Sault Ste. Marie, Ontario, from a quarry on the Algoma Central Railway, to be used in the manufacture of silica brick.

In Quebec, a number of silica plants were in operation in 1947. Canada China Clay and Silica Company, Limited, with a plant near St. Rémi d'Amherst, obtains china clay and various grades of silica sand from a decomposed and fractured quartzite in which the vugs are filled with china clay. This material is crushed and washed to separate-out the clay and impurities. The dried sand is screened and made into glass sands, sand-blast sand, and foundry sand. It finds a ready market in the Montreal district.

Canadian Carborundum Company produces silica at St. Canut, Two Mountains county, from a quarry in a large outcrop of Potsdam sandstone. The products are used chiefly in the company's abrasives plant at Shawinigan Falls.

St. Lawrence Alloys and Metals, Limited, Beauharnois, produces silica in a large number of screen sizes in its plant at Mélocheville from an outcropping Potsdam sandstone. Most of this output is used in the company's plant at Beauharnois for the production of silicon, ferrosilicon, and other ferro-alloys. Some of the silica products are also shipped to the Niagara Falls area of Ontario, and to United States points on the Great Lakes.

Consumers Industrial Minerals, Limited produced some silica sand in its crushing and screening plant near St. Julienne from a quartz vein.

Canadian Flint and Spar Company, Limited, with a quartz quarry and grinding plant at Buckingham, produces small quantites of high-grade silica sands for special uses, and silica flour for use in the pottery industry. Crude quartz from this area is used as flux in the electro-chemical plant of Electric Reduction Company, Buckingham.

In Nova Scotia, Dominion Steel and Coal Company obtains quartzite from Chegoggin Point in Yarmouth county to make silica brick at Sydney for use in furnaces at its steel plant. The quartzite was formerly obtained from the quarry of J. P. Nairn at Leitches Creek, Cape Breton Island, but production ceased there in March 1947. Deposits of natural silica sand in the province were operated in the past, and from one of these at River Denys silica sand was produced for use in foundries and for sandblasting. Experimental work to purify natural silica sand from the beaches at Port Mouton and Barrington Passage and make it suitable for commercial purposes has not proved successful so far.

Uses, Specifications

Silica sand is generally prepared from a friable sandstone or quartzite by crushing, washing, drying, and screening to recover different grades of material according to the use for which it is required. Natural silica sands are usually too impure to warrant removal of the impurities, although in certain cases this might prove satisfactory depending upon the ease of separation of the various minerals in the sand and the size of the silica sand grains. In the manufacture of glass, for instance, the sand used should range between 20 and 100 mesh and the iron (Fe_2O_3) content should be less than 0·025 per cent. Sand-blast sand would probably range from 8 mesh to 48 mesh in various closely sized grades, but the purity of the sand need not be nearly so high as for glass sands. The physical properties of these sand-blast sands are of great importance, especially shape of grains and friability.

Steel foundry sands grade a little finer than glass sand, but, again, the purity is usually not so important.

Sandstone in run-of-mine size is used by the cement companies to increase the silica ratio of their original mix.

Silica ground to 150 mesh or finer and prepared from very pure quartz or high-grade silica sand is known as "potters' flint" in the ceramics industry. In the paint industry, air-separated material 250-mesh or finer is required. Fine silica is required also in the rubber, soap, building products, and chemical industries.

Smelter operators, in many cases, use as a flux a siliceous ore containing recoverable amounts of the precious or base metals.

Quartz, quartzite, or sandstone in sizes from 6 inches to ½ inch are used in the manufacture of ferrosilicon and metallic silicon, and of certain types of abrasives.

Quartzite of high purity and crushed to about 8 mesh is used to manufacture silica brick.

In producing silica for the above uses, regularity of shipments and meeting of rigid specifications are important factors.

Quartz in crystal form, without flaws, transparent, and possessing the necessary piezo-electric properties, is valuable in radio frequency control apparatus. Crystals may also be cut and ground for lenses and prisms, or fused to make clear fused quartz equipment. No quartz with the necessary properties for these uses has been found in Canada, the only present world sources of supply being Brazil and Madagascar.

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 prices advanced slightly during the latter part of 1947 over those prevailing at the commencement of the year.

Silica Sand

—	Various grades		Silica, quartz	99% Silica, soft
	Toronto, carload lots	Toronto, L.C.L.	110-220 grade,	Decomposed, 325 mesh
Dec. 47.............	Ton $10.00-$10.50	Ton $14.50	Carlots per ton $14.00-$20.00	Carlots per ton $30.00-$35.00
Jan. 47.............	$ 9.00-$ 9.50	$13.50-$14.50	$14.00-$20.00	$30.00-$35.00

SODIUM SULPHATE (NATURAL)

Sodium sulphate occurs in beds and in the form of highly concentrated brines in many lakes and deposits in Western Canada. All of the Canadian output, however, comes from Saskatchewan. The sodium sulphate recovered from the lakes is in the hydrous form (55·9 per cent water of crystallization, and known as Glauber's Salt), and usually the water of crystallization is removed in rotary kilns before shipping to market as anhydrous sodium sulphate, known to the trade as "salt cake". A small quantity is marketed in the hydrous form. Large reserves of sodium sulphate are contained in the crystal beds and brines of these lakes.

Anhydrous sodium sulphate is also obtained as a by-product from the manufacture of muriatic acid and from the viscose industry. So far, however, output of this by-product material in Canada has been small.

Canada produced 163,290 tons of anhydrous sodium sulphate valued at $1,793,043 in 1947, compared with 105,919 tons valued at $1,117,683 in 1946. The operating plants in Saskatchewan were producing to capacity and there was some difficulty in supplying full demand. The principal producers of natural sodium sulphate in Saskatchewan in 1947 were: Natural Sodium Products, Limited, with plant at Bishopric; Horseshoe Lake Mining Company, Ormiston; Midwest Chemical Company, Palo; Sybouts Sodium Sulphate Company, Gladmar; and Saskatchewan Minerals Sodium Sulphate Division, with plant at Chaplin Lake, 40 miles west of Moose Jaw. The plant at Chaplin Lake is owned and operated by the Saskatchewan Government and was brought into production in the latter part of 1947. It has a capacity of 100,000 tons a year. There was considerable activity throughout the year at a number of other deposits in Saskatchewan.

The output from Saskatchewan is shipped to the pulp mills on the Pacific Coast of Canada and to those in Eastern Canada; to a number of plants in the United States; and to glass plants in Western and Eastern Canada. The erection of several new sulphate pulp plants in Canada and the changing-over of some pulp mills from the soda process has materially increased the demand for sodium sulphate.

Export figures for 1947 are not available. Shipments to the United States showed a marked increase during the war, and these continued at a high level in 1947. Imports of sodium sulphate, including Glauber's salt and salt cake, for 1947 were 11,212 tons valued at $216,656, compared with 22,139 tons valued at $277,753 in 1946.

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 small extent for medicinal purposes, and for tanning.

The price of natural sodium sulphate from the deposits in Saskatchewan in 1947 averaged over $10 per 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 centered in the Eastern Townships, Quebec, and of ground talc in the Madoc area, Hastings county, Ontario. The average output in the period 1941-47, inclusive, was about 30,000 tons a year. 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. Tonnage production is about equally divided between the two provinces. Very little talc has been produced elsewhere in Canada.

Canada produces a surplus of ground talc available for export, and 21 per cent of the production in 1947 was exported. It produces its entire 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 Quebec, Broughton Soapstone and Quarry Company, with mine, 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 Kinnear's Mills in Leeds township. Soapstone blocks are produced by Charles Fortin, of Robertsonville, Thetford township. Some quarry and sawing waste is shipped to the grinding plant of Industrial Fillers, Limited (formerly Pulverized Products, Limited), 4829 Fourth Avenue, Rosemount, Montreal. Baker Mining and Milling Company operates a mine and 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 Ontario, output of prime white foliated talc products from the Madoc area during the 41 years since operations were commenced is estimated at about 460,000 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 mine and 25 per cent from the Henderson. 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, including steatite insulators, but no commercial use of beneficiation has been made.

In British Columbia, some ground soapstone for local roofing and building use is produced in Vancouver by George M. Richmond and Company, 4190 Blenheim Street, from waste imported from the state of Washington.

Production and Trade

Production (sales) of talc and soapstone in Canada in 1947 was 26,709 short tons valued at $266,377, compared with 29,353 tons valued at $303,684 in 1946. The 1947 figures cover ground material sold by primary producers, sawn soapstone blocks and bricks, crayons, and a small tonnage of waste sold for grinding. An additional small tonnage of ground soapstone was made from imported waste. Of the 1947 total, 26,193 tons valued at $249,346 comprised ground material, and 490 tons valued at $20,369 was sawn soapstone blocks and talc crayons. These figures compare with 28,006 tons of ground material valued at $255,342, and 1,444 tons of soapstone blocks and crayons valued at $43,296 in 1946. Ontario supplied 51 per cent of the ground material and Quebec 49 per cent. All of the cut soapstone and talc was produced in Quebec.

Exports of talc and soapstone, comprising mainly ground material, but including also a small amount of sawn soapstone blocks and talc crayons, totalled 5,807 short tons valued at $68,394, compared with 6,402 tons valued at $74,991 in 1946. Of the total, 94 per cent went to the United States and the remainder chiefly to the United Kingdom. Soapstone blocks to the value of $1,120 were exported to Australia.

Imports of talc, mainly ground material, in 1947 were 8,472 short tons valued at $196,697, compared with 6,736 tons valued at $150,972 in 1946. Of the 1947 imports, 93 per cent was obtained from the United States and the remainder from Italy. According to estimates by the United States Bureau of Mines, world production of talc, including steatite and pyrophyllite (the latter classed for statistical purposes as talc) amounted to 770,000 metric tons in 1946, of which the United States produced 414,641 metric tons. In 1947, the United States produced a record of 468,324 metric tons of talc, pyrophyllite, and soapstone. No production statistics were available for such important producers as China, Germany, Japan, Korea, and Norway.

In the United States, New York continued to be the leading producing state in 1946, followed by North Carolina, California, Vermont, Georgia, and Maryland, with smaller amounts from Nevada, Washington, Pennsylvania, Texas, and Virginia. The New York talc is mainly of the fibrous, tremolitic variety which is favoured for paint and paper use.

Uses

Ground talc, including soapstone and pyrophyllite, is used chiefly in the paint, roofing, paper, rubber, insecticide, and ceramic industries, and these six uses consumed 84 per cent of the production in the United States in 1946. It is used also in foundry facings, bleaching fillers for textiles, cosmetics and pharmaceuticals, soaps and cleansers, plaster, polishes, plastics, and for rice polishing.

According to estimates by the Dominion Bureau of Statistics, Canada used 25,270 tons of ground talc in 1946 (figures for 1947 are not available), distribution by industries being: roofing, 32 per cent; paints, 21 per cent; pulp and paper, 12 per cent; insecticides, 10 per cent; rubber, 10 per cent; cosmetics and pharmaceutical preparations, 5 per cent; clay products, 4 per cent; soaps and cleansers, 3 per cent; miscellaneous, 3 per cent. Ontario used 53 per cent; Quebec, 36 per cent; Manitoba, 6 per cent; and British Columbia, 3 per cent.

Steatite is the mineralogical name given to compact, massive talc having no visible grain, which can be sawn, turned, drilled, and otherwise machined into any desired form. Such material is used for the production of fired shapes that are employed mainly as electrical insulators and for burner tips. Because of the small amount of natural steatite available, its high cost, excessive machining and firing losses, the aforementioned articles are made largely from high-talc ceramic bodies. Suitable ground talc for the purpose must be high-grade, low in lime and iron, and in the trade 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 $8 a ton f.o.b. rail. Domestic grey talc suitable for roofing, rubber, and paper use, sold in 1947 for $7.50 to $10 a short ton, according to fineness; similar talc from Vermont was quoted at $11.50 to $12.50 in bulk. White talc from Madoc, Ontario, continued to be quoted at from $8.50 for the coarser, roofing grade, $9.50 to $28 for finer mesh sizes, to $44 for minus 400-mesh material. New York fibrous talc, 325 mesh, sold for $18.50 to $20. Imported superfine Italian and French cosmetic talcs may cost as high as $80 per ton, delivered.

Average value of the ground talc produced in Ontario in 1947 was $10.65 per ton, and of the ground material (comprising both talc and soapstone) supplied by Quebec, $8.34 per ton. Average value of sawn soapstone furnace blocks was $30 per ton, or $2.70 per cubic foot, and of talc crayons about $250 per ton, or $1.06 per gross. Soapstone waste for grinding sold for $2 per ton, f.o.b. mine. Average declared unit value of exports of ground talc was $11.60 per ton.

Tariffs

Under the new Multilateral Trade Agreement, effective January 1, 1948, the duty on ground talc exported to the United States was reduced from 17½ per cent to 10 per cent ad valorem on material valued at not over $14 a ton. On material valued at over $14 a ton, the duty remains at 35 per cent. 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 15 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 in place of magnesia. It can substitute for talc for many trade uses, and for this reason it is often recorded with talc in production statistics. One of its largest uses is in insecticides.

The leading world source of pyrophyllite, reported as such, is North Carolina, which produced 97,765 short tons in 1946. Small amounts are derived also from Newfoundland. 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) actually is pyrophyllite. The same sources credit Korea with an output of 41,211 metric tons of pyrophyllite in 1944, and Japan proper with 454,533 metric tons in 1939. The Japanese production in 1945 was reported as nearly 200,000 tons.

In Canada, some rather low-grade, sericitic pyrophyllite occurs at Kyuquot Sound on the west coast of Vancouver Island, from where a small quantity was shipped about 30 years ago for use in refractories and cleanser products.

Pyrophyllite sells for about the same price as talc. Quotations for North Carolina material in 1947 were $7 per ton for 140-mesh, rubber grade; $9 to $10 for 200-mesh, insecticide grade; and $14 for 325-mesh material, all bulk, f.o.b. mines.

WHITING SUBSTITUTE

Whiting substitute (also referred to as domestic whiting, and as marble flour) is finely pulverized white limestone, white marble, calcite, or marl. Whiting substitute may also be made from lime or from the waste calcium carbonate sludge resulting from the manufacture of caustic soda. 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 1947.

White marble, calcite, and white limestone, when used for whiting substitute, are pulverized to degrees of fineness 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

Final statistics are not yet available, but it is estimated that about 12,000 tons of whiting substitute was produced in 1947, the producers being: Industrial Fillers, Limited, Montreal (formerly Pulverized Products, Limited), Marlhill Mines, Limited, Thorold, Ontario; Gypsum, Lime, and Alabastine, Canada, Limited, Winnipeg; and Beale Quarries, Limited, Van Anda, Texada Island, British Columbia.

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 readily available, more competition from this source can be expected. However, prospects for the domestic industry are good because of the steadily increasing demand for mineral fillers and because of the, in general, superior whiteness of whiting substitute made from calcite. This property is particularly important for some of the newer applications of this product.

Little or no whiting substitute is exported. Imports of whiting, crude chalk, and prepared chalk were valued at $409,679 in 1947, compared with $423,783 in 1946.

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 Marlhill Mines, Limited, Thorold, 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 substance, 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 into 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

Coal production 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 51 per cent of the coal produced in Canada in 1947 was mined in Alberta, and almost 26 per cent came from Nova Scotia.

Production and Trade

Canada produced 15,868,866 tons of coal valued at $77,475,017 in 1947, compared with 17,811,747 tons valued at $75,820,159 in 1946. The minimum output since 1911 was 11,738,913 tons in 1932, and the maximum, 18,865,030 tons in 1942.

Production of Coal by Provinces

Province	1946 Tons	1947 Tons
Nova Scotia	5,452,868	4,118,196
New Brunswick	370,655	345,194
Manitoba	....	....
Saskatchewan	1,523,489	1,571,147
Alberta	8,826,311	8,070,430
British Columbia	1,638,424	1,763,899
Canada	17,811,747	15,868,866

Production of Coal in Canada by Kinds[1]

	1946 Tons	1947 Tons
Bituminous	12,851,365	11,062,210
Sub-bituminous	3,436,893	3,235,509
Lignite	1,523,489	1,571,147

[1] Coals classed according to A.S.T.M. Classification of coal by Rank—A.S.T.M. Designation: D388-38

Total imports of coal entered for consumption in Canada amounted to 28,891,930 tons, compared with 26,106,599 tons in 1946. Imports of bituminous coal, practically all of which came from the United States, amounted to 24,610,045 tons, compared with 21,475,040 tons in 1946. Imports of anthracite amounted to 4,281,682 tons, compared with 4,631,387 tons in 1946. Imports of British anthracite decreased from 101,496 tons in 1946 to 51,660 tons in 1947.

Exports of coal from Canada amounted to 714,549 tons (706,408 tons bituminous, and 8,141 tons lignite), compared with 862,489 tons in 1946. The exports went chiefly to Newfoundland and the United States.

The apparent Canadian consumption of coal in 1947, including briquettes, was 44,283,537 tons, compared with 43,238,088 tons in 1946 and with 30,315,140 tons in 1939.

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 about 25 per cent lower than in 1946, and about 39 per cent lower than the 1934-43 average.

In New Brunswick, about 3 per cent of the total Canadian production of bituminous coking coal was mined in the Minto field. Production in New Brunswick in 1947 was 7 per cent lower than in 1946, and was 15 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 suspended during the year.

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 almost 10 per cent of the total Canadian output of all coals and was about 3 per cent higher than in 1946. It was about 39 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, Redcliffe, 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 1947. Of the total production in Alberta about 60 per cent was bituminous, and 40 per cent sub-bituminous and lignite, but mainly the former. The total production was 33 per cent higher than the 1934-43 average. A large part of the sub-bituminous coal shipped from Alberta to Ontario (*see* under "Markets and Uses" below) 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 1947, strip operations were continued under private ownership and produced 316,224 tons of coal in comparison with 432,671 tons in 1946.

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 11 per cent of the total Canadian output, was 7·5 per cent higher than in 1946, and 2·8 per cent higher than the 1934-43 average.

Markets and Uses

The coal production from Nova Scotia and New Brunswick is 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 of their coal resources, methods of mining and beneficiation, and markets, to determine what changes and improvements were required to maintain the industry on an economic basis. No practical steps, however, have been taken to date.

Because of serious fuel shortages the movement of Alberta coal into Ontario was continued in 1947. During the year a total of 160,721 tons of Alberta coal, in comparison with 345,406 tons in 1946 was marketed in Ontario. This consisted of 49,545 tons of bituminous coal and 111,176 tons of sub-bituminous coal, the latter being entirely for domestic use.

Owing to the shortage of various fuels, briquettes continued to find an increasing market in Canada. During 1947 a total of 579,121 tons of briquettes was consumed, compared with 509,673 tons in 1946. These consisted of 37,744 tons made from carbonized Saskatchewan lignite, 282,898 tons made from low volatile coals from the Cascade and Nordegg areas in Alberta, and 258,479 tons imported from the United States and prepared from low volatile bituminous coals, or anthracite or a mixture of both.

Use of the process developed in the Bureau of Mines, Ottawa, 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 apparently continued to affect 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.

The expansion of the industrial requirements for metallurgical coke and manufactured gas has curtailed the normal expansion in the use of domestic coke. The production of carburetted water-gas from coke to meet the increased demands for gas has necessitated the construction of new producer units and the operation of reserve equipment at capacity. The construction of new carbonization equipment and repairs to existing batteries have been undertaken at several plants, and certain war-time emergency equipment and unprofitable operations have been abandoned.

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, one Curran-Knowles installation, 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 Quebec, which normally produces domestic coke and supplies Montreal with gas, 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 has a rated capacity of 415,000 tons of coal a year; and the coke ovens of Steel Company of Canada, Limited, 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 1947 was 3,501,130 tons, compared with 3,363,109 tons in 1946.

Production by provinces was reported as follows:

Provinces	1946	1947
	Tons	Tons
Nova Scotia, New Brunswick, and Quebec	950,717	931,953
Ontario	2,133,344	2,261,395
Western Provinces	279,048	307,782
	3,363,109	3,501,130

Coal processed for the manufacture of coke amounted to 4,669,826 tons, of which 1,101,459 tons was of Canadian origin and 3,568,367 tons was imported from the United States. Petroleum coke produced at the refineries amounted to 78,125 tons, compared with 69,615 tons in 1946.

Imports of coke were 832,289 tons, compared with 1,122,846 tons in 1946. Exports were 133,970 tons, of which 126,686 tons went to the United States, and the remainder chiefly to the United Kingdom and Italy. Exports in 1946 amounted to 63,172 tons.

NATURAL GAS

Natural gas is the ideal fuel, but in Canada abundant supplies are available only in Alberta. The Stony Creek field in New Brunswick produces natural gas for Moncton and adjoining communities, but the supply is barely adequate to meet requirements and no large expansion could be undertaken on the basis of presently established reserves. In 1947 the production in New Brunswick amounted to 489,810 M cubic feet which, on the basis of efficiency in burning and heat units, would be equivalent to approximately 24,500 tons of high-rank coal.

The southwestern peninsula of Ontario has had a long record of gas production and the principal fields are in Kent and Haldimand counties. In 1947, in Lambton county, Imperial Oil, Limited discovered a new field at Kimball, 11 miles southeast of Sarnia. The discovery well, Imperial Kimball No. 2, showed an initial open-flow of 435 M cubic feet at a depth of 2,150 to 2,195 feet. Two dry holes and three gas wells were completed in this field during the year. In the winter of 1947-48 southwestern Ontario experienced an acute gas shortage with costly industrial shut-downs. This is a situation that is very difficult to remedy. Application was made by the Union Gas Company in 1946 to the Federal Power Commission in Washington for the importation of gas into Ontario by the Panhandle Eastern Gas Company and plans were made to bring in gas, but the shortage of gas in the United States in cities adjoining Ontario caused the cancellation of this concession. The application, however, has been renewed.

The search for natural gas in Ontario in 1947 was extensive and out of 405 wells of all types completed, approximately 89 were exploratory and 148 were development gas wells. The initial flows of most of these wells were less than 100 M cubic feet and only in 8 did the flow exceed 500 M cubic feet. About 90 per cent of the total wells drilled in Ontario in 1947 were seeking natural gas rather than oil.

The Becker field, discovered by Imperial Oil, Limited in 1946, was extended by drilling 23 wells, of which 10 were dry holes, 9 were oil, and 4 were gas wells. This field produced 20,263 barrels of oil and 130,000 M cubic feet of gas in 1947.

The deepest well drilled in Ontario in 1947 was Imperial Rhodes No. 2 on lot 13, concession 7, Raleigh township, Kent county. This well was completed in the Trenton formation as a dry hole at a depth of 3,351 feet.

The production of natural gas in Ontario in 1947 was 7,785,921 M cubic feet, which was 14·8 per cent of the total amount of natural gas produced in Canada.

There is no commercial gas production in Manitoba although there are a few small wells in the southwestern part of the province that are used locally.

In Saskatchewan, gas is produced in three areas, namely, Lloydminster, Unity, and Kamsack. The Kamsack wells are only about 150 feet deep and have very small flows at a very low pressure. Deeper drilling has not yielded any further flows, so that the field is relatively unimportant.

The Unity field has been developed around End Lake about 5 miles southwest of the town. It has 5 productive wells in the Viking sand and 3 wells in the Unity sand that lies directly on top of the Palæozoic limestone. The total reserves are estimated to be slightly more than 25 billion cubic feet.

The Lloydminster field lies on the Alberta-Saskatchewan boundary, but the gas supply for the town comes from wells in Saskatchewan. In Alberta one well, Shaw No. 4, is supplying about 300 M cubic feet a day to the Excelsior refinery. The gas in the Lloydminster field is obtained in the Colony sand which is at the top of the Lower Cretaceous. There is also some gas in wells in the lower or Sparky sand, but as this is the oil-producing sand the gas is used only for pumping individual wells by gas engines. In 1947, gas was withdrawn from 4 wells for a supply for Lloydminster and the amount produced was 167,034 M cubic feet. During the same period 3 wells in the Unity field supplied 75,681 M cubic feet for consumption in Unity.

In Alberta, the Viking-Kinsella field in the east central part of the province supplied Edmonton and all towns on the Edmonton-Calgary C.P.R. line as far south as Red Deer. Calgary is supplied mainly from the Turner Valley field. A pipeline joins Calgary with the Bow Island and Foremost fields in southern Alberta, and during peak load periods, which now exceed a rate of 100,000 M cubic feet a day, these fields may be used to augment the supply from Turner Valley.

Previous to the discovery of the Leduc field in 1947, the shortage of oil in the Prairie Provinces made it imperative that new supplies be found and it appeared that synthetic gasoline made from natural gas might have to meet part of this demand. This led to a vigorous search for new gas supplies, which was very successful. Imperial Oil, Limited undertook to delimit the Viking-Kinsella field and many wells were drilled. The field is now estimated to cover 572 square miles and includes the Fabyan producing area from which gas is obtained to supply Wainwright. The reserves that have been established are approximately 1,000,000,000 M cubic feet, which is the largest proven reserve in Alberta. In southern Alberta, McColl-Frontenac and Union Oil companies also undertook a drilling campaign to establish gas reserves. This led to the discovery of the Pendant d'Oreille field, south and east of Pakowki Lake, and of the Manyberries field, 35 miles southeast of Foremost. The Black Butte and Smith Coulée areas were also found to the south of the Pendant d'Oreille field and close to the International Boundary. The reserves that have been established for these fields are estimated to be about 330,000,000 M cubic feet.

In 1947 another gas well was completed by Shell Oil Company of Canada in the Jumpingpound field, 20 miles west of Calgary. This field has had no commercial production, but considerable gas from the discovery well drilled in 1944 has been used to drill further wells. The field, as outlined, contains 6,300 acres and has probable reserves of more than 900 billion cubic feet.

There are many areas in Alberta from which natural gas might be produced and small fields have been developed close to many small towns such as Brooks, Tilley, Hanna, Vermilion, St. Paul, and Athabaska. The Medicine Hat field is one of the larger and older producing areas and it has been greatly extended recently by drilling to the northeast.

A recent calculation of natural gas reserves in the Prairie Provinces gives the proven and probable reserves for Alberta as 3,168,000,000 M cubic feet, and for Saskatchewan as 65,000,000 M cubic feet. In addition to the areas for which computation of reserves has been made, there are many potential gas areas where the undeveloped reserves appraised on the basis of limited information from drilling and available geological data are exceedingly large. Development of these potential fields will not be undertaken until a wider market is assured.

One of the important discoveries in 1947 was the Gulf Oil Pincher Creek structure that contains natural gas and condensate. Drilling is still proceeding in the hope that the lower horizons may have crude oil. This well reached the top of the Palæozoic at 11,700 feet. Tests in the upper part of the Palæozoic limestone indicated 44,000 M cubic feet of gas with perhaps more than 1,000 barrels of distillate a day. No production tests have been made of the complete porous section. The field is similar in type to Turner Valley and it appears to have prospects for very large production.

The net gas withdrawals in Alberta in 1947 were 49,001,806 M cubic feet.

There is no natural gas production in British Columbia. During 1947 a very large acreage in the Peace River area of British Columbia was acquired by permit, and drilling will be done in 1948 with the stated objective that if sufficient gas can be found it will be piped to Vancouver. The reserves required to accomplish this should be at least 1,000 billion cubic feet, and preferably larger.

PEAT

Peat is widely distributed in Canada and is found in every province. In its natural state it consists of about 90 per cent water and 10 per cent vegetable matter in various stages of decomposition and disintegration. In general, it occurs in two distinct forms, unhumified sphagnum or moss peat, and well-humified grass or sedge peat, usually known as fuel peat.

Peat moss is the dead fibrous moss that has been excavated from peat bogs, dried, shredded, and pressed into bales or smaller packages. Its value depends upon its highly absorptive nature, and its main uses are for stable bedding and poultry litter, and for soil conditioning.

Small amounts of peat fuel have been produced intermittently in Ontario and Quebec. In 1947 there was a small output at Gads Hill near Stratford, Ontario.

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.

In 1947 the main producing areas were: the Fraser River delta area, near New Westminster, B.C., and Rivière du Loup district in Quebec. Together, these accounted for more than 80 per cent of the Canadian production. The deposits in both these areas were being intensively developed in 1947. Those in British Columbia are expected to last for 10 to 15 years at the 1947 rate of production, and those in Quebec a somewhat longer period. There are a number of peat bogs in the Maritime Provinces awaiting development.

The operation of a peat bog requires much hand-labour. Mechanical diggers and cutters have been tried, but hand-digging and stacking are still almost universal. It is generally admitted that mechanization will have to be introduced in order to reduce the cost of production, especially in view of the competition from European peat which has already started to arrive at Atlantic ports.

In 1947, the thirty-five plants in operation produced 80,019 tons of peat moss valued at $2,279,821. British Columbia produced 58 per cent of the total tonnage; Quebec, 27 per cent; Ontario, 10 per cent; and Manitoba and New Brunswick, the remainder. The Canadian production is practically all exported to the United States for use as horticultural moss, and for poultry and stable litter.

In British Columbia, fourteen companies produced 46,104 tons valued at $1,588,349, the largest producers being Industrial Peat, Limited, Western Peat, Limited, and B.C. Peat Company. Blundell Peat Company started to produce in 1947.

In Quebec, fourteen companies produced 21,292 tons valued at $383,795, the largest producers being Premier Peat Moss, Limited, Isle Verte; and Maple Leaf Peat, Limited, and Perfect Peat Products, Limited, Rivière du Loup.

In Ontario, three companies produced 8,250 tons valued at $170,443, the largest producer being Arctic Peat Moss Corporation, Limited, near Fort Frances.

In New Brunswick, two new plants came into production, namely, Atlantic Peat Moss Company, Limited, and Western Peat Company, Limited, both at Shippigan.

In Manitoba, the main production came from the property near Whitemouth, operated by Winnipeg Supply and Fuel Company, Limited.

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 peat arrived in Montreal from Holland in 1947.

The price of peat moss varies from $22 to $36 a ton according to location, the average price for the Canadian production in 1947 being about $29 a ton.

In 1947, a co-operative investigation was started by the Departments of Agriculture and Mines and Resources, Ottawa, to test the value of humified peat as a source of organic matter for depleted and exhausted soils. Test plots at selected areas in Quebec, Ontario, and New Brunswick are being used to determine the value of peat for this purpose.

CRUDE PETROLEUM

Foreign countries supply much of the crude oil refined in Canada. Only on the Prairie Provinces is there hope of changing this situation in the immediate future. Formerly, most of the crude oil imported into Canada for refining came from United States, but this is gradually changing because of the fact that for the first time since oil was found in that country it has now reached the point where net imports exceed exports, and within it there is no excess productive capacity. This radical change is not because of any decline in United States production. In fact, production is now larger than ever before and in the last three months of 1947 was more than 640,000 barrels a day greater than the average daily yield in 1945, the peak production of the war years. It has occurred as the result of a great increase in consumption for all purposes.

In 1947 in the United States 33,646 wells were drilled[1], of which 5,539 wells were exploratory, resulting in 1,130 productive wells and 4,409 dry holes. These productive wells discovered 932 new oil, gas, and distillate fields and new productive zones in old fields, an increase of 244, or 35·5 per cent over 1946. Thus, new productive areas are being opened up at an increased rate, but, even so, the demand for oil products has outstripped the discovery rate.

These facts in regard to oil in the United States are of great significance to Canada. Over the past few years, imports of crude oil into Canada have increased; but the percentage from United States has decreased, with a corresponding increase from South America, particularly from Venezuela, where production is now about 1,200,000 barrels a day. In 1940, for example, imports of crude oil into Canada amounted to 42,623,500 barrels; of this, 29,636,700 came from United States and 12,986,800 barrels from South America and Trinidad. Venezuela supplied 3,248,600 barrels and Colombia 9,263,300 barrels. In 1947 crude oil imports into Canada were 68,446,700 barrels, an increase of more than 60 per cent over 1940. Of these imports, 38,837,400 barrels came from United States and the remainder from the Caribbean area, with 27,127,940 barrels from Venezuela and 1,894,910 barrels from Colombia. Most of the imported crude oil from Venezuela came into Eastern Canada, and in September 1947, imports from this country amounted to 83,000 barrels a day. In view of the demand for oil in the United States it is obvious that Eastern Canada, now depending to a considerable extent upon imports from Venezuela, will continue to draw more heavily on this source or on the Near East oil if this should become available in large quantities when the Trans-Arabian pipelines are completed.

The production (well output) of oil in Canada was as follows:

—	1946 (Barrels)	1947 (Barrels)
New Brunswick	28,584	23,129
Ontario	123,082	131,295
Saskatchewan (Lloydminster)	136,874	540,117
Alberta		
Turner Valley		
Crude oil	5,937,362	5,022,350
Natural gasoline	434,210	427,225
Taber and West Taber	206,925	205,236
Vermilion	183,946	138,401
Wainwright	15,114	18,325
Conrad	212,645	202,929
Lloydminster (Alberta)	76,187	304,236
Princess	64,953	106,920
Leduc	....	372,427
Miscellaneous fields	7,190	11,235
Total Alberta	7,427,072	7,503,825
Northwest Territories	177,282	227,474
Total for Canada	7,604,354	7,731,299

[1] World Oil, vol. 127, No. 11, p. 68, Feb. 1948.

The small production in New Brunswick comes from Stony Creek field near Moncton. In 1947 extensive explorations were carried out between Moncton and Sussex by a major oil company in an effort to delimit favourable geological conditions for new fields.

In Gaspe the search for oil was continued. This search has been under sporadic investigation for many years and much drilling has been done. It is in the Appalachian belt where there are favourable structural conditions and where oil seepages have been known from the days of early settlements. The main lack in the wells so far drilled has been the absence of sufficiently porous reservoir beds to yield oil in commercial amounts. Shows of oil and small yields have been obtained in many wells.

In Ontario, the yearly production is less than two days' refinery runs. There is little prospect of substantially increasing this yield.

For many years production in the Prairie Provinces came mainly from Turner Valley, but the yield of this field has been decreasing and is now less than half that of 1942, the peak year. Discovery of the Leduc field, 18 miles southwest of Edmonton, in February 1947, was opportune and production in Alberta at the end of 1947 was again increasing. This was due mostly to the Leduc field, but the expansion of the Lloydminster field on the boundary between Alberta and Saskatchewan was also an important factor. The Leduc oil is suited to make gasoline and light oil products, whereas the oil from Lloydminster is heavy and asphaltic and is suited to make road oils, asphalt, and bunker "C" fuel oil. Thus, the two oils are not competitive.

Leduc is the most important crude oil discovery made in Western Canada since Turner Valley. It is expected that the rapid expansion of this field will, in a year or so, meet all prairie demands for light oil products. From 1941 to 1947, the consumption in the Prairies increased 47 per cent, and, in 1947, prairie refineries processed 14,060,000 barrels of crude oil. As domestic production was less than half of this, the remainder, amounting to approximately 20,000 barrels a day, was imported from United States, from which country Alberta received 1,406,000 barrels, Saskatchewan 5,351,000 barrels, and Manitoba 540,000 barrels. Crude oil is not readily available in the United States in areas adjoining Western Canada and much of this oil came from Wyoming, North Texas, New Mexico, and the Midcontinent fields.

Exploration in Alberta was very active in 1947. The amount drilled was 883,938 feet, resulting in one hundred and two completed oil wells, fourteen incomplete but probable oil wells, thirty-three gas wells, seventy-five dry holes, and one salt well.

In Saskatchewan, a drilling program surpassing all previous years was undertaken in the Lloydminster-Lonerock area. The amount drilled was 204,-485 feet in one hundred and five wells, of which eighty-nine were development wells and ten were exploration wells in the Lloydminster area.

In Manitoba, 1,750,000 acres of Crown lands in the southwest part of the province were reserved and leased during 1947. Extensive seismic work was undertaken by Brandon Exploration Company, a subsidiary of California Standard Company. Two wells were drilled by independent operators. One was abandoned at the top of the Precambrian at a depth of 2,519 feet, and the other was suspended at a depth of 1,540 feet. There is no oil production in Manitoba.

In the Northwest Territories the oil from the Norman Wells field is used only for local purposes, and products are transported by river and lake barges to the mines on Great Bear and Great Slave Lakes. The expansion of the mines at Yellowknife will bring increased demands for oil products. The Norman Wells field is being operated considerably below the capacity of the presently drilled wells, and refinery facilities are adequate for all immediate requirements.

British Columbia has no oil or natural gas production, but some leasing occurred in 1947 in the Peace River area of the province. This may lead to some drilling, but development costs are likely to prove rather high. No adequate outlets are at present available for any considerable volume of oil from this area and to provide them, as, for example, by pipeline to the Pacific Coast, would mean proving up a sufficient volume of oil to meet the construction costs and the operation of pipeline facilities. It is thought that a reserve of perhaps 300,000,000 barrels would have to be established to justify such an expenditure. At present, British Columbia imports most of its crude oil requirements from California, which has the second largest production of any state in the United States. Demand for oil products, however, has reached the point where new discoveries at an accelerated rate will be necessary to keep pace with consumption, and in 1947 some oil was imported from Venezuela through the Panama Canal to British Columbia. The cost of transporting this oil from Venezuela is much higher than from California, but it seems likely that such imports will increase unless new extensive fields are found in California in the near future.