CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH

THE CANADIAN MINERAL INDUSTRY IN 1951

Reviews by the Staff of the Mines Branch

Price, 25 cents

No. 841

CONTENTS

Product	Author	Page
I. METALS		
Aluminium	Woodrooffe, H. M	1
Antimony	McClelland, W. R	3
Arsenic	McClelland, W. R	5
Bismuth	McClelland, W. R	7
Cadmium	Neelands, R. E	9
Chromite	Janes, T. H	10
Cobalt	Janes, T. H	14
Copper	Buck, W. K	19
Gold	Graves, H. A	25
Iron Ore	Buck, W. K	29
Lead	Neelands, R. E	35
Magnesium	Woodrooffe, H. M	39
Manganese	Janes, T. H	40
Mercury	Janes, T. H	43
Molybdenum	Janes, T. H	45
Nickel	Buck, W. K	48
Platinum Metals	Buck, W. K	52
Selenium and Tellurium	Neelands, R. E	54
Silver	Neelands, R. E	56
Tellurium (see Selenium)		
Tin	McClelland, W. R	60
Titanium	Buck, W. K	61
Tungsten	Janes, T. H	64
Zinc	Neelands, R. E	69
II. INDUSTRIAL MINERALS		
Abrasives (Natural)	Janes, T. H	77
Asbestos	Woodrooffe, H. M	80
Barite	Bruce, C. G	83
Bentonite	Matthews, J. G	86
Brucite (see Magnesite)		
Cement	Simpson, R. A	89
Clays and Clay Products	Phillips, J. G	91
Corundum (see Abrasives)		
Diatomite	Janes, T. H	95
Feldspar	Bruce, C. G	97
Fluorspar	Carr, G. F	99
Garnet (see Abrasives)		
Granite	Carr, G. F	102
Graphite	Bruce, C. G	104
Grindstones (see Abrasives)		
Gypsum and Anhydrite	Simpson, R. A	106
Iron Oxides	Wait, E. H	109
Kaolin (see Clays)		
Lime	Woodrooffe, H. M	110
Limestone, (General	Woodrooffe, H. M	112
Limestone (Structural)	Woodrooffe, H. M	114
Magnesite and Brucite	Woodrooffe, H. M	115
Marble	Woodrooffe, H. M	117
Mica	Bruce, C. G	118
Nepheline Syenite	Bruce, C. G	122
Phosphate	Bruce, C. G	123
Pyrites (see Sulphur)		
Roofing Granules	Janes, T. H	125
Salt	Matthews, J. G	129

71392—1½

CONTENTS—*Conc.*

Product	Author	Page
II. INDUSTRIAL MINERALS—Conc.		
Sand and Gravel	Picher, R. H.	132
Silica	Woodrooffe, H. M.	135
Sodium Sulphate	Matthews, J. G.	137
Sulphur and Pyrites	Janes, T. H.	139
Talc and Soapstone	Bruce, C. G.	145
Vermiculite	Bruce, C. G.	147
Volcanic Dust (see Abrasives)		
Whiting	Woodrooffe, H. M.	149
III. FUELS		
Coal	Swartzman, E.	151
Coke	Burrough, E. J.	157
Natural Gas	Quantz, Miss M. Joan[1]	158
Peat	Swinnerton, A. A.	163
Petroleum (crude)	Quantz, Miss M. Joan	165

[1]Geological Survey of Canada.

NOTE:—The figures of production and trade are those published by the Dominion Bureau of Statistics. Market quotations are obtained chiefly from standard marketing reports issued in Montreal, New York, and London.

PREFACE

This report contains reviews for 1951 on each of the metals and minerals produced in commercial quantity in Canada in that year. The introductory section covers the principal developments in the mineral industry as a whole for the year. Mimeographed separates of the reviews were issued during the first half of 1952. In these, preliminary production figures as supplied by the Dominion Bureau of Statistics are given, whereas the present report gives the final ~~fiscal~~ figures.

As noted in the table of contents, the reviews on crude petroleum and natural gas were prepared by an officer of the Geological Survey of Canada.

The Branch is indebted to all those who contributed data for use in the reviews, particularly to operators of mineral producing properties and to the Dominion Bureau of Statistics.

JOHN CONVEY,
Director, Mines Branch.

INTRODUCTION

Notable headway was again recorded by the mineral industry in 1951, the value of its production reaching a new high of $1,245,483,595 compared with $1,045,450,073 in 1950. Fourteen metals and minerals accounted for over 90 per cent of this total. In order of value they were gold, nickel, copper, zinc, crude petroleum, coal, asbestos, lead, sand and gravel, clay products, cement, iron ore, stone, and silver.

The index of the physical volume of production for the industry as a whole, based on 1935-39 average=100, rose from 149.5 in 1950 to a record 163.9 in 1951.

Metals and minerals continued to figure prominently in Canada's export trade, the total value in 1951, excluding manufactured or chiefly manufactured products, being $526,248,569, an increase of about 27 per cent over the previous year. Reflecting the country's industrial growth, new records were established in the post-war domestic consumption of several of the metals and minerals.

In world output, Canada leads in the production of nickel, asbestos and the platinum metals, is second in zinc, gold, aluminium, and gypsum, third in silver, cadmium, and feldspar, fourth in lead, antimony, bismuth, fluorspar, and ilmenite, and fifth in copper and cobalt.

METALS

The value of metal output in 1951 reached a record $745,588,728 with increases over 1950 in all but gold, tin, tellurium, indium, and tungsten concentrate. Increases in volume of output over 1950 were established by all metals except gold, lead, silver, tin, tellurium, tungsten concentrate, and indium: records were also made in the output of iron ore, cadmium, antimony, ilmenite and zinc. The value of aluminium output is not included since the metal is made from imported materials.

Prices of the base metals continued to rise in 1951. Copper increased from 26 cents in January to 28.15 cents in December, lead from 17.85 cents to 19.50 cents, zinc from 19.33 cents to 21.35 cents, and nickel from 51.75 cents to 58.5 cents.

Exports of copper, lead, nickel, and zinc rose to $339,961,219, an increase of $62,366,553 over 1950. Most of the exports went to United States but increasing amounts of lead, zinc, and nickel were shipped to England.

Exploratory and development work on base metal properties and prospects reached record levels. New mines were brought into production, there was a revival of interest in many dormant properties, and extensive expansion of mine, mill, and refinery capacity.

Major developments included the entry into production of Hudson Bay Mining and Smelting Company's zinc fuming plant and zinc oxide treatment plant at Flin Flon, Manitoba; preparations for production at several properties, among which were the Lynn Lake copper-nickel deposit of Sherritt Gordon Mines Limited in northern Manitoba, the zinc-silver property of Barvue Mines Limited in western Quebec, the copper property of Gaspe Copper Mines in Gaspe, Quebec, and the zinc-lead-copper mine of Mindamar Metals Corporation Limited in Nova Scotia. Other major projects included the $65,000,000 program of The Consolidated Mining and Smelting Company of Canada Limited for power development and modernization and the expansion of productive facilities; the steady changeover by The International Nickel Company of Canada Limited from combined open-pit and underground operations to all-underground production; and the discovery by Falconbridge Nickel Mines Limited of what appears to be a major orebody at Fecunis Lake in the Sudbury area, Ontario.

Of primary importance to the Canadian economy is the great aluminium industry which began to take shape in British Columbia on Aluminum Company of Canada's Kitimat project. The project, which will cost an estimated $550,000,000 will result eventually in doubling Canada's present output of 500,000 metric tons of aluminium annually.

Canada has stepped to the forefront with regard to another metal of great importance to the defence programme and generally—tungsten. The deposits near Salmo, British Columbia, are both richer and more extensive than was at first thought, and it is expected that when full production is reached they will be supplying some 750 tons of ore per day. This will constitute the largest single source of tungsten in the free world.

Canadian supplies of cobalt, another strategic metal, were increased following a raise in price by the Federal Government and the resultant stimulation of production from the Cobalt-Gowganda area of Ontario.

Canada's position as a producer of iron ore was enhanced during the year mainly as a result of developments in Ontario, the Quebec-Labrador region, and Newfoundland. These give indications of an overall production of from 30 to 40 million tons of high grade iron ore a year, possibly within the next ten to fifteen years. In northwestern Ontario, Steep Rock Iron Mines Limited continued to develop the Errington mine, now an open-pit operation, into a complete underground operation with a proposed annual output of 1,500,000 tons. Concurrently with this the Hogarth mine is being prepared for production by open-pit methods, and is expected to enter production in 1953 at a rate of 1,000,000 to 1,500,000 tons a year. Studies by the company of its various deposits in the area, including those under option to other companies, suggest an eventual overall production of from 10 to 15 million tons a year.

Preparation for production was commenced at Bethlehem Steel Corporation's magnetite deposits at Marmora in Hastings county, Ontario, the main operation at present being removal of the 100-foot capping of limestone. Production, scheduled to commence in 1954, is expected to rate at 500,000 tons of concentrate a year which will be shipped to Picton on Lake Ontario and from there by water to the company's operations at Lackawana near Buffalo.

Notable progress was made toward preparing the Quebec-Labrador deposits for production in 1954. By the end of 1951 ten miles of track had been laid and 125 miles of grading had been completed on the 360-mile railroad to connect the deposits with the port of Seven Islands on the Gulf of St. Lawrence. No attempt was made by the company in 1951 to increase ore reserves, which at the end of that year remained at 417,707,000 tons of proven ore. Although present plans call for the production of 10,000,000 tons a year these take into consideration the possibility of an eventual annual output of 20,000,000 tons or more a year.

At Dominion Steel and Coal Corporation's Wabana hematite mines in Newfoundland, work continued on the mechanization and modernization programme designed to raise production to 2,500,000 tons a year.

In British Columbia, Argonaut Company Limited commenced steady production of iron ore from its magnetite deposits near Quinsam Lake on the east coast of Vancouver Island. Output was expected to reach a rate of 50,000 tons monthly in the near future. Production from the magnetite deposits of Texada Iron Mines Limited on Texada Island was expected to commence in 1952.

In the gold industry, operators were again faced with high production costs and a declining price for gold, the latter resulting from the improved position of the Canadian dollar in relation to the United States dollar. The search for gold was considerably less active than in 1950 largely because of the greater interest in base metals and uranium. No new mines were brought into production during 1951, but development work was continued on a number of prospects, several of which appear to hold definite promise of becoming producers. New orebodies were discovered at several producing mines and at least five companies expanded milling capacity or increased the daily tonnage milled.

Commencing October 1, 1951 Canadian producers of gold were given the choice by the Federal Government of selling their production on premium markets under Government regulation, or for those eligible, of continuing to receive cost aid under the Emergency Gold Mining Assistance Act. In December, 1951, the Minister of Finance announced that the Federal Government proposed to introduce legislation in Parliament to extend the operation of the Act to the end of 1953.

INDUSTRIAL MINERALS

Gains over the previous years in both volume and value of output were recorded by most of the industrial minerals in 1951. Among those which established records in volume output were asbestos, graphite, gypsum, salt, sulphur, sodium sulphate, magnesite and brucite, fluorspar, nepheline syenite, titanium dioxide and the structural materials. Total value was $267,040,774, a 17·6 per cent increase over 1950.

Output of asbestos, the principal mineral of the group, was valued at $81,584,345, the gain of 24 per cent over 1950 being mainly a reflection of the higher prices obtained for all fibre groups. Over 97 per cent of the output came from the Eastern Townships of Quebec, and the remainder from the Matheson area in northern Ontario where the new mine of Canadian Johns-Manville Company Limited completed its first full year of production. Canada accounts for about 70 per cent of the world output.

Developments in the asbestos industry included the proposed erection by Asbestos Corporation Limited of a 5,000-ton mill to treat the ore from its Normandie mine in the Eastern Townships where a new orebody is being developed; the erection by Johnson's Company Limited of a new and larger mill at its Black Lake property, and acquisition of the chrysotile deposit in the McDame Lake area of northern British Columbia by Cassiar Asbestos Corporation Limited which plans to erect a mill to recover fibre from the deposit.

Production of salt reached a record 964,525 tons in 1951. A newly formed company, Canadian Salt Company Limited, took over the plants of the Salt Division of Canadian Industries Limited at Windsor, Ontario, and at Neepawa, Manitoba, and also the plant of Alberta Salt Company Limited at Lindbergh, Alberta.

The demand for sodium sulphate, particularly for use in the pulp and paper industry, continued to outstrip supply, and imports to meet industrial needs in eastern and western coastal areas of Canada rose to 22,700 tons compared with 18,000 tons in 1950.

Sales of mica of all classes in Canada increased 28 per cent in volume and about 100 per cent in value compared with 1950. Exports, mostly to the United States, increased 40 per cent in volume and 200 per cent in value. The production came from Ontario, Quebec, and British Columbia, in that order.

The output of clay products continued to increase in spite of a smaller volume of sales caused by credit restrictions and other exigent economy measures. Certain ceramic products fell into this category, such as low tension electrical insulators, domestic tableware, and sanitary ware.

Although production of cement reached a record 17,007,812 barrels, imports of 2,327,429 barrels were necessary to meet domestic requirements. However, expansion programmes, commenced in 1950 and 1951, were expected to lead to an increase in capacity of 5,320,000 barrels by mid-1952.

Several projects were undertaken during 1951 that will make Canada less dependent upon outside sources of supply for its requirements of elemental and other forms of sulphur. In one of these, Shell Oil Company of Canada brought a plant into operation early in 1952 in the Jumpingpound field in Alberta that will recover elemental sulphur at the rate of 10,000 tons annually from the scrubbing of sour natural gas from that field. In another project at Turner Valley, Alberta, Royalite Oil Company will recover about the same amount from the Turner Valley field in a plant scheduled to enter production in 1952.

At Copper Cliff, Ontario, Canadian Industries Limited is building a $1,500,000 plant to produce about 90,000 tons of liquid sulphur dioxide a year from stack gasses obtained from flash smelting units developed recently by The International Nickel Company of Canada Limited in its adjacent plant.

At Valleyfield in Quebec, Nichols Chemical Company Limited began an expansion programme designed to double its 100,000-ton annual output of sulphuric acid by late 1952. At Kimberley in British Columbia The Consolidated Mining and Smelting Company of Canada Limited planned to build a fertilizer plant which will include a sulphuric acid plant to have an annual capacity of 100,000 tons of acid.

FUELS

Of increasing significance to the national economy is the marked expansion Canada has been witnessing in the development of its crude petroleum and natural gas resources. Expenditures in excess of $200,000,000 were made in 1951 on the exploration and development of these resources. By the end of the year exploratory activity, in addition to covering large areas in Alberta, Saskatchewan, and Manitoba, had spread northwestward into the Peace River areas of Alberta and British Columbia and into areas south and west of Great Slave Lake in the Northwest Territories. Several important oil discoveries were made, the most outstanding being the Wizard Lake and Bonnie Glen fields south of the Leduc field in Alberta. Of significance also were two discoveries of medium grade crude oil in Saskatchewan, and two in southwestern Manitoba. Recoverable reserves of crude oil in Alberta at the end of the year were estimated at approximately 1,500,000,000 barrels.

Production, which largely reflects market outlet capacity, rose 64 per cent over the 1950 output to about 48 million barrels following the opening of the 1,127-mile pipe line from Edmonton to Superior, Wisconsin. Approval for construction of the 700-mile Trans-Mountain pipe line from Edmonton to Vancouver was given by the Federal Government in December, 1951. To keep pace with increased production, refinery capacity was increased at Edmonton and Winnipeg and building was started on a refinery at Froomfield near Sarnia.

Natural gas continued to be discovered in increasing quantities in western Canada mainly in conjunction with the search for oil and by the end of the year reserves were being built up at a rapid rate.

Proposals for the export of natural gas from Alberta continued to be of major interest. In January, the Alberta Petroleum and Natural Gas Conservation Board presented to the Alberta Government its interim report respecting applications for permission to remove gas from the province. From the data presented by the applicants, the Board reached the decision that the disposable gas reserves in Alberta at January 1, 1951 were 4,439 billion cubic feet within economic reach and 219 billion cubic feet beyond economic reach, The Board estimated the province's requirements for the 30-year period, 1951 to 1980, at 3,059·9 billion cubic feet.

Increased competition from the use of oil and natural gas was a main reason for the decline in the Canadian output of coal from its all-time peak of 19,139,112 tons in 1950 to 18,586,823 tons in 1951. Although output decreased, consumption at 44,839,204 tons, remained about the same and close to 60 per cent of it was supplied by imports, chiefly from United States. It may be noted that, for railway use, the consumption of coal in Canada in 1951 was only slightly greater than that in 1941, while the consumption of fuel and diesel oil showed close to a four-fold increase during the same period. In the case of domestic and building heating the use of coal showed a small percentage decline during the 1941-51 period while that of fuel oil in 1951 was about 3½ times greater than in 1941.

The coal industry is continuing its effort to improve the quality of its products by the use, on an increasing scale, of the most modern methods of coal beneficiation. This programme has been necessary not only because of the increased competition from oil and natural gas, and to a lesser extent from imported solid fuels, but owing also to the general deterioration in the quality of coals as mined, brought about by increasing mechanization and the steady depletion of some of the best coals. The programme during 1951 resulted in the establishment of several cleaning, drying, and briquetting plants in Alberta, Nova Scotia, and New Brunswick.

I. METALS

ALUMINIUM

Production of aluminium in Canada in 1951 was 447,095 tons, a peacetime record and 90 per cent of maximum wartime output achieved in 1943.

Important developments now underway will add greatly to Canada's productive capacity for ingot aluminium. At Kitimat, British Columbia, Aluminum Company of Canada Limited is building an aluminium reduction works which will have an ultimate capacity of 500,000 tons annually. The first production is scheduled for early 1954 at the initial rate of 91,000 tons per year. A major hydro electric power development is under way to supply the requirements of the new plant. In the province of Quebec, a new reduction works at Isle Maligne with an annual capacity of 50,000 short tons is nearing completion. Two hydro electric power sites on the Peribonka River are being developed to supply the new plant as well as increase power to all the Saguenay plants.

Canada is the second leading aluminium-producing country with approximately one-fifth of the world's smelting capacity. The principal producer, Aluminum Company of Canada, Limited, has reduction plants at Arvida, Isle Maligne, Shawinigan Falls, La Tuque, and Beauharnois in Quebec. The latter was reopened in April, 1951. To supply these plants alumina is recovered from imported bauxite at a treatment plant in Arvida.

The company also has in operation aluminium and aluminium alloy fabrication works at Kingston and Etobicoke in Ontario and Shawinigan Falls in Quebec. An associate, Aluminum Goods, Limited, operates a fabrication plant in Toronto.

Favourable sites for the development of low cost electrical power, accessible to sea transportation, have been an important factor in the establishment of Canada as a principal aluminium-producing nation. Existing reduction plants use alumina recovered mainly from British Guiana bauxite. Other important raw materials are Newfoundland fluorspar, coal and coke from United States, and cryolite from Greenland direct and by way of United States. Alumina recovered in Jamaica from bauxite mined in that country will supply the new Kitimat works.

There are no occurrences of bauxite in Canada. However, anorthosite, nepheline syenite, and certain clays and shales may be considered potential low grade ores of the metal. These occur in many areas. Although considerable technical advance has been made in the direction of using low grade materials, economic factors have prevented their acceptance. The Bayer process for recovery from bauxite remains the standard process.

Uses and Prices

Uses for aluminium continue to increase. It is available from fabrication plants in many forms: castings, forgings, sheet; a variety of rolled and extruded shapes, tubes, rods, wire, foil; powder and paste. In recent years, advances have been made in the use of aluminium in the building trades, in the electrical industry and in transportation where its light weight is advantageous.

The price of aluminium ingot, 99½ per cent (minimum), in 15-ton carload lots, f.o.b. reduction works, remained at 17 cents a pound until October when it was increased to 17½ cents, with a further increase to 18 cents in November.

Production, Trade, and Consumption

	1951		1950	
	Short tons	$	Short tons	$
Production, Ingot	447,095		396,882	
Imports: Bauxite				
From: British Guiana	1,782,507	9,419,892	1,679,196	7,091,870
Trinidad	314,640	1,599,632	7,459	28,972
Surinam	153,578	1,140,516	27,576	227,617
United States	139,612	3,149,235	90,970	2,239,082
Other countries	11,422	63,738	56,426	302,584
Total	2,401,759	15,373,013	1,861,627	9,890,125
Imports: Cryolite				
From: Denmark	3,858	593,517	2,646	381,184
United States	2,658	508,898	1,088	217,484
Total	6,516	1,102,415	3,734	598,668
Imports: Aluminium Products				
Semi-manufactured	....	3,387,455	....	1,267,987
Fully manufactured	....	8,109,502	....	6,879,077
Total	....	11,496,957	....	8,147,064
Exports: Primary Forms				
To: United Kingdom	191,342	57,223,813	138,814	39,223,555
United States	105,479	34,533,614	160,509	45,895,471
Australia	12,480	4,491,810	5,034	1,599,108
Brazil	9,893	3,409,342	5,329	1,610,190
Switzerland	5,087	1,702,836	558	186,139
Netherlands	5,042	1,816,770	4,249	1,184,107
Germany	5,033	1,798,968	141	40,048
Mexico	3,324	1,129,814	1,429	421,881
Uruguay	3,203	1,058,538	280	78,417
Italy	3,060	1,028,159	3,509	1,093,322
Sweden	2,050	779,219	2,487	856,672
Argentina	1,354	522,038	....	....
Other countries	7,067	2,524,496	13,387	4,180,635
Total	354,414	112,019,417	335,726	96,369,545
Exports: Semi-fabricated				
To: United States	7,721	4,216,292	3,718	1,936,904
India	1,659	731,236	3,359	1,519,898
Mexico	1,188	531,191	683	277,908
Brazil	1,068	539,917	199	86,235
Union of South Africa	63	29,040	1,109	520,133
Other countries	3,106	1,538,251	2,377	1,151,675
Total	14,805	7,585,927	11,445	5,492,753
Exports: Manufactured Products				
To: United States	....	1,079,805	....	357,055
Venezuela	....	561,606	....	1,931,014
Siam	....	493,442	....	1,518
Colombia	....	329,658	....	156,492
Cuba	....	146,872	....	176,088
Egypt	....	111,720	....	....
Jamaica	....	89,915	....	9,065
New Zealand	....	88,698	....	10,147
Other countries	....	1,024,451	....	1,020,314
Total	....	3,926,167	....	3,661,693

Production, Trade, and Consumption—Conc.

—	1951		1950	
	Short tons	$	Short tons	$
Exports: Scrap				
To: United States	3,575	1,146,894	4,642·9	1,343,393
Brazil	161	48,808	....	....
Colombia	83	25,603	....	....
United Kingdom	50	2,000	....	....
Other countries	82	24,619	0·1	60
Total	3,951	1,247,924	4,643·0	1,343,453
Consumption, Ingot	87,500	....	65,000	....

ANTIMONY

The world demand for antimony remained strong for most of 1951. Canadian requirements continued to be met by imported antimony metal, domestic production of antimonial lead; and by the utilization of antimonial lead scrap, largely in the form of old battery plates.

No metallic antimony is produced in Canada, the output being in the form of antimonial lead, antimony ore Doré slag, and antimonial flue dust. The contained antimony output from these sources in 1951 was 3,351 tons compared with 322 tons of contained antimony (in antimonial lead only) in 1950.

Canadian Occurrences

Deposits, largely as the mineral stibnite (Sb_2S_3), occur in Newfoundland, Nova Scotia, New Brunswick, eastern Quebec, British Columbia, and Yukon.

Newfoundland

On the west shore of Mortons Harbour on New World Island, Notre Dame Bay, a deposit was worked intermittently from 1890 until 1916 and a small amount of ore was exported. The workings are reported to be in a fair state of preservation and consist of a 230-foot tunnel about 10 feet above tidewater with a shaft to the surface at the inner end, and a shorter tunnel at 55 feet above sea level. The results of some recent sampling are reported in the Mines Branch review on antimony for 1950.

Nova Scotia

During the summer of 1951, 12 drill-holes totalling 3,500 feet were put down on the West Gore deposit in Hants county about 25 miles east of Windsor. This deposit was first worked in 1884 and mining was carried on at different periods up to 1917. The property is now owned by Antimony-Gold Mining and Smelting Corporation Limited. The ore occurs as lenses of auriferous stibnite in fissure veins in slate and quartzite. The main shaft has a depth of 840 feet. Several tailing dumps contain an estimated 34,000 tons of material which is reported to carry a small antimony content. A small deposit, presumably jamesonite (lead-antimony sulphide), occurs near Lansdowne, Digby county. A test pit was dug on the showing in 1949 and in 1951 two short diamond drill holes were put down. The drilling failed to disclose any appreciable zone of mineralization.

New Brunswick

At Lake George, Prince William parish, York county, stibnite showings in quartz veins extend for a length of a mile with a width of half a mile. Between 1868 and 1931 the deposit was worked intermittently and smelting operations were carried on during several of these active periods. Numerous shafts have been sunk, the deepest being 375 feet. In 1947 renewed interest was taken in the property and since that time intermittent exploratory work has been undertaken. Some diamond drilling was done, several of the dumps were sampled, and in 1951 one of the shafts was dewatered and some underground sampling was carried out.

Quebec

A deposit of stibnite in South Ham township, Wolfe county, was worked around 1874, but has been idle for many years. Some drilling was carried out in 1951, but the results were not encouraging.

British Columbia

The ore of The Consolidated Mining and Smelting Company's Sullivan mine at Kimberley contains a small amount of antimony which is ultimately recovered in the form of an antimonial lead alloy from the lead refining residues and flue dust at the company's smelter, Trail, B.C.

A deposit at Stuart Lake in the Fort St. James area was developed by a shaft in 1940 and small shipments of ore were made for test purposes.

There are several occurrences of antimony in the Bridge River area, one of which, at the head of Truax Creek, has been under development since early in 1949, first by Bellore Mines Limited, and later by Gray Rock Mining Company Limited. During 1951 a 2,000-foot tram line was erected and the cross-cut and drift were extended. A diamond drilling program was carried out. A small lot of hand picked ore was prepared for shipment.

Yukon

The principal occurrences are in the Wheaton district. A deposit on the east side of Carbon Hill was partly developed during the past two years. Samples analysed from 16·64 per cent to 34·63 per cent antimony.

Uses

Antimony is used chiefly as an alloying element with lead to which it imparts hardness and mechanical strength. Its characteristic property of expanding on cooling makes it a particularly important constituent in type metal alloys. Antimonial lead is used for battery plates, cable covering, and in the chemical and pulp and paper industries for sheet, pipe, etc. It is a component of most bearing metals, and is alloyed with lead and tin in making solders, foil, collapsible tubes, and type metal.

Sulphides of antimony are used as pigments in paint manufacture and in the rubber industry. The oxides are used in the production of porcelain enamel frits. The oxide is also the base for the flame-proofing of textiles and plastics and in fire-retardant paints.

Prices

The average Canadian price of antimony in 1951 was 58·292 cents a pound according to the Dominion Bureau of Statistics.

Domestic antimony in the United States, according to E.&M.J., "Metal and Mineral Markets", was 38·742 cents in January, increasing to 45·350 cents in September, and to 53·350 cents in December. The average price for the year was 45·666 cents a pound.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production: (content of antimonial lead alloy, in ores shipped, in flue dust, and in Doré slag)	3,351	1,436,713	322[1]	215,586
Imports: (regulus)				
From: United States	343	343,806	911	509,511
Belgium	231	241,201	553	294,426
United Kingdom	84	79,039	74	36,426
Yugoslavia	23	23,120	29	13,855
China	....	....	28	14,617
Czechoslovakia	....	....	11	4,885
Total	681	687,166	1,606	873,720
Exports: (antimony content of antimonial lead)	229	....	287	....

	1950	1949
Consumption of antimony regulus by specified industries	Short tons	Short tons
White metal foundries	907	683
Electrical apparatus	68	63
Silverware	8	11[2]
Brass foundries	14	10[2]
Miscellaneous	....	....
Total	997	767[1]

[1] The only production in 1950 was the antimony content of antimonial lead alloy.

[2] Revised.

It is estimated that the world antimony supply and demand were about in balance during 1951. China, formerly the principal producer, has practically ceased to be a supplicr for world markets. The principal producers are Mexico, Bolivia, South Africa, United States, Yugoslavia, and Czechoslovakia.

The United States is the largest consumer. Texas Mining and Smelting Company, Laredo, Texas is the principal producer of refined antimony in the United States and uses ores and concentrates that are obtained almost exclusively from Mexico and Bolivia. The Bradley Mining Company's smelter at Stibnite, Idaho, treats local ores, the output of which is about 96 per cent of the domestic production of antimony ores.

ARSENIC (ARSENIOUS OXIDE)

Arsenical ores are widely distributed in Canada, but the production of arsenic is limited to a few localities where its recovery as a by-product is an essential requirement in the treatment of silver-cobalt and certain gold ores. A total of 1,177 tons of refined white arsenic (As_2O_3) valued at $129,435 was produced in 1951 compared with 397 tons valued at $52,029 in 1950. Most of the output goes to the United States.

There was a strong world demand for refined arsenic during the greater part of 1951. Towards the end of the year, however, the situation changed and there was a definite decline in markets.

World production of arsenic is practically all derived as a by-product in the treatment of gold, silver, cobalt, lead, and other base metal ores. The leading producing countries are Sweden, United States, Mexico, France, Australia, Italy, and Japan.

Production, Trade, and Consumption

—	1951		1950	
	Pounds	$	Pounds	$
Production (refined arsenious oxide)	2,353,362	129,435	794,091	52,029
Exports [1]	1,842,200	77,872	361,400	17,382
Imports [2]	35,231	7,773	16,290 [3]	3,229
	1950		1949	
Consumption				
Glass industry	384,079	....	392,560	....
White metal alloys	95,687	....	34,828	....
Insecticides and miscellaneous chemicals	107,293	....	49,313	....
Total	587,059	....	476,701	....

[1] Excludes those for which no payment is received.
[2] Arsenious oxide and arsenic sulphide.
[3] Revised.

O'Brien Gold Mines, Limited and Beattie-Duquesne Mines Limited, in Cadillac and Duparquet townships respectively, in Quebec, were the principal producers of crude white arsenic, which is recovered as a by-product in the roasting of arsenical gold ores. Production from the Beattie mine continued to be stored in the crude form. The output of the O'Brien mine was shipped to Deloro Smelting and Refining Company Limited, Deloro, Ontario, where it was refined to the white arsenic of commerce.

Deloro Smelting and Refining Company, the only producer of refined white arsenic (As_2O_3) in Canada, is essentially a cobalt refinery and arsenic recovery is an integral and necessary part of the operations in the treatment of arsenical cobalt ores. Its output was obtained from the O'Brien crude arsenic, from silver-cobalt ores of northern Ontario and French Morocco, and from residues produced by Eldorado Mining and Refining (1944) Limited. Plant extension and new construction in 1951 increased roasting capacity to 100 tons of refined arsenic per month.

The gold-arsenic concentrates produced by Bralorne, Kelowna Exploration, and other gold mines in British Columbia, were shipped to the smelter at Tacoma, Washington, but as no payment is made for the contained arsenic this output is not included in the Canadian production figures.

The mine and arsenic refinery of Asfe Mines Limited, Douglas Lake, Saskatchewan, were not in operation during 1951.

Uses

The largest use of white arsenic in Canada is as an oxidizing agent in the manufacture of glass where it acts as a decolourizer. In the form of calcium and lead arsenate it is used in the manufacture of insecticides and weed-killers. The greater part of the world output is consumed in these compounds.

Other uses are in the manufacture of wood preservatives, pigments for metal finishing, dyestuffs, cattle dip, bearing metals and alloys, and pharmaceuticals. In the medicinal field it has been largely displaced by penicillin. There is a small but growing demand for metallic arsenic for use in alloys.

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

Prices

According to E.&M.J. "Metal and Mineral Markets", the price in 1951 of refined arsenious oxide (white arsenic, minimum 99 per cent As_2O_3) in barrels, carload lots, delivered was 6½ cents a pound.

BISMUTH

Canadian production of metallic bismuth continued to increase in 1951, the output being over 17 per cent greater than in 1950. The Consolidated Mining and Smelting Company of Canada, Limited, Trail, British Columbia, accounted for the entire production which is derived from the residues in the electrolytic refining of lead bullion.

There was a small production of oxychloride of bismuth by Molybia Corporation Limited, at the plant of Molybdenite Corporation of Canada Limited, La Corne, Quebec. This output is a by-product from the purification of molybdenite concentrates. There was also a small by-product production from the silver-cobalt ores of Ontario.

Canadian Occurrences

Occurrences of bismuth minerals in Canada are rare, the most important being in the lead-zinc-silver ore of The Consolidated Mining and Smelting Company's Sullivan mine, at Kimberley, British Columbia. Some sections of the Lucky Four Copper property near Chilliwack contain small amounts of bismuth and there are a few other minor occurrences in the province.

Small amounts of bismuth occur in association with the silver-cobalt ores of the Cobalt district in northern Ontario.

Bismuth occurs in association with molybdenite in the ore of the La Corne mine, western Quebec. Small tonnages of bismuth concentrates and metallic bismuth were produced from this mine in 1946 and 1947 and in recent years there has been an intermittent production of oxychloride of bismuth.

A discovery of bismuth in the form of cosalite (lead-bismuth sulphide), made in Marlow township, Frontenac county, Quebec in 1951 is being developed by Lachance Mines Limited. Stripping and trenching has exposed a zone for 1,000 feet. A steeply dipping quartz vein a foot or more in width, with numerous cross veins intersecting at right angles, extends over most of this length. The veins are mineralized with pyrite, galena, and cosalite. Diamond drilling is planned for 1952.

Immediately south of the Lachance property, Consolidated Rochette Mines Limited drilled 12 holes in 1951 in a mineralized zone in which cosalite is reported to occur.

A small deposit of bismuth occurs in association with copper and antimony on Pond Island in the Bay of Exploits, Notre Dame Bay, Newfoundland.

Production and Trade

—	1951		1950	
	Pounds	$	Pounds	$
Production				
British Columbia (metal)...........	191,471	451,872	162,616	365,886
Ontario (in ore)....................	15,000	35,400	....	....
Quebec (in ore)....................	23,827	56,232	29,005	65,261
Total..................	230,298	543,504	191,621	431,147
Exports				
Metal............................	88,000	....	114,000	....
Imports				
(Bismuth-bearing ore gross weight). From: United States...............	585	2,145	59	206

World production is estimated at about 1,500 metric tons a year, the principal producers being Mexico, Peru, South Korea, United States, and Canada.

Uses and Consumption

Owing to its extreme brittleness bismuth is seldom used alone, but because of its low melting point it is an important component in a number of low-fusible, non-ferrous alloys. These usually contain from 40 to 60 per cent bismuth with varying proportions of other metals, such as tin, cadmium, lead, antimony, indium, and zinc. They are used for sprinkler plugs and other fire protection appliances; electrical fuses; low-melting point solders; dental amalgams; and tempering baths for small tools. The tendency of bismuth to expand on solidification, makes its alloys highly desirable for a number of applications. Bismuth is used in the production of radar equipment and in making optical glass. A new and important use is in the industrial application of atomic energy.

Bismuth salts are used extensively in medicinal compounds and pharmaceutical products.

Canada uses about 50 tons of bismuth a year, the principal consumers being: Canada Metal Company Limited, Toronto; Mount Royal Metal Company Limited and Merck and Company Limited, Montreal; and Mallinckrodt Chemicals Limited, Ville LaSalle, Quebec.

Prices

The average Canadian price of domestic bismuth in 1951 was $2.25 a pound, according to the Dominion Bureau of Statistics.

CADMIUM

Canadian production of cadmium increased to 1,326,920 pounds in 1951 from 848,406 pounds in 1950. Consumption and exports also increased. The price of the metal in Canada was quoted at $2.65 a pound throughout the year.

Production, Trade and Consumption

—	1951		1950	
	Pounds	$	Pounds	$
Production				
British Columbia and Yukon	1,179,752	3,161,735	706,950	1,640,124
Saskatchewan and Manitoba	147,168	394,410	141,456	328,178
Total	1,326,920	3,556,145	848,406	1,968,302
Exports				
To: United Kingdom	745,026	1,970,326	367,812	832,399
France	33,600	111,075	19,800	42,099
Sweden	22,400	78,923	38,080	81,298
Germany	10,976	38,745	....	....
Switzerland	4,480	15,041	2,208	4,815
United States	5,399	14,519	231,605	500,941
Other countries	2,969	9,134	16,500	36,300
Total	824,850	2,237,763	676,005	1,497,852
Consumption	290,000	....	232,000	
Refinery Production by Principal Countries[1]				
United States	8,114,238	....	8,849,690	....
Canada	1,326,920	....	848,406	....
Italy	450,514	....	166,150	....
Tasmania (Australia)	432,100	....	499,747	....
Great Britain	321,592	....	261,588	....

[1]American Bureau of Metal Statistics, except for Canada.

Cadmium usually occurs in the form of greenockite (cadmium sulphide) in close association with zinc sulphide. In Canada it is recovered from the cadmium precipitate obtained in purifying zinc electrolyte at the electrolytic zinc plants of The Consolidated Mining and Smelting Company of Canada, Limited at Trail, British Columbia, and of Hudson Bay Mining and Smelting Company Limited at Flin Flon, Manitoba. The refinery at Trail has a rated capacity of 700 tons of cadmium a year and the Flin Flon refinery, 180 tons. If required both refineries can produce a 99·99 per cent cadmium product.

Most of the output of cadmium at Trail comes from zinc concentrates produced from the lead-zinc ores mined at The Consolidated Mining and Smelting Company's Sullivan mine at Kimberley, British Columbia. The remainder originates in the zinc ores of a number of mines in British Columbia and elsewhere which ship zinc concentrate to the Trail smelter for treatment. Among the more important of these mines in relation to the cadmium content of their shipments in 1951 were: Reeves MacDonald Mines Limited, Canadian Exploration Limited, Britannia Mining and Smelting Company, Limited, all in British Columbia, and United Keno Hill Mines Limited in Yukon.

Hudson Bay Mining and Smelting Company's cadmium production came largely from its copper-zinc orebody at Flin Flon on the Saskatchewan-Manitoba boundary. The company also treated zinc concentrate containing cadmium from Sherritt Gordon Mines Limited at Sherridon and from Cuprus Mines Limited near Flin Flon, both in Manitoba. Sherritt Gordon ceased operating its Sherridon Mine in September.

Uses

The chief use of cadmium is for electro-plating iron, steel, and to a lesser extent, copper alloys. Where price is not of prime significance it is preferred to zinc as an electro-plating medium for the following reasons:

1. A thinner coating provides equal protection.
2. The metal can be plated more uniformly on intricately shaped objects.
3. The rate of deposition per unit of electric current is higher.
4. Cadmium has a higher resistance to atmospheric corrosion, especially under hot and humid conditions, and it retains its metallic lustre longer.

Cadmium-plated articles include a wide range of items used chiefly in the manufacture of aircraft, automobiles, and household appliances.

Another important use is in the white metal alloy industry, especially in the manufacture of cadmium-base bearing metals for use in high-speed internal combustion engines. These bearing alloys contain about 98 per cent cadmium.

The addition of 0·7 per cent to 1·0 per cent of cadmium strengthens copper without seriously reducing its electrical conductivity.

Cadmium is used also in making low-melting point solders and fusible alloys for sprinkler apparatus, fire detector systems, and valve seats for high pressure gas containers.

Cadmium sulphide and cadmium sulphoselenide (red lithopone) are standard agents for producing, respectively bright yellow and red colours in paints, ceramic materials, inks, rubber, and leather. Cadmium nitrate is used in white fluorescent lamp coating, and the oxide, hydrate, and chloride are used in electroplating solution. Cadmium bromide, chloride, and iodide are used in the preparation of special photographic film. Cadmium stearate is used in large tonnages as a stabilizer in making vinyl plastics.

Prices

The average Canadian price of cadmium in 1951, estimated by the Dominion Bureau of Statistics, was $2.68 a pound. In New York the price throughout the year was $2.55 a pound for commercial sticks and $2.80 a pound for special shapes.

CHROMITE

No shipments of chromite of Canadian origin have been reported since 1949 when 361 tons of stockpiled ore were shipped from the old Montreal pit of Union Carbide Company in the Black Lake area of the Eastern Townships of Quebec. Peak wartime shipments of 29,595 tons were made from this area in 1943.

Although Canada's production of chromite is negligible, the availability of abundant electric power at reasonable rates has enabled the establishment of an extensive chrome addition agent industry in Ontario and Quebec. Consumption of imported chromite, mainly for metallurgical purposes, was 126,940 tons in 1951, a 40 per cent increase over 1950 and almost double that of 1949.

Production, Trade and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Imports (chromite)				
From: Union of South Africa........	55,569	445,484	57,610	498,973
United States*..............	43,775	1,725,080	12,055	432,730
Southern Rhodesia...........	23,717	918,227	5,058	184,700
Cuba......................	12,847	254,230	6,944	108,234
Turkey....................	11,090	419,853	12,317	409,964
Other Countries.............	....	....	25,341	557,954
Total.................	146,998	3,762,874	119,325	2,192,555
Consumption (chromite).............	126,940	....	90,798	....
Consumer's stocks Dec. 31 (chromite)	47,276	....	32,842	....
Exports (ferrochrome)				
To: United States...............	36,008	7,378,426	31,706	6,202,364
United Kingdom............	7,327	2,740,828	874	230,592
Other countries.............	396	108,125	336	109,230
Total.................	43,731	10,227,379	32,916	6,542,186

*Imported via United States but country of origin unknown.

Occurrences

Chromite (FeO. Cr_2O_3), the only commercial ore of chromium, has a theoretical composition of 68 per cent chromic oxide (Cr_2O_3) and 32 per cent iron oxide (FeO), but is never found in nature of this purity as some of the iron and the chromium are replaced by magnesium and aluminium. It is a heavy (S.G. 4·6), opaque, shiny black or brownish black mineral that can readily be scratched by a knife (H—4·5) and has a pale chocolate brown streak. Chromite is not magnetic but is frequently found in association with magnetite which is very magnetic and quite similar in appearance except that its streak, or powder, is black.

Chromite is a common constituent of peridotite rocks and the serpentines derived from them and is often associated with asbestos. Its most common occurrence in Canada is in bands of dunite within serpentine masses in which it may occur as disseminations, blobs, small lenses, and more or less continuous narrow bands of disseminated ore separated by almost barren rock. Dunite, with which chromite is associated, is a fine-grained, grey-black, iron magnesium rock which is sometimes mistaken for chromite. It has a dull appearance and on being scratched with a knife or powdered, is pale grey in colour rather than brown.

Quebec

Most of the chromite deposits in Canada from which production was obtained in the past are between Quebec city and Sherbrooke in the Eastern Townships of Quebec but no 'mine' production has been reported since 1947.

The old 'Montreal' pit in the Black Lake district in the Eastern Townships was reopened in 1941 by Union Carbide Company and was operated for the company by Orel Pare until closing in 1947. Small shipments from stock have been made by this company since that time. During World War II production was also obtained from the Sterrett mine in Cleveland township and the Reed-Belanger property in the Black Lake district, both of which ceased operations in 1944. The Chromeraine mine, also in the Black Lake area, was operated for a short time in 1943 and 1944 by Wartime Metals Corporation. The Sterrett mine has been acquired by Albert Metals Corporation, Ltd., (a wholly-owned subsidiary of Ascot Metals Corporation, Ltd.) and diamond drilling was carried out in 1951.

Manitoba

During the summer of 1942 extensive low grade chromite deposits were discovered in the Lac du Bonnet district in southeastern Manitoba about 80 miles northeast of Winnipeg. Various zones of disseminated chromite bands have been traced for considerable distances in the Bird River complex of ultrabasic rocks in this district. There is no massive chromite within any of the zones. The average grade of the main chrome band is about 20 per cent Cr_2O_3 and is readily beneficiated by gravity processes to a product containing 35 to 40 per cent Cr_2O_3 with a chrome-iron ratio of about 1·4:1. Test work has been conducted by Hudson Bay Mining and Smelting Company Limited and by the Mines Branch, Ottawa, in an effort to raise this low chrome-iron ratio to market requirements. The results of this work are contained in Mines Branch Memorandum Series Report No. 116 together with an extensive reference on work performed by various agencies along similar lines. J. D. Bateman in his paper "Bird River Chromite Deposits, Manitoba" (Transactions C.I.M.M. Volume XLVI, 1943) estimates that the reserves of the combined Page and Chrome deposits, upon which most of the work has been done, are 10,000,000 tons to a 660-foot horizon. These deposits are similar in character to the large low-grade chromite reserves of Montana in the United States. Processes are available to beneficiate the chromite concentrates, obtained by the mechanical concentration of these ores, and thereby to raise the chromium-iron ratio from the present 1.4:1 to 3:1.

Consumption in Canada

Although Canada's production of chromite is negligible, the availability of abundant electric power, at reasonable rates, has enabled the establishment of an extensive chrome addition agent industry. High and low ferrochrome is made by an electric furnace process for domestic consumption and export by the Electro Metallurgical Company of Canada, Limited, in its works at Welland, Ontario. Ferrochrome contains from 67 to 71 per cent chromium with carbon ranging from a minimum of 0·03 per cent to a maximum of 2·00 per cent. Chromium metal for the non-ferrous industry is also made at Welland.

The Chromium Mining and Smelting Corporation, Limited, at Sault Ste. Marie, Ontario, produces, in electric open-arc furnaces, "Chrom-X" and other exothermic chrome addition agents from ores containing about 45 per cent Cr_2O_3 with a chrome-iron ratio as low as 1.6:1. This company, through American subsidiaries, operates plants at Riverdale (Chicago) Illinois, Woodstock, Tennessee, and Mead (near Spokane) Washington.

Canadian Refractories Limited in its plant at Kilmar, Quebec, produces a full line of chrome refractories for furnace linings from imported ores.

World Production and Consumption

World production of chromite, of all grades, has averaged more than 2,000,000 metric tons annually since 1948 from a post-war low of 1,100,000 metric tons in 1945. Russia has, for many years, led the world in the production of chromite with an estimated annual production of from 300,000 to 600,000 tons. With Russian chromite no longer available to free world markets, Union of South Africa, Southern Rhodesia, Turkey, the Philippines, and Cuba have become the main suppliers with minor amounts from New Caledonia and India.

Southern Rhodesia, Turkey, and Russia are large producers of metallurgical grade chromite. The Philippines, Cuba, and Southern Rhodesia supply high-grade refractory ores. The Union of South Africa is the chief source of chemical grade ore.

The United States, by far the largest consumer of chromite of all grades, is deficient in reserves of chromite and depends, almost entirely, upon imports. In 1950, an all time high in consumption of chromite, amounting to 980,369 short tons of all grades, averaging 42.4 per cent Cr_2O_3, was reported by the United States Bureau of Mines.

Uses and Specifications

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

The chromium content, the ratio of chromium to iron in the ore or concentrate, the amount of non-chromium bearing material in the ore, and the physical character of the ore are the chief factors determining the grade and use of the material.

For standard metallurgical uses chromite should contain a minimum of 48 per cent chromic oxide (Cr_2O_3) with a chromium to iron ratio of 3:1 or more and the material should be in lump form.

For special types of chrome addition agents such as Chrom-X, lower grade ores with a ratio of 1.6:1 are being used.

Refractory chromite should contain 57 per cent or more of combined Cr_2O_3 and alumina (Al_2O_3) with approximately 35 per cent Cr_2O_3 and should be as low as possible in silica and iron. The ore should be hard and lumpy, not under 10-mesh, and the chromite should be present in an evenly, finely divided state rather than as coarse blobs with silicates.

There are no fixed limits for chemical grade ore except those imposed by price and the effect of grade on plant capacity. In contrast to metallurgical and refractory ore, concentrates and fines are preferred and a low chromium to iron ratio is not harmful provided the chromium content is high (44-46% Cr_2O_3). The silica content should be low.

Although the grades were named for the major uses, some interchange of grade is possible. Chemical ore has been used for metallurgical purposes, metallurgical concentrates and fines for chemical purposes, and metallurgical lump for refractory purposes.

Metallurgical Uses. Chromite finds its largest single use in the steel industry where it is mainly consumed in making ferro-chromium for use in the manufacture of stainless and other alloy steels. Some chromite is used directly in the steel bath. Chromium increases hardness and shock resistance and imparts high tensile strength and ductility to steels. Other metallurgical uses include the manufacture of certain cast iron and non-ferrous alloys. The addition of chromium to cast iron reduces the grain size greatly, increases its resistance to wear and corrosion and reduces oxidation at high temperatures. There is no completely satisfactory substitute for chromium in stainless and other alloy steels but some of the chromium can be replaced by molybdenum or manganese.

Refractory Use. Refractory grade chromite is manufactured into bricks for use as a neutral lining for furnaces. Most of these bricks are used in basic open-hearth steel furnaces. Because chromite refractories resist both acid and basic attacks at high temperature, it is common practice to use a course of chromite bricks near the slag line in open-hearth furnaces, separating the silica bricks of the roof and side and the dolomite or magnesite bricks of the hearth and banks. Chromite is used with magnesia to make chrome-magnesia refractories.

Chemical Uses. The largest uses for chemical grade chromite are in the manufacture of pigments and the tanning of leather with the surface treatment of metals being the next-most-important use. In all chemical uses, sodium bichromate is the primary chemical produced from chromite. Chromium metal is also produced from chemical grade ore with sodium bichromate being the intermediate product. The metal is finding increasing use in the production of high-temperature alloys, such as are used in jet aircraft engines, etc. Sodium bichromate is used as the agent in cleansing, pickling, galvanizing, and red dip for brass.

Prices

E. & M. J. "Metal and Mineral Markets" of December 20, 1951 quoted prices for chromite and allied products as follows:

(*a*) *Chrome Ore*—per long ton, dry basis, f.o.b. cars, New York. (Dec. 28, 1950 quoted prices in brackets).

(1) Indian and Rhodesian	
48 per cent Cr_2O_3, 3 to 1 ratio, lump	\$43 to \$45 (\$36 to \$38)
48 " " Cr_2O_3, 2·8 to 1 ratio	\$40 to \$42 (\$34 to \$35)
48 " " Cr_2O_3, no ratio	\$31 to \$32 (\$25).
(2) South African (Transvaal)	
48 per cent Cr_2O_3, no ratio	\$34 to \$35 (\$27)
44 " " Cr_2O_3, no ratio	\$27 to \$28 (\$20)
(3) Turkish	
48 per cent Cr_2O_3, 3 to 1 ratio, lump	\$53 to \$54 (\$43 to \$44)
(4) Brazilian	
44 per cent Cr_2O_3, 2·5 to 1 ratio, lump	\$32 (\$31)

(*b*) *Ferrochromium*—per pound of contained chromium containing 65 to 69 per cent chromium, in lump form in carload lots, delivered to the eastern zone: 23·65 to 24·15 cents.

(*c*) *Chromium* (chrome metal)—per pound on 97 per cent grade \$1.12 for spot transactions and \$1.07 on contract.

COBALT

Normally in adequate supply, cobalt became one of the scarcest and most strategic metals during 1951. This situation developed from the increasing consumption of cobalt in jet engine alloys, armour plating, as a binder in the manufacture of cemented carbide tools and the cores of armour-piercing shells, in magnets for radar equipment, and in other essential military items. Civilian needs for cobalt have also increased, especially in the fields of high-operating temperature engines and in permanent magnets for electronic uses.

In the third quarter of 1950, the demand had become so great that voluntary rationing was begun by suppliers. Commencing with the fourth quarter of 1951 available world supplies were made the subject of international allocation through the International Materials Conference.

In Canada in 1951, the Federal Government raised the price of cobalt contained in cobalt ores and concentrates to stimulate production and to increase the incentive for operators to search for, mine, and recover cobalt in the Cobalt-Gowganda areas of Ontario. This resulted in a large increase in shipments of cobalt contained in both cobalt and silver ores.

The following table shows the cobalt content of ore shipments (cobalt and silver ores combined) from the Cobalt-Gowganda areas for the years 1949, 1950, and 1951:

*Cobalt Content of Ore Shipments from the Cobalt-Gowganda Areas**

(Short tons)

Destination	1951	1950	1949
Canadian refiners ** or consumers	151.5	46	26
United States	14	25	6
United Kingdom	......	......	19
Total	165.5	71	51

*From figures supplied to the Mines Branch.

**These shipments from mine production are not necessarily included in Production and Trade figures (*q.v.*) until processed and shipped from refineries as metal, oxides, or salts.

The Deloro Smelting and Refining Company, Limited, Deloro, Ontario, acts as purchasing agent for the account of the Canadian government for the cobalt contained in cobalt ore shipments. The cobalt content of the silver ores shipped to Deloro are purchased by the company for its own account. Cobalt from both sources is contained in the above table. The purchase of cobalt for Government account is to remain in effect until 600,000 pounds of recoverable cobalt have been accumulated or until March 31, 1954, whichever event occurs first.

Production and Trade

(Short Tons of Contained Cobalt)

—	1951	1950
Shipments (from Canadian ores)[1]		
In concentrates exported	14	12
In metal, alloy, oxides, and salts produced	461	280
Total	475	292
Exports		
In concentrates		
To: United States	18	8
As metal, oxides, and salts[2]		
To: United Kingdom	350	189.6
United States	73	0.4
Other countries	3	4.0
Total	426	194.0
Imports		
As cobalt concentrate[3] (Gross weight)		
From: French Morocco	1,844	1,956
(Concentrates contain from 10-15% cobalt)		
As metal, oxides, and alloys[4]		
From: Various sources	80	13

[1] Not necessarily mined in the years specified.

[2] Includes production from ores, concentrates, alloys, etc., of foreign and domestic origin but does not include the cobalt contained in the nickel bottoms shipped to International Nickel's refinery at Clydach, Wales, where the cobalt is recovered as cobalt oxide.

[3] From French Morocco for U.S. Government account, treated at Deloro, Ontario.

[4] From figures supplied to the Mines Branch by the Department of Defence Production.

Ontario

THE COBALT AREA

The production of cobalt in this area, and in the Gowganda area, is closely tied to the production of silver. Since production began in 1904 the mining of silver has been the prime concern of the operators with cobalt being a by-product. As a result, high grade cobalt veins carrying low silver values, were frequently left 'in place' underground as it did not pay to mine them. However, in 1951, because of a substantially higher price being paid for cobalt content, mine operators began taking a 'second look' at cobalt occurrences carrying low silver values. The ore in the Cobalt camp occurs generally in calcite in narrow, fault-fissure veins, a few inches wide and up to a few hundred feet long, which are limited vertically to within a comparatively short distance (up to 300 feet) of the diabase-greenstone or diabase-conglomerate contact. The cobalt ore minerals in the calcite veins, and sometimes disseminated in the enclosing rocks, consist largely of arsenides and sulpharsenides-smaltite ($CoAs_2$) and cobaltite ($CoS_2, CoAs_2$)—and are associated with arsenopyrite, native silver and frequently with sulphides and sulpharsenides of nickel, copper, silver, lead, bismuth and antimony.

Since the start of milling operations at Silver Miller Mines Limited in October, 1949 activity on new developments in the area and reopening of old properties has necessitated much additional mill capacity. At the close of 1951, five mills, including Silver Miller's, were treating ores from the many operations in the area and that of Hellens Mining and Reduction Company Limited was expected to come into operation early in 1952. Shippers of cobalt-silver concentrates in 1951 included the following companies: Cobalt Lode Silver Mines Limited, Silver Miller Mines Limited, Silanco Mining and Refining Company Limited, Shag Silver Mines Limited, Mensilvo Mines Limited, Harrison-Hibbert Mines Limited, and Cross Lake Lease.

The mill of United Cobalt Mines Limited, on a custom basis, treated ore from Harrison-Hibbert Mines, Shag Silver Mines, and the La Rose Rouyn mine of Silver Miller. Ore from Cobalt Lode, Silver Miller, Silanco, and Mensilvo were concentrated in their own mills.

Silanco Mining and Refining Company Limited. In 1951, Silanco, which operates the Beaver Temiskaming mine, reopened the Aguanico mine, and intends to concentrate the latter's ore in the Colonial mill where ore from the Beaver Temiskaming operation is concentrated. No plans have been announced for rebuilding the smelter of The Cobalt Chemical and Refining Company Limited in which Silanco has a large interest. The main smelter building was destroyd by fire in April, 1950.

Hellens Mining and Reduction Company Limited. At the end of the year, this company was constructing a 500-ton cyanide mill to treat the tailings from the Beaver Temiskaming mine (Silanco) which, together with a number of other properties and dumps, were leased on a 10 per cent gross royalty basis. Heads were expected to average about 4 ounces of silver to the ton and well over 1,000,000 tons of tailings are reported on hand. Eventual treatment of about 1,000 tons a day is expected by the end of 1952.

Nipissing-O'Brien Mines Limited. M. J. O'Brien Limited and Nipissing Mines Company Limited announced the amalgamation of their holdings in Coleman township. A new company, Nipissing-O'Brien Mines Limited, was formed in January 1952, to operate the properties with development funds being supplied by both O'Brien and Nipissing. The adjoining O'Brien and Nipissing mines were two of the largest producers in the old Cobalt camp and both were long-lived operations.

Penn-Cobalt Silver Mines Limited. At the end of 1951, this company was planning the construction of a 300-ton mill to treat ore from the Foster and Penn-Canadian mines which had been leased from Silanco on a 20-year basis with a gross of 10 per cent payable in metals produced. At the Foster mine an orebody containing copper, zinc, and lead was outlined by diamond drilling in 1951. Silver-cobalt occurrences were also encountered in underground development work.

THE GOWGANDA AREA

Siscoe Metals Limited. Siscoe Metals which operates the former Miller Lake-O'Brien mine near Gowganda about 45 miles north and west of Cobalt, was a major producer of silver concentrate containing cobalt and its 100-ton mill was in continuous operation during 1951. In milder weather a 500-ton flotation plant was used to treat tailings averaging about 4 ounces of silver to the ton, accumulated from former operations. Development work in the mine continued to prove up faulted extensions of formerly worked veins and to develop new ore at depth (1,200 feet).

Castle-Trethewey Mines Limited. This company operated its 100-ton mill for about 6 months in 1951. The narrow, high-grade silver veins containing cobalt, encountered on the levels from 1,000 to 1,200 feet in the Capitol mine, were the source of mill feed. These veins are considered to be extensions of the vein systems in the Siscoe Metals mine which adjoins the Capitol mine on the north and east.

New Morrison Mines, Limited. This company was formed in April, 1951, to acquire the holdings of W. J. Nine Silver Mines Limited and the former Morrison Mines Limited. New Morrison has been undertaking underground exploration and development on the property which is in Nicol township not far from Siscoe Metals' holdings.

THE SUDBURY AREA

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

The International Nickel Company of Canada, Limited. Since 1947, International Nickel has recovered cobalt from the electrolyte in its nickel refinery at Port Colborne, Ontario. The cobalt is recovered by mechanical precipitation and is shipped as an impure cobalt oxide to the company's plant at Clydach, Wales. Production of contained cobalt in oxide form reported by the company as shipped from Port Colborne in 1951, was 343 tons compared with 221 tons in 1950. Cobalt is also a constituent of the nickel 'bottoms' shipped directly from the Copper Cliff smelter to Clydach where it is recovered as oxide, but this is not reported as part of Canadian production.

Falconbridge Nickel Mines Limited. In 1951, Falconbridge planned to recover cobalt from nickel residues in its electrolytic nickel refinery at Kristiansand, Norway. However, this recovery is not expected to begin until well into 1952, due to late delivery of equipment.

OTHER DEVELOPMENTS IN CANADA

Sherritt Gordon Mines Limited. Sherritt Gordon's copper-nickel ores at Lynn Lake, Manitoba, contain minor amounts of cobalt which will be recoverable when refining operations commence late in 1953. The company estimates that approximately 300,000 pounds of cobalt will be produced annually at its refinery to be built near Edmonton.

Eldorado Mining and Refining (1944) Limited. Eldorado, which is a Crown-owned company, ships a cobalt-bearing residue obtained from the treatment of radium-uranium concentrates at its refinery in Port Hope, Ontario, to Deloro for the recovery of cobalt. The cobalt originates in concentrates shipped from Eldorado's mining operations at Great Bear Lake in Northwest Territories.

Sursho Mining Corporation. Sursho announced the discovery and staking by Michael and James Walsh, of a potentially valuable cobalt prospect in the Mount Wright area, about 185 miles north of Seven Islands and some 35 miles west of the railway being built to the Labrador-Quebec iron fields.

World Production

Virtually all cobalt production is derived from the treatment of ores in which other metals, such as copper, nickel, iron, arsenic, lead, silver, and gold, are associated. Belgian Congo, Northern Rhodesia, French Morocco, United States, and Canada (in that order) together contribute about 95 per cent of the world output. Union Minière du Haut Katanga in the Belgian Congo, and Rhokana Corporation, in Northern Rhodesia, produce cobalt from their copper operations. The estimated world production in 1950 was 7,100 tons compared with 5,900 tons in 1949.

Uses

At least 75 per cent of the world production of cobalt is used in the metallurgical industry and most of the remainder in the ceramic industry. Its principal metallurgical use is in making permanent magnets and magnet alloy steels, followed by stellite alloys which contain 40 to 50 per cent cobalt, 30 to 37 per cent chromium, and 12 to 17 per cent tungsten. Stellite alloys are used in high-speed, high-temperature cutting tools and in die materials.

Many of the high temperature alloys developed during World War II contain from 13 to 66 per cent cobalt. Capable of maintaining strength at high operating temperatures while resisting wear corrosion, these alloys are being used for various component parts of gas turbines, jet aircraft engines, and turbo-superchargers.

Cobalt is used in carbide-type alloys, welding rods, as a binder for tipping tools, in electroplating, and with other chemicals in nickel-plating solutions as an undercoating for chromium plating.

Cobalt oxide is used chiefly in the ceramic industry because of its fine colouring properties and is one of the best known groundcoat frits for porcelain enamels.

There are no satisfactory substitutes for cobalt in its principal uses.

Prices

Cobalt in Cobalt Ores or Concentrates. To maintain incentive of the operators of the Cobalt-Gowganda areas to continue to mine and search for cobalt ores in the face of increased operating costs, the Canadian Government, during the year, announced two price increases for the cobalt contained in cobalt ores and concentrates. The prices paid a pound of contained cobalt, f.o.b. Cobalt, Ontario, with treatment charges to the purchaser's account as of April and December, 1951, were:

Cobalt Content	*April*	*December*
7 to 7·99 per cent	$1.00	$1.20
8 to 8·99 per cent	1.15	1.50
9 to 9·99 per cent	1.30	1.80
10 to 10·99 per cent	1.40	2.00
11 to 11·99 per cent	1.50	2.00
12 per cent & over	1.60	2.00

The silver in cobalt ores containing the above percentages of cobalt is paid for at the rate of 50 per cent of the silver in the first 100 ounces and 75 per cent of all silver over 100 ounces, at current market prices.

Toward the end of 1950, cobalt in ores or concentrates was purchased by Deloro at 6 cents per unit per pound plus 20 cents, with payment for silver at 50 per cent of the content at current market price. Thus if an ore had contained 10 per cent cobalt the price per pound of contained cobalt would have been $10 \times 6 + 20 = 80$ cents.

Cobalt in Silver Ores or Concentrates. The price of cobalt contained in silver ore or concentrate, paid by Deloro was substantially increased early in 1951 from 5.5 cents per unit per pound to the following schedule:

Cobalt Content	*Price per pound of contained cobalt*
Up to 2.99 per cent	15c
3 to 3.99 " "	25c
4 to 4.99 " "	35c
5 to 5.99 " "	50c
6 to 6.99 " "	65c
7 to 7.99 " "	80c
8 to 8.99 " "	95c
9 to 9.99 " "	$1.10

Freight from Cobalt to Marmora, Ontario, and smelting and refining charges on silver ores, are charged to the seller's account.

E. & M.J. "Metal and Mineral Markets" of December 20, 1951, quoted the following prices for cobalt metal and oxides (1950 prices in brackets):—

Cobalt Metal, per pound, 97 per cent to 99 per cent cobalt, rondelles or granules, in 500 to 600 lb. containers $2.40 ($2.10) f.o.b. New York or Niagara Falls, freight collect.

Cobalt Oxide, ceramic grade, 350 lb. containers, 70 to 71 per cent cobalt, $1.76 ($1.60) a pound east of the Mississippi.

Canadian prices, f.o.b. Deloro, are comparable to the E. & M.J. quotations listed above.

COPPER

Production of copper, all forms, totalled 269,971 tons valued at $149,026,216. This represents an increase of 2.2 per cent over 1950 production and a value increase of 21.0 per cent. Ontario contributed 47.7 per cent of the total tonnage from copper-nickel ores in the Sudbury area. The peak year for copper was 1940 when production totalled 327,797 tons.

Output of refined copper from the refineries of The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario, and Canadian Copper Refineries Limited at Montreal East, Quebec, was 245,466 tons compared with 238,204 in 1950. Consumption was 134,174 tons compared with 106,868 in 1950, an increase of 25.6 per cent.

Exploration and development of copper deposits were maintained at a high level throughout the year. For Ontario, the long-range programme of underground mine development and expansion continued at International Nickel; and Falconbridge embarked on an extensive programme of expansion designed to increase capacity. There was active development of many old copper properties in Ontario, Quebec and Newfoundland, and intensive prospecting for new deposits throughout Canada.

Canada was the fourth largest producer of copper, the first three being the United States, Chile, and Rhodesia. As an exporter, Canada ranked third.

Copper was placed under control in 1951 by the International Materials Conference. The allocations for each participating country were in the form of a "total entitlement for consumption"—the amount of primary metal which might be processed or consumed by the country concerned, either from domestic production or imports. Canada accepted the allocations plan and assumed the responsibility of ensuring that its allocations were not exceeded. This was accomplished by means of an "order approval" system, administered by the Department of Defence Production.

Production, Trade and Consumption

—	1951			1950		
	Short tons	$	% tonnage	Short tons	$	% tonnage
Production all forms*						
Ontario	128,809	70,861,789	47·7	117,210	54,411,033	44·4
Quebec	68,866	38,151,738	25·5	72,891	34,141,997	27·6
Saskatchewan	31,625	17,520,373	11·7	28,982	13,575,052	11·0
British Columbia	21,932	12,110,779	8·1	21,088	9,823,569	8·0
Manitoba	15,839	8,774,768	5·9	20,817	9,750,846	7·8
Newfoundland	2,899	1,606,233	1·1	3,221	1,508,910	1·2
Northwest Territories	1	536	...	...	...	...
Total	269,971	149,026,216	100·0	264,209	123,211,407	100·0
Production, refined	245,466	...	...	238,204	...	...
Exports, in ingots, bars, slabs, etc.						
To: United Kingdom	51,918	28,161,956	...	64,326	28,420,435	...
United States	28,843	15,758,548	...	50,425	22,658,320	...
France	5,700	4,252,210	...	5,064	2,147,633	...
Sweden	3,998	3,630,388	...	...	...	...
India	3,649	1,941,091	...	6,683	3,102,021	...
Brazil	2,688	1,459,393	...	858	366,588	...
Italy	2,452	1,866,446	...	1,075	517,087	...
Germany	1,258	1,147,116	...	55	31,489	...
Netherlands	...	...	...	1,872	706,776	...
Switzerland	224	116,770	...	1,867	806,536	...
Other Countries	1,102	688,937	...	2,019	908,845	...
Total	101,832	59,022,855	...	134,244	59,665,730	...
Exports, in rods, strips, sheets, tubing						
To: United States	4,166	2,374,086	...	8,916	4,379,982	...
Switzerland	3,017	1,786,706	...	2,423	1,244,548	...
Denmark	1,875	1,054,371	...	280	148,427	...
Netherlands	1,478	835,651	...	1,708	841,039	...
New Zealand	1,271	982,531	...	474	269,398	...
Ireland	269	163,324	...	...	...	...
Austria	252	140,559	...	...	...	...
United Kingdom	6	3,459	...	1,377	580,395	...
Other Countries	957	857,741	...	764	566,818	...
Total	13,291	8,198,428	...	15,942	8,030,607	...
Exports, in ore, matte, regulus						
To: United States	28,941	11,575,820	...	25,494	10,197,800	...
Norway	6,310	2,524,120	...	6,119	2,447,420	...
United Kingdom	1,044	417,440	...	686	274,460	...
Germany	558	223,080	...	...	...	...
Total	36,853	14,740,460	...	32,299	12,919,680	...
Consumption, refined	134,174	...	...	106,868	...	...

* Blister copper made from Canadian ore plus recoverable copper in concentrates, matte, etc., exported.

Newfoundland

Buchans Mine. The Buchans mine of American Smelting and Refining Company treated 324,000 tons of copper-lead-zinc ore during 1951, from which 12,424 tons of copper concentrates, containing 2,959 tons of copper, were produced. The estimated gross value of these concentrates was $2,323,061. They were shipped to the Tacoma plant of the American Smelting and Refining Company.

Of interest in the province was the active investigation by Falconbridge Nickel Mines Limited of the old Gull Pond, Rambler, and Tilt Cove properties. Work was also done at Seal Lake, Labrador, where an interesting discovery of native copper has been made.

Nova Scotia

Mindamar Metals Corporation Limited. At the company's zinc-lead-copper Stirling mine in Richmond county, exploration, underground development, erection of a 500-ton mill, and installation of mining plant and machinery took place during 1951. Production was scheduled to commence in 1952.

Quebec

Noranda Mines, Limited. The smelter of Noranda Mines, Limited treated 1,225,000 tons of copper-bearing materials, including custom ore yielding 68,943 tons of copper. Anodes were sent to the company's refinery in Montreal East, operated by a subsidiary, Canadian Copper Refiners Limited.

Noranda's Horne mine produced 1,328,368 tons of ore which yielded 25,734 tons of copper as well as gold, silver, and pyrite concentrate. The ore reserve at the end of 1951 was 16,582,000 tons. There is also a large tonnage of low-grade ore which contains approximately 50 per cent pyrite.

The Waite-Amulet mine and the adjoining Amulet-Dufault property, controlled by Noranda, milled 387,754 tons of ore from which 12,776 tons of copper was recovered, as well as zinc, gold, silver, and pyrite concentrate. The ore reserve at the end of 1951 was 1,958,687 tons. The new East Waite mine is expected to come into production in April, 1952.

Gaspe Copper Mines Limited, a subsidiary of Noranda, in the Gaspe Peninsula, about 20 miles inland from the South Shore of the St. Lawrence river, had a reserve of approximately 65,000,000 tons of ore of a grade in excess of 1·25 per cent copper at the end of 1951. The company plans to prepare the property for a rated daily production of 6,500 tons.

Quemont Mining Corporation Limited. The Quemont property, which adjoins Noranda's Horne mine, treated 772,781 tons of ore, and produced 60,106 tons of copper concentrate which was treated in the Noranda smelter. Copper extracted was 22,936,242 pounds. Of the ore treated during 1951, 59.9 per cent was produced from cut-and-fill mining, 36·9 per cent from sub-level stoping, and the remainder from development headings. Ore reserves at the end of 1951 stood at 9,438,000 tons, averaging 1.44 per cent copper and containing values in gold, silver and zinc.

Development of "20" orebody in the lower part of the mine continued in preparation for production by the middle of 1952. A primary crusher, installed on the 2,400-foot level and designed to serve a system of ore passes, began operation in December.

Normetal Mining Corporation, Limited. The company milled 359,266 tons of ore, resulting in the production of 32,410 tons of copper concentrates and 14,063,295 pounds of copper. The copper concentrates were shipped to the

Noranda smelter for treatment. Ore reserves at the end of 1951 were 2,434,300, averaging 2.67 per cent copper and containing appreciable values in zinc, gold and silver. Development continued on the lower levels.

East Sullivan Mines Limited. During 1951 this mine, in its third year of operation, treated 904,762 tons of ore in its 2,500-ton mill. The resultant copper concentrates were shipped to the Noranda smelter for treatment. The copper recovered totalled 27,004,243 pounds with an almost equal amount of zinc and appreciable quantities of gold, silver, and pyrite concentrates. The mine is partly developed to a depth of 1,950 feet. Ore reserves total 4,950,000 tons, of which 4,375,000 tons averaging 1.63 per cent copper, are classed as positive ore.

East Sullivan Mines Limited, in partnership with Sullivan Consolidated Mines Limited, is now developing the property of Federal Zinc and Lead Company in the Gaspe peninsula. It plans also to carry out underground development work on the old Huntingdon property of Quebec Copper Corporation in the Eastern Townships of Quebec.

Golden Manitou Mines Limited. Exploration continued on the company's new copper-bearing zone located 800 feet north of the main ore zone. The new zone, in May 1951, was estimated to contain 1,000,000 tons of ore averaging 2.5 per cent copper. It has been partly opened on only one level—the 1,720 foot horizon. At present Golden Manitou produces zinc and some lead, copper, gold and silver. A bulk lead-copper concentrate is shipped to the American Smelting and Refining Company's smelter at East Helena, Montana, U.S.A. Copper refining takes place in this company's refinery at Tacoma, Washington.

Ascot Metals Corporation Limited. In 1951, the second year of production, Ascot Metals Corporation Limited treated 139,566 tons of ore containing 1,589,970 pounds of copper as well as zinc-lead, gold, and silver. The rate of milling was about 420 tons per day at the end of 1951; this is expected to be increased to 600 tons per day during 1952. A bulk copper-lead concentrate was shipped to the American Smelting and Refining Company's smelter at East Helena, Montana, U.S.A. and copper refinery took place at Tacoma, Washington. Production came from both the Moulton Hill mine and the Suffield mine, in Ascot township, near Sherbrooke.

Other Developments in Quebec. The Opemiska Copper Mines (Quebec) Limited diamond drilled and made preparations to reopen its old mine (inactive since 1936) in Levy township in the Chibougamau area. Production was planned to commence in 1952. Considerable activity took place at the Mervill Island copper-gold property of Campbell-Chibougamau Mines Limited in the Chibougamau area; at the copper-gold prospect at Rainville Copper Mines Limited, in Bourlamaque township; and at the old copper-pyrite property in the Eastern Townships, now being developed by Weedon Pyrite and Copper Corporation Limited.

Ontario

The International Nickel Company of Canada, Limited. More ore was mined underground than in any other year in the company's history. Its ore, all from the great nickel-copper basin in the Sudbury area, was drawn from 5 underground mines—the Frood-Stobie, Creighton, Levack, Garson, and Murray mines—and from the Frood-Stobie open pit. Total production of ore was 11,800,000 tons compared with 9,849,000 in 1950. Output of refined copper from the refinery at Copper Cliff was 236,954,595 pounds.

By means of differential flotation at Copper Cliff, bulk concentrates are separated into two products—a copper concentrate low in nickel and a nickel concentrate low in copper. The copper concentrate is treated in reverberatory furnaces and converters to make blister copper which is refined in the nearby refinery.

Considerable progress was made in the program of underground development and expansion which is designed to increase hoisting capacity to 13,000,000 tons by 1953.

At Creighton the new No. 7 shaft started hoisting ore in July. The ore was obtained from a lower grade orebody, mined by the large-scale, low-cost caving method. The new 10,000-ton concentrator, was completed; its concentrate is transported by a 7½-mile pipe line to the reduction plants at Copper Cliff.

The Frood-Stobie open pit operation is expected to be completed by the end of 1953 at which time all production will be from underground. Preparation is proceeding at No. 7 and No. 8 shafts of Frood-Stobie for underground production by means of low-cost, blasthole methods of mining.

Total reserves of ore at the end of 1951 were 253,704,771 tons containing 7,693,122 tons of nickel-copper.

Falconbridge Nickel Mines Limited. Production at Falconbridge Nickel Mines Limited totalled 1,086,125 tons of copper-nickel ore from the Falconbridge and McKim mines.

Matte from the smelter at Falconbridge is treated in the company's refinery at Kristiansand, Norway, for recovery of the metals.

At the Falconbridge property, development continued at the main mine, and a new shaft to service the orebody at the eastern limits of the property reached 245 feet. At the Hardy mine, which is being developed for a 1000-ton per day rate, shaft sinking reached 1,028 feet.

The Company's expansion programme in the Sudbury district is well under way. Milling additions were largely completed, but delayed delivery held up hoist and smelter increases for 6 to 8 months. Total developed and indicated ore reserves of the properties in the Sudbury district at the end of 1951 totalled 19,116,500 tons containing 1.00 per cent copper.

Other Developments in Ontario. There was considerable activity at the Coldstream Copper Mine, 90 miles west of Fort William in the Kenora district, and much interest was shown by a number of companies in a copper discovery in the vicinity of Dogpaw Lake, in the same district.

Manitoba and Saskatchewan

Hudson Bay Mining and Smelting Co. Limited. This company operates a copper-zinc-gold-silver mine and metallurgical plant at Flin Flon on the Manitoba-Saskatchewan border. The metallurgical plant consists of concentrator, cyanide plant, zinc electrolytic plant, and copper smelter. Power is supplied from the 110,000 h.p. plant 56 miles to the north on Churchill River.

In 1951 the company mined 1,823,870 tons of ore, two-thirds of which came from Saskatchewan.

The smelter treated copper concentrates and direct smelting ore from the Flin Flon mine and copper concentrates from the property of Cuprus Mines Limited, 13 miles southeast. Sherritt Gordon copper concentrates from Sherridon were also treated up to the latter part of the year, when that property was shut down. Residues from the zinc plant were added to the copper smelter feed for recovery of contained gold, silver and copper in the smelter. Resultant slag is treated for recovery of zinc in the new smelter slag fuming plant which started operations during the year. The Company shipped 39,301 tons of blister copper to the Montreal East refinery of Canadian Copper Refineries Limited, for its own account.

Cuprus Mines Limited mined 86,514 tons of ore in 1951. The copper and zinc concentrates were trucked to the smelter at Flin Flon. Additional compressors have been installed.

At the Schist Lake mine, 3½ miles southeast of Flin Flon, development work was continued during the year. A total of 3,288 tons of development ore was trucked to Flin Flon.

At the North Star mine, 12 miles due east of Flin Flon or about 24 miles by road, sinking operations were commenced after the erection of a steel head-frame and the necessary campsite and mine surface structures.

Sherritt Gordon Mines Limited. Milling at the company's Sherridon mine ceased on September 17, 1951 and the last shipment of concentrates from the property took place on September 21. The mine produced 366,244,806 pounds of copper as well as zinc concentrates, gold and silver, from the time that recoveries began in March 1931 until production ceased in 1951.

Development progressed considerably at the Lynn Lake mine of Sherritt Gordon Mines Limited, in northern Manitoba, about 120 miles north of Sherridon. The "A" shaft was sunk to a depth of 1,625 feet, and development of the "A" orebody for mining was underway. Crushing is to be carried out on the 16th level. Sinking will start at the "El" Shaft in June 1952. Construction of the power plant at Laurie River fell behind schedule somewhat during the year, due to the finding of a fault in the river bed which delayed completion of the downstream cofferdam and hence the dewatering of the river bed. Pouring of concrete for the dam commenced in June 1951. The power dam, 900 feet long and up to 60 feet high, will have a 55-foot head and develop 7,000 horse-power. Forty-four miles of right of way for the transmission line were completed, and considerable progress was made in clearing right of way for the railway line, and in constructing the first 8-10 miles of the railroad grade. During the early part of winter, moving of equipment and houses from Sherridon to Lynn Lake was begun.

A nickel and copper concentrate will be made at the mine and the copper concentrate will be shipped to Flin Flon for smelting. Production is planned at the rate of 8,000,000 pounds of copper, 17,000,000 pounds of nickel, 300,000 pounds of cobalt, and 70,000 tons of ammonia sulphate yearly.

Ore reserves at the end of 1950 were 14,055,000 tons averaging 0·618 per cent copper and 1·223 per cent nickel. No further attempt was made to increase ore reserves in 1951.

British Columbia

Copper Mountain Mine. Operations at the Copper Mountain copper-silver-gold mine of The Granby Consolidated Mining, Smelting and Power Company, Ltd., 12 miles from Princeton, resulted in the production of 25,604,540 pounds of saleable copper in 1951, compared with 25,108,691 pounds in 1950. The mill at Allenby, eight miles north of the mine, treated 1,794,882 tons of ore averaging 0·899 per cent copper. All concentrates were shipped to American Smelting and Refining Company's smelter at Tacoma, Washington. Ore reserves total 3,100,-000 tons containing an estimated 0·97 per cent copper.

Britannia Mining and Smelting Co., Limited. During 1951, the company operated its mill at the rate of 2,950 tons per day, treating 821,201 tons of ore from its mine at Britannia Beach 25 miles north of Vancouver. The 26,750 tons of copper concentrate, and 600 tons of copper precipitate which were obtained from mine waters, were shipped to the smelter at Tacoma, Washington, resulting in the production of approximately 7,500 tons of copper, as well as zinc, gold, and silver. The zinc content of the ore produced was higher than the copper content, throughout the year as in 1950. Exploration continued to reveal interesting intersections and extensions of known ore occurrences.

The Consolidated Mining and Smelting Company of Canada, Limited. During 1951, the Big Bull and Tulsequah Chief properties of "Cominco", in the Atlin district not far from Yukon Territory, were placed in production. The gold-silver-copper-lead-zinc ore was treated in the concentrator at the Polaris-Taku mine, 5 miles distant, and the resultant copper concentrate was shipped to Tacoma, Washington, for refining.

Uses and Prices

As a result of its high electrical conductivity, copper finds its greatest utilization in the electrical industry. Slightly over 50 per cent of the world's production is used in a great variety of products associated with this industry. A substantial part of the remainder is consumed in the various copper alloys which are used in the manufacture of many industrial and household articles.

Domestic electrolytic copper in the United States was controlled throughout the year at 24·20 cents a pound, f.o.b. refinery. The price of copper imported into the United States was controlled at 27·425 cents during the last 6 months of 1951. In Canada the domestic price fluctuated from 26·000 cents a pound at the beginning of the year to 29·550 cents in June and 28·150 cents at the end of the year. The difference between the Canadian domestic and American import prices resulted from the rate of exchange.

GOLD

Total production of gold in Canada, which has risen steadily each year from 1946 to 1950 inclusive, decreased to 4,392,751 fine ounces in 1951 compared with 4,441,227 in 1950 and the record of 5,345,179 in 1941. The decrease was mainly a result of the cessation of operations at 5 mines due to exhaustion of ore reserves, and the temporary shut-down of one other.

Prospecting for gold was considerably less active than in 1950 because of a greater interest in base metals and uranium. No new mines were brought into production during 1951, but development work continued at several prospects, a number of which have definite promise of becoming eventual producers.

At several producing mines new orebodies were discovered which added substantially to ore reserves and at least 5 companies expanded milling capacity or increased the tonnage milled.

Estimated world output of gold in 1951 was approximately 24 million fine ounces compared with 24·3 million in 1950. The Union of South Africa was still far in the lead, followed by Canada and United States.

Commencing October 1, 1951, Canadian producers of gold were given the choice by the Federal Government, of selling their production on premium markets under Government regulation, or for those eligible, of continuing to receive cost-aid assistance under the Emergency Gold Mining Assistance Act. In December 1951, the Minister of Finance announced that the Federal Government proposed legislation to extend the operation of the Act for another 2 years, or until the end of 1953.

Ontario

Production of gold in Ontario came from 46 quartz gold mines and as a by-product, from the copper-nickel mines of the Sudbury area. The leading quartz gold producers were Kerr-Addison, Hollinger, McIntyre, Dome and Lake Shore, in that order.

A number of mines increased their gold output with existing mill capacity, while others, namely Kerr-Addison, Campbell Red Lake, and New Dickenson increased their mill capacity and tonnage milled. New ore-bodies were discovered at Pickle Crow.

Production

—	1951	1950
	Fine ounces	Fine ounces
Ontario		
Auriferous quartz mines:		
Porcupine	1,062,951	1,100,122
Kirkland Lake	454,986	448,391
Larder Lake	352,135	341,081
Patricia	349,404	336,854
Thunder Bay	137,291	131,413
Matachewan	41,984	50,048
Sudbury	23,717	36,930
	2,422,468	2,444,839
Base metal mines	40,511	36,271
Total	2,462,979	2,481,110
Quebec		
Auriferous quartz mines	724,878	743,241
Base metal mines	342,428	351,404
Total	1,067,306	1,094,645
British Columbia		
Auriferous quartz mines	223,142	238,949
Placer operations	18,802	14,632
Base metal mines	48,048	36,909
Total	289,992	290,490
Northwest Territories		
Auriferous quartz mines	212,211	200,663
Manitoba		
Auriferous quartz mines	126,867	137,020
Base metal mines	37,047	54,705
Total	163,914	191,725
Saskatchewan		
Placer operations	....	....
Base metal mines	110,216	79,784
Total	110,216	79,784
Yukon		
Placer operations	77,504	93,339
Newfoundland		
Base metal mines	8,515	9,254
Alberta		
Placer operations	97	152
Nova Scotia		
Auriferous quartz mines	17	65
Grand total, ounces	4,392,751	4,441,227
Total value	$161,872,873	$168,988,687

Broulan and Porcupine Reef amalgamated to form a new company known as Porcupine Reef Gold Mines Limited. Newlund continued development of its gold prospect in Echo township, Kenora district, 25 miles southeast of Sioux Lookout, and installed a new electrical mining plant. Underground work and levels are co-ordinated with those of the adjoining Windward mine which is under the same management.

During 1951, Central Patricia, Hard Rock, and Magnet Consolidated mines were closed owing to exhaustion of known ore reserves. Production at Hollinger Consolidated was considerably reduced owing to a strike which lasted 58 days, while operations at Renabie were suspended for 137 days as a result of a fire which seriously damaged the headframe.

Hotstone Gold Mines Limited completed a geophysical survey of its Deer Lake property in the Kenora area in preparation for drilling during 1952. Other prospects upon which work was done were Orofino and Ladulama in the Sudbury area and Lake Beaverhouse and Queenston in the Larder Lake Area.

Quebec

Quebec was next to Ontario in output of gold, production coming from 20 quartz gold mines and from 10 base metal mines. The chief producers among the quartz gold mines were Lamaque, Malartic Goldfields, Sigma, East Malartic, Consolidated Beattie, and Sullivan, while those among the base metal mines were Noranda, Quemont and East Sullivan.

Anglo-Rouyn and Perron closed during the year owing to depleted ore reserves, and Consolidated Duquesne suspended shipments of ore to the mill of Consolidated Beattie while concentrating on shaft sinking and development work. On December 10th, the latter two companies were amalgamated to form one corporation, Beattie-Duquesne Mines Limited.

Lamaque Mine in Bourlamaque township continued developing its No. 2 Mine, an eastward extension of the Sigma ore zone, by completing shaft sinking to 1,344 feet with 9 stations and loading pockets. Mill tonnage is to be increased from 1,500 to 2,000 tons a day in 1952. Elder, 10 miles west of Noranda, completed new surface buildings and commenced sinking No. 2 shaft. East Malartic sunk No. 4 inclined shaft to the 2,485-foot level and commenced a deep exploration program which at the end of the year was showing remarkably favourable results. Development at Barnat in the Malartic area was planned to include a new surface plant at No. 3 shaft. In the Rouyn area, Donalda began operating its new 350-ton mill in April, while Heva was reopened and commenced shipments of ore in July to the mill of Powell Rouyn. Bevcourt, in Louvicourt township, which in 1950 shipped ore to the mill of Perron Gold Mines, bought that company's mill which it began installing on its own property.

Campbell Chibougamau, a copper-gold prospect in Chibougamau township, Quebec, continued an extensive program of diamond drilling with plans for shaft sinking and underground development in 1952.

British Columbia

Gold output came mainly from 6 quartz gold mines. In order of output, these mines were Bralorne, Kelowna, Pioneer, Cariboo Gold Quartz, Island Mountain, and Polaris-Taku.

Polaris-Taku, in the northern coast area, was closed early in 1951 when the mill was leased for a 5-year period by The Consolidated Mining and Smelting Company of Canada. The mill is now being used to treat ore from that company's Big Bull and Tulsequah Chief mines which produce gold, copper, silver, lead and zinc.

Placer gold production was obtained principally from the Noland underground placer mine at Atlin, the other sources being a few small placer mining companies and individuals.

Base metal mining operations, chiefly by The Consolidated Mining and Smelting Company were another source.

The decrease in gold output in British Columbia during 1951 resulted mainly from suspension of operations at Polaris-Taku and a general tendency to concentrate on the mining of higher grade ores. There was a decline in exploration and development.

Northwest Territories

Since 1938, when the first gold brick in the Northwest Territories was poured at the Con Mine, production has increased steadily. This increase has been especially noticeable during the past 5 years when total production increased from 62,517 fine ounces in 1948 to 212,211 fine ounces in 1951, and has been due to increased tonnage milled at Giant Yellowknife and an improvement in the grade of ore treated at the other three producers.

At Giant, enlargement of the capacity of the mill and roasting plant proceeded. During 1951 the average milling rate was 415 tons a day and it is planned to increase this rate to 750 tons a day by 1953 and later to 1,000 tons, if conditions permit.

Con-Rycon milled an average of 320 tons a day. By mid year, all broken ore was removed from the Rycon section of the mine and no further development work was contemplated for the time being.

Production at the Negus mine continued to average 225 tons a day with all production being obtained from the Campbell shear zone. The new roaster unit to treat the stockpile of roaster concentrates now on hand was expected to commence operation early in 1952.

Discovery Yellowknife, in the Quyta-Giauque Lake area which commenced production in February 1950 has been successful in finding new high grade ore at depth. In 1951, the shaft was deepened to the 1,000-foot horizon and it is anticipated that further deepening of the shaft will be commenced in the near future. The construction of a hydro-electric power line will commence in 1952 and with electric power available costs will be reduced.

Development work was intensified at the Lasalle Bulldog, and Salmita properties in the Yellowknife area. Prospecting for new gold properties was considerably less than in 1950 because of greater interest in base metals and uranium.

Manitoba

Three quartz-gold mines, namely, Nor-Acme in the Snow Lake district, and San Antonio and Ogama-Rockland in the Rice Lake district, accounted for the greater part of the gold production in 1951. The remainder came from the Manitoba portion of the Hudson Bay Mining and Smelting Company's mine at Flin Flon. There was a decrease in total production due mainly to the closing down of Ogama-Rockland in July.

At San Antonio, a two-year development program was commenced which will open ten new levels and deepen the mine to 3,940 feet. The mill operated close to its capacity of 550 tons a day.

At Nor-Acme, the 5-compartment shaft was deepened from 938 to 1,490 feet and 3 new levels were established.

Prospecting for gold was active in the northern part of the province.

Saskatchewan

All gold production was obtained as a by-product of the operations of the Hudson Bay Mining and Smelting Company at Flin Flon, on the Manitoba-Saskatchewan boundary. Saskatchewan's share from this source was 38 per cent higher than in 1950.

Yukon

Production, all from placer operations, decreased from that of the previous year due largely to the shutting down of 1 of the dredges operated by Yukon Consolidated. This company, which is the largest producer, operated 7 dredges on creeks within a 50-mile radius of Dawson. In 1951, production from 5,878,422 cubic yards of gravel was valued at $1,932,500. Proven gravel reserves are over 111,000,000 cubic yards.

Yukon Gold Placers operates a 4½-cubic foot bucket line dredge on each of its two properties, one on Thistle Creek and the other on Henderson Creek. Clear Creek Placers also operates a dredge on Clear Creek, 60 miles east of Dawson. Yukon Explorations Limited is a successful placer mining operation on Sixtymile Creek near the Alaska border. Burwash Mining Company operated on Burwash Creek in the Kluane Lake district on the northeast front of the St. Elias Mountain range. The Alaska highway has made it possible to bring in heavy machinery for placer operations.

Newfoundland

Gold production in Newfoundland amounted to 8,515 ounces and was all obtained as a by-product from base metal operations.

Alberta and Nova Scotia

Neither of these two provinces has any producing gold mines, but negligible amounts of gold were obtained, in Alberta from small placer operations, and in Nova Scotia from old quartz-gold mines.

IRON ORE

Canada's production (shipments) of iron ore in 1951—4,179,027 tons[1] valued at $31,141,112—increased 29.8 per cent over production in 1950. Expansion and new developments indicate a continually increasing output during the next few years.

Progress continued to be made in the Steep Rock Lake area in preparation for underground mining at the Errington mine and open pit mining at the Hogarth mine. Of major interest in the Michipicoten area was the discovery of siderite ore, of a grade equal to the Helen ore, at a depth of 5,380 feet. In the Labrador-New Quebec area preparations for production were made on three deposits, and progress was made in the construction of the railway from Seven Islands, of docks, terminal facilities, and water power installations. At Wabana in Newfoundland, the world's longest underground conveyor belt system was completed during the latter part of 1951. This is part of a broad program of expansion on which considerable progress was made. At Marmora, in southeastern Ontario, initial preparation for the stripping of the 100 to 150-foot capping of limestone commenced, as a preliminary to exposing the magnetite orebody. On Vancouver island in British Columbia the first shipments of magnetite concentrates in sizeable proportions took place from the Campbell River deposits. The output of iron ingots, resulting from the smelting of ilmenite at Sorel, increased eight-fold.

[1]All tonnage figures are in long tons, unless otherwise stated.

Developments at Properties

Newfoundland

Wabana. Shipments from the Wabana hematite mines, of Dominion Steel and Coal Corporation Limited, increased 47 per cent over those in 1950. This was due mainly to an increase in overseas shipments of 696,912 tons, the major part of which proceeded to the United Kingdom. Total shipments in 1951 were 1,540,176 tons compared with 1,044,237 tons in 1950.

Present commitments are directly responsible for the expansion program commenced at Wabana during 1951. Germany has placed orders for 500,000 tons a year for 5 years; the United Kingdom has ordered 1,000,000 tons a year for a similar period; and the company's steel mills at Sydney have called for 900,000 tons a year. Smaller contracts have been negotiated as well. The high phosphorus and silica content limits the more general use of Wabana ore in Canadian and American furnaces.

Work in recent years has been confined entirely to the submarine field, with production coming from three mines (Nos. 3, 4, and 6) by means of three shafts (or slopes). Ore extraction is by the "room and pillar method" with mining being carried on 3 miles out to sea. Dominion Wabana, in 1951, altered its method of ore haulage from the three-slope system to the conveyor belt system, with the belt running up one side of No. 3 slope. This installation is part of a mechanization and modernization program designed to raise production to 2,500,000 tons a year by 1952.

Labrador-New Quebec

Iron Ore Company of Canada, Limited. During 1951, Iron Ore Company of Canada, Limited carried out preparations for production on 3 hematite deposits, and continued geological mapping and exploration on concessions in Labrador and Quebec. No attempt was made to increase reserves which remain at 417,707,000 tons of proven ore. Present plans call for the production of 10,000,000 tons per year with initial production, in 1954, to be 2,500,000 tons. All planning has taken into consideration the possibility of an output of 20,000,000 tons per year, if circumstances warrant such an increase.

Preliminary work was carried out during 1951 on docks and ore terminus at Seven Islands. A 358-mile railway is in process of being constructed from Seven Islands to Knob Lake in Ungava. By the end of 1951, 10 miles of track had been laid and 125 miles of grading had been completed. A 2,250-foot tunnel was driven in the spring of 1951, and the main span of the Moisie River bridge was completed late in the year.

At Seven Islands' ore terminus, arrangements will permit either direct loading onto ships or storage in one of four stockpiles, each stockpile having a capacity of 440,000 tons. Ore loading equipment at the terminus is designed to handle 6,000 tons per hour when loading onto stockpiles and 8,000 tons per hour when loading directly onto ships. In 1951, two 30,000 ton ore carriers were under construction.

Power at the mines will be provided by the harnessing of the Menihek rapids, 25 miles southwest of Burnt Creek; progress was made on this project during 1951. Water power resources at Eaton Canyon and at Grand Falls, 70 miles northwest and 140 miles southeast, respectively, of Burnt Creek, provide potential hydroelectric power reserves. The terminus at Seven Islands will be supplied by a power development on the Ste. Marguerite River, 20 miles to the west.

Bethlehem Steel Corporation, has already contracted for 30,000,000 tons of ore, for delivery over a 25-year period.

Other Concessions and Claims in the "Labrador Trough". Fenimore Iron Mines Limited actively explored its concession and claims, in the northern end of the "Labrador Trough", in 1951. As yet, no deposits of commercial size have been located.

Other companies holding iron ore concessions, or claims, in the same area are: Norancon Exploration Quebec Limited, Quebec Labrador Development Company, Limited, Fort Chimo Mines Limited, and Great Mountain Iron Corporation.

Quebec

Quebec Iron and Titanium Corporation. Located in the Allard Lake area about 27 miles north of Havre St. Pierre on the Gulf of St. Lawrence, are probably the largest known deposits of ilmenite in the world, with about 150,000,000 short tons of ore indicated by drilling, averaging 35 per cent TiO_2 and 40 per cent iron. The most important ore body is the main orebody at Lac Tio, where the estimated reserves exceed 125,000,000 short tons of ilmenite. The Cliff deposit, on the western shore of Lac Tio, contains approximately 12,000,000 short tons of ore of the same quality as that in the main orebody. There are also a number of smaller deposits. That at Grader Lake, 2 miles south of Lac Tio, may be classed as one of these. Known reserves of this deposit are 200,000 short tons.

Mining operations are carried out by open-cut methods. The ore is shipped 27 miles by rail to Havre St. Pierre and then by boat to Sorel on the St. Lawrence River. In 1951, 372,112 short tons were mined and shipped to the smelter at Sorel, an increase of 271,395 short tons over 1950 shipments.

At Sorel, Quebec Iron and Titanium Corporation has completed 1 of 5 contemplated furnaces; two others were near completion at the end of 1951. The products are low-carbon iron and a titanium dioxide slag containing 70 per cent titanium dioxide. The iron is desulphurized, cast into ingots and sold as a high-grade metallic iron. The rated capacity of the plant when completed will be 500 tons of iron and 700 tons of titanium dioxide slag daily to be obtained from 1500 tons of ore.

In 1951, the production of iron and steel ingots totalled 15,554 short tons.

Minnesota-Huron Iron Company. The Minnesota-Huron Iron Company, a wholly-owned subsidiary of the W. S. Moore Company of Duluth, Minnesota, continued to investigate the old Bristol magnetite deposits in Bristol township, Pontiac county, about 35 miles northwest of Ottawa.

In 1950, the company optioned the property; a drilling programme was commenced during the fall of 1950 and completed in June of 1951. During the early part of 1951, there were 44 drill holes put down on the property, ranging in depth from 174 feet to 504 feet. The manner in which the deposits occur is such that they may be mined by open-pit methods.

Ore reserves developed on the Bristol property, as a result of the 1950-51 drilling programme have not yet been announced but they are understood to be very substantial.

Ontario

Algoma Ore Properties Limited. All production from Algoma Ore Properties Limited was from underground operations at the Helen Mine in the Michipicoten area. The company is using the block-caving and sub-level stoping systems of mining and the conveyor-belt method of lifting ore to the surface. Part of the ore requires treatment in a sink-float plant before sintering.

The ore is conveyed to the sinter plant at Jamestown, 3 miles distant, by aerial tram and railway. The production of sinter at Jamestown amounted to 1,188,842 tons during 1951; shipments totalled 1,211,234 tons. About one-third is used by Algoma Steel Corporation and the remainder is sold on the open market, principally in the United States, where it is much in demand due to its comparatively high (3 per cent) content of manganese and its self-fluxing quality.

The company announced that it had established, by diamond drilling the presence of a new orebody directly east of the Helen and Victoria mines. The orebody, to be called the Alexander Mine, has a grade of ore equal to that of the Helen or Victoria.

Ore reserves of the Helen Mine are estimated to be 100,000,000 tons of proven siderite ore containing 35 per cent iron. An unusually deep diamond drill hole completed in July 1951, indicated that the siderite orebody continues to a vertical depth of at least 5,380 feet, and remains unchanged in grade and width.

At the Siderite Hill deposits, 3 miles northeast of the Helen Mine, ore reserves total 100,000,000 tons of siderite ore with an average grade of 34 per cent iron. At the Britannia property, about 8 miles northeast of the Helen Mine, ore reserves total 30,000,000 tons of siderite ore containing an average of over 41 per cent iron. In the Goulais River area, about 50 miles northeast of Sault Ste. Marie, ore reserves total more than 150,000,000 tons, averaging approximately 30 per cent iron.

Algoma Ore Properties, in 1951, continued its investigations of the magnetite deposits near Calabogie, in Renfrew county.

Jalore Mining Company, Limited. This company continued the investigation of the Ruth and Lucy properties in the Michipicoten area. Over 40,000,000 tons of ore have been outlined by diamond drilling.

Steep Rock Iron Mines Limited. This company shipped 1,325,889 tons of (hematite) ore from the northern part of the Errington open pit on the company's "B" ore zone. This is an increase of 9 per cent over 1950 shipments.

All of the known ore bodies and ore zones, 8 in number, lie within the basin of Steep Rock Lake and are owned by Steep Rock Iron Mines Limited which has leased some of the ore zones to other companies. During 1951, extensive exploration was carried out on "C" ore zone by the Caland Ore Company, a subsidiary of Inland Steel Company of Chicago, which has this deposit under option to lease, on a royalty basis.

Steep Rock Iron Mines continued its expansion program which is planned to increase the output to 3,000,000 tons by 1955 and 3,500,000 or 4,000,000 tons by 1956. This program includes preparing the "A", or Hogarth, ore body for open pit mining and the "B" or Errington Mine for underground production.

The Hogarth open pit is designed to produce 2,500,000 tons a year and the Errington underground mine, 1,500,000 tons a year. In the latter, a 3-compartment service shaft is being sunk to a depth of 1,250 feet to provide 2 production levels and 1 drainage level beneath the pit. By the end of 1951 the shaft had been sunk to a depth of 932 feet below the collar, and 2 of the 3 level stations had been cut. It is anticipated that the block caving method of mining will be used. All ore will be brought to surface by belt conveyors.

Proven and probable ore reserves as at November, 1950, were estimated at 66,000,000 tons of unstated grade. This tonnage represents drilled reserves in the Hogarth Mine to 410 feet depth and in the Errington Mine to 290 feet depth. Exploratory drilling on these zones has revealed the occurrence of high grade iron ore at more than three times these depths.

Marmoraton Mining Company Limited. The magnetite deposits of Marmoraton Mining Company, Ltd. near Marmora in Hastings County had been explored by August of 1951, by 30 diamond drills holes. These ore deposits are leased to its parent company, the Bethlehem Mines Corporation, a wholly-owned subsidiary of Bethlehem Steel Corporation. Bethlehem Mines Corporation is planning an open-pit operation, with production to commence by 1954. Preliminary work was commenced, in 1951, preparatory to the removal of a 100-to 150-foot capping of limestone. It will take about 2 years.

A magnetic concentration plant will be erected on the property, since the ore is low in grade, averaging approximately 40 per cent iron. Production is planned at the rate of 500,000 tons of concentrate a year, based on an average of 1,750 tons a day. The concentrate is to be shipped by rail to a Lake Ontario port and by water to the Bethlehem Steel Corporation's operations at Lackawanna, near Buffalo, N.Y.

British Columbia

The Argonaut Co., Ltd. The Argonaut Co., Ltd., of Campbell River, commenced production at its magnetite deposits near Quinsam Lake on the east coast of Vancouver Island.

The company took an option on the Iron Hill mine in 1949 and in 1951 constructed wharves, roads and a mill. Shipments commenced in September 1951, and reached a total of 101,371 tons of magnetite concentrates. Production is expected to reach 50,000 tons a month, early in 1952.

The ore is mined by open-cut methods and is beneficiated to raise the iron content to approximately 58 per cent. The concentrated ore is trucked over a 22-mile improved, dirt road to Campbell River where it is stockpiled. A conveyor belt system is used to transfer the ore from stockpile to ocean-going vessels.

Ore reserves of the Iron Hill deposit have been estimated at 1,700,000 tons.

Other Developments is British Columbia. Texada Iron Mines Limited carried out a diamond drilling program on the magnetite deposits on Texada Island between Vancouver Island and the mainland. Exploration neared completion by the end of 1951, and roads were being built. Shipments are expected to commence in the spring of 1952.

Quatsino Copper-Gold Mines, Limited continued systematic drilling on its Elk River (Quatsino) magnetite deposits—a program which it commenced in 1950. By December 1951, the orebody had been tested by 32 holes for a length of 200 feet and a depth of 200 feet. The width of the body is about 60 feet. The company, in December 1951, estimated ore reserves at 922,000 tons. These include proven ore reserves of 535,000 tons, grading 57 per cent iron after 10 per cent beneficiation by magnetic separation, and indicated ore reserves of 387,000 tons. The survey for a road from tide-water to the property was commenced during the latter part of 1951.

Production and Trade

Shipments of Canadian iron ores by properties are shown in the following table:

Iron Ore Production (Shipments) in Canada
By Properties

(Thousands of Long Tons)

—	Steep Rock hematite	Wabana hematite	Helen sinter	Quinsam Lake BC–magnetite
1950	1,217	1,044	958	....
1951	1,326	1,540	1,211	101

A large part of the Ontario iron ore was exported to the United States where it was much in demand because of its high grade and good furnace qualities. Much of the ore used in the blast furnaces of Ontario was imported from the United States. British Columbia iron ore was exported to Japan. Wabana iron ore was used in the furnaces at Sydney, Nova Scotia, and exported to the United Kingdom and Germany. Ore imported from overseas was used at Sydney, Nova Scotia, mainly as open-hearth lump ore.

Canadian Production, Trade and Consumption of Iron Ore

—	1951		1950	
	Long tons	$	Long tons	$
Production (Shipments)	4,179,027	31,141,112	3,218,983	23,413,547
Imports				
From: United States	3,294,883	21,329,066	2,656,838	15,971,317
Sweden	7,862	94,990	9,147	99,776
Brazil	109,922	1,064,434	75,574	729,991
United Kingdom	....	....	10	643
Liberia	8,242	182,775	....	....
Total	3,420,909	22,671,265	2,741,569	16,801,727
Exports				
To: United States	1,950,632	13,121,180	1,813,970	12,329,032
United Kingdom	692,707	3,796,025	127,311	707,013
Germany	135,592	857,431	47,536	273,737
Japan	101,218	821,501	....	....
Total	2,880,149	18,596,137	1,988,817	13,309,782
Indicated Consumption	4,719,787	....	3,971,735	....
Domestic Production as a percentage of indicated consumption	88·5		81·0	

Blast Furnaces, Open Hearth Furnaces, and Electric Furnaces Operated by Primary Steel Producers in Canada

(Net Tons)

—	Blast Furnaces		Open Hearth		Electric [1]	
	No.	Annual Capacity	No.	Annual Capacity	No.	Annual Capacity
Dominion Steel and Coal Corporation Limited, Sydney, Nova Scotia	4	730,000	15	685,000	1	28,000
Algoma Steel Corporation Limited, Sault Ste. Marie, Ontario	5	1,035,000	12	886,000	......	....
Canadian Furnace Company Limited, Port Colborne, Ontario	2	223,000	......	....	......	....
The Steel Company of Canada, Limited, Hamilton, Ontario	3	745,000	13	1,155,000	1	91,500
Dominion Foundries and Steel Company, Limited, Hamilton, Ontario	1	280,000	4	202,900	5	175,400
Total	15	3,013,000	44	2,928,900	7	294,900

[1]Eight other companies, engaged in the secondary production of steel, operate electric furnaces having a combined capacity of approximately 460,000 net tons.

The new 1,000-ton blast furnace of Dominion Foundries and Steel Company at Hamilton was blown in during 1951. The Algoma Steel Corporation has announced the intention to construct a new blast furnace to be known as No. 6, and increase open-hearth capacity to 1,240,000 tons a year. The Steel Company of Canada continued construction of the 1,000-ton blast furnace to be completed by the end of 1952, and the four 250-ton open hearths which may be in full production by 1953.

Several other steel companies that make steel from scrap in small open-hearth furnaces and electric furnaces require a small tonnage of lump ore.

LEAD

Canada's production of 158,231 tons of lead was about 4 per cent less than in 1950 due chiefly to a decrease in output by The Consolidated Mining and Smelting Company of Canada Limited, the principal producer. The peak year was 1942 when 256,071 tons were produced. There was a slight increase in domestic consumption of refined lead but exports were less than in 1950.

Six new lead-zinc mines came into production during the year, and on thirteen other properties development toward production was under way. The price of the metal increased from 17·85 cents to 19·50 cents during the year.

British Columbia

At The Consolidated Mining and Smelting Company's Sullivan mine near Kimberley 2,533,212 tons were milled compared with 2,680,962 tons in 1950. The underground belt conveyor system was extended down to the 2,850-foot level and a coarse crushing plant was installed at that horizon. The conveyor system now has a vertical range of over 1,000 feet. Open-cut mining of a portion of the orebody near surface was commenced after the removal of a substantial quantity of gravel overburden. At the company's smelter at Trail, where lead and zinc concentrates from the Sullivan mine are treated, 162,001 tons of refined lead was produced. About 30 per cent of the production came from custom ore and concentrate which were shipped to Trail by a number of Canadian and foreign mines. Renovation of the lead smelter was continued with little interruption of production.

The Consolidated Mining and Smelting Company brought its Tulsequah Chief and Big Bull copper-lead-zinc mines in the northern coast area into production. Ore from both properties was milled at the 250-ton mill of Polaris Taku Mining Company Limited, leased by The Consolidated Mining and Smelting Company for that purpose. Preparations were well advanced to start production, in 1952, of lead and zinc concentrates at the company's Bluebell mine on Kootenay Lake at 500 tons a day, and at its H.B. mine near Salmo at 1,000 tons a day.

The other producers of lead ore and concentrates included Canadian Exploration Limited and Reeves MacDonald Mines Limited near Salmo; Base Metals Mining Corporation Limited at Field, and at its revived Cork Province mine near Kalso; Violamac Mines Limited near Sandon; Silver Standard Mines Limited near Hazelton; Silbak Premier Mines Limited near Stewart; Giant Mascot Mines Limited near Spillamacheen; and Yale Lead and Zinc Mines Limited at Ainsworth. The last two companies came into production in 1951.

Emerald Glacier Mines Limited acquired the former 200-ton Kenville mill near Nelson to which it commenced shipping high-grade lead-zinc ore from its new mine near Tahtsa Lake in the west-central part of the province.

Estella Mines Limited near Cranbrooke started producing zinc and lead concentrates in its new 150-ton mill.

Mastadon Zinc Mines Limited (subsidiary of Golden Manitou Mines Limited) prepared to commence production of zinc and lead concentrates at its mine in the Big Bend area, 17 miles north of Revelstoke.

Production, Trade and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production, all forms				
British Columbia	127,764	47,017,311	133,660	38,627,700
Newfoundland	16,444	6,051,427	17,918	5,178,320
Quebec	7,756	2,854,323	7,676	2,218,475
Yukon	6,267	2,306,085	6,443	1,861,957
Total	158,231	58,229,146	165,697	47,886,452
Production, refined (includes lead from imported ores)	162,001	....	170,023	....
Exports in ore				
To: United States	7,585	2,421,705	4,023	900,795
Germany	6,230	2,252,756	1,689	556,297
Belgium	5,833	2,091,502	13,564	4,103,418
Total	19,648	6,765,963	19,276	5,560,510

—	1951		1950	
	Short tons	$	Short tons	$
Exports, refined lead including scrap				
To: United States	60,888	21,579,460	106,382	29,795,474
United Kingdom	34,888	12,246,268	8,276	2,157,474
Brazil	4,702	1,976,951	932	239,092
Argentina	2,148	920,490	...	...
Belgium	1,563	633,174	289	10,500
Union of South Africa	1,120	450,424	...	...
Japan	773	265,724	...	...
Pakistan	220	86,254	...	...
Venezuela	106	59,609	590	193,164
Other countries	749	305,764	494	148,726
Total	107,157	38,524,118	116,963	32,544,430
Exports				
Lead manufactures				
To: Venezuela	...	42,346	...	43,274
Cuba	...	24,576	...	23,950
United States	...	11,355	...	3,436
Peru	...	7,282	...	...
Brazil	...	3,293	...	...
Italy	...	3,165	...	...
India	...	...	...	15,704
Other countries	...	10,382	...	7,629
Total	...	102,399	...	93,993
Imports of tetraethyl lead compounds				
All from United States	11,304	8,996,288	11,604	8,817,224
Domestic Consumption of refined lead				
Solders and alloys[1]	9,466	...	10,480	...
Wire coating and cable covering	14,269	...	12,758	...
Paints and pigments	8,289	...	6,183	...
Storage batteries[2]	23,373	...	21,832	...
Hot dipping and annealling	1,982	...	1,531	...
Foil and collapsible tubes	81	...	43	...
Ammunition	1,318	...	564	...
Miscellaneous	1,570	...	1,332	...
Total	60,348	...	54,723	...

[1] Excluding lead in antimonial lead for storage batteries.
[2] Includes new lead and lead content of antimonial lead.

Ontario

Operational control of Matarrow Mines Limited near Matachewan was acquired by the neighboring Matachewan Consolidated Gold Mines Limited which carried out considerable preproduction development at the Matarrow mine and made plans to commence production of lead and zinc concentrates at the Consolidated Matachewan mill in 1952.

Ontario Pyrites Company Limited made plans to reopen the former Treadwell Yukon and Sudbury Basin properties near Sudbury and to sink a 750-foot development shaft. A large tonnage of copper-lead-zinc ore has been indicated by diamond drilling.

Penn-Cobalt Silver Mines Limited reopened the Foster mine near Cobalt at which 300,000 tons of ore grading 3 per cent zinc and 1½ per cent lead was disclosed by drilling.

Quebec

Lead concentrate was produced by New Calumet Mines Limited, Pontiac county; Anacon Lead Mines Limited, Portneuf county; Golden Manitou Mines Limited, Abitibi county; and by Consolidated Candego Mines Limited, North Gaspe county. Ascot Metals Corporation Limited produced a bulk copper-lead concentrate from its Moulton Hill and Suffield mines near Sherbrooke. New Calumet and Anacon shipped their lead concentrate to the Trail smelter; the other producers shipped either to United States or to Europe.

In the fiscal year ended September 30, 1951, New Calumet produced lead concentrate containing 3,320 tons of lead from the milling of 259,214 tons of ore. Commercial ore was found in several newly developed sections of the property.

Anacon Lead Mines milled 219,276 tons of ore and produced lead concentrates containing about 2,300 tons of lead. New zinc-lead ore was found by drilling north of the "C" orebody.

Consolidated Candego Mines resumed milling at about 40 tons a day in February and produced 820 tons of highgrade lead concentrate in 1951. Development of the company's rich but erratic ore zones continued.

New Brunswick

Considerable exploration was carried out on the lead-zinc occurrences in the northern part of the province, and several deposits which appeared of commercial significance were outlined.

Nova Scotia

Mindamar Metals Corporation Limited rehabilitated the Stirling zinc-lead-copper mine in the southern part of Cape Breton Island. The building of a new 500-ton concentrator on the property neared completion. Ore reserves were augmented substantially by exploratory drilling.

Minda-Scotia Mines Limited carried out an intensive drilling program on its lead-zinc occurrences in Colchester county.

Newfoundland

Buchans Mining Company Limited produced 28,070 tons of lead concentrate from its zinc-lead-copper mine in the central part of the province. All the ore was mined in the old sections of the property but development at the company's new Rothermere mine 3 miles to the northeast continued and production from it is expected in 1952. Concentrates were shipped to United States and Europe.

Yukon

Exploration and development on a fairly large scale was carried out on the rich silver-lead-zinc deposits of the Mayo district by a number of mining companies. United Keno Hill Mines Limited, the principal operator, and as yet the only commercial producer, shipped concentrates and crude ore, containing 6,518 tons of lead, to the smelter at Trail, British Columbia. Developments by the company were directed chiefly toward deepening the workings at its Hector mine but development work was also carried on at 5 of its other mines in the area. A cyanide plant was constructed to recover silver from the concentrator tailings and this unit was placed in operation in December. The Northwest Territories Power Commission commenced a hydro-electric power development on the Mayo river which is expected to be completed early in 1953.

Northwest Territories

The Consolidated Mining and Smelting Company continued the drilling of its zinc-lead property at Pine Point, Great Slave Lake, with encouraging results. Exploration will be continued in 1952.

American Yellowknife Gold Mines Limited outlined a fairly large orebody at its property near O'Connor Lake. The ore averages 15 per cent combined lead and zinc. The company planned to carry out underground exploration in 1952.

Uses

The principal uses of lead vary in different countries. In Canada, storage battery manufacture and cable covering are the chief outlets. Other important uses are for tetraethyl lead compounds; bearing metal and solders; red lead, and litharge; and white lead. The metal is used also for plumbing, caulking, packaging foil, type metal, chemical products, and in the manufacture of ammunition.

Prices

The Canadian price of lead fluctuated between 17·85 cents a pound and 19·5 cents a pound. It was 19·5 cents a pound at the end of the year. The average price was 18·4 cents a pound.

MAGNESIUM

Magnesium ingot was produced in Canada during 1951 at the Haley, Ontario plant of Dominion Magnesium Limited, and at the Arvida, Quebec plant of Aluminum Company of Canada, Limited. The current defence program has increased greatly the demand for magnesium in the fabrication of light alloy shapes, castings and forgings. Aluminum Company of Canada is undertaking a $2,000,000 expansion of its Arvida electrolytic plant. Full production is expected to be reached in the spring of 1953. Much of the output will be exported to United Kingdom.

Dominion Magnesium have under construction at Haley a new foundry for the production of light alloy components for jet engines and aircraft frames. On completion, capacity is expected to be 200 tons of castings monthly. The company also completed changes in its main plant to permit the simultaneous production of ingot magnesium and calcium.

Several foundries in Canada are now engaged in the manufacture of magnesium castings of various types. These comprise: in Quebec province, Robert Mitchell Company, Limited, Montreal; in Ontario, Aluminum Company of Canada, Limited at Etobicoke, Canadian Magnesium Products, Limited at Preston, Grenville Castings, Limited at Merrickville, Barber Die Castings at Hamilton, and Light Alloys, Limited, subsidiary of Dominion Magnesium, Limited at Renfrew and Haley; and in British Columbia, Western Magnesium Limited, Vancouver.

Canadian Sources

Canada has several potential sources of magnesium metal including magnesite, dolomite, serpentine, brucite, and sea water. At present, brucite and dolomite are the raw materials used in domestic production.

Dolomite, which occurs in several provinces, is quarried by Dominion Magnesium Limited at Haley, Ontario where it is processed by the thermal ferrosilicon method. Brucite, a magnesium hydroxide mineral, occurs in granular form in certain crystalline limestone deposits in the provinces of Quebec, Ontario, and British Columbia. It is recovered at Wakefield, Quebec, as magnesia which is used in the production of magnesium metal in the electrolytic magnesium plant of Aluminum Company of Canada at Arvida.

Production, Trade, Uses, and Prices

Information on Canadian production, exports and imports of magnesium metal is not available for publication.

The main use for magnesium is in light alloy components in aircraft construction where large quantities of the metal are required. Physical properties of magnesium are such that it may be formed with facility into numerous useful articles by casting, forging, extrusion, or sheet working. The light weight and high strength-to-weight ratio of many of these alloys have been important considerations in expanding its use.

The price of magnesium in United States, f.o.b. production works, in ingot form and carload lots, remained at 24½ cents a pound throughout the year.

MANGANESE

Canada imports all its requirements of manganese as none of the known deposits is of commercial grade. These imports are obtained from the producing countries directly, or via the United States, and in 1951 amounted to 222,082 short tons, compared with 135,698 tons in 1950.

From time to time efforts have been made to utilize the bog manganese ores of New Brunswick but no continuing production has resulted.

Although Canada produces no manganese ore, its production of manganese addition agents has averaged about 80,000 tons a year over the past few years, a development resulting from the availability of abundant electric power at reasonable rates. Over 85 per cent of the output of addition agents has been in the form of ferromanganese, mainly high carbon content, and most of the remainder as silicomanganese.

Imports of manganese ore and exports of ferromanganese for 1951 and 1950 are shown in the following tables:

Canadian Imports of Manganese Ore

Country from which shipped	1951	1950
	Short tons	Short tons
United States*	95,086	21,718
Gold Coast	88,687	87,328
India	17,467	25,879
Brazil	8,288	....
French Oceania	7,744	....
Others	4,810	773
Total	222,082	135,698

*This ore entered Canada via the United States but country of origin is not known.

Ores of Manganese

Sedimentary manganese deposits, the only commercial source of manganese, have been formed from manganese-bearing silicates by a process of weathering and redeposition as oxides either into irregular bodies lying in clays or sands, as carbonate bands in sediments, or as bog deposits.

*Canadian Exports of Ferromanganese and Spiegeleisen**

Country of Destination	1951	1950
	Short tons	Short tons
United States	66,570	24,085
Mexico	775	2,123
Venezuela	91	6
Others	72	711
Total	67,508	26,925

*Exports of spiegeleisen were 354 tons in 1950. There were no exports in 1951.

The most important economic ores of the numerous manganese minerals are the black oxides of which pyrolusite (MnO_2) is the most important, followed by psilomelane and manganite which are hydrous oxides of manganese. Most commercial deposits are a mixture of all three minerals, together with varying amounts of sand or clay, and iron oxide. They are of secondary origin and have been formed near the surface by the leaching of manganese-bearing silicates by ground waters with subsequent redeposition in irregular masses and beds as oxides. The largest and most valuable manganese deposits in the world are of this type and are generally found in warm, humid climates where the influence of natural weathering agents is much more rapid than in temperate climates.

Rhodochrosite, the manganese carbonate, is not considered an 'ore' of manganese. Deposits of rhodochrosite are stratified sediments interbedded commonly with shales and limestones. The beds may contain manganese oxides in association with the nodular, pink manganese carbonate and individual beds may range from a few inches to several feet in thickness.

Bog manganese, or wad deposits, are composed of amorphous, earthy material formed by precipitation from surface waters that have leached manganese on passing through rocks, mainly silicates, that are manganese-bearing. They commonly occur as basin-shaped deposits a few feet deep or as small benches on gently sloping hillsides. The consolidated lumps occurring in the loose bog manganese are termed wad. There are many of these bog deposits in Canada, particularly in the Maritime Provinces and, to a less extent, in British Columbia and Manitoba. Bog deposits that are forming today are merely soft, wet oozes which dry to a very fine powder. The manganese is present chiefly as pyrolusite. These deposits are precipitated from springs issuing at the surface and consist of manganese oxides and iron hydroxides.

Canadian Occurrences

There are no known commercial manganese deposits in Canada. It appears that the large residual-replacement types of deposit are confined to special climatic and rock conditions where rock decay is deep and thorough and the enclosing rocks are of higher manganese content than is usual. Such conditions occur where the major part of the world's supply of manganese is mined. In Canada, occurrences are limited chiefly to bog type deposits.

Small tonnages of manganese ore have been produced from time to time from several of the many bog deposits in New Brunswick but there has been no continuing production. Other bog deposits occur in Nova Scotia, Manitoba, and British Columbia but they are of low and variable grade and lack sufficient tonnage and continuity to make them attractive economically. One of the larger bog deposits in New Brunswick (Dawson Settlement) has been estimated to contain 42,690 long tons of wet ore which on a dry basis would represent 13,120 long tons and would contain 3,280 long tons of manganese according to analysis.

In Newfoundland, at Conception and Trinity bays, deposits of the carbonate type of manganese (rhodochrosite) occur sporadically over a large area. The main manganese bed at Manuels river, Conception Bay, is only 0.7 foot thick but the total thickness of manganiferous sediments is reported to be 17 feet and to consist of manganese and calcium carbonates, some manganese oxides, and many impurities such as barite, iron carbonate, and jasper. The associated sediments are red and green calcareous shales. The tenor of ore over mining widths (up to 10 per cent Mn) is too low for profitable extraction. Recoveries, on beneficiation, are only about 60 per cent in test work to date.

Replacement type manganese deposits in Canada are best illustrated by those at the Hill 60 mine, Cowichan lake, Vancouver Island, British Columbia, and at Markhamville in King's County, New Brunswick. At the latter a limestone is covered with 8 to 20 feet of residual clay in which are nodules and masses of manganese ore. In the underlying limestone are irregular deposits of manganese ore which follow the bedding and in places branch into pipes and veins.

Large tonnages of manganiferous iron ore averaging about 50 per cent iron and 7.9 per cent manganese have been reported as occurring in the "Labrador Trough".

World Sources

Total world production of manganese ores, in recent years, has been estimated at 4,500,000 metric tons of which Russia is credited with a production of about 1,800,000 tons. Since 1950, when Russia sharply curtailed her shipments to the United States, increasing amounts of ore of all grades have been supplied by other producers, chiefly India, Union of South Africa, the Gold Coast, and Brazil.

United States, the largest consumer of manganese ore, imports about 2,000,000 short tons of all grades each year. Consumption of manganese ore in Russia is estimated at about two thirds the consumption of United States.

Uses

About 95 per cent of the manganese consumed is used in the steel industry and the remainder in the manufacture of dry cell batteries and chemicals. There are no satisfactory substitutes for manganese in its major uses. The consumption of manganese per short ton of steel manufactured is about 13 pounds, of which about 11.7 pounds is in the form of ferromanganese, 1 pound as silicomanganese and the remainder as spiegeleisen and ore.

Specifications for metallurgical grade of manganese call for a minimum of 48 per cent manganese and maxima of 7.0 per cent iron, 8.0 per cent silica, 0.15 per cent phosphorus, 6.0 per cent alumina, and 1.0 per cent zinc. The ore should be in hard lumps less than 4 inches, and not more than 12 per cent should pass a 20 mesh screen.

Manganese ore for battery use must be a manganese dioxide (pyrolusite) ore of not less than 75 per cent MnO_2 and not more than 1.5 per cent iron and should be very low in such metals as arsenic, copper, zinc, nickel, and cobalt. Canada annually consumes about 4,000 tons of this type of ore which is imported mainly from the Gold Coast.

Manganese ore for chemical use contains 35 per cent or more manganese and is used to make manganese sulphate (fertilizers) and other salts which are used in the glass, enamel, paint pigment, rubber, and pharmaceutical industries.

Prices

The following information on the purchase of manganese ores appeared in the December 20, 1951, issue of E. & M. J. "Metal and Mineral Markets":

(1) On long-term contracts involving large tonnages prices are wholly nominal and a matter of negotiation.
(2) Indian ore—$1.20 to $1.25 a long ton unit of manganese, c.i.f. United States ports, duty extra, basis of 46 to 48 per cent manganese.
(3) Chemical grades—Brazilian or Cuban, coarse or fine, minimum 80 per cent MnO_2, carloads, in barrels, $65 to $70 a long ton; Javan or Caucasian 85 per cent minimum, $75 to $80 a long ton; Domestic (U.S.), 70 to 72 per cent, $45 to $50, f.o.b. mines.
(4) On current business on the basis of 46 to 48 per cent manganese, 95 cents to $1 a long ton unit (22.4 lb.), c.i.f. United States ports, duty for account of the buyer (¼ cent a lb. of contained Mn.).

MERCURY

No mercury has been produced in Canada since September, 1944, when operations at the Pinchi Mine of The Consolidated Mining and Smelting Company of Canada Limited at Pinchi Lake in the Omineca Mining Division of northern British Columbia were suspended. However, since then shipments from stock have been made which, in 1951, were 58,235 pounds of mercury (766 flasks) valued at $149,035, compared with 8,100 pounds (106 flasks) valued at $10,024 in 1950. During World War II, mercury was also produced from the Takla Mine of Bralorne Mines Limited, which is north of the Pinchi Mine and also in the Omineca Mining Division. These two mines, if necessary, could supply Canadian requirements of mercury for many years.

Peak Canadian production was reached in 1943 when 22,240 flasks of mercury (76 pounds each) were shipped. The overall grade of ore mined at Pinchi was about 0·5 per cent mercury. The grade of ore at the Takla property was roughly the same.

All operations were suspended when the supply of foreign mercury, particularly from Spain and Italy, became more readily available and the price per flask dropped from over $200 to less than $100. The grade of Spanish ores has averaged about 5 per cent mercury; those of Italy have averaged about 0·9 per cent; and those of the United States just under 0·5 per cent. Spanish reserves are sufficient to supply the world requirements of mercury for many decades.

Occurrences in British Columbia

Although there are approximately 25 mercury minerals, only one—cinnabar—is of commercial importance. Cinnabar has the composition HgS and contains 86·2 per cent mercury and 13·8 per cent sulphur when pure. It is generally scarlet or brownish red with a bright, somewhat oily appearance, and has a scarlet or vermilion streak. It is of igneous origin and is found in porous rocks that had an impervious capping of lava, shale, or clay overlying them at the time of its deposition. Subsequent erosion of this capping exposes the porous host rocks containing the cinnabar. All known deposits of cinnabar in Canada occur in British Columbia and many showings were found and prospected during World War II in the belt of favourable rocks between the Pinchi Mines and the Takla property. The ore occurs as discontinuous stringers, small grains, or scattered blobs, frequently in veins or stringers of dolomite or calcite. Many of these occurrences are described in Bulletin No. 5, "Mercury Deposits of British Columbia" by John S. Stevenson, published by the British Columbia Department of Mines.

Trade and Consumption

(All Quantities in Pounds)

—	1951	1950
Exports		
To: United States	58,235	8,100
Imports		
From: United States [1]	308,027	372,706
Italy	....	233,220
Mexico	....	3,660
Spain	....	3,800
United Kingdom	145	619
Total	308,172	614,005

—	1951	1951 [3]	1949 [3]
Consumption			
Pharmaceuticals and Fine Chemicals	36,404	56,088	62,309
Heavy Chemicals	221,844	88,094	373,131
Electrical Apparatus	15,732	6,534	9,137
Gold Mines [2]	6,000	6,000	6,000
Miscellaneous [2]	10,000	10,000	10,000
Total	289,980	166,716	460,577

[1] Country of origin not necessarily United States.
[2] Estimated.
[3] Revised.

World Production and Trade

The Spanish-Italian quick silver combine, Mercurio Europeo, formed in 1928, was dissolved on January 1, 1950. The combine was formed to market mercury and controlled its price and output throughout the world during its existence. Spain, by herself, is in a position to control the world marketing of mercury because of 'Almaden—the world's greatest mercury mine'. This mine, after more than twenty centuries of exploitation, is still producing ore that is about 5 times as rich as that of its closest competitor. Reserves, grading 5 to 6 per cent mercury, are large enough to maintain the present rate of production of 40,000 to 50,000 flasks per year for the next 200 years.

Spain's nearest competitor has been Italy with two producing mines—the Monte Miata Mine, with a grade of ore of about 1·3 per cent mercury and the Idria Mine with a grade of about 0·6 per cent. United States, Canadian, and Mexican mines have been treating ore that varies from 0·3 to 0·8 per cent mercury, with furnace feed rarely reaching 1 per cent.

Recently world production has been about 150,000 flasks per year, compared with a peak war production in 1942 of about 270,000 flasks. During the war years, when mercury was selling at more than $200 per flask, the increased production was obtained from countries that usually are not producers of mercury. However, since the price returned to normal, low-grade producers have not been able to compete with producers in Spain and Italy.

Uses

In recent years, large quantities of mercury have been used in the initial installations of mercury cells for the electrolytic production of caustic soda and chlorine. These cells were developed in Germany and were introduced in America following World War II. After initial installation, they require only minor amounts of mercury for replenishment.

Electrical apparatus, including the mercury cell, is the principal consumer by far of mercury. The preparation of pharmaceuticals, and the manufacture of industrial and control instruments are the next largest consumers. Large amounts are used in the manufacture of agricultural disinfectants and fungicides, and in the manufacture of anti-fouling compounds, such as oxides, which are used in the coating of ships' hulls. Mercury is also used as a catalyst; in dental preparations; as a fulminate in making munitions and blasting caps; and in amalgamation and general laboratory use.

Prices

E. & M. J. "Metal and Mineral Markets" for December 27th, 1951 quoted mercury at $212 to $215 a flask of 76 pounds, c.i.f. New York. Prices at the end of 1950 quoted from the same source were $138 to $141 a flask. These prices include the $19 a flask United States import duty for foreign-produced mercury. Wide fluctuations in price have occurred frequently and rather rapidly over the years as mercury is a commodity which is open to market speculation.

MOLYBDENUM

Molybdenum is one of the most strategic ferro-alloying metals in the manufacture of steels for defence production purposes and may be substituted, in some uses, for tungsten which is also of great strategic importance. Main suppliers of tungsten for many years have been China, Korea, and Burma, but with the unsettled conditions in those countries, the metal has been in very short supply—placing a greater accent on molybdenum.

Due to its strategic importance, steps were taken in United States to distribute, on an equitable basis, available supplies of molybdenum and to increase mine production of molybdenite. In the third quarter of 1951 the metal came under the allocation of the International Materials Conference.

The molybdenite content of shipments of concentrates in Canada amounted to 191 short tons valued at $228,958 in 1951, compared with 52 short tons valued at $60,059 in 1950. These shipments came from the La Corne mine of Molybdenite Corporation of Canada, Limited in western Quebec and were exported to Europe.

There are no plants in Canada for the conversion of molybdenite concentrates into the various molybdenum addition agents (molybdic oxide, ferromolybdenum, calcium molybdate). Canadian requirements are imported from United States through Climax Molybdenum Company, for which Railway Power and Engineering Corporation is the Canadian distributing agent, and through Molybdenum Corporation of America, New York.

Molybdenite Corporation of Canada. All shipments of molybdenite concentrates in 1951 came from this company's La Corne mine, about 35 miles north of Val d'Or in western Quebec.

The mine was developed to 550 feet with four levels and operated during World War II by Wartime Metals Corporation, a government agency. The mine was closed in December, 1947, at which time company engineers estimated 130,000 tons of ore in reserve which averaged about 0·5 per cent MoS_2. The ore contains some bismuth as bismuth sulphide (Bi_2S_3). During 1949 and the early part of 1950, stockpiled molybdenite concentrates, which carried a high percentage of bismuth, were retreated and about 110 tons of molybdenite concentrate, containing bismuth oxychloride, were shipped to Europe. Early in 1951, mill test runs were made on about 10,000 tons of ore hoisted from underground stopes, and in June underground mining operations were resumed on the 250, 375 and 550-foot levels. By the end of the year, milling rate was about 280 tons a day.

Other Occurrences in Canada

There are many other occurrences of molybdenite in Canada. Of the 300 to 400 known occurrences, practically all are associated with pegmatite dykes, and the molybdenite occurs as "splashes" of flake material within the dyke. However, this type of occurrence seldom "makes ore" as tonnages and continuity are lacking. A deposit consisting of small disseminated flake in gneiss or schist associated with structural fault conditions, would offer more opportunity for successful operation than one of the pegmatitic variety.

The mine of Indian Molybdenum Limited in Preissac township, Quebec, and the Moss mine of Quyon Molybdenite Company Limited, near Quyon, Quebec, were closed in 1944, after being operated during the latter war years. Molybdenite occurs in association with copper at the mine of New Ryan Lake Mines Limited, about 4 miles northwest of Matachewan, Ontario. This company ships copper concentrates to Noranda Mines for smelting and some test work has been done in an effort to make a satisfactory recovery of the molybdenite contained in these concentrates.

Production, Imports and Consumption

—	1951		1950	
	Short Tons	$	Short Tons	$
Production (shipments)				
Contained MoS_2	191	228,958	52	60,059
Imports				
Molybdic Oxide, All from United States	283	553,222	222	283,159
Calcium molybdate, vanadium oxide, and tungsten oxide for the manufacture of steel, All from the United States	31	50,230	76	67,475
Ferromolybdenum [1] From United States	158	255,868	125	183,725
Consumption [2] (Contained Mo)				
Molybdic oxide	196	....	183	....
Ferromolybdenum	127	....	72	....
Calcium molybdate	8	....	4	....
Total	331	....	259	....

[1] From United States Export Statistics.

[2] Compiled by Department of Defence Production.

World Production

During the past few years, the estimated world production of molybdenum contained in ores and concentrates has ranged from 11,000 to 16,000 tons annually, compared to a peak production of about 31,500 tons in 1943. Detailed data on world production, particularly as applied to Russia, are incomplete, but 90 per cent or more of the total production comes from United States with the remaining chief sources of supply being Chile and Mexico.

For many years, Climax Molybdenum Company was the chief producer in United States from ores mined at its Climax property in Colorado. Recovery of molybdenite, as a by-product, from large copper operations in United States has grown steadily, and in 1949 the Kennecott Copper Corporation surpassed Climax as the chief producer of molybdenite. With United States Government aid, steps are being taken to expand operations at the Climax mine so that by 1955 output of concentrates will be nearly doubled. Miami Copper Company also recovers molybdenite as a by-product from its copper operations at Miami, Arizona. The Questa mine of the Molybdenum Corporation of America at Questa, New Mexico, has been operated solely for the recovery of molybdenite since 1919. Chile and Mexico recover molybdenite as a by-product from copper operations.

Uses

About 70 per cent of molybdenum production is consumed in the manufacture of steel. It is added to the steel bath as molybdic oxide, calcium molybdate, or ferromolybdenum, and about 20 per cent is used in grey iron and malleable castings. In general, when an entire open-hearth heat is to be alloyed to not over 0·8 per cent molybdenum the addition is in the form of molybdic oxide or calcium molybdate, whereas ferromolybdenum is used when higher percentages of molybdenum are desired. Molybdenum is also used to intensify the effect of other alloying metals such as nickel, chromium, and vanadium.

Most molybdenum alloy steels contain from 0·15 to 0·5 per cent molybdenum but in some instances percentage is considerably higher. High speed tool steels, for example, contain up to 9 per cent molybdenum. Alloys containing up to 25 per cent molybdenum are being used in increasing amounts in jet propulsion engines, turbo superchargers, and gas turbines. Molybdenum also increases the resistance of stainless steels to chemical action.

The use of molybdenum in various forms in the chemical, electrical, and ceramic industries amounts to about 10 per cent of the total consumption. Molybdenum wire and sheet are used in the incandescent lamp and radio industries, and new alloys suitable for heating-elements, electrical resistances, and contact points contain molybdenum. The salts of molybdenum are used in pigments, in vitreous enamels for coating steels and sheet iron, in welding rod coatings, in lithographing and printing inks, and in many similar applications.

Market Specifications

A marketable molybdenite concentrate must contain not less than 85 per cent molybdenum sulphide (MoS_2) and copper, arsenic, and bismuth must be held to very low limits. In deposits containing large, pure flakes or crystals, a marketable grade can be obtained by hand picking but such operations would be uneconomical. Molybdenite ores usually respond well to flotation concentration.

On December 1, 1950, Climax Molybdenum Company announced the following prices for its products (corresponding prices for 1949 are shown in brackets):

Product	Price per pound contained molybdenum
Molybdenite concentrate	$1.00 (0·90)
Ferromolybdenum	1.32 (1·10)
Molybdic oxide briquettes	1.14 (0·95)
Calcium molybdate	1.15 (0·96)

No price changes were made in 1951. All prices are f.o.b. Langeloth, Pennsylvania, except for the concentrate which is quoted f.o.b. Climax, Colorado.

The import duty into United States was increased on January 1, 1951, from 17½ cents to 35 cents a pound of contained molybdenum in concentrates. Therefore, the present duty on a short ton of 90 per cent MoS_2 concentrate (1,080 pounds of Mo) would be $378 in United States funds.

NICKEL

Production of nickel, all forms, was 275,806,272 pounds, valued at $151,269,994. This was an increase in tonnage of 11·5 per cent and an increase in value of 34·9 per cent, compared with production in 1950. The peak year was 1943 when 288,018,000 pounds were produced. Output, in 1951, came from mines operated by The International Nickel Company of Canada Limited and Falconbridge Nickel Mines Limited in the Sudbury area of Ontario. More than 50 per cent was refined in Canada at International Nickel's plant at Port Colborne, Ontario.

About 95·1 per cent of 1951 production was exported, in the form of matte, oxide, or refined metal; 64·1 per cent went to the United States and, 22·7 per cent to the United Kingdom.

Nickel was placed under allocation by the International Materials Conference in October, 1951, because demand exceeded supply. Great efforts were made by producing countries during 1951 to increase production, to explore promising areas, and to promote the use of substitutes. A new alloy, Incoloy, which contains less nickel, was introduced in United States for substitution in some heat resisting applications.

In Canada, several major developments took place. Sherritt Gordon Mines Limited made progress in the development of its Lynn Lake deposits in Manitoba, and planned to commence production in 1953. International Nickel continued its long-range underground mine development and expansion program and expects to complete it in 1953, to compensate for the loss of ore from its open pit operation. Falconbridge embarked on an extensive program of expansion designed to increase capacity from 25,000,000 pounds to 40,000,000 pounds annually. Exploration of other properties was carried out in the Sudbury area near Ferguson Lake, at Rankin Inlet on the west coast of Hudson Bay, in three areas in Manitoba, and in Rolette township, Quebec.

The mines on the rim of the Sudbury basin in Ontario provide the major part of the world supply of nickel. By-products, resulting from the treatment of the Sudbury nickeliferous pyrrhotite and pentlandite ore, are copper, platinum group metals, gold, silver, and minor qualities of cobalt, selenium, and tellurium, and from the smelter gases, sulphuric acid.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production, all forms	137,903	151,269,994	123,659	112,104,685
Exports, by forms				
Matte or speiss	57,882	60,286,680	53,090	46,423,080
Oxide	944	802,064	1,667	1,308,141
Refined	72,357	75,600,713	66,894	57,568,522
Total	131,183	136,689,457	121,651	105,299,743
Exports, by destination				
United States	88,394	92,415,560	88,543	76,184,024
United Kingdom	31,342	32,323,665	21,645	18,997,379
Norway[1]	11,255	11,744,952	10,888	9,574,232
Brazil	61	66,312	57	50,627
Belgium	28	30,472	235	213,013
Chile	23	23,726	7	6,688
Mexico	21	23,101	38	34,069
Australia	18	18,974	13	12,669
Italy	17	17,470	143	147,663
Other countries	24	25,225	82	79,379
Total	131,183	136,689,457	121,651	105,299,743

[1] For refining and re-export only.

The International Nickel Company of Canada, Limited. Ore mined during 1951 totalled 11,799,320 tons, from which 243,865,030 pounds of nickel, all forms, was produced.

By means of differential flotation at Copper Cliff, the ore is concentrated into two products—a copper concentrate low in nickel and a nickel concentrate low in copper. The copper concentrate is treated in reverberatory furnaces and converters to make blister copper, which is refined in the nearby copper refinery. The nickel concentrate is roasted, then treated in reverberatory furnaces and converters to give a matte which is cooled under controlled conditions so that particles of nickel and copper compounds crystallize separately. The matte is ground and the copper separated from the nickel by flotation. The nickel concentrate is subjected to a sintering operation to produce a dense "nodular" nickel sintered matte, which is shipped to the company's refineries at Port Colborne, Ontario, and Clydach, Wales, and to its plant at Huntington, West Virginia. Some nickel oxide sinter is shipped to market for direct use in the production of nickel alloys and alloy steels. The copper concentrate joins the main copper circuit. Final refining of the precious metals obtained from the copper and nickel refineries is carried out at the company's precious metals refinery in United Kingdom.

Considerable progress was made in the underground development and expansion program of International Nickel during 1951. The program is designed to increase the hoisting capacity to 13,000,000 tons a year by 1953. The company presently draws its ore from 5 underground mines in the Sudbury area—the Frood-Stobie, Creighton, Levack, Garson, and Murray mines—through 13 operating shafts, and from the Frood-Stobie open pit.

Hoisting of ore in the new No. 7 shaft, at Creighton started in July, 1951. The ore for this shaft is obtained from a lower grade orebody which is mined by the large-scale, low-cost, caving method. The new Creighton concentrator, with a capacity of 10,000 tons daily, was completed during 1951. Its concentrate is transported by a 7½-mile pipe line to the reduction plants at Copper Cliff.

The Frood-Stobie open pit operation is expected to be completed by the end of 1953 at which time all production will be from underground. Preparation is proceeding at No. 7 and No. 8 shafts of the Frood-Stobie mine for underground production by means of low-cost, blasthole methods of mining. At the Crean Hill mine, inoperative since 1919, dewatering and reconditioning of the shaft was completed in April, 1951, in preparation for intensive underground exploration.

Reserves of proven ore at the end of 1951 were 253,704,771 tons containing 7,693,122 tons of nickel-copper.

Falconbridge Nickel Mines Limited. Ore production was 1,086,125 tons from the copper-nickel ores of the company's Falconbridge and McKim mines in the Sudbury area. At the Falconbridge property development continued at the main mine and work was commenced on a new shaft to service the orebody at the eastern limits of the property. Sinking reached 245 feet by the end of the year. At the Hardy Mine, which is being developed for a 1,000-ton production rate, shaft sinking reached 1,028 feet.

Ore reserves reported at the end of 1951 were:

—	Tons	% Nickel	% Copper
Developed ore, Falconbridge and McKim Mines	10,102,500	1·64	0·87
Indicated ore, Sudbury District properties	9,014,000	1·85	1·14
Total reserves	19,116,500	1·74	1·00

The company's expansion program was well under way. Milling additions were largely completed but delayed delivery of equipment held up hoist and smelter increases 6 to 8 months beyond original plans.

At Falconbridge, mine ore is separated into direct smelter feed and lower-grade mill feed. After crushing, the latter is concentrated by flotation and the concentrate sintered for blast furnace feed. Copper-nickel matte from the furnaces is blown to shipping grade in Pierce Smith converters, and is then shipped to the company's electrolytic refinery at Kristiansand, Norway, for recovery of the metals. Material shortage delayed progress on refinery changes and additions, but the program was nearing completion at the end of the year.

Sherritt Gordon Mines Limited. Development progressed considerably at the Lynn Lake mine of Sherritt Gordon Mines Limited, in northern Manitoba, during 1951. The "A" shaft was sunk to the 20th level, at a depth of 1,625 feet, and development of the "A" orebody for mining was under way. Crushing is to be carried out on the 16th level. Sinking will start at the El Shaft in June 1952.

Construction of the power plant at Laurie River fell behind schedule somewhat during the year, due to the finding of a fault in the river bed which delayed completion of the downstream cofferdam and hence the dewatering of the river bed. Pouring of concrete for the dam, which is to be 900 feet long and up to 60 feet high, commenced in June, 1951. The power plant will develop 7,000 horsepower, under a 55-foot head.

Forty-four miles of right of way for the transmission line were completed, and considerable progress was made in clearing right of way for the railway line, and in constructing the first 8-10 miles of the railroad grade. During the early part of the winter the moving of equipment and houses from Sherridon to Lynn Lake was begun.

The company expects production to commence in late 1953. Both a nickel and a copper concentrate will be made at the mine; the copper concentrate will be shipped to Flin Flon for smelting; the nickel concentrate will be shipped to Fort Saskatchewan, a small town about 11 miles outside Edmonton, Alberta, for refining by the Forward ammonia-leaching process. Production is planned at 17,000,000 pounds of nickel, 8,000,000 pounds of copper, 300,000 pounds of cobalt, and 70,000 tons of ammonia sulphate yearly.

Ore reserves at the end of 1950 were 14,055,000 tons averaging 1·223 per cent nickel and 0·618 per cent copper. No further attempt was made to increase ore reserves in 1951.

Other Explorations and Developments. East Rim Nickel Mines, Limited and Nickel Offsets Limited continued developing their properties in the Sudbury nickel area.

Rankin Inlet Nickel Mines Limited explored its property near Rankin Inlet on the west shore of Hudson Bay, Northwest Territories, by means of diamond drilling, geophysical surveying, and mapping. International Nickel carried on exploration at its concession in the Ferguson Lake area in Northwest Territories and at its property in the Shebandowan Lake area in Ontario. There was interest and activity, during the year, in other localities, the most important ones being:

Mystery Lake area in Manitoba; Reed Lake area, western Manitoba; Bird River-Maskwa Lake area, eastern Manitoba; and Rolette township, Quebec.

World Production

The Petsamo mine in Russia is the principal single source of nickel outside Canada. In the silicate deposits of New Caledonia a modernization programme was commenced to increase production in 1952. In Cuba, the reopening of the Nicaro property was well advanced. During its period of operation in World War II, Nicaro production totalled 59,131,314 pounds of nickel oxide. Renewed production is expected in 1952 at the rate of 30,000,000 pounds per year. At Rustenberg, South Africa, there is a small steady output of nickel in conjunction with the production of platinum. In United States, the National Lead Company is expected to produce 9,300,000 pounds of nickel, over the next 5 years from nickel-bearing ores in Missouri. During 1951, the following nickel ore deposits were investigated: nickel-bearing sulphides in East Griqualand; high-grade garnierite ore in Niquelandia, State of Goias, Brazil; nickel silicate ore in Celebes Islands; and nickel-bearing ores at Larymna, Greece.

Uses

About 63 per cent of the free world's annual output of nickel is used in United States. In an effort to conserve nickel, a new alloy, Incoloy (35 per cent nickel, 20 per cent chromium, and 45 per cent iron), was introduced, and is being substituted for the usual high nickel-content alloy in many heat-resisting applications.

The following table, published by United States Bureau of Mines, indicates the major uses of nickel in United States:

Uses of Nickel in United States in 1950
(Exclusive of Scrap)

	Pounds of nickel	Per cent
Ferrous:		
Stainless steels	41,822,486	21·2
Other steels	35,554,167	18·0
Cast iron	9,761,622	4·9
Total Ferrous	87,138,275	44·1
Non-ferrous[1]	56,277,952	28·4
High-temperature and electric resistance alloys	11,407,174	5·8
Electroplating		
Anodes	34,847,601	17·6
Solutions	1,481,215	0·8
Catalysts	2,015,234	1·0
Ceramics	604,766	0·3
Others	4,035,482	2·0
Total, all uses	197,807,699	100.0

[1] Comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium alloys, magnesium and aluminum alloys, Monel, Inconel and malleable nickel.

Prices

The world base price of electrolytic nickel at the beginning of 1951 was 50·5 cents a pound. On June 1, it advanced to 56·5 cents a pound f.o.b. Port Colborne, Ontario (in terms of United States dollars, including 1·25 cents United States import duty) and remained at that price for the remainder of 1951. The corresponding Canadian price was 51·75 cents a pound until June 7, when it increased to 58·5 cents a pound. It continued at 58·5 cents a pound for the remainder of the year.

PLATINUM METALS

Production of platinum metals in Canada in 1951 reached a total of 318,388 fine ounces valued at $22,492,622, gains of 16·5 per cent in output and 26·1 per cent in value over 1950.

Canada produces about one-half of the annual world output of these metals, the sources of its output being the nickel-copper ores of the Sudbury district, Ontario. Most of the remainder comes from Russia, Transvaal, Colombia, and East Griqualand. Plans were completed in 1951 to double the capacity of South Africa's major producer of platinum, Rustenburg Platinum Mines Limited, and to refine the matte in South Africa instead of exporting it to London, England for refining.

Canada's output of the platinum metals is obtained as a by-product in the treatment of the nickel-copper ores of The International Nickel Company of Canada Limited, and Falconbridge Nickel Mines Limited, in the Sudbury area, International Nickel being much the larger producer. This company collects the platinum metals, along with gold and silver, in the refinery residues, which are shipped to the company's precious metals plant at Acton for refining. A major portion of the refined metals is exported to United States, partly via Canada, which accounts for the substantial Canadian imports of the metals.

Falconbridge Nickel Mines Limited refines its nickel and copper matte at its plant in Kristiansand, Norway, where the platinum metals are recovered as anode residues.

Small amounts of platinum occur in the nickel-copper sulphide deposits of Sherritt Gordon Mines Limited at Lynn Lake in Manitoba. These deposits are being prepared for production, which is expected to commence late in 1953.

Production[1] *and Trade*

—	1951		1950	
	Fine Ounces	$	Fine Ounces	$
Production				
Platinum	153,483	14,542,515	124,571	10,255,929
Palladium, rhodium, ruthenium, iridium and osmium	164,905	7,950,107	148,741	7,578,144
Total	318,388	22,492,622	273,312	17,834,073
Exports of Platinum metals in concentrates and other forms except scrap.				
To: United Kingdom	....	15,301,795	....	11,549,685
United States	....	14,928,891	....	9,650,977
Other countries	....	109,524	....	126
Total	....	30,340,210	....	21,200,788

—	1951	1950
	$	$
Imports of Platinum metals, all forms		
From: United Kingdom	16,990,357	21,260,917
United States	935,346	573,751
Other countries	779	386
Total	17,926,482	21,835,054

[1] The annual Canadian output of platinum metals, as recorded by the Dominion Bureau of Statistics, does not correspond with the annual amount recovered from ore treated. The reason is that the anode residues containing these metals are gathered at irregular intervals and the accumulations of these residues at the refineries are shipped to the precious metals refinery in Acton near London, England, at similarly irregular intervals.

Consumption

Canadian consumption of the platinum metals is relatively small. The United States is the chief consumer and the table below is included to indicate the relative amounts used in the principal platinum-consuming industries.

Platinum Metals, (fine ounces) Used in the United States in 1950

(from The American Bureau of Metals Statistics)

—	Platinum	Palladium	Other Platinum Metals	Total	Percentage of total amount used
Chemical	114,430	16,673	13,875	144,978	29·2
Electrical	45,229	80,024	3,316	128,569	25·9
Dental and Medical	18,182	18,359	371	36,912	7·4
Jewellery and decorative	127,374	35,293	12,810	175,477	35·4
Miscellaneous	3,783	107	6,119	10,009	2·1
Total	308,998	150,456	36,491	495,945	100·0

Uses

The jewellery and decorative trades still rank first in the consumption of the platinum metals as a group. This outlet, however, has been decreasing in importance during the past decade while the importance of the chemical and electrical industries as outlets has been increasing and at present the metals are of the utmost strategic industrial importance.

It is mainly because of their high catalytic activity, resistance to corrosion, resistance to oxidation at high temperatures, and their resistance to molten oxides and silicates, that the metals are used extensively in the chemical industry. Their chief catalytic use is in the production of nitric and sulphuric acid, which involves the oxidation of a mixture of synthetic ammonia and air by passing it through a red-hot rhodium-platinum alloy gauze. Platinum is used also as a catalyst in making sulphuric acid by the oxidation of sulphur dioxide to sulphur trioxide. Palladium and platinum are excellent catalysts for hydrogenation and dehydrogenation.

The numerous electrical applications of the platinum metals are based chiefly upon their resistance to oxidation, sulphidation, spark erosion, high temperatures, and their good mechanical properties. Platinum, either pure or hardened with percentages of ruthenium or iridium, is employed for contacts in voltage regulators, thermostats and relays, and the 2 alloys are used for contacts in high-tension magnetos, which are of particular importance in aircraft.

Platinum and iridium-platinum are suitable for insoluble anodes in various electroplating processes, including the recovery of metals from waste solution. Platinum rupture discs are used for the safe handling of corrosive liquids and gases. Chemical laboratories use platinum for crucibles, electrodes, and other equipment, and with the use of the micro-chemical technique, many new pieces of platinum equipment have come into production.

Prices

Prices of platinum metal remained steady in 1951 at $90 an ounce troy on wholesale lots, and $93 on sales to consumers f.o.b. New York. The prices of the other metals in the platinum group also remained constant and were as follows: osmium, $200 an ounce troy; iridium, $200 an ounce troy, sponge or powder; palladium, $24 an ounce troy; rhodium, $125 an ounce troy; ruthenium $90 to $93 an ounce troy—all prices f.o.b. New York (E. & M.J. "Metal and Mineral Market" quotations).

SELENIUM AND TELLURIUM

Selenium and tellurium occur in small amounts in many deposits of copper sulphide and gold ores but they are nowhere produced except as a by-product in Canada. The metals are recovered from the anode slimes accumulated in the electrolytic refining of copper. Selenium is relatively of far greater industrial importance than tellurium and in 1951, owing largely to increased demand for war purposes, was generally in short supply.

The two Canadian producers are Canadian Copper Refiners Limited, subsidiary of Noranda Mines Limited, at Montreal East, Quebec, and The International Nickel Company of Canada Limited at Copper Cliff, Ontario. At Montreal East, selenium and tellurium are recovered from the refining of copper anodes made at the Noranda smelter, Noranda, Quebec, from copper sulphide ores of that area and from blister copper produced by Hudson Bay Mining and Smelting Company, Limited, at Flin Flon, Manitoba. Canadian Copper Refiners has the largest selenium and tellurium plant in the world. The selenium and tellurium recovered at the Copper Cliff refinery originate in International Nickel's extensive copper-nickel deposits in the Sudbury area.

Production and Trade

—	1951		1950	
	Pounds	$	Pounds	$
Production, Selenium				
Quebec	165,575	536,463	46,245	111,913
Manitoba and Saskatchewan	134,619	436,165	152,019	367,886
Ontario	82,409	267,005	63,709	154,176
Total	382,603	1,239,633	261,973	633,975
Exports, Selenium and Salts				
To: United States	201,867	799,058	343,787	744,574
United Kingdom	166,956	498,022	187,659	421,886
India	1,000	2,296	2,200	5,408
Hong Kong	440	1,008	....	....
Italy	....	....	3,587	10,528
Other countries	210	861	5,168	12,747
Total	370,473	1,301,245	542,401	1,195,143
Production, Tellurium				
Manitoba and Saskatchewan	2,612	4,806	4,065	7,724
Ontario	6,301	11,594	6,010	11,419
Total	8,913	16,400	10,075	19,143

United States and Canada are the principal producers of both metals; smaller quantities are produced in Australia and in a number of European countries.

About 13,000 pounds of selenium was consumed in Canada in 1951 in the steel, glass, and rubber industries compared with about 9,000 pounds in 1950.

Quantities of tellurium exported from or consumed in Canada are not available.

Uses

A very pure form of selenium is used in increasing amounts in the manufacture of dry plate rectifiers of the type used for charging batteries and for radio, television, and signal equipment.

In glass manufacture selenium is used to impart a red or ruby colour to glass, and in smaller amounts as a de-colourizer. Small additions of selenium to rubber promote resistance to heat, oxidation, and abrasion.

A unique characteristic of selenium is its increase in conductivity on exposure to light. Because of this property, selenium is used to make photoelectric or light-sensitive cells for automatically operating alarms, swinging doors, lamps etc., in television equipment, and in sound film.

Selenium is used also as an antioxident in lubricating oil; for fat hardening; as a catalyst in the petroleum industry; in the hydrogenation of coal; for treating skin diseases; and for making certain inks and insecticides.

Selenium dioxide is used in a number of compounds, particularly accelerators for vulcanizing rubber. Ferroselenium or iron selenide (about 50 per cent selenium) is used as a master alloy for addition to steels to improve machinability. Selenium oxychloride is used as a solvent; sodium selenite in the preparation of an insecticide; sodium selenate in glass manufacture; and sodium sulphoselenite to produce brown tones in photographic toning baths. Cadmium sulphoselenite pigments are used to prepare durable outdoor paint with colours ranging from orange to maroon.

Tellurium is used fairly extensively but in small amounts as a chill inducer to prevent shrinkage in iron castings. It is used to improve the durability of rubber; in zinc refining; in the ceramic and glass industries, where it imparts bluish or brownish tints; in toning silver tints; and when added to copper it improves the machinability of the metal without reducing the electrical conductivity.

Prices

The average Canadian prices for selenium and for tellurium are estimated to have been $3.20 and $1.85 a pound respectively in 1951. In New York, black powdered selenium, 99·5 per cent pure, was quoted at $3 to $3.50 a pound throughout 1951 and tellurium at $1.75 a pound.

SILVER

Canada's production of 23,125,825 ounces of silver in 1951 was slightly less than the amount produced in 1950 but the value of the production $21,865,467, was the highest on record. Most of the output came from the treatment of base metal ores. Exports of silver especially to United States were considerably higher but domestic consumption was slightly lower. The price of silver in Canada increased from 84·81 cents an ounce to 96·5 cents an ounce during the year. It was 90·37 cents an ounce at the end of December. The average price estimated by the Dominion Bureau of Statistics was 94·5 cents an ounce.

Production, Trade, and Consumption

—	1951		1950	
	Fine oz.	$	Fine oz.	$
Production, by provinces				
British Columbia	8,342,414	7,887,752	8,528,107	6,892,416
Ontario	4,520,094	4,273,749	4,408,620	3,563,047
Quebec	4,154,290	3,927,881	4,343,379	3,510,319
Yukon	3,442,788	3,255,156	3,202,779	2,588,486
Saskatchewan	1,454,341	1,375,079	1,207,796	976,141
Manitoba	613,141	579,725	893,099	721,803
Newfoundland	534,519	505,388	575,524	465,138
Other Provinces	64,238	60,737	62,127	50,211
Total	23,125,825	21,865,467	23,221,431	18,767,561
Production, by sources				
Base metal ores	19,433,360	....	19,543,479	....
Gold ores	712,716	....	709,980	....
Silver-cobalt and silver ores	2,959,988	....	2,945,256	....
Placer gold operations	19,761	....	22,716	....
Total	23,125,825	....	23,221,431	....
Imports of silver, unmanufactured				
From: Mexico	1,002,738	802,523	329,090	263,272
United States	27,561	26,616	10,158	8,006
United Kingdom	20,000	19,037	190	241
Other countries	....	....	2,167	2,157
Total	1,050,299	848,176	341,605	273,676

Production, Trade, and Consumption—Concluded

—	1951		1950	
	Fine oz.	$	Fine oz.	$
Imports of silver, manufactures				
From: United Kingdom	....	572,846	....	574,727
United States	....	193,827	....	121,006
Denmark	....	41,765	....	36,083
Germany	....	11,252	....	9,000
Japan	....	9,433	....	14,057
Other countries	....	15,816	....	19,420
Total	....	844,939	....	774,293
Exports of silver in ore and concentrate				
To: United States	2,188,073	1,855,379	3,260,214	2,564,823
Germany	125,158	113,946	29,369	23,436
Belgium	100,057	90,624	204,524	154,340
Total	2,413,288	2,059,949	3,494,107	2,742,599
Exports of silver bullion				
To: United States	14,610,558	13,678,466	8,353,183	6,676,807
Belgium	734,943	709,646	....	....
Morocco	30,775	26,698	....	....
Cuba	5,000	4,848	2,000	1,700
Total	15,381,276	14,419,658	8,355,183	6,678,507
Exports of silver, manufactures				
To: United States	....	165,832	....	252,853
Other countries	....	13,816	....	14,720
Total	....	179,648	....	267,573
Consumption by uses				
Coins	3,483,876	....	3,459,938	....
Sterling	1,702,378	....	2,404,746	....
Anodes	907,431	....	1,166,289	....
Silver nitrate	1,165,589	....	1,025,161	....
All other uses	714,361	....	612,732	....
Total	7,973,635	....	8,668,866	....

British Columbia

The Sullivan lead-zinc mine at Kimberley, owned and operated by The Consolidated Mining and Smelting Company of Canada Limited, is Canada's largest silver producer. The ore is concentrated near the mine and lead and zinc concentrates are shipped to the company's smelter, zinc plant, and refineries at Trail where the silver is recovered from the tank slimes resulting from the electrolytic refining of lead bullion.

The output of 14,417,390 ounces of refined silver was an all time record. Most of the production came from the treatment of custom ores and concentrates which were shipped to Trail by a large number of mining companies in Canada and other countries.

Torbrit Silver Mines Limited near Alice Arm in the Cassiar district was the second largest silver producer in the province. Its output, including bullion and silver in concentrate, was 2,051,190 ounces. The mine was shut down for 44 days owing to a labour strike.

Other important producers were Silver Standard Mines Limited, near Hazelton; Highland Bell Limited, Beaverdell; and Violamac Mines Limited and Western Exploration Company Limited in the Slocan district.

Saskatchewan and Manitoba

Hudson Bay Mining and Smelting Company Limited shipped blister copper containing 1,975,195 ounces of silver produced from its copper-zinc orebody at Flin Flon on the interprovincial boundary. In addition to its own concentrate the company treated copper concentrates containing precious metals from Cuprus Mines Limited and Sherritt Gordon Mines Limited, both located near Flin Flon in Manitoba. Sherritt Gordon ceased operations in September after the exhaustion of its orebody.

Ontario

The revival of production from silver-cobalt ores of the Cobalt and Gowganda districts, which commenced in 1949, continued and the output contained in shipments of high grade ore and silver concentrates was in excess of 4,000,000 ounces. A considerable portion of this silver, however, was not refined during the year and is therefore omitted in the production table.

The principal producers in the Cobalt area were Silver Miller Mines Limited, Cobalt Lode Silver Mines Limited, and Silanco Mining and Refining Company Limited, and in the Gowganda area the producers were Siscoe Metals Limited and Castle-Trethewey Mines Limited. Castle-Trethewey resumed production in May after rehabilitating its mine and 125-ton mill. There had been no production at this property since 1931.

Hellens Mining and Reduction Company Limited constructed a 500-ton cyanide mill at Cobalt to re-treat tailings which had accumulated in Cobalt Lake and other tailings disposal areas from previous milling operations. The plant went into operation early in 1952.

Most of the silver ore and concentrate produced at Cobalt and Gowganda was shipped for refining either to the Deloro Mining and Smelting Company Limited, Deloro, Ontario, or to Noranda Mines Limited, Noranda, Quebec. A small amount of concentrate was exported to firms in the United States.

The International Nickel Company of Canada Limited sold 1,027,921 ounces of silver which it recovered as a by-product from the treatment of its copper-nickel ores in the Sudbury area.

Ontario's 44 gold mines in operation in 1951 produced 433,661 ounces of silver as a by-product. Hollinger Consolidated Gold Mines Limited was the largest producer, with a silver output of 88,776 ounces from its Hollinger and Ross mines.

Quebec

The principal producer was Noranda Mines Limited which recovered 2,483,-200 ounces of silver from the refining of copper anodes at the plant of its subsidiary Copper Refiners Limited at Montreal East. Of this amount 594,100 ounces was estimated to have originated in ore from the company's Horne mine at Noranda, the remainder came from copper concentrates shipped to the Noranda smelter by Waite Amulet Mines Limited, Normetal Mining Corporation Limited, Quemont Mining Corporation Limited and East Sullivan Mines Limited, all in northwestern Quebec, and from silver concentrates shipped from mines in the Cobalt and Gowganda areas of Ontario.

Other silver production in the province came from the zinc-lead ores of New Calumet Mines Limited, Anacon Lead Mines Limited, and Consolidated Candego Mines Limited, and from the zinc-lead-copper ores of Ascot Metals Corporation Limited and Golden Manitou Mines Limited.

Barvue Mines Limited, a subsidiary of Golden Manitou Mines Limited, outlined by drilling, 17,500,000 tons of ore to a depth of 700 feet at its property near Barrault, Abitibi county. The ore was estimated to average 3·26 per cent zinc and 1·13 ounces per ton of silver. Construction of a 4,000-ton concentrator was commenced and production was expected to begin in mid-1952.

Nova Scotia

Mindamar Metals Corporation Limited, constructed a new 500-ton concentrator at its zinc-lead-copper mine in Cape Breton Island. The ore contains about 2 ounces of silver per ton. Production of concentrates commenced in April 1952.

Newfoundland

Buchans Mining Company Limited shipped copper, lead and zinc concentrates containing about 500,000 ounces of silver from its mine located near the centre of the province.

Yukon

United Keno Hill Mines Limited in the Mayo district, produced lead and zinc concentrates and cyanide precipitates containing 3,480,965 ounces of silver. A new cyanide plant to treat flotation tailings was built, and put into operation in December. The company carried out considerable preproduction development at its Onek mine about 4 miles east of the Hector mine which has been the principal source of ore during the last 6 years. It was proposed to build a new 300-ton mill at the Onek property.

A number of other companies carried out exploration or development on claims adjoining the United Keno Hill properties with encouraging results.

Construction of a hydro-electric power plant on the Mayo river was commenced. The completion of this project, expected early in 1953, should provide adequate power at a relatively low cost for development of the Mayo area.

Refineries

Plants for the production of fine silver are listed below:

Quebec. Canadian Copper Refiners Limited, Montreal East.

Ontario. The Royal Canadian Mint, Ottawa, The International Nickel Company of Canada Limited, Copper Cliff, Hollinger Consolidated Gold Mines Limited, Timmins, Deloro Smelting and Refining Company Limited, Deloro.

British Columbia. The Consolidated Mining and Smelting Company of Canada Limited, Trail.

Uses

Much of the world's silver production is minted into coins. Ornaments, jewellery, sterling and silver-plated ware are other uses of long standing.

Increasing amounts of silver are being consumed in the electrical field, especially for low resistance conductors in scientific equipment. Silver alloys are used in various types of solders, bearings, and in dentistry.

Silver nitrate is used chiefly in the preparation of light-sensitive emulsions for use on photographic film.

The metal is commonly sold in bars 99·99 per cent pure, weighing about 1,000 troy ounces, but is also obtainable as rolled sterling sheets, 925 parts silver and 75 parts copper, or as sterling wire and in granulated or powdered form.

Prices

The price of silver in Canada was based on the New York price paid for foreign silver but it fluctuated in relation to the value of the Canadian dollar in terms of United States currency. In January, the Canadian price increased from 84·8 cents an ounce to 94·87 cents an ounce due to a curtailment in sales by the Bank of Mexico. Then followed a gradual increase to a peak of 96·2 cents in May. Thereafter there was a general decline to 90·37 cents at the end of the year. The average price in Canada in 1951 was 94·4 cents an ounce.

TIN

World mine production of tin declined 1·2 per cent in 1951 and the estimated production of tin metal was 166,000 long tons compared with 172,500 long tons for 1950. In spite of continued disorders, Malayan tin production was maintained at almost the same level as in 1950. In the United States restrictions on the use of tin were continued and the establishment of a ceiling price for the purchase of tin, considerably below the existing world price, had an unsettling effect on world tin markets.

Canadian production dropped to 155 long tons valued at $494,073 compared with 356 long tons valued at $828,259 in 1950. The output in 1951 amounted to only a little over 3 per cent of domestic requirements which have risen progressively from 3,628 long tons in 1947 to 4,731 long tons in 1951. The Consolidated Mining and Smelting Company of Canada Limited has been the sole producer since 1941. At the company's Sullivan mine at Kimberley, British Columbia, a portion of the small cassiterite (SnO_2) content of the lead-zinc-silver ore is recovered from the tailings in flotation operations. The concentrate obtained is smelted and refined.

Over 80 per cent of the world production of tin comes from British Malaya, Indonesia, Bolivia, Belgian Congo, Thailand, and Nigeria.

Canadian Occurrences

There are a number of minor occurrences of cassiterite in Canada but no deposits of economic grade have been found. These occurrences are in the New Ross area, Lunenburg county, Nova Scotia; in the Sudbury and Thunder Bay district, Ontario; in the Lac du Bonnet district, southeastern Manitoba; in southern British Columbia; in the Mayo district, Yukon; and in the Yellowknife area, Northwest Territories. The showings occur in pegmatite dykes, except in some creeks in the Yukon where stream tin is found in placer gravels, and in southern British Columbia where cassiterite and stannite ($Cu_2S.\ FeS.\ SnS_2$) are found in association with certain base metal ores.

Uses and Consumption

Over 80 per cent of the tin used in 1951 in Canada was for tin plate and solder. Tin was used also to make babbitt metal, bronze, and type metal; in tinning; as foil and collapsible tubes; and in chemicals. Aluminium has replaced tin to a large extent for foil and collapsible tubes.

The demand for electrolytic tin plate in preference to the standard hot-dipped plate continued to increase and output was almost 50 per cent of the total tin plate production in 1951. Canada now ranks as the third largest producer of tin plate.

Prices

The Canadian price of tin f.o.b. Montreal or Toronto was $1.60 a pound at the beginning of 1951, increasing to $2 in March. The price subsequently decreased and was quoted at $1.15 a pound at the end of the year.

Straits tin was quoted in New York at $1.53 a pound in January. The price rose to its highest point of $1.83 in February. It subsequently declined and was fixed by the Reconstruction Finance Corporation at $1.03 a pound in August, where it remained the rest of the year.

Production, Trade, and Consumption

—	1951		1950	
	Long tons	$	Long tons	$
Production	155	494,073	356	828,259
Imports: tin and allied products				
Blocks, pigs, and bars.				
From: Malaya	3,025	9,092,210	2,312	5,048,945
United States	1,456	5,065,427	501	1,038,173
Belgium	875	2,754,492	1,028	2,276,695
United Kingdom	734	2,513,818	947	1,915,493
Netherlands	40	130,411	29	58,024
Bolivia	5	20,470	....	....
Total	6,135	19,576,828	4,817	10,337,330
Tin Plate				
From: United States	773	124,021	1,090	194,287
United Kingdom	758	235,226	397	95,223
Total	1,531	359,247	1,487	289,510
	Pounds		Pounds	
Tin Foil				
From: United States	8,192	13,098	9,065	11,130
United Kingdom	113	125	25,478	5,742
Total	8,305	13,223	34,543	16,872
Babbitt Metal				
From: United States	21,500	19,017	32,400	6,343
United Kingdom	8,500	4,946	12,900	9,180
Germany	....	....	56,000	5,674
Netherlands	....	....	32,000	18,461
Total	30,000	23,963	133,300	39,658
	Long tons		Long tons	
Consumption				
Tin plate and tinning	2,678	....	2,440	....
Solder	1,203	....	1,427	....
Babbitt metal	421	....	317	....
Brass and bronze	310	....	159	....
Tin foil and collapsible tubes	32	....	41	....
Miscellaneous	87	....	142	....
Total	4,731	....	4,526	....

TITANIUM

Shipments of ilmenite from the Allard Lake deposits in Quebec in 1951 to the plant at Sorel, Quebec, totalled 372,112 short tons compared with 100,717 short tons in 1950, the first year of production. Shipments of titanium dioxide concentrate (electric smelter slag) from Sorel totalled 8,040 gross tons, having a titanium dioxide (TiO_2) content of 5,781 tons. There continued to be a small production of ilmenite from the St. Urbain area in Quebec. Titanium metal powder, made directly from imported refined titanium dioxide, continued to be produced on a pilot plant scale by Dominion Magnesium Limited at Haley, near Renfrew, Ontario.

Titanium is fourth in abundance among the earth's metals, but it is usually too sparsely disseminated for commercial extraction. The principal ores are ilmenite and rutile. The latter contains up to 60 per cent titanium, but ilmenite which contains up to 31·6 per cent is cheaper and more plentiful. No rutile is mined in Canada.

Quebec Iron and Titanium Corporation. This company has in the Allard Lake area what are probably the largest known deposits of ilmenite in the world, with about 150,000,000 tons of ore indicated by drilling, the average grade being 35 per cent TiO_2 and 40 per cent iron. The most important orebody is the Main orebody at Lac Tio where the estimated reserves exceed 125,000,000 tons of ilmenite. The Cliff deposit, on the western shore of Lac Tio, contains approximately 12,000,000 tons of ore of the same quality as that in the Main orebody. There are also a number of smaller deposits. One of these is at Grader Lake, 2 miles south of Lac Tio, its known reserves being 200,000 tons. The Allard Lake ilmenite deposits are high-temperature, late magnatic injections into the surrounding anorthosite rocks.

Mining operations at Allard Lake are carried out by open-cut methods. The ore is shipped 27 miles by rail to Havre St. Pierre and then by boat to Sorel on the St. Lawrence River.

At Sorel, Quebec Iron and Titanium Corporation has completed 1 of 5 contemplated furnaces and 2 others were nearing completion at the end of 1951. The rated daily capacity of the plant, when completed, will be 500 tons of low carbon iron and 700 tons of titanium dioxide slag containing 70 per cent TiO_2, to be obtained from the treatment of 1,500 tons of ore a day. The iron from the completed furnace is desulphurized, cast into ingots, and sold as a high grade metallic iron. The TiO_2 slag is cast into slag cakes, cooled, and later crushed to minus ½ inch size and sold f.o.b. Sorel.

The Sorel installation was originally built to supply the pigment industry with TiO_2 concentrates, but production is now of considerable interest to the titanium metal industry also, as a potential source of supply of raw material.

Other Occurrences of Ilmenite in Canada

Ilmenite was discovered in the St. Urbain area of Charlevoix county, Quebec in 1666 and there has been a small production from the various properties since 1908. During World War II production reached substantial proportions to help meet the demand created by the interruption of shipments from India. The deposits occur in a body of anorthosite which is roughly elliptical in outcrop with dimensions 20 miles (north-south) by 9 miles. The principal deposits in the area are the Furnace, Bignell, General Electric, West and East Coulombe, and the Joseph Bouchard (or Glen). The General Electric deposit is notable for its content of rutile. It has furnished most of the ilmenite shipped from St. Urbain. During 1951, St. Lawrence Iron and Titanium Mines Limited actively investigated the Furnace and Coulombe deposits.

Some ilmenite was mined in past years from the Ivry deposit in Beresford township, Quebec. Ilmenite and magnetite occur nearby in the Desgrosbois deposit. In Quebec, titaniferous magnetite occurs near St. Charles Village, Bourget township; near the Bay of Seven Islands; in the Natashquan iron sands; and in the Chibougamou district. It occurs also at Mine Centre, Ontario; near Burmis, Alberta; and near St. Georges, Newfoundland.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production				
Ilmenite				
From Allard Lake area [1]	372,112	....	100,717	....
From St. Urbain area	1,674	9,790	1,253	7,706
Total	373,786	....	101,970	....
Titanium dioxide concentrate				
From Allard Lake ilmenite smelted at Sorel	19,643	....	2,248	....
Titanium dioxide content [2]	14,123	738,577	1,596	149,565
Shipments				
Domestic				
Ilmenite from St. Urbain area	50	....	....	....
Exports				
Ilmenite from St. Urbain area	1,624	....	1,253	....
Titanium dioxide, content of the slag (from Allard Lake ilmenite smelted at Sorel)	5,781	302,304	....	....
Imports [3] of titanium dioxide and of pigments containing not less than 14 per cent titanium.				
From: United States	26,052	6,838,500	23,987	6,117,925
United Kingdom	3,596	1,623,779	3,138	935,706
Total	29,648	8,462,279	27,125	7,053,631

	1950	1949
	Short tons	Short tons
Consumption		
Paint industry:		
Titanium dioxide	7,946	5,894
Extended titanium dioxide pigments	13,796	10,832
Polishes and dressings industry:		
Titanium dioxide	127	124
Pulp and paper industry:		
Titanium dioxide	797	576
Rubber goods industry:		
Titanium dioxide	540	359
Linoleum industry:		
Titanium dioxide	1,328	....
Primary iron and steel industry:		
Ferrotitanium	143	142

[1] Allard Lake ilmenite is not evaluated before smelting at Sorel.

[2] The evaluation is placed upon the titanium dioxide content of the titanium dioxide concentrate (electric smelter slag).

[3] Includes a comparatively small amount of antimony pigments.

Uses

Titanium oxide (titanium white), the most important compound of titanium, has wide use as a pigment in paints and in the manufacture of ceramics, cosmetics, food products, paper, and rayon. A small amount of titanium is used in the iron and steel industry as ferrotitanium and ferrocarbontitanium, to purify and strengthen steel. The production of titanium metal from titanium dioxide is increasing rapidly. It should be noted, however, that this production is mainly for defence purposes and that the widespread use of titanium metal awaits the development of a cheap method of extracting it from its ores.

Titanium oxide, in the natural form of rutile, is used commonly as a coating for welding rods. Crystals of titanium oxide, made artificially, have a very high index of refraction and are being used for certain purposes in place of diamonds. Small amounts of titanium tetrachloride are used for purifying alloys of aluminium. Titanium carbide is the hard ingredient of the "carbide" high-speed cutting steels, usually mixed with tungsten carbide.

Because of its high strength-weight ratio, titanium metal has a special application in supersonic aircraft and about three-quarters of the metal being made is going into air compressors for jet aircraft engines. It is used also in alloys of stainless and heat-resisting steels, where the size of the product is small. Certain alloys with cobalt and nickel are used as filaments in vacuum tubes.

The metal has many desirable qualities. It melts at about 1800°C, can be rolled, drawn or forged, and has a specific gravity of 4·5 (iron is 7·8). It has excellent corrosion resistance, except to certain acids. 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 p.s.i. However, the task of extracting the metal from the ore is made difficult by the tendency of molten titanium to devour every substance it touches. If it is allowed to absorb air, the metal becomes impure and brittle. It will quickly dissolve refractory brick, normally used to line metal-smelting furnaces. Its melting point is higher than that of the materials often used in its melting pots.

Despite these smelting problems, new production facilities at Henderson, Nevada, are expected to increase greatly world production of titanium metal in 1952.

Prices

Prices in the United States at the end of 1951 were as follows:

E. & M.J., "Metal and Mineral Markets":

ilmenite—per gross ton, 56 to 59 per cent TiO_2, f.o.b. Atlantic seaboard, $16 to $18 nominal.

rutile—94 per cent TiO_2 minimum, 5¼ to 6¼ cents per pound, nominal.

titanium metal—96 to 98 per cent, $5 per pound.

TUNGSTEN

Tungsten is of the utmost strategic importance as a ferro alloy element in the manufacture of steels and cutting tools for defence production purposes. With the loss to the Western world of the main sources of tungsten from China, Korea, and Burma, due to unsettled conditions in those countries, alternate sources of supply were sought. Steps were taken by the National Production Authority (N.P.A.) in United States to increase production from existing sources and to find additional sources by setting floor and ceiling prices on tungsten. On April 5, 1951, it was announced by the United States Government that domestic scheelite ores, with a minimum content of 60 per cent WO_3 would be purchased at $65 a short ton unit f.o.b. mine. Available world supplies of tungsten were brought under allocation by the International Materials Conference in the 3rd quarter of 1951.

In Canada, shipments of scheelite and wolframite amounted to only 1·4 tons WO_3 content valued at $7,098, compared with 142 tons WO_3 content valued at $160,343 in 1950. Most of the latter consisted of shipments from stock at the Emerald property near Salmo, British Columbia. Imports of scheelite from Brazil were 28 tons in both 1950 and 1951. Imports of ferrotungsten from United States, Japan, and Portugal were 504 short tons valued at $2,609,399 in 1951 compared with 107 tons valued at $282,966 in 1950.

During 1951, Canadian Explorations Limited discovered a large tungsten orebody (Dodger) about ½-mile east of the Emerald property near Salmo, British Columbia and made plans to purchase and increase the capacity of the new 250-ton mill completed by the Federal Government during the year. Western Uranium Cobalt Mines Limited leased the Red Rose mine south of Hazelton, rebuilt the mill, and made small shipments of scheelite concentrates. Black Diamond Tungsten Limited was formed in 1951 to prospect and explore wolframite zones discovered near Atlin, British Columbia, in 1950. In Ontario, Hollinger Consolidated Gold Mines announced plans to recover scheelite from underground operations. Several other companies acquired, examined, and did some exploratory work on numerous tungsten occurrences throughout Canada.

There are no plants in Canada for the conversion of tungsten concentrates to ferrotungsten, the usual addition agent. However, high-grade scheelite concentrates may be added directly to the steel bath because of the comparative ease with which calcium enters the slag. Atlas Steels Limited, Welland, Ontario, purchases scheelite concentrates carrying a minimum of 60 per cent WO_3 (70 per cent preferred) for the manufacture of alloy steels. Limits on the content of impurities such as of sulphur and phosphorus are quite low and frequently concentrates must be chemically treated to meet rigid specifications.

Kennametal Incorporated, Latrobe, Pennsylvania, announced plans to build an ore dressing and electric smelting works at Port Coquitlam, British Columbia to manufacture tungsten carbide. The raw material (tungsten ores and concentrates) for this plant will be obtained from sources in British Columbia. The parent company operates a plant at Latrobe and has distributed its products through a Canadian subsidiary, Kennametal of Canada Limited.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Shipments—Scheelite (gross weight)	1·3	......	943	......
Wolframite (gross weight)	0·7	......	......	......
Total WO_3 Content	1·4	7,098	142[1]	160,343
Imports—Scheelite[2]				
From: Brazil	28	150,493	28	49,942[4]
Ferrotungsten[3]				
From: United States	411	1,978,987	46	150,574
Japan	76	492,143	50	111,847
Portugal	17	138,269	......	......
United Kingdom	......	......	11	20,545
Total	504	2,609,399	107	282,966
Consumption in the primary iron and steel industry:				
Ferrotungsten[3]	......	......	117	302,872
Scheelite[2]	......	......	84	116,411

[1] Does not represent year's production, most of it being shipment from stock.
[2] Contains approximately 60 to 65 per cent WO_3.
[3] Contains approximately 79 per cent tungsten.
[4] Revised.

Canadian Exploration Limited. The scheelite orebody at the Emerald mine in southern British Columbia was discovered in 1942 and the Federal Government, through Wartime Metals Corporation, built a mill and produced about 400 tons of tungsten concentrate to the autumn of 1944. The mine and plant were sold to Canadian Exploration Limited, a subsidiary of Placer Development Limited, who operated the property during most of 1947 and 1948. In the latter year, when the price of tungsten concentrates dropped below $20 a short ton unit, mining and milling operations ceased and the mill was changed over to treat lead-zinc ores from the near-by Jersey mine. The Federal Government, late in 1950, purchased the remaining tungsten ore reserves in the Emerald mine and announced a 250-ton per day mill would be built to treat the ore.

In 1951, Canadian Exploration Limited discovered a large tungsten orebody (Dodger) about ½-mile east of the Emerald deposit. The Dodger orebody is reported to contain about 1,000,000 tons of ore of about the same grade as that of the Emerald reserves. The company made plans to purchase the new mill from the Federal Government and to increase its capacity to 750 tons a day. The mill began operations on November 27, 1951, and by the end of the year was treating about 210 tons of tungsten ore daily from the Emerald mine. Early in 1952, it is expected, about 225 tons of ore a day will be coming from the Dodger orebody. When the full production rate of 750 tons a day is reached the operation will become the largest single source of tungsten in the free world.

The original Emerald orebody occurs in a limestone-dolomite trough which is underlain by granite. This type of occurrence is typical of scheelite which is usually found in lime rocks close to a granite contact. The orebodies occur as lenses near the base of the plunging trough and are spread out over a considerable distance somewhat like beads on a string. Paralleling this formation and slightly to the east several flat lying beds of lead-zinc ore, which extend for almost a mile in length, are found. These bodies comprise the workings of the Jersey mine. Underlying the lead zinc orebody is the company's new tungsten orebody (Dodger). Scheelite is found in association with quartz and pyrrhotite within the ore zones. Minor pyrite and some molybdenite are also present.

Other Occurences

Black Diamond Tungsten Limited, a subsidiary of Transcontinental Resources Limited, was formed in 1951 to explore and develop wolframite occurrences about 12 miles east of Atlin, British Columbia near the Yukon boundary. To the end of 1951, prospecting and field work on the company's holdings exposed 6 wolframite-bearing zones. Underground exploration by adit and drifting will be undertaken on the most promising zone, No. 5, in 1952. Company estimates indicate 281 tons of ore per vertical foot averaging slightly under 1 per cent WO_3 in the combined Nos. 1 and 5 zones.

Western Uranium Cobalt Mines Limited leased, from Consolidated Mining and Smelting Company, the Red Rose Mine south of Hazelton, British Columbia, which was operated during World War II. At the time of closing, estimated ore reserves amounted to about 15,000 tons averaging 1 per cent WO_3. The 100-ton a day mill was rebuilt in 1951 and small shipments of scheelite concentrate were made overseas.

Many occurrences of tungsten, mainly as scheelite, are described in "Tungsten Deposits of British Columbia" by John S. Stevenson, published by the British Columbia Department of Mines in 1943.

Hollinger Consolidated Gold Mines announced plans to recover scheelite from underground operations as it did in World War II during the previous period of tungsten recovery. The Hollinger mill treated about 53,000 tons of scheelite from which 266,000 pounds of tungsten was recovered. Scheelite occurs, in the Hollinger mine, in association with gold-bearing zones and in some places occurs in sufficient quantity for the economic recovery of tungsten. Scheelite occurs in most of the producing gold mines in Ontario and Quebec but is seldom found in sufficient quantity to merit its extraction except in times of emergency. During World War II Hollinger treated ores from several nearby mines for tungsten recovery.

Other Developments

Several mining firms in 1951 acquired, examined and did some exploratory and development work on numerous tungsten occurrences in Canada.

Tungsten Corporation of Canada Limited acquired the scheelite property on Outpost Island of Great Slave Lake from Marwood Mines Limited, which was formerly owned and operated by Reno Gold Mines Limited.

Scheelaur Mines Limited was formed to examine and develop occurrences of scheelite near Red Lake, Ontario.

Carnegie Mines Limited acquired claims in the Burnt Hill area of New Brunswick on which occurrences of wolframite were found.

Bordulac Mines Limited reopened its gold property in Western Quebec in Dasserat Township about 20 miles west of Noranda. Scheelite is found in association with the gold quartz veins of the mine. The shaft was dewatered in 1951 and drifting underground extended known vein occurrences.

Several occurrences of wolframite in the Yukon were examined. The Yukon Tungsten Corporation acquired ground along the Alaska highway about 5 miles north of mile 701. Another property on the Stikine River about 40 miles south of Telegraph Creek was prospected.

Scheelite occurs in the Herb Lake area, Central Manitoba. One group of claims, formerly owned by Snow Lake Gold Mines Limited, was developed further.

Ores of Tungsten

Wolframite (FeMn) WO_4

Wolframite, the principal ore of tungsten, is a dark brown to black, heavy mineral containing 76·4 per cent WO_3 (tungstic oxide) when pure. It has a black to dark reddish-brown streak and occurs frequently in crystals somewhat tabular in shape, or crystal aggregates. The most extensive deposits are in the Nanling belt in Krangsei, Kwantung, and Hunan provinces in China, formerly a source of over 60 per cent of the annual world output. Large deposits of wolframite also occur in Korea and Burma.

Scheelite ($CaWO_4$)

Scheelite is a heavy, fairly soft, usually buff but sometimes white mineral with a dull lustre, containing 80·6 per cent WO_3 when pure. It is the common ore mineral of tungsten in Canada but most of the numerous Canadian occurrences are small. Scheelite is commonly associated with quartz and frequently occurs in patches in gold-bearing quartz veins in Canadian gold mines. It can be readily detected in the dark by its brilliant, pale bluish-white fluorescence under ultra violet light and purple filter. When scheelite occurs in quartz it can be identified in the field by its colour (usually buff), heavy weight, and its relative softness (it can be scratched with a knife). Iron stained white rocks, particularly quartz, might be mistaken for scheelite but quartz will scratch glass while scheelite will not. Brownish-buff ankerite (iron carbonate) and buff calcite might be mistaken for scheelite but they both effervesce when pulverized and treated with hydrochloric acid. Massive, white scheelite closely resembles barite which is also a heavy, relatively soft mineral.

World Production

Annual world production of tungsten declined from the wartime peak in 1943 of about 61,000 tons of concentrate containing 60 per cent WO_3 to a low of about 19,000 tons in 1946 when prices dropped to below $18 a short ton unit of WO_3.

In normal times China produced about 60 per cent of the world's requirements with Korea and Burma providing an additional 15 to 20 per cent. The loss of Chinese and Korean production as a result of the war in Korea, and that of Burma due to unsettled conditions in that country has forced consumers to look elsewhere for supplies of this strategic metal. Increased production, in recent years, has come from United States domestic sources, Tasmania, Portugal, Bolivia, and Brazil. Many other countries supply minor amounts of tungsten concentrates. Canada will be among the major suppliers of tungsten when the Emerald and Dodger orebodies, near Salmo, British Columbia, are in full production at a rate of 750 to 1,000 tons a day.

Production of tungsten ores in United States declined from about 11,000 tons in 1943 to 4,000 tons in 1946 but has been increasing since then at a rapid rate. Many new properties in the western states were opened in 1951 and the life of many existing producers was lengthened by new ore disclosures. Most of the production is obtained from treatment of scheelite ores. Climax Molybdenum recovers wolframite as a by-product from its molybdenite mill tailings at Climax, Colorado.

Uses

Tungsten, in its major uses, has no satisfactory substitute, and above all other ferro-alloying metals, is indispensable in its military applications. Its chief use is that of an alloy ingredient in the manufacture of high-speed tool steels which are necessary in the production of precision military equipment. It is the hardest metal used by industry and its ability to retain this hardness even at high heat makes it invaluable. Tungsten-steel tools maintain a sharp cutting edge at working temperatures far above those that ruin carbon-steel tools.

The use of tungsten in alloys in gas turbine and jet propulsion applications is due to its ability to maintain great strength at high operating temperatures as well as to its resistance to corrosion. Tungsten carbide cores are used in the manufacture of armor-piercing shells, particularly anti-tank projectiles, as it maintains its hardness even at a bright-red heat which is far above the softening temperature of high-speed steel.

The pure metal is used in contact points for electrical circuits in many devices such as telephones, thermostats and aeroplane magnetos. It enters into the manufacture of armor plate, propeller blades, and armor for submarine cables. Its compounds are used to flameproof and waterproof materials. Tungstic acid is one of the ingredients used in processing toluol to TNT.

Stellite, a non-ferrous alloy, contains 10 to 15 per cent tungsten with higher percentages of chromium and cobalt and is manufactured in Canada by Deloro Smelting and Refining Company Limited at Deloro, Ontario. The rapid expansion in the manufacture of tungsten carbide for drill bits used in mining and excavation work requires increasingly large amounts of tungsten.

Prices

Prices of WO_3 a short ton unit have varied from a low of about $8 to nearly $70 during the 1910-1950 period. The United States, in 1951, established floor and ceiling prices of $60 and $65 a short ton unit of WO_3 respectively on domestic ores for a guaranteed period of time. When this occurred, world prices stabilized at approximately the same figures.

In buying and selling tungsten ores (scheelite or wolframite) the price is always quoted as so many dollars a short ton unit of WO_3. A unit as applied to tungsten ores, is 1 per cent of a ton of contained tungsten tri-oxide (WO_3). Thus, a short ton unit is 20 pounds of WO_3 or 15·86 pounds of tungsten (W). Therefore a concentrate containing 70 per cent WO_3 would contain 70 units and would bring, at $65 a short ton unit, 70 x $65=$4,550. Similarly, an ore containing 0·9 per cent WO_3, assuming 80 per cent extraction, would be worth 0·9 x ·80 x $65=$46.80 a ton.

To date the only purchaser of scheelite concentrates in Canada has been Atlas Steels Limited, Welland, Ontario. No market for wolframite has existed in this country but it is likely that Kennametal Incorporated will be purchasers of both scheelite and wolframite concentrates for their proposed electric smelting works to be built at Port Coquitlam, British Columbia.

ZINC

There was an increase of 27,885 tons in the production of zinc mainly due to a larger output of refined zinc by The Consolidated Mining and Smelting Company of Canada Limited at Trail, British Columbia, and by Hudson Bay Mining and Smelting Company Limited at Flin Flon, Manitoba. The production of zinc concentrate in Newfoundland and Quebec was about the same as in 1950. The value of the output, 135,762,643 was a record high.

Most of the concentrates produced in western Canada are refined in the zinc plants at Trail and Flin Flon, while those produced in eastern Canada are exported to United States or Europe. The Canadian price of ordinary electrolytic zinc increased from 19·33 cents a pound to 21·35 cents during 1951.

British Columbia

The Consolidated Mining and Smelting Company's Sullivan lead-zinc-silver mine at Kimberley is Canada's largest producer of zinc, milling about 8,000 tons of ore a day. Major developments at the Sullivan mine included the downward extension of the belt conveyor system, which now covers a vertical range of over 1,000 feet, and the removal of a sizeable amount of gravel overburden in preparation for open pit mining which commenced in December. Zinc and lead concentrates, produced at Kimberley, were shipped to the company's smelter and zinc plant at Trail where the metals were recovered. Production was 163,894 tons of refined zinc which was the company's largest output since 1942. An extension to the zinc plant, to provide for an additional output of 66 tons a day, was expected to be completed in 1952. In addition to concentrates from the Sullivan mine the company purchased ores and concentrates from about 20 mining companies in British Columbia and from several in United States and other countries for treatment at its Trail plants.

The Consolidated Mining and Smelting Company prepared its Bluebell lead-zinc mine on Kootenay Lake and its H.B. zinc-lead mine near Salmo for production in 1952. Construction of a 500-ton concentrator was commenced at the Bluebell and a 1,000-ton concentrator at the H.B. In the north coast area the company brought its neighbouring Tulsequah Chief and Big Bull zinc-lead properties into production in mid-1951 as a combined operation at a rate of 250 tons a day.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production, all forms[1]				
British Columbia (inc. Yukon)	171,595	68,294,875	147,926	46,300,744
Quebec	86,363	34,372,439	85,819	26,861,397
Manitoba and Saskatchewan	54,685	21,764,530	48,943	15,319,357
Newfoundland	28,469	11,330,799	30,539	9,558,647
Total	341,112*	135,762,643	313,227*	98,040,145
*Includes slab zinc	218,578	....	204,367	....
Exports of refined metal				
To: United States	84,281	30,925,225	108,117	29,767,815
United Kingdom	55,415	20,432,293	35,823	9,901,647
India	1,949	1,224,559	1,853	648,006
France	1,626	941,978	....	....
Switzerland	1,384	879,635	....	....
Other countries	1,477	1,020,079	1,087	276,201
Total	146,132	55,423,769	146,880	40,593,669
Exports in Ore				
To: United States	94,530	14,087,417	76,484	8,838,982
United Kingdom	31,978	7,376,617	16,421	2,627,436
Belgium	9,679	2,185,199	24,216	3,652,837
Norway	8,992	1,844,964	....	....
Japan	3,553	513,137	80	17,168
Other countries	5,861	1,145,761	12,360	2,263,255
Total	154,593	27,153,095	129,561	17,399,678
Exports of scrap, dross and ashes				
To: Japan	1,998	597,956	39	13,843
Belgium	1,785	325,805	3,204	313,287
Netherlands	358	76,030	162	20,479
United States	209	30,362	1,455	310,955
Other countries	160	61,817	225	58,046
Total	4,510	1,091,970	5,085	716,610
Exports of zinc manufactures				
To: United States	....	543,326	....	122,236
Other countries	....	237,849	....	60,924
Total	....	781,175	....	183,160
Imports of zinc and zinc products				
From: United States	....	5,303,961	....	4,134,332
United Kingdom	....	333,451	....	619,426
Other countries	....	274,285	....	110,256
Total	....	5,911,697	....	4,864,014
Consumption				
Galvanizing	24,314	....	23,711	....
Zinc oxides and dust	9,796	....	9,692	....
Brass and copper products	10,812	....	6,523	....
Die-casting alloys	2,856	....	4,025	....
Dry batteries	2,783	....	2,315	....
Secondary smelters[3]	9,563	....	7,660	....
Miscellaneous	899	....	444	....
Total	61,023	....	54,370	....

[1] Includes zinc estimated to be recoverable from concentrate exported.
[2] Includes zinc recovered from imported concentrates.
[3] Most of the virgin zinc consumed in secondary smelting plants goes into alloys which are subsequently diecast, and into brass. They are not included in brass and diecasting alloys above, the amounts not being available separately.

Among other producers of zinc concentrate in British Columbia were the following:

Company	Mine Location
Reeves MacDonald Mines Limited	Salmo district
Britannia Mining and Smelting Company Limited	Howe Sound
Canadian Exploration Limited	Salmo district
Sheep Creek Gold Mines Limited, (Zincton)	Slocan district
Sheep Creek Gold Mines Limited, (Paradise)	Near Invermere
Base Metals Mining Corporation Limited (Field)	Field
Base Metals Mining Corporation Limited (Cork Province)	Slocan district
Base Metals Mining Corporation Limited (Vancouver Island)	Near Duncan
Silbak Premier Mines Limited	Portland Canal district
Western Exploration Company Limited	Slocan district
Silver Standard Mines Limited	Near Hazelton
Kootenay Belle Gold Mines Limited	Slocan district

Base Metals Mining Corporation Limited completed the installation of a 100-ton flotation mill at its Cork Province mine from which it commenced the production of zinc and lead concentrates in April. The company's subsidiary, Vancouver Island Base Metals Limited, reopened the former Twin "J" mine, north of Victoria, and commenced milling in July at 150 tons a day to produce zinc and copper concentrates.

Western Exploration Company Limited installed a sink-float plant at its 225-ton concentrator at Silverton.

Kootenay Belle Gold Mines Limited acquired 6 former lead-zinc properties near Sandon where it installed a sink-float plant. The ore is milled at the company's 300-ton mill at Retallack together with ore from the neighbouring Whitewater mine.

Yale Lead and Zinc Mines Limited constructed a 250-ton sink-float plant and a 190-ton concentrator at its property near Ainsworth. Production of lead and zinc concentrates commenced in April.

Western Mines Limited acquired the Kootenay Florence zinc-lead mine at Ainsworth and initiated a development program designed to increase production at this property.

Estella Mines Limited commenced producing zinc and lead concentrates in a new 200-ton mill at Wasa in the East Kootenay district.

Emerald Glacier Mines Limited near Tahtsa Lake in the west central section of the province commenced shipping high-grade lead-zinc ore.

Mastadon Zinc Mines Limited (a subsidiary of Golden Manitou Mines Limited) made preparations to commence production of zinc and lead concentrates at its property in the Big Bend area near Revelstoke in 1952.

Manitoba and Saskatchewan

Hudson Bay Mining and Smelting Company Limited milled an average of 5,000 tons of ore a day from its copper-zinc mine at Flin Flon on the interprovincial boundary. Production, at the company's electrolytic zinc plant, was 54,684 tons of slab zinc from zinc concentrates produced at Flin Flon and concentrates purchased from Cuprus Mines Limited and Sherritt Gordon Mines Limited. The construction of a zinc fuming plant and a zinc oxide treatment plant was completed and the plants put into operation. These installations are designed to increase zinc recovery by the fuming of zinc-bearing slag from the copper smelter, the zinc content of which is increased by the addition of zinc plant residue (25 per cent zinc). The zinc oxide fume is then treated in the oxide treatment plant to produce slab zinc.

Underground development of the company's North Star mine 12 miles east of Flin Flon was commenced.

Cuprus Mines Limited, a subsidiary of Hudson Bay Mining and Smelting Company, 13 miles southeast of Flin Flon, produced 9,318 tons of zinc concentrates averaging 44·6 per cent zinc.

Sherritt Gordon Mines Limited at Sherridon, 40 miles northeast of Flin Flon, ceased operations in September upon exhaustion of the orebody. The company had been a continuous producer of copper since 1937 and of zinc concentrate since 1942. Removal of plant and equipment to the company's copper-nickel property at Lynn Lake, 147 miles north of Sherridon, was commenced.

Ontario

Matarrow Mines Limited near Matachewan, passed operational control to the neighbouring Matachewan Consolidated Gold Mines Limited. Considerable preproduction development was done and plans were formulated to produce lead and zinc concentrates in the Matachewan Consolidated mill in 1952.

Penn-Cobalt Silver Mines Limited reopened the Foster mine near Cobalt in which it outlined by drilling 300,000 tons of ore averaging 3 per cent zinc. The erection of a 300-ton flotation mill was under consideration.

Ontario Pyrites Company Limited made plans to reopen the Treadwell Yukon and Sudbury Basin properties near Sudbury at which a large tonnage of copper-lead-zinc ore has been indicated by diamond drilling.

Quebec

Zinc concentrates were produced together with concentrates of either copper or lead by the following 10 companies:

Company	Mine Location
Waite Amulet Mines Limited	Near Noranda
Quemont Mining Corporation Limited	Noranda
Harrison Drilling and Exploration Company, Ltd.	Noranda
Normetal Mining Corporation Limited	Normetal
East Sullivan Mines Limited	Near Val d'Or
Golden Manitou Mines Limited	Near Val d'Or
New Calumet Mines Limited	Pontiac County
Anacon Lead Mines Limited	Portneuf County
Ascot Metals Corporation Limited	Sherbrooke
Consolidated Candego Mines Limited	North Gaspe County

Waite Amulet, together with its adjoining subsidiary Amulet Dufault Mines Limited, produced concentrates containing 14,292 tons of zinc from the milling of 387,754 tons of ore. Its new East Waite shaft was completed to a depth of about 2,000 feet and considerable development of the East Waite orebody was carried out. Exploration below the "C" shaft workings and the lower "A" orebody substantially increased reserves.

Normetal milled 359,266 tons and concentrates containing 21,354 tons of zinc were produced. Three new levels were developed in the main ore zone, the deepest at 4,160 feet.

Quemont produced 12,362 tons of zinc in concentrate from the milling of 772,781 tons of ore. Stoping on three levels was commenced in the East ore zone.

Harrison Drilling and Exploration Company leased the Eldona mine and commenced production of zinc concentrate from a small zinc orebody on that property. The ore was milled in the former McWatters Gold Mines' mill.

East Sullivan Mines Limited milled 904,762 tons of ore, producing concentrates containing 13,280 tons of zinc. A new high-grade zinc orebody was discovered below the 1,800-foot level. The company carried out an exploration program on the Federal Zinc and Lead property in Gaspe Peninsula where encouraging results were reported.

Golden Manitou mine produced concentrates containing 16,521 tons of zinc. The Manitou shaft was deepened 445 feet to provide 3 new levels.

New Calumet produced concentrates containing 11,567 tons of zinc. Commercial ore was found in several newly developed sections of the mine.

Anacon Lead mine located an important new zinc-lead zone to the north of its "C" orebody. To the north of Anacon, but adjoining that property, United Lead and Zinc Mines Limited and Montauban Mines Limited commenced a joint underground development program on a zinc orebody part of which occurs in each property. It was planned to construct a 600-ton sink-float plant and concentrator and to bring the properties into production in 1952.

Ascot Metals Corporation established 3 new levels at its Moulton Hill mine and carried out extensive development at the Suffield mine which it operates through a wholly-owned subsidiary, Suffield Metals Corporation Limited. Over a million tons of zinc-copper-lead ore was outlined at the Suffield and production was commenced during the year, the ore being trucked 12 miles to the Ascot mill.

Consolidated Candego Mines resumed milling at about 40 tons a day in February and produced 974 tons of zinc concentrate from the high grade lead-zinc occurrences on its property.

Barvue Mines Limited, located a few miles north of Barrault, Abitibi county, commenced the construction of a 4,000-ton a day concentrator which is expected to be in operation in mid 1952. The mining of the orebody, estimated at 17,000,000 tons averaging over 3 per cent zinc, will be by open cut methods in preparation for which a large amount of clay overburden was removed.

New Brunswick

Considerable exploration was carried out on the zinc-lead occurrences in the northern part of the province, and several deposits were outlined which may prove of commercial importance.

Nova Scotia

Mindamar Metals Corporation Limited rehabilitated the Stirling zinc-lead-copper mine in southern Cape Breton Island. Construction of a new 500-ton concentrator on the property neared completion. Ore reserves were substantially increased by exploratory drilling.

Newfoundland

Buchans Mining Company Limited shipped 58,910 tons of zinc concentrate averaging about 56 per cent zinc from its zinc-lead-copper mine in the central part of the province. All ore was mined in the old sections of the property but development of the company's new Rothermere mine 3 miles to the northeast continued and production from it is expected in 1952. The concentrates were exported to United States, United Kingdom and Europe.

Yukon

Exploration and development of the rich silver-lead-zinc deposits in the Mayo area was continued by a number of companies. The output of United Keno Hill Mines Limited, the only commercial producer, included concentrates containing 3,587 tons of zinc which were recovered at Trail, British Columbia. The Northwest Territories Power Commission commenced a hydro-electric power development on the Mayo River to supply power to mines in the area.

Northwest Territories

The Consolidated Mining and Smelting Company continued exploratory drilling of the large zinc-lead property in which it holds controlling interest at Pine Point on the south shore of Great Slave Lake. Results were reported to be encouraging and plans were made for underground exploration.

American Yellowknife Gold Mines Limited outlined a medium sized orebody near O'Connor Lake. The ore was reported to average 15 per cent combined lead and zinc.

World Production in 1951

The following table was compiled from the 1951 year book of the American Bureau of Metal Statistics, except for Canada:

—	Mine Production tons[1]	Smelter Production tons[2]
United States	679,111	931,833
Canada	341,112	218,578
Mexico	197,019	57,990
Europe (except Russia)	456,333	791,098
Russia	163,000	163,000
Australia	179,507	86,264
Other countries	403,993	98,113
Total	2,420,075	2,346,876

[1] Zinc content or estimated as recoverable zinc.
[2] Includes production from secondary material.

Uses

Of the wide range of industrial uses for zinc the more important are in galvanizing, die-casting and the manufacture of brass products. In the United States, 887,000 tons were consumed in 1951; in the United Kingdom, the second largest consumer, 283,700 tons were used.

The metal is marketed in grades which vary according to their content of lead, iron, cadmium and other impurities. In North America, the principal grades produced are "Special High Grade" used chiefly for diecasting; "Regular High Grade" used for brass manufacture and "Prime Western" used for galvanizing. In Canada, zinc is refined only by the electrolytic process, by which most "Special" and "Regular High Grade" zinc is produced. To fill orders for "Prime Western", Canadian producers debase their product to meet specifications.

Galvanizing, which is effective in rust prevention, is the application of a thin coating of zinc to iron or steel. The zinc, which has an affinity for iron, is usually applied by hot dipping. However, for some purposes such as wire screening, the coating is applied by electroplating.

Zinc base alloys are used extensively for diecasting complex shapes, especially automobile parts. They are prepared from high grade electrolytic zinc to which is added 3 to 4 per cent aluminium, up to 3·5 per cent copper, and 0·02 to 0·1 per cent magnesium.

Brass, a copper-zinc alloy containing up to 50 per cent zinc, has many diversified uses in industry and the arts.

Rolled zinc is used for fabrications exposed to corrosion, such as weather stripping, fruit jar sealer rings, battery cups, boiler and hull plates, and brake linings. Zinc dust is used to make zinc salts and compounds; for purifying fats; for manufacturing dyes; and to precipitate gold and silver from cyanide solution. Zinc oxide is used in compounding rubber, and in making paint, ceramic materials, inks, matches, and many other commodities. Among the more important of the zinc compounds and products are lithopone, zinc carbonate, zinc chloride, zinc stearate, zinc sulphate, and zinc sulphide.

Prices

The price of zinc increased by about 2 cents a pound during 1951. At the end of the year, based on deliveries in Montreal or Toronto, the price a pound was, for Prime Western 20 cents, for Regular High Grade or Ordinary Grade "A" 21·35 cents and for Special Electrolytic (99·99 per cent pure) 21·5 cents.

II. INDUSTRIAL MINERALS

ABRASIVES (NATURAL)

Brief reviews only are given below of corundum, emery, garnet, grindstones, oilstones and pulpstones, volcanic dust (pumicite), and grinding pebbles.

Corundum (Al_2O_3)

There has been no production of corundum in Canada since completion of the treatment of tailings at the disposal dump on the Craigmont property, Renfrew county, Ontario, in October 1946. From 1944 to the close of this recovery operation, approximately 2,600 tons of concentrate containing 1,726 tons of fine corundum, was shipped to American Abrasive Company at Westfield, Massachusetts, the only dealer in corundum on the Continent, for use in polishing precision lenses for optical instruments.

Several deposits of corundum are known to occur in the nepheline syenite belt which is about 100 miles long and 6 miles wide and crosses Haliburton, Hastings, and Renfrew counties in eastern Ontario. However, these deposits are small and scattered, with the corundum content rarely reaching 5 per cent.

In 1951 Ortona Gold Mines Limited, Toronto, optioned the Monteagle property on which occurs a large deposit of a nepheline-feldspar mixture containing, according to engineer's reports, about 5 per cent fine-grained corundum and some fine muscovite mica. The deposit outcrops on the east bank of the York River in Monteagle township, about 9 miles northeast of Bancroft, eastern Ontario. Towards the end of 1951 beneficiation test work to obtain clean, marketable products was begun by Ortona in the Mines Branch laboratories.

Production and Trade

Canada imported 80 tons of corundum ranging from fine to coarse grain in 1951 compared with 103 tons in 1950. Most of the imports are used in making grinding wheels and the remainder for precision lens grinding. Imports enter Canada via United States from the Transvaal, Union of South Africa, the chief world producer for the past 30 years.

Uses and Prices

Grain corundum is used in making grinding wheels, and very coarse grain in 'snagging' wheels. Both types of wheels are used in the metal trades where the hardness of corundum coupled with its characteristic of fracturing into sharp cutting edges makes it an ideal cutting tool. The finest corundum (flour grades) is used for polishing high precision lenses.

Quotations on crude corundum imported into United States are estimated to have varied from $90 to $110 a ton, according to grade. A minimum corundum (Al_2O_3) content of 90 per cent is desired. Prices of prepared grain vary considerably according to mesh size and at the end of 1951, prices quoted in E. & M. J., "Metal and Mineral Markets" were: natural, per pound, size 8 to 60 inclusive, 8½ cents; 70 to 275, 9½ cents; 500, 28 cents; 850 to 1,000, 45 cents; 1,200 to 1,600, 65 cents; and 2,600, 70 cents.

Emery

True emery is an intimate mixture of corundum and magnetite, with or without hematite, and varies in hardness and toughness according to the amount of iron oxides present. Emery is massive, nearly opaque, and dark grey to blue-black with a reddish tint depending upon the amount of hematite present. The iron oxide is inseparable from the corundum, and while it detracts from the efficiency of emery as an abrasive, it adds to its polishing action. The grain shape of emery is more or less round and for this reason the cutting action of emery is slight. In fact it is more of a polishing agent than a cutter.

Commercial emery has not been found in Canada although some deposits of corundum east of the Madawaska river in Ontario are so intimately mixed with magnetite that they are practically a coarsely crystalline emery.

The three main emery producing countries of the world are Greece, Turkey, and United States. Grecian (or Naxos) emery contains approximately 65 per cent corundum with about 25 per cent of the remainder occurring as magnetite. Turkish emery approaches that produced in Greece in corundum content and quality. American emery, most of which comes from the states of New York and Virginia, and which is the softest of the three, contains about 45 per cent iron oxide.

Canadian imports of emery for abrasive uses were valued at $160,115 in 1951 compared with $106,890 in 1950. A large part of United States production, about 5,000 tons a year, is consumed as the 'nonskid' agent in concrete and asphalt floors in industrial plants due to its marked resistance to wear and its non-skid nature. The balance of the output, together with imports from Greece and Turkey, is used in abrasive products such as grinding wheels, abrasive sticks, and coated papers.

American first grade emery ore was quoted in E. & M. J. "Metal and Mineral Markets" at the end of the year at $12 a ton f.o.b. New York, and grain emery, f.o.b. Pennsylvania was quoted at 10 cents a pound for Turkish and Naxos grain, and 6½ cents a pound for American grain.

Garnet

There was no mine output of garnet in Canada in 1951. Niagara Garnet Company Limited, Sturgeon Falls, Ontario, completed a 4-mile road into its property during the year. This company operates a garnet deposit intermittently near River Valley in Dana township, Ontario, and in past years shipped minor amounts of flour grades and graded grain to United States' consumers. The garnet is of good grade and occurs in crystals ranging from the size of marbles up to crystals 4 inches in diameter. The garnets, which occur in a band of mica schist, are roughly concentrated by crushing and trommel-screen sizing at the pit site and then trucked 40 miles to the mill at Sturgeon Falls where they are further crushed and concentrated to about 95 per cent garnet grain, and prepared for market either as garnet grain or as flour grades of garnet.

Over 85 per cent of the world output of garnet comes from deposits which are owned and operated by Barton Mines Corporation near North Creek, New York. The product from these deposits is regarded as world standard garnet. Production in United States has averaged about 8,000 tons of all grades during the past few years.

Consumption and Uses

Canadian consumption of garnet grain, for making sandpapers, amounts to approximately 350 tons a year, the two Canadian consumers being Canadian Durex Abrasives Limited, Brantford, and Canada Sandpapers Limited, Preston, both in Ontario. These companies import graded grain for their needs.

Consumers in the United States over the past several years, have used from 6,000 to 8,000 tons annually of all types. Most of the garnet is used for making coated abrasive papers but the use of garnet in sandblasting is increasing. Flour grades (minus 350 mesh) are used in the polishing of precision lenses.

Prices

The cost of ungraded garnet concentrates suitable for sandpapers, according to E. & M. J., "Metal and Mineral Markets" at the end of the year was $93 a ton f.o.b. New York. Prices of other garnet products ranged up to $160 a ton with the superfine powders in 5 to 10 micron size selling for approximately $200 a ton.

Grindstones, Oilstones, Pulpstones, Etc.

Material suitable for these stones occurs in certain sandstone beds in Nova Scotia, New Brunswick, and on the coast of British Columbia. Although many years ago the output was considerable it is now small because demand is almost negligible due mainly to competition from artificial abrasives.

The only Canadian producers of grindstones, Read Stone Company Limited of Sackville, and Bay of Chaleur Grindstone Company of Clifton, both in New Brunswick, shipped approximately 100 tons of grindstones valued at $10,000 in 1950 (1951 figures not available). Read Stone Company, by far the larger operator, obtains its material from quarries near Stonehaven. Bay of Chaleur Company obtains its material at low tide along the Bay of Chaleur near Grand Anse.

The use of pulpstones of natural sandstone in magazine grinders of pulp mills has been largely displaced by the use of an artificial abrasive in the form of segmental pulpstones built of bonded silicon carbide grit. Most of these are supplied by Norton Company of Canada Limited, Hamilton, Ontario. Pulpstones supplied by Canadian Carborundum Company Limited to Canadian firms are made in its United States plant and imported into Canada. About 800 artificial pulpstones are in use in Canadian pulp and paper mills with about 300 in stock at the various mills. Some segmental pulpstones of artificial abrasive material are exported.

Volcanic Dust (Pumicite)

Volcanic dust or pumicite is a natural glass or silicate, atomized by volcanic explosions and thrown into the air in great clouds which ultimately settle into beds varying from a few inches to many feet in thickness. The dust occurs as finely divided powder of a white to grey or yellowish colour and is composed of small, sharp angular fragments of highly siliceous volcanic glass.

Pumice is a highly cellular, glassy volcanic rock or lava which is formed in the vicinity of volcanoes as porous blocks of a white or light grey colour. It has the same composition as normal rhyolites, and when ground has the same appearance and character as pumicite.

Widespread deposits of volcanic dust occur in Saskatchewan, Alberta, and British Columbia but due either to thinness of beds, or remoteness from markets, there has been no production for many years.

Volcanic dust is used in Canada mainly for making scouring and cleansing aids. Lightweight building blocks composed of pumice aggregate and cement mixture are made at several block plants in British Columbia. The pumice aggregate is imported from nearby Oregon and Washington at prices ranging from $6 to $9 a short ton f.o.b. Vancouver plants.

In United States increasing amounts of pumicite and pumice are being used as concrete admixture and concrete aggregate. Pumicite is also consumed as a carrier or filler as well as a cleaning and scouring agent in soaps and powders.

Imports are grouped with a number of similar products (pumice, pumicite, volcanic dust, lava, and calcareous tufa) and in 1951 were valued at $128,957 compared with $127,885 in 1950 and $105,997 in 1949. Most of these imports came from United States.

At the close of 1951, according to E. & M. J., "Metal and Mineral Markets" the price of pumice stone, a pound, f.o.b. New York, or Chicago, packed in barrels, was 3 to 5 cents for powdered and 6 to 8 cents for lump. These prices varied widely, depending on availability, end use, and quantity required.

Grinding Pebbles

Extremely hard, tough, and rounded pebbles, usually of flint, are used in cylindrical or conical mills for the grinding of ores and minerals mainly of a non-metallic nature where iron contamination from the usual steel grinding balls would prove detrimental.

Grinding pebbles were produced in the past in several localities. Production in recent years, however, has been confined to Alberta where W. May produces pebbles from deposits at Elkwater and ships them to several Canadian mining and milling companies.

ASBESTOS

Canadian production of chrysotile asbestos established a record in 1951 for the second successive year. Shipment of 973,198 tons of all grades valued at $81,584,345 was an increase of 11 per cent in volume and 24 per cent in value over the previous year. The greater increase in value is mainly a reflection of higher prices affecting all fibre groups. Output came principally from the Eastern Townships of Quebec but also from Matheson in northern Ontario where ths new mine of Canadian Johns-Manville Company Limited completed its first full year of production. Most of the output is exported, over 75 per cent alone going to United States.

Although foreign sources, especially in Africa, have grown in importance, Canada has maintained its prominent position and in 1951 produced approximately 70 per cent of world output. Since demand for higher quality grades exceeded supplies, Canadian mines operated at capacity, but their increased output was a reflection of plant expansion undertaken previously. Uses for spinning fibre in both civilian and defence industries have increased more rapidly than production, and to conserve supplies consumption in United States has been placed under control order.

There were a number of important developments during the year. In Quebec, two major mines planned new mills to increase recovery and improve efficiency of their operations. In Quebec and British Columbia new orebodies were being prepared for early production. Exploration and development were intensified in northern Ontario, Quebec, British Columbia, and Newfoundland.

Although demand for higher quality fibre grades exceeded supply, difficulty in marketing 'shorts' occurred during the latter part of the year. Decreased demand is believed to be a consequence of curtailed production in the automobile and buildings industries, principally in United States.

Production in Canada is confined entirely to chrysotile from the provinces of Quebec and Ontario but other deposits occur in British Columbia and Newfoundland and minor occurrences have been reported in Saskatchewan and Manitoba.

No commercial occurrences of amosite or crocidolite are known in this country. There are, however, several deposits of fibrous tremolite, actinolite, and anthophyllite (amphibole). In general, their fibres are longer but harsher,

Production and Trade

	1951		1950	
	Short tons	$	Short tons	$
Production (shipments)				
Crude	748	568,725	904	587,569
Milled fibres	333,001	49,399,632	305,194	41,002,785
Shorts and refuse	639,449	31,615,988	569,246	24,264,214
Total	973,198	81,584,345	875,344	65,854,568
Exports of crude				
To: United States	464	358,875	555	330,568
Other countries	196	189,528	290	213,077
Total	660	548,403	845	543,645
Exports of milled fibres				
To: United States	199,168	29,106,915	180,854	23,502,603
United Kingdom	30,707	4,585,368	29,887	3,856,543
France	16,373	2,815,133	14,128	2,204,787
Belgium	13,466	2,149,550	9,444	1,403,885
Australia	10,435	1,531,480	9,346	1,246,156
Japan	7,668	1,053,404	3,796	484,174
Argentina	6,151	1,108,264	850	169,375
Mexico	5,125	808,092	4,881	693,225
Germany	4,940	733,833	4,004	593,617
Brazil	4,130	684,739	5,319	768,979
Other countries	26,431	4,277,791	27,289	4,190,307
Total	324,594	48,854,569	289,798	39,113,651
Exports, shorts and refuse				
To: United States	512,433	24,592,389	485,597	20,351,920
United Kingdom	38,023	1,666,600	22,483	876,075
France	17,620	1,193,360	6,765	384,927
Belgium	11,986	814,267	7,818	473,161
Germany	9,165	630,026	5,227	280,306
Other countries	27,833	2,033,217	11,446	727,819
Total	617,060	30,929,859	539,336	23,094,208
Exports of manufactures (Brake linings, clutch facings, roofing, packing, etc.)				
To: United States	....	742,263	....	386,820
Brazil	....	187,735	....	3,005
Mexico	....	110,853	....	48,324
Argentina	....	67,437	....	....
India	....	50,921	....	5,819
Venezuela	....	36,846	....	43,238
Other countries	....	301,936	....	236,187
Total	....	1,497,991	....	723,393
Imports [1]				
Packing	....	259,644	....	179,000
Brake linings for motor vehicles	....	627,797	....	461,938
Clutch facings for motor vehicles	....	275,921	....	285,222
Brake linings and clutch facings	....	105,429	....	53,304
Miscellaneous manufactures	....	2,159,662	....	1,651,888
Total	....	3,428,453	....	2,631,352

[1] Seventy-nine per cent from United States in 1951.

and lack the strength of chrysotile. They are not suitable for spinning but offer higher resistance to acids and are preferred for filtration of acidic solutions. Development work on a minor scale has been carried out in previous years on tremolite deposits near Calabogie, Ontario and St. Luc de Matane in Quebec.

Quebec

Seven principal companies were producing the mineral throughout the year with mines located in the Thetford, Black Lake, and Danville areas of the Eastern Townships.

Canadian Johns-Manville Company Limited, the leading producing company, operates at Asbestos the Jeffrey mine which is the world's largest single asbestos mine. Conversion from open pit to underground mining had reached a point at the end of the year where most output was derived by block caving.

Asbestos Corporation Limited operates the King and Beaver mines at Thetford Mines, the British Canadian at Black Lake, and the Vimy Ridge in Coleraine township. The company intends to develop a new orebody near the latter property to be known as the Normandie mine. Erection of a 5,000-ton a day mill is contemplated with production scheduled for 1954.

Johnson's Company Limited is erecting a new and larger mill at its Black Lake property. The company also operates an underground mine at Thetford Mines.

A small production in the last quarter was reported by the Cie d'Amiante Continental Ltée in Coleraine township from a property formerly held by Coleraine Quebec Asbestos Company Limited.

Underground development work on an asbestos deposit underlying Black Lake was carried out during the year by United Asbestos Corporation Limited.

Dominion Asbestos Corporation Limited announced plans for production in 1953 from a deposit in Ham township near St. Adrien.

Production of chrysotile in the Eastern Townships has been continuous since 1878. Core drilling to depths of 1,700 feet have indicated persistence of fibre comparable in quality to that being produced at present. Much of the fibre is recovered from veins ranging in width from one half inch down. However, veins up to 5 inches or more are found occasionally. In occurrences of this type the fibres are oriented across the vein so that width of the latter is indicative of fibre length. Part of the production, principally in the East Broughton area, is derived from slip fibre usually found in fault veins.

Ontario

During 1951 Canadian Johns-Manville completed the first full year of production from its Munro mine near Matheson, northern Ontario.

During the latter part of the year Van Packer Mines of Canada Limited acquired the property of Teegana Mines Limited near South Porcupine in the Cochrane district and undertook exploratory diamond drilling.

Further exploration of serpentine areas in northern Ontario was undertaken, supplementing magnetometric surveys with diamond drilling.

British Columbia

Cassiar Asbestos Corporation Limited, formed during the year, acquired the chrysotile deposit in the McDame Lake area of northern British Columbia. As a result of further development the company is planning a mill to recover fibre from the talus slope. The deposit is at an elevation of 5,800 feet and is reached by 100 miles of road from the Alaska Highway.

Newfoundland

Newfoundland Asbestos Limited explored chrysotile occurrences in the Lewis Brook-Bluff Head area on the West Coast of Newfoundland. A small mill is planned .

World Review

Estimated world output of all varieties in 1951 exceeded 1,400,000 tons of fibre.

Although asbestos minerals are mined in several countries, in most instances production is small. However, operations in Africa are now extensive with the Union of South Africa, Swaziland, and Southern Rhodesia contributing substantial quantities to the world's supply of fibre.

The Union of South Africa is the source of much of the world's amosite and crocidolite, and is contributing increasing amounts of chrysotile. Production of 1951 totalled 105,322 tons of which 59,455 was amosite, 25,565 crocidolite and 20,300 chrysotile.

Production in Southern Rhodesia is chiefly from the Shabani district, and is estimated to have been 78,000 tons in 1951. Extensive exploration and prospecting has been undertaken prompted by an increasing demand for low iron chrysotile which is important to the defence industry.

In the United States, high quality low iron chrysotile is mined in Arizona. In addition, chrysotile is derived from a deposit in Vermont. A number of other states are currently producing varying amounts of the amphibole varieties.

Russia has been an important source of chrysotile but definite information on current output is lacking. However, certain grades have been offered recently in west European countries.

Uses and Prices

Uses for asbestos are numerous and varied. Longer fibre types find application principally in the manufacture of asbestos textiles, certain kinds of packing and insulation, and friction-resistant materials. Medium fibre grades are used in the manufacture of asbestos-cement products such as pipe, tile, millboard, siding, shingles and roofing, and in the manufacture of asbestos paper.

Uses for short fibre material include protective coatings, plastics, lubricating greases, and special industrial fillers having characteristics acceptable for numerous applications.

During the year, there was an increase in the price of Canadian asbestos in almost all categories. According to E. & M. J. "Metal and Mineral Markets" for December 20, 1951 prices f.o.b. mine, short tons were as follows:

Crude No. 1	$960–$1,500
Crude No. 2	595– 900
Spinning fibres	275– 475
Shingle stock	123– 170
Paper stock	85– 119
Waste	63– 70
Shorts	30– 63

BARITE

Primary production (sales) of crude and ground barite in Canada in 1951 rose to 98,113 tons, an increase of 27 per cent over 1950 and more than double that of 1949. Almost the entire output was exported, more than half as crude. Canadian Industrial Minerals Limited with mine and mill at Walton, Hants county, Nova Scotia, again accounted for most of the output. Mountain Minerals Limited, with mine at Parson, British Columbia and Maritime Barytes Limited, with mine and mill at Brookfield, Nova Scotia, accounted for the remainder.

Barytes is of widespread occurrence in Canada, numerous occurrences being recorded in Ontario, Nova Scotia, British Columbia, Quebec and Manitoba.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production (mine shipments)				
Crude	51,619	444,175	48,280	366,256
Ground	46,494	687,742	28,897	384,122
Total	98,113	1,131,917	77,177	750,378
Imports (ground)				
From: United States	842	30,409	1,593	55,946
Germany	152	5,038	436	10,842
Italy	72	1,919	11	230
United Kingdom	2	105	49	3,077
Total	1,068	37,471	2,089	70,095
Exports				
Crude	49,261	....	33,451	....
Ground	45,729	....	37,090	....
Total	94,990	....	70,541	....

—	1950 Short tons	1949 Short tons
Consumption		
Paints	1,457	1,202
Rubber Goods	589	559
Glass	265	184
Miscellaneous	1,821	1,200
Total	4,132	3,145

Nova Scotia

Canadian Industrial Minerals Limited continued to produce crude barytes for the chemical trade and ground barytes for industrial filler and drilling mud.

Maritime Barytes Limited, treating a barite-siderite ore by flotation, commenced operations in July and made limited shipments during the last half of the year.

British Columbia

Mountain Minerals Limited continued the production of white barytes from its mine at Parson on the Columbia River in the southeastern part of the province.

World Sources

United States is by far the largest producer of barytes and contributes over half the world output. Canada is a leading producer. Other producers include United Kingdom, Italy, India, Greece, Brazil, Argentina, and Spain.

Uses and Specifications

Ground barite is used principally as a pigment and extender in paints; as a filler in rubber goods; in moulded flint glass; in chemicals; and in drilling mud.

For drilling mud, barite is combined with bentonite and other materials to form a heavy suspension used in drilling oil and gas wells to overcome gas pressures and to remove cuttings from the drilling face. For these purposes barite with a minimum barium sulphate ($BaSO_4$) content of 95 per cent, minimum specific gravity of 4·2, and an absence of soluble salts is required. Size required is about 98 per cent minus 325 mesh.

As a filler for the rubber and paint trades barite should contain not less than 95 per cent $BaSO_4$, grind to a pure white colour, and be free from carbonaceous impurities.

For the chemical trade barite should have a minimum of 95 per cent $BaSO_4$, maximum of about 3 per cent silica, and 1 per cent Fe_2O_3. Colour is not important.

For the glass trade barite should be relatively pure, particularly as regards Fe_2O_3, which should not exceed 0.04 per cent.

Barite is used as a filler in a number of commodities including paper, linoleum, textiles, and asbestos products. It is used also in materials to provide protection against X-rays; in glass to improve brilliancy and cutting properties; and as a heavy medium in sink and float processes, particularly coal washing.

Barium chemicals are used widely in industry. Barium carbonate is used to reduce "dry house" scum on bricks; in pharmaceuticals; as a flux in the enamelling and ceramic trades; and in heat-treatment compounds. The chloride is used as a pigment in lithographic inks; in the purification of salt brine and in water treatment; as a mordant in dyeing textiles; and in many other applications. Other compounds include the hydrate, phosphate, oxide, sulphide, stearate, and chlorate.

Statistics pertinent to the trade and consumption of barium compounds in Canada are shown in the following table:

Trade and Consumption of Barium Compounds

—	1951		1950	
	Short tons	$	Short tons	$
Imports of barium compounds				
Lithopone (70 per cent $BaSO_4$)				
From: United States	5,053	852,723	4,601	649,420
United Kingdom	1,420	228,292	3,382	400,729
Other countries	438	108,702	171	19,523
Total	6,911	1,189,717	8,154	1,069,672
Blanc fixe (precipitated $BaSO_4$)				
From: United States	111	11,942	459	28,882
United Kingdom	46	5,941	114	9,702
Belgium and Luxembourg	87	7,872	104	7,775
Other Countries	127	12,775	45	3,332
Total	371	38,530	722	49,691
	1950 Pounds		1949 Pounds	
Consumption of main barium compounds in the chemical and allied products industry:				
Barium chloride	155,629		319,817	
Barium nitrate	119,776		86,087	
Barytes	3,282,691		2,626,420	
Blanc fixe	531,195		417,945	
Lithopone	9,727,558		11,625,803	

Prices

Final 1951 quotations on barytes as published in E. & M.J. "Metal and Mineral Markets" were as follows: Georgia, crude, jig and lump $13 to $13.50 a long ton; Missouri crude minimum 94 per cent $BaSO_4$, less than 1 per cent iron, $10.40; 93 per cent $BaSO_4$ $10.15 a ton f.o.b mines.

Tariffs

Canadian:	
British preferential	—free.
Most favoured nation	—25 per cent ad valorem.
General	—25 per cent ad valorem.
United States:	
Crude and unmanufactured	—$3 per ton.
Ground or otherwise manufactured	—$6.50 per ton.

BENTONITE

Canada's output of bentonite continued to come from Manitoba and Alberta. Although large deposits exist in British Columbia there has been no production for several years, and in Saskatchewan, where occurrences are widespread, development is still in the research stage.

The output of processed bentonite in Manitoba decreased 13 per cent compared with 1950 while in Alberta the output of processed bentonite increased 45 per cent. The increase in Alberta production was due principally to increased usage of bentonite to seal irrigation canals and ditches and also as a dusting agent in weed killers. The oil well drilling industry which formerly consumed most of the Alberta output now obtains its supply almost wholly from United States.

Manitoba

All of the output of activated clay in Canada is produced by Pembina Mountain Clays, Limited, Winnipeg, Manitoba. The clay is mined, coarse ground, and dried at Morden and shipped to Winnipeg for activation. Output of crude bentonite to the end of 1951 is estimated at over 78,000 tons.

Bentonite occurs near the base of the Pembina member of the Vermilion River formation which is of Upper Cretaceous age. This bentonite horizon is very pronounced from the United States border northwestward to Miami, (some 65 miles southwest of Winnipeg) and extends for a distance of approximately 35 miles. Beyond this, sporadic occurrences of bentonite have been reported in the Vermilion River formation all along its trend to the northwest across Manitoba, a distance of approximately 250 miles.

Alberta

Alberta's production, which has all been of the colloidal, swelling variety, comes from the Red Deer Valley at Drumheller. Gordon L. Kidd and Aetna Coal Company, Drumheller, reported shipments in 1951.

The Aetna Coal Company mines an 8-inch bed of good quality swelling bentonite that occurs in the No. 1 coal seam.

Gordon L. Kidd strip mines a bed of swelling bentonite averaging about 4 feet thick just north of Drumheller.

Crude bentonite from these sources is sent to Alberta Mud Company, Limited, Calgary, where it is dried and ground.

Production, Imports, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production, crude bentonite mined:				
Manitoba	13,413	....	11,965	....
Alberta	564	....	272	....
Total	13,977	....	12,237	....
Processed bentonite[1]	....	499,454	....	534,873
Imports, activated bentonite:				
From: United States[2]	....	374,200	....	334,444
Germany	....	....	....	1,527
Total	....	374,200	....	335,971

—	1950	1949
	Short tons	Short tons
Consumption		
Steel furnaces	3,168	3,092
Iron furnaces	1,854	1,800
Petroleum refining	8,663	8,421
Oil well drilling	15,000[3]	15,000[3]
Soaps	563	871
Pulp and Paper	272	182
Miscellaneous	989	200
Total	30,509	29,566

[1] Includes ground natural bentonite and activated material.
[2] Considerable unrecorded amounts of bentonite are imported from United States for oil well drilling and foundry use.
[3] Estimated.

Many deposits of swelling and non-swelling bentonite occur in the southern half of the province. All of the main known deposits occur in sedimentary rocks of Upper Cretaceous age.

Large deposits of non-swelling bentonite of high purity are present on the McLeod River southwest of Edson. In the past, one of these locations was opened by underground mining and 2 carloads of the bentonite are reported to have been shipped for use in the preparation of cosmetics.

Bentonite occurs in small amounts associated with the coal being mined in the Edmonton district. Beds of bentonite up to 1½ feet thick occur south of Camrose. A 2-foot thickness of bentonite occurs in the Belly River formation southwest of Milk River. Bentonite up to 2 feet thick occurs on the north side of the Milk River Ridge. There are numerous bentonite beds from a few inches up to 1½ feet thick in the Bearpaw formation on the St. Mary River south of Lethbridge. South of Medicine Hat, the Bearpaw formation flanking the Cypress Hills contains numerous beds of bentonite, most of which are thin but have remarkable lateral persistence. Beds up to 4 feet wide have been noted. No information is available as to the quality of these various deposits.

Saskatchewan

Both swelling and non-swelling bentonite is widely distributed in the Upper Cretaceous and Tertiary sediments in southern Saskatchewan, especially in the Cypress Hills and Wood Mountain areas. Bentonite occurs at Pelly where the beds are comparable to those being mined at the same stratigraphic horizon in southern Manitoba.

The Resources Utilization Branch of the Saskatchewan Department of Natural Resources has been actively pursuing a research program on Saskatchewan bentonites. During the year a 40-ton carload of bentonite was taken from St. Victor in the Wood Mountain area for pilot plant tests. The beneficiated bentonite was then tested as a drilling mud in both shallow seismic test drilling and in deep test holes with satisfactory results. The same bentonite when tested as a foundry sand bonding material compared very favourably with commercial products.

Laboratory tests on the use of Saskatchewan bentonite for decolourizing oils have shown that a bentonite from Rockglen in the Wood Mountain area equals a standard decolourizing bentonite in efficiency while bentonite from a deposit at Pelly in northeastern Saskatchewan is somewhat more effective.

There has been no production in Saskatchewan other than trial shipments.

British Columbia

Non-swelling bentonite of high purity occurs in gently dipping, Tertiary sediments at Princeton and Quilchena where the beds are up to 15 feet thick. The main occurrences are as follows:

1. Quilchena Creek, approximately 2 miles south of Quilchena Post Office. The mineral rights are held by Quichon Cattle Company Limited, Quilchena, B.C.

2. Outskirts of Princeton on Copper Mountain Railway. The mineral rights are held by Princeton Properties Limited represented by Francis Glover, Vancouver, B.C.

3. Five miles south of Princton on Copper Mountain Railway. The mineral rights are held by H. Knighton, Princeton, B.C.

Uses

Bentonite is used chiefly in refining mineral and vegetable oils; as a bonding ingredient in foundry sands; and to control the viscosity of oil-well drilling muds.

To a minor extent it is used as a filler in paper, rubber, and other products; as a detergent in soaps and cleaners; as a coagulant for clarifying wines, honey, and turbid waters; as a stabilizer in various hydraulic cements and emulsions; as a carrier for insecticides, fungicides, and herbicides; and in toiletries, and medicinal preparations. It is used for grouting dams and irrigation ditches and to prevent seepage around foundations of buildings. Bentonite is used also in bonding and plasticizing ceramic bodies and ore briquettes for smelting. Treated bentonite is used as a dessicant to prevent atmospheric moisture from entering packaged goods and for coating small seeds to increase their bulk and facilitate sowing.

Most of the output in Manitoba undergoes activation and is used in bleaching and refining petroleum products. Alberta bentonite is now used mainly as a carrier for weed killers and for grouting irrigation canals and ditches. Smaller amounts from Alberta are used by the gold and coal mining industries in exploratory drilling; in foundry work; and as a drilling mud in oil well drilling in the province.

Prices and Tariffs

The price of bentonite varies within wide limits depending upon the degree of processing it has been given. Activated bentonite, for bleaching use, cost about $80 a ton in bulk carload lots, delivered eastern Canadian points. Alberta crude bentonite in 1951 sold for $5.50 a short ton at the mine. The selling price of processed Alberta bentonite was increased in the latter part of 1951 from $35 a ton to $40 a ton f.o.b. Calgary plant.

Wyoming and South Dakota standard 200 mesh bentonite sold for $12.50 a ton, f.o.b. plant bagged in carload lots. Oil well grade bentonite sold for $14 a ton, f.o.b. plant bagged in carload lots. Special grades in dust form were quoted as high as $90 a ton. Powdered Mississippi bentonite sold for $14 a ton, bagged, in carload lots, f.o.b. plant.

Bentonite not further manufactured than ground enters Canada duty free. Activated bentonite imported into Canada pays 10 per cent ad valorem. The United States duties on bentonite were reduced early in 1951 from 75 cents a ton to 37½ cents a ton on unmanufactured bentonite and from ¼ cent a pound and 30 per cent ad valorem to ⅛ cent a pound and 15 per cent ad valorem on activated bentonite.

CEMENT

Production of cement in 1951 continued to lag behind consumption and to meet the deficiency 2,327,429 barrels were imported, almost half from United States and the greater part of the remainder from United Kingdom.

Nevertheless, cement production passed that of the previous peak year, 1950, by 256,000 barrels, amounting to 17,007,812 barrels valued at $40,446,288. This was an increase of 1.6 per cent in production and 12.7 per cent in value. At the same time, salaries and wages and costs of fuel, electricity, process supplies, materials, and containers increased by $2,290,100 or 11.2 per cent.

Consumption of cement in recent years has risen rapidly, mainly owing to accelerated activity in the building industry and construction of power dams. For instance, in 1939 apparent per capita consumption was 0.49 barrels or 174 pounds a year; in 1951 it was 1.38 barrels or 483 pounds a year—an increase of 177.6 per cent. In the same period production increased 196.7 per cent which indicates a narrowing of the gap between domestic supply and demand.

Expansion programs, commenced in 1950, and 1951, are expected to add 5,320,000 barrels of cement to the annual output. In 1951, capacity was increased by 1,500,000 barrels but this took place too late in the year to have any marked effect on production. Three new plants were put into operation near the end of the year and with completion of expansion programs in established mills, the industry should produce enough cement in 1952 to satisfy the nation's demands.

Raw materials for making cement are found throughout Canada and consequently plants can be strategically located near important marketing areas. Producing provinces are: British Columbia, Alberta, Manitoba, Ontario, Quebec, New Brunswick, and Newfoundland.

Five companies with a total of 24 kilns are engaged in processing Portland cement from raw materials, while a sixth imports and grinds clinker for producing white cement.

Canada Cement Company Limited is the largest producer in Canada. The company operates plants at Exshaw, Alberta; Fort Whyte, Manitoba; Port Colborne and Belleville, Ontario; Montreal and Hull, Quebec; and Havelock, New Brunswick. Expansion programs when completed will add 3,200,000 barrels of cement to the annual production. The plant at Havelock, on which construction was started in the autumn of 1950, burned the first clinker in December, 1951, and is the only dry process plant in Canada. In addition a new kiln is being added to each of the plants at Belleville, and Exshaw. Storage, mixing and batching facilities, capable of accommodating an additional unit are being installed.

Expansion plans of British Columbia Cement Company, Vancouver Island, and St. Mary's Cement Company, Ontario, were under way with another kiln to be added in each case. This will increase the output of each by 700,000 barrels annually.

Two new plants were completed late in 1951 in Quebec and Newfoundland, and are to be on regular production in 1952. Le Ciment Quebec, Incorporated, St. Basile, has a capacity of about 400 barrels daily. Output is primarily for use in the Quebec City area. North Star Cement Limited of Newfoundland at Cornerbrook has a mill capable of producing 600,000 barrels of cement annually.

Medusa Products Company of Canada Limited, grinds imported clinker for the production of white cement at Paris, Ontario.

Production, Trade and Consumption

—	1951		1950	
	Barrels of 350 lbs.	$	Barrels of 350 lbs.	$
Production	17,007,812	40,446,288	16,741,826	35,894,124
Exports				
To: United States	1,485	7,223	23,897	111,234
Other countries	1,105	5,163	12	117
Total	2,590	12,386	23,909	111,351
Imports				
From: United States	1,033,043	3,900,867	453,951	1,640,991
United Kingdom	862,783	2,317,176	834,805	1,874,161
Belgium	390,192	1,101,132	68,784	167,989
Germany	39,735	120,407	12,319	35,238
Other countries	1,676	8,277	16,360	70,602
Total	2,327,429	7,447,859	1,386,219	3,788,981
Imports—Clinker				
All from United States	45,812	157,202	44,745	154,174
	1950		1949	
Consumption[1]				
In cement products industry	3,390,141	9,878,165	2,580,347	7,465,871
Total value of products made in cement products industry	....	41,197,382	....	32,693,645

[1] The consumption of cement in the cement products industry accounted for approximately 19 per cent of total production and imports of cement in 1950. the remainder being absorbed directly into the construction industry.

Uses

While the major portion of cement in Canada is used in fresh concrete construction, appreciable quantities are channeled into the manufactured concrete products industry. The number of commodities manufactured has increased from concrete bricks and building blocks to such items as precast roof and wall slabs, and prestressed concrete beams. With continued demand for accelerated construction the production of pre-fabricated concrete products (capable of replacing steel) should develop accordingly.

Production of manufactured concrete products in Canada during 1950 accounted for 13,560,563 bags of cement valued at $9,878,165. This was a marked increase over the previous year's figure of 10,321,389 bags at $7,465,871.

Ready-mix concrete, concrete hollow building block, brick, drain pipe, sewer pipe, water pipe, culvert tile and other products were processed. Value of all manufactured concrete products was $41,197,382 an increase of 26 per cent over the 1949 peak.

A total of 431 plants operated in the cement products industry in 1950. Ontario plants accounted for 57 per cent of the total production; Quebec establishments, 27 per cent, and works in Alberta and British Columbia 8 and 5 per cent respectively. The remaining 3 per cent was distributed among other provinces.

Prices

The price of cement varied with the locality. The following table gives the average price per barrel in the more important market areas:

—	1951	1950
Montreal	$2.56	$2.29
Toronto	3.10	2.82
Winnipeg	2.81	2.56
Regina	4.12	3.75
Vancouver	3.39	3.18

CLAYS AND CLAY PRODUCTS

The value of clay products manufactured in Canada in 1951 was $40,475,960, an increase of 9·7 per cent over the value in 1950. Imports of clay products, chiefly from United States and United Kingdom, amounted to $40,288,311.

The output of clay products has steadily increased since the end of World War II and this trend has continued in spite of deterents on sales for certain ceramic products, such as low tension electrical insulators, domestic tableware, and sanitary ware caused by credit restrictions or other exigent economy measures. The war production program continues to accentuate the demand for all types of refractory products which are so essential in metallurgical, or, for that matter, all types of manufacturing plants. High tension electrical insulators are still in comparatively short supply, and developments in the field of electronics, particular for defence purposes, have brought about a resumption in demand for special ceramic dielectrics or other special ceramic components.

Programs to improve the quality of clay products (particularly refractories and structural clay products) have been actively pursued, and efforts to find new or better raw materials have been extended. About 160 plants are engaged in the manufacture of clay products in Canada, most of them being established near the centres of population.

Four kinds of clay are required by the clay products industry in Canada, namely: common clays for structural items; stoneware clays for sewer pipe, flue linings, etc.; fireclays for refractories; and china and ball clay for porcelains, sanitary ware, tableware, and wall tile. China clay is also used in the paper and rubber industries.

Common clays are produced in all provinces; stoneware clays in Saskatchewan and British Columbia and to a lesser extent in Manitoba and Nova Scotia; fireclays in Saskatchewan and British Columbia and to a lesser extent in Nova Scotia. China clay is not produced at present in Canada but there is some production of ball clay in Saskatchewan. Imports of clay in 1951 were valued at $3,004,065.

Production and Trade

—	1951	1950
	$	$
Production from domestic clays		
Clays, including bentonite	635,444	652,498
Clay products		
From: Common clays [1]	18,888,415	17,080,672
Stoneware clays [2]	3,229,684	3,491,648
Fireclays [3]	620,429	472,189
Other products	153,684	93,881
Total	23,527,656	21,790,888
Production from imported clays [4]		
From: Stoneware clays	736,803	806,742
Fireclay	2,101,515	1,859,908
China clay	14,109,986	12,428,874
Total	16,948,304	15,095,524
Grand Total	40,475,960	36,886,412
Imports of clay		
Fireclay	502,025	411,660
China clay	1,697,816	1,494,349
All others, including activated, filtering, and bleaching clays	804,224	703,437
Total	3,004,065	2,609,446
Imports of clay products		
From: United States	21,983,083	16,774,342
United Kingdom	16,265,501	12,972,660
Other countries	2,039,727	1,228,537
Total	40,288,311	30,975,539
Exports of clay		
To: United States	34,752	14,906
Other countries	424	....
Total	35,176	14,906
Exports of clay products		
To: United States	968,843	511,944
Brazil	384,464	408,025
New Zealand	239,599	220,354
Pakistan	118,462	....
Belgium	103,093	87,190
Other countries	688,243	958,853
Total	2,502,704	2,186,366

[1] Building brick, structural tile, drain tile, floor tile, etc.
[2] Sewer pipe, flue liners, etc.
[3] Fireclay blocks and shapes, firebrick.
[4] Electrical porcelains, sanitary ware, sewer pipe, tableware, pottery, ceramic floor and wall tile, thermal insulation and refractories.

Average prices for various kinds of clays are difficult to obtain because of the variability in quality. However, an approximate indication of price range for 3 types of imported clay is as follows:

Kind of Clay (imported)	*Price Range (f.o.b. shipping point, per ton)*
Fireclay	$4.50 to $ 6.00
China clay	9.00 to 30.00 depending on grade
Ball clay	6.00 to 20.00 " " "

Common Clays

The value of building brick, structural tile, drain tile, etc. produced in Canada in 1951 from domestic common clays was $18,888,415 compared with $17,080,672 in 1950.

Clays or shales suitable for the production of good quality bricks and tile are not plentiful in Canada. However, good brick clays occur in all provinces not too distant from the more thickly populated areas, but because of the greatly increased demand for structural clay products new and better raw materials are sought. Surveys sponsored in recent years by companies, provincial governments and the Federal government have unearthed many new deposits, some of which have led to the establishment of new plants. Other deposits discovered have enabled the manufacture of improved products by existing plants. Co-operation is given by the Mines Branch of this Department by carrying out evaluation tests on samples submitted from all parts of Canada, and also, in the field, in connection with exploitation or development of new deposits.

There has been great demand for lightweight concrete aggregate. "Haydite" (shale bloated by heat treatment) is produced in a large plant near Toronto, but the demand exceeds supplies. As a result of investigations carried out by the Mines Branch numerous clays and shales throughout Canada have been found to be satisfactory for the production of lightweight aggregate. Reports on these investigations in the Prairie Provinces, Ontario, and the Maritime Provinces, are available. Due to the trend towards lightweight concrete construction as well as the diminishing supply of cinders this work has assumed increased importance.

Stoneware Clays

The value of stoneware articles (sewer pipe, flue liners, artware, etc.,) produced in Canada from domestic stoneware clays was approximately $3,229,684 in 1951 compared with $3,491,648 in 1950. The value of such products made from imported clays in 1951 was $736,803. In 1950 it was $806,742.

The largest production in Canada of stoneware clays is in southern Saskatchewan, particularly in the vicinity of Eastend. The clay is selectively mined and is shipped to Medicine Hat, Alberta, where, owing to the availability of cheap natural gas, it is used extensively to make a wide variety of stoneware articles, sewer pipe, pottery, etc. Tableware (including vitreous hotel ware) is also being made in this area, with imported china clay as part of the body composition.

The stoneware clays or semi-fireclays that occur associated with the fireclays in the Sumas Mountain, south of Vancouver, are utilized on a rather large scale for making sewer pipe, flue liners, and 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 developed extensively for ceramic use. Stoneware clays or semi-fireclays occur also near Williams Lake and Chimney Creek Bridge in British Columbia, and near Swan River and Pine River, Manitoba, but they are difficult of access and have not been exploited extensively.

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

Fireclays

The value of refractories produced in Canada from domestic fireclays in 1951 was approximately $620,429 compared with $472,189 in 1950. The value of refractories made from imported clays in 1951 was $2,101,515. In 1950 it was $1,859,908.

Two large plants and a few small plants make fireclay refractories from domestic clay. Firebrick and other refractory materials are made at a plant about 50 miles south of Vancouver on a large scale from the high grade, moderately plastic fireclay that is extracted by underground mining from the clay beds in the Sumas Mountain. Other smaller enterprises have been established in this area in recent years for the manufacture of refractories or allied products from material obtained from the Sumas Mountain deposits. Some of this material is exported to northwestern United States for use in making refractories. A plant at Claybank, Saskatchewan, utilizes the highly plastic refractory clays obtained by selective mining of the "whitemud" beds in the southern part of the province. Small amounts of the most refractory clays in the deposits near Shubenacadie, Nova Scotia, have been used for refractory purposes by the steel plant at Sydney, and some of the Musquodoboit clay has been used for the production of stove linings, as well as for foundry purposes.

Other production of fireclay refractories (firebrick, high temperature cements, plastic refractories, etc.) particularly in eastern Canada, is from imported clays.

The rather extensive deposits of plastic fireclays that occur in the Mattagami, Missinaibi, and Abitibi Rivers in northern Ontario have received little attention owing to their remoteness and to certain difficulties attending efforts to extract uniform high-quality material.

Suitable deposits of such alumina or alumina-silica minerals as bauxite, sillimanite, kyanite, and andalusite, valuable raw materials for the production of super-duty refractories, have either not been found in commercial quantities in the various provinces, or economical methods of exploiting them have not been developed.

Fireclays imported from the United States enter Canada duty free if not further processed than ground.

China and Ball Clay

The value of china and ball clay products made in Canada in 1951 was $14,109,986. In 1950 it was $12,428,874. Large quantities of china clay are also imported for use in the paper and rubber industries. Imports of china clay in 1951 were valued at $1,697,816, of which $1,052,325 worth came from the United States, and $645,491 worth from the United Kingdom.

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 some years ago to refine the kaolinized material found there into high-grade china clay, and to recover washed silica sand as a by-product. However, this project was abandoned in 1948 because of mining and operational difficulties.

None of the several other smaller deposits of kaolin in Quebec has been developed. One of these is near Point Comfort, Thirty-one Mile Lake, Hull county, the others being near Brebeuf, Lake Labelle, and Chateau Richer.

The clay deposits in northern Ontario (see "Fireclays" above) contain material that may be classified as crude china clay, and in British Columbia, parts of the extensive clay deposits that occur along the Fraser River, about 25 miles above Prince George, yield high-grade crude kaolin. However, their distance from industrial centres has prevented development.

The Saskatchewan Government is continuing its extensive program of exploration of the ball clay and other clay resources, particularly in the southern part of the province, largely with the hope that markets for western ball clays may be expanded in eastern Canada and United States.

China clay imported from England or United States is used to make electrical and other porcelains, sanitary ware, tableware, ceramic floor, and wall tile, etc.

DIATOMITE

Production of diatomite in Canada is small, practically all of the domestic requirements being met by imports from United States. Output (sales) which comes from Nova Scotia and British Columbia totalled 92 short tons in 1951 compared with 49 tons in 1950.

Most of the 300 known occurrences of diatomite in Canada are of the bog type (Recent freshwater origin) and the processed material is not suitable for the major uses. Material of Tertiary age, suitable for all uses except filtration, occurs in dry, compact beds in the Cariboo area of British Columbia but development has been hindered by transportation difficulties.

Production, Trade, and Consumption.

—	1951		1950	
	Short tons	$	Short tons	$
Production (sales)	92	3,148	49	1,665
Imports				
From United States	21,067	709,332	18,246	599,127

	1950	1949
	Short tons	Short tons
End-Use Consumption[1]		
Fertilizer dusting	7,873	6,944
Filtration	7,539	6,722
Fillers	2,227	2,292
Insulation	305	189
Concrete admixture	60	80
Chemicals and miscellaneous	7	10
Total	18,011	16,237

[1] Based on information supplied to the Mines Branch.

Canadian Deposits

Diatomite consists of microscopic siliceous, skeleton remains of diatoms, a form of algae.

The bog type material is of Recent (geologically) freshwater origin and occurs as a grey to brown to black mud or ooze in the swamps and lake bottoms of northern Nova Scotia, in southern New Brunswick, in the Muskoka area of Ontario, and in the bogs of northwestern Quebec. The largest known freshwater (swamp) deposit in Canada occurs at Digby Neck, Nova Scotia, from which some calcined diatomite is shipped each year to a Toronto firm that manufactures a lime diatomite brick for insulation purposes.

The material of Tertiary age occurs in dry, compact beds and is very light in weight with relatively low moisture content. It is from white to cream in colour. The Tertiary freshwater deposits near Quesnel in the Cariboo area of British Columbia extend for many miles along the Fraser river, are compact, and in places, are up to 40 feet thick. Small amounts of this diatomite have been marketed for insulation purposes, and tests have shown the material to be suitable for nitraprill coating if the moisture content is brought under 5 per cent.

World Production

United States is, by far, the largest producer and consumer of diatomite, the average annual production for the three-year period 1948-50 was 340,980 short tons valued at $6,153,780. During 1951 the production of prepared diatomite reached new record levels following the trend of recent years. It is reported that industrial requirements were not fully met for some highly processed filter-aid grades but additional processing facilities are expected to correct this condition in 1952. Production comes from 4 states; California, Oregon, Nevada, and Washington; California being the leading producer. Most of the output comes from 2 companies; Johns-Manville Corporation (Celite products) from deposits at Lompoc, California, and Great Lakes Carbon Corporation, Dicalite Division, (Dicalite products) from deposits near Bradley in California, Terrebonne in Oregon, and Basalt in Nevada. Quincy Corporation operates deposits in Quincy, Washington. The United States reserves of high quality diatomite are adequate for all requirements for many years to come.

Other producing countries include Denmark (Moler), Germany (kieselguhr), Algeria, Japan, France, and Union of South Africa.

Uses

Diatomite has become recognized as one of the basic and more important industrial minerals being an almost indispensable tool in the chemical, food-processing, and other filtration industries. One of its biggest and newest uses is in the preparation of antibiotics such as streptomycine.

Diatomite is used as a fertilizer dusting agent in coating ammonium nitrate prills (nitraprills) by The Consolidated Mining and Smelting Company of Canada Limited, in its plants at Warfield, British Columbia, and Calgary, Alberta, and by North American Cyanamid Limited in its plant at Welland, Ontario. Since the diatomite coating is highly porous it tends to absorb moisture, thus preventing the nitraprills from caking and sticking together, or from packing when the bags of fertilizer are stacked. Specifications, for this use, call for uncalcined diatomite of 95 per cent minus 325-mesh with less than 5 per cent moisture content.

Diatomite is used to speed the rate of filtration and to clarify solutions in many industries across Canada. These include sugar refining, liquor distilling, dry cleaning, syrup making, water filtration and purification, and filtering pregnant solutions in the goldmining industry. Most of the remainder is used as fillers in the paint, paper, rubber, soap, textile, and chemical industries.

Some Canadian diatomite is used in making lime-diatomite insulation bricks by a Toronto firm which uses Nova Scotia calcined diatomite. Minor amounts are consumed in concrete admixtures, insecticide carriers, insulation materials, metal polishes, etc.

The United States Bureau of Mines reports that in that country filtration accounts for about three-fifths of the total consumption; fillers for about one-quarter; insulation, about one-tenth; and other uses, including abrasives, the remainder. In Canada the nitraprill coating requirements account for about 44 per cent of the total consumption, filtration uses about 42 per cent, fillers about 12 per cent and the insulation, concrete admixture, carriers, etc. use the remainder.

Prices

Diatomite varies widely in price depending upon the use to which it is put, and the quantity purchased. Prices in 1951 did not change materially from those in effect during 1950. Filtration grades, f.o.b. Toronto or Montreal, varied from $100 to $160 a ton in ton lots with filler grades somewhat lower at $75 to $110 a ton. Diatomite for other purposes varied from $30 to $60 a ton f.o.b. consuming plants. Diatomite purchased in small lots for insecticide carriers, metal polishes, etc., ranged in price up to $200 a ton. Imported diatomite insulation bricks varied from $50 to $250 a thousand according to grade, source, and insulating properties.

FELDSPAR

Feldspar production rose 14·6 per cent in volume over 1950 to 40,749 short tons. Quebec and Ontario are the only producers with Quebec providing most of the output. The peak year was 1948 when 54,851 tons were produced.

Exports, mainly to United States, increased 28 per cent.

Quebec

Canadian Flint and Spar Company Limited, Ottawa, with mines in Derry, West Portland, and Templeton townships was the principal producer. Numerous smaller producers in the Buckingham district contributed to the output.

The grinding mill of Canadian Flint and Spar Company at Buckingham continued production of ground spar for the domestic trade. Bon Ami Company Limited, Montreal, continued to grind feldspar for its own use.

Ontario

Canadian Flint and Spar Company, operating in the Verona and Perth areas, and Bathurst Feldspar Mines Limited, operating in Bathurst township supplied most of the output. The remainder was produced by Bowser Bros. and Messrs. W. Cameron and L. Aleck, in Murchison township and by other smaller producers.

Uses and Specifications

For its main uses feldspar must be low in iron and in other colouring oxides. For whiteware, porcelain, glass, etc., the iron (Fe_2O_3) content should not exceed 0·06 per cent. Users of dental spar may tolerate up to 0·10 per cent.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production				
Quebec	28,000	425,370	29,788	378,782
Ontario	12,749	125,727	5,760	49,619
Total	40,749	551,097	35,548	428,401
Imports				
All from United States	194	4,915	144	3,702
Exports				
To: United States	19,003	150,614	14,956	97,616
Other countries	829	23,207	509	15,141
Total	19,832	173,821	15,465	112,757

	1950	1949
	Short tons	Short tons
Consumption		
Clay products	6,911	7,111
Cleansers	2,831	3,164
Glass	4,286	2,902
Enamelling	1,849	1,966
Abrasives	9	15
Total	15,886	15,158

The highest quality of feldspar is potash microcline of high purity. Feldspar comprising mixtures of potash and soda spar (albite) are subject to lower grading. For ceramic use, colour is not important. For cleansers, however, for which both potash and soda spar are accepted, the material should be of good white colour.

Markets, Prices, Tariffs

Canadian Flint and Spar Company Limited is the principal purchaser of crude feldspar of all grades in Canada. Bon Ami Limited purchases white spar for cleanser use. Buyers of Canadian ceramic grade spar in United States include Consolidated Feldspar Corporation, Rochester, New York, and Shenango Pottery Company, New Castle, Pennsylvania. Buyers of dental grade include Myerson Tooth Corporation, Cambridge, Massachusetts; Dentists' Supply Company, New York City; and Universal Dental Company, Philadelphia, Pennsylvania.

Prices for No. 1 crude feldspar in 1951 ranged up to $10 a short ton f.o.b., rail. The average declared unit value of crude shipped to United States was $7.90 a short ton compared with $7.27 in 1950. Final 1951 quotations for ground pottery grade, f.o.b. Toronto or Montreal, bagged, carload lots—$24.20 a short ton; less than carload lot—$26.40 a short ton.

The duty on crude feldspar entering United States (effective June 6, 1951, by the Torquay Agreement) was 12½ cents a long ton and on ground feldspar 7½ per cent ad valorem.

FLUORSPAR

Production of fluorspar in Canada in 1951 reached a new high of 74,211 tons valued at $2,189,875, compared with 64,213 tons valued at $1,553,004 in 1950. As in 1950, approximately 90 per cent of the output came from Newfoundland and the remainder from Ontario. Exports, all to United States, reached a peak of 21,461 tons, an increase of 50 per cent over that of the previous year. Imports totalled 8,188 tons, an increase of over 400 per cent above the 1950 total, and came mainly from Mexico, Spain, and United States.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production (shipments)				
Newfoundland	67,925	1,966,477	55,595	1,290,361
Ontario	6,286	223,398	8,618	262,643
Total	74,211	2,189,875	64,213	1,553,004
Imports				
From: Mexico	2,670	74,663	579	10,528
Spain	2,292	74,249	....	....
United States	1,360	55,113	844	38,609
Other countries	1,866	35,095	149	17,686
Total	8,188	239,120	1,572	66,823
Exports [1]				
To: United States	21,461	....	14,238	....

	1950	1949
	Short tons	Short tons
Consumption		
Heavy chemicals and non-ferrous smelters	29,620	32,947
Steel furnaces	21,800	21,136
Glass	484	432
Enamelling and glazing	229	297
White metal alloys	4	14
Total	52,137	54,826

[1] From United States Import Statistics.

Ontario

The Madoc area in Hastings county continued to supply all of the production. Output in 1951 was about 27 per cent lower than that of 1950. The Rogers mine of Reliance Fluorspar Mining Syndicate Limited, about 1½ miles southwest of Madoc, was the only producer in 1951, although the Bailey mine of Millwood Fluorspar Mines Limited, located 1 mile northwest of the Rogers mine, made several shipments from ore stockpiled during the previous year.

Some fluorspar was mined in the Madoc area in the early years of the present century, but the deposits first received serious attention during and immediately following World War I when a number of mines were opened and shipments totalling about 20,000 tons were made. Production then decreased, and until 1939 seldom exceeded 100 tons in any one year. With the outbreak of World War II, operations were resumed at several of the larger mines, and in the ten-year period ending in 1949, shipments totalling over 70,000 tons were made. The Rogers mine has been a steady producer since 1943, and together with the Bailey mine, has produced all of the fluorspar mined in Ontario since 1948.

Operations ceased temporarily at the property of Cardiff Fluorite Mines Limited near Wilberforce, Haliburton county, with the completion of its exploration and development program in March, 1951. This work, consisting of 315 feet of shaft sinking and some 800 feet of drifting and crosscutting, commenced in June of the previous year.

Newfoundland

All the commercial fluorspar veins occur in the vicinity of St. Lawrence, a town on the southeast coast of Newfoundland, most of the veins being within 6 miles of St. Lawrence Harbour. St. Lawrence Corporation Limited and Newfoundland Fluorspar Limited are the two producers.

Production of St. Lawrence Corporation came from 6 mines in 1951, with the Iron Springs mine, the only producer the previous year, supplying about 75 per cent of the total production. By means of a combination gravity and flotation mill the company turns out one of the highest grade concentrates in the world; the particular mill circuit being used at any time depending upon the grade of ore mined and the grade of concentrate desired. Production in 1951 totalled 27,201 tons of concentrates, consisting of 6,074 sub-metallurgical, 6,899 metallurgical, and 14,228 acid grade, compared with 19,956 tons in 1950, consisting of 4,600 metallurgical, 946 assaying 94 per cent or better, and 14,410 acid grade. Shipments amounted to 30,726 tons compared with 17,780 tons in 1950, and consisted of 6,060 tons sub-metallurgical to steel plants in United States, 8,160 tons metallurgical to steel plants in Canada, and 16,506 tons acid grade to United States. The acid grade flotation concentrates were shipped to a subsidiary, St. Lawrence Fluorspar, Incorporated, at Wilmington, Delaware, where they were dried before reshipping to the chemical and ceramic industries.

Production of Newfoundland Fluorspar Limited, a subsidiary of Aluminum Company of Canada Limited, is derived from the Director mine, 1½ miles west of St. Lawrence. In 1951, ore was treated in the recently erected heavy-media separation plant at the Director mine and yielded 42,457 tons of metallurgical grade concentrates, compared with 36,032 tons of hand-picked, crushed ore, having an average calcium fluoride content of 75 per cent, in 1950. Shipments totalled 42,065 tons compared with 37,815 tons in 1950, 33,868 tons of metallurgical and sub-metallurgical grade to Arvida, Quebec, and 8,197 tons of metallurgical grade to the steel plants in Canada. At Arvida, the heavy-media product is improved by flotation, and with the exception of a few shipments to other consumers, is used in the manufacture of aluminium by the electrolytic process.

No serious estimate of Newfoundland's ore reserves can be made, but they are probably very large. Over 24 veins have been located, none of which has been completely traced longitudinally or vertically. However, fluorite mineralization is known to extend for as much as three miles longitudinally, and at depths of over 500 feet no significant changes are noted in grade or width.

The fluorspar veins in Newfoundland are steeply dipping, ranging from vertical to 65 degrees with a few minor exceptions, and vary in width from a few inches to more than 20 feet. The 'higher grade' veins, averaging between

4 and 5 feet in width, have a CaF_2 content of at least 95 per cent, and silica content of 1 to 4 per cent, while the 'lower grade' veins average between 15 and 20 feet in width, have a CaF_2 content of about 75 per cent, and a silica content of 10 to 15 per cent.

Other Occurrences

Fluorspar deposits occur also in Ross township, Renfrew county, Ontario; in Huddersfield township, Pontiac county, Quebec; in the Lake Ainslie district, Cape Breton Island, Nova Scotia; and at the Rock Candy mine of The Consolidated Mining and Smelting Company of Canada Limited, near Grand Forks, British Columbia.

Uses and Specifications

Fluorspar in Canada is consumed chiefly in the manufacture of aluminium fluoride used in the aluminium industry. The fluoride is added directly to the pots as a make-up to the electrolyte. The other uses of fluorspar in order of importance are: as a powerful fluxing agent in the steel industry, where about 6 pounds of spar are required per ton of steel made in the open hearth, and 20 pounds per ton for that made in the electric furnace; in the manufacture of heavy chemicals; and in the ceramic industry as a fluxing and opacifying ingredient in glass and enamels. Fluorspar is used in small amounts in numerous other metallurgical industries, including foundries and various metal-refining plants.

In United States the largest consumer is the steel industry, which also consumes substantial quantities of hydrofluoric acid and sodium fluoride. The next largest use is in the manufacture of hydrofluoric acid.

Standard fluxing gravel, or lump grade, for metallurgical use is usually sold on a specification of a minimum of 85 per cent CaF_2, and maximum of 5 per cent silica and 0·3 per cent sulphur. Fines should not exceed 15 per cent.

Glass and enamel grades call for not less than 95 per cent CaF_2, with maxima 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 silica. Like the ceramic grade, it is used mainly in powder form.

Prices

Prices received for fluorspar vary widely, and the following quotations can serve only as a general guide to prices obtained by producers and dealers in Canada. The prices for various grades of fluorspar can be ascertained only by direct negotiation between buyer and seller.

In 1951, quotations in Canadian Chemical Processing for metallurgical gravel, 85 per cent grade fluorspar remained at $60 a ton, carlots, f.o.b. Toronto. For ceramic ground, 95 per cent grade, in bags, the quotations opened in January at $4.10 to $4.25 per 100 pounds, and increased to $4.65 to $5.40 by the end of the year.

In United States, quotations in the E. & M. J. "Metal and Mining Markets" indicate that prices for metallurgical grade increased by about $2 a ton during 1951. Based on effective units of CaF_2, and f.o.b. Kentucky-Illinois mines, 1951 year-end prices were as follows: 70 per cent and over, $43 a ton; under 60 per cent, $41; and pellets, 60 per cent, $34. "Effective units" are computed as actual CaF_2 content less $2\frac{1}{2}$ times the percentage of contained silica. Acid grade fluorspar, 97 per cent CaF_2, bulk, opened at $46.50 to $50, then increased to $60 in October where it remained for the rest of the year. Ceramic grade fluorspar, 95 per cent CaF_2, calcite and silica variable, 0·14 per cent Fe_2O_3, was quoted at $45 a ton, bulk, and $48.50 a ton, in bags, f.o.b. Rosiclare, Illinois. Foreign fluorspar, metallurgical grade, duty paid, was quoted at $38 to $40 a short ton; and acid grade, duty paid, was quoted at $52, Atlantic seaboard.

Tariffs

The duty on fluorspar containing more than 97 per cent CaF_2 entering United States in 1951 was $5.00 a short ton from January 1 to June 5 and, by the Torquay Agreement, $1.875 a short ton for the remainder of the year; the duty on fluorspar containing 97 per cent or less was $7.50 a short ton. Fluorspar enters Canada duty free.

GRANITE

Production of granite, all forms, in 1951, showed a decrease in tonnage and increase in value compared with that of 1950. Granite used as concrete aggregate, road metal, roofing granules, breakwater, etc., accounted for over 97 per cent of the tonnage but little more than 55 per cent of the value. The remaining tonnage is used as polished building stone and monumental stone.

The term '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. A large part of Canada is underlain by such rocks, but to be economically productive, granite must have certain qualities such as strength, uniformity, colour, etc., and the deposits must be near transportation facilities and markets.

Quebec is the granite province of Canada because of the proximity of the granite areas to population centres and transportation facilities. Small quantities are produced in all provinces with the exception of Alberta and Saskatchewan. Ontario produces a considerable tonnage of crushed granite.

In Quebec grey granite is the principal rock quarried and comes from many districts, including Rivière-à-Pierre, St. Samuel, St. Sebastien, Stanhope, Scotstown, and Stanstead. Black granite is produced at St. Joseph d'Alma in the Lake St. John district and in the Noranda area; dark bluish-grey granite in the Mount Johnson area about 40 miles east of Montreal; and red granites in the Grenville, Guenette, and Lake St. John districts.

In Nova Scotia, grey granite is produced in the Nictaux and Shelburne areas, and black granite from the Shelburne area.

New Brunswick has deposits of red, black, and grey granite of good quality. Grey granite is produced in the Hampstead area.

In Ontario, black granite is now being produced at River Valley and red granite at Vermilion Bay. Some development work was done on the red granite near Lyndhurst.

In Manitoba small amounts of red, grey, and black granite are quarried near the Manitoba-Ontario boundary for the Winnipeg market.

British Columbia has widespread occurrences of granite in varied colour, one of the best known building stones being the andesite from Haddington Island. The grey granite from Nelson Island is also used extensively in building.

Production and Trade

	1951		1950	
	Short tons	$	Short tons	$
Production of monumental and building granite				
Rough	16,641	289,119	18,447	281,804
Dressed	25,345	2,357,349	18,823	1,906,608
	41,986	2,646,468	37,270	2,188,412
Production of rubble and riprap, roofing granules, concrete aggregate, road metal, etc.	1,908,578	3,367,653	2,033,782	2,782,732
Total	1,950,564	6,014,121	2,071,052	4,971,144
Exports of granite and marble (unwrought)				
To: United States	3,715	89,001	5,579	76,184
Imports of granite				
Rough				
From: United States	....	95,374	....	73,915
Sweden	....	32,578	....	53,718
Finland	....	10,047	....	18,456
Norway	....	8,563	....	....
Total	....	146,562	....	146,089
Sawn				
From: United States	....	25,679	....	29,263
Sweden	....	10,080	....	5,150
Finland	....	3,237	....	5,051
Other countries	....	2,803	....	....
Total	....	41,799	....	39,464
Granite Manufactures				
From: Sweden	....	75,017	....	94,772
Germany	....	61,577	....	667
Finland	....	26,646	....	14,108
United States	....	10,594	....	12,705
Other countries	....	2,239	....	867
Total	....	176,073	....	123,119

Uses

Granite is usually quarried in Canada for use as building or monumental stone and in both cases there is a large amount of waste in the quarries. Some of the large irregular blocks are used as riprap to strengthen breakwaters and causeways against heavy washes or currents while some of the smaller pieces are crushed for concrete aggregate or are used as poultry grit, paving blocks, or curbstones. Granite, as a building stone is used chiefly for ornamental purposes forming the outside facing of the lower portion of many buildings.

Some of the granite produced in Canada has good export possibilities, especially the red and black varieties which are much in demand as a monumental stone in United States.

GRAPHITE

Production of natural graphite dropped sharply in 1951, due to the unexpected flooding, late in 1950, of the Black Donald mine near Calabogie, Ontario. This mine which was the sole producer in Canada, was operated by Black Donald Graphite Limited, a subsidiary of Frobisher Limited. The company has continued operations on a reduced scale with ore from surface excavations on lateral extensions of the Black Donald orebody, with tailings from the lake bottom, and with small shipments from properties under development near Perth, Ontario, and Buckingham, Quebec.

Artificial graphite is produced by Electro-Metallurgical Company of Canada Limited, Welland, Ontario.

Shipment of finished products in 1951 (1950 figures in brackets) of which 73 per cent was exported to United States consisted of 1,327 (2,893) tons of amorphous foundry grades, 38 (389) tons of dust and 204 (304) tons of high grade lubricating and pencil flake.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Shipments by types				
Amorphous foundry grades	1,327	162,401	2,893	280,734
Dust grades	38	5,083	389	53,959
High grade lubricating and pencil grades	204	63,683	304	56,122
Total	1,569	231,167	3,586	390,815
Shipments by destination				
United States	73·4 per cent		86·8 per cent	
Domestic market	26·6 per cent		13·2 per cent	
Exports, crude and refined				
To: United States	1,148	155,769	3,032	311,508
Other countries	4	767	12	1,949
Total	1,152	156,536	3,044	313,457
Imports, unmanufactured				
From: Mexico	....	47,354	....	35,502
Ceylon	....	24,028	....	9,885
United States [1]	....	22,557	....	26,053
Other countries	....	2,786	....	....
Total	....	96,725	....	71,440
Imports, ground and manufactured [2]				
From: United States	....	466,392	....	319,157
United Kingdom	....	7,332	....	4,417
Other countries	....	2,787	....	6,868
Total	....	476,511	....	330,442
Imports, crucibles				
From: United States	....	119,762	....	86,488
United Kingdom	....	95,535	....	77,654
Total	....	215,297	....	164,142

[1] Mainly re-exported graphite.
[2] Excluding crucibles.

Total unmanufactured imports, which showed an increase over 1950 of 35 per cent in value, came chiefly from Mexico (49 per cent), Ceylon (25 per cent), and United States (23 per cent).

Ground and manufactured imports (excluding crucibles) increased 44 per cent in value to an all time high of $476,511. Crucible imports, all from United States and United Kingdom, increased 31 per cent in value.

Production in Canada, mostly of small flake and amorphous, has come in the past from widely scattered deposits in the crystalline limestones and gneisses in the general Ottawa region and in adjacent sections of eastern Ontario and western Quebec. Other deposits are known to occur in New Brunswick, Labrador, Manitoba, British Columbia and Northwest Territories.

Principal world sources are Madagascar (large flake), Ceylon (plumbago), and Mexico (amorphous).

Uses

The iron and steel industry accounts for a high percentage of the consumption of graphite in the form of crucibles, foundry facings, and other refractories. Other consumers include manufacturers of heavy chemicals, electrical apparatus, paints, polishes, lubricants, 'lead' pencils, and various compounds used as cement and protective coatings. Colloidal graphite is used for the impregnation of wearing metal surfaces to reduce friction.

Carbon-graphite is used as a structural material for bearings and related parts, particularly in equipment liable to exposure to a wide temperature range.

Carbon content, type (flake, crystalline, or amorphous), and mesh size in the case of the flake graphite, are the principal factors governing application and value but specifications vary according to consumers' preferences. No universal code of specifications is available.

Artificial graphite is employed as an alternative to natural amorphous in many applications. Its principal uses are for the manufacture of heavy electrodes, dry batteries, lubricants, commutator brushes, and colloidal graphite.

Canadian consumption of graphite by industries in 1949 and 1950 was:

	1950 Short tons	*1949* Short tons
Iron and steel		1,332
Paints	52	72
Electric apparatus		125
Heavy chemicals		186
Prepared foundry facings		222
Polishes	33	27
Brass and bronze foundries	30	32
Total		1,996

Prices

Final Canadian quotations in 1951 as published in Canadian Chemical Processing were: Graphite, various grades, 7½c to 90c a lb.; plumbago, s.t. extra, 8¾c to 18c a lb.

Final United States quotations as published in E. & M. J. "Metal and Mineral Markets" for December 20, 1951, were:

Crystalline flake, natural, per lb. carload lots, f.o.b. shipping point:
- 85 per cent to 88 per cent C crucible grade, 13c
- 96 per cent C special and dry usage, 22c
- 94 per cent C normal and wire drawing, 19c
- 96 per cent special for brushes, 25c

Amorphous, natural, for foundry facings:
- Up to 85 per cent C, 10c per lb.

Madagascar, c.i.f. New York:
"Standard grades 85 per cent to 87 per cent C", $250 per ton.
Special mesh, $300 to $325 per ton.
Special grade 99 per cent C, $725 per ton.

Amorphous graphite, Mexican, f.o.b. point of shipment (Mexico), per metric ton, $9 to $16, depending on grade.

Tariffs

Canadian	British	Most Favoured Nation	General
Crucibles	Free	15 per cent	15 per cent
Graphite, not ground or otherwise manufactured	Free	7½ " "	10 " "
Graphite, flakes	Free	5 " "	10 " "
Graphite, ground and manufactures of n.o.p.	15 per cent	20 " "	25 " "
Graphite foundry facings of all kinds	15 " "	22½ " "	25 " "

United States

Amorphous	—	5 per cent ad valorem
Crystalline: lump, chip, and dust	—	7½ per cent ad valorem
Crystalline flake	—	15 per cent ad valorem, but not less than 0·4125 cents nor more than 0·825 cents per pound.

GYPSUM AND ANHYDRITE

Gypsum, or hydrous calcium sulphate, is found in every province except Saskatchewan and Prince Edward Island. Nova Scotia is the chief producer followed by Ontario, Manitoba, British Columbia, and New Brunswick.

During the post war years, production of crude gypsum rose sharply from 1,810,937 tons in 1946 to a record of 3,802,692 tons in 1951.

Most of the output of crude gypsum, crushed to a size convenient for handling, is exported, 79 per cent alone going to United States. The remainder is calcined to form a partially dehydrated product known as plaster of Paris which is used domestically mainly in the manufacture of plasters and wall boards. A new foreign market was found when New Zealand imported 2,500 tons of crude gypsum in 1951.

Anhydrite, or anhydrous calcium sulphate, is of little commercial importance in Canada, and production is limited chiefly to quarries in Nova Scotia where its removal is sometimes necessary to the mining of gypsum.

Nova Scotia

Many deposits in various parts of the province were explored during 1951 but production was still limited to deposits in Victoria county in Cape Breton Island and in Hants county on the mainland. Most of the production is exported to United States but small quantities are processed in Nova Scotia and Quebec.

Canadian Gypsum Company Limited, a subsidiary of United States Gypsum Company, and the largest producer of gypsum, operates quarries at Wentworth near Windsor in Hants county. The gypsum is shipped 15 miles by rail to a storage and shipping pier at Hantsport from where it is taken by company boats to United States Gypsum Company's plants at various points on the eastern seaboard of United States.

National Gypsum Company (Canada), Limited operates a quarry for export purposes in Hants county at Walton; and Windsor Plaster Company, Limited produces raw gypsum from a small quarry near Brooklyn for its plaster mill in Windsor.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production, crude gypsum				
Nova Scotia	3,190,030	4,107,822	3,185,199	3,802,786
Ontario	262,581	672,276	199,314	875,217
Manitoba	134,704	509,276	114,555	1,037,510
British Columbia	105,908	263,072	84,627	620,108
New Brunswick	109,469	328,407	82,641	371,885
Total	3,802,692	5,880,853	3,666,336	6,707,506
Exports of crude and ground gypsum, plaster of Paris, and wall plaster				
To: United States	3,019,495	3,112,662	2,963,793	3,053,239
Puerto Rico	9,632	17,605	6,260	11,261
New Zealand	2,540	3,509	...	...
Other countries	60	65	23	128
Total	3,031,727	3,133,841	2,970,076	3,064,628
Imports of gypsum, plaster of Paris, and wall plaster				
From: United States	17,124	346,852	23,120	433,710
United Kingdom	255	7,531	167	4,872
Total	17,379	354,383	23,287	438,582

In Victoria county, National Gypsum Company (Canada), Limited, and Victoria Gypsum Company, Limited, operate quarries at Dingwall and Little Narrows, respectively. From Dingwall the gypsum is shipped principally to company-owned plants in United States but some is sold to gypsum plants in Quebec and to cement plants in eastern Canada. From Little Narrows the gypsum is exported to United States and the West Indies.

Ontario

Gypsum Lime and Alabastine, Canada, Limited at Caledonia, and Canadian Gypsum Company Limited at Hagersville, manufacture a wide variety of gypsum plasters and wallboards from gypsum rock obtained from beds underlying the plants.

Manitoba

Gypsum Lime and Alabastine, Canada, Limited and Western Gypsum Products Limited produce gypsum plasters and wallboards at Winnipeg. The former company obtains gypsum rock from its own quarry at Gypsumville, and the latter from a mine at Amaranth, both in Manitoba.

British Columbia

Gypsum Lime and Alabastine, Canada, Limited produces gypsum plasters and wallboards at its New Westminster plant from gypsum rock obtained from the company quarry at Falkland. Rock from the same quarry is shipped to Calgary, Alberta, for processing.

Columbia Gypsum Products Incorporated continued development of the gypsum deposits at Windermere and exported some gypsum to the company plant at Spokane, Washington, and sold to buyers in Alberta.

A new producer, Alan Howard Company, started shipping crude gypsum in March, 1951, from a deposit near Mayook in the Fort Steele mining district some 7 miles northwest of Warden, British Columbia, on the Canadian Pacific Railway line between Fernie and Cranbrook.

Alberta

Gypsum Lime and Alabastine, Canada, Limited produces gypsum plasters at its plant in Calgary from raw gypsum obtained from the company's quarry at Falkland, British Columbia.

Western Gypsum Products, Limited, which also has a plant in Calgary, produces plasters and wallboards from raw gypsum obtained from the company's mine at Amaranth, Manitoba, and from the new gypsum deposits at Windermere, British Columbia.

New Brunswick

From deposits of gypsum near its Hillsborough plant Canadian Gypsum Company Limited produces all grades of plaster and wallboard, including high quality plasters for specialized uses. Products are used in various parts of Canada.

Quebec

Gypsum Lime and Alabastine, Canada, Limited produces plasters and wallboard at its Montreal East plant, from rock obtained from Dingwall, Nova Scotia.

Newfoundland

There are vast deposits of gypsum in Newfoundland, well located for transportation but undeveloped. The Provincial Government erected 2 factories for the production of gypsum plaster, and plaster board and lath. The capacity of the plaster plant is to be 200 tons daily and the capacity of the board plant is to be 250,000 square feet of wallboard or 285,000 square feet of plaster lath a day. The plants will use local gypsum taken from a deposit in the Bay St. George area, district of St. Georges, Port au Port, on the west coast.

Uses

Gypsum

Calcined gypsum is the principal component of plasters and wallboards. When heated at a low temperature, gypsum gives off three-quarters of its water of crystallization. The resultant product known as plaster of Paris, sets quickly to a hard porous mass when water is added. Plaster of Paris, as such, has only limited uses, as in moulding work where quick setting is required, or in ceramic work where its porous properties are essential. To make plasters and wallboards, certain materials are added to 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 made also from calcined gypsum such as acoustic boards, partition tile, fire-resisting walls, insulating tile, etc. Gypsum is added in small quantities to Portland cement where it acts as a retarder in the time of set of the cement.

Gypsum, in 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. Production in Canada is usually limited to quarries where the removal of anhydrite beds is essential to the continued production of gypsum. The material is used as a soil conditioner on peanut crops in United States. Anhydrite, however, is a potential source of sulphur compounds and in several plants in Europe is being used for such purpose.

Prices

The nominal price of crude gypsum in 1951 as quoted by Canadian Chemical Processing was $3 to $3.50 a ton f.o.b. quarry or mine. However, large contracts with seaboard quarries were at prices much below these figures.

IRON OXIDES (OCHRES)

The iron oxide industry in Canada is relatively small. The production of natural iron oxides and ochres has been confined for many years to the Province of Quebec and has come chiefly from the Trois-Rivières area. The term ochre is commonly used to designate those forms of iron hydroxide that are used in making pigments and polishing rouge, for colouring oil cloth and linoleum, and for purification of coal gas. Extensive deposits of such material occur in St. Maurice and Champlain counties, Quebec, where some of the deposits have been in continuous production since 1886.

Sherwin Williams Company of Canada Limited, the only Canadian producer of calcined iron oxides, operated a deposit and a calcining and grinding plant at Red Mill, Quebec, a few miles east of Trois-Rivières, and worked another deposit at Champlain, about 12 miles northeast of Trois-Rivières.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production (sales)				
Quebec	13,342	262,277	13,696	262,632
Imports: ochres, siennas, umbers				
From: United States	1,173	72,032	1,398	79,967
United Kingdom	161	9,010	146	9,076
Other countries	136	2,587	....	....
Total	1,470	83,629	1,544	89,043
Exports, iron oxides				
To: United States	2,918	347,252	3,500	341,980
United Kingdom	217	11,106	20	1,628
Brazil	103	20,550	....	....
Mexico	93	15,888	100	16,803
France	89	14,603	50	7,521
Other countries	226	40,346	264	43,963
Total	3,646	449,745	3,934	411,895

Quebec

Output included both crude ochre and calcined oxide, most of it being in the form of crude, uncalcined ochre.

Producers in 1951 shipped crude air-dried ochre from 8 deposits in Champlain and St. Maurice counties, within 20 miles of Trois-Rivières, and from a deposit at St. Raymond, Portneuf county. The output is marketed in Quebec, Ontario, Nova Scotia, British Columbia, and eastern United States.

Sherwin Williams Company of Canada Limited produced calcined, milled, and air-floated products, in its plant at Red Mill, Champlain county. The output is used principally in mineral pigments and polishing rouge.

Manitoba

The large deposits near Grand Rapids and Cedar Lake remained undeveloped due to lack of markets.

Saskatchewan

The principal deposit of possible economic interest is at Loon Lake, 32 miles from St. Walburg on the Canadian National Railway.

British Columbia

From 1921 to 1949 there was a small annual output of iron oxide from a deposit at Alta Lake, New Westminster area, but no production was recorded in 1950 or 1951. Bog iron ore suitable for treatment of illuminating gas occurs in the Peace River district but deposits have not been developed.

Uses

Canadian consumption of iron oxide by the illuminating gas industry in 1950 was 11,624 tons valued at $114,138. The paint industry in 1950 consumed 2,453 tons of calcined iron oxide valued at $378,423, and 268 tons of ochres, siennas, and umbers valued at $51,514.

Iron oxide pigments are used as colouring agents and fillers in making 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; in wood stains and wood fillers; and in colouring cement, stuccos, and mortar.

Prices

The Canadian price of red iron oxide, f.o.b. Toronto or Montreal, as given by Canadian Chemical Processing, varied from 8 to 15 cents a pound in 1951, while yellow, brown, and black iron oxides varied between 5 and 15 cents. Siennas sold at 6 to 12 cents a pound, and umbers at 7 to 10 cents a pound. These prices were for the natural iron oxides, umbers, and siennas. Prices for the synthetic varieties were slightly higher.

LIME

Lime production in Canada in 1951 of 1,241,041 tons valued at $14,082,520, exceeded that of any previous year. Seven provinces contributed to the total with Ontario and Quebec accounting for 87·0 per cent. Although building trades are important consumers (16 per cent) most of the lime output is used industrially. It is an important raw material to pulp and paper mills, metallurgical plants, and several chemical processes.

Approximately 45 plants are in operation with 150 kilns ranging in size from the small pot type to the large rotary types. Lime is produced by a number of companies for use as a raw material in their own processes.

Since limestone and lime plants are distributed widely, lime does not enter into international trade except to a minor extent along the International Boundary.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production				
Quicklime	982,689	11,387,428	885,219	9,748,936
Hydrated lime	258,352	2,695,092	238,969	2,532,148
Total	1,241,041	14,082,520	1,124,188	12,281,084
Production by provinces		%		%
Newfoundland	436	0·1	396	0·1
New Brunswick	20,954	1·7	23,694	2·1
Quebec	460,842	37·1	393,905	35·0
Ontario	619,769	49·9	571,490	50·8
Manitoba	53,024	4·3	49,281	4·4
Alberta	30,670	2·5	33,564	3·0
British Columbia	55,346	4·4	51,858	4·6
Total	1,241,041	100·0	1,124,188	100·0
Imports (quicklime)		$		$
From: United States	14,620	156,869	13,921	155,424
United Kingdom	84	2,561	150	4,536
Total	14,704	159,430	14,071	159,960
Exports				
To: United States	35,463	533,461	33,033	508,283
Other countries	23	700	40	1,170
Total	35,486	534,161	33,073	509,453
Production, showing purpose for which used or sold				
Pulp and paper mills	232,463	2,813,208	210,290	2,397,303
Metallurgical	201,047	1,585,596	158,204	1,162,442
Building trades	171,267	2,651,185	182,558	2,738,830
Sugar refineries	21,247	279,285	23,883	321,599
Glass works	11,730	145,892	13,633	159,892
Agriculture	14,709	199,584	14,088	187,863
Sand-lime brick	13,437	144,397	12,813	132,190
Other industrial uses	541,261	5,960,803	489,086	5,030,217
Various non-industrial uses	33,880	302,570	19,633	150,748
Total	1,241,041	14,082,520	1,124,188	12,281,084

Deposits of limestone suitable for production of lime occur in all provinces except Prince Edward Island. However, because of its important rôle as a raw material in industry, much of the output is concentrated near the main industrial areas of Ontario and Quebec. Presence of large markets has aided the development of larger kilns and more efficient production techniques.

In spite of wide distribution of limestone high calcium deposits close to the consuming areas and of a quality that will yield white chemical lime are not plentiful.

High calcium lime is produced in British Columbia, Alberta, Quebec, and Newfoundland; both dolomitic and calcium limes are available in Ontario, Manitoba, and New Brunswick.

Lime is marketed as a hydrate and as quicklime. The latter accounts for 79 per cent of the output and is produced as lump or pebble in bulk or containers or as crushed and pulverized lime, in which case it is bagged. Hydrate of lime, a dry slaked form with a fineness of 95 per cent or more through 325 mesh is sold in containers, usually multiwall bags.

Uses

Lime is the lowest-cost alkali available for control of acidity. It is essential to the production of calcium cyanamide, calcium carbide, soda ash, and other chemicals. Large quantities are used by the pulp and paper mills, metallurgical plants, and in the manufacture of glass and sugar.

Building trades use approximately 16 per cent of output, principally in mortars and plasters.

In agriculture, lime is important in the control of soil acidity, the correction of calcium deficiency, and as an ingredient in spray mixtures and dusting compounds.

Prices

Geographical location of plants and variations in lime quality are factors effecting price. However, according to Canadian Chemical Processing, the price of lump quicklime f.o.b. plants in carload lots in December, 1951, ranged from $10.25 to $11 a ton with high calcium hydrate in 50-pound sacks selling at $15 to $16 a ton.

LIMESTONE (GENERAL)

Production of limestone from Canadian quarries in 1951 was greater than in any previous year. Excluding stone for cement and lime-making, output was 15,531,948 tons valued at $20,901,704, about a 27 per cent increase in volume over 1950.

Widespread distribution of limestone and its suitability for a variety of uses have lead to its position as the most widely quarried rock in the country. Ontario, Quebec, Newfoundland, Nova Scotia, New Brunswick, Manitoba, Alberta, and British Columbia contribute to production. The two first-mentioned provinces supply 88 per cent of the limestone marketed in Canada for general uses.

Composition of Canadian limestones ranges from high calcium through magnesian to dolomite and includes both argillaceous and siliceous varieties. There are large deposits of brucitic limestone and dolomitic magnesite, some of which are being worked. In spite of plentiful limestone deposits, there is a scarcity of high calcium stone that meets exacting modern chemical and metallurgical specifications and that is economically accessible. It is anticipated that to provide future requirements it may be necessary to consider underground mining or beneficiation of impure deposits.

Trade in limestone between Canada and other countries is limited because of its position as a low-cost commodity and its wide distribution. However, local geographic and economic conditions result in export to United States of a small amount of stone for sugar refining, metallurgical, and wood pulp industries. In other localities a small quantity is imported from United States for similar uses.

Production

	1951		1950	
	Short tons	$	Short tons	$
Limestone (general)[1]	15,531,948	20,901,704	12,267,432	15,964,617
Limestone for:				
Manufacture of cement	4,246,501	....	4,119,216	....
" " lime	2,204,149	....	1,928,127	....
Total	21,982,598	....	18,314,775	....

[1] Includes structural limestone and marl for agricultural purposes.

Uses

Limestone is marketed in several forms ranging from dimensional blocks for the building industry to pulverized material as an industrial filler. Crushed stone for concrete aggregate, road metal, and railway ballast account for 82 per cent of production. Approximately 12,742,445 tons were used in this manner in 1951.

The manufacture of glass, processing of beet sugar, metallurgical and pulp and paper industries require a substantial quantity of limestone. In the pulp and paper industry limestone is a raw material in the calcium bisulphite process. In 1951, 1,508,003 tons were used by the chemical and metallurgical industries.

Screenings from the preparation of crushed stone at several quarries are now pulverized and marketed as asphalt filler, agricultural limestone, and as an industrial filler in several other uses. High quality white limestone is ground as whiting substitute.

In Canada increasing amounts are used as liming materials to correct acidity conditions in soil and to remedy calcium and magnesium deficiency. At present the chief market is in the Province of Quebec and smaller quantities are sold in Ontario, Manitoba, Nova Scotia, New Brunswick, British Columbia, Newfoundland, and Alberta. Sales of agricultural limestone and marl in 1951 amounted to $1,361,215.

A high purity dolomite is used in Canada as a source of magnesium in the thermal ferro-silicon process. The metal is also produced by another method using magnesia recovered from brucitic limestone.

At Dundas, Ontario, dolomite is dead-burned for use as a refractory in basic open hearth steel furnaces. Dolomitic magnesite mined at Kilmar, Quebec, and magnesia recovered from brucitic limestone at Wakefield, Quebec, are raw materials used in the manufacture of basic refractories in this country. Brucitic limestone also supplies a source of magnesia for other purposes and of hydrated lime. An argillaceous form of dolomite is used in Canada in the manufacture of rock wool.

Prices

The price of limestone varies according to the use to which it is put. As a stone crushed for concrete aggregate or road material the price a ton at the quarry is often as low as $1 to $1.50.

LIMESTONE (STRUCTURAL)

During 1951 there was a marked increase in the quarrying of dimensional limestone in Canada. Reported output was 80,833 tons valued at $2,709,907 compared with 72,263 tons valued at $1,803,061 in 1950. The increase was due to a wider use of Manitoba and Quebec stone. Production in Ontario decreased in 1951. A small output of 200 tons was reported from New Brunswick.

During the year, Canada Crushed and Cut Stone Limited was formed, consolidating the larger stone dressing plants in the Toronto area and the Queenston quarry.

In modern construction practice the principal outlet for structural limestone is in the larger types of buildings. For this application the stone must be prepared principally in the form of large slabs of accurate dimensions. Therefore, the output of the main quarries is directed chiefly towards large mill blocks or sawn slabs for shipment to stone-dressing plants where the stone is finished to the customers' specifications. Suitable stone must be heavily bedded, free from cracks and other defects, and must be easily worked. It must also have the desired colour and texture and be sufficiently durable to resist weathering action. Occurrences of this type are not plentiful in Canada with the result that a considerable quantity of stone is imported from the United States and the United Kingdom.

There are a number of small quarries, especially in the province of Quebec, which prepare hand-trimmed stone in the form of sills and lintels for use as facing in residences and small buildings.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production, limestone for building purposes [1]				
New Brunswick	200	400	200	300
Quebec	38,119	1,640,004	26,337	1,136,449
Ontario	35,396	421,564	40,745	455,002
Manitoba	7,118	647,939	4,981	211,310
Total	80,833	2,709,907	72,263	1,803,061
Imports, building stone (except marble and granite)				
From: United States	17,283	284,759	9,308	135,252
United Kingdom	824	12,952	310	11,370
Other countries	7	307	....	....
Total	18,114	298,018	9,618	146,622
Exports, building stone unwrought (except marble and granite)				
All to United States	295	7,205	128	2,951

[1] Value of production refers to stone marketed as mill blocks or in finished condition by the quarry and does not include the value of work done on the stone by cut-stone contractors.

The principal areas in Quebec where building stone is quarried are at St. Marc des Carrieres, Portneuf county and in the vicinity of Montreal. In both bases the stone is grey.

In Ontario near Queenston in the Niagara district, heavily-bedded deposits of the Lockport formation are quarried to produce a silver-grey and variegated buff and grey stone, used principally in large public buildings.

At Tyndall, Manitoba, a unique mottled limestone in buff and grey is quarried for both exterior and interior use. The stone is capable of taking polish which gives it a pleasing appearance.

Prices

Price of mill blocks depends on several factors including quarry location, size, grade of stone, and ease of quarrying. A typical price is in the order of $2.25 a cubic foot at quarry.

MAGNESITE AND BRUCITE

Production of magnesia in the form of calcined brucite granules and dead-burned dolomitic magnesite amounted to $2,437,773. The increase from $1,717,879 reported in 1950 is largely a reflection of a greater demand for these materials in the production of metallic magnesium and basic refractories.

At the present time the only deposits of magnesia minerals worked in Canada for magnesia products are in the province of Quebec near the Ottawa River.

In Argenteuil County at Kilmar, dolomitic magnesite is mined by underground methods to supply raw material for the basic refractories plant of Canadian Refractories Limited. Control of impurities is maintained in a heavy media separation plant. The mill product is ground, dead-burned in a rotary kiln, and made into a variety of refractory products. Manufacturing facilities will be increased considerably on completion of a new plant nearby at Marelon, Quebec.

At Wakefield, Quebec, the Aluminum Company of Canada, Limited, recovers magnesia from a deposit of brucitic limestone. The mineral brucite, a magnesium hydroxide is distributed as granules through a matrix of calcite. The recovery process separates these constituents into marketable forms of magnesia and hydrate of lime. The former is used in the production of basic refractories, as a source of metallic magnesium, as a general chemical and as a fertilizer. Hydrate of lime is distributed to the building trades, metallurgical, pulp and paper industries, and to agriculture.

Other deposits of the mineral occur in the Wakefield area, near Bryson in Quebec; Rutherglen, Ontario; and on West Redonda Island in British Columbia.

Although there are several occurrences of both hydromagnesite and magnesite in western Canada, principally in British Columbia and Yukon, there is no production. Most of these occurrences are either limited in extent or far from transportation. The most important deposits of magnesite are those owned by The Consolidated Mining and Smelting Company of Canada Limited at Marysville near Cranbrook, British Columbia. Impurities of silica and alumina can be removed by a flotation process devised by the company.

The earthy hydromagnesites found near Atlin and Clinton in British Columbia have been worked intermittently.

Uses

All dolomitic magnesite recovered in Canada is used in the manufacture of basic refractories. Bricks and shapes in many sizes, refractory cements, and dead-burned grain are marketed.

—	1951		1950	
	Short tons	$	Short tons	$
Production [1]—Dolomitic magnesite, and brucite	....	2,437,773	....	1,717,879
Imports				
Dead-burned and caustic-calcined magnesite				
From: United States	4,745	334,511	5,259	494,895
Norway	1,542	70,262	....	....
India	124	15,543	35	4,732
United Kingdom	109	10,291	693	68,269
Total	6,520	430,607	5,987	567,896
Magnesite firebrick				
From: United States	....	484,248	....	414,335
United Kingdom	....	8,768	....	....
Total	....	493,016	....	414,335
Magnesia alba and levis				
From: United States	894	210,121	550	126,852
United Kingdom	61	21,284	65	24,449
Total	955	231,405	615	151,301
Magnesia pipe covering				
From: United States	....	78,424	....	14,046
United Kingdom	....	41,592	....	10,670
Total	....	120,016	....	24,716
Magnesium carbonate				
From: United Kingdom	838	82,139	1,439	157,966
United States	339	53,426	238	30,685
Total	1,177	135,565	1,677	188,651
Magnesium sulphate				
From: Germany	1,928	41,609	1,036	22,505
United States	944	43,614	1,084	52,044
United Kingdom	127	7,642	413	19,017
Netherlands	66	2,140	260	7,078
Total	3,065	95,005	2,793	100,644
Exports				
Basic refractories, dead-burned				
To: United States	3,667	178,747	2,132	90,357
Brazil	1,200	73,220	450	31,055
Other countries	35	2,082	20	1,020
Total	4,902	254,049	2,602	122,432

[1] Does not include value of secondary products such as finished refractories but does include the value of a small amount of magnesium metal.

Magnesia from brucite deposits is used in the production of magnesium metal by the electrolytic process. It is also used by the refractory industry in making both burned and chemically bonded bricks and shapes and as a general chemical and fertilizer. Ground magnesia has been used in the preparation of magnesium bisulphite liquor. It has also been demonstrated experimentally that it is possible to use it in magnesium oxychloride and oxysulphate cements, and in the production of magnesia insulation.

MARBLE

Production of marble in Canada during 1951 amounted to 63,982 tons valued at $492,820 compared with 55,179 tons at $436,502 the previous year. Increased production is accounted for principally by higher output reported by producers in the province of Quebec.

Canadian marble is quarried principally for crushing and grinding and is marketed as terrazzo chips, poultry grit, stucco dash, whiting substitute, marble flooring, and as an aggregate in the manufacture of artificial stone. Slightly more than one-half of this country's output comes from deposits in the province of Ontario. Except for a few hundred tons from British Columbia, the balance is from operations in the province of Quebec. Although in both Ontario and Quebec mill blocks are quarried for further dressing into decorative stone, most ornamental marble is imported, principally from Italy and the United States in the form of mill blocks or sawn slabs which are then finished to customers' specifications.

Production

—	1951		1950	
	Short tons	$	Short tons	$
Quebec	25,637	289,334	20,602	250,114
Ontario	38,113	196,986	34,227	174,738
British Columbia	232	6,500	350	11,650
Total	63,982	492,820	55,179	436,502

Imports

(By countries of origin)

Type of Marble	United States	Belgium	Italy	France	Other Countries	Total 1951	Total 1950
	$	$	$	$	$	$	$
Rough	30,504	8,914	61,931	2,581	....	103,930	124,187
Sawn	80,816	6,944	108,787	4,273	....	200,820	125,720
Tombstones	49,248	....	4,761	....	....	54,009	63,153
Manufactures	38,480	2,245	16,987	508	956	59,176	98,529
Ornamental, for churches	....	....	17,604	488	....	18,092	55,958
Total	199,048	18,103	210,070	7,850	956	436,027	467,547

In addition to the above, mosaic flooring materials, part of which are marble, were imported to the value of $319,268.

Quebec

Missisquoi Stone and Marble Company Limited operates the largest marble quarry in Canada at Phillipsburg near the foot of Lake Champlain, quarrying a clouded grey marble. Products include mill blocks, sawn slabs, and finished marble. In addition marble is crushed and sized for terrazzo chips and poultry grit.

Orford Marble Company Limited quarries mill blocks of a serpentine variety in red, green, and grey from a deposit near North Stukely in Shefford county. Terrazzo chips are also prepared at this quarry.

At Portage du Fort, Pontiac county, Canadian Dolomite Company Limited quarries a white crystalline variety of dolomite which is crushed and sized for the production of terrazzo chips, stucco dash, artificial stone aggregate, and similar products.

South Stukely Marble & Terrazzo Company in Shefford county produces terrazzo chips and marble dust from a white marble deposit.

There is an intermittent production of a brown marble from building stone quarries at St. Marc des Carrieres, Portneuf county. This material has been used for store counters and wainscotting.

Ontario

Mill blocks and terrazzo chips are produced from a black marble by Silvertone Black Marble Quarries Limited at St. Albert Station, 30 miles southeast of Ottawa.

Terrazzo chips in red, pink, buff, green, black, and white are produced by Stocklosar Marble Quarries from deposits in the vicinity of Madoc, Hastings county. Verona Rock Products Limited, Verona, 20 miles northwest of Kingston, and Bolenders Limited north of Haliburton at Eagle Lake, produce poultry grit and stucco dash from white limestone.

Pulverized Marble Products, Limited, quarried crystalline dolomite from a deposit on the outskirts of Kaladar in Lennox and Addington counties for the production of plaster aggregate.

Manitoba

There are a number of undeveloped occurrences of highly coloured marbles along the Hudson Bay and the Flin Flon branches of the Canadian National Railway and at Fisher Branch, 100 miles north of Winnipeg.

British Columbia

A small tonnage of white marble is quarried by Marble and Associated Products from a quarry near Victoria for use mainly as stucco dash and as whiting substitute in the manfacture of putty.

There are several undeveloped occurrences in the province.

MICA

Primary production (sales) of mica of all classes in Canada in 1951 increased nearly 28 per cent in volume and almost doubled in value over 1950. The value of 1951 production was over four times that of 1949.

Production was derived from Ontario, Quebec, and British Columbia in that order.

Exports, unmanufactured, mostly to United States increased 40 per cent in volume and 200 per cent in value over 1950.

Ontario

North Bay Mica Company Limited, North Bay, Ontario, which operates the former Purdy mine at Eau Claire was again the only regular producer of sheet muscovite in Canada.

Production, Trade, and Consumption(1)

—	1951		1950	
	Pounds	$	Pounds	$
Production (primary sales)				
Trimmed	230,532	288,309	180,730	153,856
Splittings	6,302	5,421	2,100	1,785
Sold for mechanical splittings	108,831	17,350	104,400	17,062
Rough, mine-run or rifted	274,980	48,646	20	4
Ground or powdered	2,062,854	75,140	2,215,919	68,253
Scrap	2,278,009	12,784	1,376,040	11,651
Total	4,961,508	447,650	3,879,209	252,611
Imports (including manufactures)				
From: United States	.....	544,948	.....	474,724
India	.....	396,222	.....	237,647
United Kingdom	.....	32,487	.....	37,741
Other countries	.....	2,810	.....	7,713
Total	.....	976,467	.....	757,825
Exports				
Trimmed				
To: United States	352,800	334,283	67,300	96,481
Other countries	77,900	44,563	.....	.....
Total	430,700	378,846	67,300	96,481
Rough				
To: United States	234,900	45,630	164,800	27,983
Other countries	11,800	3,430	.....	.....
Total	246,700	49,060	164,800	27,983
Ground				
To: United States	770,000	43,918	560,000	28,117
Other countries	5,000	172	.....	.....
Total	775,000	44,090	560,000	28,117
Scrap				
All to United States	980,400	10,555	1,183,000	12,585
Total	2,432,800	482,551	1,975,100	165,166
Mica manufactures				
To: Brazil	.....	1,329	.....	1,000
United States	.....	655	.....	426
Other countries	.....	233	.....	49
Total	.....	2,217	.....	1,475

—	1950		1949	
	Pounds	$	Pounds	$
Consumption				
Paints	1,680,720	.....	1,137,583	.....
Electrical apparatus	485,602	.....	531,149	.....
Rubber goods	349,792	.....	383,361	.....
Roofing	.....	.....	2,284,000	.....
Wall paper	.....	.....	158,000	.....
Mica products	118,108	.....	105,534	.....
Total	.....	.....	4,599,627	.....

2,634,222

(1) Final figures.

71392—9½

Producers of phlogopite included Messrs. Blackburn Bros. operating in Loughborough township, W. C. and W. E. Green, Perth Road, operating a deposit near Portland, and F. J. Powers, Stanleyville, operating in North Burgess township.

R. W. Watts, Perth, produced biotite from a deposit owned by the Bancroft Mica and Stone Products Mining Syndicate Limited near Bancroft.

Suzorite Company Limited, Cornwall, Ontario, continued to produce ground mica for the roofing and filler trades from suzorite rock previously mined from a large deposit in Suzor township, Quebec.

Quebec

Principal producers included Messrs. Blackburn Bros., Cantley; E. Wallingford, Perkins; Adelard Poirier, Wilsons Corner; and E. and J. Renaud, Perkins; all in Hull township. Numerous smaller producers operating scattered deposits mostly in the Gatineau and Lievre River areas contributed to the output.

There was no reported production of muscovite in Quebec.

The grinding plant of Messrs. Blackburn Bros., located at Cantley, continued to produce roofing and lubricating grades throughout the year.

British Columbia

Ground mica, chiefly for the local roofing trade, is produced in Vancouver by George W. Richmond and by Fairey and Company from deposits of schist rock near Albreda.

Uses and Specifications

Mica is used in three principal forms, namely; natural sheet, used mainly for electrical insulation; splittings, used in making builtup sheet; and ground mica, used mainly in the roofing, paint, and rubber trades.

The quality of sheet mica depends upon its colour, splitting qualities, and freedom from cracks, blow holes, gas inclusions, ripples, rulings, mineral inclusions, hardness, and other physical characteristics. In general the lighter coloured phlogopite and clear muscovite have the highest electrical qualities and therefore bring the highest prices.

Splittings, comprising films as thin as one-thousandth of an inch or less, are used in various pressed and moulded forms, including sheet, cloth, (mica with cloth backing), paper, tape for binding insulation, tubes, washers, and many other shapes. They are manufactured from both muscovite and phlogopite according to use. Micanite is the general term used for all bonded mica sheet.

Ground mica of all classes is used extensively as an extender and pigment in paint; as a filler and dusting agent in roofing materials; and in rubber. It is also used in mould washes for foundry work, lubricants, wallpaper, pipe enamel, annealing, Christmas tree snow, and in high frequency insulators.

Muscovite is usually sold on the basis of its grading by size and quality according to specifications of the American Society for Testing Materials. Grade sizes of muscovite mica block and films (A.S.T.M. Designation 351-49T) are as follows:

A.S.T.M. grade sizes	Area of max. rectangle, sq. in.	Minimum dimension of one side in.
OOEE Special	100 and over	4
OEE Special	80 to 100	4
EE Special	60 to 80	4
E Special	48 to 60	4
A-1 (Special)	36 to 48	4
No. 1	24 to 36	3
No. 2	15 to 24	2
No. 3	10 to 15	2
No. 4	6 to 10	1½
No. 5	3 to 6	1
No. 5½	2¼ to 3	⅞
No. 6	1 to 2¼	¾

O—Over E—Extra

Although specified to apply to muscovite, the above grading is applied sometimes to phlogopite or amber mica. However, in Canada, amber mica is usually subject to size grading by linear dimensions, the following scale (in inches) being most commonly in use: 1x1 and 1x2, 1x3, 2x3, 2x4, 3x5, 4x6, 5x8 and larger.

The quality classification of sheet muscovite provides for 6 grades as follows: clear, clear and slightly stained, fair stained, good stained, stained, heavy stained, and black stained and spotted. In all grades excepting the last (black stained and spotted) the mica must be free from mineral inclusions and in all but the last two, free from mineral inclusions and cracks.

No formal grading applying specifically to phlogopite has been established.

Markets

Mica buyers in Canada include: Blackburn Bros., Blackburn Building, Ottawa; Walter C. Cross, Hull, Quebec; and Mica Company of Canada, Hull, Quebec.

Buyers in United States include: A. O. Schoonmaker Insulation Co., Inc., New York, N.Y.; F. D. Pitts Company Inc., Newton 67, Mass.; Electronics Mechanics Inc., Clifton, N.J.; and Mica Products Company, Dept. 4, Los Angeles, Calif.

Prices

Prices offered for trimmed sheet by Ottawa region dealers at the close of 1950 were approximately as follows:

Linear Dimensions (inches)	Price per Pound $
1x1 and 1x2	0·30
1x3	0·75
2x3	1·25
2x4	1·60
3x5	2·10
4x6	2·60
5x8	3·25

Grinding scrap sold from about $15 to $22 a ton delivered at plant depending on quality.

Tariffs

The following tariffs were in force at the end of 1951:

Canadian

Mica, phlogopite and muscovite, unmanufactured, in blocks, sheets, splittings, films, waste and scrap.

British preferential	10 per cent ad valorem.
Most favoured nation	10 per cent ad valorem.
General	25 per cent ad valorem.

United States

Mica, unmanufactured, not more than 15 cents per pound—4 cents per pound; above 15 cents per pound—2 cents per pound and 15 per cent ad valorem.

Cut or stamped to dimensions, shape or form—40 per cent ad valorem.

Films and splittings, not cut or stamped to dimensions—not over 0·0012 inch thick—12½ per cent ad valorem; over 0·0012 inch thick—20 per cent ad valorem.

Plates and built-up mica, and all manufactures of mica, or of which mica is the component material and chief value—25 per cent ad valorem.

Untrimmed phlogopite from which no rectangular piece exceeding 2 inches in length or 1 inch in width may be cut—5 per cent ad valorem.

Waste and scrap—not more than 5 cents per pound—12½ percent ad valorem; more than 5 cents per pound but not above 15 cents per pound—4 cents per pound; above 15 cents per pound—2 cents per pound; and 15 per cent ad valorem.

Ground or pulverized—12½ per cent ad valorem.

NEPHELINE SYENITE

Shipments of nepheline syenite in Canada in 1951 rose almost 24 per cent above 1950 to 81,108 short tons, almost all of which was ground glass and pottery grades. Exports rose 10 per cent in the same period. Production continued to be confined to American Nepheline Limited, Lakefield, Ontario, sole producer in the Western Hemisphere, operating extensive deposits on Blue Mountain, Peterborough county, Ontario.

Deposits of nepheline syenite are known to occur elsewhere in Ontario near Bancroft, Hastings county; Gooderham, Haliburton county; in the French River area, Georgian Bay district; and at Fort Caldwell, Thunder Bay district. In Quebec, nepheline syenite occurs in the Labelle-Annonciation and other areas, and in British Columbia, in the Ice River district near Field.

Canada and Russia are the only important producers of nepheline syenite. Canada is the sole source of high grade ceramic material.

Uses

Nepheline syenite is used almost exclusively for ceramic purposes, for which it is favoured principally because it effects a significant lowering of firing temperatures. It is valued in the glass batch because of its high alumina content (23 per cent in Lakefiield nepheline syenite) to which are attributed low annealing temperature, reduced coefficient of expansion, increased tensile strength, hardness, and brilliancy.

Nepheline syenite is used in all types of pottery, enamels, floor and wall tile, as a bond in refractory cements, porcelain balls and liners, and in other ceramic products. About two-thirds of the annual Canadian production is consumed by the glass industry.

B-grade dust, a by-product, finds a limited market for use in cleansers, enamels, and certain clay products.

Prices and Tariffs

Prices of processed nepheline syenite remained the same as in 1950 as follows: f.o.b. Lakefield, Ontario, glass grade, 28-mesh, bulk carload lots, $14 a ton; pottery grade, 200-mesh, bulk carload lots, $18 a ton; grade B, 150-mesh, bagged, carload lots, $10 a ton.

Nepheline syenite, all classes, entered United States free of duty.

Production and Trade

—	1951	1950
	Short tons	Short tons
Production of crude (ore transported to storage)	194,814	100,251
Shipments		
Ground		
Glass grade	53,029	45,497
Pottery grade	23,641	16,387
Miscellaneous	3,618	3,390
Total ground	80,288	65,274
Crude	820	364
Total shipments	81,108	65,638
Exports of crude and processed materials		
To: United States	56,942	50,982
Netherlands	1,195	1,133
Puerto Rico	900	1,184
United Kingdom	442	313
Other countries	298	739
Total	59,777	54,351

PHOSPHATE

With the exception of a few tons mined in North Burgess, Ontario, there was no production of phosphate in Canada in 1951. Phosphate mining in Canada virtually ceased about 50 years ago with the development of extensive sedimentary deposits in United States which have since provided a low cost source of supply.

Reserves of apatite, of which no estimate is available, occur in numerous scattered deposits in the general Ottawa region of Ontario and Quebec. Production in the past reached a maximum of about 30,000 tons a year, almost 90 per cent of which came from Quebec.

Imports of phosphate rock, superphosphate, and phosphoric acid rose slightly above 1950 levels. Consumption increased almost 10 per cent in the same period.

Uses

Phosphate rock is used chiefly in the manufacture of commercial fertilizers, mostly in the form of superphosphate made by treating the raw material with sulphuric acid. In United States, furnacing processes developed in recent years (mostly by T.V.A.) have given rise to the production of phosphatic fertilizers of the slag type. Finely ground phosphate rock, untreated, is also applied directly to the soil on a minor scale.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production	6	94	129	1,069
Imports, phosphate rock				
From: United States	487,312	3,028,071	481,566	3,154,910
Netherlands Antilles	9,092	128,828	8,960	128,181
French Africa	3,307	22,000	500	13,250
Total	499,711	3,178,899	491,026	3,296,341
Imports, superphosphate				
From: United States	187,537	3,354,901	165,038	2,711,778
Netherlands	375	32,371	17,684	423,528
French Africa	....	....	100	2,650
Total	187,912	3,387,272	182,822	3,137,956
Imports, phosphoric acid				
All from United States	308	37,824	300	35,175

—	1950	1949
	Short tons	Short tons
Consumption		
Fertilizers	419,000	390,370
Chemicals	43,957	28,949
Steel furnaces	49	....
Refractories	252	191
Miscellaneous	9,183	10,209
Total	472,441	429,719

Phosphorus and many phosphorus compounds enter into the manufacture of a large variety of products including detergents, flame retardents, water softeners, pigments, opacifiers, food preservatives, pharmaceutical preparations, livestock feed supplements, flotation reagents, glass, rodent poisons, pyrotechnics, non-ferrous alloys as a hardening agent, and many others. Ferros-phorphorus is used in iron and steel castings to increase fluidity, and in rolled sheet to prevent sticking.

Specifications

To be acceptable for acid treatment phosphate ore or concentrates should be virtually free from common impurities such as iron oxides, calcite, and ferromagnesian minerals. The grade should approach 80 per cent tri-calcium phosphate.

For furnace treatment common impurities are tolerated within reasonable limits but purchasers prefer rock containing a minimum of 70 per cent tricalcium phosphate. Size specifications call for a minimum of 80 per cent plus 10 mesh.

Prices

Closing 1951 quotations for Florida pebble phosphate f.o.b. mines were as follows: 76-77 per cent B.P.L. (bone phosphate of lime), $7 a long ton; 66-68 per cent, $3.95. These quotations show a slight increase over closing prices for 1950.

The price offered by eastern consumers for domestic phosphate was $15 a short ton for 80 per cent B.P.L. f.o.b. works with a penalty or bonus of 19 cents a unit below or above that figure.

Phosphate rock is not dutiable under the Canadian tariff.

ROOFING GRANULES

The total consumption of roofing granules in Canada has been increasing steadily over the past several years and in 1951 amounted to 124,640 short tons valued at $3,085,520 compared with 122,766 short tons valued at $2,975,568 in 1950. Domestic production accounts for less than one-third of consumption and is confined to two producers—Building Products Limited of Montreal, and Geo. W. Richmond of Vancouver.

Canadian manufacturers of roofing and sidings imported 91,112 tons of granules valued at $2,305,434 in 1951 compared with 86,977 tons valued at $2,144,517 in 1950. All of these granules were imported from United States, most of them being supplied by Minnesota Mining and Manufacturing Company, Central Commercial Company, and R. J. Funkhouser & Company. Minor amounts of roofing granules were supplied by Advance Industrial Supply Company and H. B. Reed Company.

Consumption and Trade [1]

—	1951		1950	
	Short tons	$	Short tons	$
Consumption				
Natural	31,643	597,215	38,532	719,287
Artificially coloured	92,997	2,488,305	84,234	2,256,281
Total	124,640	3,085,520	122,766	2,975,568
Consumption by colour				
Black and grey	40,689	808,636	34,710	651,579
Red	23,092	551,602	27,138	638,620
Green	37,978	980,654	38,086	951,327
Blue	10,526	364,813	11,152	383,604
Buff and brown	4,158	111,255	5,010	134,895
White and grey-white	8,197	268,560	6,670	215,534
Total	124,640	3,085,520	122,766	2,975,559
Imports				
From United States	91,112	2,305,434	86,977	2,145,517

[1] Compiled from figures supplied to the Mines Branch. Total consumption increase in 1951 over 1950 amounted to 1·5 per cent with a total value increase of 3·7 per cent over 1950.

An increasing preference by Canadian consumers for artificially-coloured granules is clearly indicated in the returns for 1951 when 92,997 tons were used compared with 84,234 tons in 1950 and 77,506 tons in 1949. Only 31,643 tons of natural granules were consumed in 1951 compared with 38,532 tons in 1950, and these figures include natural black and grey granules used by some manufacturers as the undercoating for artificially-coloured granules.

About two-thirds of the consumption consisted of granules made from rocks of igneous origin, crushed to size, and artificially coloured. The remainder consisted of granules made from slate (24·3 per cent of total)—of which about half were natural and half artificially coloured, and granules made from rocks of igneous origin of natural green, black, or buff colour.

Roofing Granule Plants In Canada

Quebec

In October, Wendell Mineral Products Limited, Montreal, officially opened its plant at Landrienne, east of Amos, where a grey rhyolite material from the company's large deposit, a short distance north of its plant, is to be crushed to size and artificially-coloured. No production, except for samples, was reported by the company in 1951.

Suzorite Company Limited in 1951 did not operate its quarry near McCarthy in Suzor township, about 160 miles east of Senneterre. The rock formerly quarried consisted of mica (50 per cent), feldspar, apatite, and pyroxene. After crushing, the mica was removed and the remaining rock was screened to granule size at the company's plant in Cornwall, Ontario, for use as undercoat granules. No production of roofing granules has been reported since 1949.

Ontario

Building Products Limited, Montreal, by far the largest producer of roofing granules in Canada, operated a black amphibole rhyolite deposit 4 miles north and west of Madoc, a pink syenite deposit about 3 miles northwest of Madoc, and a grey basalt quarry near Havelock, taken over from Ontario Rock Products Limited in 1950. Late in 1951 operations at the company's crushing and screening plant west of Madoc were discontinued and all rock was then trucked about 20 miles to the company's plant at the site of the basalt quarry near Havelock for crushing and sizing. Building Products Limited continued to supply road metal for road surfacing from the Havelock quarry and, from the undersize, produced roofing granules. Granules are artificially-coloured in a plant near the quarry site—the only plant in Canada presently manufacturing artificially coloured granules.

British Columbia

Geo. W. Richmond quarries a dark grey slate at McNab Creek, Howe Sound, and a green siliceous rock at Bridal Falls near Chilliwack. He produces natural granules in his Vancouver plant for shipment to western roofing manufacturers.

Roofing and Siding Plants in Canada

Granule-coated roofings and sidings are manufactured by 9 companies at a total of 15 plants across Canada as follows:

Company	*Location of Plant*
Bishop Asphalt Papers Limited	Portneuf Station, Quebec. London, Ontario.
The Brantford Roofing Company, Limited	Brantford, Ontario.
Canadian Gypsum Company, Limited (Formerly Toronto Asphalt Roofing Manufacturing Company, Limited.)	Mount Dennis, Ontario.
The Philip Carey Company Limited	Lennoxville, Quebec.
Building Products Limited	Montreal, Quebec, Hamilton, Ontario, Winnipeg, Manitoba, Edmonton, Alberta (new in 1951).
Sidney Roofing & Paper Company Limited,	Victoria, British Columbia, Lloydminster, Alberta (new in 1951).
Canada Roof Products Limited	Vancouver, British Columbia.
The Barrett Company Limited	Montreal, Quebec, Vancouver, British Columbia.
Canadian Johns-Manville Company Limited,	Asbestos, Quebec.

Specifications and Colouring

Specifications for rock types suitable for making roofing granules are very rigid and few rocks are able to meet all specifications.

Rocks suitable for granules should be hard and tough enough to withstand breakage and dusting through handling with mechanical equipment. The stone should be fine-grained with low porosity so as to withstand weathering effects from freezing and thawing and so that a minimum of pigment is required to 'cover' the granule. Any stone source for roofing granules should contain a minimum of acid reactive materials such as carbonates, sulphides, sulphates, or high alkali materials. Pyrites by themselves in small quantities do no harm, but pyrites in conjunction with calcium or magnesium carbonates predestine a granule to poor weathering. A rock suitable for making granules should break well with a not too sharp fracture and yield, on crushing, a high percentage in the granule size range ($-10 + 35$ mesh for coarse and minor amounts of $-28 + 48$ mesh for fines). No stone source should be considered unless it contains many years' supply of rock having uniform characteristics chemically, physically, and mineralogically and unless it lies within economical haulage distance of roofing plants.

A granule should have 'tooth', or adhesive properties in relation to asphalt and the ability to wet well with that material. For instance granules made from quartz, feldspar, and some rhyolites do not have this latter property mainly because, on crushing, the source rock fractures with quite a glassy, smooth face.

There is no rule by which to determine the ability of a granule to take colour but in general for a full range of colours a light shade base granule is preferred to a dark shade one because less pigment is required to 'hide' the colour of the base granule.

Opacity of rock granules appears to be a very important property by which to determine the acceptability of a base rock material. When ultraviolet light penetrates the granules the resultant deterioration of the asphalt underneath causes a loss of adhesion of the granules to the asphalt and this results in ultimate loss of the granules from the roofing. Some mannfacturers and consumers of granules claim that the infra-red (heat) rays of the sun have a more direct influence on the durability of roofings than ultraviolet.

Specifications for granules used in undercoating are as rigid as those for topcoat granules with the exception of colouring characteristics which are not important. Because undercoat granules can be made from dark rocks and left in their natural colour, they are cheaper than artificially-coloured topcoat granules.

Processes for colouring granules are covered by many patents, the two most widely used being the Sodium Silicate Process in which the granules are thoroughly coated with sodium silicate, clay, the required pigment, a little titanium dioxide and heated to the required temperature in a rotary kiln, and the Phosphoric Acid Process in which the granules are mixed thoroughly with zinc oxide, clay, liquid phosphoric acid, the required pigment, and then heated.

The original colour of granules is usually heightened by 'oiling' after colouring with a paraffin base oil. This oiling also improves the original adhesiveness of the granule to the asphalt but its effect tends to wear off after exposure to weathering agencies.

Many tests have been devised for determining the quality of granules, both uncoloured and coloured, but actual weathering provides the most satisfactory check. The large manufacturers of roofing granules and some consumers test the quality of their granules at test panel stations in relatively warm, humid areas where weathering agencies are most destructive.

A good granule shingle should have a life expectancy of at least 20 years, and there are many roofs made of such shingles which are still in good condition after 25 years or more.

United States Production

The production of roofing granules in 1950, as reported to the U.S. Bureau of Mines, amounted to 1,797,729 short tons, valued at $26,852,848, which was an increase of 33 per cent in quantity and 34 per cent in value, compared with 1949. Production was the largest on record, and average value showed an increase of $0.19 a short ton over 1949, also a record year. The production of natural granules increased 39 per cent, the artificially-coloured 32 per cent, while the brick granules decreased 42 per cent. The average value for natural granules increased from $8.75 to $8.80; artificially-coloured from $16.86 to $17.21, and brick from $17.42 to $19.31 a short ton.

Prices

Prices of roofing granules depend upon the type of granule and whether the colour is natural or artificial. Imported natural granules in 1951 averaged $18.71 a short ton, compared with $18.67 a short ton in 1950 f.o.b. Canadian roofing manufacturing plants. The average price of artificially-coloured granules a short ton in 1951, with comparative 1950 figures in brackets were: reds $23.88 ($23.53); greens $25.53 ($24.98); blues $34.65 ($34.40); buff or brown $26.75 ($26.97); and white or grey-white $32.76 ($32.31). The average value of all types a short ton f.o.b. Canadian roofing plants was $24.75 in 1951 compared with $24.24 in 1950.

SALT (SODIUM CHLORIDE)

Canadian salt plants operated at higher capacities in 1951 and production increased from 858,896 short tons in 1950 to 964,525 short tons. Over 90 per cent of the output is obtained from brine. Salt beds or brines occur in all provinces but production is limited to Ontario, Nova Scotia, and the Prairie Provinces.

A newly formed company, Canadian Salt Company Limited, took over the plants of the salt division of Canadian Industries Limited at Windsor, Ontario, and Neepawa, Manitoba, and also the plant of Alberta Salt Company Limited, at Lindberg, Alberta.

Imports, consisting chiefly of grain sizes and of purities not obtainable in Canada, continued at a high level and totalled 258,822 short tons.

Much additional information on the extent and location of huge reserves of rock salt underlying the Prairie Provinces was obtained from oil drilling operations. These reserves have assumed great significance with the development of the oil industry and associated chemical industries both of which will serve to create markets for the chemicals produced from rock salt.

With the exception of Malagash Salt Company Limited, Malagash, Nova Scotia, which mines salt, all the salt produced in Canada is obtained by artificial evaporation, as nearly all the deposits occur at great depths. Thus most of the Canadian production is of the finer grades. These artificial evaporation plants are mostly in Ontario and in the Prairie Provinces. The fishing industries, which prefer a coarse salt and are mainly on the Atlantic and Pacific seaboards, obtain a large part of their requirements from the West Indies and California, where the salt is produced by the solar method.

Thus, the geographical distribution of the Canadian deposits, together with the necessity of using artificial evaporation methods of recovery, prevents any one company from producing grades to suit all consumers. Accordingly, the importation of some of the coarser grades not now produced in Canada will have to continue until methods are developed to produce these grades by evaporation or other processes.

Nova Scotia

The only salt mine in Canada is operated at Malagash, Cumberland county, by Malagash Salt Company, Limited. The mined rock salt is crushed, screened, and sold chiefly as a de-icing salt for roads and railways. It is also used as fishery, refrigerator, hay, and dairy salts; as stock licks; and for dust laying.

Fine salt from vacuum pan evaporators is produced near Amherst by Dominion Salt Company, Limited, from a brine obtained from massive salt beds which come within 860 feet of the surface at this point.

Ontario

Most of Ontario's large output of salt is used to supply its expanding chemical industries. The salt is obtained from wells drilled 800 to 1,500 feet below the surface at Goderich, Sarnia, Warwick and Sandwich in southwestern Ontario.

Dominion Salt Company Limited operates plants at Sarnia and Goderich, the main production being fine salt from vacuum pan evaporators.

At Sandwich, Canadian Salt Company Limited, produces fine and coarse salt from vacuum evaporators and from open-type grainers.

Purity Flour Mills, Limited, produces fine and coarse salt at its plant in Goderich, and Warwick Pure Salt Company Limited produces coarse salt only from open pan evaporation of brine obtained from wells on its property near the village of Warwick.

Brunner-Mond Canada Limited, operates a large soda ash plant at Amherstburg, the brine for which is obtained from wells several miles to the north.

Dow Chemical of Canada Limited produces caustic soda and chlorine at its plant in Sarnia from its nearby brine wells.

Manitoba

Canadian Salt Company, Limited at Neepawa, the only producer of salt in the province, produces fine salt by vacuum evaporators from a nearly saturated brine which is obtained by pumping salt beds lying over 1,000 feet below the surface. Magnesium and calcium chloride salts are also obtained by evaporation of this brine.

Production and Trade

—	1951		1950	
	Short tons	$ Value	Short tons	$ Value
Production by Types				
Fine vacuum salt	320,438	5,718,714	290,538	4,816,077
Coarse grainer salt	7,784	190,400	9,869	273,919
Mined rock salt	74,812	410,531	57,068	438,155
Salt produced for chemical purposes [1]	561,491	1,586,332	501,421	1,483,155
Total	964,525	7,905,977	858,896	7,011,306
Production by Provinces				
Ontario	772,585	4,789,990	696,582	4,639,867
Nova Scotia	127,252	1,631,904	101,930	1,080,154
Alberta	19,718	472,562	25,606	539,287
Manitoba	16,778	358,391	16,592	378,297
Saskatchewan	28,192	653,130	18,186	373,701
Total	964,525	7,905,977	858,896	7,011,306
Imports				
From: United States	197,891	1,380,972	170,991	1,158,715
Bahamas	23,084	106,875	33,853	220,685
Jamaica	16,529	127,274	182	910
United Kingdom	6,996	165,510	10,268	180,142
Other countries	14,322	173,795	22,945	173,911
Total	258,822	1,954,426	238,239	1,734,363
Exports				
To: United States	3,762	37,642	3,776	42,514
New Zealand	581	14,808	....	....
Bermuda	152	7,100	138	6,347
Other countries	66	3,297	186	4,113
Total	4,561	62,847	4,100	52,974
Apparent Consumption	1,218,786	9,797,556	1,093,035	8,692,695

[1] Mainly in brine and used by the producers in the manufacture of chemicals.

Saskatchewan

Dominion Tar and Chemical Company Limited, through its subsidiary Prairie Salt Company Limited, operates a vacuum pan plant for the production of fine salt at Unity. The brine is obtained from salt beds about 3,500 feet below the surface.

Alberta

The plant of Canadian Salt Company Limited, at Lindbergh obtains brine from salt beds lying over 2,800 feet below the surface. Natural gas is obtained from strata above the salt beds and is used as fuel for the production of fine salt from vacuum pan evaporators.

Areas of Potential Production

Newfoundland

Salt springs occur at several places in the carboniferous area in western Newfoundland. It is possible that salt beds will be found in this area.

Nova Scotia

Massive salt beds have been discovered on the west coast of Cape Breton Island and there is evidence of other salt beds from brine springs in Antigonish, Pictou, and Cumberland counties on the mainland.

Prince Edward Island

Salt beds were discovered in Hillsborough Bay at a vertical depth of over 2 miles.

New Brunswick

Large domes of salt at shallow depths have been explored at Weldon and Dorchester in the southeastern part of the province.

Quebec

Carboniferous sediments outcrop on the Magdalen Islands in the Gulf of St. Lawrence and it is probable that salt beds could be found in this area.

Ontario

The drilling for gas and oil has continued to outline the vast area in the southwestern part of the province which is underlain by salt beds.

Prairie Provinces

Salt beds underlie these provinces in the shape of a huge crescent extending from the extreme northern part of Alberta to the central part of Saskatchewan and the boundary of Manitoba. The beds vary in thickness from a few feet to a total of many hundreds of feet in one section. The reserves of salt in this area are practically incalculable and may prove to be of great importance for their content of potassium salts.

British Columbia

Deposits of salt have been indicated by salt springs at various points, the best indication being at Kwinitsa, 45 miles east of Prince Rupert on the Canadian National Railway.

Uses

Fine grades of salt are used chiefly in the chemical industries, and extensively for household and food purposes, whereas the coarse grades are used in the curing of fish and hides, for ice and dust control on highways, for dairy uses, and in refrigeration.

The fine grades of salt are made in vacuum pan evaporators, usually double or triple effect, from saturated brines obtained by circulating fresh water through salt beds.

Coarse salt is obtained in Canada by open type evaporators and by mining, crushing, and screening rock salt. Although coarse salt produced from open type evaporators is pure, it is very expensive, and is thus used only where purity is essential such as in making dairy products. The mined salt is impure and can be used only for such purposes as de-icing and dust control of highways.

Cheap coarse salt of fair purity is required for such uses as the curing of fish. This salt is obtained principally by solar evaporation of sea water in tropical or semi-tropical countries, and this chiefly accounts for Canada's relatively large imports of salt for the fishing industry on both the east and west coasts.

Prices

According to Canadian Chemical Processing the price of salt advanced slightly during 1951.

	December 1951	December 1950
Fine industrial salt, per ton, bulk, carlots, f.o.b. plant ..	$ 8.80	$ 8
Coarse industrial salt, per ton, bulk, carlots, f.o.b. plant ..	$17.80	$17

SAND AND GRAVEL

The production of sand and gravel has steadily increased since the end of the war. In 1951, output amounted to 92,972,821 tons, valued at $44,627,559 an increase in volume of over 212 per cent since 1945. In terms of value, sand and gravel was ninth among all the minerals produced in Canada and second among the industrial minerals.

Sand and gravel are produced commercially in all provinces except Prince Edward Island, the leading provinces being Ontario, Quebec, and British Columbia. Since the materials are widespread, a great many deposits are worked across the country, all of them near consuming centres.

Distribution of principal sand and gravel operators in 1950 by provinces, was as follows:

Provinces	No. of Principal Operators[1]
Newfoundland	2
Nova Scotia	4
New Brunswick	3
Quebec	52
Ontario	190
Manitoba	13
Saskatchewan	62
Alberta	8
British Columbia	34

[1]Does not include production by railway companies for ballast, or production by counties and townships in Ontario for road use.

Production

	1951		1950	
	Short tons	$	Short tons	$
Production by provinces				
Newfoundland	1,483,951	648,346	1,619,389	780,315
Nova Scotia	1,756,641	1,527,052	1,600,932	1,488,593
New Brunswick	2,966,210	2,229,258	4,789,585	2,997,779
Quebec	31,297,949	10,616,701	20,313,415	7,172,632
Ontario	39,218,058	19,905,293	30,271,214	15,551,406
Manitoba	2,832,110	929,989	2,720,951	721,494
Saskatchewan	2,951,813	1,874,071	2,104,797	1,439,870
Alberta	4,289,021	3,194,446	3,866,662	2,572,795
British Columbia	6,177,068	3,702,403	5,808,218	3,709,875
Total	92,972,821	44,627,559	73,095,163	36,434,759
Production by type				
Sand [1]				
Moulding sand	36,421	86,900	38,740	105,909
Building, etc.	7,972,740	5,116,901	6,850,339	4,151,672
Core sand	1,855	3,490	1,534	2,946
Other sand, etc.	363,780	158,699	127,867	41,475
Sand and gravel				
Railway ballast	6,991,189	2,291,532	5,132,371	1,361,439
Concrete road building	62,305,240	27,941,202	49,768,234	24,512,834
Mine filling	3,412,226	950,941	3,385,384	800,988
Crushed gravel	11,889,370	8,077,894	7,790,694	5,457,496
Total	92,972,821	44,627,559	73,095,163	36,434,759

[1] Does not include production of natural silica sand or silica sand manufactured from quartz or silica rock.

In connection with the large amounts of sand and gravel which would be required in the construction of the proposed St. Lawrence River seaway project, it is of interest to note the existence of a large deposit on Grenadier Island in the Thousand Island region of the St. Lawrence River. The deposit is composed of granitic rocks and forms a narrow strip about three-quarters of a mile long, rising in places to 80 feet above the river level. The material is unusually clean, and the whole deposit is probably large enough to supply all the aggregate needed for the seaway project.

Practically all large commercial sand and gravel plants are now equipped to crush and screen gravel. The product can successfully compete with most types of crushed stone especially since both coarse and fine aggregate can be obtained from the same pit whereas when crushed stone is used the fine aggregate usually has to be obtained from a separate source.

In periods of high demand a large proportion of building sand and gravel is obtained from rivers or lakes, and is excavated either with dredging boats or portable dredging equipment installed at the shore.

Uses

The main uses for sand and gravel are in concrete works, buildings, and road construction. Other uses are as railway ballast and mine fill. Sand is used chiefly in the building industry, concrete, and roadwork, as moulding sand, core sand, and for other special purposes.

Gravels vary widely in composition and relative size of particles, and these factors determine suitability for various end uses. About 16 per cent of output is washed and screened; the remainder is marketed as pit-run or bank gravel for use primarily in concrete works, road construction, buildings, and as railway ballast and mine fill in cases where grade and purity are not of paramount importance. For concrete aggregate used in the construction of chemical plants, limestone free gravel is much preferred to crushed limestone because the latter is easily attacked by acids.

Gravel for Roadbuilding

Gravel is a good material for low cost, all-weather road surface where the amount of traffic is not large enough to justify the expenditure for a more permanent type of surface. Such roads have proved to be satisfactory in the sparsely settled areas of northern Ontario and Quebec. In Newfoundland probably over 75 per cent of the gravel used goes into road building. Many stretches of road are built entirely of gravel from the bottom of the fill to the top of the wearing course.

A great deal of gravel is used in paved rural roads, either as crushed and screened aggregate for the pavement proper, or as pit-run or crusher run gravel for the base course. For main highways, a binder or stabilizer is usually incorporated into the base course and the latter is compacted to a pre-determined density before laying the top course.

Most of the gravel used for road work comes from pits operated exclusively for that purpose. Usually these pits are worked intermittently on a stock-piling basis.

Beach or stream gravels are not as desirable as bank gravels for road purposes since they are deficient in binding material and contain a high proportion of hard, rounded, smooth pebbles. Most bank or pit-run gravels in eastern Canada contain some friable or partly disintegrated particles which, on being ground by the action of traffic, yield a fairly good cementing material.

Gravel for Ballast

Usually the railroads operate quarries only when long stretches of line are to be ballasted. On the mail railway lines pit run gravel is being gradually replaced by crushed stone which is either purchased from commercial plants or processed by contract in quarries owned by the railway companies.

Sand

The greater part of the sand output is used in concrete work, cement and lime mortar, and wall plaster. For these structural uses, sands have to be clean but the specifications for such sand are otherwise fairly broad so that the material can usually be obtained from deposits located close to the consuming point. There are certain definite requirements in sands, however, for moulding practice, in glass manufacture, and for other special purposes.

Moulding sand is a mixture of sand and a bonding material that is ordinarily impure clay containing iron oxide. The degree of coarseness and fusibility of the sand and the amount of bonding material depend on the purposes for which the sands are required. There is a growing practice for large foundries to buy ordinary sand and process and blend it to the required grade.

SILICA MINERALS

The output of silica minerals in Canada increased 10 per cent during 1951 to help meet the expanding requirements of industry; 1,904,885 tons valued at $2,258,468 were produced compared with 1,730,695 tons at $1,740,268 the previous year.

Canadian requirements for silica sand of the high quality grades are met principally by United States sources. Imports of 692,937 tons in 1951 increased markedly over those of 1950. High-grade silica is an important raw material in the manufacture of glass, abrasives, and sodium silicates.

Interest has continued concerning the possible production of this grade of material from Canadian sources. Investigation of deposits of quartzite and silica sand in Eastern Canada have shown that, with beneficiation, the specifications of the glass and ceramic industries may be met.

Dominion Silica Corporation Limited was incorporated during the year with the intention of working a deposit in Labelle County, Quebec. Erection of a mill at Lachine is in progress.

At the present time the Canadian output of quartz, quartzite and silica sand is used as fluxing material in the metallurgical industry and in the manufacture of silicon and ferro silicon alloys and of abrasives. There is a production of silica brick for the steel industry.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production, quartz and silica sand.....	1,904,885	2,258,468	1,730,695	1,740,268
Production, silica brick (thousands of bricks)...........................	3,510	465,229	3,126	408,813
Imports, silica sand				
From: United States...............	692,655	1,988,888	569,724	1,555,937
United Kingdom............	282	2,145	123	3,312
Belgium....................	....	....	3,515	5,699
Total.................	692,937	1,991,033	573,362	1,564,948
Exports, quartzite				
All to United States...............	281,379	838,227	195,430	540,940

Nova Scotia

Quartzite from Chegoggin Point, Yarmouth county, is used by the Dominion Steel and Coal Corporation, Limited, in the production of silica brick at Sydney.

There are in the province potential sources of high quality silica in certain beach sands, sandstones and quartzites.

Quebec

Silica sand from the sandstone deposit at St. Canut in Two Mountains county is quarried by the Canadian Carborundum Company, Limited, for production of abrasives at Shawinigan Falls.

St. Lawrence Alloys and Metals, Limited, produces ferrosilicon at Beauharnois using Potsdam sandstone from a quarry at nearby Melocheville.

Ontario

Kingston Silica Mines, Limited, works a deposit of Potsdam sandstone near Joyceville, north of Kingston, Ontario. The sand is used in steel foundries, and in the making of artificial abrasives.

Lorrain quartzite is quarried by Dominion Mines and Quarries, Limited, at Killarney, Georgian Bay, and Canadian Silica Corporation, Limited, Sheguinda, Manitoulin Island, for the manufacture of silicon and ferrosilicon alloys. A large part of the production is exported to the United States.

Algoma Steel Corporation, Limited, quarries quartzite at Bellevue, north of Sault Ste. Marie for the manufacture of silica brick for the company's steel plant.

Other Areas

Silica for metallurgical flux is quarried near Noranda, Quebec; Sudbury, Ontario; Flin Flon, Manitoba; and Trail, British Columbia.

Uses

Principal uses for quartz and quartzite are to supply siliceous metallurgical flux and for the production of silicon and ferrosilicon. If the quartz is of sufficient quality it may be ground to a fine powder and marketed as silica flour for various uses, mainly in the ceramics industry. Crushed quartzite is used as a source of silica in silica brick, for sand blasting, and infrequently, as a silica sand for glass manufacture, etc.

Sandstone is broken down and cleaned to produce silica sand for use in glass making, steel foundry sand, sodium silicate, and the manufacture of artificial abrasives. Coarser grades are used in sand blasting and the fines as fillers for asbestos-cement products, paints, and soaps. In value of products this is the most important silica raw material.

Quartz crystals. Clear crystals of quartz without flaws and possessing the necessary piezo-electric properties, are valuable in radio frequency control apparatus. Very few suitable crystals have been found in Canada. Although Brazil continued to supply most Canadian requirements there was a small production from an occurrence near Lyndhurst, Ontario.

Specifications

Typical specifications for the more important uses of silica are given below.

I. Silica Sands

Glass Making—Grains should vary in size from 28 mesh to 150 mesh. For container-glass the Fe_2O_3 content should be under 0·04 per cent. For optical glass the iron oxide content should be as low as 0·015 per cent. Other impurities such as alumina, lime, magnesia, titanium oxide, and alkalies should be closely controlled. Shape of grain is of little importance.

Foundry Sands—Silica content must be over 95 per cent and grain size and shape is of great importance. Size varies from 20 mesh down to 200 mesh depending upon type of casting, foundry practice, etc., while the grain is usually rounded in shape.

Artificial Abrasives—Grain size is usually coarser than glass sands. The chief impurity to be eliminated is alumina. Silica content must be well over 99 per cent and iron content usually under 0·10 per cent iron oxide.

Sodium Silicate—The specifications are similar to those for glass sand as far as impurities are concerned but grain sizes are slightly coarser.

Sand Blast—This requires a very tough clean grain of between 8 and 48 mesh in size.

II. Lump Silica

Ferrosilicon—Lumps should contain over 98·5 per cent silica and under 1·0 per cent alumina, with size varying from over 1″ to a maximum of from 3½″ to 4″.

Fluxes—These are dependent upon the type of smelter but initial cost must be low.

Silica Brick—Lump is crushed to about 8 mesh maximum size. Silica content should be above 98 per cent; alumina and iron oxide content low; and alkali content very low.

III. Silica Flour

Ceramics—Silica content should be over 99 per cent and iron oxide, under 0·10 per cent. Size is generally all minus 325 mesh.

Fillers—White colour is usually very important and size of material generally all minus 150 mesh. Silica content should be 90 per cent and over, dependent upon the industry.

Prices

The price per ton of the several grades of silica varies greatly, depending upon quality and the marketed form. Silica generally is a low-priced commodity, and, therefore, the location of a deposit with respect to markets is of 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 the southwestern Ontario, Toronto, or Montreal areas. In Western Canada the main markets are in Alberta and Manitoba. West of Winnipeg, the silica needs are almost entirely imported.

Prices according to Canadian Chemistry Processing remained virtually unchanged during 1951.

SODIUM SULPHATE (NATURAL)

Industrial demand for natural sodium sulphate, particularly by the pulp and paper industry, continued strong in 1951. Production, which comes entirely from Saskatchewan, increased 47 per cent to 192,371 short tons compared with the 1950 output, while exports increased 123 per cent to 63,179 short tons. Demand, however, outstripped supply, and imports to meet industrial needs in eastern and western coastal areas of Canada rose to 22,667 short tons compared with 17,961 short tons in 1950. In line with the increased demand, prices at Saskatchewan plants moved upward on non-contract sales during the year.

Large reserves of sodium sulphate occur in beds and in highly concentrated brines and in alkali lakes mainly in Saskatchewan but also in Alberta.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production (Shipments).............	192,371	2,383,770	130,730	1,615,867
Imports				
From: United States...............	14,060	283,518	12,826	184,650
United Kingdom............	7,942	143,196	4,307	63,029
Germany...................	582	12,951	828	16,577
Netherlands................	83	4,005	....	....
Total..................	22,667	443,670	17,961	264,256
Exports[1] to United States...........	63,179	735,902	28,375	302,329

[1]From United States Import Statistics.

The producers of natural sodium sulphate in 1951 were:

Natural Sodium Products Limited at Bishopric.
Ormiston Mining and Smelting Company Limited at Ormiston.
Midwest Chemicals Limited at Palo.
Sybouts Sulphate Company at Gladmar.
Saskatchewan Minerals, Sodium Sulphate Division, at Chaplin.

During the year, Saskatchewan Minerals expanded the capacity of its plant at Chaplin by installing an additional kiln and evaporator.

A cold wet summer and fall created harvesting difficulties for those plants using the brine pond crystallization method.

Although production methods vary considerably, the trend is toward the production of a higher grade product by means of the crystallizing pond.

In some lakes the sodium sulphate occurs as an actual bed in a dried-up lake or under a saturated brine; in others, as a brine with little or no actual crystal beds. In late summer months the brine in all lakes is usually almost saturated and is pumped from the lake into an enclosed pond. After being subjected to more evaporation and the effects of cooler weather, the sodium sulphate crystallizes out and the excess brine is returned to the main lake. The crystal, or glaubers, salt is collected and stockpiled. It is then fed to a dehydrating plant to remove the water of crystallization which amounts to over 50 per cent of the weight of the crystal. A dehydrating plant usually consists of a simple rotary kiln and a crushing and screening plant. The finished salt commonly known as "salt cake" is shipped in bulk. The product from this crystallizing pond method is usually purer than that produced from the mining of the salt beds with all their included silt and other salts.

Uses and Prices

The largest single use of sodium sulphate is in the sulphate process for making kraft pulp. Kraft pulp is used chiefly in the manufacture of brown wrapping paper and corrugated board boxes in which a high degree of strength is required.

Sodium sulphate is used in some of the synthetic detergent cleaning powders as a diluent and to improve the detergent action. It is also used in the manufacture of heavy chemicals among which are sodium carbonate, sodium silicate, sodium sulphide and sodium hydroxide.

Other minor uses of sodium sulphate are in the glass, dye, and textile industries. Small amounts are used for medicinal purposes, and for tanning.

The price of sodium sulphate varies considerably depending upon the size and the period of time covered by contract, and the purity of the salt cake supplied.

The price of salt cake was quoted in Canadian Chemical Processing at $13 a ton, f.o.b., plant from January to March. For the remainder of 1951 the price quoted was $14.

SULPHUR AND PYRITES

Sulphur production in Canada in recent years has been limited to recovery from by-product pyrites and smelter gases. In 1951, total output from these sources was 371,790 short tons sulphur equivalent compared with 301,172 tons in 1950.

Products were in the form of sulphur dioxide and sulphuric acid only since no elemental sulphur has been produced in Canada since 1943. Several projects were under way in 1951 to increase domestic production of these compounds and to commence production of elemental sulphur.

Canadian Production, Trade, and Consumption

—	1951	1950
	Short tons	Short tons
Production (sulphur content)		
By-product pyrites shipped	215,363	150,487
Recovered from smelter gases	156,427	150,685
Total	371,790	301,172
Imports		
Crude, roll, and flour sulphur		
From: United States	393,172	390,333
Mexico	2,756	......
Total	395,928	390,333
Exports (sulphur content of by-product pyrites)		
To: United States	114,542	110,368
Japan	30,411	......
France	23,342	......
United Kingdom	7,937	......
Mexico	1,807	1,284
Total	178,039	111,652
Consumption (sulphur or its equivalent)		
Pulp and paper	......	282,608
Heavy chemicals	......	230,693 [1]
Rubber goods	......	2,524
Insecticides	......	4,114
Explosives	......	1,900
Miscellaneous	......	1,193
Total	......	523,032

[1] Includes sulphur equivalent from smelter gases.

Most of the sulphur requirements of Canadian industry, particularly the pulp and paper industry, have been supplied for many years by United States' Frasch-mined sulphur from Texas and Louisiana. However, the shortage of sulphur has been acute since the middle of 1950 when the producers of elementary sulphur in United States found it necessary to begin limited allocation. By the end of 1950, the surface stockpiles of elemental sulphur, normally sufficient for 2 years, had dropped to about a six-month supply. The National Production Authority in the United States put brimstone under export allocation at the beginning of 1951 to an amount which approximated 80 per cent of average monthly consumption during 1950. Domestic consumers were restricted to 100 per cent of their average monthly rate for 1950, and, on January 1, 1952, were further restricted to 90 per cent. For purposes of distribution, the International Materials Conference considers the needs of Canada and United States as a unit.

Some United States' authorities have expressed the view that by 1954 the gap between world supply and demand will have been bridged. At present this is approximately 1,500,000 long tons. By 1954, four new domes are to be in production and these, coupled with new and expanded recovery plants, are expected to come close to filling the gap in predicted world demand.

Sulphuric Acid in Canada

The production of sulphuric acid was 813,210 tons (100 per cent) in 1951 compared with 756,110 tons in 1950.

Sulphuric acid from smelter stack gases is produced in Canada by The Consolidated Mining and Smelting Company of Canada Limited at Trail, British Columbia, and Canadian Industries Limited at Copper Cliff, Ontario. Nichols Chemical Company Limited, at 3 plants in Canada, manufactures acid for sale from domestic by-product pyrite sources. North American Cyanamid Limited, Welland, Ontario, and Canadian Industries Limited, Hamilton, Ontario, manufacture acid from imported brimstone for consumption in their own fertilizer plants. Dominion Steel and Coal Corporation Limited and Aluminum Company of Canada, Limited, import brimstone for acid manufacture, the output being consumed in their plants at Sydney, Nova Scotia and Arvida, Quebec, respectively. The rated yearly capacity of these 9 plants was, prior to 1951, about 775,000 tons of 100 per cent acid.

The following tables, give the production, trade, and consumption figures of sulphuric acid for the years 1948 to 1951:

Production, Imports, Exports, and Apparent Consumption of Sulphuric Acid, 1948-1951

(Short tons of 100 per cent acid)

Year	Production	Imports	Exports	Apparent consumption[1]
1948	679,448	59	29,478	650,029
1949	707,717	24	17,336	690,405
1950	756,110	332	44,417	712,025
1951	813,210	1,162	57,000	757,372

[1] No allowance made for changes in inventories.

Production and Factory Sales of Sulphuric Acid, 1948-1950

(Short tons of 100 per cent acid)

	1948	1949	1950
Production	679,448	707,717	756,110
Factory Sales	242,671	235,093	284,681
Value	$3,879,814	$3,924,573	$4,873,859

Consumption of Sulphuric Acid By Industries, 1950

Industry	Net tons of 100% Acid
Fertilizers	503,865
Heavy chemicals	59,745
Coke and gas	34,878
Iron and steel	26,175
Explosives	25,331
Petroleum refining	15,726
Textiles	23,593
Non-ferrous metal smelting and refining	12,944
Plastics	7,779
Soaps	6,418
Electrical apparatus	5,713
Pulp and paper	2,246
Miscellaneous chemicals	2,265
Leather tanning	1,891
Adhesives	687
Sugar refining	254
Vegetable oils	155
Total	729,665

New Projects to Increase Domestic Production

During the year several projects for recovery of sulphur, or its equivalent, from domestic sources were begun by Canadian industry and were expected to be in operation during 1952. These projects are outlined below:

Shell Oil Company of Canada expects to recover, early in 1952, elemental sulphur at a rate of about 10,000 tons annually from the scrubbing of sour natural gas from the Jumping Pound field of Alberta. The gas contains about 3.5 per cent by volume of hydrogen sulphide (H_2S) and a 90 per cent recovery of sulphur is expected from the 25,000,000 cubic feet of gas to be cleaned daily.

Royalite Oil Company expects to recover from 9,000 to 10,000 tons of elemental sulphur annually, starting June, 1952, from its Turner Valley gas field in a plant similar to Shell Company's Jumping Pound plant.

Canadian Industries Limited in 1951, at its plant at Copper Cliff, Ontario, increased output of sulphuric acid by about 60 per cent. This company is also building a $1,500,000 plant at Copper Cliff to produce about 90,000 short tons of liquid sulphur dioxide a year from stack gases obtained from flash smelting units recently developed by The International Nickel Company of Canada, Limited in its adjacent plant. The new flash smelting process results in production of a gas containing 75 per cent or more sulphur dioxide and eliminates the costly concentration step involved in the use of a more dilute gas. This plant is expected to be in operation late in 1952 and the liquid sulphur dioxide output will be distributed to pulp and paper companies in Ontario and Quebec.

Nichols Chemical Company Limited began, in mid-1951, a $2,500,000 expansion project at its works in Valleyfield, Quebec, to double its 100,000 short tons annual output of sulphuric acid by late 1952. By-product pyrite, from Canadian sources, will continue to be the source of sulphur in the operations.

Aluminum Company of Canada, Limited, at Arvida in Quebec, concluded arrangements with Barvue Mines, Limited, to roast the latter's zinc concentrates for recovery of contained sulphur. Sulphur dioxide from the smelter gases will be used to manufacture about 45,000 tons of acid a year to be consumed within the company's works. It is planned to install a fluo-solid roaster. Production of acid will begin late in 1952.

The Consolidated Mining and Smelting Company of Canada, Limited, early in 1951, announced plans for the construction of a fertilizer plant at Kimberly, British Columbia, adjoining the concentrator. Two others operated by the company are at Trail, British Columbia and Calgary, Alberta. The new plant will have as part of the whole project a sulphuric acid plant with an annual capacity of about 110,000 tons of acid and will use about 300 tons of pyrrhotite tailings per day, from the concentrator. Iron oxide sinter, from the roasting of the tailings, will be stockpiled and may eventually become a source of iron. In the fertilizer plant at Trail some pyrrhotite is being burned to augment the production of acid from smelter stack gases.

Noranda Mines Limited, by the end of 1951, had made no announcement concerning the construction of a commercial plant for treatment of pyrite concentrates to produce elemental sulphur, sulphur dioxide, and iron oxide sinter. The marketing of the large quantities of sulphuric acid produced in the process appears to have been the difficulty. Noranda has an estimated 100,000,000 tons of pyrite reserves containing about 50 per cent pyrite and low values in copper. In 1950 the company took a 50-year lease on 50 acres of property belonging to MacDonald Mines Limited.

Large reserves of material, containing about 80 per cent pyrite and low zinc values, have been outlined by underground development and exploration.

Britannia Mining and Smelting Company, Limited has accumulated about 200,000 tons of pyrite as a by-product from its copper operations at Britannia Beach, British Columbia, where about 200 tons of pyrite is being recovered daily as a flotation concentrate. Columbia Cellulose Company, a subsidiary of Celanese Corporation of America, is constructing a $27 million dissolving pulp mill near Prince Rupert, British Columbia, and has entered into an agreement with Britannia to purchase pyrite for the manufacture of sulphuric acid. It was announced that a second mill is to be built in southwestern British Columbia which will likely use additional quantities of Britannia's by-product pyrite for acid manufacture.

Elemental Sulphur in Canada

Canada has no known deposits of elemental sulphur. From 1935 to 1943 elemental sulphur was produced from smelter gases by The Consolidated Mining and Smelting Company at Trail, British Columbia, using a coke reduction process. Since 1943 the sulphur dioxide in stack gases has been used by the company to make sulphuric acid, which in turn, is used to make fertilizer in its plant at Trail. There has been no further production of elemental sulphur.

The recovery of sulphur in elemental form from "sour" natural gases containing hydrogen sulphide (H_2S) is a development of recent years and as mentioned before, such projects were underway in 1951 at Jumping Pound and Turner Valley. The amount of H_2S in natural gases varies with the fields but large volumes of proven reserves have been established in the Pincher Creek, Jumping Pound, and Turner Valley fields of Alberta which are estimated to contain 8, 4, and 2 per cent hydrogen sulphide gas, respectively. One million cubic feet of H_2S gas contains approximately 44.6 tons of elemental sulphur of which 80 to 90 per cent is recoverable.

Recovery from the gases of Jumping Pound and Turner Valley fields by Shell Oil Company and Royalite Oil Company, respectively, will amount to about 20,000 tons annually by the end of 1952.

Fortune Oils Limited, while drilling for oil in 1950 about 100 miles north of Edmonton, reported the discovery of elemental sulphur in the cuttings from 2 holes about 10 miles apart. This company and Dominion Tar and Chemical formed Sunbeam Sulphur Mines Limited to core drill the sulphur find. No detailed results of the drilling had been published by the end of 1951, but the sulphur horizon was reported to occur at 3,000 feet. It should be noted that no elemental sulphur has been mined in Texas and Louisiana from depths greater than 2,000 feet.

Recovery of elemental sulphur from coke-oven, oil refinery, and other industrial gases does not appear to be practicable in Canada at present. Several processes are used in plants in the United States for such recovery but overall annual output amounts to only about 50,000 long tons.

Anhydrite and Gypsum in Canada

The extensive deposits of anhydrite and gypsum in Canada, particularly in New Brunswick and Nova Scotia, constitute a huge potential source of sulphur and its compounds. Plants for the recovery of sulphur as sulphuric acid and production of Portland cement from anhydrite are in operation in England and on the Continent.

Pyrites in Canada

Canada's output of pyrite in recent years has been obtained as a by-product from the treatment of base metal ores and has been considered as a small profit operation, bringing from $2 to $2.50 a long ton f.o.b. the mine to the producers. Production in 1951 came from the Noranda, Waite Amulet, Quemont, and East Sullivan mines in western Quebec, and from the Britannia mine in British Columbia. Most of the output from these mines has been sold under contract for a long period ahead.

Consolidated Mining and Smelting Company uses some pyrrhotite tailings to augment its output of sulphuric acid from stack gases at Trail, British Columbia.

Normetal Mining Corporation Limited, with mine in Desmeloizes township, western Quebec, expects to recover about 200 long tons of by-product pyrite a day from the treatment of about 1,000 tons of copper-zinc ore. Barvue Mines in Barraute township in western Quebec, may recover about 200 tons of by-product pyrite from its 4,000-ton-per-day zinc operation which is expected to come into operation in June, 1952.

By-product pyrite is consumed in the manufacture of sulphuric acid at the plants of Nichols Chemical Company at Valleyfield, Quebec, at Sulphide, Ontario, and at Barnat, British Columbia. The only Canadian paper company burning pyrite as a source of sulphur in its sulphite plant is St. Lawrence Paper Mills Limited at Three Rivers, Quebec. All other pulp and paper companies burn imported elemental sulphur.

Large deposits of pyrite occur in several localities in Canada. Near the turn of the present century, before the deposits of Texas and Louisiana were brought into operation, large shipments of high grade pyrite were made from mines in Newfoundland and the Eastern Townships of Quebec. Operations are being resumed on several of these long-idle properties. Nearly massive pyrite bodies were mined, in conjunction with chalcopyrite, at Pilley's Island in Newfoundland and at the Eustis mine (now Albert Metals Corporation) near Sherbrooke in the Eastern Townships. Ascot Metals Corporation Limited and Suffield Metals Corporation Limited, with properties near Sherbrooke, are developing copper-lead-zinc orebodies with pyrite as a possible by-product. Weedon Pyrite and Copper Corporation Limited, working on a former copper-pyrite producer, the old Weedon mine about 40 miles northeast of Sherbrooke, dewatered the mine workings in 1951 and planned to produce copper and pyrite concentrates after further development. Noranda Mines has blocked out about 100,000,000 tons of pyrite reserves with low copper values in the No. 5 zone of its Horne mine. The company has also leased, for 50 years, the mine area (50 acres) of MacDonald Mines Limited in Dufresnoy township where substantial reserves of pyrite exist.

Several mines in Ontario which produced pyrite for acid manufacture before the advent of Frasch-mined sulphur seem to merit re-examination. Shipments of pyrite grading above 40 per cent sulphur were made up to about 1923 from several properties in eastern Ontario and from Northland Pyrites mine about 12 miles north of Timagami. The Goudreau Lake deposits, about 18 miles southwest of Missinaibi, consist of large pyrite lenses of good grade material on which relatively little exploratory work has been done. The Vermilion Pyrites mine about 7 miles west of Sioux Lookout was developed on 6 levels through a 59° incline shaft to a slope depth of about 625 feet. It appears to be one of the larger known Canadian deposits of good grade pyrite. There are many other occurrences of pyrites in Ontario.

In British Columbia, large tonnages of pyrite associated with copper and zinc sulphides have been indicated by drilling in the Ecstall River deposits near its junction with the Skeena River about 35 miles above Port Essington. Britannia Mining and Smelting Company Limited recovers about 200 tons of pyrite (flotation concentrate) a day from its copper operations at Britannia Beach where the stockpile has reached about 100,000 tons.

Uses

Sulphur in the elemental form is used in making a long list of commodities, including rubber and insecticides, and large tonnages are used in the manufacture of paper. Most of the sulphur from all sources, however, is converted into sulphuric acid, which is used chiefly in the manufacture of fertilizer, steel, and explosives, and in the petroleum refining, textile, chemical, and metallurgical industries. In Canada, the largest consumer, by far, of elemental sulphur is the pulp and paper industry which used about 70 per cent of imports in 1950.

Prices

In the latter half of 1950 the price of brimstone, a long ton, f.o.b. Texas and Louisiana mines, was advanced from $18 to $22. This price remained in effect throughout 1951 and meant that, with transportation charges added, elemental sulphur was laid down at $28 to $38 per long ton at Canadian plants, depending upon location.

Prices quoted in trade journals for Canadian pyrites have ranged from nominal $9 to $11 a long ton, f.o.b. point of shipment, to as high as $22. Such quotations should be regarded with caution. The highest price paid for Canadian by-product pyrite in 1951, appears to have been 15.4 cents a long ton unit, f.o.b. mine ($7.39 a long ton, 48 per cent sulphur content) for only a small shipment.

Nearly all production from present sources in Canada is under contract for long periods and the price paid for any year's production is subject to negotiation between buyer and seller.

During 1950 prices ranged from about 5 to 7 cents a long ton unit of contained sulphur, f.o.b. mine ($2.40 to $3.36 a long ton of pyrite containing 48 per cent sulphur).

TALC AND SOAPSTONE

Primary production (sales) of talc and soapstone in Canada in 1951 totalled 24,846 short tons, a decrease of 24 per cent compared with that of 1950. Production is entirely from the Eastern Townships of Quebec and the Madoc area in Ontario.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production (Sales)				
Ground	24,606	263,628	32,163	340,953
Sawn soapstone blocks and talc crayons	240	19,996	441	24,042
Total	24,846	283,624	32,604	364,995
Imports				
From: United States	8,549	271,206	8,081	248,087
Italy	667	32,269	853	38,497
Other countries	67	2,802	40	1,436
Total	9,283	306,277	8,974	288,020
Exports				
To: United States	3,519	45,670	4,306	55,401
Ecuador	90	1,176	105	1,351
Other countries	134	2,011	56	869
Total	3,743	48,857	4,467	57,621

—	1950 Short tons	1949 Short tons
Consumption		
Roofing	9,739	8,595
Paints	9,023	5,378
Rubber	3,290	3,002
Pulp and paper	1,634	3,827
Toilet preparations	861	864
Clay products	716	882
Other uses	7,515	7,199
Total	32,778	29,747

Approximately 15 per cent of the output was exported, mostly to United States. Exports dropped 16 per cent in 1951, while imports, consisting mainly of special grades for the ceramic, paint, and cosmetic trades, rose 3 per cent.

Canadian requirements of sawn dimension soapstone blocks and crayons are met by domestic producers.

Quebec

Broughton Soapstone and Quarry Company, Limited, Broughton Station, continued to produce ground talc, sawn soapstone blocks, bricks, and crayons. Baker Mining and Milling Company, Limited, with mine and mill near Highwater, continued production of ground talc. Eastern Townships talc is adapted for use as filler material where colour is of secondary importance.

Ontario

Canada Talc, Limited, (since July 1951, Canada Talc Industries Limited), Madoc, continued production of prime white talc for ceramic, cosmetic, and filler trades.

British Columbia

Ground talc is produced from imported materials by Geo. W. Richmond and Company for the local roofing trade.

Uses and Specifications

The roofing, rubber and paint industries account for the bulk of Canadian consumption. Lower grade talc is used as a surfacing material and dusting agent in asphalt paper roofing, as a filler and dusting agent in rubber products, and as a polishing agent for wire nails, rice, peanuts, and other commodities. For paint use, colour, particle shape, packing index, and oil absorption are the principal factors. The ceramic trade demands prime white colour and the paper industry, talc of high brightness, high retention, low abrasiveness, and freedom from chemically active substances. For lubricants, talc must be soft, free from grit and have high slip. Talc of high purity is demanded for the cosmetic and pharmaceutical trades.

Other uses include cleansers, plaster, polishes, plastics, foundry facings, linoleum and oilcloth, oil absorbent preparations, and filler for textiles, pipeline enamel, and other products.

Steatite, the massive, compact form of talc is used in making ceramic insulators.

Purchasers of crude talc for grinding purposes include Industrial Fillers, Limited, Montreal, Quebec, and Geo. W. Richmond and Company, Vancouver, British Columbia.

Prices

Final 1951 quotations as published in Canadian Chemical Processing were unchanged from 1950 as follows: $9.50-$44 a short ton according to size and quality f.o.b. Madoc, Ontario. Imported Italian in bags, a pound, 4 to 5 cents, f.o.b. Montreal or Toronto.

Tariffs

Canadian

Ground Talc

British	10 per cent ad valorem
Most favoured nation	15 per cent ad valorem
General	25 per cent ad valorem

Micronized Talc	
British	free
Most favoured nation	5 per cent ad valorem
General	25 per cent ad valorem
United States (1950 rate in brackets)	
Crude and unground	⅛c per pound
Washed and powdered:	
not more than $14 per ton	8¾(10) per cent ad valorem
more than $14 per ton	10(14½) per cent ad valorem
Cut, sawn blocks, crayons, dices and other forms	½c per pound.

PYROPHYLLITE

Pyrophyllite, a mineral similar to talc, but with alumina substituted for magnesia, is adaptable generally to the same uses as talc. Pyrophyllite has been produced intermittently in Newfoundland from a large deposit near Manuels, Conception Bay. There was no production in 1951.

VERMICULITE

There has been no production of vermiculite in Canada up to the present. Imports, all from United States and Union of South Africa rose 16 per cent in value over 1950 to $305.339.

During the year, Siscoe Vermiculite Mines Limited, Cornwall, Ontario, continued surface development of its property near Stanleyville, North Burgess township, Ontario and conducted limited development on other occurrences in the same locality. North Bay Mica Company, North Bay, Ontario carried on extensive surface development work on a deposit of dark green plastic vermiculite on the Farrel farm one-half mile north of Stanleyville village. H. G. Green, Lakefield, Ontario, reported the discovery of vermiculite over a considerable area in Cavendish township, north of Missisauga Lake. Occurrences near DeWitt Corners and Verona also were reported..

World Sources

United States and South Africa are the principal suppliers of crude vermiculite. In United States the deposit at Libby, Montana is outstanding. Other deposits occur in North and South Carolina, Wyoming, Texas, Colorado, Georgia, and other states. In South Africa the principal deposits occur at Palabora, East Transvaal, and others in Tanganyika, Kenya, Uganda, and other areas. Russia is known to be a producer, and occurrences have been reported in India, Australia, and Japan.

Description and Uses

Vermiculite, a hydrated magnesium aluminum silicate, resembles mica closely but is softer and inelastic. Colours range from black through brown and dark green to almost colourless. Its principal characteristic is its ability to expand many times on heating, and in its expanded form it possesses low bulk density, low thermal conductivity, high heat resistance, chemical inertness, and acoustic properties. Vermiculite is generally regarded as a product of alteration and is usually associated with metamorphosed ultra-basic rocks.

The principal uses for vermiculite are loose insulation in buildings; concrete and plaster aggregate; lightweight fire-resistant and acoustic tile and wallboard; rooting medium; and soil amendment. It is also used in lubricants, dry chemicals (as a diluent), combination refractory and insulating brick, as a pigment and extender in paint, and as decorative filler in wallpaper. Vermiculite has been used as fireproof deck covering and partitions on ships, as loose insulation in fire and sound-proof partitions in vehicles and aircraft, as filler for life jackets and in finely powder forms, for oil-less bearings.

Markets and Specifications

Purchasers of imported raw vermiculite include F. Hyde and Company, Limited, Montreal; Insulation Industries (Man.) Limited, Winnipeg; Vermiculite Insulating Limited, Montreal; and Suzorite Company of Ontario, Limited, Cornwall, Ontario.

Trade and Consumption

—	1951	1950
	$	$
Imports, crude		
From: United States	269,867	201,278
Union of South Africa	35,472	61,281
Total	305,339	262,559

—	1950		1949	
	Short tons	$	Short tons	$
Consumption				
Ore used in the miscellaneous non-metallic mineral industry	18,540	485,546	14,680	378,583
Products				
Insulation	....	798,542	....	632,317[1]
Other	....	192,000	....	88,096[1]
Total	....	990,542	....	720,413[1]

[1] Revised.

Raw vermiculite is usually sold as concentrate screened to commercial sizes. Specifications vary according to the requirements of individual purchasers but in general, foreign impurities should not exceed 5 per cent and total unexpandable material 10 per cent.

Size classifications are approximately as follows:

Acoustic tile $-\frac{1}{2}$ inch $+ 3$ mesh
Loose insulation $-3 + 14$ mesh
Concrete and plaster aggregate, soil amendment, etc. -6 or $-8 + 65$ mesh.

Bulk densities of expanded vermiculite sold in Canada range from under 5 pounds per cubic foot for loose insulation to over 7 pounds for concrete and plaster aggregate.

Prices and Tariffs

According to E. & M.J. "Metal and Mineral Markets", vermiculite prices during 1951 were as follows: crude, cleaned and screened f.o.b. Montana Mines, $12-$14 a short ton; South African, f.o.b. Atlantic ports, $30-$32.

Crude vermiculite enters both Canada and United States free of duty.

WHITING SUBSTITUTE

Production of whiting substitute in Canada in 1951 was 18,380 tons valued at $190,727 compared with 17,603 tons at $172,460 in 1950. Canadian producers include: Industrial Fillers Limited at Montreal, Quebec; Marlhill Mines Limited, Thorold, Ontario; Gypsum Lime and Alabastine (Canada) Limited, Winnipeg, Manitoba; and Beale Quarries Limited, Vananda, Texada Island, British Columbia.

Production, Trade, and Consumption

—	1951		1950	
	Short tons	$	Short tons	$
Production, stone processed for whiting:				
Marble	12,100	146,040	10,587	128,248
Limestone	6,280	44,687	7,016	44,212
Total	18,380	190,727	17,603	172,460
Imports				
Whiting, Gilder's whiting, and Paris white				
From: United States	13,972	377,325	15,109	385,824
United Kingdom	5,779	83,561	4,339	56,647
Other countries	814	8,112	1,888	14,919
Total	20,565	468,998	21,336	457,390
Chalk, prepared				
From: United States	...	4,447	...	5,650
United Kingdom	...	364	...	881
Total	...	4,811	...	6,531
Miscellaneous, chalk, china, Cornwall or cliff stone (ground or unground), and mica schist				
From: Germany	...	13,863	...	3,271
United States	...	5,325	...	11,339
United Kingdom	...	194	...	848
Total	...	19,382	...	15,458

—	1950	1949
	Short tons	Short tons
Consumption, ground chalk and whiting		
Paints	10,657	9,682
Rubber goods	6,444	6,176
Linoleum and oilcloth	6,386	5,913
Miscellaneous chemicals	983	827
Electrical apparatus	763	700
Explosives	255	273
Gypsum products	154	106
Tanneries	138	146
Medicinal and pharmaceuticals	102	114
Soaps	84	45
Enamelling	66	67
Non-ferrous smelters	49	49
Adhesives	13	...
Miscellaneous	16	140
Total	26,110	24,238

In general in this country it is customary to refer to whiting substitute as domestic whiting or marble flour. It is a pulverized form of white limestone, calcite, marble, or marl but it may also be prepared from calcium carbonate which has been precipitated in certain chemical processes. Canadian production is entirely from marble and limestone. Fine grinding is essential in the manufacture of whiting substitute and minus 200 to minus 400 mesh is desirable.

True whiting, necessary for certain uses, is prepared from chalk, and domestic needs for the raw material and much of the finished product are supplied by imports.

Uses

Whiting and whiting substitutes are used in a large number of industries in the manufacture of a variety of products such as paints, rubber goods, linoleum and oilcloth, moulded plastic articles, cleaning compounds, polish, putty, explosives, and as a filler in paper. Whiting substitute of high purity and good colour may be used in the paint industry as an extender. In this use oil absorption and particle shape are important factors. To be of interest to the rubber industry, whiting substitute must have suitable fineness, the right degree of workability, and a proper effect on finished rubber. Particles should disperse readily, and bond well with rubber.

Prices

Prices of limestone whiting were the same as in 1950: 99½ per cent −325 mesh, bagged, in carload lots, $6 to $10 a ton f.o.b. U.S. points. Precipitated whiting was quoted in United States at $18 to $20 a ton carload lots f.o.b. works.

III FUELS

COAL

Canadian coal production decreased by about 2.9 per cent from its all time peak of 19,139,112 tons in 1950, being 18,586,823 tons. Alberta contributed about 41 per cent of the total, Nova Scotia 34 per cent, Saskatchewan 12 per cent, and British Columbia 9 per cent, the remaining 4 per cent coming mainly from New Brunswick.

Consumption decreased from 44,874,000 tons in 1950 to 44,095,075 tons in 1951. Of this consumption approximately 60 per cent was supplied by imports, in both years, chiefly from United States and United Kingdom.

The trend to favour strip mining continued in Saskatchewan, Alberta, New Brunswick, and British Columbia, the proportion of coal so mined increasing by 1.6 per cent compared with that of 1950. The efforts to improve the quality of products by modern methods of beneficiation resulted in the establishment of several cleaning, drying, and briquetting plants in Alberta, Nova Scotia, and New Brunswick. The use of fuel oil for domestic and building heating continued to increase to the detriment of coal consumption, and the increased fuel requirements of the railways were almost completely filled by the use of diesel oil.

Production, Trade, and Consumption

The following tables, based on information provided by the Dominion Bureau of Statistics, give the production, trade, and consumption of coal for 1951 and 1950:

Imports of Coal[1]

(Short tons)

Country of Origin	1951			1950		
	Anthracite	Bituminous	Total	Anthracite	Bituminous	Total
United States....	3,561,775	22,841,694	26,403,469	3,890,254	22,538,403	26,428,657
United Kingdom.	291,656	....	291,656	395,867	28,007	423,874
Other countries..	....	54	54	262	38	300
Total...	3,853,431	22,841,748	26,695,179	4,286,383	22,566,448	26,852,831

[1] From Trade of Canada. Includes briquettes but excludes coal exwarehoused for ships' stores.

Exports of Coal

(Short tons)

Destination	1951	1950
United States..........	292,497	347,849
Japan..........	90,646	....
Brazil..........	32,718	34,005
United Kingdom..........	11,297	....
St. Pierre and Miquelon..........	7,809	13,093
Other countries..........	116	14
Total..........	435,083	394,961

Production of Coal by Provinces[1]

(Short tons)

—	1951				1950			
	Bituminous	Sub-Bituminous	Lignitic	Total	Bituminous	Sub-Bituminous	Lignitic	Total
Nova Scotia	6,307,629	....	....	6,307,629	6,478,405	....	....	6,478,405
New Brunswick	653,439	....	....	653,439	607,116	....	....	607,116
Saskatchewan	....	....	2,223,318	2,223,318	....	....	2,203,223	2,203,223
Alberta	4,659,312[2]	3,000,017	....	7,659,329	4,794,647[2]	3,321,573	....	8,116,220
British Columbia	1,739,412	....	....	1,739,412	1,730,445	....	....	1,730,445
Yukon	3,696	....	....	3,696	3,703	....	....	3,703
Total	13,363,488	3,000,017	2,223,318	18,586,823	13,614,316	3,321,573	2,203,223	19,139,112
Value.............$	89,244,992	15,432,166	4,361,677	109,038,835	89,409,538	16,686,164	4,044,697	110,140,399

[1] Coals classed according to A.S.T.M. Classification of Coal by Rank—A.S.T.M. Designation D388-38.

[2] Includes a small quantity of semi-anthracites from the Cascade area.

Consumption [1] of Coal in Canada for Fiscal Year 1951-1952 [2]

(Short tons)

—	Bituminous[3]	Anthracite	Briquettes	Total
Domestic	8,550,000	3,362,000	319,000	12,231,000
Industrial	13,848,000[4]	220,000[5]	....	14,068,000
Railroads	10,712,000	....	258,000	10,970,000
Coke and Gas	5,388,000	....	....	5,388,000
Water transportation	528,000	....	....	528,000
Government	....	....	2,000	2,000
Total	39,026,000	3,582,000	579,000	43,187,000

[1] Both domestic and imported coal.
[2] From Dominion Coal Board Annual Report covering fiscal year ending March 31.
[3] Includes lignite.
[4] Includes coal used by the mines.
[5] Includes uses other than industrial.

Briquettes

Consumption of briquettes in Canada decreased from 643,325 tons in 1950 to 566,156 tons in 1951, mainly due to the fact that one of the largest producers in Alberta was inoperative because of destruction of its plant by fire. The consumption consisted of: 48,170 tons made from carbonized Saskatchewan lignite, 347,829 tons made from low volatile bituminous and semi-anthracitic coals from the Nordegg and Cascade areas in Alberta, and from medium volatile bituminous coal from the Crowsnest and Mountain Park areas of Alberta; and 170,157 tons imported from United States and prepared from low volatile bituminous coals and anthracite, alone and mixed. A new plant operating in the Big Valley area of Alberta started briquetting sub-bituminous coal during the latter part of the year, producing just over 1,700 tons.

Nova Scotia and New Brunswick

High and medium volatile bituminous coking coals are produced in the Sydney, Cumberland, and Pictou areas, and some non-coking bituminous coal is mined in the Inverness area. A substantial proportion is consumed locally by the railways, steel and paper industries, the power plants, and as a domestic fuel. However, with the proposed adoption of diesel locomotives by the maritime railways, the railway market will shrink and lend impetus to the development of other markets. Shipments of coal from Nova Scotia to various centres in central Canada amounted to 1,810,847 tons in 1951, in comparison with more than 2,500,000 tons in 1950.

Saskatchewan

Only lignite is produced, most of the output being from the Bienfait division of the Souris area, the other main producing fields being the Estevan and Roche Percee divisions of the same area. Approximately 65 per cent of the output is shipped to Manitoba for domestic and industrial use, and although oil has made serious inroads into that market, Saskatchewan lignite has not only held its own but has slightly increased its market.

Alberta

Alberta produces almost all ranks of coal, including a small tonnage of semi-anthracite. In 1951, about 61 per cent was bituminous, and 39 per cent sub-bituminous and lignite, mainly the former.

Bituminous coals ranging from high to low volatile, are produced in the Crownsnest, Nordegg, and Mountain Park areas, and are used mainly in the railway and industrial steam markets but also in the commercial and domestic markets.

In several areas of the foothills (Lethbridge, Coalspur, Saunders, and others) lower-rank bituminous non-coking coals are produced. These are used mainly in the domestic and commercial markets, but the industrial and railway markets for certain types are substantial.

The coal in the Drumheller, Edmonton, Brooks, Camrose, Castor, and Carbon areas is sub-bituminous, and that in the Tofield and Redcliff areas is on the border of sub-bituminous and lignite. They are used mainly in the domestic and commercial markets but also to a small extent in the production of industrial steam.

The Cascade area was the only field that produced semi-anthracite in 1951.

British Columbia

Bituminous coking coals, ranging from high to low volatile, are mined on Vancouver Island and in the Crowsnest, Telkwa, and Nicola areas. Minor quantities of sub-bituminous coal are produced, mainly in the Princeton field. In the Kootenay (Crowsnest) area, medium-temperature oven (by-product) coke is manufactured mainly for industrial consumption.

Yukon

Bituminous coal was produced in the Carmacks mine mainly to supply the heating requirements of the Mayo mining camp.

Developments

Strip Mining

Strip mining of coal was practised in all coal-producing provinces with the exception of Nova Scotia, the amount so mined being 5,764,810 tons, or 32.2 per cent of the total. In Saskatchewan over 99 per cent of the coal mined was produced by strip methods, in Alberta almost 38 per cent, in New Brunswick over 68 per cent, and in British Columbia about 18 per cent. These percentages show small but definite increases over the corresponding ones for 1950, the largest increase, 12 per cent, taking place in New Brunswick.

The tendency to favour strip mining, wherever possible, is based on the larger output per man-day that can be achieved, as shown in the following table which is calculated from figures published by the Dominion Bureau of Statistics.

Average Output of Coal per Man-day, 1951

(Short tons)

—	Strip Mines	Underground Mines
Nova Scotia	....	2·10
New Brunswick	4·98	1·51
Saskatchewan	22·45	3·54
Alberta	8·82	3·61
British Columbia	38·63	3·30
Yukon	....	1·39
Canada	11·20	2·60
Average—3·42		

In Saskatchewan the high productivity is accounted for by the use of high capacity machinery in level terrain; the seams are 5 to 6 feet thick with an average burden of about 30 feet. By contrast, in New Brunswick the seam is very thin, not exceeding 24 inches in thickness with the burden also averaging about 30 feet.

In British Columbia stripping is mostly in the mountain areas with associated underground mines, the coal being cleaned in a common preparation plant, the personnel of which is not allocated against strip mines. Consequently productivity is higher than should be the case.

The development of strip mining has been facilitated by the introduction of heavy, mobile earth-moving equipment such as drags, shovels, scrapers, and bulldozers, aided by improved methods and equipment for drilling and blasting rock. The continued development and improvement of the machinery has greatly increased the amount of coal which can be recovered economically by strip mining. For example, in New Brunswick, 50 feet or more of cover are commonly removed to reclaim a seam of coal as thin as 18 inches. This is a ratio of 1 to 33, whereas some years ago a ratio of 1 to 12 was considered the maximum.

Coal Beneficiation

The coal industry is continuing its efforts to improve the quality of its products by the introduction, on an increasing scale, of the most modern methods of coal beneficiation. This program has become necessary because of 2 factors: increasing competition from oil and natural gas and, to a lesser extent, from imported solid fuels; and a general deterioration in the quality of coals as mined, brought about by increasing mechanization and the steady depletion of the best coals.

Thus, during 1951, one company in Nova Scotia began to operate a Baum jig plant to clean the production from 2 mines, and another, after successfully operating in 1950 a pneumatic heavy-medium plant for cleaning domestic sizes retained on a $\frac{1}{4}$ inch screen, has since installed and is operating a similar plant to dry clean the 0 x $\frac{1}{4}$ inch fines.

Two pneumatic cleaning plants were installed in Alberta, one in the Coalspur area and the other in the Drumheller area, and the installation of other dry cleaning plants was under consideration in those areas where non-caking bituminous and sub-bituminous coals are mined.

In the Nordegg area in Alberta a plant was completed to clean all sizes retained on a $\frac{1}{4}$ inch screen using wet cleaning methods and including thermal dryers to reduce the moisture content. This plant is unique because its total production is briquetted to produce low asphalt-content briquettes for use in railway locomotives, and higher asphalt-content briquettes for domestic consumption. The higher asphalt content is required to produce an agglomerated, compressed mass with satisfactory handling qualities.

Also in Alberta, where coal preparation is more extensive than in any other area, fluidized dryers for fine coal have been successfully introduced, with 3 units now established in the Crowsnest area and 1 constructed in the Mountain Park area. Preliminary drying of the fines is necessary as a pretreatment for pneumatic cleaning or briquetting.

In New Brunswick a pulsating-type screen dryer for slack was installed at one of the strip mines with a view to preparing a product that would not freeze in the cars in the winter and would be more acceptable generally to the consumer.

In the Big Valley area of Alberta, where extensive strip operations have been underway in sub-bituminous coal seams, a briquetting plant was constructed in 1951 to manufacture coal cubes with asphalt binder. This plant is still in its infancy and no data are available concerning the product or its market reception.

In connection with the establishment of these methods of coal beneficiation, the Mines Branch has conducted tests and research, both in the laboratory and in the field.

Consumption of Coal in Relation to Oil

The following tables, compiled from data supplied by the Dominion Bureau of Statistics and the Department of Transport, compare the consumption of coal and oil in Canada in the last 10 years.

Fuel Consumed by Railways

(Mainly for locomotives)

—	Coal Thousands of Tons	Fuel and Diesel Oil Millions Imp. Gals.	Heat Equivalent * of Oil in Terms of Coal Thousands of Tons	Heat Equivalent of Oil as Per Cent of Total Coal and Oil
1941	9,536	73·2	498·9	5·0
1942	10,614	73·9	503·7	4·5
1943	11,987	77·8	530·6	4·2
1944	11,993	60·3	411·1	3·3
1945	12,084	98·9	674·3	5·3
1946	11,632	102·6	699·5	5·7
1947	12,331	108·4	739·1	5·7
1948	12,422	113·7	775·2	5·9
1949	11,444	162·9	1,110·7	8·8
1950	10,966	245·8	1,675·9	13·3
1951	10,505	260·4	1,775·4	14·5

* Estimated in terms of coal at 13,000 Btu/lb. taking oil at 9·33 lb./gal. with a calorific value of 19,000 Btu/lb.

Fuel Consumed for Domestic and Building Heating

(For installations consuming less than 500 tons per annum)

—	Coal Thousands of Tons	Fuel Oil [1] Millions Imp. Gals.	Estimated Heat Equivalent of Oil in Terms of Coal Thousands of Tons	Heat Equivalent of Oil as Per Cent of Total Coal and Oil
1941	12,163	146·8	1,001	7·6
1942	13,711	124·0	848	5·8
1943	14,981	95·4	650	4·2
1944	12,571	103·3	705	5·3
1945	13,498	143·8	980	6·8
1946	13,454	323·0	2,202	14·1
1947	13,117	343·0	2,338	15·1
1948	13,429	384·3	2,619	16·3
1949	12,473	445·5	3,037	19·6
1950	13,398	[2]	[2]	....
1951	12,158	586·9	4,001	24·8

[1] Exclusive of stove oil.
[2] Indications are that there was a substantial increase over 1949 in fuel oil consumption.

In reference to the above table it may be noted that although the railways had a slightly larger number of steam locomotives in service in 1951 than in 1939, the number of diesel locomotive units increased from none in 1939 to approximately 570 in 1951, with the expectation of a further increase to about

700 in 1952. Thus, although the quantity of locomotive coal consumed in 1951 was about the same as before the war, there has been a steady increase in the use of diesel oil to handle the marked increase in railway traffic in the intervening years.

The continued increase in the use of oil for domestic and building heating, at the expense of coal is also quite evident, the heat equivalent of oil consumed as part of the total coal and oil rising to 25.9 per cent in 1951. There was a reduction in the quantity of coal consumed for such purposes of nearly 10 per cent from 1950 to 1951.

COKE

Production of coke, all types, was 4,109,988 tons compared with 4,103,594 tons in 1950. About 96 per cent was made from bituminous coal, close to 75 per cent of which was imported from United States. Petroleum coke produced at the refineries was 164,689 tons compared with 122,191 tons in 1950.

Imports of coke were 956,755 tons, an increase of more than 300,000 tons over 1950, and included 353,397 tons of petroleum coke. Exports decreased almost 200,000 tons to 219,340 tons.

Production and Trade

—	1951		1950	
	Short tons	$	Short tons	$
Production from bituminous coal				
Ontario	2,466,842	37,251,442	2,536,975	36,746,944
Nova Scotia, New Brunswick, Quebec, and Newfoundland	1,160,208	19,004,760	1,108,634	16,726,922
Manitoba, Saskatchewan, Alberta, and British Columbia	304,576	3,592,630	319,067	3,510,155[1]
Total	3,931,626	59,848,832	3,964,676	56,984,021
Production of pitch coke	13,673	263,132	16,727	274,336
Production of petroleum coke	164,689	1,674,174	122,191[1]	1,140,603[1]
Total all types	4,109,988	61,786,138	4,103,594[1]	58,398,960[1]
Bituminous coal used to make coke				
Imported	3,963,571	41,821,089	3,984,434	41,258,627
Canadian	1,290,745	10,069,875	1,297,913	10,142,559
Total	5,254,316	51,890,964	5,282,347	51,401,186
Imports, all types				
From: United States	956,737	16,910,494	642,053	11,026,824
United Kingdom	1	44	201	3,103
Other countries	17	945	....	....
Total	956,755	16,911,483	642,254	11,029,927
Exports, all types				
To: United States	197,661	3,120,931	395,665	5,535,752
Other countries	21,679	841,336	17,678	785,453
Total	219,340	3,962,267	413,343	6,321,205

[1] Revised.

Coke is produced from coal in Canada with several types of carbonization equipment, namely, 8 by-product coke oven plants, 1 beehive plant, 1 Curran-Knowles installation, 7 continuous vertical retort plants, and 8 installations of horizontal "D" retorts. Most of the output is obtained from standard by-product coke ovens in eastern Canada and is used for metallurgical and domestic purposes. The manufactured gas industry, which processes coal in retorts and small gas ovens, produces approximately 300,000 tons of coke a year which is mostly required for auxiliary gas manufacture at the plant where it is produced. Petroleum coke is used extensively in the aluminium industry, less than 25 per cent of the available stocks being processed as fuel for domestic or industrial heating.

The increased demand for metallurgical coke has resulted in the construction of 1 new by-product coke oven plant at Dominion Steel Foundries Limited, Hamilton, Ontario, and the addition of new batteries to plants in Sydney, Nova Scotia and to the plant at Michel, British Columbia. Plans were made by other companies for expansion of their coke oven plants. International Coal and Coke Company Limited did not operate its beehive plant at Coleman, Alberta during the year.

Approximately 80 per cent of the coal used in the production of coke in Canada is processed by 6 companies at by-product coke oven plants in eastern Canada as listed in the following table:

Producer	Location	Annual Rated Capacity tons of coal
Dominion Steel and Coal Corporation	Sydney, Nova Scotia	813,000
Montreal Coke and Manufacturing Company*	Ville La Salle, P.Q.	656,000
Algoma Steel Corporation Limited	Sault Ste. Marie, Ont.	1,761,000
Hamilton By-Product Coke Ovens Limited	Hamilton, Ontario	415,000
Dominion Steel Foundries Limited	Hamilton, Ontario	300,000
Steel Company of Canada Limited	Hamilton, Ontario	641,000

* The company normally produces domestic coke and also supplies Montreal with gas.

The manufacture of beehive coke was continued on a much reduced scale in 1951 by one company in western Canada, namely, The Crowsnest Pass Coal Company Limited, in its plant at Michel, British Columbia.

The supply of domestic coke in Canada is largely dependent upon the market conditions which create a demand for metallurgical coke. In periods of emergency the supply may be further curtailed by allocation to essential users, which is the main reason for the wide variations in consumption from year to year.

NATURAL GAS

Production of natural gas in 1951 was 79,460,667 M cubic feet, an increase of 11,638,437 M cubic feet over that of 1950. About 87·9 per cent was contributed by Alberta and 10·6 per cent by Ontario. Saskatchewan, New Brunswick, and Northwest Territories produced minor quantities in that order.

Five applications for gas export were heard during the year by the Alberta Petroleum and Natural Gas Conservation Board and it was expected that the Alberta Government would announce its decision regarding export early in 1952. The new gas reservation and lease policy which, broadly, makes available "gas only" rights in certain areas was put into effect by the Alberta Government as an incentive to speed gas exploration and to build up a reserve surplus.

In Alberta, more than 60 gas strikes resulted in important extensions to previously known fields. Jumpingpound went on gas production for the first time in May with the completion of a scrubbing plant in Calgary, and gas was distributed to southern Alberta and later in the year by a new pipeline, westward to Exshaw and Banff. A 10-mile pipeline was completed in November from the Erskine sector of the Stettler oil field to service the town of Stettler with natural gas. With this outlet 2 'wet gas' wells, formerly capped, were placed on production. Construction began on 2 new sulphur extraction plants, one at Turner Valley and one at Jumpingpound, which together are expected to produce about 20,000 tons of elemental sulphur a year commencing in 1952.

In Ontario, 133 successful gas wells were drilled within known fields, 4 in the Salina-Guelph formations and 129 in Clinton-Medina formations. It is estimated that about 31 billion cubic feet were added to Ontario's gas reserves as a result of the 1951 development drilling.

Other discoveries in Canada were: in Northwest Territories—1; in British Columbia—3; and in Saskatchewan—4.

Production

Provinces and Fields	1951		1950	
	M cu. ft.	$	M cu. ft.	$
Alberta				
Turner Valley	30,592,235	...	28,846,738	...
Viking-Kinsella	19,288,478	...	18,908,554	...
Leduc	5,379,167	...	1,654,855	...
Jumpingpound	4,435,792	...	...	...
Medicine Hat	3,567,764	...	3,784,895	...
Redcliff	1,752,046	...	1,436,145	...
Other fields	4,861,349	...	3,972,789	...
Total	69,876,831	3,493,842[1]	58,603,976	2,930,199[1]
Ontario				
Kingsville, Tilbury, Romney, and Raleigh	1,986,211	...	1,761,648	...
Zone	261,070	...	439,299	...
Dawn, oil springs	2,434,635	...	...	...
Kimball and Beecher	...	...	2,375,620	...
Haldimand	1,682,314	...	1,584,476	...
Welland	549,399	...	548,806	...
Other fields	1,529,213	...	1,299,639	...
Total	8,442,842	3,377,137[2]	8,009,488	3,203,795[2]
Saskatchewan	860,082	86,008	813,554	71,564
New Brunswick				
Stony Creek	261,579	194,312	361,877	214,665
Northwest Territories	19,333	7,621	33,335	12,818
Canada, total	79,460,667	7,158,920	67,822,230	6,433,041

[1] The value of production based on a well-head valuation of 0·05 cents per M cu. ft.
[2] Wholesale value of natural gas produced.

Alberta

Alberta produced 69,876,831 M cubic feet of natural gas during 1951 as compared with 58,603,976 M cubic feet in 1950. Of this total gas output, 93 per cent came from 5 fields—Turner Valley, Viking-Kinsella, Leduc, Jumpingpound, and Medicine Hat-Redcliff—which are connected by pipeline to local markets.

Sixty gas strikes resulted in important extensions to previously known fields, particularly around Medicine Hat, Provost, and Bonnyville, or established new potential gas areas. Most of these discoveries were capped pending market outlets.

Discoveries in 1951

At Okotoks, 15 miles south of Calgary, natural gas with high hydrogen sulphide content was struck in Devonian limestone. At the discovery well, after the well casing had been perforated between depths of 8,490 to 8,580 feet, gas flowed at rates up to 5,000 M cubic feet daily. Gas at rates up to 400 M cubic feet daily was also reported during drill stem tests in Mississippian beds.

One of the most promising of the 1951 gas discoveries was a Mississippian limestone 'wet gas' strike at Majeau Lake. About 30 feet of an indicated 85-foot saturated zone was opened at the discovery well at depths of from 4,210 feet to 4,240 feet, and on flow tests, the well rated between 9,000 and 10,000 M cubic feet of gas daily plus separator recovery of around 24 barrels a day of 60 degrees A.P.I. gravity condensate and some water.

An important discovery was made at Neapolis, 38 miles north-northeast of Calgary, which recorded Alberta's deepest and most southerly find of productive Devonian D_3 reef zone at a depth of about 8,100 feet. After acid treatment, several tests made between depths of 8,100 to 8,121 feet indicated open-flow potentials of from 50,000 to 70,000 M cubic feet of gas and about 400 barrels of 58 degrees A.P.I. gravity naphtha daily.

Perhaps the most outstanding gas and oil discovery of the year was made at Bonnie Glen about 5 miles south of Wizard Lake field where the thickest Devonian productive reef yet encountered in Canada was opened. The gas cap of this D_3 zone was 397 feet thick, and on drill stem tests, natural gas flowed at rates up to 10,500 M cubic feet daily, with accompanying naphtha of over 60 degrees A.P.I. gravity, thereby classing the well as one of the largest 'wet gas' discoveries in Canada. Below the gas-oil interface, more than 290 feet of D_3 oil zone was opened.

In addition, commercially significant discoveries of natural gas were made throughout Alberta from the International Border to the Peace River area. Twenty gas strikes were made in the Viking sand or its equivalent; 2 were made in other sands of Colorado age; 22 wells found gas horizons in Lower Cretaceous beds; gas was discovered in Triassic beds at North Tangent; at Chinook, gas was found in the detrital zone above the Mississippian; 5 strikes were made in Mississippian strata; and 3 in the Devonian D_2 zone. 'Wet gas' was also found at Buffalo Lake in Lower Cretaceous sands and in the Sunburst sand at Chancellor.

Other Developments

At Turner Valley, Royalite Oil Company, Limited, commenced construction of a $350,000 sulphur plant, which is expected to be in operation by the spring of 1952. The plant will recover elemental sulphur from the hydrogen sulphide to be removed from Turner Valley natural gas. Capacity of the plant will be about 30 tons a day, and it is expected that the first year of operation will yield about 9,300 tons of sulphur.

Shell Oil Company of Canada's Jumpingpound gas and oil fields, 20 miles west of Calgary, were discovered in 1944, but went on gas production for the first time in May with the opening of a gas-scrubbing plant at Calgary, which has a capacity of 25,000 M cubic feet daily. A newly constructed pipeline from the field delivers the natural gas to the plant, where it is processed for distribution throughout southern Alberta. Later in the year a gas pipeline from Jumpingpound westward to Exshaw and Banff was also completed, and construction begun at the field on a sulphur extracting plant scheduled to have an initial annual production of about 10,000 tons of sulphur.

A 10-mile gas pipeline from the Erskine sector of the Stettler oil field was completed to service the town of Stettler with natural gas. The line, constructed by the Stettler Gas Company, cost about $440,000. As a result of the system's completion, 2 'wet gas' wells, formerly capped, were placed on production in the Erskine area.

Export of Natural Gas

Proposals for the export of natural gas from Alberta continued to be of major interest. In January, the Alberta Petroleum and Natural Gas Conservation Board presented to the Alberta Government its interim report respecting applications for permission to remove gas from the province. From the data presented by the applicants, the Board reached the decision that the disposable gas reserves in Alberta at January 1, 1951, were 4,439 billion cubic feet within economic reach and 219 billion cubic feet beyond economic reach. The Board estimated the province's requirements for the 30-year period, 1951 to 1980, at 3,059·9 billion cubic feet.

The Board further stated its belief that the present system of disposing of Crown lands and the establishment of Crown reserves, although fair and equitable for oil development, is not well suited for gas exploration and development. It, therefore, recommended that the Government make available "gas only" rights in specific zones for exploration and lease in large blocks on a drilling performance basis. This new gas reservation and lease policy was put into effect as an incentive to speed gas exploration and build up a gas reserve surplus.

By the end of 1951, the Board had completed all gas export hearings that had been under way for 2 years, and was preparing its report to the provincial government. Five applicants for export permits were heard during the year. Two companies, Canadian Delhi Oil Limited and Western Pipe Lines proposed the building of lines eastward from Alberta, the former to reach Montreal and to supply markets in Saskatchewan, Manitoba, and Ontario en route, and the latter to Winnipeg and thence southward to the Minneapolis-St. Paul area of the United States. Two other companies, Westcoast Transmission Company Limited and Alberta Natural Gas Company, proposed building pipelines to the west coast, the former from the Peace River area via Pine Pass, Prince George, and Fraser Valley to Vancouver, with a southern extension to Seattle and Portland, and the latter from Pincher Creek through Crowsnest Pass to Kingsgate, British Columbia, where it would enter the United States, and from there westward and northward to Vancouver. Prairie Pipe Line Limited, now affiliated with Pacific Northwest Pipeline Corporation, proposed the building of a pipeline from Pincher Creek through Crowsnest Pass and across the International Boundary at Kingsgate. This line would join with one from Texas to the United States Pacific Northwest to be built by the Pacific Northwest Pipeline Corporation.

It was expected that the Alberta government would announce its decision regarding export of natural gas early in 1952.

Northwest Territories

The Norman Wells field, in which about 12 wells operated during 1951 to supply local oil and gas needs, produced 19,333 M cubic feet of natural gas.

In August, a test well, North West Territories No. 1, 1½ miles southeast of Fort Providence was completed at a depth of 1,678 feet. In a drill stem test between 1,067 and 1,097 feet, presumably in Middle Devonian Slave Point limestone, a relatively small flow of gas estimated at 40 M cubic feet daily was obtained, and the well was capped as a potential gas producer.

British Columbia

For the past few years interest in exploration for oil and gas in British Columbia has centred in the northeastern part of the province, and 13 wells were drilled in this region in 1951. Of these, one well resulted in British Columbia's first oil strike; a follow-up well was abandoned; one exploratory well proved unproductive and 2 others were drilling at the year's end. The remaining 8 wells were completed in the Dawson Creek area, where gas was discovered in March.

The discovery well is located about 18 miles north of Dawson Creek. The strike was made in Commotion Creek sands when, in a drill stem test between 3,086 and 3,126 feet, a gas flow measured at 1,450 M cubic feet daily was encountered. The well was completed at a depth of 3,232 feet and capped as a potential gas producer. Two previous wells located 6½ miles northwest and 5½ miles southwest of the discovery well respectively, had been abandoned in 1951. Further drilling during the year to determine the areal extent of the gas pool resulted in 3 dry holes and 2 capped gas wells.

Saskatchewan

Saskatchewan's 1951 gas production came chiefly from the Lloydminster-Lone Rock Lower Cretaceous oil and gas field and the Unity Cretaceous gas field, with a minor amount from the Kamsack gas area, where the shallow productive zone is a shale encountered at about 180 feet below the surface. Total gas production increased to 860,082 M cubic feet in 1951 from 813,554 M cubic feet in 1950, although only one development well, in the Lone Rock sector, was completed as a gas producer during the year.

Three gas discoveries were made as a result of increased exploratory activity in search for oil throughout the province. Gas was struck in Jurassic sand at Tompkins, in southwest Saskatchewan, in a drill stem test between depths of 3,631 and 3,661 feet. A gas flow at a maximum rate of 2,071 M cubic feet daily was obtained. At Brock, a gas discovery well obtained a natural gas flow at a rate of between 5 and 8 M cubic feet a day from the drill stem test of Viking sand at 2,357 to 2,380 feet in depth, while at Dodsland, a well obtained natural gas from Viking sand flowing at the rate of 442 M cubic feet daily on drill stem test.

Natural gas was discovered in the Viking sand at a depth of 2,775 feet at Coleville, about 18 miles west of Dodsland. The discovery well also struck heavy crude oil in Mississippian sands, and by the end of the year the area had attained oil-field status, with 6 wells capable of oil production and 11 drilling. One well had been completed as a Viking gas producer.

Ontario

During 1951, 133 successful gas wells were drilled within known fields in southwestern Ontario. Of these, 4 found production in the Salina-Guelph (Silurian) formations at depths of 1,800 to 2,600 feet, and 129 produced from the Clinton-Medina (Silurian) formation at depths of 450 to 1,400 feet. Average initial production from the Salina-Guelph wells was 3,171 M cubic feet a day, and from the Clinton-Medina wells, 56 M cubic feet a day.

Six new Salina-Guelph gas pools were discovered, 5 in Lambton county and one in Kent county. Two deeper gas pools were discovered in the Guelph formation in Lambton county. It is estimated that about 31 billion cubic feet were added to Ontario's gas reserves as a result of 1951 exploratory drilling.

The Union Gas Company of Canada, Limited, continued to import small volumes of gas from the United States during the summer; this was placed in underground storage for use in winter periods of peak consumption.

New Brunswick

The Stony Creek Mississippian oil and gas field 9 miles south of Moncton produced 261,579 M cubic feet of natural gas for local use. No new gas wells were established in 1951, and production declined by 100,298 M cubic feet from that of 1950.

PEAT

Production of peat moss was 76,809 tons, an increase of 2·1 per cent compared with that in 1950. The peak year was 1946 when 96,839 tons were produced. Output in 1951 came from 35 producers, the chief ones being in the Fraser River delta in British Columbia, and in the Rivière du Loup area in Quebec.

Most of the production is exported to United States, where two-thirds is used for horticultural moss, and one-third for poultry and stable litter.

Production

—	1951			1950		
	Producers	Short tons	$	Producers	Short tons	$
British Columbia...	13	46,947	1,700,030	13	45,565	1,498,219
Quebec............	14	21,657	436,833	14	17,873	360,459
Ontario...........	3	1,804	72,557	5	5,613	206,625
New Brunswick....	3	4,587	161,934	3	5,534	168,321
Manitoba and Nova Scotia..........	2	1,814	61,654	2	610	23,246
Total.....	35	76,809	2,433,008	37	75,195	2,256,870

Peat moss is the dead fibrous moss that has been excavated from peat bogs, dried, shredded, and pressed into bales or smaller packages. It is valuable for its highly absorptive nature, and its main uses are for stable bedding, poultry litter, and soil conditioning.

Peat is widely distributed throughout Canada. 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 and generally occurs in two distinct forms, unhumified sphagnum or moss peat, and well humified grass or sedge peat, better known as fuel peat. In recent years a small amount of fuel peat has come from Gads Hill Station near Stratford, Ontario.

British Columbia

The peat operations in the Fraser River delta near New Westminster are the largest in Canada. From this small area, 13 companies in 1951 produced over 46,947 tons, almost two-thirds of the total Canadian production. The largest producers are Industrial Peat Limited, and Atkins and Durbrow Limited.

Four bogs are being worked, namely: Pitt Meadows, Byrne Road, Lulu Island, and Delta (or Burns). These deposits are expected to last for 10 or 15 years at the present rate of production.

Manitoba

Western Peat Company Limited, the only producer in Manitoba, operates the Julius, or Shelley, bog about 50 miles east of Winnipeg.

Ontario

Three companies produced 1,804 tons of peat moss in 1951. The larger operator was Arctic Peat Moss Company, Limited, Fort Frances. In 1951, Atkins & Durbrow (Erie) Limited ceased operations on the Welland bog.

Quebec

The peat moss deposits now being worked in Quebec are mainly in the lower St. Lawrence region. In 1951, 21,657 tons were produced by 14 companies, most of the production coming from 2 companies: Premier Peat Moss Corporation with operations at Rivière du Loup, Isle Verte, and Cacouna; and Tourbieres Rivière-Ouelle in the Rivière du Loup area. Four smaller companies were not active in 1951.

New Brunswick

The most important peat moss deposits are in Northumberland and Gloucester counties on both shores of Miramichi Bay, and on Miscou and Shippigan islands. Three companies were engaged in peat moss production in 1951, namely: Fafard Peat Moss Company at Pokemouche; Western Peat Company at Shippigan; and Atlantic Peat Moss Company Limited on Shippigan Island. Their total production was 4,587 tons.

Nova Scotia

Annapolis Peat Moss Company Limited, the only producer, operated the Caribou bog near Berwick, and produced a small tonnage of peat moss in 1951.

Peat for Agricultural Uses

A co-operative investigation was started in 1948 by the Department of Agriculture, and the former Department of Mines and Resources (now the Department of Mines and Technical Surveys) to test the value of humified peat as a source of organic matter for soils deficient in humus. As this is a long term investigation it will be some time before the actual effects can be accurately measured. However, an examination of the apple orchards where humified peat was applied indicates that while peat alone has not, as yet, effected any marked improvement, peat mixed with lime and/or fertilizer showed noticeable improvement in the fertility of the orchard soil.

Price

The price of peat moss varied according to location from $21 to $41 a ton. The average price for the Canadian output was $32 a ton, $6 less than the average for 1950.

An interesting development concerning soil conditioning materials, has been the production by Monsanto Chemical Company, St. Louis, of a synthetic material, "Krilium", which the company claims is the same as the resin produced by the breakdown of humus material. It is the sodium salt of hydrolysed polyacronitrite. At present it is being tested by the United States Department of Agriculture. The price in 1951 was $2 a pound which made it too expensive for large scale use.

CRUDE PETROLEUM

Canada's production of crude petroleum showed a further marked increase in 1951 even though the maximum output from many fields was restricted by lack of marketing facilities. Canadian crude oil and natural gasoline production for the year totalled 48,130,561 barrels, an increase of 65 per cent over the 1950 output. About 96 per cent of the output is from Alberta.

Canadian oil refineries used 127,000,000 barrels of crude oil in 1951, of which 83,000,000 barrels were imported. Total imports of refined petroleum products amounted to 30,000,000 barrels.

Increased transportation, storage, and refining facilities have enabled the expansion of outlets for Canadian crude oil, particularly for that of Alberta where the "market proration" allowed each field was correspondingly raised. Therefore, 1952 production figures more nearly represent total Canadian potential production than do those of 1950. Increase in these market allowables as well as in the number of producing wells is responsible for raising western Canada's 1951 production 66 per cent above that of 1950.

During its first full year of operation the Interprovincial Pipeline from Edmonton, Alberta, to Superior, Wisconsin, delivered about 13,000,000 barrels of crude oil to the Lakehead for tanker movement to eastern Canadian markets. Oil pipelines from the Excelsior, Joseph Lake, and Wizard Lake oil fields to Edmonton refineries and the Interprovincial Pipeline terminus were constructed. In December, 1951, Federal Government approval was granted to build a 695-mile oil pipeline from Edmonton through the Yellowhead Pass and interior of British Columbia to Burnaby, a short distance north of Vancouver. Estimated cost of the line, which will have an initial capacity of 75,000 barrels of crude oil daily, is $80,000,000. Construction was commenced in the spring of 1952, with completion expected by the end of 1953.

Refining capacity in western Canada was increased with the opening of a 5,200 barrels-a-day-capacity refinery at Edmonton, and one at Winnipeg which has a capacity of 10,800 barrels of crude oil daily. In Ontario, building was started on the refinery of Canadian Oil Companies Limited at Froomfield, near Sarnia, which will have an initial capacity of 20,000 barrels of crude oil a day and tank storage space for 1,700,000 barrels of crude oil and finished products. The plant will contain Ontario's first fluid catylitic cracking unit.

Construction of the 64-mile section between Sarnia and London, Ontario, of the Sarnia-Toronto products pipeline was begun.

Canadian crude oil reserves reached a total of about 1·5 billion barrels in 1951, a 30-fold increase since the discovery of Leduc in 1947.

During 1951, new records were set by western Canada's petroleum industry in exploration and drilling, and over $215,000,000 were spent by Canadian and foreign companies in the search for oil and gas. At the end of the year a record of 153 geophysical units were operating. Alberta ranked next to Texas in North America with 120 units compared with 105 at the end of 1950. At the end of 1951, 220 drilling rigs were in operation compared with 139 at the end of 1950. About 120 were working in proven or semi-proven oil or gas areas and the remainder on exploratory wells. Well completions in western Canada totalled 1,371, an increase of 359 over 1950. These resulted in 816 oil wells, 125 gas wells, and 430 abandonments. A record of 108 discoveries was made, including 40 oil strikes which extended previously known field limits or established new potential oil areas or fields. Alberta accounted for 35 of these discoveries; Saskatchewan, 2; Manitoba, 2; and British Columbia, 1.

Production of Crude Petroleum in Canada [1]

(In barrels of 35 imperial gallons)

—	1951	1950
Alberta		
Redwater	23,177,607	10,746,472
Leduc—Crude oil	13,743,118	10,589,472
Natural gasoline	43,597	15,022
Turner Valley—Crude oil	2,952,307	3,344,007
Natural gasoline	457,773	431,362
Acheson	918,158	51,393
Lloydminster	900,469	809,801
Joseph Lake	727,936	168,855
Excelsior	723,005	272,186
Golden Spike	640,972	292,873
Stettler	606,068	246,198
Taber	182,449	114,916
Big Valley	155,580	10,215
Conrad	142,497	110,062
Princess	92,189	122,909
Campbell	60,436	60,012
Vermilion	44,557	49,041
Jumping Pound—Crude oil	41,936	362
Natural gasoline	13,657	....
Del Bonita	30,344	12,668
Whitemud	25,803	45,437
Normandville	16,376	28,200
Wainwright	14,238	15,360
Dina	12,646	17,887
Other areas	706,693	40,906
Total	46,430,411	27,595,616
Saskatchewan (Lloydminster)	1,249,281	1,041,098
Ontario	197,171	250,655
Northwest Territories	227,449	186,729
New Brunswick	15,551	17,137
Manitoba	10,698	....
Grand total	48,130,561	29,091,235
Total value	$118,316,242	$84,762,000

[1] For Alberta, actual production; for other provinces, shipments to refineries.

ALBERTA

Production from several Alberta oil fields increased greatly during 1951 due to the operation of the Interprovincial Pipeline. These fields included Redwater, Leduc-Woodbend, Acheson-Stony Plain, Stettler, Joseph Lake, Excelsior, Golden Spike, and Big Valley.

Among other fields found since the Leduc discovery in February, 1947, Duhamel, Ellerslie, and Bon Accord had the most successful drilling activity with consequent increase in production.

Establishment of new local industries using Lloydminster-type heavy crude oil was responsible for an increase in output from the Lloydminster field.

Little or no drilling was done in older fields such as Dina, Wainwright, Princess, and Vermilion, and production from them declined. Output from the Conrad, Taber, and Del Bonita oil areas increased in 1951.

Some important extensions were made to previously known fields. Producing limits were extended in the Leduc-Woodbend field, particularly in the Kavanagh area of D_2 zone production southeast of the main field, and Lower Cretaceous oil was discovered in the corridor connecting the northern limits of the Leduc field with the southern part of Woodbend. At Stettler, a ½-mile north and northeastern extension of the Devonian D_2 zone-producing limits was established. The Golden Spike field's northern D_2 and D_3 zone-producing limits were extended 1 mile, and a discovery of Devonian D_1 zone oil was made ½ mile east of the D_3 zone discovery well at a depth of about 4,620 feet. Extensions to the Campbell field were made 2 miles northeast and 2¼ miles northwest. At Big Valley, the Devonian D_2 zone producing limits were extended ⅜ mile southward, and Lower Cretaceous production limits were extended ½ mile east at Barons.

Discoveries

The most important field discovery in 1951 was made at Wizard Lake, 5 miles southwest of the Devonian D_2 zone-producing limits of the Leduc field. The discovery well encountered about 55 feet of oil-saturated porous limestone in the Devonian D_2 formation after finding gas in Viking sand and light crude oil in the Lower Cretaceous formation. Oil in commercial quantity was also discovered in the Devonian D_3 zone, and the well was placed on production from that horizon without fully penetrating the porous D_3 section. A follow-up well, however, penetrated over 620 feet of oil-saturated D_3 zone above the water line to establish the thickest Devonian oil-productive section yet found in Alberta.

Several other new oil fields were established as a result of drilling to follow up 1951 oil strikes. At Camrose, 17½ miles southeast of the Joseph Lake Viking oil pool, oil in commercial quantity was discovered in Viking sand of Cretaceous age. At Bashaw, a Devonian D_3 zone oil pool was established when a discovery well opened 19 feet of productive zone above the water line of which, roughly, the upper half appeared to be gas cap and the lower half oil column. Large volumes of gas with some oil had previously been found in the D_3 zone in this area 1¼ miles east and 3 miles northeast. On the basis of the greater oil recovery at the new well, it was assumed that a new reef had been found that was not connected with the reef reservoir supplying the large gas flow at the former 2 wells. Devonian D_3 zone oil was struck at Caprona, about midway between the Stettler D_2-D_3 field 8 miles north and the Big Valley D_2-D_3 field 8 miles south. A Devonian D_2 and D_3 dual zone oil discovery was made 3 miles southwest of the Duhamel Devonian oil field at New Norway in the central Alberta plains region. At Armena, oil was discovered in commercial quantity in Viking sand, following non-commercial oil shows made in the Viking at a number of other wells in that area, which is 10 miles southeast of the Joseph Lake Viking oil field. An oil strike was made in Basal Cretaceous sand at Alliance, and

Important Alberta Oil Fields, Discovered Prior to 1951

Field	Year of Discovery	Producing Formation	Lithology of Producing Formation	Depth to Top of Producing Zone (Feet)	No. of wells at end of 1951		Total Completions in 1951	A.P.I. Gravity of Oil (Degrees)
					Capable of Production	On Production		
Redwater............	1948	U. Devonian, D_3 zone	Limestone	3,100	898	893	176	34—36
Leduc-Woodbend......	1948	L. Cretaceous	Sandstone	4,200	22	21	....	37·5—39
	1947	U. Devonian, D_2 zone	Dolomite	5,100	365	347	325	38—40
	1947	U. Devonian, D_3 zone	Dolomite	5,300	413	411	....	38—40
Turner Valley........	1913	L. Cretaceous	Sandstone	3,100	3	2	0	
	1924	U. Mississippian	Limestone, Dolomite	3,450—9,150	327	286	1	43
Acheson-Stony Plain	1950	L. Cretaceous	Sandstone	3,941—4,250	4	3	....	36·5
	1950	U. Devonian, D_3 zone	Dolomite	4,950	51	50	56	37
Lloydminster.........	1939	L. Cretaceous	Sandstone	1,920	223	156	88	9—16
Joseph Lake..........	1949	Viking (Cretaceous)	Sandstone	3,270	70	65	47	36
Excelsior.............	1949	U. Devonian, D_2 zone	Dolomite, Limestone	3,820	32	31	10	36—37
Golden Spike.........	1949	U. Devonian, D_2 zone	Limestone	5,000	1	1	....	....
	1949	U. Devonian, D_3 zone	Limestone	5,365	8	8	5	34—38
Stettler..............	1949	L. Cretaceous	Sandstone	4,250	2	2	....	....
	1949	U. Devonian, D_2 zone	Dolomite	5,200	30	30	21	24—31
	1949	U. Devonian, D_3 zone	Dolomite	5,330	13	13	....	....
Duhamel.............	1950	U. Devonian, D_2 zone	Dolomite	4,500	5	5	....	....
	1950	U. Devonian, D_3 zone	Dolomite	4,700	7	7	15	34—35
Taber................	1942	L. Cretaceous.........	Sandstone	3,200	21	11	0	18—23
Big Valley............	1950	U. Devonian, D_2 zone	Dolomite	5,240	18	17	....	33·6—34·2
	1950	U. Devonian, D_3 zone	Dolomite	5,300	4	4	21	33—33·5
Conrad...............	1949	Ellis (Jurassic)	Sandstone	3,200	17	15	0	26
Campbell.............	1949	L. Cretaceous	Sandstone	3,700	12	5	3	31—35

gas and heavy crude oil were discovered at Bonnyville in the Lower Cretaceous, rating a 2-mile southward extension of the Bonnyville gas area of east-central Alberta and establishing oil production there. A Devonian D_2 and D_3 dual zone oil discovery was made at Glen Park in the 5-mile stretch separating Wizard Lake from the Leduc field. Oil was discovered in a Lower Cretaceous sand at Armisie, 4¾ miles north of the Ellerslie Lower Cretaceous pool. A Devonian D_2 zone oil horizon was found at Drumheller, where Lower Cretaceous production had been obtained in 1950.

Several important strikes were made which have yet to be evaluated. These included a gas and oil strike at Bonnie Glen which opened the thickest Devonian productive reef ever encountered in Canada. About 397 feet of gas cap was penetrated above the gas-oil interface, and natural gas flowed at rates up to 10,500 M cubic feet daily with accompanying naphtha of over 60° A.P.I. gravity. About 290 feet of Devonian D_3 oil zone was drilled through below the gas-oil interface before the water-line was reached. Gravity of the Devonian oil was estimated at 42° A.P.I. In the East Edmonton area, oil of gravity 28°-29° A.P.I. was discovered in a 50-foot porous section of Basal Quartz sand, and 6 miles east of Redwater, at Skaro, 37° A.P.I. crude oil was struck in fragmental limestone.

Three other Devonian oil strikes were made at Pine Lake, Octave, and Clive. One strike was made in Viking sand at Morinville, and one in the Lower Cretaceous at Dewdrop Lake.

Northwest Territories

About 12 wells operating in the Norman Wells Upper Devonian oil and gas field produced 224,826 barrels of crude oil in 1951, the output being for local requirements.

British Columbia

Fifteen wells were drilled in unproven territory or in the Dawson Creek gas area in 1951. These resulted in one oil well, 3 gas wells, and 11 abandoned wells. Considerable geological exploration was also carried on, principally in the northeastern part of the province.

The province's first oil strike was made 5 miles south of Fort St. John along the Alaska Highway in a Permo-Pennsylvanian (late Palæozoic) crystalline, porous dolomite at a depth of 5,635 feet. Estimated gravity of the crude oil received in drill stem tests was 38° A.P.I. The well was still testing at the end of 1951.

Saskatchewan

Saskatchewan production in 1951 came almost entirely from the Lloydminster heavy crude oil region. Exploratory activity reached a peak and almost the entire southern half of the province, about 50,000,000 acres, is under permit or lease. A total of 112 exploratory and development wells was completed, resulting in 53 oil wells, 6 gas wells, and 53 abandoned wells.

A Mississippian heavy oil pool was discovered at Coleville, 100 miles southeast of Lloydminster. The discovery well opened more than 60 feet of oil-bearing sand at a depth of about 2,694 feet. The well also found gas in Viking sand. By the end of the year, 5 more wells were capable of production in the region.

The Williston Basin extends northwards from United States into southeastern Saskatchewan and southwestern Manitoba. Saskatchewan's first discovery of Williston Basin crude oil was made in 1951 when a well at Dahinda, 50 miles south-southwest of Regina, received a small recovery of 20° A.P.I. gravity crude oil during a drill stem test between depths of 4,694 and 4,704 feet in Mississippian dolomite. The well was later abandoned.

At Eatonia, 120 miles southwest of Saskatoon, heavy crude oil of gravity 12°-14° A.P.I. was discovered in Lower Cretaceous sand at depth of about 2,978 feet.

Manitoba

An oil pool in Mississippian limestone was discovered 9 miles east of Virden in the Williston Basin area. A productive zone was found between 2,200 and 2,340 feet and on tests after acidization, the discovery well was reported to be capable of producing 8 to 10 barrels of 33° A.P.I. gravity crude oil daily with approximately 65 per cent water. By the end of the year, 3 step-out wells were also on production from the same horizon.

Eleven exploratory ventures drilled in 1951 were abandoned.

Ontario

All the oil and gas fields in Ontario are in the southwestern part of the province. In 1951, 316 wells were drilled, of which 262 were drilled within field limits. These resulted in 8 oil wells, 133 gas wells, and 121 abandoned wells. The new oil wells, located in Elgin, Kent, Lambton and Middlesex counties, produced from shallow Devonian horizons and had an average initial production of 12 barrels of crude oil daily. Exploratory drilling resulted in the finding of 2 small shallow Devonian oil pools in the Rodney area of Elgin County.

Leasing activity increased considerably in 1951, and the number of active gravitymeter parties rose from a monthly high of 4 in 1950 to 15.

New Brunswick

Production is from the Stony Creek oil and gas field 9 miles south of Moncton, from which the yearly output of both oil and gas is declining. The yield is from interbedded sandstones and shales of the Alberta formation, Mississippian in age. During 1951, only 2 wells were drilled and both were abandoned. An exploratory well at Alberta Mines, a few miles south of Stony Creek, was also abandoned.