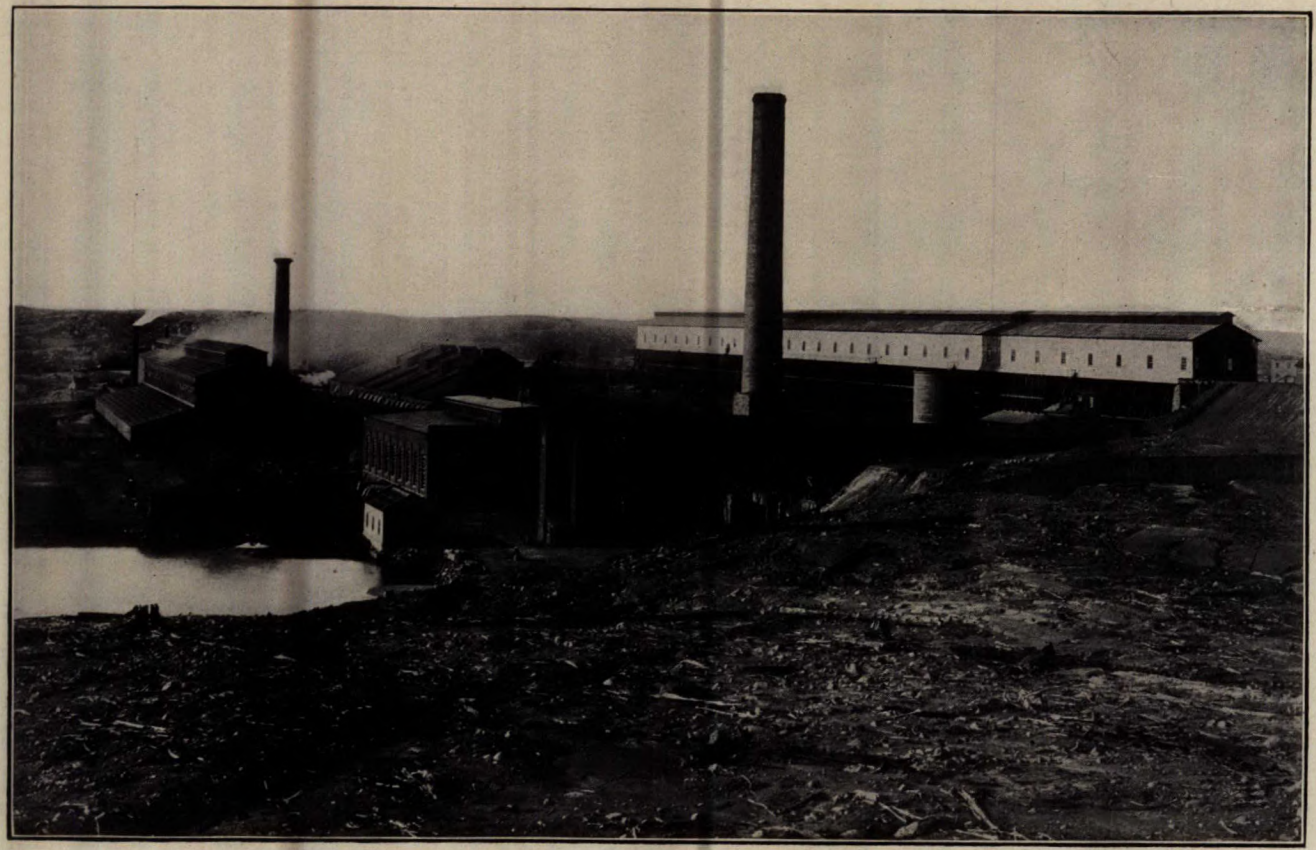

Canadian Copper Co.'s smelter at Copper Cliff, Ont. (Smelting nickel and copper ores.)

CANADA
DEPARTMENT OF MINES
HON. LOUIS CODERRE, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
MINES BRANCH
EUGENE HAANEL, PH.D., DIRECTOR.

Economic Minerals and Mining Industries

OF

CANADA

BY
THE STAFF
OF THE
MINES BRANCH

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ECONOMIC MINERALS

AND

MINING INDUSTRIES

OF

CANADA

1913

PREFACE.

NUMEROUS minerals of economic importance, widely distributed, occur in the Dominion of Canada, although, as yet, only small fractions of the probable productive areas have been carefully prospected. Within her boundaries, Canada still possesses large areas of great potential importance, and each season brings to light new deposits or minerals not hitherto discovered.

This pamphlet has been compiled under the direction of Mr. J. McLeish, Chief of the Division of Mineral Resources and Statistics, who has had the co-operation of several officers of the Mines Branch staff; more particularly Messrs. C. T. Cartwright, L. H. Cole, H. Frechette, H. S. deSchmid, and A. W. G. Wilson; and the objective has been to present in a popular form a brief sketch of the more important economic minerals, and of the mining and metallurgical industries of Canada.

A short introductory statement, giving some data of general interest, and including a brief description of the main geographic and geologic features of the country, precedes the detailed descriptions. Each individual metal or mineral product is treated separately, and arranged in alphabetical order. The occurrence or distribution of each mineral is, in general, taken up in geographical order, from east to west. At the end of the pamphlet brief summary statements of the mineral production of each province of the Dominion are included; in which reference is made to the laws governing mining and the ownership of mining lands in the various Provinces and Territories; and the names and addresses are given of the several government departments—whether Provincial or Dominion—administrating these laws or regulations.

In this brief description many interesting and important details have, of necessity, been omitted, and, in many instances, reference is made to localities or occurrences where preliminary investigations have indicated only future possibilities.

The particulars and statistics have all been compiled from official sources, and, where advisable, published papers and reports have been freely quoted from: for which, general acknowledgment is here made.

More detailed information respecting any particular mineral, ore, product, or district, may usually be obtained from the proper official department of the various Provincial Governments, or from the Director of the Mines Branch of the Department of Mines, Ottawa.

(Signed) **Eugene Haanel,**
Director.

June 4, 1913.

MINERAL RESOURCES AND MINING INDUSTRIES OF CANADA.

INTRODUCTORY.

The Dominion of Canada occupies the northern portion of the continent of North America—exclusive of Alaska: all the Arctic islands between Greenland and the 141st meridian being included within its boundaries. Its area is about 3,729,665 square miles.[1] The island of Newfoundland—including some of the lesser islands on the east coast of the continent—and a narrow strip of land along the adjacent Labrador coast, forms a separate colony, under the British Crown. Inclusive of Newfoundland, British North America has an area of about 3,772,000 square miles. Canada extends from east to west about 3500 miles, and from north to south about 1400 miles. The most southern point is in Essex county, Province of Ontario, near latitude 42° 16′ N.

This large area necessarily presents great diversity of topographic features, and strata of nearly all geological horizons are represented. On the basis of certain structural features, it is possible to recognize six great physiographic units. The greatest single structural unit covers an area of over 2,000,000 square miles. This unit extends, in a more or less U shape, from Labrador on the east to Coronation gulf on the west, bordering the great Hudson Bay depression. It is underlain by a mass of ancient crystalline rocks, very diverse, and highly metamorphosed—the roots of the most ancient mountain range on the continent. These mountains were probably the first land areas of the North American continent. The originally overlying portions were gradually removed by various erosive processes, until now, throughout this vast area, mountain forms are no longer seen; but their basal structures still remain. So great has been erosion, that the region is now characterized almost everywhere by the existence of remarkably even skylines. Here and there, low domed residuals rise a few feet above the general level, making notable breaks in the otherwise nearly even surface.

In detail the topography of this area is characterized by innumerably small domes and basins, with a relief of only a few hundred feet or less. Scattered over its surface are numberless small and large lakes, with numerous streams, which exhibit many rapids and falls. Nowhere else in the world are small lakes and connecting streams so plentiful and so widely distributed. The greater portion of the southern part of the region is covered with dense forests of spruce. The higher portions of the area in Labrador, and the extreme northern portions of both the eastern and western limbs, are nearly destitute of trees; although some few occur in protected basins. The remarkably even skyline, and certain other features which characterize the region as a whole, have caused it to be designated the **Laurentian Peneplain.** It is, however, a very ancient peneplain, which has been elevated and partially dissected and denuded, producing the present hummocky topography. The elevation of the plane, as shown by the skylines, varies from about 500 feet

[1] The area of the United States, including Alaska, is 3,617,673 square miles.

above the sea-level to about 1500 feet, a very considerable portion lying below the 1000 ft. contour. The area is sometimes known as the **Laurentian Plateau.**

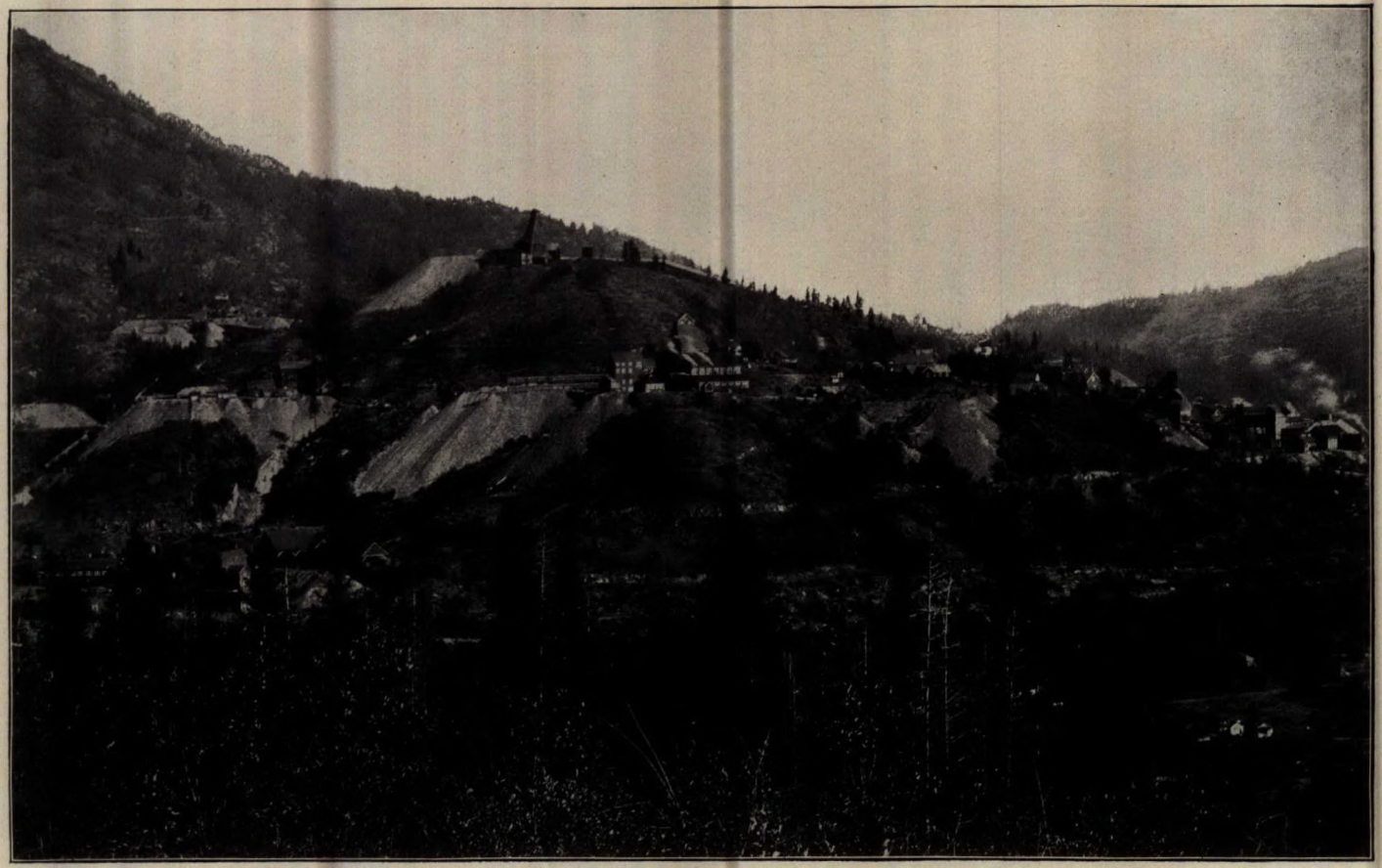
This area is underlain by ancient crystalline rocks, ranging from the Laurentian to the Keweenawan formations. It is a region of great potential importance as a producer of minerals of economic value. The mica and phosphate deposits of the Ottawa valley; the silver mines of Cobalt; the gold deposits of Porcupine; the nickel-copper deposits of Sudbury; and the iron mines of the Michipicoten district, all occur within this region. Its importance—already demonstrated as a source of such minerals as graphite, feldspar, mica, corundum, iron ores, both magnetites and hematites, silver, cobalt, copper, nickel, and gold—will, undoubtedly, be greatly extended in the future.

The **Hudson Bay basin** occupies a central depression in the Laurentian peneplain. The bay itself is a great inland sea, some 600 miles from east to west, and nearly 1000 miles from north to south. Bordering the southern and southwestern portion of this basin, is an area underlain by Palæozoic rocks, sloping gently bayward, which may be designated the **Hudson Bay Coastal Plain.** At present this region is largely unexplored, but is known to contain deposits of rock salt and gypsum.

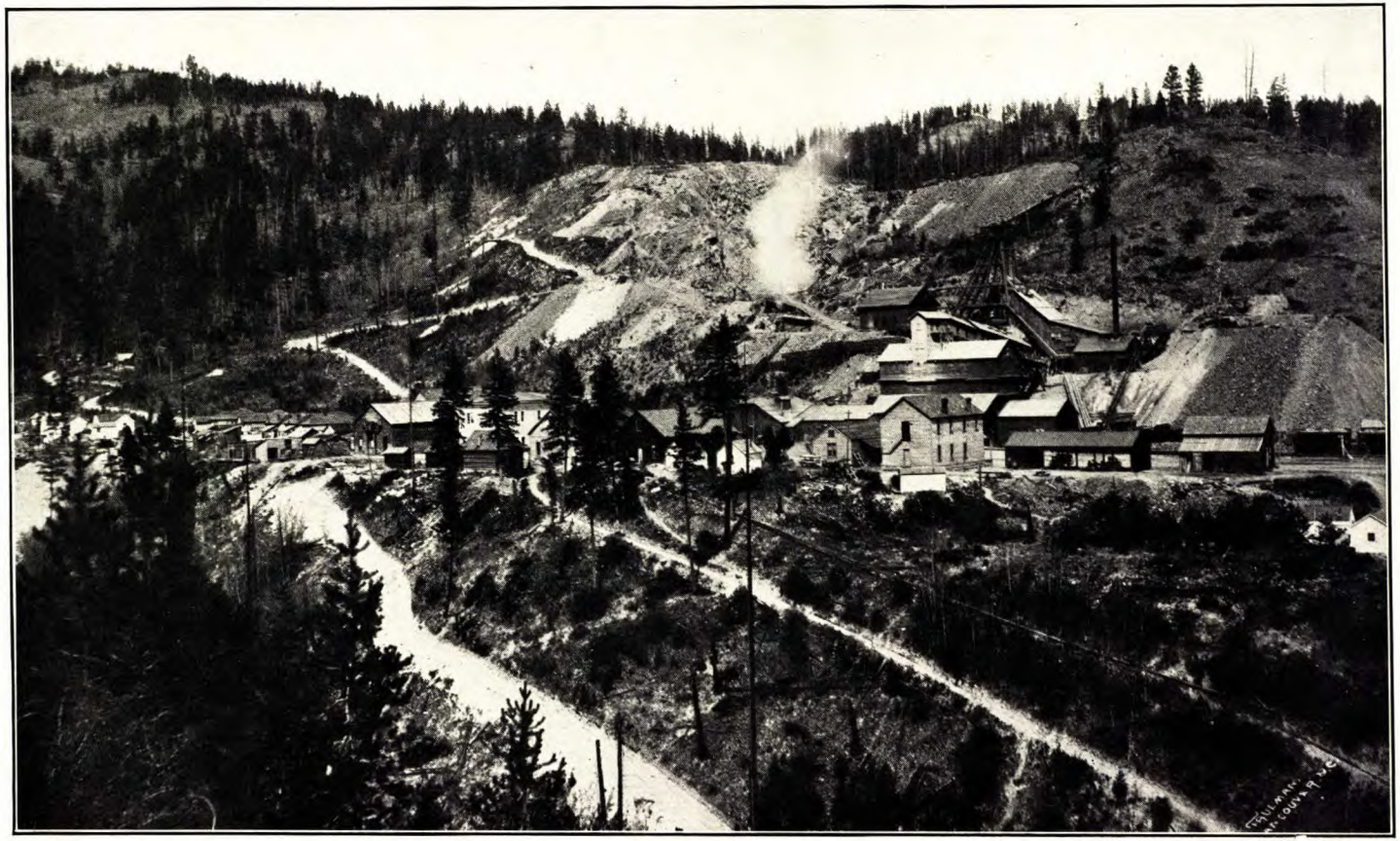
Southeast of the Laurentian plateau, including a portion of the province of Quebec (south of the St. Lawrence river and east of Sherbrooke) and the whole of the Maritime Provinces, we find the northern extremity of the belt of Appalachian mountain folds, which extends along the Atlantic coast of the continent. This area was termed the **Acadian region** by Dawson. It is underlain chiefly by Palæozoic rocks, which have been subjected to considerable folding, and, afterwards, were degraded. On the extreme east, on the Nova Scotia coast, a number of basins contain residuals of the carboniferous system, in which very important coal fields occur. A larger but shallower basin of carboniferous rocks also occurs in New Brunswick. The other mineral products of this area are copper, gold, sulphur, gypsum, oil, gas, sandstones, limestones, clays, and building and ornamental stones of various kinds.

The next important physiographic unit is the ancient belted coastal plain which now forms the St. Lawrence drainage basin (the **St. Lawrence basin**). It extends from the city of Quebec to Lake Huron, and includes the St. Lawrence lowland in the vicinity of Montreal, and the lowland areas in the province of Ontario, adjacent to the great lakes. This region is underlain by Palæozoic sediments, limestones, sandstones, and shales. Its mineral products are salt, gypsum, natural gas, petroleum, building stones, brick clays, and the raw materials of various cements, limes, and mortars. This section is one of the most populous areas in Canada, and, although essentially an agricultural area, a very considerable percentage of the people are connected with the industries which arise through the occurrence of these natural products.

Westward of the Laurentian plateau, from the city of Winnipeg and Lake Winnipeg, we have the **Great Plains** area, or the **Interior Continental Plateau,** extending to the foothills of the Rocky mountains, a distance of about 600 miles. Northward from the United States boundary, at parallel 49° N., to the Arctic ocean, is a distance of about 1600 miles. This area includes two great river basins: the Saskatchewan basin on the south, and the Mackenzie basin on the north, the divide between them lying not far from 56° N. latitude. The entire area is underlaid by sedimentary strata, ranging in age from early Palæozoic to later Mesozoic. The southern part of the area, including the greater portion of the Saskatchewan basin, forms the great



Mines at Rossland, B. C.



Mother Lode mine, near Greenwood, B. C.

wheat raising districts of Canada. While it is by no means all occupied, the country is dotted with small towns and settlements, and is traversed by numerous railways and their branch lines, including three transcontinental systems. The northern part of the area, including nearly the whole of the Mackenzie basin, is only partially explored, and contains very few inhabitants.

The southern parts produce natural gas, building stones, and the raw materials for cements and mortars. The northern part is known to contain deposits of rock salt, gypsum, coal, and tar sands, and it will also produce natural gas, and, probably, petroleum. The stream beds along the western edge of the area contain immense gravel deposits washed down from the mountains, some of which are known to be auriferous. The most important mineral product of the area, however, is lignite coal, which occurs very widely distributed over the western portion of the area, and especially in the southern parts; many of the seams are quite thick, and the deposits form an exceedingly important source of fuel for the western provinces of Canada.

The mountain belt of British Columbia and the Yukon constitute the next great physiographic unit. This is the northern portion of the great **Cordilleran belt,** which extends along the whole western side of the North American continent, from Central America to Alaska. The Canadian portion of the belt is about 1300 miles in length. On the eastern flank of this Cordilleran belt, we have the **Rocky Mountain ranges,** composed chiefly of Palæozoic and Mesozoic rocks. This mountain belt is particularly important, because of the immense reserves of bituminous coal of Cretaceous age, found in many sections of the ranges.

Westward of the Rocky mountains, lie a series of mountain ranges, collectively designated as the **Gold ranges.** They are composed of Archean rocks, with which are associated granites and a great thickness of older Palæozoic beds, all much disturbed and metamorphosed. Westward of these ranges lies a section of country with somewhat diversified topography, which is usually described as the **Interior plateau** of British Columbia. Its width from east to west is about 100 miles; its extent from north to south probably about 500 miles. It differs from the mountain ranges to the east chiefly in the lack of any lofty mountain peaks; its main elevation is about 3500 feet above sea-level. The plateau has been the seat of much volcanic action during Miocene times.

Beyond the plateau to the north the whole width of the Cordillera appears to be mountainous, about as far as the 59th parallel of latitude. Still farther north the ranges decline or diverge, and in the basin of the upper Yukon rolling or nearly flat land, at moderate elevations, again begins to occupy wide intervening tracts.

The western border of the Cordillera, along the Pacific coast, is formed by the **Coast range.** This range runs northward from near the estuary of the Fraser river to beyond the head of Lynn canal. It has a breadth of about 100 miles. It consists largely of granite batholiths, on the margins of which occur highly altered Palæozoic sediments.

Beyond the coast range, near the edge of the continental plateau, a partly submerged range of mountains forms Vancouver island and the Queen Charlotte islands. The rocks resemble those of the Coast range; but include also masses of Triassic and Cretaceous strata, which have participated in the folding. Later Miocene and Pliocene beds occur along some parts of the shores.

The Cordilleran belt of America is noted for its important deposits of economic minerals, especially silver, gold, and copper. In western Canada, it contains important copper, copper-gold, and silver deposits; and large erturns have also been obtained from gold bearing gravels. Reference has already been made to the Cretaceous coal deposits of the eastern part of the

belt. Similar deposits of Cretaceous age occur on Vancouver island, and have been for many years the most important source of fuel on the Pacific coast.

The Cordilleran region of Canada, when fully explored, is, undoubtedly, destined to become one of the most important mining sections of the world.

The following tabulated statement shows the mineral production in Canada according to the published records of the Division of Mineral Resources and Statistics of the Mines Branch. The quantities of metals shown include not only the product of refineries, etc., which is comparatively small, but also the metals contained in smelter products produced and the metals estimated as recovered from ores produced and shipped outside of Canada for treatment.

The metals are valued for statistical purposes at the market value of the refined product.

Non-metallic products are valued as shipped from the mines. The ton of 2,000 lbs. is used throughout.

A record of the production in each of the provinces will be found at the end of the report.

Mineral Production of Canada in 1912.

Product.	Quantity.	Value.
Metallic.		$
Cobalt oxide and nickel oxide.....Lbs.	349,054	156,256
Cobalt material, mixed cobalt and nickel oxides..... "	1,285,280	163,988
Copper, value at 16·341 cents per pound... "	77,832,127	12,718,548
Gold.....Ozs.	611,885	12,648,794
Iron ore sold for export.....*Tons	118,129	328,950
Iron pig,[1] from Canadian ore..... "	36,355	450,886
Lead, value at 4·467 cents per pound.....Lbs.	35,763,476	1,597,554
Nickel, value at 30 cents per pound..... "	44,841,542	13,452,463
Silver, value at 60·835 cents per ounce....Ozs.	31,955,560	19,440,165
Zinc ore.....Tons.	6,415	215,149
Total.....	.....	61,172,753
Non-Metallic.		
Actinolite.....Tons.	92	1,000
Arsenic, white..... "	2,045	89,262
Asbestos..... "	111,561	3,117,572
Asbestic..... "	24,740	19,707
Coal..... "	14,512,829	36,019,044
Corundum..... "	1,960	239,091
Feldspar..... "	13,733	30,916
Fluorspar..... "	40	240
Graphite..... "	2,060	117,122
Grindstones..... "	4,412	52,090
Gypsum..... "	578,458	1,324,620
Magnesite..... "	1,714	9,645
Manganese..... "	75	1,875
Mica..... "		143,976
Mineral pigments:—		
Barytes..... "	464	5,104
Ochres..... "	7,654	32,410
Mineral water..... "		172,465
Natural gas.....M.cub. ft.	15,286,803	2,362,700
Peat.....Tons.	700	2,900
Petroleum, value at $1·418 per barrel... Bls.	243,336	345,050
Phosphate.....Tons.	164	1,640
Pyrites..... "	81,526	314,085
Quartz..... "	100,242	195,216
Salt..... "	95,053	459,582
Talc..... "	8,270	23,132
Tripolite..... "	38	230
Total.....	.....	45,080,674

* All tons of 2000 lbs.

[1] The total production of pig iron in 1912 was 1,014,587 tons, valued at $14,550,999, as compared with 917,535 tons, valued at $12,307,125, in 1911.

Mineral Production of Canada in 1912—Continued.

Product.	Quantity.	Value.
Structural Materials and Clay Products.		
Cement, Portland.....Bls.	7,132,732	9,106,556
Clay products: ($10,575,709)		
Brick, common.....No.	769,191,532	7,010,375
" pressed..... "	125,180,422	1,609,854
" paving..... "	4,579,500	85,989
" moulded and ornamental..... "	371,356	8,595
Fireclay and fireclay products.....		125,585
Fireproofing and architectural terra-cotta...		448,853
Pottery.....		43,955
Sewerpipe.....		884,641
Tile, drain.....		357,862
Kaolin.....Tons.	20	160
Lime.....Bus.	8,475,839	1,844,849
Sand-lime brick.....No.	96,448,402	1,020,386
Sand and gravel (partial record).....		1,512,099
Slate.....Sq.	1,894	8,939
Stone: ($4,726,171).		
Granite.....		1,373,119
Limestone.....		2,762,936
Marble.....		260,764
Sandstone.....		329,352
Total.....	.....	28,794,869
Grand total.....	.....	135,048,296

Dawson, Yukon Territory.

ECONOMIC MINERALS AND ASSOCIATED INDUSTRIES.

METALLIC MINERALS.

Aluminium.

Bauxite the commercial ore of aluminium has not yet been found in Canada but the metal aluminium is produced from ores imported from France, Germany, and the United States, in extensive reduction works situated at Shawenegan Falls, Quebec. The plant is operated by the Northern Aluminium Company, a subsidiary of the Aluminium Company of America. A portion of the bauxite used at these works is mined from the Company's mines in the States of Arkansas and Georgia, and refined at East St. Louis, U.S.A.

The Shawenegan plant covers an area of about 10 acres and includes reduction buildings and a wire mill. The Company employs the Hall, or Heroult electric reduction process for the manufacture of aluminium. The furnaces, or cells as they are locally termed, are rectangular in shape, the bottom of the cells forming one electrode, while a number of carbons suspended over the cells form the other electrode. These cells work continuously, the reduced metallic aluminium collecting at the bottom, whence it is tapped off from time to time, and moulded into bars. There are 340 cells in operation, each producing, on an average, 150 pounds of aluminium, of 99.4% fine per day.

The Company owns and operates a water power plant developing about 40,000 horse-power.

There are numerous occurrences of feldspar in Canada, some of which are very pure, and it is possible that with improved processes of manufacture, these may become important sources of aluminium in the future.

The exports of aluminium in ingots, bars, etc., from Canada during 1912 were 9,143 tons, valued at $2,002,363, besides manufactures of aluminium valued at $10,898.

Antimony.

Ores of antimony consisting mainly of stibnite or sulphide of antimony have been found and worked in a number of localities in eastern Canada, chief among which are the mines at West Gore in Hants county, Nova Scotia, and in the Parish of Prince William, York county, New Brunswick. In both cases mining operations have been intermittent in character, and the total shipments of ore and concentrates during 25 years does not seem to have exceeded 7,000 tons. The ore at West Gore is auriferous, although the presence of gold was not recognized in the earlier shipments which consisted of high grade ore carrying 50 per cent and upwards of antimony. A mill for treating low grade ore was built in 1907 and 1908. No ore was mined or milled in 1912. Native antimony and stibnite occur at Prince William, New Brunswick, and the deposits have been worked at various times since 1863. A small smelting plant was erected many years ago with a reputed production of a ton of metal per week. The Canadian Antimony Company

erected a new plant in 1909 consisting of stack furnaces and a reverberatory furnace for reducing the antimony oxide, the latter furnace having a capacity of from two to three tons of metal per 24 hours. This plant is also idle at the present time.

In addition to the above there is an occasional recovery of the metal in the lead smelting and refining plant at Trail, B.C., antimony being a minor constituent of some of the silver-lead ores of southern British Columbia.

The occurrence of antimony minerals has also been noted at South Ham, in Wolfe county, province of Quebec.

In British Columbia, stibnite has been reported at Watkinsons about 23 miles above Lytton, on the Fraser river; on Cadwalladar creek, Lillooet district; on the Alps and Alturus claims, north fork of Carpenter creek, Slocan district, and in the Atlin district on the west shore of Taku Arm, about 10 miles north of Golden Gate. Occurrences have also been noted in the Yukon district on a small stream flowing into the Stewart river about 5 miles above Gordon Landing, while more recently important antimony-silver veins have been found on Carbon and Chieftain hills in the Wheaton River district, northwest of Lake Bennett in the southern Yukon.

Arsenic.

Arsenopyrite or mispickel ores are found abundantly in eastern Ontario, particularly in the county of Hastings. These deposits are usually auriferous and the Deloro mine in Marmora township was worked for many years for the recovery of both gold and white arsenic.

In northern Ontario, mispickel has also been found in quantity on the shores of Net lake near Lake Timagami; in Davis township, Nipissing district; near Schreiber on the Canadian Pacific railway, and also in the Rainy River district.

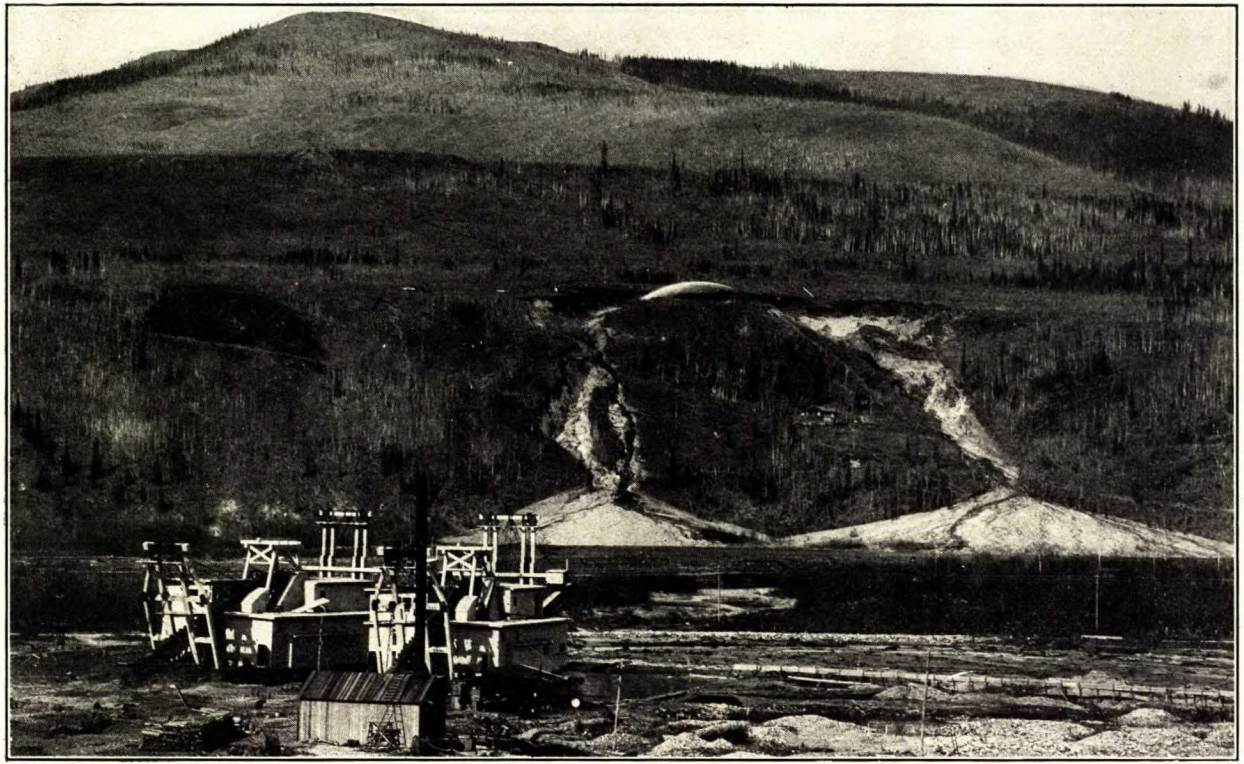
For a number of years a small quantity of mispickel concentrate was produced at the gold mine operated at Goldboro, Nova Scotia. The arsenical concentrate was produced from the residue of the mill concentrates after the gold had been extracted by bromo-cyanide.

The present production of white arsenic in Canada is being derived altogether from the silver-cobalt-nickel-arsenic ores of the Cobalt district in Ontario, the arsenic being recovered as a by-product in the several smelting works situated at Thorold, Deloro, Orillia, and Copper Cliff, the latter plant having been recently closed down. The annual production of white arsenic during the past five years has been from 1000 to 2000 tons, the greater part of which is exported.

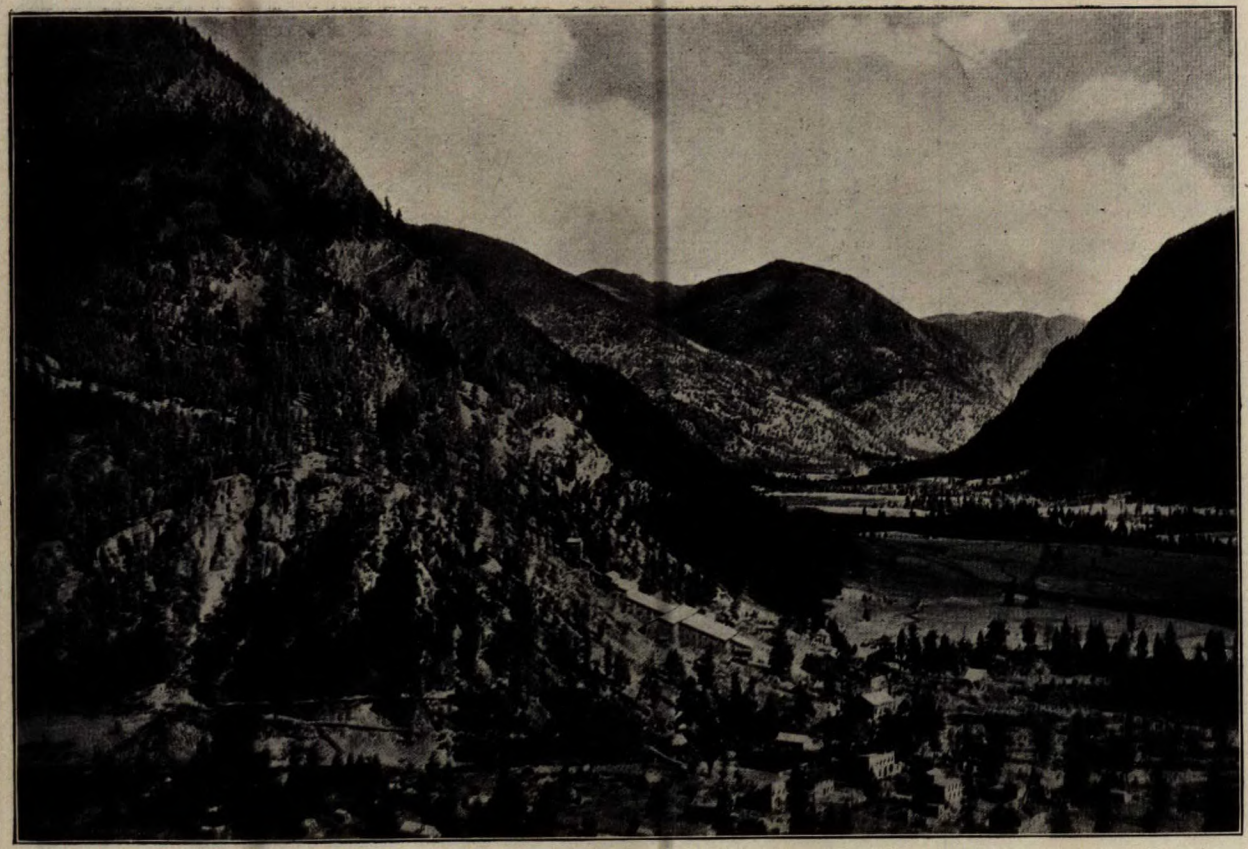
Cobalt.

Previous to the discovery of the now famous ore deposits of the Cobalt district of northern Ontario, the metal cobalt had already been noted as a constituent of the Sudbury nickel-copper deposits, in fact a small recovery therefrom was reported 1892 to 1894.

The silver-cobalt-nickel ores of the Cobalt district are discussed under the article on silver, since these ores, with one or two exceptions, are mined primarily for their silver contents, the cobalt being a by-product for which the mine owners now receive no return whatever. This fact is rather curious, when it is remembered that these ores have displaced nearly all others in supplying the world's demand for cobalt. Although most of the ore producing veins of this camp are chiefly silver bearing, a number have been found in which the silver values are negligible.



Dredges on Bonanza creek, Yukon.



Daly Reduction Co.'s mill, Hedley, B. C.

Cobalt is being recovered, in the form of cobalt oxide and cobaltic material containing nickel or nickel oxide and a little silver, in Canadian smelters situated at Copper Cliff, Deloro, Thorold, Orillia, and North Bay respectively. It is quite possible also that recovery is being made in other smelters, outside of Canada, to which a considerable tonnage of these ores has been shipped. The production has been sufficient to cause a falling off in the price of cobalt oxide from $2.50 a pound in 1907 to less than a dollar a pound in 1911 and 1912. It is estimated that in 1911 about 852 tons of metallic cobalt were contained in the ores shipped from the Cobalt camp. About 21·5 tons of metals were recovered in Canadian smelters contained in cobalt oxide, and 119 tons contained in " crude cobalt material."

Copper.

Native copper occurs in Canada in a number of different localities; it has been found in the Maritime Provinces in the trap sheets which occur on both sides of the Bay of Fundy; it is known to occur in Ontario, in certain copper-bearing amygdaloids of the Keweenawan series which occur along the east coast of Lake Superior; it has been found in central British Columbia; and recent explorations have confirmed information obtained nearly a century and a half ago, that very important copper-bearing amygdaloids occur along the arctic coasts of Canada, near Coronation gulf and in Victoria land. None of these deposits are being exploited commercially. The small amount of exploration work performed in the more easily accessible areas has not disclosed concentrations of native copper at these points in sufficient quantity to make it practical to operate them commercially by present methods, the content being usually one per cent or less. The areas of copper-bearing rocks around Coronation gulf have not been investigated commercially as yet. The preliminary reports available seem to indicate the occurrence in this vicinity of copper ranges which cover an area greater than the well-known copper-bearing rocks of the State of Michigan.

Minerals containing copper as an essential constituent occur in many places throughout Canada. Those commercially important are the sulphides; carbonates and oxides also occur, usually in association with sulphide deposits, but they are relatively of minor importance. The two sulphides, chalcopyrite and bornite, are the most important; locally chalcocite is also found occasionally. In Nova Scotia copper sulphide minerals have been found at a number of points, but no important producing mines have been developed. The better known localities are: Cheticamp, Lochaber, and Coxheath. In New Brunswick, also, no ore bodies of known commercial importance have been discovered, although small deposits have been found in a number of localities in the southern part of the province.

In Quebec, particularly in the district known as the Eastern Townships, numerous occurrences of the sulphide minerals have been discovered during the last seventy-five years. Some of these discoveries were important enough to warrant explorations and commercial development, and many small mines have been in operation for varying periods of time. The types of ores which occur in this province may be classified on the basis of their composition as follows:—

Pyrite and chalcopyrite, nearly pure sulphides, the copper content varying from a mere trace to more than 12 per cent, as at Eustis, Capelton, and elsewhere.

Pyrite and chalcopyrite disseminated through a highly siliceous gangue, as at the Suffield mine.

Chalcopyrite and bornite disseminated through a calcareo-magnesian limestone, as at Actonvale and vicinity.

Bornite in a siliceous gangue, usually quartz, as at Harvey hill.

Pyrrhotite, containing a small amount of chalcopyrite, as at the Memphremagog mine.

Chalcopyrite and pyrite with quartz, and associated with a basic igneous rock, as at the old mines near St. Flavien.

Chalcocite, in small amount, associated with quartz, and, more rarely, with serpentine, occurring in several localities, but relatively unimportant.

The most important producing district occurs in the vicinity of Sherbrooke, Quebec. At the present time there are two active mines in this district, one of which has been in continuous operation for about 30 years. There are also a number of properties that are worthy of further investigation. The ores from the active mines are almost pure pyrites, containing some chalcopyrite, and occasionally a little chalcocite. The sulphur content of the ore, which runs over 40%, is utilized for the manufacture of sulphuric acid, and the copper is then recovered from the cinder residues obtained at the acid works, by blast furnace smelting, with other ores. The Quebec sulphide ores of copper nearly all contain small amounts of gold and silver.

In Ontario, in addition to the occurrences of native copper, to which reference has already been made, there are four different districts in which copper-bearing minerals occur. These, in order from east to west, are:—

North Hastings district, where some chalcopyrite occurs in association with pyrites deposits.

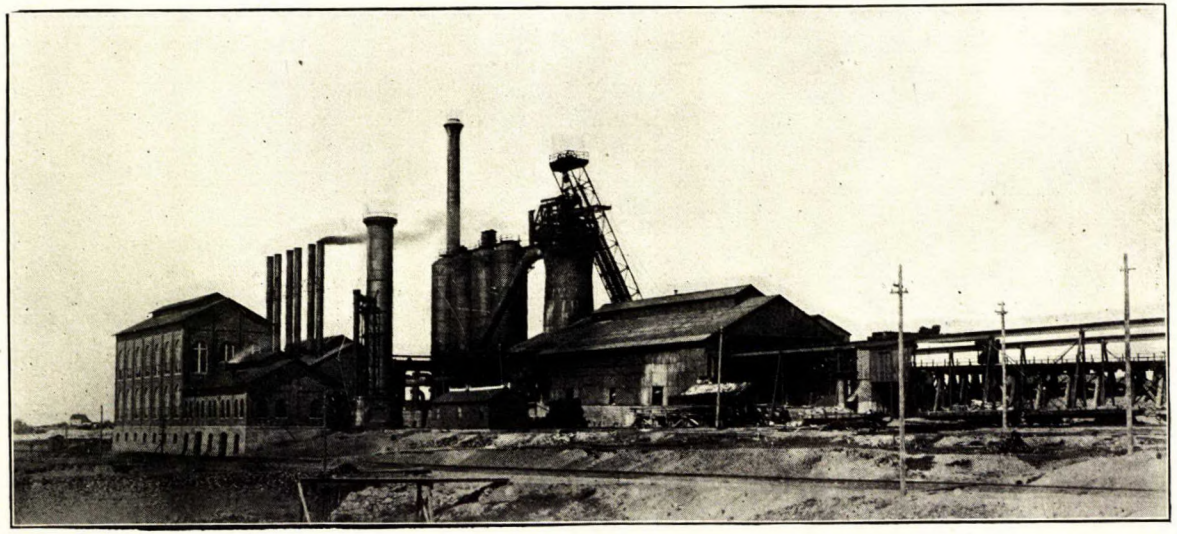
Parry Sound district, where some rich pockets of bornite and chalcopyrites were found.

Sudbury district, where copper sulphides, chiefly chalcopyrite, occur in association with nickel sulphides in the well known deposits of nickeliferous pyrrhotite of that region.

North shore of Lake Huron, comprising the area westward from the Sudbury district to Lake Superior, and extending northward for at least 40 miles. In numerous localities throughout this area quartz veins, sometimes of considerable width and lineal extent, are found. Many of these veins contain small flakes and masses of chalcopyrite, occasionally of considerable size. The number of recorded claims is large; prospecting has been carried on in many localities and in some few instances extensive development work has succeeded prospecting. Some of the earliest discoveries of copper ores in Ontario were in this district—at the old Wallace mine, now long since abandoned, and at the well known Bruce mines. Ore shipments have been made intermittently from a number of localities in this district, but none of the properties have been operated continuously for any length of time. These ores are all highly siliceous. It has long been known that occurrences of copper minerals are widespread in this district, and many prospects have been discovered which contain low grade ores. They have rarely been sufficiently explored to demonstrate their extent. The difficulty of recovering the copper content economically has not been surmounted. Without some adequate method of concentration, it has not been possible to exploit the prospects for any length of time in any locality.

In northern Ontario at the Alexo mine, near Matheson, chalcopyrite associated with a nickeliferous pyrrhotite occurs in serpentine. Mining operations are in progress and a small tonnage of copper-nickel ore has already been produced.

Copper sulphides have also been found in the district west of Port Arthur, where a little prospecting has been done, and in a number of localities



Blast furnace plant at Sydney Mines, N. S. (Nova Scotia Steel and Coal Co.)

in the Timiskaming and Timagami districts. A small amount of copper is recovered annually from some of the silver ores of Cobalt and vicinity.

Ontario's production of metallic copper in 1912 was 22,232,000 pounds, valued at $3,670,518, on the basis of the New York average market price for the year. Nearly the whole of this was obtained from the pyrrhotites of the Sudbury district. In this locality two large smelting plants are in active operation, treating ores obtained from their own mines by blast furnace smelting. A third company has been exploring other properties during the last few years, and another large smelting plant will probably be erected in the near future. The ores are all nickeliferous copper-bearing pyrrhotites and they also contain small amounts of the precious metals. A more complete description of the ore bodies of the Sudbury district is included in the paragraphs dealing with the metal nickel.

British Columbia is at present the principal copper-producing province of the Dominion of Canada, copper-bearing minerals being found in numerous localities in various parts of the province. The important minerals are usually chalcopyrite or bornite, or both. These may occur alone, but usually they are found in association with other minerals, the commonest of which are pyrrhotite, magnetite, pyrite, mispickel, and, occasionally, blende and galena. The known occurrences are too numerous to be considered individually in a review of this character. The principal districts in which important discoveries have been made are in southern British Columbia, in the West Kootenay and Kamloops districts, and in the Coast district at a number of points along the mainland and on some of the coastal islands. The most important active producing mines are at Rossland, at Phoenix and at Motherlode in the interior, and at Britannia or Howe sound, Texada island, and Granby bay on the coast. Prospecting exploratory work and development is also being carried on at a number of points, both in the interior of southern British Coulmbia and at several coastal points.

The ore deposits of Rossland occur in fissure veins and in lodes or shear zones, the ore forming a network of veinlets in the fractures, and also replacing more or less completely the intervening fragments of country rock, sometimes also partially replacing the wall rock. The ores may be classified, according to Brock, on the basis of their mineral contents, as follows:—

a. Pyrrhotite and chalcopyrite, with some pyrites and occasionally a little arsenopyrite, massive or mixed with gangue and rock matter. Free gold occurs, though but rarely visible. Rarely, molybdenite and magnetite are found, and, on a few occasions, blende and galena have been seen. This ore is the typical ore of the district, and, at times, the pyrrhotite contains 0·65% nickel and 0·59% cobalt.

b. Pyrrhotite, coarse textured and massive, containing very little copper and little gold.

c. Veins of pyrite and marcasite with arsenopyrite and some blend and galena. Such veins occasionally contain silver as an important constituent.

d. Impregnations of arsenopyrite, pyrrhotite, pyrite, molybdenite, a little chalcopyrite, bismuthinite, and native gold. These occur particularly in and around small pegmatitic or aplitic alkali syenite dykes.

e. Gold-bearing quartz veins.

The gangue associated with the Rossland ores is usually more or less altered country rock, with which is associated some quartz, and, in places, calcite. The principal valuable constituent recovered from the ores is gold, so that strictly the ores should be classed as gold ores containing a little copper. The ores, however, are treated by blast furnace smelting and the gold is afterwards recovered from the copper matte. The gold content of the ore varies

from 0·4 to about 1·5 ounces per ton; the silver varies from 0·3 to 2·5 ounces per ton; the copper from 0·7% to about 3·5 %. Ores containing higher values in gold, or more copper, have been found occasionally.

The ore deposits of the Boundary district are, at present, the most important deposits of copper-bearing ores in Canada. The ore bodies occur in mineralized zones in altered limestones. They lie at different horizons in this zone, but generally occur in the lower or outer portions. They range in size from small lenses, less than 20 feet in thickness and 100 feet in length, to huge ore bodies, such as that at the Knob Hill-Ironside mine at Phoenix, which has a thickness of 125 feet, a known width of 900 feet and a length of about 2,500 feet. The ore throughout is remarkably uniform and is almost self-fluxing. It consists of finely disseminated chalcopyrite with pyrites and hematite, in a gangue composed essentially of epidote, garnet, quartz, calcite and chlorite. Magnetite occurs in distinct masses, or lense-like bodies, both in and along the borders of the main ore bodies. The chalcopyrite carries all the copper, gold, and silver, the average ore containing from 1·2 to 1·6% of copper, with about $1 in gold and silver per ton. The important producing mines are located in or near the town of Phoenix, and at Deadwood, about 4 miles from Greenwood, B.C. The ores are smelted in water-jacketed blast furnaces, producing a matte that is afterwards treated in bessemer converters.

The ore deposits of the Coast district are of three distinct types. The Britannia mines, on Howe sound, are producing chalcopyrite ores, containing small quantities of gold and silver. These ores occur in a mineralized shear zone of considerable extent, and are highly siliceous. The development work is very extensive, and there is reason to believe that the deposits will prove to be very large. The ores are concentrated and shipped to the United States for treatment. Several mines on Texada island produce bornite, with which is associated more or less chalcopyrite. The ore bodies occur as a series of lenses in limestones, but usually more or less closely associated with certain igneous intrusions. Very important deposits of pyrites, with which is associated chalcopyrite, have been found less than a mile from tide water, near Granby bay, and about 110 miles from Prince Rupert. Extensive development work, performed during the last three years, has shown that these deposits are very large and preparations are under way to mine these ores and to treat them in blast furnaces.

Copper sulphides, chiefly chalcopyrite and bornite, occur at many points along the Pacific coast and on the adjacent islands. Some prospecting and some development work have been done at a few points and the future will probably witness the development of other important producing mines.

There are three copper smelting plants in operation in southern British Columbia. One at Trail treats the ores of the Rossland camp, producing a copper matte in which the precious metals contained in the Rossland ores are collected. This matte is shipped to the United States for refining. A very extensive plant, at Grand Forks, B.C., treats ores derived from Phoenix, in the Boundary district, and another at Greenwood smelts ores from the Motherlode, and some other mines belonging to the operating company. Both of these plants are equipped with water-jacketed blast furnaces, and with bessemer converters for making blister copper. On the coast there is a fully-equipped smelting plant, at Ladysmith, on the east side of Vancouver island, about 65 miles north of Victoria. This is a custom plant, and at present it is not being operated. A new plant is also under construction at Anyox, on Granby bay, and it is expected that it will be in operation in December, 1913.

All smelting companies in British Columbia smelt custom ores in addition to treating ores from their own mines, and it is probable that the new smelter at Anyox will also accept custom work.

The total copper production of British Columbia, in 1912, is estimated at 50,526,656 pounds, valued at $8,256,561, New York market average prices for the year.

Ores containing copper have been discovered at a number of points in the Yukon Territory, and one mine, the Pueblo, at Whitehorse, gives promise of becoming an increasingly important producer.

Gold.

Gold, with its mystic influence on man, is usually the first sought mineral in a new country. In Canada, as elsewhere, we find the quest of gold one of the earliest of our industries. In Nova Scotia, in Ontario, and in British Columbia, mining may be said to have commenced in earnest at nearly the same time, about 1860, largely due to the influence of the discoveries in California. From this beginning the industry has grown until the gold production of Canada in 1912 was valued at $12,648,794, of which $6,106,677 was recovered from alluvial deposits.

For a few years, 1898 to 1904, due to the Klondike placer output, the production was higher, but otherwise the growth of output has been uniform.

Gold was discovered in Nova Scotia in 1858, but 1862 really marks the beginning of gold mining. Since that date the production has been fairly steady, averaging about $400,000 per annum. The gold bearing rocks of the province form a belt varying in width from 10 to 70 miles and extend some 260 miles in length along the Atlantic coast. In this area the gold occurs in the free state in saddle-shaped quartz veins in many respects similar to those of Bendigo, Australia. At West Gore there is an occurrence of auriferous stibnite. This deposit was worked for some time for the antimony before the presence of the gold was recognized, but in later years it was a fairly steady producer of gold.

The occurrence of alluvial gold in southern Quebec has long been known, the first recorded discovery being in 1824 on the Gilbert river, a tributary of the Chaudiere, at a point about 50 miles southeast of Quebec city. Mining commenced in 1847 and operations have been carried on intermittently since. Alluvial gold has been found and worked along the valley of the Chaudiere and many of its tributaries from a point some distance below the mouth of the Gilbert river eastward almost to the International Boundary.

A small amount of gold also comes from the ores of the Eastern Townships where pyrites and chalcopyrite are found in lenses replacing country rock. These are mined for their copper and sulphur content, and the gold is recovered as a by-product.

Though gold has not yet been discovered in paying quantities in northern Quebec, it is by no means improbable that deposits similar to those of Porcupine may be found there.

Amongst the various gold bearing districts of Ontario may be mentioned the eastern Ontario gold belt in Hastings and neighbouring counties, Parry Sound district, the Porcupine and Larder Lake areas, Wanapitei lake, the district north of Lake Huron, Michipicoten, Shebandowan lake, Sturgeon lake, and Lake of the Woods.

The eastern Ontario gold belt was first exploited in 1866. This district comprises the southeastern part of Peterborough county and passes through the northern parts of Hastings, Lennox and Addington, and Frontenac counties. The gold deposits occur in the older rocks of the Hastings-

Granville series generally near granite intrusions. There are many small mines in this area which have been intermittently worked since discovery.

The Porcupine gold area is situated in northern Ontario, about 450 miles north of Toronto and 120 miles north of the Cobalt silver district. The most important developments have taken place in the township of Tisdale, but promising discoveries have also been made in other townships in the vicinity including Whitney, Ogden, Shaw, Deloro, and Langmuir. There are also producing properties in Munro and Guibord near Matheson, in Otto at Swastika, and in the vicinity of Larder lake. The occurrence of gold bearing quartz has been known in this district for a number of years, but it was not until the summer of 1909 that discoveries of importance were made and interest aroused. Early in 1910 a rush started and around the original discoveries lots were staked for miles regardless of the values they contained. The best looking finds were tested during 1910 and early in 1911 the construction of several mills was well under way. Although the first mill only started in July 1912, the gold production from the district for that year was about $1,700,000.

The rocks of the Porcupine area may well be classed as Pre-Cambrian, and are similar to the older formations occurring at Cobalt. The gold is associated with quartz in irregular fissures running through both the Keewatin and Timiskaming series.

Gold as well as others of the rarer metals is recovered in the refining of the mattes from the Sudbury copper-nickel ores.

The mines of western Ontario embrace a number of classes, but all are located in Keewatin rocks or in intrusive granites or gneisses. Many properties have been worked intermittently though few continuously.

In Manitoba some attention is at present being paid to the area lying southeast of Lake Winnipeg and along the Ontario boundary where some discoveries have recently been made.

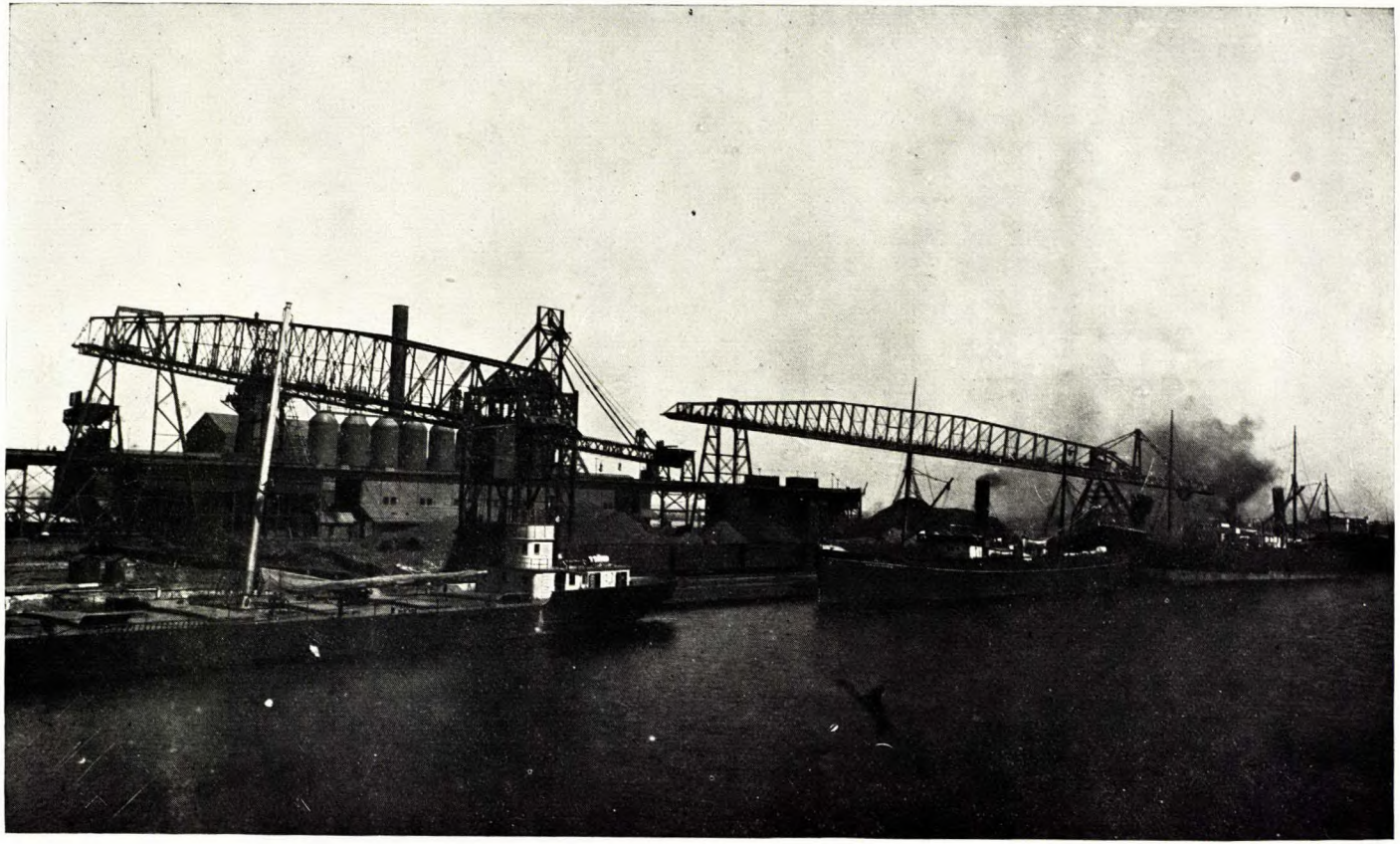
Alluvial gold has been found in many of the rivers of Alberta, Saskatchewan, and the North West Territories, though actual production has been limited to a small recovery from the Saskatchewan river immediately above and below Edmonton.

About the time Simon Fraser, in the first years of the nineteenth century, crossed the Rockies to the head of the river now bearing his name, the early settlers of Vancouver island had begun to realize the wealth of British Columbia, and had sailed away from Moresby island, one of the Queen Charlottes, with a cargo of rich gold ore which paid them well for their enterprise, but for some reason they did not repeat the venture. Practically, therefore, the first mineral development is that due to the Fraser River gold rush in 1858 and succeeding years, when the Cariboo and Quesnel districts were discovered, followed in 1874 by the discovery of gold in Cassiar.

Lode gold mining may be said to have commenced in 1890 with the staking of the Rossland gold-copper camp, followed by the discovery of the large low grade copper-gold ore bodies of the Boundary. These ores, though one of the main sources of the province's gold production, are complex gold-silver-copper ores and are mentioned under the head of copper. Practically all the copper ores of the province are auriferous to a greater or less extent. The Nickel Plate mine at Hedley in the Similkameen is the premier gold mine of the province and its 40 stamp mill has been a steady producer for a number of years, its 1911 output being valued at $679,000.

The ore here is an auriferous mispickel with varying amounts of copper and iron pyrites occurring in bodies replacing country rock along or near the contact of igneous rocks.

Helen iron mine, Michipicoten, Ont.



Blast furnace and ore docks, Sault Ste. Marie, Ont.

In the Nelson district there are several gold properties working, some shipping ore to the smelters, but the larger number stamp milling and shipping the concentrates. Amongst these are the Granite, near Nelson, the Dundee, Wilcox, and Yankee Girl at Ymir, the Mother Lode and Queen, on Sheep creek, and the Second Relief at Erie. Besides this district, there are a few gold mines operating in the Lardeau; at Paulson and Carmi, in the Boundary; on Bridge river west of Lillooet; Princess Royal island; Moresby island; and on Taku Arm, Atlin lake.

There is still a very considerable production of gold from the placer and hydraulic properties of the province, the chief centres being the Cariboo district, Quesnel, the Omineca and Atlin, and there is yet much country which is comparatively unexplored. The gold is either in the original pre-glacial gravels, or in more recent deposits derived from these.

As early as 1878 miners began to enter the Yukon and finds were made in various parts of the district from year to year. Discoveries were made on Fortymile creek, on the Lewes river, and Upper Pelly and Stewart rivers, tributaries of the Yukon, but it was not until 1894 that gold was found on Quartz creek, a tributary of the Indian river, which enters the Yukon above the Klondike river at whose mouth Dawson City now stands. Discoveries followed on Hunker and Bonanza creeks, the latter being especially rich. The news of this discovery resulted in the historic rush of 1897–8, a stampede which is probably unparallelled in the history of mining. The building of the Whitehorse and Yukon railway from Skagway to the foot of the Whitehorse rapids greatly aided the development of the district. The population in 1900 reached 30,000 and the gold production amounted to $22,275,000. From that year it decreased annually, having fallen by 1907 to $3,150,000. Since that date, owing to the introduction of improved methods and machinery, chiefly large electrically operated gold dredges, the production has again increased until in 1912 it was $5,549,296.

The gold production of the Yukon from 1885 to December 31, 1912, amounted to 7,087,141 fine ounces, valued at $146,503,749. The principal sources of production of the Klondike River area were Upper and Lower Bonanza, Eldorado, and Hunker creeks, while on the Indian River slope are Dominion, Gold Run, Sulphur, and Quartz. These creeks are estimated by Mr. R. G. McConnell to have produced a total of $119,000,000 in gold up to 1907, while he estimated a future production from the Klondike basin alone of $53,600,000

Gold is also recovered at the head waters of the Sixtymile river, south of Dawson, and in the Kluane district in the southwestern part of the Yukon, as well as being widely distributed throughout the territory. Further prospecting will probably reveal other gold bearing creeks, some possibly as rich as previous discoveries.

Within the last few years increasing attention has been paid to the quartz properties of the district and one mill is now operating near Dawson. The development of lode mines is yet in its infancy but promises well for the future.

Iron.

Although iron ores are widely distributed in Canada, the present extensive metallurgical industry in iron and steel has been developed to a very large extent on the basis of imported ores, chiefly the conveniently situated and comparatively cheaply mined ores of Bell island, Newfoundland, and ores from the iron ranges on the south shore of Lake Superior. There are, nevertheless, a number of important iron ore deposits that have already contributed considerable outputs in the past, and there are numerous occur-

rences which in the future may constitute valuable sources of supply for this metal.

In the province of Nova Scotia the principal iron ore deposits are those at Clementsport, Nictaux, and Torbrook in Annapolis county; Brookfield and Londonderry in Colchester county; the Pictou iron range in Pictou county; and Whycocomagh in Inverness county. A wide variety of ore is found including hematites, magnetite, bog ore, limonite, and carbonates.

The Nictaux and Torbrook field is practically the only one being actively exploited at the present time. Formerly this, together with the Londonderry and Pictou deposits, produced considerable quantities of ore which were smelted at Londonderry, Pictou, and New Glasgow. For a number of years past blast furnace operations have been transferred entirely to Sydney and North Sydney, Cape Breton, where large and extensive plants have been erected by the Dominion Iron and Steel Company and the Nova Scotia Steel and Coal Co.

These two plants include blast furnaces with a total daily capacity of about 1700 tons. Coking plants with by-product recoveries, Bessemer convertors and open hearth furnaces, steel finishing mills for billets, rails, rods, wire nails, bolts and nuts, etc. The Nova Scotia Steel and Coal Co. has an extensive steel plant at New Glasgow. Both companies own or control their own collieries near Sydney and limestone quarries conveniently situated. They own and operate their iron mines on Bell island, Newfoundland, the ore from which not only supplies all demands at Sydney, but is shipped to the United States and Europe.

Iron ores are found in the province of New Brunswick in Carleton county near Woodstock. These ores were utilized in blast furnace operations at Woodstock begun in 1848, and carried on at intervals for 20 years thereafter. Other occurrences of iron have been noted at West Beach and Black river on the Bay of Fundy, near St. John, and also in Charlotte county, near Lepreau. The most important deposits, however, yet found in this province are those in the township of Bathurst, county of Gloucester. One of these, the Nipisiguit deposit consisting chiefly of magnetite, was discovered in 1902, and has since been actively developed. Shipments of ore have been made to the United States and to Great Britain. It seems reasonable to expect that in the future other deposits of iron ore may be located over a considerable extent of territory in this district.

Along the north shore of the St. Lawrence river in the province of Quebec, beds of magnetite have been reported at many points. The ore is found in two forms, viz., as massive deposits interstratified with the gneiss and limestone of Laurentian or as beds of iron sands along the beaches often in considerable thickness and of great extent. These ores, while carrying a large percentage of magnetic oxide of iron also frequently contain a considerable amount of titanic acid, in fact during the past few years several thousand tons have been shipped for the titanium content.

Deposits of ilmenite or titaniferous iron ore also occur north of Montreal at St. Jerome, St. Lin, Ivry, and other points.

In the townships of Leeds, Inverness, South Ham, and Ascot, several small deposits of magnetite are known to occur, but they have not as yet been proved to be of commercial importance.

Limonite or bog iron ores have been mined for 180 years in the St. Francis River district, east of the St. Lawrence, and the St. Maurice river to the west. Small furnaces have been in fairly continuous operation at Drummondville and Radnor Forges and the product has been an excellent quality of charcoal pig iron.

Magnetite ores have also been found in the townships of Grenville, Templeton, Hull, and Bristol, some of which have been worked to a considerable extent in past years.

As early as the year 1800 attempts were made to smelt iron ores in Ontario and between that date and 1883 several enterprises were started only one of which was successful. This was the furnace at Normandale in Norfolk county, now long since abandoned, where the bog ores of the vicinity were smelted with charcoal as fuel.

In eastern Ontario, chiefly in the counties of Hastings, Frontenac, and Renfrew, and served by the Central Ontario railway and the Kingston and Pembroke railway, numerous deposits of iron ore, both hematites and magnetites, are found. Some of these such as those in the township of Mayo, are of considerable extent. Many have been opened up and several hundred thousand tons were shipped to smelters in the United States and Canada.

In the northern portion of the province active mining operations are at present being carried on at Moose mountain, 20 miles north of Subdury, at the Helen mine near Michipicoten, northwest of Sault Ste. Marie, and at the Atikokan range west of Port Arthur. The Moose Mountain deposit situated in the township of Hutton is a large and important deposit of magnetite, there are in fact several deposits constituting what is known as the Moose Mountain range. Shipments are being made by way of the Canadian Northern railway and Key harbour on Georgian bay.

The Helen mine in the Michipicoten range is the largest iron ore producer in Canada, the output approaching 1,000 tons per day. The deposit is some 1,400 feet long with an average width of 400 feet. The ore produced is of three grades, hematite—hard and compact, containing 60 per cent or over, hard brown limonite and hematite, 57 to 55 per cent iron, and soft brown limonite containing 53 to 54 per cent iron. The ore is shipped by rail to Michipicoten harbour and thence by boat to the smelters at Sault Ste. Marie, Midland, Hamilton, or the United States market. A number of other deposits in the same vicinity are being developed.

The Atikokan range is situated along the Atikokan river, 140 miles west of Port Arthur on the Canadian Northern railway. Outcrops have been traced for a distance of nearly 12 miles but prospecting has been carried on chiefly in the vicinity of Sabawe lake. The ore from this range is used in the blast furnace at Port Arthur.

In addition to the iron deposits being actively operated, there are in northern Ontario a number of known iron ranges some of which may prove to be valuable ore reserves. About 26 miles east of Port Arthur in the vicinity of Loon lake, is an iron range which has already attracted considerable attention. The ore consists mainly of hematite but is mixed with a great deal of lean material. The Mattawin range is situated in the district of Thunder Bay about 48 miles west of Port Arthur and follows the Mattawin river for a distance of about 4 miles. The ore consists of alternate bands of jasper and magnetite, and is low grade and siliceous and would require concentrating.

East of Lake Nipigon is an iron formation known as the Lake Nipigon range. The iron bearing rocks are here divisible into three ranges called the Northern, Southern, and Middle ranges. The ore is magnetite or hematite associated with jasper. No commercial ore bodies have been found as yet.

In the district of Nipissing the Timagami and other ranges, have attracted considerable attention but remain practically unexplored.

These are but a few of the known occurrences of iron in Ontario. In a review of the iron ores of this Province[1] A. B. Willmott records about 50 separate occurrences of iron ore in the northern and western portions, and not including the deposits in Hastings, Frontenac, and other counties in the eastern part of the province.

The smelting industry has grown to large proportions in this province, furnaces have been installed at Deseronto, Hamilton, Midland, and Sault Ste. Marie, the present capacity of which is about 2,000 tons per day. In addition to these a new furnace is under construction at Port Colborne, and the United States Steel Corporation is making preparations for the erection of a large plant near Sandwich. At Hamilton and Sault Ste. Marie there are large and well equipped steel plants and rolling mills producing bars, steel rails, and other steel products.

The prairie provinces of Manitoba, Saskatchewan, and Alberta have as yet furnished no production of iron, but there are a number of known occurrences of hematite, limonite, and clay iron stone.

In the province of British Columbia, some iron ore has been mined on Texada island and shipped to the smelter at Irondale, Wash., but beyond this the iron industry of the province may be said to be as yet undeveloped. A number of occurrences of iron ore, chiefly magnetite have been noted on Vancouver island. These, so far as observed, on the coast, are usually found on the end or flank of a ridge following roughly the contours of the hills and occur almost always along and adjacent to the contact of limestone and some eruptive rock. Among those that have attracted attention might be mentioned the properties at Head bay, Klaanch river, Quinsam river, and Gordon river on Vancouver island, and the Texada Island ores already mentioned. In the interior of the province occurrences of iron have been noted at Kamloops, Kitchener, Bull Run, Burmis, and elsewhere, but no mining has been done on any of these deposits with the exception of a small shipment of ore as a flux from the Cherry Bluff mine near Kamloops.

The total production of pig iron in Canada in 1912 was 1,014,587 short tons and of steel ingots and castings 957,681 short tons. That the domestic production is insufficient to meet home demands is indicated by the large imports which in 1912 exceeded 1,300,000 tons of pig iron, ingots, blooms, etc., plates, bars and rods, structural steel, rails, pipe, nails, wire forgings, castings, etc. The opportunity in so far as the market is concerned for the development of Canadian iron resources is evident.

Lead.

In Canada lead is derived entirely from galena ores the great majority of which are argentiferous, and therefore much that is said of silver is applicable to lead and similarly on account of associated blende much that is said of lead covers the ground in connexion with zinc.

In Nova Scotia argentiferous galena ores have been worked near Musquodoboit in Cape Breton county in the Pre-Cambrian rocks. They also occur at various points in the lower Carboniferous limestones.

Veins of galena are found in the Silurian rocks of New Brunswick and have been found at various points through the Eastern Townships, in Gaspe, in Portneuf county, and on Calumet island, where they have been worked to some extent.

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[1] The Iron Ores of Ontario, A. B. Willmott, Journal of the Canadian Mining Institute, Vol. XI. p. 108.

Copper and lead smelter at Trail, B. C.

Electrolytic lead refinery at Trail, B. C.

In Ontario the Frontenac lead mine was opened about 1868 and a smelter was erected in 1879; operations however ceased in 1882. Various properties have been worked from time to time, and the Frontenac is once more being operated. The ores are galena carrying little silver.

A lead smelter, that of the North American Smelting Co., is in operation at Kingston, treating Ontario, United States, and British Columbia ores.

Practically all the lead produced in Canada in recent years has come from the British Columbia silver bearing galena ores. The Blue Bell mine was discovered in 1825 but active operations in the Ainsworth camp date from about 1888, with Sandon camp following in 1892 and the discovery of the North Star, St. Eugene, and Sullivan in East Kootanay in that year and the next. The latter are large bodies, comparatively low in silver content, the St. Eugene ore being argentiferous galena with some zinc blende and a little pyrite forming irregular lenses in a fissured zone within Pre-Cambrian quartzites.

There are a few producing mines in the Sheep Creek district, south of Nelson, but the largest number of mines are located in the Ainsworth and Slocan districts. The Sandon-Silverton camps especially are showing promise, development at depth having been very satisfactory. The ores are argentiferous galena and tetrahedrite with native silver and sometimes gold, argentite, zinc blende, etc., in veins cutting sediments. The ores of the Lardeau may be said to belong rather to the silver ores than to the lead, and the same may be said of the Greenwood camp. The West Fork of the Kettle river will probably add some shippers to the list with the opening of traffic on the Kettle Valley railway, and the Canadian Northern railway may provide shipping facilities for the silver-lead properties of the North Thompson River valley.

West of Princeton in the Similkameen, at Leadville, a new camp is opening up but no shipments have yet been made. On the coast, Portland Canal district is another silver-lead camp, and the newer discoveries toward the Bear river are most promising.

The present year will see shipments from several mines in the neighbourhood of Hazelton on the Skeena river. Development has been going on quietly for several years awaiting the advent of transportation, with the result that the camp starts shipments with a fair amount of development done.

The lead ores of British Columbia are nearly all shipped to the smelter of the Consolidated Mining & Smelting Co., at Trail, which operates in connexion therewith an electrolytic lead refinery, the products of which are refined gold, silver, and lead, copper sulphate, and antimony.

A few of the Coast ores find their way to American smelters.

In the Yukon there are several properties which have been developed and have shipped occasionally, but in most cases as yet the transportation charges have been found too heavy a burden. With further development of the country these will probably become shippers.

As mentioned elsewhere the prospects of finding more lead ore bearing areas throughout Canada and especially in the more remote districts are most favourable, and many districts now known only await transportation facilities.

Molybdenum.

This mineral occurs as molybdenite or molybdite, and although found in numerous localities in many parts of the country, there has as yet been practically no recovery of the metal in Canada with the exception of small amounts obtained while developing or exploring properties. With regard to the loca-

tion of molybdenite deposits, Dr. T. L. Walker, in his special report[1] on this subject, states that in Canada they are usually found in the Archæan regions, and are probably due to the influence of masses of granite. Molybdenite occurs in quartz veins, pegmatite dykes (probably connected with the granite masses), and along contact borders of granite or pegmatite with crystalline limestone.

Most of the known occurrences are described by Dr. Walker who selects the following list as representing the most promising deposits as they were to be seen in 1909 and 1910: island opposite Romaine, lower St. Lawrence; Aldfield and Egan townships, north of the Ottawa river. Deposits in the vicinity of Kewagama lake in the northern part of Pontiac county, Que., near the Grand Trunk Pacific railway; Brougham, Lyndoch, and Ross townships in Renfrew county, Sheffield township, Addington county, and Cardiff township, Haliburton county, in eastern Ontario; and the Giant mine, Rossland, B.C.

Nickel.

Minerals containing nickel have been found in a number of localities throughout Canada, but the important commercial deposits at present exploited are confined to two localities, both in the province of Ontario. These are the Cobalt and Subdury districts. It should be mentioned, in passing, that pyrrhotites carrying a small amount of nickel are known to occur near St. Stephen, New Brunswick, and also in several other localities in Ontario. Similar occurrences have been reported from British Columbia. These, however, are comparatively low in grade and have not been successfully exploited.

In the Cobalt district niccolite, an arsenide of nickel, occurs either alone or associated with other less important nickel-bearing minerals in the veins in which the native silver and silver-bearing minerals are found. The average percentage of nickel in the ores shipped from Cobalt varies considerably for the different mines. For the whole district the average is probably between 3 and 5 per cent. The total tonnage is very small and only a portion of the nickel is recovered as the oxide.

The Sudbury nickel region has sharply defined geological boundaries, since all the ore deposits are connected with a single great sheet of eruptive rock, called norite. This sheet is roughly boat-shaped, with a blunt bow turned towards the southwest and a square stern towards the northeast. The sheet is basin-shaped, its interior is filled with sedimentary rocks and only the upturned edges are exposed. The basin is 36 miles in length, from southwest to northeast, and 16 miles in width. All the known ore deposits occur either along the edge of the sheet, or less than 4 miles away from it, on projections or "offsets." In the early days the nickel deposits were grouped in two ranges—a main, or southern, range, and a northern range, but since it has been proved that the ores are all connected with the edges of a single sheet of eruptive rock, one may think of them all as belonging to a single oval range. It is found that the important deposits are not distributed uniformly around the basin, but that there are rich portions separated by barren portions. It is probable that in the near future a third, or eastern, range will be recognized, and possibly a fourth, or western range, though at present the ore deposits at the west end are not known to be of much importance.

[1] Report on the Molybdenum Ores of Canada, by T. L. Walker, Ph.D. Mines Branch, Dept. of Mines, Ottawa, 1911.

Creighton nickel-copper mine, Ont., Canadian Copper Co.

At present, the main nickel range may be defined as running from the Sultana mine, 6 miles southeast, to the Victoria mine, then turning northeast for 23 miles to the Sheppard mine, and finally east for 4 miles to the Garson mine. There is, however, a gap of about 5 miles towards the southeast, between the Crean Hill and Gertrude mines, where no ore has been found. Along this somewhat irregular line of 33 miles on the southern margin of the nickel-bearing eruptive, 17 mines have produced ore, and within 2 or 3 miles to the south of it, 10 other mines have been worked.

Practically all the ore hitherto mined and smelted in the region must be credited to the southern range. The northern range is not so continuous as the southern, but is generally reckoned as extending from certain deposits in Levack township to the Whistle mine at the northeast corner of the basin, a distance of 25 miles. There are, however, two gaps of 6 miles each, so that there are only 13 miles of the margin of the nickel eruptive which are ore-bearing. In addition, however, some ore has been found for 6 miles west along an offset.

Coleman recognizes two main varieties, or types, of ore bodies in the region, which he designates as " marginal " and " offset " deposits.

Many of the more important nickel deposits occur at the basic margin of the norite, lying between it and the adjoining country rock. They are commonly irregular sheets of ore, occupying the lowest parts of the country rock, penetrating all its fissures and enclosing blocks of it of all shapes and sizes. They may, however, have a very distinct foot wall, where the country rock was not shattered by the influx of ore and norite, or where faulting has brought a smooth surface of country rock against the ore. Passing upward through a varying thickness of pure ore containing very little of the rock minerals, the blending of rock and ore, called pyrrhotite-norite, occurs, passing finally into norite with a few blebs of ore. The inner and upper margin is very indefinite, being fixed in mining simply by commercial considerations. The thickness of workable ore may vary from a few feet to 100 feet, or more; the length is equally variable, ranging from 100 feet or 200 feet to 700 feet. The depth to which marginal deposits go is unknown. The Creighton has been explored by mining to 700 feet and diamond drilling has shown that it extends to at least 900 feet.

The " off-set " deposits of Coleman include ore bodies connected with dyke-like projections from the basic edge of the norite, or more or less separate masses of ore and norite not visibly connected with the main body of rock, but almost certainly having underground connexions. Typical offset deposits differ completely from the marginal deposits. They are often more or less columnar in shape, forming pipe-like ore bodies. The contents of these pipe-like bodies differ considerably from those of the marginal deposits, being more rocky, and containing usually more copper ore, as well as more of the precious metals: gold, silver, platinum, and palladium. Another type of offset, with very different features from the columnar type, is recognized in the Frood-Stobie offset, which contains the greatest mass of nickel ore thus far discovered in the district, or in the world. In this case there is no observable connexion with the basic norite edge. The offset, however, lies parallel to the edge and at a distance varying from 4,000 feet to 8,000 feet to the southeast. The ore resembles that of a marginal deposit more than that of the columnar offsets, and the ore body dips at an angle of 60° towards the basic edge. It is a long irregular sheet, enclosing much rock, and its connexion with the edge of the norite is probably at a considerable depth below the surface. The ore is known by diamond drilling to extend northwest beneath

the country rocks to a depth of more than 1,000 feet. This deposit probably contains over 35,000,000 tons of ore.

The nickel-bearing minerals that have been reported from the Sudbury region are pyrrhotite, pyrite, marcasite, pentlandite, polydymite, gersdorffite, millerite, and nickelite. Of these, pyrrhotite and pentlandite are the only ones having any important relation to the ore deposits, and the former is the only one visibly present in all the ore deposits. There is some doubt, however, as to whether pyrrhotite is nickel-bearing in itself, since its nickel content may be due to finely disseminated pentlandite. In addition to the sulphides containing nickel and iron, a sulphide of copper and iron, in the form of chalcopyrite, is almost invariably present. It comes next in amount to pyrrhotite and pentlandite and is always a more conspicuous component of the ore, because of its colour. Copper pyrites may be either intimately mixed with the pyrrhotite or form considerable masses by itself. It is especially common near the walls of ore bodies or associated with masses of rock enclosed in the sulphides, so that, as a rule, rocky ore contains a higher percentage of copper than ore rich in sulphides. In two important mines—the Copper Cliff and Crean Hill—copper is present in larger amounts than nickel, and at Garson and Victoria mines it about equals the nickel; but all the other mines contain more nickel than copper.

The metallic content of the ores varies considerably in the different mines. The nickel content reported averages about 2·09% and the copper 1·85%. If the losses in roasting and smelting are assumed to be 15% of the metallic contents, the proportions of metals in the ores will be 3·09 of nickel and 2·12 of copper, making a total of 5·21 per cent. The ores also contain small amounts of the precious metals, including platinum and palladium.

The metallurgy of the Sudbury ores includes four distinct processes:—

Roasting of the ores in open heaps, to remove part of the sulphur.

Smelting in water-jacketed blast furnaces, to produce a low grade matte, containing about 33 per cent copper-nickel and nearly all the precious metals.

Converting the furnace matte in Bessemer basic converters, to make a matte containing about 80 per cent copper-nickel.

Refining the converter matte, separating the nickel, copper, and precious metals.

At the present time, the first three processes are carried on in Canada in the Sudbury district. The converter matte, however, is shipped either to the United States or to England for final treatment in the refineries.

The most promising recent find of nickel ore in Canada, aside from the Sudbury deposits, is the Alexo mine in northern Ontario, near the town of Matheson. This deposit consists of pyrrhotite, containing nickel, associated with chalcopyrite in a serpentine rock, the latter having been formed by the alteration of a peridotite. This occurrence of ore is similar to the Sudbury deposits. Mining operations are in progress and a small amount of ore has already been shipped to the smelter at Copper Cliff.

There are two strong companies carrying on mining and smelting operations in the Sudbury nickel region. A third company has recently acquired properties containing great reserves of ore, and is planning the erection of an extensive plant.

The total production of nickel (contained in matte) in 1912 was 44,841,542 pounds, valued on the basis of refined metal at $13,452,463. There was also a recovery from the same ores of 22,231,725 pounds of copper, valued at $3,632,886, on the basis of the New York market average price of copper for the year.

Power plant, High Falls, Spanish river, Canadian Copper Co.

Platinum, Palladium, etc.

Both platinum and palladium occur as constituents of the nickel-copper ores of the Sudbury district in Ontario, though in very small amounts. After smelting the ores to a Bessemer matte containing about 80 per cent of the combined metals nickel and copper, it is found that this matte contains from 0·17 to 0·5 oz. of the platinum metals per ton, the proportions varying with the ores from different mines. The precious metals are recovered from the residues remaining after the treatment of the mattes for nickel and copper.

Platinum has also been found in many of the gold placer deposits, its occurrence in this manner having been noted on the Riviere du Loup, Quebec, on the Similkameen, Tulameen, Tranquille, Fraser, North Thompson, and other creeks and rivers of British Columbia, on the Yukon and its tributaries, and the Teslin and other rivers of the Yukon district.

Silver.

The silver produced in Canada at the present time is derived from three main sources, the silver-cobalt-nickel ores of the Cobalt district, Ontario, the argentiferous galena of British Columbia, and the recovery at the smelters from the complex gold-silver-copper ores of the different provinces. There is also a slight recovery from gold mill bullion and from placer gold.

In Nova Scotia there are some argentiferous galena deposits near East Bay and Musquodoboit, Cape Breton, which have been intermittently worked.

Champlain mentions a galena property on Lake Timiskaming, Quebec; this was afterwards known as the Wright mine, and was worked for some time. At Calumet island there are several silver bearing galena deposits which have been worked at various times.

A small amount of silver is also contained in the copper sulphide ores of the Eastern Townships, and whilst, as yet, no discoveries have been made, it is by no means improbable that areas similar to Cobalt district may yet be found in this province.

In Ontario, as early at 1846, veins carrying silver were found on the shores of Lake Superior in the district about Port Arthur, and from 1866 to 1903 the district produced silver. The most famous silver mine was known as the Silver Islet and the vein was found on a small island, some 90 feet square, lying near Thunder cape. The ore bearing veins of quartz and carbonates traversed a large dyke of diabase cutting it along a fault plane. Only where the vein traversed the diabase, did it carry silver, elsewhere except gangue material, it bore only galena, sparingly disseminated. When the mine was abandoned in 1884, work had been carried to a depth of 1,160 feet, and it is estimated that $3,250,000 of silver had been extracted.

The position that Canada now holds as a silver producers country, being third on the world's list of silver producers, must be credited in large measure to the mines of the Cobalt district.

Cobalt, situated on the main line of Ontario's government railway, 330 miles north of Toronto, has the mines closely clustered round and even beneath the town, while other are distributed in a southeasterly direction for a distance of 4 miles. This comprises the Cobalt silver district proper, and while isolated productive mines have been found in the outlying country, such as the Casey, 19 miles north of Cobalt, the Wettlauffer, 20 miles south, and the Millerett and Miller-Lake O'Brien, 50 miles northwest, nevertheless none of these newer discoveries have yet disclosed a district comparable to the parent camp.

The silver deposits of Cobalt are found in assoeiation with Pre-Cambrian roeks. These belong to the Huronian and Keewatin formations and through them has been introdueed a later diabase in the form of a sill. This intrusive need not neeessarily be eonsidered the souree of the ore deposits, but the indieations are that it was the means of opening up the way for their introduetion from other adjaeent sourees. About 80 per eent of the produetive veins oeeur in the Huronian formation, while the remaining 20 per eent is about evenly divided between the Keewatin and the later diabase. As a rule the Cobalt silver deposits are not known to extend to great depths. Below the sill most of the silver is found within a depth of 200 feet.

The Beaver whieh is above the diabase has the deepest workings in ore in the distriet, having attained a depth of 700 feet. To offset this shallowness of the ore, the salvation of the eamp seems to lie in the faet that the veins are numerous. The veins are approximately perpendieular and vary in width from a mere eraek up to 12 inehes or more oeeasionally. The values are not eonfined to the vein roek itself, but in many eases extend into the adjaeent wall roek, making a valuable milling ore. In exeeptional eases this disseminated ore has a stoping width of 15 feet and from 5 to 6 feet is not uneommon. The vein filling is usually ealeite or dolomite earrying native silver assoeiated with the arsenides of eobalt and niekel. A traee of gold is found in the ores as well as a small amount of mereury, and in 1912 one of the mines was paid for a small copper eontent.

There are in Ontario six smelters for the treatment of ores from the Cobalt distriet. The produets from these inelude, fine silver, white arsenie, eobalt oxide, niekel oxide, and in some eases a semi-refined mixture of the eobalt and niekel oxides.

From the eopper-niekel ores of the Sudbury distriet silver is being reeovered in the refining of the matte.

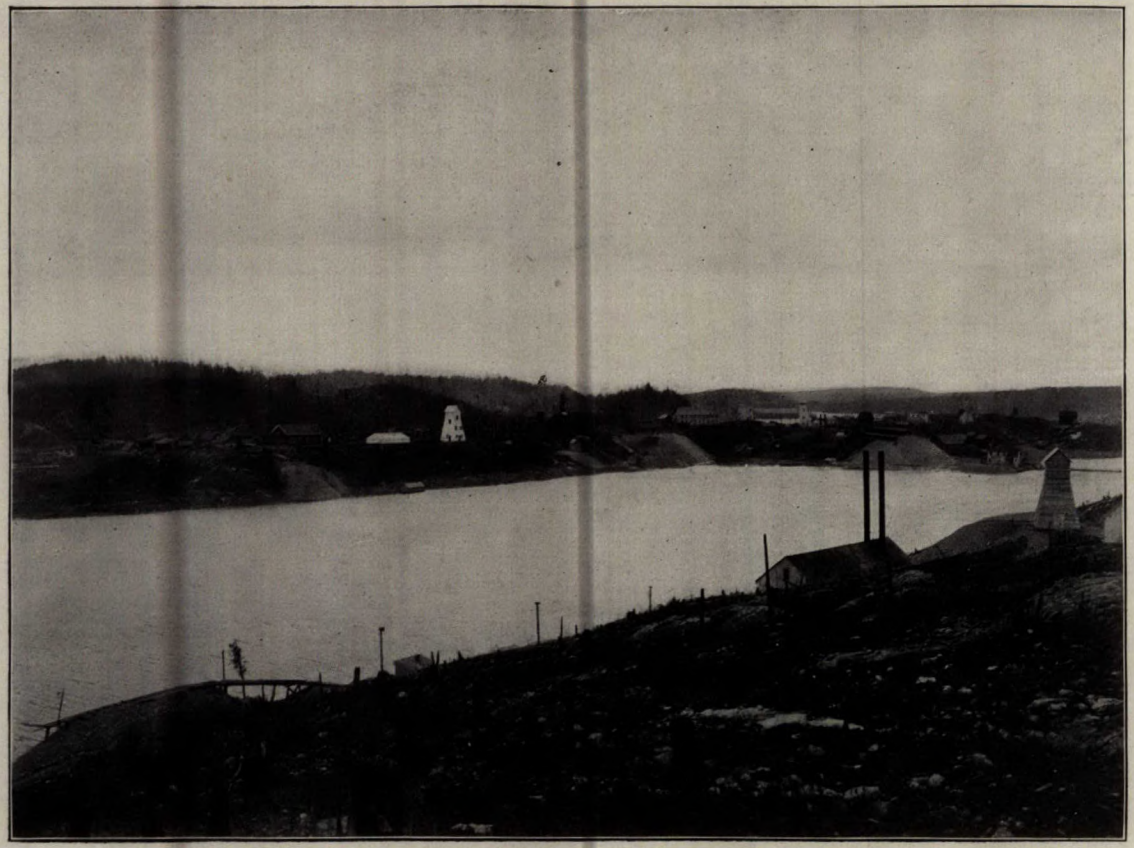
The silver produetion of British Columbia eomes mainly from the argentiferous galena ores of the provinee whieh will be more fully deseribed in the ehapter on lead. In the East Kootenay the ore bodies are large and the silver eontent low, and the same may be said of the ore bodies in the Sheep Creek division of West Kootenay and the Blue Bell mine on the east shore of Kootenay lake. The ores of the Sloean distriet are mueh higher in silver, probably averaging 75 oz. per ton of ore, whilst the ores of the Sloean City and the Lardeau divisions are what are known as dry ores, eontaining little galena, the values being in native silver and sometimes a little gold assoeiated with argentite, pyrargyrite, tetrahedrite, ete.

A few galena and high grade deposits are being worked in the Boundary distriet, notably near Greenwood, and the eompletion of the Canadian Northern may see shipments from the North Thompson River valley.

In the neighbourhood of Hazelton on the Skeena, a number of new properties are just entering the shipping list. The ore is galena earrying gold values in silver.

As mentioned before there is a eonsiderable amount of silver reeovered from the gold and gold-eopper ores and alluvial gold produetion of the provinee. These are more fully deseribed under gold and eopper. The eopper-gold ores are treated in the various eopper smelters of British Columbia, whilst the galena and silver ores go mainly to the lead smelter of the Consolidated Mining & Smelting Co. at Trail, B.C.

The silver from the Yukon (outside of the small amount from the few lode mines now working) is derived from the plaeer gold bullion, but there are



Mines in Kerr Lake section, Cobalt district.

Silver vein, Casey Cobalt mine, Cobalt district, Ont.

many silver lead properties which will probably become steady shippers with further development of the country.

Tin.

The occurrence of tin ore has been reported from several localities, the most important being perhaps the discovery of cassiterite, near New Ross, Lunenburg, Nova Scotia. With respect to this occurrence Mr. Faribault states[1] that "A tin bearing vein was also discovered by Ernest Turner, at Mill Road, four miles north of New Ross, and has been prospected under the management of A. L. McCallum. It has been proved to a depth of 20 feet, and for a length of 250 feet, while the float has been traced half a mile towards the north. The vein is 24 inches wide, mostly made up of quartz, merging with granite at the sides, and carries at the middle a streak of rich ore from three to five inches wide. Several assays of the ore made by Mr. McCallum have given from 10 to 30 per cent tin, and 8 per cent copper, present in the form of cassiterite and chalcopyrite, with association of tungsten-bearing zinc minerals."

Tin minerals have also been reported from several localities in British Columbia and from the Yukon district.

There has as yet been no commercial production or recovery of tin from Canadian sources.

Tungsten.

The tungsten bearing mineral scheelite has been found at a number of localities in Canada, but the only place at which it has been worked commercially is at Scheelite Mines, Moose River district, N.S. Here it occurs in quartz veins cutting the quartzites and slates of the gold bearing series. The quartz veins also carry mispickel and several other minerals but are not gold bearing. A mill has been erected and about 15 tons of concentrated ore (72% scheelite) have already been shipped. Scheelite also occurs in the Malaga gold mining district, Halifax county, while at one locality near South East Margaree in Inverness county, C.B., from 300 to 500 lbs. of hübnerite (Fe, Mn) WO_4 were recovered from a large detached mass of quartz. The mineral has also been noted at New Ross, in Lunenburg county, and at Perry lake, West Waverley, Halifax county, N.S.

In the province of Quebec, scheelite has been found in Beauce county, in a quartz vein traversing Pre-Cambrian rocks, while in Ontario it is found occurring in small nodular masses in parts of the veins around Pearl lake, Porcupine gold mining district.

In British Columbia its occurrence has been noted in quartz veins on the Meteor claim, Slocan City mining division, West Kootenay, and also in the Cariboo district at Hardscrabble creek where the scheelite appears to be very irregularly distributed in the country rock.

In the Yukon territory at Dublin gulch, scheelite is encountered in small water worn nodules of yellowish colour, which are caught in the sluice boxes at Highet creek.

The mineral is employed in the steel manufacturing industry making a tungsten steel of high tensile strength.

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[1] Summary Report Geological Survey Branch, Department of Mines, 1910.

Zinc.

The close association of zinc blende with galena and its wide distribution has made its treatment one of the economic problems of mining in Canada, and its history is interwoven with the history of the silver-lead mines.

In the province of Quebec, Calumet island has been the centre of the greater part of the lead-zinc mining. Several tons of mixed galena and blende were obtained on lots 10 and 11, range IV, Calumet township, in the early nineties, and in 1897 and 1898 The Grand Calumet Mining Co. shipped several hundred tons of ore to Belgium. In 1903 the Lawn mine shipped 5½ tons of zinc ore to England. Some exploration work was done in later years, and in 1910 the Canada Metal Co. started work, making a trial shipment the next year.

In Ontario the Zenith mine at Rossport, Thunder Bay, was discovered in 1881, and in 1899 the first Ontario zinc shipment appears to have been made from it. The Balfour mine was also worked for zinc. In 1902 the Richardson mine at Long Lake, Frontenac county, began shipping, and, in recent years, has been the zinc producer of the province. The last couple of years no zinc shipments have been made from this property.

The occurrence of zinc blende in British Columbia is frequently mentioned in the earlier reports on the province, but only in 1902 is definite reference made to zinc shipments from the Payne and Bosun mines.

In 1904 we find a number of mines producing zinc concentrate, though of this a great deal was apparently never shipped. In the next few years much experimentation was done on processes for zinc treatment, impelled by the high American import duty on zinc in ores. 1905 saw the appointment of the Zinc Commission by the Dominion Government, for the purpose of investigating the zinc resources of British Columbia and their commercial possibilities. The exhaustive report of the Commission was published in 1906. An electric smelting furnace was erected at Nelson in 1908, but did not go into commercial operation. At the present time two mines in the province, the Lucky Jim, and the U.S. are operating for zinc alone, while the Monarch, Hewitt, Noble Five, Ruth, Slocan Star, Standard, Van Roi, and Whitewater are producing hand picked zinc ore or concentrates as a by-product from the milling of galena ores. These concentrates as a rule carry values in silver. It is a notable fact that for some years the Lucky Jim was worked for its silver-lead values only.

Other properties occur on Lynn creek near Vancouver, at Quatsino on Vancouver island, and at Owen lake, near Hazelton. These as yet, however, have made no shipments.

The majority of the British Columbia galena properties carry enough zinc blende to make its separation and possible recovery a question of much importance.

At present all British Columbian ores are shipped to the smelters in the United States. Shipments from Ontario are usually made to European smelters.

The Mines Branch of the Department of Mines is now investigating the possibility of producing spelter by an electric smelting process. While considerable progress has been made during the last two years, the commercial practicability of the results obtained has yet to be determined.

Asbestos quarry, Black Lake, Que.

NON-METALLIC MINERALS.

Asbestos.

Supplying as they do a large proportion of the world's consumption of asbestos, the Canadian deposits of this mineral are of particular interest. While occurrences of the mineral have been noted in other localities and provinces, the principal areas are those found in the Eastern Townships, province of Quebec. The present workable deposits are—as far as exploration work has shown, and with the exception of the Danville quarries—confined to the great serpentine range which strikes through the townships of Broughton, Thetford, and Coleraine. Leaving some scattered deposits in the townships of Wolfstown and Ireland out of consideration, the total length of this productive serpentine belt is twenty-three miles, with a width varying from 100 feet in the extreme easterly part to 6,000 feet in the Mock Lake area; however, the serpentine belt as a whole in many places far exceeds the width indicated above. Active mining began about 1880.

The principal deposits occur at Thetford, Black Lake, Danville, and East Broughton: those at Thetford and Black Lake being the most important. The mineral occurs in a series of narrow and irregular veins, occasionally attaining a width of six inches, though those of the larger size are comparatively rare. Veins with three or four inches of fine fibre were, in the first years of working, quite plentiful; but as the mines increased in depth these appear to decrease somewhat in size. The veins reticulate through the rock in all directions. The deposits are worked by open quarrying, the long fibred asbestos of the larger veins being readily separated out, while the smaller material is carefully cobbed. This separation was at first accomplished entirely by hand, but mechanical treatment has been gradually introduced and perfected until now large mills are in operation in which the rock is broken and crushed in various ways; and the fiberized asbestos taken up from screens by suction fans, and blown into collectors or settling chambers.

The annual production is now over 100,000 tons, valued at upwards of $3,000,000: and includes a wide variety of grades from the long fibred crude asbestos, valued at $300 a ton, down to the shortest mill fibre, valued at only $2 or $3 per ton, and " asbestic " sand used for wall plaster, and valued at from 75c. to $1.50 per ton.

Chromite.

Though chromite is found in several parts of Canada, the only known occurrences of economic interest are situated in the province of Quebec. In this province, it is found in irregular deposits in the serpentine rocks of the counties of Brome, Megantic, Richmond, and Wolfe. Some of these deposits have been worked, the principal ones being in the township of Coleraine, Megantic county. The ore in some cases is sufficiently graded for direct shipment, while in others concentration is necessary.

During the past few years the output of chromite—or chrome iron ore, as it is also called—has been very small. This is probably due to the falling off of the market value of the ore.

In its natural state, chromite is used in the manufacture of special firebrick for metallurgical purposes, on account of its high refractory and basic properties. It is also employed in the making of electrodes for arc lamps, but the main use for this mineral is found in the manufacture of chrome steel. The chromium contained in it gives to the steel great toughness and hardness, producing a product suitable for armour plate, metal

working tools, and many special uses. Various chromic salts and colours used in commerce are derived from this mineral.

The principal market for chromite is in the United States, but some of that produced in Canada has been manufactured into chrome steel by electric smelting at Buckingham, Quebec.

It may be permitted to mention here, as an item of interest, that minute diamonds were discovered associated with chromite, which is an accessory constituent of the peridotites in the Tulameen district, British Columbia, and also with some of the chromite in Quebec.

Coal.

Canada is particularly fortunate in the possession of enormous coal resources. Coal mining was one of the first mining industries to be established, and is still the most important in value of output. Though the development of this industry has been rapid in the past, it seems certain that its future growth will be even more rapid, owing to the settlement and influx of population into those parts of the country—more particularly in the western provinces—in which the principal coal fields exist. Coal is found in five provinces, as well as in the northern territories, the relative importance of each, based on annual output, being as follows: Nova Scotia, British Columbia, Alberta, Saskatchewan, New Brunswick, and Yukon Territory.

Two of the most productive of the Canadian coal fields are situated on the sea-boards, one on the Atlantic coast, and the other on the Pacific coast; a fact which is very important from an Imperial standpoint. In each case these coal fields are located on the respective coasts; both have extensive submarine extensions, and are fortunate in possessing fine natural harbours, capable of accomodating ships of any tonnage. Another coal field is situated in the proximity of the metal mining centres of British Columbia, and within easy reach of the copper and lead smelting centres of both the southern part of the province, and of the adjoining states to the south. Large tracts of the new western provinces of Alberta and Saskatchewan are underlaid by fossil fuels. All of these coal fields, as well as others of less importance are briefly described in the following notes, in geographical order, beginning with the eastern provinces, and proceeding westward.

To convey some preliminary idea as to the geographical position of the coal fields in the respective provinces, the central point of each of the principal coal areas is given in the accompanying list by intersections of latitudes and longitudes (west of Greenwich). These, of course, are only to be taken as a rough guide, and a help to locate the fields. Many of these coal areas are at present well developed, and producing steadily. In others, mainly in the western part of Canada, owing to lack of means of transportation or present lack of market, only prospecting work has been done; but their coals constitute valuable reserves which, in many cases, will be drawn upon in the near future, considering the rapid rate at which the west is developing, and the establishment of numerous new means of transportation and of communication.

Geographical Position of Coal Fields.

Fields.	Latitude.	Longitude.
Nova Scotia:—		
Sydney field	46° 10′	60° 10′
Inverness field	46° 10′	61° 30′
Pictou field	45° 35′	62° 35′
Cumberland field	45° 40′	64° 20′
New Brunswick:—		
Grand Lake field	46° 05′	66° 00′
Manitoba:—		
Turtle Mountain field	49° 00′	100° 00′
Saskatchewan:—		
Estevan or Souris field	49° 05′	103° 00′
Alberta:—		
Belly River field	49° 40′	112° 40′
Frank-Blairmore field	49° 35′	114° 25′
Cascade field	51° 12′	115° 30′
Jasper Park field	53° 12′	118° 00′
Edmonton field	53° 50′	113° 30′
British Columbia:—		
Crowsnest field	49° 30′	114° 55′
Nicola Valley field	50° 20′	120° 50′
Telkwa Valley field	54° 30′	127° 10′
Groundhog coal field	56° 45′	128° 15′
Nanaimo field, V.I	49° 10′	123° 55′
Comox field, V.I	50° 00′	125° 00′
Suquash field	50° 37′	127° 15′
Graham island, Q.C.I	53° 10′	132° 00′
Yukon Territory:—		
Tantalus field	62° 10′	136° 10′
Yukon River field	64° 30′	140° 00′

In the province of Nova Scotia there are several large areas of bituminous coal, most of which are being actively worked. Besides supplying local requirements, these coals are shipped to the provinces of Quebec and Ontario, the eastern part of the United States, New Brunswick, Newfoundland, Prince Edward Island, and the West Indies.

The coal bearing measures of this province belong to the Carboniferous, and are practically confined to the one horizon usually designated as the Productive Coal Measures.

The Sydney field is situated in the northeast corner of Cape Breton county, with the magnificent deep water harbour of Sydney as its central

point; it also includes a small portion of Victoria county. It is bounded on three sides by the Atlantic ocean, and the land areas amount to approximately 200 square miles, being about 32 miles in length from northwest to southeast, and about 6 miles in width. The extent of the sea areas is unknown; but a great part of the local field is submarine.

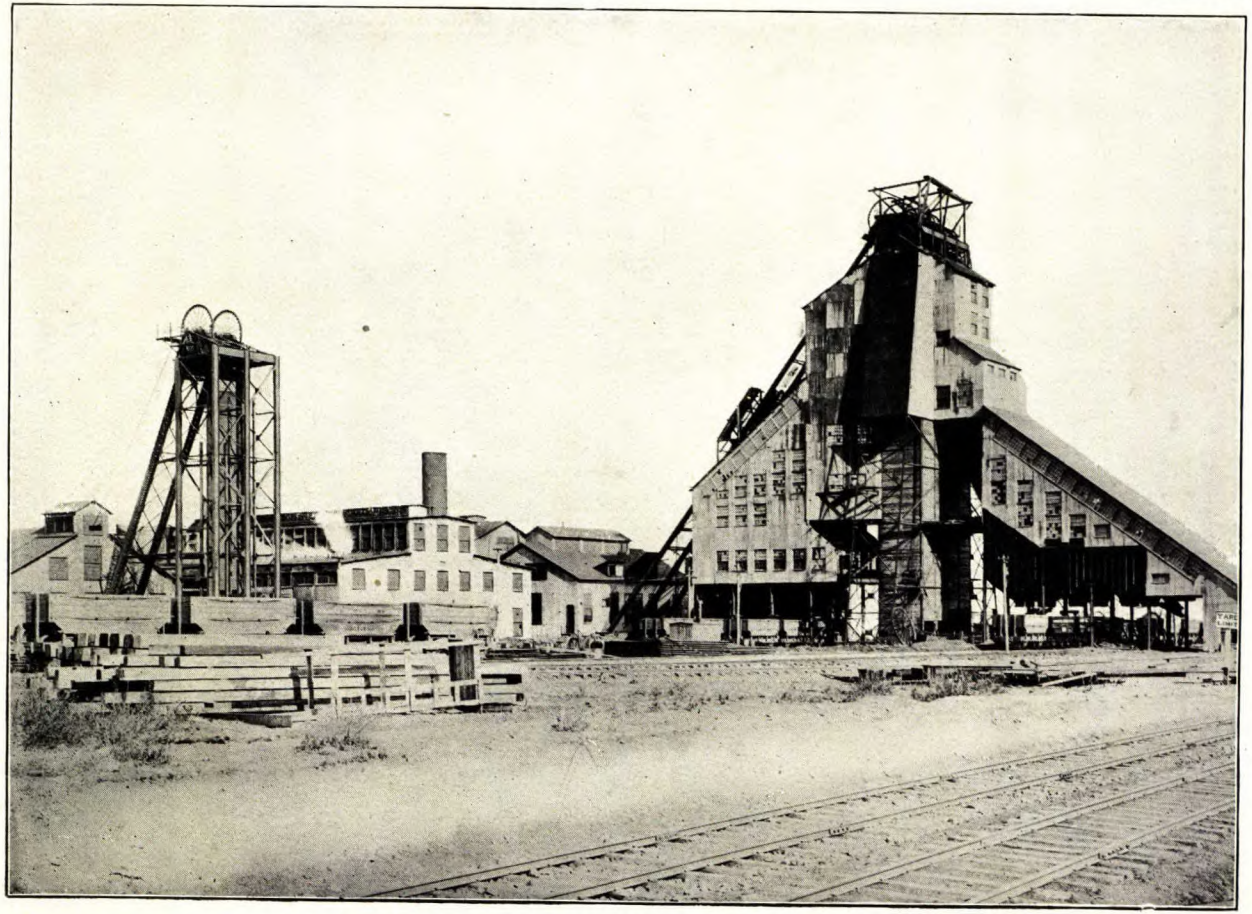
Within this area the existence of nine different seams has been recognized, ranging in thickness from 3 to 12 feet; these dip at low angles 5 to 12 seaward. There are now working in the district 24 collieries, the output of some amounting to as much as 890,000 tons a year each. The total production of the field for the year 1912 was nearly 6,000,000 tons.

The coal measures of the Inverness field comprise a series of narrow areas on a line extending from Judique to Margaree, along the western shore of Cape Breton island. The exposed measures skirt the shores of the Gulf of St. Lawrence for a distance of about 60 miles and extend inland a few miles, but dip under the sea to unknown distances. Some of the areas have been worked since 1866, but no extensive operations were undertaken until railway connexion was made with the Intercolonial in 1900.

The Pictou field, situated in the centre of Pictou county, in the easternmost field on the mainland of Nova Scotia. Its area is comparatively small; the coal measures which constitute it extend about 12 miles in an east and west direction, and have a maximum width of about 3 miles; its total area is approximately 25 square miles. The town of New Glasgow lies on its northern boundary about half-way between the eastern and western extremities. The field, therefore, lies about 9 miles from the shore of Northumberland strait. Although small in extent, its geology is complicated, and the correlation of strata is rendered difficult owing to the occurrence of numerous faults which surround it, and cross it in diverse directions. Active mining began at about the same time as in the Cape Breton field. There are now five collieries, with a total annual output of about 785,000 tons.

In Cumberland county there are two areas of Productive Coal Measures, and active operations are carried on in both districts. One of these, the Springhill coal field, is situated approximately in the middle of the county and about 20 miles from the sea-coast; the other, the Joggins or Northern Area, is bounded on the west by Chignecto bay. The coal seams range from 25 to 13 feet in thickness. In both fields are well developed collieries worked by slopes driven into the seams. The total production of the Cumberland field for the year 1912 was about 654,525 tons.

In the province of New Brunswick the coal seams which are being worked are referable to the Millstone Grit formation, which in Nova Scotia underlies the Productive Measures. Only two areas have been developed into producing coal fields. The first of these, which is also the largest, is the Grand Lake area, situated in Queens county. In this coal field the measures are very nearly horizontal, and for this reason, while they do not comprise a great thickness of strata, they occupy a considerable area. Two seams of coal occur in this field, separated in places by partings of various thicknesses. The top of one is about 20″ thick, while the lower bench is 10″. Sometimes they come together and make a workable seam of 30″. The coal occurs quite near the surface, and the deepest shafts in the district do not exceed 40 feet. This field embraces an area of about 112 square miles. The coal industry in the district can hardly be said to have passed the preliminary stages, although it has been established for many years. Small mines are comparatively numerous, each being worked individually and many of them intermittently. The second field in which mining is being carried on on a small scale is in Kent county, in the vicinity of Beersville. A small seam,



Colliery Dominion No. 2, Dominion Coal Co., Glace Bay, N. S.

under 20″ in thickness, is worked on the banks of Coal branch, a tributary of the Richibucto river. The annual output of the province is now from 50,000 to 60,000 tons.

In western Canada, unlike the eastern part of the Dominion, where the coal seams are found in horizons of Carboniferous age, the mineral fuels are associated with rocks of Cretaceous and Tertiary ages. This remark applies to the coal fields of the plains and the interior of British Columbia, as well as to the coal-bearing areas of Vancouver and Graham islands.

The Turtle Mountain coal field in southern Manitoba is approximately bisected by the longitude meridian 100° 15′ west, and its length in Canada is about 40 miles east and west along the 49th parallel of latitude, which practically bisects it. The southern half lies in the State of North Dakota. The breadth in Canada is about 20 miles north and south.

According to Mr. D. B. Dowling, "the coal horizon does not appear to consist of a series of seams in continuous sheets, but rather of deposits which are limited in extent, though repeated over large areas, and often superposed without the intervention of much clay and sand. The material from which the coal was derived seems in many instances to have been made up of a large percentage of woody matter, but a great part is probably composed of much smaller plant remains, similar in character to much of that in our present swamps and peat bogs, though of different species, such as would be found in a warmer climate." In quality, this fuel is lignite, rather high in moisture. It disintegrates easily on drying, and will not stand long transportation in its natural state, but could be of great importance for local usage. Seams have been worked at various points in a small way, but no regular mining is done.

In the province of Saskatchewan, the Souris coal field forms the northern extension of the North Dakota lignite bearing region. The brown coal beds are in this case contained in horizons constituting the base of the Tertiary. The seams are numerous, but owing to the character of the country and to the thick covering of superficial deposits, it is very difficult to study the coal formation in this district. The area covered by the coal-bearing horizons in this part of the province of Saskatchewan exceeds 4,000 square miles; it extends some 150 miles along the International Boundary, from longitude 102° westward, and has an approximate average width of 25 miles north and south. Of this immense tract, only a very small portion is being worked or has been studied in detail; very little is known of its possibilities beyond the small area in which are situated the mines near Estevan on the St. Paul line of the Canadian Pacific railway.

The lignite is rather low in fixed carbon, and high in moisture. These conditions make it difficult to transport or to store without great loss, and are also productive of great waste in the course of mining. On a comparatively short exposure to the air, the contained water is lost, and this causes a disintegration, and in time a reduction to powder.

From the commercial standpoint, the lower seam is the most important, and as it attains a thickness of 8 feet, this would yield some 11,000 tons an acre, or nearly 10,000,000 tons to the square mile.

Gas producer trials on these coals as well as on other lignites from Alberta show them to be excellent fuels for use in gas producers. The annual output of the Souris field is about 200,000 tons, which finds a market locally and in the Province of Manitoba.

Alberta possesses by far the most extensive coal areas of any province in Canada—in fact, the greater part of the southeastern part of the province

appears to be underlaid with coal—Dowling has estimated the known and mineable coal areas at not less than 30,000 square miles. These coal areas occur in three divisions of the Cretaceous. The lowest is exposed in long narrow belts in the outer ranges of the Rocky mountains and the foot-hills. These areas besides providing the best coal, are also important in that they contain many thick seams, thus ensuring a large supply of valuable coal. The middle division found occasionally in the foot-hills is better known as the Lethbridge coal-bearing rocks which are exposed over a large area in eastern Alberta, and furnishes a coal which grades from bituminous to sub-bituminous and lignite. The higher coal-bearing beds are well exposed in central Alberta, and from the well-known coal seams on the North Saskatchewan have received the name "Edmonton beds." These, in the western edge of the area, contain seams approaching bituminous, but in the eastern part the coal is sub-bituminous.

Coals of the Edmonton Formation or Upper Cretaceous

The area occupied by these rocks is a large triangle, with its western edge parallel to the Rocky mountains, and the eastern edge nearly north and south adjacent to Lethbridge coal areas. It forms a trough in the centre of which is the remnant of the sandstone formation of the early Tertiary. The western portion produces coal that may in many cases be classed as a soft bituminous, while the eastern portion contains sub-bituminous coals only.

In the immediate vicinity of Edmonton there is a very persistent bed of lignite, lying practically horizontal a few feet above the level of the river, and this is extensively worked. This seam gives from 5 to 6 feet of good, clean, lignite, which is mainly used for domestic purposes.

The Belly River coal formation occupies the middle of the Cretaceous in the geological scale and includes the Lethbridge-Medicine Hat area, the Battle River area, as well as areas in the foot-hills and on the Peace river near Dunvegan. The principal collieries are being operated between Taber and Lethbridge and at Lundbreck. The quality of the coal varies from sub-bituminous to lignite, the higher class coal being found on the western margin.

On the eastern slopes of the Rocky mountains there occurs a zone of crumpled rocks which have been subjected to very great dynamic disturbances including folding and faulting. The coal bearing areas of this zone consist of elongated troughs of lower and middle Cretaceous rocks formed by the folding of the strata. The quality of the coals of these measures varies from bituminous coking and non-coking coals to anthracite containing 85 per cent or more of fixed carbon; the amount of volatile matter depending largely on the degree of dynamic disturbance undergone by the beds.

The whole belt of the foot-hills and adjoining disturbed country to the east of it might be considered as an almost continuous zone strung with disconnected coal-bearing troughs of rocks of the Kootanie series; but from the commercial standpoint it may be divided into separate, and more or less well-defined coal fields, of which the Blairmore, Frank, Cascades, and Jasper Park areas are being worked. The Blairmore-Frank field is situated in the southern part of the province and is served by the Crows Nest branch of the Canadian Pacific railway. The coal, as a rule, is of good quality, although generally high in ash; when sufficiently pure or after washing, it yields a good coke. There are 12 large collieries in active operation, besides a number of less important openings. In the Cascade Mountain region on the main line of the Canadian Pacific railway, of which Banff is a well known point,

Coal Creek colliery, Crows Nest Pass Coal Co., Fernie, B. C.

two coal areas are now being worked, the respective centres of which are Canmore and Bankhead. The coal produced at Bankhead mine is very high in fixed carbon, and is practically an anthracite. It is very friable, and as prepared for the domestic market, it requires a great deal of sizing and screening. This results in the production of a very large proportion of fines, or anthracite dust, which is briquetted and makes a very satisfactory fuel. The Cascade basin also extends south of the main line of the Canadian Pacific railway, below the Canmore area, and good seams of coal have been discovered in the district of the Kananaskis river. Farther northward, important areas have been discovered in the Bighorn basin between the Saskatchewan and Brazeau rivers, the Nekanassin area extending from the Brazeau river to the head waters of McLeod river, and the Jasper Park areas. There are important developments in progress on the line of the Grand Trunk Pacific railway, or tributary to it, and one or two collieries are already in operation. Altogether, including large and small, there are nearly 250 collieries now in operation in the province.

The coal production of the province of Alberta has increased from less than 100,000 tons in 1886 to nearly 4,000,000 tons in 1912, and it will probably not be many years before the output exceeds that of any other province.

In British Columbia there are three main districts in which coal mining operations are being actively pursued. These are the Crowsnest Pass region in the eastern part of the province; the Nicola Valley district, in the central part; and the east coast of Vancouver island. Besides these, other coal basins are known and more or less prospected, but at present are too remote from means of communication to be of immediate economic value, although they constitute a reserve of fossil fuels with great possibilities.

The Crowsnest Pass coal field is situated immediately west of the summit of the Rocky mountains, in Crowsnest pass. It is all included within the province of British Columbia, excepting a small portion in the immediate vicinity of the pass, which crosses the watershed into the province of Alberta. The Crows Nest branch of the Canadian Pacific railway crosses the northern part of the coal field, and skirts its western edge for a distance of 25 miles. The rocks of the coal field are of Cretaceous age. Mr. Jas. McEvoy has made an approximate estimate of the total available coal in this field. By taking the area covered by the coal measures as being 230 square miles, and assuming a workable thickness of coal seams of 100 feet, which does not appear to be excessive, he arrives at a total quantity of 22,595,200,000 tons. The opening of the coal mines in this field marked an epoch in the development of British Columbia. Before this time the smelting industries of the Kootenays, and of Washington in the United States, had to depend, in a great measure, on coke from the coast coal mines, the transportation of which, added to a comparatively high initial cost, rendered this fuel very expensive; in fact, the cost of fuel to the smelters has since then been reduced to about one-half. Three large companies are now operating, and the output in 1912 was 1,413,583 tons or about 50 per cent of the total output of the province.

Immediately to the north of the Crowsnest Pass basin of coal measures, but separated from it by a belt of the underlying limestones, there is another trough of coal-bearing Cretaceous rocks, which extends for a distance of some 50 miles, crossing the summit of the main range, into Alberta, at the Kananaskis pass. The difficulties of access, as compared with the other coal areas lying close to the railway, have militated against the immediate active development of these areas; but a railway line, connecting with the Canadian Pacific railway at Michel, has been located. and it is probable that before long this coal field will be exploited. That large quantities of

coal exist in these measures was definitely proved in 1901, by a party of the Geological Survey, when in a section of 3,386 feet, some 12 seams were observed, varying in thickness from 8″ to 35 feet.

The southern interior of the province contains a number of coal fields of growing importance. Near Princeton, one colliery has been already opened and has made small shipments of lignitic coal; but the area of this field is great—probably nearly 50 square miles—so that there appears a certainty that several other mines will eventually be opened up. In the Tulameen valley, near Granite creek, the Columbia Coal & Coke Co. is endeavouring to open up a colliery; there are some very promising outcrops, etc., high up on Granite creek and Collins gulch, but the long tunnel which the Company is driving to cut the coal at depth has not, as yet, been successful in cutting workable coal. Mr. Camsell, of the Geeological Survey, estimates this basin to have an area of about five square miles. The Nicola Valley coal field is situated to the south of Nicola lake in the Kamloops district of British Columbia. Although not as extensive as the Crowsnest field, or the Vancouver Island field, it is yet of great economic importance. It stands mid-way between them, hence the coal of the Nicola valley is manifestly destined to find a market in a considerable part of central British Columbia.

In the northern interior there is another prospective field which attracts great interest at present, owing to its proximity to the line of the Grand Trunk Pacific railway, which is being constructed through this district. This is the Telkwa Valley field, in the northern part of British Columbia. Some of these areas are of considerable extent, and several have been proved to contain coal of good quality and in beds of workable thickness. The character of the coal varies from a bituminous to a semi-anthracite.

About 140 miles by trail north from Hazelton near the headwaters of the west fork of the Skeena river, is another coal field of great promise, known as the Groundhog coal field. This coal is anthracite or semi-anthracite in character. From present indications and developments it would seem though this coal field would prove to be one of the most important developments that the province has seen for many years. The field is, as yet, only slightly developed, and, if but a fraction of its present promise is fulfilled, it is bound to have a wonderfully stimulative effect upon the future of the province. The centre of this field lies approximately in 56° 45′ north latitude, 128° 15′ west longitude. It was first discovered in 1903, though its full extent was not at that time recognized. More recent explorations have shown the field to extend in a northwesterly direction about 75 miles, and to have a width in places of about 30 miles. The rocks in which the coal occurs have been classed as of Cretaceous age. As illustrating the comparative importance of such an area as this, it may be stated that this area alone probably contains as much coal—possibly ten times as much—as is found in all the present known coal areas in the province of Nova Scotia.

Vancouver island has been the seat of a coal mining industry since 1836, which in recent years has not only supplied a local demand but has been largely exported, to the State of California. The Vancouver Island fields, now being exploited are situated on the east coast of the island. These coal measures may be naturally divided into two distinct fields, separated by a gap of 12 miles of crystalline rocks in the district of Nanoose. The northern area is the Comox field, and the southern one the Nanaimo field. Another field, until recently quite undeveloped, exists in the vicinity of Suquash, about 125 miles to the north. Seven collieries are now in operation in the district, and the production in 1912 was 1,571,682 tons.

The coals of the various seams, although each has its own individual characteristics, are, as a whole, much alike, and furnish a bituminous coal of fair grade, the amount of fixed carbon in the best quality ranging from 50 to 60 per cent. and the percentage of ash from 5 to 10 per cent. The most striking feature of the seams is their great variability in thickness and character. The thickness varies from a few inches to over 30 feet, sometimes within a lateral distance of less than 100 feet.

Coal is also found in the Queen Charlotte islands, the most important coal-bearing group known in this group of islands being that found in a development of Cretaceous rocks on Graham island, the most northerly island of the group. In this field, coal outcrops have been located in several places between the Skidegate channel and Yakoun lake in the interior of the island.

In the Peace River valley extensive coal fields are located and partly prospected, but these are as yet far from transportation.

Near Bear lake and river, tributaries of the Fraser river near its most northerly head, and near the located line of the Grand Trunk Pacific railway, a coal area is being developed which, according to recent reports, has considerable promise and, being near the railway, assumes importance.

In the Yukon territory, coal and lignite occur quite extensively. Three of the most important localities containing these fossil fuels are: (1) The Whitehorse coal area; (2) the Tantalus coal area; and (3) the Rock Creek coal area. In the two most southerly localities first mentioned, the coal measures occur mainly in the Tantalus conglomerates, but are also found, to some extent, in the upper portions of the underlying Laberge series. These rocks are all Jura-Cretaceous in age. The coals in the Rock Creek area, so far as is known, are all lignites, and occur in beds of Tertiary age. Probably the most important of these coal-bearing districts is the Tantalus area, which crosses Lewes river midway between Whitehorse and Dawson, and in which are situated the Tantalus mine, the Tantalus Butte property, and the Five Fingers mine. Coal is being mined in the Tantalus field and in the Rock Creek area at Coal creek below Dawson.

The total production of coal in Canada in 1912 was 14,498,302 tons. Canada is also a very large importer of coal, the imports in 1912 having amounted to 14,595,810 tons, and exports 2,127,133 tons. The central provinces of Ontario and Quebec being the chief centres of population, are large consumers of coal, and owing to their extreme distance from domestic source of supply find it more economical to import coal from the nearer fields of the United States.

Corundum.

In spite of the large increase, in late years, in the manufacture and consumption of artificial abrasives, such as carborundum, alundum, etc., natural corundum is still preferred for certain purposes, and the Canadian deposits of this mineral yield practically the entire supply. In 1912 the production amounted to 1,960 tons, valued at $239,091.

The corundum mines are situated in the eastern portion of the province of Ontario, in the townships of Carlow and Raglan, and mining operations have been in progress since 1900. At present, mining is being conducted solely by one corporation—the Manufacturers Corundum Company—who have acquired the mines and mills formerly operated by the Ontario Corundum Company, in Carlow, and the Canada Corundum Company, in Raglan.

The corundum occurs in the form of crystals of various sizes, disseminated in syenite, and is won by quarrying the matrix, hand-sorting the broken rock, and crushing the richer material, with subsequent wet concentration. The average corundum content of the rock treated does not much exceed 6 per cent, and, as from $1\frac{1}{2}$ to 2 per cent are lost in concentrating, the recovery represents about 4 per cent of the crude material.

Corundum-bearing rocks were first recognized in this area in 1897, and the mineral is found sparingly, but widely distributed in the rocks of this district.

Feldspar.

This mineral is employed at the present time almost entirely in the pottery industry (where, in a finely ground form, it is mixed with the clay to act as a flux), or in the enamelling of cooking and similar utensils. Attempts are being made, also, to utilize the mineral as a source of potash, of which it contains as high as 14 per cent.

Feldspar has been mined in Canada since the year 1890, and the present average annual production is 12,000 tons. Practically the whole of the output is exported to the United States, where it is consumed in the New Jersey and Ohio potteries. Almost the entire production of Canadian feldspar is derived from the province of Ontario—the principal mines being located in the county of Frontenac, about twenty miles north of the town of Kingston on the St. Lawrence river. A few small deposits, also, have been worked in the Parry Sound district, in the vicinity of the Muskoka lakes. Formerly feldspar was mined to some extent, also, in the province of Quebec—the deposits being located in Ottawa county. No development of these properties has taken place during recent years—the distance from the United States factories rendering mining unprofitable. One mine in this region yields a remarkably pure white feldspar, which is in demand for the manufacture of artificial teeth.

Veins or dykes of pegmatite (a rock having feldspar as its main constituent) are of common occurrence throughout large areas in both Ontario and Quebec, and have in some instances been mined for the mica which they often carry. These deposits vary in width from mere stringers of a few inches to massive bodies of over a hundred feet. Such deposits, while, at the present time, often too remotely situated, or containing too many impurities in the way of accessory minerals to allow of the feldspar being employed for pottery purposes without considerable expensive cleaning, constitute large reserves of the mineral, which may ultimately prove of value as a source of potash or for other purposes.

Fluorspar.

A deposit of fluorspar has been worked in the county of Hastings, province of Ontario, where a large vein of this mineral occurs. About 250 tons have been mined to date, the output being consumed in steel furnaces and other smelting works. The vein averages two to three feet in width and has been traced for a distance of about fifty feet. The fluorspar occurs often in large and well-formed crystals of a beautiful green colour. These are frequently coated with crystallized barytes, and are much prized as museum specimens.

Mineralogically the occurrence of fluorite has been noted at several points in New Brunswick, Quebec, Ontario and British Columbia, and one

occurrence near Nelson, B.C., was investigated as a possible source of the mineral.

Further uses of fluorspar are: as a substitute for cryolite in the manufacture of aluminium; as a bond in the manufacture of emery wheels; in carbon electrodes—to increase the lighting efficiency and to decrease the current; as a desulphurizing agent in the open-hearth roasting of ores. It is also used in the manufacture of hydro-fluosilicic acid employed as an electrolyte in the electrolytic refining of lead.

Graphite.

Graphite is found in many parts of the provinces of Ontario and Quebec, and also, to a lesser extent, in several of the other provinces.

On Cape Breton island and in the counties of Guysborough, Colchester, and Kings, Nova Scotia, graphite has been observed, but no deposits of commercial importance have yet been recorded.

In New Brunswick—though in late years no graphite has been mined—there are several deposits that have been worked on a small scale, at intervals, since 1853. These are situated in St. John county near the city of St. John. It also occurs in the counties of Charlotte, Kings, and Westmorland.

In Quebec, only one company is operating at present, though several others have been mining and milling graphite until recently, and will probably resume work later. The principal deposits of graphite are situated in the townships of Buckingham and Lochaber, Ottawa county, near the town of Buckingham, and in the township of Grenville, Argenteuil county.

In Ontario four companies are engaged in mining and milling graphite. The operating mines are situated in the following townships: Brougham, Renfrew county; Cardiff and Monmouth, Haliburton county; Monteagle, Hastings county; and North Elmsley, Lanark county. Other important deposits of graphite are found in the counties of Haliburton, Hastings, Addington, Frontenac, Leeds, and Lanark. Some of these deposits have already been worked to some extent.

Both in Quebec and Ontario the majority of deposits of graphite occur in the rocks of the Hastings-Grenville series and are of three classes:—

(1) Veins of columnar or foliated graphite.

(2) Lenticular masses of flake or amorphous graphite.

(3) Flakes of graphite disseminated through the country rock (crystalline limestone, gneiss, and quartzite.)

Practically all of the deposits in which mining has been done belong to the third class. The graphite is extracted from the rock and prepared for the market by an elaborate system of milling.

In British Columbia graphite is reported to have been found at Rivers inlet and Alkow harbour.

Explorers have reported the presence of this mineral in several localities in the far northern parts of Canada.

Graphite is used in manufacturing pencils, crucibles for metallurgical purposes, electrical apparatus, stove polish, lubricants, heat and weather resisting paints, foundry facings, etc., etc.

Artificial graphite is made in Canada near Niagara Falls by means of an electric process.

Grindstones.

The Millstone Grit, a carboniferous formation which is widely distributed in Nova Scotia and New Brunswick, is quarried and manufactured into grindstones of excellent grades. These range in size from very small stones to those used for the grinding of wood pulp, which weigh about $2\frac{1}{2}$ tons each.

The producing quarries and works are situated at Lower cove and Quarry island in Pictou county, Nova Scotia; and in New Brunswick at Woodpoint, Rockport, and Beaumont in Westmorland county, Stonehaven and Clifton in Gloucester county, and Quarryville in Northumberland county.

Stone, reported to be suitable for grindstones, is found in a number of localities in other provinces, but has not been quarried to any extent.

Gypsum.

Many large deposits of gypsum occur distributed throughout Canada; the most extensively mined areas being those in the Maritime Provinces of Nova Scotia and New Brunswick where the mineral is found associated with rocks of the lower Carboniferous series. Many of these deposits are exposed in cliffs which vary from 50 feet to 200 feet in height.

In Nova Scotia, the principal districts in which gypsum is found are in Hants county, near Windsor; in Cumberland county near Amherst; in Victoria county near McKinnon Harbour; Baddeck, and St. Anne; and in Inverness county near Cheticamp. Gypsum also occurs in large quantities along the coast of Cape Breton island, in the interior, and along the shores of the Bras d'Or lakes.

In New Brunswick the principal deposits occur in Albert county in the district around the town of Hillsborough; near Petitcodiac in Westmorland county; and in the northern part of the province on the Tobique river at Plaster Rock, in Victoria county.

A comparatively small proportion only of this mineral mined in these two provinces is manufactured in Canada into plaster of Paris, wall-plaster, fertilizer, etc., the greater part being shipped crude to the United States.

Gypsum occurs in several of the islands of the Magdalen group, province of Quebec, where it is also associated with the limestones of the lower Carboniferous series.

In Ontario deposits are found in Haldimand county along the banks of the Grand river, the occurrence being in the Onondaga formation in beds averaging about 4 and 11 feet in thickness. A small annual output, which is mostly calcined, has been maintained for many years. Occurrences have also been noted in the northern part of the province along the banks of the Moose river in the Hudson Bay basin, about 30 or 40 miles south of Moose Factory.

In Manitoba large workable deposits of gypsum occur in an area about 8 miles square situated about 170 miles north of the city of Winnipeg. These deposits are being operated and the rock transported to Winnipeg, where it is calcined. Gypsum has also been encountered in drilling operations in the southern part of the province.

In the prairie provinces gypsum is found north of the city of Edmonton at several localities in the district tributary to the Mackenzie river.

Gypsum quarry, Cheverie, N. S.

It is also found in British Columbia at the following places: Salmon river in the southern part of the Kamloops Mining Division; Spatsum on the main line of the C.P.R. about 189 miles to the northeast of Vancouver; on the banks of the Thompson river about 20 miles to the north of the town of Kamloops; at Merritt in the Nicola valley, and in the Tulameen district on Granite creek, about 10 miles up the Tulameen river from the town of Princeton.

The quality of the gypsum found in Canada, more especially the white rock found in Nova Scotia, New Brunswick, and Ontario, is of an exceptionally high grade. The mineral is used in many of the fine arts, and is extensively employed in the manufacture of structural materials, such as plaster of Paris, hardwall plasters, cement, etc. It is also used in the crude state as a fertilizer. The output of crude gypsum for the year 1912 was 576,498 short tons, valued at $1,320,883.

Magnesite.

Magnesite is being quarried in the township of Grenville, Argenteuil county, Quebec, about 10 miles north of the town of Calumet. It occurs in the crystalline dolomitic limestone of the Hastings-Grenville series, at several points in this township, but the extent of the deposits is not known as much of the country is covered with soil and vegetation.

This mineral also occurs in deposits of considerable size in Brome county, Quebec; in several localities near Atlin, British Columbia, and in Yukon territory. These deposits have not been worked on account of contained impurities in some cases, and in others on account of lack of a close market.

Magnesite, after being calcined, is used in the making of sulphite pulp, fireproof flooring, firebrick for basic steel and copper furnaces, etc., and in the preparation of chemical products of magnesia.

During calcination it gives off carbon dioxide equal to about half its weight. Where the calcining is done in retorts, the carbon dioxide may be saved and stored in iron cylinders, under pressure, for use in aerating soda water, etc.

Manganese.

Ores of manganese found in Canada comprise pyrolusite, manganite, psilomelane and wad or bog manganese, and these are found principally in the eastern provinces of Nova Scotia and New Brunswick.

Mining operations have been conducted at Loch Lomond, Cape Breton, Tennycape, Walton and Cheverie in Hants county, East Onslow and Londonderry in Colchester county in Nova Scotia. In New Brunswick there are numerous occurrences and production has been obtained from Markhamville and Jordan Mountain in Kings county; Ouacco head, St. Johns county; Shepody mountain and Dawson settlement, Albert county.

Considerable deposits have been found on the Magdalen islands in Quebec, and occurrences have been noted at various points in Ontario and on the east coast of Hudson bay.

The only active operations being undertaken at present are those at New Ross in Hants county, Nova Scotia, where the Nova Scotia Manganese Co. are developing a property from which several hundred tons have already been shipped.

Mica.

Canada is one of the three principal mica-producing countries of the world, the others being India and the United States. The average value of the mica produced annually in Canada during the last ten years has been about $185,000.

With the exception perhaps of Ceylon, Canada is the only country, as far as is yet known, in which the variety phlogopite—or " amber mica," as it is termed in the trade—is known to occur in economic quantities. The mica of commerce is of two kinds—muscovite, or " white mica," and phlogopite, or "amber mica." The former is obtained from both India and the United States, while the latter is secured almost wholly from Canada. Of the two varieties, phlogopite commands rather the higher price, being softer and more flexible and altogether more suitable for use as an insulator—this being the principal use to which mica is put at the present day.

The amber mica deposits of Canada are comprised within an area of approximately 1200 square miles in the province of Quebec, and 900 square miles in the province of Ontario. The two districts are separated geographically by the Ottawa river, and geologically by a belt of sedimentary rocks about 40 miles wide. The city of Ottawa lies between the two productive areas and is the seat of the mica industry—all the important works engaged in trimming and in otherwise preparing the mineral for the markets being located in that place.

Deposits of white mica, also, occur in Canada, and occurrences of this variety (some few of which have been worked at various times), are known from Labrador in the east to the Rocky mountains in the west, while several Arctic expeditions have returned with good specimens from the far north.

Though the average dimensions of mica sheets do not much exceed 3 x 5 inches, plates of enormous size are sometimes obtained. Crystals have been found which measured over 4 feet across and weighed nearly two tons.

About 300 mines have been worked for mica at various times in Canada, but at the present day no more than 25 are in active operation. Among the large operators may be named: The General Electric Company, of Schenectady, N.Y., Webster & Company, Ottawa; Blackburn Bros., Ottawa; Wallingford & Company, Ottawa; O'Brien & Fowler, Ottawa; Kent Bros., Kingston.

Mineral Pigments.

Ochres, wad and ferruginous clays, suitable for manufacturing into paint, are found in many parts of Canada. These mineral pigments, when raw or burnt, give a range of colours including golden ochre, yellow ochre, cinnamon yellow, sienna, umber, Vandyke brown, Indian red, etc., etc.

Though they have been employed in small quantities, for local use, in many districts, the commercial exploitation is limited, at present, almost entirely to the provinces of Quebec and Ontario.

In Quebec there are numerous deposits of ochre in the counties to the north of the St. Lawrence river, resulting from the decomposition of iron pyrites contained in the rocks of the Laurentian hills. In the neighbourhood of Three Rivers much ochre of good quality is dug each year and manufactured into paint. Deposits are also being worked in Nicolet county, on the opposite side of the St. Lawrence.

In Ontario deposits of importance are found in various sections of the province, including Algoma district and Norfolk, Leeds, and Halton counties.

In Nassagaweya township, Halton county, there is a deposit from which ochre is now being produced in small quantities.

In Nova Scotia and New Brunswick, deposits of ferruginous clays and wad, as well as the ochre deposits of Colchester county, Nova Scotia, have been worked on a small scale from time to time. In the western provinces, deposits of workable size and grade are said to exist, but no production is reported.

Barytes

Deposits of barytes ($BaSO_4$) are found in commercial quantities distributed throughout northeastern Nova Scotia at Lake Ainslie, Inverness county, North Cheticamp, Inverness county, Five Islands and Stewiake, Colchester county, and near River John, Pictou county. At the three latter places, deposits have proved to be pockety and difficult to work at a profit, but in the vicinity of Lake Ainslie the deposits have been found to be larger and more continuous, and since 1890 the shipments of this mineral have averaged nearly 2000 short tons per annum.

At Lake Ainslie, the barytes, with some calcite and fluorite, forms a series of roughly parallel veins cutting Pre-Cambrian felsites. The veins, though showing many irregularities in size, are fairly persistent, one nearly vertical vein having a width of from 7 to 14 feet for a depth of at least 250 feet. In several instances the veins locally attained thicknesses of 20 feet.

Although this mineral is mined only at Lake Ainslie, barytes deposits are known to occur at several other localities in Canada, the more important localities being: township of Hull, province of Quebec; in the province of Ontario in the townships of Bathurst and North Burgess (Lanark county), McNab (Renfrew county), Drummer and Galway (Peterborough county), and Summerville (Victoria county). Large veins also occur on Jarvis, McKellars, and Pie islands in Lake Superior and also in northern Ontario near the headwaters of the Wanapitei river.

The product of the mill in operation at Lake Ainslie is used in the paint manufacturing trade.

Mineral Water.

Spring waters containing minerals in solution, or, as they are usually termed, mineral waters, occur in very many sections of the country. Many of them are being utilized commercially, both as potable waters and for bathing purposes. At several of the springs, where the water has curative properties, hotels and sanitariums are being operated. Some of these are thermal or hot springs and are principally used for baths.

Natural Gas.

The oldest and, at the present time, the largest natural gas producing district in Canada is the territory bordering on the east and north shores of Lake Erie. This area can at present be divided into several distinct fields, but the intervening areas between these fields are fast being drilled, and the results tend to show that in all probability the whole of this district is underlaid by gas producing strata. In the counties of Haldimand, Welland, Essex, and Kent, large supplies appear to be available. In these counties the gas horizons are in the Clinton, Medina, Trenton, and Guelph formations. In Essex, county, a single well, drilled 1020 feet to a horizon in the Guelph formation, yielded gas at the rate of 10,000,000 cubic feet per day. The gas from the Ontario district is piped to all the larger towns in the southern

peninsula, where it is used for industrial and domestic purposes. The yield from this district for 1911, from 1027 producing wells, was 10,863,000 M. cubit feet.

In New Brunswick an important and extensive gas producing area is found in the counties of Albert and Westmorland. The main anticlinal, along which drillings are being carried on, lies approximately 11 miles to the south of Moncton, the general trend being east and west. At the close of 1911 there was available an output of about 40,000,000 cubic feet per day. In the season of 1912 the field was further extended and proved by a number of additional wells, the total number of such holes now being 23, each with a pressure at the collar of over 100 lbs. per sq. inch. At the present time the gas is being utilized to supply the towns of Moncton and Hillsborough, but it is proposed in the near future to further extend the distribution.

In the province of Quebec, a number of wells were drilled in the vicinity of Three Rivers and the gas obtained from these wells was utilized locally for a short time, but operations have since been abandoned.

Natural gas is reported to have been encountered in Saskatchewan in wells drilled at Estevan in the southern part of the province.

Natural gas has also been found in northern Alberta along the Athabaska river. In the southern part of the province, in an extensive area of which Medicine Hat is the centre, natural gas has been found in the Niobrara formation in a number of wells drilled to a depth of 1000 feet. Recently, wells drilled on Bow island, 40 miles west of Medicine Hat, encountered a strong flow of gas, and this gas is being piped 170 miles to Calgary, and also to Lethbridge, McLeod, and other towns in southern Alberta. The gas possibilities of the lower Cretaceous measures of Alberta and other western provinces, where capped by the upper members of the series, and where they are not so deep as to be beyond commercial reach, may be considered to be exceptionally promising, and at the present time considerable prospecting is being carried on with a good measure of success.

The total production of natural gas in Canada for 1912 was 15,286,803,000 cubic feet, valued at $2,362,700.

Peat.

The peat deposits of Canada are quite extensive and constitute an important reserve of fuel that has as yet been but little utilized. The most important areas so far as known are those found in the provinces of Quebec and Ontario. A number of these have been systematically examined and surveyed by the Mines Branch with a view to determining their character and extent. The Branch has also carried out a comprehensive investigation of the fuel values of peat, having built a plant in Ottawa for demonstrating the feasibility of the manufacture and use of peat gas in gas engines. During the past two years air dried peat fuel from the government bog at Alfred was sold in Ottawa, and peat from a privately owned bog at Farnham, Que., was disposed of in Montreal. In both cases the fuel was in considerable demand for use in open grates and in kitchen ranges. The Alfred bog is now being operated as a private enterprise and a considerable production is anticipated.

Petroleum.

At the present time the principal oil fields in Canada are situated in the peninsula of southwestern Ontario, between Lake Huron and Lake Erie. The first oil was found in Lambton county in 1862, and active production has been continued ever since. Until 1907, the Lambton County fields in which there have been about 11,000 producing wells were by far the largest producers; since then, several new districts have been opened up, the most prominent ones being the Tilbury district in Kent county and the Onondaga district in Brant county. The oil districts are all situated within an area underlain by Devonian strata, usually on an anticlinal axis, and the petroleum is largely obtained from horizons in the Onondaga formation at depths varying in the different localities. When the wells are first drilled, the natural pressure is usually sufficient to force the crude oil to the surface, sometimes producing what are known as gushers. After the flowing period, the oil has to be pumped. While some of the smaller districts became exhausted in a few years, many of the pools being only a few hundred feet wide and perhaps a quarter of a mile long, others have continued to furnish oil for a long period.

Four refining companies are operating in Canada distilling about 10 million gallons of Canadian crude oil per year, but the greater part being distilled at these refineries is still being imported from the United States. The total production for Canada for the year 1912 was 243,336 barrels valued at $345,050.

In New Brunswick, in the district lying 11 miles to the south of Moncton, oil is being pumped in small quantities from the holes which produce the gas of this district. Although the production so far is not large, drill holes are continually being sunk, and it is hoped that very shortly a stronger and more continuous yield will be the result.

In Alberta, although oil has not been encountered in commercial quantities, prospecting for it is being carried on vigorously, and there is every probability that this province will be added to the list of producers at a very early date.

In connexion with the oil industry in Canada, mention should be made of the existence of extensive deposits of bituminous shales and tar sands.

Beds of bituminous shales, as at present recognized, are found in Gaspe, New Brunswick, and Nova Scotia. Those in New Brunswick are without question the most important. They occur in the counties of Albert and Westmorland and extend in an easterly and westerly direction over a distance of 40 miles. During the past 10 months extensive exploration, by means of diamond drilling and surface work, has demonstrated not only the quantity but the quality of these valuable deposits. It is anticipated that in the near future a plant, with a capacity for an initial daily treatment of 2000 tons of shale, will yield approximately 80,000 gallons of crude oil per day.

Tar sands are known to occur in Alberta along the Athabaska river for a distance of upwards of 100 miles north and south of Fort McMurray. Although the existence of these deposits has been recognized for many years, no steps have as yet been taken to accurately determine their possibilities.

Phosphate.

Canada at one time produced large quantities of mineral phosphate, or apatite, the output in 1890 amounting to nearly 32,000 tons. In this year, however, the competition of foreign countries, more particularly the southern

United States, caused a decline in the price of the mineral, with a consequent falling off in production in Canada. The annual output has continued to decline, until, at the present time, the average production falls short of 1000 tons a year. Practically the whole of this amount is obtained as a by-product in the mining of mica—the two minerals occurring in close association in many of the mines. What has been said as to the distribution of the amber mica deposits in Canada, under the head of "Mica," applies also to the occurrence of phosphate. The greatest phosphate producing area in Canada, however, was the Lièvre River district, in the county of Ottawa, province of Quebec. A very rich belt of phosphate-bearing rock traverses this region and has been exploited in the past by a number of important mines, all of which have been closed down for a number of years.

The phosphate deposits of Canada are found associated with a very old series of rocks, principally granite and gneiss in which the apatite occurs in the form of veins and pockets. These bodies are very irregular in size and shape and are very difficult, as well as expensive, to mine, owing to the fact that large quantities of dead rock have to be handled in order to secure a relatively small amount of phosphate. The deposits of the southern United States, on the other hand, as well as those of Tunis, Algiers, and most other phosphate-producing countries, are of a sedimentary nature, and occur close to, if not actually at, the surface of the ground. These beds can be easily and cheaply exploited with the aid of steam-shovels and dredges—a course which it is impossible to pursue in the case of Canadian deposits. In spite of the large quantities of apatite which have been taken from the old phosphate mines in Canada, the deposits are believed to be still very extensive, and they would doubtless be worked again, should a new use be found for the mineral or should prices warrant it.

The sole uses to which mineral phosphate is put at the present time are the manufacture of phosphorus and fertilizer.

Nearly all the phosphate now produced in Canada is consumed at the town of Buckingham, Que., where two works have been established to treat the mineral, namely: the Electric Reduction Company, engaged in manufacturing phosphorus, and the Capelton Fertilizer Company, making phosphatic fertilizer.

Pyrites and Sulphur.

Native sulphur is not known to occur in Canada in deposits large enough to be utilized commercially. The chief domestic source of sulphur for industrial uses is the mineral pyrites, which, in the pure state, contains 53·54% sulphur and 46·66 % iron.

Important deposits of iron pyrites occur in Quebec in the Sherbrooke district; in Ontario in the Hastings district of central Ontario, and at a number of localities east and northwest of Lake Superior. Other deposits have been found in the northern part of British Columbia at Granby bay and near Port Essington on the Skeena river. Deposits of pyrrhotite, a closely related, mineral containing, when pure, about 39% of sulphur, also occur in the southwestern part of New Brunswick, in Quebec, and in Ontario.

In Quebec, active mining operations have been carried on continuously for more than thirty years; the first pyrites used in a sulphuric acid plant in America is said to have come from the Eustis mine in this province. At present there are two producing mines; the total output is about 65,000 tons containing about 42 % sulphur. About one-half of this is used in Canada for the manufacture of sulphuric acid; the balance is shipped to the United States. The Quebec pyrites contains a small quantity of copper and a little

gold and silver, all of which are recovered by treating the cinder residues obtained in the acid works where the sulphur content is recovered.

In Ontario four pyrites mines are producing ore, two in the Hastings district, one north of Lake Superior and one northwest of Fort William. Some of this ore is used in sulphuric acid plants in Canada, the balance is shipped to the United States. In addition to the operating mines, there are several properties upon which diamond drilling has shown the existence of large bodies of pyrites. In the Sudbury district of Ontario, huge ore bodies of massive pyrrhotite are being mined as ores of nickel and copper. These ores are treated by roasting in open heaps and then smelting in blast furnaces. No attempt is made at present to utilize the sulphur content of these ores because it would cost more to save the sulphur than it is worth. There is probably nearly 100,000,000 tons of this ore available, and in the future it may prove profitable to save a portion of the sulphur. There are also numerous pyrites prospects in the province of Ontario, some of which may prove to contain valuable deposits of pyrites.

Pyrites ores in British Columbia are not mined for their sulphur content. The only location that has been thoroughly explored is that at Granby bay, about 110 miles northeast of Prince Rupert. Here development work has shown the existence of ore bodies containing in the aggregate about 12,000,000 tons. Preparations are being made to mine this ore and smelt it in water-jacketed blast furnaces to recover its copper content. The sulphur it contains will not be saved because there is no market for it on the Pacific coast.

Salt.

Extensive beds of salt or salt producing springs are found in nearly every province of the Dominion of Canada.

The largest, and, at present, the only producing district, is situated in the southwestern peninsula of the province of Ontario, bordering on Lake Huron, the St. Clair river, Lake St. Clair, and the Detroit river. The salt here exists as beds in the Salina formation of the Silurian system, which formation in the productive area is covered by upwards of 1000 feet of other strata, chiefly Devonian.

In this district, the principal plants are located at Windsor, Sarnia, Sandwich, Goderich, Clinton, and Kincardine. A prominent feature of the salt produced from the brine in Canada is its remarkable purity and also its freedom from other salts detrimental to its use in the production of caustic soda and bleaching powder. There is a good opportunity for the soda industry in the Dominion and it is assuming larger proportions each year. At Sandwich, a plant has been recently erected for the manufacture of caustic soda and bleaching powder from the brine.

The production in Canada is obtained wholly from the evaporation of salt brines, either natural or else formed by the pumping of water down drill holes to the salt beds and the re-pumping of the water when it has become a saturated solution.

In Nova Scotia salt springs have been noted from time to time and endeavour has been made to turn these brines to commercial use. These springs come from the rocks of the lower Carboniferous series. The principal localities are in Antigonish county near Antigonish; in Inverness county near Whycocomagh; Cumberland county near Springhill; and in Hants county near Walton. Strong brines were also encountered in bore-holes at depths of 1400 and 1870 feet at Cheverie in Hants county.

In New Brunswick, salt springs are known to occur in the vicinity of Sussex and at Saltspring brook, both in Kings county, and on the Tobique river in Victoria county. These springs, like those in Nova Scotia, have their sources in the lower Carboniferous rocks.

Manitoba furnishes brine springs of varying strength from the northwestern part of Lake Winnipegosis, at Salt point, near the mouth of the Bell river, which empties into Dawson bay. Salt springs also occur on the Red Deer peninsula in the southern part of Winnipegosis lake. Salt was manufactured here as early as 1820 but of late years there has been no production.

Numerous springs have been noted from time to time in the prairie provinces, especially in the Mackenzie River basin, and numerous lakes in the district lying to the north of the Cypress hills in the southern part of the prairies are known to be saline.

In British Columbia, salt springs have been noted in several places, the principal one being at the north end of Admiral island near Nanaimo. The discovery of an important deposit of rock salt has recently been reported from Kwinitsa, a station about 45 miles east of Prince Rupert on the Grand Trunk Pacific railway. This discovery if confirmed will be of great practical importance to the marine fishing industries established on the Pacific coast.

In the year 1912, the production of salt in Canada was 95,053 short tons, valued at $459,582.

Talc.

Talc or bodies of talcose mineral—in part steatite, or soapstone—have been found at many places in the Dominion, but with the exception of the mines near Madoc, Ont., they have not been mined to any great extent. In Hastings, Frontenac, Leeds, and other counties in eastern Ontario, a number of such deposits have been discovered; and in Brome county, Quebec, as well as in the Eastern Townships and in the Maritime Provinces, steatite deposits of possible economic importance are known.

In the province of Ontario, near the village of Madoc, in Hastings county, a large body of talc has been worked for several years. There are now two mines in active operation and the annual production is about 8,000 tons. The value of the crude mineral is about $2 per ton at the mine, while the ground talc from the mill averages from $8 to $10 per ton.

Two mills have been erected, one at Madoc, and a smaller mill erected more recently near Eldorado, which are engaged in grinding the crude talc and preparing it for the trade. Most of the finished product finds a market in Canada, a large proportion being consumed in the paper industry. Other uses of the powdered mineral are in the manufacture of cosmetics, insulating coverings, dressing for leather, enamel paints, French chalk, and as sizing for cotton cloths. Massive talc finds numerous uses because of its refractory qualities, its resistance to the action of most acids, and its possession of a high dielectric strength.

Tripolite.

In Nova Scotia and New Brunswick the bottoms of many of the small lakes are covered with tripolite, or, as it is also called infusorial earth, diatomaceous earth, fossil flour, keiselguhr, etc. This material is made up of the minute siliceous shells of diatoms mixed with small quantities of lime, alumina, and other impurities.

The more important deposits, some of which have been worked, from time to time, are situated in Victoria, Cumberland, Cape Breton, and Inverness counties, Nova Scotia, and in Kings and St. John counties, New Brunswick.

At present only one company is actively engaged in Canada in the digging of tripolite and preparing it for the market. This company is carrying on its operations at Bass River lake in Cumberland county, Nova Scotia.

Deposits of tripolite are also reported to occur in Quebec, Ontario, and British Columbia, but none of these have ever been worked, nor do they appear to be of immediate value.

The principal uses to which tripolite is put are as a polishing material, and in making non-conducting coverings for steam pipes, etc. It is also used as a filler in the manufacturing of rubber goods, in the making of water filters, and by paint manufacturers for making a wood filler. Before the introduction of wood pulp, as the absorbent for nitro-glycerine in the manufacture of dynamite, tripoli was used for this purpose.

Cement.

Materials used in the manufacture of cement in Canada include marls, limestones, clays, and blast furnace slag. The occurrence of cement materials is so widespread and abundant in all parts of the country that the question of their utilization is largely economic, being dependent upon the market for the product, the comparative availability of suitable raw materials in different localities, the cost of fuel, and the transportation facilities.

There are at present 24 completed cement plants in Canada, with a total daily capacity of about 28,800 barrels, besides several plants in course of construction. The total production in 1912 was 7,132,732 barrels, valued at $9,106,556, and in addition, 1,434,413 barrels were imported.

The operating plants are distributed as follows: one at Sydney, Nova Scotia, using blast furnace slag, three in the province of Quebec, two of which are near Montreal, and one near Hull, adjacent to the city of Ottawa, each using local limestone and clay. In the province of Ontario there are fifteen plants with a total daily capacity of nearly 16,000 barrels. Of these 11 use marl and four limestone. The marl plants are located at Marlbank, Durham, Owen Sound, Lakefield, Hanover, Blue Lake, Raven Lake, Orangeville, and Ottawa. The limestone plants are located at Belleville and Port Colborne.

Formerly considerable quantities of "Natural Rock" cement were made from a suitable calcareous limestone found in the Niagara peninsula, but this has now been entirely superseded in Ontario by the production of Portland cement. In the province of Manitoba, a "Natural Portland" cement is made at Babcock, southwest of Winnipeg. Alberta has three limestone plants, located respectively at Calgary, Exshaw, and Blairmore. A second limestone plant is being constructed at Blairmore, while a marl plant is being constructed near Marlboro about 145 miles west of Edmonton.

British Columbia has one rock plant at Tod Inlet, near Victoria, and a second under construction at the same place, while another rock plant is nearing completion at Princeton.

Clays and Clay Products.

Clays or shales suitable for the manufacture of ordinary common and pressed building brick, pottery, tile, sewerpipe, etc., are found widely distributed in almost every province of Canada, and are being utilized wherever there is a demand or a market for clay products. Fireclays or clays suitable for the manufacture of firebrick have been found at only a comparatively few points, including Shubenacadie, N.S., Dirt hills, Sask., and Clayburn, B.C., and as yet are utilized to a comparatively limited extent only.

Kaolin or china-clay has been found in the county of Argenteuil, province of Quebec, near St. Remi de Amherst, and a washing plant has been erected for the preparation of the material. The extent and importance of the clay working industry is shown by the value of the production which in 1912 exceeded $9,000,000, and amongst non-metallic products was next in importance to coal. The consumption probably exceeds this value by at least one-third, owing to the large imports particularly of firebrick and of earthenware and chinaware.

Building Stone and Stone Quarries.

There is scarcely any variety of stone which may not be used for building purposes, and in view of the great area and diversity in geological structure possessed by Canada, it is difficult to place any limitations upon the possibilities in the utilization of building stone and other quarry products. It may well be claimed that Canada possesses in great abundance every kind of stone required for the purposes both of common and decorative architecture; these are only commercially available, however, in districts provided with transportation facilities and where conditions respecting production are otherwise favourable for economic working.

A convenient classification of building and other stone includes: (1) granite syenite gneiss and other igneous rocks; (2) limestone and dolomite; (3) marbles; (4) sandstone; (5) slates.

At many quarries, particularly of granite and limestone, very large quantities of stone are crushed for use in making concrete and for other purposes, in fact the value of crushed stone produced is now greater than that of ordinary or dimension building stone.

At the present time quarries are being actively operated in the localities as shown hereunder:—

Granite is quarried in Nova Scotia, near Halifax and at Nictaux in Annapolis county; in New Brunswick in the the vicinity of St. George, Charlotte county, and at Hampstead, Queens county; in Quebec in the counties of Beauce, Stanstead, Iberville, Portneuf, and Argenteuil, while considerable quantities of syenite which is intrusive in limestone are quarried with the latter in the vicinity of Montreal. In Ontario, granite is quarried in the counties of Hastings, Leeds, Ontario, and the districts of Muskoka and Parry Sound; trap rock is quarried in the county of Peterborough, and also near Bruce Mines, Algoma, and Port Arthur, Thunder bay. Most of the quarries in British Columbia are on the west coast on Burrard inlet, or on islands conveniently situated for transportation to Vancouver and Victoria. The total value of the production of granite in 1912 was $1,373,119.

Limestone is extensively quarried, not only as a building stone, but for the manufacture of lime and cement and for use as a flux in metallurgical operations. Quarries in Cape Breton, N.S., supply stone chiefly used for

fluxing in the iron and steel furnaces at Sydney, while near St. John, N.B., the output is used mainly in the manufacture of lime. There are numerous quarries in Quebec and Ontario, those in the former province being situated chiefly on the Island of Montreal and in the near-by counties of Soulanges and St. Hyacinthe, also in the counties of Portneuf and Quebec, north and west of the city of Quebec, and in the county of Wright, near the city of Hull. In Ontario, limestone quarries are widely distributed through the whole of the southern portion of the province included between the great lakes and Ottawa river, and particularly the more southerly portion of this area. In Manitoba the operating quarries are chiefly at Garson Quarry, Gunton, Stonewall, Tyndall, and Stony Mountain. In Alberta, limestone is quarried for lime burning or cement manufacture at Frank and Blairmore in the Crowsnest district, and at Exshaw and Kananaskis on the C.P.R. main line in the foot-hills of the Rocky mountains. At Fife, Boundary district, B.C., limestone is quarried for use in the Trail smelter. The total value of the production of limestone in 1912, not including stone used for lime burning, or cement, was $2,762,936. There was produced 8,475,839 bushels of lime, valued at $1,844,849.

Marble is obtained in Quebec, at Philipsburg and South Stukely; in Ontario in the counties of Hastings and Lanark. A number of quarries not at present operating have also been opened in British Columbia. The value of the output of marble quarries in 1912 was $260,764.

Sandstone.—Very fine building stones are obtained in the counties of Cumberland and Pictou, N.S., and in Northumberland and Westmorland counties, N.B. In Ontario, sandstone is quarried in the counties of Carleton, Halton, and Peel. Several quarries have been opened in Alberta at Brickburn, Glenbow, Rockburn, Rockdale, Stanton, etc. In British Columbia, sandstone quarries are operated on Saturna, Haddington, and Denman islands. The total value of the production of sandstone in 1912 was $329,352.

Slate.—Roofing slates have been quarried at Danville, Corris, Brompton, Melbourne, and New Rockland in southern Quebec, the quarries at New Rockland having been almost continuously operated since 1868. A new quarry has recently been opened up at Botsford in Temiscouata county. In the province of Ontario, some development work has been undertaken on a slate property, near New Liskeard in Hudson township. Roofing slate has also been obtained on the west coast of British Columbia.

STATISTICS OF MINERAL PRODUCTION IN THE PROVINCES OF CANADA, WITH SOME NOTES ON THE MINING LAWS OF THE DOMINION OF CANADA AND OF THE SEVERAL PROVINCES.

A summary table of the mineral production in the whole of Canada has already been given in the introduction to this pamphlet, and further details of the record of production during the years 1911 and 1912 in each of the provinces are given in the following pages.

The conditions on which mining lands or mining rights may be acquired in Canada are not uniform throughout the country, but vary with the different provinces. This is due to the fact that, with certain exceptions, Crown lands and mining rights are owned or controlled by the provinces, and each province sells or leases mining lands or mining rights according to its own laws or regulations. The exceptions are, the provinces of Manitoba, Saskatchewan, and Alberta, the Yukon, and North West Territories, the public lands of which are still held by the Federal Government at Ottawa and are leased or disposed of under Dominion regulations.

NOVA SCOTIA.

Area, 21,428 sq. miles. Population 1911, 492,338.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Gold.....Ozs.	7,781	160,854	4,385	90,638
Iron ore, sold for export.....Tons	22	50	30,857	168,877
Pig iron from Canadian ore (a)..... "	.....	.....	.....	.....
Barytes..... "	50	400	464	5,104
Coal..... "	7,004,420	14,071,379	7,783,888	17,374,750
Grindstones..... "	380	3,382	374	3,760
Gypsum..... "	353,999	406,457	376,082	481,493
Manganese..... "	5½	300	75	1,875
Tripolite.....	20	122	38	230
Clay products.....	.....	274,249	.....	272,053
Lime.....Bus.	639,200	130,555	709,596	145,121
Stone.....	.....	292,914	.....	324,630
Other products.....	.....	68,735	.....	53,705
	.....	15,409,397	.....	18,922,236

(a) Total production of pig iron in Nova Scotia in 1911 was 390,242 tons, valued at $4,682,904, and in 1912 was 424,994 tons, valued at $6,374,910.

One of the smallest as well as one of the oldest of the Canadian provinces, Nova Scotia, has always been an important mining centre and her deposits of coal, gold, iron, and gypsum have been mined for many years.

Situated on the Atlantic seaboard, the facilities for water shipment are unexcelled, and a very large industrial development has taken place in the iron and steel industry at Sydney, New Glasgow, and Londonderry based on the locally available fuels, fluxes, and ores, as well as the iron ores of Newfoundland.

Other minerals produced include tungsten, antimony, barytes, manganese, infusorial earth, arsenic; as well as clays, quarry products, cement, lime, etc.

Prospecting and mining rights are granted direct from the Crown under the "Mines Act" (Chapter 18 of the Revised Statutes of Nova Scotia 1900 and amendments thereto), while mining is carried on under the regulations provided in the "Coal Mines Regulation Act," and "The Metalliferous Mines Regulations Act."

Nova Scotia furnishes encouragement and assistance to the mining industry by providing core drills owned by the Department of Mines and made available to applicants under certain conditions and regulations for the prospecting or development of mining lands.

Copies of the Mining Laws, Regulations, mine reports, maps, and other literature, may be obtained from the Commissioner of Public Works and Mines, Halifax, Nova Scotia.

NEW BRUNSWICK.

Area, 27,985 sq. miles. Population 1911, 351,899.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Iron ore, sold for export.....Tons	31,120	69,464	71,520	127,716
Coal..... "	55,781	111,562	44,780	89,560
Grindstones..... "	4,186	49,560	4,038	48,330
Gypsum..... "	93,205	115,044	82,757	185,821
Mineral water.....	.....	19,843	.....	.....
Natural gas.....M. ft.	.....	.....	173,903	36,549
Petroleum.....Bls.	2,461	3,019	2,679	3,799
Clay products.....	.....	38,000	.....	54,910
Lime.....Bus.	613,728	132,897	616,835	133,742
Stone*.....	.....	73,441	.....	90,577
	.....	612,830	.....	771,004

* There is also an important production of cut and polished granite at St. George from both imported and local stone of which the value in 1911 was $86,658 and in 1912 $82,935.

Gypsum, coal, iron ore, manganese ore, sandstone abrasives, natural gas, petroleum, oil shales, together with limestone and building and ornamental stones of granite and standstone, form the principal mineral resources of this province, although the occurrence of many other minerals has been noted.

Prospecting and mining licenses may be taken out under authority of the "General Mining Act" of the province of New Brunswick. Information respecting licenses, mining regulations, royalties, etc., may be had from the Surveyor General, Department of Crown Lands, Fredericton, New Brunswick.

PRINCE EDWARD ISLAND.

Area, 2,184 sq. miles. Population 1911, 93,722.

This little province, consisting of the island of the same name in the Gulf of St. Lawrence, has practically no mineral industries. It is uniformly fertile and well peopled and has important fisheries. Red sandstones suitable for masonry may be quarried in some places, and clays occur that may be used for brick-making. It may be that coal-seams underlie the island or some part of it, but if so, they appear to be at a depth too great for utilization at the present time.

QUEBEC.

Area, 706,834 sq. miles. Population 1911, 2,002,712.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Copper.....Lbs.	2,436,190	301,503	3,282,210	536,346
Gold.....Ozs.	613	12,672	642	13,270
Iron ore, sold for export.....Tons	3,616	6,479	1,185	4,232
Pig iron from Canadian ore (a)..... "	379	9,949	.....	.....
Silver.....Ozs.	18,435	9,827	9,465	5,758
Asbestos and asbestic..Tons	127,414	2,943,108	136,301	3,137,279
Chromite..... "	157	2,587	.....	.....
Feldspar..... "	17	255	100	2,000
Graphite..... "	374	33,084	604	50,680
Magnesite..... "	991	5,531	1,714	9,645
Mica.....	.....	69,465	.....	81,044
Mineral water.....Gals.	.....	63,637	92,873	36,736
Ochres and iron oxides.Tons	3,612	28,173	7,654	32,410
Peat..... "	200	800	500	2,000
Phosphate..... "	586	4,909	164	1,640
Pyrites..... "	39,122	247,555	60,849	243,396
Quartz.....	548	684	556	1,240
Cement.....Bls.	1,614,730	1,963,439	2,714,685	3,134,499
Clay products.....	.....	1,341,467	.....	1,680,300
Kaolin.....Tons	.....	.....	20	160
Lime.....Bus.	1,428,392	356,453	1,729,614	474,595
Slate.....Sq.	1,833	8,248	1,894	8,939
Stone.....	.....	1,894,892	.....	1,957,703
Other products.....	.....	.....	.....	243,126
	.....	9,304,717	.....	11,656,998

(a) There was no production of pig iron during 1912, while in 1911 the total production was 658 tons, valued at $17,282.

There was also in this province an important production of aluminium from imported ores.

This province with its boundaries recently extended to include the great north country of Ungava, reaching to the shores of Hudson bay and Hudson strait, is now geographically the largest province in Canada, but as in all of the central and western provinces, the settled or populated section is con-

fined to a comparatively narrow fringe of territory along the southern border, and the greater part of the northern area is scarcely even explored.

Quite a wide variety of mineral products are obtained as will be noted in the above table. In the southeastern portion of the province, south of the St. Lawrence river, in an area usually referred to as the " Eastern Townships", are found alluvial gold deposits of Beauce county, copper pyrites, asbestos, and chromite deposits, bog iron ores, and large marble and granite quarries. North of the St. Lawrence are bog iron ores at Three Rivers, etc., and titanium ores north of Montreal, while farther west, north of the Ottawa river, are found magnesite, graphite, phosphate, feldspar, mica, iron ore, molybdenite, with lead and zinc at Calumet island and near Lake Timiskaming.

Miners' certificates, mining licenses, and mining concessions are granted by the Provincial Government under authority of the " Quebec Mining Law Act " of 1892, with amendments; and all information desired respecting the mines, mineral resources, and mining laws of the province may be obtained on application to the Superintendent of Mines, Bureau of Mines, Department of Colonization, Mines and Fisheries, Quebec City, Quebec.

ONTARIO.

Area, 407,262 sq. miles. Population 1911, 2,523,208.
Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Copper.....Lbs.	17,932,263	2,219,297	22,250,601	3,635,971
Gold.....Ozs.	2,062	42,625	86,523	1,788,596
Pig iron from Canadian ore (b).....Tons	41,807	603,455	36,355	450,886
Iron ore sold for export. "	5,379	12,577	14,567	28,125
Nickel.....Lbs.	34,098,744	10,229,623	44,841,542	13,452,463
Cobalt oxide and nickel oxide..... "	154,174	221,690	349,054	156,256
Cobalt mineral & mixed cobalt and nickel oxide "	1,260,832		1,285,280	163,988
Silver.....Ozs.	30,540,754	16,279,443	29,214,025	17,772,352
Zinc ore.....Tons	.....	.....	10	3,750
Actinolite..... "	67	736	92	1,000
Arsenious oxide..... "	2,097	76,237	2,045	89,262
Corundum..... "	1,472	161,873	1,960	239,091
Feldspar..... "	7,706	51,684	13,633	28,916
Fluorspar..... "	34	238	40	240
Graphite..... "	895	36,492	1,456	66,442
Gypsum..... "	27,399	98,018	53,119	176,056
Mica.....	.....	59,212	.....	62,932
Mineral water.....	.....	136,778	.....	131,529
Natural gas.....M. ft.	10,863,871	1,807,513	12,529,463	2,036,245
Ochres.....Tons	10	160	.....	.....
Peat..... "	1,263	3,017	200	900
Petroleum.....Bls.	288,631	354,054	240,657	341,251
Phosphate.....Tons	35	297	.....	.....
Pyrites..... "	43,544	118,265	20,677	70,689
Quartz..... "	59,978	83,181	99,686	193,976
Salt..... "	91,582	443,004	95,053	459,582
Talc..... "	7,300	22,100	8,270	23,132
Cement.....Bls.	3,090,786	3,741,039	3,044,713	3,372,897
Clay products.....	.....	3,916,575	.....	4,864,700
Lime.....Bus.	3,360,265	538,902	3,376,193	573,269
Sand-lime brick.....No.	29,502,186	237,662	36,371,002	328,548
Stone.....	.....	892,305	.....	1,109,164
Other products.....	.....	408,110	.....	363,668
	.....	42,796,162	.....	51,985,876

(b) The total production of pig iron in Ontario in 1911 was 526,635 tons, valued at $7,606,939; in 1912, 589,593 tons, valued at $8,176,089.

Ontario now produces the largest output as well as the greatest variety of mineral products of any of the Canadian provinces, being credited with over 38 per cent of the total Canadian mineral production in 1912. The extent and variety of production is shown in the above tabular statement. The principal metalliferous ores are the nickel copper deposits of the Sudbury district, the silver-cobalt-nickel arsenides of the Cobalt and surrounding areas, the gold fields of eastern Ontario and of Porcupine and of numerous other widely scattered areas in the northern and western sections, and the iron ores of Hastings and Frontenac counties, as well as those north and west of Lake Superior. In the eastern portions of the province are found important deposits of corundum, feldspar, fluorspar, graphite, mica, phosphate, pyrites, talc, lead and zinc ores, etc. In the southern section, including a highly developed agricultural area, are found the deposits of petroleum, natural gas, gypsum, and salt, this area also containing numerous stone quarries, lime kilns, and clay and cement plants, etc.

Iron blast furnaces are in operation at Hamilton, Deseronto, Midland, Sault Ste. Marie, and Port Arthur, while metallurgical works for the reduction of nickel, copper, silver, or lead ores are found at Copper Cliff, Coniston, North Bay, Orillia, Thorold, Kingston, and Deloro, and electric furnaces for the production of ferro alloys are operating at Buckingham, Welland, and at Sault Ste. Marie.

The acquisition of mining claims in Ontario depends in the first instance upon the discovery of valuable mineral, followed up by staking and recording, performance and proof of work, and applying for a patent and paying a small price per acre, as per the conditions and regulations set forth in the "Mining Act of Ontario" 1906, and amendments thereto.

For the encouragement of metal refining, a small bounty is offered on the production of refined nickel, nickel oxide, cobalt, cobalt oxide, copper sulphate and on white arsenic from mispickel ores, under the conditions and regulations provided in the "Metal Bounty Refining Act."

Information respecting miners' licenses, mining laws, provincial bounties, reports of the Bureau of Mines, etc., may be had on application to the Deputy Minister of Mines, Department of Lands, Forests and Mines, Toronto, Ontario.

MANITOBA.

Area, 251,832 sq. miles. Population 1911, 455,869.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Calcined gypsum.....Tons	43,000	372,000	66,500	481,250
Cement.....Bls.	21,350	28,289	12,127	16,068
Clay products.....	.....	834,428	.....	1,018,051
Lime.....Bus.	706,888	140,629	818,237	168,257
Sand-lime brick.....No.	9,679,985	98,376	27,594,874	294,700
Stone.....	.....	318,050	.....	383,095
Other products.....	.....	.....	.....	101,653
	.....	1,791,772	.....	2,463,074

Outside of clay and quarry products, gypsum is the only mineral being mined in Manitoba although the occurrence of gold has been noted, and gold claims are being exploited on the southeastern border of the province adjoining the Ontario boundary and in an area immediately east of Lake Winnipeg. Salt was for many years produced in small quantities from brine near Lake Winnipegosis. There is also a considerable lignite coal field near the southern boundary of the province, but mining operations are not being conducted thereon.

The Crown lands, including mining rights in the provinces of Manitoba, Saskatchewan, Alberta, and the Yukon, and North West Territories are owned and controlled by the Dominion Government, and reference to the laws in force regarding the disposal of mining lands will be found under North West Territories.

SASKATCHEWAN.

Area, 251,700 sq. miles. Population 1911, 492,432.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Coal.....Tons	206,779	347,248	225,342	368,135
Brick, common and pressed.....No.	21,071,660	224,758	30,538,771	332,943
Lime.....Bus.	.....	.....	4,000	1,440
Sand-lime brick.....No.	(a)	(a)	16,292,114	207,671
Other products.....	.....	64,700	.....	255,453
	.....	636,706	.....	1,165,642

(a) In 1911, included in other products.

The provinces of Manitoba, Saskatchewan, and Alberta, embracing an enormous area of comparatively level prairie land, are popularly known as the " Prairie Provinces," and are essentially agricultural domains. Each, however, is underlain by important coal areas consisting of lignites in Manitoba and Saskatchewan, and changing to bituminous and semi-anthracites, as the Rocky mountains are approached. The raw materials for the manufacture of brick, tile, and cement are found at a number of localities in these provinces. Limestones and building stones also occur. The Saskatchewan lignites are mined at Estevan.

While the disposal of coal lands and mining rights generally, is made by the Dominion government (see under North West Territories), coal mining operations are carried on under the regulations and inspection provided in the Coal Mines Regulation Ordinance of the province.

ALBERTA.

Area, 255,285 sq. miles. Population 1911, 374,663.

Population in 1913 estimated at over 500,000.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Gold.....Ozs.	10	207	.....	1,509
Coal.....Tons	1,511,036	3,979,264	3,240,577	8,113,525
Natural gas.....M. ft.	780,286	110,165	2,583,437	289,906
Cement.....Bls.	512,176	1,241,535	821,165	1,775,898
Clay products.....	.....	1,052,751	.....	1,356,184
Lime.....	434,038	100,407	704,035	166,520
Sand-lime brick.....No.	3,500,000	20,000	10,732,000	139,952
Sandstone.....	.....	158,344	.....	81,391
Other products.....	.....	.....	.....	148,704
	.....	6,662,673	.....	12,073,589

The mineral resources of this province include: coal, natural gas, alluvial gold, and clay and quarry products. Although petroleum has not yet been found in commercial quantities, its ultimate discovery seems to be confidently anticipated. The production of coal has increased very rapidly during the past few years, and it appears certain that Alberta will, in the very near future, be the largest coal producing province in Canada. Natural gas has been found over a wide area. In the north is an enormous area of tar sands, the commercial value of which has not been fully determined.

As in the other prairie provinces, the disposal of mining lands or leases is made by the Dominion government at Ottawa (see under North West Territories), while coal mining has been carried on under the conditions imposed by the "Provincial Coal Mines Regulation Act," 1906. This Act and all amendments thereto is repealed and superseded by "The Mines Act" of Alberta, assented to March 25, 1913, and to come into force August 1, 1913.

BRITISH COLUMBIA.

Area, 355,835 sq. miles. Population 1911, 392,480.

Mineral Production 1911 and 1912.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Copper.....Lbs.	35,279,558	4,366,198	50,526,656	8,256,561
Gold.....Ozs.	238,496	4,930,145	251,815	5,205,485
Lead.....Lbs.	23,784,969	827,717	35,763,476	1,597,554
Silver.....Ozs.	1,887,147	1,005,924	2,651,002	1,612,737
Zinc ore.....Tons	2,590	101,072	6,405	211,399
Coal..... "	2,542,532	7,945,413	3,208,997	10,028,116
Gypsum..... "	780	1,875	.....	.....
Mineral water.....	.....	3,500	.....	4,200
Cement.....Bls.	401,000	601,500	511,539	767,038
Clay products.....	.....	675,505	.....	996,568
Lime.....Bus.	351,014	117,756	517,329	181,905
Sand-lime brick.....No.	2,953,072	23,889	5,458,412	49,515
Stone.....	.....	698,811	.....	779,611
Other products.....	.....	.....	.....	385,946
	.....	21,299,305	.....	30,076,635

For many years British Columbia was the premier mining province of Canada, and was only displaced in so far as magnitude of output is concerned in 1907, when Ontario forged ahead. In a certain sense, this province is still of first importance owing to the fact that mining is probably its most important industry. Physiographically the province embraces a series of mountain ranges beginning at the Rocky Mountain range forming the eastern border, and extending to the Pacific coast, the principal features of which have already been described in the introductory chapter.

Coal and metalliferous ores including gold, silver, copper, lead and zinc, together with clays, building stone, and gypsum, constitute the chief mineral resources. Antimony, platinum, molybdenum, and mercury are also found.

With the exception of the placer gold mining of the Cariboo district, active productive mining operations are at present confined principally to the extreme southern portion of the province and to a district on Vancouver island, and on the coast. The chief centres of activity are the Crowsnest coal mines, the metalliferous mines of East and West Kootenay, of which Moyie, Ainsworth, Slocan, Sandon, Nelson, and Rossland are important centres, and the Boundary district, including Grand Forks, Phoenix, Greenwood and Hedley, Britannia bay and Texada island on the coast and Nan-

aimo and Comox on Vancouver island. The Portland Canal district has recently assumed considerable importance.

Much prospecting and development is being undertaken at many points on or near the coast, while the construction of the Grand Trunk Pacific railway will provide easy access to a number of districts in that portion of the interior which it traverses.

Important smelting industries have been established at Nelson, Trail, Grand Forks, Greenwood, in the southern interior, and at Ladysmith on the coast, the fuel for which is provided by the coal mines of Comox, the Crowsnest, or of Alberta. A new copper smelting plant will be in operation at Anyox or Granby bay, in December, 1913.

Mining locations are granted under the laws of the province to discoverers, for nominal fees, and absolute titles may be obtained by developing such properties. The mining laws include a "Placer Mining Act," "Mineral Act," "Inspection of Metalliferous Mines Act," "Coal Mines Act," "Coal Mines Regulation Act," etc., and full information respecting miners' certificates, the mining law and regulations, mining reports and maps, etc., may be obtained on application to the Provincial Mineralogist, Victoria, British Columbia.

YUKON DISTRICT.

Area, 207,076 sq. miles. Population 1911, 8,512.

Mineral Production 1911 and 1912.

Products.	1911		1912	
	Quantity.	Value.	Quantity.	Value.
		$		$
Copper.....Lbs.	.....	.....	1,772,660	289,670
Gold.....Ozs.	224,197	4,634,574	268,447	5,549,296
Silver..... "	112,708	60,078	81,068	49,318
Coal.....Tons	2,840	12,780	9,245	44,958
	.....	4,707,432	.....	5,933,242

This district, which geographically is a continuation of the great Rocky Mountain range extending northwesterly from the 60th degree of latitude, the northern boundary of British Columbia, to the 141st meridian, the Alaskan boundary, has already become famous on account of the Klondike gold fields, situated in the vicinity of Dawson, on the Yukon river. Placer gold is still the principal mineral product, although there is an increasing output of copper and silver ores and of coal. The district also possesses important coal fields. Gold ores and ores of copper, silver, lead, and antimony have been found widely distributed, and the region undoubtedly possesses enormous mining possibilities.

The Crown lands and mining rights are controlled by the Dominion government at Ottawa and disposed of or leased according to the regulations in force and referred to under North West Territories.

NORTH WEST TERRITORIES.

Area, 1,242,224 sq. miles. Population 1911, 17,196.

The North West Territories, as at present constituted, include all that northern portion of Canada above the 60th parallel of latitude, extending from Hudson bay on the east, to the Yukon district on the west, and including all of the northern Arctic islands that belong to Canada. It is practically unpopulated, except for a few Indians and fur traders.

Little is known of the country beyond what has been learned from a few explorations of some of the principal rivers. In respect to its mineral resources, the occurrence of coal in the Mackenzie basin and of native copper in the Coppermine River district has long been known. Alluvial gold has been found on many of the streams, while the occurrence of iron ores, mica, graphite, salt, and gypsum, have been noted. The northern part of North America and the great Arctic Archipelago to the north of this continent, contain large areas of the older rocks in which metalliferous and other minerals will no doubt eventually be developed, but in regard to which little is yet known.

As has already been explained, the ownership of Crown lands and mining rights in the North West Territories and the Yukon district, and in the provinces of Manitoba, Saskatchewan, and Alberta, are still retained under the control of the Dominion government at Ottawa. With the exception of the "Yukon Placer Mining Act" and amendments, no statutory mining law has been enacted by the Dominion government although a proposed general Act is at present under consideration. The disposal of mining lands or leases is made under the "Yukon Placer Mining Act" above mentioned, and under regulations provided and approved by Order in Council.

Following is a list of the regulations in force at this date (May, 1913);—

Statutory Act.

"Yukon Placer Mining Act" and amendments.

Regulations approved by Order in Council:—

Dredging regulations, Yukon Territory.

Regulations governing the issue of leases to dredge for minerals in the submerged beds of rivers in Manitoba, Saskatchewan, Alberta and the North West Territories, excepting rivers in the Yukon Territory.

Regulations for the disposal of quartz mining claims.

These regulations shall be applicable to all minerals defined as such on Dominion Lands, situated elsewhere than in the province of British Columbia.

Coal Mining Regulations:—

Regulations for the disposal of coal mining rights, which are the property of the Crown in the provinces of Manitoba, Saskatchewan and Alberta, the Yukon Territory, the North West Territories, the Railway Belt in the province of British Columbia, and within the tract containing three and one-half ($3\frac{1}{2}$) million acres acquired by the Dominion government from the province of British Columbia, and referred to in Sub-section (b) of Section 3 of the "Dominion Lands Act."

Regulations for the issue of permits to mine coal on Dominion Lands for domestic purposes only.

Regulations for the disposal of petroleum and natural gas rights, the property of the Crown in Manitoba, Saskatchewan, Alberta, the North West Territories, the Yukon Territory, the Railway Belt in the province of British Columbia, and within the tract containing three and one-half ($3\frac{1}{2}$) million acres of land acquired by the Dominion government from the province of British Columbia, and referred to in Sub-section (b) of Section 3 of the "Dominion Lands Act."

Regulations for the leasing and administration of lands containing limestone, granite, slate, marble, gypsum, marl, gravel, sand, clay, or any building stone, in the provinces of Manitoba, Saskatchewan, and Alberta, the North West Territories, the Railway Belt of British Columbia and Dominion Forest Reserves and Parks, etc.

Regulations governing the issue of permits to remove sand, stone, and gravel, the property of the Crown, from the beds of rivers and lakes in Manitoba, Saskatchewan, Alberta, the North West Territories, and within the Railway Belt in the province of British Columbia.

Full information regarding Dominion mining laws and regulations may be obtained from the Controller, Yukon and Mining Lands Branch, Department of the Interior, Ottawa, or from any Dominion Lands Agent.

Summary of the Mineral Production by Provinces in 1912.

Province.	Metallic.	Non-metallic, except clay and stone quarry products, etc.	Clay and stone quarry products and other structural materials.	Total.
	$	$	$	$
Nova Scotia	259,515	17,867,212	795,509	18,922,236
New Brunswick	127,716	364,059	279,229	771,004
Quebec	559,606	3,598,070	7,499,322	11,656,998
Ontario	37,452,387	3,921,243	10,612,246	51,985,876
Manitoba		481,250	1,981,824	2,463,074
Saskatchewan		368,135	797,507	1,165,642
Alberta	1,509	8,403,431	3,668,649	12,073,589
British Columbia	16,883,736	10,032,316	3,160,583	30,076,635
Yukon	5,888,284	44,958	.....	5,933,242
	61,172,753	45,080,674	28,794,869	135,048,296

Annual Mineral Production in Canada since 1886.

Year.	Value of production.	Value per capita.	Year.	Value of production.	Value per capita.
	$	$ c.		$	$ c.
1886..	10,221,255	2.23	1900..	64,420,877	12 04
1887 ..	10,321,331	2 23	1901..	65,797,911	12 16
1888 ..	12,518,894	2 67	1902..	63,231,836	11 36
1889 ..	14,013,113	2 96	1903..	61,740,513	10 83
1890 ..	16,763,353	3 50	1904..	60,082,771	10 27
1891 ..	18,976,616	3 92	1905..	69,078,999	11 49
1892 ..	16,623,415	3 39	1906..	79,286,697	12 81
1893 ..	20,035,082	4 04	1907..	86,865,202	13 75
1894 ..	19,931,158	3 98	1908..	85,557,101	13 16
1895 ..	20,505,917	4 05	1909..	91,831,441	13 70
1896 ..	22,474,256	4 38	1910..	106,823,623	14 93
1897 ..	28,485,023	5 49	1911..	103,220,994	14 42
1898 ..	38,412,431	7 32	1912..	135,048,296	18 27
1899 ..	49,234,005	9 27			

Bounties on Mineral Production.

The Dominion government at the present time offers bounties on the production of petroleum and lead.

The bounty paid on petroleum is at the rate of 1½ cents per imperial gallon on crude petroleum produced from wells in Canada, and the bounty is payable under the conditions and regulations provided in the "Petroleum Bounty Act."

The "Lead Bounty Act" of 1908 provided for the payment of a bounty on lead contained in lead ores mined in Canada and shipped to a Canadian smelter, at the rate of 75 cents per hundred pounds or approximately £3 10s per ton of 2,240 lbs., subject to the restriction, that when the price of lead in London exceeds £14, the bounty shall be reduced by such excess. This Act has been renewed in 1913 for a further period of five years. The bounty is payable subject to the terms of the Act and of the regulations provided thereunder.

Bounties were formerly paid on the production of iron and steel, but these expired automatically in 1912 and have not been renewed.

Reference has already been made in the remarks under Ontario to the bounty offered by the Ontario government on the production of cobalt nickel, copper and arsenic.

The administration of the Dominion Bounty Acts is under the direction of the Minister of Trade and Commerce, and full information in respect thereto may be had from the Deputy Minister of Trade and Commerce, Ottawa.

Ore and Fuel Testing Plants.

The Mines Branch of the Department of Mines has installed, at Ottawa, a modern and well equipped laboratory—The Dominion of Canada Ore Dressing and Metallurgical Laboratory—for the purpose of experimental concentration and metallurgical tests with Canadian ores and minerals.

There are also ore testing plants at the principal mining schools in Canada, including the Nova Scotia Technical School, Halifax, N.S.; the University of McGill, Montreal; Kingston School of Mines, Queen's University, Kingston; and the University of Toronto, Toronto, Ont.

A fuel testing station has been established by the Mines Branch at Ottawa, the Dominion of Canada Fuel Testing Plant, to demonstrate that peat could be economically utilized as a fuel for power purposes in a producer gas power plant, and to test the fuel and power producing values—on a commercial scale and in a commercial gas producer—of the bituminous coals of the extreme eastern and western provinces and of the lignites of Manitoba, Alberta, and Saskatchewan.

A plant is also about to be erected by the Government of the province of Saskatchewan at Estevan, for the purpose of assisting the development of the coal mining industry by testing the lignite coal of that district.

CANADA
DEPARTMENT OF MINES
MINES BRANCH
HON. LOUIS CODERRE, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
EUGENE HAANEL, PH.D., DIRECTOR.

MINERAL MAP OF CANADA

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