CANADA
DEPARTMENT OF MINES
HON. W. A. GORDON, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY
W. H. COLLINS, DIRECTOR

ECONOMIC GEOLOGY SERIES
No. 8

Zinc and Lead Deposits of Canada

BY

F. J. Alcock

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1930

Price, 75 cents

No. 2229

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PREFACE

This account of the lead and zinc deposits of Canada is based on such information as was available before the close of 1928. Most of the deposits mentioned can never be sources of zinc or lead, but the available information regarding them is, in many cases, more detailed or more nearly complete than in the case of important sources of the metals. The information regarding individual deposits, as herein presented, is, therefore, very unequal and this is particularly so in the case of the deposits of British Columbia. In that province there are hundreds of claims on which zinc and lead minerals occur and to treat them in the same way as the occurrences of eastern Canada was not found possible under existing conditions.

Zinc and Lead Deposits of Canada

CHAPTER I

INTRODUCTION

HISTORICAL SKETCH

Lead has been known from the beginning of history. The use of zinc, on the other hand, is of comparatively recent date. That zinc was known in ancient times is proved by a zinc idol discovered in a prehistoric settlement at Dordosch, Transylvania, and by two bracelets filled with zinc found in the ruins of Cameros, which was destroyed, 500 B.C., but probably such knowledge was only local. An alloy of zinc, brass, was known to the ancients, but they were unaware that it contained any other metal besides copper. Aristotle in the fourth century B.C. mentions the preparation of what was apparently brass under the name of Mossinœcian copper, which he describes as being bright and light coloured, not produced by the addition of tin but by being melted with a peculiar earth found on the shores of the Black sea. There is no evidence, however, of the common use of brass until the days of the Roman empire. In the time of Augustus the Romans discovered that by melting copper with a certain ore, smithsonite, a yellow alloy of a more golden colour than bronze could be obtained, and from then on brass was regularly used in making Roman coins.

The Chinese are credited with having been acquainted with lead as early as 2000 B.C. and with having used flattened pieces of it as money. They also used it for debasing more valuable coinage. Pliny, however, states that lead was discovered by Midas, King of Phrygia in Asia Minor, a rather legendary monarch who lived over a thousand years B.C. Lead is mentioned in the Old Testament. After the destruction of the Midianites (Numbers XXXI) Moses commanded the Israelites to purify lead and other metals by fire. No exact distinction was made between lead and tin, so it is uncertain which is really meant in some of the ancient writings. The ancients worked silver-lead ores in Assyria, Chaldea, Phoenicia, Arabia, Persia, India, China, Tunis, and Algeria. The Phoenicians worked lead mines in the sixteenth century B.C., in Cyprus and Thasos.

The uses of lead were numerous. Reference has been made to its use in coins by the Chinese. The Egyptians employed it for glazing pottery, for making solder, and for making amulets and other articles. The Phoenicians used it for filling wooden anchors. In India it was used as a charm and for making weaver's weights; red lead was used as a cosmetic and for medicinal purposes. Lead pipes were used in Asia. Lead was used in the manufacture of many ancient bronzes. White lead was used as an ointment by the Egyptians.

In Europe, the mining of lead began at an early date. It is thought that the Laurium deposits in Greece were worked as early as the Trojan wars, or about 1200 B.C. During the sixth and fifth centuries B.C. they were worked on a considerable scale, and to a lesser extent down to the beginning of the present era. Many uses were made of the metal. The bronze coins from 500 B.C. to 50 B.C. contain from 3 to 30 per cent of lead. It was used for making such objects as ornaments, weights, and bullets for slings, and it was also made into pipes. White lead, probably a mixture of the carbonate and acetate, was manufactured in Rhodes, at Corinth, and in Lacedomonia for use as an ointment or cosmetic.

In Spain lead and other ores were mined by the Phoenicians or by the natives with whom they traded. The former also mined or encouraged the mining of lead in Sardinia and probably also in northern Spain, in France, and in Sicily. Later, their successors, the Carthaginians, engaged in mining in these countries. They were in turn succeeded by the Romans, who mined lead on a large scale in Spain, Sardinia, and Africa. The Romans used the metal for much the same purposes as the Greeks, in masonry, in hoops for casks, for buckets, and even kettles, for vases and coffins. Water-pipes, some with a diameter as much as 30 inches, were used extensively. After the Roman period mining languished for centuries.

During the Middle Ages, lead ores were mined at many places in Europe. In France, for the first time since the days of the Romans, lead mining was resumed during the time of Charlemagne, about 800 A.D. The Moors operated lead mines in the French Pyrenees and in different parts of Spain. In Germany, the earliest known lead mine was in the Harz mountains in the tenth century. In the twelfth century mining at Freiberg in Saxony began. In Silesia the production of lead in the thirteenth century was an important industry. There was a decline after this for a couple of hundred years, but in the fifteenth and sixteenth centuries, the properties were reopened and there has been a continuous production ever since. Zinc and lead ores were mined in Belgium from early times. In Hungary lead mining was begun at Pribram in the ninth century and at Mies before the year 1100. In Russia, the lead deposits in the province of Irkutsk were found in 1691. In Poland large quantities of lead ore were mined in the sixteenth and seventeenth centuries. The lead deposits of Sala in Sweden are reported to have been worked as early as the sixth century and were certainly worked by 1280.

In Great Britain it is possible that some of the deposits of Cardiganshire and other counties were worked by the ancient Britons; the Romans, however, certainly conducted operations on a considerable scale. Waste and slag heaps, old furnace remains, coins, tools, etc., are found in North Wales, Northumberland, Durham, Cumberland, Yorkshire, Flintshire, Somersetshire, and the Isle of Man. With the withdrawal of the Romans, the industry waned, though several mines in Derbyshire were operated by the Saxons and Danes before the Norman conquest. The deposits in Cardiganshire were extensively worked during the reign of Elizabeth. In general, during the sixteenth, seventeenth, and eighteenth centuries lead mining was of great importance in England and large amounts were produced and exported.

The word zinc appears to have been first used by Basil Valentine in the fifteenth century, but he does not refer to it especially as a metal nor does he appear to have been acquainted with its properties. Paracelsus (1493-1541) mentions it several times and discusses some of its properties. Agricolla in his " De Re Metallica," 1556, describes the metal but makes no mention of the method of extracting it from its ores. Who first isolated it as a metal is not known but probably it was first produced in the east. In the sixteenth and seventeenth centuries zinc was imported into Europe from East India and China.

The production of zinc in Europe on a commercial scale was first begun in 1740 near Bristol, England. It is stated that the method employed was Chinese, introduced by Dr. Isaac Lawson who had some years previously journeyed to China in order to study the process. Towards the end of the century, Johann Rubberg of Pless, Silesia, visited England, learned the art, and later returned to his native country to found its zinc-smelting industry. Early in the nineteenth century a Belgium process resulted from experiments carried out by Abbé Dory, and the first zinc works of Belgium were established about 1809 at Liège. It was not until about 1820, however, that the industry became well established.

Lead ore was mined in South America before the coming of the Spaniards. Articles of lead have been found in the graves of the native Peruvians. The silver-lead mines of Peru were worked by the Portuguese, and after 1630 operations were carried out on a considerable scale. In Bolivia the silver mines were discovered in 1545 and were worked from then into the seventeenth century. In Chile lead mining operations began about the beginning of the eighteenth century.

In North America the earliest lead mining took place in Mexico. Silver and lead deposits were worked by the Aztecs. The Spaniards worked mines as early as 1520, but the most active period was around 1700.

In the United States lead was mined in a few places before the days of the Revolution. The extensive Missouri deposits were opened about 1720 and have given a continuous production ever since. The deposits of the upper Mississippi valley were not developed until near the close of the eighteenth century. The discovery of the lead and silver ores of the western states, Utah, Nevada, Montana, Colorado, and Idaho, dates from the period of 1860 onward.

Zinc ores occur with those of lead in many parts of the United States, but in the early days of mining they do not seem to have been recognized. The first reference to them in the Mississippi valley is in 1810. The zinc deposits of New Jersey were discovered in 1820.

The first production of zinc in the United States was at the arsenal at Washington in 1838, the ore being zincite from New Jersey. The process, however, did not prove to be a commercial success. The New Jersey Zinc Company was organized in 1848 with works at Newark where zinc white was manufactured. In 1860 works at Bethlehem, Pennsylvania, were erected by the Lehigh Zinc Company. In the upper Mississippi valley the zinc industry began in 1860 with the erection of works at Mineral Point and at La Salle, Illinois. In Missouri, the first zinc plant was erected in 1867 at Potosi and others were built shortly after. The plants at Joplin were not erected until after 1883.

In Canada the production of lead is much older than that of zinc. East and West Kootenay districts have always been the greatest producers. As early as the eighteen-twenties, Indians and Hudson's Bay Company's trappers had discovered an outcrop of lead ore on the site of the present Blue Bell mine on the east shore of Kootenay lake, but it was not until 1865 that active prospecting for lode deposits began. In the early nineties the activity of the silver-lead-zinc region of the Slocan reached its culmination and a continuous production has been maintained down to the present time.

In the early days smelting and refining of Canadian ores was carried out by lead smelters in the United States. Then followed a period in which the Hall Mines smelter at Nelson, which is now no longer operating, and the Canadian Smelting Works at Trail treated the ore from this region, sending the base bullion for refinement to the United States. In 1903 electrolytic refining of lead was undertaken for the first time by the plant at Trail. At this time the chief lead-producing property was the St. Eugene mine at Moyie. In 1906 this mine and the Canadian Smelting Works at Trail were taken over by the Consolidated Mining and Smelting Company of Canada, Limited. In 1910 the same company acquired the Sullivan mine at Kimberley, which, in 1914, became the largest producer of lead in Canada, a position it has maintained to the present.

The Consolidated Mining and Smelting Company not only treat at Trail the ores from their own properties, but also maintain there a flotation plant with a capacity of 600 tons per day to treat custom ores from other properties. In 1926, ores from as many as one hundred properties in widely separated parts of British Columbia were treated.

In eastern Canada the chief producer of lead at the present time is the Kingdon mine at Galetta. This was discovered about forty years ago and some work was done in 1884 and 1885 by James Robertson. It then lay idle until 1914 when the Robertson estate resumed operations. It has been a steady producer ever since. The Tetreault zinc mine at Notre-Dame-des-Anges, Quebec, also produces lead concentrates.

The zinc industry in Canada has been of comparatively recent development. Nearly all the silver-lead ores of British Columbia carry more or less zinc, but since its presence was detrimental to the recovery of the silver and lead in blast furnaces, the ores were heavily penalized for their zinc content. In 1916, as a result of the demand for zinc during the war, the Consolidated Mining and Smelting Company of Canada undertook to prepare zinc electrolytically. The process was perfected and now zinc concentrates from the Sullivan and other properties are treated at their plant at Trail, British Columbia. At several places old mill tailings are now being treated by flotation for their zinc content, as for example at the St. Eugene mine at Moyie and the Whitewater near Kaslo. In eastern Canada the Tetreault property, discovered in

1910, maintains a steady production. Other properties such as those at Calumet island, Quebec, and Long lake, Ontario, have made small shipments of ore, but are idle at present.

USES

Zinc

The most important use of zinc is in galvanizing, a process consisting in depositing a thin coat of the metal on iron in order to prevent rusting. The second most important use is in the manufacture of alloys, particularly brass. Rolled sheet zinc employed for a variety of purposes, such as roofing, etc., consumes the next largest amount of the zinc produced; the desilverization of lead bullion, castings, and other miscellaneous uses account for the remainder of the consumption.

The alloys of zinc are numerous and include: (1) those consisting of zinc and copper, which form the different types of brass; (2) those of copper, zinc, and nickel, forming the "German" or "nickel silvers"; (3) those of zinc with tin and other metals, known as the "anti-friction metals"; (4) those of zinc with aluminium for purposes where strength and lightness are required. Zinc also forms useful alloys with iron and with silver, and is also added in small quantities to certain alloys such as some of the bronzes in order to increase their wearing power.

Zinc dust, a by-product from the distillation process, is commonly sold under the name of "Blue Powder". It is used as a reducing agent in organic chemistry, particularly in the manufacture of aniline dyes, the preparation of indigo and of hydrogen, and in the distillation industries. It is also used for the recovery of gold and silver from cyanide solution.

The most important compound of zinc is zinc oxide, largely used as a pigment under the name zinc white. It serves as a substitute for white lead. Considerable quantities are also used in the rubber manufacturing industry.

Lithopone, consisting of a mixture of zinc sulphide and barium sulphate, is used as a pigment, and as a filler for rubber goods, linoleum, enamel paints, and table oilcloth.

Zinc is also used in the form of numerous salts such as the chloride, used as a wood preservative, and the sulphate employed in medicine and in dye and glue manufacture.

Lead

Lead, like zinc, is used in the form of the metal, as alloys with other metals, and in compounds. The metal is used extensively as sheeting and as piping for water and corrosive solutions. Sheet lead is used as plates for storage batteries, as a protective covering for electric cables, and as a lining for sinks, acid chambers, and vats for chemical manufacturing processes, etc.

Lead is used in a large number of alloys. Those of most importance include type metal, bearing metal, shot, solders, casting metals, certain brasses, and fusible alloys used for the protection of electrical apparatus and in automatic sprinklers for protecting buildings against fire. These alloys have a considerable range in composition. The presence of tin in lead alloys has the effect of hardening the lead without increasing its brittleness or altering its malleability. The presence of antimony imparts hardness, but renders the product brittle, so that where the content exceeds 24 per cent, a third metal, commonly tin, is used to counteract this effect. Battery plates commonly contain 94 per cent lead and 6 per cent antimony; engraving plates 60 per cent lead and 40 per cent antimony with usually a little tin; type metal 82 per cent lead, 15 per cent antimony, and 3 per cent tin; and bullets 6 per cent antimony with small amounts of arsenic. Bearing metals consist of lead and antimony with or without the addition of copper, tin, or zinc. Solder is commonly an alloy of tin and lead, but sometimes other metals are added. Besides solder, lead-tin alloys are used for pewter, toys, and organ pipes. Fusible alloys for electric circuits and automatic sprinklers are composed of lead, tin, cadmium, and bismuth in various proportions. The presence of these other metals with lead lowers the melting point below the boiling point of water.

The chief uses of lead compounds are for the manufacture of pigments, of which the most important is white lead, with red lead ranking second. Others include lead chromes, orange lead, and several of minor importance.

White lead is a basic lead carbonate $2(PbCO_3)Pb(OH)_2$. It is used either alone or mixed with zinc oxide and barites. Red lead (Pb_3O_4) is used for painting structural steel, as a pipe-joint cement, and in making glass. Litharge (PbO) is used in assaying as a flux, in rubber manufacture, and in making glass. The carbonate, acetate, and other compounds of lead are used in medicine.

The use of lead has steadily increased during the past few years. The manufacture of storage batteries for automobiles has been the main factor causing this increase, and greater demands have also been made by the cable business, the building industry, and the paint trade.

MINERALS

Neither zinc nor lead is mined as the metal, since both oxidize and also combine with other substances common in the earth's crust. Both occur in a large number of minerals which are listed in the succeeding chapter, but the important ores are few. Of the lead ores the three most important are galena, cerussite, and anglesite. Galena is lead sulphide, containing 86·6 per cent lead and 13·4 sulphur. In many cases it bears silver and is commonly mined for its content of that metal. It is much the most important ore of lead. Cerussite, also known as white lead ore or carbonate ore, contains 77·5 per cent lead and 22·5 per cent carbon dioxide and oxygen. It is formed by carbonated waters acting on galena and other lead compounds. Anglesite is the sulphate of lead. It contains 68·31 per cent lead and is formed by the oxidation of galena.

The chief zinc minerals are sphalerite, smithsonite, calamine, franklinite, zincite, and willemite. Sphalerite, which is the most important, is also known as blende, and when it contains a considerable impurity of iron, as black jack. Its composition is zinc sulphide, containing 67 per cent zinc and 33 per cent sulphur. Smithsonite is zinc carbonate and contains 51·9 per cent zinc. It is formed by the action of carbonated waters on other zinc minerals. Calamine is hydrated zinc silicate and contains 54·2 per cent zinc. Franklinite is an oxide of iron, manganese, and zinc and contains from 16 to 20 per cent zinc. Zincite is zinc oxide containing 80·3 per cent zinc. Willemite is zinc silicate containing 58·5 per cent zinc.

PRICES

Zinc

The price of zinc during the past fifteen years has varied from 5 cents a pound to over 21 cents a pound. It reached a peak in 1915 owing to the great demand for war materials, the average price for June of that year being 20·038 cents with an average price for the year of 13·054 cents. In succeeding years, the price fluctuated greatly depending on the supply and demand and reached its lowest level in 1921 when the average price was 4·655 cents a pound. From 1923 to 1928 it averaged over 6 cents.

Lead

From 1900 to 1913 the price of lead varied from 3·5 cents a pound to 6·35, the average of the period being 4·55 per pound. With the war came a new demand for lead along with other metals. A high was reached in 1917, when the average price at Montreal for June was 14·62 cents, with an average for the year of 11·137 cents. In succeeding years the price fluctuated greatly, reaching a low during the period of industrial depression in 1921, when the average price at Montreal for the year was 5·81 cents.

PRODUCTION

Within recent years Canada has taken an important place among the world's producers of zinc and lead. In 1927 it ranked fourth as a lead producer, being exceeded by United States, Mexico, and Australia; and sixth as a zinc producer, being exceeded by United States, Belgium, Upper Silesia, Germany, and France. This increased production of the two metals is largely due to the Consolidated Mining and Smelting Company of Canada which perfected at its smelter at Trail a process for treating the complex zinc-lead ores of its Sullivan property at Kimberley, and which also provided a custom mill that has enabled a large number of smaller properties of the Slocan and other mining districts of British Columbia to get their ores treated. The silver-lead ores of Mayo district, Yukon, supply the remainder of the lead production of western Canada outside of British Columbia. In eastern Canada the Kingdon mine at Galetta, Ontario, has maintained a steady production of lead since 1914; at the lower levels zinc ore also occurs; zinc concentrates are separated and stored until a sufficient supply is obtained to make an export shipment. Small quantities of lead are recovered from the silver-lead-bismuth bullion exported by the Ontario smelters that handle the ores of Cobalt region. The Tetreault mine at Notre-Dame-des-Anges, Quebec, is a source of zinc and some lead.

Statistics for the production of zinc and lead in Canada are given in Chapter VII.

CHAPTER II

MINERALOGY OF ZINC AND LEAD

ZINC

GENERAL

There are very few primary zinc ore minerals. By far the most important is the sulphide, sphalerite or zinc blende. It is almost always present in greater or lesser amounts in sulphide ores the world over and occurs in deposits ranging in origin from those formed under conditions of high temperature to those formed practically at the surface. Wurtzite, which has the same composition but which crystallizes in the hexagonal system, is rare and its primary origin is doubtful. The oxides zincite and franklinite, the silicates willemite and troostite, with several rarer silicate varieties, are confined practically entirely to the deposits at Franklin Furnace, New Jersey. Gahnite, or zinc spinel, in some cases is present in deposits formed under conditions of high temperature, but is of no economic importance.

The common secondary ore minerals formed by the oxidation of primary ones by the action of surface solutions include: smithsonite, the carbonate; calamine, the silicate; and hydrozincite, an hydrated zinc carbonate. Willemite is also probably formed during oxidation. Various other arsenates, vanadates, sulphates, and carbonates are less common.

SOLUBILITIES OF ZINC COMPOUNDS

The solubilities of four zinc salts as determined by Kohlrausch are given below. The upper number in each column represents the number of grammes of the anhydrous salt held in solution in a litre of water at a temperature of 18 degrees C.; the lower number shows the molar solubility or the number of mols[1] contained in a litre of the saturated solution.

Table of Solubility

Zinc Salts

$ZnSO_4$	$ZnCl_2$	$ZnCO_3$	$Zn(NO_3)_2$
531·2 3·1	2·039 9·2	0·04? *0·0003?	1·178 4·7

Lead Salts

$PbSO_4$	$PbCl_2$	$PbCO_3$	$Pb(NO_3)_2$
0·041 0·00013	14·9 0·05	0·001 0·00003	516·6 1·4

*R. C. Wells gives 0·00017 (U.S. Geol. Surv., Bull. 540, p. 107).

[1]The number of mols is the weight, in grammes, of dissolved salt, divided by the molecular weight of the salt.

This table shows how readily zinc sulphate, chloride, and nitrate are soluble; the carbonate is more soluble than the carbonate of lead. A litre of pure water dissolves at ordinary temperature and pressure 0·0000706 mol of freshly precipitated zinc sulphide. The solution of zinc sulphide is, however, slow, and much less important than as zinc sulphate. The latter may form from the sulphide by the action of sulphuric acid produced by the oxidation of pyrite or other iron sulphides and is more readily formed in the presence of ferric sulphate. Where pyrite is not present in deposits, zinc blende oxidizes more slowly. The chloride of zinc is even more soluble than the sulphate and its solid phase is not known in ore deposits.

The tendency of sphalerite to oxidize in the presence of pyrite, and the solubility of the resulting ferric sulphate explains why zinc blende is commonly leached out at the surface of sulphide deposits, whereas the galena or lead sulphide remains either only slightly affected or oxidized to anglesite and cerussite.

CLASSIFICATION OF ZINC MINERALS

I. Native element
    Zinc (?)
II. Sulphides
    Sphalerite (including varieties, marmatite and pribramite), guadalcazarite, wurtzite
III. Sulpho-salts
    None
IV. Haloids
    Zinc iodide (?); zinc bromide (?)
V. Oxides
    Zincite, gahnite, automolite, dysluite, kreittonite, franklinite, hetærolite
VI. Oxygen salts
    (1) Carbonates
        Smithsonite, monheimite, hydrozincite, aurichalcite
    (2) Silicates
        Willemite, troostite, calamine, clinohedrite, hardystonite, leucophoenicite, rœpperite, jeffersonite, schefferite
    (3) Niobates, tantalates
        None
    (4) Phosphates, vanadates
        Hopeite, tarbuttite, descloizite, adamite
    (5) Borates, uranates
        Sussexite
    (6) Sulphates, chromates, tellurates
        Zinkosite, goslarite
    (7) Tungstates and molybdates
        None
VII. Salts of organic acids
    None

CHARACTER AND OCCURRENCE OF ZINC MINERALS

Zinc. Zinc in the form of hexagonal prisms with tapering pyramids, strongly striated horizontally, has been prepared artificially. Native zinc has been reported from near Melbourne, Australia; from northeastern Alabama and with sphalerite from Shasta county, California. Its existence in each case, however, needs confirmation.

Sphalerite. Sphalerite (ZnS) is much the most abundant zinc mineral and is very widespread. It is commonly known as zinc blende or simply blende and its dark-coloured variety is frequently referred to as black jack. It crystallizes in the tetrahedral group of the isometric system and in many cases occurs as tetrahedrons. It is, however, more commonly massive, cleavable, or coarse to fine granular and compact. The cleavage is dodecahedral and highly perfect. The hardness varies from 3·5 to 4 and the specific gravity from 3·9 to 4·1. The lustre is resinous to adamantine and the streak brown to white. The colour shows a great range, from almost colourless through shades of light and honey yellow to dark brown and black.

Sphalerite is formed under a wide range of conditions. Large masses occur as contact metamorphic deposits and in veins formed at great or moderate depths. It also forms deposits precipitated from cold solutions in regions remote from igneous rocks.

Marmatite is a variety of zinc blende containing 10 per cent or more of iron. It is commonly dense, massive, varying in colour from dark brown to black. The zinc ore of the Sullivan and some other important properties of Canada consists of this variety. The presence of iron is a detriment to the ore and long presented metallurgical difficulties.

Pribramite is a green or yellow variety containing cadmium. The amount of the latter is not known to exceed 5 per cent.

Guadalcazarite. Guadalcazarite (Hg, Zn)S is a sulphide of mercury, but containing zinc up to 4 per cent. It occurs massive with cinnabar, barite, and quartz at Guadalcazar, Mexico.

Wurtzite. Wurtzite (ZnS) has the same composition as sphalerite, but when crystallized forms hemimorphic hexagonal crystals. It is brownish black and has a specific gravity of 3·98. When sphalerite is heated to about 1100 degrees and cooled to 100 degrees inside of two hours, microscopic examination shows that it is completely transformed into wurtzite. Of the two minerals, sphalerite is stable below 1020 degrees and wurtzite is stable above 1020 degrees.

Zinc Iodide-Zinc Bromide. Iodine and bromine are stated by Mentzel to occur with a cadmium-bearing zinc in Silesia and on that account it is inferred that iodide and bromide of zinc exist in nature, though they have not yet been distinguished.

Zincite. Zincite (ZnO) or red oxide of zinc, is a deep red or orange-yellow mineral with a hardness of 4 to 4·5 and a specific gravity of 5·43 to 5·7. Its crystallization form is hexagonal-hemimorphic, but natural crystals are rare, the usual form being foliated, massive, or in coarse particles and grains. It is associated with willemite and franklinite at Franklin Furnace, New Jersey, and at Sterling Hill near Ogdensburg, New Jersey. It is a primary mineral, occurring in vein-like masses, formed under conditions of high temperature.

Gahnite. Gahnite ($ZnAl_2O_4$) or zinc-spinel is a primary mineral formed under conditions of high temperature, but is of no economic importance. It is commonly dark green and its crystal habit is octahedral, in many cases with faces striated. It has been reported from Renfrew county, Ontario, as dark green crystals lining cavities in hair brown corundum.

Automolite ($ZnAl_2O_4$), or zinc gahnite, contains sometimes a little iron; *dysluite* (Zn, Fe, Mn)O. (Al, Fe) $_2O_3$, and *kreittonite.* ((Zn, Fe, Mg)O. (Al, Fe) $_2O_3$), are varieties of gahnite.

Franklinite. Franklinite (Fe, Zn, Mn)O. (Fe, Mn)$_2O_3$, the oxide of iron, zinc, and manganese, is an iron-black mineral with a hardness of 5·5 to 6·5 and specific gravity of 5·07 to 5·22. It crystallizes in the isometric system, commonly as octahedrons, and also occurs massive and granular. It occurs abundantly at Mine Hill, Franklin Furnace, New Jersey, with willemite and zincite in granular limestone and at Sterling Hill, 2 miles distant, associated with willemite. It has been reported in Ontario in Hastings county from Tenney's farm, 2 miles from Madoc village.

Hetærolite. (ZnO. $Mn_2O_3H_2O$) occurs as radiated fibrous coatings with botryoidal surface. Its colour is dark brown. It is intimately associated with chalcophanite at the Passaic zinc deposit of Sterling Hill, New Jersey. It is not known elsewhere.

Smithsonite. Smithsonite ($ZnCO_3$), the carbonate of zinc, is rhombohedral in crystallization. It is rarely well crystallized but more often occurs uniform, botryoidal or stalactitic, and in crystalline encrustations. Its colour varies from white, grey, greenish, brownish white to green, blue, and brown. Smithsonite is commonly formed in the oxidized zones of zinc-bearing veins, and is most abundant in deposits that occur in limestone. It is commonly precipitated where zinc sulphate waters attack limestone. Calcium sulphate is formed at the same time, but is more soluble and either goes in solution or is deposited with the smithsonite as gypsum. Smithsonite produced in this manner forms valuable secondary zinc deposits in limestone wall-rock surrounding partly oxidized lead ore, as at Tintic, Utah; Leadville, Colorado; and in other districts.

Monheimite. Monheimite $(Zn,Fe)CO_3$, the zinc-iron carbonate, is also a secondary mineral formed in the same manner as smithsonite and commonly associated with it in limestone. It is usually yellowish brown and rarely well crystallized. It is common at Leadville, Colorado; Tintic, Utah; and Kelly, New Mexico; and in the F.M.D. mine in Jefferson county, Colorado, with secondary pyrite it coats fractures in an amphibolite schist.

Hydrozincite. Hydrozincite ($ZnCO_3.2Zn(OH)_2$), the hydrous form of smithsonite, occurs as thin white coatings on smithsonite near the surface. It is always secondary.

Aurichalcite. Aurichalcite ($2(Zn,Cu)CO_3.3(Zn,Cu)\ (OH)_2$), a basic carbonate of zinc and copper, is a pale green to sky-blue mineral occurring as drusy encrustations, commonly in the form of rosettes and fan-like groups of pearly lustre. It is always secondary, being deposited by cold descending solutions.

Willemite. Willemite (Zn_2SiO_4) crystallizes in hexagonal prisms and also occurs massive and in disseminated grains. Its colour varies from white and greenish yellow to apple green, flesh-red, and yellowish brown, often dark brown when impure. Its streak is uncoloured, its hardness is 5·5, and specific gravity 3·89 to 4·18. It is abundant in the primary ores of Franklin Furnace, New Jersey. It has rarely been reported as a secondary mineral. It occurs as such, however, at Morenci, Arizona, and at Tres Hermanas, New Mexico, it is found in considerable quantities formed apparently from sphalerite by oxidation.

Troostite. Troostite is a variety of willemite in which manganese replaces a part of the zinc. It occurs at Franklin Furnace in large reddish crystals.

Calamine. Calamine ($Zn_2 H_2SiO_5$), the hydrated zinc silicate, is much more abundant than willemite. It is commonly associated with smithsonite in the oxidized zones of zinc deposits. It is not known to occur as a primary mineral deposited from hot solutions. Calamine is a white mineral, in some cases with a bluish or greenish shade, in others yellowish to brown. It crystallizes in the orthorhombic system, the crystals usually implanted, showing one extremity only. Its hardness is 4·5 to 5 and specific gravity 3·40 to 3·50. Its lustre is vitreous, and its streak white. Calamine occurs in the oxidized zones of many of the sulphate deposits of the western United States. It has been reported in small quantities at the Skyline claim in Ainsworth district, British Columbia, and at the Hudson Bay mine, Sheep creek, in Nelson mining division.

Clinohedrite. Clinohedrite (H_2 Ca Zn SiO_4) crystallizes in the monoclinic system. It forms complex crystals and also occurs massive and granular. It is white to pale amethystine and is found associated with garnet, willemite, and hancockite in the Parker shaft at Franklin Furnace, New Jersey.

Hardystonite. Hardystonite (Ca_2 Zn Si_2O_7) crystallizes in the tetragonal system. It is commonly massive, granular, and coarse columnar. Its only known occurrence is near the Parker shaft, Franklin Furnace, New Jersey.

Leucophœnicite. Leucophœnicite (H_2(Mn, Zn, Ca)$_7$ Si_3O_4) occurs as grains and minute crystals of a purplish red colour at the Parker shaft, Franklin Furnace, New Jersey.

Rœpperite. Rœpperite ((Fe, Mn, Zn, Mg)$_2SiO_4$) is a zinc-bearing variety of tephroite. It is a flesh-red to ash-grey mineral found at Sterling Hill and Franklin Furnace, New Jersey.

Jeffersonite. Jeffersonite ((Ca, Mg) (Fe, Mn, Zn) (SiO_3)$_2$) is a zinc-bearing monoclinic pyroxene occurring as well-formed dull crystals and also massive granular. Its colour is dark green to black. It occurs in large crystals at Sterling Hill, New Jersey, whereas at Franklin Furnace it is more commonly massive. It is very abundant at these places wherever granite intrusions are found in the ore-bodies, both in the granite and the limestone or ore.

Schefferite. Zinc schefferite is a term applied to a coarse granular or foliated variety, having the same formula for its composition as jeffersonite. It is white to light brown and resembles orthoclase, owing to its perfect basal parting. It is intimately associated with franklinite and willemite in ore from Parker shaft, Franklin Furnace, New Jersey.

Hopeite. Hopeite, a zinc phosphate with the composition 3ZnO, P_2O_5, $4H_2O$, is rare. It is orthorhombic in crystallization. It occurs most abundantly at Broken Hill, northwestern Rhodesia, where it is found in a cave in an outcrop of ore. In the cave are large amounts of bone breccia and the bright, colourless, transparent crystals of hopeite are found in association with calamine and vanadinite coating bones and inside teeth and bones. It was doubtless formed by the reaction of phosphoric acid with a soluble zinc salt. Parahopeite has the same chemical composition, but is triclinic.

Tarbuttite. Tarbuttite (4ZnO, P_2O_5, H_2O,) is another phosphate found at the Broken Hill mines in Rhodesia. It is quite abundant at this locality and large, well-crystallized speciments are common. The material varies greatly in appearance. The most distinctly crystallized material occurs as an encrustation on masses of cellular or stalactitic limestone and is in many cases associated with descloizite and pyromorphite. The crystals of tarbuttite are in some cases perfectly colourless and transparent, but more usually they are pale shades of yellow, brown, red, or green, with varying degrees of transparency. As a rule the crystals are thickly clustered together, but some occur singly on the matrix or attached to pyromorphite crystals. The crystals are triclinic, with parallel faces. They invariably tend to grow in sheaf-like aggregates. The mineral shows one perfect cleavage and the lustre on this surface is distinctly pearly. The hardness is 3·75 and the specific gravity 4·12 to 4·15. It results from the action of phosphate solutions on the earlier formed secondary minerals in the upper oxidized deposit of ore. Pseudomorphs of tarbuttite after calamine, descloizite, and smithsonite occur.

Descloizite. Descloizite ($(Pb,Zn)_2V_2O_8.(Pb,Zn)(OH)_2$), a vanadate of zinc and lead, is a cherry-red and brownish red to light or dark brown, or black mineral. It occurs in small crystals, is in many cases drusy and also massive, or fibrous radiated with mammillary surface. The mineral is brittle and has no cleavage. At Broken Hill, Rhodesia, it occurs in large quantities, usually associated with tarbuttite.

Adamite. Adamite ($Zn_3 As_2O_8.Zn(OH)_2$), an hydrated zinc arsenate, is a honey-yellow, violet, red, green, or colourless mineral, occurring as small crystals in many cases grouped in crusts and granular aggregations. It is a rare mineral of secondary origin. It occurs at the ancient zinc mines of Laurium, Greece, at Cap Garonne, France, and at Chañarcillo, Chile.

Sussexite. Sussexite ($H(Mn, Mg, Zn)BO_3$) is a white, silky, fibrous mineral of secondary origin found at Franklin Furnace.

Zinkosite. Zinkosite ($ZnSO_4$) is reported as occurring at a mine in the Sierra Almagrera, Spain.

Goslarite. Goslarite ($ZnSO_4.7H_2O$) occurs on the walls of some mine workings as a filiform or moss-like efflorescence. It is formed by the decomposition of sphalerite. Owing to its solubility it is comparatively rare in most districts.

LEAD

GENERAL

Lead-bearing minerals are much more numerous than those that contain zinc, but like the zinc minerals, comparatively few may be considered as ores. Of the primary minerals, the sulphide, galena, is by far the most common; others such as bournonite, jamesonite, and a great number of other lead sulphantimonides, are of little economic importance.

The secondary ore minerals are much more numerous than the primary ones. The oxides, massicot, minium, and plattnerite, and the chlorides and oxychlorides, which include a number of mineral species, are comparatively rare and of little importance. The carbonate, cerussite, and the sulphate, anglesite, are, however, important ores. Certain hydrous basic sulphates of lead with iron and copper are fairly common, but are never sufficiently abundant to produce ores. They include beaverite, linarite, and plumbojarosite.

Certain other minerals are locally of sufficient abundance to be considered ores. Of these may be mentioned pyromorphite ($(Pb,Cl)Pb_4(PO_4)_3$), mimetite, a corresponding arsenate, and vanadinite, a corresponding vanadate; also wulfenite ($Pb\ Mo\ O_4$), crocoite ($PbCrO_4$), and stolzite ($PbWO_4$), all of secondary origin.

A number of silicates of lead with other oxy-salts occur at the Franklin Furnace deposits, but they are only sparingly developed.

SOLUBILITIES OF LEAD COMPOUNDS

The table on page 8 gives the solubilities of four lead compounds as determined by Kohlrausch. It shows how slightly soluble lead is as compared with zinc. All lead salts are difficultly soluble, particularly the carbonate. The sulphate is slightly soluble and the chloride more so and it is as the latter that a certain amount of transportation of lead in solution may be effected.

Freshly precipitated lead sulphide is dissolved sparingly in cold water, its solubility being 0·0000036 mol in a litre. In dilute sulphuric acid galena is slightly attacked, especially when ferric sulphate is also present. The first change is to anglesite, $PbSO_4$. Cerussite in turn forms from anglesite and once formed is exceedingly stable. Where, however, free sulphuric acid or ferric sulphate or chloride are present it may be put into solution, and a whole series of basic lead iron sulphates may be developed.

CLASSIFICATION OF LEAD MINERALS

I. Native element
   Lead

II. Sulphides, selenides, tellurides, arsenides, antimonides
   Galena, cuproplumbite, alisonite, altaite, clausthalite, naumanite, lehrbachite, zorgite

III. Sulpho-salts
   Zinkerite, sartorite, andorite, galenobismutite, schirmerite, jamesonite, dufrenoysite, cosalite, kobellite, brongniardite, semseyite, schapbachite, freieslebenite, diaphorite, breulangerite, embrithite, plumbostite, bournonite, aikinite, lillianite, guitermanite, jordanite, meneghinite, geocronite, beegerite, kilbrickenite, epiboulangerite, franckeite, cylindrite

CLASSIFICATION OF LEAD MINERALS—*Continued*

IV. Haloids
  Cotunnite, percylite, matlockite, mendipite, laurionite, fiedlerite, penfieldite, daviesite, schwartzembergite

V. Oxides
  Massicot, minium, plattnerite

VI. Oxygen salts
  (1) Carbonates
    Cerussite, hydrocerussite, phosgenite
  (2) Silicates
    Barysilite, ganomalite, hyalotekite, roeblingite, kentrolite, melanotekite, nasonite
  (3) Niobates and tantalates
    None
  (4) Phosphates, arsenates, vanadates, antimonates
    Pyromorphite, mimetite, vanadinite, endlichite, bindheimite, nadorite, ecdemite, ochrolite, bayldonite
  (5) Borates, uranates
    None
  (6) Sulphates, chromates
    Anglesite, crocoite, phœnicite, vauquelinite, hinsdalite, leadhillite, plumbojarosite, lanarkite, caledonite, linarite, corkite, beaverite
  (7) Tungstates and molybdates
    Wulfenite, stolzite, raspite
  (8) Salts of organic acids
    None

CHARACTER AND OCCURRENCE OF LEAD MINERALS

Lead. Native lead is rare, but it has been reported from a number of localities. The only listed Canadian occurrence is from near Dog lake, Thunder Bay district, Ontario, where it occurs in thin strings in quartz. It crystallizes in the isometric system, but crystals are rare.

Galena. Galena is the common ore of lead. It is one of the most abundant of the sulphides and one of the easiest to recognize. Its most distinctive features are its lead-grey colour, its cubic cleavage, and its high specific gravity 7·4 to 7·6. Its hardness is 2·5 to 2·75. It commonly occurs in masses showing cubic cleavage and either coarse or fine; it is occasionally fibrous or plumose. In some camps, as for example the Slocan region of British Columbia, gneissic varieties are common, the banded structure being produced apparently by slight deformation of the ore.

Galena is lead sulphide, PbS, but it commonly contains silver and in some cases selenium, zinc, cadmium, antimony, bismuth, copper, and manganese as sulphides, and also in some cases native silver and gold. Argentiferous galena may contain from a few thousandths of one per cent of silver to one per cent and more and is often mined as an ore of silver.

Galena is formed under a great variety of natural conditions, occurring in deposits formed under conditions of high temperature to those formed near the surface under conditions of low temperature. Owing to its relative insolubility it is stable in the oxidized zone, remaining as float or in outcrops of veins when all the zinc blende that originally accompanied it has been leached away. It has been found in the sluice boxes of placer mines, has been ploughed up in the fields of the southwestern Wisconsin zinc deposits and in the outcrops of ore veins at various mining camps.

Secondary galena has been described from a number of camps, but there is little evidence that it has formed in any considerable amounts in lode ores. In the zinc-lead region of Mississippi valley there is, however, considerable evidence that lead has been transported in cold carbonated solutions and later precipitated as galena. It is possible that the galena in the calcite veins of eastern Ontario may have had a similar origin.

The other lead-bearing sulphides, selenides, etc., are rare and do not form ores of lead. No Canadian occurrences are listed.

Jamesonite. Of the numerous sulpho-salts in which lead occurs none is of economic importance. Three of them, jamesonite, bournonite, and meneghinite have been reported in Canada. Jamesonite ($2PbS, Sb_2S_3$) is a steel-grey to dark-lead-grey mineral with a hardness of 2 to 3 and specific gravity of 5·5 to 6. It has a metallic lustre and greyish black streak. It crystallizes in the orthorhombic system in acicular crystals and also occurs in compact masses or fibrous masses. It is a primary mineral. At Zimapan, Mexico, it occurs in considerable abundance with albite, pyrrhotite, and sphalerite in a deposit that has replaced limestone at considerable depths. In Star canyon, Humboldt county, Nevada, argentiferous jamesonite occurs in quartz with galena and tetrahedrite. It is reported from British Columbia from Spillimacheen river, Golden mining division; from some claims at the head of Kettle river, Greenwood mining division; with silver-lead ores at Silver Bell mine, Omineca mining division; and at Reco mine, Slocan district. It is stated to occur near Fredericton, New Brunswick, and at two localities in Frontenac county, Ontario.

Bournonite. Bournonite ($(Pb, Cu_2)_3Sb_2S_6$) is a steel-grey to black orthorhombic mineral in appearance much resembling tetrahedrite. It is a primary mineral associated with tetrahedrite in some veins in Bradshaw mountains, Arizona. It occurs in eastern Ontario with quartz at Madoc and at Marmora in Hastings county, at Darling in Lanark county, and with pyrite and dolomite in Bagot, Renfrew county.

Meneghinite. Meneghinite ($4PbS.Sb_2S_3$) is a blackish lead-grey mineral. It occurs in slender prismatic crystals of the orthorhombic system and also is found massive. It occurs with quartz and dolomite in Barrie township, Frontenac county, Ontario, and at Marmora, Hastings county.

Cotunnite. Cotunnite ($PbCl_2$) is a white or yellowish mineral occurring in acicular orthorhombic crystals and in semicrystalline masses. It is soft and has a specific gravity of 5·24. It is rare, occurring in the crater of Vesuvius, and a lead chloride, probably cotunnite, has been found replacing chalcocite at Grand Gulch, Arizona. The other chlorides and oxychlorides of lead are also of rare occurrence.

Massicot. Massicot (PbO), the yellow lead oxide, is comparatively rare. It occurs as an oxidation product of galena and other lead compounds. It is found with cerussite in some oxidized lead ores in the Coeur d'Alene district, Idaho. In Mexico between Monterey and Ceralvo it has accumulated in considerable amounts in gravels along the streams.

Minium. Minium, or red lead (Pb_3O_4), has a vivid red colour mixed with yellow and has an orange-yellow streak. It occurs as a comparatively rare oxidation product of lead ores.

Plattnerite. Plattnerite (PbO_2) is another rare mineral found in the oxidized zones of some lead deposits. It is iron-black with a chestnut-brown streak. It occurs at the "As You Like" mine, Mullan, Coeur d'Alene district, Idaho, with pyromorphite and limonite, and at Leadhills and Wanlockhead, Scotland.

Cerussite. Cerussite ($PbCO_3$) is, after galena, the most important ore of lead. It is unknown as a primary mineral, but is a very common secondary product, particulary after galena. It occurs in many cases in the form of a heavy sand, called by miners, "sand carbonate." Cerussite crystallizes in simple orthorhombic crystals in many cases tabular, prismatic, or pyramidal. Twinned forms often repeated, yielding six-rayed stellate groups, are common. Hardness is 3 to 3·5 and specific gravity 6·46 to 6·574. The colour is white, grey, greyish black, in some cases tinged blue or green. The lustre is adamantine to vitreous, pearly or resinous, and is in some cases submetallic. Cerussite is most commonly found in deposits where the country rock is limestone. In many cases the carbonate replaces galena. Commonly lead sulphate may form intermediately between the sulphide and carbonate. The oxidation of siderite may supply carbonate for the formation of cerussite. Owing to its low solubility, lead carbonate is comparatively stable.

Phosgenite. Phosgenite ($PbCO_3$ $PbCl_2$) is a rare, white, grey, to yellow mineral of secondary origin. It is tetragonal in crystallization forming prismatic crystals. It is rather sectile, has a hardness of 2·75 to 3; a specific gravity of 6·0 to 6·3, and an adamantine lustre.

Silicates. Silicates of lead are rare. They are found sparingly, however, in the two unique deposits of contact-metamorphic origin at Langban, Sweden, and at Franklin Furnace, New Jersey. At the former locality ganomalite ($Pb_3Si_2O_7(Ca,Mn)_2SiO_4$), hyalotekite ($(Pb,Ba,Ca),B_2(SiO_3)_{12}$). kentrolite ($3PbO.\ 2Mn_2O_3SiO_2$), and melanotekite ($3\ PbO.\ 2\ Fe_2O_3.3\ SiO_2$), occur; at the latter roeblingite ($5\ H_2CaSiO_4).2Ca,Pb,SO_4)$) and nasonite ($Pb_4(PbCl)_2Ca_4(Si_2O_7)_3$) are found. Barysilite ($Pb_3\ Si_2\ O_7$) is present at the Harstig mine, Pajsberg, Sweden.

Pyromorphite. Pyromorphite ($(PbCl)Pb_4(PO_4)_3$), or green lead ore, is the main metallic phosphate. Its crystallization is hexagonal pyramidal; it occurs in prismatic crystals, many barrel-shaped and many in branching groups of prismatic crystals in nearly parallel position tapering down to a slender point. It also occurs globular, uniform, botryoidal, and sometimes fibrous or granular. Its hardness is 3·5 to 4; its specific gravity 6·5 to 7·1. Its colour is green, yellow, and brown of different shades, in some cases greyish white to milk-white. It is distinguished by its hexagonal form, its high specific gravity, and its resinous lustre. It is commonly developed in outcrops of lead ores that are exposed to waters carrying chlorine and phosphoric acid. In Fort Steele mining division, British Columbia, a yellow and a green variety of pyromorphite occurs in fine crystals with galena and cerussite in fractured zones at the Society Girl claim, Moyie. An analysis shows that arsenic is present in small quantities, which may account for the green colour of the mineral.

The other minerals of the phosphate division are rarer, do not form ores of lead, and have not been reported in Canada. Like pyromorphite, they are of secondary origin.

Anglesite. Anglesite ($PbSO_4$) is a white mineral in some cases tinged with yellow, grey, green, or blue. It is transparent to opaque. Its lustre is highly adamantine in some specimens inclining to resinous and vitreous in others. It crystallizes in the orthorhombic system, forming prismatic crystals and also pyramidal types. It has one distinct cleavage. Its hardness is 2·75 to 3, and specific gravity is 6·3 to 6·39. Anglesite is known only as a secondary mineral and is commonly formed after galena. In some cases it forms as an intermediate form between galena and cerussite, and is commonly found associated with carbonates and sulphide in oxidized zones. In Slocan mining division, British Columbia, anglesite occurs in crystals with cerussite and galena at the Wellington mine, 2½ miles northeast of Bear lake, and with linarite in cavities in an ore-body consisting of coarsely crystalline galena and chalcopyrite at the Beaver group, Beaver mountain.

Hinsdalite. Hinsdalite ($2(PbSr)O\ 3Al_2O_3 . 2SO_3 . P_2O_5 . 6H_2O$) forms an ore of lead at the Golden Fleece mine, Lake City, Colorado. It occurs associated with quartz, barite, pyrite, galena, tetrahedrite, and rhodocrosite in veins in rhyolite. Its origin was apparently near the surface, but whether from ascending or from surface waters is not known.

Plumbojarosite. Plumbojarosite ($PbO . 3Fe_2O_3 . 4SO_3 . 6H_2O$) locally forms an ore of lead. It is always secondary, being found only in the oxidizing zones of lead deposits, particularly in arid regions. Its colour is light ochre yellow to dark brown. It may be distinguished from the hydrated iron oxides by its smooth, oily feel, as contrasted with the harsh, gritty feel of limonite. It occurs in many of the lead camps of the western states.

Other sulphates, such as linarite, corkite, and beaverite, are of less importance and like plumbojarosite are all of secondary origin.

Wulfenite. Wulfenite ($PbMoO_4$), yellow lead ore, is an unimportant ore of lead. It is bright red to orange, in some cases brown, greyish, white, or nearly colourless—rarely green. Its streak is white and its lustre resinous to adamantine. It has a good pyramidal cleavage, but is very fragile and brittle. Its crystallization is tetragonal-pyramidal and it usually occurs in tabular hemihedral crystals. It also occurs granular massive. Its hardness is 2·75 to 3 and its specific gravity is 6·7 to 7·0. It is a secondary mineral occurring with other lead ores.

Stolzite. Stolzite, lead tungstate ($PbWO_4$), occurs in pyramidal tetragonal crystals of green to grey or brown colour. It occurs at Zinnwald in Bohemia with quartz and mica and at Southampton, Mass. *Raspite* has the same composition as stolzite, but is referred to the monoclinic system. It occurs in small, tabular crystals of a brownish yellow colour at the Broken Hill mines, New South Wales.

COMPARISON OF ZINC AND LEAD MINERALS

Zinc and lead are alike in that their sulphides are by far their commonest minerals and their most important ores. These sulphides, sphalerite and galena, are so commonly found together that a large number of deposits are spoken of as lead-zinc ores or, if the galena is argentiferous, as silver-lead-zinc ores. Though the two minerals are so commonly associated, it has been found in many deposits the world over that the zinc predominates in the lower zone of mineralization, below the main galena occurrence, suggesting a formation under conditions of higher temperature and pressure than those under which the lead was formed. Where silver-bearing minerals are present, they occur more characteristically in the upper zone, although small quantities may be distributed with the other metals. There is in many instances, however, a considerable overlapping of the general zonal arrangement.

Of the minerals of less importance may be noted the large number of sulpho-salts of lead, most, however, of only rare occurrence, and of zinc there is none. Of the oxides, zinc has several varieties of primary origin, whereas the three oxides of lead are all secondary. Of the oxygen salts, the general higher degree of solubility of zinc salts allows less opportunity of their remaining as minerals than those of lead. We hence find the lead carbonates, silicates, phosphates, and sulphates more common than those of zinc. Zinc, on the other hand, forms one primary silicate, willemite. The greater abundance of these secondary minerals of lead and the large number of primary sulpho-salts account for the much greater number of lead minerals as compared with those of zinc, 84 as listed as compared with 33.

CHAPTER III

GEOLOGY

CLASSIFICATION OF ZINC AND LEAD DEPOSITS

Occurrences of zinc and lead deposits may be classified genetically in the following manner:

I. Primary
- (1) Syngenetic (originating at the same time as the enclosing rock)
  - A. Disseminations in sediments
- (2) Epigenetic (originating later than the enclosing rock)
  - A. Ore-bearing cavity fillings
    - (*a*) Fissure veins
    - (*b*) Gash veins
    - (*c*) Stockworks
    - (*d*) Saddlereefs
    - (*e*) Breccia fillings
  - B. Impregnations
    - (*a*) Amygdaloids
    - (*b*) Shear zones
    - (*c*) Metamorphic cavities
    - (*d*) Dolomitization cavities
    - (*e*) Rock pores
  - C. Cave deposits
  - D. Replacements
    - (*a*) Massive
    - (*b*) Lode fissure
    - (*c*) Disseminated
  - E. Contact metamorphic

II. Secondary (formed from other deposits)
- (1) Residual
- (2) Placers

Ore deposits fall into two major divisions; first, those of primary origin; and second, those of a secondary nature formed from primary ores. Of the two, in the case of both lead and zinc, the primary are much the more important. They in turn fall into two divisions, the syngenetic and the epigenetic, depending respectively on whether the minerals were formed contemporaneously with the country rock in which they occur or whether they were formed later than the country rock.

SYNGENETIC DEPOSITS

Syngenetic occurrences of zinc and lead are never important enough to make ore deposits, but they are interesting as a possible source of the zinc and the lead in certain types of epigenetic deposits. Small amounts of zinc and lead are present in certain igneous rocks, either as small, disseminated particles of the sulphides or in part as integral constituents of certain minerals, mostly silicates, which make up the rock. Of eighteen selected samples of the quartzose porphyries of Leadville, Colorado, fifteen were found to contain lead, the richest carrying 0·0064 per cent of PbO; the average being 0·002 per cent. In similar rocks 0·008 and 0·0043 per cent of ZnO was reported. Decomposition and erosion of the rocks sets free the zinc and lead, the sulphides being oxidized to sulphates which can be transported in surface solutions, and the silicates of the metals being decomposed and taken into solution chiefly as bicarbonates.

Zinc and lead occur disseminated in certain sediments. Analyses of manganese nodules and of "red clay" and "blue mud" collected by the Challenger expedition and reported by Clarke in "The Data of Geochemistry," show small amounts of both zinc and lead. Large numbers of analyses of Palæozoic sediments in Missouri show zinc, lead, and copper. In the Precambrian crystalline rocks, the average per cent of zinc is 0·009 and that of lead 0·004. In the Cambrian and Ordovician dolomites zinc is only about one-half as plentiful as in the crystalline rocks, and in the Mississippian limestones it is only about one-ninth. Lead on the average is less than one-fourth as plentiful in the Cambrian and Ordovician dolomites as in the Precambrian crystalline and a little over one-fourth in the Mississippian limestones. In the Cambrian and Ordovician dolomites there is a little less than one-fourth as much lead as zinc and in the Mississippian limestones there is on the average one-tenth more lead than zinc. The average of nine samples of limestones and dolomites from Dubuque region, Iowa, gave 0·00326 per cent of lead and 0·00029 per cent of zinc. L. Dieulafait detected zinc in hundreds of samples of Jurassic limestone from central France. He also reported zinc in seawater and in ashes of seaweeds.

The source of the zinc and lead in oceanic sediments is a problem of interest. Murray is of the opinion that the greater part of the pelagic red clay consists of dust of volcanic or meteoric origin which has been carried out to sea, and that the metals had their source in this material. Siebenthal[1] believes that this origin may be true for the metal content of the red clay, but does not account for the relative total percentage of the metals, arsenic, nickel, cobalt, copper, lead, and zinc, which in the blue clays amount to 0·0981 as compared with 0·0637 per cent in the red clays. The blue mud is in large part clastic, and was derived from the land masses and hence the volcanic and meteoric material has been much diluted. It must be concluded, therefore, that the water-borne clastic material is either more highly metal-bearing than the volcanic and meteoric material or else that a third source, the sea, has supplied metallic content to the sediments. The latter possibility is supported by a number of facts, the presence of zinc and lead in corals, in the ashes of seaweed, in manganese nodules, and in seawater itself at different places. An analysis of a composite sample of silt from the Mississippi delta furnishes additional evidence. Though this mud was brought down from a drainage basin in which are great deposits of zinc and lead, the analysis shows that it contains only one-half as much lead and one-eighth as much zinc as the terrigenous blue mud laid down at great distances from the

[1]Siebenthal, C. E.: "Zinc and Lead Deposits of the Joplin District"; U.S. Geol. Surv., Bull. 606,, p. 76.

land. It seems, therefore, necessary to conclude that the metals were transported in solution and not as integral parts of the silt.

An answer to the question how the metals in solution have become fixed in the sediments has been suggested by A. H. Phillips.[1] He gives analyses of the tissues of various animals found in the neighbourhood of Tortugas island, gulf of Mexico. The animals include, Fasciola, Strombus, Limulus, Gorgonia, and certain Holothuroidea. All of these show appreciable amounts of copper, iron, and manganese. All but the Holothuroidea show zinc. Lead was found in traces only in the Fasciolaria. The mud bottom around these coral islands showed copper, zinc, iron, and manganese, which indicates that the metals become fixed 2 feet below the ocean floor. Unio also contains copper and zinc.

The common occurrence of grains of galena and sphalerite in fossils suggests that decaying organic matter may have caused precipitation of zinc and lead from solution.[2]

EPIGENETIC DEPOSITS

The epigenetic types, or those formed later than the rock in which they occur, include all the primary deposits of zinc and lead of any commercial importance. As a basis of classification the manner in which the entrance into the country rock was gained may be used. Was there an original opening or cavity for the material or did it have to drive out some of the rock material in order to make room for itself?

Of the first type, that of cavity fillings, we may distinguish five varieties of which the first two are especially important. They are fissure veins, gash veins, stockworks, saddlereefs, and breccia fillings.

FISSURE VEINS

Fissure veins are probably the commonest type of zinc and lead deposits occurring in Canada. As examples may be mentioned the zinc-lead veins of central Gaspe, Quebec, the numerous calcite-barite-galena veins of eastern Ontario, and the galena-sphalerite veins of Slocan district, British Columbia.

Fissure veins are commonly fault fissures. The fissures that developed into the calcite veins of eastern Ontario and the faults in the Palæozoic strata of Ottawa valley had undoubtedly the same origin. The stresses that produced the fissures may be either tensional, compressional, or torsional. Commonly two or more sets of fissures may be produced simultaneously.

Veins usually pinch and swell; in many cases they branch into two parallel fissures or into several of irregular courses. The character of the country rock has much to do with determining the form a fissure takes. In strong rocks such as quartzite or massive limestone fractures are much more persistent than in weak rocks like shale or schist. In interbanded strong and weak rocks, deformation commonly produces a series of cross fractures in the strong beds, whereas the weak beds take up the

[1] Phillips, A. H.: Am. Min., March, 1923, p. 53.
[2] Van Ingen, G.: Bull. Geol. Soc. Am., vol. 26, p. 85 (1915).

movement without fracturing. Such cross fractures may be important loci of deposition of minerals.

Veins behave in the vertical plane much as they do in the horizontal plane; in depth they may pinch and swell; at a change of formation they may die out, branch, or enlarge. It is commonly asked to what depth a vein may be expected to go. No certain answer can be given, but a commonly applied rule is that depth is equal to length. Much of a vein, however, may have been removed by erosion, so at best this rule can serve only as a general guide.

Fissure veins are not equally mineralized throughout their length and depth. The richer, workable parts are termed "shoots," the locations of which depend on a number of factors that in many instances are not fully understood. Where a vein traverses rocks of different kinds, some particular rock variety may have been more influential than others in precipitating metals from solution. Intersections of veins are in many cases favourable places for the location of shoots.

For Canadian example of lead and zinc-bearing veins no better region can be selected than Slocan district, British Columbia. This area, lying between Kootenay lake and Slocan lake, has been a great producer of silver and lead and in recent years there has been a renewal of interest in the region as a silver-lead-zinc producer. The country rocks are a series of sediments and volcanics intruded by stocks and batholiths of granite. The fissures occur in the granite and in the intruded rocks, but are much more abundant in the latter, particularly in the Mesozoic Slocan series of slates, argillites, quartzites, and limestones. The strike of the important veins is northeast across the bedding planes of the sediments. Certain properties illustrate the importance of cross fractures in a strong bed between weaker strata. On the Lucky Jim, for instance, a bed of massive limestone about 60 feet thick lies between beds of weak shale. The weak beds have been very little fissured, but the limestone has been traversed by a series of cross fractures which served as channels for the mineralizing solutions. Replacement and deposition along these traverse fissures has resulted in important ore-bodies. The Slocan veins vary in width from narrow stringers up to 50 feet and in length up to several thousand feet. Several veins, such as the Whitewater, the Hewitt, and the Slocan Star-Silversmith have been followed to depths of over 1,000 feet along their dip. They pinch and swell, and though commonly lens-shaped, are usually narrow in comparison with their length and depth. The mineralogy of the veins depends largely on the distance the solutions have travelled. There are two types of ores known respectively as the "dry" and the "wet." The former occur in veins in the granite or near granite contacts, and are silver ores consisting of ruby silver, grey copper, etc., in a gangue of quartz. The "wet" ores were deposited by solutions that travelled farther and hence were of lower temperature. They consist of argentiferous galena and sphalerite in a gangue of quartz and siderite.

GASH VEINS

Gash veins occupy cavities formed by solution. They characteristically occur in limestone where joints have been irregularly enlarged. Many of the deposits are of fair width, but soon play out when followed along the strike or dip. Deposits of galena and sphalerite form typical gash veins, and the most important region holding this type of zinc and lead deposits is in the valley of the Mississippi. This broad zone is underlain by flat-lying limestone ranging in age from Ordovician to Mississippian. The zinc and lead ore occurs in Arkansas, Missouri, Oklahoma, Kansas, Illinois, Wisconsin, and Iowa. The deposits reach eastward as far as western Virginia and Tennessee. Similar ores on a small scale occur in Pennsylvania and New York. The commonest type of occurrence in this field occurs in fractures or joint-planes which have been enlarged by solution. Zones of brecciation are also commonly mineralized and fault planes more rarely. In places the mineralization follows certain sedimentary horizons and where the strata are slightly disturbed a tendency has been observed for the mineralization to occur in pitching troughs. The mineralogy of these deposits is simple. The two principal minerals are sphalerite and galena. The former is yellow, light brown, or red, contains little iron, but in many cases cadmium. As a rule the galena does not carry silver, although in places it does in small amounts. Pyrite is always present in greater or less amounts; there is also always some marcasite and in some cases a little chalcopyrite. Nickel and cobalt are commonly present in small amounts. The gangue mineral of greatest importance is dolomite; barite occurs in certain districts; quartz is not common but secondary chert with bitumen is important in many districts. Near the surface a series of secondary zinc and lead minerals occur, sulphates, carbonates, and silicates, of which the principal ore-forming kinds are smithsonite, calamine, and anglesite.

STOCKWORKS

A large number of fissures following many directions is spoken of as a stockwork. This is not an important type of zinc or lead occurrence. It is more important in connexion with certain gold and tin deposits.

SADDLEREEFS

During the folding of sedimentary strata, openings tend to form between the beds on the summits of the anticlines and if filled with vein mineral are called saddlereefs. These form important sources of gold in Victoria, Australia, and in the Gold-bearing series of Nova Scotia. At Broken Hill, New South Wales, a deposit of silver, lead, zinc ore has been opened up over a length of 3 miles. It lies in a folded complex of schists of sedimentary and igneous origin and its foot-wall follows a fault zone. On the hanging side the ore bulges out forming large masses that seem to follow the folded schists, giving rise to saddle-like bodies. They, however, are probably due at least partly to replacement.

BRECCIA FILLINGS

Breccia consists of angular fragments of rock in a matrix of some cementing material. Some breccias are of sedimentary origin, but from the point of view of ore deposits the important types are fault breccias, which result from the shattering of rocks along certain planes and the later deposition of vein material, commonly silica or carbonate, which cements the angular fragments into a compact rock. In the vein material valuable ores may occur. Breccia fillings commonly accompany other varieties of cavity fillings. Fissure veins and gash veins have associated with them, in very many cases, mineralized brecciated zones. The fissure veins of Slocan district, British Columbia, and the zinc-lead veins of Gaspe are commonly bordered by zones of brecciated rock mineralized with sulphides.

IMPREGNATIONS

Impregnations are deposits formed by the filling of small openings or zones of weakness in rocks. This class of deposits includes a number of varieties. The filling of vesicles in lava flows forms an amygdaloidal variety which is more important in the case of copper than of zinc or lead deposits. In Gaspe peninsula basic lava flows of Devonian age locally contain amygdules of calcite with galena and calcite, but not so far as known, in sufficient quantities to form ores.

Impregnations in shear zones are very numerous. They commonly occur in schistose rocks. A rubbing movement, back and forth along a zone of weakness, has produced the zone along which solutions subsequently travelled and deposited their mineral content. Some shear zones have widths of hundreds of feet. An excellent example is the zone in Slocan district, British Columbia, on which the Ruth-Hope, Silversmith-Slocan Star, and Richmond-Eureka properties are located. It has been traced for over a mile and its width varies up to over 400 feet. On the Silversmith it branches into two zones each over 200 feet wide. The zone traverses slates and argillites of the Slocan series and consists of sheared, shining black graphitic material. The ore-shoots are located irregularly in this zone. The ore minerals are galena and sphalerite with a gangue of quartz and spathic iron.

Impregnations may take place in lenticular spaces in metamorphic rocks produced when the metamorphism took place, or in pores in rocks, or in openings produced when a limestone is dolomitized. These, however, do not produce important deposits of zinc or lead. Dolomitization cavities are sometimes important in allowing solutions to traverse and replace rock. Some of the galena-sphalerite deposits of the Aspen, Colorado, region are due to this method of formation.

CAVE DEPOSITS

A type of ore deposits of minor importance in some regions occurs as a lining of caves. In Joplin region and in the states of Iowa and Wisconsin, this type is encountered. In places stalactites and stalagmites of ore occur in the caves.

REPLACEMENTS

Replacement deposits of both lead and zinc are extremely important. In this type no open space ever existed other than was necessary to permit access of the mineralizing solutions. The ore-bodies grew by the gradual replacement of the rocks by the new material. This process is known under a variety of names besides replacement, substitution, metasomatism, metasomatic interchange, etc.

Replacement deposits display a great variety of forms. In general, however, they are linear, with their thickness small as compared with their length and depth. There is commonly a relationship between the form the replacement takes and the channels of access for the solutions. The channel may be a shear zone and a simple lens may result; the channel may be a single fissure or a series of parallel or intersecting fissures, and replacement along such channels will naturally afford, in the main, bodies related in form to that of the original channels. Where the channels cross rocks of different types there will be selective replacement, some beds being more easily attacked than others. There may be an abrupt change from ore to unmineralized country rock or the boundary between the two may be very indefinite.

The sizes of replacement bodies vary greatly. They may consist of small mineralized zones bordering filled rock cavities or they may be of any size up to huge masses equalling or exceeding in size all other types of ore deposits. The Sullivan pyrrhotite-pyrite-sphalerite-galena deposits, British Columbia, have a length of over 6,000 feet on the main level, a width above this level of over 1,700 feet, and a thickness up to 272 feet. The Flin Flon lens of northern Manitoba, consisting of iron, copper, and zinc sulphides, has a length on the surface of 2,593 feet, a greatest width of 400 feet which, however, includes some bands of unmineralized rock and extends to a depth of over 900 feet. The Henriette-Wolftone-R.A.M. shoot at Leadville has a maximum length of 3,500 feet, a maximum width of 1,600 feet, and a greatest thickness of 200 feet. Where replacements of massive limestones take place, the deposits are apt to attain great size owing to the facility with which this process goes on in this easily soluble rock. Though limestones are the most easily replaced rocks, it is not true that the largest masses or even the greatest number of masses occur in limestone. The Sullivan mass occurs in quartzite and the Flin Flon in sheared greenstone. In fact there are few minerals that are not susceptible to replacement. Of the sedimentary rocks limestone is the most easily replaced, quartzite fairly easily, and rocks high in alumina least easily. Igneous rocks are readily replaced. Probably the most resistant rock is shale.

Replacement deposits may be recognized by a number of features, not all necessarily observable in any one deposit. One of the commonest features is the preservation of rock structures such as bedding, crossbedding, fossils or dolomitization rhombs in the case of sediments, and phenocryst and vesicular structure in the case of igneous rocks. Induced rock structures such as joints, faults, breccias, folds, or schistosity may also be preserved. If within a mass of ore there are masses of unreplaced rocks, commonly called " horses ", and if these are completely surrounded by ore and still have their original structure, i.e., if the strike and the dip of their bedding correspond to that of the adjacent unmineralized country rock, the replacement origin cannot be doubted.

The presence of completely or partly faceted crystals in rock masses is another criterion of replacement that may be employed. Along the edges of ore masses due to replacement where the transition from ore to country rock is gradual, crystals are commonly found that have all their faces developed, unlike crystals that formed in cavities and must have been attached either to the walls or to some earlier formed crystal and hence could not have their faces completely developed. Crystals cutting across fossils, across grains of quartz in sandstone, or across laminæ of shale are evidence of replacement. In igneous rocks this type of evidence can be used, however, only where the crystals could not be original minerals of the rock. For example, a complete crystal of magnetite in an igneous rock is likely to be an original constituent of the rock rather than of secondary origin.

Replacement takes place by the introduction of material in solution. It may be in solution in surface waters, which reached it from the upper part of a deposit, and carried it down through cracks and fissures. These solutions are at low temperature and pressure and are responsible for much secondary sulphide-enrichment and replacement by secondary oxides. The material may be in solution in seawater or water of lakes and streams and may replace soluble carbonates accumulating on the bottom of the water basin or channel. The Clinton iron ores are considered by some authors to have originated in this way.

The greater number of replacement deposits were, however, produced by heated solutions given off by cooling, igneous masses. Though probably highly heated and under considerable pressure, they nevertheless usually operated at temperatures and pressures too low to produce contact metamorphism. The Stirling zinc deposit of Cape Breton, the copper-zinc deposit of the Rouyn field, Quebec, the Mandy and Flin Flon ore-bodies of Manitoba, and the Sullivan of British Columbia are examples of this type of deposit.

The replacing material may be carried by water at temperatures and pressures above the critical point and hence in a vaporous condition. Such solutions have their source in molten magmas and operate on heated rock masses in the neighbourhood of the intrusive. The replacing action, where the attached rock is limestone, may be supplemented by intense contact metamorphism.

CONTACT METAMORPHIC

Contact metamorphic deposits form a very important variety. They are less important in the case of zinc and lead than in that of copper. They are due to actions accompanying the intrustion of igneous rocks and their characters are influenced by the nature of the rock that is intruded. Acid or intermediate varieties of the intrusives produce the greatest effects owing to the relatively large amount of volatile material which they contain. These varieties include granite, diorite, quartz diorite, monzonite, and quartz monzonite. Of these, the monzonites and quartz monzonites are the most common producers of contact metamorphism, with the diorites and quartz diorites next and the granites last. Of the intruded rocks that are most susceptible, limestones and calcareous sediments are most important for the development of ore deposits. Sandstones are changed into quartzites at igneous contacts and argillaceous rocks are commonly converted into dense, hard hornfels, containing biotite, andalusite, staurolite, scapolite, garnet, and feldspar. These rocks, however, rarely produce ores.

The forms that contact metamorphic ore-bodies take are very irregular. They are almost always bunchy, but in many cases there is a tendency to form rudely tabular bodies lying about parallel to the contact of the intrusive. In limestone they commonly occur immediately at the contact, from which they do not often extend more than 100 feet. Examples, such as in the Magdalena mines in New Mexico, are known, however, where deposits reach out along certain beds for a distance of 2,000 feet or more, but these are decidedly exceptional. In most cases the ore-bodies are small, but occasionally they contain millions of tons of ore. In this type of deposit, it is very necessary to be conservative in estimation of tonnage, and exploration work should be concentrated on the neighbourhood of the intrusive contact.

The mineralogy of contact deposits is very characteristic. Ores of the copper group are marked by the association of magnetite, specular hematite, pyrite, chalcopyrite, bornite, chalcocite, molybdenite, and pyrrhotite. Zinc-lead contact deposits consist of sphalerite, galena, and in some cases jamesonite, in many cases with small quantities of magnetite. Iron deposits are made up of magnetite, with small amounts of specularite, pyrite, chalcopyrite, bornite, chalcocite, and pyrrhotite. The gangue minerals in all these types are equally characteristic. They consist of lime silicates such as garnet, either grossularite or andradite, vesuvianite, pyroxene, epidote, spinel, wollastonite, ilvaite, zoisite, actinolite. Much of the material required for the formation of these lime-silicate minerals came from the magma and the ores were entirely supplied by it. The absence of certain minerals such as siderite, dolomite, and sericite is almost as striking a feature of contact deposits as the presence of the lime-silicates. Other features, such as the interweaving of contact and ore minerals and the fading out of the deposit into the unaltered rock, are typical.

A number of zinc-lead deposits in Canada have this origin. The most important in southern Canada is the Tetreault mine near Notre-Dame-des-Anges, Portneuf county, Quebec. Here a band of limestone now altered largely to secondary silicate mineral is interbedded with sedimentary gneiss. The rock series lies between two batholithic masses of granite and on the property itself is cut by pegmatite dykes. The limestone band has been largely altered to actinolite and pyroxene, but many other lime-silicate minerals such as epidote, garnet, wilsonite, etc., are present. The ore consists of sphalerite with subordinate amounts of galena concentrated in masses along the foot-wall side of the actinolite band. Similar occurrences in bands of Grenville limestone are found near Renfrew, Ontario, and at Long Lake, Ontario.

A typical contact metamorphic zinc deposit occurs near Lund on the British Columbia coast about 8 miles north of Powell river. The rocks are limestones and volcanics of probable Jurassic age, intruded by granite of the Coast Range batholith. The deposits occur near the contact of the limestone and the granite. The limestone at the contact has been altered to a silicate rock consisting of garnet and epidote. The chief ore mineral is light yellow sphalerite. Accessory minerals include magnetite, which in places occurs in considerable masses, pyrrhotite, chalcopyrite, and bornite. The ore deposits are irregular and bunchy. Certain lamprophyre dykes of post-mineral age cut both the granite and the ore zone.

SECONDARY DEPOSITS

Secondary zinc and lead deposits, or those formed from primary ores by the action of surface solutions, are much less important than the primary types. In deposits that contain sphalerite and galena but no pyrite, oxidation proceeds slowly, galena changing to anglesite and cerussite and zinc blende to calamine and smithsonite. Where small amounts of pyrite are present changes take place much more rapidly. Pyrite readily parts with a part of its sulphur to form, with oxygen and water, sulphuric acid, and ferrous sulphate. The latter is very unstable and oxidizes readily to ferric sulphate. The following are important reactions:

$$
\begin{array}{lcl}
FeS_2+3O+H_2O & = & FeS + H_2SO_4 \\
FeS+H_2SO_4 & = & FeSO_4+H_2S \\
FeS_2+2O+2H_2S & = & FeS+2H_2O+3S \\
S+3O+H_2O & = & H_2SO_4 \\
2FeSO_4+ O+H_2SO_4 & = & Fe_2(SO_4)_3 + H_2O \\
PbS + Fe_2 (SO_4)_3 & = & PbSO_4 +2FeSO_4 + S \\
ZnS + Fe_2 (SO_4)_3 & = & ZnSO_4 +2FeSO_4 + S
\end{array}
$$

Reactions with the wall-rock in the oxidized zone will tend to precipitate the material from solution. Against limestone walls the zinc will form as the carbonate, smithsonite, whereas against silicate wall, calamine will tend to be produced. Limestone walls will precipitate the lead as cerussite, whereas silicate walls will tend to produce anglesite.

Secondary minerals have been mined as ores at the Paradise mine in Windermere district, British Columbia, and at the H.B. and the Emerald in Sheep Creek district, Nelson mining division. The ore at the Paradise is highly oxidized and consists mainly of lead carbonate. In places it contains some residual fragments of galena and locally some sphalerite and pyrite are also present with the galena. The secondary ore is commonly spoken of as sand carbonates. The ore occurs in isolated pockets or lenses in bedded veins and in fissures in a shattered limestone zone. Most of the secondary ore has been already mined and future work will be on shoots of primary sphalerite and galena. At the H.B. the ores are chiefly secondary zinc minerals, whereas at the Emerald, lead ore is of chief importance.

PLACERS

Mechanical disintegration of ore deposits allows of their being carried to stream beds. If they can resist chemical attack by surface waters and are heavier than the average detrital material, they may be concentrated by the action of the running water, and placer deposits may result. In the case of zinc and lead, only the latter can form deposits of this kind, sphalerite being too readily attacked and zinc salts too soluble for zinc minerals to accumulate in this way. Galena, however, is much more resistant to chemical attack. Large blocks are commonly found in float, in many cases with cavities from which the sphalerite, which was originally present, has been leached. The high specific gravity of galena also renders it possible to accumulate in placers.

GEOLOGY OF CANADA WITH REFERENCE TO ZINC AND LEAD DEPOSITS

GENERAL

Canada falls naturally into six major geological divisions: (1) the Appalachian and Acadian region, comprising the Maritime Provinces and most of that part of the province of Quebec lying south of St. Lawrence river; (2) the St. Lawrence region; (3) the Canadian Shield, the large V-shaped area covering nearly 2,000,000 square miles around Hudson bay and underlain by Precambrian rocks; (4) the Arctic archipelago and Hudson Bay lowland, the latter underlain by flat-lying Palæozoic strata; (5) the Interior Plains region of Manitoba, Saskatchewan, and Alberta, which stretches north down Mackenzie valley to the Arctic ocean; and (6) the Cordilleran region of British Columbia and the Yukon, consisting of mountainous country underlain largely by disturbed strata. A fuller account of these natural provinces is given in report No. 1 of this series, " The Geology and Economic Minerals of Canada ". The types of zinc and lead ores that occur in these different geological provinces present a considerable variety and are related to several metallogenetic epochs.

APPALACHIAN AND ACADIAN REGION

The Appalachian and Acadian region covers 84,000 square miles and includes the provinces of Nova Scotia, New Brunswick, Prince Edward Island, and that part of Quebec lying south of St. Lawrence river and east of a line running from Quebec city south to lake Champlain. The Appalachian portion is a continuation of the great Appalachian Mountain system, which extends from near the gulf of Mexico to the extremity of Gaspe peninsula, a distance of 1,700 miles. The boundary between it and the Acadian region is Restigouche river and Chaleur bay.

The Appalachian region in general is a mountainous country. South of New York it contains two parallel ranges, the Alleghenys and the Appalachians, but in northern New York, the New England states, and in Canada the system is less regular. Green mountains, Vermont, White mountains, New Hampshire, and Notre Dame mountains, southern Quebec, are all parts of this system. Notre Dame mountains form three roughly parallel ridges with isolated hills separated from each other by deep valleys. The general trend is northeast and the elevations reach as high as 3,100 feet. Southwest of Quebec city the country is lower, but in Gaspe peninsula it again rises and a belt of flat-topped country reaching elevations of from 3,000 to 4,200 feet extends down the middle of the peninsula. This high country is commonly known as Shickshock mountains.

The Acadian region is also one of ridges, plateaux, and valleys. The northwestern part of New Brunswick is a plateau in which the valley of

St. John river is deeply entrenched. The central part of the province is more rugged with ridges and hills rising to elevations of over 2,000 feet. The southeastern part of the same province, except along the bay of Fundy, and all of Prince Edward Island is a lowland which nowhere rises more than 600 feet above the sea. This is bordered in the southern part of New Brunswick by a region of flat-topped ridges bordering the bay of Fundy and rising to elevations of 1,000 feet. Nova Scotia is an upland with a general elevation along its northeast trending axis of about 1,000 feet. On the southeast it drops gradually to the ocean; on the northwest the descent is more abrupt to a lowland region surrounding Cobequid hills and extending into New Brunswick. The southern extension of this lowland is the narrow Annapolis-Cornwallis valley. Cape Breton Island is an upland divided by valleys into a series of isolated, flat-topped ridges and plateaux which in the north reach elevations of 1,500 feet.

The rock formations of the Appalachian and Acadian province are largely of Palæozoic age. Both older and younger rocks occur, however, locally. A belt of Precambrian extends along the bay of Fundy in the province of New Brunswick, and the island of Cape Breton is largely underlain by rocks that are considered of that age. The Gold-bearing series of Nova Scotia, consisting of a thick series of quartzites and slates extending along the southeast border of the province, is usually considered late Precambrian. It is extensively intruded by Devonian granite.

Measures of Cambrian and Ordovician age form a belt along St. Lawrence river. They are made up largely of limestones and shales that have been described under the term Quebec group. In Gaspe peninsula they are accompanied by volcanics with interbedded clastic sediments. The rocks of the Quebec group were deformed and intruded by peridotite intrusions in the Ordovician, a metallogenetic epoch responsible for the asbestos and chromite deposits of the region.

South of the band of Ordovician strata in Gaspe is a great thickness of sediments ranging in age from Silurian to Middle Devonian; in northwestern New Brunswick is a wide area occupied by similar rocks. In places these formations overlap the rocks of the Quebec group and in other localities they have been thrust over them. The axial planes of the folded Silurian and Devonian rocks trend in a northeast direction, but towards the eastern end of Gaspe peninsula they swing to the east. In places they lie in great open folds, but over much of the region the folding is closer with the beds locally crumpled and thrust-faulted. Associated with these rocks in New Brunswick are Ordovician strata and igneous rocks, both volcanic and intrusive.

The main period of folding and of igneous intrusion of the Appalachian and Acadian region, and as a result the chief metallogenetic epoch, was the middle Devonian. Granites of this age occur in Quebec, New Brunswick, and Nova Scotia. The centre of Gaspe peninsula is occupied by a batholith of granite with outlying masses and dykes of syenite and porphyry. It is these intrusions that are responsible for the formation of the zinc-lead deposits on the headwaters of Cascapedia river. In New Brunswick granite stocks and batholiths outcrop along two zones. One begins in the southwestern part of the province and runs in a northeasterly direction towards Chaleur bay; the second extends easterly roughly paralleling the bay of Fundy. The metalliferous deposits that have been located in the province are largely confined to these zones and it is along the borders of these intrusive masses that prospecting might be expected to yield the best results. Much of this country is, however, thickly wooded and covered with a heavy overburden that renders prospecting difficult. Certain occurrences, however, suggest that deposits of commercial value may some day be developed. Near Woodstock a showing of galena has been opened up at the Dominion No. 1 property, and in Albert county zinc and lead deposits have been found at the Lumsden near Albert and on Teahan's prospect near New Ireland.

The Devonian granite batholiths of Nova Scotia have already been mentioned. The Stirling zinc deposit in Cape Breton island is a replacement related to an intrusive of that age, and other minor occurrences have been reported.

The great lowland area in the southeastern part of New Brunswick and on Prince Edward Island is underlain by rocks of Carboniferous age and similar strata extend along the northern part of Nova Scotia. These sediments, which for the most part are flat-lying, are the source of coal, gypsum, and salt, but being younger than the batholithic intrusives are less likely prospecting fields for metalliferous deposits than the older formations. In Nova Scotia a narrow strip of Triassic sandstone and volcanics forms the youngest rock formation of the region.

ST. LAWRENCE REGION

The St. Lawrence region is a lowland extending from the city of Quebec westward to lake Huron. It is made up of three divisions. The first stretches westward up Ottawa River valley to about 50 miles above the city of Ottawa. Below Montreal its average elevation, except for eight hills composed of intrusive rocks, is about 100 feet. The second division extends from Kingston westward to the Niagara escarpment and rises gently from 246 feet at lake Ontario to an elevation of 850 feet. The third extends from the Niagara escarpment westward, occupying the country between lakes Huron and Erie, and reaching a maximum elevation of 1,700 feet.

The underlying rocks of this region are sediments, for the most part little disturbed, which range in age from Cambrian to Devonian. The Cambrian consists of the Potsdam sandstone; the Ordovician, Silurian, and Devonian consist largely of limestones and shales. The only intrusive rocks are the igneous masses forming the Monteregian hills. These are eight in number, of which six occur along an east and west line stretching eastward from Montreal. These hills have centres composed of intrusive rock and flanks of altered and hardened sediments. The intrusives consist of various alkali types such as nepheline syenites, essexites, etc.

In eastern Ontario occur a large number of galena-bearing veins. A large majority cut Precambrian rocks in the region lying between the first and second divisions of the St. Lawrence lowland province. Several, however, in their upper parts traverse Ordovician limestone, making it apparent that all the veins are of post-Ordovician age and belong with the St. Lawrence region rather than with the Canadian Shield.

The origin of these galena veins is a problem of interest. They occupy fault fissures and have sharp, clean-cut walls, often showing slickensiding. The gangue is largely calcite, but barite is commonly present and locally fluorite and selenite. The ore is galena with locally a little sphalerite. The galena is either non-argentiferous or contains but low values in silver. The mineralogy suggests a low temperature origin, and two sources have been suggested. The first theory is that the veins were formed by surface solutions working along fault fissures, and that these solutions derived their material from the limestone beds which they had been traversing. The low temperature character of the minerals and the low silver content of the galena are features in favour of this hypothesis. The second theory of origin is that the solutions had their source in some intrusive mass. There are no post-Ordovician intrusives nearer than mount Royal at Montreal, but it is possible that an intrusive mass or masses similar to the types occurring in the Monteregian hills, underlie portions of eastern Ontario and supplied solutions for the formation of veins along certain fault lines. The presence of fluorite in some of the veins is in favour of this interpretation.

The most important of these deposits is the Kingdon vein at Galetta from which a steady production of lead is maintained. The Frontenac vein at Perth Road near Kingston is another strong vein which has been mined for lead. The Ramsay at Carleton Place, the Hollandia near Bannockburn, and many others have also been developed for lead.

CANADIAN SHIELD

The Canadian Shield is a great V-shaped area surrounding Hudson bay. Its area is 1,825,000 square miles, or over one-half that of the whole of Canada. It is a plateau-like region seldom rising more than 1,500 or 2,000 feet above the sea except in eastern Quebec and Labrador where elevations of over 5,000 feet are reached. Its most characteristic feature is its low relief. Standing anywhere on an elevation an even sky-line meets the eye in every direction. In detail, however, the region has a very irregular topography, consisting of low, hummocky hills and ridges separated by depressions which are commonly occupied by lakes or muskegs. The numerous lakes that cover the region form the second most characteristic topographical feature. They are of all shapes and sizes and are commonly marked by many islands. The rivers are as a rule mere successions of lake expansions connected by reaches in which rapids and waterfalls are numerous.

The rocks of the Canadian Shield are mainly of Precambrian age, forming a continental mass which in Precambrian times extended in all directions beyond the present limits of the Shield. During the succeeding Palæozoic and Mesozoic eras, it was many times at least partly flooded by seas that advanced over it and later retreated. The sediments that accumulated in these seas were largely swept away by later erosion.

Since the beginning of the Cambrian, the Shield has been a stable mass, which has been unaffected by folding or mountain-building movements.

Precambrian history, on the other hand, was very complex, including periods of volcanism, sedimentation, folding, mountain-building, and igneous intrusion, and long periods of quiescence in which erosion was the active process. Precambrian time can conveniently be divided into two major divisions which may be termed early and late Precambrian. Early Precambrian in turn falls into two divisions, in the earlier of which volcanism took place on a tremendous scale and lavas, usually referred to as Keewatin, accumulated over wide areas in thicknesses measured in thousands of feet. With the lavas are locally associated sediments in many cases altered to mica schists. In eastern Ontario and southwestern Quebec is a thick series composed of limestone, quartzite, and sedimentary gneiss known as the Grenville series which is also usually referred to this first part of the early Precambrian period. This period was terminated by widespread but gentle folding movements accompanied by some intrusion of granite. During the second period of the early Precambrian a thick formation of clastic sediments, referred to in northern Ontario as the Timiskaming series, was deposited. This period of sedimentation was succeeded in turn by a mountain-building revolution which was accompanied by widespread intrusion of granite, often referred to as the Algoman batholiths. This formed one of the great metallogenetic epochs of the Precambrian, most of the gold ores, and the copper-zinc sulphide replacement deposits such as the Horne, the Amulet, and Waite-Montgomery of northern Quebec and the Mandy, Flin Flon, and Sherritt-Gordon of northern Manitoba being related to these intrusions. A long period of erosion followed in which country was worn down to one of low relief before the deposition of the formations of late Precambrian time commenced.

The late Precambrian includes the long period during which the Huronian and Keweenawan formations accumulated. The Huronian rocks consist largely of quartzite, dolomite, slate, and iron formation. The Keweenawan consists of sandstone with which are associated great thicknesses of lava flows.

The late Precambrian was also an important metallogenetic period. Intrusions of both acid and basic composition took place. The Killarney granite cuts both the Huronian and Keweenawan rocks. In Timiskaming region the Huronian is intruded by thick sills of quartz diabase. These are responsible for the Ontario silver deposits. In Sudbury district an intrusion of norite between the base of the Huronian rocks and the older complex on which they rest produced the copper-nickel ores of that region. Deposits of zinc in the same basin are also related to the intrusions of this period.

The last period of mineralization affecting the Canadian Shield is the one to which reference has already been made in connexion with the St. Lawrence River region, the one in which the lead-bearing calcite veins of post-Ordovician age were produced. These veins are numerous in eastern Ontario, but only a few have proved of sufficient size to warrant their development for lead.

ARCTIC ARCHIPELAGO AND HUDSON BAY LOWLAND

The islands of the Canadian Arctic archipelago cover more than 500,000 square miles of land area. They include at least twenty having each an area of over 500 square miles, of which Baffin island with an area of 211,000 square miles is the largest. The islands in general form plateaux. In Baffin island the plateau surface rises from 2,000 feet in the south to over 5,000 feet in the north, with peaks rising to elevations of over 6,000 feet. The higher regions are composed largely of Precambrian rocks. Palæozoic strata, lying nearly horizontal, cover wide areas. The most widespread formation is the Niagara or mid-Silurian. On the south side of Ellesmere island over 8,000 feet of strata ranging in age from Middle Silurian to Upper Devonian are exposed. Carboniferous and Triassic sediments also occur on Ellesmere and Tertiary sands and lignites also occur here and in the northwest of Baffin island.

The southwest border of Hudson bay is a lowland underlain by flat-lying strata, ranging in age from Ordovician to Cretaceous. This belt forms an area varying in width from 100 to 200 miles and with a length in a northwest direction of about 800 miles. It rises with a scarcely perceptible gradient from sea-level to an elevation of about 400 feet.

No zinc or lead deposits have been reported as yet from either of these regions. A variety that might be expected to occur somewhere in the flat-lying Palæozoic sediments is the Mississippi Valley type. The severe climatic conditions and the inaccessibility have as yet prohibited prospecting on any extensive scale.

INTERIOR PLAINS

The Interior Plains region of Canada is part of a vast district in the interior of the continent stretching from the gulf of Mexico to the Arctic ocean. In the United States, this includes the great lead and zinc field of the Mississippi Valley region. In Canada this province has no producing properties, but occurrences of the Mississippi Valley type are known to be present on Great Slave lake.

The Interior Plains stretch from the Canadian Shield on the east to the Rocky mountains on the west. At the American border the region has a width of 800 miles, but 1,500 miles to the northwest, at the mouth of Mackenzie river, the width is less than 100 miles. Between Great Bear lake and Mackenzie river, within the northwestern part of the province, is a chain of mountains, the Franklin range, composed of folded strata. Elsewhere throughout the region, however, the underlying rocks are nearly horizontal sediments of Palæozoic, Mesozoic, and Tertiary age.

The southern part of the Interior Plains region of Canada is composed of two main geological divisions. The first is a narrow belt known as the Manitoba lowland. It is underlain by flat-lying Palæozoic strata ranging in age from Ordovician to Devonian which lap over the Precambrian rocks of the Canadian Shield and commonly present a low escarpment at their border. To the north this Palæozoic belt broadens out to form the great Mackenzie lowland.

The second division is a wide belt extending westward to the Rockies. It is underlain by Cretaceous rocks whose border where they overlap the

Palæozoic rocks is a rather abrupt rise known as the Manitoba escarpment, varying in height from 400 to 1,000 feet. From elevations of from 1,000 to 2,000 feet the surface of this second division rises gradually westward until at the border of the mountains the elevations are between 4,000 and 5,000 feet. Wood mountain and Cypress hills are plateaux of flat-lying Tertiary rocks rising to elevations up to 1,000 feet above the level of the surrounding Cretaceous rocks.

The zinc and lead occurrences on Great Slave lake are in dolomite of Middle Devonian age. The deposits so far discovered occupy the crests of what are believed to be low anticlinal folds. The metallic minerals are galena, sphalerite, marcasite, and pyrite, with their oxidation products, smithsonite, yellow oxide of lead, and limonite. The occurrences appear to be pipe-like rather than bedded. Five deposits are known and the amount of ore is considered to be large. These occurrences suggest the possibility that in other localities in this vast physiographic province similar occurrences may some time be uncovered.

CORDILLERAN REGION

The Cordilleran region is the greater producer of zinc and lead in Canada. It comprises the mountainous country bordering the Pacific ocean, or in a general way the province of British Columbia and Yukon territory. It has an average width in Canada of 400 miles and a length in a northwest direction of 1,500 miles. The region is made up of three principal zones. On the east is the Rocky Mountain range, along the coast is a broad belt of mountains known as the Coast range, and between is an intermediate belt composed of plateaux and mountain ranges.

The Rockies have a maximum width of 100 miles and extend from the United States border north to Liard river, a distance of 850 miles. They have many peaks ranging from 10,000 to 12,000 feet in height. North of Liard river the mountains lie 100 miles farther east, between Yukon plateau and Mackenzie district, and are known by the name, Mackenzie mountains.

The Coast range on the west consists of a broad belt of mountains stretching from the international border northward for 1,000 miles into the Yukon. Its width varies from 50 to 100 miles and with it is commonly included the mountainous country of Vancouver and Queen Charlotte islands. The coast-line is marked by long fiords and many islands and the mountains rise abruptly from the water.

The Interior region of plateaux and ranges is separated from the Rocky mountains on the east by a long depression known as the Rocky Mountain trench, occupied by Kootenay river, the headwaters of the Columbia and the Fraser, and by Parsnip and Finlay rivers which unite to form the Peace. On the western side the plateau country either joins the Coast range directly or is separated from it by mountain ranges such as the Cascade of southern British Columbia. The northern part of this interior region is the Yukon plateau, a rolling upland dissected into a series of flat-topped ridges by valleys entrenched to depths of several thousand feet. The Interior Plateaux of southern British Columbia stand at elevations of from 3,000 to 4,000 feet, with valleys cut to a depth of 1,000 feet lower. Between the Interior Plateau proper and the Rocky Mountain trench in southern British Columbia are a series of ranges separated by northwest trending valleys. Of these the Selkirks, reaching elevations up to over 11,000 feet, are the most important.

The rocks of the Cordilleran region range in age from Precambrian to Recent. The Rocky and Mackenzie mountains and the Ogilvie range of northern Yukon consist of sediments of Precambrian, Palæozoic, and Mesozoic age. These were folded in Eocene times. The Coast range consists largely of a complex batholith intruded in late Jurassic or early Cretaceous times into sediments and volcanic rocks of earlier Mesozoic age. The interior belt of plateaux and ranges is underlain largely by late Palæozoic, Mesozoic, and Tertiary sediments and volcanics. The pre-Tertiary beds are cut by numerous igneous rocks related to the Coast Range batholith.

The geological history of the Cordilleran region may be briefly summarized as follows. In Precambrian times sedimentation took place in the Yukon and in central British Columbia where limestones, gneisses, and schists, known under the name Shuswap, occur. The rocks that have been included under this time were, however, altered by intrusives and may consist of metamorphosed phases not only of Precambrian but also later systems. In late Precambrian time another series of quartzites and related sediments accumulated along the site of the present Purcell range. From the Cambrian to the Mississippian sedimentation progressed in the Rocky Mountain and Purcell region. During Pennsylvanian times sedimentation and volcanism took place to the west. Triassic and Jurassic times from the Rocky Mountain region westward to the Pacific were marked by volcanic activity on a great scale. In late Jurassic or early Cretaceous times, mountain building took place. The Selkirk and Coast ranges were formed and the Coast Range batholith intruded. In later Cretaceous time sedimentation took place on either side of the Jurassic ranges. Late Cretaceous was a period of erosion in which the mountains were peneplaned and the granite cores of the mountains were unroofed.

In the Eocene came the Laramide revolution in which the Rocky mountains were built. The base-levelled region to the west was also uplifted and subjected once again to active erosion. Parts of the Interior Plateau region were also folded and local igneous intrusions took place. During the succeeding Oligocene period, local movements again occurred, with intrusions and possibly general uplift. The Miocene was a period of great fissure eruptions and during the Pliocene volcanism again took place with general uplift and subsequent valley cutting. During the Pleistocene most of the region, with the exception of some of the higher portions, was covered by the Cordilleran ice cap, and the whole region was depressed. Recent times have been marked by uplift varying from 450 to 1,000 feet.

The intrusion of the Coast Range batholith formed the most important event in the history of the Cordilleran region from the point of view of ore deposits. A few deposits of British Columbia may be of younger or older age, but nearly all may be said to be related to it. The intrusion accompanied folding and mountain building and later erosion uncovered the upper parts of the intrusive mass. The exposed part of the batholith forms a continuous band averaging about 100 miles in width, along the Pacific coast in Canada. To the east of this main mass are numerous smaller intrusions that represent batholiths and stocks, most of which are probably connected at depth with the main mass. The intrusion of all these did not necessarily take place at the same time, but all or nearly all are of Mesozoic age, presumably pre-late-Cretaceous.

The prevailing rock of the Coast Range and subsidiary batholiths varies in composition from granite to diorite and the metals of the ore deposits associated with it are gold, silver, copper, lead, zinc, iron, antimony, arsenic, manganese, molybdenum, and tungsten. The deposits are not scattered uniformly around the main mass, nor do all the smaller masses show a like proportion of mineral occurrences. In places, apparently, dissection has been so deep that most of the mineral deposits have been eroded away, whereas in other places erosion has not progressed sufficiently deep to expose the mineralization. The nature of the intruded rock as a precipitating agent, and the character of the contact, whether steep or gently sloping, are also factors determining the presence or absence of mineralization at any particular point. Certain intrusive masses were evidently great mineral carriers. For example, the Nelson batholith has hundreds of deposits chiefly of the silver-lead-zinc variety in and around it and numerous mines have produced and are producing ore.

The mineralization around these intrusive masses exhibits a zoning. At the border of the intrusion the minerals present are of the high temperature variety such as scheelite, wolframite, molybdenite, and magnetite. The gold deposits also occur in this zone. Gradually the zone changes into one in which copper is the chief metal present, and still farther from the intrusive mass are the silver-lead-zinc deposits. The zoning developed essentially in a vertical direction with respect to the upper surface of the intrusive batholiths that lie beneath the surface and that here and there protrude to relatively high levels, but it has been made apparent locally in a horizontal plane. Hanson[1] has described an example of such zoning in Zymoetz River area, along the eastern border of the Coast Range batholith. As the result of plotting the available information concerning the deposits of British Columbia east of the batholith on large scale maps he concludes that in other districts there is to be observed a similar zonal arrangement which would probably be still more apparent if the information about the location, elevation above sea-level, and the mineral content of the veins had been more complete.

The deposits of zinc and lead are commonly of the intermediate temperature variety. Though they are usually associated together there is a tendency for the zinc to extend over into the copper zone nearer the parent intrusive. In the Cordilleran region the zinc-lead deposits form three main types, fissure veins, replacements, and contact metamorphic. The Sullivan, as an example of a replacement deposit, the Slocan deposits as examples of fissure veins, and the occurrence at Lund as a contact metamorphic have already been mentioned and will be described in more detail in a later chapter.

[1]Hanson, G.: "Zoning of Mineral Deposits in British Columbia"; Trans. Roy. Soc., Canada, sec. IV, pp. 119-126 (1927).

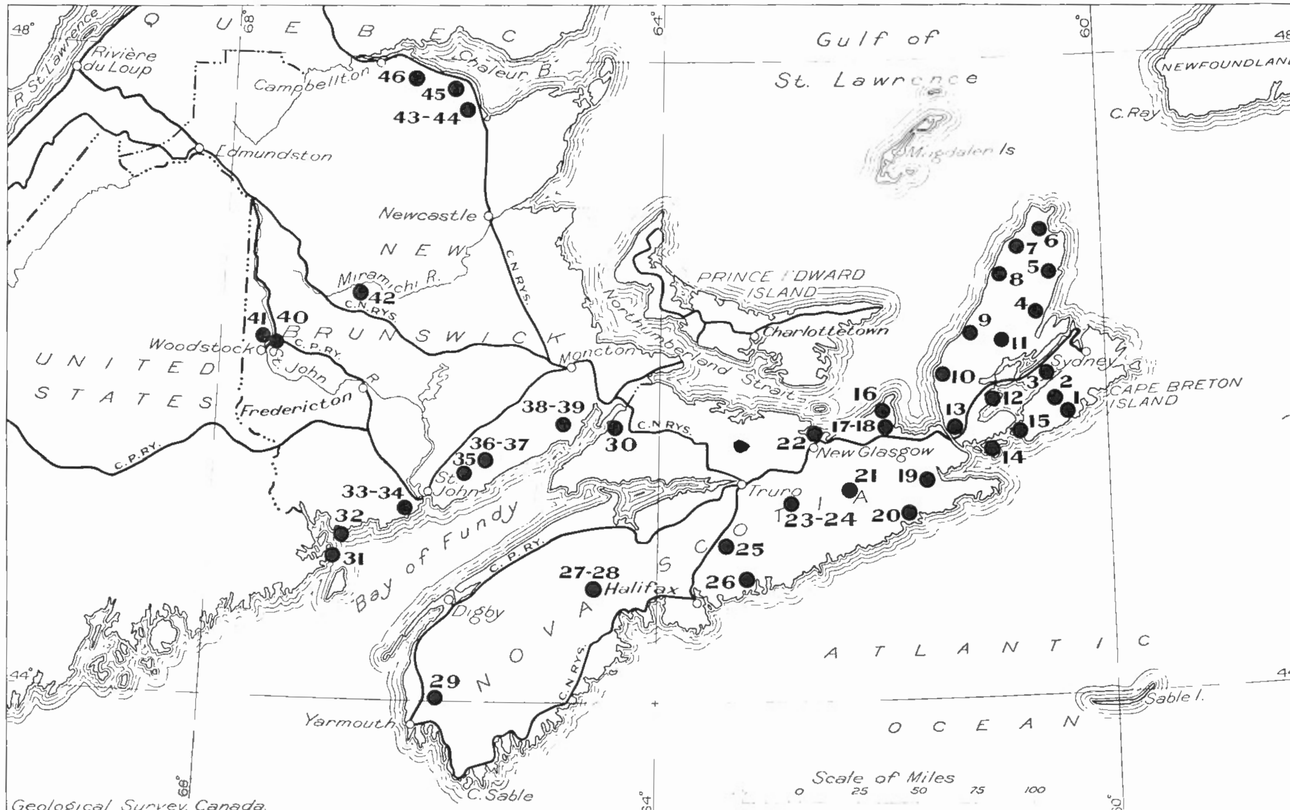


Figure 1. Index map of Nova Scotia and New Brunswick showing location of zinc and lead occurrences. For explanation of figure See page 40.

Explanation of Figure 1

Nova Scotia

1. Stirling
2. Loch Lomond
3. Boisdale
4. North and Barachois rivers
5. Clyburn valley
6. Aspy bay
7. Pleasant bay
8. Faribault brook
9. Southwest Margaree
10. Port Hood
11. Middle river, Victoria county
12. Washaback mines
13. Hawkesbury harbour
14. Arichat
15. St. Peters
16. Arisaig
17. Antigonish Harbour
18. Ohio river
19. Salmon river, Guysborough county
20. Wine Harbour
21. Hirschfield galena prospect
22. Pictou Coal Field
23. Pembroke
24. Leadvale
25. Gay river
26. Dunbrack
27. New Ross
28. Ramsay lake
29. North Carleton
30. Joggins coal mine

New Brunswick

31. Campobello
32. Frye island
33. Musquash harbour
34. Frenchman creek, St. John county
35. Quispamsis
36. Hammond river
37. Norton
38. Teaham prospect
39. Lumsden
40. Dominion No. 1
41. Britton mine
42. Winding hill
43. Rocky brook
44. Nigadoo
45. Elmtree
46. Bighole brook

CHAPTER IV

OCCURRENCES IN EASTERN AND CENTRAL CANADA

NOVA SCOTIA

(1)[1] Stirling Zinc Property

(*See* Figures 2, 3, and 4)

References

Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept. 1916, pp. 255-260.
Hayes, A. O.: Geol. Surv., Canada, Sum. Rept. 1917, pt. F, p. 30; 1918, pt. F, pp. 20-21.
Weeks, L. J.: Geol. Surv., Canada, Sum. Rept. 1924, pt. C, pp. 199-217.
McLaren, G. R.: N.S. Dept. of Public Works and Mines, Reports on the Mines, 1925, pp. 169-172; 1926, p. 88.
Legg, R. E.: N.S. Dept. of Public Works and Mines, Report on the Mines, 1927, p. 100.

LOCATION

Stirling is about 4 miles inland from the south coast of Cape Breton, the nearest point on the coast being Framboise cove. It is 35 miles by road from the railway at St. Peter and approximately 40 miles from the railway at Sydney.

HISTORY

The first development work on the property is believed to have been carried out in 1904 when a small pit was opened. Since the occurrence was then regarded as a copper prospect the small amounts of sulphides of that metal present did not encourage further work. Zinc blende was found, however, and during the war the property became of interest as a possible producer of zinc. In August, 1916, two licences to search were granted to Mr. James Nolan, and he took two leases of one-half square mile each. In 1927 six leases were held, five of which were owned by the Eastern Mining and Milling Company.

Diamond drilling was done by Hayden and Stone, and shot drilling by the New Jersey Zinc Company, both of which operations were performed under options that were not taken up. Both, however, showed the presence of ore with depth.

In the spring of 1925 an option on the property was taken by the American Cyanamid Company of New York. In July they commenced sinking a shaft alongside the main ore zone. It was put down to a depth of 400 feet and over 500 feet of work carried out on that level. Work was discontinued in the summer of 1926.

[1]This and the numbers attached to all locality names are locality numbers and appear on the various index maps (Figure 1, etc.)

In May, 1927, work was commenced on the property by the British Metal Corporation (Canada). Using the same shaft, they proceeded with horizontal work on the 200-foot level.

TOPOGRAPHY

The relief around Stirling is low. There are numerous lakes and ponds and few elevations reach a height of 200 feet above these adjacent depressions. Outcrops are few and are confined to the beds of streams and the shores of lakes with an occasional showing on areas of flat land. The hills consist of gravels and boulders deposited during the Pleistocene glaciation and the differences of relief are apparently due largely to the varying thicknesses of this ice-deposited overburden.

GEOLOGY

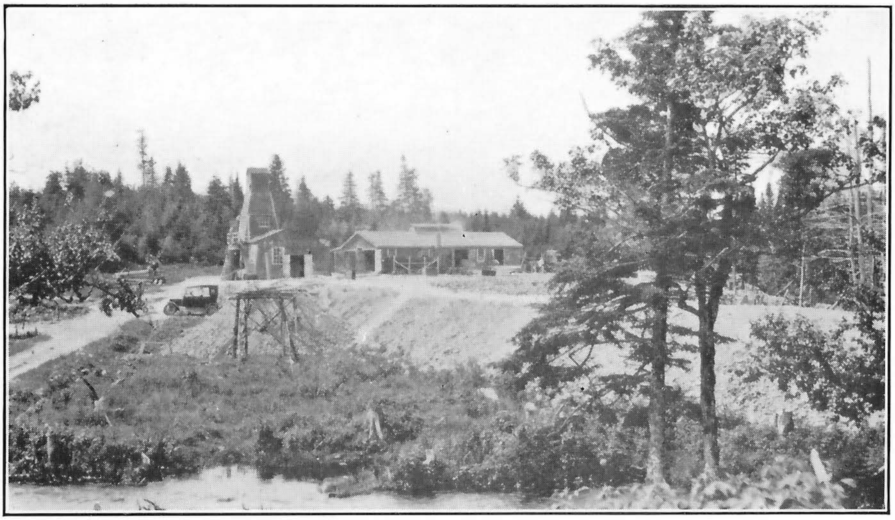
The rock succession according to Weeks is as follows:

Devonian (?)	Quartz diorite, granite, basic intrusives
May possibly be later than the intrusives.	Sandstone, arkose, conglomerate
	Unconformity
	Slate, shale, with a conformable sandstone member
	Unconformity (?)
	Volcanic flows, tuffs
	Unconformity
Precambrian (?)	Quartzite, quartzite-conglomerate
Precambrian	Schist complex, cut by a granite-gneiss

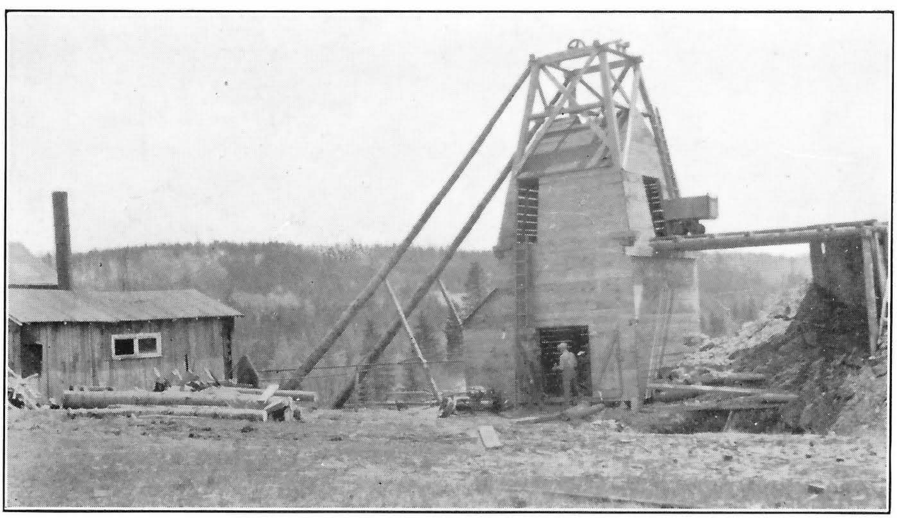
The Precambrian schists outcrop along the coast between Fourchu and Capelin cove. They are highly metamorphosed rocks of, apparently, volcanic origin and are intruded by granite-gneiss which outcrops on the coast around Capelin cove. The granite-gneiss has been intensely deformed and for that reason it and the associated schists are considered to be the oldest rocks in the district.

Quartzite believed to be possibly of Precambrian age is exposed on Five Island lake and branches of Marie Joseph river. It is white, is in some cases conglomeratic, and as a rule shows considerable deposited silica. Around Stirling lake it is cut by many small diabase dykes and by a stock of quartz diorite. On Framboise river, above Five Island lake, a small outcrop of the quartzite seems to dip under volcanics.

In the vicinity of the Stirling ore deposits, the predominant rock is rhyolite or rhyolite tuff; greenstone occurs nearby, and also outcrops of sericite schist. A group of slates, with a sandstone member, is believed to be younger than these volcanics. Similar strata on the nearby Mira river



A. Stirling zinc mine, Cape Breton, N.S.



B. Leadvale galena-sphalerite property, Leadvale, N.S.

were placed by Matthew from fossil evidence in the Cambrian. On Middle and Framboise rivers are exposures of reddish sandstone, arkoses, and conglomerates characterized by comparatively low dips.

Intrusive rocks cutting the older strata and possibly also younger than any of the sediments consist of quartz diorite, granite, and basic dykes. In the neighbourhood of Stirling the quartz diorite forms two stocks. The rock is coarse grained, grey, and consists of quartz, acidic plagioclase, hornblende, chlorite, and magnetite. Deformation has been slight. Granite is found on the Loch Lomond road, on the Saint Esprit road, and the road to Capelin cove. It is a coarse-grained, fresh variety similar to the Devonian granites of the Nova Scotian mainland. Diabase dykes and small masses of diorite porphyry cut the volcanics.

CHARACTER OF THE DEPOSIT

The mineral deposits occur as replacements of members of the supposedly younger volcanic series, consisting in greater part of acid flows and tuffs. These rocks have been sheared into sericite and chlorite schists and the replacement took place in parallel bands following the planes of schistosity. In places the original rock has been altered to quartz, whitish dolomite, sphalerite, chalcopyrite, and pyrite. There is every degree of replacement from country rock containing small amounts of disseminated sulphides to masses of ore consisting of solid sulphides. Nearly everywhere the ores are banded, the banding being parallel to the strike of the orebody and the schistosity of the volcanics.

The ore minerals are sphalerite, galena, chalcopyrite, and pyrite. The associated gangue minerals consist mostly of quartz and feldspar with small amounts of other minerals common to volcanic rocks, they being the unreplaced residuals of the original country rock. The ore is extremely fine in grain, and gangue and ore minerals are alike in size and intimately admixed. The high-grade ore is black or dark grey with a slight bluish tint and with yellow streaks richer in pyrite and chalcopyrite producing the banded appearance. The lower grades of ore form complete gradations from high-grade ore to country rock with slight mineralization.

Ore has been exposed by surface trenching over a length of 450 feet. The width of the deposit is somewhat obscure, but in one trench, " A ", it is 90 feet which includes, however, two bands of schist.

A small zone of mineralization is located on Copper brook, nearly a mile below the main workings. The mineralized zone outcrops on the brook for a few yards and consists of a pyrite replacement of a rhyolite.

DEVELOPMENT

The relative positions of surface exposures, trenches, etc., are shown in Figure 2. The terms high grade, intermediate grade, and low grade are applied respectively to ore with assay contents of zinc of 20 per cent and over, from 10 per cent to 20 per cent, and for less than 10 per cent.

In trench " A " mineralization is represented by five bands of ore, one high grade on the north, separated from the remainder by 1·1 feet of fine-grained, slightly schistose greenstone, two intermediate, and two low-grade,

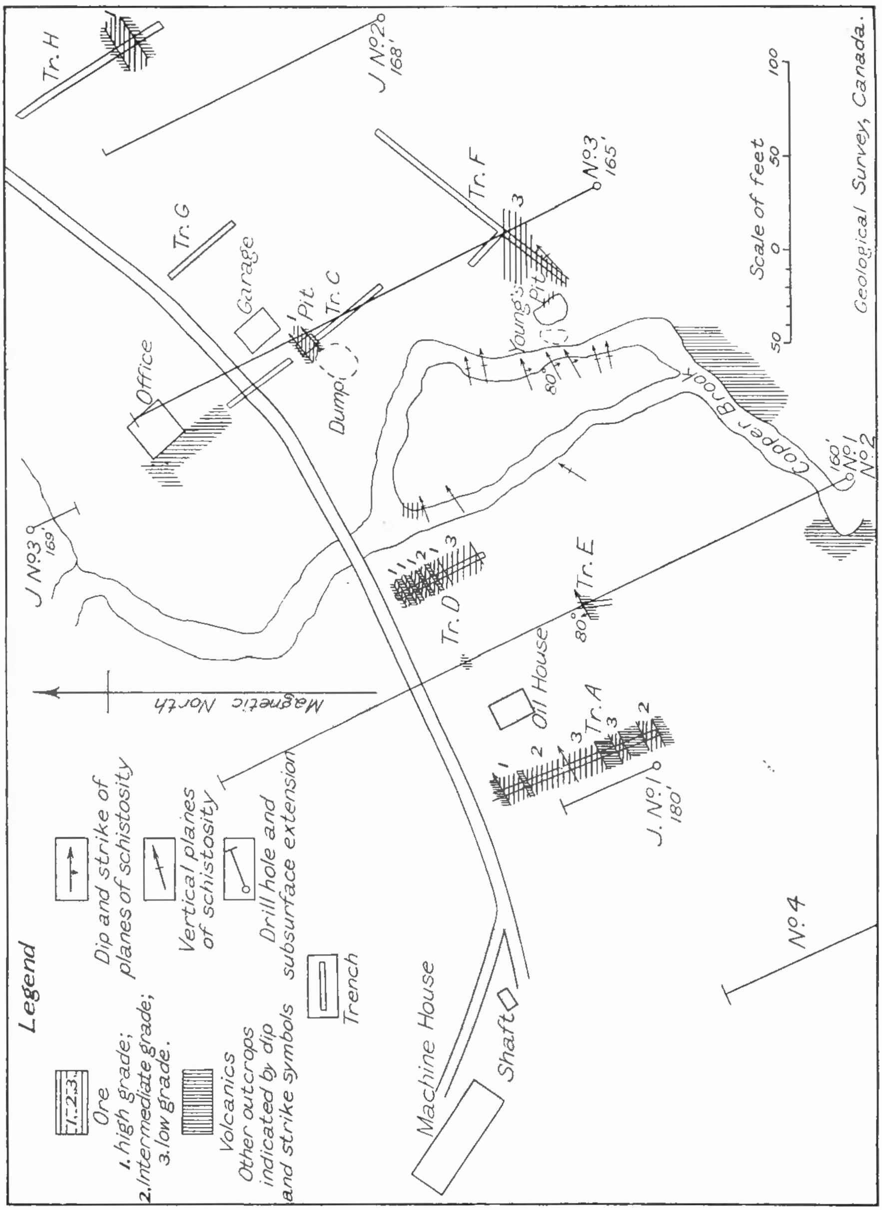


Figure 2. Stirling zinc deposit, Richmond county, N.S.

belts. The wider of the two intermediate-grade belts contains 2 feet of estimated high-grade ore, but when assayed as a whole, the body is of intermediate grade. The succession and widths of ore and country rock are shown in Figure 2. In trench " D " which lies 120 feet northeast of " A ", are four bands of high-grade ore, separated by thin bands of greenstone, and one band each of intermediate and low-grade ore. In trench " C ", 140 feet northeast of " D ", no exposures are observable, but in the pit high-grade ore is exposed on two opposite walls. In trench " H " a width of high or medium grade ore of 11 feet, containing a few stringers of schist, was measured. Trench " F " shows volcanic rock mineralized with pyrite and some sphalerite, and cut by stringers of quartz.

The preceding account is essentially derived from the report by Weeks. In the summer of 1926 the property was visited by M. E. Wilson who examined the underground work performed by the American Cyanamid Company. In August, 1927, the writer visited the property and was shown the work performed to that date by the British Metal Corporation (Canada). The rocks as seen underground consist of volcanics, rhyolites, dacites, etc., all more or less altered. Associated with them are some finely banded types that are apparently tuffs. All contain disseminated pyrite. At places the rocks change into varieties consisting largely of secondary dolomite and pyrite and locally there is a development of talc along shear planes. The schistose phases with dolomite and pyrite carry, as a rule, low values in zinc, with traces of lead and copper. The ore zones consist of solid masses of sulphides or of schist with sulphides. The sulphide masses consist of an intimate mixture of sphalerite, pyrite, chalcopyrite, and galena. In August, 1927, a zone of ore 35 feet wide averaging 17 per cent zinc was being followed. In December, 1928, the company stated that they had followed the ore zone on the 200-foot level for a distance of 600 feet and had blocked out 200,000 tons of ore between that level and the surface.

ORIGIN

The deposits are replacements of the volcanic rocks. The gangue material consists of remnants of the altered volcanics. In the higher grades of ores, the gangue occurs in isolated blebs in the ore minerals, these relations being reversed in the lower grades. The pyrite represents the earliest stage of mineralization. It is found throughout the ores in distinct crystals, surrounded by the other ore minerals. Occasionally a tongue of sphalerite cuts into a pyrite crystal suggesting a replacement of the pyrite by the later sphalerite. Sphalerite, galena, and chalcopyrite fill cracks and interstices in pyrite fragments showing that the latter were fractured prior to the deposition of these minerals.

The source of the mineralizing solutions is believed to be the deep-seated intrusives that cut the volcanics. The replacement followed the planes of schistosity in the volcanics.

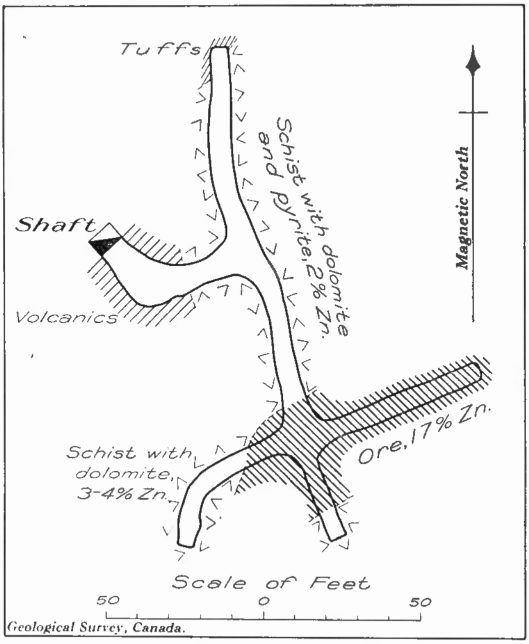


Figure 3. Stirling zinc deposit, plan of 200-foot level, August, 1927.

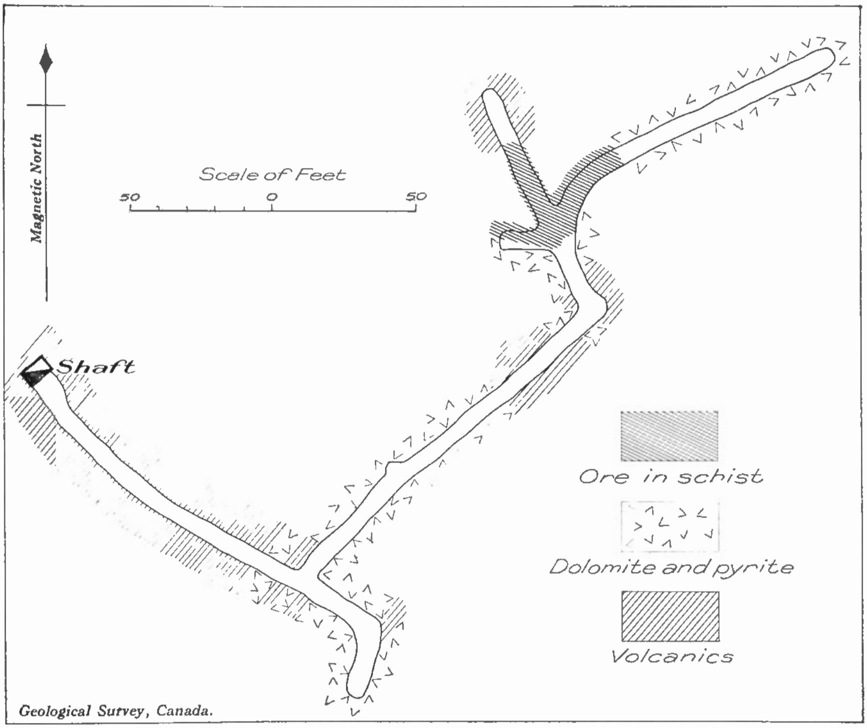


Figure 4. Stirling zinc deposit, plan of 400-foot level.

(2) Loch Lomond

References

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1882-84, pt. H, p. 93.
Hoffmann, G. C.: Geol. Surv., Canada, Ann. Rept. 1898, pt. R, p. 23.

Fletcher reports:

" ....Near the head of Loch Lomond, small pits have been sunk in massive grey limestone containing fossils. A minute quantity of galena is disseminated in it as small grains. In a large brook between this point and Mira river is a dark breccia, probably one of the basal beds of the Millstone Grit, containing large fragments of compact felsite, bound together by a rusty calcareous cement containing galena. Some of the layers for a thickness of 4 feet have been mined and several tons of ore extracted. A specimen analysed by Mr. Adams yielded 2·879 ounces of silver to the ton, the galena constituting but a small proportion of the whole."

Hoffmann reports:

"From the Rev. Mr. Sinclair's place, Loch Lomond, Richmond county, a white, subtranslucent quartz, carrying small quantities of galena and copper pyrite. The sample, consisting of several fragments, weighed 17 pounds. Assays showed it to contain:

Gold........................none
Silver........................1·225 ounce to the ton of 2,000 pounds

Determinations of the lead and copper in this zone:

Lead........................9·43 per cent
Copper......................2·03 per cent"

(3) Boisdale Silver-lead Prospect

Reference

Rept. Dept. of Mines, N.S., 1909, p. 175.

"This company (The King Edward Exploration, Smelting, Refining, of Cape Breton, Limited) have carried on extensive prospecting and development work for galena along the contact of the Carboniferous limestone with the conglomerate at rear of Boisdale, Cape Breton county. A number of test pits have been put down ranging in depth from 15 to 40 feet, and at a point about one-quarter of a mile in a westerly direction from the junction of Gillis Lake road with the Bourinot road, a shaft has been sunk on a galena prospect. At the end of the year this shaft was down 70 feet deep, with drifts east and west at the bottom, 29 and 30 feet respectively. The deposit, so far opened in the shaft, is from 2 to 7 feet in width, and in places shows much of galena."

(4) North and Barachois Rivers

References

Fletcher, H.: Geol. Surv., Canada, Repts. of Prog. 1876-77, pp. 451-452; and 1882-84, pt. H, p. 94.

Fletcher reports:

"The hills between St. Ann harbour and North river, which attain a height of upwards of 1,000 feet, furnish some of the grandest scenery of the island. On the west shore of the harbour, after leaving the fringe of red Carboniferous rock at the base of the bar, we encounter compact felsite and porphyry, of greenish and other colours, succeeded near McDonald pond by syenite, which is said also to occupy the tops of these hills. A mile or two from the shore, on the road between McDonald pond and the upper settlement of North river, a number of small quartz veins occur, abounding in specks of galena, copper pyrites, black and honey-coloured blende and iron pyrites.

They seem to have no persisting nor definite direction, but blend with the red syenite. On a small tributary of Barachois brook, near the road, several of them have been sufficiently developed to prove their worthlessness. In one place, a quartzose belt, 3 or 4 feet wide, occurs in a soft, slaty, greenish black rock.

On Donald McDonald's farm, about a mile north of the bridge at the head of tide-water in North river, a much more important deposit has been mined by Messrs. Ingraham, Blackett, Gisborne, Dr. McKay, and others, without satisfactory results. The vein is ill-defined, but varies from 2 to 3 inches to a foot in thickness, being in one place split by a band of 18 inches mixed quartz and feldspar. The vein-stone is quartz, often brecciated, carrying galena, copper pyrites, and black blende in abundance. A parting divides it from the overlying rock, while the lower, and generally the richest, part, adheres strongly to the foot-wall. The trend of this vein is about north 26 degrees west—in one place north 6 degrees west—the dip easterly at an angle of 45 degrees; but both strike and dip are variable. The wall-rock is a greenish, jointed, porphyritic felsite, followed higher in the brook by red and green mottled felsites, like those of Gabarus, Louisburg, and Coxheath.

An analysis, made for Mr. Gisborne at the Boston School of Technology, of a sample of 900 pounds of ore from this vein, yielded at the rate of 501 pounds of concentrated ore to the ton, or 155 pounds of ingot lead, and 2·95 ounces of silver."

In the 1882-84 Report of Progress Fletcher reports:

"Some further desultory work has been done at the North river of St. Ann at the mine. In the workings the vein now dips north 83 degrees east 30 degrees, and carries calcspar, varying from 1 foot to 7 inches downward, but where thickest it is barren and split by bands of the country rock. In one place it is 6 inches thick and contains ¾ of an inch of galena, but generally the galena is mixed with yellow and purple copper ore, or sometimes nearly replaced by black blende.

Further explorations in the veins in the syenite of the Barachois vein have not led to an improvement in their prospects, the largest being less than 6 inches in thickness. In some places, however, the vein consists almost entirely of galena, while in others copper pyrites is present.

(5) Clyburn Valley

Reference

Wright, W. J.: Geol. Surv., Canada, Sum. Rept. 1913, p. 282.

LOCATION

Clyburn brook is in Victoria county, Cape Breton, and empties into the Atlantic ocean about 40 miles north of Sydney. Three prospects have been opened up in this locality on silver-lead ores, one on Blue brook, one on Slate brook, and a third on the ridge between the two brooks. These two streams enter Clyburn brook from the north about 1½ miles and 2 miles, respectively, west of the Franey gold mine.

GEOLOGY

The rocks of the region consist of Lower Carboniferous conglomerate, dolomitic limestone, gypsum, sandstones, and shales, and a pre-Carboniferous complex consisting of slates and schists, intrusive, grey, gneissoid quartz diorite, dark basic dykes, and a batholith and dykes of pinkish granite.

DEPOSITS

The silver-lead deposits on Blue brook and Slate brook occur in a zone along the contact between the granite and the intruded slates and schists.

The granite is fine-grained and is considerably shattered and impregnated with pegmatitic material and quartz. The quartz is bluish white and occurs as small veins and irregular masses up to several feet across. Some of the masses have well-defined boundaries; others grade into pegmatite and granite. The galena occurs chiefly in small, irregular vugs in the quartz and granite. Small amounts of sphalerite and pyrite are also present.

An assay of a sample gave the following: gold, 0·0; silver, 9·37 ounces per ton; lead, 9·6 per cent.

ORIGIN

The deposits are considered to have been deposited with the pegmatitic and aplitic rock in which they are found and to have had their origin in the granite.

POSSIBILITIES

The sporadic nature of the deposits and their association with pegmatite do not appear to offer any hope that they will ever be of commercial importance.

(6) Aspey Bay, Victoria County

Reference

Fletcher, H.: Geol. Surv., Canada, Ann. Rept. N.S., vol. XVI, pt. A, p. 297 (1907).

Galena is reported by Fletcher to occur in small quantities in limestone at the contact of the Lower Carboniferous limestone with Precambrian gneiss and pegmatite.

(7) Pleasant Bay, Inverness County

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1882-83-84, pt. H, p. 93.

Fletcher reports:

"At Pleasant bay, near the mouth of Mackenzie river, grey quartzose grit with patches of greenish and reddish fine sandstone is associated with a dark grey and brownish, highly bituminous, limestone, with calcspar veins. The veins hold galena, which is also disseminated in the limestone and grit. These rocks do not extend far inland, but are surrounded by the underlying gneiss. The galena occurs chiefly in two veins 5½ and 3 feet thick respectively, and a shaft 15 to 20 feet deep has been sunk in each. The galena contains both silver and gold, and is associated with copper pyrites. At the mouth of the river, copper pyrites and galena appear in specks with iron pyrites and fluorspar in the strings of white quartz that penetrate the syenite and granite.

Professor How mentions bitumen also as found in the calcite of this locality. The "mine" has been known for many years and a large sum of money spent in exploring it."

(8) Faribault Brook Prospects

References

Woodman, J. E.: N.S. Dept. of Mines, 1898, pp. 18-39.

Grandin, M. V.: "Notes on the Deposits of South Cheticamp, Cape Breton Island, N.S."; Proc. and Trans. N.S. Inst. of Sci., vol. XI, pp. 347-360 (1902-1906).

Mason, F. H.: (Quoted) Geol. Surv., Canada, Ann. Rept., N.S., vol. XV, pp. 242-3 (1907).

LOCATION

Faribault brook, or L'Abime brook, as it is known locally, is a branch of Cheticamp river which enters the gulf of St. Lawrence immediately north of Cheticamp or Eastern Harbour in the northern part of Cape Breton island. Eastern Harbour has no railway connexions, but may be reached by motor or by steamer from Mulgrave. The galena prospect lies about 5 miles to the northeast on the east bank of Faribault brook, 1,100 yards above the mouth. An old wagon road can be followed to within a short distance of the property.

HISTORY

The creek was first prospected for gold. In 1897 an outcrop of quartz and galena was discovered near the creek. A shipment of cobbed ore was made to Swansea. A mill was then erected on the property. No. I incline was put down in 1898 and No. II in 1901. A dam was built on the brook and a flume 2,600 feet long brought the water to the mill. Not enough ore was found to make the property a commercial success and work was discontinued.

In 1927 work was again carried out on the property. It has been leased by Mr. R. E. G. Burroughs, and two companies—Alderson, MacKay, and Armstrong, and the Harvie Mining Company—had leases from him. The main workings were pumped out and a prospecting campaign was carried out in the surrounding region.

TOPOGRAPHY

The region around Cheticamp shows two natural divisions, a narrow plain along the coast and a high plateau to the east. The latter has an average elevation of about 1,200 feet and is cut by deep gorges and valleys. Settlements are confined to the narrow seaboard plain.

GEOLOGY

The rocks of the region around Cheticamp fall into two main divisions, Carboniferous sediments, and a complex of schists and crystalline rocks of pre-Carboniferous, probably Precambrian age. The former consist of conglomerates, sandstones, shales, limestones, and gypsum, occupying the seaboard plain and the fringe of ridges along the foot of the escarpment at the edge of the plateau. The pre-Carboniferous rocks form the high plateau and consist of granites, syenites, gneisses, and schists. Along the edge of the plateau granitic rocks are the most abundant and are cut by dark basic dykes. The pre-Carboniferous complex has been extensively sheared and faulted. The contact between the Carboniferous and older rocks is a fault plane following the course of the escarpment.

In the neighbourhood of the galena prospect the rocks are schists whose planes of schistosity vary considerably in strike and dip. At the main workings they strike north 70 degrees east magnetic and dip about 30 degrees northwest. The schists are of two varieties, a light-coloured sericite type containing nodules of garnet, and dark-coloured chlorite and hornblende schists. The former probably represent altered quartzose sediments and the latter basic volcanic rocks. At the dam 2,600 feet above the mill-site, the rocks are dark volcanics. About a quarter of a mile above the dam the rocks are quartzose biotite-sericite schists whose schistosity planes are almost flat. The schists in places carry disseminated arsenopyrite.

ORE DEPOSITS

The mineralization consists of sulphides and quartz along the foliation planes of the schists and in places forming stringers cutting across the schistosity. The amount of mineralization is very small and it is difficult to understand why a mill was erected on such small showings. The sulphide minerals are galena, sphalerite, arsenopyrite, pyrite, chalcopyrite, and pyrrhotite. Woodman mentions the presence of niccolite in some of the quartz stringers. The sulphides for the most part lie along the foliation planes in small lenses. These lenses are for the most part less than an inch in width at most, and only a few feet long, and occur irregularly distributed. Some of the lenses consist of solid sphalerite, others of solid galena, and in still others the two sulphides are associated. In places the sulphide lenses cut across the foliation planes.

DEVELOPMENT

At the mill-site there are five openings on the north or east side of the creek. Under ordinary conditions these are full of water. No. 3 is the deepest and was pumped out at the time of the writer's visit in 1927, so that an examination was possible. It is an incline approximately 110 feet long dipping north at an angle of 20 degrees and following the foliation planes of the schists which consist of a dark grey schist overlying a white sericite schist. The mineralization consists of a few narrow lenses of galena and sphalerite lying along the foliation planes. The lenses average less than 1 inch in width. The greatest width is about 5 inches. In the face at the bottom of the incline, a few small stringers of sulphides cut across the schistosity. The results of a series of seven channel samples in this incline were furnished by Mr. R. E. G. Burroughs. These were taken at intervals of 10 feet in the lower part of the incline. The highest values obtained were 1·02 per cent Pb and 0·87 per cent Zn; the average of all the samples was 0·67 per cent Pb and 0·66 per cent Zn.

No. 2 working is an incline whose opening is about 20 feet west of that of No. 3. It joins No. 3 incline at a point 35 feet from the mouth of No. 3. Workings Nos. 1 and 4 are shallow cuts. Working No. 5 is an incline to the north about 35 feet long; an average of six channel samples across its walls gave 0·09 per cent Pb and 1·5 per cent Zn.

A few scattered lenses of sulphides have been found in the schists on the south side of Faribault brook.

About a quarter of a mile above the dam on Faribault brook an opening was made in the rocks on the right bank of the stream. The mineralization here consists of small quartz stringers and small lenses of pyrrhotite and arsenopyrite along the foliation planes of the quartzose schists.

DAPHINE BROOK

In the summer of 1927 an occurrence of sulphides was found on Daphine brook, a tributary of Cheticamp river, which it joins about three-quarters of a mile east of Faribault brook. The prospect is $\frac{3}{4}$ mile up the brook and nearly 1 mile east of the prospect on Faribault brook. The rocks are dark grey, biotite-sericite-quartzose schists. In places throughout a distance of 200 feet along the creek, mineralization consisting of sulphides and associated quartz is exposed. The sulphides consist of sphalerite, galena, pyrrhotite, chalcopyrite, and pyrite. In places the sulphides are disseminated in the rock and in other places they form masses, with minor amounts of quartz, lying for the most part along the foliation planes. The largest lens exposed at the time of the writer's visit has a maximum width of 7 inches and an exposed length of about 3 feet.

ORIGIN

The presence of pyrrhotite and arsenopyrite suggests that the deposits are of high temperature origin and it is believed that the source of the solutions was the granite which intrudes the schists. The mineralization was later than the development of the schistosity. This is shown by the presence of seams of sulphides and quartz, which occupy fractures cutting across the foliation planes. The deposits are believed to be due largely to replacement, the fractures and schistosity planes having served as planes of access for the mineralizing solutions. They may, however, be due in part to impregnations along planes of shear.

(9) South West Margaree

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1882-84, pt. H, p. 93.

Fletcher reports:

"On the hill at D. Norman McVarish's, South West Margaree, one of these limestone strata (Carboniferous) is full of minute veins of calcspar and quartz, holding minute traces of galena."

(10) Port Hood

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1882-84, pt. H, p. 94.

Fletcher reports:

"A small vein containing galena, of no commercial value, was also found in the sandstone of the Coal Measures at Port Hood, between two seams of coal, and traces of galena also occur in the Precambrian rocks as in Cheticamp river."

(11) Middle River, Victoria County

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1882-83-84, pt. H, p. 30.

On Middle river, according to Fletcher, small amounts of zinc blende occur with hornblende schists and intrusive granite and syenite.

"In the river as far as Duncan brook, talc, hornblende and mica-schists, and quartzite form rapids. On the weathered surface there are scattered minute, red crystals of garnet . . . . . Some of the hornblende schists pass into coarse, reddish syenite and contain emerald green spots of quartz and dark brown specks of crystalline zinc blende. Coarse, rough jointed, broken granite and a dark trappean and diorite rock, speckled with quartz, feldspar, and iron pyrite, somewhat vesicular and traversed by a 1-foot vein of quartz, break through talcose mica-schist and coarse granite."

The mineral association suggests an intermediate or high temperature origin with the granitic intrusive as the source of the sphalerite.

(12) Washaback Mines, Victoria County

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1876-77, p. 451.

Fletcher reports:

"Mining operations were undertaken on a small scale about 12 years ago by Mr. Alexander Cameron, of Baddeck, and others, to test the value of the quartz veins of the schistose rocks of Burnt Head and Boulaceet Harbour. At the former place a number of irregular, ferruginous quartz veins, the largest about 15 inches thick, hold traces of argentiferous galena, copper, and iron pyrites. An analysis, by Dr. Hayes, of Boston, of specimens from one of these veins, shows it to contain 39 ounces 10 pennyweights, 12 grains of silver to the ton. At Boulaceet Harbour another vein, which varies from ½ inch to 4 inches in thickness, with small barren feeders, runs nearly at right angles to the strike of the rocks, and dips eastward at an angle of 27 degrees. In this vein a rich pocket of galena, containing gold, sulphide of silver, copper and iron pyrites, produced at the rate of 18 ounces, 9 pennyweights, 3 grains of gold and 97 ounces, 10 pennyweights, 14 grains of silver to the ton. Scattered through the hornblendic and quartzose rocks in which the vein is contained are grains of copper pyrites and specular iron ore. As there appeared to be little prospect of the discovery of other rich pockets, and as the rock is hard to work, the mine was abandoned."

(13) Hawkesbury Harbour, Inverness County

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1879-80, pt. F, p. 85.

Fletcher reports that bed No. 53 in the section at Hawkesbury harbour consists of "light grey, fine, flaggy, and shaly sandstone, with minute veins of calcspar. One of these veins contains black and honey-coloured zinc blende."

(14) Arichat Harbour, Richmond County

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1879-80, pt. F, p. 123.

Fletcher reports:

"A considerable quantity of this ore of lead (galena) was discovered many years ago in the limestone at the head of Arichat harbour, and to some extent wrought."

(15) St. Peters, Richmond County

Reference

Fletcher, H.: Geol. Surv., Canada, Rept. of Prog. 1877-78, pt. F, p. 18.

Fletcher reports:

"Limestone, bluish and grey, compact, crystalline, and concretionary, massive or slaty, contorted and variable in dip; seen on the eastern side of mount Granville and in many places on the Bras d'Or as far as McNab cove. At St. Peters it is full of small specks and strings of galena; and chloritic matter is found between the layers; contains here only a few doubtful encrinites."

(16) Arisaig, Antigonish County

Reference

Fletcher, H.: Geol. Surv., Canada, Ann. Rept., vol. II, pt. P, p. 122 (1887).

Fletcher reports:

"Behind and to the westward of Arisaig chapel, and also at the pier, several openings have been made on very small, irregular veins, in which specks of iron and copper pyrites and galena were observed.

The occurrence in the Carboniferous limestone of specks and crystals of galena, of no economic value, is so common as to attract little attention, although it has sometimes led to the unprofitable expenditure of money in the hope that these traces might lead to richer deposits."

(17) Antigonish Harbour, Antigonish County

Reference

Fletcher, H.: Geol. Surv., Canada, Ann. Rept., vol. II, pt. P, p. 83 (1887).

Fletcher reports:

"These rocks (Carboniferous), particularly gypsum, are also found on Antigonish harbour, below the bridge as far as the mouth. An outcrop of limestone, near Taylor's road, is grey, massive, and spotted with galena."

(18) Ohio River, Antigonish County

Reference

Fletcher, H.: Geol. Surv., Canada, Ann. Rept., vol. I, pt. A, p. 23 (1886).

Many of the exposures of Carboniferous limestones of Ohio river contain traces of galena in addition to copper, and have been mined, but without profit.

(19) Salmon River, Guysborough County

Reference

Fletcher, H.: Geol. Surv., Canada, Ann. Rept., N.S., vol. II, pt. P, pp. 122, 156 (1887).

At the Salmon River mine veins cutting staurolite gneiss consist of quartz with calcite, galena, pyrites, and other minerals. The source of the veins is evidently the granite which intrudes the metamorphosed sediments.

(20) Wine Harbour, Guysborough County

Reference

Faribault, E. R.: Geol. Surv., Canada, Ann. Rept., vol. XVI, pt. A, p. 344 (1907).

Faribault reports:

" An association of quartz with some chloritic schist, carrying small quantities of pyrrhotite, pyrite, sphalerite, galena, and arsenopyrite, and some native gold. From the property of the Plough Lead Mining Company, Wine Harbour, Guysborough county, province of Nova Scotia."

(21) Hirschfield Galena Prospect

(*See* Figure 5)

Reference

Wilson, M. E.: Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 83.

" This deposit is situated on the south bank of the west branch of St. Mary river about 2 miles west of Glenelg post office, Guysborough county. It is said to have been discovered by David Smith in 1873 and was first worked in 1875 by Francis Zwicker who drove the main adit to within 10 feet of its present termination. Since that time some additional development work has been performed by George Hirschfield. This includes the upper adit (about 15 feet higher than the lower) driven in 1904, and the extension of the main adit and the west drift in 1925. The property is held at present under lease by Mr. Hirschfield.

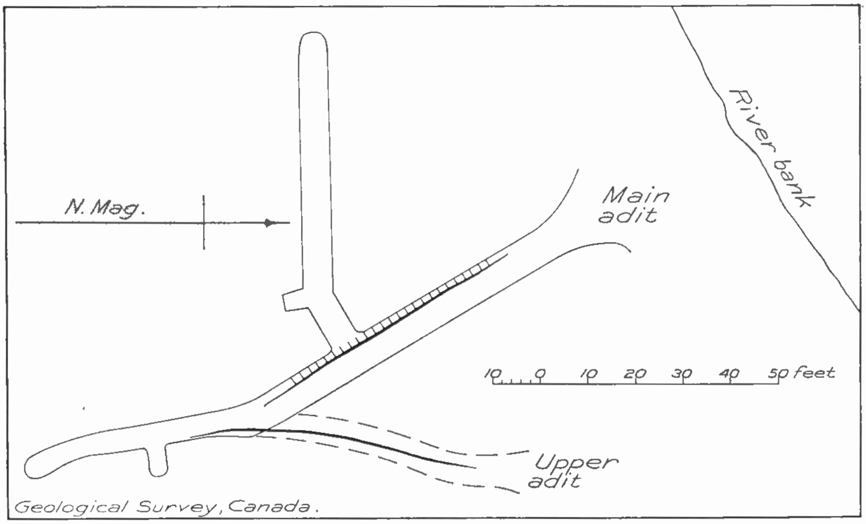


Figure 5. Plan of workings, Hirschfield prospect, Guysborough county, N.S. Veins are shown by heavy lines; and the fracture zone bordering the west vein by short, parallel lines.

The rocks in which the deposit occurs are interstratified, impure quartzite and slate belonging to the Gold-bearing series, and strike about east-west magnetic. They stand almost vertical at the entrance to the main adit, but elsewhere dip 75 degrees to the north. The galena occurs in two veins (Figure 5). The east vein trends about north-south magnetic and has a maximum width of 6 inches. The west vein trends north 30 degrees west magnetic and has a maximum width of 8 inches, but is joined on its west side by a fracture zone up to 2½ feet wide, in which there is considerable galena in places. According to assays made for Mr. Hirschfield, the galena carries from 15 to 16 ounces of silver to the ton of lead.

These deposits are obviously too small to be of much value, but they are important in so far as they may indicate the presence of more extensive deposits nearby. There are two factors that have a bearing on this possibility—the source of the galena and the presence of a large fracture or other opening in which galena could be deposited. The deposits as shown on the geological map (No. 36 West River St. Mary, Geol. Surv., Canada) lie several hundred feet north of a dyke of granite which may be the source of the galena. On the other hand, they are adjoined on the north by Carboniferous conglomerate resting unconformably on the Gold-bearing series and numerous deposits of galena are known to occur in Nova Scotia along this contact. In the one case the possible continuation of the deposit might lie to the south and in the other to the north."

(22) Pictou Coal Field, Pictou County

Reference

Poole, H. S.: Geol. Surv., Canada, Ann. Rept., vol. XIV, pt. M, p. 37 (1906).

Poole reports galena and zinc blende in nodules in the Coal Measures.

(23) Pembroke

Reference

Fletcher, H.: Geol. Surv., Canada, Ann. Rept., N.S., vol. V, pt. II, pt. P, p. 186.

The deposit is near Glenbervie post office, upper Stewiacke valley, Colchester county. The rocks are hard, blue limestones of Carboniferous age. The development work was carried out near the base of the limestones where they rest on red and grey slates.

A visit was made to the property in 1925. Evidence of considerable exploration work in the form of tunnels, pits, and shafts is to be observed. One tunnel is said to have a length of 135 feet. No sign of extensive mineralization was observed. Small stringers of calcite cut the limestone. It is reported that large masses of galena were encountered, but none was observed by the writer. Disseminated galena in the Carboniferous rocks is present in many places in Nova Scotia, but the amounts are apparently too small to be of commercial importance.

(24) Leadvale Galena-Sphalerite Property

(*See* Figures 6 and 7)

References

Reports of Department of Mines, Nova Scotia: 1881, p. 14; 1882, p. 11; 1883, p. 24; 1884, p. 34; 1926, p. 83; 1927, p. 95.

Geol. Surv., Canada, Ann. Repts., N.S.: vol II, pt. P, p. 162; vol. III, pt. A, p. 98; vol. V, pt. P, p. 186; vol. VI, pt. S, pp. 84-85.

Hardman, J. E.: "On the Occurrence of Galena at Smithfield, N.S."; Jour. Can. Min. Inst., vol. I, pp. 215-219.

Murphy, G. F.: "Report on the Smithfield Lead Property"; N.S. Report on the Mines, 1925, pp. 120-125.

Wilson, M. E.: Geol. Surv., Canada, Sum. Rept. 1926, pt. C, pp. 79-83.

LOCATION AND HISTORY

"This property is situated at Leadvale (formerly known as Smithfield) in Colchester county, about 12 miles southeast of Truro. It lies 9 miles in a straight line and 13 miles by road from Brookfield station on the Canadian National.

Development work on the deposit was begun in 1881 and continued at intervals to 1884. During this period shafts Nos. 1 and 2 were sunk and a small smelter constructed in which about 300 tons of ore were treated. During the winter of 1894-95 operations were resumed for about 6 months. At this time shafts Nos. 3 and 4, and three diamond-drill holes (Figure 6) were put down. No further work was attempted

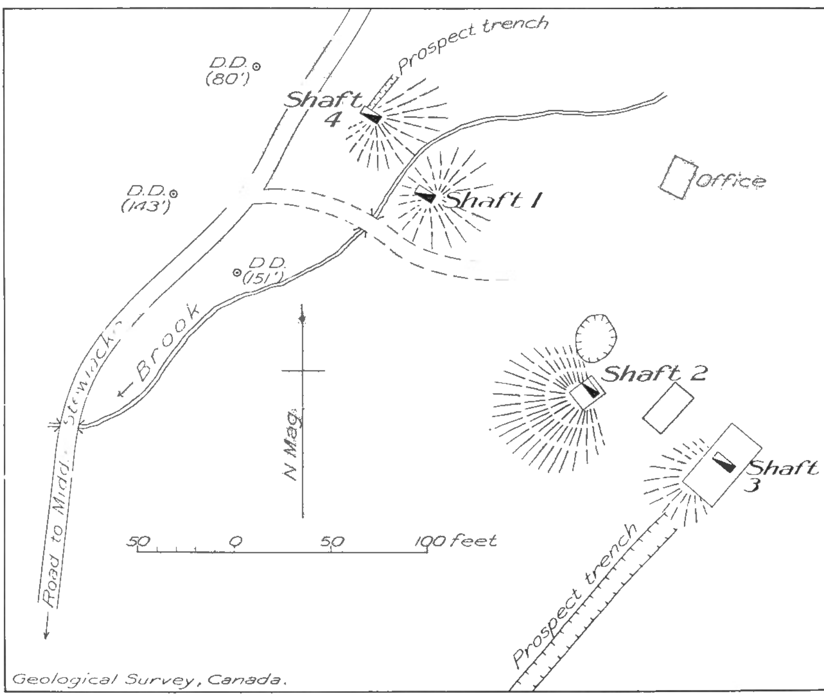


Figure 6. Surface plan of Leadvale galena-sphalerite property, Colchester county, N.S.

until 1925, when Mr. R. E. G. Burroughs and associates obtained an option on the property and in 1926 dewatering the workings for the purpose of determining the extent and grade of the ore. It was at this time that the deposit was examined by the writer."[1]

An option from Mr. Burroughs was taken in turn by the British Metal Corporation (Canada) and work by this company was commenced on January 1, 1927, and continued until July of the same year when the option was dropped.

GEOLOGY

"No rock outcrops were observed anywhere near the openings, but development work has shown that the deposit occurs in grey limestone close to its contact with red, impure sandstone (Figure 7). The limestone, the ore deposit, and the sandstone for several feet from its contact with the limestone, have been very much broken, a

[1]The quotations are from the report by M. E. Wilson.

condition indicating that faulting has occurred along the contact of the sandstone and limestone since the deposit was formed. The bedding of the sandstone, which appears to be parallel to the contact of the limestone, trends north 55 degrees west magnetic and dips about 70 degrees south. According to Fletcher the limestone belongs to the Carboniferous and the sandstone to the Devonian. It has been discovered by W. A. Bell that the sandstone contains fossils of the Horton series and, therefore, belongs to the lower or middle part of the Mississippian or Lower Carboniferous and that the limestone is Windsor and belongs to the Upper Mississippian. The nearest outcrops

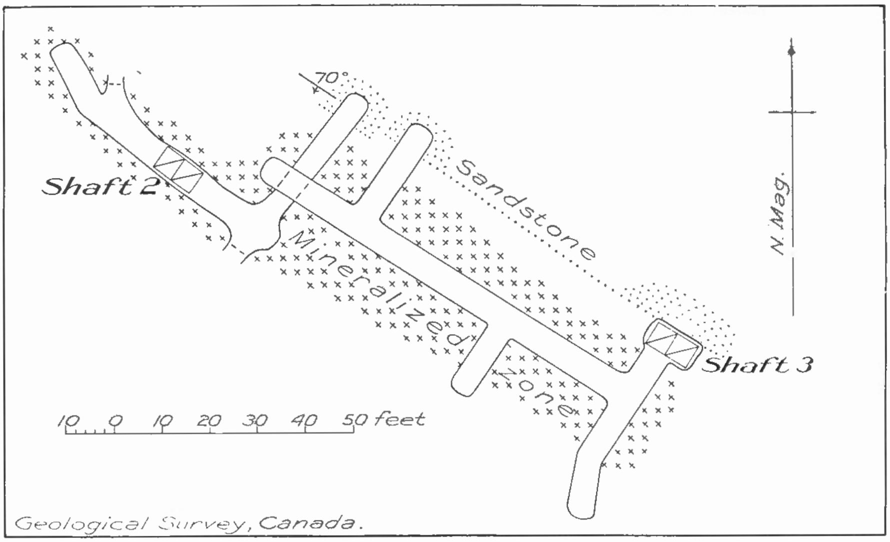


Figure 7. Plan of workings, Leadvale galena-sphalerite property, Colchester county, N.S.

to the deposit, seen by the writer, lie about 2,000 feet westward. The most southerly of these lie behind Mr. Lewis Fisher's house and consist of thin-bedded, blue-grey limestone striking east-west magnetic and dipping 40 degrees south. The limestone is considerably jointed and cut by seams of calcite, but is not cut by a fault. North of this point there is an outcrop of irregularly bedded limestone striking in the same direction and dipping 55 degrees south. Uniformly bedded sandstone having the same strike and dip is exposed 35 feet north of this point. The contact hidden between these two exposures is presumably the same contact as that seen in the mine workings and is so indicated on Fletcher's map."[1]

CHARACTER OF DEPOSIT

"The deposit as exposed in the shafts, drifts, and crosscuts is composed of angular blocks of ore and of grey limestone, enclosed in a muddy matrix of finely broken ore and limestone. The ore masses consist chiefly of pyrite, and galena, with smaller proportions of sphalerite and calcite. The galena in the ore-blocks occurs in veins cutting the pyrite and as a matrix enclosing fragments of pyrite. The sphalerite and calcite occur as aggregates within the galena. The limestone forming the blocks within the breccia is a grey variety cut by numerous veinlets of calcite. The ore-breccia zone trends north 55 degrees west magnetic, is from 25 to 30 feet wide, and has a known length in the workings of 220 feet. It is stated, however, that ore was cut in a diamond-drill hole situated about 100 feet south of the No. 1 shaft, the most westerly shaft in which ore was found.

[1] Geol. Surv., Canada, Map No. 636 (Truro Sheet).

A number of samples, representing as nearly as could be obtained an average across widths of 4 to 5 feet, were taken from the faces of the drift and the walls of the crosscuts for the purpose of determining, if possible, the approximate average grade of the deposit. Analyses and assays of these samples made by A. Sadler and R. J. Offord of the Mines Branch showed that they contained from a trace of silver and no lead and zinc, up to 0·28 ounce of silver a ton, 2·05 per cent of lead, and 0·88 per cent zinc. Gold was absent from all the samples. Twenty channel samples, taken by W. L. Goodwin, who examined the property previous to the writer, showed a similar variation in grade up to 26·69 per cent of lead, 0·34 ounce of silver a ton, and 10·62 per cent of zinc. The average was 0·14 ounce of silver a ton, 5·04 per cent of lead, and 3·51 per cent zinc. The difference in the average grade of the samples collected by the writer and those collected by Mr. Goodwin is probably due, for the most part, to the fact that the writer's samples were chiefly from the walls of the drifts. A sample taken by Mr. Goodwin across a width of 7 feet on the east wall of the westerly of the south crosscuts from No. 3 shaft (Figure 7) contained 8·48 per cent of lead, 0·42 per cent of zinc, and 0·17 ounce of silver a ton, whereas two samples taken by the writer across adjacent widths of 4 feet on the opposite side of the same crosscut contained, respectively, 0·54 and a trace of lead, 1·46 and no zinc, and 0·10 and a trace of silver. It is evident, therefore, that it is impossible to determine the average grade of ore in a deposit of this irregular character by the usual sampling methods. Nevertheless, the results of the assays indicate that the deposit is probably not of average workable grade throughout its whole extent, but that within the mineralized zone there may be a deposit at least 5 to 10 feet wide and containing 5 per cent of lead and 3 per cent of zinc."

DEVELOPMENT

" The development work performed on the property (Figures 6 and 7) includes four shafts having the following depths: No. 1, 30 feet; No. 2, 55 feet; No. 3, 40 feet; No. 4, 40 feet; and drifts and crosscuts from shafts Nos. 2 and 3 as shown in Figure 7. It is stated by Gilpin that there is also a crosscut extending for 40 feet south from shaft No. 1 in which there is ore for 30 feet. This was not examined by the writer. Three diamond-drill holes are said to have been drilled to depths of 80, 143, and 151 feet respectively, at the points indicated in Figure 7. It was in the hole between the road and creek that ore is said to have been cut at the bottom."

The property was visited in early June, 1927, when development work was being carried out by the British Metal Corporation (Canada). This work is carried out from No. 2 shaft which is vertical to the 50-foot level. Below this level it was continued to the 100-foot level on an angle of 65 degrees southwest. Drifts were run both ways along the breccia zone. To the northwest 84 feet of drifting was done, at the end of which short crosscuts 10 and 12 feet long, respectively, were driven southeast and northeast. To the southeast a drift approximately 100 feet was carried from the shaft. A crosscut was also driven from the shaft across the breccia zone. The above measurements are the total of the work performed by the British Metal Corporation.

Conditions on the 100-foot level are similar to those described for the shallower depths. The ore consists of rounded masses of sulphides in a broken zone represented in places by heavy blue clay. At the time of the writer's examination only 98 feet of the 100-foot level had been driven 32 feet to the northwest and 66 feet to the southeast. Ore breccia was encountered northwest of the shaft for a distance of 20 feet, but beyond this, to the northwest, the drift showed no ore. Little ore was seen to the southeast of the shaft. The material taken from the workings was hand sorted, the sulphide blocks being piled by themselves. The writer was informed that this material ran about 5 per cent combined lead and zinc. Assays of this type which would correspond to a mill run form probably the best average that can be made.

ORIGIN

The deposit was formed originally along the contact between the limestone and the underlying sandstone-shale series. The ore zone was, however, so extensively broken and sheared by later movements that its original character and dimensions can only be conjectured. The first problem is whether the solutions that deposited the sulphides had their source in some underlying igneous rock or were of surface origin and picked up their iron, lead, and zinc content during their circulation through overlying rock.

A study of the ore masses furnishes a certain amount of information. In places blocks of limestone are surrounded by pyrite and contain disseminated pyrite. This suggests that the original mineralization took place along a zone of movement, that pyrite and other sulphides were deposited in this fracture zone in places surrounding brecciated fragments of limestone and in places replacing the limestone. Again the ore masses show in places a distinct banded effect. One specimen collected by the writer shows a band of pyrite one-quarter of an inch thick surrounding a small limestone fragment. This in turn is surrounded by a layer of galena an eighth of an inch wide, and a third band sharply marked off from the galena consists of white calcite with which is associated brown resinous sphalerite. Both the calcite and the sphalerite carry tiny crystals of pyrite. This banded arrangement of the minerals is suggestive of an origin from heated solutions given off by an igneous mass. It is very common in deposits having that origin. On the other hand it is very difficult to imagine how descending solutions that had leached their iron, lead, and zinc content from surface rocks would give such a selective precipitation.

The silver content of the ores is low, but it is as great or greater than that in the zinc-lead ores of Gaspe which are known to be related to bodies of syenite and granite of Devonian age and which intrude the rocks in which the deposits lie.

No igneous rocks of post-Mississippian age are known to outcrop in the vicinity of the deposit. The rocks in which the deposit lies, however, are folded and stand at high angles, a condition that suggests that igneous rocks may be present nearby at depth. It is the opinion of the writer that such is the case, and that the ores were deposited by ascending heated solutions.

After the deposit was formed movement on an extensive scale took place along the same line of weakness. The ore deposit was broken up and the adjacent rocks were brecciated, sheared, and ground. The largest mass of ore obtained in the workings had a diameter of 2 feet. This shows that the deposit originally had a width of at least that amount. How much greater is not known.

POSSIBILITIES

The work performed by the British Metal Corporation led to the conclusion that the deposit offers little hope of proving a commercial success. The grade of even their hand-picked ore was low. In addition no large tonnage was opened up. Along much of the 100-foot level little ore was encountered.

(25) Gay River Galena-Sphalerite Deposit

Reference

Wilson, M. E.: Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 83.

"About three-fourths of a mile south of Gay river, Halifax county, some pits in which galena and sphalerite occur have been opened in grey to buff Windsor (Mississippian, Carboniferous) limestone close to its contact with the Gold-bearing series. The limestone lies as a veneer of irregular thickness over the surface of the older series, with masses of the older rock projecting through in places. The galena and sphalerite occur in calcite aggregates or in irregular zones up to ¼ inch wide. They have no regularity, but occur more or less everywhere in small amounts. On the whole the proportion is small. Samples from one of the dumps collected by Mr. Burroughs contained 1½ to 3 per cent of lead, but this would represent a maximum rather than the average of the deposits. The known deposits exposed in the property, therefore, are not of workable grade under present market conditions. They are of interest, however, in that they occur at the base of the Windsor limestone, a relationship which is similar to that of a number of galena deposits in Nova Scotia and which possibly has some bearing on the origin of these deposits."

(26) Dunbrack Argentiferous Galena Prospect

Reference

Hayes, A. O.: Geol. Surv., Canada, Sum. Rept. 1917, pt. F, p. 30.

LOCATION

The property is in Halifax county about 3 miles northwest of Musquodoboit Harbour village. The vein crosses the post road immediately west of South Meadow lake.

HISTORY

Galena was discovered on the property in 1888 by Mr. John Kerr; the early development work was, however, carried out by Mr. James C. Dunbrack. Work was carried out in 1910, and later in 1916.

GEOLOGY

The rocks in the region around Musquodoboit Harbour consist of slates and quartzites of the Gold-bearing series intruded by Devonian granite. Near the contact with the intruded rocks the granite is a grey, coarse-grained, porphyritic, biotitic variety with crystals of feldspar up to 2 inches in length. The Dunbrack deposit occupies a zone of weakness in the granite.

DEPOSIT

The deposit is a fissure vein striking northwest and dipping northeast at an angle of 70 degrees. Its average width is 2 feet 6 inches. Hayes states:

"The assemblage of minerals, including large crystals of quartz and feldspar, suggests that the fissure was first filled by a pegmatite dyke. The brecciated character of the assemblage indicates that movement took place along the dyke and in the resulting fissure silica in the form of agate and opalescent silica was deposited re-cementing the brecciated material. Further fracturing of the vein followed, with the introduction of the metallic minerals. Cross fractures in the siliceous vein rock may have given rise to a layered character of the metallic minerals which cross the ore-shoot with flatter dip than that of the vein."

In 1925, at the time of the writer's visit to the property, the shafts were full of water and the examination was limited to the surface exposures and the mineral specimens on the dump. The gangue is largely white, pink, or smoky quartz and dense, opalescent silica. Small vugs are lined with quartz crystals or with malachite, or with malachite over quartz. Galena occurs in big masses, with coarse cleavage faces. Chalcocite is found also. It is commonly surrounded by malachite or chrysocolla. It is apparently of secondary origin, for in places it is found surrounding chalcopyrite.

DEVELOPMENT

"In 1910, a shaft was sunk to a depth of 75 feet through 15 feet of glacial drift and 60 feet of vein rock, and a tunnel was driven 375 feet southeastward. A second shaft was also sunk at a point 600 feet southeast of the first, to a depth of 40 feet, 20 feet being in solid vein rock. The development work was found to be too expensive and was discontinued.

In 1916 Mr. Robert Ewing of New Orleans, La., took over the property . . . . . securing the services of Mr. M. G. Haverfield as engineer. Mr. Haverfield unwatered the northwest shaft and workings, sampled the tunnel, and kindly supplied the results of the analyses and assays."

Analyses of Samples Taken from Tunnel Southeast from Northwest Shaft

Distance from northwest shaft	Width of vein	Pb	Au	Ag
Feet	Ft. Ins.		$	Oz.
14	2 6	1·5	1·40	Trace
54	2 6	1·8	1·60	Trace
134	1 6	4·4[1]	1·60	0·40
225	2	14·0[2]	2·40	1·00
287	2 6	2·0	3·20	0·40
342	1 6	1·3	2.40	0·50

[1]This shoot extended for 10 feet along vein.
[2]This shoot extended for 10 feet along vein.
Assays and analyses made by assayer of Tough Oakes Gold Mines, Kirkland Lake, Ontario, aided by W. F. John, mill superintendent, and M. G. Haverfield, November 1916.

"There is evidently no workable ore in these workings, as the better grade chutes are small and far apart and the average value too small to pay.

The shafts sunk in 1910 were made 6 to 14 feet, but Mr. Haverfield deepened the southeastern shaft as a prospecting shaft 5 to 12 feet, giving room for raising ore by means of a steel tub and plank skidway and for a compartment for a ladderway. This shaft was sunk to a depth of 110 feet and prospecting tunnels driven 100 feet each way from the shaft along the vein from the 95-foot level. Fortunately this shaft was sunk on an ore-shoot which was found to be 76 feet in lateral extent along the vein, 26 feet northwest and 50 feet southeast of the shaft. The highest grade ore appears to be along 40 feet of the southeasterly portion. The vein varies in width from 2 feet to 4 feet, averaging 2 feet to 6 inches, the strike is north 47 degrees west magnetic, and dip 70 degrees northeast.

At the time of the writer's visit to the property on April 30, 1917, this shaft was sunk to a depth of 105 feet and two groove samples were taken across the vein at the bottom of the shaft. The results of the analyses are as follows:

Analyses of Groove Samples from Southeastern Shaft

—	1	2	3
Lead	22·39%	1·25%	16·22%
Silver	2·36 oz. to ton	2·48 oz. to ton	1·40 oz. to ton
Gold	None	None	None
Copper	0·50%	1·21%	0·70%
Bismuth	None	None	None
Zinc	0·64%	0·30%	2·90%
Manganese	Trace	Trace	Trace

1. Average sample across southeast face, bottom southeast shaft at 105-foot depth, 21 feet drift and 84 feet vein.
2. Average sample across northwest face, bottom southeast shaft at 105-foot depth.
3. Grab sample from picked ore from lower part of south shaft taken from shaft house.

" A conservative estimate of the ore blocked out and ready to stope is 600 tons of 20 per cent lead ore, or 240,000 pounds of lead. Sinking costs totalled about $50 per foot, and if the ore continues in depth as it promises a further 400,000 pounds of lead would be developed by sinking an additional 100 feet.

ORIGIN

The source of the metallic sulphides was probably deep-seated and if this is so it would indicate persistence in depth and a probable increase in lateral extent along the vein."

(27) New Ross, Lunenburg County

References

Faribault, E. R.: Geol. Surv., Canada, Ann. Rept., vol. XV, pt. AA, p. 186 (1907); p. 148 (1906); p. 82 (1907).

In the 1907 Summary Report Faribault states:

" The following minerals have been found to occur in the granites at New Ross: cassiterite, monazite, one of the columbite minerals, durangite, amblygonite, a lithium mica probably lepidolite, wolframite, scheelite, hübnerite, molybdenite, zinc blende, beryl, apatite, tourmaline, fluorite, pyrolusite, manganite, limonite, hematite, magnetite, siderite, bismuthinite, argentiferous galena, copper, iron and arsenical pyrites, kaolin and fire-clay, crystals of black, smoky quartz, large crystals of white, smoky quartz, some of which measured 27 inches long by 10 inches thick."

The amounts of zinc and lead sulphides are evidently very small. They were evidently derived from the granite under conditions of high temperature.

(28) Ramsay Lake, Lunenburg County

Reference

Faribault, E. R.: Geol. Surv., Canada, Ann. Rept., vol. XVI, pt. A, p. 344 (1907).

Faribault reports:

" An association of quartz, feldspar, and mica, with small quantities of calcite and fluorite, holding a little molybdenite and sphalerite, and some particles of chalcopyrite and pyrite. From vein in granite on Caraway island, in lake Ramsay, Lunenburg county, province of Nova Scotia."

(29) North Carleton, Yarmouth County

Reference

Robinson, A. H. A.: " Notes on Zinc and Lead in Eastern Canada "; Investigations of Mineral Resources and the Mining Industry, 1925, Mines Branch, Department of Mines, p. 62.

" In 1923, the American Smelting and Refining Company are reported to have done some work on an occurrence of zinc, lead, and copper at North Carleton, Yarmouth county. There is a shaft on the property, said to be 66 feet deep, with some drifting and a dump containing about 60 tons of ore. Results are said to have been so disappointing that work was stopped and the property abandoned."

(30) Joggins Coal Mine

Reference

Harrington, B. J.: Geol. Surv., Canada, Rept. of Prog. 1876-77, p. 481.

Harrington reports:

" Coarsely crystalline galena, very pale in colour, and mixed with white calcite and black coal matter. The specimen was from Mr. A. J. Hill, C.E., who found it in the underclay of the Cumberland seam at the Joggins. The galena is stated to fill fissures conformable to the line of a " trouble " and to come into contact with the coal. It was assayed for silver but contained only the merest traces."

NEW BRUNSWICK

(31) Campobello, Charlotte County

References

Bailey, L.W.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. M, p. 34 (1899).

Bailey reports:

" At several points on this island, veins of galena, usually in association with sphalerite or zinc blende, have been observed, but at one point only they have been found large enough to lead to any expenditure of capital. This point is near the eastern extremity of the harbour of Welshpool, not far from the former residence of Admiral Owen, where, nearly forty years ago, a quantity of the above ores, chiefly galena, was found to occur in connexion with a series of chloritic and hornblendic strata, probably of Huronian age. A level being opened in the bank, not far above high-water mark, several tons of very good ore were extracted, but while the vein, as first exposed, was several feet wide, consisting of galena with associated barite and pyrite, at the distance of 20 feet or so it dwindled down to a thickness of only a couple of inches. It was then abandoned.

In this connexion, it is of some importance to notice that ores of lead have been observed at a number of localities in the neighbouring district of Washington county, Maine, some of which, as near Lubec, have at times been the basis of more or less extended mining operations.

On Magaguadavic river, half a mile below the village of St. George, is a small island upon which, it is said, a vein of galena occurs, yielding masses of pure ore as large as a barrel."

(32) Frye Island, Charlotte County

Reference

Bailey, L. W.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. M, p. 34.

Bailey reports:

"The geology of this island, also known as L'Etang island, and situated near the mouth of L'Etang harbour, is complicated, and is fully described in the Geological Survey Report for 1870-71 (page 86). Of the rocks met with, the most important in the present connexion is a series of limestones, in part dolomitic, and associated with quartzites, that form the shore of that portion of the island which overlooks the "Back bay." They are quite similar to rocks to be presently noticed both on the mainland of Charlotte county and in St. John county, and, with the latter, have been referred to the Laurentian system. Intersecting these limestones, which also carry more or less serpentine, are a number of well-defined lodes consisting mainly of quartz, but containing also considerable quantities of barite and fluorspar, besides veins of galena. One of these lodes, when stripped, showed a width of from 6 to 8 feet, with a course about east-northeast, while two other lodes, each about 6 feet, and approximately parallel, approached the first with a course about northeast or nearly that of the enclosing strata. Portions of these lodes contain numerous small veins of galena, sometimes associated with blende or pyrite, but no considerable body of ore was visible. Beyond stripping the lodes and the firing of a few blasts no attempt has been made to mine the ore."

(33) Musquash Harbour, West Side, St. John County

References

Bailey, L. W.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. M, p. 35.
Harrington, B. J.: Geol. Surv., Canada, Rept. of Prog. 1877-78, pt. G, p. 52.

Bailey reports:

"The Laurentian syenites which occur here carry veins of white quartz holding sulphides of copper and lead. A specimen of the pure galena, assayed by Dr. B. J. Harrington, in the laboratory of the Geological Survey, yielded 14·219 ounces to the ton. The extreme hardness of the country-rock, as compared with that of Frenchman creek, is against its profitable working."

A sample of galena separated as far as possible from the gangue of quartz, gave, according to Harrington, 14·219 ounces of silver to the ton.

(34) Frenchman Creek, St. John County

Reference

Bailey, L. W.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. M, p. 35.

Bailey reports:

"The rocks of this locality bear much resemblance to those of Frye island, Charlotte county, and are almost certainly of Laurentian age. The principal rock is a whitish or cream coloured, more or less siliceous limestone, becoming in parts dolomitic; but with this are dark grey to black, rubbly slates, while a little to the north, and covering a space of many acres, are very heavy beds of dark grey quartzite. In visiting the locality in 1897, a trench was found to be in process of excavation on a bed of dolomite, disclosing a series of small veins, from 1 to 3 inches in width, in which, besides quartz, was contained a quantity of galena associated with honey-yellow sphalerite or zinc blende and some tetrahedrite. Stainings of green and blue copper carbonates were also noticeable.

The locality is on the farm of Mr. John Burchell, and was being prospected by Mr. C. J. Weldon, of St. John. The amount of work, however, so far done, has been too small to afford any data for an estimate of its value. Samples having been sent for analysis to the office of the Survey, and there, freed from all gangue, the metallic sulphides were found by Dr. Hoffmann to contain no gold, but to carry silver to the extent of 25·08 ounces to the ton of 2,000 pounds."

(35) Quispamsis, Kings County

Reference

Bailey, L. W.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. M, p. 36.

Bailey reports: "Galena with pyrites and blende, in Laurentian gneiss."

(36) Hammond River, Kings County

Reference

Bailey, L. W.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. M, p. 36.

Bailey reports:

"Hammond river, near Wanamake's Inn, parish of Upham. Galena, with copper-pyrites, in quartz veins penetrating diorite and petro-siliceous rocks of Huronian age. The veins are small, but carry a little silver. An assay by Dr. F. D. Adams gave silver 3·099 ounces to the ton."

(37) Norton, Kings County

Reference

Bailey, L. W., and Matthew, G. L.: Geol. Surv., Canada, Rept. of Prog. 1870-71, p. 228.

A visit was made in the summer of 1925 to Norton. A few small calcite veins carrying galena were found cutting Lower Carboniferous limestone, but nothing to warrant exploration work.

(38) Teahan Prospect, Kerry, Albert County

Reference

Robinson, A. H A.: "Notes on Zinc and Lead in Eastern Canada"; Investigations of Mineral Resources and the Mining Industry, 1925, Mines Branch, pp. 62-64.

"The Teahan prospect occurs near the junction of Barrett and Keirstead brooks, on the headwaters of the upper Salmon river, in Alma parish, Albert county. It is about 8 miles by road from Elgin village on the Canadian National railway; and about the same distance from Alma, on tidewater on the north shore of the bay of Fundy. The present discovery was made in 1919 by J. E. Teahan, sen., of Kerry P.O., on the bank of the brook about 1,000 feet from an old shaft and the remnants of an old copper smelter, where an attempt was made about 40 years ago to open what appears to be the same lode or vein as a copper mine (probably the old Goodfellow or Mineral Vale mine).

The only exposure, about 40 feet in diameter, in some shallow pits and strippings, at the edge of the brook, shows a heavily mineralized zone about 30 feet wide, striking south 55 degrees west magnetically with an apparent dip to the north. The country rock is a thinly laminated, extremely fissile crumpled talcose or chloritic schist. In the southerly part of the exposure the mineralization consists of fine-grained pyrite, but on the northerly side this is accompanied by considerable amounts of zinc, lead, and copper sulphides irregularly distributed through a gangue made up chiefly of magnesite and dolomite, with smaller amounts of quartz. Structurally the deposit shows a fine-grained portion (banded in places parallel to the schistosity of the country rock), which has been fractured and faulted and the interstices filled with coarser-grained massive material. Most of the quartz and the richer copper concentrations appear to be associated with this interstitial material which is chiefly magnesium-calcium carbonate, whereas, the finer-grained banded portions contain little or no lime but some magnesium carbonate.

Two specimens of different types of the ore, No. 1, showing rather coarse-grained copper minerals (chalcocite or tennantite) in quartz and carbonate gangue; No. 2, a fine-grained mixture of pyrite, galena, sphalerite, and carbonate, were analysed in the Mines Branch laboratory with the following results:

		No. 1	No. 2
Lead	per cent	2·62	13·65
Zinc	"	7·44	23·69
Copper	"	11·86	0·13
Arsenic	"	3·57	Nil
Gold	oz. per ton	0·44	0·07
Silver	"	14·94	5·60

A general sample weighing 116 pounds, sent by Mr. Teahan to the Mines Branch Ore Testing Laboratories, to determine the possibilities of separating the lead and zinc constituents of the ore, analysed as follows:

Lead	1·26 per cent
Zinc	14·27 "
Copper	2·35 "
Arsenic	0·76 "
Antimony	trace
Gold	0·03 oz. per ton
Silver	3·91 "

In April, 1927, work was carried out on the property under an option from Mr. Teahan by N. A. Timmins, Incorporated. Several trenches were put down on the opposite side of the brook from the main showing, but did not reach down to bedrock and afforded little additional information. An open-cut was also made above the old one in the bank of the brook. No new ore was opened up, and the option was dropped.

(39) Lumsden

(*See* Figure 8)

LOCATION

The Lumsden mine is in Albert county, New Brunswick, about 9 miles north of Albert village. It is on Lumsden mountain at an elevation of about 1,200 feet above sea-level. A wagon road, over which an automobile can be driven with difficulty, leads to the property. Ratty brook, a branch of Crooked creek, crosses the property and the original discovery was in it. The property is owned by Messrs. I. C. Prescott, G. D. Prescott, and W. A. McPherson of Albert.

GEOLOGY

The rocks of the district belong to a complex of grey and green schistose rocks, apparently of volcanic origin, intruded by red granite. Some members of the complex apparently represent flows and other tuffs, all of which have been more or less altered by shearing movements. Their age has been referred to as Precambrian. The nearest known granite mass is about three-quarters of a mile to the north of the mineralized zone. It is probably of Devonian age and is considered to be responsible for the mineralization.

DEPOSIT

The deposit consists of mineralization along a zone which has been traced for about 500 feet in a northeast direction. The zone consists of sheared volcanic rocks mineralized with tennantite, chalcopyrite, galena, sphalerite, pyrite, and quartz. In places there is a well-defined wall and in others the mineralization fades out into the country rock. The zone where it crosses Ratty brook has a width of 28 feet and in the adit that cuts it at right angles it has a width of 26 feet. The strike of the deposit is northeast and the dip as seen in the shafts is steep to the northwest.

DEVELOPMENT

Development up to the end of 1927 consisted of two shafts, an adit, test pits and trenching, and two diamond drill holes.

Shaft No. 1 (*See* Figure 8) was sunk 38 feet at an angle of 68 degrees to the northwest, following a well-defined foot-wall. Shaft No. 2, 365 feet northeast of No. 1, is said to have a depth of 50 feet and to slope at an angle of 77 degrees to the north. The ore shows copper and zinc sulphides with little or no galena. The tunnel has a length of 155 feet, and shows a mineralized zone 26 feet wide.

Two diamond drill holes were put down on the property in the months of December, 1917, and January and February, 1918, under the direction of Mr. J. C. Beidelman of the Federal Zinc and Lead Company, Montreal, who has kindly supplied the logs.

No. 1 hole was located 155 feet northwest of No. 2 shaft. It was put down at an angle of 58 degrees to intersect the mineralized zone. It was continued for a length of 248 feet, but no signs of mineralization were encountered except some specks of chalcopyrite from 211 to 213 feet.

No. 2 hole was started 150 feet west of No. 1 at a distance of about 180 feet from the foot-wall of the mineralized zone. It was put down at an angle of 58 degrees for a distance of 288 feet. The only mineralization encountered consisted of 3 feet of quartz from 257 to 260 feet, showing some chalcopyrite.

If the mineralized zone continues downward with the same northerly dip it shows in the shafts, these holes should have intersected it. Since they did not do so either the mineralized zone does not continue to a depth of 250 feet below the surface or else its dip changes so that the holes failed to reach it.

In the summer of 1928, work was carried out on the property from early June until late August by the Huronian Belt Company. The work consisted of trenching to determine the position, extent, and width of the mineralized zone, and sampling to determine its values. Only very small

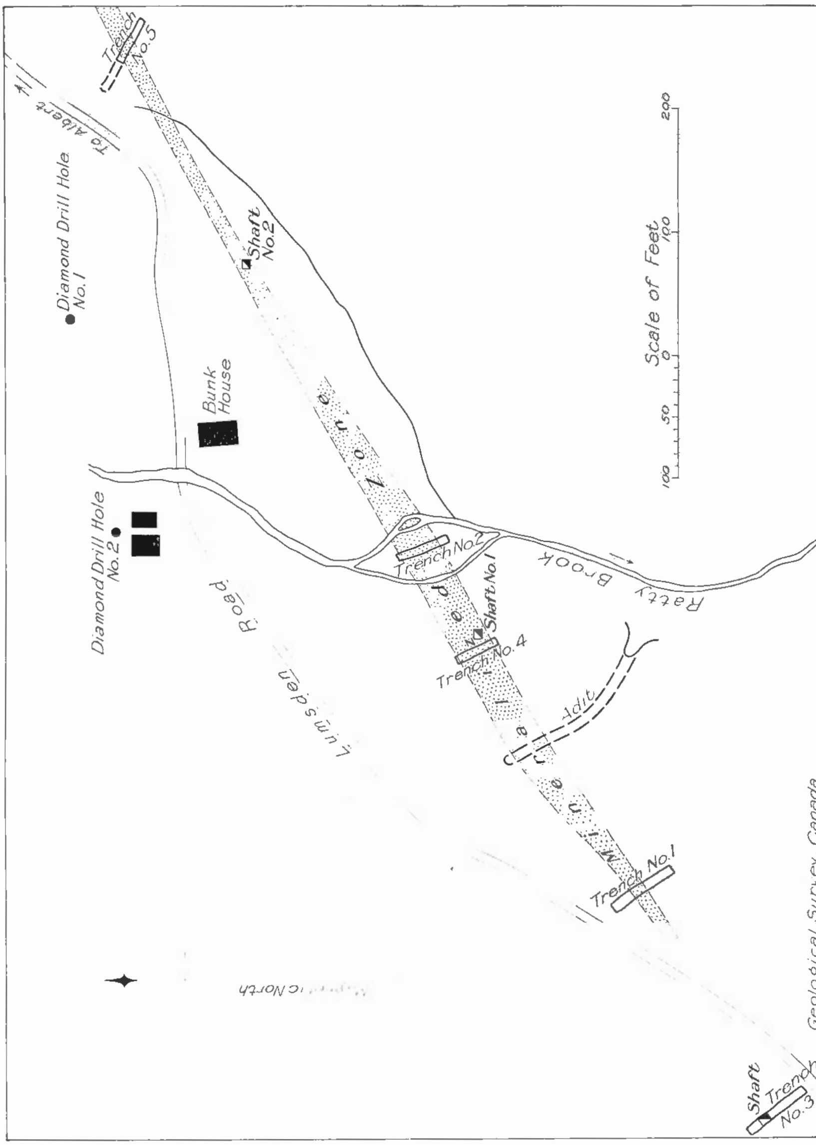


Figure 8. Lumsden mine, Albert county, N.B.

amounts of galena and sphalerite were obtained. An attempt was made to discover if there were any other ore-bearing zones on the property, but none was located and the option was dropped.

Mr. W. M. Goodwin has furnished the following notes about the work performed in 1928.

Trench No. 1, 263 feet west of No. 1 shaft, is 60 feet long and 18 feet deep in the centre section. The mineralized zone is here 8 feet wide.

Trench No. 2 is approximately 85 feet to the northeast of shaft No. 1. The mineralized zone is here 28 feet wide. It consists for the most part of quartz with some calcite carrying varying quantities of zinc and copper sulphides.

Trench No. 3 is 440 feet to the west of shaft No. 1. A trench 5 feet wide and 60 feet long was dug to a depth of 8 feet and some float was encountered and followed down to a depth of 19 feet. A winze was then sunk where the gossan capping was thickest to a depth of 28 feet. Schist was encountered at this depth and crosscuts were driven into the hanging- and foot-walls, making a width at the bottom of the shaft of 16 feet. Small stringers of vein material were encountered, but no appreciable mineralization was found and work was discontinued.

Trench No. 4 is located 15 feet to the west of shaft No. 1, and is 35 feet long. The mineralized zone has here a width of 29 feet.

Trench No. 5, 197 feet northeast of shaft No. 2, was dug into the side of a slope a distance of 30 feet, being 18 feet deep at the south end. A crosscut was then driven into a hillside until the mineralized zone consisting of quartz carrying iron pyrites with some small traces of copper sulphides was exposed for a width of 35 feet.

Shaft No. 2 was bailed out. The foot-wall consists of schist carrying some iron pyrites and the hanging-wall is softer with large, elliptical masses of hard pyrite scattered through the schist.

A pit was also sunk on the line of strike 750 feet west of trench No. 3, to a depth of 16 feet. Schist was encountered, but it proved to be unmineralized. Another pit was dug 240 feet west of trench No. 5 to a depth of 19 feet and again no signs of mineralization were seen.

(40) Dominion No. 1, Lead Property, Woodstock

LOCATION

Dominion No. 1 property is on the east side of St. John river about 2 miles southeast of Woodstock, Carleton county. It is held by H. G. Noble and associates of Woodstock.

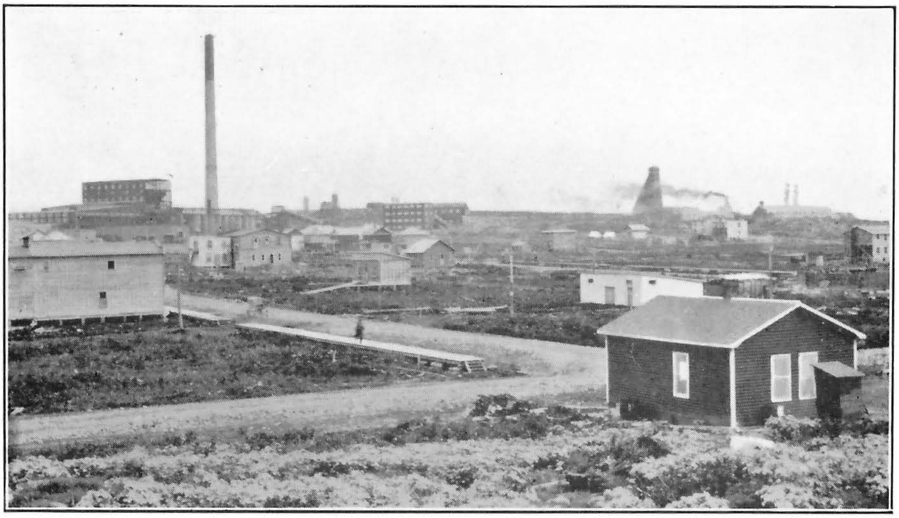
HISTORY

A shaft, 23 feet deep, was sunk on the ore zone and in addition some trenching was carried out by the owners. In 1927 the Timmins interests took an option on the property and carried out work from March until June. The shaft was extended to a depth of 60 feet, but work was then abandoned. The writer visited the property in 1925 and again in August, 1927, but at both times the shaft was full of water so that only an examination of the surface exposures and dumps could be made.

GEOLOGY

The rocks of the region are Palæozoic quartzites and argillites intruded by Devonian granite. The strike of the sediments is northerly and the dips steep.

A. Dominion No. 1, galena prospect, Woodstock, N.B.



B. Horne mine and smelter, Noranda, Que., September, 1927.

DEPOSIT

The ore zone is along the contact of argillite and quartzite. The rocks are conformable, strike north 15 degrees east magnetic, and dip east. The dumps, made up of material from the shaft, consist of argillite.

The minerals present are argentiferous galena, sphalerite, pyrite, and quartz. They occur in stringers and as masses and disseminations in the argillite. Solid sulphide, a foot wide, is reported to occur in places in the shaft. A trench runs 80 feet south from the shaft. It shows stringers of quartz, but no continuous vein. Two hundred feet south of the shaft a little stripping has been done, but no ore was uncovered.

CONCLUSION

The deposit is undoubtedly related to the intrusion of granite of the region and, therefore, though no body of ore of sufficient size to offer much encouragement to do further work has been uncovered, larger bodies of ore may occur at depth.

(41) Britton Mine, Woodstock

References

Ingall, E. D.: Geol. Surv., Canada, Ann. Rept., vol. V, pt. II, pt. SS, p. 89; pt. I, pt. AA, p. 62 (1893).
Ingall, E. D.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. S, p. 119.

A visit was made in 1925 to the old Britton mine which is situated about 5 miles north of Woodstock on the west side of St. John river. The workings consist of one shaft which is reported to be 150 feet deep. The work was carried out about 1890 and argentiferous galena is reported to have been obtained.

At the present time there is little to be observed at the property. Outcrops to the north of the shaft are quartzite, badly jointed. Slate also occurs on the dump. Some of the rock fragments on the dump are cut by quartz stringers; others contain a little pyrite and show iron stain, but the amount of mineralization is very small and the property is apparently of no economic importance.

(42) Winding Hill Galena Prospect

References

Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept. 1916, p. 254.
Young, G. A.: Geol. Surv., Canada, Sum. Rept. 1917, pt. F, p. 14.

The Winding Hill galena prospect is situated in Stanley parish, York county. The mineral showings are close to the road leading from Taxes river to Miramichi river, and about 7 miles, measured along the road, in a northerly direction from Maple Grove station on the Canadian National railway.

Young states:

"Rock exposures are very few in this vicinity, but on the west side of the road and close to it, two shallow trenches show the country rock to be light coloured, siliceous, and schistose, presumably altered forms of the dark slates exposed in the general vicinity on Taxes river and its tributaries. In the trenches the rock is traversed by numerous, narrow, irregular aggregates of finely granular galena with smaller amounts of pyrite and zinc blende. The aggregates are usually small, the largest seen measuring not over three-quarters of an inch by one-quarter inch. They are not abundant and are not uniformly distributed. Iron pyrites is distributed through the country rock and veins in varying amounts. About one-quarter mile north-northeast another trench shows the same general conditions. About half a mile or more farther eastward along the general direction of strike, silicified and partly schistose rocks outcrop along Middle Hayden brook, but there only iron pyrite was seen.

Apparently mineralization has taken place along a zone striking parallel with the best of the rocks. Up to July, no ore-body had yet been discovered, but the amount of work done on the property is very slight. The longest trench was not over 30 feet in length and it is not apparent whether the trenches were located on one side only of the zone or whether they disclosed it for the greater part of its width. It would seem desirable to make an attempt to strip the zone completely across from one side to the other.

Cairnes reports that a sample taken across 6 feet of the best mineralized portion of the walls of one of the trenches yielded only 1·27 per cent lead and no gold or silver, and another sample taken across 8 feet of the face of the adjoining trench assayed only 1·24 per cent lead and no gold or silver."

(43) Rocky Brook Silver-Lead-Zinc Prospect

(*See* Figure 9)

References

Jack, Edward: " Metalliferous District in the County of Gloucester "; Thirty-third Ann. Rept. Crown Land Dept., N.B., 1893, Appendix C, pp. 15-19.

Young, G. A.: Geol. Surv., Canada, " Bathurst District, New Brunswick "; Mem. 18E, p. 76.

LOCATION

The Rocky Brook silver-lead-zinc prospect, also known as the Gilbert prospect, is owned by Messrs. G. S. Gilbert and George Gilbert of Bathurst, N.B. It is situated about 12½ miles as the crow flies northwest of Bathurst on Rocky brook, a tributary of Millstream river. The first part of the journey from Bathurst can be made with a car; then for a distance of 5 miles an old wood road can be followed with a wagon, and for the remaining 1½ miles there is only an old, poorly marked trail.

HISTORY

The first work on the property was done some thirty-five or forty years ago by Professor Jack of Fredericton. One shipment of 40 tons of ore in bags was made to Bathurst. In May, 1927, an examination of the property was made by Mr. W. M. Goodwin of the Pioneer Mining Corporation, the results of whose assays were given the writer by Mr. Gilbert.

GEOLOGY

Outcrops in the region are few. The trail to the property leads past the Millstream iron ore deposit which consists of irregular bands of magnetite in a gangue of garnet rock. The rocks exposed at the deposit are dark slates of Ordovician age. In Bathurst region the Nipisiguit granite of Devonian age cuts the earlier Palæozoic sediments.

CHARACTER OF DEPOSIT

The original discovery was an iron-stained outcrop (No. 7, Figure 9) in the bank of Rocky brook. No large mass of ore is visible here, but small, irregular patches of sulphides, sphalerite, pyrrhotite, pyrite, arsenopyrite, and a little galena, occur. Some quartz stringers are also present. Work has been carried out at eleven places (*See* Figure 9) over a distance

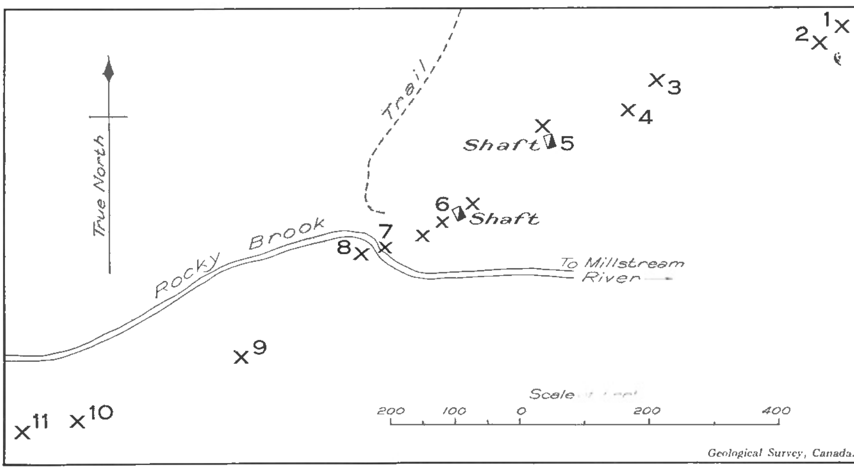


Figure 9. Rocky Brook or Gilbert prospect, Rocky brook, N.B.; workings and rock outcrops are numbered as in text.

of 1,400 feet along a northeast-southwest course. In the three northeasternmost workings, Nos. 1, 2, and 3 (Figure 9) nothing is to be observed. No. 4 is a trench in rock and some ore is to be seen on the dump. Working No. 5 is a shaft and trench in rock. Most of the trench shows no mineralization, but some of the best ore specimens, consisting of pyrrhotite with iron-bearing sphalerite, galena, pyrite, and quartz, were taken from this shaft. Of the workings at locality No. 6, one is a shallow shaft with an incline at the bottom. The rock from here shows disseminated sulphides. Locality No. 7 is the outcrop in the creek that led to the staking of the deposit. Working No. 8 is a pit that shows small amounts of sulphides. In workings Nos. 9, 10, and 11 no ore or rock is to be observed.

The following assay returns were furnished by Mr. Gilbert; the samples assayed were selected by W. M. Goodwin from the dumps at the various openings.

Pit No.	Lead	Zinc	Silver	Gold
	%	%	%	Oz.
6	0·21	0·90	3·76	0·01
6	0·07	0·53	1·985	0·01
5	0·14	1·43	2·88	0·015
5	0·07	0·68	5·505	0·025
4	0·07	0·75	1·725	0·02
4	0·07	2·64	0·83	Tr.
Ore shipment	0·07	14·02	3·00	0·05

ORIGIN

The mineralogy of the deposit with the presence of pyrrhotite is evidence that it is of high temperature origin. The solutions that produced it probably had their source in the Nipisiguit granite which intrudes the early Palæozoic rocks of the district. That granite is present at no great distance is shown by the adjacent Millstream iron deposit which consists of magnetite in a garnet rock, two minerals that are characteristics of contact metamorphic deposits.

POSSIBILITIES

Though no large body of ore is exposed at present there is evidence of a mineralized zone along which ore-bodies may be found. The scarcity of outcrops makes prospecting difficult and suggests the use of electrical methods for the search of sulphide lenses.

(44) Nigadu River

References

Ells, R. W.: Geol. Surv., Canada, Repts. of Prog.: 1879-80, pt. D, p. 45; 1880-82, pt. D, pp. 21-22.
Hoffmann, G. C.: Geol. Surv., Canada, Rept. of Prog. 1880-82, pt. H, p. 13.

Ells reports:

"On the Nigadu, near the contact with the Silurian rocks, indications of galena were noted, and at the forks of this stream, about 8 miles from its mouth, a deposit of considerable extent occurs, which bids fair to be of some importance. Since our visit to this place in 1879, mining operations have been commenced, the sample of the ore obtained being of good quality, but the extent of the vein has not yet been fully determined."

In the 1880-82 report Ells states that the deposit was opened up to a considerable depth, but that it did not fulfil the expectations of the proprietors of the mine.

Hoffmann's report on a sample from the property is as follows:

"A fine crystalline galena, associated with a little zinc blende, in a more or less weathered rocky gangue. The metallic sulphides constituted but a small proportion of the whole. It contained:

Gold..	trace
Silver..	5·811 ounces to the ton of 2,000 pounds."

(45) Elmtree, Gloucester County

References

Geol. Surv., Canada, Repts. of Prog.: 1880-82, pt. D, p. 22, pt. H, p. 13; vol. VII, pt. M, p. 148; vol. X, pt. M, pp. 36-37, pt. S, p. 119.
Hudson, J. E.: "Elm Tree Mines"; Thirty-second Ann. Rept., Crown Land Dept., N.B., 1892, Appendix C, pp. 11-15.
Young, G. A.: Geol. Surv., Canada, Mem. No. 18E, p. 75.
Robinson, A. H. A.: "Notes on Zinc and Lead in Eastern Canada"; Mines Branch, 1925, p. 69.

LOCATION

This deposit is on Elmtree river about 4 miles as the crow flies from its mouth at Elmtree on Chaleur bay. The Canadian National railway crosses the stream about a mile from the coast. An automobile can be driven to the property. This property has been known since 1880, and in 1882 the Elm Tree Mining Company was incorporated to work it.

HISTORY

About 1918 further exploratory work was done on the property. A few diamond drill holes were put down and a considerable number of surface trenches excavated to bedrock. Sulphides were found in a number of these, but nothing of sufficient importance to encourage further development work. At the time of the writer's visit in 1925 the trenches were caved in and all that could be seen was a single exposure in the creek. No records of the results of the diamond drilling could be obtained.

GEOLOGY

The rocks of the vicinity consist of the Elmtree slates of Silurian age. Granite of Devonian age cuts the early Palæozoic rocks of the region and is undoubtedly responsible for the mineralization.

DEPOSIT

The deposit, as exposed in the bed of the stream, consists of a mineralized zone from 1½ to 13 feet in width striking in a general north-northwest direction. From near the main exposure in the creek a branch mineralized zone strikes northeast. The best mineralization occurs at the junction of these two fracture zones.

These zones consist of country rock cut by calcite and quartz stringers and mineralized with sulphides. The latter consist of pyrite, chalcopyrite, sphalerite, and galena, in scattered grains and small aggregates. The relative amounts of sphalerite and galena vary greatly, but in general, zinc blende predominates. On the west side the main zone has a fairly distinct wall, but on the opposite side the boundary is less distinct, the slates being altered, cut by calcite stringers, and partly mineralized.

CONCLUSIONS

Other zones mineralized with small veins occur along the upper parts of Elmtree river, on Rocky brook, a tributary of Millstream river, and on Nigadu river. No ore-body of workable size has yet been proved in the area, but the scattered mineralization suggests that this is a region where something worth developing may be found.

(46) Bighole Brook

LOCATION

Bighole brook is a tributary of Jacquet river, Restigouche county. It joins the latter from the west about a mile south of Sunnyside settlement. The mineral showings are about 4 miles from the mouth of the brook above a falls which has a drop of about 20 feet. The most direct route to the showings is from Nash Creek station on the Canadian National railway by road to Lorne settlement, from which a trail about 2½ miles long leads to a point on Bighole brook just above the falls. Four claims on the lower part of the river are held by Mr. Edward Sullivan of Campbellton. Two claims adjoining those upstream and two others about 2 miles above the falls are controlled by Mr. Alexander Doyle of McLeod Siding.

GEOLOGY

The rocks on the claims are volcanics of Lower Devonian age. They vary from andesites to rhyolites. Some are amygdaloidal, and in places porphyritic varieties containing lath-shaped feldspars up to an inch or more in length occur. Below the falls on Bighole brook and along Jacquet river similar volcanics are interbedded with fossiliferous Devonian shales. Granite intrusives of late Devonian age cut these rocks at several localities in Jacquet River region.

DEPOSITS

The deposits are veins and replacements in the volcanics. Above the falls are a few veins the largest of which is 8 inches wide. The ore minerals are galena and sphalerite in a gangue of quartz and carbonate. The carbonate is largely yellowish white ankerite, but some barite may be present. The veins are too small to be of economic importance.

On one of Doyle's upper claims about 2 miles above the falls a shear zone in the volcanics is mineralized with solid sulphides, chiefly dark sphalerite with some pyrite. The width of the sulphide zone is from 1 to 3 inches.

POSSIBILITIES

The region is difficult to prospect since the rock exposures are practically limited to the stream courses. The mineral showings on Bighole brook are too small to be of importance themselves, but they show that the region is mineralized and indicate the possibility of larger deposits being present somewhere in the district.

(47) Other Reported Occurrences

References to other occurrences in New Brunswick include:

(*a*) Small veins carrying chalcopyrite and galena at several points along the coasts of St. John and Charlotte counties. (Geol. Surv., Canada, Ann. Rept., vol. X, pt. A, p. 97.)

(*b*) On Magaguadavic river, half a mile below St. George, on a small island, a vein containing galena was reported to occur. (Geol. Surv., Canada, vol. X, pt. M, p. 35.)

(*c*) Galena reported to occur on Passamaquoddy bay. (Geol. Surv., Canada, vol. XV, pt. AA, p. 150.)

(*d*) Between Tomogonops and Little rivers, two affluents of Northwest Miramichi river, argentiferous galena and pyrites occur in which traces of gold are likewise reported to be found. (Geol. Surv., Canada, vol. VII, pt. M, p. 148.)

(*e*) Galena is said to occur with barite in a vein at Gouldville settlement, $1\frac{1}{2}$ miles east of Memramcook, Westmorland county. (Geol. Surv., Canada, vol. X, pt. M, p. 125.)

(*f*) Galena in small quantities occurs on Tobique river. (Geol. Surv., Canada, Ann. Rept., vol. I, pt. G, p. 30.)

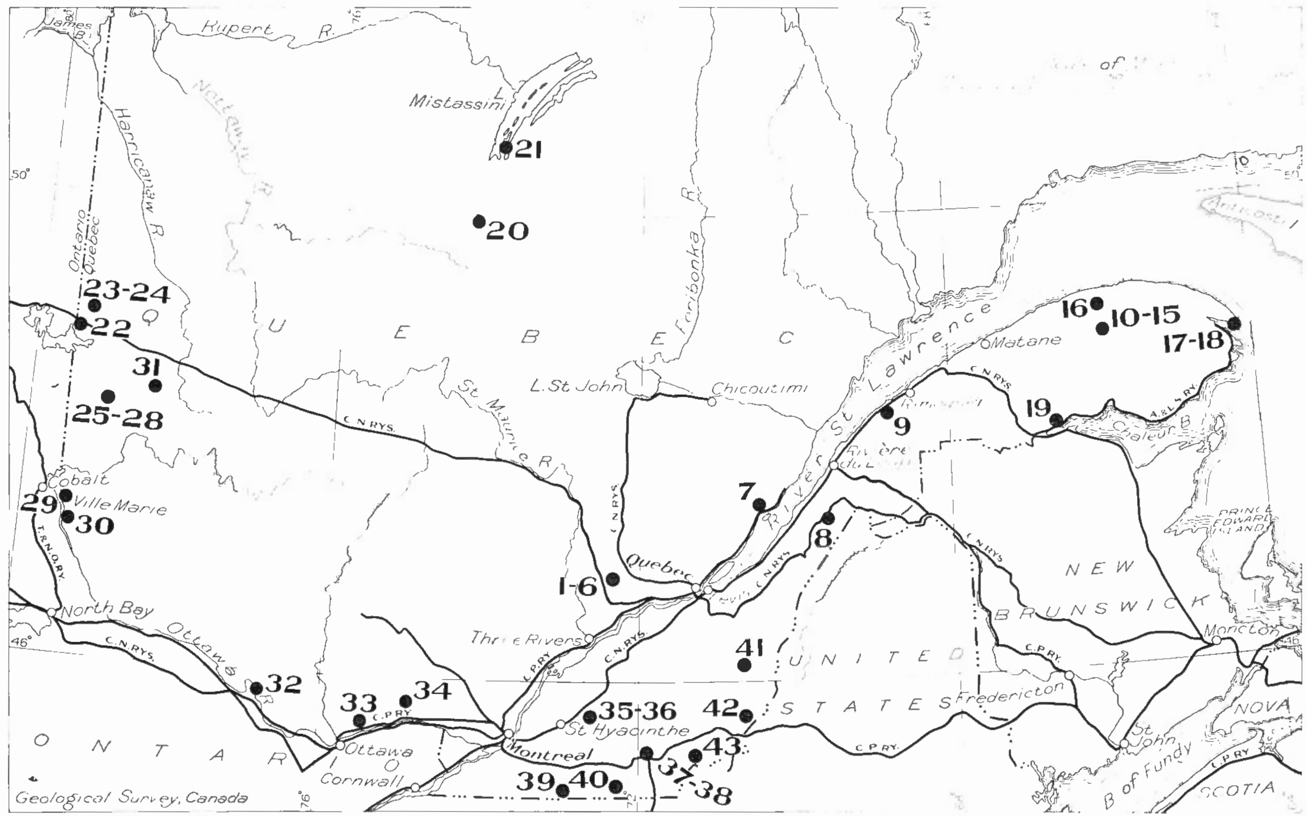


Figure 10. Index map of portion of Quebec showing location of zinc and lead occurrences. For explanation of figure *See* page 78.

Explanation of Figure 10

1. Tetrault
2. Montauban
3. Block C, Montauban
4. Chavigny
5. Laurentide
6. Lot 8, range IV, SW. Montauban
7. Baie St. Paul
8. Woodbridge
9. St. Fabien
10. Federal
11. Lyall and Beidelman
12. New Richmond Mining Company
13. Pioneer Mining Corporation
14. North American
15. Gaspe Mines, Limited
16. Marsouins
17. Little Gaspe cove
18. Indian Cove
19. Cross Point
20. David lake
21. Lake Mistassini
22. La Reine
23. Desmeloizes
24. Abana
25. Horne
26. Waite-Montgomery
27. Aldermac
28. Amulet
29. Wright
30. Fabre
31. Poiriers lake
32. Calumet
33. Buckingham
34. North Petite Nation river
35. Upton
36. Acton
37. Ascot
38. Moulton hill
39. St. Armand
40. Owl's Head
41. St. Francis
42. Risborough, Marlow, and Spalding
43. Ditton and Emberton

QUEBEC

(1) Tetreault Mine, Notre-Dame-des-Anges

(*See* Figures 11, 12)

References

Low, A. P.: Geol. Surv., Canada, Ann. Rept., vol. V, pt. AA, p. 45.
Ells, R. W.: Geol. Surv., Canada, Ann. Rept., vol XI, pt. J, pp. 45-47.
Denis, T. C.: Ann. Repts. on Mining Operations in the Province of Que.: 1911, p. 27; 1912, p. 29; 1914, p. 28; 1915, p. 29; 1916, p. 38; 1917, pp. 29-31; 1918, p. 42; 1919, p. 46; 1920, pp. 50-56; 1921, p. 46; 1922, pp. 37-38; 1923, p. 59; 1924, p. 81; 1925, p. 39; 1926, p. 39; 1927, pp. 49-56.
Uglow, W. L.: "Lead and Zinc Deposits in Ontario and in Eastern Canada"; Ont. Bureau of Mines, vol. XXV, pt. II, pp. 3-5.
Bancroft, J. A.: "The Geology of Parts of the Townships of Montauban, Chavigny, and the Seignory of Grondines, including a Description of the Zinc and Lead Deposits in the Vicinity of Notre Dame des Anges, Portneuf County"; Report on Mining Operations in the Province of Quebec, 1915, pp. 103-143.
Staff of the British Metal Corporation (Canada): "Mining and Milling at the Tetreault Mine"; Bull. Can. Inst. Min. and Met., March, 1928.

LOCATION

The Tetreault mine is in Montauban township, Portneuf county. The municipality of Montauban, immediately adjoining the mine, is about 6 miles by road from Notre-Dame-des-Anges, the nearest railway station on the Canadian National railway, 126 miles by rail northeast of Montreal and about 52 miles in a straight line west of Quebec city. The property is connected by 19 miles of dirt-and-gravel road with the Provincial Highways system of Quebec province. Quebec city by road is 78 miles distant and Montreal is 160 miles. Notre-Dame-des-Anges is on Batiscan river about 20 miles from St. Lawrence river. Montauban lies about 1½ miles from the Batiscan.

HISTORY

Zinc ore was discovered by Mr. Elzéar Gauthier in the summer of 1910 on lot 39, range I, Montauban. In 1911 Mr. Pierre Tetreault acquired the mineral rights of the ground now forming the Tetreault mine, and in the following year erected a concentrating mill. Mining operations were continued during 1913 and 1914 and about 1,300 tons of high-grade zinc ore was shipped from sinking operations, but the mill failed to produce a commercial grade of zinc concentrates from the complex ore.

In October, 1914, the Weedon Mining Company leased from Mr. Tetreault 900 feet of the mineralized zone stretching south of the small lake on lot 40. In the following year, a separate company, the Zinc Company, Limited, was incorporated to work this portion of the property. In the spring and summer of 1916 a new mill, with a capacity of 200 tons of ore per day, and embodying some oil flotation in the flow sheet, was erected. A zinc oxide plant was also erected at Notre Dame station to treat mixed zinc and iron sulphides from the concentrator, but after being successfully operated for some time it was destroyed by fire. Work at the mine was continued by the Zinc Company until 1921. In this period of operation, production of zinc and lead amounted to $680,000, with other values in gold and silver.

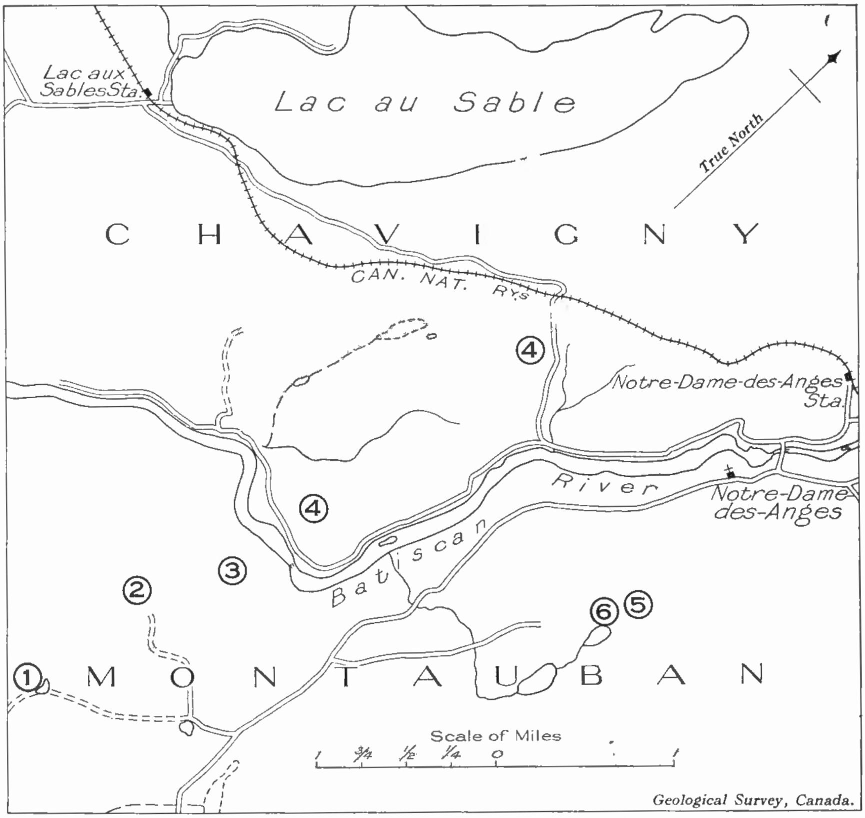


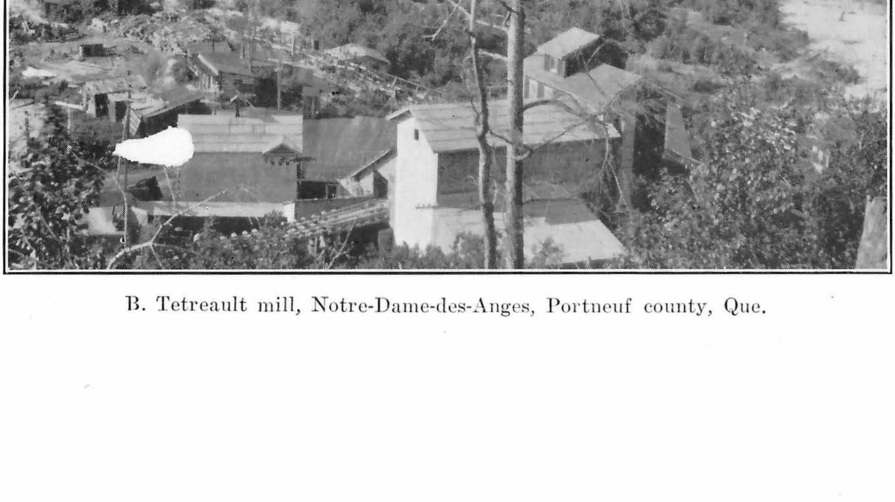
Figure 11. Index map showing location of zinc and lead occurrences in the vicinity of Notre-Dame-des-Anges, Portneuf county, Que. 1, Tetreault mine; 2, Montauban Mining Syndicate prospect; 3, Prospects in block C, Montauban township; 4, Prospects in Chavigny township; 5, Laurentide zinc prospect; 6, Prospect in lot 8, range IV, SW. Montauban township.

In the spring of 1923 the property was reopened by the Pierre Tetreault estate, which operated until October, 1924, when the British Metal Corporation (Canada), Limited, began operations.

GEOLOGY

The solid rocks of the region are all Precambrian. The geology is of the typical Grenville type. The rocks are paragneisses, quartzite, limestone, and lime silicate rocks intruded by amphibolite, granite, and pegmatite.

A. Tetreault mine, Notre-Dame-des-Anges, Portneuf county, Que.



B. Tetreault mill, Notre-Dame-des-Anges, Portneuf county, Que.

The oldest rocks are a series of sediments that have been metamorphosed to gneisses and schists. A few prominent bands consist of massive beds of white quartzite, which in thin section is seen to consist of quartz with small flakes of muscovite and in some examples minor amounts of orthoclase and microcline and a few, minute, rounded grains of zircon. The quartzites grade by increase of the amounts of mica and feldspar into gneisses and schists.

The sedimentary gneisses and schists are the most abundant rocks of the series. They are very finely banded, and owing to the varying composition of the original beds it is possible in most places to determine the original bedding planes. The commonest types are light to dark grey quartz-biotite and quartz-biotite-hornblende gneisses. Many are rusty on the weathered surface due to the oxidation of disseminated grains of pyrite and pyrrhotite. In many places they are garnetiferous and some carry sillimanite and others cordierite. One of the most striking occurrences of sillimanite gneiss is on the southern parts of lots 7 and 8, range V, SW., and the northern parts of lots 9 and 10, range IV, SW., Montauban, where a band of nodular, grey, biotite gneiss lies between two bands of white quartzite. The nodules are about the size and shape of almonds, and consist of quartz grains enclosing flakes of muscovite and penetrated by numerous fibres of sillimanite. Sillimanite also occurs in gneiss on the Tetreault property where the gneiss is dragfolded into the tremolite band south of the shaft. Cordierite gneiss consisting of quartz, muscovite, and cordierite, with needles of sillimanite and accessory rutile and pyrrhotite, occurs in the shaft on lot 40; it is more abundantly developed on the property of the Montauban Mining Syndicate, north of the Tetreault property.

A band of carbonate rock, now metamorphosed largely to tremolite, occurs intercalated with the gneisses. The tremolite is white and occurs in fibrous bunches and radiating masses. In places associated with it are crystals of pale green pyroxene, apparently diopside. In places considerable limestone remains and one variety when struck with a hammer is brightly phosphorescent. The ore deposits are associated with the carbonate-tremolite band.

Intrusives into the sediments are altered basic rocks which are now amphibolites. On the Tetreault property there are two bands of these rocks and they, for the most part, follow the strike of the gneisses. The larger of the amphibolite bands has a width varying from 10 to 60 feet. The smaller lies between the larger and the band of tremolite rock and has a width averaging about 5 feet. Along the borders of these bands red garnets up to three-quarters of an inch in diameter are numerous in many places, both in the bordering gneiss and in the amphibolite, within a zone about 6 inches wide. The evidence of the intrusive origin of the amphibolites briefly stated is as follows. Though in places they are schistose and resemble somewhat the gneisses with which they are associated, they are usually more massive and in some hand specimens appear only slightly altered basic igneous rocks. Though for the most part they follow the strike of the gneisses, close examination shows that locally they send small offshoots across the structural planes of the sediments. In trench No. 10 (*See* Figure 12) at the north end of the property, the amphibolite contains

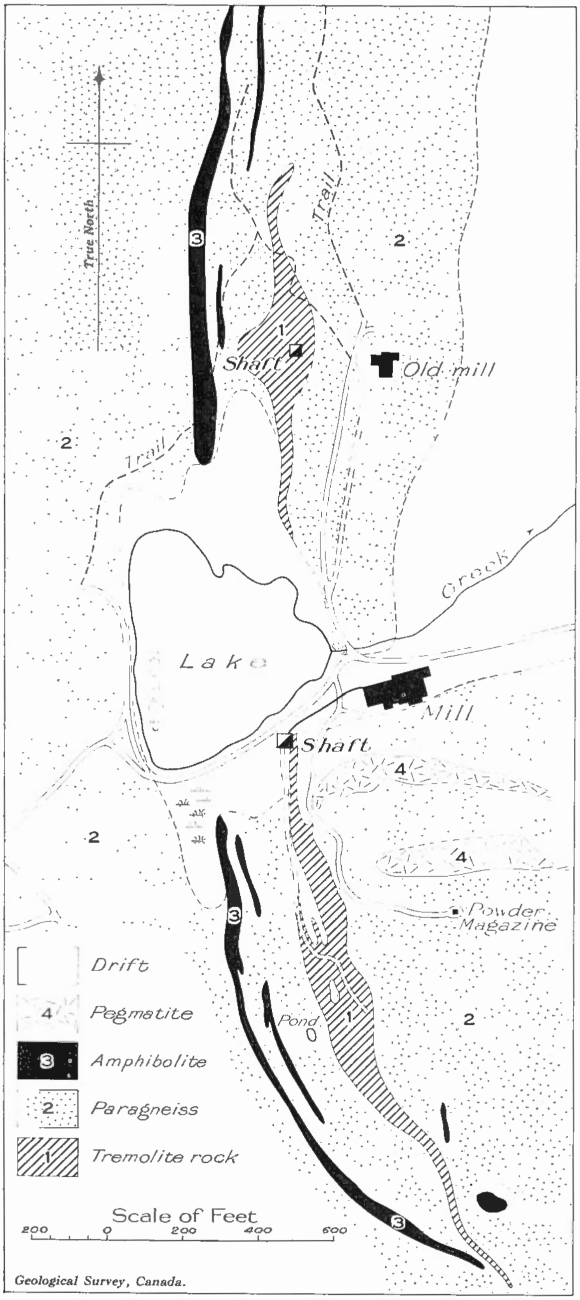


Figure 12. Tetreault mine, Notre-Dame-des-Anges, Portneuf county, Que.

an inclusion of gneiss. In thin sections the chief constituents are seen to be green hornblende and plagioclase, with quartz, orthoclase, biotite, calcite, and iron ore in small amounts, but in some sections augite crystals partly altered to hornblende are visible. The rocks are considered, therefore, to be intrusive and to have been altered during the period of metamorphism accompanying the intrusion of the granite.

Much of the district surrounding the Tetreault property is underlain by granite and granodiorite, part of which is gneissoid. One large lobe lies 2 miles north of the property and another 2 miles east. Under the microscope the common variety of these batholithic rocks is seen to consist of quartz, microcline, orthoclase, and acid plagioclase with usually a little muscovite and biotite. Hood mountain, which forms a prominent elevation east of Batiscan river, about 3 miles from Notre-Dame-des-Anges village, is composed of coarse, white granite passing into pegmatite. In places the granite has penetrated along structural planes of the paragneisses giving examples of " lit par lit " injection. On the Tetreault property granite is represented by pegmatite dykes only. Two dykes varying up to 90 feet in width outcrop on the hill south of the mill. They consist chiefly of feldspar and quartz. The feldspars are orthoclase, microcline, and albite, in part forming graphic intergrowths with quartz. Biotite occurs in crystals and bunches. Aggregates of black tourmaline are present and small, red garnets are scattered through the rock.

ORE DEPOSITS

The ore of commercial grade is confined to the limestone-tremolite band which can be traced on the surface for a distance of 3,000 feet. The band varies in width from a few feet to over 100 feet, at one point near the old mill bulging to a width of 200 feet. At either end it tapers out to nothing. The strike of the band is north and the dip is steep to the east.

The valuable ore minerals are zinc blende and galena. The former is a dark variety and in places occurs in large masses, but more often it is intimately associated with galena, pyrrhotite, pyrite, chalcopyrite, and gangue minerals. Gold and silver values are present, the latter amounting to about one and one-half ounces per unit of lead. The galena is both argentiferous and auriferous, the iron sulphides and chalcopyrite carry varying quantities of the precious metals, and it is known that native silver and a native silver-gold alloy occur. The zinc averages in the proportion of three to one of lead.

The associated gangue minerals afford a considerable variety. As already mentioned the most abundant is tremolite, and the richest pockets of ore occur where the alteration of the original limestone to tremolite and other silicates is most complete. Reference has already been made to pale green gangue and to a carbonate rock that is phosphorescent when rubbed or struck in the dark. The latter is more commonly associated with lean ore zones. The pyroxene occurs as large crystals, some over 4 inches in diameter and a foot in length, which locally are fractured and along the fractures hold zinc blende. Other minerals present include anorthite, epidote, and garnet. The garnet is andradite and occurs as scattered crystals and irregular masses. Considerable quantities of purplish wilsonite accompany the ore. Phlogopite, varying in colour from brown to almost white, occurs as disseminated flakes and also as masses. In places parts of phlogopitic areas are altered to talc and chlorite. Crystals of titanite have been found at several places, one wedged-shaped crystal having a length of 6 inches. Small flakes of graphite have been found and locally a little molybdenite. Quartz and recrystallized calcite and dolomite occur and a few arsenopyrite crystals were discovered in one pit.

The ore is of two varieties: sphalerite with small amounts of the other metallic sulphides; and a complex ore consisting of a fine-grained, intimate mixture of zinc blende, galena, pyrrhotite, pyrite, and minor amounts of chalcopyrite. The gangue minerals are usually rather abundantly associated with the second type and there are all gradations between high-grade ore and barren gangue. The main zone of mineralization is along the foot-wall of the tremolite band. On the hanging-wall side the ore masses pass into lower grade disseminated ore. The ore masses or pockets are irregular in size and shape. They vary from less than 1 foot to over 50 feet in thickness. On the 200-foot level a large body of ore took the form of a gigantic letter S.

ORIGIN

The abundance of pyrrhotite in the ore and the presence of garnet, phlogopite, and other high temperature minerals is evidence that the deposit was formed at high temperatures. The general mineral association of lime silicate minerals suggests that the conditions of formation were those of contact metamorphism. As has been already pointed out the deposit lies between two lobes of a batholith and although the surface outcrops of the latter are 2 miles distant, the intrusion may underlie the deposit at comparatively shallow depths. The presence on the property of pegmatite dykes which undoubtedly had their origin in the granite suggests that such is the case. During the process of metamorphism the limestone band was more easily affected than the adjacent quartzose sediments and basic intrusive rocks, and proved the easiest channel for the escape of the mineralizing solutions. These carried silica, metallic sulphides, and gold and silver. The carbonate rock was altered to lime silicates and the ores were deposited during the process.

DEVELOPMENT

The following notes about development and production are taken from the paper by the staff of the British Metal Corporation (Canada), Limited. Unless otherwise stated the term " shaft " refers to the main working shaft immediately to the west of the lake.

" Prior to the advent of the British Metal Corporation, practically all mining had been carried out south of the shaft. It was estimated that close to 250,000 tons had been extracted from the stopes and very little more could be expected from this portion of the mine.

The shaft had been sunk to a depth of 300 feet at 60 degrees, with stations at 85, 200, and 300 feet, and a winze sunk a farther 100 feet to what is known as the 400 level. At the 200, 300, and 400 levels, short drifts extended northward and small, open stopes from each of these levels had been started.

In addition, the old Tetreault shaft about 1,000 feet to the north was at a depth of 100 feet, with a small amount of stoping done in its vicinity.

Development (by the British Metals) commenced in October, 1924, and consisted of the simultaneous drifting north on the foot-wall contact of limestone and gneiss at the 300- and 400-foot levels. Shoot raises put up at frequent and regular intervals determined the width of the ore-body, and served subsequently to open the stopes. The information gained led to discontinuance of the 300 level, the slope distance between levels being only 100 feet. The shaft was deepened to 400 feet to speed up development on this level.

By this means ore was blocked out at the rate of 500 tons per day from October until milling operations were started in February, 1925.

More recent development includes sinking the shaft to the 500-foot level and extended development on the 100, 200, 400, and 500-foot levels, with connexions between levels and to the surface. Where the ore-body flattened or widened, in conformity with the folding, to greater widths than could be handled through the main drift shoots, crosscuts were run into the foot-wall and secondary shoot raises were driven to win the ore.

The total development carried out from October, 1924, to December, 1927, amounts to:

	Feet
Drifting	5,543
Crosscutting	1,606
Raising	4,998
Winzes	275
Miscellaneous	440
Total	12,862

The condition of the Tetreault mine a short time previous to the operations of the British Metal Corporation, was one of curiously arrested development.

South of an arbitrarily created east-west line, passing close to the main shaft, development and ore extraction had been practically completed. North of that line no prospecting, exploration, or development had been done whatever until the vicinity of the old Tetreault shaft was reached, almost exactly 1,000 feet distant.

The work done since 1924 to the present has demonstrated the continuity of the ore-body over the whole of this distance, and it has been found superior in size and grade to that part previously worked to the south. Development is still continuing along original lines, and the plan adopted to the present has resulted in a constantly increasing ratio of ore reserves to extraction.

Current production at the Tetreault mine is 450 to 500 tons (of 2,000 pounds) per day of run-of-mine ore assaying roughly 9 per cent zinc, 3 per cent lead, 0·1 per cent copper, 0·09 ounce gold, and 8·3 ounces silver.

Zinc concentrates are produced carrying 50 per cent zinc and containing 93 per cent of the zinc in the mill feed, while lead concentrates carry 45 to 47 per cent lead and contain 95 per cent of the lead in the feed. Over 70 per cent of the gold and silver in the feed is collected in the lead concentrates by methods which result in a lower grade concentrate than might otherwise be expected.

Ore milled during 1927 amounted to 130,800 tons of run-of-mine and 21,420 tons of tailings from previous operations, resulting in the production of 21,800 tons of zinc concentrates and 7,890 tons of lead concentrates.

Ore milled from February, 1925, to December 31, 1927, amounted to 285,283 tons of run-of-mine, and 35,798 tons of tailings, resulting in the production of 50,100 tons of zinc concentrates and 15,200 tons of lead concentrates. Reports would indicate that some 250,000 tons of ore had been taken from the mine prior to commencement of operations by the British Metal Corporation. This would bring the total output of Tetreault mine as at December 31, 1927, to 535,283 tons."

(2) Montauban Mining Syndicate Prospect

References

Denis, T. C.: Report on Mining Operations in the Province of Quebec, 1915, p. 30; 1916, p. 38; 1917, p. 31.
Bancroft, J. A.: "The Geology of Parts of the Townships of Montauban and Chavigny and of the Seignory of Grondines."
Report on Mining Operations in the Province of Quebec, 1915, pp. 133-136.

LOCATION

The claims of the Montauban Mining Syndicate are on the southern parts of lots 43 and 44 and the southeastern part of lot 45, range I, SW., Montauban township, Portneuf county (*See* Figure 11). The property is about two-thirds of a mile north of the Tetreault mine and on the same general strike of the rock formations.

DEPOSITS

The following description of the geology and the deposits is taken from Bancroft's report.

"The dark grey gneisses, rich in small pink garnets and phlogopite, and often carrying cordierite and occasionally some actinolite, strike north 15 degrees to 20 degrees east and dip at angles that vary from 10 degrees to 50 degrees towards the southeast. At least, near the line between lots 43 and 44, these gneisses enclose a band, the true width of which has not been exposed, which is composed chiefly of phlogopite, actinolite, cordierite, and quartz, and within which a few crystals of anorthite, rutile, spinel, arsenopyrite, and a very few flakes of molybdenite are present. Here, with a width of approximately 300 feet, the gneisses, within which zinc blende, galena, and chalcopyrite may be found, occupy higher ground which gradually descends toward the north and east. The gneisses are crumpled into broad rolls both along the strike and parallel to the dip. Irregularly lenticular veins of black zinc blende, galena, pyrrhotite, and chalcopyrite are enclosed within the gneiss parallel to its foliation. Occasionally, the veins contain much quartz, but, in general they are composed chiefly of zinc blende with much less galena, chalcopyrite, pyrrhotite, and a little pyrite. In addition to the veins, certain narrow bands of the gneiss are very irregularly mineralized with the metallic sulphides mentioned. In tracing either the veins or the mineralized bands along the strike, they are found to pinch and swell in an extremely irregular manner. For several yards they may be an inch or two in width and then for a few feet or yards may widen out until they may attain a maximum width of between 2 and 3 feet. In following them down along the dip, they similarly pinch and swell, but more or less in sympathy with the "rolls" of the gneiss. Some of the veins are only a few feet long; none has been found that exceeds 120 feet in length. The extremely irregular distribution and character of the mineralization is best illustrated by a detailed description of the workings.

About 200 yards from the southeastern boundary of lot 44, and approximately 15 yards from the line which separates it from lot 43, a vertical shaft (6 feet by 11 feet) has been sunk to a depth of 50 feet. Work commenced upon an outcrop of the garnetiferous cordierite-gneisses enclosing a vein of the metallic sulphides which is said to have had a true thickness of about 2 feet. The gneiss is dipping from 35 degrees to 40 degrees towards the southeast. Twenty-eight feet from the surface a crosscut was driven towards the southeast for 7 feet and a drift, 22 feet in length, was extended towards the southeast following a few narrow, irregular stringers of zinc blende, with a little galena and pyrrhotite. At its bottom, the shaft has penetrated a band containing much phlogopite and actinolite, which is apparently identical with that exposed in an opening on lot 43 near its boundary with lot 44.

From the bottom of the shaft, a crosscut has been extended for 68 feet toward the southeast. Seven or eight feet in from the shaft, a vein of the metallic sulphides mentioned has a width of from 8 to 22 inches on the roof of the crosscut, but on following it along the dip to the floor, it is found to diminish to 2 or 3 inches in thickness. This vein proved to be even more irregular in the drift which here followed it for 50 feet toward the southwest where it apparently has completely pinched out.

Twenty-three feet within the crosscut from the shaft, the gneiss for a width of 4 feet is traversed parallel to its foliation by a large number of stringers of compact white granular quartz which contain only a few specks of zinc blende and galena.

Forty-four feet from the shaft, the crosscut penetrated a band of the gneiss which, varying from a few inches to 3 feet in width, is very irregularly mineralized with chalcopyrite and a little zinc blende, galena, pyrrhotite, and pyrite; from this band, some spectacular specimens of copper ore may be taken.

In the remaining 21 feet, the crosscut passed through gneiss of which only one or two very narrow seams were characterized by the presence of a few grains of the sulphides.

Forty-five feet from the shaft, a winze, 56 feet in depth, on a slope of 70 degrees, was sunk with the intention of following the band of gneiss that contains chalcopyrite. At first the dip of the gneiss was 55 degrees toward the southeast, but at a depth of 25 feet it had decreased to 30 degrees and 40 feet down it flattened to 15 degrees. Beneath this roll in the gneiss, the winze passed into a heavy band composed chiefly of flakes of phlogopite with actinolite and quartz and containing a few widely scattered grains of zinc blende, galena, and chalcopyrite.

From the bottom of the winze, a crosscut was extended for 95 feet toward the east. For 19 feet, it passed through the greasy phlogopite-actinolite band and then penetrated a compact granular quartz vein, 5 feet in thickness. Beyond this quartz vein, the crosscut passed into the dark grey gneiss, dipping from 35 degrees to 50 degrees toward the southeast. Sixty-two feet from the winze, a mineralized band of the gneiss was encountered, which with characteristic irregularity varied from a few inches to 2 feet in thickness. To the northeast and southeast, drifts were extended for 90 and 50 feet, respectively, until the ore had pinched out. For a few feet or yards along the strike, the ore occurs as a definite vein of black zinc blende with a little galena, pyrrhotite, and occasionally grains of chalcopyrite; for longer distances the gneiss contains scattered grains and is traversed by narrow stringers of these sulphides. Within the remaining 33 feet of the crosscut, the gneiss is essentially barren, although in a very few places, scattered grains of zinc blende and galena may be found upon some of the planes of foliation.

About 220 feet to the southwest of the shaft within which the above work has been done, there is another vertical shaft, which in 1914 was sunk to a depth of 34 feet. When the property was examined, the shaft contained water, but it appears to have been sunk upon the crest of a "roll" in the gneiss, the dip here being 10 degrees to 20 degrees toward the southeast. It is said that the shaft penetrated several veins and streaks of ore which were similar in character to those already described.

On lot 43, several openings have been made which show that the gneisses are locally impregnated with a few disseminated grains of zinc blende and galena, but no discoveries have as yet been made that would warrant the sinking of a shaft.

The Montauban Mining Syndicate has not shipped any ore. For the most part, rock and ore have been accumulated together in the dump, while they have been looking forward to the construction of a concentrating mill. By handpicking the dump and including the ore that has been placed in sacks and on the floor of the shaft-house, it is probable that about 25 tons of high-grade zinc ore, carrying a few per cent of lead, could be sent to market. Sufficient ore has not been developed to warrant the erection of a mill."

Work was continued on the property during 1916 and altogether the underground work, including shafts, crosscuts, winze, and drifts, amounted to 400 linear feet. A mill was erected during the months of October, 1917, to February, 1917, but no machinery was installed, and work was discontinued.

(3) Block C, Range II, SW., Montauban

Reference

Bancroft, J. A.: " The Geology of Parts of the Townships of Montauban and Chavigny and of the Seigniory of Grondines "; Report on Mining Operations in the Province of Quebec, 1915, pp. 137-139.

Bancroft reports:

" Block C is almost completely covered with a heavy blanket of stratified sands and clays. Close to its boundary with lot 43, range I, SW., a few small outcrops of the paragneisses appear in the bed of a small stream, and, for a few yards to the southeast of this stream, the bedrock lies near the surface. On a line corresponding to the continuation of the mineralized zone upon which the shafts of the Montauban Mining Syndicate, on lot 44 (*See* Figure 11), have been sunk, a few shallow excavations, from 6 inches to 2 feet in depth, have been made to bedrock.

One opening, 7 feet from the boundary with lot 43, has disclosed a quartzose vein in the paragneiss, from 18 inches to 2 feet in width, which is rich in zinc blende and galena. The gneisses are striking north 32 degrees east and dipping steeply toward the southeast.

Thirty feet toward the northeast, in the direction of the strike, another opening displays the presence of two similarly mineralized veins or bands, one of which is 3 feet in width and separated by 18 inches of barren gneiss from another band, a foot in width, which carries much galena and zinc blende. One or two small blasts of dynamite have been discharged in the bedrock.

About 40 yards farther towards north 32 degrees east, the sand has been removed and similar paragneisses have been exposed, but no mineralization is in evidence. In this distance of 40 yards, the strike has changed to north 12 degrees east, hence in searching for a possible continuation of the mineralized bands, one should strip the bedrock for a few yards toward the northwest.

Thirty-five yards towards north 12 degrees east and close to the small brook mentioned above, the gneiss, for a width of 3 feet, is traversed parallel to the strike, which has changed to north 22 degrees east, by numerous, small, barren quartz stringers, none of which exceeds 3 inches in width. To the northeast, in the direction of their strike, these gneisses then pass beneath a very heavy covering of stratified sands and clays for a distance of approximately a quarter of a mile when they form the low, rocky mound which is situated less than 200 yards from Batiscan river below shoot No. 8 and close to the south of the old wagon road that here passes across block C to the seigniory of Price. On the summit of this mound, two small openings in bedrock, the largest of which is 3 feet in depth, show the gneiss to be traversed by irregular stringers of quartz. Both the veinlets of quartz and the gneiss adjacent to them contain abundantly disseminated grains of pyrrhotite and a few of zinc blende.

That portion of block C in the vicinity of the openings near the boundary with lot 43 is sufficiently promising to be worthy of further prospecting work. Stripping will undoubtedly reveal a zone of the gneiss enclosing irregularly lenticular veins of galena, zinc blende, and quartz that both along the strike and with depth will prove to pinch and swell in a very irregular manner."

(4) Chavigny Township

Reference

Bancroft, J. A.: " The Geology of Parts of the Townships of Montauban and Chavigny and of the Seigniory of Grondines"; Report on Mining Operations in the Province of Quebec, 1915, pp. 138-139.

The geology of Chavigny township is described in the report on the Tetreault mine. Regarding the mineral showings and prospects Bancroft reports:

" Considerable prospecting work has been done in searching for a possible continuation of this mineralized zone to the north of Batiscan river in Chavigny township. Numerous small openings have been made in rock outcrops along what corresponds roughly to the continuation towards the northeast of a line joining the shafthouses of the Zinc Company, Limited, and the Montauban Mining Syndicate. A very few grains of zinc blende and chalcopyrite, together with more profusely scattered grains of pyrrhotite and pyrite, have been found in a small opening on lot 18, range I, SW. (approximately 600 yards from the river up lot line 17-18 and 100 yards to left), and in another opening on lot 8 of the same range (about 450 yards from the river up lot line 8-9 and 100 yards to right) [*See* Figure 11]. Both of these openings are in paragneisses.

Apparently it was not observed by the prospectors that to the north of the river, the strike of the gneissoid rocks makes a broad, sweeping curve from north 39 degrees east at shoot No. 8 to north 72 degrees east on the northwestern end of lot 10, range I, SW. Moreover, numerous small intrusions of fine-grained and intensely foliated granitoid gneiss have repeatedly interrupted the paragneisses, or, locally changed their strike.

What would appear to be at least a portion of the zone sought for was discovered toward the northwestern end of lot 10, range I, SW. . . . . . Here, a massive band, which is almost entirely composed of tremolite, quartz, and small amounts of pyroxene and calcite, possesses a maximum width of 20 feet and is intercalated between highly altered quartzites. The location of this band may readily be approached by observing an outcrop of sheared white quartzites to the left of the bend in the road leading to Lac-au-Sable just prior to where the road follows the line between lots 9 and 10, range I, SW. This outcrop is further distinguished by disseminated grains of pyrrhotite, together with a very few grains of chalcopyrite in the quartzite, and by the presence of tremolite on some of the planes of foliation. If the strike of these quartzites be followed up the hill to the left, the tremolite-rich band will be located.

Within portions of this band of highly altered, impure magnesian limestone, grains of pyrrhotite are abundantly disseminated. A very careful search also revealed the presence of a very few particles of chalcopyrite, two or three grains of zinc blende, and a few small flakes of molybdenite. A few samples composed of tremolite and quartz, impregnated with pyrrhotite, were submitted to the Provincial Laboratory, Ecole Polytechnique, Montreal, where on assay they yielded 20 cents per ton in gold.

None of the discoveries that have been made to the north of Batiscan river within this area are of the least commercial importance."

(5) Laurentide Zinc Property

References

Denis, T. C.: Report on Mining Operations in the Province of Quebec, 1914, p. 28.

Uglow, W. L.: "Lead and Zinc Deposits in Ontario and in Eastern Canada"; Ont. Bureau of Mines, vol. XXV, pt. II, pp. 3-5.

Bancroft, J. A.: "The Geology of Parts of the Townships of Montauban and Chavigny and of the Seigniory of Grondines"; Report on Mining Operations in the Province of Quebec, 1915, pp. 139-141.

LOCATION

The Laurentide zinc property is on lot 6, range V, SW., and lot 7, range IV, SW., Montauban township, Portneuf county (*See* Figure 11). The general geology of the region is described in the report on the Tetreault property.

DEPOSITS

The following description of the property is given by Bancroft:

"Prospecting work has also been done on the southeastern end of lot 7, range IV, SW., and on the adjacent portion of lot 6, range V, SW., of Montauban township, by the Laurentide Mining Company which includes at least some of the leading members of the Montauban Mining Syndicate. To the south of the village and about 2½ miles from Notre-Dame-des-Anges railway station, these prospects are situated, just beyond the crest of a ridge chiefly composed of massively bedded white quartzites that here form the margin of the higher land that one encounters in ascending from the sandy terraces of the valley of Batiscan river. That mineralization which has taken place is confined to a zone of quartzose-biotite gneisses that lies between the white quartzites and the contact of the batholith of gneissoid granodiorite which occupies a wide area toward the south and east. The quartzose biotite-gneisses enclose a few narrow bands, up to 8 inches in thickness, that are almost entirely composed of biotite. Intercalated between the beds of white quartzites are sillimanite-bearing and garnetiferous biotite-gneisses which, in common with the quartzose biotite-gneisses, are the highly metamorphosed equivalents of what originally were feldspathic and argillaceous sandstones. Here, these metamorphosed sedimentary rocks strike north 10 degrees east and dip 30 degrees to 50 degrees to the southeast beneath the margin of the body of granodiorite. They are traversed by a few dykes of light grey gneissoid granite, that, attaining a few yards in width, trend parallel to the strike. Locally, they are also intersected by small, ramifying dykes of aplite and pegmatite.

Two shafts have been sunk upon this property. Since 1914 the prospecting has been discontinued, and both shafts were full of water. In the southwestern corner of lot 6, range V, SW., a vertical shaft (No. 1) has been sunk to a depth of 30 feet. Disseminated grains of zinc blende, galena, pyrite, and pyrrhotite were present upon a few of the planes of foliation and within two or three very narrow stringers of quartz. About 160 yards southeast of the line between ranges IV and V, SW., and either on or very close to the boundary between lots 7 and 8, a shaft (No. 2) has been sunk to a depth of 62 feet on a slope of about 40 degrees. At the bottom of the shaft, a crosscut, 15 feet in length, was driven toward the northeast. Eastward from the shaft and at a distance of 170 feet, at right angles to the strike, the contact of batholith of granodiorite is situated. At the shaft, the quartzose biotite-gneisses are somewhat contorted along the strike. The shaft is said to have been sunk upon a band of the gneiss which, for a thickness of 4 feet, was traversed by irregular lenticular veins of black zinc blende with a small amount of pyrite and pyrrhotite and a very few grains of galena and chalcopyrite. The individual veins are said to have been very variable in width. At a certain stage in the deepening of the shaft, a vein of almost solid zinc blende would possess a thickness of from 1 to 2 feet; a few feet farther down, this would be replaced by grains of the metallic sulphides disseminated along certain of the planes of foliation of the gneiss and within narrow stringers of quartz, trending parallel to the foliation. At the surface, exposures of the gneiss, in strike with, and immediately adjacent to, the shaft, enclose only a few very narrow and irregular seams of the sulphides; within a few feet along the strike, only widely scattered grains of the sulphides are present.

No ore has been shipped from the property. Mr. E. J. Thibault informed me that from Shaft No. 2, 9 or 10 tons of handpicked zinc ore of a good grade were placed in sacks and stored in a small building near the shaft house."

(6) Lot 8, Range IV, SW., Montauban Township

Reference

Bancroft, J. A.: "The Geology of Parts of the Townships of Montauban and Chavigny and of the Seigniory of Grondines"; Report on Mining Operations in the Province of Quebec, 1915, p. 141.

Bancroft reports:

"Sixty-five feet from shaft No. 2 of the Laurentide Mining Company and on the same mineralized zone, a shaft was sunk, during July and August, 1915, to a depth of 26 feet on a slope of 40 degrees toward the east. A band of the gneiss, with a maximum width of 15 inches, contains some grains of black zinc blende and pyrite that are disseminated parallel to the foliation.

Sixty feet farther southward along the strike, where the rock exposures descend to the low soil-covered land that borders a small lake, an opening 4 feet deep has been made. The gneiss contains a few very widely scattered grains of zinc blende, pyrite, and chalcopyrite."

(7) Baie St. Paul Lead Veins

Reference

Logan, W. E.: "Geology of Canada, 1863," pp. 161-162.

LOCATION

Baie St. Paul is on the line of the Canadian National railways running east from Quebec along the north shore of the St. Lawrence to La Malbaie. It is approximately 60 miles east of Quebec. The lead veins are situated on rivière au Moulin in a small gorge immediately behind the old mill on the west side of the bay about one mile from the village.

GEOLOGY

The veins occur near the contact of Precambrian gneiss and Trenton limestone. The former is a granite-gneiss, mostly massive but locally well banded, the trend of the foliation at the lower falls being 45 degrees magnetic. It contains red garnets, is jointed locally, and is traversed by small calcite stringers. The limestone is well-bedded in beds up to 7 inches in thickness. At the lower falls one layer is conglomeratic, consisting of fragments of limestone and shale in a dark argillaceous limestone matrix. The contact of the limestone with the gneiss is a thrust fault plane. Away from the contact the limestone dips at angles of from 20 to 30 degrees; at the contact the beds are dragged up and have dips of from 75 to 90 degrees. The fault runs in a northwest direction and is irregular in outline. Rivière au Moulin follows the contact of the two formations for the distance between the upper and lower falls.

CHARACTER OF DEPOSIT

The deposits are veins traversing the gneiss. Small calcite stringers also cut the limestone, and the age of all the veins and stringers may safely be concluded to be post-Trenton. The main vein is exposed for a length of 20 feet in the floor and walls of the gorge above the lower falls. It strikes 150 degrees magnetic. Its greatest width is $3\frac{1}{2}$ feet which includes a band of granite-gneiss over 1 foot wide. The gangue is calcite with minor amounts of apple-green fluorite. Small amounts of galena are disseminated through it. A second vein occurs in the gneiss below the upper cascade. It is exposed for a length of about 50 feet, has a maximum width of 2 feet, and strikes southeast parallel to the joint-planes of the gneiss.

The veins exposed are entirely too small and their galena content too meagre to be developed as lead properties.

(8) Woodbridge

Reference

Obalski, J.: Mining Operations in the Province of Quebec, 1903, p. 51.

Galena occurs on lot 7, XXI, of Woodbridge, Kamouraska county, 11 miles from St. Pascal on the Canadian National railway. The deposit is a vein of barite and calcite from 2 to 3 feet wide which can be followed for about 200 feet. A little galena is disseminated through the vein. A picked specimen of the galena assayed only traces of silver.

(9) St. Fabien

References

Report of Commissioner of Crown Lands, Province of Quebec, 1883, p. 95.
Report on Mining Operations in the Province of Quebec, 1926, p. 42.

On cadastral lot 158 of St. Fabien parish, Rimouski county, there is a calcite vein, varying from 1 to 8 inches in width, carrying cubes of galena, some of which are 1 inch across. The vein cuts beds of conglomerate and compact sandstone. Barite accompanies the calcite. In 1926 a shaft was put down to a depth of about 50 feet.

(10-15) Central Gaspe

(*See* Map 2129, in pocket)

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"Gaspe Peninsula; Its Geology and Mineral Possibilities"; Rept. on Mining Operations in the Province of Quebec, 1927, pp. 162-181.
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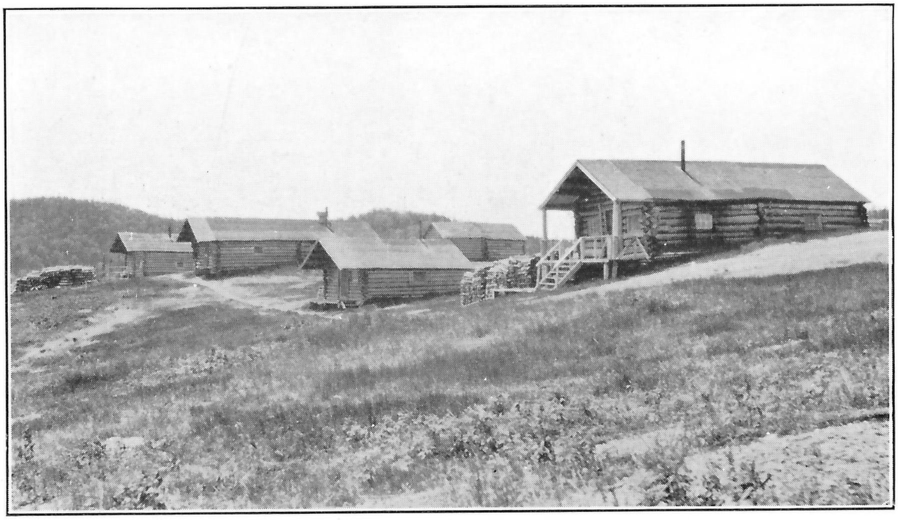
Mailhiot, Adhemar: "Geological Reconnaissance in the Gaspe District"; Rept. on Mining Operations in the Province of Quebec during the Year 1917, p. 117.
"Geology of a Portion of the Projected Townships of Lemieux, County of Gaspe, P.Q."
Report on Mining Operations in the Province of Quebec for the year 1918, p. 134.

LOCATION

The zinc-lead field of central Gaspe lies in Lemieux township, Gaspe county. It is drained by Brandy brook and the north branch of Berry Mountain brook, two headwater tributaries of Cascapedia river. It is



A. Federal mine, Lemieux township, Gaspe, Que.

B. Upper waters of Ste. Anne river; typical of the interior of Gaspe, Que.

reached by the road up Cascapedia valley from Cascapedia station on the branch line of the Canadian National railway which runs eastward along the north shore of Chaleur bay. The road from Cascapedia to the Federal mine is 45 miles long. It follows the east bank of the Cascapedia for 35 miles as far as Berry Mountain camp and the west side of Berry Mountain brook for the remaining 10 miles. The road is well graded and for part of the summer season motor cars and trucks can be driven over it to the Federal mine. From the Federal camp a trail 3½ miles long leads to the Pioneer camp on a branch of Brandy brook. Other trails follow the main valleys.

HISTORY

Interest in the region as a possible mineral producer was aroused in 1909 with the finding of pieces of galena float on a hill near Berry Mountain brook, on the site of the present Federal mine. In the following year James McKinley staked the hill and proceeded to search for the deposit from which the fragments had come. A company, known as the New Richmond Prospecting and Mining Company, was organized to develop the claims. In 1915 Messrs. Lyall and Beidelman entered the field and leased blocks " D " and " E " from this company. They also staked other claims and formed a company known as the Federal Zinc and Lead Company. Another company, the North American Mining Company, was organized with blocks " L ", " O ", " P ", " Q ", " R ", " S ", " T " as their holding.

The Federal Zinc and Lead Company in succeeding years carried out a considerable amount of development on their property and some work was also done by the North American. Interest then lagged for several years until 1925, when new holdings were taken up by the Pioneer Mining Corporation of Canada and the Gaspe Mines, Limited. The taking of an option on the Federal holdings by the National Smelting Company of London in 1926 led to an additional interest in the region and other companies entered the field and took up blocks, viz., Phelps-Dodge, Mining Corporation of Canada, Harvie Mining Company, M. J. O'Brien, Limited, Minerals Exploration Company, Cascapedia Mines, and others. During the summer of 1927 prospecting operations were carried out by all these companies.

TOPOGRAPHY

The interior of Gaspe is a plateau dissected by deep, steep-sided valleys. The highest part of the plateau is a belt of country lying north of the medial line of the peninsula and known as Shickshock mountains. It is developed on a zone of hard rocks consisting of volcanics, serpentine, and granite. The summits reach elevations varying up to 4,200 feet which is the approximate height of the highest dome on Tabletop mountain. The mountain summits show broad, flat surfaces. Mount Albert, which has an elevation of over 3,700 feet, has for a length of 3½ miles and a width of 1½ miles, a surface almost as flat as the western prairies. Tabletop has a length of over 15 miles and a width of about 5 miles. It shows a rolling, mature surface dotted with lakes and ponds.

East of the granite mass of Tabletop, the upland surface is about 1,000 feet lower, and both north and south of the Shickshocks there is a similar rather abrupt descent to a lower plateau region. North of the mountain belt this lower plateau is developed largely on shales and slates, whereas to the south it is formed mainly on limestones and sandstones.

The zinc-lead belt of Lemieux township lies south of Shickshock mountains. The characteristic topography consists of broad, flat-topped, interfluvial areas separated by deep valleys. The elevation of the upland surface varies from about 1,800 to 2,800 feet, with a general slope to the south towards where the streams converge to join the Cascapedia. To the immediate northeast of the area rises mount Lyall, 3,100 feet high, the most conspicuous topographic feature visible from the Federal belt. It is really an outlier of Tabletop mountain.

The area is drained by the north branch of Berry Mountain brook, Brandy brook, and North Brandy brook. The valleys of these streams and their tributaries are entrenched to depths as great as 1,000 feet below the plateau surface. The valley sides are commonly steep and the change from the flat plateau summit to the valley slopes is abrupt. The degrees of steepness of the valley sides depend to a considerable extent on the character of the bedrock. Hard volcanics and horizontally-lying limestones commonly give very steep cliffs. Folded shales give gentler slopes. Locally the streams have cut narrow gorges and in places there is a tendency for them to disappear underground for short distances.

GEOLOGY

The following is the rock succession in the mineralized belt of central Gaspe:

Table of Formations

Upper or Middle Devonian....................	Veins Porphyry Syenite
Middle Devonian............................	Sandstone
Middle or Lower Devonian....................	Volcanic rocks
Lower Devonian..............................	Limestone, argillite, quartzite, tuffs

The most important mineral deposits of the region lie in the Lower Devonian sediments. These consist of grey limestone, in places fossiliferous, dark argillaceous rocks, tuffaceous rocks, and locally quartzite. Overlying all these is a thick series of dark-coloured volcanic flows, in places amygdaloidal. With them are associated in places acid flows and breccias. These rocks are in turn overlain by a clastic series equivalent to Logan's Gaspe Sandstone of Middle Devonian age. The rock varies from grey to buff, in some cases with a greenish or reddish tinge.

Intrusive into the above rocks are dykes and masses of porphyry and syenite. The porphyry is a dense, light-coloured rock with small phenocrysts of feldspar. The syenite is a holocrystalline rock, in places with crystals of feldspar over an inch in length. These rocks are considered to be differentiates of a granite batholith that outcrops in the centre of Gaspe peninsula to the north of the zinc-lead region of Lemieux township.

CHARACTER OF DEPOSITS

The deposits lie in the Lower Devonian series of argillites, limestone, and tuffs. These rocks are intruded by numerous dykes and stocks of syenite and porphyry. The deposits are veins and breccia zones. In some places the veins show sharp contact with the enclosing rock, in other places there is more or less gradual transition from massive vein material through a brecciated zone into barren country rock. Fragments of country rock of all sizes and shapes lie in the veins. These are marked by sharp angles and borders, and many are entirely separated from their neighbours by vein material.

The deposits apparently follow fault and brecciation planes, with mineralization to a less extent along joint-planes. Some of the larger veins strike northeast, others strike north and northwest. Their dip is for the most part steep, usually over 70 degrees. There has also been movement after the period of mineralization. One fault parallels the west wall of the Federal vein. The same vein, 180 feet north of the north crosscut, is cut off on the 100-foot level by another fault.

The veins are younger than the syenite intrusives and in places cut them or follow the contact between the syenite and the intruded sediment. Some of the strongest and richest veins of the area follow such contacts.

MINERALOGY

The vein minerals are sphalerite and galena in a gangue of quartz and carbonate. Pyrite, marcasite, and chalcopyrite are present in minor amounts. The sphalerite is for the most part light yellow, varying locally to a reddish brown, and is almost free from iron.

In the surface exposures and to a certain extent in the upper parts of the veins, sphalerite has been leached out by surface waters. Some of the surface specimens have a white coating of an intimate mixture of smithsonite, calamine, and hydrozincite. A soft, white kaolin mineral is also found in the Federal mine, on the 100-foot level, and even on the 250-foot level, but only in small amounts. On the 20-foot level a greenish yellow mineral belonging to the kaolinite group was also found.

The galena, as a rule, is less abundant than the sphalerite, but in places occurs in large masses. Some of the masses show strain effects produced by movement after the period of mineralization.

The most abundant gangue mineral is quartz of two varieties, white and amethystine. In places the quartz is banded and commonly there is good comb structure. Where the latter structure is shown, the centre almost always consists of the amethystine variety. In some places the central bands consist of amethystine quartz and the outer of white quartz. Carbonate gangue consisting of dolomite and a light yellow ankerite is also fairly abundant. It is intimately associated with the white quartz and usually accompanies the sphalerite and galena mineralization.

Movements took place during the period of mineralization. In places along the walls of the veins are parallel sets of quartz bands with central comb structure showing that reopening took place a number of times. In other places the vein material has been fractured and is recemented by later quartz. Small, narrow stringers of carbonate can also be found traversing the quartz.

ORIGIN

The deposits are believed to be genetically related to the deep-seated intrusive rocks of the area. The syenite and porphyry dykes and masses represent early differentiates of the granite batholith which outcrops north of the map-area and which undoubtedly extends below it. During the late stages of crystallization of the magma, siliceous sulphide-bearing solutions escaping from the still molten intrusion travelled along lines of fracture for considerable distances and deposited their sulphide and silica content along these fracture planes and brecciated zones. Fractures along which dykes had been intruded were reopened in places and formed channels of access. Earth movements continued during the period of mineralization. The veins were repeatedly reopened and even after vein deposition ceased further faulting took place. Practically all the deposits have been formed by the filling of cavities. At one place, however, an example of replacement was found. In the middle of block A, in a trench opened during 1927 to trace the extension of a newly discovered vein, the limestone along the contact with a syenite dyke shows small, detached masses of sphalerite of irregular shapes and not accompanied by quartz or carbonate.

(10) Federal Zinc and Lead Company

(*See* Figure 13)

The Federal Zinc and Lead Company owns blocks C, F, G, H, K, J, M, N, and have under lease blocks D and E (*See* map in pocket). Their main camp is on block H and most of their underground development work has been on it.

Block H. Numerous vein showings can be observed on the Federal hill in the northeast corner of block H. The one on which most work has been done is the No. 1 or Federal vein. This vein has a known length of over 600 feet and an average width of 8 feet. In places it is considerably wider and, locally, it is bordered by mineralized breccia. Several veins intersect it. No. 1 shaft was sunk on it to a depth of 257 feet. A description of the underground workings is given in Summary Report, 1921, part D. The amount of horizontal work is as follows:

	Feet
North drift (100-foot level)	657·3
Drift from No. 1 west crosscut north (100-foot level)	34·2
South drift (No. 1 level)	360·8
Drift around Federal shaft (100-foot level)	73·8
	1,126·1
No. 1 west crosscut north (100-foot level)	180·4
No. 2 west crosscut north (100-foot level)	164·0
No. 1 east crosscut north (100-foot level)	30·9
No. 1 west crosscut south (100-foot level)	48·0
Adit (100-foot level)	126·8
Adit (250-foot level)	104·0
West crosscut (250-foot level)	165·0
East crosscut (250-foot level)	61·0
	880·1

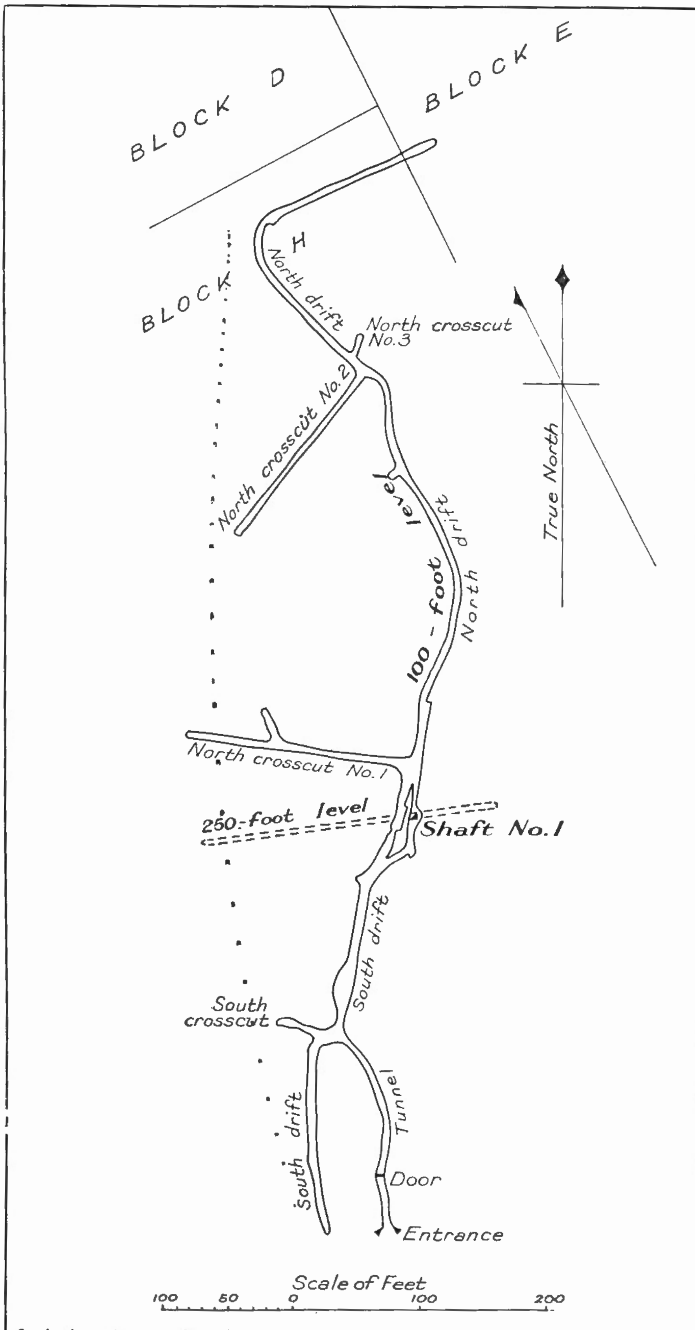


Figure 13. Plan of underground workings, Federal zinc and lead mine, Lemieux township, Gaspe county, Que.

The McKinley or vein No. 16 forms a large outcrop on Federal hill 900 feet southwest of No. 1 shaft. The length of this vein has not been determined, but it is exposed in the road east of the main outcrop. The vein shows a width of 60 feet which includes, however, a horse of country rock. It carries galena and sphalerite and is bordered on the north by a breccia zone.

In the spring and summer of 1925 the Federal Zinc and Lead Company drilled six holes from the underground workings on block H. The results of this drilling may be summarized as follows:

D.D.H. No. 1
Location: 250-foot level, 146 feet west of shaft and 20 feet from west face
Direction: Easterly with drift
Dip: 55 degrees. At 300 feet and 595 feet, 60 degrees
Length: 596 feet
Log: 0–51 feet, argillites
51–88 feet, syenite
88–596 feet, argillites

D.D.H. No. 2
Location: 250-foot level. Face of west crosscut, 166 feet west of shaft
Direction: West with drift
Dip: Horizontal
Length: 416 feet
Log: 0–416 feet, tuffs, argillites, limestones
124 to 126 feet, vein of quartz carrying sulphides

D.D.H. No. 3
Location: 250-foot level, 12 feet from face of west crosscut, 154 feet west from shaft
Direction: West, directly under D.D.H. No. 2
Dip: 26 degrees
Length: 520 feet
Log: 0–520 feet, tuffs, argillites, limestones

D.D.H. No. 4
Location: 250-foot level, east crosscut facing south opposite north face of vein
Direction: 43 degrees west of south magnetic
Dip: 17 degrees
Length: 620 feet
Log: 0–198 feet, tuffs, argillites, etc.
198–486½ feet, syenite
486½–609 feet, argillites
609–620 feet, syenite
17 to 21½ feet, vein of quartz carrying sphalerite
90½ to 96½ feet, vein of quartz carrying sphalerite and galena

D.D.H. No. 5
Location: 250-foot level; face of east drift; same setup as No. 4
Direction: East magnetic
Dip: Horizontal
Length: 590 feet
Log: 0–154½ feet, argillites, tuffs, etc.
154½–329 feet, syenite
329-445½ feet, argillites
445½–590 feet, syenite

D.D.H. No. 6
Location: 100-foot level; north drift 475 feet north of the shaft
Direction: Northwest with drift
Dip: Horizontal
Length: 60 feet
Log: 0–23½ feet, altered syenite porphyry
23½–60 feet, argillites

Block C. In September, 1926, discoveries of heavy float were made in the northeastern part of block C, near the head of a valley leading to Brandy brook. Trenching was carried out for a distance of 500 feet and vein material, in places showing widths of from 12 to 20 feet, located. In the winter of 1927 one drill-hole was put down in a northeast direction at an angle of 40 degrees to the horizontal. Its length was 399 feet. A few narrow seams of quartz were encountered, but no strong vein was located. The dip of this vein was, however, unknown at the time the hole was drilled.

Block J. In the southeastern corner of block J two veins nave been located. The more westerly of the two strikes north 28 degrees east magnetic, and has been traced for 300 feet. It shows quartz and galena, but the width of the vein has not been proved, although one exposure of 20 feet has been uncovered. The eastern vein strikes approximately north 15 degrees east magnetic, and shows a width of from 10 to 40 feet of quartz with ore in places. To the south it crosses to block N, to the northeast to block T of the North American Mining Company, and has been traced for over 500 feet by trenches.

(11) Lyall and Beidelman Properties

Lyall and Beidelman hold four patented blocks, A, B, W (1467A), X (1467B), and a large number of other holdings. The latter include blocks U, V, Y, Z, 6 (1477), and location numbers 662-666, 956-958, 1806-1819, and 2429-2436 (*See* map in pocket).

Block A. In July and August of 1926 discoveries were made and work done on block A, and in 1927 important further discoveries were made. The first finds were made in the southern part of the block south of the trail that leads to Brandy brook, and is commonly called the Pioneer trail. A vein was traced, by six trenches, up the bank on the south side of the creek for a distance of about 400 feet. This vein strikes northeast and judging from the material taken from the trenches, has good values. Definite information about the width of the vein was difficult to obtain at the time of the writer's visit owing to the condition of the trenches, but in places it apparently exceeds 20 feet.

In the summer of 1927 a vein was located in the middle of the southern half of the block, north of the Pioneer trail. This vein lies on the slope facing Brandy brook along the lower contact of a syenite dyke. The finding of quartz and large masses of galena float led to its discovery and stripping uncovered a vein from which were taken solid pieces of galena weighing up to 200 pounds. This vein is commonly referred to as the Lead vein. The contact between the syenite and argillites was exposed by a series of trenches, and galena and sphalerite mineralization was found to continue for over 1,000 feet. The strike of the vein zone is northeast. It lines up with the other vein on block A mentioned above and the two may be parts of one continuous vein. It closely follows the syenite contact, but in places lies entirely in the sediments, whereas in other places quartz veins and stringers cut the syenite. The largest exposure is the southwest end where the richest galena specimens were obtained. Owing to the exposure being on the side of a hill and along a dyke, it is difficult to say how thick the vein is at this point. Vein widths of over 12 feet occur in some of the trenches and at the discovery trench a considerably greater thickness is present. The mineralization consists of galena and sphalerite with pyrite and chalcopyrite in a gangue of quartz and carbonate. Barite also occurs in one trench. Another trench shows, near the vein, limestone containing small, irregular masses of sphalerite, evidently a result of replacement.

Block B. In the summer of 1926 discoveries of quartz were made at several places near the middle of block B. Towards the centre of the block, at elevation 1,550, two trenches exposed a vein with a width of from 12 to 15 feet striking a little east of north. Galena and sphalerite are both present with the quartz. This vein is on the same line of strike as the Lead vein of block A, and if continuous with it, must be a very strong vein zone crossing the two blocks.

Several other veins have been picked up on block B paralleling the Lead vein, but little has been done as yet to trace them.

Block 6 (1477). In the summer of 1925 vein showings were discovered in Brandy Brook region on blocks 6, X, and W, and since that time this locality has attracted more attention than block H. The rocks are argillaceous sediments cut by syenite.

A series of trenches has opened up what is known as the Big vein. This strikes northeast across the extreme northwest corner of block W and the eastern part of block 6. It follows closely the lower or northern border of the syenite intrusion, in places, however, cutting it. The vein has been traced for a distance of about 1,000 feet. It shows widths from 10 to 35 feet, with good sphalerite and galena values.

Three diamond-drill holes, Nos. 2, 4, and 5, respectively, were drilled to intersect this vein. They were located on the slope below the vein outcrops and directly southeast. No. 2 was put down at an angle of 12 degrees to the horizontal for a distance of 428 feet. From 338 to 350 feet quartz and good zinc and lead values were encountered. Hole No. 4 was located about 200 feet southwest of No. 2. It was put down at an angle of 25 degrees to the horizontal for a distance of 392 feet. Breccia and vein material were passed through between 346 and 363 feet; from 350 to 363 solid vein matter carrying 18·57 per cent zinc and 4·13 per cent lead was obtained. Hole No. 5 was located approximately 180 feet southwest of No. 4. It was put down at an angle of 15 degrees to the horizontal for a length of 479 feet. Two veins, 6 and 7 feet thick respectively, and separated by 5 feet of argillites, were encountered from 224 to 231 feet and from 236 to 244 feet. These holes show that the vein dips from 64 to 77 degrees to the southeast and that for a length of 400 feet at least the vein maintains a width of about 13 feet with good sulphide values.

In the west bank of the brook, opposite the cabins of Brandy Brook camp, a vein outcrops. It shows 6 feet of quartz and ore in a wider crushed zone. A number of other trenches were opened up in the vicinity to trace the vein, and other quartz showings were located. During 1927, however, little could be observed in these trenches. A diamond-drill hole No. 8 was put down in a northwest direction to cut this zone. The length of the hole was 399 feet and the angle to the horizontal 47 degrees. It cut three veins at the following distances: 256 to 272 feet, 305 to 317 feet, and 353 to 364 feet.

Block W. Besides the Big vein to which reference has already been made and which cuts across the northwest corner of block W, several other veins are exposed along the northern border of the block, along the west bank of the valley leading to Berry Mountain brook. Outcrops of what appear to be several veins occur in a series of trenches along the southern margin of the syenite dyke. Diamond-drill hole No. 3 was put down in a southeast direction to cut this zone. The length of the hole is 376 feet and its angle to the horizontal 20 degrees. It began in syenite, but at a distance of 90 feet it passed into argillites. At the following places it traversed quartz veins, 98 to 102 feet, 119 to 120 feet, 155 to 158 feet, 221 to 240 feet.

Claim 961. In October, 1926, an iron-stained zone was found on claim 961 and a series of trenches were opened for 500 feet along a northward-trending line, down to the brook that crosses the claim and up the north slope. The iron-stained zone is from 50 to 75 feet wide wide. It consists of broken argillites mineralized with quartz, siderite, calcite, barite, hematite, pyrite, chalcopyrite, and tennantite. Masses of secondary malachite occur with the chalcopyrite and tennantite. Diamond-drill hole No. 10 was put down in a direction north 70 degrees east astronomic, to cut this zone. The length of the hole was 549 feet and the angle to the horizontal 50 degrees. The hole traversed argillites for the entire distance. In a few places seams of quartz with pyrite and hematite were found, but no strong mineralized zone was penetrated.

Claim 965. Mineralization consisting of quartz and specular iron occurs in the southeast corner of claim 965. Chalcopyrite also is to be found on the steep slope near the north boundary of claim A. In the narrow part of the claim between block A and claim 364 of the Pioneer main block, a series of trenches opened showings of quartz along the border of a syenite dyke. The showings in some of these trenches have promising widths of vein material. The mineralization consists of quartz, carbonate, and barite, with chalcopyrite, galena, and sphalerite.

(12) The New Richmond Mining Company Properties

The New Richmond Mining Company owns blocks D and E. These are under lease to the Federal Zinc and Lead Company.

Block D. A series of trenches in the eastern part of block D has traced a vein known as No. 14. This lines up with the vein at shaft No. 3 on block E. Altogether on this line of strike there are quartz showings for a distance of over 2,000 feet.

In the southeastern corner of D is located shaft No. 2 which has a depth of 18 feet and was sunk on a vein wider than the shaft.

Block E. On block E, shaft No. 3 was sunk to a depth of 64 feet on the Bois or No. 14 vein. This vein shows a maximum width of 18 feet. It strikes northeast and, as has been mentioned above, continues into block

D. Northeast of the shaft a series of trenches has traced what is probably a continuation of the vein on the valley slope facing Berry Mountain brook. At one place the vein follows the lower contact of a syenite dyke. This vein shows the usual mineralization with, locally, more chalcopyrite than is present in the Federal vein.

During the summer of 1927 trenching was performed on two newly discovered veins on block E, about 500 feet north of shaft No. 3. These two veins lie about 200 feet apart and strike northeast. Both show good sphalerite and galena mineralization with widths of from 8 feet to at least 15 feet.

A vein was also discovered on block E near its western border, on the trail from Federal hill to Berry Mountain brook. A trench across the trail has exposed a vein about 10 feet wide carrying good zinc and lead mineralization. A syenite dyke is exposed immediately to the north.

(13) Pioneer Mining Corporation of Canada Properties

The Pioneer Mining Corporation holds two blocks of claims, and their associated company, the Huronian Belt, one block. The Pioneer main block lies west of and adjoins the Federal, and the Lyall and Beidelman holdings. It consists of thirty-six claims, Nos. 359 to 378, 1542 to 1547, 1685 to 1689, and 1711 to 1715. The north block lies north of the Mineral Explorations holdings and consists of fourteen claims, Nos. 1690 to 1703, inclusive. The Huronian Belt block lies east of the Pioneer north block and the Minerals Exploration block, and north of the Lyall and Beidelman holdings. It consists of thirty-five claims, Nos. 1548 to 1567, 1680 to 1684, and 1723 to 1732, inclusive.

Active prospecting was commenced by the company in 1926. Their cook-house was built the same year, and in the early months of 1927 their other camp buildings were erected and mining machinery brought in. Work was continued until November, 1927. It consisted of surface examination, mapping, trenching, and exploratory tunnels. It was concentrated largely near their main camp on North Brandy brook and on the claims adjacent to their camp on Brandy brook.

Many mineral showings were located on the claims. The one which received most attention is known as the Pioneer "Big vein." This is a mineralized zone that crosses claims 374 and 1686 in a northwest direction and which was traced by trenches, spaced at an average distance apart of about 120 feet, for a length of 2,300 feet. The zone is on a flat summit where the overburden is deep, so that the trenches do not show fresh rock nor fresh vein material. The vein zone was traced by the iron-stained character of the overburden. The trenches show loose, crumbly quartz, iron-stained quartz with sphalerite, galena, and marcasite, rounded masses of galena with an iron-stain coating, and chambered quartz with malachite and chalcopyrite. This iron-stained zone reaches widths up to 100 feet. At the north end it tapers down to 8 feet. At the south end, in trench No. 18, it has a width of about 30 feet. This trench shows some large blocks of galena with minor amounts of chalcopyrite. The average width of the stain-zone is about 30 feet. Just what widths of vein this actually represents, it is impossible to say. Between trenches No. 6 and No. 8 is an offset of about 50 feet suggesting a fault.

Two shafts were sunk on the zone in an effort to get through the weathered material into the fresh, unaltered vein. The north shaft was sunk 73 feet and the south 39 feet. In the north shaft the vein zone appears to have a dip to the west of 65 degrees. A crosscut 25 feet long from the bottom of the south shaft indicates that here the vein zone has a westerly dip of 52 degrees. Owing to trouble with water, work was discontinued without obtaining definite information about the widths of the vein zone.

The largest single piece of work carried out by the Pioneer was the driving of a tunnel, No. 3, from a point in the valley above the main camp. It was expected that this tunnel would serve several purposes. It was driven in an easterly direction in order to reach eventually the "Big vein" which it would tap 400 feet vertically below the surface trenches. It could thus be used as a working tunnel for the extraction of ore should the vein prove of workable value. It was also designed as an exploratory tunnel in the hopes that other veins might be picked up. The tunnel was driven for 530 feet and two side-drifts, 175 feet and 80 feet long, respectively, were opened from it. In order to reach the "Big vein" zone it is still necessary to carry the tunnel forward about 1,000 feet.

The tunnel traverses almost horizontal shales. One hundred feet from the portal, vein A, 5 feet wide, was encountered and drifted on to the south for 175 feet. For the first 106 feet of the drift the average values were found to be 5·78 per cent zinc, and 0·73 per cent lead across a width of 65 inches. From near the end of the drift a crosscut to the west for a distance of 20 feet shows a mineralized zone 12 feet wide. Two narrow veins, B and C, were cut in the main tunnel at distances of 10 feet and 40 feet respectively from vein A. They show steep dips to the east. Two hundred feet from the portal a shatter zone was encountered which continues for a distance of 130 feet. Thirty feet of this, which shows better mineralization than the rest, is known as vein D. For a distance of 42 feet along this part of the tunnel eastward from where drift No. 4 branches off, the values averaged 0·96 per cent zinc. Drift No. 4 was driven along the shatter zone for a distance of 80 feet. Sixty feet along it a vein 54 inches wide with a dip of 60 degrees to the east was cut. The remaining part of the tunnel shows two narrow veins, F and G, but otherwise no mineralization.

Work was also carried out at a number of other places. Tunnel No. 1 was driven from a point farther up the valley in an easterly direction parallel to No. 3, for a distance of 80 feet. Near the face it intersected a narrow vein. Tunnel No. 2 follows vein No. 18 for a distance of 8 feet. This vein has been traced by ten trenches above for a distance of about 700 feet. Vein No. 14 is exposed in two trenches, in one of which 18 inches of solid galena was found in an oxidized zone.

In the eastern part of the block, mineral showings were located on claims 364, 365, 366, 368, 369, and 372, and a considerable amount of surface work was done. A few exposures show quantities of chalcopyrite. The overburden here is also very heavy and makes it very difficult to trace and prove veins by surface work alone. The result was that, though encouraging finds were made, nothing of proved importance was opened.

(14) North American Mining Company Properties

The North American Mining Company owns blocks L, O, P, Q, R, S, T.

Block L. Earlier work consisted in the sinking of a shaft 30 feet deep, and the opening of some trenches on block L. Quartz with sphalerite and galena mineralization was found, but the amount of work done was insufficient to enable any statement to be made about the possibilities at this place.

A small amount of work has recently been done near the eastern boundary line of block L. Here some trenches show mineralization of quartz, as vein and breccia, carrying sphalerite and galena over a width of 22 feet. Nearby on block N of the Federal Zinc and Lead Company, mineralization has been found at the contact of syenite and shales. At the boundary between L and H, 670 feet from the eastern border of L, a trench 66 feet long shows 8 feet of quartz carrying good values of sphalerite.

Block T. During the summer of 1927 work was carried out on block T. Immediately east of the boundary between it and block J of the Federal Zinc and Lead Company, some large pieces of galena float were discovered. Trenching located two veins 5 feet and 10 feet wide, respectively, separated by 30 feet of shales. It is probable that these are the continuation of the two veins that cross the southeast corner of block J in a northeast direction.

Six hundred feet northeast of the trench in which these two veins were exposed, on the same general strike, other mineralized quartz discoveries were made. These are along the lower or northwest flank of a syenite dyke. At the time of the writer's visit work had just commenced on this vein. Good galena specimens were exposed and it looked as if an attractive vein might be opened up.

A considerable amount of work was also done on another discovery on block T, known as vein No. 45. A mineralized vein and breccia zone were uncovered, but owing to the heavy overburden definite results concerning the size and character were not obtained.

(15) Gaspe Mines, Limited, Properties

Gaspe Mines, Limited, is controlled by Honourable John Hall Kelly. During the summer of 1927 prospecting was carried out on some of the claims and a number of veins were located.

Vein No. 1 lies in the northwest corner of Location No. 647. It shows a large exposure of quartz, 12 feet across, mineralized with sphalerite and galena, but not enough work had been done at the time of the writer's visit to trace it under the heavy overburden. At a distance of about 200 feet southeast of this find is a vein from 2 to 2½ feet wide called the Crooked vein. It strikes in a northwest direction.

Vein No. 2 lies near the middle of claim 647. It strikes about north and south, following at its northern end the border of an intrusive mass of syenite. It has been traced for a distance of 600 feet. In places it shows a width of quartz of 7 feet and in one trench the width of the mineralized zone, consisting of vein and breccia, is 20 feet.

No. 3 vein lies in claim 648, on the wood road built in 1927 and crossing the claim. The one place where it is exposed shows less than a foot of quartz. Vein No. 4 lies in the northeast corner of claim 650. It has been traced by trenches for a distance of over 300 feet in a northwest direction. It shows good sphalerite and galena values and varies in width up to over 12 feet.

Vein No. 5 lies in the northwestern part of claim 647. It has been traced by trenches for a distance of over 700 feet. It shows a vein and breccia zone in places 25 feet wide. It lies on the same line of strike as No. 2 vein, and is probably a continuation of it. To the north it crosses to claim 646. On the latter claim, 250 feet to the northwest of where the vein crosses the claim line, another quartz vein was uncovered in a trench.

Vein No. 6 lies to the southeast of No. 5. In one trench a 2-foot vein of quartz with sphalerite, galena, and chalcopyrite is exposed. In a second trench there is considerable iron-stain in the overburden, with sphalerite and galena masses in the weathered rock. A third trench shows black argillites cut by narrow quartz stringers.

(16) Marsouin River

References

Denis, T. C.: Reports on Mining Operations in the Province of Quebec: 1917, p. 32; 1918, p. 43.

Deposits of zinc blende and galena are reported to occur in the township of Christie on the west branch of Marsouin river about 11 miles inland from St. Lawrence river. Details about the character, size, and number of the occurrences are lacking.

(17) Little Gaspe Cove Lead Veins

References

Geol. Surv., Canada: 1863, pp. 400, 691; 1880-82, pt. DD, p. 15.

These deposits are near the eastern end of Gaspe peninsula. Logan reports:

"The limestones, in their exposures of 4 miles, at cape Gaspe, present numerous dislocations, with dykes, and with veins of calcareous spar, sometimes with galena. One of these localities is in the bight of Little Gaspe cove, where the limestone is washed by the waters of the bay. Here are several fissures, holding these two minerals, and having a direction of north 55 degrees east, with an underlie to the northward. Near to these veins is a dislocation, with a downthrow on the northwest side, by which the limestone is brought against the higher sandstones. It is probable that the mineral veins have some connexion with this dislocation.

The lode occurs in a mass of stratified limestone, which dips about southwest 24 degrees, and rises northward into a hill 700 feet in height, which constitutes Gaspe promontory. It has a breadth of about 18 inches; and is composed of calcspar holding masses of galena, together with small portions of blende and copper ore. A trial shaft was sunk here to the depth of 20 feet upon the main vein; from which, and from several smaller parallel veins in the vicinity, about 20 tons of 60 per cent ore were recently obtained. Besides the two localities already mentioned (Indian cove and Little Gaspe cove), galena has been observed in veins in several other localities in the limestones on the south side of Gaspe promontory; and also on the north side, in a vein which may perhaps be a continuation of that of Little Gaspe cove. Small quantities of galena have been found in veins in the limestones at Percé; and also at Anse Cousin, in a vein cutting the sandstone, in the vicinity of the greenstone dyke mentioned on page 402."

These deposits are similar in many ways to that of the Federal in central Gaspe. They are fissure vein deposits mineralized with galena, blende, and chalcopyrite. At the Federal the gangue is largely quartz, although some carbonate is present, whereas with these deposits the gangue is apparently all calcite. In other respects the deposits are very similar. The Federal veins are of intermediate temperature origin related to the acid Devonian intrusives of the peninsula. A granite batholith is exposed in the middle of the peninsula and offshoots from it are exposed in the surrounding region. In the neighbourhood of the Federal property the Devonian volcanic rocks are mineralized with galena-bearing veins. The greenstone dykes outcropping near the deposits of Indian cove and Little Gaspe cove are to be correlated with these volcanic rocks and hence it is probable that the period of mineralization in this region also was later than the intrusion of these basic dykes. It is to be concluded, therefore, that the source of the material was granitic intrusives of the peninsula.

(18) Indian Cove Lead Veins

References

Geol. Surv., Canada: 1863, pp. 400-401; 1880-82, pt. DD, p. 15.

Logan reports:

"The other locality of galena is in Indian cove. Here is a downthrow to the southeastward, of at least 30 fathoms, by which the higher sandstone is brought opposite to the limestone. Between these walls, there is a lode about 12 feet wide; composed of the veins of the two rocks cemented together by calcareous spar, and including numerous small veins of the same mineral, with crystals of galena. The principal one of these veins is about 2 inches wide in the thickest part: it has an underlie north 74 degrees west 55 degrees; but the general course of the whole lode, in which the small veins occur, is about north 18 degrees east, and the underlie appears to be westward. The dislocation in this place points to a traverse valley or depression in the hills behind, which appears to run across to the opposite side of the promontory, in a course nearly northeast. In a dislocation on the northeast side of the promontory, which is supposed to correspond with this fault, and where a continuation of the lodes might be expected, no ore has yet been observed.

Tranverse dislocations are of common occurrence in this vicinity. One of them, in a recess about a quarter of a mile above Indian cove, is filled with white calcareous spar, which has a thickness of 9 feet in one part, and 1 foot in another. The underlie of the vein is south 65 degrees east$<$76 degrees, and the dip of the strata at the spot is south 55 degrees west$<$22 degrees. On the north side of the promontory, seven dislocations, in a space of about 1½ miles, may be seen at one view, from a convenient distance out on the water. The displacements in six of these compensate one another; and the slope or underlie of the faults, in every instance, is in the direction of the downthrow.

Greenstone dykes, intersecting both the limestones and the sandstones, are seen in several places."

This deposit is located near the one at Little Gaspe cove and undoubtedly has the same origin.

(19) Cross Point

(*See* Figure 14)

LOCATION AND HISTORY

A silver-lead deposit occurs on lot 1, Restigouche range, township of Mann, Bonaventure county, near Cross point on the Gaspe coast opposite the town of Campbellton, New Brunswick. It lies about half a mile north of the line of the Canadian National railway.

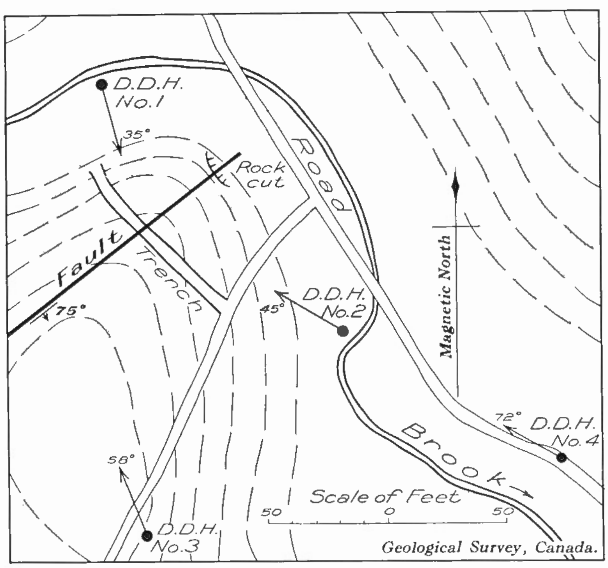


Figure 14. Cross Point silver-lead prospect.

The deposit was staked in the spring of 1927 by Mr. J. C. Beidelman, vice-president and general manager of the Federal Zinc and Lead Company of Montreal, and a small amount of surface work was carried out in the summer of that year. In the summer of 1928 four diamond-drill holes were put down to intersect the mineralized zone, but the results were discouraging. In December, 1928, and January, 1929, electrical prospecting was carried out on the property by the Radiore Company for the owners.

GEOLOGY

The rocks of the property are volcanics of Lower Devonian age. In places they are dense greenstones, in others they are porphyritic. In composition they are andesites. In thin section they are seen to consist of a glassy matrix holding numerous phenocrysts of labradorite feldspar. Small amounts of magnetite are present.

DEPOSITS

The mineralization consists of argentiferous galena with which is locally associated some quartz and calcite, occurring as replacements chiefly along fractures in the volcanics. The main fracture strikes northeast and dips steeply to the southeast. Mineralization occurs along it with widths up to 9 inches in the cut in the face of the cliff where the discovery was made. In the trench to the southwest cross fractures intersect the main fracture and the best ore occurs at such intersections. Solid ore with widths up to 6 inches occurs in places along the main fracture; along the cross fractures the ore usually fingers out to nothing in distances of a few inches. In addition to the mineralization along the fractures, galena is present also in massive rock near the fractures and in places there is a matrix of galena surrounding feldspar phenocrysts which have remained unreplaced. Across the creek to the east small showings of galena have been found in volcanic rocks.

DEVELOPMENT

There is a heavy overburden of glacial material. A small amount of work was done at the open-cut where the discovery was made and a trench was dug to the southwest farther up the hill.

Four diamond-drill holes were put down to intersect the main fracture zone, one from the northwest and three from the southeast. The following is a summary of the drilling:

D.D.H. No. 1

Location: Northwest of mineral zone, near creek
Direction: Approximately south 15 degrees east magnetic
Dip: 35 degrees
Length: 243 feet
Log: Volcanics; 197-243 sheared and broken rock; no mineralization

D.D.H. No. 2

Location: Southeast of discovery, near creek
Direction: North 60 degrees west, magnetic
Dip: 45 degrees
Length: 255 feet
Log: Volcanics, dense to porphyritic; a few stringers of calcite less than ¼ inch thick; no mineralization

D.D.H. No. 3

Location: On hill 120 feet southwest of No. 2
Direction: North 22 degrees west, magnetic
Dip: 58 degrees
Length: 269 feet
Log: 1-52 feet glacial drift; 52-269 feet volcanics, at 187 a shear zone and at 229 specks of galena in volcanic rock

D.D.H. No. 4

Location: In road 106 feet south of No. 2
Direction: North 60 degrees west, magnetic
Dip: 72 degrees
Length: 228 feet
Log: Rock volcanic. From 176-204 feet rock broken, sheared, altered, difficult to drill, 211–228 feet rock powder

ORIGIN

The fact that the galena is argentiferous suggests that the deposit originated from solutions given off by an intrusive, igneous mass. In the interior of Gaspe there are intrusive masses of syenite and granite of late Devonian age and similar ones may underlie this deposit at no great depth.

POSSIBILITIES

The amount of ore exposed at present is too small to be of economic importance. Its character, however, justified exploration work to see if workable deposits might not be present. Though the results up to date have been disappointing the region is one that is worth prospecting.

(20) David Lake

Reference

Mawdsley, J. B.: Geol. Surv., Canada, Sum. Rept. 1927, pt. C, pp. 15, 20.

In David Lake area, Chibougamau district, at a locality a mile north of Proulx bay at the northeast end of lake Doré, is a mineralized zone in which sphalerite is associated with quartz, calcite, chalcopyrite, and pyrrhotite.

Mawdsley also reports:

"Carbonization and, at points, pyrite and chalcopyrite mineralization, are to be found in the 8-mile shear extending east from lake Asinitchibastat to a point 1½ miles northwest of the north end of Cache lake. In this shear, in the greenstone just north of the granite contact, at a point a mile north of the northeast corner of David lake and half a mile east of the stream flowing into the the north end of David lake, the sheared greenstone is strongly carbonated and disseminated pyrite is sparingly present. The stripping of some moss disclosed a 1½-inch vein striking with the shearing at 10 degrees north of west. The vein is composed of about 2 per cent of cubical pyrite up to 2 millimetres in size, 70 per cent of light-coloured sphalerite containing minute particles of chalcopyrite, and the rest white granular quartz."

(21) Lake Mistassini

Reference

"Report on the Geology and Mineral Resources of the Chibougamau Region"; Department of Colonization, Mines, and Fisheries, Province of Quebec, pp. 68, 132, 185, 213.

Galena and zinc blende are present in small amounts in limestone at the narrows on lake Mistassini about 2 miles northeast of the Hudson's Bay Company's post. The limestone contains Cryptozoan forms and has been supposed to be of Lower Ordovician age. Though for the most part flat-lying it has been locally flexed and sheared. In places along the shore for a distance of 500 feet it contains small bunches of galena and zinc blende none over an inch in diameter. The deposits are not of commercial importance.

(22) La Reine Township

Reference

Tanton, T. L.: Geol. Surv., Canada, Sum. Rept. 1915, p. 169.

Tanton reports:

"The discovery of a pegmatite vein carrying galena with gold and silver values, in a fluorite-quartz-feldspar gangue, was reported by Mr. Freeland from lots 7 and 8, La Reine township, Quebec. This property lies 3 miles east-northeast from the mouth of Okikodosik river" (lake Abitibi and close to the Ontario-Quebec boundary).

(23) Zinc in Desmeloizes Township

Reference

James, W. F., and Mawdsley, J. B.: Geol. Surv., Canada, Sum. Rept. 1925, pt. C, p. 78.

LOCATION

The property includes 800 acres and comprises, in range X, the south halves of lots 38 to 42 inclusive, all of 43 and 44, the south halves of 45 to 49 inclusive, and in range IX, the north halves of lots 46 and 47. It lies 11½ miles due north of Dupuy, on the Canadian National railway, 8 miles east of the Ontario-Quebec boundary. From Dupuy there is a good automobile road for 2½ miles, beyond which a winter road 9 miles long has been completed to the property.

GEOLOGY

The rocks exposed by the trenching are of Keewatin age, with the possible exception of a porphyry which may be intrusive. The Keewatin is made up of volcanic flows of varying, but usually intermediate or andesite, composition. Interbedded with them are some banded sediments, probably waterlain tuffs. The flows and sediments have a strike of probably 30 degrees north of west, and their dip is vertical.

The porphyry forms the southwest wall of the mineralized zone and may in fact form much of the altered rock within the zone. It is much sheared near the mineralized area.

DEPOSITS

"The mineralized area is exposed in the main series of trenches and at the time of visiting the property was exposed over a length of more than 200 feet and a width of from a few feet at the northwest to about 60 feet at the southeast. The mineralized area is composed of much altered rocks which originally were probably quartz porphyry or volcanics of unknown composition, but are now strongly carbonated and sheared, and in places silicified. The shearing is vertical and has a strike of 140 degrees. Within this area are four mineralized zones striking from 130 degrees to 140 degrees, dipping vertically, and separated from one another by areas of barren or slightly mineralized rock.

One zone lies at the southeast corner of the general mineralized zone. It contains two bands of solid chalcopyrite and pyrite, 1 and 2 feet wide, respectively, and separated by 3 feet of disseminated pyrite and chalcopyrite. Some quartz stringers are associated with the sulphides. This zone narrows considerably northwesterly along the strike. In a trench, 60 feet away, a little disseminated pyrite and chalcopyrite are all that are visible and in a trench at 80 feet along the strike no mineralization has been encountered.

The second and most important mineral zone is about 20 feet southwest of the first and is exposed northwesterly in various trenches for 140 feet and 80 feet farther northwest a mineralized mass is found which probably is a continuation of the same zone. The zone over the distance of 140 feet swells and pinches from a width of 4 to 10 feet. Within it are bands of nearly solid sulphides. The best cross-section shows a band 1½ feet wide of sphalerite with a little pyrite intermixed. On one side is a band of nearly equal width formed of 50 per cent chalcopyrite and 50 per cent glassy quartz, and on the other side is a 2-inch band of solid pyrite. In the southeasternmost trench a 6-inch band of disseminated sphalerite is also present. The rest of the 8 or 10 feet making up the zone is formed of bands of silicified and sheared quartz porphyry and greenstone containing a small amount of disseminated pyrite. Along the strike of this mineral zone the mineralization in places is represented by disseminated sphalerite, chalcopyrite, and pyrite developed over a width of 4 to 5 feet. A little galena was seen in a couple of places.

A third mineral zone occurs in the southeasternmost trench, southwest of the second-mentioned zone. This third zone is of minor importance and is visible only in the most southeasterly trench, where it is represented by 1 foot of solid pyrite. In the same trench, 12 feet farther southwest, is the northeastern edge of the fourth mineral zone, there exposed over a width of 8 feet. Its continuation is revealed in cross trenches to the northwest over a distance of 160 feet. It narrows progressively in this direction to where it is not more than 2 feet wide. The gossan top of this mineralized band had not been removed when the property was examined. Very probably the chief mineralization is pyrite.

The country rock lying between the last three-mentioned mineral zones is very probably porphyry sheared beyond recognition to a quartzose sericite schist, high in carbonates, light grey in colour, with a silky lustre on its partings. Between the first and second mineral zones, the country rock towards the southeast is a sericite schist, probably originally a porphyry. Towards the northwest the country rock is a greenstone, which in places shows little shearing.

The two trenches, 800 feet to the southeast of the main strippings, are 50 feet apart and in both is visible a sheared zone which strikes 10 degrees south of east in the northwesternmost trench and 27 degrees south of east in the most southeasterly trench. In the northwesternmost trench the mineralization consists of a band 4 feet in width, composed of 50 per cent of pyrite and of contiguous bands 4 and 8 feet wide of disseminated pyrite. In the southeasternmost trench, 50 feet away, the mineralization consists of a little pyrite and a few quartz stringers. The country rock is a chlorite schist.

Although assays have been reported showing in some cases values in gold, and in others, values in silver, the chief and essential values are in the base metals. The showings in the main strippings become progressively more interesting as the low ground is approached. Whether mineralization increases below the heavy drift of the low ground is a matter of pure conjecture. It is not certain that the mineralization in the trenches 800 feet southeast of the main strippings is related to the mineralization found in the main showings. If further work is deemed advisable, the position for it is in the low ground adjacent to and southeast of the main showings.

(24) Abana Mine

LOCATION

The Abana mine lies in Desmeloizes township, north of Dupuy, on the Canadian National railway.

DEPOSIT

The deposits consist of lenses and disseminations of zinc blende and chalcopyrite lying in a shear zone. Diamond drilling and underground development have shown the existence of several ore-bodies. From information so far available it is gathered that large sections of the two developed ore-bodies have a high sphalerite content and that the main tonnage to be mined from them will be the zinc blende.

(25) Horne Mine

References

Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1923, pt. CI, p. 116.
Geol. Surv., Canada, Sum. Rept. 1925, pt. C, p. 46.
Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 48.

LOCATION

The Horne property is located in Rouyn township, Quebec, about a mile north of the town of Rouyn. It is the principal property of Noranda Mines, Limited, and is noted for its large deposits of chalcopyrite.

GEOLOGY

The rocks consist of Keewatin rhyolite and dacite with breccias and tuffs of similar composition. These rocks are cut by large numbers of dykes of diorite and two dykes of later gabbro. The rocks have been twisted into a drag-fold accompanied by a good deal of subsidiary faulting. The ores are replacements of beds of breccia or tuffs and are probably also related in some way to the faulting.

DEPOSITS

Most of the deposits consist of copper ore. Only one body of zinc ore has yet been discovered and very little development has been done on it. It has been explored by a drift on the first level near shaft No. 2 and in this drift it is 25 feet wide. A few diamond drill holes have been put in from the level to determine the extension of the body downward.

POSSIBILITIES

In view of the smallness of the zinc body it is improbable that it will be mined for some time at least. In any case no great tonnage of zinc ore is likely to be produced unless other and larger bodies are found.

(26) Waite-Montgomery

Reference

Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1925, pt. C, p. 44.

LOCATION

The Waite-Montgomery lies in western Quebec near the east edge of Duprat township about 4 miles from the south boundary in claim A2864.

HISTORY

The property was staked in March, 1925, by J. H. C. Waite, C. H. Ackerman, and T. Montgomery. The discovery was accidental. It happened that a tree in a muskeg was blown down so that the moss and soil around it were lifted by the roots. A patch of ore was revealed on the surface thus laid bare and this patch was noted by Mr. Montgomery in crossing the swamp.

GEOLOGY

The rocks consist of rhyolite lavas of Keewatin age. The ore-body appears to be a replacement of these lavas. The lavas lie almost flat with a gentle dip to the southeast and the dip of the ore-body corresponds to this.

DEPOSIT

The ore-body is a large mass of sulphides consisting of a core of chalcopyrite surrounded by a rim of zinc blende, pyrrhotite, and pyrite. At the time of its examination by Cooke in 1925 the ore-body was exposed only in a few trenches and none of the contacts with the country rock was visible.

According to the 1927 annual report of the company there had been blocked out by diamond drilling 140,160 tons of ore averaging 7·46 per cent copper and 2·49 per cent zinc, 27,460 tons averaging 2·64 per cent copper and 10·34 per cent zinc, and 288,150 tons of ore averaging 11·52 per cent zinc, or a total of 455,770 tons averaging 2·46 per cent copper and 8·67 per cent zinc.

The property will yield a large tonnage of copper ore; the zinc ores will probably have to be concentrated and shipped to some zinc smelter.

(27) Aldermac Mines, Limited

Reference

Cooke, H. C., James, W. F., Mawdsley, J. B.: "Geology and Ore Deposits of the Rouyn-Harricanaw Region, Quebec"; Geol. Surv., Canada, Mem. (in preparation).

LOCATION

The property consists of eight claims, Nos. M.L. 1951, 1952, 1953, T2986, 2987, 2988, 2989, and 2990, aggregating 747 acres in the western half of Boischatel township.

HISTORY

The property was staked by the Towagmac Exploration Company in 1923. The ore-body was discovered by dip-needle exploration in the autumn of 1925. A 65 per cent interest was sold to N. A. Timmins, Inc., in return for expenses of development, and this interest was later transferred to Noranda mines. In 1927 the property was incorporated under the name of Aldermac Mines, Limited, of which Noranda Mines held 60 per cent of the stock, and the Towagmac Exploration Company 35 per cent.

The property was examined by H. C. Cooke in 1927, at which time a shaft was sunk below the 125-foot level, and some hundreds of feet of drifting done at that level. Since that time the shaft has been sunk to 1,000 feet and drifts opened at 500, 750, and 1,000 feet.

GEOLOGY

The rocks are Keewatin lavas and breccias varying from rhyolite to trachyte in composition. They are cut by dykes of syenite porphyry, quartz diorite, and later gabbro. The syenite porphyry is the only rock, other than lavas, found in the underground workings. The flows and tuffs strike approximately east, and dip 60 to 70 degrees south.

DEPOSITS

The deposits are lenses of sulphides replacing rhyolite breccia. Replacement has been complete except at the edges of the bodies where the solid sulphides pass into rock thickly sprinkled with sulphide. The underground workings show two of these lenses, one almost vertically above the other, and each apparently dipping south with the formation. The upper lens consists mainly of pyrrhotite with some pyrite, and enriched with chalcopyrite and a little zinc blende. The lower lens, which is much the larger, consists mainly of pyrite, with some chalcopyrite and zinc blende. Copper and zinc content is low, averaging less than 2 per cent copper and 2 per cent zinc.

POSSIBILITIES

Development is being vigorously prosecuted in the hope of discovering higher grade sections in the ore-body. The present grade is so low that it is doubtful if the deposit can be mined at a profit in spite of its large size. Investigations are also in progress with a view to developing uses and a market for the pyrite.

(28) Amulet Mines, Limited

Reference

Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1925, pt. C, p. 39.

LOCATION

This property lies in western Quebec, astride the Duprat-Dufresnoy line about 2 miles from the south boundary.

HISTORY

The property was located in the autumn of 1924 or spring of 1925. The first important discovery was a flat-lying mass near the south end of the property and development was carried out on this throughout 1925 and part of 1926. A shaft was sunk on a discovery made early in 1926 farther to the north and a considerable amount of underground work done. In 1927 it was noted that the ore-bodies were closely related to a rock known as dalmatianite and diamond drilling on this basis resulted in the discovery, in the vicinity of the shaft, of large ore-bodies.

GEOLOGY

The rocks of the property are Keewatin rhyolites lying flat or nearly so on the crest of a broad anticline. The ore deposits are replacements of the lavas and certain of the flows in the vicinity of the ore-bodies appear to have been altered to the rock known as dalmatianite. This is a dark, brownish black rock containing, in certain phases, rounded whitish nodules up to $\frac{3}{4}$-inch diameter embedded in the dark matrix. The weathered appearance of the rock has a very striking spotted appearance. Amygdaloidal and pillow structure present in the rock show that it is of flow origin.

DEPOSITS

The deposits consist of large and small masses of zinc blende and chalcopyrite. The masses are of very irregular shapes. In general the zinc blende forms the bulk of the ore, perhaps 75 to 80 per cent. A good deal of pyrite and pyrrhotite are also present and appear to have been the first sulphides formed, the sphalerite and chalcopyrite replacing them. Several of these masses are known, at least two of which are of fairly large size. Very little is known as yet, however, as to the actual size and shape of the masses. Practically nothing has been given out so far regarding ore reserves or possible tonnages.

ORIGIN

The origin of the ores is not known. It is supposed that there is some relationship between the ore-bodies and a large mass of granodiorite lying directly to the east, but full proof has not as yet been produced. As already stated the ores have replaced certain of the lavas, but as yet the causes for the localization of the deposits are not determined.

DEVELOPMENT

Development of the principal bodies has so far been confined to diamond drilling and by this means the deposits have been outlined to a certain extent. A shaft has been sunk near the main bodies and it is probable that when mining begins the underground workings from this shaft will be driven into the newly-discovered masses of ore. It will be necessary to erect a concentrator for the separation of the zinc and the copper and it is understood that this is already projected.

POSSIBILITIES

Considerable tonnages of zinc can be produced from the property very cheaply and a smaller tonnage of copper. The life of the mine will probably depend on the success of the management in discovering new ore-bodies.

(29) Wright Mine, Duhamel Township

(*See* Figure 15)

References

Reports of Commissioner of Crown Lands, Province of Quebec: 1888, p. 93; 1891, p. 84; 1893, p. 103; 1894, p. 88; 1896, p. 152; Ann. Repts. Colonization and Mines, Province of Quebec: 1898, p. 19; 1899, p. 24; 1900, p. 21; 1901, p. 19; 1902, p. 13; 1903, p. 51; 1906, p. 34; 1915, p. 31.

Geol. Surv., Canada, Ann. Repts.: vol. IV, pt. K, p. 79, pt. S, p. 58; vol. V, pt. S, p. 90, pt. SS, p. 89; vol. X, pt. I, pp. 99, 147-148.

Barlow, A. E.: Geol. Surv., Canada, Pub. No. 962, pp. 133, 145-147.

Wilson, M. E.: Geol. Surv., Canada, Pub. No. 1064, pp. 29, 36, 38.

McRae, J. A.: "History and Romance of the Oldest Mine in Canada"; Can. Min. Jour., August 19, 1921, pp. 665-667.

Cooke, H. C.: "Wright Mine, Duhamel Township, Quebec"; Geol. Surv., Canada, Sum. Rept. 1925, pt. C, pp. 20-27.

LOCATION

The Wright silver-lead mine is on the east shore of lake Timiskaming, approximately one-quarter mile south of the boundary between Duhamel and Guigues townships. It is readily reached by boat from Haileybury, 6½ miles on the other side of the lake; or by road from either North Timiskaming on the north or Ville Marie on the south.

HISTORY

"The property was located initially on March 24, 1686, by a party of French explorers under the command of the Sieur de Troyes, and its location is shown on an early French map published in 1744.

There are no illustrations or drawings in existence which deal with the mine as it appeared more than two centuries ago. Indeed there is but meagre mention made of the deposit until about 1850. It was about this date that Mr. E. V. Wright of Ottawa, who owned the timber on this locality, rediscovered the deposit.

Wright was engaged in removing timber from his concession when the calks on his boots chipped off some of the galena and lead-bearing ore. Samples of the ore were taken to Ottawa where they lay for several years on the desk of the discoverer. About 1870, it occurred to Wright to have the samples assayed. The result of the assay was such as to arouse considerable interest. Shortly after this, Mr. Wright, accompanied by J. M. Courier and Mr. Eustis from Boston, came up and commenced work, sinking a shaft to a depth of about 12 feet. From this shaft they took out about 10 tons of ore. Details of the result are lacking. It is recorded, however, that a second shipment was made by raft, but the crude conveyance smashed up in a mad plunge through the rapids at Deux Rivières.

Nothing was done until 1885, when George Goodwin of Ottawa, together with G. P. Brophy, advanced sufficient money to pay for sinking the shaft a farther 50 feet in depth as well as installing some mechanical equipment and a five-ton stamp mill. This plant was afterwards burned. No ore was shipped as a result of this work.

About 1890 Robert Chapin, at that time president of the Ingersoll Rock Drill Company (N.Y.), bought the property and made an option payment on the basis of $125,000. He installed the first air compressor in the country, and built a 50- or 60-ton mill. He continued the shaft to a depth of 250 feet and did considerable lateral work. This resulted in the shipment of a considerable quantity of concentrates, the value of which seems to be impossible to estimate at this date. It is said that Mr. Chapin became involved in some bad investments which caused him to abandon the mining project with the result that the property reverted to Wright, the principal holder.

In 1895 Wright sold the property to the Petroleum Oil Trust of London, England. the new owners sank the shaft another 50 feet in depth and did several hundred feet of drifting and crosscutting at the bottom level, as well as some work at the 250-foot level. The mill was also operated, the concentrates being shipped to Swansea, Wales. No figures are available as to the amount of concentrates produced.

The mill and buildings as erected by the Petroleum Oil Trust are still standing, although the machinery has been pretty well all removed. The writer visited the mine, June 18, 1921, together with the members of the Ontario Mine Manager's Association. . . . These buildings are of the old-fashioned type, features being the many gables as well as having a ground floor entrance and a second story entrance by stairways leading from the ground.

A few years ago, the Wright mine was bought by the Timmins-McMartin interests of Montreal, and is still owned by them."[1]

In 1925 the mine was pumped out by the owners in order to sample it. An examination at this time was made by H. C. Cooke.

GEOLOGY

Cooke reports:

"The rocks in the immediate neighbourhood of the mine consist wholly of conglomerate of the Cobalt series. About a mile southeast there is a high hill of flat-bedded quartzite and arkose that may belong to the Gowganda or Lorrain formations of the Cobalt series. About one-quarter mile south of the mine, flat-lying Palæozoic limestones outcrop on the lake shore. The Cobalt conglomerate appears to be, in its lower parts at least, a true basal conglomerate formed almost entirely of material derived from the rocks immediately underlying. This rock is an ordinary rather acid rhyolite such as may be found in many places in the Keewatin series, made up of numerous phenocrysts of white feldspar up to 2 or 3 mm. long, and many smaller phenocrysts of quartz, embedded in a fine-grained greyish matrix. The higher beds of conglomerate in a 40-foot cliff some 200 feet back from the shore exhibit a more normal assortment of pebbles. The conglomerate extends downward the full depth of the mine shaft, 330 feet, and the conglomerate hill behind rises more than 120 feet above the collar of the shaft, as determined by levelling roughly with a Brunton compass; so that the conglomerate is more than 450 feet thick. The pebbles of the conglomerate both within the ore-body and outside of it are all very well rounded.

DEPOSIT

The ore is a breccia made of fragments of Cobalt conglomerate cemented together by coarse-grained white calcite, galena, and zinc blende. It outcrops on the shore of the lake, the outcrop being bounded on the inshore side by non-brecciated conglomerate. Between the outcrop and the shaft 20 feet inland, the surface is covered with the loose materials of the dump, but the shaft enters the southeast edge of the ore-body, so that the mass of non-brecciated conglomerate between the shaft and the ore on the shore is evidently a horse.

The shaft reaches a depth of 330 feet and levels have been run at depths of 50, 100, 179, 230, and 330 feet. The workings on the different levels are shown in Figure 1 [Figure 15] together with the outlines of the ore-body as observed and conjectured.

It will be observed from the plans of the different levels that the ore-body is an almost vertical pipe broadly oval in cross-section; and, further, that this pipe is largest in diameter between the 100 and 179-foot levels. The limits of the ore-body are those of the brecciated zone.

No cause could be found accounting for the formation of a body of breccia of such extraordinary shape. A pipe of this sort might be formed at the junction of two faults, but no evidence of pre-ore faulting on a large scale could be discovered. There are a few small faults around the edges of the ore-body at which the mineral veinlets stop abruptly, but nothing that would seem likely to account for so exten-

[1] McRae, J. A.: Can. Min. Jour., August 19, 1921.

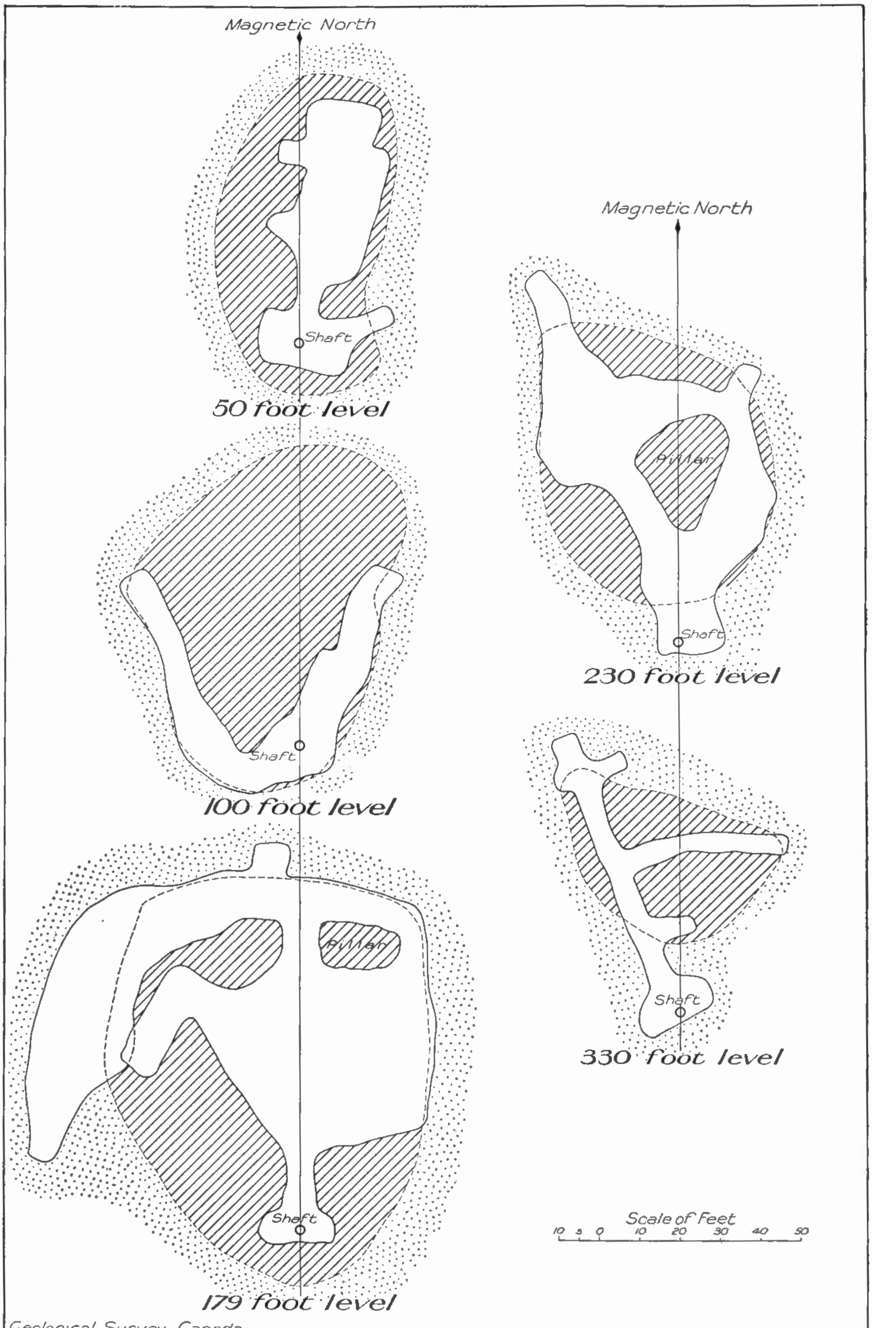


Figure 15. Plans of levels, Wright mine, Duhamel township, Que. Country rock indicated by pattern of dots, ore still remaining by pattern of diagonal lines. (Except where crossed by workings, the position of boundary of ore-body is inferred.)

sive a brecciation. It is to be noted, however, that the introduction of the ore into the conglomerate must have been accompanied by a considerable increase in the volume of the whole, since there is no evidence that the ore has replaced any of the conglomerate; and the pressures thus produced were probably relieved by upward movement, since relief of pressure would be possible only in this direction. Under such conditions it is possible that there may have been originally in the conglomerate only a few comparatively small cracks that were filled with ore; and that the upward movements resulting from the pressures developed by crystallization caused further brecciation. Under this conception the greater part of the brecciation would be contemporaneous with the ore deposition rather than of earlier date.

If this theory be true, the stresses forcing the rocks upward as crystallization proceeded might be expected also to cause some rupture of the walls of the deposit, with formation of horizontal open fissures. Such fissures are in fact rather numerous in the mine, and are of all sizes up to a foot in width. They are now filled mainly with quartz, which, as it is found in the mine only in these fissures, is evidently a later vein filling. The quartz is accompanied by galena, sphalerite, and calcite, all of which might have been, and probably were, taken into solution from the deposit by the solutions carrying the quartz and later deposited in the open horizontal fissures. These fissures contain numerous open vugs, and pass from the edges of the ore deposit into the unbrecciated country rock.

The ore has a rather definite vertical variation. At the surface and on the two upper levels the ore is very largely argentiferous galena with very little sphalerite. The proportion of sphalerite increases downward to the 179-foot level, where it is largest. Below the 179-foot level both sulphides decrease in quantity. An occasional grain of pyrite is to be found throughout the mine, but more of it occurs in the 330-foot level than elsewhere.

The results of several hundred assays made when the mine was sampled about eight years ago, were placed at the writer's disposal; but as the location of only a few of these was indicated on the mine maps and it is evident from the character of the underground workings that practically all samples must have been taken within the ore-body, it was considered best to average them by levels in the hope of arriving at some conception of the changes taking place with depth. The results obtained are as follows:

Level	Silver	Lead	Zinc
	Oz. per ton	Per cent	Per cent
50-foot	1·72	9·62	None
100-foot	0·63	0·2	0·8
179-foot	0·86	3·16	1·63
230-foot	1·1	2·25	0·95
330-foot	0·36	0·36	0·77

The results show certain interesting regularities. If the values for the 100-foot level be omitted from consideration, the results become even more regular. It seems justifiable to omit the averages of the values obtained on the 100-foot level, as the workings on that level are comparatively small and closely follow the edges of the ore-body where the proportion of ore to rock is invariably low. So far as could be seen during the examination, the ore on the side of the drift toward the middle of the ore-body is of much the same grade as that in the levels above and below. The lead values decrease downwards with great uniformity. The silver values decrease to a minimum at 330 feet depth, though not with the uniformity of the lead. Zinc, on the other hand, increases from zero at the 50-foot level to a maximum at the 179-foot level, then decreases downward.

Another point of interest is the entire lack of correspondence between the silver values and the amounts present either of galena or of galena and sphalerite combined. This lack of correspondence between the amounts of silver and of sulphides present is equally obvious on scanning the individual assays from which the above averages were derived. The wide variations in the proportions of silver to sulphide render it obvious that no uniform relationship exists between them. It may reasonably be inferred, therefore, that the silver is not present in solid solution in the sulphides, but more probably is mixed with it irregularly in the form of one of the silver sulphides.

All available facts point to the conclusion that the deposit was formed by descending meteoric waters rather than by hot, ascending solutions. The cause of the precipitation and the reason for the concentration at this particular spot are as yet unknown. The difference in the behaviour of the lead and zinc sulphides is one commonly found in deposits of character similar to this and is due to the greater solubility of zinc compounds, causing them to be carried somewhat farther before precipitation takes place. The source of the ores is, therefore, to be sought in the rocks formerly overlying the present deposit. As flat-lying Ordovician limestones overlie the Cobalt series within short distances to the south, west, and north, it may reasonably be assumed that they overlay the area around the mine also, and have since been eroded away. How the lead-zinc minerals came to be present in the Palæozoic rocks can be only a matter of speculation."

(30) Fabre Township

References

Wilson, M. E.: Geol. Surv., Canada, Pub. 1064, p. 38. Sum. Rept. 1907, p. 63.
Barlow, A. E.: Geol. Surv., Canada, Sum. Rept. 1906, p. 117.

The Keewatin rocks in Fabre township on the east side of lake Timiskaming locally contain galena, but no large quantities have been located.

(31) Poirier Lake

Reference

Bancroft, J. A.: Report on Mining Operations in the Province of Quebec, 1911, pp. 201-203.

Poirier lake is on the boundary between La Pause and Pressiac townships, Témiscamingue county. Bancroft states:

"About two-thirds of a mile northward from Poirier lake a rocky ridge, which in part is devoid of trees, rises to an altitude of approximately 100 feet. The ridge extends nearly east and west corresponding to the strike, south 80 degrees east, of the highly schistose rocks of which it is composed. The schists are traversed by a series of veins or stringers of quartz, frequently containing a little calcite and epidote, and occasionally bearing small amounts of galena, zinc blende, pyrite, and a few specks of copper pyrites. Although these veins may seem to recur at widely separated intervals along a definite line, they can seldom be traced for more than a few feet before they become very narrow and finally disappear. They display a maximum width of 4 feet, but can be traced for only a few yards before they terminate.

A group of mineral claims are situated there, having for their chief centre of attraction a vein, 4 feet wide, containing a considerable percentage of galena, zinc blende, and pyrite, with an occasional particle of copper pyrites in a gangue of calcite and quartz. At the time of our visit, Mr. George Richmond, who made the discovery, was engaged with a few men in sinking a shaft, which had reached a depth of 10 feet. A few feet westward from the shaft, the vein pinches out, but stringers of barren quartz occasionally occur in line with its projection; several hundred feet westward one of these quartz veins, about 18 inches wide, contains a little galena and zinc blende. For a few yards eastward from the shaft, the bedrock is covered, but upon reappearing at the surface there is no evidence of the presence of the vein.

Striking south 80 degrees east and dipping 87 degrees toward the south. this vein is situated between a small dyke of fine-grained diorite on the north and actinolite schist on the south. Although in part distributed through the gangue of calcite and quartz, the galena, zinc blende, and pyrite occur chiefly along or adjacent to fractures in the gangue. Of the economic minerals present, galena is the most abundant, zinc blende tends to occur near the walls of the vein, and the pyrite, which is present in very subordinate amount, is crystallized in beautiful, small pyritohedrons. At the bottom of the shaft the vein was 7 inches narrower, pyrite was becoming slightly more abundant, and a dyke of aplite, 2 to 4 inches wide, intersected the southern margin of the vein. In thin section under the microscope this aplite is found to be almost entirely composed of microcrystalline quartz with epidote of bright yellow-green colour, which apparently has been derived from the alteration of a small amount of feldspar. So analogous is this aplite to similar dykes, which are associated with, and genetically related to, the "newer diabase" in other districts, that it lends emphasis to a belief that the vein owes its origin to the intrusions of quartz diabase in the district.

I was informed that after our departure from the district, the shaft was sunk to a depth of 40 feet, where there was about 8 inches of vein matter in the form of stringers running in all directions.

The body of ore is by no means large enough to even suggest the possibility of its being developed into a mine for lead and zinc. An assay of an excellent sample taken from the shaft at a depth of 8 feet, containing small galena, zinc blende, and pyrite, shows the presence of 47 cents per ton in silver and not a trace of gold."

(32) Calumet Zinc and Lead Mine

(*See* Figure 16)

References

Ann. Repts., Commissioner Crown Lands, Quebec: 1892, p. 78; 1893, p. 103; 1894, p. 88; 1895, p. 54; Ann. Repts., Dept. Colonization and Mines, Quebec: 1898, pp. 18-19; 1899, p. 24; 1906, p. 34; 1911, pp. 26-27; 1912, p. 29; 1913, pp. 57-58; 1916, p. 39; 1917, p. 31; 1925, pp. 43-45; 1926, p. 4.

Geol. Surv., Canada, Ann. Repts.: vol. VI, pt. S, p. 101; vol. VII, pt. A, pp. 61-62; vol. VII, pt. S, p. 87; vol. X, pt. S, pp. 114, 120, 229; vol. XI, pt. A, pp. 10, 118, pt. S, pp. 104, 192; vol. XII, pt. S, p. 141; vol. XIII, pt. S, p. 156; vol. XIV, pt. S, p. 157; vol. XV, pt. AA, p. 135, pt. S, pp. 242-243.

Uglow, W. L.: Ont. Bureau of Mines, vol. XXV, pt. ii, pp. 5-7 (1916).

Goranson, R. W.: Geol. Surv., Canada, Sum. Rept. 1925, pt. C, pp. 105-124.

LOCATION

The Calumet lead and zinc property is on lots 3 to 12, range IV, in the southwestern part of Calumet island which is situated in Ottawa river about 58 miles northwest of Ottawa. Campbells Bay, on the Waltham branch of the Canadian Pacific railway, following the north side of Ottawa river, is the nearest station to the property.

HISTORY AND PRODUCTION

The property[1]

"was staked by John Lawn and turned over to James and Calvin Russell who did some development work and in 1893 shipped a few tons of ore to Swansea, England. This sample is said to have contained 13 per cent lead, 38·9 per cent zinc, and 11 ounces of silver per ton.

[1] Quotations are from the report by R. W. Goranson.

The Grand Calumet Mining Company of Ottawa worked the mine in 1897 and 1898, and in 1898 shipped ore.

In 1911 the mine was taken over by the Calumet Metals Company. The same year a concentrating mill with a capacity of 150 tons was erected.

In 1913 the property was operated by the Calumet Zinc and Lead Company. A law suit instituted by some of the shareholders resulted in an order of the court that the property should be sold at public auction for the benefit of the plaintiff shareholders. The sale was made in 1917 and the property was bid in for the English bondholders.

The following statement of production was obtained from the files of the Mines Branch, Department of Mines.

Year
1893: 13½ tons shipped to Swansea, Wales
1894: No shipment
1895: Idle
1896: No information
1897: No information
1898: 1,100 tons shipped to Antwerp, Belgium, averaging 32 per cent zinc, 9 per cent lead
1912: No shipments; construction
1913-14: No information
1915: Idle
1916: No information
1918: 22 tons shipped to Omaha, Nebraska, from old stock; lead, 19,892 pounds; gold, 6·2 ounces; silver, 1·335 ounces."

In 1926 the British Metal Corporation (Canada), Limited, took an option on the property and carried out underground work from May until October. The option was then dropped.

GEOLOGY

The rocks of the region are all Precambrian. They belong to three series: (1) limestone of the Grenville series; (2) amphibolites which were once diorites and gabbros, belonging to the Buckingham series, intrusive into the Grenville rocks; and (3) granite cutting both of these series.

The rocks on the property are chiefly amphibolites. They are green to black, schistose varieties consisting chiefly of hornblende and feldspar, the latter ranging from albite-oligoclase to labradorite, with apatite, carbonate, garnet, quartz, biotite, magnetite, and ilmenite as accessories. Here and there remnants of diopside, hypersthene, and micropegmatite can be found. In places the amphibolites contain patches consisting of carbonate and lime-silicate minerals including diopside, tremolite, scapolite, clinozoisite, etc. These probably represent altered limestone inclusions. Locally granite pegmatites are present and have caused the formation of microcline, orthoclase, titanite, quartz, zircon, and apatite in the amphibolites.

ORE DEPOSITS

The ore deposits occur replacing amphibolite along a shear zone that has a general trend of north 20 degrees west. The planes of schistosity dip rather steeply to the west. The important ore minerals are sphalerite and galena. Galena in places is more abundant than sphalerite, but the ratio of the latter to the former is, on the average, about three to one. Pyrrhotite and its alteration product marcasite are very abundant. Pyrite,

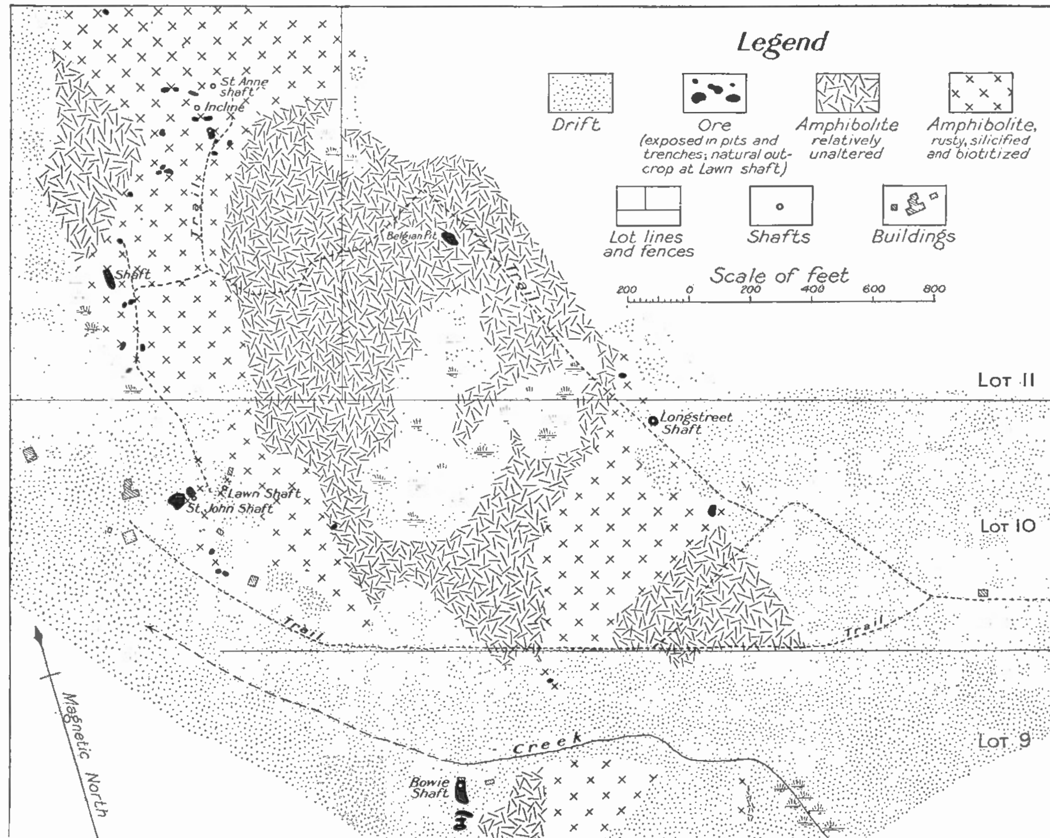


Figure 16. Calumet lead and zinc mine, Calumet island, Que.

chalcopyrite, and tennantite are present in small amounts. Silver is present and appears to be associated with the galena, but tennantite may be the carrier. The latter is always associated with galena.

The ore occurs as lenticular deposits in the schistose rocks. The walls of the individual lenses are not very clearly defined and ore minerals are commonly disseminated in small bunches and pockets through the rocks in the general ore zone. Along the strike, also, the mineralization is irregular, with mineralized portions separated by barren patches and the underground workings show that in vertical section the same features occur. With the heavy sulphide ore masses there is usually carbonate present which is believed to be primary calcite. This suggests that the localization of the ore was due to the presence of limestone masses which, as compared with the enclosing amphibolite, were more easily replaced. Examples where such calcite occurs are in the ore lenses across the face of the Bowie cut, in the Lawn workings, and in the ore from the Longstreet and Ste. Anne shafts (*See* Figure 16). Where calcite remnants are absent, the ore is of poorer grade.

In the neighbourhood of the sulphide masses the enclosing rock is highly altered. At the immediate boundary of the ore masses, amphibolite is practically unrecognizable as such. It is a coarse-grained rock consisting chiefly of phlogopite and lenses of greasy-looking quartz, with remnants of highly altered feldspar which is near oligoclase in composition. Lesser amounts are present of pleonaste, zircon, sillimanite, apatite, sericite, epidote, chlorite, serpentine, calcite, and pink garnet. The phlogopite is the chief mineral and occurs as large flakes. Pyrrhotite, galena, and sphalerite aggregates are commonly elongated streaks. They replace phlogopite along cleavage planes. Where plagioclase is extensively sericitized, galena is scattered through it as very ragged grains and as perfect crystals extending from narrow veinlets. Where limestone has been present in the mineralized area there are additional lime-silicate minerals, including tremolite, diopside, scapolite, green hornblende, clinozoisite, and andesine; phlogopite, titanite, quartz, and calcite are also present. The intensity of the alteration of the country rock decreases from the local sulphide-bearing areas.

"The southern extremity of the ore-bearing zone is not known, but about midway along the boundary between lots 7 and 8 there is exposed a biotitized, silicified zone about 850 feet wide, and in this zone an open-cut 6 feet wide and about 24 feet long east and west, displays a small amount of chalcopyrite, sphalerite, pyrrhotite, and galena scattered through amphibolite in small, isolated lenses and patches. This same zone also crops out along the boundary between lots 8 and 9, but only small, scattered grains of sulphides were there observed.

Five shafts and numerous open-cuts have shown the zone to contain ore lenses on lots 9, 10, and 11 (*See* Figure 18). The shafts and cuts were full of water at the time of the writer's examination (1924), and, therefore, the following notes on underground development are based on reports made by others at various times.

The most southerly working is the Bowie shaft on lot 9. The opening consists of a series of trenches which increase in depth to the north, the deepest being 42 feet. From the lowest bench a vertical shaft was sunk 32 feet and a level driven at 52 feet from the original surface. The ore now exposed in the cut is chiefly sphalerite with abundant galena, pyrrhotite, and, in places, chalcopyrite. It forms lenses, some of which are nearly solid sulphide, up to 2 feet wide and about 6 feet apart across the face of the cut, with smaller bunches of sulphide scattered irregularly between them. The face of the cut is 34 feet wide, and an average sample across the whole face would be low grade.

The Lawn shaft is 1,312 feet northwest of the Bowie. It has a depth of 57 feet 8 inches. A cut has been made 100 feet west of this shaft and a small incline sunk which dips toward the shaft. This incline is stated to be about 18 feet deep and has gone through considerable limestone judging from its dump. The ore here contains more lead than at the Bowie, and is reported to have a fair amount of silver. Farther west is a shallow pond, about 5 feet deep, from which ore has been extracted. Galena and sphalerite were found along the edge of the cut, but no estimate of the amount could be made. The ore horizon here, judging from the openings, is thus probably more than 200 feet wide.

Eight hundred feet north of the Lawn shaft there is an open-cut about 70 feet long and 30 feet wide. At the bottom of this cut there is a shaft, said to be 18 feet deep, from which a 12-foot level has been run north. The exposed ore at the bottom of this shaft is, according to a report by John E. Hardman, over 20 feet wide and dips 50 to 55 degrees west. There are galena and sphalerite at the surface which have been heavily stained by the oxidation of pyrrhotite, but the best ore now to be found here is from the dump, and may represent a lens that enlarges downwards to a maximum size at a depth of 18 feet or more. Between this open-cut and the Lawn shaft are a number of small cuts and trenches. They show pyrrhotite, sphalerite, galena, and, in places, chalcopyrite, scattered in small bunches through a rusty, biotitized, and silicified amphibolite. The average quality of the ore seen was very low grade, but the cuts are not so disposed as to permit of estimating the amount and tenor of the ore.

Six hundred feet north and a little west of the above-described open-cut is the St. Anne shaft which was sunk vertically to a depth of 120 feet, at which depth crosscuts were driven presumably to the east, to strike the ore lenses on which the shaft had been sunk. The dump from this shaft consists chiefly of calcite impregnated with galena and sphalerite. If the dump is representative of the material extracted from the underground workings, then this is the most promising locality on the property. The type of ore appearing in the materials on the dump does not outcrop.

Eighty feet southeast of the St. Anne shaft an incline has been sunk, but to what depth is not known. There are numerous open-cuts and pits scattered around this incline, which have been made in highly altered amphibolite. They all display sulphides scattered in small patches through the rock. The average ore is low grade. The mineralized area, as indicated by these openings, is about 300 feet wide.

A few hundred feet east of the mineralized zone on which all the foregoing workings are situated is a second zone separated from the first by relatively unaltered amphibolite. On this zone is the Longstreet shaft, stated to be 143 feet deep. It was sunk on the outcrop made by the discoverer of the property. The ore, as indicated by the dump, is galena and sphalerite, which appear to have replaced limestone inclusions in the amphibolite. About 100 feet northeast of this shaft is a small open-cut which displays abundant galena and sphalerite. The width of this ore lens could not be determined.

Nine hundred feet northwest of the Longstreet shaft is an open-cut about 60 feet long, which seems to be about 15 feet deep, but is now full of water. It has been called the "Belgian pit." The ore extracted here was probably from a narrow galena-sphalerite lens. Some ore still outcrops around the pit, but no large amount is now visible.

The above completes the account of the visible mineralization. The mineralized zone has been trenched and proved to contain sulphide lenses at intervals over a length of about 2,600 feet, and, from indication offered by the outcrops, the zone may continue north for another 400 feet. The zone was traced south over lot 8 and so probably extends across five lots. Over this whole length the outcrops are exceedingly rusty, the rock is heavily biotitized and silicified, and all the cuts contain ore minerals. But because of the irregular, pockety nature of the ore lenses no estimate of the tonnage can be given and it should not be assumed that productive ore-bodies will be found over the whole zone.

The valuable metals in the ore are zinc, lead, and silver. Locally, galena may be more abundant than sphalerite, but the ratio of sphalerite to galena is, on the average, about as three to one. Samples have been taken at various times and places. Some of the assay results are as follows:

—	1	2	3	4	5	6
Zinc, per cent	29·19	7·58	16·60	15·51	12·30	13·00
Lead, per cent	13·75	4·50	6·64	4·75	3·84	6·00
Copper, per cent	3·17	....	....	....	....	....
Silver, ozs., per ton	14·50	8·90	18·2	13·00	12·00	15·00
Gold, ozs., per ton	....	....	....	....	....	0·03

1. An average sample of the dumps taken in 1911 by C. W. Willimott, of the Geological Survey, Canada.
2. Sample from the Lawn pits from surface to 10 feet depth.
3. Sample from Lawn pits from 10 to 15 feet depth.
4. Sample from Lawn shaft at depth of 57 feet on the incline.
5. Samples from the bottom (18 feet depth) of the Russell shaft.
6. Average of assays on record made by Ledoux and Company, Ricketts and Banks, Cornell University, etc.

The data regarding samples Nos. 2 to 6 have been taken from a private report made by John E. Hardman."

ORIGIN

The character and mineralogy of the deposit suggest an origin similar to that at the Tetreault property at Notre-Dame-des-Anges, i.e., deposition at high temperature due to the action of intrusive granite. As at the Tetreault the richer ore occurrences are associated with carbonate rock.

(33) Buckingham Township

Reference

Geol. Surv., Canada, Ann. Rept., vol. X, pt. S, pp. 120, 135 (1899).

LOCATION

The veins are on the south half of lot 21, range IV, Buckingham township, Papineau county, Quebec.

GEOLOGY

The chief rock type of the region is crystalline limestone of the Grenville series. Quartzite and sedimentary gneiss of the same series also occur on the property. At the time of the writer's visit to the property in the autumn of 1925 most of the exposures were covered with snow, which rendered a complete examination of the surrounding rocks impossible.

DEPOSIT

Two veins are exposed on the property. The first strikes north 35 degrees west magnetic, cutting limestone, and has been traced for about 350 feet. It varies in width from 2 to 16 inches, the average width being about 4 inches. It pinches and swells and follows minor curves. The gangue is barite which is well banded. Galena occurs disseminated in the barite.

The second vein lies about 75 feet to the northeast. It strikes about north 45 degrees east magnetic, cutting limestone, and has been traced for about 500 feet. The vein pinches and swells. Its average width is about 6 inches. The gangue is banded barite. In places it contains solid bands of galena from 1 inch to $1\frac{1}{2}$ inches in width. At one place a branch vein strikes in a southeast direction towards the first vein. An old shaft was sunk to a depth of 50 feet on the vein, but at the time of visit it was full of water.

The veins as exposed at the surface are too narrow to be of commercial importance as sources of lead.

(34) Petite-Nation River

Reference

"Geology of Canada, 1863," p. 689.

The Petite-Nation enters Ottawa river from the north about 35 miles east of the city of Ottawa. Logan reports:

"Among others a vein of 6 or 8 inches is said to exist upon the North Petite Nation river, on the seigniory of the Honourable L. J. Papineau. Galena has also been brought from the Gatineau and the Black river; in the former case, associated with the purple fluorspar."

(35) Upton Township

Reference

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863," p 690.

Logan states:

"In the Quebec group of eastern Canada, . . . ores of lead have been occasionally met with associated with the copper deposits . . . In these localities galena is found in small, interstratified masses, or layers. One of these is on lot 51, range XXI, of Upton, where irregularly distributed patches of fine-grained galena, from 1 to 4 inches in thickness, occur in the copper-bearing magnesian limestone. They are sometimes distinctly interstratified with the rock, and overlain by portions of copper pyrites."

(36) Acton and (37) Ascot Townships

Reference

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863," pp. 516, 690.

Logan states:

"Galena occurs in similar (1 to 4 inches in thickness as in Upton) masses, also with copper pyrites, and with a little blende, on lot 32, range V, of Acton. A like variety of fine-grained galena is found with copper pyrites on lot 9, range IX, of Ascot. These ores of lead contain but little silver. Although the galena in none of these deposits appears to be of workable quantity, its presence in interstratified masses is not to be overlooked in a region where the numerous deposits of copper ore, which occur under similar conditions, are occasionally found to be of very great extent and importance."

(38) Moulton Hill

Reference

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863," pp. 516, 518, 691.

Moulton hill is on lot 15, range IV, of Ascot, near Lennoxville, Sherbrooke county. A quartz vein, about 4½ feet wide, here carries argentiferous galena and arsenopyrite. The vein traverses black shale. The amount of galena present is too small to be of economic importance. Silver assayed 65 ounces to the ton of lead.

(39) St. Armand

Reference

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863," pp. 516, 590.

Logan states:

"At Cooks Corner, in St. Armand, a vein of white quartz running with the strike, cuts the black slates and limestone of the region. It has a breadth of 5 or 6 inches, and contains small portions of galena, with a little copper pyrites and blende. The lead of this ore was found to contain a notable proportion of silver."

(40) Owls Head, Potton Township

Reference

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863," p. 691.

On the shore of lake Memphremagog, on lot 8, range XI, of Potton township, a quartz vein traverses black slates of Upper Silurian or Devonian age. The vein is described as being about 10 feet wide. The galena is confined to a small portion of this breadth. Specimens of solid ore, 2 or 3 inches in thickness, have been taken out. The galena is silver-bearing.

(41) St. Francis

References

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863," pp. 516, 517.
Ells, R. W.: Geol. Surv., Canada, Ann. Rept., vol. II, pt. J, p. 57 (1887).

Logan states:

"A vein which occurs at the rapids of the Chaudière in St. Francis, Beauce, contains, in a gangue of quartz, argentiferous galena, blende, mispickel, besides cubic and magnetic pyrites, with minute grains of native gold. A portion of galena from the assorted and washed ore, which still retained an admixture of blende and pyrites, gave by assay 69 per cent of lead, and 32 ounces of silver to the ton of 2,240 pounds of ore. The assay of a second portion gave, however, not less than 256 ounces of silver to the ton. This result was probably due to the presence of a fragment of native silver, or some rich silver ore among the dressed galena; inasmuch as a third assay, of another portion of the ore, more carefully dressed than the first, yielded 37 ounces of silver to the ton. The silver from the cupellation of the reduced lead contained a little gold, and both silver and gold were obtained from the blende and pyrites of the same vein. One thousand grains of the pyrites, still mingled with a small portion of the other ores, were roasted, and then fused with litharge, borax, salt of tartar, and metallic iron. The resulting button of lead gave by cupellation 0·15 grain of an alloy of gold and silver. Seven hundred grains of the blende treated in the same manner gave 0·19 grain of a similar alloy, of a pale yellow colour. The two precious metals seem thus to be generally disseminated throughout the ores of this vein."

(42) Risborough, Marlow, and Spalding; (43) Ditton and Emberton Townships

Reference

Ells, R. W.: Geol. Surv., Canada, Ann. Rept., vol. II, pp. 56-59 (1887).

Ells reports:

"....several veins of galena have been discovered, more especially near the boundary of the townships of Risborough and Marlow; they have been opened to some extent and favourable prospects were found. The localities where work was principally done are on lots 1, 2, and 3, ranges XIV, XV, and XVI, Risborough, and lot I, range VII, Marlow...............

At the first, a more northerly shaft, the rock is a hard, greyish sandstone. with interstratified beds of black and grey slates, finely wrinkled and in some places containing cubes of iron-pyrites. It dips generally southeasterly 70 degrees to 75 degrees, as nearly as could be ascertained. The vein, which is styled the "main vein," has a width of 10 to 12 inches, composed of quartz, carrying galena, copper and iron-pyrites, and some blende, in some places heavily charged, in others comparatively barren, probably from half to a third of the vein carries ore in fair quantity. This shaft was about 30 feet deep, and the vein is of uniform width for that distance. The rock in contact is slightly charged with iron-pyrites. Twenty feet west of this shaft, another vein of about 10 inches, called the "north vein" carries ore of a peculiar quality. The gangue is a rusty white quartz, with brownish, grey slates on the north wall, and a dyke of very hard, brownish, dioritic rock, spotted with greenish grey, separates it from that in the shaft just described. The ore, where exposed at the surface, is confined to the north side, but as only three or four shots have been fired, the opening is small.

In the second or small shaft, sunk about 35 feet south of that seen in the north shaft, the lode goes down vertically, with a width of about 1 foot. It is apparently not as rich as the main vein, but carries galena, blende, and pyrites irregularly disseminated, the former, so far as observed, in comparatively small quantity. The vein cuts across the bedding at a small angle, and is intersected by another vein of irregular size, ranging from a few inches to nearly 2 feet in width. The diorite does not show in this shaft. This latter vein has also been opened 130 feet east, where it crops in the spur of a knoll, and has a course of about north 68 degrees east. The shaft is 18 feet deep.

Nearly a mile southwest, another opening has been made in slates and sandstones of similar character, which dip south 15 degrees east, $<$ 70 degrees, on a vein of rusty white quartz, from 16 to 18 inches wide, styled the "Armstrong vein," which cuts across the bedding and carries minerals similar to those already described. The trench being full of water, the proportion of ore could not be definitely ascertained, but the mineral appears to be disseminated in bunches, large portions of the vein being barren, others comparatively rich. A short distance to the southwest of this, two other veins were noted, of which the largest (the "Senator" vein) has a width of 18 to 20 inches, the other of about 3 inches. In character of gangue and contained mineral, this resembled closely the last. The containing rocks are hard sandstones and wrinkled slates, like those of the Ditton gold-field.

The vein seen in shaft No. 2 was intersected by a crosscut put in 1,400 feet southwesterly from that point.

On lot 1, range VII, Marlow, veins, 10 to 12 inches thick, were seen, cutting slates and sandstones similar to those just noted, carrying in places a large quantity of blende and pyrites, with some galena. The rocks here dip south 10 degrees east 80 degrees. The principal vein dips south 40 degrees east 45 degrees, but smaller veins of an inch or more run with the bedding planes.

Assays of the ore from these several veins show the presence of a fair proportion of silver. These have been kindly furnished me by Mr. F. Torrance, and are as follows: One specimen from the "north vein" assayed by R. E. Page, of Laval University, gave 430 ounces of silver per ton of 2,000 pounds. Ore from the outcrop of the "Senator" gave 260 ounces per ton, and one from the "main vein", assayed by Prof. Richards, of the School of Technology, Boston, a little over 29 ounces per ton. The assays by Professor Richards from a good quality of the ore taken from the Armstrong and Senator veins, gave good returns. Assays by Prof. J. T. Donald, of Montreal, gave for the "Armstrong" vein, half an ounce of gold per ton, with traces only of the precious metals from the other leads. Assays made by Mr. Hoffmann, in the laboratory of the Geological Survey, from different veins, and ordinary samples, gave 43,663 ounces of silver to the ton, with traces of gold. Galena is also reported by Mr. Gordon, of Sherbrooke, in what may be the extension of this belt southwestward, in the township of Spalding, about 3 or 4 miles north of the International railway, and the same distance west of the boundary, though no particulars are to hand concerning the exact location. Traces of galena were also observed at several places in the quartz veins of Ditton and Emberton, but no attention has as yet been paid to these.

(44) Bouchette Zinc Prospect

Reference

Wilson, M. E.: Geol. Surv., Canada, Mem. 136, p. 136.

LOCATION

The Bouchette zinc prospect is on lot 41, range XI, Bouchette township, about 3 miles as the crow flies east of Burbridge on the Canadian Pacific line running from Ottawa to Maniwaki.

DESCRIPTION

Wilson's description of the prospect is as follows:

"A series of trenches and prospect pits in which northeasterly trending pyroxene-sulphide zones are exposed, has been excavated on the southeast slope of a northeasterly trending limestone ridge.

The most important of these openings, a shaft situated near the north end of the series of excavations, was filled with water at the time the property was visited, so that nothing could be learned regarding the character of the deposit in the shaft, except indirectly from an examination of the dump. The rocks exposed on the north and south faces of the pit in which the shaft has been sunk, named in order from east to west, consist of rusty granite gneiss, sulphide-bearing pyroxenite, and limestone. The pyroxenite zone has a width of 10 feet and dips 50 degrees to the eastward, conforming to the dip of the limestone gneiss contact. The material exposed on the dump consists mainly of pyrite, pyrrhotite, and pyroxene. Sphalerite was observed to occur disseminated in pyroxene masses in which the proportion of other sulphides present was small, but the proportion of the mineral, even in selected samples, was not more than 5 to 10 per cent. A thin section of the sphalerite-bearing pyroxenite was examined under the microscope and was found to consist of a pale green pyroxene, scapolite, sphalerite, and pyrite, the sphalerite, pyrite, and pyroxene occurring as inclusions in the scapolite.

The second most important opening observed on the property is a pit 10 feet long, 6 feet wide, and 10 feet deep, situated about 500 feet southwest of the shaft. On the south face of this excavation a mass of rusty pyroxenite 3 feet long and 1½ feet wide occurs as an inclusion in crystalline limestone. On the northwest face a mass of the pyroxenite 2 feet wide projects into the pit. This mass is adjoined on the west by a band of amphibolite, elsewhere the rock exposed in the pit is crystalline limestone.

A number of small pits and trenches have been excavated in the crystalline limestone at intervals between the main shaft and the pit described above, but with the exception of an irregular sulphide lead 2½ feet wide, exposed on the north face of the pit situated approximately 100 feet south of the main shaft, sulphide leads, as far as was observed, were entirely absent in these openings.

(45) Richmond Gulf and Little Whale River

References

Bell, R. G.: Geol. Surv., Canada, Rept. of Prog. 1877-78, pt. C, p. 20.
Low, A. P.: Geol. Surv., Canada, Ann. Rept., vol. VIII, pt. L, p. 282.

LOCATION

Silver-bearing galena is reported by Bell and Low to occur on the east coast of Hudson bay between Richmond gulf and Little Whale river.

Bell reports:

"Lead: In the lower part of the magnesian limestone portion of the series, there is a band about 25 feet in thickness of an open or drusy character in which galena, in bunches, occurs in sufficient quantities to be of commercial value. In 1858-59, the Hudson's Bay Company obtained 9 tons of this ore from numerous small openings which were made about 3 miles northeast of their establishment at Little Whale river, but it appears to be equally or more abundant in some spots in the same band of limestone on the south side of the river. This band is traceable to Richmond gulf, at the entrance of which I found bunches of galena in it, which would weigh upwards of 100 pounds. Specimens from 'the mine' on the north side of Little Whale river which I brought to Montreal in 1875 were found by Dr. Harrington to contain 5·104 ounces of silver to the ton of ore. That from the south side of the inlet of Richmond gulf he finds to contain, when separated from the gangue, 12·03 ounces of silver in every 2,000 pounds of the ore."

Low states:

"This metal (silver) has only been found associated with lead in the limestones of the Cambrian area of the east coast of Hudson bay, where, according to Dr. Bell (Geol. Surv., Canada, Rept. of Prog., 1877-78, pt. C, p. 20) it occurs in bunches of galena in a band of magnesian limestone 25 feet thick, in quantities sufficient to be of commercial value. This band was traced from Little Whale river to Richmond gulf, a distance of about 12 miles. Assays by Dr. Harrington, give 5·104 to 12·03 ounces of silver per ton. An opening was made by the Hudson's Bay Company at Little Whale river several years ago, but the working proved unprofitable and was soon abandoned. This galena-bearing band of limestone was not observed in the Cambrian areas of the interior, and that ore was only found in small quantities in a few little quartz-veins along with pyrites."

ONTARIO

(1) Renfrew Zinc Prospect

References

Ells, R. W.: "On the Geology of a Portion of Eastern Ontario"; Geol. Surv., Canada, Ann. Rept., vol. XIV, pt. J.
Alcock, F. J.: "A New Zinc Prospect"; Can. Min. Jour., March 16, 1923, p. 208.

LOCATION

The property is situated on lot 2, concession III, Admaston township, Renfrew county. It lies less than 4 miles from the town of Renfrew and an automobile can be driven to the property.

HISTORY

Zinc ore was found on the property in the summer of 1922. Messrs. Joseph Legree and William Dean acquired the mineral rights and opened up a pit. In the autumn of 1925 the Coniagas Company took an option on the property. A considerable amount of surface stripping and trenching was carried out and five diamond drill holes were put down. The company did not take up their option. Early in 1926 the Ottawa Valley Syndicate in turn took up an option on the property and carried out diamond drilling. In the spring of 1926 the British Metal Corporation (Canada), Limited, carried out about 2,000 feet of diamond drilling on the property. Altogether in 1926, twenty holes with a total of 4,745 feet of core were drilled.

GEOLOGY

The solid rocks of the region are all of Precambrian age and consist of sediments and igneous rocks intruded by granite-gneiss and its differentiates. The sediments belong to what is known as the Grenville series. The commonest rock type of the series in this region is limestone. It is white on the freshly broken surface, commonly weathering brownish, and is quite coarsely crystalline. It is marked by the presence of numerous rosettes and rods of tremolite and locally small, yellowish flakes of phlogopite are common in it. Associated with the limestone are bands of quartzite and fine-grained sedimentary gneiss, which represent metamorphosed clastic beds deposited with the limestones. Two small areas of these rocks occur near the zinc prospect.

The igneous rocks associated with the limestone consist of hornblende schists. They were originally either basic lava flows interbanded with the limestones, or eruptives intruded into them. Their original character has been completely changed by the intrusion of the granites of the region. They are now black rocks whose freshly broken surfaces show a glistening appearance due to the cleavage faces of the hornblende crystals.

All these rocks have been intruded by granite-gneiss. This rock is pinkish and is a biotite-granite. Pegmatitic differentiates also occur.

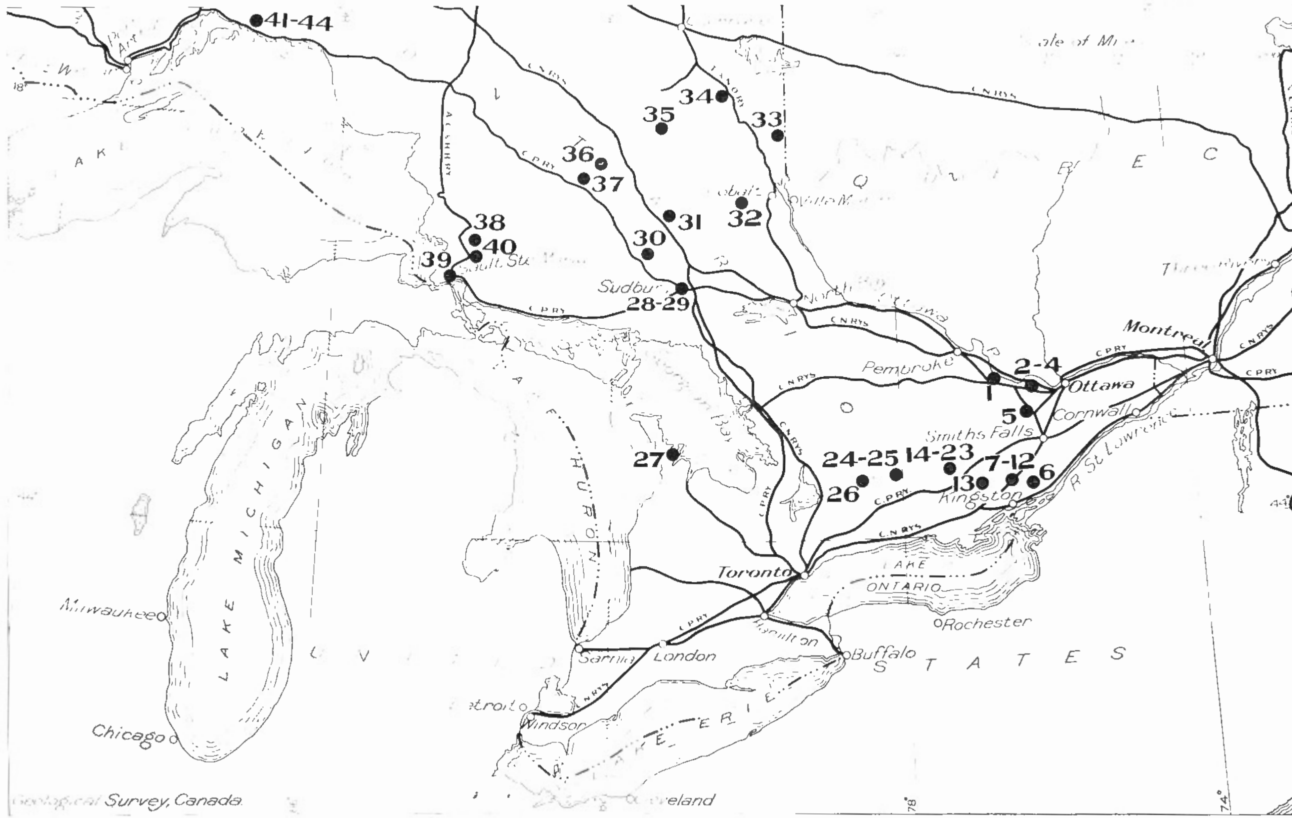


Figure 17. Index map of southeastern Ontario showing location of zinc and lead occurrences. For explanation of figure *See* page 134.

Explanation of Figure 17

1. Renfrew zinc prospect
2. Kingdon mine, Galetta
3. Campbell lead prospect
4. Fitzroy township
5. Ramsay lead mine
6. Lansdowne lead veins
7. Frontenac lead mine
8. Storrington lead vein
9. Long Lake zinc mine
10. Bedford lead veins
11. Barrie township, Frontenac county
12. Ore Chimney
13. Sheffield Township zinc prospect
14. Hollandia lead mine
15. Katherine lead and zinc mine
16. Elzevir township, Hastings county
17. Chrysler lead property
18. Blackburn lead vein
19. Roberts lead property
20. Stewart lead property
21. Webber property
22. Lake group of lead veins
23. Tudor group of lead veins
24. Methuen lead vein
25. Union Creek lead mine
26. Crown King lead prospect
27. Albemarle zinc mine
28. Sudbury zinc-lead region
29. Pru's mine, Bowell township
30. Geneva zinc-lead mine
31. Lead-zinc deposits in Cunningham township
32. Lady Evelyn and Haycock locations
33. Skead township
34. Bourke deposits
35. Jamieson claim, Kamiskotia area
36. Jefferson lead and zinc deposit
37. Ruel zinc prospect, Marshay township
38. Vacheresse lead-zinc claims
39. Victoria mine
40. Cascade mine
41. Thunder Bay silver-lead-zinc region
42. Black River
43. Zenith zinc mine, Rossport
44. Gesic zinc mine

DEPOSITS

The ore occurs in the Grenville limestone. The mineralized zone has been traced by a series of pits and trenches running in a southwest direction for a distance of half a mile. It is possible that this zone represents one or more shear zones. In one trench towards the southwest end of the property there is evidence of faulting. Many of the pits show only scattered crystals of sphalerite in the limestone.

The ore consists of sphalerite with minor amounts of galena. The sphalerite is of a brown colour with resinous lustre. An analysis of a sample of the purest ore that could be collected gave the following results:

	Per cent
Iron	3·36
Zinc	62·48
Sulphur	34·16

The ore disseminated through the limestone shows in places a distinct banded effect. The strike is in a northeast direction. There is a considerable variation in the ore both across and along the strike of the banding. Associated with the sphalerite are small amounts of pyrite and chalcopyrite. The gangue minerals are calcite, tremolite, and a pale green diopside.

The largest amount of ore exposed is at the original pit where a zone of good grade ore has a width of 15 feet. A grab sample consisting of chips taken from both sides along the entire length contained 9·95 per cent zinc. Near this pit the surface of the mineralized zone has been stripped for a length of 125 feet. The ore-bearing zone has here a width varying from 12 to 20 feet. Most of the ore is low grade, but patches and bunches of high-grade ore are present.

ORIGIN

The deposit was formed under conditions of contact metamorphism by the action of granite during its intrusion into the limestones and accompanying rocks. The limestone was apparently recrystallized with the production of calcite, tremolite, and pyroxene, and solutions from the granite, apparently rising along a fracture zone, impregnated the limestone with sulphides. Like most contact metamorphic deposits the ore-body is very irregular, making it most difficult to predict what quantities of ore may be expected to be found. The deposit is similar in many ways to that of the Tetreault mine at Notre-Dame-des-Anges, Portneuf county, Quebec, where large masses and pockets of ore in a carbonate-tremolite band have been profitably mined.

POSSIBILITIES

The amount of exposed ore of sufficient grade to be mined is too small to be of economic importance. Diamond drilling on three successive occasions, by three different companies, failed to locate workable deposits.

(2) Kingdon Mine, Galetta

(*See* Figures 18, 19)

References

Ont. Bureau of Mines, Ann. Repts., vols.: XXIV, pt. i, p. 162; XXV, pt. i, pp. 130, pt. ii, pp. 21-22, pt. iii, p. 33; (Dept.) XXXI, pt. i, p. 19, pt. x, p. 65; XXXII, pt. i, p. 20; XXXIII, pt. vii, p. 95; XXXIV, pt. i, pp. 163, 164; XXXV, pt. i, p. 135; XXXVI, pt. i, pp. 142-143.

Wilson, M. E.: Geol. Surv., Canada, Mem. 136, pp. 95-101.

Eng. and Min. Jour., vol. 122, No. 3, p. 105 (July 17, 1926).

Bruce, E. L.: "Barytocelestite from the Kingdon Lead Mines, Galetta, Ontario"; Am. Min., vol. 12, No. 11 (Nov., 1927).

LOCATION

The Kingdon mine is on Chats island in Ottawa river. It is about $1\frac{1}{4}$ miles north of Galetta village, about 5 miles east of Arnprior, and 40 miles by motor highway from Ottawa. It lies about midway between the Ottawa-Parry Sound and Ottawa-Capreol branches of the Canadian National railways. Ore shipments are hauled by road a distance of about 2 miles to Galetta on the former branch.

HISTORY

The first work performed on the property was carried out by James Robertson between July, 1884, and September, 1885. No. 1 shaft was sunk to a depth of 50 feet and drifts were driven along the vein for distances of 50 feet and 40 feet to the southeast and northeast respectively. The galena taken out during these operations was cobbed from the calcite gangue and shipped in bags to Kingston, Ontario. No further work was done until 1914 when the James Robertson estate resumed operations which have continued to the present.

GEOLOGY

The rocks of the region belong chiefly to a complex of Precambrian age. A few patches of sandstone and dolomite of Beekmantown age, however, overlie the complex. The Precambrian rocks consist of Grenville limestone in which dykes and masses of garnetiferous quartz diorite, granite, and pegmatite are included. The limestone is crystalline and banded, striking for the most part in an east-west direction.

DEPOSIT

The deposits are in the form of two fissure veins. The main vein cuts across the Grenville limestone and its inclusions of diorite, granite, and pegmatite, in a direction about 50 degrees west of north, magnetic, and dips about 80 degrees southwest. The chief ore mineral is galena which occurs in grains, clusters of crystals, and thin sheets, usually parallel to the banding of the gangue. In places, especially along the wall of the vein, sphalerite is also present. The gangue is calcite commonly banded; small amounts of barite, barytocelestite, fluorite, selenite, and hematite

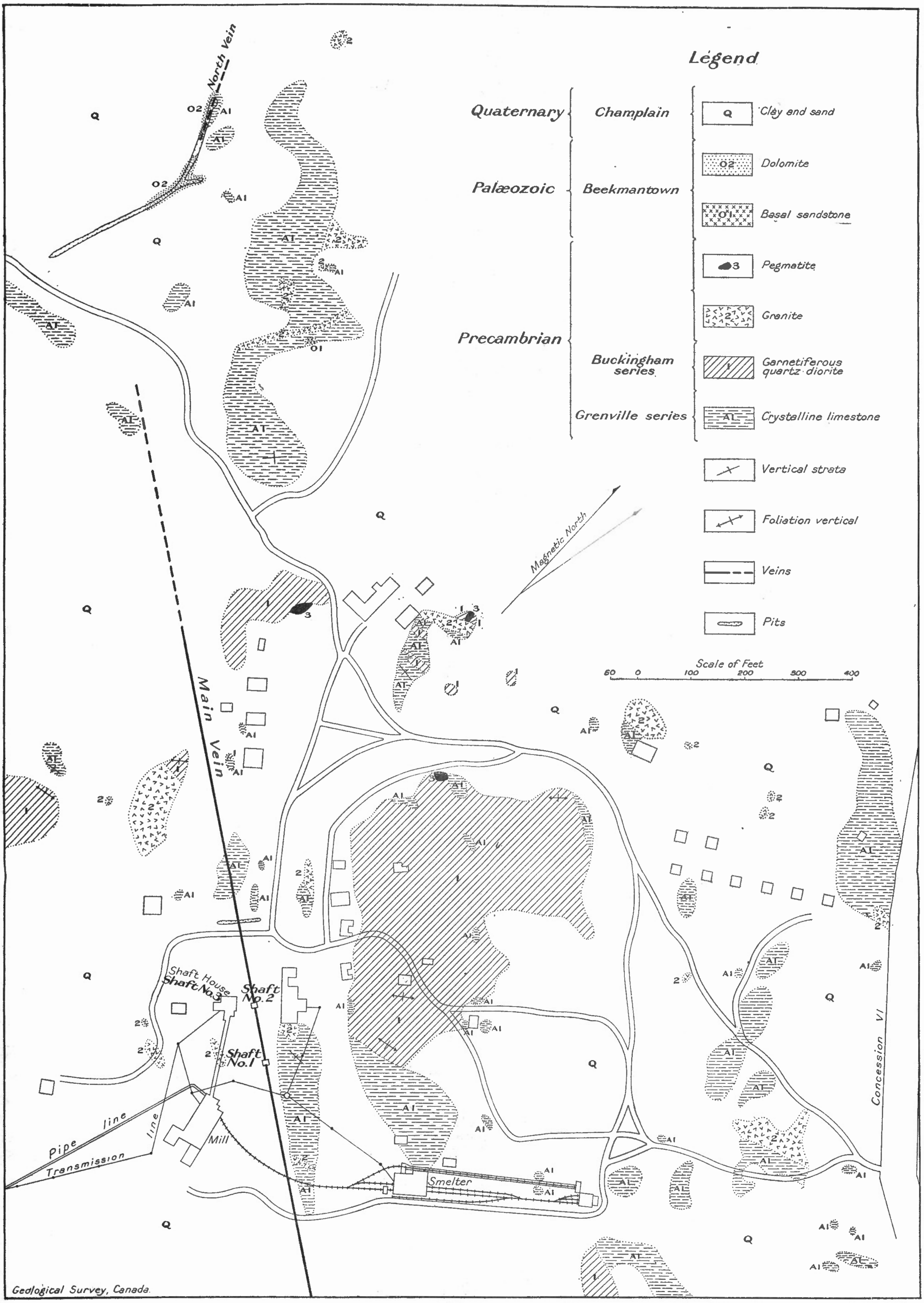


Figure 18. Surface plan, Kingdon mine, lots 23 and 24, con. VI, Fitzroy tp., Carleton co., Ont.

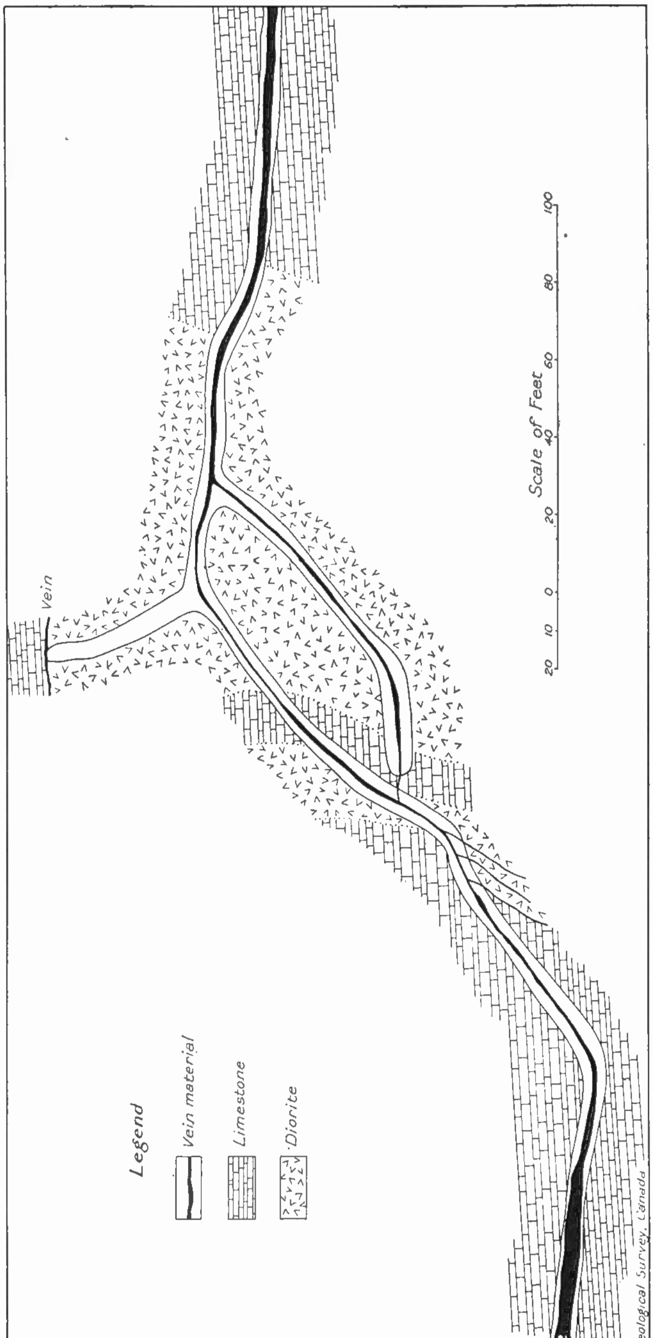


Figure 19. Plan of part of third level, Kingdon mine.

also occur. The width of the vein varies from a few inches to over 10 feet with an average of about 5 feet. It has been followed in the underground workings to a depth of over 1,300 feet and for a length of over 2,700 feet. The proportion of galena present varies greatly from point to point along the vein.

That the fissure occupied by the vein is due to faulting is shown by the striated surface of the vein wall, by the broken condition of the wall-rocks, and by the way in which masses of diorite, granite, and pegmatite contained in the Grenville limestone have been displaced along the fissure plane. The amount of displacement as indicated by the variation in the character of the rock on the opposite walls of the vein was evidently considerable. There is also a definite relationship between the character and width of the vein and the rock forming its walls. Where the wall-rock is diorite, granite, or pegmatite the vein breaks into numerous small veinlets, whereas where the wall-rock is limestone, the vein is usually well defined and at least several feet in width.

The north vein like the main one occupies a fault fissure. It, however, is delimited by Beekmantown dolomite on the west and Grenville limestone on the east, so that the west side has evidently been downthrown with respect to the east. The vein strikes north 25 degrees west magnetic and has a width of from 2 to 2½ feet in the part exposed.

DEVELOPMENT

The main vein has been followed to a depth of 1,326 feet by a shaft. The lowest level is 1,275 feet. In April, 1928, the longest level was the 1,025-foot. Its length east of the shaft at that date was 722 feet and west of the shaft 2,020 feet, making a total length of 2,744 feet. The majority of the other lower levels are from 100 to 200 feet shorter.

PRODUCTION

The ore is concentrated and the galena concentrates smelted on the property. In 1927 the amount of lead sold by the company was 7,346,180 pounds. Since the only other production of lead in the province is small, resulting from the treatment of cobalt-silver ores, the table in Chapter VII for the production of lead in Ontario gives approximately the production of the Kingdon mine since 1914.

(3) Campbell Lead Prospect

References

Wilson, M. E.: Geol. Surv., Canada, Mem. 136, p. 102.
Uglow, W. L.: Ont. Bureau of Mines, vol. XXV, pt. ii, pp. 22, 23.

LOCATION

The property is on the undivided northwestern extension of concession VI, Fitzroy township, that projects into Ottawa river at the head of Chats fall. It lies about 1¼ miles northwest of the Kingdon mine near Galetta and only a few hundred yards west of the Ottawa-Capreol branch of the Canadian National railway. The deposit lies between the high and low water marks of Ottawa river.

HISTORY

The property is owned by Mr. Jos. Campbell of Arnprior. A certain amount of surface work was carried out by Mr. Campbell and associates during the summer of 1908 and the winters of 1910-11 and 1916-17. The work in 1916-17 was performed by an association known as the Ottawa Lead and Zinc Company, but work was discontinued before the organization of the company was completed.

In the autumn of 1925 the Ottawa Valley Syndicate secured an option on the property. A certain amount of diamond drilling was carried out and work was then discontinued.

GEOLOGY

The rocks of the region consist of flat-lying remnants of Beekmantown dolomite resting unconformably on a complex composed chiefly of Grenville limestone, but including also scattered masses and dykes of diorite, granite, pegmatite, and related rocks. One of the remnants of the Beekmantown dolomite overlies the limestone a few hundred yards south of the main pits.

CHARACTER OF DEPOSIT

The deposit consists of outcrops of calcite along a line that trends in a northwesterly direction along the shore of Chats lake. At times of low water the pits located on these showings are exposed, but for the greater part of the year water covers the outcrop to a depth of from 4 to 5 feet. The writer made two visits to the property in the autumn of 1925. At one place a galena-bearing calcite vein about 6 inches in width was observed and at other places loose masses of limestone cut by narrow veinlets of calcite up to 1 inch in width occur. Uglow states, however, that the vein varies in width from a few inches to 3 feet, and although it has not been traced continuously for more than 70 feet it is known to outcrop over a total length of 500 feet. The vein material consists of calcite containing scattered cubes of galena.

DEVELOPMENT WORK

The development work performed on the property consists of a pit 25 feet long, 15 feet wide, and 15 feet deep, a shaft 16 feet deep on the mainland to the east of the vein zone, and a cement coffer dam placed in the water over the outcrop of the vein. The openings on the mainland were excavated in the hope, apparently, of intersecting other veins parallel to that beneath the water or of eventually sinking to sufficient depth to drive a crosscut beneath the lake to intersect the vein.

The diamond drill holes put down by the Ottawa Valley Syndicate in 1925 were sunk from the landward side. They did not cut any vein material. This must be interpreted in either one of two ways: (1) that the vein has a very low dip beneath Chats lake so that the drill holes went down parallel to it instead of cutting it; or (2) that no vein is present at the points where the holes were put down.

(4) Fitzroy Township

References

Logan, W. E.: "Geology of Canada, 1863", p. 689.
Ells, R. W.: Geol. Surv., Canada, Ann. Rept., vol. XIV, p. 68 (1906).

Ells reports:

"Galena also occurs in the township of Fitzroy near the road leading from Galetta to Fitzroy harbour. A lead-bearing vein was opened on lot 20, range VIII, having a width of 6 inches, cutting crystalline limestone, but it apparently has never been worked."

(5) Ramsay Lead Mine

References

Geol. Surv., Canada, "Geology of Canada, 1863", pp. 688-689.
Ont. Bureau of Mines, Rept. Roy. Com. Min. Res., Ont., 1890, p. 146.

LOCATION

The property is situated on lot 3, concession VI, Ramsay township, Lanark county, Ontario, about one mile from Carleton Place.

HISTORY

In 1858 work was carried out on the property. A shaft 37 feet deep was sunk and the vein material for a distance of about 450 feet was mined. It is reported that 26 tons of ore, yielding 80 per cent lead, was obtained. Trouble arising from a great influx of water caused the abandonment of the work. Later, work was resumed and a second shaft 21 feet deep was sunk 630 feet southeastward from the main shaft where a second vein joins the main one. The company met with many difficulties, particularly the flooding of the mine, and after exhausting their capital, they ceased operations.

In the autumn of 1925, the Ottawa Valley Syndicate took up the property and commenced work. Surface stripping was carried out on a vein running nearly parallel to the old main Ramsay vein and diamond drilling was also carried out on the main vein.

GEOLOGY

The surface rocks of the vicinity consist of grey dolomite of the Beekmantown formation of early Ordovician age. The beds lie nearly horizontally and rest on grey sandstone of the Potsdam formation which was encountered in shaft No. 2. These two series lie on Precambrian limestone and gneiss.

DEPOSIT

The deposits are fissure veins. The main vein has a bearing from north 50 degrees west to north 55 degrees west, with a steep dip to the northeast. Its width varies from 2½ to 5 feet.

The gangue is calcite. The ore mineral is galena. The galena content varied considerably along the vein. Some portions were nearly barren, whereas in others big masses were encountered. The ore-bearing portion of the vein varied in width from 8 to 24 inches. Small amounts of pyrite, chalcopyrite, and sphalerite occur in the vein.

A diamond drill hole was put down by the Ottawa Valley Syndicate in January, 1926, to intersect this vein. The hole was started at a point 55 feet east of the vein and put down at an angle of 70 degrees to the southwest for a distance of 235 feet. No strong vein was intersected. The following is the log of the hole.

Feet	Notes
0 - 9	Casing
9 - 112	Potsdam sandstone
112 - 235	Grenville crystalline limestone in places pyroxenic

From 200 feet to 235 feet the core is cut by minute calcite veins containing galena and zinc blende.

The second vein lies on the opposite side of the road from the main Ramsay vein. This vein or vein zone has been traced by pits for a distance of 2,300 feet. Its general trend is north 65 degrees west, magnetic. Its width varies from less than 1 to 9 feet, averaging about 2 feet. For a distance of 250 feet, it has been stripped continuously. Throughout this distance it maintains a width varying from 2 to 3 feet and shows galena in bunches and streaks. The gangue is calcite. The walls are sheared, showing horizontal striations.

ORIGIN

The deposit was formed under conditions of low temperature by solutions travelling along fault planes. The deposit is of interest as furnishing data regarding the age of the calcite-barite veins of eastern Ontario. Most of these veins lie in Precambrian rocks. The Ramsay, however, which is similar to the others in mineralogy and general character, is known to be of later age than early Ordovician, and thus the age of them all is similarly established.

(6) Lansdowne Township

References

Logan, W. E.: Geol. Surv., Canada, "Geology of Canada, 1863", p. 688.
Ells, R. W.: Geol. Surv., Canada, Ann. Rept., vol. XIII, pt. A, p. 138.

Galena-bearing veins occur in Lansdowne township, Leeds county, on lots 2, 3, 4, and 6, range VIII. The rocks are crystalline limestones cut by red granite, and by dykes of white pegmatite. The galena veins are small.

Logan reports:

"One of these, on lot 2, range VIII, has been traced for a quarter of a mile, running nearly northwest and southeast, and has an average breadth of 2 feet. Through the gangue, which is of calcspar and heavyspar, galena is irregularly distributed in crystals and small masses; and it is also found disseminated in the crystalline limestone which forms the walls of the veins. Trial shafts were at one time sunk here; but the mine was abandoned. Another lode running north 65 degrees west, was subsequently found on lot 3, of the same range. It traverses crystalline limestone, and has a breadth of from 6 to 12 inches. Through the gangue, which is calcspar, galena is found in masses sometimes 5 or 6 inches in diameter. A trial shaft of 50 feet, which was sunk on this lode in 1854, on the land of Mr. Buel, is said to have yielded sufficient ore to pay the expenses of sinking. A branch lode diverges from the main one near the shaft; and in the same neighbourhood there occur four other lead-bearing lodes parallel with the main, the whole being included in a breadth of about 1,000 feet. These run obliquely across the lots, and thus intersect the lands of several proprietors. On lot 4, range VIII, Messrs. Foley and Company have sunk a small shaft upon one of the lodes."

(7) Frontenac Lead Mine

(*See* Figures 20, 21, 22)

References

Geol. Surv., Canada, Ann. Repts.: 1866-69, pt. E, p. 164; pt. F, p. 182; 1870-71, p. 314; 1871-72, p. 147; 1874-75, p. 163.

Ont. Bureau of Mines, Ann. Repts., vols.: I, p. 240; VII, p. 234; XIII, pt. i, p. 94; XV, pt. i, p. 92; XVI, pt. i, pp. 78-79; XXII, pt. i, p. 137; XXIII, pt. i, p. 176; XXIV, pt. i, p. 162; XXV, pt. ii, pp. 18-21; XXV, pt. iii, pp. 31-33; (Dept.) XXX, pt. x, p. 65; XXXV, pt. i, p. 134; Rept. Roy. Com. Min. Res. Ont., 1890, pp. 145-146.

LOCATION

The Frontenac property is situated in Loughborough township, Frontenac county, about 18 miles north of Kingston. It consists of the south half of lot 16 and part of lot 15, concession IX, and the south half of lot 14, concession X. The nearest railway station is Perth Road on the Canadian National. The railway crosses the property and passes alongside the mill. Perth Road station is about one mile from the mine.

HISTORY

As early as 1866, a shaft had been sunk on the property. In 1875, the property was leased to an English company and about 2,000 tons of ore was mined. In 1880, a lead smelter was built to treat the ore, but after two years of operation, mine and smelter were both closed.

In 1911, the property was taken over by the North American Smelting Company, Limited, of Kingston, Ontario. No. 3 shaft was sunk to a depth of 150 feet and 500 feet of drifting was carried out.

In 1925, the property was acquired by Mr. J. M. Forbes of Ottawa and associates and in 1926 and 1927 development work was carried out by the Forbes Galena Mines, Limited, organized to work the property. Number one shaft was carried down from a depth of 267 feet to 313·6 feet and drifting was carried out on the 300-foot level.

GEOLOGY

The property is underlain entirely by Precambrian rocks. Two miles to the south are flat-lying beds of the overlying Potsdam sandstone. The Precambrian rocks consist of altered sediments of the Grenville series intruded by granite and pegmatite. The Grenville rocks include sedimentary gneisses and crystalline limestone. The sedimentary gneisses are grey rocks, very micaceous and in places highly siliceous passing into quartzites. Associated with them in places are grey pyroxenites, apparently altered limestones. Locally the gneisses are injected "lit par lit" by granite, giving an intimate mixture of igneous and altered sedimentary material. The strike of the series is about north 30 degrees east and the dip varies from 65 degrees northwest to vertical. A band of reddish granite

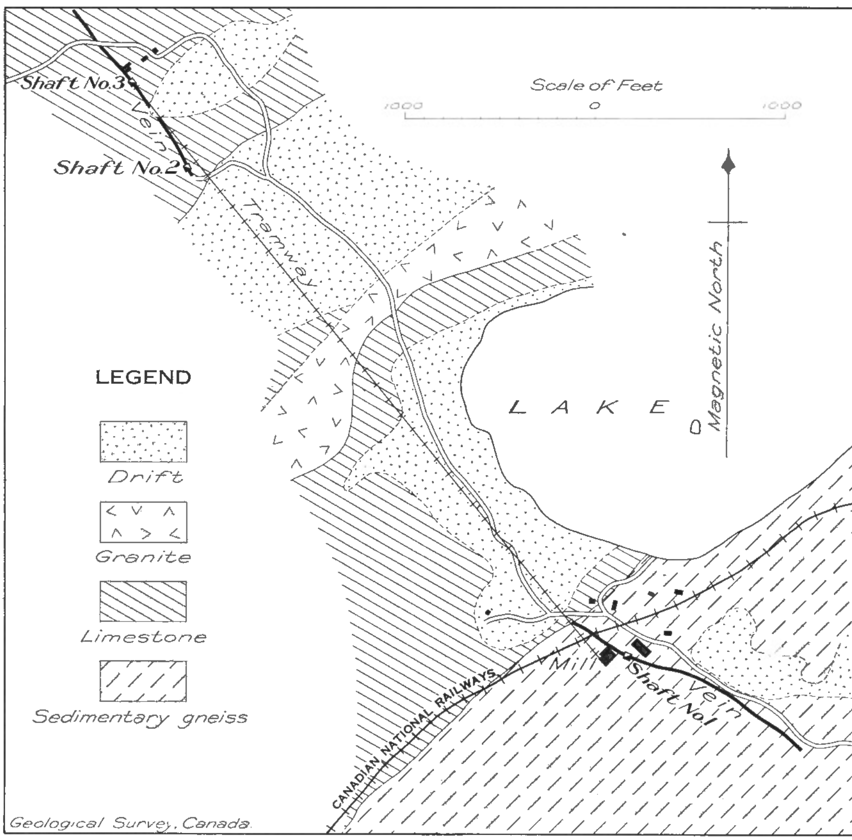


Figure 20. Surface plan, Frontenac mine, Perth Road, Ont.

cuts across the property between No. 1 and No. 2 shafts. Towards its border are concentrations of mica upon which pits have been sunk. Pegmatite dykes intersect both the limestone and the gneisses.

DEPOSIT

The deposit is a fissure vein or veins striking northwest almost normal to the strike of the Grenville sediments. In the southeastern part of the property in the neighbourhood of No. 1 shaft (*See* Figure 20), the vein strikes about north 70 degrees west magnetic. It has been traced here by surface and underground work for a distance of 1,500 feet. No. 3 shaft is situated 4,000 feet northwest of No. 1 shaft and there the vein strikes north 30 degrees west magnetic and has been traced by pits for a distance of 1,000 feet. Between these two areas is low ground and it is not known whether these occurrences form two separate veins or are merely parts of the same fissure. The former alternative is probably correct, i.e., that there are two strong veins and not one only.

The widths vary from less than 1 foot to 22 feet, with an average of about 10 feet. The walls are commonly smooth and are in places slickensided, showing deposition has been along a fault plane on which there has been movement. Along the northeastern wall is a zone of gangue material reaching in places a thickness of 6 feet. Horses of country rock occur in the vein. In places the vein material itself is sheared, showing movement has taken place since the formation of the vein.

The gangue consists of calcite, which commonly shows a well-banded structure. In the underground workings large rhombs of calcite over 6 inches across occur locally.

The ore mineral is galena which occurs as disseminated grains and clusters in the calcite. It does not occur uniformly throughout the vein, but is usually found in narrow zones parallel to the crustification. Its occurrence is so irregular that sampling is difficult. Small amounts of yellowish-brown sphalerite and a little pyrite are found in the vein. The former is found in most abundance in the northwestern part of the property near shaft No. 3 where it occurs as fine-grained, tabular masses, parallel to the crustification, separated by bands of calcite. Openings in the vein in places show crystals of sky-blue celestite up to 2 inches in length. Marcasite also occurs lining vugs.

The silver content of the galena is low, seldom exceeding $1\frac{1}{4}$ ounces to the ton of galena.

DEVELOPMENT

No. 1 shaft has a depth of 313·6 feet. From it drifts have been run along the vein on six levels at intervals of about 50 feet. The accompanying vertical section shows lengths of the drifts and the location of the stopes. Information about the grade of material taken from the stopes is not available.

Shaft No. 2 has a depth of 40 feet. Near it a tunnel 60 feet long has been driven along the vein. In 1911, shaft No. 3 was deepened from 47 feet to 150 feet and 500 feet of drifting carried out on this level, 250 feet in either direction.

CONCLUSIONS REGARDING THE DEPOSIT

The vein or veins are strong and well defined. They undoubtedly persist in depth and for a considerable distance in a horizontal direction beyond the points to which they have as yet been followed in the underground workings. The factor on which the future of the property depends is the lead content. As exposed in the underground workings, it is too low to ensure profitable mining at the present prices of lead. On the other hand the richer portions have undoubtedly been taken out during former operations. Should ore-shoots be found that would bring the average grade of the vein material up slightly higher, the future of the property would be assured. It would seem quite possible that such shoots might be found under a scheme of systematic exploration.

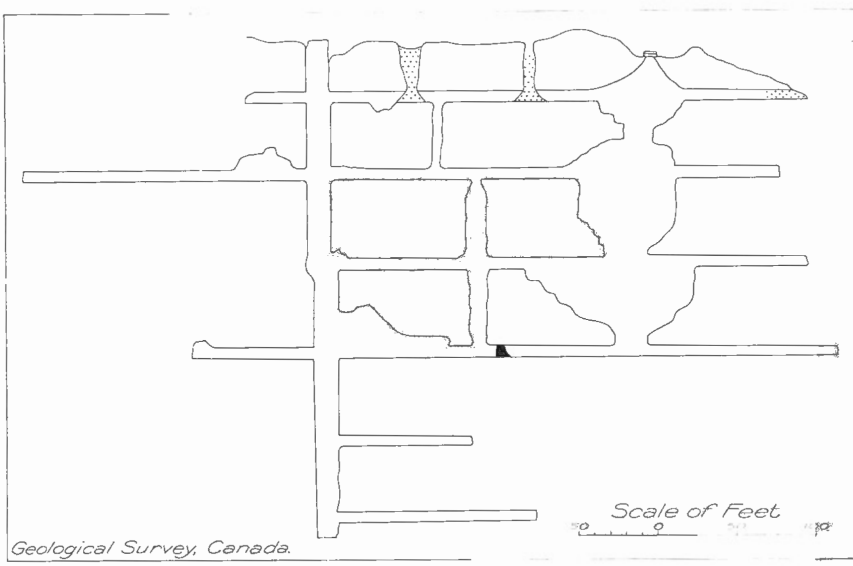


Figure 21. Frontenac mine; vertical section through No. 1 shaft.

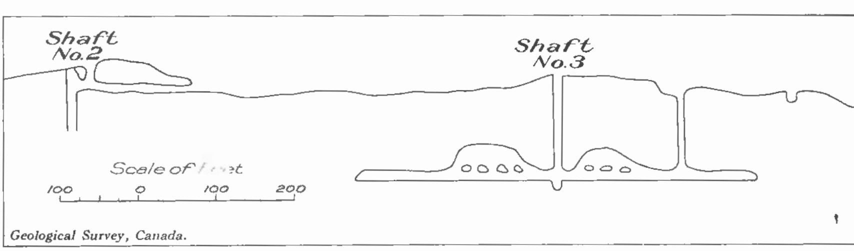


Figure 22. Frontenac mine; vertical section through No. 2 and No. 3 shafts.

(8) Storrington Lead Vein, Frontenac County

Reference

Vennor, H. G.: Geol. Surv., Canada, Rept. of Prog. 1870-71.

Vennor reports:

"In the township of Storrington, near the shore of Dog lake, about 2 miles from the village of Battersea, another well-defined lead vein has been uncovered, and would appear to be in strike of one of the lodes belonging to the Frontenac Company".

(9) Long Lake Mine

(*See* Figure 23)

References

Geol. Surv., Canada, vols.: XIV, pt. A, p. 184; XV, pt. A, pp. 435, 439; pt. AA, p. 135; pt. S, pp. 239, 244; XVI, p. 142.

Ont. Bureau of Mines, Ann. Repts., vols.: XII, pp. 25, 139; XIII, pp. 11, 94; XIV, pt. i, pp. 15, 39, 79; XVI, pt. i, p. 79; XVII, p. 84; XVIII, pt. i, p. 134; XIX, pt. i, p. 126; XX, pt. i, p. 109; XXI, pt. i, pp. 42, 160; XXIV, pt. i, p. 165; XXV, pt. ii, pp. 44-48.

Uglow, W. L.: "Ore Genesis and Contact Metamorphism at the Long Lake Zinc Mine, Ontario"; Econ. Geol., vol. XI, No. 3, April-May (1916).

LOCATION

This property, which has also been known as the Richardson or Olden zinc mine, is situated on lot 3, concession V, and lot 3, concession VI, Olden township, in the central part of Frontenac county, Ontario, about 42 miles by road north-northwest of Kingston. The nearest railway stations are Parham, 5 miles distant, on the Montreal-Toronto line of the Canadian Pacific railway, and Mountain Grove on the Montreal-Peterborough-Toronto line of the Canadian Pacific.

HISTORY

The property is owned by James Richardson and Sons, Limited, Kingston, Ontario. Work was carried on at different periods between the years 1897 and 1915. The richer portions of the ore lenses at the surface were taken out, but no thorough exploration was made to determine the amount of ore present. In the winter of 1914-15 an option on the property was taken by American interests known as the Long Lake Zinc Company. The workings were dewatered and examined, but in May, 1915, the option was dropped. In the autumn of 1927 some of the pits and shafts were dewatered and examinations made.

GEOLOGY

The rocks of the surrounding region are all of Precambrian age and of typical Grenville type. Sixteen miles to the south flat-lying Palæozoic strata overlap these older rocks. The succession at the property is as follows:

Granite
(Intrusive contact)
Gneissic gabbro and diorite
(Intrusive contact)
Crystalline limestone, quartzite, paragneisses, green schists

The green schists, paragneisses, and quartzites occur in the general region, but the only member of this early group found on the property is crystalline limestone. It forms a belt varying in width up to 400 feet and extending for a length of 4,000 feet. The general strike is north 20 degrees east and the dip is steep, from 80 degrees to 90 degrees to the north. North of the main band is a smaller lens of limestone surrounded

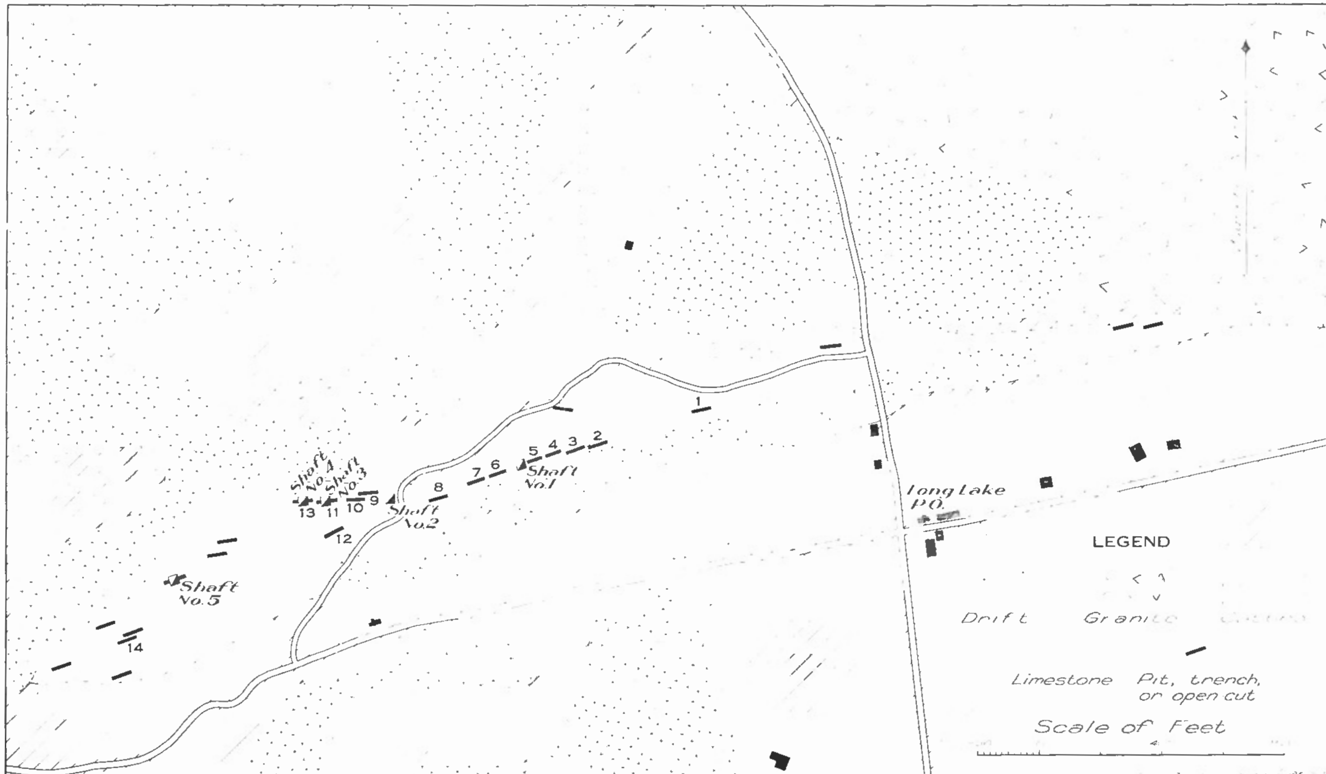


Figure 23. Surface plan. Long Lake mine, Long Lake, Ont.

by gabbro and intruded by granitic dykes. The limestone is coarsely crystalline with rhombs in places 3 inches across. On the other hand some of the bands are fine-grained.

The limestone is flanked on either side by dark gabbro and diorite which, commonly, is distinctly gneissic. These rocks vary considerably in appearance and composition. Towards the north edge of the area represented by the accompanying Figure No. 23, they are fine-grained and porphyritic. At the west end of the area is a coarser-grained phase, on the weathered surface of which, in places, grey laths of feldspar are to be observed varying from $\frac{1}{4}$ inch up to 1 inch in length. In places the rock passes into a pegmatitic phase which has the composition of a syenite, with crystals of red feldspar 3 inches in length. The contacts between this type and the commoner variety which it cuts are not sharp, but the two grade gradually into one another.

Cutting these rocks is granite occurring as dykes and as a large intrusive mass lying to the north and northeast. It is a massive, coarse-grained rock consisting of orthoclase, microcline, and albite feldspars, quartz, and minor amounts of biotite and hornblende. Aplitic dykes cut the limestone bands.

CHARACTER OF DEPOSIT

The ore consists of sphalerite, with varying amounts of pyrite and pyrrhotite and small quantities of galena and chalcopyrite. The sphalerite is dark brown. Where coarse-grained, it is free from the other sulphides. Galena is reported to have been taken out of the workings in places in large masses. It is most abundantly developed near the northern border of the limestone band. Its more common occurrence, however, is as small grains intimately associated with the zinc blende. The chief gangue is the calcite of the limestone band. With the sulphides are also associated greenish diopside, quartz, and vein calcite.

The ore occurs as lenses in the band of crystalline limestone; and as grains disseminated in the same general ore-bearing zones. All gradations appear to exist between the lenses and the disseminated type of ore.

Ore was found in three belts or horizons in the limestone band. The first stretches both east and west from the mill at a distance of about 50 feet from the northern border of the limestone. Most of the development has been carried out on this zone. The second horizon is approximately parallel to the first at a distance about 200 feet from the northern border of the limestone. The third is situated near the eastern end of the limestone band where a few trenches have been opened, but no mining carried out. Other occurrences of sulphides in the limestone band are also known.

The ore lenses vary considerably in both size and shape. They may pinch and swell in several places. As a rule they are about circular in section along their strike. In length they vary from about 5 feet to 100 feet and in width from a few inches to 14 feet. The largest single body of ore mined, occurred at the western shaft where a lens with a width of 14 feet outcropping for a length of 90 feet was mined to a depth of 40 feet. As a general rule, individual lenses appear to be entirely separate bodies. In places, however, a narrow zone showing thinly disseminated sphalerite and pyrite may be found connecting adjacent bodies.

ORIGIN

Uglow has described these deposits as anamorphosed low-temperature deposits. He regards them as having been formed in the limestone before the intrusion of either the basic intrusives or later granite, much in the same manner as the zinc ores in the Upper Mississippi valley were formed. The deposits were then altered by the intrusives into their present form. The chief argument in favour of this conclusion is the fact that certain granite dykes were found to traverse both the limestone and the ore lenses in the limestone. Hence some of the granitic intrusives at least must be later than the period of mineralization.

The writer is inclined to the opinion that the deposits had an origin similar to those of Calumet and Tetreault. The occurrence and mineralogy are similar for all three and suggest an origin by solutions at high temperature from the intrusive granite under conditions of contact metamorphism. The granite dykes are regarded as late differentiates intruded after the metamorphism of the limestone and the formation of the ores.

DEVELOPMENT

Development work has been carried out over a length of approximately 3,500 feet. This work consists of:

(1) Five shafts, on ore, varying in depth from 60 feet to 125 feet.
(2) About 350 feet of drifting, mainly in ore.
(3) Three open-cuts up to 60 feet long and 40 feet deep.
(4) Twenty-five pits and trenches varying in depth from 3 to 30 feet.

In addition, about 1,000 feet of diamond drilling has been done, distributed over a number of shallow holes crossing the ore horizons.

DESCRIPTIONS OF WORKINGS

In the autumn of 1927 a number of shafts on the property were dewatered for examination. On November 3, M. E. Wilson, of the Geological Survey, examined the shafts and pits that had been dewatered, and made the following notes:

Shaft No. 2

This shaft is said to be 100 feet deep. It adjoins a wall on the west and an open pit on the east. In the shaft at a depth of 20 feet, a lead near the south wall consists of two high-grade zones and a lean zone in the middle, total width 1 foot. At 40 feet there is a lead 3 to 4 inches wide near the west wall. At 60 feet there is a lead 3 inches wide. At 80 feet there is a drift to the west 70 feet long. In this drift, at 40 feet west of shaft, a lead in the roof can be seen; from 40 to 60 feet, in the drift, there is a lead of mixed ore and calcite 2 to 8 feet wide; in the face of the drift the lead pinches in a diagonal direction. There is a drift to the east at 70 feet down the shaft in which a lead $2\frac{1}{2}$ feet wide is exposed close to the shaft, but 5 feet to the east it pinches out. At 20 feet from the shaft, in the end of the drift, the lead is up to 2 feet wide.

Shaft No. 4

This shaft is said to be 115 feet deep. At 60 feet, a drift about 100 feet long, runs east. In the face of the drift a lead of zinc blende up to $2\frac{1}{2}$ feet wide is exposed. The ore zone consists of almost solid sphalerite surrounded by coarsely crystalline limestone showing crystals up to 2 inches in diameter. The roof of the drift is about 10 feet high for 10 feet from the face and at this point there is an ore zone $3\frac{1}{2}$ feet wide in limestone bearing disseminated zinc blende. Twenty feet west of the face of the drift, a zone of blende 2 feet wide is exposed in the floor.

Shaft No. 5

Shaft No. 5 is said to be 80 feet deep. An open pit extends both west and east. West of the shaft, the pit is 25 feet deep and is open for 30 feet, but continues underground for 70 feet. The debris has been cleared from the bottom of the drift for 40 feet from its end. Zinc blende is exposed for a length of from 40 to 60 feet over a width of 5 feet. The average width is 4 feet. Along the north wall a zone of zinc blende 3 feet wide is exposed on the bottom of the drift for a length of 60 feet. A leaner zone 6 feet wide and 70 feet long pinches to 2 feet or less as it passes up the face.

The following notes refer to the pits that were dewatered at the time of Mr. Wilson's visit. The pits are numbered from east to west and their locations are shown on the accompanying map of the property (No. 2129).

Pit No. 1. An opening 25 feet long, 6 to 8 feet wide, 5 to 6 feet deep. There is an irregular, rusty zone in the bottom, probably altered ore. The maximum width is 18 inches, the average width 1 foot. The wall-rock is limestone.

Pit No. 2. Eleven feet, by 15 feet, by 5 feet. Filled with debris.

Pit No. 3. A trench to bedrock, 100 feet long, 5 to 7 feet wide, and 3 to 5 feet deep. Shows a rusty-weathering zone or mass of lenticular form, with a maximum width of 3 feet. It pinches out entirely 4 feet from the east end. The average width is 2 feet. The wall-rock is crystalline limestone.

Pit No. 4. An opening 20 feet, by 10 feet, by 8 feet, filled with debris.

Pit No. 5. An opening 100 feet long, 10 feet wide, and 15 feet deep.

West of shaft No. 1 there is a pit 20 feet long, 4 to 8 feet wide, and 4 feet deep, showing a zone of zinc blende 3 feet wide decreasing to 3 to 4 inches at 20 feet west of shaft.

Pit No. 6. Filled with debris except at west end where the face, 6 feet wide, is exposed but shows no ore.

Pit No. 7. Twenty feet, by 5 feet, by 5 feet. Shows a narrow lead averaging 4 inches wide, maximum width 6 inches. It has an irregular trend and is possibly absent for several feet from the east end.

Pit No. 8. Ten feet, by 5 feet, by 10 feet. An old opening showing some disseminated sulphides, including sphalerite in limestone in the form of two irregular zones, one 2 inches wide and 6 feet long and the other 4 to 10 inches wide and 8 feet long. In the interval between this pit and shaft No. 2, are zones of sulphide disseminated in limestone. These zones are irregular, have widths from ½ inch to 6 inches, and continue for lengths up to 50 feet and then fade out. They lie parallel to the banding of the limestone.

Pit No. 9. This pit is 30 feet northwest of shaft No. 2. It is 20 feet long, 6 to 10 feet wide, and 20 feet deep. A lead of high-grade ore 6 feet long and up to 1 foot wide occurs in the east face.

Pit No. 10. This pit is 25 feet southwest of pit No. 9 and 60 feet from shaft No. 2. A lead, apparently the one on which the shaft is located, shows for a length of 15 feet, a width of 5 to 7 feet, and a depth of 20 feet. A lead 4 to 5 inches wide passes irregularly down the east face. A lead about 1 foot wide is exposed for 6 feet down the west face, it gradually fades out downward.

Pit No. 11. A trench 40 feet long, 20 feet wide, and 10 feet deep, with a small shaft (No. 3) in the middle.

Pit No. 12. One hundred feet south of shaft No. 3 is a trench in which a lead is exposed for 140 feet as follows:

East end of trench to 20 feet	2 to 4 inches wide
20 to 30 feet	4 inches wide
30 to 40 feet	4 to 12 inches wide
40 to 50 feet	8 to 12 inches wide
50 to 70 feet	3 to 6 inches wide
70 to 80 feet	5 to 6 inches wide
80 to 110 feet	2 to 6 inches wide
110 to 130 feet	2 to 5 inches wide
130 to 140 feet	1 to 12 inches wide

Pit No. 13. Sixty feet long, 10 feet wide, and 20 to 28 feet deep. There is a poorly defined ore zone along the north wall of the east face. The zone is not regular, it is probably 3 feet wide at the widest and averages about 2 feet. It is high grade only in spots. At the top of the face the zone disappears except for a small mass of pyrite 4 feet long and 1 foot wide. The east end of this pit is 25 feet from No. 4 shaft. A ridge 5 to 6 feet wide separates the pit from the opening adjoining the shaft. At the top of this ridge there is an ore zone, high grade, 3½ feet wide, but pinching downward as seen on west face of pit.

Pits No. 14. Two hundred feet southwest of shaft No. 5 there are two pits. The east pit is 20 feet long, 2 to 8 feet wide, and 3 to 10 feet deep. There is a lens of rusty material, probably ore, 2 to 6 feet wide in the bottom. The west pit is 15 feet, by 8 to 12 feet, by 1 to 5 feet, and shows a rusty lead 6 inches to 1 foot wide over a length of 15 feet. Beyond these there is an old pit 15 feet, by 10 feet, by 15 feet, near which some high-grade ore is piled up.

(10) Bedford Lead Veins

References

"Geology of Canada, 1863," pp. 687-688. Ont. Bureau of Mines, vol. XXV, pt. ii, pp. 25-26.

Along the road from Fermoy to Sangster, Bedford township, Frontenac county, occur several calcite-barite, galena-bearing veins. The most important of these was examined by the writer in 1925. The following description of the others is taken from the "Geology of Canada, 1863."

"Several veins containing galena are met with cutting the Laurentian limestone in the township of Bedford. One of them, on lot 21, range VIII, has a direction about east and west, with an underlie to the north<80 degrees. It is 4 feet wide, and consists chiefly of calcspar, through which galena is disseminated in crystals or in seams, sometimes 1 inch or 2 inches in thickness. A shaft was formerly sunk here to a depth of 25 feet. Two other veins similar in character are met with near the line between lots 18 and 19 of the same range, the one running north 20 degrees west, and the other north 37 degrees west. A little to the west of these, and on lot 19, range VII, on the property of Mr. Weston Hunt of Quebec, are five nearly parallel lodes, running northwest, and included in a breadth of a quarter of a mile. They traverse crystalline limestone, and include galena in a mixture of calcspar and heavyspar. A specimen from one of them shows a breadth, across the vein, of 5 inches of solid galena. About a mile to the eastward of these lodes, there are others on land belonging to the proprietor of the last. Shallow trial shafts were, many years ago, sunk upon these, but the amount of lead ore obtained from them is not known. On lot 13, range V, Bedford township, Messrs. Foley and Company of Montreal have sunk a trial shaft to a depth of 16 feet, on a lode of 6 inches, the gangue of which is heavy spar. The lode traverses the crystalline limestone, and enters the gneiss, in both of which rocks it holds good masses of galena".

The following is a description of the property visited by the writer:

LOCATION

The deposit is located on lots 16, 17, and 18, concession VI, Bedford township, on the farm of John Murphy of Fermoy. The mineral rights have been the subject of litigation. The nearest railway facilities are distant about 10 miles at Westport on the Brockville and Westport branch of the Canadian National railway.

GEOLOGY

The country rocks of the region consist of sediments of the Grenville series intruded by granite. The chief variety is limestone, which is coarsely crystalline and locally contains disseminated graphite as displayed in a pit at the west end of the property. In places interbanded with the limestone are grey gneissic bands. The regional strike of the sediments is northeast and the dips about vertical. Cutting the sediments are granites of Precambrian age. Small quartz veins carrying black tourmaline locally cut the sediments and are obviously related to the granitic intrusives.

DEPOSIT

The deposit is a vein striking north 60 degrees west to north 85 degrees west, the average direction being about north 75 degrees west magnetic. The vein cuts limestone and granite, the wider parts being in the limestone. It pinches and swells, varying in width from a few inches to 4 feet. The walls are sharply defined and locally horses of country rock occur in the vein. The gangue minerals are white and pink calcite, and white barite, weathering yellowish. The material is well banded. In places calcite predominates, in others barite is the more abundant mineral, commonly both occur in the same band.

The chief sulphide is galena. It occurs in masses and small disseminated grains throughout the gangue. Masses up to 10 inches thick occur and at the bottom of one pit a sheet of solid galena 24 inches in width was reported. On the dump at the deepest shaft a little pyrite and black sphalerite were collected.

DEVELOPMENT

The vein has been traced by pits and trenches for a distance of over 1,600 feet. Over most of this distance it contains galena in varying amounts. Two shafts have been sunk on it. At the bottom of one, which is 26 feet deep, the vein is said to have a width of 4 feet. The second shaft is said to be 90 feet deep and is reported to show four stringers uniting to produce a width of $4\frac{1}{2}$ feet of vein material.

The vein throughout the greater part of its length is rather narrow at the surface, but its length and mineral content are encouraging. Should it widen with depth, it might prove of commercial importance.

(11) Barrie Township, Frontenac County

References

Ells, R. W.: Geol. Surv., Canada, Ann. Rept., N.S., vol. XIV, pt. J, pp. 44, 67.
Uglow, W. L.: Ont. Bureau of Mines, 1916, vol. XXV, pt. ii, p. 11.

The following notes are from the report by Uglow.

" LOCATION

Several openings have been made on both sides of the road from Myer Cave to Ardoch, and near the portage to Whitefish lake a short distance south of Perry. The chief deposits occur on lots 9 and 12, concession VIII.

GEOLOGY

The rocks consist of a steeply dipping series of Precambrian sediments striking about north 50 degrees east, magnetic, and consisting of finely crystalline, bluish, slaty limestone, sheared pseudo-conglomerate, and mica schist. The series is intruded in several places by granite, and it is in the general vicinity of the intrusives that the ore minerals occur.

CHARACTER OF THE ORE AND GANGUE MINERALS

The ore minerals consist of fine-grained argentiferous galena, pyrite, chalcopyrite, and zinc blende. The gangue consists chiefly of a mixture of quartz and calcite.

Several assays of the ore from this place were made in the laboratory of the Geological Survey, the percentage (=quantity) of silver, in one case from a sample from lot 12 of rather coarsely crystalline galena, being 137·883 ounces to the ton of 2,000 pounds and a trace of gold, while a sample from lot 9 of the same range gave 119·583 ounces of silver to the ton, but no gold (Geol. Surv., Canada, Ann. Rept., N.S., vol. XIV, pt. J, p. 67).

OCCURRENCE OF ORE

The ore occurs both as stringers and lenses up to 5 feet thick, running parallel to the strike of the country rock, and also in a minor degree as an impregnation in the silicified limestones. As a general rule, both the galena and the quartz are very fine-grained.

GENESIS OF THE ORE

The highly argentiferous nature of the ore, the presence of gold values, the fineness of the grain of the galena, and its association with quartz, suggest that the deposits were formed by heated solutions which had a genetic relation to the intrusive masses in the vicinity.

DEVELOPMENT

Four shallow shafts, full of water at the time of examination, are on the properties. Very little ore mineral of any commercial value was seen."

(12) Ore Chimney

References

Ont. Bureau of Mines, Ann. Repts., vols.: XIX, pt. i, p. 49; XXII, pt. i, pp. 135, 136, pt. ii, p. 55; XXIII, pt. i, p. 173; XXIV, pt. i, p. 159; XXV, pt. i, p. 129.

LOCATION

A property formerly worked by the Ore Chimney Mining Company is situated on lots 34, 35, and 36, concession I, Barrie township, Frontenac county, 3 miles southeast of Cloyne. The company was incorporated in 1909. The property was closed down in December 1915.

GEOLOGY

The rocks at the property are banded, grey chert and conglomerate, of Precambrian age. The conglomerate is made up of pebbles similar to the chert and rests unconformably on its bevelled and eroded edges. The ore is a mixture of zinc blende and galena with some chalcopyrite, and with values in gold. The published accounts give no description of the character and size of the deposit.

DEVELOPMENT

A shaft was put down to a depth of 340 feet, and the following horizontal work was carried out.

First level at 108 feet, east drift 17 feet, south drift 6 feet, and crosscut 25 feet
Second level at 150 feet, north drift 107 feet, south drift 79 feet, and total crosscutting 78 feet
Third level at 250 feet, north drift 83 feet, south drift 100 feet, and total crosscutting 237 feet
Fourth level at 300 feet, crosscutting 31 feet
Fifth level at 332 feet, crosscutting 44 feet

(13) Sheffield Township Zinc Deposit

Reference

Uglow, W. L.: Ont. Bureau of Mines, Ann. Rept., vol. XXV, pt. ii, p. 48.

LOCATION

This prospect is on the west half of lot 10, concession XV, Sheffield township, county of Addington. The nearest railway station, 8 miles distant, is Enterprise on the line of the Canadian Pacific railway.

GEOLOGY

The rocks of the region consist of sediments of the Grenville series intruded by Precambrian granite. The sediments consist of crystalline limestones and micaceous gneisses; the granite is massive and coarse grained.

DEPOSIT

"The chief ore mineral is zinc blende of a dark chocolate-brown colour. With it are associated small amounts of galena and pyrite. The gangue consists chiefly of crystalline limestone, with minor quantities of lime silicate minerals.

The sphalerite occurs disseminated through the crystalline limestone near the granite contact in grains varying from the size of a pea to that of a walnut. No massive ore was seen. Certain belts within the limestone appear to be richly mineralized, while others are about barren."

DEVELOPMENT

"Scarcely any development has been done on the property. There are two pits on the zone of mineralization, one of which is about 8 feet and the other 2 feet deep. The mineralized belt may be followed by intermittent outcroppings for at least 150 feet. In no place is this belt wider than 5 feet."

ORIGIN

Uglow is of the opinion that the sulphides were original constituents of the limestone and were simply segregated at the time of the granite intrusion, which produced conditions of flowage in the limestone. An alternative hypothesis is that the occurrence is of a contact metamorphic origin. Its location at the granite contact and the presence of lime-silicate minerals suggests this mode of origin.

COMMERCIAL POSSIBILITIES

The amount of ore is apparently too small and its grade too low for the deposit to be of economic importance.

(14) Hollandia Lead Mine

(*See* Figure 24)

References

Barlow, A. E.: Geol. Surv., Canada, vol. XII, pt. A, p. 130.
Uglow, W. L.: Ont. Bureau of Mines, Ann. Rept., vol. XXV, pp. 23-24.
Ont. Bureau of Mines, Ann. Repts., vols.: VIII, p. 32; XIII, pt. i, pp. 11, 94; XIV, pt. i, pp. 15, 79; XV, pt. i, pp. 40, 91; XVI, pt. i, p. 78.

LOCATION

The property is on lots BA and BB, concession VI, Madoc township, Hastings county. It is about 2 miles northeast of Bannockburn on the Canadian National railway. The railway line is distant about ½ mile directly west from the property. A good automobile road leads from Bannockburn to the property.

GEOLOGY

The rocks of the region are of Precambrian age and consist of sedimentary gneisses, quartzose schists, and crystalline limestone of the Grenville series. These rocks stand on edge or at high angles and have a general strike of about north 45 degrees east. Quartz veins cut them.

CHARACTER OF DEPOSIT

The deposit is a calcite vein which occupies a zone of dislocation striking north 50 degrees west about at right angles to the strike of the gneisses. The dip is steep to the northeast and in places is vertical. In places the vein reaches a width of 10 feet. Its average width is about 4 feet. The walls are polished and slickensided. Horses of country rock occur in the vein.

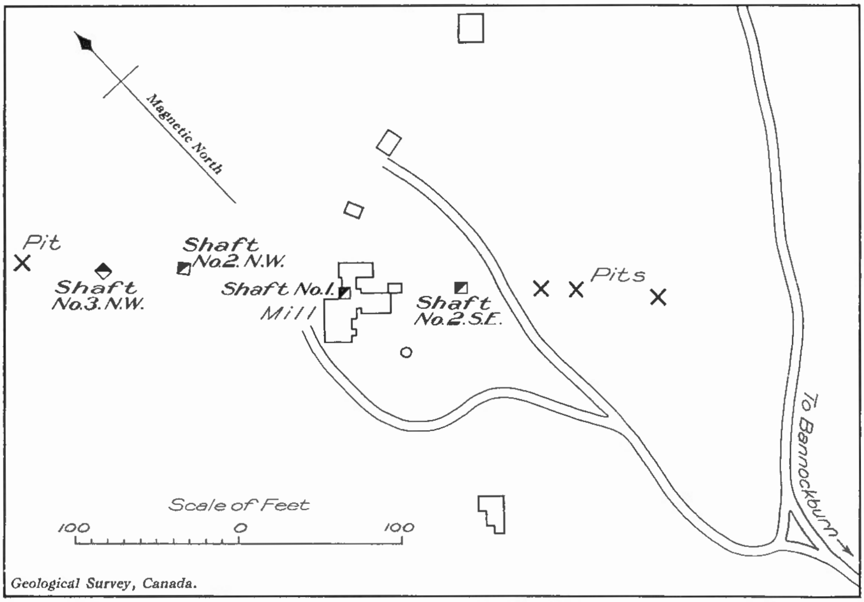


Figure 24. Surface plan, Hollandia mine.

The vein commonly shows good crustification. The ore is chiefly galena with here and there negligible amounts of sphalerite. Small quantities of pyrite are also present. The gangue minerals are calcite and barite, the latter in minor amounts. The galena occurs as crystals scattered through the gangue and as tabular masses commonly located close to the foot-wall. In places, however, it is concentrated towards the middle of the vein. Large masses of galena were found in the upper parts of the vein and were mined; it is probable similar concentrations may occur in other parts of the vein.

DEVELOPMENT

The vein has been developed for a length of over 400 feet by four shafts and several test pits. The shafts are known as No. 1, which is the working shaft and is 90 feet deep; No. 2 S.E., 132 feet deep; No. 2 N.W., 65 feet deep, and No. 3 N.W., 40 feet deep.

It is reported that all four shafts produced high-grade ore from the upper part of the vein for a depth of 20 to 40 feet. The part of the vein between shafts No. 2 S.E. and No. 2 N.W. has been stoped out to the surface. It is probable that the upper part of the vein carried higher values in galena than the lower part now shown in the workings.

No. 1 shaft has two compartments, is 90 feet deep, and has a 5-foot sump. It is timbered by solid cribbing for a depth of 30 feet, below which there is solid rock which does not require timbering. From the bottom of the shaft a drift has been driven east for 181 feet and west for 159 feet. These drifts are on the vein for 300 feet from the face of the east drift. Forty feet from the face of the west drift is a fault and beyond this the drift is not in the vein. In the west face, however, several deep drill holes which were never blasted are said to have shown galena, pointing to the probability that an advance in a northwest direction of a few feet might again strike the vein. According to the surface showings the vein should continue for a distance of at least 150 feet beyond the western face of the drift.

According to information supplied to the writer, sampling of the vein along the drift gave values in lead varying from less than 1 per cent to over 12 per cent, one streak of clean galena 2 to 3 inches wide gave an assay of 69·2 per cent. It is probable that by careful mining, and by mixing clean galena and high-grade, disseminated ore with lower grade material a mill feed approximating 6 per cent lead might be obtained.

CONCLUSION REGARDING THE PROPERTY

The property has been robbed of the high-grade ore that was in sight. It is possible, however, that further development might open up new shoots.

(15) Katherine Lead and Zinc Mine

References

Geol. Surv., Canada, Ann. Repts., vols.: XII, pt. A, p. 130; XV, pt. S, p. 243; Mem. 6, p. 349.
Ont. Bureau of Mines, Ann. Repts., vols.: X, pp. 129-130; XI, pp. 58, 60, 207; XV, pt. i, p. 91; XVI, pt. i, p. 79; XXV, pt. ii, p. 24.

LOCATION

The Katherine lead and zinc property is on lot 6, concession XI, Lake township, Hastings county. The nearest point on the railway is Millbridge, about 3 miles distant, on the Trenton and Maynooth branch of the Canadian National railways.

GEOLOGY

The exposures in the vicinity of the property are well-banded, grey quartzites and sedimentary gneisses and mica-schists of the Grenville series. As exposed in one of the main trenches, they strike east and west magnetic and dip 50 degrees north. They are locally drag-folded.

DEPOSIT

The deposit is a vein striking northwest. At the old workings very little can now be seen as the pits and shaft are full of water. The following two quotations give some information about this part of the vein.

"The vein and associated rocks are very similar to the occurrence worked at the Hollandia mine, with the exception that a considerable proportion of zinc blende accompanies the galena. A shaft was sunk 125 feet deep, and at a depth of 100 feet a level was driven north 200 feet and some stoping done. Half a mile south of this shaft another was sunk to a depth of 18 feet. Some prospecting was done by means of a drill, and a hole 292 feet deep was made."[1]

"The vein carries argentiferous galena and zinc blende in calcite, the average of the ore showing 10 ounces of silver. It lies wholly between walls of diorite, with a width varying from 1 to 4 feet, and a known longitudinal extension of half a mile . . . . Half a mile south of the main shaft is the south shaft . . . . The vein here is less highly mineralized having, however, a width of 9 feet, with six ore-bearing streaks, containing galena, but no zinc."[2]

In the winter of 1925 some new work was done about 500 feet southeast of the main shaft. The vein at this place was opened for a length of 70 feet. It has here a strike of south 55 degrees east magnetic and a dip of 70 degrees northeast. The country rock is a hard, bluish quartzite. The vein has an average width in the trench of about 4 inches, increasing in places to 7 inches. The gangue is calcite and barite showing good crustification. Galena occurs in bunches and seams in the vein.

On the dump near the main shaft specimens can be collected showing calcite and barite mineralized with galena, sphalerite, and pyrite.

(16) Elzevir Township, Hastings County

Reference

Vennor, H. G.: Geol. Surv., Canada, Sum. Rept. 1866-69, p. 164.

Vennor reports:

". . . . . on lot 18, range I, Elzevir township, a lead-bearing lode running northeast, and intersecting the diorites . . . . The gangue of this lode consists of quartz, which in a breadth of 3 feet, exposed in an opening which had been made, appeared to be much mixed with fragments of the wall-rock. The galena is scattered through the gangue in small, irregular, but somewhat abundant bunches, in which the crystals are smaller than is usual in the lodes of other parts of the district. At the time of my visit, which was not long after the discovery of the lode, but a small quantity of ore had been taken out . . . . the galena is said to hold a considerable but variable quantity of silver".

(17) Chrysler Lead Property

LOCATION

The Chrysler lead property is on lot 2, concession II, Limerick township, county of Hastings. It includes approximately 100 acres. The nearest railway point is Gilmour on the Canadian National railway. A good motor road leads from Gilmour to the property, a distance of about 4 miles.

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[1]Adams and Barlow: "Geology of the Haliburton and Bancroft Areas, Ontario"; Geol. Surv., Canada, Mem. 6, p. 349 (1910).

[2]DeKalk, C.: Ont. Bureau of Mines, vol. X, p. 130 (1909).

GEOLOGY

The rocks of the region consist of Grenville limestone, quartzites, quartz-schists, and limy slates, cut by basic intrusives of the Buckingham series and by quartz veins. The sediments are, as a rule, well banded, striking northeast. They are locally drag-folded. The intrusives are dark, massive rocks of the composition of diorite. The most abundant ferro-magnesian mineral is hornblende, biotite occurs in smaller amounts.

DEPOSIT

The deposit is a calcite vein cutting across the sediments and the intrusives. It strikes north 50 degrees west magnetic, and dips vertically. In places it reaches a width of 8 feet, but the average width, as shown in various open-cuts and pits, is about 5 feet. The vein has been opened up continuously for a distance of 500 feet, and undoubtedly extends a much greater distance.

The gangue is largely calcite which occurs in bands and is coarsely crystalline. Barite occurs in bands, usually toward the centre of the vein. The walls are sharply defined. In places the wall-rock on the two sides of the vein is quite different, showing that the vein is along a fault fissure in which there has been considerable displacement.

The ore is galena, which, as a rule, is concentrated in a band towards the middle of the vein. The streak of solid galena is 2 to 3 inches wide, but in places increases to 10 inches. Locally there are two or three parallel, narrow, mineralized zones. In places galena is present near the walls of the vein.

The mineralized portion of the vein as exposed in the workings is narrow, but the vein itself is so strong as to suggest that more work might open up shoots of commercial size.

(18) Blackburn Lead Vein

LOCATION

In 1925 a galena-bearing vein was uncovered on the farm of George Blackburn, lot 11, concession II, Tudor township, Hastings county. The property is near Wolf lake. A road from Bannockburn, about 4 miles distant, passes by the deposit.

GEOLOGY

The rocks are quartzites, gneisses, and limestone of the Grenville series. In the main pit, the rock is grey, well-banded quartzite. Nearby is a band of limestone about 40 feet wide. The strike of the series is north 10 degrees east magnetic, and the dip around 90 degrees.

DEPOSIT

The deposit is a vein cutting across the sediments. At the time of the writer's visit, in 1925, only one pit, about 7 feet deep, had been opened on it. It showed a vein of calcite up to 6 inches wide and smaller stringers.

The vein strikes north 18 degrees west and is vertical. It is well mineralized with galena. Small fragments of country rock are included in the vein and some of them show slickensided surfaces. As exposed at the time of examination the deposit was too small to be of commercial importance.

(19) Roberts Lead Property

LOCATION

The Roberts vein is on lots 4 and 5, block B, Tudor township, county of Hastings. Outcrops of vein material have been found on lots I to VI of block B, in a line running towards the Hollandia vein, and all may belong to the same fault fissure. The chief work has been done near the boundary between lots 4 and 5 near the Canadian National railway about 2 miles northwest of Bannockburn.

GEOLOGY

The rocks of the region are sedimentary gneisses of the Grenville series well exposed in railway cuts near the main workings. The rocks are well banded, strike northeast, and dip about 48 degrees northwest. In places they are crumpled. They are dark coloured, but a lighter quartzitic variety is seen at the shaft.

DEPOSIT

The deposit is a calcite vein carrying galena. In the shaft, which during the winter and spring of 1925 was sunk to a depth of 20 feet, the vein shows a width of 10 inches. There are, in addition, stringers of calcite through the country rock. In the neighbourhood of the shaft the vein has been traced by pits and trenches in a northwest direction for about 200 feet, but away from the shaft it is narrower. The vein is well mineralized with galena and associated pyrite. The vein as exposed at present is too small to be of economic importance, but considering the excellent lead values it carries and the fact that it is on the same line of strike as the larger Hollandia vein, it is possible that along this zone larger deposits may be present.

(20) Stewart Lead Property

LOCATION

The Stewart property is on lots 1 and 2, block A, Tudor township, Hastings county. The nearest town is Bannockburn on the Canadian National railway.

GEOLOGY

The property is near the Hollandia and the country rock consists of the same type of quartzose schists and micaceous quartzites of the Grenville series as is found at that property. Their strike is north 15 degrees east magnetic and they stand vertically.

DEPOSIT

The deposit is a vein striking north 45 degrees west magnetic. It has been traced by pits and trenches for 250 feet, and a shaft 20 feet deep has been sunk at one point. The vein varies in width from a few inches to 3 feet. The gangue is calcite. In places it contains small horses of country rock. In the shaft, 10 feet below the surface, the vein has a width of 10 inches and shows solid galena for a width of 5 inches. At the bottom of the shaft the vein is 4 inches wide. In the trenches where the vein widens to 3 feet, there is little galena.

(21) Webber Property

LOCATION

The Webber property is on lot 29, concession VI, Madoc township, Hastings county, near the village of Bannockburn.

GEOLOGY

The rocks of the neighbourhood are quartzose schists and sedimentary gneisses of the Grenville series, striking northeast and standing vertical. They are traversed by quartz stringers which in places follow, and in other places cut across, the structural planes.

DEPOSIT

The deposit is a quartz vein striking north 35 degrees east. One pit 10 feet by 10 feet, and about 15 feet deep has been sunk on it. In the northeast side of the pit the vein has a width of 18 inches, and in the southwest wall a width of 3 feet. The quartz is mineralized with pyrite and small amounts of galena and sphalerite. The rocks bordering the vein are rusty and carry considerable pyrite. The amounts of galena and sphalerite present are much too small to be of commercial importance.

On lot 29, concession V, Madoc township, is a somewhat similar occurrence of galena. The rocks here consist of massive Grenville limestone cut by numerous, small, irregularly shaped veins and stringers of quartz. As a rule the stringers follow the bedding of the rock which here strikes about north 15 degrees east magnetic. The veins carry chalcopyrite, feldspar, and, in one pit, small amounts of galena.

These deposits are apparently of intermediate to high temperature origin, due to the granitic intrusions. They are thus of Precambrian age, and are entirely distinct from the galena-bearing calcite veins of much later age which are found in this same general region.

(22) Lake Group of Lead Veins

Reference

Vennor, H. G.: Geol. Surv., Canada, Rept. of Prog. 1866-1869, p. 163.

LOCATION

This group is located in Lake township, Hastings county.

DESCRIPTION

Vennor reports:

"The west half of lot 10, concession XI, of Lake, is another of the localities mentioned by Mr. Macfarlane. On this lot, which was some time since bought by

Messrs. Gillum and Kesterman, of Belleville, occurs the Donahue vein, striking north 50 degrees west, and standing in a vertical attitude. Little, however, has been done, and although the lode has a width in some parts of from 20 to 24 inches, bounded by regular walls of grey calc-schist, the galena occurs only in scattered and irregular patches, and in considerable quantity.

On lot 8, concession XI, of Lake (or possibly in concession X), a vertical vein, holding galena in a gangue of heavy spar, runs through a calc-schist in the direction of north 45 to 50 degrees west. The lode varies in thickness from 10 to 18 inches, and is bounded by well-defined walls. Little had been done on this lot up to 1867, but in the short distance then uncovered, I saw extracted some masses of ore, at a depth of 3 feet from the surface, which weighed from 15 to 40 pounds, and I was informed that when first discovered much larger masses had been taken from the vein. The lode is supposed to be on the property of Mr. Wm. Sweeney, of Tudor, but in consequence of the defective manner in which the township has been surveyed, there at present exists a dispute as to the ownership of the lot."

(23) Tudor Group of Lead Veins

References

Vennor, H. G.: Geol. Surv., Canada, Rept. of Prog. 1866-69, pp. 162-163.
Macfarlane, T.: Geol. Surv., Canada, Rept. of Prog. 1863-66, pp. 103-105.

LOCATION

These veins occur in Tudor township, county of Hastings. Several of them were visited by the writer in the summer of 1925.

GEOLOGY

The rocks of the region are quartzites, paragneisses, and limestone of the Grenville series, intruded by Precambrian granite. The general strike of the sediments is northeast, but they show local variations and drag-folding.

DEPOSITS

The deposits are calcite-barite veins striking northwest across the structure of the country rock. All those observed by the writer are small. On block B, lot 30, is a showing on which some work has been done in recent years. A trench 80 feet long has been opened. It shows a vein up to 8 inches in width striking north 75 degrees west magnetic and dipping 80 degrees northeast. The gangue is chiefly barite with minor amounts of calcite. The ore mineral is galena, but is not abundant.

The following description of others of these veins in Tudor township is taken from H. G. Vennor's report.

"Many of the localities known as affording galena have been noticed in Mr. Macfarlane's report for 1866, but during my explorations in Tudor, having visited all the lead-bearing lodes, openings were found to have been made in some, of which the localities only had been previously indicated, and one or two were in a better condition for inspection than at the time of Mr. Macfarlane's visit.

One of these on lot 28, range B, in Tudor, is a vertical vein running north 70 degrees west, the strata of calc-schist dipping 270 degrees $<$ 76 degrees. At the time of Mr. Macfarlane's visit, a shaft which had been sunk on it to a depth of 37 feet was half full of water, preventing him from doing more than to state the information he had received from others. In 1867, I found that the lode, of which the veinstone is barytes and calcspar, had yielded on the average three-quarters of an inch of galena;

but the bottom of the shaft showed no more than half an inch of barytes, without galena. I was informed by Mr. W. Kesterman, of Belleville, then superintending the mine, that there had been extracted from the vein about 6 tons of galena, 4½ of which were sent to New York for sale, after being simply crushed and found to yield 66 per cent of lead.

On lots 31 and 32 of the range east of the Hastings road, in Tudor, a lead-bearing vein runs in a vertical attitude north 75 degrees west, cutting the grey calc-schists with strike north-northeast.

In 1867 it has been traced in the direction given, across both the lots mentioned, with very good surface indications, and was known as the Murphy mine. The Hastings Lead Mining Company subsequently sunk a shaft on it, which, I understand, had been carried down to a depth of 125 feet, but the result being unsatisfactory, the work was abandoned.

On lots 28 and 29, concession XIV, of Tudor, there is a vein of red and white heavy spar holding galena, and cutting the calc-schists. Its bearing is north 5 degrees east, and it stands in a vertical attitude, while the enclosing rock, also vertical, strikes almost due north and south. It was discovered some eight years ago, and was first opened in 1859. In 1867 the mine was leased by Messrs. Lombard and Company, of Boston, who were working it at the time of my exploration in Tudor, and I had an opportunity of examining the shaft when free from water. The walls were regular and well defined, the width between them being in some parts from 18 inches to 2 feet, and the ore appeared in scattered and irregular bunches in the gangue. When first opened, this vein yielded some large masses of ore, but, as in a previously mentioned instance, they greatly diminished, descending, and at the bottom of the shaft, which was 25 feet deep, there was scarcely any ore. In 1868, at the depth of 42 feet, the mine was abandoned. It may be remarked that many of these veins in Tudor, yielding considerable bunches of ore near the surface, show little more than traces of galena at the depth of a few feet. Of twenty-five localities in Tudor, in which galena was discovered and partly worked, only one, the Murphy mine, continued to be worked in 1868".

(24) Methuen Lead Vein

Reference

Vennor, H. G.: Geol. Surv., Canada, Rept. of Prog. 1866-1869, p. 163.

LOCATION

In the southeast corner of Methuen township, Peterborough county.

DESCRIPTION

Vennor reports:

"There occurs a northwest and southeast lode near the southeast corner of Methuen, where, in 1868, a shaft was being sunk by Messrs. Parker and Baker. On this lode two or more shafts have been opened on the eastern edge of lot 2, range I, close to the boundary line of Lake township. The lode cuts grey, vertical calc-schist, striking north 20 degrees east, and is composed of calcspar and heavy spar, the former being of a rose or flesh-red colour, in which there is a good show of galena. The average width of the lode is about 18 inches, and it has been traced in a southeasterly direction for nearly 3 miles into Marmora."

(25) Union Creek Lead Mine

Reference

Adams, F. D.: Geol. Surv., Canada, Ann. Rept., N.S., vol. VI, pt. J, pp. 14-15.

Adams reports:

"A deposit of lead has been opened up on lot 20, range A, Galway township, Peterborough county, Ontario. A shaft with lateral drifts has been sunk to a depth of about 100 feet, but this at the time of my visit was filled with water. Near it, however, a short tunnel is driven in the vein from a hill side. In this the vein is seen to vary somewhat in width, but to be 14 inches wide at its widest part. The veinstone is barite with some calcite, carrying in the tunnel a few grains of iron pyrite, zinc blende, and galena. A considerable amount of galena has been taken from the shaft where the vein is said to be somewhat wider and contains the galena in pockets. I was informed that about 30 kegs of galena have been shipped. A number of specimens of the galena and barite as well as a few of calcite and zinc blende now lie about the mouth of the shaft. As the value of the galena would depend largely on its content of silver, which metal is almost invariably found in galena, but is present in very variable quantities in the galenas from different localities, I selected some of the pure galena from the shaft and handed it to Mr. Hoffmann for examination. It was, however, found to contain neither gold nor silver. Its value will, therefore, depend on the high percentage of lead which it contains. The vein cuts gneiss which is interstratified with crystalline limestone."

The deposit was worked in 1911, and some ore was concentrated in the mill.

(26) Crown King Lead Prospect

Reference

Uglow, W. L.: Ont. Bureau of Mines, vol. XXV, pt. ii, pp. 26-27 (1916).

LOCATION

Lot 1, concession VII, Somerville township, Victoria county.

GEOLOGY

The rocks of the region consist of crystalline limestone and micaceous sedimentary gneisses of the Grenville series, standing vertically and striking northeast.

DEPOSITS

The deposits consist of three parallel veins striking north 50 degrees west magnetic across the strike of the country rock. The veins vary in width up to 4 inches. They consist chiefly of barite which is banded parallel to the walls. The ore mineral is galena. It occurs as masses in the barite with only small quantities in the disseminated form.

DEVELOPMENT

The veins are stripped at intervals for a distance of 200 feet. There are three small pits in this distance, the main one has a depth of 17½ feet.

COMMERCIAL POSSIBILITIES

"The zinc blende appears to be confined to the surface beds of the dolomite, and there are no indications of any special conditions which might lead to important ore concentration. In these circumstances new ore-bodies are to be looked for on the surface rather than at lower levels."

ORIGIN

The deposit is of the Mississippi Valley type consisting of gash veins and impregnations in dolomite.

(27) Albemarle Zinc Mine

References

Williams, M. Y.: Geol. Surv., Canada, Sum. Rept. 1912, p. 281.
Ont. Bureau of Mines, Ann. Repts., vols.: XXIV, pt. i, p. 151 (1915); XXV, pt. ii, p. 42.

LOCATION

This property is on the north half of lot 30, concession II, Albemarle township, Bruce peninsula, about 4 miles from Wiarton.

GEOLOGY

The rocks of the region are dolomites of Niagaran age. They are very porous, especially in the fossiliferous portions.

DEPOSIT

Williams states:

"Zinc blende occurs filling pore spaces and cavities, and partly replacing fossils and the country rock. The greatest accumulation of ore was found in cavities open to the surface and evidently dissolved out by meteoric water. Loose ore was mixed with pebbles and earthy materials and in one place as much as 110 pounds of ore were obtained from a single pocket.

DEVELOPMENT AND PRODUCTION

Prospecting was begun in 1910 and, when visited, the open-cut was about 100 feet long, 30 feet wide, and 33 feet deep. Ore was obtained down to 20 feet in depth, below which no ore was observed, although these lower beds are rather more porous than in the ore horizon. In all, a carload lot of ore was shipped from the prospect. The blende is said to assay 69·76 per cent zinc."

(28) Sudbury Zinc-Lead Region

References

Coleman, A. P.: Ont. Bureau of Mines, Ann. Repts.: vol. VIII, p. 33; vol. XIV, pt. iii, p. 95; The Nickel Industry, Mines Branch, Dept. of Mines, Ottawa, 1913, p. 101.
Ont. Dept. of Mines, Ann. Repts.: vol. XXXV, pt. i, p. 30; vol. XXXVI, pt. i, p. 144.
Buisson, A.: "The Recent Zinc Discoveries near Sudbury, Ontario"; Second (Triennial) Empire Mining Congress.
Loney, E. D.: "A Promising Future for Sudbury District"; Can. Min. Jour., June 17, 1927, p. 497.
"The Sudbury Basin"; Can. Min. Jour., July 15, 1927, pp. 567-568.
"The Early History of Errington Mines"; Can. Min. Jour., July 22, 1927, p. 582.
"Prospecting Sudbury District"; Can. Min. Jour., Sept. 2, 1927, p. 698.
Hubbell, A. H.: "Mining Lead-Zinc-Copper Ore in the Sudbury District"; Eng. and Min. Jour., Oct. 13, 1928, pp. 568-570.
"The Errington Mine"; Can. Min. Jour., Nov. 11, 1927, p. 897.
"Zinc-Copper Deposits at Chelmsford"; Can. Min. and Met. Bull., Feb., 1928, pp. 194-195.
Annual Reports, Treadwell Yukon Company, Limited, 1926-1927.

LOCATION

A zinc-lead field with great possibilities lies in the Sudbury basin in the townships of Balfour, Creighton, Dowling, Fairbank, Cascaden, and Trill. The mineralized zone extends in a northeast-southwest direction along Whitson river and the south side of Vermilion lake. The Errington mine of the Treadwell-Yukon lies about 18 miles west of Sudbury and about 5 miles southwest of Chelmsford on the Canadian Pacific railway.

HISTORY

The first prospecting in the interior of the Sudbury basin was carried out in 1897 when James Stobie staked the land around Stobie falls on Vermilion river on the lot to the west of that on which No. 1 shaft of the Treadwell-Yukon Company stands. A shaft was sunk on the property, but work on it was discontinued in the autumn of the same year. In the meantime on the adjoining lot to the east, Alphonse Ollier discovered an outcrop of zinc-lead ore. The post office of Platinum near this cropping received its name from the belief that the ore contained platinum. In succeeding years the discovery on the Ollier lot was patented by Ollier and associates and various attempts made to dispose of it to operating companies. The complex nature of the ore, however, discouraged development. One tunnel 40 feet long and numerous test pits, however, were excavated by one United States company who later abandoned the enterprise.

In 1924 diamond drilling for coal was carried out on the Morley Arthur farm to the northeast of the Ollier lot, and at a depth of 600 feet a zone of sulphides was encountered. The drill cores were afterwards acquired by Mr. Joseph Errington who had been one of the superintendents in charge of the original work carried out on Vermilion river. He recognized the same type of ore as that occurring at Stobie falls and on the Ollier lot and conceived the idea of ore possibly continuing throughout the intervening area. He acquired options on a large area of ground which in July, 1925, were taken over by the Treadwell-Yukon Company, a subsidiary of the Bunker Hill and Sullivan. A drilling campaign was immediately commenced. After some 50,000 feet were drilled, sinking operations were begun in August, 1926, and drifting and crosscutting done to explore the ore zone.

A number of other companies acquired adjacent territory. To the west of the Treadwell-Yukon holdings claims were taken by the National Lead. The Sudbury Basin Mines holds claims along Vermilion lake. Diamond drilling has proved an ore zone on their property.

GEOLOGY

The rock succession in Sudbury basin is as follows:

Chelmsford sandstone
Onwatin slate
Onaping tuff
Trout Lake conglomerate

These Precambrian rocks rest on the nickel-bearing eruptive intruded between them and the older Huronian and pre-Huronian rocks upon which they were deposited.

The Trout Lake conglomerate is coarse and has a thickness of from 20 to 400 feet. It contains boulders of granite, porphyry, and quartz, some of which are well rounded. Much of it has been metamorphosed by the underlying eruptive. It passes gradually into the Onaping tuff. This is greenish black to black and is made up of angular glass fragments in a tuffaceous matrix. It has an estimated thickness of 3,700 feet. It shows a foliation in a northeast direction. The Onaping tuff in turn passes gradually into the Onwatin slate. The latter is black, highly carbonaceous, and has an estimated thickness of 3,800 feet. It locally contains veins of anthraxolite associated with quartz. It is also locally pyritic. In places the bedding is well marked by beautiful colour banding, but commonly the slaty cleavage is the distinctive structural feature. Locally where the colour banding can be observed the series is seen to be severely drag-folded with the cleavage planes parallel to the axial planes of the drag-folds. The Chelmsford sandstone is a dark grey rock varying from 800 to 1,500 feet in thickness. In places it is well bedded. It also is locally foliated, showing a fracture cleavage that causes it to break into slabs that have no relation to the bedding planes. Near its base are shaly layers showing a sort of gradation between it and the Onwatin slate. At its border where it overlaps the slate there is commonly a low escarpment.

All these rocks are cut by quartz veins and stringers.

Intrusive beneath these rocks is a laccolithic sheet of the nickel-bearing eruptive. This sheet has a length of 36 miles, a width of 17 miles, and varies in thickness from ½ mile to 2 miles, the average thickness being 1¼ miles. At its lower side the sheet consists of norite, at its upper of micropegmatite, with, intervening, a gradual transition from one to the other. Along the lower border of the intrusive are large masses of pyrrhotite and other sulphides, forming the famous nickel and copper ores of Sudbury region. The acid or upper part of the magma was responsible for the metamorphism of the adjacent sediments and was probably the source of the solutions producing the quartz veins that traverse these rocks.

DEPOSITS

The ore zone on which exploration is being carried out by the Treadwell-Yukon lies within the belt of Onwatin slate. At the time of the writer's visit, in the autumn of 1925, drilling was being done north of Whitson river, on lot 9, range VI, Creighton township, and on lots 5 and 6, range I, Balfour township, immediately south of Whitson creek. One pit was also being opened on lot 9 at the base of a low cliff of Onwatin slate. The overburden at the foot of the cliff is marked by a red-stained gossan zone. In the pit are exposed dark iron-bearing sphalerite, pyrite, chalcopyrite, galena, and quartz. In places, the quartz occurs in fibrous aggregates, some over 6 inches in length.

Along the strike of the mineralized zone, at a number of places, are outcrops of a grey rock which under the microscope is seen to consist of quartz and carbonate with small, dark areas consisting of ground-up slate. In places the fragments of slate are large enough to be distinguished in hand specimen. This material evidently is the result of quartz and carbonate deposition along a shear zone.

In the Canadian Mining Journal of March 18, 1921, page 215, Mr. C. H. Hitchcock pointed out the probability of a fault zone traversing this part of the Sudbury basin. He wrote:

"In the southern part of Trill township just north of the Sultana mine, basic norite rests against acid norite. The nickel formation appears faulted, the displacement amounts to approximately 6,000 feet. In line with this fault on the opposite side of the nickel basin, in Capreol township just north of Clear lake, the norite is faulted again, showing a displacement of 2,500 feet. The Bennett and La Forest prospects are really the same ore zone, but have been separated ½ mile by the above fault.

As the strike of the fault in both Trill and Capreol townships is the same, namely 63 degrees northeast, and the direction of the displacement is the same, it appears very likely that this fault cuts the whole nickel basin for a distance of 30 miles.

An economic item of interest is that the zinc deposits south of Chelmsford are in exact line of this fault. It is possible that these deposits have a genetic relation to the great fault. Much of this fault zone in the centre of the nickel basin is soil covered, therefore other zinc deposits may exist and the line of this fault may be a promising zone to prospect."

The ore deposits occur along this line of faulting. Details about the deposits have not been published, but the ores apparently occur as lenticular masses, in two zones about 1,100 feet apart. The ore is an intimate mixture of zinc, lead, copper, and iron sulphides, the proportions of the first three varying widely. In one diamond drill hole ore was found to be present at a depth of 1,100 feet.

DEVELOPMENT

In 1925 and 1926 some 50,000 feet of diamond drilling was done. The work was too widespread to permit of accurate interpretation of the results, but it justified underground development. Shaft No. 1 was begun in July, 1926, and sunk in that year to the 300-foot level. According to the 1927 report of the company, drifting and crosscutting from this shaft developed about 1,000,000 tons of ore in the Ollier ore-body above the 300-foot level. The assays of all samples taken from this ore, including samples from waste bands, averaged 0·021 ounce gold, 2·15 ounces silver, 1·33 per cent copper, 1·33 per cent lead, and 5·74 per cent zinc.

Shaft No. 2 was commenced in May, 1927, at a distance of 4,900 feet slightly north of east of shaft No. 1. It was sunk to a depth of 600 feet and stations were cut on the 300 and 500-foot levels. On March 1, 1928, the connexion between No. 2 shaft and the east drift of No. 1 shaft was made by the completion of a crosscut 1,200 feet long on the 300-foot level. Crosscutting work opposite No. 2 shaft disclosed wide bands of vein matter, but only one of these contained ore; this has a width of 16 feet and an average content of 0·015 ounce gold, 1·80 ounces silver, 0·54 per cent copper, 3·4 per cent lead, and 9·1 per cent zinc. Diamond drilling in this section of the ore-body has indicated a large tonnage of ore, one hole showing a width of 74 feet of ore. This section is being explored from the 500-foot level.

Shaft No. 3 is located 11,000 feet east of No. 2. Diamond drilling in this region showed widths of ore up to 35 feet.

ORIGIN

It seems most probable that the mineralizing solutions responsible for the formation of the ore-bodies had their origin in the acidic or upper portion of the Sudbury eruptive. It is probable that the faulting and shearing of the sediments of the basin took place at the time when the eruptive was intruded and that the fracture planes thus produced formed channels for the circulation of the mineralizing solutions.

(29) Prue's Mine, Bowell Township

Reference

Coleman, A. P.: "The Sudbury Nickel Field"; Ont. Bureau of Mines, vol. XIV, pt. iii, p. 95 (1905).

Coleman reports:

"At several points the tuff (Onaping) has been found to contain small deposits of sulphides, especially zinc blende and galena, but never on such a scale as to be of economic importance. Such deposits are known at points to the north of Fairbank lake and along the same side of the basin towards the east, but the largest visited by us was a little east of the south end of Trout lake in Bowell township, where a location (W.D. 252, sometimes called Prue's mine) has been taken up, and a small shaft sunk showing quartz, with zinc blende, galena, and a little copper pyrites. A dark grey eruptive rock occurs beside the shaft and its eruption probably influenced the formation of the small ore-body."

(30) Geneva Zinc-Lead Mine

(*See* Figure 25)

Reference

Quirke, T. T.: Geol. Surv., Canada, Sum. Rept. 1920, pt. D, pp. 7-18.

LOCATION

The deposit is on lot 7, range VI, Hess township, Sudbury district. It is reached from Geneva on the Canadian Pacific railway, about 3½ miles north of Cartier. From Geneva station a boat can be taken to the head of Geneva lake, a distance of about 3 miles, and from there a trail 1⅛ miles long leads to the property. A wagon road from the end of the lake follows a slightly longer route.

HISTORY

The property was staked in the summer of 1925 by Mr. J. H. Collins. The discovery was a small mineralized showing outcropping through drift. The presence of huge boulders in the drift necessitated much work in uncovering the deposit. Surface work exposed a vein. It was traced by pits and trenches and in 1926 diamond drilling was carried out by the Collins-Babson interests to determine the underground character.

In August, 1927, the property was optioned by the Towagmac Exploration Company and about 2,000 feet of drilling was carried out by them. Later the option was exercised and in May, 1928, a subsidiary company known as the Lake Geneva Mining Company was formed to take over the operating of the property.

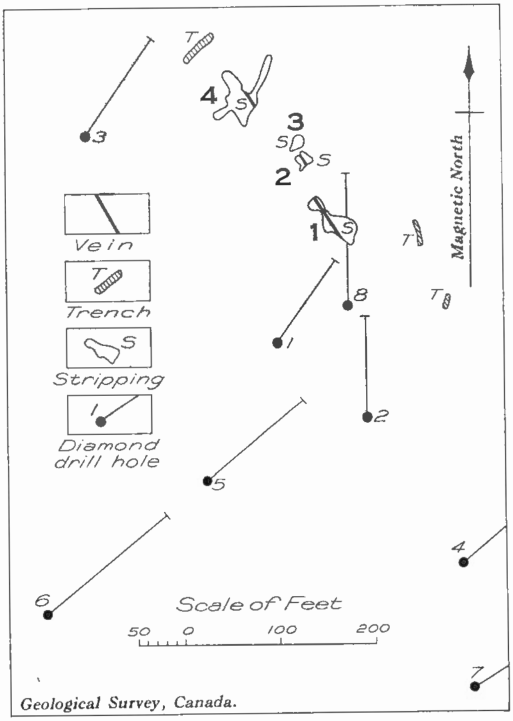

Figure 25. Geneva zinc deposit showing surface work as in 1926.

In September, 1925, the property was visited by the writer and in 1926 by C. Tolman who supplied the writer with his notes and descriptions.

GEOLOGY

The rocks of the region according to Quirke have the following succession.

Keweenawan	Basic intrusions (diabase and norite)		
(Intrusive contact)			
			Feet
Huronian	Cobalt series	Lorrain quartzite....	1,700
		Gowganda formation	1,200
	Bruce series	Serpent formation...	700
		Espanola formation..	120
		Mississagi formation.	470
(Unconformity)			
Granite intrusions (alaskite)			
Keewatin volcanic rocks and schists			

The deposit is situated in a complex series of quartzite-greywackes, banded tuff-like rocks, and an assortment of hornblende, mica, and chlorite schists probably representing, in part at least, metamorphosed volcanics. Such rocks appear to be best referred to the Keewatin; their general structure in the vicinity of the deposit is northwest with steep dips to the southwest. These rocks are intruded by granitic dykes ranging in width from a few inches to 6 feet or more. They have the composition of a syenite and are slightly porphyritic. A syenite mass of similar composition outcrops about one-third of a mile to the south and another larger mass lies about the same distance to the north, and it is probable that the dykes are related to these intrusives.

DEPOSIT

The deposit is a vein striking northwest, and dipping at the surface about 45 degrees southwest, following in a general way the strike and dip of the schistosity of the country rock. The latter consists for the most part of banded quartzite-greywacke. At one place syenite porphyry is present on the hanging-wall and at others hornblende schist, possibly an altered andesite, is present in the vicinity of the foot-wall. The vein has definite walls; the rock immediately adjoining, however, is usually heavily impregnated with pyrite.

The vein was traced on the surface by pits and trenches for 400 feet and showed widths varying from a few inches to over 3½ feet. To the south surface exploration was hindered by the presence of a swamp. Beyond the swamp, over 700 feet wide, the vein was not observed, though rock exposures are plentiful and there is a slightly pyritized zone roughly in the general line of strike of the vein. To the northwest the vein is lost in an area of shearing and complex faulting. The rocks there consist of altered volcanics, banded tuff-like material, quartzite-greywackes, basic dykes, and intrusive granite. Shearing movements have formed crush conglomerates in which angular to subangular granite fragments represent dykes or apophyses broken by movement and isolated in the country rock. Small, isolated areas of mineralization occur in this region, pyrite being the predominant, and in most places the only, sulphide mineral; sphalerite and galena, in very small quantities, are the other sulphides sometimes found.

The chief ore mineral in the vein is sphalerite, typically fine-grained. In some places small areas more coarsely crystallized are present, usually confined to the centre of the vein and commonly having associated with them patches of coarsely crystallized calcite. Somewhat similar bunches of quartz are present, but with them is associated coarsely crystallized galena. There is a sparse, but fairly constant, dissemination of pyrite.

Megascopically the ore, except for the small, coarse-grained areas of quartz and calcite mentioned above, appears to consist almost entirely of a structureless mass of solid sulphides, but under the microscope a polished surface of the typical fine-grained sphalerite ore shows about 25 per cent of dark, siliceous-appearing gangue. In addition to the disseminated pyrite, microscopic particles of galena and to a less extent chalcopyrite are seen in irregular masses, but with rounded or embayed outlines. The pyrite is in equidimensional grains having a somewhat spongy appearance caused by the inclusion of many microscopic, rounded particles of sphalerite and minor amounts of galena and chalcopyrite.

ORIGIN

It is assumed that the mineralizing solutions that produced the deposit had their origin in the younger granite of the region and that they represent residual products attending its consolidation.

DEVELOPMENT

Before the property was optioned by the Towagmac Exploration Company, the ore-body had been exposed by a number of trenches and shallow open-cuts, and eight diamond drill holes had been put down.

Trench 1. This was the first trench to be made; its position is indicated on Figure 25. The surface vein material has been shot away forming a shallow open pit. The central part of the pit is obscured by broken ore. The vein in the southern part of the exposure averages about 3 feet wide; the northernmost 20 feet is about 2 feet wide. The vein has a general strike of north 40 degrees west, dip 45 degrees southwest, and consists predominantly of fine-grained sphalerite and disseminated pyrite with little visible gangue of a dark, siliceous-appearing nature. The northern half of the exposure is slightly coarser, the pyrite is more sparsely disseminated, and, in the middle of the vein, are bunches of coarsely crystallized calcite surrounded by exceptionally coarse sphalerite. In this part of the vein were noted some quartz bunches with associated coarsely crystallized galena. As seen in polished section galena and chalcopyrite are disseminated throughout in microscopic particles.

The country rock, except in the northern part of the trench, is a quartz-mica schist, markedly garnetiferous in places, evidently an altered greywacke quartzite, the sedimentary banding of which can still be distinguished. The vein seems to parallel the schistosity. The stratification dips southeast at about 50 degrees; its general strike is difficult to determine, but at no place does it appear to depart greatly from that of the schistosity.

In the northern part of the trench, syenite porphyry forms the hanging-wall of the vein. This rock, somewhat sheared, contains sporadic phenocrysts of flesh-coloured feldspar in a medium-grained groundmass of feldspar, a little quartz, and some mica. Under the microscope the rock is seen to be composed essentially of potassium feldspar, some scattered albite crystals, very little quartz, and about 10 per cent of dark mineral now entirely altered to chlorite. As accessories, considerable titanite and scattered apatite and zircon crystals are present. Quite large areas of carbonate, probably calcite, occur and within the feldspars considerable sericite has developed. Much pyrite is disseminated throughout.

In the northeast corner of the trench the rock is a compact hornblende schist. This rock under the microscope proves to be composed essentially of albite and green hornblende. Little quartz is present. Particles of titanite-like material, many of which have a nucleus of magnetite, form an accessory mineral. Although no original structure is preserved, this rock could well have been an andesite. Whether the rock represents a dyke, intrusive sheet, or flow, is not indicated by the field evidence.

All the rock exposed in pit No. 1 is rather heavily pyritized. In the northeastern part of the trench is a narrow shear zone, striking about west, containing some quartz and mineralized sparingly with extremely fine-grained galena and pyrite. It is reported that some free gold was noted on the surface and that selected samples gave very high assay returns. The zone varies greatly in width, is not over 8 inches at its widest part, and the mineralization is bunchy. It appears to pinch out within the confines of the trench.

Trench II. The vein here maintains a width of about 3 feet and is very like, in general character, to the exposure in trench No. 1. In the southern part of the trench there is a bunch of quartz with considerable coarse-grained galena. The remainder of the vein consists of fine-grained sphalerite with usually a very subordinate amount of disseminated pyrite. One or two small zones appear to contain a larger percentage of pyrite than of sphalerite. The wall-rock is a pyritized quartz mica schist.

Trench III. The sphalerite vein does not appear to have been exposed in this trench. The rock is a quartz mica schist, in which considerable pyrite has developed. A little very fine-grained galena was noted.

Trench IV. In the northern part of the trench a vein 2½ feet wide, similar to that described above, is exposed. The southern part of the trench is a pit 12 feet or more deep, filled with water. The vein, about 2 feet in width, is said to continue at the bottom. The immediate country rock is a quartz mica schist, in places strongly garnetiferous. Throughout much of it a fine lamination, in addition to the not very marked schistosity, can be distinguished. A thin section of this rock was found to consist of quartz bands containing a few streaks of sericite alternating with bands of sericite and chlorite in proportions of about 3 to 1, with much subordinate quartz. There is probably about one-third as much chlorite in the rock as sericite.

In the several other trenches, rock is exposed only in the trench immediately northwest of trench No. IV. The rock there is a quartz mica schist.

DRILL HOLES

Eight diamond drill holes have been put down with the object of intersecting the vein at depth. Information on the position, direction, depth, and material encountered was furnished by Mr. Collins. From the information received the position of the holes is as represented on Figure 25.

Hole No. 1, the first to be drilled, was put down 130 feet south of trench 1 in a direction north 35 degrees east and at an angle of 50 degrees to the horizontal. It cut the vein at a depth of 113 feet or 87 feet vertical. The vein had a width of 4 inches. Drilling was continued and at 114 feet another vein, 5 inches wide, was intersected. The hole was continued to a depth of 159 feet without encountering further mineralization.

Hole No. 3, the second to be drilled, was next put down 300 feet west of trench 1 and 140 feet southwest of the approximate line of strike of the vein. This hole follows a direction of north 35 degrees east and its inclination is 60 degrees. It was continued to a depth of 241 feet without intersecting any vein material.

The next hole drilled was No. 2, situated 135 feet east of No. 1. Its direction is north magnetic, and its inclination to the horizontal, 40 degrees. The vein was intersected at 117 feet. The width of vein material passed through was 11 feet 6 inches, giving an actual width normal to the vein of 7 feet 6 inches. Drilling was continued to 139 feet without encountering further mineralization.

No. 4 hole was located 195 feet east of No. 2. Its direction is north 50 degrees east, angle 50 degrees. The vein was encountered at 130 feet. The mineralized zone had a width of 20 feet and consists of iron pryrites interspersed with sphalerite and little galena. Sphalerite did not form in a wide body as it did in No. 2. The hole was continued to 163 feet.

Number 5 hole is located 200 feet west of No. 2. It has a direction of north 50 degrees east and an angle of 65 degrees. It was designed to intersect the vein at a depth of 250 feet. The first vein was cut at 230 feet and was 15 inches wide at a vertical depth of 215 feet. The second vein was intersected at 236 feet and was 2 feet 3 inches in width. Drilling was continued to a depth of 308 feet without encountering further mineralization.

Hole No. 6 is located 330 feet southerly of No. 5. It has a direction of north 50 degrees east and an angle of 70 degrees. The first vein was cut at 339 feet or 319 feet vertically. The vein had a width of 8 feet. Between 369 and 400 feet, zinc and iron sulphides were encountered. The hole was continued to 485 feet.

Hole No. 7 was located 200 feet southwest from a point on the strike of the vein about 440 feet from trench 1. Its direction is north 50 degrees east, angle 60 degrees. A well-defined vein 3 feet in width was intersected at 215 feet 6 inches. The hole was continued to a depth of 325 feet without striking further mineralization.

Hole No. 8 was drilled 65 feet south of trench 1 in a direction north magnetic and at an angle of 50 degrees. A zinc vein 4 inches in width was cut at 70 feet. The hole was continued to 400 feet without encountering further ore.

Little information is available as to the probable deviation of the holes from their initial direction. However, assuming no deviation, it would appear that hole No. 3 has been extended much below where the vein should have been encountered, and that the dip of the vein in its upper part is between 50 degrees and 60 degrees, whereas below a vertical depth of 200 feet it appears to be about 40 degrees.

Assays

The following assay results are reported by J. H. Collins.

Hole No. 1. Assays of $0.60 gold at 113 feet and of $0.40 gold at 114 feet. A zinc assay of a width of 5 feet gave 1 per cent.

Hole No. 2. Traces of gold, 0·99 ounce of silver, and 11·5 per cent zinc between 95 and 102 feet.

Hole No. 4. An assay of 20 feet, from 130 to 150 feet, gave: gold, trace; silver, 1 ounce; zinc, 1 per cent.

Hole No. 5. Gold, trace; silver, between 229 and 239 feet, 18 ounces, and between 239 and 244 feet, 6·72 ounces; zinc, 12 per cent across 9 feet.

Hole No. 6. Zinc 13·98 per cent over 5 feet.

Hole No. 7. Zinc 21·18 per cent over 3 feet.

Hole No. 8. Gold, $7.23 per ton and trace of silver between 145 and 150 feet.

The development work carried out by the Towagmac Exploration Company consisted in some 2,000 feet of diamond drilling. This indicated above the 150-foot vertical depth, an approximate total of 77,350 tons of ore of an average grade of 4·5 per cent lead, 13 per cent zinc, and $1.90 in gold and silver, or a value of $20.30 per ton. The vein is reported to have an average width of 5 feet in the section explored, and the tonnage estimate is claimed to be over only a limited portion of the main ore-body.

In 1928 a shaft was sunk to a depth of 250 feet and crosscutting early in 1929 was begun on the 235-foot level.

(31) Lead-Zinc Deposits in Cunningham Township

By Ellis Thomson

LOCATION

These deposits are in the central part of Cunningham township, Sudbury district, and are associated with the northern and central bands of iron formation in this township. They are accessible from Ridout station, on the Canadian Pacific railway, by a canoe route down Ridout river and up Isaiah creek, a tributary flowing north through Cunningham township.

HISTORY

The first discovery was made on the northern iron range in 1913 and 1914, a block of nine claims being staked and surveyed for Austen and Nicholson, A. A. McLaren, and J. Halliday of Chapleau. A later discovery was made in June of 1926, on the central iron range, by Robert Allen of Chapleau and Roy Kostka of Ridout.

GEOLOGY

The deposits occur in iron formations intercalated between Keewatin basic volcanic flows and in close proximity to an isolated boss of granite which intrudes both the volcanics and the iron formations. At one point on the northern range several porphyritic offshoots of the granite cut the iron formation and have had a noticeable effect on the local deposition of ore.

DEPOSITS

The lead-zinc-copper ores are found in small, discontinuous veins. These follow the planes of schistosity in some places, whereas in others they cut across the schistosity and occupy joint planes or fissures. The iron formation, which constitutes the country rock, consists for the most part of alternating bands of white and rusty granular quartz, with small amounts of associated hematite, limonite, pyrite, and pyrrhotite. The principal ore minerals are sphalerite, chalcopyrite, and galena, in that order of prevalence; pyrite and covellite are rarer constituents. Although the gangue is chiefly finely divided granular silica, considerable calcite has been introduced later, probably along with the sulphides. The chalcopyrite has weathered in places to malachite and azurite. At one point in the northern range some erythrite, or cobalt bloom, is to be seen, but no metallic cobalt mineral was found associated with it. Both bands of iron formation have suffered considerable brecciation and the ore minerals have replaced the rock fragments in places. The metallic minerals show evidences of movement and there would appear to have been two periods of brecciation, followed by two corresponding periods of cementation.

ORIGIN

There seems little reason to doubt that the ore solutions originated in the nearby boss of granite and that they deposited their load of metallic minerals in the iron formation, rather than in the Keewatin volcanics, because the granular silica member of the iron formation, being more brittle, constituted a better medium than the more plastic schists on either side. That there was considerable movement in this part of the district is evidenced by the extensive faulting of the iron ranges and their intense brecciation in many places. The presence of epidote and clinozoisite in those parts of the iron formation carrying the ore, as well as the replacement of the rock-forming minerals by the ore minerals in the brecciated portions, would seem to point to contact metamorphic action as an important factor.

DEVELOPMENT

Very little work has been done on the deposits. A block of nine claims has been staked on the northern range and fairly extensive stripping carried out to reveal the small veins of zinc-lead-copper ore. In the central range, discovery of these ores was made in June, 1926, and a small amount of stripping has been done at this locality also. Both of the ranges outcrop in burnt-over country, so that little work was needed to reveal the deposits at the surface.

ECONOMIC POSSIBILITIES

The discoveries made to date are entirely short, discontinuous veins. The amount of barren country rock that would have to be handled for their exploitation represents a decided obstacle from a commercial point of view. It may be, however, that further exploration will uncover deposits of larger dimensions, if not on the surface possibly at depth. With the latter possibility in mind, a few test-holes put down with the diamond-drill, where the ore is most plentiful, might reveal a large deposit whose surface indications were comparatively unpromising. Although the iron formation bands, made up in these ranges largely of the granular silica member, are brittle and provide but short channel-ways for the deposition of the ore, it may well be that this feature becomes less prominent even 100 feet or so below the surface.

(32) Lady Evelyn and Haycock Locations

References

Barlow, A. E.: Geol. Surv., Canada, vol. X, pt. I, pp. 141-142 (1899).
Ont. Bureau of Mines, Ann. Repts., vols.: IX, p. 198; XIII, pt. i, p. 101; XVI, pt. ii, p. 67; XIX, pt. ii, p. 131; XXV, pt. ii, pp. 15-16.

LOCATION

The deposits are on the shores of Lady Evelyn lake close to where the lake empties into Montreal river. The locality is about 28 miles west-southwest of Haileybury, Timiskaming district.

DEPOSITS

Barlow gives the following description of the occurrences:

"The western shore of this portion of the lake is composed of diabase that rises abruptly from the surface of the water and often forms steeply sloping or perpendicular cliffs. The contact between this rock and the slates is concealed for the most part by the lake, the eastern shore being altogether composed of a very distinctly banded greenish slate, which also rises into rather important elevations, having apparently been protected to a considerable extent from denudation by the proximity of the more unyielding diabase. The contact, for a short distance, runs inland along the western shore, leaving a comparatively narrow strip composed of the slates, which are seen to have been much shattered and broken up by the intrusion of the diabase. Some considerable masses of segregated quartz were here noticed filling irregular cavities and fissures produced during the eruption. Associated with the quartz is more or less calcite, and in this gangue were noticed galena, copper-pyrites, iron pyrites, and zinc blende. The banded slates on the eastern shore dip in an easterly direction at an angle of about 18 degrees, and associated with and cutting these are similar segregated masses of "gash veins", in which galena is the prevailing constituent. The property on which these veins are situated is owned by Messrs. Klock and Haycock, and is locally known as the Haycock mine or location. A considerable amount of development work has been done, looking chiefly to testing the quality and extent of the ore-bodies, but the inaccessibility of the locality would be a sufficient hindrance to any further operations, unless the deposit should prove of an exceptionally rich character. (Silver runs from 2 to 8·75 ounces per ton)".

(33) Skead Township

References

Wilson, M. E.: Geol. Surv., Canada, Sum. Rept. 1909, p. 179; Geol. Surv., Canada, Mem. No. 17, p. 56.
Burrows, A. G., and Hopkins, P. E.: Ont. Dept. of Mines, Ann. Rept., vol. XXX, pt. vi, p. 10.

Burrows and Hopkins report:

"There are two occurrences of argentiferous galena in Skead township, one on the Mageau-Authier claim, W.D. 1001, in lot 12, concession V, the other on the De Villiers claim on the west-central part of lot 12, concession VI. On the former location a

50-foot shaft has been sunk vertically on a quartz-calcite vein in a Keweenawan diabase sill remnant. The vein strikes 15 degrees north of east, averages 6 inches in width, the calcite in places containing galena, zinc blende, cobalt bloom, and pyrite.

On the De Villiers location is a calcite vein from a few inches to 1 foot in width, averaging about 6 inches, striking 15 degrees north of east and dipping vertically. The vein, which has been uncovered for a distance of 450 feet, lies in Keewatin diabase and basalt, Timiskamian conglomerate, and Algoman porphyry, and apparently passes under a Keweenawan gabbro remnant on the west. The vein contains zinc blende, cobalt bloom, pyrite, and, in places, large pieces of galena which, on analysis, showed 4 ounces of silver per ton and no gold.

Calcite veins carrying galena are reported to have been found on claims L. 66 and L. 67, on lots 11 and 12, concession IV, Skead township.

M. E. Wilson, in his report on the Larder Lake area, refers to a silver-lead occurrence on claim B.G. 229, on the Hearst-McElroy boundary, 4 miles north of Skead township, owned by the North Canadian Gold Mines, Limited. Several irregular veins of galena, blende, and chalcopyrite, up to 10 inches in width, occur in Keewatin greenstone. They all pinch out quickly when followed along the strike."

(34) Bourke Deposits

Reference

Burrows, A. G., and Hopkins, P. E.: Ont. Bureau of Mines, vol. XXIII, pt. ii, p. 34.

LOCATION

Deposits of galena and sphalerite have been reported from the shores of Wolf and Twin lakes, in the vicinity of Bourke station on the Temiskaming and Northern Ontario railway, Timiskaming district.

DEPOSITS

Burrows and Hopkins report:

"Narrow calcite veins, carrying small amounts of galena and zinc blende, have been found in the greenstone on the west shore of Wewegimok. To the south of Wolf lake there are several quartz-calcite veins carrying similar minerals. On claim H.R. 580, belonging to Mr. Dan Smith, of Sesekinika, one of these veins has been stripped or trenched for 200 feet. The vein, which is 14 inches wide at one place on the surface, carried a high proportion of galena and zinc blende. A shaft has been sunk 50 feet and several tons of lead-zinc ore have been piled up. The quartz has been deposited along the walls of the fissure, while the calcite, with most of the sulphides, has filled the centre."

(35) Jamieson Claim, Kamiskotia Area

Reference

Finley, F. L.: "Kamiskotia Gold Area"; Ont. Dept. of Mines, Ann. Rept., vol. XXXIV, pt. vi, pp. 62, 63.

LOCATION

A lead-zinc-silver prospect occurs in the southwest corner of Jamieson township, in Kamiskotia gold area, Cochrane district.

DEPOSIT

The rocks consist of Precambrian, medium-grained diabase intruded by a small, dyke-like body of quartz porphyry. The outcrop is traversed by two nearly parallel shear zones striking north 53 degrees east and 450 feet apart. The south zone, which has a width of from 2 to 6 feet, consists of interbanded schist and glassy white quartz, sphalerite, and a little chalcopyrite and pyrite. The north zone contains galena and native silver, the most promising showing being at the west edge of the outcrop.

"The centre of the shear zone at this point is marked by 12 inches of clay gouge, which on each side is paralleled by small veins of quartz and calcite, in part cross-cutting the interbanded schist. The width of the shear zone at this point is about 8 to 10 feet, and the dip is vertical or nearly so. The veins contain pyrite, chalcopyrite, sphalerite, galena, and native silver, which, too, have been deposited in the order given and occur in fractures in the gangue and in blebs and bunches. More or less replacement of the schistose, sericitized diabase by the sulphides has occurred. Some of the calcite veinlets are barren and show a delicate banding due to the alternation of coarser and finely crystalline layers.

In a second pit in the porphyry, gouge is absent, and the rock is minutely and irregularly fractured. The fractures contain chiefly sphalerite and quartz with small amounts of galena. Two hundred and fifty feet to the northeast, the diabase is silicified across a width of 10 feet and is traversed by quartz and calcite veinlets containing the same sulphides and a little native silver. The line between the second and third pits is drift covered and occupies a slight depression. It would be of interest to determine the character and extent of the mineralization on leaving the porphyry.

The native silver, occurring as minute and very delicate flakes through calcite and galena, will not withstand the abrasive action in the preparation of polished sections. It is thought that the silver is primary, since there is no evidence of secondary enrichment. A specimen of vein matter containing much galena, but as far as observed no visible silver, gave an assay of 14·44 per cent lead and 32·7 ounces of silver per ton. The high ratio of silver to lead would indicate that native silver was present. The specimen was a grab sample higher in sulphides, and particularly galena, than the average across the whole width of the shear zone.

In the northeast corner of Turnbull township, a shear zone in gabbro contains quartz and sphalerite, while in Godfrey township, on claim 8,325, a similar occurrence in greenstone has been cut by a trench. All these deposits occur around the north edge of the granite stock, in concession VI, Godfrey, and are probably genetically connected with it, or with its underlying extension. Additional prospecting around the contacts of this intrusive might lead to further discoveries of a similar character."

(36) Jefferson Lead and Zinc Deposit

References

Moore, E. S.: "A Lead and Zinc Deposit in Keewatin Iron Formation"; Trans. of the Can. Inst. of Min. and Met., part of vol. XXIX (1926). Ont. Dept. of Mines, Ann. Rept., vol. XXXV, pt. ii, pp. 94-96 (1926).

LOCATION

The property, consisting of a group of twenty-three mining claims known as the Jefferson claims, is in the townships of Genoa and Marion, Sudbury mining division, near the north end of Rush (or Sahkatawichtah) lake. The nearest railroad station is Stackpool, on the Canadian National railway.

HISTORY

The discovery of lead and zinc was incidental to the diamond drill exploration of the iron range in which it occurs. The claims were staked in October, 1908, with a chain of other claims along the iron range by W. E. Smith, formerly of Sudbury, Ontario, and now of Smith and Reitz, a law firm of Minneapolis, Minnesota. During the drilling operations galena and sphalerite were found in cores from two holes and a resulting search in the vicinity led to the discovery of a streak of rock containing these minerals a short distance to the east of the holes. A pit was sunk on this outcrop in 1912 to a depth of 8 feet and at the bottom an attractive showing of galena was uncovered. Stripping revealed other small exposures of galena and sphalerite in the iron formation.

In the summer of 1925 Ellis Thomson visited the deposit on behalf of the Geological Survey. The information for the present report is based partly on material supplied by Thomson as a result of his examination. In the latter part of the same season E. S. Moore also studied the deposit in connexion with work on the iron formation.

The property is controlled by the Jefferson Mining Corporation.

GEOLOGY

The geology of the district is described by E. S. Moore as follows:

" At this point the rock is all granite, which extends westward to a point near the north end of Sahkatawichtah (Rush) lake, where it splits around a large area of Keewatin rocks, which spreads out to the west and southwest. A long iron-range runs through this Keewatin area for a distance of about 12 miles, from the head of Rush lake westward beyond the Woman river, and the iron formation is almost continuous for this distance. The portion of this range lying westward from Rush river has been described by R. C. Allen ("Iron Formation of the Woman River Area", by R. C. Allen, Ontario Bureau of Mines, 18th Report, 1909), as a number of claims were staked in that section before the eastern section of the range was staked. The western portion of the iron range consists chiefly of ferruginous cherts with some pyrite and a little carbonate, whereas the section extending for about 3 miles eastward from Rush river consists for the most part of carbonate, pyrite, silica, and a little magnetite. Pyrrhotite is rare in this section, but abundant in much of the eastern portion of the range where pyrite and magnetite are also found in the siliceous iron formation. Carbonate is present, but much less abundant in the eastern than in the central section of the range. In claim W.D. 717, galena, sphalerite, and chalcopyrite also occur in the banded iron formation.

There are several parallel bands of the iron formation in this range, the formation being interbedded with basic and acid lava flows and minor amounts of sedimentary rocks. The dip of the beds in most places varies from vertical to 70 degrees southward and the beds on the south margin of the range consist of quartzite, conglomerate, felsite-breccia, and rhyolite. On the north side the rocks are chiefly acid and basic lavas with intrusions of coarser greenstone cutting them and the iron formation to a lesser extent. This greenstone is well exposed along the north side of the main band of iron formation, near the west boundary of Genoa township. It may be later than Keewatin.

Quartz porphyry and feldspar porphyry intrusions cut the iron formation in a number of places. In one section of the range the iron formation is completely eliminated for a short distance by one of these intrusions of porphyry with large phenocrysts of quartz. One dyke of quartz and feldspar porphyry runs through the sulphide-bearing portion of the iron formation almost without a break across three claims. It varies from a few inches to over 4 feet in width and it lies first on the north side, then in the centre, and finally on the south side of the iron formation. It was penetrated in several of the drill-holes, but it is not seen close to the shaft on the galena deposit.

There are several large dykes of olivine diabase, apparently of Keweenawan age, cutting transversely across the iron range north and south. They vary from 8 to 90 feet in width and they have not affected the iron formation beyond cutting out portions of it and faulting it in one place to a distance of 35 feet."

DESCRIPTION OF THE DEPOSIT

The lead-zinc deposit occurs mainly in the form of one vein, which cuts the iron formation at a slight angle. This vein has been traced for about 200 feet. Traces of ore have also been found a few yards to the north of this main vein in the iron formation proper.

The strike of the vein is 45 degrees and it has a dip of 80 degrees to the north-northwest. It is from 6 to 12 inches wide at the surface, but widens at the bottom of the small pit to 34 inches. The wall-rock is impregnated with ore minerals for a short distance on either side of the vein, so that the total width of ore-bearing material at the bottom of the shaft is about 38 inches. The chief metallic minerals are galena, pyrite, and sphalerite in that order of prevalence, but considerable chalcopyrite, as well as a little pyrrhotite, is also associated with these main minerals. The gangue is chiefly quartz in granular form, although some little carbonate is also found.

No. 3 drill-hole where the lead-zinc ore was first discovered showed the following section between the depths of 225 and 253 feet.

Feet	
225 –228½	high-grade lead-zinc ore
228½–230	rock
230 –237½	low-grade lead-zinc ore
237½–248½	high-grade ore
248½–251	mixed sulphides and rock
251 –253	medium-grade ore

This drill-hole is approximately 350 feet from the small pit and is located along the general line of strike of the vein as shown by surface explorations. From this it would appear that the deposit, if continuous throughout this distance, is of respectable dimensions. It seems likely, also, that the length of 400 feet so far revealed by surface and diamond drill exploration, represents but part of the whole length and that the vein, in all probability, extends at least an equal distance beyond the drill-hole. An analysis of the solid sulphide material from the vein, made by Provincial Assayer, gave: lead 73·46 per cent, zinc 6·01 per cent, silver—none.

Cornering this claim to the northeast is a claim owned by C. R. Scott of Barrie and staked in 1921. Here a shaft has been sunk to a depth of 40 feet on a 6-foot vein of quartz and graphite material, cutting across a succession of acid and basic volcanic flows of the Keewatin series. Galena, sphalerite, chalcopyrite, and pyrite are sparsely scattered through quartz gangue, low values in gold and silver being obtained from these metallic constituents. Six shallow trenches in other parts of the claim have served to explore the surface thoroughly.

ORIGIN

Moore is of the opinion that the vein formation is a result of igneous activity. The pyrrhotite, chalcopyrite, galena, and sphalerite cannot be regarded as part of the original iron formation. The close association of the sulphides with the quartz and feldspar porphyries suggests that they may have been derived from the same magma. Possibly the porphyries came from the granite magma. The only other igneous rock on the claims that might be considered as a possible direct relative of the sulphide ores, is the coarser greenstone which lies along the iron formation to the west of the galena and sphalerite deposit; this is regarded, however, as a less likely source of the ores than the acid rocks.

COMMERCIAL POSSIBILITIES

As has been already mentioned, the deposit requires further work to test out its value. The present showings, however, seem to warrant further expenditures.

(37) Ruel Zinc Prospect, Marshay Township

Reference

Uglow, W. L.: Ont. Bureau of Mines, vol. XXV, pt. ii, pp. 9-10 (1916).

" LOCATION

This property is situated 4 miles southwest of Felix, on the Canadian National railway, about 56 miles by rail north of Sudbury, and about 8 miles south of Ruel Station. A bush trail leads from Felix to the property.

OCCURRENCE AND NATURE OF THE ORE

The country rock is a massive greenstone or altered gabbro, associated with a lean, greenish, carbonate phase of the iron formation. The latter strikes about east and west. The ore is a fine-grained intimate mixture of galena and sphalerite, occurring in at least two zones parallel to the strike of the country rock. Pyrrhotite occurs in places, as well as pyrite and traces of chalcopyrite. The ore minerals seem to be of the nature of an impregnation in the greenstone and the iron formation. The galena occurs generally in very narrow, vein-like stringers cutting through the blende. The ore is not usually clean, but contains bunches of barren rock scattered through it. It is reported that pyrrhotite was the original discovery, and that on sinking, zinc blende was encountered. The bottom of the shaft is reported to be in high-grade sphalerite.

EXTENT AND DEVELOPMENT

A shaft reported to be 60 feet deep, but full of water at the time of the writer's (W. L. Uglow) examination, and six surface trenches, constitute the total development on the property. Traces of the ore may be seen in a general east-west direction across three claims, but continuous development has not proved more than 250 feet of ore deposit."

(38) Vacheresse Lead-Zinc Claims

Reference

Gledhill, T. L.: Ont. Dept. of Mines, vol. XXXV, pt. ii, p. 51 (1926).

LOCATION

The property is in the west-central part of township 23, range X, district of Algoma, 8 miles northeast of Searchmont station on the Algoma Central railway. It can be reached by automobile from either Searchmont or Sault Ste. Marie. The property is about one-quarter mile south of Goulais river. The discovery was made and staked by F. Vacheresse of Sault Ste. Marie in the spring of 1926.

GEOLOGY

R. C. Emmons examined the deposit in 1926 and supplied notes on the geology. A basic dyke of diabasic composition and texture cuts granite of probable pre-Huronian age. The dyke is approximately 10 chains wide at the workings, and extends north to Goulais river. Considerable shearing within the dyke has resulted in extensive chloritization. The trend of both the dyke and the shearing is about north 30 degrees west.

DEPOSIT

The deposit is a vein that lies within the dyke along the zone of shearing. The width of the vein is about 6 feet. The vein was stripped for 125 feet and is said to be traced by pits and trenches for 1,680 feet. The ore minerals consist of dark sphalerite, galena, chalcopyrite, and pyrite in a gangue of quartz, siderite, and chlorite. Sphalerite is the most abundant ore mineral.

A sample taken across 5 feet at the place of discovery assayed 12 per cent zinc. A sample taken across a rich streak 2 feet wide gave: zinc, 20 per cent; lead, 3·5 per cent; silver, 40 ounces; gold, none. Four channel samples, at what appeared to be average points in the vein, gave, across 6 feet: from 2 to 4 per cent zinc, together with smaller amounts of lead, and from 1 to 3 ounces of silver with no gold.

A later discovery of galena has been made by Angus Bussineau, in township 3 H, Mississagi forest reserve, 12 or 13 miles east of the zinc-lead find in township 23. An assay of a sample said to have come from the claim was made by Mr. McNeill, Provincial Assayer, and is as follows: silver, 127·2 ounces per ton; lead, 42·47 per cent.

(39) Victoria Mine

References

Geol. Surv., Canada, Ann. Repts.: 1876-77, pp. 211, 480; 1877-78, pt. G, p. 51; vol. III, pt. H, p. 13; vol. X, pt. S, p. 121; vol. XV, pt. S, p. 248.

Ont. Bureau of Mines, Rept. Roy. Com., 1890, pp. 29, 30, 147. Ann. Repts., vols.: VIII, p. 123; IX, pt. i, p. 198; XIX, p. 9; XXIV, p. 238; XXV, pt. ii, pp. 13, 14; (Dept.) XXXV, pt. ii, p. 45.

LOCATION

The Victoria mine is near the north boundary of section 26, Duncan township, immediately north of Sandy lake and about 8 miles north of the Canadian Pacific Railway line running to Sault Ste. Marie. It is reached from Garden River by a road about 10 miles long.

GEOLOGY

The following notes on the deposit and its geology have been supplied by R. C. Emmons who visited the property in 1926.

The main country rock of the district is granite of probable pre-Huronian age. It is commonly red, coarse grained, and consists of red feldspar and quartz, with usually minor amounts of hornblende and mica.

Variations in texture are to a fine-grained, almost aplitic rock, and to a very coarse, pegmatoid granite. Dykes of pegmatite, aplite, and lamprophyre are not uncommon locally. Where sheared, the granite has a crushed appearance, with grains of quartz and feldspar in a chloritized matrix. The sheared granite is dark and occurs along a surface depression.

Older rocks included in the granite consist of coarse hornblendite and diabasic greenstone. Dykes of dioritic composition and commonly of diabasic texture, cut the granite in a direction slightly west of north. Some of these dykes are sheared in a direction parallel to their trend; others are quite fresh and massive. The Victoria and the Cascade deposits lie between two of these dykes.

DEPOSIT

The deposit consists of mineralization along a shear zone. A mass of chlorite schist, approximately 40 feet wide and sharply bounded by granite on both sides, lies in the shear zone. A few augen of less altered material in the green schist indicate that the schist is formed from a dioritic igneous rock. Sulphides are disseminated through the schist and are present in quartz veins in the schist. Most of the veins are parallel to the planes of schistosity, but many cut across the foliation. The sulphides include argentiferous galena, sphalerite, pyrite, and chalcopyrite. Calcite and a small amount of specularite also occur with the quartz.

ORIGIN

Into a country rock of granite containing many large, metamorphosed inclusions and a few, fine-grained lamprophyre dykes, there were intruded dykes of a diabasic nature. This dyke intrusion was preceded, accompanied, and followed by extensive fracturing and local shearing of the country rock, some of the fractures being quite persistent. Solutions, thought to be genetically related to the diabase dyke intrusives, advanced along certain of these fractures and, where conditions were favourable, deposited their mineral content.

DEVELOPMENT

The main shaft was sunk to a depth of 410 feet and drifts were driven along the ore zone at intervals of about 50 feet. A second shaft 100 feet deep was sunk in granite 200 feet south of the main shaft near a granite schist contact. The work was commenced in 1875 and shipments were made from 1878 to 1880, but no record of the production is available. A small amount of work was done during the winter of 1924-25.

(40) Cascade Mine

References

Geol. Surv., Canada, Ann. Repts.: vol. III, pt. H, p. 13; vol. X, pt. S, p. 121; vol. XV, pt. S, p. 248.

Ont. Bureau of Mines, Roy. Com. Min. Res. Ont., 1890, pp. 29, 147. Ann. Repts., vols.: VIII, p. 123; XIX, pt. i, p. 9; XXIV, pt. i, p. 238; XXV, pt. ii, p. 14.

"The Cascade mine is situated in Jarvis township about half a mile directly north of the Victoria mine. The country rock here is a granite carrying occasional greenstone schist inclusions. The showing occurs in one of these inclusions about 10 feet in width, outcropping in the valley of Weashkog creek. The narrow schist belt follows a line of strong disturbance; the schists and to some extent the bordering granite have been crushed and in places brecciated. The crushed schists carry some sphalerite, argentiferous galena, and copper and iron pyrites in disseminated grains, but the showing is not an impressive one. A shaft was sunk near the northern tip of the schist inclusion and some drifting done. The search for a commercial ore-body proved unsuccessful, and a mill put up somewhat prematurely is now dismantled."[1]

(41) Thunder Bay Silver-Lead-Zinc Region

By T. L. Tanton

References

Ingall, E. D.: "Report of Mines and Mining in Lake Superior"; Geol. Surv., Canada, Ann. Rept., vol. III, pt. H (1889).

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Uglow, W. L.: "Lead and Zinc Deposits in Ontario and Eastern Canada"; Ont. Bureau of Mines, vol. XXV, pt. ii (1916).

Tanton, T. L.: "Silver Islet and Vicinity"; Trans. Can. Min. Inst., vol. XXIII (1920). Articles in Geol. Surv., Canada, Sum. Repts.: 1919, pt. E; 1920, pt. D; 1921, pt. D; 1924, pt. C. Memoir on Fort William and Port Arthur map-area in preparation.

LOCATION

The Thunder Bay silver-lead-zinc region in Thunder Bay district, Ontario, embraces an area on the north shore of lake Superior 150 miles long and 25 miles wide extending from the International Boundary along Pigeon river northeasterly to the vicinity of Nipigon.

HISTORY

The first mining locations in this region were taken up in 1846. Several parcels of land, each embracing 10 square miles, were located in that year. A period of intensive prospecting followed the discovery of rich silver ore at Thunder Bay mine in 1866 and before the end of 1868 numerous veins of the silver-bearing type were found close to the north shore of lake Superior east of Fort William, including Silver Islet vein, the richest of all the known deposits. The latter was found in the course of a geological examination of a mining location that had been taken up twenty-two years previously. Between 1882 and 1891 the silver-bearing area was explored and developed west of Fort William to the vicinity of the International Boundary. The more important mines in this part of the region are in two groups, one of which is at Silver mountain and the other in the vicinity of Rabbit mountain. Beaver mine, one of the latter group, was the greatest individual producer west of Fort William. Since 1892, nearly all the numerous mines in the region have lain idle, but from time to time a re-examination or further development of known veins has resulted in additional production from certain mines. The largest production since

[1] McConnell, R. G.: Ont. Dept. of Mines, vol. XXXV, pt. II, p. 45 (1926).

1892 has come from West End Silver Mountain mine. The most recent production of silver ore was from Silver Islet mine in 1922.

Ever since the commencement of mining activity in this region it has been known that local concentrations of lead, zinc, and copper ores occur in the veins of the silver-bearing type and that these concentrations are more widely and uniformly distributed through individual veins than the silver ore. Lead ore was produced from Enterprise mine, McTavish township, in 1872. More recently and particularly since 1926 several veins in the region northeast of Thunder bay have been developed in the hope of proving the existence of lead and zinc ore-bodies of commercial value.

The veins on Jarvis and McKellar islands in Thunder bay have been mined for barite.

Three mines were in operation in the region in 1927, Neepatyre and West End Silver Mountain mines and a property on Whitefish river west of Strange township. At each of these, pebble dash for stucco work was produced from vein material consisting chiefly of coarsely crystalline calcite.

GEOLOGY

The region in which the veins occur is underlain by a complex of ancient schistose volcanic and sedimentary rocks and intrusive granite and granite-gneiss classified as Early Precambrian. Lying unconformably above is a group of nearly flat-lying strata in which three series are recognized; Animikie, Sibley, and Osler. Each series is made up of a basal conglomerate and a peculiar assemblage of lavas, tuffs (or fragmental lava of local derivation), chemical precipitates, and clastic rocks. All of the above-mentioned rocks have been intruded by diabase dykes; and, in the flat-lying strata there are also extensive diabase sills up to 250 feet thick. These intrusives and the strata younger than the Early Precambrian are classified as Late Precambrian.

Subsequent to the intrusion of the diabase a great number of nearly vertical faults and fissures were developed whose positions and trends bear a relation to those of the dykes and inclined sills, there being a considerable number parallel and a smaller number at right angles to the trends of these intrusive masses. These fissures were cemented by vein material.

DEPOSITS

The fissure fillings are of the following types: simple veins, vein stockworks, and vein material occurring as cement around brecciated fragments of country rock along shatter zones. No replacement deposits have been observed. Variations between simple veins and breccia cement may occur in a single deposit between short distances, these changes being due largely to the physical properties of the enclosing rock and, to some extent, to the amount of deformation that took place when the fissuring occurred. The veins range in width from a fraction of an inch up to 70 feet; the majority of the productive veins have maximum widths of 20 feet or less and they pinch and swell when traced through distances of a few yards.

Throughout the region the veins characteristically consist of calcite, barite, fluorite, white and amethystine quartz, and, when mineralized, carry galena, zinc blende, chalcopyrite, and pyrite in varying proportions, and, in certain localities, silver ores, small amounts of gold, and minerals containing cobalt, nickel, arsenic, antimony, bismuth, and mercury. Platinum is said to have been found by assaying vein material rich in chalcopyrite from the Detroit-Algoma mine at Pearl.

All these minerals occur as primary deposits. The parts of the mineralized veins that carry galena, zinc blende, and chalcopyrite are commonly found to have been deposited early in the process of cementation; where veins show zonal banding these minerals are commonly concentrated near the walls; and where veins are found cutting one another in stockworks, these minerals are notably more abundant in earlier formed material. Amethyst and barite are commonly found to have been deposited somewhat later than the other primary minerals with which they are associated. The rich concentrations of silver ore at all mines other than Silver Islet are chiefly of secondary origin; silver and argentite occur in wire and leaf form in vugs and along the cleavage cracks of primary minerals and in the wall-rock; the secondary concentrations are irregularly distributed through the veins in pockets with maximum dimensions seldom exceeding 20 feet, spaced at intervals varying from a few feet to hundreds of feet, and localized vertically within 200 feet of the present surface.

Silver Islet vein differs from all other known veins in the region in that more silver occurs in the primary vein deposit than in the secondary. In the primary deposit silver and argentite are microscopically intergrown with various minute, branchiate assemblages of galena, zinc blende, niccolite, cobaltite, smaltite, domeykite, chalcopyrite, and tetrahedrite; these assemblages are disseminated through a gangue of pink calcite which contains magnesium and manganese, quartz, and, locally, barite. A secondary deposit of silver in wire form occurs along with white calcite and minor amounts of galena, zinc blende, marcasite, and pyrolusite in vug fillings. The alteration products, cerargyrite, erythrite, and annabergite, occur in the upper part of this mine. Inflammable gas and saline waters were encountered in Silver Islet mine.

The primary deposits in the mineralized veins are believed to have been brought in by waters emanating from a magma from which came, prior to the time of vein formation, the extensive diabase intrusives of the region. The veins are associated in time and place with the diabase intrusives, but the latter, as now exposed, had consolidated and were affected by faulting prior to the time of vein deposition. Zinc blende and galena, the most widely distributed and evenly disseminated metallic minerals in the veins, are for the most part of primary origin. The majority of the silver concentrations have resulted from the solution of primary silver minerals in the upper parts of veins by circulating underground waters and the redeposition of silver minerals in cavities and crevices lower down in the veins where chemical and physical conditions suitable for precipitation were encountered. There is no one rock formation in the district specially favourable for mineral concentrations, rich ores have been found locally in all of the various rock types that occur.

DEVELOPMENT

Development work has been done on at least one hundred and seventy-five veins distributed throughout the region. All of these carry metallic minerals locally. The production from the silver mines has been recorded as follows:

Mine[1]	Value of ore produced
Silver Islet	$3,250,000
Silver Mountain	500,000
Beaver	550,000
Badger and Porcupine	300,000
Rabbit Mountain	50,000
Thunder Bay	20,000
Shuniah	50,000
3A and Beck	10,000
Jarvis Mining Company	40,000
	$4,770,000

Subsequent to the date of the report containing the above statement, $10,000 worth of ore was produced from Silver Islet mine in 1922. Since that date there has been no production of silver ore.

Veins were being developed in 1927 as lead-zinc prospects at the following localities: at Silver lake near Loon; at Pike lake near Pearl station, Canadian Pacific railway; mining lots A, B, and C, McTavish township; a group of claims, held by E. Nurmela, east of Ancliff station, in lots 3, 4, 5, and 7, McTavish township; properties in Dorion township locally known as Ogema, Dorion, and Malotte mines, and on recently discovered veins on lots adjoining or lying between these properties; in an unsubdivided area lying less than 3 miles north of Dorion township and west of Wolf lake; in Nipigon township southwest of Nipigon village; and in the vicinity of Ozone station on the Canadian Pacific railway.

ECONOMIC POSSIBILITIES

Available information indicates that the known deposits of silver ore of commercial value have been mined out to the limits of safety. It is possible that further discoveries of rich silver ore may yet be made; this inference is warranted by the fact that many of the known veins of the silver-bearing type have not been thoroughly explored and by the fact that many drift-covered faults, similar to those in which the mineralized veins occur, can be identified, many of these are in notches on the highlands of the region. Past experience indicates that search for rich silver ore should be confined to upper parts of veins within 200 feet of the present surface.

The known deposits of lead and zinc minerals in the region are numerous and widely distributed, none of the mineralized veins is entirely free of these minerals. No profitable lead-zinc mines have, as yet, been developed on any of the veins. It is possible that bodies of well-mineralized lead and zinc-bearing vein material may be found that are larger than are yet known, in which case mines may be established on single veins. It is possible that mining for the recovery of gangue, such as is now being carried on at Neepatyre mine, will warrant the expense of hand cobbing lead and zinc ore as a by-product which can be shipped periodically.

[1]Ont. Bureau of Mines, vol. XIX, pt. 2, p. 208 (1913).

In the dumps of the abandoned silver mines and of the prospects which have been, or are being, developed, there are portions of vein material rich in lead and zinc. At present it is not known that any single property has ore of quality and quantity sufficient to warrant the installation of a concentrator and reduction plant. It is possible that if a customs concentrator and smelter were in the region a recovery might be made by the individual property owners by selecting for treatment rich ore which has resulted from their operations. A very considerable aggregate tonnage of rich lead and zinc ore could be produced from the numerous small and widely distributed deposits in the region.

There are several veins in various parts of the region that are similar in general character to those which are now being worked for pebble dash for stucco work.

Concentrations of barite of possible economic value are known on Jarvis and McKellar islands and elsewhere.

In the report on the geology of Thunder Bay region, the following deposits are described:

North Lake area: veins along three faults.

Bishop Lake area: seven faults cemented with vein material.

Little Gull Lake area: Silver Fox; Mink; Silver Glance; Geroux vein; La Plante's vein; R 432; 124 X; 32 X.

Arrow Lake area: K 155; 18 XL; R 277; 11 T; W 279; 143 X; R 301.

Whitefish Lake area: R 119; R 208; Medicine Bluff; Scripture's vein; Caldwells' vein; R 345; 173 T (including Queen mine); T.B. 3027; Wolverine mine; Arrow River and Whitefish Lake Mining Companies; R 192; Y 5; T.B. 6588; Y 2; 17 E and R 190; Star mine; Y 4; Sunset Lake vein.

Silver Mountain area: Augusta mine; Silver Mountain mines; Crown Point mine; R 64; Silver Hill; R 70; R 79; R 135 (Woodside's vein); R 115 (Tchiatin's vein); R 111; R 110; Palisades mine; R 98.

Marks township: Echo lake; lot 4, concession VI.

O'Connor township: lot 11, concession III, 143 T; lot 9, concession I; Royal vein, Empress mine.

Rabbit Mountain group: O'Connor, Paipoonge, Gillies, and Scoble townships, Peerless vein, Porcupine mine; 200 T; Badger mine; Climax mine; West Beaver mine; Silver Creek mine; Beaver mine; Beaver Junior; Elgin vein; Rothwell mine; concession D, lot 3, Paipoonge township; lot 2, concession D, Paipoonge; lot 1, concession D, Paipoonge; 151 T; lot 6, concession C, Paipoonge; Victoria mine; lot 11, concession C, Paipoonge; 146 T; R 48; Rabbit Mountain mine; Rabbit Mountain Junior (57 T); Big Bear vein; Federal mine (Copelands' vein); Parson's mine.

Pearson township: Henrietta mine; Hidden Treasure mine; Woodbeck vein.

Veins near Kakabeka Falls: Stephen lake; D 4, Oliver township; Twist lake.

Oliver township: concession I, lot 11; concession I, lot 7; concession II, lot 6; concession II, lot 5; concession IV, lots 6 and 7; concession V, lot 1.

Paipoonge township: lots 4 and 5; Algoma mine.

Neebing township: Neepatyre mine; Eastern extension Neepatyre vein; lot 20, concession III; lot 17, concession IV; lot 17, concession V.

McIntyre township: lot 47; C; D; lots 1 and 2; southwest corner lot 54; lot G, North Shore vein; Mitchell vein; Emmon's mine; Dawson mine; Osmun mine, lot 53.

Port Arthur group: lot 51, McIntyre township; Singleton mine; Shuniah mine; Current River veins; Thunder Bay mine; lot 6, Macgregor township.

North Shore Thunder Bay group: Beck or Silver Harbour mine; Algoma mine; Cornish mine; Three A mine; lot 1 A, Macgregor township; lot 10, 10 Z; Buck island; Palette island; Lambert island; Perry point; lot 13, Knobel point; Caribou island; Blende lake.

Loon Lake group: Oklend veins; Silver Lake veins.

Pearl group: Detroit-Algoma mine; Johnston veins; Lawrence vein; Davis veins; Barr vein; Enterprise mine; mining lots A and B, McTavish township.
Ancliff group: veins east of Ancliff; Granite islet, Black bay.
Dorion group: Ogema mine; T.B. 6795; Goodmorning Lake vein; Lindburg vein; T.B. 6006; concession VII, lots 4, 5, and 6, Dorion township; Johnson vein, lot 11, concession VI, Dorion township; Anderson-Bingham veins; Lebel vein; Dorion Lead and Zinc Mines, Ltd.; Thunder Bay Lead and Zinc Mining Company; concession VI, lot 4, Stirling township.
Nipigon township: concession III, lot 9.
Ozone group: T.B. 6038; T.B. 4588; T.B. 3745; T.B. 4737; T.B. 4533.
Group east of Silver Islet: Harrison's and St. Ignace locations, St. Ignace island; Nipigon Strait veins; Fluor island; Edward Island mine; Porphyry island.
Silver Islet.
Group west of Silver Islet: Angus islands; McKellar island; Pie island; Thompson island; Spar island; Jarvis island; Victoria island and McKellar point; Stewart's location near Pigeon river; Pine bay; Big Trout bay; Cloud lake; lot 5, concession II, Crooks township; Caldwell island; Mink island; Sturgeon bay (K 13); K 17; Prince's mine; Loch Lomond; Loch Lomond tunnel.

(42) Black River

Reference

Logan, W. E.: "Geology of Canada, 1863", pp. 689-690.

LOCATION

North shore of lake Superior.

DEPOSIT

Logan reports:

"At a mining location at the mouth of Black river, to the north of the slate islands, the Laurentian rocks are seen near the contact with the Huronian schists. Here a vein of quartz occurs in the granitic gneiss. It runs nearly east and west, with a breadth of from 1½ to 5 feet, and holds galena and iron pyrites. The latter is more abundant near the shore; but about 20 rods beyond, in the hill, the galena predominates. According to Prof. Hadley, this ore is extremely rich in silver; the lead reduced from it containing 2 to 3 per cent of the precious metal. This galena, according to the same authority, contains a trace of selenium."

(43) Zenith Zinc Mine, Rossport

By T. L. Tanton

References

Geol. Surv., Canada, Ann. Rept., vol. XV, pt. S, pp. 244-247 (1907).
Ont. Bureau of Mines, Ann. Repts., vols.: IX, pp. 86-87; X, p. 110; XI, pp. 27, 298; XII, p. 25; XXIV, pt. i, p. 13; XXV, pt. ii, pp. 7-9.

LOCATION

The Zenith mine on mining location 30 T, which is a square measuring half a mile on each side, lies in an unsubdivided portion of Thunder Bay district, 13 miles north of the Canadian Pacific railway at a point about 5 miles east of Rossport on the north shore of lake Superior. During the period of the mine's activity it was connected with the railway by a winter road which crossed twelve small lakes, the terminus being at Zinc siding, $1\frac{1}{2}$ miles west of Winston flag station. The road has become obstructed by fallen trees and forest growth in the period of disuse since 1901.

HISTORY

The mine is owned by the Grand Calumet Mining Company, Limited, of Ottawa.

The existence of the zinc ore was known as early as 1882, but owing to its inaccessibility was not worked until the winter of 1898-99. Operations were then carried on discontinuously until 1901, since which time the mine has been idle. The total amount of ore shipped was 1,065 short tons, the average zinc content of this material is said to have been 45 per cent. The cost of transporting the ore from the mine to the railway, 13 miles distant, is said to have been $2 per ton.

GEOLOGY

The country between Zenith mine and the Canadian Pacific railway is characterized by an irregular succession of great rocky hills and ridges between which are lakes, swamps, and sand-plains. The hills, though showing from a distance the mammilated outline which is common throughout this glaciated region, are very rugged in detail, and cliffs and abrupt irregularities of slope commonly occur. The local relief near the railway is approximately 800 feet; in the vicinity of Zenith mine it is about 150 feet; the small lake near Zenith mine is 1,000 feet higher than lake Superior according to an aneroid measurement. With the marked decrease in the local relief which is to be observed in ascending toward the north there is a corresponding increase in the proportion of drift-covered areas as compared with the rocky outcrops; and in the immediate vicinity of Zenith mine there are extensive concealed areas immediately surrounding the rock ridge in which the zinc ore was found. The ridge at Zenith mine consists of diorite. A great number of slightly different phases of this rock occur within the well-exposed area which is some 800 feet long and less than 300 feet wide. The most abundantly developed phase is a medium-grained, greenish grey rock consisting of about equal parts of hornblende and plagioclase with magnetite as the chief accessory mineral. Textural variations occur between phases having crystals 1 cm. long and fine-grained phases with crystals averaging 2 mm. in length. Gradational variations also occur between phases relatively rich in hornblende, and others relatively rich in feldspathic constituents. In the tunnel a small seam of pink syenite with indefinite margins traverses the dioritic rock. The rock is not schistose as a whole and no gneissoid structure is visible. The diorite body lies in an area in which highly altered basic lavas and their schistose equivalents are the predominant rocks and this assemblage is intruded by a great batholith of granite which approaches, on the south and west, to within $1\frac{1}{2}$ miles of Zenith mine. The pre-batholithic complex has been assigned to the Keewatin, it extends for many miles north and east of Zenith mine. Diorite similar to that in which the zinc ore occurs, can be traced in discontinuous outcrops southerly from Zenith mine to within a short distance of the granite contact where it is cut by pegmatite dykes. It appears to merge into a diorite which differs from it only in that the hornblende cleavage surfaces yield more brilliant reflections, the feldspathic constituents are whiter, and there is locally a gneissoid structure due to alternate bands of phases differing slightly in the proportions of their mineral constituents. The gneissoid diorite in turn passes gradationally within a fraction of a mile into banded hornblende gneiss such as commonly occurs at granite-Keewatin boundaries and which has been interpreted as a product of the assimilation of the ancient basic rocks in the granitic batholith. Pegmatite dykes occur at irregular intervals through the hornblende gneiss. In certain outcrops of the diorite between 1 mile and 1½ miles south of Zenith mine there are platy masses of hornblende schist within the massive, coarser-textured rock.

DESCRIPTION OF DEPOSIT, DEVELOPMENT, ETC.

The development work on the property consisted of stripping and test pitting and the construction of shafts, open-cuts, and a tunnel. On the southern slope of the rocky ridge along the north shore of a small lake, the principal excavations are disposed as follows: shaft No. 1, 35 feet deep; 100 feet west of this, a tunnel 75 feet long including 18 feet of open-cut at the mouth, driven northerly into the hill, its direction changing to northeast in the final 20 feet; about 30 feet north of, and 40 feet above, the mouth of the tunnel is an open stope, on the brow of the ridge, with walls having a maximum height of 10 feet; about 100 feet west of the open stope, is shaft No. 3, 12 feet deep; and 400 feet westerly from this, over the crest of the ridge, is shaft No. 2, 40 feet deep.

Shaft No. 2 was sunk in a mass of black, crystalline sphalerite bearing a small amount of disseminated chalcopyrite. This solid sulphide material forms approximately one-third of a sphalerite-rich segregation in the diorite. The segregation is of lenticular shape, measuring 40 feet in an easterly direction and having a width of 12 feet. The surrounding diorite is coarse to medium-grained, massive, and with no indication of shearing or foliation of any kind. The solid sulphide ore may be traced through a series of gradational changes into diorite in which sphalerite crystals are disseminated in the same manner as the hornblende crystals. Very small amounts of pyrite, chalcopyrite, and pyrrhotite are disseminated irregularly through the zinc-bearing diorite. There are no definite boundaries between the zinc-bearing diorite and the surrounding rock, but the limits of the richly mineralized lens can be identified within a few feet, or occasionally inches, by the more or less abrupt, though gradational, change in the sphalerite content; within the lens the zinc-bearing diorite carries amounts of sphalerite that vary from place to place, but on the average, are approximately equal to one-half of the volume of the rock; just beyond the margins of the lens the sphalerite crystals are sparsely scattered through the diorite and disappear a few feet from the lens. With the exception of sphalerite, no mineral foreign to the country rock has been noted in the zinc-rich segregations. In the open stope at the brow of the cliff, a coarse-grained mass of sphalerite was mined and it is believed to have been a segregation similar to one just described. It was lenticular with its longer axis trending north and south.

At the other working, however, along the southern face of the slope and at a lower elevation, the sphalerite segregations are not in compact lenses or pockets, but have very irregular boundaries with tongue-like projections in various directions. Where these projections are distinct and traceable for several feet, they have the appearance of veins in that their walls are sharply defined, the country rock contains no disseminated sphalerite, and the vein-like material consists almost entirely of sphalerite with minor amounts of chalcopyrite and pyrrhotite. The sphalerite maintains its black, massive, crystalline character throughout. In the tunnel the various sphalerite tongues appear to form the matrix of a brecciated mass of the country rock which here consists of diorite and chlorite schist; the schistosity and slickensides trending in a great variety of directions conforming to the boundaries of the blocks. In the open-cut an irregular-shaped ore-body, locally as much as 4 and 5 feet wide, was stoped up to 15 feet to the surface. In the tunnel 12 feet from the entrance, a band of solid sphalerite a foot wide runs down into the floor, and at 30 feet beyond this a tongue-like mass can be traced for 10 feet. It has a maximum width of 15 inches in its upper part and pinches out at the base. These ore-bodies represent the wider parts of the sphalerite matrix cementing the brecciated country rock, and very numerous, irregularly disposed, small seams occur between and beyond them.

ORIGIN

The genesis of the ore is intimately related to that of the diorite in which it occurs. The origin of this rock is problematical. It is possible that it is an intrusive, or it may have resulted from the partial fusion and recrystallization of Keewatin lavas. Heat and material contributions may have been supplied from the granitic magma which may reasonably be inferred to have existed under this area. The zinc blende bodies appear to have formed as magmatic segregations. In those occurrences where the massive sphalerite cements brecciated blocks of diorite with sheared margins, it is inferred that dislocation extended to a body of still fluid sphalerite segregation.

COMMERCIAL POSSIBILITIES

Small stock piles of sorted and unsorted zinc ore were observed near various workings in 1920. It was estimated that these would make up about 150 tons of rich zinc ore.

The irregularity of size and distribution which characterizes the ore-bodies renders it difficult to estimate the probable tonnage that remains in place. The present known showings would not appear to warrant further mining operations in themselves, but it is possible that further large segregations might be found by exploring, by diamond drilling, in the vicinity of small showings between and beyond the previously mined segregations.

A small pocket of sphalerite ore is reported to occur on the Parker claim on the east side of Birch lake. This is said to be similar, in its geological relationship, to the occurrence at Zenith mine.

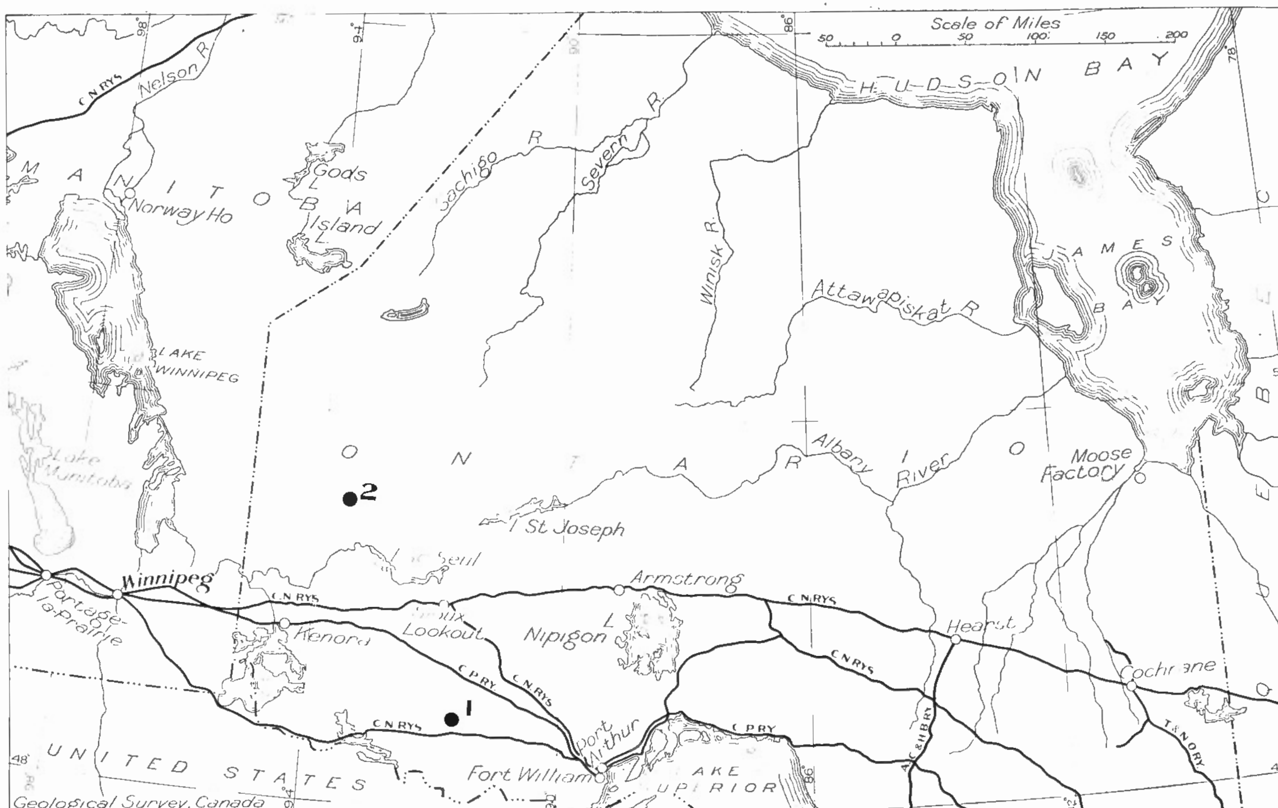

Figure 26. Index map of western Ontario showing location of zinc and lead occurrences. 1, McKinnon vein, Steeprock lake; 2, Red Lake.

(44) Gesic Zinc Mine

By T. L. Tanton

References

Geol. Surv., Canada, Ann. Rept., vol. XV, pt. S, p. 248.
Ont. Bureau of Mines, vol. IX, p. 87; vol. XXV, pt. ii, p. 9.

LOCATION

The Gesic zinc mine, on mining location E.S. 79, lies 1 mile and 30 chains south of the Zenith mine. The property embraces ten locations, aggregating 400 acres, and lying east, west, and north of E.S. 79.

HISTORY

In 1900 the owners were W. A. Johnston, C. Palmer, and J. Hare of Toronto. Development work was in progress in 1900. No production of ore has been reported; the property has lain idle since 1901.

GEOLOGY

The rocks on the property are a complex of hornblende schists intruded by granite dykes, intimately intermingled with gneissose dioritic rocks and amphibolites. The contact between the great granite batholith of this region and the greenstone assemblage lies about 10 chains south of the mineralized shear zone and trends east and west.

DEPOSIT

The deposit is a shear zone mineralized with sphalerite. It is said to be traceable over several locations with a strike of east and west. The writer saw no ore in place when examining the property in 1920.

DEVELOPMENT

A shaft inclined 50 degrees or 60 degrees north, was sunk to a depth of at least 23 feet on the so-called vein. It is reported that zinc blende in promising quantities was encountered at depth.

(1) McKinnon Vein, Steeprock Lake

Reference

Uglow, W. L.: Ont. Bureau of Mines, vol. XXV, pt. ii, pp. 11-12 (1916).

"LOCATION

The deposit is located about 10 miles northeast of Atikokan station on the Port Arthur-Winnipeg line of the Canadian National railway.

GEOLOGY

The vein lies within the Archæan complex, close to the contact of greenstone schists and intrusive granite. No sedimentary rocks are known in the immediate vicinity. A dyke of diabase seems to form one wall of the deposit.

NATURE OF THE ORE MINERALS

These consist chiefly of argentiferous galena and zinc blende, with pyrite and minor amounts of chalcopyrite.

NATURE OF THE GANGUE

The ore minerals are associated with a gangue of white sugary quartz.

OCCURRENCE OF THE ORE MINERALS

The deposit is a quartz vein about 10 to 15 feet in width and stripped at the time of examination for a length of about 100 feet. The metallic minerals occur disseminated throughout the vein in rather fine grains and in places quite abundantly."

(2) Red Lake

Reference

Bruce, E. L., and Hawley, J. E.: Ann. Rept. Ont. Dept. of Mines, vol. XXXVI, pt. iii, p. 55 (1927).

LOCATION

On the west shore of East bay, Red lake, Patricia portion of Kenora district, north of the mouth of the bay.

DEPOSIT

The deposit is a quartz vein traversing greenstone.

"The vein containing silver-bearing galena discovered in July, 1922, is close to the western shore of East bay, half a mile north of the narrows. The vein is lenticular, strike north 35 degrees east vertical. At the widest point seen it has a width of 18 inches, from which maximum width it tapers to a stringer each way in a distance of 15 to 20 feet. Somewhat north of the widest part, approximately one-half of the vein material is galena. The length of the part carrying this proportion is only a couple of feet and the width is one foot. Throughout most of the vein less than one-quarter of the total mineral content is galena. Samples were chipped across the vein at three places and assayed at the Provincial Assay Office with the following results:

—	Silver	Lead
	Oz. per ton	Per cent
1	3·0	2·51
2	14·1	8·75
3	1·4	1·22

Assayer, W. K. McNeill.

Sample No. 1 was taken towards the north end of the lens, width sampled 1 foot.

Sample No. 2, 2 feet south of No. 1 at part of vein carrying greatest proportion of galena, width sampled 1 foot.

Sample No. 3, widest part of the vein exposed, width sampled 18 inches.

It is evident from the assays that the silver bears a fairly constant ratio to the percentage of lead present and hence is no doubt directly associated with the galena, and not in the form of native silver.

It is probable that this occurrence belongs to the same period of mineralization as the gold-bearing quartz veins and that the granite boss immediately east of it may be the parent rock. The greater proportion of galena in the vein can be explained by the smaller size of the exposed granite mass; that is, the boss has been truncated nearer its apex, hence the galena-bearing vein probably is at a higher level and farther from the mineral-introducing granite than are those quartz veins of lower galena contact."

Galena and sphalerite occur in small quantities on other claims in Red Lake region. On the Howey gold mines and McIntyre-Porcupine mines, galena and sphalerite are present in small amounts in the quartz veins.

Lead telluride has also been reported. On claim KRL 1517, sphalerite of a deep purplish colour is found scattered through a fracture zone, a lens 2 feet long with a maximum width of 2 inches occurring at one place.

Other Occurrences in Ontario

The following is a list of occurrences recorded in the literature, which are of no commercial importance as a source of either lead or zinc but which show how widely spread the sulphides of zinc and lead are to be found.

Occurrence	Minerals	Character of deposit	References
Lake tp., con. XI, lot 11, Hastings co.	Galena	In calcite veins	Geol. Surv., Canada, 1863-66, p. 105
Limerick tp., con. II, lots 27-29, Hastings co.	"	" "	" " "
Marmora tp., con. III, lots 28, 29, Hastings co.	"	" "	" " "
Marmora tp., con. XI, lot 1, Hastings co.	Sphalerite		Ont. Bureau of Mines, vol. IV, p. 38
Tudor tp., con. III, lot 32, Hastings co.	Galena	In calcite veins	Geol. Surv., Canada, 1863-66, p. 108
Tudor tp., con. V, lot 12, Hastings co.	"	" "	" " "
Tudor tp., con. VI, lot 11, Hastings co.	"	" "	" " "
Tudor tp., con. VII, lot 10, Hastings co.	"	" "	" " "
Tudor tp., con. XIX, lots 26, 27, 28, Hastings co.	"	" "	" " "
Tudor tp., con. A, lots 21-28, Hastings co.	"	" "	" " "
Tudor tp., con. B, lots 5, 6, Hastings co.	"	" "	" " "
Tudor tp., con. B, lots 27, 28, Hastings co.	"	" "	" " "
Madoc tp., Hastings co.	Sphalerite, jamesonite	With pyrite in schist	Ont. Bureau of Mines, vol. XXII (ii), p. 101
Madoc tp., lot 24, con. II, Hastings co.	Galena, sphalerite	In quartz veins	" " XVIII (i), p. 135
Queensboro mine, Madoc tp., Hastings co.	Jamesonite	" "	" " XVI (i), p. 161
Barrie tp., con. IX, Frontenac co.	Galena, sphalerite, meneghinite		" " XI, p. 203
Barrie tp., con. X, lot 24, Frontenac co.	Sphalerite	With quartz, pyrite, calcite, etc.	" " XIV (i), p. 77
Beamsville, Clinton tp., Lincoln co.	Galena	In limestone	Geol. Surv., Canada, 1863, pp. 324-5
Parry Sound, Parry Sound dist.	Sphalerite	In schist with chalcopyrite	Ont. Bureau of Mines, vol. XXIII (ii) pp. 21, 24
Goudreau area, Algoma dist.	Sphalerite and galena	In quartz veins	Dept. " XXXVI (ii), p. 62
Caribou lake, Algoma dist.	Galena		Bureau " XV (i), p. 70
Deroche township, Algoma dist.	"	In calcite vein	" " XIX (i), p. 69
Manitouwick, Algoma dist.	"	In quartz vein	" " VII, pp. 189, 197
Michipicoten area, Algoma dist.	Galena, sphalerite	With other sulphides	Dept. " XXXVI (ii), p. 86
Straight lake, Moncrieff tp., Sudbury dist.	"		" " R.C., p. 106
Graham tp., Sudbury dist.	"	In quartz vein	" " R.C., pp. 106, 425
West Shiningtree gold area, Sudbury dist.	Sphalerite and galena	In auriferous quartz veins	" " XXXV (vi), pp. 90-91
Trout lake, Bowell tp., Sudbury dist.	" "	In quartz veins	Bureau " XIII (i), p. 201; XIV (iii), p. 121
Wawa creek, Algoma dist.	Sphalerite	In quartz veins	Ont. Bureau of Mines, vol. IX, p. 114
Worthington mine, Sudbury dist.	Galena	Vein	" " XXXV (i), p. 30
Hodgetts tp., Sudbury dist.	"	In calcite vein	Geol. Surv., Canada, Sum. Rept. 1911, p. 252
Beatty-Munro gold area, Timiskaming dist.	"	In auriferous quartz veins	Ont. Bureau of Mines, vol. XXIV (i), p. 180
Lake Abitibi gold area, Timiskaming dist.	Sphalerite	" "	" " XVI (i), p. 219; XVIII (i), p. 269
Kirkland Lake gold area, Timiskaming dist.	Sphalerite, galena, altaite	" "	Ont. Bureau of Mines, vol. XXIII (ii), pp. 21, 24; (Dept.) XXXII (iv), p. 23

Porcupine gold area, Timiskaming dist	Sphalerite, galena	" "	Ont. Bureau of Mines, vol. XX (ii), p. 24; XXI (i), p. 232; XXIV (iii), pp. 33, 36; (Dept.) XXXIII (ii), pp. 53, 75, 79
Kenogamissi gold area, Timiskaming dist	" "	" "	Ont. Dept. of Mines, vol. XXXII (iii), pp. 29,35
Larder Lake gold area, Timiskaming dist	" "	" "	Bureau " XVI (i), pp. 214, 215
Boston Creek gold area, Timiskaming dist	" "	" "	" " XXV (i), p. 252
Boston-Skead gold area, Timiskaming dist	" "	" "	Dept. " XXX (vi), p. 17
Blanche River area, Timiskaming dist	" "	In quartz-calcite veins	" " XXXI (iii), p. 16
Marshy lake, Sudbury dist	Galena	In quartz vein	Bureau " XI, p. 224
Timagami Lake region, Timiskaming dist	"	" "	" " R.C., pp. 56, 58
Mistogo falls, Rickard tp., Cochrane dist	Sphalerite	In calcite vein	Dept. " XXVIII (ii), p. 63
Lake Wendigo (Ingram and Pense tps.), Timiskaming dist	Galena, sphalerite	In quartz veins	Bureau " XVI (i), p. 135; XIX (ii), p. 149
Cross lake, Timagami Lake region, Timiskaming dist	Galena	With pyrite in calcite	Ont. Bureau of Mines, vol. XVI (ii), p. 67; XIX (ii), p. 131
Gowganda, Timiskaming dist	"	In quartz-calcite vein	Geol. Surv., Canada, Mem. 33, p. 103
Frontier mine, South Lorrain tp., Timiskaming dist	Galena and sphalerite	In calcite veins	Ont. Dept. of Mines, vol. XXXI (ii), p. 352
Rosie creek, Shiningtree area, Cochrane dist	Galena	In quartz-calcite veins	Bureau " XIX (ii), p. 194
Cobalt area (general), Timiskaming dist	Galena and sphalerite	In calcite veins	" " XVI (ii), p. 4; XIX (ii), pp. 2, 4; XX (i), p. 128; XXV (i), p. 258
Oxford Cobalt and Victory mine, Cobalt area, Timiskaming dist	Galena and sphalerite	" "	Ont. Dept. of Mines, vol. XXXI (i), p. 184
Buffalo mine, Cobalt area	" "	" "	" " XXXI (i), p. 69
Crown Reserve mine, Cobalt area	" "	" "	" " XXXI (i), p. 109
Nipissing mine, Cobalt area	" "	" "	" " XXXI (i), pp. 50, 51, 52
O'Brien mine, Cobalt area	" "	" "	Ont. Dept. of Mines, vol. XXXI (i), pp. 124, 125
Middleton Schreiber-Duck Lake area, Thunder Bay dist	Galena	" "	Ont. Dept. of Mines, vol. XXX (iv), p. 25
Jackfish bay, Thunder Bay dist	"	With quartz, chalcopyrite, and pyrite	Bureau " X, p. 86
Pointe aux Mines, Thunder Bay dist	Galena and sphalerite	In calcite vein	" " IX, p. 209
Seine River region, Rainy River dist	Sphalerite, galena	In auriferous quartz veins	" " IX, pp. 67, 71, 81; XXV (2), pp. 11, 12
Rainy River dist	" "	" "	Geol. Surv., Canada, vol. XI, pt. A, p. 92
Harold lake, Rainy River dist	Galena	" "	" " VI, pt. AA, p. 29
Foley mine, Shoal lake, Rainy River dist	Galena and sphalerite	" "	Ont. Dept. of Mines, vol. XXXIV (vi), p. 26
Big Duck Lake area, Thunder Bay dist	" "	" "	Bureau " XXIV, p. 11
North Wind lake, Thunder Bay dist	Sphalerite	" "	Dept. " XXXIV (vi), p. 67
Tashota-Onaman gold area, Thunder Bay dist	Sphalerite, galena	In quartz veins	Dept. " XXXIV (vi), pp. 80-83
Lake of the Woods region, Kenora dist	" "	"	Geol. Surv., Canada, vol. I, pt. CC, p. 144

Occurrence	Minerals	Character of deposit	References
Kenora district	Sphalerite, galena	In quartz veins	Ont. Bureau of Mines, vol. VII, pp. 39, 112; XVII, p. 47; X, p. 101
Mikado mine, Kenora dist.	" "	"	" " VI, p. 106
Sultana mine, Kenora dist.	" "	"	" " IX, p. 40
K 157 island, Kenora dist.	" "	"	" " VI, p. 104
Rush bay, Lake of the Woods	" "	"	Dept. " XXXIV (vi), p. 26
New Klondyke region, Dyment, Kenora dist.	" "	"	Bureau " X, p. 101
Jackfish lake, Kenora dist.	" "	"	" " V, pp. 76, 77

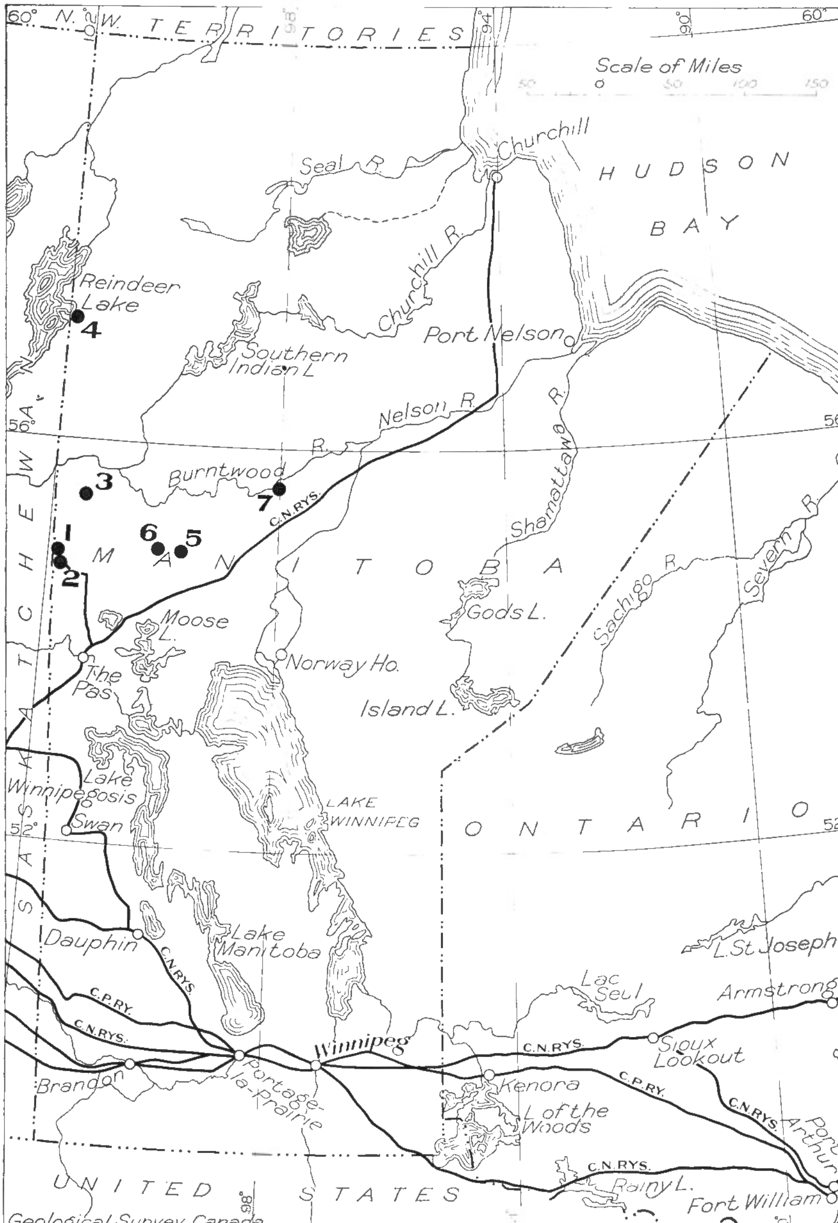

Figure 27. Index map of Manitoba showing location of zinc and lead occurrences. 1, Flin Flon; 2, Mandy; 3, Sherritt-Gordon; 4, Reindeer lake; 5, Wekusko river; 6, Snow lake; 7, Mystery lake.

MANITOBA AND SASKATCHEWAN

(1) Flin Flon

(*See* Figures 28, 29, 30)

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LOCATION

The Flin Flon ore-body is on the boundary between the provinces of Manitoba and Saskatchewan, most of it lying in Manitoba. In 1928 a railway from the town of The Pas was completed to the property, a distance of about 85 miles.

HISTORY

The Flin Flon ore-body was staked in the summer of 1915 by the Creighton-Mosher group of prospectors. Some trenching was done on the iron-stained outcrops and in the autumn the claims were recorded. Other prospectors were attracted to the area by the news of the discovery and it was not long before the whole neighbourhood was staked.

Diamond drilling was commenced in March, 1916, by New York and Boston interests, and in four months, 6,000 feet were drilled. Then, failing to come to an agreement with the owners, work ceased. The next year certain Toronto interests agreed with the owners to continue drilling, and carried on until July, 1918. The total footage drilled was 25,664 feet; the number of holes forty-four. This drilling blocked out the ore-body and showed that it extended 900 feet below the surface. In March, 1920, an option was taken on the property by New York and Canadian interests. In order to check the diamond-drilling results already obtained, it was decided to do underground development work. Two shafts were sunk on the ore-body, 500 feet apart. From No. 1 shaft, which was sunk 210 feet, a drift 266 feet in length was run along the ore-body on the 200-foot level, and on the same level two crosscuts were also driven, one to the north of the shaft for 318 feet and another to the south for 245 feet. Shaft No. 2 was sunk to a depth of 304 feet, and from it a crosscut was driven for 160 feet on the 100-foot level and another for 173·5 feet on the 300-foot level. This work confirmed the diamond-drilling results both as regards tonnage and values.

In May, 1921, the Mining Corporation of Canada bought a majority interest in the property, and carried out exploration work searching for more ore deposits in the vicinity of the property. In 1922 they carried out diamond-drilling operations on a number of other claims near Flinflon.

In 1925 the Whitney interests of New York took an option on the property and in 1926 and 1927 experimental work was carried out, in a test plant, on concentration and cyaniding. In November, 1927, the option was

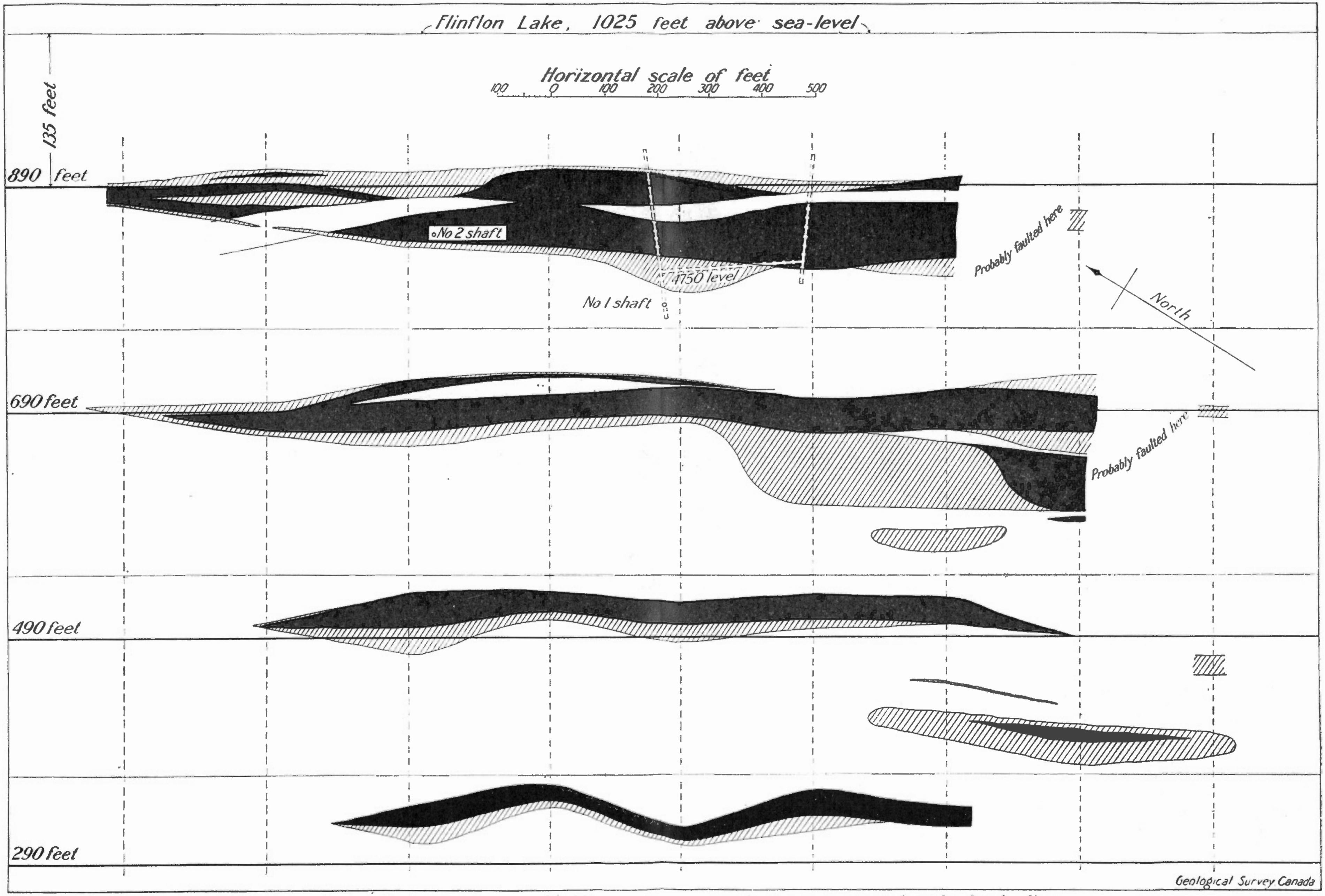

Figure 28. Plans of Flin Flon ore-body at levels 200 feet apart. Sulphide ore shown by solid black and disseminated ore by sloped ruling.

taken up and the property bought from the Mining Corporation of Canada, the latter, however, retaining a 15 per cent interest in all the holdings. A new company, the Hudson Bay Mining and Smelting Company, was organized on December 27 to develop the property.

GEOLOGY

The rocks of the region surrounding Flinflon are of Precambrian age. They consist of a series of volcanics overlain unconformably by a clastic sedimentary series and the whole intruded by acid and basic irruptives. The volcanic series is made up of both basic and acid varieties. The former consist of basic lavas, tuffs, and agglomerate, with certain irregular intrusive bodies and schists derived from all these types. The latter consist of rhyolite flows, quartz porphyry and rhyolite porphyry dykes and fragmental volcanic rocks. The clastic sedimentary series which overlies the volcanics is known as the Upper Missi series and consists of arkose and conglomerate.

The earlier intrusive rocks are of basic composition consisting of lamprophyre, amphibolite, gabbro, and peridotite intruded as dykes and small masses. These were followed by batholithic intrusions of granite and granite-gneiss accompanied by dykes of granite and granite porphyry. East of Cliff lake, near Flinflon, is a mass of coarsely crystalline porphyritic granite. Locally, later basic dykes are found cutting the granitic types.

DESCRIPTION OF THE DEPOSIT

The ore-body lies in greenstone and strikes north 30 degrees west. To the northeast of the deposit the greenstone is massive and amygdaloidal, showing its flow origin. Some banded tuffs associated with flow rocks on the summit of Flinflon hill east of the wagon road strike north 12 degrees west. The deposit dips from 60 to 70 degrees to the northeast and the boring records show that it pitches at a low angle to the south. Dykes of quartz porphyry were encountered by the drill; one of these dykes forms the hanging-wall of the ore-body for some distance. The ore-body is a fairly regularly shaped lens, tapering gradually to the northeast and ending rather bluntly to the southwest. As shown in the plans and cross-sections, it breaks up at the southwest end into two parts with minor mineralized zones. The total length of the ore-body on the surface is 2,593 feet; at a depth of 900 feet it has a length of over 1,000 feet. It has a greatest width of 400 feet, but this includes some bands of unmineralized greenstone which occur in the ore-body. The largest of these masses forms the prominent ridge along the strike of the ore-body between the two shafts. At a depth of 900 feet the ore-body narrows to 35 feet. It has been calculated that there are 18,000,000 tons of ore without including the unmineralized horses of country rock or the ore below the 900-foot level.

MINERALOGY

The principal minerals in the ore-body are pyrite, sphalerite, and chalcopyrite. Assays show that gold and silver are present. Arsenopyrite, galena, and magnetite have also been recorded, and small amounts of native

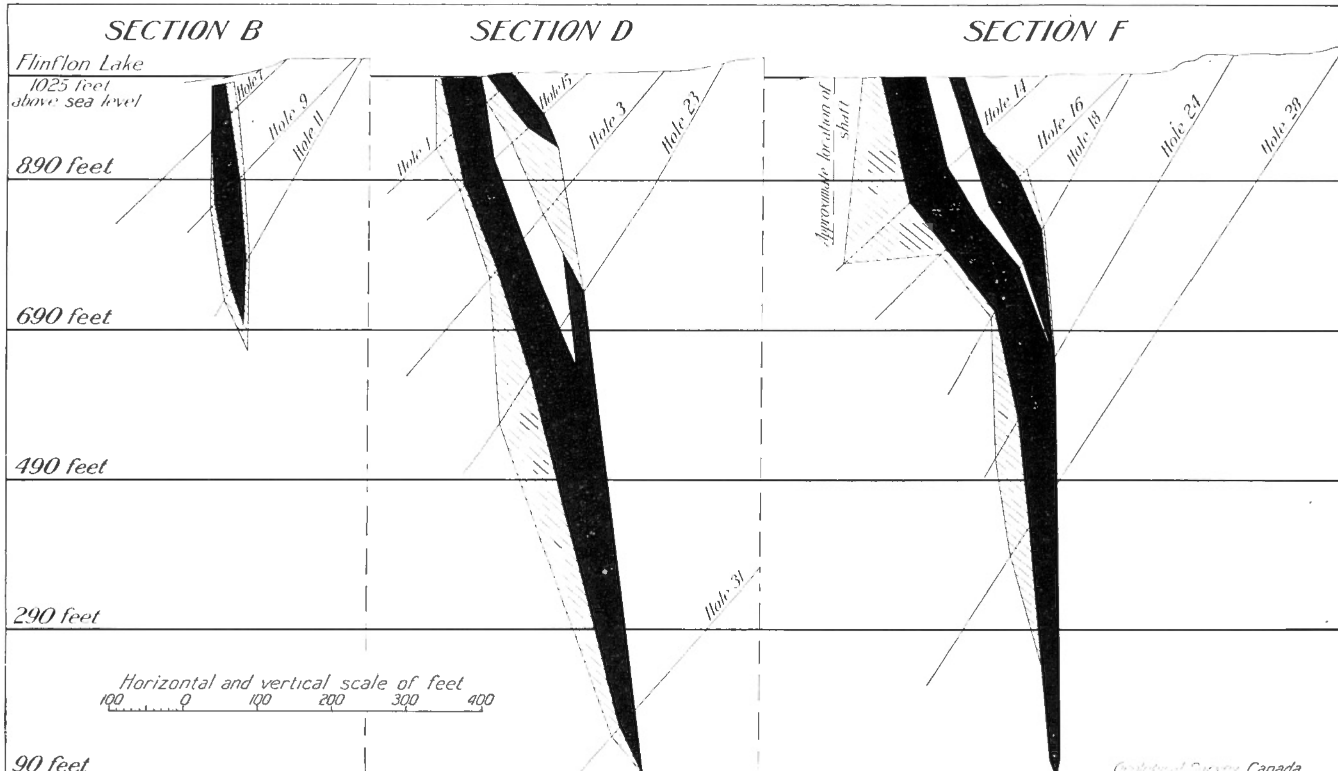

Figure 29. Vertical sections, Flin Flon ore-body. Sulphide ore shown by solid black, and disseminated ore by sloped ruling.

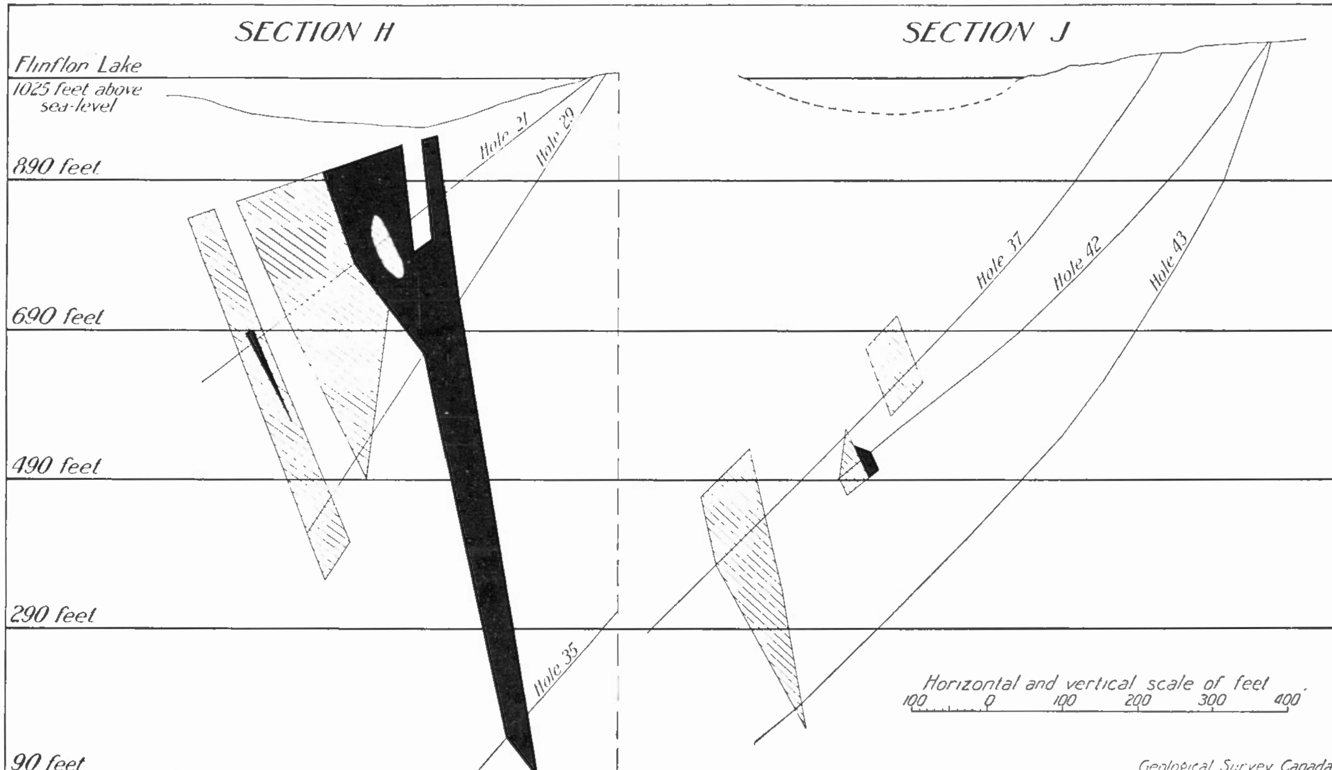

Figure 30. Vertical sections, Flin Flon ore-body. Sulphide ore shown by solid black, and disseminated ore by sloped ruling.

copper have been found in the upper part of the deposit. Quartz is present in places between grains of pyrite, and as local veinlets traversing the sulphides. Calcite is rare, but occurs in places with the quartz.

The ore consists of two fairly distinct types, known respectively as the solid sulphide variety and the disseminated ore. The solid sulphide variety consists chiefly of very fine-grained, pale-coloured pyrite, containing sphalerite, chalcopyrite with some rare fragments of schist, and some quartz and calcite. In places there is a distinctly banded effect where the sphalerite and chalcopyrite form narrow bands in the pyrite. The sphalerite is dark and on the weathered surface assumes a bluish tarnish, probably due to the development of a film of covellite. The disseminated ore consists of country rock, chiefly chlorite schist, impregnated with sulphides. The solid sulphide variety forms the central part of the lens, though in places it extends to the hanging-wall, whereas the disseminated ore is largely confined to a zone along the foot-wall. Disseminated ore is also found on the hanging-wall in the upper part of the deposit, but the copper content is here less than in the disseminated ore on the foot-wall. In places, as shown in both plan and section, disseminated ore forms a zone on either side of the central, solid sulphide type. Boundaries between the disseminated and solid sulphide types are, as a rule, fairly distinct, though in places a gradation between the two varieties is found. Contacts between the solid sulphides and the horses of unmineralized rocks are also, as a rule, quite sharp. In places the disseminated variety of ore runs as high as 3 to 5 per cent copper, though the ore-body as a whole averages only approximately 1·71 per cent copper. The sphalerite is more abundant on the hanging-wall side than elsewhere in the deposit. The average zinc content for the whole ore-body is about 3·45 per cent. The gold and silver values are, respectively, 0·074 and 1·06 ounces per ton. Galena is rare in the ore-body, but it has been found lining vugs in the country rock.

A rather interesting occurrence of native copper is reported in the ore-body. In sinking shaft No. 2, the massive greenstone of the large horse was left behind at a depth of 60 feet and solid sulphide ore entered. Resting on the surface of the ore at this point was found an aggregate of crystals of native copper. Wallace is of the opinion that the copper was deposited by descending solutions in post-Glacial time.

ORIGIN OF THE DEPOSIT

The deposit was, clearly, formed by replacement. The presence of unsupported masses of rock in the ore-body, some of them schistose with the plane of the schistosity parallel to that of the wall-rock, and the character of the disseminated ore, consisting, as it does, of country rock partly replaced by sulphides, can be explained only by this method of formation. It is clear also that replacement was along a shear zone. The country rock away from the ore-body and the horses of rock in the ore-body consist of massive greenstone. On the other hand the rock containing the disseminated ore and the minor rock inclusions in the ore are largely chlorite schist. At the end of the crosscut from the No. 2 workings, quartz porphyry, probably a dyke, forms the hanging-wall of the deposit. The greenstone was apparently more easily sheared than the harder porphyry. The sheared rock was in turn more easily replaced than those that were less altered; the amount of shearing, therefore, was apparently the chief factor that facilitated the replacement and hence determined the size and shape of the ore-body.

The source of the solutions that caused the replacement is an interesting problem. There are two possible sources: (1) the basic igneous intrusives of post-Missian age; and (2) the granite of the region. In favour of the former possibility it may be said that, locally, the basic intrusives were found to contain pyrite of apparently primary origin, and at one place, the lamprophyre across the Flin Flon ore-body was seen to contain chalcopyrite, this, however, in a narrow zone suggesting later infiltration. In places, also, the Missi arkose in the neighbourhood of Beaverdam lake was found to contain pyrite near the contact with the lamprophyre intrusion. The position, also, of the two known ore-bodies of the region, the Mandy and the Flin Flon, in a zone adjacent and parallel to the zone of basic intrusives, suggests a possible genetic relationship with them.

It has usually been considered, however, that the mineralizing solutions came from the granite. The chief argument in favour of this conclusion is the presence of quartz in the ore-body, showing that the solutions that caused replacement must have been siliceous and hence more likely to have come from a granitic magma than from a basic one. Quartz is found interstitially between grains of pyrite and as small stringers cutting the ore. At the east end of the crosscut from shaft No. 2 on the 100-foot level, very siliceous bands occur in the disseminated ore. On the surface of the deposit just east of the unmineralized horse of greenstone, is also found a siliceous rock. It is light and porous like pumice, and consists of quartz. It is apparently a replacement of country rock by quartz and sulphides, from which the sulphides were subsequently leached out.

Aside from these occurrences of silica, the presence of gold and silver in the ore is suggestive of an origin from the granite. The gold-bearing veins of the region are clearly attributable to the closing phases of the intrusion of the granite batholiths, and it is probable that the sulphides were derived from the same source. Evidence from certain other sulphide bodies in the region points to the same conclusion. On the north arm of lake Athapapuskow, deposits of pyrite and chalcopyrite are found at several places associated with greenstone and acid porphyry rocks. In this region no basic intrusives of post-Missian age are known to occur. There is also a great deal of quartz associated with these sulphide occurrences and the source of the deposits is, clearly, the adjacent granites. It seems highly probable, therefore, that the Mandy and Flin Flon ore-bodies are attributable to the granite intrusives rather than to the lamprophyres and associated rocks.

The solutions that brought the ore were hot. The wall-rock near the sulphide zone contains much sericite. Some of the more badly altered rock, near the ore-body, consists only of sericite, quartz, and pyrite. Irregular masses of talc, also, have been found in the chlorite schist and in the sericite schist of the foot-wall. It is to be concluded, therefore, that the deposition of the ore was the result of the replacement of a sheared zone in volcanic rocks by solutions from intermediate to high temperatures given off from the granite intrusives. The shearing took place during the period of folding that accompanied the granite intrusion, and the replacement occurred towards the close of the period of intrusion. The solid sulphide ore was formed first. Towards the close of the period of mineralization the solutions were relatively richer in copper and gave rise to the disseminated ore on either side of the solid sulphide mass.

DEVELOPMENT, TREATMENT, ETC.

According to the 1928 annual report of the Hudson Bay Mining and Smelting Company, the ore reserves above the 900-foot level amount to 18,000,000 tons, averaging: copper, 1·71 per cent; zinc, 3·45 per cent; gold, 0·74 ounce; silver, 1·06 ounces. With copper at 15 cents a pound and zinc at 6 cents, the average value per ton is $11.25. The estimated profit is $3.50 per ton.

The ore will be mined and treated at the rate of 3,000 tons per day. Mining will be carried on simultaneously by both open-pit and underground methods. Open-pit operations will be conducted in the central part of the ore-body where the width on the surface reaches 300 feet. Some 5,000,000 to 6,000,000 tons of ore will be mined in this way.

The ore will be crushed and treated in a flotation mill which will deliver copper concentrates, zinc concentrates, and tailings for cyanidation. The copper concentrates will be smelted in a reverberatory furnace, the matte converted, and the blister copper, containing the greater part of the gold and silver values, shipped for refining. The zinc concentrates will be roasted, leached, and a refined zinc recovered by electrolysis will be cast in marketable form and shipped.

(2) Mandy Mine

(*See* Figures 31, 32)

References

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LOCATION

Mandy mine is on a small peninsula on the west side of the northwest arm of Schist lake, about 2 miles south of the north end of the arm. It lies about 3½ miles southeast of Flinflon.

HISTORY

The property was staked in the autumn of 1915 by two prospectors, Messrs. Reynolds and Jackson. J. E. Spurr, Geologist of the Tonapah Mining Company, was examining some other mining prospects in the region at the time and he immediately obtained an option on the discovery for his company. In the following January a preliminary examination was made and it was decided to prospect the property by diamond drilling. In the spring a drill was installed, the first to be used in northern Manitoba, and by midsummer the entire ore-body had been blocked out and the values ascertained. It was found that there were 25,000 tons of massive chalcopyrite averaging about 20 per cent copper, with additional gold and silver values to the amount of $5 a ton, and about 180,000 tons of lower grade ore consisting of mixed copper, iron, and zinc sulphides, with gold and silver values.

The ore-body was too small for a smelter to be erected on the property. Owing, however, to the war price of 26 cents a pound for copper, it was decided to commence mining operations immediately. The main difficulty was that of transportation. Mining machinery had to be taken in and the ore had to be sent to Trail, British Columbia, to be smelted. Operations began in January, 1916. Buildings and stables were erected and 80 miles of winter road was made. In the first three months of operation mining machinery was taken in from The Pas, and 3,800 tons year, and 5,000 tons were teamed from the mine to Sturgeon Landing. In the spring a powerhouse and other mine buildings were erected and a shaft begun in order to carry on underground operations on the 100-foot and 200-foot levels.

During the succeeding winter, stoping was started from the 100-foot level. The ore mined, which amounted to 7,500 tons, was transported by barges down Schist lake, hauled to Sturgeon Landing, and thence shipped by boats and barges to The Pas. For transport on Schist lake four barges and two steamers were built, and in addition considerable work was done on Schist creek in making a channel and dam in order to get a passage to lake Athapapuskow.

In the third year mining operations were carried on from the 200-foot level. Eight thousand tons of ore was teamed 7 miles and piled near the outlet of Schist lake, whence it was hauled out the following year, and 5,000 tons were teamed from the mine to Sturgeon Landing. Three hundred teams of horses were employed. The average load of a single team for the whole winter was $6\frac{1}{2}$ tons and the cost of the transportation was $37\frac{1}{2}$ cents a ton-mile.[1]

In 1917 and 1918 the Ross Navigation Company, of The Pas, transported the ore from Sturgeon Landing to The Pas, but in 1919 the Mandy Mining Company took over their boats and handled all the transportation themselves. In all, four steamers and seven barges were employed between Sturgeon Landing and The Pas, a distance by water of 120 miles. At The Pas the ore was loaded on freight cars and shipped to Trail. The

[1]These figures are given by G. R. Bancroft, Mandy Mining Co.

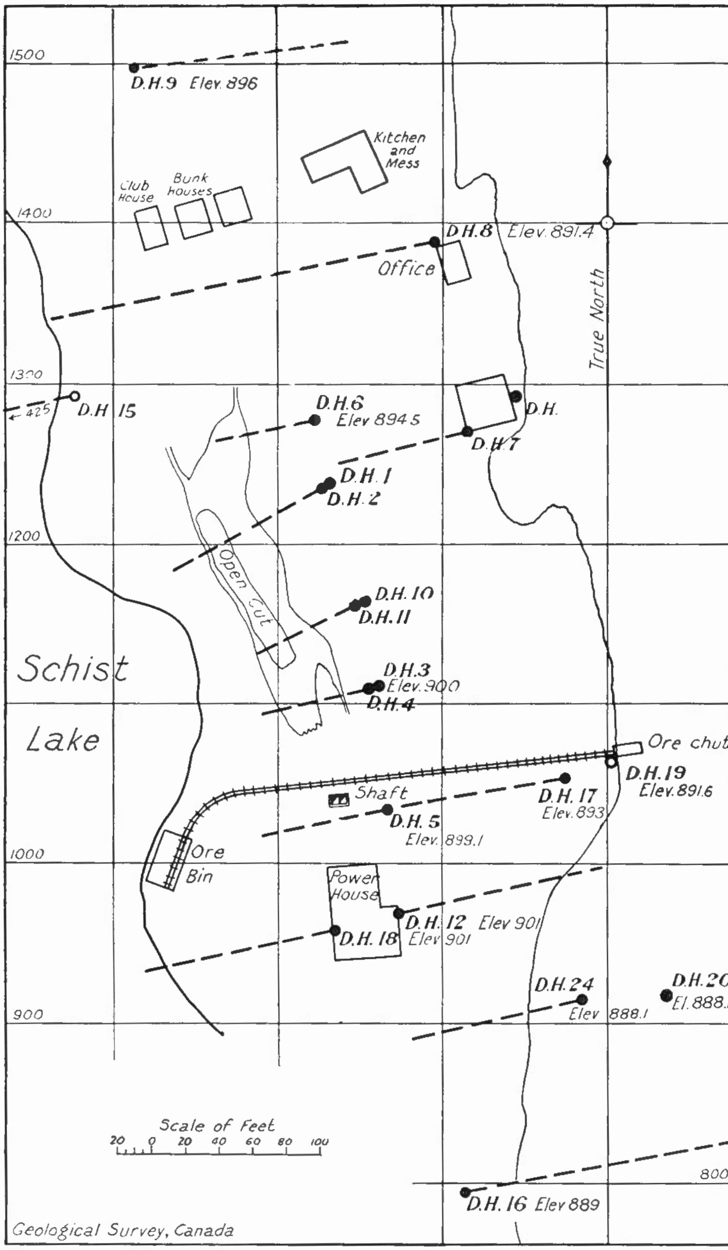

Figure 31. Plan of Mandy mine showing drill-hole projections.

last shipment was made in August, 1920. Mining operations lasted for three years and the work of transportation for four. The time from the actual mining of the ore until the date of delivery at the smelter was one year. Altogether 25,000 tons of high-grade ore was thus handled. The amount and value of copper produced were as follows:

Year	Lbs.	Value
		$
1917	1,116,000	303,329
1918	2,339,751	576,234
1919	3,348,000	625,775
1920	3,032,577	534,604
Total	9,866,328	2,039 943

In addition to the copper the ore averaged $5 a ton in gold and silver.

DESCRIPTION OF THE DEPOSIT

The rocks on the peninsula on which the Mandy ore-body occurs

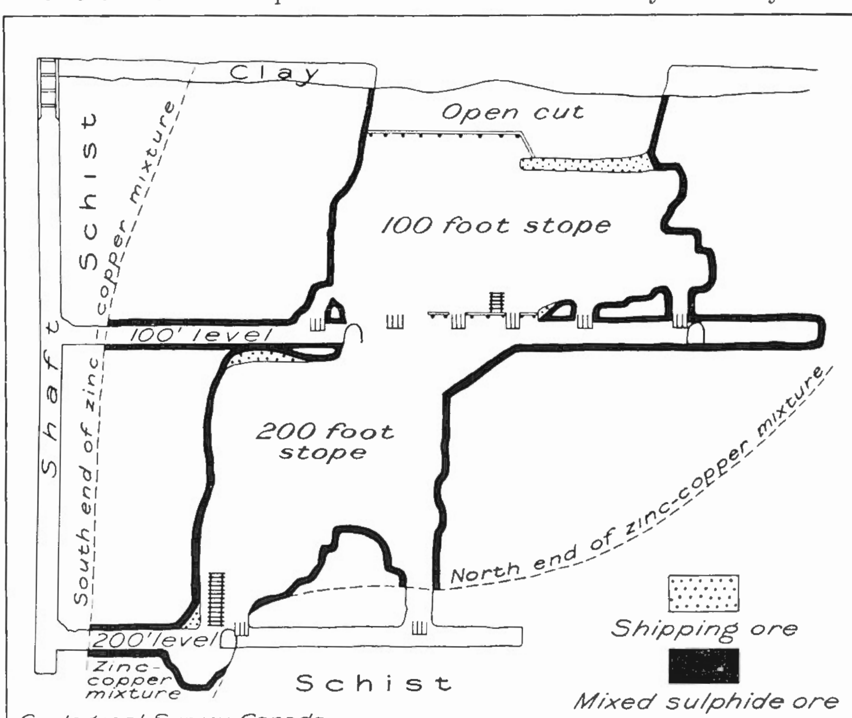

Figure 32. Vertical section of stope of Mandy mine, 1920.

are greenstone, pyroclastics, and chlorite schists. The ore lens is in a band of schist with massive greenstone on either side. The lens is 225 feet long and has a maximum width of 40 feet. It is rather irregular in shape, and its longer axis parallels the strike of the schist ana greenstone bands.

At either end a narrow vein of sulphides branches off from the lens, following the strike of the schist. The ore at the south end is dominantly chalcopyrite, that at the northern end is composed chiefly of pyrite. Bruce is of the opinion that before mineralization took place a drag-fold existed at this place in the schistose bands and that the replacement of the drag-folded rock gave rise to the ore-body. The outline of the deposit is strongly suggestive of this drag-fold origin. The lens dips from 75 to 80 degrees to the east and pitches at a high angle to the south. As shown on the plan of the deposit, the central part consisted of high-grade chalcopyrite surrounded by sphalerite and pyrite. This central lens of chalcopyrite had a maximum width of 12 feet on the surface and a length of 100 feet. On the 100-foot level it widened to over 18 feet. Its strike is not quite the same as that of the whole sulphide deposit. The zones of the various sulphides are not sharply demarcated, but merge into each other. The zone of the various sulphides shows a well-banded structure, and a rough banding is to be seen also in the pyrite zone. The average values in the chalcopyrite lens were: copper, 19 per cent; gold, 0·10 ounce a ton; silver, 2½ ounces a ton.

The deposit showed the effect of strong glaciation. Practically fresh sulphides were exposed at the surface beneath the covering of moss, the weathering products formed in pre-Glacial time having all been scoured off. Locally, the adjacent rocks show slight copper stains and in certain small fissures in the ore chalcanthite was found encrusting the sulphides, but the amount of secondary minerals in the deposit is very small.

MINERALOGY AND PARAGENESIS

The metallic sulphides in the ore-body were deposited in the following order: pyrite and arsenopyrite; sphalerite and chalcopyrite; galena. Pyrite is the most abundant mineral and is the chief mineral of the outer zone of the ore-body. The pyrite zone grades from the massive sulphide type into country rock impregnated with sulphides. It contains much chalcopyrite and pyrite. In places there is a rough, banded appearance due to the parallel arrangement of zones of pyrite, zones of pyrite with chalcopyrite, and zones of pyrite with sphalerite as the chief constituents between the pyrite grains. The pyrite occurs as cubes and irregular grains. In places it shows signs of deformation, grains being fractured, and the fractures filled with later minerals. Other specimens of pyrite show no evidence of deformation. Arsenopyrite is present as small grains throughout the ore-body and was apparently deposited along with the pyrite.

Chalcopyrite formed the central part of the lens. In polished sections it shows inclusions that appear black by reflected light. These inclusions, which consist of country rock, are impregnated with pyrite, and in places their edges are broken and cemented by sphalerite and chalcopyrite. The chalcopyrite and sphalerite were, apparently, introduced at the same time. They are intimately intergrown in many places and in many cases occur as a matrix cementing pyrite grains, filling fractures in pyrite, or less commonly replacing pyrite. The chalcopyrite is massive and on the freshly broken surface is rather paler in colour than is common for that mineral. An analysis of the purest ore that could be selected gave 28·96 per cent copper. Pure chalcopyrite should contain 34·5 per cent copper and the lower amount in the Mandy ore is evidently due to inclusions of country rock.

The sphalerite is massive and shows no signs of cleavage or crystal faces. It is dark in colour, with a metallic lustre quite different from ordinary black-jack. Locally, chalcopyrite and sphalerite form a well-banded variety of ore, but in this type chalcopyrite is present in the sphalerite bands, and sphalerite in the chalcopyrite bands, with no evidence of fracturing or subsequent introduction of one mineral into the other. These bands vary in width from a quarter of an inch or so to extremely narrow bands. An analysis of the purest sphalerite ore that could be selected gave the following results:

	Per cent
Zinc	46·21
Copper	1·70
Iron	12·80
Gold at the rate of 0·07 oz. Troy per ton	
Silver at the rate of 0·85 oz. Troy per ton	

Some of the iron represented in this analysis may be in the form of pyrite and chalcopyrite, but most of it is certainly contained in the sphalerite. Galena is found in small quantities in the chalcopyrite and sphalerite.

The gangue minerals include quartz and carbonates. They are found filling fractures in the pyrite and between pyrite grains. Of the carbonates, calcite is much the most abundant; minor amounts of dolomite are reported by Hanson. The quartz is later than the pyrite, but most of it is earlier than, or of the same age as, the chalcopyrite and sphalerite. Most of the carbonates, on the other hand, are later than the sulphides. Some vugs in massive chalcopyrite were found lined with minute rhombohedral crystals arranged in parallel position. Some of these crystals are ankerite; others, owing to lack of magnesia, could be called ferro-calcite. A few cavities were found to contain beautiful crystals of selenite.

ROCK ALTERATION

The lens lies in a zone of chlorite schist which under the microscope is seen to be a mass of secondary minerals. The actual wall-rock is in places a fissile sericite schist. The chief peculiarities of the rock adjacent to the lens, as contrasted with the country rock away from the ore-body, are the complete removal of the feldspars, the increase in the amount of secondary quartz and carbonates, the presence of sericite and sulphides, and the presence of rutile. This alteration was effected undoubtedly by hydrothermal solutions.

GENESIS

It is concluded that the Mandy ore-body was formed in a sheared zone in volcanic rocks. Solutions, probably derived from the granite, deposited pyrite in the shear zone replacing the schistose rock. Later movement took place during the period of deposition, and towards the end of this period the solutions became relatively richer in copper and zinc. Towards the end of the period chalcopyrite deposition was dominant, and the central lens of chalcopyrite and the chalcopyrite veins cutting the sphalerite zone were formed.

(3) Sherritt-Gordon

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Wright, J. F.: " Geology and Copper-Zinc Deposits of Cold Lake Area, Manitoba "; Bull. Can. Inst. Min. and Met., April, 1929.

LOCATION

The Sherritt-Gordon property is situated at the southeast end of a narrow lake lying east of Kississing lake. The latter is a large body of water tributary to Churchill river, on the main canoe route from Cumberland House on Saskatchewan river by way of lake Athapapuskow to Churchill river. The property is 100 miles north of The Pas and 40 miles northeast of Flinflon. The railway to the property branches off the line to Flinflon at Cranberry Portage.

HISTORY

The oxidation zone was discovered in 1922 by an Indian of The Pas district named Philip Cherlot, who staked it but did not record his claims. In January of the following year Carl Sherritt staked and recorded the first claim, and a few days later adjoining claims were staked by David Burke and Cherlot. These latter two, however, allowed their claims to run out. In 1924 the claims were re-staked by Sherritt and Madole and the first ore was uncovered by Sherritt in March, 1924. In 1925 an option on the property was taken by Earle and Fasken, but it was dropped in September, 1926. Later in 1926 an option was taken by the Victoria Syndicate, but subsequently dropped. In 1927 a company known as the Sherritt-Gordon Mines was organized to purchase the Sherritt-Madole property and development work was commenced.

GEOLOGY

The rocks of the Kississing Lake area are all of Precambrian age. They consist of the Amisk-Wekusko lavas and sediments which are overlain conformably by the Kisseynew sedimentary gneisses, and the whole are cut by basic and granitic intrusives. The Amisk-Wekusko series consists of andesite and dacite flows with beds of tuff, greywacke, quartz-hornblende schist, quartz-biotite-garnet schist, and chlorite schist. The Kisseynew sedimentary gneisses consist of quartzite gneiss, quartz-biotite-garnet gneiss, hornblende-plagioclase-quartz-garnet gneiss, and granitized sediments produced by the injection and impregnation of igneous material. The basic intrusives consist of picrite, gabbro, and diorite. The granitic intrusives are later than the basic and are granite and granite-gneiss, aplite, and pegmatite.

DEPOSITS

The deposits consist of massive and disseminated replacements of fractured and sheared zones in the Kisseynew sedimentary gneisses. Most of the Sherritt-Gordon ore is within quartzite adjacent to a black, hornblende-plagioclase-garnet gneiss that forms the hanging-wall.

Wright describes the deposit as follows:

"The Sherritt-Gordon ore-body is a long, narrow zone of fractured and sheared rock that has been impregnated by pyrrhotite, sphalerite, chalmersite, and chalcopyrite. These sulphides were deposited in all the open spaces available, and also have replaced the schistose and gneissic rock along bedding and foliation planes. In places, bodies of massive sulphide, 2 feet or more in width, were formed, but most of the ore consists of quartzite gneiss intimately intermixed with veinlets, small lenses, and specks, of sulphides. The outer limits of the sulphide mineralization are not sharp, as pyrrhotite is distributed in small grains in the hanging-wall rock from 50 to 100 feet from the centre of the shear zone. The outline of the ore-bodies will also be irregular, for the proportion of pyrrhotite, chalcopyrite, and sphalerite present varies along the strike. Locally, bodies of pegmatite completely fill the fractured zone. The ore-bodies follow closely the dip and strike of the beds of the sedimentary gneiss. From the northwest end of the deposit, the dip gradually steepens from 45 degrees northeast to vertical near the southeast end, and at the east end the dip of the gneiss and ore-body is steep and in the reverse direction from the dip farther west.

In hand specimens of the ore, the sulphides appear intimately intermixed, but in polished specimens the pyrrhotite is seen to be cut by sphalerite and chalcopyrite. In some specimens, chalcopyrite contains inclusions of sphalerite. In specimens carrying abundant chalcopyrite, the pyrrhotite, chalmersite, and chalcopyrite appear to have crystallized together. In specimens with only a small amount of pyrrhotite, the chalcopyrite and sphalerite are intimately intergrown. There is no evidence of a long time-interval between the deposition of the sulphides, and apparently their order of formation was governed, to some extent at least, by the relative abundance of the various metals present.

The metallic sulphides are clearly later than the silicate gangue minerals, the more abundant of which are quartz, feldspar, hornblende, biotite, and garnet. In addition to these minerals, some thin sections of the sulphide-bearing rock were found to contain actinolite, tremolite, augite, epidote, zoisite, titanite, magnetite, sericite, and chlorite. The sulphides penetrate the feldspar and other silicate minerals as veinlets along fracture and cleavage planes, and inclusions of silicate minerals, including chlorite and sericite, are abundant in the sulphides. Many specimens of massive sulphides contain elliptical-outlined blebs of quartz, which are interpreted as remnants of the original siliceous rock that was replaced to make room for the bodies of massive sulphides.

ORIGIN OF THE DEPOSITS

The copper-zinc deposits are believed to be genetically related to the granitic intrusives of the map-area. The sills and dykes of granite, pegmatite, and aplite occurring along or near the mineralized shear-zones represent a phase of a granite magma, and indicate that undoubtedly granite extends beneath much of the map-area. Although pegmatitic magma penetrated almost every plane of weakness in the Kisseynew sediments, a few of the larger fractured and sheared zones were not completely filled. Some of the partly filled fractured zones were reopened after the consolidation of the pegmatitic magma, and these fractures, and all open spaces not occupied by pegmatite, were filled by the ore materials, which, in addition, were able to penetrate and replace some beds of the quartzite gneiss, and, at a few points, the hornblende-garnet gneiss and pegmatite.

There is a close genetic relation between the pegmatitic dykes and the copper-zinc deposits. At many places, a few grains of pyrrhotite and chalcopyrite are present in massive pegmatite, and here the sulphides must have crystallized with the silicate minerals of the rock. This suggests a common source for the pegmatitic magma and the metallic sulphides. Along the Sherritt-Gordon deposit, however, fractured pegmatite is cut by veinlets of pyrrhotite, chalcopyrite, and quartz, which were introduced after the rock had consolidated. Some of the Sherritt-Gordon ore appears to be sheared pegmatite replaced by sulphides. Sphalerite is generally the abundant sulphide present in association with the dark grey, more basic varieties of pegmatite. Some lenses of massive pyrrhotite are cut by narrow stringers of vitreous pegmatitic quartz, and chalcopyrite, replacing the pyrrhotite, is abundant adjacent the quartz. Veins of pegmatitic quartz, carrying sulphides and gold, are also developed along graphite-bearing shear-zones in the foot-wall quartzite gneiss of the Sherritt-Gordon deposit. It would seem that the pegmatitic magma, carrying small quantities of the sulphides, first entered the fractured and sheared zones, to be followed by the ore materials, the end phase of which was also siliceous and pegmatitic in character.

DEVELOPMENT

Surface exploration of this deposit has been done at five points, where the outcrop was near the surface, and this trenching proved the presence of a mineralized zone for approximately 5,300 feet of the 13,600 feet along which the mineralization may extend. The remaining distance of 8,300 feet between and beyond where the surface work has been done is drift covered, and here it is more economical to drill shallow pilot holes than to attempt to trench; for the upper part of the deposit is generally weathered, and the hanging-wall rock caved so that it is impossible to determine the grade and the width of the ore without sinking at least 50 feet. To the middle of September, 1928, some eighty-eight holes had been drilled to intersect the ore-zone at from 125 feet to 400 feet below the surface. Only a few holes were drilled to the 700 and 1,000-foot horizons. The holes are spaced at intervals of about 250 feet along a distance of 4,400 feet from the east end of the deposit and 6,200 feet from the northwest end. The intervening length of 3,000 feet has not yet been explored by diamond drilling.

During the winter of 1928, two surface plants, capable of developing the property to the 1,000-foot level, were installed. Early in the summer, the east shaft had reached a depth of 260 feet, and lateral work was commenced on the 125-foot and 250-foot levels. On the 125-foot level, 1,600 feet of drifting has been completed, and widths of ore from 14 to 50 feet are reported to average from \$18 to \$20 per ton gross metal content. The average metal-content of this ore is 3·25 per cent copper, 7 per cent zinc, and approximately \$1 in gold and silver. At the present west shaft, approximately 7,000 feet northwest of the east shaft, exploration was commenced on the 375-foot level, and crosscuts south to the ore-zone at this horizon are reported to show widths of from 22 to 30 feet, averaging 2·3 per cent copper and 3 per cent zinc. No underground work has been done at the northwest end, but here the diamond-drill intersections showed, on the average, higher copper than elsewhere. Several estimates of tonnage and grade of ore of this deposit have been published, and these estimates give a general idea of the large size of the deposit and of the general grade of the ore to the depths explored. It is to be expected that underground exploration will prove the deposit to be much larger and higher in grade at some points than has been indicated by the few drill intersections. Late in 1929, the railway will be completed to the mine, and then large-scale developments can be undertaken more economically. It has recently been announced that a 1,500-ton unit of a concentrator will be built. Electric power will probably be developed at one of the large falls on the Churchill river, approximately 50 miles northwest of the deposit."

(4) Reindeer Lake

Reference

Stockwell, C. H.: Geol. Surv., Canada, Sum. Rept. 1928, pt. B.

LOCATION

A zinc-lead-copper prospect lies on the east shore of Reindeer lake near the Manitoba-Saskatchewan border. It is 175 miles north of Flinflon and 145 miles northwest of the Sherritt-Gordon. It can be reached by a long water route from Sturgeon Landing via Sturgeon-weir, Churchill, and Reindeer rivers, and Reindeer lake.

HISTORY

The property was staked in the autumn of 1927 by E. L. Brown and John Drybrough, field men for a Toronto syndicate organized by Percy E. Hopkins. The showing was brought to Mr. Brown's attention by an Indian. In December the group was increased to twenty claims, while representatives of Nipissing staked a block of twelve to the west. Other parties have tied on to the original group.

GEOLOGY

The geology consists of sedimentary and granite gneisses of the Kisseynew series, intruded by gabbro, diorite, and pegmatite dykes.

DEPOSIT

The showing consists of massive sulphides consisting of pyrite, pyrrhotite, sphalerite, galena, and chalcopyrite in varying quantities. The discovery shows a width up to 20 feet and has been traced by surface trenching and diamond drilling during the summer of 1928 for a distance of 800 feet.

(5) Wekusko River

LOCATION

This deposit occurs north of Wekusko lake in The Pas Mineral Belt. It lies immediately north of Wekusko river about half-way between Herblet lake and Herb bay on Wekusko lake.

GEOLOGY

The deposit lies in a series of garnetiferous gneisses and sericitic schists of apparently sedimentary origin. These are intruded by Precambrian granite and pegmatite dykes. The deposit lies near these intrusives.

DEPOSIT

A hurried visit was made to the deposit in the autumn of 1920 when only a slight amount of work had been done on the property. The deposit consists of impregnations of sulphides in the gneiss. In places, specimens heavy with galena can be collected. Sphalerite, pyrrhotite, and pyrite accompany the galena. The latter is reported to carry silver values. Insufficient work had been done on the property at the time of the writer's visit to form an estimate of the size of the deposit.

ORIGIN

The mineralogy of the deposit suggests a high temperature origin and the close proximity of the granitic intrusives makes it probable that these are the source of the mineralizing solutions.

(6) Snow Lake

Reference

Alcock, F. J.: Geol. Surv., Canada, Mem. 119, p. 38.

LOCATION

Snow lake lies in The Pas Mineral Belt about 3 miles northwest of Wekusko lake. It drains by means of Snow river into one of the bays at the north end of Wekusko lake. A showing of galena is exposed on the south shore about half-way along the lake nearly opposite where the winter trail to Herblet lake commences.

GEOLOGY

The rocks of the region consist of Precambrian greenstones and sedimentary gneisses and schists intruded by granite. The deposit occurs in greenstone.

DEPOSIT

The deposit is a vein carrying considerable quantities of galena. The gangue consists of white, translucent quartz, but considerable amounts of a light, greyish white, coarse to fine crystalline, slightly ferruginous dolomite are also present. The galena, with which are sphalerite and small quantities of pyrite, is reported to carry values in silver, but the extent of the deposit exposed at present is very small.

The deposit is believed to be genetically related to the intrusions of granite which are numerous in the region.

(7) Mystery Lake

A zinc-lead deposit containing silver values occurs on Mystery lake situated between Manasan and Burntwood rivers, northern Manitoba. The area is reached from mile 185 on the Hudson Bay railway by a portage route crossing Paint and Ospwagan lakes.

The deposit was staked by Gordon Murray and taken over by J. P. Gordon and associates, who carried out diamond-drilling operations on the deposit during the summer of 1928.

It is stated that mineralization occurs along a length of 3,400 feet and over a width up to 45 feet.

Other Occurrences

Occurrences of galena have been found in the region along the Hudson Bay railway at various places; on Setting lake near mile 137, at mile 185, on Pineimuta (Partridge Crop) lake near mile 205, and at mile 279 and mile 286.

Sphalerite and galena occur in Oxford Lake area[1], and in Oiseau River area[2]. Argentiferous galena was reported from a lake north of Nelson House near the divide between Burntwood and Churchill rivers.[3]

[1] Geol. Surv., Canada, Sum. Rept. 1925, pt. B.
[2] Geol. Surv., Canada, Sum. Rept. 1924, pt. B.
[3] Geol. Surv., Canada, Mem. 30, pp. 88, 128.

Galena occurs in the gold-bearing quartz veins of Elbow lake[1] and of Amisk lake.[2]

Jamesonite and sphalerite were found in a quartz vein cutting granite-gneiss north of lake Athabaska, Saskatchewan.[3]

ALBERTA

The following occurrences of zinc and lead minerals are reported from Alberta:

(1) Massive zinc blende near the head of Cascade creek, Rocky mountains, Alberta (Geol. Surv., Canada, Ann. Rept., vol. X, pt. S, p. 230).
(2) Zinc blende from South fork of Red Deer river (Geol. Surv., Canada, Ann. Rept., vol. VIII, pt. A, p. 122).
(3) Galena from Castle mountains, near Eldon station, Canadian Pacific railway (Geol. Surv., Canada, Ann. Rept., vol. XI, pt. A, p. 164).
(4) Sphalerite with pyrite, in quartz, from Storm mountain, Rocky mountains (Geol. Surv., Canada, Ann. Rept., vol. XI, pt. A, p. 164).
(5) Galena near Twin lakes. "Near the Twin lakes (Bow River region) fragments of galena occur, and a vein of the mineral has been discovered and located here. . . . . A specimen, in which the galena contributed only a small part, yielded an ounce of silver to the ton" (Geol. Surv., Canada, Ann. Rept., vol. I, pt. B, p. 137 (1886)).

MACKENZIE DISTRICT

Lead-Zinc Zones of Great Slave Lake

By J. Macintosh Bell

LOCATION AND ACCESS

Deposits of lead-zinc ores occur about 12 miles south-southwest of Pine point on Great Slave lake and about 32 miles southwest of Resolution. The deposits are covered by seventeen claims with a total area of 1,317 square miles, the property of the Great Slave Lake Trust, of Boston, and of the Atlas Exploration Company, Limited, with headquarters in Ottawa. The claims are reached by a good foot-trail 11 miles long, which leaves the shore of Great Slave lake about 3 miles east of Pine point and only a few miles off the route of the steamer traffic between Resolution and Mackenzie River points.

TOPOGRAPHY

The claims are situated in almost flat country, about 200 feet above Great Slave lake, to which the descent is imperceptible, save at a point about 2 miles back from the shore, where some low, shaly limestone ridges provide a slight local relief. The country consists mainly of sand or boulder-strewn plains, diversified with swamps. In places there are very low ridges of gravel or sand. The forest, which is open and park-like, is generally of small trees, and consists of Banksian pine, white and black

[1] Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 40-44.
[2] Geol. Surv., Canada, Mem. 105, p. 59.
[3] Geol. Surv., Canada, Sum. Rept. 1916, p. 156.

spruce, tamarack, aspen, balsam-poplar, and birch. The whole country gives evidence of having been burned over some forty to fifty years ago, and, again, in the vicinity of the claims, within more recent years. The soil is almost invariably poor and unsuitable for a heavy timber growth.

GENERAL GEOLOGY

The underlying rock of the locality covered by the claims is dolomite belonging to the Presqu'île group of the Middle Devonian. Judging by the few exposures of solid rock between the claims and Great Slave lake, this dolomite passes downward into bituminous shale and shaly limestone which may represent the lower measures of the Presqu'île formation or, more probably, the upper part of the formation below, namely, the Pine Point limestone. The dolomite in which the lead-zinc deposits occur is generally open and cavernous in texture, is whitish, greyish, or drab in colour, and is in places mildly impregnated with petroleum. Characteristic recurved crystals of white dolomite in many cases line the open spaces. The boulder clays and sands of Glacial age, which surround and in places overlie the deposits, appear to be inconsiderable in thickness, in the immediate vicinity of the claims.

Exposures of dolomite are fairly common in the immediate vicinity of the deposits, though areally considered they occupy but a small fraction of the total surface. For this reason and because of the complexity of the jointing and the generally recrystallized character of the rock, the structure is difficult to interpret. There appear, however, to be a series of very gentle folds having a general strike of about north 70 degrees east (true), with minor pitches in either direction at right angles to the strike. The direction of major jointing varies from north 40 degrees east to north 85 degrees east. Minor jointing generally much less definite in character is about north 60 degrees west.

NATURE OF THE ORE ZONE

The lead-zinc deposits so far discovered occupy the eroded shattered crests of what are considered to be low anticlinal folds. Their outcrop is characterized by sink-holes, which, in the case of three of the four deposits, almost completely surround the ore-zones and in general appear to mark the surface limitations. The visible sink-holes are obviously post-Glacial in age. It is clear that they are due to the dissolution of the ore minerals, more particularly pyrite. Their maximum depth below the general level is about 20 feet. Where the deposits are capped by barren dolomite, or dolomite low in lead and zinc, or by glacial material, the surface, apart from the sink-holes, gives no indication to betray the occurrence of mineral deposits beneath; it shows merely the characteristic flat country, covered by coarse grass with occasional trees. Where, however, the ore actually outcrops, there is little vegetation, the soil is occasionally rusty, reddish, or greyish with, commonly, considerable detrital ore minerals.

The metallic minerals in the lead-zinc deposits are galena, sphalerite, and pyrite, together with the oxidation products thereof; smithsonite, yellowish oxide of lead, and various brown and red hydrous oxides of iron. Though assays of silver as high as 7 ounces to the ton have been found, in general silver values may be considered negligible.

The mineralization, so far discovered, is limited to five zones, which will be later described. Within these zones there occurs everywhere more or less dissemination of ore-minerals, and through this relatively less mineralized material ramify deposits of great irregularity of shape and size and of varying character—roughly horizontal impregnations along favourable beds, vertical or inclined enrichments along joint-planes. In places the ore is a breccia, the ore-minerals cementing fragments of dolomite. Present knowledge of the deposits indicates that they are roughly circular or elliptical in horizontal cross-section. There is apparently a very general zonal arrangement as regards the occurrence of the three metallic elements. Lead minerals seem to be more conspicuous towards the centre of the deposits, though found in places even on the outermost edge. Zinc minerals, however, largely replace those of lead towards the peripheries, and iron minerals at the very edge. The deposits are oxidized to the greatest depth reached in any prospecting shaft, the oxidation being most apparent where iron minerals are conspicuous. Highly oxidized beds lie in places below these which show little obvious oxidation. The deposits possess a general similarity to those of the same elements occurring in the Tri-State region of Mississippi valley. The vertical extension, it is thought, will depend on a change of rock downward from the porous dolomite showing at and near the surface. Data to gauge the thickness of the Presqu'île formation at the claims (the base of which would seem to be the controlling factor in the depth of mineralization) are not available. Near the south shore of Great Slave lake the thickness is estimated at about 200 feet.

DETAILED DESCRIPTION OF THE SEVERAL ZONES

The lead-zinc zones so far discovered are five in number, namely:

(a) Melville zone
(b) Iltyd-Gordon zone
(c) Iltyd-Colcoughly zone
(d) Little Gwynn zone
(e) Gwynn zone

(a) *Melville Deposit*

The Melville zone is demarcated on the south and east by a pronounced sink-hole. Northerly a few shallow sink-holes are visible, but easterly the surface is flat and unbroken. The only points at which the ore outcrops are at the inner and outer edge of the main sink-hole, the latter being much the more conspicuous occurrence. The further extension of the zone has been proved by numerous test pits which indicate a length of 280 feet and a breadth of 260 feet. A group of small sink-holes extending northwesterly for 250 feet beyond the boundary of the ore as already delineated suggest a continuation of the zone in this direction, although three test pits sunk in this locality have failed to reveal material classifiable as ore.

The grade of the zone may be judged from a number of test pits sunk to depths varying from 7 to 21 feet, of which the uppermost 5 to 12 feet is glacial material. Where the quality of lead and zinc was commercially important it was found to vary in grade from a maximum of 29·42 per cent Zn and 30·80 per cent Pb to a minimum of 17·52 per cent Zn and 4·55 per cent Pb.

(b) *Iltyd-Gordon Zone*

The surface expression of the Iltyd-Gordon zone is unlike that of the other three occurrences. The various outcrops are not only depressed, but certain exposures are in places elevated a few feet above the surrounding country. There are two inconspicuous sink-holes adjacent to the southern boundary of the zone, but nothing comparable to the depressions associated with the other occurrences.

The various exposures of ore are, for the most part, not ore actually in place at the surface but untransported detrital material formed from the breaking up of the dolomite and ore enclosed therein. Very little boulder clay and few boulders derived therefrom occur on certain of these exposures, which are almost free from vegetation. Grass-covered boulder clay shows, however, between the several exposures and around them, but certain features suggest that the ore is not continuous immediately beneath this intervening covering. The detrital ore is in places extremely heavy and contains but little admixture of foreign material or of fragments of enclosing dolomite. Elsewhere dolomite fragments predominate.

The Iltyd-Gordon zone extends for a length of 900 feet and has a maximum width of 200 feet. Although it is believed that ore in appreciable quantities occurs everywhere within these dimensions, it would appear that it does not come to the surface over the whole area of the ellipse. Judging by the exposures, the material in the western half of the occurrence is of much better quality than the eastern portion, much of which is low grade at the surface.

A large number of shallow test pits have been sunk on the zone. A channel sample down the side of the deepest shaft, 35 feet (B. 4·1), near the western centre of the zone, showed the following values in zinc and lead over the widths indicated from the surface.

Feet	Zn %	Pb %
0–13	9·90	23·50
13–35	19·45	18·65

(c) *Iltyd-Colcoughly Zone*

Like the Melville deposit, the Iltyd-Colcoughly is almost completely surrounded by pronounced sink-holes. These are large and conspicuous to the north, northeast, and northwest; small and disconnected to the southeast and southwest. A number of well-defined depressions break the regularity of the generally flat surface within the ellipse of outer depressions. The test pits so far sunk outside the depressions have not shown the presence of appreciable quantities of lead-zinc minerals.

The dimensions of the zone as at present indicated are about 280 feet by 270 feet. It is possible that further exploration will extend the length southerly by a further 100 feet.

Natural cliff-like exposures of ore and enclosing dolomite occur along the western and southwestern edge of the sink-holes which form the limit of the deposit on the west and northwest. The central part of the locality is occupied by an elliptical outcrop of rich ore and dolomite in place, largely overlain by the small fragments shed therefrom, the whole being practically free from vegetation.

A large number of shallow test pits have been sunk on this zone and one shaft, C. 1, near the middle, has been extended to a depth of 55 feet. The percentages in zinc and lead over the widths indicated in channel samples taken down the side of this shaft are as follows:

Feet	Zn %	Pb %
0–18	16·87	43·29
18–30	26·25	20·65
30–42	4·65	6·90
42–55	5·60	9·01

(d) *Little Gwynn Zone*

The Gwynn ore occurrence consists of two separate zones—the Big Gwynn and the Little Gwynn about 175 feet apart. It is quite possible that exploration between them will show that there is a continuous ore-body below the vegetation-covered boulder clay obscuring the dolomite beneath.

The Little Gwynn is entirely depressed; the edges rather more than the centre where there is a mass of shaken ore-bearing dolomite largely shrouded by coarse ore and dolomite detritus which passes outwards into finer material containing numerous ore fragments. This finer material at the edge of the depression is very rusty. The dimensions of the zone are approximately 135 feet by 90 feet. A channel section down the wall of a test pit sunk to a depth of 15½ feet in the middle of the deposit showed 30·78 per cent Zn and 20·10 per cent Pb.

(e) *Big Gwynn Zone*

The Big Gwynn is demarcated on every side, except the south, by sink-holes. The main one of these, which almost completely surrounds the deposit, is wide but irregular and shows numerous outcrops of dolomite containing ore, together with fragments shed therefrom, and on the extreme western and eastern edges barren dolomite. The centre of the zone is covered by glacial material. The dimensions of the zone as at present delineated are 250 feet by 220 feet.

The zone at the inner edges of the sink-holes shows a number of natural exposures of beds of very rich ore, interstratified with material of lower grade. A cliff face on one of the richer outcrops has been deepened by a test pit to 6½ feet, over which width a channel sample contained Zn 26·09 per cent and Pb 40·62 per cent.

Several test pits have been sunk through the boulder clay covering the middle of the zone, to the ore beneath, and a shaft, D. 4, at the centre of the main depression, has been extended to a depth of 51 feet. The upper part of the material penetrated is a gossan showing irregular veins of limonite, large chunks of galena, and some smithsonite. A channel sample of the material penetrated in the 51 feet over the widths indicated is as follows:

	Feet	Zn %	Pb %
D-4	0–19	4·81	12·87
	19–28	25·55	8·45
	28–40	2·8	Nil
	40–51	9·95	2·79

EXTENSION OF THE ORE ZONES

As previously indicated, there is no reason to suppose that the deposits will not extend downward to the point where the porous dolomites are replaced by shaly limestones. As regards possible lateral extension it is natural to conclude that any depressional areas formed previous to the glacial period would have been filled by debris originating therefrom. It, therefore, seems probable that other zones than those now shown will occur beneath the glacial deposits along the two indefinite ridges—(a) Gwynn-Melville, (b) Colcoughly-Iltyd-Gordon—where structural conditions apparently similar to those occurring at the known deposits exist and elsewhere beneath the almost all pervading sand and gravel. The known deposits are of high grade in both lead and zinc, and appear to contain large quantities of ore.

ORIGIN OF THE DEPOSITS

The deposits are thought to be the result of the progressive concentration of lead, zinc, and iron sulphides in the joints, bedding planes, and cavities of the shattered Presqu'île formation, by meteoric waters, which derived their metallic content from the dissolution of the same minerals, originally more widely disseminated through parts of the Presqu'île formation now removed by erosion or from some similarly eroded superior formation. The oxidation and dissolution of the original sulphides at and near the present surface, which occurred subsequent to the first period of concentration, produced in places leached outcrops, or (depending on structure or chemical content) further enrichments, with oxidation products and secondary or tertiary sulphides. As the ore now visible is everywhere more or less shattered, decomposed, or oxidized, it is believed to be possible that originally concentrated material has as yet not been reached in any of the various prospecting shafts.

Figure 33. Index map of Yukon showing location of lead occurrences. 1, Mayo district; 2, Upper Beaver River area; 3, Dawson district; 4, Sixtymile district; 5, Windy Arm district; 6, Wheaton district.

CHAPTER V

OCCURRENCES IN WESTERN CANADA

YUKON

By W. E. Cockfield

Silver-lead-zinc deposits occur in Yukon in Mayo, Twelvemile, Sixtymile, Windy Arm, and Wheaton districts. Deposits are also reported to occur on Rude creek in Klotassin district, on Boswell river, in Big Salmon district, and on Ffteenmile creek, 25 miles below Dawson, but concerning these reported discoveries there is little accurate information available. The deposits of Mayo district and of Windy Arm have been the only producers to the present and of late years the entire production has come from the Mayo camp. On account of transportation and mining costs only high-grade deposits have been worked in the territory.

(1) Mayo District

References

Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept. 1915, pp. 27-29.
Cockfield, W. E.: Geol. Surv., Canada, Sum. Repts.: 1918, pt. B, pp. 4-7; 1919, pt. B, pp. 4-6; 1920, pt. A, pp. 1-6; 1921, pt. A, pp. 1-7; 1923, pt. A, pp. 1-29; 1924, pt. A, pp. 1-18; 1925, pt. A, pp. 1-14.

LOCATION AND ACCESS

Mayo district forms a part of the watershed of upper Stewart river, lying to the east of the mouth of McQuesten river. Stewart river is a tributary to Yukon river entering 70 miles above Dawson. The town of Mayo, situated 180 miles above the confluence of the two rivers, acts as a base for the district. Entry to the district is afforded in summer by the White Pass and Yukon route, which maintains a regular train and riverboat service connecting at Skagway, Alaska, with steamship lines from Vancouver and Seattle. In winter the only means of entry is a stage service from Whitehorse, the northern railway terminus.

HISTORY

Silver-lead-zinc deposits were first discovered in Mayo district about the year 1906 when the deposit known as the Silver King mine was located on Galena creek. The first real development work done on this property was in 1912 or 1913 by two lessees. They shipped 59 tons of ore to the smelter at Trail, which returned $269 in gold, silver, and lead. In 1914 this property changed hands and mining was then continuously carried on until 1917 when the single ore-shoot developed on the property was exhausted, and the mine was closed down. Prospecting for lode deposits, however, had been stimulated by the success of this property and from 1915 to 1918 deposits were discovered on Rambler hill, Lookout mountain, and mount Cameron. The deposit on Lookout mountain was worked by local capital for several years and small shipments were made, but failure to find ores of shipping grade caused the closing down of the property. In 1919 the deposits of Keno hill were discovered by Louis Beauvet, and almost immediately Yukon Gold Company took options on the original group of claims. This led to a stampede to the district and to the staking of upwards of a thousand claims. Prospectors spread out over the country and in the few years following, argentiferous galena was discovered on some of the surrounding hills and also to the northeast in the valley of Beaver river. Periodically fresh finds are reported, and it seems certain that others will be made from time to time.

In 1920 a subsidiary company, Keno Hill, Limited, was formed to take over the holdings of Yukon Gold Company, and the claims were prospected and put into shape for shipping high-grade ore. The first shipments were made during the winter of 1920 when about 2,000 tons of ore was hauled to Mayo to await the opening of navigation in the spring. In 1921 Treadwell Yukon Company, Limited, entered the field, acquiring some promising claims on the western slope of Keno hill, adjoining some claims taken up by Keno Hill, Limited, in addition to its original group. This group was prospected during the following two years; Keno Hill, Limited, however, confining most of its attention to the original group. Shipments of ore were made in 1922, 1923, and 1924; but in 1924 Keno Hill, Limited, definitely abandoned the field, leasing the claims of the original group to some individuals, and the Sadie claim to the Treadwell Yukon Company. In 1924 Treadwell Yukon Company, Limited, believed that their property was sufficiently developed to justify the erection of a small mill, and a mill of 100 tons capacity daily was erected and commenced operating early in 1925. Individual miners also shipped considerable ore during this period of development, practically all shipments coming from Keno hill until 1925-1926 when Galena hill began shipping.

In 1923 float was discovered on Galena hill, which lies across the valley of Christal creek from Keno hill and is in reality an extension of the Keno Hill camp. Prospecting which followed resulted in the discovery of certain ore-bodies of importance and shipments were made from there in 1925 and 1926.

In 1925 options were taken on some of the claims on McKay hill in the Beaver River area by the Consolidated Mining and Smelting Company and prospecting work was carried out there in 1926.

Mining in Mayo district is carried on under peculiar conditions. Shipments of ore for the most part can be made only during the winter when the state of the roads permits of hauling heavy loads. The charge for freighting varies greatly with the distance and state of the roads. Treadwell Yukon Company, Limited, uses caterpillar tractors for haulage, and were successful in cutting the freighting costs by over 50 per cent by this method. Ore hauled in the winter is stacked at Mayo to await shipment by river boat in the spring. It is thus, at times, over a year from the time ore is mined until it reaches the smelters on the Pacific coast.

GENERAL GEOLOGY

The greater part of Mayo district is underlain by schists and gneisses which are thought to be of Precambrian age. The schists are intruded by dykes, sills, and laccoliths of greenstone, by stocks of granite, and by thin dykes and sills of granite porphyry and quartz porphyry. The age of these intrusives has not been satisfactorily determined, but the greenstones are thought to be of about Devonian age, and the acid intrusives to be Mesozoic or possibly in part of Tertiary age.

The schist series consists of quartzite, quartz-mica schist, graphite schist, sericite schist, and chlorite schist. Of this group the quartzite, quartz-mica schist, and graphite schist are believed to belong to the Nasina series as described by McConnell in his report on Klondike region. In the type sections these rocks consist of alternating bands of white and blue, thinly laminated quartzites, that pass gradually into dark grey quartz-mica schists and finally into black graphite schists. In Mayo district, however, the quartzites are as a rule more blocky and homogeneous than in Klondike region. This series represents a great thickness of siliceous and argillaceous sediments which have been metamorphosed into quartzites, quartz-mica schists, and graphite schists. The sericite and chlorite schists are present only in minor amounts, and are believed to represent altered volcanics of acid and intermediate composition.

The greenstones occur as dykes, sills, and laccoliths throughout the area. They are in many cases sheared and altered, and now consist of secondary minerals to such an extent that it is difficult to determine their original composition.

The granite stocks are composed of a grey biotite granite and occur arranged along a line stretching from Lansing mountains east of Stewart river to Potato hills near the valley of the Klondike. Three such stocks occur. The central of these occurs north of Mayo lake, about 8 miles to the east of Keno hill. These are believed to be cupolas of a batholith extending under much of the district.

The quartz and granite porphyries occur as dykes and thin sills. They are light coloured to white rocks of massive appearance showing crystals of quartz and feldspar. An important feature of these rocks is that they contain particles of the minerals of the ore-bodies such as pyrite, galena, and occasionally tetrahedrite. These are common along joint-planes, but also occur in the body of the rock.

KENO HILL

Keno hill is 42 miles by boat from Mayo, and has been the important producer of Mayo district. Commencing with a shipment of 2,100 tons in 1921, the camp has shipped 23,300 tons of ore and concentrates, the maximum shipment being in 1923 when a production of about 8,000 tons was attained.

The ore deposits of Keno hill are practically all fissure veins, that is they represent vein material deposited in fault fissures. The faults which gave rise to these veins are all of the normal type and this applies also to post-mineral faults. No reverse or thrust faults have been recognized. As a general rule the displacements along the faults are small; the maximum horizontal displacement noted being about 500 feet.

The veins may be divided into two classes, which have been termed longitudinal and transverse, depending on whether they follow the trend of the strata or cut across them. These two fault systems represent two stages of mineralization, the longitudinal faults being the earlier. In general these strike north 30 to 40 degrees east magnetic and the transverse faults make angles of 70 to 80 degrees with them. There is, however, considerable variation in direction of the faults in different parts of the area, and mineralization rather than direction is the criteron to determine to which class a vein belongs.

The strata in the area have a general east-west trend, but near the hillock known as Monument hill, the beds bend sharply to the south, and continue to the southward across Lightning creek, where they gradually resume their former direction. It is believed that the transverse faulting is directly attributable to this flexure, owing to the bending of resistant beds such as quartzite and greenstone. The origin of the longitudinal faults has not been satisfactorily solved; they may, however, be due to stresses developed at the time of intrusion of the granite mass referred to before.

The earlier mineralization consists of quartz, arsenopyrite, and pyrite. After being filled, the longitudinal fissures remained planes of weakness affected by subsequent movements. When the transverse fissures were mineralized, they probably acted as the main circulation channels for the ore-bearing solutions and considerable amounts of the ore minerals were deposited in them. The chief minerals of the second stage are siderite, freibergite, galena, and sphalerite.

Other minerals less common are native silver, argentite, covellite, chalcopyrite, pyrargyrite (ruby silver), polybasite, jamesonite, limonite, manganite, calcite, cerussite, malachite, azurite, and barite.

Location of Ore-shoots. It commonly happens that where a transverse vein intersects a longitudinal vein and passes upward from hard rock, such as greenstone or quartzite, to schist, the vein below the schist is an extremely favourable location for the formation of ore-shoots. This is probably due to the fact that the fissure through the harder rock remained relatively open, whereas in the schist the fissure was more or less sealed by a clayey, impervious gouge, forming a dam which forced deposition below it. It cannot, however, be affirmed that the schist is always barren of ore, for ore-bodies are known to occur in it, but the rule given will be found to apply in the majority of cases to the transverse veins. In the longitudinal veins the causes of the localization of ore-shoots are not so well understood, but in many cases the occurrence of black schist along either wall of the fault is accompanied by ore.

Genesis. By far the greater number of veins on Keno hill represent a simple filling of fault fissures. Replacement of wall-rock operated only to a slight extent except in the case of the Sadie-Treadwell vein. The ore minerals are in most cases fastened to the polished wall of the fault fissures, but do not project into them. In certain cases there is evidence of the solution of the wall-rock. This is shown in No. 9 vein of Keno Hill, Limited, where large, drusy cavities lined with crystals of siderite and galena occur in the foot-wall. Replacement of wall-rock occurs in the Sadie-Treadwell vein which presents many characters not exhibited in the other veins of the area. This vein, or rather mineral zone, follows an old line of weakness represented by quartz-arsenopyrite veins. It was probably reopened by a fault that branches and reunites, with cross faults between the main fractures. The country rock in the vicinity was badly shattered, the jointing emphasized, and the ore-bearing solutions penetrated each minute crack and crevice, widening it, and in places, replacing the country rock. In places the mineral zone is a network of tiny veinlets of siderite enclosing fragments of the country rock. As a rule these fragments lie in their original positions, but in certain instances they were rotated. These veinlets represent on a small scale what has taken place on a large scale. Veins of ore project into the country rock, in many cases at right angles to the main trend of the ore zone. Examination of thin section shows that these veins grew by replacement of the country rock. Fragments of quartzite or residual masses of granulated quartz and feldspar are included in siderite. In some cases, also, individual grains of quartz are seen with siderite projecting into them. It is consequently believed that the Sadie-Treadwell ore zone represents a fault complex along which the deposit grew by widening of fissure as the minerals were deposited, and by replacement.

The veins of Keno hill traverse schists, quartzite, and greenstone alike. The greenstone must, therefore, have been sufficiently consolidated to permit of fracturing at or before the time of mineralization. Moreover, the greenstone bodies by reason of their small size would be unlikely to hold solutions for long periods, particularly after the development of the faults. The acid dyke rocks carry small amounts of galena, pyrite, and tetrahedrite. As these were not injected until long after the greenstones were consolidated and even sheared, it is doubtful if the greenstones had any effect on mineralization.

The presence of small particles of the ore minerals in the acid dyke rocks suggests that these rocks may have been the source of the ore deposits. It is not thought, however, that these small bodies of acid intrusives caused the extensive mineralization of Keno hill, but rather that both they and the mineralizing solutions had their origin in a larger body of magma. A large mass of granite occurs to the east of Keno hill, and other masses occur in the district. The age of these granites has not been determined, owing to the lack of sedimentary rocks that would serve as time-markers. They have usually been considered contemporaneous with the Coast Range intrusives which in Yukon are about Jurassic.

Secondary Enrichment. There is little evidence to show that secondary enrichment played any important part in the formation of these deposits. On account of the frozen zone near the surface, an exceptional barrier to the processes of weathering exists. Consequently any secondary deposits were formed prior to this frozen zone—which dates from the Pleistocene—and were thus likely destroyed by glaciation. The rapid exhaustion of the rich shipping ore of No. 9 vein, Keno Hill, Limited, might at first sight seem to imply secondary enrichment. However, the location of the ore-shoot is controlled by a bed of schist near the present surface, which acted as a dam to the mineralizing solutions, and the maximum load was deposited in the vein near the location of the dam. Continuing downward is a body of disseminated ore. The drop in values is due largely to the inclusion of crushed country rock and gangue minerals in the vein, both of which occur sparingly in the upper workings. Assays of clean galena from the lower workings show nearly as high a silver content as in the upper workings. In the second place, post-mineral fractures, though rare, do occur in this vein, but there is no evidence of circulation along these channels which must have been good conduits for downward-moving waters, and no evidence of enrichment in their vicinity.

In the Treadwell-Yukon vein, the controlling factors of deposition have not yet been recognized. Consequently the relationship of this deposit to the present surface is not so well understood. It has suffered intense post-mineral faulting, both longitudinal and transverse to the ore-body, which is cut up into a series of fault blocks. These faults would serve as excellent channels for the downward circulating waters, and along them one would expect to find evidence of secondary deposition if any took place, but there is no sign of any.

The main minerals of the deposits are considered to be usually primary. Native silver, pyrargyrite, covellite, and polybasite have been found, and these are all deemed secondary. All these minerals, however, are present in such small quantities that prolonged search is necessary to secure specimens. The geological evidence and the mineralogical composition of the main ore-bodies, therefore, both point to a primary origin.

The ore deposits are believed to have been formed at moderate depths by hot, ascending solutions; the mineralizing solutions are considered to have had their origin in the magma that gave rise to the acid dykes and sills; and it is thought that changes in the ores with depth depend upon changes in primary deposition.

Silver Values. In large shipments of ore the silver has proved to be remarkably uniformly distributed through galena when free from gangue. The shipments made up to 1923 averaged very close to 200 ounces of silver to the ton, and this may be taken as the average of the galena on the hill. Where much freibergite is present, this content is increased greatly.

Description of Properties

As upwards of a thousand claims have been staked on Keno hill, only those properties that have shown promise are described. The descriptions are complete up to the year 1923 only. In some cases data which are considered reliable have been added.

Keno Hill, Limited

Keno Hill, Limited, was organized in 1920 to work certain claims then held by Yukon Gold Company, Limited. The original group consisted of several claims: Roulette, or Discovery claim, Keno Scotty, Solo No. 2, Pinochle, Wolverine, and Rico, and a number of fractions. These claims are staked across the top of the ridge, and extend into the basin of Faro gulch on the north, and Charity gulch on the south. Frame buildings were erected near the summit of the hill, and a power line 4 miles long, connected the property with a 100 K.W. steam power plant on Duncan creek.

The principal veins of the original group are twelve in number. These consist of two longitudinal veins, Nos. 1 and 6, and ten transverse veins cutting across between these two. Numbers were assigned to the veins in order of their discovery, and it seems probable that certain numbers were assigned to different parts of the same veins. Thus No. 9 and No. 2 are probably the same vein, but work which would prove this was never carried out. No. 9 was the principal producing vein, although Nos. 1, 3, 4, 5, and 12 have each contributed a small tonnage. There are adits on each of these productive veins. On vein No. 3 a shaft has been sunk to a depth of 150 feet, with levels at 30, 75, and 150 feet. The first level is 140 feet long, and reaches the surface on the steep slope of Faro gulch and forms an adit. The second level is 180 feet long and is also connected with the first by a winze, with an intermediate level. This winze also connects the second and third levels. Five small ore-shoots were encountered in these workings. The only one of any size extended from the surface to slightly below the first level. It was 40 feet long and pitched to the south, following the zone where the fault fissure has schist on both walls, i.e., the ore-shoot is formed in quartzite below a schist capping. Other small ore-shoots occurred near the entrance of the adit, and near the junction of the shaft and the second level. The balance of the ore found in these workings consisted of small stringers.

Vein No. 9 produced 8,000 tons of high-grade shipping ore up to the time it was closed down by Keno Hill, Limited, and small shipments have been made since that time by lessees operating the property. The ore-shoots of this vein are composed of clean sulphides, chiefly galena in the upper 200 feet, following the top of the quartzite. With the exception of small stringers practically no shipping ore was discovered below the second level, although the workings were carried to a depth of over 400 feet. The masses of clean galena in the upper workings averaged 200 ounces of silver to the ton and could be shipped directly from the mine. In the lower workings there is an abundance of disseminated galena, which requires milling before shipment. In the upper workings zinc averaged 0·5 per cent, and in the lower workings 7 to 8 per cent. The extent of the workings has not yet fully proved that there are no other ore-shoots in this vein, as the vein if persistent must intersect a second longitudinal vein, No. 6, where the chances for further shoots of ore would be increased.

Vein No. 1 has three adits, 230, 140, and 150 feet long. These are approximately 60 feet apart on the dip of the vein, and are connected by winzes. They tapped an ore-shoot 60 feet long and 14 inches thick in the upper workings, which, however, pinched out below. As this vein is one of the main fractures on the hill, having been traced across the original group and also found on the Maple Leaf claim of the Shamrock group, it is possible that other ore-shoots will be found along it. Vein No. 6, the second longitudinal vein crossing the property, is mineralized with quartz, pyrite, arsenopyrite, and jamesonite. The workings on it consist of several open-cuts. This vein carries small values in gold.

Vein No. 2 is probably the continuation of No. 9. A prospect shaft was sunk on it in 1920, but no further work was done. In veins Nos. 4, 5, and 12 small ore-shoots were encountered, but the largest ore-body in any of the veins, No. 9 excepted, proved to be less than 200 tons.

As a rule the veins on the original group had little gangue material. The ore where found was reasonably clean. More siderite was encountered on veins in greenstone, i.e., Nos. 2, 4, 5, than in the others. Most of the development work on the original group was done on veins of the transverse type. These have proved disappointing as the ore-shoots have proved to be small.

In 1923 Keno Hill, Limited, suspended operations on the original group, in order to prosecute work on the Sadie-Friendship group on the western slope of the hill. As this deposit did not prove up to expectations, the company abandoned the field in 1924, leasing its properties.

Sadie-Friendship Group

This group of claims was staked in 1920 and acquired by Yukon Gold Company under option in 1921. It consists of the Sadie and Friendship claims on the western slope of Keno hill. Little work was done until the winter of 1922-23, when a camp was erected. Three prospect shafts were put down 35, 20, and 75 feet deep following the dip of the vein. From a short level close to the surface, 360 tons of ore was extracted. The power plant on the property was not adequate to cope with the flow of water, however, and the workings were allowed to fill, until electric power, made free by the closing of the workings on the top of the hill, was available. In the winter of 1923-24, however, a shaft was sunk to a depth of about 180 feet, and prospecting of the property was undertaken. As the results were not satisfactory, the property was closed down, and later the Sadie claim was leased to Treadwell-Yukon Company, Limited, who owned the adjacent claims, the option on the Friendship claim being allowed to lapse. It is reported that since that time, Treadwell-Yukon Company has developed the Sadie claim by driving a tunnel from its own property, and has located ore-bodies of substantial size.

Amongst the claims prospected by Keno Hill, Limited, was the Lucky Queen, owned by H. Morrison. It is situated on Gambler gulch on the northern slope of the hill. The workings consist of two short adits and a winze 40 feet deep, but these were inaccessible at the time of examination of the property, owing to caving. Information concerning the property was furnished by A. K. Schellinger, engineer in charge for Keno Hill, Limited.

The vein was about 2 feet wide, and consisted of crushed country rock, cemented with quartz carrying freibergite. The freibergite occurs as stringers in the quartz, possibly 5 or 6 feet long and 1 or 2 inches in thickness. These stringers also penetrate the wall-rock. Near the winze is a cross fissure carrying galena. During 1922-23 the company took out 20 tons of ore averaging 200 ounces of silver to the ton. Included in this shipment were seven sacks of selected ore averaging 700 ounces of silver to the ton.

Treadwell-Yukon Company, Limited

This company in 1921 acquired a number of claims on the western slope of the hill, adjoining the Sadie-Friendship group. The chief holdings include the Bluestone, Ladue Lotus, Mary, Lansing, Bluebell, Poca Plata, Tunnel, Travice, and Silver Bell claims, and a number of fractions. The company is also working the Sadie claim of Keno Hill, Limited, under lease, and has an option on the Caribou claim on the top of Keno hill.

The workings are situated chiefly on the Ladue and Bluestone claims. Three shafts were sunk, Nos. 1 and 2 on the Ladue claim, and No. 3 on the Bluestone claim. The latter was a prospect shaft and was abandoned. Shafts 1 and 2 are approximately 400 feet apart, and levels were driven between the two at 50, 90, and 160 feet, and the 300-foot level was driven both north and south from No. 1 shaft. A drainage tunnel 3,000 feet long was driven to tap the vein at a depth of 500 feet, and the workings driven from this have been connected up with the upper workings through the shafts. The 200-foot level has been extended southwest to connect with the workings of the Sadie claim. This level, which crosses the Bluestone and part of the Sadie claim, is reported to have tapped important ore-bodies.

The 400-foot level driven since the completion of the drainage tunnel showed important shoots of ore near No. 1 and No. 2 shafts.

The 600-foot level has been driven 900 feet northeast from the drainage tunnel and has disclosed a body of siderite mostly too low in silver to be considered ore.

The ore is deposited along a shear zone, consisting of a fault that branches and re-unites, with cross faults at varying angles between these two. This faulting shattered the country rock and possibly also emphasized the jointing. The ore-bearing solutions filled the fissures and also penetrated the country rock along all available openings, so that in places the country rock is cut by a reticulating series of veinlets of siderite. The growth of the ore-bodies along the openings is in part due to the replacement of the country rock. The ore minerals are irregularly distributed, and consist of siderite, with galena, zinc blende, and freibergite. The ore is valuable chiefly for its silver content, and contains about equal amounts of lead and zinc. In many places the ore minerals are sufficiently concentrated to permit of hand-sorting, but most of the ore requires milling before shipping.

There are two main ore-shoots, one located near No. 1 shaft and known as No. 1 ore-body; and the other near No. 2 shaft known as No. 2 ore-body. The best ore found to date occurred on the 400-foot level, where No. 1 ore-body had an average assay value of 72 ounces in silver to the ton, 7 per cent lead, and 11 per cent zinc; and No. 2 ore-body 62·4 ounces of silver to the ton, 4·2 per cent lead, and 2·6 per cent zinc.

The vein is cut into a series of fault blocks by post-mineral faults. Many of these have a throw of only a few inches to a few feet, but the displacement along some of the more important faults is considerable.

A mill has been erected on the property, which has a capacity of about 100 tons daily. The mine is fully equipped with machinery. Power is furnished by a diesel engine driving an electric generator and a 75 K.W. steam-driven generator, a 165 H.P. diesel engine driving a compressor, and a 15 H.P. gasoline-driven hoist. The camp is equipped with buildings, and the haulage is looked after by four 10-ton caterpillar tractors.

This company has produced 93,629 tons of ore and shipped 8,021 tons of crude ore and 4,021 tons of concentrates since 1923. The contents of this ore are given as 4,027,839 ounces of silver and 9,318,585 pounds of lead. Production at the present rate seems assured for a number of years.

The Caribou claim, also under option to this company, is situated towards the eastern end of Keno hill. It was prospected by Keno Hill, Limited, in 1920 and 1921, but was allowed to revert to its original owners. On the summit of the hill was a vein about 5 feet wide striking north 45 degrees east and dipping 72 degrees to the southeast. The mineralization consisted of 4 to 5 inches of galena in a gangue of quartz, carbonates, and oxides. The outcrop was traced along the northern face of Caribou hill, where a considerable body of ore was found below the intersection of this vein with a flat-dipping fault. A tunnel was started here by Keno Hill, Limited, but was abandoned. No further data with respect to this property are available.

Lake Group

The Lake group consists of three claims, Lake Nos. 1, 2, and 3, staked in an easterly direction from the northeast corner of Treadwell-Yukon Company's holdings. These claims are owned by A. Hollenbeck, D. Cunningham, and R. Stewart.

Development is practically all confined to Lake No. 1 and consists of a shaft and a series of ditches, used for ground-sluicing, and a number of open-cuts. Float has been found at a number of points, but the main work has been confined to two veins, occurring close to the southern boundary of the property. The southern vein outcrops 100 feet from the boundary of the property, and strikes north 27 degrees east astronomic, and dips 35 degrees to the southeast. It is 5 feet wide, and is well mineralized with siderite, quartz, galena, chalcopyrite and freibergite, pyrite, and zinc blende. A shaft had been sunk 15 feet in 1923, but work was suspended on account of the flow of water. To the west of the shaft the vein is cut by a southeasterly-dipping fault of small displacement.

The second showing lies 150 feet to the north of the shaft and consists of a shear zone in schist, nearly parallel to the vein at the shaft. A short open-cut has been driven along the vein, which exhibits mineralization similar to that of the southern vein.

Onek Mining Company, Limited

The Onek Mining Company, Limited, was organized in 1922 to secure options on a number of claims on Keno hill. This company was under control of the Slate Creek Mining Company. A number of claims were secured and considerable prospecting done, but the chief work was done on a group of four claims, the Fisher, Lone Star, Galena Farm, and Rondo, situated on the southern and western slope of the hill close to Keno Hill townsite. Operations were discontinued in 1922, and eventually the holdings of the company were taken over by the Reserve Mining Company. No further work has been done by this company, however, but the claims have been leased to individuals who have taken out important amounts of ore.

A vein has been traced by means of open-cuts and underground workings across the Fisher, Lone Star, and part of the Galena Farm claims. On the Lone Star it is faulted about 100 feet to the north as shown by the line of open-cuts. The underground workings consist of a vertical shaft 135 feet deep, and two levels at 50 and 100 feet, which are 30 and 97 feet long respectively. The vein gives evidence of continuity on the surface and there is no evidence of change in mineralization to the depth that the workings have been carried. The mineralization consists of siderite, galena, and lead carbonate. A fairly persistent streak of galena varying from 2 to 20 inches in thickness is exposed in the workings. The values, as shown by a number of assays, range around 80 ounces of silver to the ton. On the 50-foot level the galena averaged 80 ounces of silver; on the 100-foot level assays across a face of 12 inches yielded as high as 140 ounces, and in the bottom of the shaft across a face of 8 inches, the galena assayed as high as 165 ounces. The values contained in the galena on this property are considerably lower than the average shipping ore from other properties.

Gambler Group

The Gambler group is situated in the basin at the head of Faro gulch, and consists of four claims, the Gambler, Lakeview, Madge, and Lost Chord, which are owned by A. Lamb, A. R. Thompson, C. Settlemier, and A. H. Dever.

One of the main longitudinal veins of the area crosses this property. It has been found at intervals across Faro gulch, and probably extends much farther than it has been traced. Two adits have been driven in this vein on the Gambler claim. The upper is 50 feet above the lower, and 81 feet to the south of it, and is 50 feet in length. An underhand stope 18 feet long and 12 feet deep is situated 18 feet from the entrance. The lower adit is 40 feet in length.

The vein, which varies in width from 4 to 6 feet, is mineralized with quartz, arsenopyrite, galena, zinc blende, freibergite, and siderite. The stope yielded 53 tons of ore about half of which assayed 230 ounces of silver and 34 per cent lead, and the remainder 135 ounces of silver and 46 per cent lead.

Silver Basin Claim

This claim is owned by R. Rasmussen and lies on the western slope of Silver Basin gulch. Development consists of one short drift and a number of trenches and open-cuts. Five veins, numbered in the order of their discovery, have been exposed by these workings. No. 1 vein is exposed in an open-cut that lies several hundred feet from the western boundary of the claim. The mineralization is typical, consisting of siderite, galena, and freibergite. No. 2 vein is exposed in a small open-cut to the northeast of the adit, and is about a foot wide. The mineralization is mostly quartz and arsenopyrite, but a small amount of galena occurs. Vein No. 3 is very similar to vein No. 1, No. 4 vein is one of the most important showings on the property. It is exposed in a series of open-cuts near the eastern boundary of the claim and has a width of 4 feet. It has been traced over a hundred feet, and also appears on the adjoining claim, Silver Basin No. 4, owned by M. Michie. The mineralization shows quartz, galena, siderite, and freibergite.

Vein No. 5 lies 150 feet to the east of No. 3 and is only partly exposed. It has apparently a width of 8 feet and is mineralized with quartz, arsenopyrite, galena, freibergite, siderite, barite, and occasional flakes of native silver.

Shamrock Group

The Shamrock group, consisting of seven claims and two fractions, owned by Messrs. A. Erickson, T. McKay, L. Beauvet, and A. Nichol, is situated near the summit of Keno hill, immediately to the west of the original group of Keno Hill, Limited. The workings consist of an adit 240 feet in length, with three crosscuts, and three prospect shafts, from the bottom of one of which a drift was run. These workings are all on the Shamrock claim. On the Reno are two open-cuts, and one on the Maple Leaf.

The adit taps a vein 80 feet from the entrance, and follows it to the end of the workings. This vein varies from 6 inches to 3 feet in thickness. The mineralization consists of galena with lead carbonates.

Two prospects shafts above the adit encountered two parallel veins. A shipment of 60 tons was taken from these workings.

On the Maple Leaf claim an open-cut partly exposes a vein thought to be the continuation of Keno Hill, Limited, No. 1 vein. On the Reno claim two veins are exposed in open-cuts. The exposures were poor, but the veins showed heavy galena mineralization.

Butyer Group

The Butyer group consists of two claims, the Stone and Rye, owned by M. Butyer, who also owns a half interest in the intervening claim. The principal workings lie on the Stone claim. The vein is exposed in three open-cuts on the northern slope of the hill, and an adit, 245 feet long, taps the vein below. In the adit the vein has a width of 12 feet and is mineralized with quartz, siderite, freibergite, chalcopyrite, and a little galena. The vein is considerably disturbed by post-mineral faulting. In the open-cuts above, the vein has a width of 12 feet and the filling is composed of schist fragments cemented with siderite, carrying galena, zinc blende, freibergite, and chalcopyrite.

A number of other claims have small showings of ore, which at the time of examination were not opened up. Practically all the shipments from Keno hill have come from the properties listed above, with the greater part of the production coming from the properties held by the organized companies. The ore reserves known to exist are chiefly located on the claims of Treadwell Yukon Company, Limited. In most cases individual miners have not pushed development far ahead of the work necessary to extract the ore. The exact tonnage available on the claims of Treadwell-Yukon Company, Limited, is not known, but it is believed that this company has ore in sight to cover operations for some years.

GALENA HILL

Galena hill is situated across Christal creek about 4 miles to the west of Keno hill. The distance of the properties from Mayo is about the same as those on Keno hill, namely about 42 miles by road.

The Silver King mine was discovered on Galena hill in 1906 and was the first lode deposit of importance discovered in Mayo district. It was mined from 1914-1916 and undoubtedly stimulated prospecting for this class of deposit in the district. It was not, however, until 1923, long after the discovery of Keno hill, that float was found on Galena hill which led to the discovery of other deposits.

Geology. In general the geology of the hill is similar to that of Keno hill, which has been described. The rocks consist of schist, quartzite, greenstone, and rhyolite. The schist-quartzite group has been divided into three members, a lower schist group, a middle quartzite group, and an upper schist group. The cleavage of the schist and greenstone closely parallels the bedding of the quartzite. In general the bedding and cleavage strike slightly north of east, except on the part of the hill to the east of its summit, where the direction is slightly south of east. The average of the dip is about 30 degrees southerly; the angle varies for the most part between 20 and 40 degrees, and is even as high as 75 degrees in the vicinity of some of the faults. All the consolidated rock formations are faulted.

Glacial deposits are thick on the lower part of the hill, and generally thin on the upper slopes and top of the hill. The ice moved southwest and on the top of the hill scattered quartzite boulders over the schist to the southwest. Most of the bedrock is covered with rock float, talus, vegetation, and glacial deposits, but the character of the bedrock may in many places be judged by the character of the float. Rock outcrops are scarce, except in the deep gulches.

The mineral deposits are fissure veins in which the ore occurs in the form of shoots. The veins follow faults which with few exceptions strike northeasterly and dip to the southeast at steep angles. The faults as a rule are not easily recognized. Fault planes are rarely exposed except in artificial excavations. Where not exposed their presence may be inferred where formations are offset along the strike. The veins have been classified on a mineralogical basis into four classes. There is no sharp dividing line between the four classes, but taken as a whole each group has certain fairly definite characteristics. The veins of group No. 1 may be called siderite-galena-freibergite veins. Manganiferous siderite is by far the most important gangue mineral; galena and freibergite are the most important ore minerals. The chief minerals formed by the weathering and oxidation of the ore and gangue minerals are cerussite, limonite, and manganese oxide, the last causing conspicuous blackening in the oxide zone. Quartz and pyrite are present as a rule, but only in small quantities. Chalcopyrite, azurite, and malachite were found in only one deposit. Native silver is reported to have been found near the surface of one deposit. Silver values as a rule are high, gold values are absent or unimportant.

A variety of deposits are included in group No. 2. The predominant gangue mineral is either quartz or ankerite; calcite is present in a few places, and siderite is either subordinate or absent. Although the ankerite carries manganese, the black oxide of the oxide zones, so conspicuous in the veins of group 1, is less conspicuous in most, though not all, of these deposits. Both galena and sphalerite were noted in all except one deposit;

pyrite is always present, and is important in most cases; limonite, cerussite, chalcopyrite, and malachite are also present. Silver values are important in some of the deposits.

The Silver King deposit, mined in the earlier years of the camp, does not resemble any of the other deposits of the hill in that it contains an important amount of ruby silver, and smaller amounts of marcasite and chert, and was a rich silver lead deposit in a gangue mostly of quartz. Small values in gold were also present.

The veins of group 3 may be called quartz-arsenopyrite veins. Quartz is the chief gangue mineral, but ankerite, calcite, and a minor amount of white mica are present in some veins. Arsenopyrite is characteristic; pyrite, galena, and sphalerite are present in most cases; pyrrhotite occurs in one case, and a speck of native gold was found in one deposit. Cerussite and limonite are present as oxidation products. The veins as a rule contain small values in both gold and silver. Deposits of this type on Galena hill have not yet shown promise of being of economic importance.

Group 4 is represented by one unimportant quartz-stibnite deposit said to carry low silver values.

The veins are faulted by northwesterly trending faults.

All the veins of group 1 occur in the quartzite, some of those of groups 2 and 3 occur in the quartzite, and the others in the lower schist and intruded greenstone. No veins are known to occur in the upper schist.

The veins cut greenstone and are probably closely related in age to the rhyolite. It is thought that both the material of the veins and the rhyolite had their origin in a granite mass which is believed to underlie most of the district.

Description of Properties

The Silver King property is situated on Galena creek, west of Keno hill proper. It was a producer of importance from 1914 to 1916. It was discovered in 1906 by H. W. McWhorter, and was afterwards allowed to lapse. It was restaked in 1912 or 1913 by McWhorter, who leased it to J. Alverson and G. Hoffman. These lessees did the first real development on the property and proved it to be of importance. They shipped 59 tons of ore to Trail, the returns of which amounted to $269 a ton in gold, silver, and lead. In the spring of 1914 the property was acquired by T. P. Aitken and H. Munroe. During the winter of 1914-15 these owners shipped 1,180 tons of ore to San Francisco. The smelter returns for this shipment included about $3 a ton in gold, and for about half the ore 280 ounces of silver to the ton and 39 per cent lead, and for the balance of the ore 260 ounces of silver and 23 per cent lead. Aitken and Munroe continued mining until 1916 when an option on the property was secured by Manley and Ives who did some drilling on the property.

The vein has a known length of 2,400 feet, strikes north 68 degrees east, and dips steeply to the southeast. The country rock on the foot-wall side is massive quartzite and on the hanging-wall side is schist and quartzite interbedded. The ore-shoot had a horizontal length of about 60 feet, and was mined to a depth of 200 feet from the surface. This shoot pitched to the northeast along the vein. The southwest end was 60 feet below the surface. The shoot averaged 3½ feet wide, and had a maximum width of

7 feet. The minerals present were chiefly galena and ruby silver in a quartz gangue; cerussite, sphalerite, iron sulphide, and siderite also occurred. In the bottom of the ore-shoot, iron sulphide and sphalerite were the predominant minerals. An examination of the dump showed the following minerals: pyrite, marcasite, sphalerite, galena, quartz, siderite, and minor amounts of chert, pyrargyrite, chalcopyrite, and manganese oxide.

The vein continues southwesterly from the Silver King property through two claims, the Mable owned by W. J. Tormey and the Adam owned by M. Evans. Material on the dumps of the shafts sunk in the vein includes siderite, ankerite, limonite, quartz, galena, and pyrite; both the siderite and ankerite are blackened by manganese oxide. No important ore-bodies have been found on these two claims.

Northwesterly from the Silver King claim the vein has apparently not been found. On the Webfoot claim, which is owned by J. Alverson, and is the first claim northwest of the Silver King, some manganese oxide and a small amount of pyrite were found on the dump of a prospect shaft; this shaft, however, lies to the northwest of the prolongation of the strike of the vein. The northeast extension of the vein has been possibly offset to the south by a cross fault which occurs higher up on Galena creek; this conclusion is supported by the fact that ruby silver float is reported to have been found to the south of the strike of the vein in a ground-sluice on the Webfoot claim.

Arctic and Mastiff Claims

These claims are at the present the most important on Galena hill. They are situated high on the northwestern slope of the hill near the head of Star creek. The owners are C. Settlemier, C. H. Bermingham, S. M. Dorr, and A. Stoner.

The claims were staked in 1921. In 1923 float was found which led to the discovery of the ore-body. In 1924, 26 tons of ore was shipped, in 1925 about 350 tons of ore was shipped, and in 1926 the shipments totalled 1,500 tons. The ore is hand-sorted for shipment. The owners state that the shipped material averages about 62 per cent lead, and 150 ounces of silver to the ton.

A shaft has been sunk to a depth of 46 feet, and a drift run for 100 feet along the vein. The floor of the drift is 38 feet below the collar of the shaft. Other workings consist of a prospect shaft and about twenty-five open-cuts.

A small amount of ore was found in sinking the main shaft, in the prospect shaft and in some of the open-cuts, but the main ore-body was opened up along the drift. The drift appears to be along the top of a tabular ore-shoot, the limits of which are not yet known. The part mined out was at least 90 feet long, and averaged 5 feet in thickness, but in some places was 9 feet thick. The hanging-wall of the ore-shoots dips at 67 degrees, the foot-wall is at a steeper angle. The strike is variable.

The minerals are galena, cerussite, and freibergite in a gangue of limonite, manganese oxide, siderite, and a very small amount of quartz and pyrite. The most abundant primary minerals of the deposit are galena and siderite. The vein has probably been offset by a northwest fault. The part of the vein described above lies on the northeast side of the fault, and appears to be offset to the southeast relative to the part on the southwest side of the fault. The latter part of the vein has been exposed by the prospect shaft and by open-cuts. The material on the dumps indicates that the vein is mineralized for a length of 300 feet from the fault with limonite, manganese oxide, and a small amount of quartz and pyrite; a little galena and cerussite were also found.

Ruby Fraction

This property, a small fraction owned by E. Bjonnes, is situated on the northeast side of the Mastiff claim. A vein 1½ feet wide, striking north 55 degrees east and dipping 67 degrees to the southeast, was prospected during the summer of 1925 by means of open-cuts. The country rock is mainly quartzite with some mica and graphite schist. The vein is mineralized with siderite, galena, a small amount of pyrite, and probably freibergite. Alteration products present are limonite, manganese oxide, and cerussite. The owner states that the galena carries from 250 to 385 ounces of silver to the ton, and the earthy cerussite carries as high as 700 ounces of silver to the ton.

Coral and Wigwam Claims

This property, part of a large block of claims owned by R. Fisher and Dr. W. E. Thompson, is situated at the head of Porcupine gulch on the northwest slope of Galena hill. The claims were staked in 1921, but no real prospecting work was done until 1924. Shipments amount to 7 or 8 tons of ore, assaying 258 ounces of silver to the ton, and 61 per cent lead.

The workings consist of a few open-cuts and three shafts along the strike of the vein. The centre shaft is 26 feet deep, and from the bottom a short drift has been run northeast along the vein, and near the end of the drift a short crosscut was driven southeast. No information is available regarding the other shafts, as these were filled with water at the time of examination.

The centre shaft, drift, and crosscut are in a shear zone striking north 53 degrees east and dipping 65 to 75 degrees southeast. The foot-wall is mica and graphite schist and the hanging-wall chiefly quartzite with some schist. Mineralization is irregular and occurs chiefly near the foot-wall of the shear zone. The primary minerals are galena, associated with a considerable amount of freibergite, in a gangue of siderite and minor amounts of quartz and pyrite. Alteration products are also present. It is reported that native silver occurred near the shaft.

Elsa Claim

This property, owned by C. Brefalt and D. Tolmie, is situated low down on the south side of Porcupine gulch. In the spring of 1925 a vein was exposed by means of ground-sluicing and was further prospected by means of an open-cut.

The country rock is quartzite with some graphite schist. The mineralization occurs in a fault which strikes north 45 degrees east and dips 70 degrees to the northwest. The walls are poorly defined in the open-cut, but the vein may be 7 feet wide. The primary minerals present are galena, siderite, freibergite, and minor amounts of quartz, pyrite, and chalcopyrite; the usual oxidation products are present. The vein material occurs in part as the cement of a quartzite breccia. The owners state that samples of the galena assayed from 69 to 82 per cent lead and from 150 to 446 ounces of silver to the ton, and that a sample of the siderite and freibergite assayed 1,450 ounces of silver to the ton. The fault probably extends a considerable distance northeast and southwest from this open-cut.

Dragon Claim

This property, owned by O. Miller, is situated on the northern slope of the hill about a mile northeast of its highest point. A vein has been prospected along its strike for a distance of 500 feet by means of three shafts 20, 24, and 42 feet deep, and five open-cuts and two sluices.

The vein, which is reported to be from 5 to 7 feet in width, strikes north 16 degrees east and dips 66 degrees southeast. The hanging-wall is quartzite and the foot-wall in most places is black schist. The minerals in the vein are siderite, limonite, manganese oxide, galena, cerussite, freibergite, and a little quartz. The ore minerals carry high values in silver, but are only sparsely distributed through the siderite which is the main constituent of the ore.

Near the northeast end of the vein the siderite ends abruptly and the mineralization is quartz, arsenopyrite, galena, and pyrite. It is assumed that this mineralization is in a cross fault which strikes north 82 degrees west.

Hector Claim

This property, owned by C. Sinyard and M. S. McCown, is situated just west of the highest part of the hill.

A vein which strikes north 48 degrees east and dips 65 degrees to the southeast was exposed by means of two open-cuts. The country rock is quartzite, graphite schist, and greenstone, the last being exposed in one of the open-cuts on the hanging-wall of the vein. Where exposed the vein is about 5 feet wide, and is filled mostly with limonite and manganese oxide. Cerussite and a little galena are also present. According to the owners the silver values are as high as 312 ounces to the ton, carried chiefly in the cerussite.

Dixie Claim

This claim, owned by J. V. Sullivan, is situated on the northwestern slope of Galena hill about 2,000 feet northeast of Porcupine gulch, and at an elevation of 3,900 feet.

The country rock is quartzite, intruded by a sill of greenstone. In two open-cuts in the quartzite 300 feet north of the greenstone some siderite float has been found. In an open-cut near the greenstone a quartz vein sparsely mineralized with arsenopyrite is exposed. It strikes roughly east-west and dips about 40 degrees south. Since the examination of this property in 1925 it is reported that an ore-body has been found, and that shipments will be made in the near future.

Rico Claim

This claim is situated on the eastern slope of the hill and is owned by H. A. Stewart.

The workings consist of a shaft and a tunnel, and a ditch for sluicing. The shaft exposes a vein in brecciated quartzite. The minerals observed were limonite, manganese oxide, a little ankerite, and minor amounts of quartz and pyrite.

Bluebird Claim

This claim, owned by A. McLeod, H. Rhor, and S. Turpin, is situated low down on the northeast slope of the hill. A vein striking north 25 degrees east and dipping 62 degrees to the southeast was exposed by means of two open-cuts. The vein is mineralized with galena, sphalerite, and pyrite, in a gangue of ankerite, calcite, quartz, limonite, and manganese oxide. The country rock is greenstone, and along the foot-wall it contains disseminated pyrite. The galena is reported by the owners to assay 292 ounces of silver to the ton and 77 per cent lead.

Tin Can Claim

This claim, owned by A. McLeod, H. Rhor, and S. Turpin, is situated low down on the eastern slope of the northeast end of the hill. The workings consist of a ground-sluice, two shafts, and a few open-cuts. The shafts have exposed a vein, which, judging from the material on the dumps, is mineralized with ankerite, calcite, quartz, sphalerite, pyrite, and a small amount of siderite, limonite, and manganese oxide. A small amount of galena is also reported to have been found.

Eagle Claim

This claim is situated on the eastern slope of the hill, and is owned by A. McLeod, S. Thurber, and Miss J. Stewart.

A vein that strikes about north 50 degrees east and dips steeply to the southeast has been prospected by means of several open-cuts, prospect shafts, and ditches. On the foot-wall side of the vein the country rock is mica and graphite schist, and on the hanging-wall side of the vein is quartzite. The vein is mineralized with quartz, siderite, pyrite, galena, sphalerite, limonite, and malachite.

Jupiter Claim

This claim, owned by R. Fisher, is situated at an elevation of 2,900 feet just west of Sandy creek on the northwest slope of the hill.

An open-cut exposes a small vein which strikes north 53 degrees east and dips 80 degrees southeast. The minerals present form bands parallel to the walls of the vein, and include quartz, ankerite, calcite, limonite, pyrite, arsenopyrite, sphalerite, and a little native gold and white mica.

Betty Claim

This claim is situated at an elevation of about 3,700 feet just east of Sandy creek on the northwest slope of the hill.

Two small open-cuts in greenstone have exposed a narrow vein that strikes about north 58 degrees and dips to the southeast. The minerals present are quartz, galena, calcite, sphalerite, arsenopyrite, pyrrhotite, cerussite, and limonite.

Crystal King Claim

This claim, situated on Christal creek at the foot of the northern slope of the hill, is owned by F. Swanson, O. Dahl, A. E. Erickson, and M. Evans.

The workings, which are now caved, are in schist. The property was worked in 1918, and showed five quartz-arsenopyrite stringers, and a shear zone 3 feet thick, through which are scattered small bunches of quartz, galena, sphalerite, arsenopyrite, and pyrite.

(2) Upper Beaver River Area

Upper Beaver River area comprises that part of the basin of Beaver river west of Braine creek. Silver-lead deposits were found on McKay hill in 1922, and since that time discoveries have been made on Grey Copper hill, and Silver hill. A trail has been cut from Keno hill to the district. These distances by this trail to the localities from Keno hill are respectively 45, 57, and 65 miles.

A canoe route to the district is also available. Canoes were taken up Stewart and Beaver rivers by Camsell and Keele of the Geological Survey in 1905, as far as the mouth of Braine creek, and it seems probable that gasoline launches could run from Fraser falls on Stewart up Stewart and Beaver rivers as far as the mouth of Rackla river. It remains to be tested whether this route is available for freighting. Provision would have to be made for portaging around Frazer falls, but a road could easily be constructed down Beaver valley to the mouth of Rackla river.

The first deposits were located on McKay hill in 1922. In 1923 high-grade float was found on Grey Copper hill, and in the same year claims were staked on Silver hill. The writer made a hurried trip to the properties on McKay hill in 1923, and returned in 1924 to map an area embracing all the then known deposits. Development work up to that time, however, included only the necessary work to legally hold the claims, and only a limited knowledge of the ore-bodies could be obtained.

In 1926 the Consolidated Mining and Smelting Company, Limited, took options on some of the claims of McKay hill, and prospected them, but the results of this examination are not yet available. It was reported that this company would continue work in 1927.

GEOLOGY

The area is part of the Ogilvie range, which is underlain largely by sedimentary rocks. These were tentatively divided into three groups. One of the groups, consisting of quartzite, slate, limestone, and conglomerate, occurs only to the south of the valley of Beaver river and Police creek, but is thought to correspond to a group of calcareous sandstone, slate, argillite, and limestone that occurs to the north of this valley. These rocks are known to be pre-Ordovician in age, and have been tentatively correlated with the Tindir group of Precambrian age occurring on the International Boundary.[1]

Overlying these are volcanic agglomerate, shale, sandstone, limestone, and shaly limestone. Fossils collected from the limestone ranged in age from Ordovician to Devonian. The limestone is massive, and the outcrops suggest the two limbs of an anticline, whose centre has been removed by erosion. The portion of Devonian limestone included is probably minor in amount; no definite stratigraphic break was recognized between the Ordovician and Silurian.

The igneous rocks are augite andesite and augite diorite. The andesites form small bodies of extrusives and intrusives and are abundant in the Tindir (?) rocks except in the quartzite south of Beaver river. They also form sills in the limestone.

The augite diorite intrusions are of small areal extent. One sill-like mass was noted to the west of Carpenter creek, and several sills to the south of Beaver river. The principal minerals are augite and plagioclase feldspar (andesine). The data as to the relative ages of the andesites and diorites are inconclusive, but the two rock types are thought to belong to the same general period of vulcanism. The andesites cut all the rocks with which they come in contact, including the Ordovician to Devonian limestone.

The silver-lead ores consist of galena with subordinate tetrahedrite and zinc blende in a gangue of quartz or calcite. A number of samples taken of the veins indicate a relatively low content of silver. Where tetrahedrite is present the silver content increases, but samples of fairly pure tetrahedrite show only 70 ounces of silver to the ton. In one case on Grey Copper hill, freibergite float has been found assaying 900 ounces of silver to the ton, but none of this was on the ground at the time of the writer's visit.

Descriptions of Properties

Silver Hill

Silver hill is situated near the head of Ervin creek, a tributary of Carpenter creek. It is a knife-edged ridge forming a spur of Carpenter ridge. Eight claims and two fractions, staked two deep across the ridge, have been located by J. Carpenter, E. Ervin, and J. McLean, of Keno hill. Several claims have been staked at either end of the group by other parties.

The rocks outcropping along the ridge consist of calcareous sandstones or dolomitic sandstones, intercalated with which are beds of impure sandy limestone. The strata strike in a general way along the ridge and dip at angles of 50 to 85 degrees to the west. Both strike and dip, however, vary rapidly from place to place. The western slope of the ridge, forming the dip slope, is steep, and exhibits numerous outcrops, particularly above the talus slope at the base. It is on this steep hillside that all the showings located to date occur. The eastern slope is more gentle and is covered with vegetation. Intrusive into the sandstones are several bodies of greenstone. The largest of these outcrops on the ridge to the east of Silver hill,

[1]Cairnes, D. D.: "Yukon-Alaska International Boundary"; Geol. Surv., Canada, Mem. 67, pp. 44-57 (1914).

in such a position that the beds of sandstone carrying the ore deposits lie above its upper contact. On the ridge to the west of Silver hill the Ordovician-Devonian limestone overlies the sandstone unconformably.

There are many short fissures in the sandstones of Silver hill, both transverse to the strike of the strata, and longitudinal. It is probable that the short, transverse fissures are due to minor crustal adjustment accompanying the intrusion of the greenstone mass. The ore deposits have formed along the short, transverse fissures, which served as channels for the mineralizing solutions. Mineralization apparently took place by replacement of the wall-rock along the fissures; this replacement was of a selective character, the impure limestone beds offering the most favourable spots for the formation of ore-bodies. The mineralization consists of galena, with subordinate sphalerite and pyrite in a gangue of calcite and siderite. Quartz is present only in minor amounts. The galena is quite fresh at the surface, being coated with only a thin film of carbonate, but in some places, an iron capping composed chiefly of limonite occurs to a depth of a few feet. The position of the ore-bodies with respect to the greenstone, and the lack of other igneous rocks in the neighbourhood, suggest that the mineralizing solutions may have had their origin in the magma that formed this greenstone mass.

Ore-bodies have been located at thirteen localities on this property. Some of these are small, whereas others have been traced by means of trenches for distances of 50 to 175 feet. The better bodies have a thickness of 3 to 6 feet.

In one case an outcrop of country rock carries irregular masses of galena with disseminated galena over a total width of 100 feet. The distribution of the galena is extremely irregular, although few large pieces of rock can be obtained that do not show specks of it. The largest mass of galena here exposed at the time of examination was 30 feet long and had a thickness of 6 inches to a foot.

One of the best showings on the property is partly exposed in a trench. This appears to be a tabular body about 26 feet thick. Its length is unknown as it has been crossed by only the one trench. It is composed mostly of galena, but carries a little pyrite and zinc blende. Near the hanging-wall is a horse of unreplaced country rock. A sample cut across this deposit yielded 65 per cent lead and 4·5 ounces of silver to the ton.

At another locality is a fault breccia, the cement of which is partly galena and pyrite. These sulphides also show in the country rock for a distance of 100 feet from the fault, but nowhere was a large body of ore visible.

Considerable development work remains to be done on this property in order to show the size and shape of the ore-bodies.

Grey Copper Hill

Grey Copper hill is situated 4 miles north of the mouth of Carpenter creek. The discovery, by R. Fisher, in the autumn of 1923, of rich freibergite float on this ridge led to a stampede to the hill, during the course of which upwards of fifty claims were staked, mostly on the snow. Only assessment work was done on them during 1924.

Only one mineral vein was noted, but float from other veins was observed. The available evidence indicates that these are of the tetrahedrite-siderite-pyrite type, very similar to those of Keno hill, with this exception, that no galena was noted in the occurrences of Grey Copper hill.

The only vein seen was on discovery claim—the Grey Copper King. This vein outcrops in a small canyon on the western face of the hill a few hundred feet above timber-line. It is partly exposed in a small open-cut, and is estimated to be 24 to 30 inches thick. The fissure strikes north 10 degrees west, and dips 78 degrees to the southwest. The vein filling consists of siderite, tetrahedrite, and pyrite, with some quartz, azurite, and malachite. The siderite makes up the bulk of the deposit, and is light brown, and coarsely crystalline. Tetrahedrite and pyrite are scattered through it in small specks and bunches. A sample of 16 inches of this vein was taken, and assayed 52 ounces of silver to the ton.

On the King Tut claim farther up the hill, it is claimed that freibergite float carrying up to 1,100 ounces of silver to the ton has been found. None of this was observed by the writer, although careful search of the vicinity was made. A vein of siderite about 20 feet long and of unknown thickness crosses the gulch at this point.

It seems evident that other veins occur, and it is not improbable that galena will be found when these are fully prospected.

McKay and Neighbouring Hills

McKay hill is situated between Beaver river and Police creek. The chief claims with mineral showings are the Carrie and Whiterock, owned by L. B. Erickson, the Snowdrift, owned by W. F. McKay, and the Black Hawk, owned by C. Beck.

The mineral deposits occur in and at the borders of small masses of amygdaloidal andesites and andesite breccias in which calcite fills the amygdules and replaces the original constituents of the rocks. No deposits are known in the Tindir (?) slates which occur at this point. The deposits are exposed at only a few points; in most instances their presence is indicated only by float.

The positions of the exposed bodies, and the distribution of the float indicate that a mineralized zone crosses the southern face of McKay hill, with a general strike of north 30 degrees magnetic, and that it passes close to the common corner of the four claims. It cannot be stated definitely whether this zone is a continuous vein with ore-shoots at intervals, or whether it consists merely of a number of lenses arranged along a single line. The latter alternative appears the more likely explanation as the float is found at isolated points. Other deposits, some of them roughly parallel with this zone, occur at different points on the claims.

The main showing lies on the Carrie claim about 400 feet to the southwest of the common corner of the four claims. At this point an open-cut has exposed a mass of galena, 12 feet 6 inches wide. The strike of the hanging-wall is north 30 degrees east, and on the foot-wall it is north, both walls being approximately vertical. In a second cut 30 feet to the northeast the ore-body is only 4 feet wide, and in a third cut 50 feet farther in this direction, no ore was found. A section across the large showing from hanging-wall to foot-wall shows as follows:

	Feet	Inches
Disseminated galena in quartz	0	6 to 10
Crushed quartz	0	12
Massive galena with tetrahedrite and blende	5	
Quartz with disseminated galena	4	6
Massive galena	2	6

A sample cut across the face of this body assayed 3·25 ounces of silver to the ton and 56·45 per cent lead. Two samples of float from the same vein taken the previous summer assayed 45·0 and 14·0 ounces of silver and 59·45 and 78·20 per cent lead, respectively.

At the common corner of the four claims the most northerly outcrop of this vein is exposed. It apparently consists of a sheeted zone about 35 feet across, including two horses of greenstone 10 and 8 feet wide. Samples showed 4·0, 10·0, and 5·5 ounces of silver, and 22·83, 44·00, and 39·38 per cent lead.

No other outcrops belonging to this zone occur, but streams of float descending the hillside indicate where other mineralized portions occur. Two samples of this float, one a sample of massive tetrahedrite, were assayed, and gave 62·1 ounces of silver and 17·80 ounces of silver, and 9·57 and 63·40 per cent lead.

Veins or ore-bodies other than those belonging to the zone described occur as follows. Two large quartz veins, apparently barren, occur near the summit of McKay hill. To the north of the summit the existence of two veins is indicated by float. One of them occurs about 100 feet, and the other 300 feet, northwest of the summit. The first apparently consists of quartz, galena, and tetrahedrite, and a sample assayed 13·2 ounces of silver, and 54·0 per cent lead. The second occurs in a small saddle, and consists of quartz, galena, and tetrahedrite. A sample of the float assayed 11·0 ounces of silver to the ton, and 44·95 per cent lead.

On the eastern end of the hill a vein outcrops on the Snowdrift claim. It is only partly exposed, with the hanging-wall and 18 inches of the vein visible. The quartz lying along the hanging-wall is barren for about the width of a foot, the remaining 4 to 6 inches is well mineralized with tetrahedrite, malachite, and azurite. The covered part of the vein probably consists of quartz and galena. Two samples were taken, the first a picked sample of the tetrahedrite, and the second a sample of the vein material, both float, and occurring in place. These assayed 38·0 ounces in silver, and 26·0 ounces of silver to the ton, and 4·58 and 19·76 per cent lead.

Quartz float has been found at two places at the eastern end of the hill, but no trenching has been undertaken on these.

Adjoining these claims is a group of four claims to the south, two to the north, and two on the west. These may be considered as belonging to the group already described. On the east and north is the Yellow Rock group of six claims owned by A. N. Martin, O. Dahl, E. Anderson, and C. Williamsen. Mineral float has been found at several points on these claims, but the ore-bodies from which it comes have not been located.

Horseshoe hill lies to the east of McKay hill, separated by the small gulch known locally as Red gulch. In the saddle at the head of the right fork of Red gulch, a large amount of vein float has been found. The float consists of quartz, galena, and tetrahedrite. Samples were taken of this float, and assayed 1·0, 0·6, and 1·0 ounces of silver to the ton, and 62·3, 42·36, and 29·15 per cent lead.

On the hills surrounding McKay hill there is considerable evidence of mineralization. Large quartz veins occur near the summit between Beaver river and Police creek, and on the Crystal claim of F. Envoldsen, on the western side of Falls creek, a vein carries galena, chalcopyrite, zinc blende, and limonite, in a gangue of quartz.

The deposits of McKay hill and surrounding hills are not sufficiently developed to permit of obtaining a good idea of their nature and genesis. None of the ores which to date have been located in place in Beaver River area are rich enough to permit of mining under existing conditions of transportation. At present the ores would have to be hauled overland 85 to 100 miles to Stewart river and then shipped to smelters on the Pacific coast, a distance of some 3,000 miles.

Lookout Mountain

Mount Haldane (or Lookout mountain) is situated to the west of Galena hill. The Lookout Mountain property is situated on a spur lying to the west of Bighorn creek, about 28 miles by road from Mayo.

This property was prospected in 1918, 1919, and 1920 by a local company, and a large amount of work was done. Promising values were found, but failure to find ore-bodies of size and grade sufficient for shipping forced the abandonment of the enterprise. The property is owned by A. Johnson.

The country rock is quartzite and quartz-mica schist with some greenstone. Small bodies of granite porphyry intrude the schist series. The vein follows an irregular fracture striking north 30 to 60 degrees west and dipping to the northeast at 50 degrees. The thickness of the vein varies from a few inches to 7 feet or more.

The mineralization consists of quartz, galena, limonite, manganite, pyrolusite, anglesite (?), cerussite, and occasional specks of copper minerals. The ore is disseminated, the galena occurring in small streaks and masses. Galena is abundant in the upper winze and along the foot-wall of the intermediate adit. On the third level are two streaks of carbonates, which carry high, but very erratic, values in silver. A small ore-shoot occurs in a winze sunk below this adit. Twenty-nine tons of hand-sorted ore were shipped, the smelter returns being 95 ounces of silver to the ton, and 59 per cent lead.

The workings consist of an upper adit 50 feet long terminated by a winze 25 feet deep; second or intermediate adit 39 feet lower and 90 feet to the north, and 59 feet long; a drift, along the vein which has been run to directly below the winze from the upper adit, an upraise has been driven to within 6 feet of the bottom of this winze; a third adit, 125 feet below the second and 32 feet to the north, is 135 feet long to where it taps the vein, and has been continued as a drift for 305 feet in a southerly direction, with winzes at 10 and 140 feet which are 55 and 90 feet deep respectively, fourth level has been driven between these two winzes.

The float from several other veins has been found across the creek, but these have not been prospected.

Davidson Mountains

Davidson mountains are situated across Ladue valley to the north of Keno hill. Prospects have been discovered at a number of points, but none of these has as yet reached the productive stage.

A winter trail leads from the road at Galena creek to mount Cameron, with side trails to Stand-to and Rambler hills.

The geology is similar to that of Keno hill. The greater part of the area is underlain by quartzites, quartz-mica schist, and crystalline limestone, with intrusive bodies of greenstone. One body of muscovite granite was noted, but none of the acid dyke rocks of the type found on Keno hill was noted.

Stand-to Hill

This property is situated on the east side of Homestead creek about 2 miles from its mouth. The workings are about 500 feet above the creek level.

The property comprises seven claims owned by J. Zahn, W. Forbes, D. Forbes, D. MacDonald, J. Falconer, and J. A. Macdonald. These claims are grouped for purposes of assessment work, and were staked in 1920.

The vein is a fault fissure having a vertical displacement of about 50 feet and has been traced for a length of 200 feet. The strike is south 50 degrees east, and the dip about vertical. The width varies from 16 inches to 2 feet, and the vein is mineralized with galena, calcite, siderite, cerussite, manganite, limonite, chalcopyrite, and quartz. Two samples were taken, and these assayed 3·30 and 17·60 ounces to the ton, and 19·36 and 4·40 per cent lead.

The workings consist of a number of trenches and a 50-foot drift on the vein.

Rambler Hill

Rambler hill is about 6 miles east of the foot of McQuesten lake. The property lies on the summit of the hill, and comprises eight claims, which are owned by A. R. Thompson, H. Colley, J. Alverson, G. Forey, J. Lake, and J. Robertson, each of whom owns an undivided eighth interest.

The vein filling consists of limonite, galena, pyrite, quartz, cerussite, anglesite (?), malachite, and chalcopyrite. Limonite makes up the greater mass of the deposits, and included in it are nodules of galena coated with oxidation products. Near the surface and extending downward for 37 feet are large masses of galena; below, these disappear leaving only small nodules in the limonite.

Galena appears in three open-cuts along the vein between the shaft and the adit. In the adit the vein appears 3 to 4 feet thick with a variable dip and strike. Galena is present as small bands and irregular masses in the vein, with chalcopyrite as small specks in the galena. Two samples of fairly pure galena were taken. These assayed 36·80 and 36·00 ounces of silver to the ton, and 54·91 and 52·60 per cent of lead.

The workings consist of a shaft and adit. The shaft is 80 feet deep, with a crosscut 12 feet long. The vein was traced 300 feet down the hillside from the shaft, and the adit started. It is comparatively short.

On surrounding claims little other than assessment work has been done, and although it is evident that other veins occur, it is impossible to give particulars with respect to these, as the surface is covered nearly everywhere with drift. On one claim, the Lucknow, owned by A. R. Thompson, a fault fissure has been traced by means of float for 2,000 feet, and at one point where a trench was dug there is a broken outcrop of galena, which has a width of possibly 5 feet.

Mount Cameron

The Mount Cameron property is situated on mount Cameron about 45 miles in a direct line from Mayo. The distance by road and winter trail is nearly 65 miles. The property consists of three claims, owned by J. Alverson, J. Scougale, and J. Philip.

The outcrop is a decomposed mass of iron and copper mineral chiefly limonite, manganite, azurite, and malachite, and judging from the material that is present on the dump the chief minerals are pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, limonite, siderite, manganite, and calcite. The galena apparently occurs in streaks and small masses that would attain a maximum width of perhaps 6 to 8 inches. The outcrop is 50 feet wide, and can be traced on the surface for 440 feet. A sample of fairly pure galena from the dump assayed 76·00 ounces of silver to the ton, and 56·83 per cent lead.

The workings consist of an adit and crosscut, but these had caved at the time of the writer's visit.

(3) Dawson District

CHANDINDU AREA

Reference

Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1918, pt. B, pp. 15-17.

Chandindu area is the region adjacent to Chandindu (or Twelvemile) river, a tributary joining Yukon river 17 miles north of Dawson. The Chandindu, 11 miles above its mouth, forks into two branches, known as the Chandindu and Little Twelvemile. The deposits of this area are situated on Spotted Fawn gulch, a tributary to Little Twelvemile creek. A road from Dawson leads to the powerhouse of Yukon Gold Company, situated at the forks of the Chandindu. From this point the flume affords a good footpath, to within 6 miles of the property, and from the end of the flume there is a trail to the property. In winter supplies may be hauled up the valley of the Chandindu and Little Twelvemile.

The region is in Ogilvie range, and for the greater part is underlain by sedimentary rocks, consisting of a lower group of red and green slates, phyllites, banded cherts, and limestone. Overlying these apparently conformably are black slates and quartzites, with impure, sandy limestone. These have all been classed tentatively as belonging to the Tindir group of Precambrian age. They are intruded by numerous bodies of acid and intermediate rocks.

The ore-bodies outcrop in the canyon of Spotted Fawn gulch, and a number of claims have been staked, but ore has been found on two claims only, the Ophir and Galena Farm, which form part of a group owned by D. B. Cole, C. Fothergill, C. Sproule, W. Mellville, W. Elliott, and Judge Craig. In the canyon of Spotted Fawn gulch, a greenstone dyke breaks through the quartzite and slate. The dyke is exposed for about 1,200 feet along its strike, and has a width of 300 to 500 feet. The veins are small fissures in the dyke and traverse it in a direction nearly parallel to the system of joint-planes.

On the Ophir claim there are two veins nearly parallel in strike, and about 4 feet apart. These dip at different angles, and intersect about 6 feet below the surface. The maximum thickness of one is 16 inches, and of the other 10 inches. The vein filling is coarsely crystalline galena with pyrite and calcite with included angular fragments of greenstone. Small specks of galena occur in the wall-rock, but are rare. About 75 feet upstream from this showing another vein similar in character but thinner and more sparsely mineralized occurs. In addition to the veins, many of the joint-planes have galena and calcite deposited in them. Four samples taken assayed 73·60, 105·00, 30·08, and 29·96 ounces of silver to the ton, and 50·11, 63·36, 20·64, and 18·62 per cent lead.

The grade of the ore is sufficiently high to stand shipment after sorting, but the deposits observed are too small to be of economic importance.

(4) Sixtymile District

MILLER CREEK

Reference

Cockfield, W. E.: "Sixtymile and Ladue Rivers Area"; Geol. Surv., Canada, Mem. 123, pp. 51-52 (1921).

Miller creek is a tributary entering Sixtymile river near the International Boundary about 60 miles by road west of Dawson.

Galena occurs in the placer concentrates on Miller creek in such quantities as to indicate that veins or disseminations of this mineral occur in the bedrock of the creek basin.

One such vein was found near the head of the creek. The country rock in the vicinity consists of quartz-mica schist, carrying lenses of crystalline limestone. On this prospect small quartz veins cut the limestone, but do not extend into the schist. They carry small bunches of galena and zinc blende. The total amount of the sulphides is small. A sample cut across several stringers, but not including the intervening country rock, assayed: gold, trace; silver, 1·40 ounces to the ton; lead, 3·60 per cent; zinc, 4·40 per cent.

High-grade float carrying ruby silver has been reported from Tenmile creek, which enters near the mouth of Sixtymile river, but the ore-bodies from which this comes have not been located.

(5) Windy Arm District

References

McConnell, R. G.: "Windy Arm District"; Geol. Surv., Canada, Sum. Rept. 1905, pp. 25-32.
Cairnes, D. D.: "Report on a Portion of Conrad and Whitehorse Mining Districts"; Geol. Surv., Canada, 1908.
"Windy Arm"; Geol. Surv., Canada, Sum. Rept. 1907, pp. 13-14.
"Windy Arm"; Geol. Surv., Canada, Sum. Rept. 1908, pp. 31.
Geol. Surv., Canada, Sum. Rept. 1916, pp. 34-44.
McLean, T.: "Lode Mining in Yukon"; Dept. of Mines, Canada, Mines Branch, 1914, pp. 188-201.

LOCATION AND ACCESSIBILITY

The area known as Windy Arm district lies between lake Bennett and Windy arm, Tagish lake, and between latitudes 60 and 61 degrees.

Carcross, a point on the White Pass and Yukon railway, serves as a distributing centre for the district. It is 68 miles from Skagway, a port of call for the coast steamers sailing from Vancouver and Seattle. From Carcross a wagon road has been built to the Big Thing, a distance of 6 miles, and another road has been built to Conrad, a deserted village on the west shore of Windy Arm. The distances from Carcross to Conrad and the Venus by water are $11\frac{1}{2}$ and $15\frac{1}{2}$ miles respectively. All the Windy Arm properties are readily accessible as practically all, except the Big Thing, are situated from $1\frac{1}{2}$ to 4 miles from Windy Arm, and at elevations of 1,200 to 3,600 feet above it.

HISTORY

During 1904 and 1905 a large number of claims were staked about Windy Arm, and most of these were subsequently acquired by Colonel Conrad and the organizations which he controlled. In the spring of 1905 Colonel Conrad commenced to develop these properties, and continued operations until 1912, when he was forced to close down, the properties being taken over for moneys advanced by the Mackenzie and Mann interests. From that time until 1916, no work was done. In 1916 the Lakinaw and Tagish Mines of Seattle, also known as the Harper Syndicate, secured a lease and option on a number of the Conrad properties, including the Montana, Mountain Hero, Vault, Venus Nos. 1 and 2, M and M, Joe Petty, Uranus No. 1 and No. 2, Little Johnnie, Capella, and Black Jack. Work was done on these properties for several seasons, but the properties were closed down again, and have not been operated since.

In 1916, the Alaska Corporation of Skagway obtained a lease on the Big Thing and operated for one or two seasons. On other properties there has been no mining done since 1912, other than the necessary representation work.

GEOLOGY

The district is underlain by cherty quartzite, slate, and limestone of about Devonian age, and by arkose, argillite, shale, and tuff of Jurassic age. These sedimentary formations are cut by andesites of Mesozoic age, and by granite belonging to the Coast Range intrusives.

The ore deposits occur as fissure veins traversing andesite. The gangue is dominantly quartz, and the ore minerals consist of pyrite, galena, and arsenopyrite, with a number of rich silver sulpho-salts such as pyrargyrite and freibergite, and stephanite. Associated with these are tetrahedrite, native silver, chalcopyrite, jamesonite, yukonite (an hydrated arsenate of calcium and iron), lead and copper carbonates, stibnite, orpiment, and realgar. Sphalerite is mentioned by McConnell as a constituent mineral of most of the deposits, whereas Cairnes does not refer to it in his more detailed description.

The deposits are valuable chiefly for their gold and silver content, but in some cases considerable amounts of galena are present. In the descriptions that follow, only those properties that have known ore-bodies of galena, or those that may be reasonably expected to have galena bodies, have been described. Veins whose values are chiefly in gold, with galena occurring only sparsely, have been omitted.

GENESIS

No discussion of the genesis of these deposits has been undertaken by the writers concerned. It is reasonably certain, however, that they were formed by mineralizing solutions from the magma that gave rise to the Coast Range intrusives. The veins are very similar to a group occurring in Wheaton district, where a similar origin has been ascribed to them.

Description of Properties

Venus

The Venus property consists of the Venus No. 1 and No. 2. It is one of the original Conrad properties, which was closed down in 1912 and not reopened until 1916. It was closed down again about 1919 or 1920 and since that time no work has been done on it.

The vein is a compound fissure in Jurassic andesites, which in this vicinity are decidedly tuffaceous. The vein strikes north 10 degrees east astronomic and dips to the west, i.e., into the hill at angles ranging from nearly flat to 60 degrees. The vein itself has been produced mainly by deposition in open crevices, as indicated by the pronounced comb structures and banding, but is also partly the result of replacement of the wall-rock. The vein as a whole is usually well-defined by two faults from a few inches up to 9 feet apart. Between these is the vein material and more or less replaced country rock, occurring in bands parallel to the walls or in irregular fragments or blocks. The actual ore ranges from an inch to 7 feet in thickness, but in most places in the underground workings is 2½ and 3 feet thick.

The vein materials include mainly quartz, galena, pyrite, and arsenopyrite, but with some jamesonite, yukonite, chalcopyrite, and tetrahedrite, as well as lead and copper carbonates. The values are mainly in silver, which occurs dominantly associated with the galena. Important amounts of gold also occur associated with the arsenopyrite. The gold and silver content of the ore varies greatly. Picked samples have been obtained that ran over $200 in gold and silver to the ton, but the gold rarely exceeds $50 to the ton, and is usually under $25. Silver varies from 1 ounce to the ton to over 100 ounces, but in general the ore in the higher grade shoots averages from $30 to $50 to the ton in all values. Much of the vein, however, is low grade, running from almost nothing to about $20 to the ton.

Workings. On the Venus No. 1 a shaft 52 feet deep has been sunk, up to 1916, with drifts about 50 feet in length in each direction from the bottom of the shaft.

On the Venus No. 2, two adits have been driven to tap the vein at different depths. The upper adit is 70 feet long and intersects the vein 75 feet below the surface. The lower adit is 600 feet long and cuts the vein 263 feet below the level of the upper adit. From the upper adit drifts have been run distances of 108 and 88 feet to the south and north respectively. Some stopes have been excavated from this level.

From the lower adit drifts have been run 583 and 622 feet to the south and north respectively. Several raises have been driven from this level, one of which reaches the surface, and stopes have been excavated. Two winzes have been sunk from the north and south drifts of the lower level, and are said to be 235 and 400 feet deep. Some drifting has also been done from these winzes.

A concentrating mill has been built on the shore of Windy arm below the mouth of the lower adit. It was designed for a capacity of 100 tons daily. The equipment includes a 100-horsepower boiler, a 75-horsepower engine, and also a partly installed hydraulic plant to obtain power from Pooly canyon. The concentrating equipment includes grizzly, Blake crusher, trommels, rolls, a Huntington mill, jiggs, four Callow screens, six Callow settling tanks, three Wilfley tables, and two Frue vanners. The mill was run only a short time when losses in the slimes were found to be extremely high, and as a result it was closed.

The mine equipment includes an engine and compressor, hoist, machine drills, ore cars, and blacksmith shop. The mine buildings, including bunk house, and cook house, have been erected on the beach near the workings.

The most recent examination of this property by the Geological Survey was made by Cairnes in 1916. At the time he estimated that 20,000 tons of ore was in sight. Part of this has been subsequently removed, but it is believed that a considerable part still remains.

Dail and Fleming Group

A number of claims generally known as the Dail and Fleming group are located immediately to the south of the Venus. These include the Venus Extension, Red Deer, Humper No. 1 and No. 2, Nipper No. 1 and No. 2, and Beach. In 1906 these claims were bonded to the Anglo-American Consolidated Company of Seattle for a period of two years. That company sank the Venus Extension shaft, and ran drifts from it, but on the expiration of the option, terms could not be agreed upon, and the property was optioned to Colonel Conrad for three years. In 1910, however, the property reverted to its original owners, and since that time only the work necessary to hold the claims in good standing has been done. Recently the ownership has changed. The claims have been divided into two groups: the first three forming the Venus Extension group, owned by I. E. Fleming; and the second three the Humper group, which is reported to be owned by John Miller and Mrs. M. Watson.

Three principal veins have been found on the property, known as the Venus, Humper, and Red Deer veins.

The Venus vein is a continuation of the vein occurring on the Venus No. 2 and has been traced across the Venus Extension, but has not been found on the adjoining claim, the Nipper No. 2. The vein possesses the same main characteristics as on the Venus property, being from a few inches to 4 feet thick, but generally from 18 to 30 inches thick. On the Venus Extension the vein is extensively leached and oxidized. Its attitude is nearly flat. Pyrite, arsenopyrite, and galena occur, also yukonite, lead carbonate, orpiment, and realgar. The gold content runs about $15 to the ton, and the silver content, except for occasional rich spots, probably does not average over 5 to 10 ounces to the ton.

The Humper vein also occurs in a fissure traversing andesites. The strike varies from east and west to north 60 degrees east astronomic, and the dip from 35 to 65 degrees to the north. The thickness is 10 to 24 inches where explored. The vein filling consists of quartz, with argentite, pyrargyrite, stephanite, galena, pyrite, and some native silver. The average content is not known.

The Red Deer vein is also a fissure in andesites. It strikes north 30 degrees east astronomic and dips northwest at about 50 degrees. Where exposed it is a few inches to 3 feet thick, and is composed mainly of quartz, which carries pyrite, galena, and some of the high-grade silver minerals.

The bulk of the development work on these claims has been performed on the Venus Extension claim which adjoins the Venus No. 2. On this claim a shaft has been sunk near the northern end of the claim for 120 feet, and at a depth of 40 feet drifts to the aggregate length of 45 feet have been run in each direction. About 200 feet from the southern end of the claim an open-cut has been run in 30 feet, and near the southern end of the claim an adit was driven 35 feet to the vein and thence continued as a drift 150 feet farther.

On the Beach and Red Deer claims only a small amount of surface work has been done.

On the Nipper No. 2 a number of pits and cuts have been excavated in the hope of locating the extension of the Venus vein. About 85 feet from the south end of the claim an open crosscut was driven 45 feet and a winze was sunk 30 feet, from the bottom of which a short drift was run on a low-grade vein 6 to 8 inches in thickness.

On the Humper No. 1 near the north end of the claim, a pit was sunk on the Humper vein. About 300 feet southwest of this pit and near the northern end of the Humper No. 2, an open-cut has been run about 20 feet into the vein, and from the end of the open-cut a winze has been sunk 16 feet. From the open-cut about 40 feet of drifting has been done and from the drifts stopes have been raised to the surface.

Montana

The Montana is one of the most important of the original Conrad properties. It also was bonded to the Harper Syndicate in 1916, and was prospected at that time, but later the option was abandoned. It is located about 3 miles southeast of the Big Thing and 2½ miles from the shore of Windy arm, and about 3,900 feet above it.

The Montana vein strikes north 43 degrees west and dips to the southwest at angles ranging from 10 to 30 degrees. It occurs in a fissure cutting volcanic rocks, and is from 2 to 5 feet thick. It is composed mainly of quartz, with which are associated galena, pyrite, arsenopyrite, pyrargyrite, argentite, tetrahedrite, native silver, and lead carbonate. The values are principally in silver, but the pyritic portions also carry gold. The vein matter is in places highly impregnated with silver minerals for a thickness of 8 to 18 inches and assays $80 to $90 to the ton. The rest of the vein is much lower in grade and requires concentration. This is considered to be one of the most important veins in Windy Arm district.

Development. A drift has been run along the vein for 700 feet and an incline shaft has been sunk on the vein for part of its depth, but departs from the vein where the vein changes dip. A short crosscut has been run from the bottom of the incline to tap the vein. Also on the adjoining Mountain Hero claim, a crosscut adit was run 300 feet and a 65-foot raise was driven from the end of adit, but no important vein was encountered in this work.

Equipment. A double cableway tram extends from Windy arm to the mouth of the crosscut on the Mountain Hero claim, which adjoins the Montana. This tramway is 18,697 feet long and has its upper terminal 3,464 feet above its lower terminal. This tramway is of little service as at present situated, but its location could be changed to serve the Montana. A 50-horsepower compressor with gasoline engine has been installed near the Mountain Hero adit. The equipment includes machine drills, blacksmith shop, and, in addition, comfortable buildings have been erected, including mess and bunk houses, and office buildings.

M and M

This is also one of the original Conrad claims which was optioned to the Harper Syndicate in 1916. The vein outcrops on the left bank of Pooly canyon near the top of the hill, and has been traced for over 400 feet. It strikes due north and dips to the west at an angle of 15 degrees. The vein is a fissure in andesite, and is in most places from 6 to 12 inches thick. It is composed mainly of quartz with pyrargyrite, stephanite, freibergite, tetrahedrite, and blue and green copper carbonates. The deposit is especially rich in the high-grade silver minerals. A shipment of 5 or 6 tons of ore by Colonel Conrad is reported to have given returns of $165 in gold and silver, the chief values being silver. Ore from this deposit can be hand-sorted to carry $100 to $200 to the ton, but parts of the vein do not run over $20 to the ton or perhaps less.

A comparatively slight amount of work has been done on this property. This includes a main drift about 90 feet long with some shorter ones 12 to 15 feet long, driven on the vein, and also some surface trenches.

Big Thing

The Big Thing will not be described in this report as its values are chiefly in gold. Although galena and sphalerite are reported to occur, they are so minor in amount that the ore-body cannot be looked upon as an economic source of lead and zinc.

Uranus

The Uranus vein is situated just above the forks of Pooly creek. The vein is traceable on the surface for about 1,500 feet, and crosses a high ridge between the two branches of the creek, and is thus naturally exposed for some depth. A tunnel was run in on the vein 180 feet in 1905. The vein in the tunnel varies in width from a few inches up to 3 or 4 feet, and carries a considerable quantity of argentiferous galena, with native silver, ruby silver, pyrite, and arsenopyrite.

Joe Petty

The Joe Petty vein consists of alternating bands of quartz and silicified and mineralized country rock, carrying layers and scattered grains of rich silver and silver-bearing minerals. A shaft following the vein was sunk to a depth of 50 feet in 1905. It showed a vein about 6 feet wide.

(6) Wheaton District

References

Cairnes, D. D.: Geol. Surv., Canada, Mem. 31 (1912).
Geol. Surv., Canada, Sum. Rept. 1915, pp. 46-49.
Cockfield, W. E.: Sum. Rept. 1922, pt. A, pp. 1-9.

Silver-lead veins have been found on the eastern face of Idaho hill in Wheaton district. The claims in this vicinity were staked in 1908, and little work has been done on them since 1910. All the veins occur in an arkose that forms part of the Laberge series, and is probably of Jurassic age. This series is cut in the vicinity by bodies of granitic intrusives, belonging to the Coast Range intrusives. The veins strike about north 12 degrees and dip at 70 degrees to the west. At least twelve veins were located on the property of the Union Mines and two on the property of the Nevada mines. The veins run from 4 to 12 inches in thickness and are exposed from 10 to 200 feet along the surface. They are fairly tabular in form, but lack as a rule sharp definition between the walls and the ore. In places the veins widen suddenly into irregular masses 4 to 6 feet wide, and 20 or more feet in length.

Mineralization consists chiefly of quartz, calcite, galena, arsenopyrite, sphalerite, pyrite, and chalcopyrite. Quartz is the most important gangue mineral, and galena and arsenopyrite are the most important metallic constituents of the ores. Assays of the better grades of galena ores yield about 50 ounces of silver to the ton, and about 40 per cent lead.

The deposits were formed by metasomatic replacement chiefly along bedding planes in the clastic rocks, but a few cross-fractures also occur. The source of the mineralizing solutions was probably the granitic intrusives.

Two properties, the Union Mines, consisting of two claims owned by W. F. Schnabel and Mr. Northrop, and the Nevada group of eight claims owned by W. F. Schnabel and C. Bush, have been located. The development includes a crosscut 15 or 20 feet in length and a certain amount of surface stripping.

Another group of veins, valuable chiefly for their gold and silver content, occur in Wheaton district. In certain instances, however, these carry considerable amounts of galena, and where this is the case, short descriptions will be given. For fuller information the reader is referred to Cairnes' report.

Wheaton Mountain

The McDonald fraction is situated near the western edge of Wheaton mountain. A fissure vein outcrops intersecting granite, which is well mineralized with argentiferous galena, and which in places constitutes the greater part of the vein fillings. A shaft 20 feet deep constitutes practically the only development work on the property.

Tally-Ho Group

This group is situated on Tally-Ho gulch and consists of eight claims owned by A. Birnie, C. J. Irvine, C. I. Burnside, and F. T. McGlashan.

The ore occurs in a brecciated fault zone in the Coast Range intrusives. The fault zone consists of fragments of granite of varying size, cemented by quartz, with a vein of quartz of varying thickness on the foot-wall. In the first 100 feet of the drift, the vein ranges from 12 to 20 inches, then for 6 feet it is from 30 to 36 inches, whence it rapidly decreases to 12 inches, and for the last 150 feet of the drift does not average more than 6 inches thick.

The quartz carries considerable argentiferous galena, fairly evenly disseminated. No other metallic mineral occurs in appreciable quantities. Near the surface for 8 or 10 feet the galena has been partly altered to lead carbonate. Assays show values ranging from \$9 to \$80 in silver and gold, and it is thought that a considerable part of the vein will average \$20 in gold and silver.

Other veins are known on this property, but they have not been developed, and nothing definite is known concerning them, except that pieces of solid galena, 6 to 8 inches in diameter, have been found.

Development work includes a drift 290 feet in length leading from which are a 40-foot raise, and a 15-foot crosscut. Of recent years further work has been done on this property by C. J. Irvine, but no details as to the results of this are available.

Becker and Cochran Property

A number of claims owned by T. Becker and H. Cochran have been located on the western face of mount Anderson. These comprise two groups, the Whirlwind and Sheep, the former consisting of six claims and the latter of five claims. There are two main veins with others of lesser importance occurring in fissures in the granitic intrusives. The veins extend about 2,000 feet along the face of mount Anderson. The greater amount of development has been done on what is called the " lower vein ". This strikes at north 68 degrees west, and dips northeast at angles of from 80 degrees to nearly vertical. The vein consists of quartz with argentiferous galena. A basalt dyke, intruded along the vein, is persistent over the length to which development has been carried. A drift known locally as No. 2 tunnel has been driven on this vein for 350 feet, throughout which distance the quartz has a thickness of 8 inches to 4 feet, with an average of about 18 inches. About 150 feet below this drift, a crosscut 172 feet long has been driven to the vein, and continued as a drift for 150 feet. This is known as No. 1 tunnel. In this drift the quartz has a thickness of from 6 inches to 4 feet, with an average of about 18 to 20 inches.

To the southeast along the face of mount Anderson vein outcrops have been exposed by a number of pits, trenches, and open-cuts, for a distance of 2,000 feet. These show the same characteristics as the vein in the drifts, and are accompanied by the same or a similar basalt dyke. They may be parts of other veins, but a more likely explanation is that they are continuations of the same vein which has been repeatedly offset to the east by cross faults.

On the Sheep group in the most southerly of three lines of outcrops there occurs an important exposure known to the owners as the " big showing ". There the basalt dyke is irregular in form, and the quartz has a thickness of $3\frac{1}{2}$ to $4\frac{1}{2}$ feet, and is well mineralized. A hundred feet beyond this showing an adit was driven to tap the vein without success, as it has apparently been faulted.

The lower vein has been carefully sampled in the lower drift, and is claimed to average $10.60 to the ton in gold, silver, and lead; but chiefly in silver and lead. The lead content was calculated on a basis of 4 cents, the deposit averaging 8·26 per cent of this metal. In the upper drift the values are slightly less than $10 to the ton.

Approximately 200 feet in elevation above the outcrop of the " lower vein ", an " upper vein " occurs which strikes due east and west, and is vertical. This vein consists of quartz with more or less disseminated galena and pyrite with some lead carbonate. An adit 35 feet long was driven to the vein, and continued as a drift along the vein for 75 feet in a southerly direction. The vein has a thickness of 4 to 20 inches, and samples indicated values of $5 to $18 in gold, silver, and lead.

The deposits are 25 miles by wagon road from Robinson station on the White Pass and Yukon railway.

Mineral Hill

The Legal Tender claim has been staked on Mineral hill lying between Thompson creek and Watson river. The claim occurs on the steep southern slope facing Watson river.

The vein on the property is a fissure in granite, which strikes in a northwesterly direction and is inclined to the northeast at angles approaching the vertical. The filling consists of quartz with argentiferous galena occurring in places plentifully disseminated through the gangue. The quartz has in places a well-defined comb structure.

A drift 100 feet long has been run on the vein, which for this distance remains persistent in strike and dip and thickness. The ore is claimed to average $30 to $40 a ton in gold and silver.

Mascot Group

The Mascot group lies about 45 miles from Robinson station on the White Pass and Yukon railway; it is staked practically on the divide between Watson river and Berney creek. The property is owned by M. Watson and E. Johnson of Carcross, and in 1921-22 was optioned to the Slate Creek Mining Company of Alaska. A small amount of prospecting was done by this company, but the option was abandoned in 1922.

The outcrop is along a steep cliff face, and is visible for about 2,000 feet. The vein varies considerably in strike, dip, and thickness, being in some places 20 feet thick and in others less than 1 foot. At the base of the cliff an adit was driven on the vein, but as it was filled with water only the surface features could be examined. According to information supplied by J. Moore Elmer of the Slate Creek Company, the vein pinched to 6 inches towards the end of the tunnel, and the values dropped to $7 a ton in gold and silver. Below the mouth of the adit the vein is 6 feet wide, but it narrows to less than 2 feet inside the portal. Assays from the outcrop, it is claimed, show values of $15 to $30 in gold and silver. The country rock is a diorite of the Coast Range intrusives. A grab sample was taken of the 6-foot portion of the vein below the mouth of the adit. This assayed 0·11 ounces of gold to the ton, 1·45 ounces of silver to the ton, and lead, not determined.

Other Districts

Silver-lead-zinc deposits have also been reported from other districts. Deposits are known to occur on Rude creek, in Klotassin district, on Boswell river in Big Salmon district, and from Fifteenmile creek in Dawson district. No datum is available with respect to these deposits.

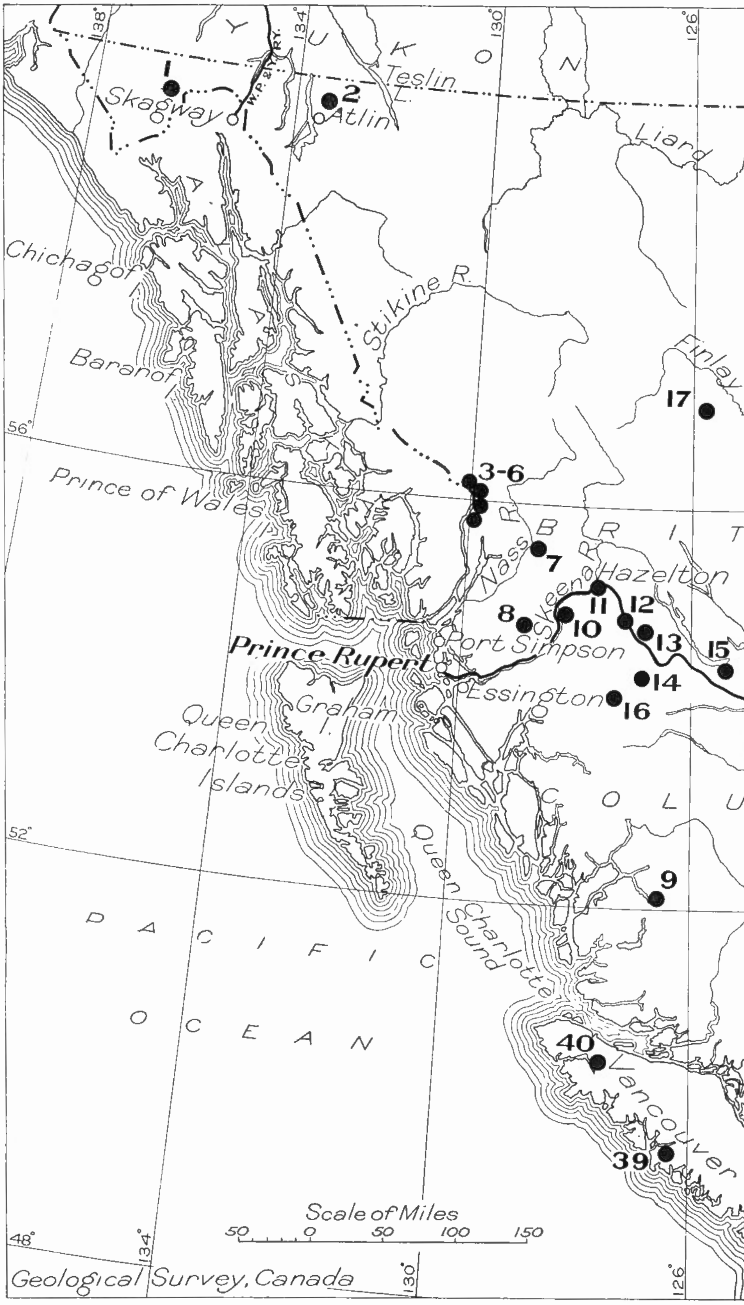
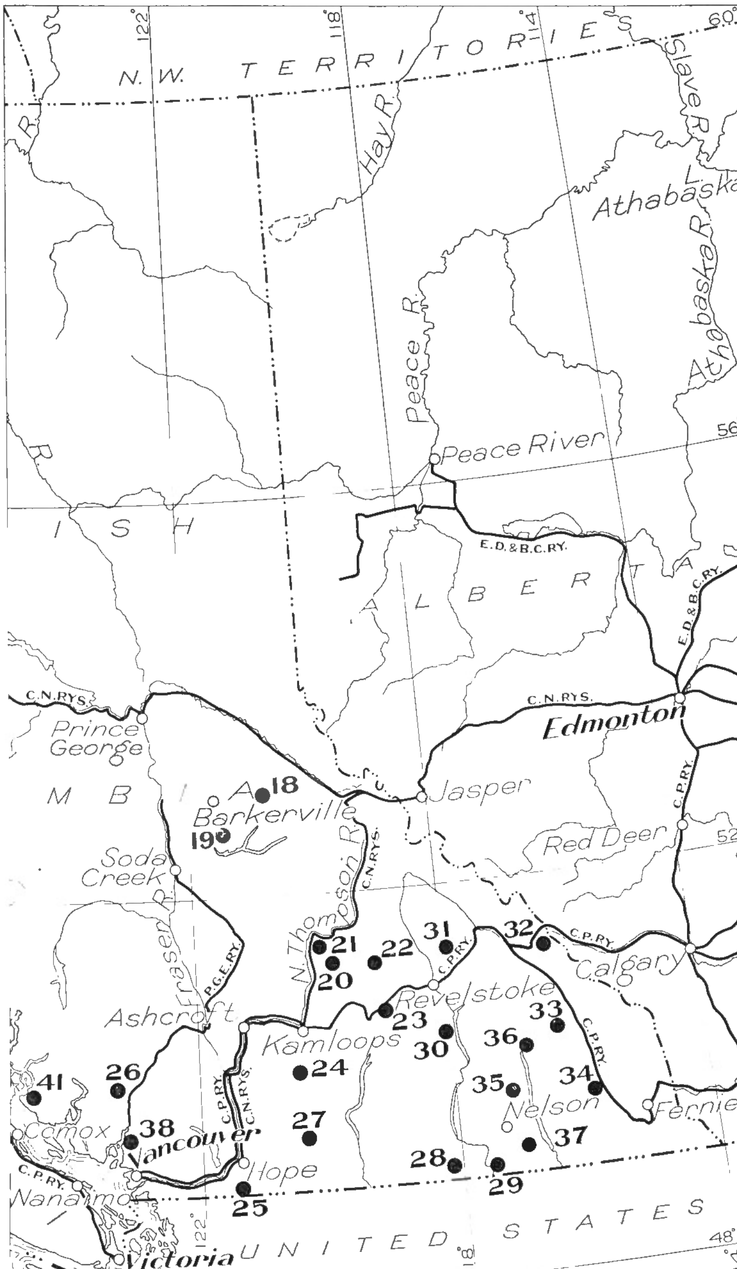


Figure 34. Index map of British Columbia showing location of



lead and zinc occurrences. For explanation of figure *See* page 264.

Explanation of Figure 34

1. Rainy Hollow section, Atlin
2. Atlin Lake section, Atlin
3. Salmon River section, Portland canal
4. Marmot River section, Portland canal
5. Bear River section, Portland canal
6. Georgia River section, Portland canal
7. Nass River mining division
8. Skeena mining division
9. Bella Coola mining division
10. Skeena section, Omineca
11. Hazelton section, Omineca
12. Smithers section, Omineca
13. Telkwa section, Omineca
14. Owen Lake section, Omineca
15. Burns Lake section, Omineca
16. Sibola section, Omineca
17. Fort Grahame section, Omineca
18. Cariboo mining division
19. Quesnel mining division
20. Barriere section, Kamloops
21. Chu Chua section, Kamloops
22. Seymour River section, Kamloops
23. Sicamous section, Kamloops
24. Nicola mining division
25. Yale mining division
26. Lillooet mining division
27. Similkameen mining division
28. Greenwood mining division
29. Grand Forks mining division
30. Arrow Lake mining division
31. Revelstoke mining division
32. Golden mining division
33. Windermere mining division
34. Fort Steele mining division
35. Slocan, Slocan City, and Ainsworth mining divisions
36. Lardeau and Trout Lake mining divisions
37. Nelson mining division
38. Vancouver mining division
39. Clayoquot mining division
40. Quatsino mining division
41. Nanaimo mining division

BRITISH COLUMBIA

British Columbia in 1928 produced over 94 per cent of the lead and nearly 88 per cent of the zinc produced that year in Canada. The greater part of both comes from the Sullivan mine at Kimberley. A large number of properties, however, ship ore to the custom plant at Trail. Silver-lead-zinc ores that were formerly penalized for their zinc content now find their zinc an asset.

As outlined in the chapter on the geology of zinc and lead deposits in Canada, the great zinc and lead producing part of the province is the belt lying east of the Coast Range batholith and more particularly the southern part, known as Kootenay district. This belt contains hundreds of properties on which lead and zinc ores occur. On by far the greatest number the ores are dominantly silver-lead with the silver forming the more valuable part.

For the description of the occurrences of British Columbia a different treatment is employed than for the occurrences in the rest of Canada, as given on preceding pages. No attempt is made to describe in detail or even to list all the properties on which zinc and lead minerals have been found. References to the more important occurrences, by mining divisions, is made so that a general idea of the distribution, character, and importance of the various deposits may be gained. In the case of Slocan region, which is to be treated in a memoir by C. E. Cairnes, a general summary, followed by tables showing the production of the various properties, is given.

The following is the production of lead and zinc in British Columbia by mining divisions in the years 1926 and 1927.

Mining divisions	1926	1927
	Lbs.	Lbs.
Lead		
Fort Steele	252,050,057	270,703,660
Slocan	4,584,822	2,906,697
Ainsworth	3,442,653	3,251,280
Portland Canal	643,061	3,663,414
Nelson	856,303	1,325,338
Omineca	645,631	398,888
Greenwood	180,495	265,996
Windermere	390,680	51,981
All others	230,235	429,169
Total	263,023,937	282,996,423
Zinc		
Fort Steele	127,750,444	132,287,862
Slocan	5,793,999	4,937,784
Ainsworth	7,500,374	4,225,392
Portland Canal	42,503	1,609,923
Nelson	1,056,026	1,342,188
All others	733,601	822,294
Total	142,876,947	145,225,443

(1, 2) Atlin Mining Division

Atlin mining division includes all the northwestern part of British Columbia which does not fall within the drainage areas of Stikine or Liard rivers. Lead and zinc minerals are known to occur in two sections known respectively as Rainy Hollow and Atlin Lake. From the latter a production of silver-lead ore has been made by the Atlin Silver Lead Mines, Limited.

(1) RAINY HOLLOW SECTION

Reference

James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 114.

Rainy Hollow section, which includes a small triangular area in the extreme northwest corner of the province, is reached from Haines, Alaska, on the west side of Lynn canal about 15 miles below Skagway. A motor road to the International Boundary has been built by the Alaska Road Commission. With improved means of communication there are properties that may become of importance.

The rocks include limestones, probably of Palæozoic age, intruded by diorite. The deposits are quartz veins and contact metamorphic ores in the limestone. In the quartz veins of the Stampede group the chief values are in gold and silver. On the Maid of Erin property, a deposit of contact metamorphic origin shows values in copper and silver, the principal ore mineral being bornite. On the Victoria and Mother Lode are deposits of lead and zinc. The Victoria ore-body consists of a lens of massive galena and sphalerite in limestone. In one cut the lens is 15 feet wide and in another 25 feet to the south it is 10 feet wide. An 8-foot sample across a part of the narrower cut assayed: gold, 0·02 ounce to the ton; silver, 6·2 ounces to the ton; lead, 28·6 per cent; zinc, 24 per cent.

The Mother Lode group of three claims adjoins the Victoria. It shows a shear zone 6 feet wide containing iron, lead, and zinc sulphides. The outcrop is 400 or 500 feet south of the Victoria showing and on the same line of strike.

(2) ATLIN LAKE SECTION

References

Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 15.
Cairnes, D. D.: Geol. Surv., Canada, Mem. 37.
Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 115; 1926, p. 107.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 114.

The claims of the Atlin Silver Lead Mines, more commonly known as the Ruffner group, occur on Leonard mountain in the vicinity of Fourth-of-July creek. They are situated above timber-line about 14 miles by road from Atlin. Atlin is served during the summer months by lake steamers of the White Pass and Yukon route which connect with the railway at Carcross, a point 68 miles from tidewater. In winter a road is maintained across Tagish and Atlin lakes, from Carcross to Atlin.

Leonard mountain is underlain by light grey, coarse-textured, granitic rocks. In places they are porphyritic with phenocrysts over an inch in length, and locally aplitic phases occur. These rocks are related to the Coast Range batholith. The granitic intrusive is invaded by dark green, fine-textured dykes of hornblende lamprophyres regarded as being basic differentiates of the granitic intrusive.

The ore deposits consist of mineralization along shear zones which follow the dark green dykes in the granite. These dykes are roughly parallel, strike north 30 degrees east to north 50 degrees east, and dip at a high angle to the northwest. They were evidently lines of weakness, for they have been crushed and sheared by movements after their intrusion. Solutions travelling along these shear zones filled the fissures and to a certain extent replaced the crushed dyke rock. The sulphate minerals consist of galena, sphalerite, arsenopyrite, pyrite, and chalcopyrite with a gangue of quartz, calcite, and ankerite. The fissure zones vary in width up to 14 feet. On the surface they are prevailingly leached and oxidized, but the depth of oxidization rarely exceeds a few feet.

There are two main veins on the property known respectively as No. 2 and No. 4, and a third, No. 3, of small dimensions, has been located at two points. Cockfield states:

"The workings consist of a shaft, three adits, and a number of open-cuts or trenches. The earlier workings lie up the slope towards the peak between Vulcan and Fourth-of-July creeks. On vein No. 2 the upper or easternmost workings consist of a shaft 75 feet deep situated on the Cherokee claim, with a drift into the hill along the vein 110 feet long at a depth of 50 feet. A short drift to the west was also run at the same depth.

Proceeding in a westerly direction along the strike of the vein the next workings, also on the Cherokee claim, consist of an open-cut and adit, about 500 feet from the shaft. The adit in reality drifts along the vein for 190 feet, but was caved 30 feet from the entrance, so that entry was impossible. The vein material at this point has a thickness of about 6 feet and consists of quartz with disseminated sulphides.

Four hundred feet farther along the strike of the vein is an open-cut in which the vein is exposed for a length of 25 feet. It has a strike of north 45 degrees east, magnetic, and a dip of 60 degrees northwest. The vein has a thickness of 6 feet throughout the length exposed, and consists of dyke rock heavily impregnated with quartz and sulphides. In another cut a few yards farther west the vein is exposed for 20 feet, has a strike of north 53 degrees east, and a dip varying from 70 degrees northwest to nearly vertical. The hanging-wall is not exposed, but the thickness as shown is about 5 feet. As in the cut above, the mineralization consists of quartz with galena, zinc blende, and arsenopyrite; the sulphides in this case, however, apparently occur in well-defined bands from 1 inch to 6 inches thick.

In a cut 400 feet to the west of these workings a length of about 40 feet of the vein is partly exposed, the hanging-wall not being visible. The vein where exposed is 6 feet thick, and consists of dyke rock and quartz containing streaks of yellow and brown oxides which probably represent leached and oxidized sulphides. For the next 2,000 feet along the strike of the vein there are no exposures. Several cuts have been excavated, but these did not encounter the vein. An exposure 2,000 feet west of the above-mentioned workings is on the Commanchee claim and consists of an open-cut about 15 feet long, which is badly sloughed, so that only a part of a reddish earthy outcrop can be seen. The approximate thickness of the vein at this point is 11 feet.

No further work has been done on the vein until a point 1,600 feet farther along the strike is reached. Here, on the steep hill-side of Fourth-of-July creek, on the Portal claim, a dyke occurs which has been trenched by six open-cuts. Below the lowest cut an adit 45 feet in length has been run with a drift along the foot-wall of the dyke and another close to the hanging-wall 25 and 20 feet long, respectively. The strike of the dyke is north 45 degrees east magnetic, and the dip is 75 degrees northwest. As shown by the underground workings the dyke, partly concealed by timbering, has an approximate thickness of 25 feet. No sulphides were observed on the foot-wall side of the dyke, but the drift towards the hanging-wall side showed a heavy band of sulphides 6 inches wide, with disseminated sulphides through the dyke rock. The sulphides at this point are galena, zinc blende, and arsenopyrite, with some chalcopyrite and pyrite. In excavating the drift ruby silver (pyrargyrite) was reported, but none was observed in place

In the six cuts above the adit, the upper two did not reach bedrock. Of the lower cuts the third is 50 feet long but is sloughed, so that the vein could not be seen. The fourth showed 20 feet of mineralized dyke rock, the fifth 20 feet of dyke rock with a shear-zone near the centre heavily stained with oxides, and the sixth 20 feet of dyke rock with mineral showings near the hanging- and foot-walls.

High assay values have been obtained at this showing. One assay shows $60 in gold and 699 ounces of silver and another $8 in gold and 447 ounces of silver, to the ton. These assays were taken over a width of 2½ to 4 feet. The average of the assays at this point, properly weighted to the widths over which they were taken, is $17.66 in gold and 265·34 ounces in silver. This average includes the higher assays.

Vein No. 3. No. 3 vein occurs 140 feet south of No. 2 vein and is exposed in two open-cuts, one near the shaft, and one 3,000 feet westerly along the strike. This occurrence is only of minor importance economically, and yet is important as showing the character and continuity of the deposits. This dyke has a thickness of about 3 feet and strikes north 45 degrees magnetic and dips 85 degrees northwest. At its exposures in open-cuts it is shattered and mineralized. At the lower cut there is a heavy stain of yellow oxide on the outcrop, with a seam of 2 inches of sulphides close to the hanging-wall. At the upper cut the general characteristics remain the same, but the mineralization is much more scanty.

Vein No. 4. Vein No. 4 is situated 1,600 feet south of vein No. 2 and has been traced on the surface for a distance of over half a mile. At the lower end of the vein, on the Barber claim, is an adit 300 feet long, which follows the vein. One hundred and eighty feet from the entrance, a crosscut 20 feet long has been run towards the foot-wall side of the dyke.

As shown by the workings, the dyke, at the point where it has been cut across, has an approximate thickness of 24 feet. At this point there is a band of sulphides 2 feet wide near the hanging-wall of the dyke, with more or less disseminated sulphides in the shattered dyke rock. Throughout the length of the adit bands of sulphides from 6 inches to 2 feet in width appear, with considerable earthy oxides. Near the face of the adit sulphides were observed in the granite several feet from the contact of the dyke with the granite. The strike of the dyke averages north 45 degrees east magnetic and the dip 63 degrees northwest.

In the upper cuts on this vein the dyke and vein material were found, but at the time of the writer's visit these cuts had sloughed so badly that little could be ascertained with regard to thickness and amount of mineralization. In the first cut above the adit there are apparenly two bands of sulphides, one towards the hanging-wall and the other towards the foot-wall side of the dyke.

A large number of samples have been taken in independent examinations of the properties. These show a gold content usually less than $4 to the ton and averaging about $6 to the ton if high assays be included. At most of the cuts, however, the gold content runs from $2 to $4 to the ton. At the adit on the Portal claim the average of the samples taken is $24.80 in gold, weighted according to the widths over which the samples were taken. The silver values at the adit on No. 4 vein, Barber claim, run about 15 ounces over an average width of 3 feet 6 inches. On the higher cuts on this vein the values are lower, running 1·24 ounces over an average width of 2·9 feet. On the lower workings on No. 2 vein the higher assays show $60 in gold and 699 ounces in silver, with an average of $17.66 in gold and 265·34 ounces of silver to the ton. This average includes the higher assays. Lead is usually from 6 to 16 per cent of the ore.

A fair estimate of the contents of the ore can perhaps be made by the result of two shipments, one of 30 tons made in July, 1924, from the shaft on No. 2 vein, and the other of 10½ tons from the adit on No. 2 vein, Portal claim.

The smelter returns from these shipments were furnished by Mr. J. M. Ruffner.

Shipments from Atlin Silver Lead Mines

	No. 1	No. 2
	30 tons, shaft No. 2 vein	10½ tons, adit No. 2 vein
Gold	0·16 oz. per ton	0·11 oz. per ton
Silver	75·70 ozs. "	193·95 ozs. "
Lead	29·25 per cent	7·7 per cent
Zinc	12·40 "	3·10 "

As many of the open-cuts were sloughed in and in others only the oxidized material from the vein outcrop was available the writer made no attempt at a systematic sampling of the property. A few samples were taken from No. 4 vein at its best exposures to serve as checks on the values stated. Two of these, Nos. 1 and 2, were from the adit near the crosscut and No. 3 from the upper workings of the same vein. The results of these assays are given below.

Sample No.	Gold	Silver	Lead
	Ozs. per ton	Ozs. per ton	Ozs. per ton
1	0·10	7·24	0·56
2	0·03	8·35	2·70
3	0·11	7·58	5·69"

Big Canyon Group[1]

Little or no work has been done on the Big Canyon group since reported on by Cairnes in 1910. The following description is summarized from Cairnes' report, and added for sake of completeness.

"Big Canyon group consists of four claims adjoining the Ruffner group on the south. It was located in 1899 and is owned by Messrs. J. Malloy, Thomas Vaughan, and M. Summers. Two main veins occur on the property, the lower of which crosses Crater creek just below the forks of the stream, and the upper of which crosses the west branch of the creek a short distance above the forks. In addition several smaller veins have been found.

As on the Ruffner group, the veins are really mineralized basic dykes cutting granite. The lower dyke has a thickness of 8 to 15 feet and has been traced for 3,000 feet. The upper dyke is 30 feet thick and has been traced for several hundred feet. From one-third to one-half of the dykes consist of ore minerals—galena, arsenopyrite, zinc blende, quartz calcite, and ankerite. These materials occur filling fissures in the dykes and have also replaced brecciated dyke material.

Description of Veins. The upper vein dyke strikes north 40 degrees east magnetic and dips 80 degrees to 85 degrees northwest. It has an average thickness of 30 feet and can be traced on the surface for several hundred feet. This dyke where visible is roughly divisible into three bands of about equal thickness. The upper zone has been subjected to repeated faulting, and now consists of brecciated fragments, cemented together with quartz, the proportion of cement increasing as the central part of the dyke is reached. The middle zone contains the bulk of the ore minerals, partly in one or more fissure veins and numerous narrow veinlets, and also in irregular bunches which lie between or have replaced the brecciated fragments. The lower 10 feet of the dyke has been only slightly affected, but lying along the foot-wall is a vein of ore about 1 foot thick.

[1]Cairnes, D. D.: "Atlin Mining District"; Geol. Surv., Canada, Mem. 37, pp. 109-114 (1913).

The lower vein strikes north 40 degrees east and dips 80 to 90 degrees northwest, and may be traced for a distance of 3,000 feet. This dyke much resembles the upper one; but is not characterized by distinct zones. The mineralization has a width of 4 to 12 feet. As in the upper dyke, the ore occurs in fissures and in irregular bodies replacing the original dyke rock.

Workings. On the upper vein two tunnels have been driven of unknown lengths, but probably exceeding 100 feet. On the lower vein, a shaft 40 to 50 feet has been sunk. This, with several open-cuts and pits, forms the development work of the property.

Surprise Group

The Surprise group consists of two claims staked by W. G. Sweet, J. Tolmier, and P. L. Eggert. These claims are situated at timber-line on the south side of Pine Creek valley at the foot of Surprise lake, about 12 miles from Atlin. The claims represent part of a group previously staked which had been allowed to lapse.

The country rock consists of chlorite schist belonging to the Gold series, a series of altered, basic, igneous rocks, probably of late Palæozoic age. Cutting the chlorite schist is a quartz vein striking north 10 degrees west, magnetic, and dipping 70 degrees southwest. This vein varies from 3 feet to 20 feet in width, and carries minor amounts of galena, chalcopyrite, and calcite. The bulk of the deposit, however, is formed by quartz, apparently barren of sulphides.

The workings consist of an adit and an open-cut. The adit is 50 feet long with a winze of unknown depth 15 feet from the entrance. The winze was filled with ice and was inaccessible at the time of the writer's visit. The open-cut is situated about 100 feet above the adit.

At the entrance to the adit the vein is 6 feet wide, and narrows to 3 feet at the face. Practically no sulphides were observed in this distance. The winze apparently encountered a small shoot of sulphides, but owing to its being filled with ice no details could be obtained.

At the open-cut the vein has a width of 20 feet, but includes several narrow bands of country rock. The quartz has been brecciated and recemented with calcite, but as at the adit, galena and chalcopyrite occur only sparingly."

(3-6) Portland Canal Mining Division

The distributing centre of the Portland Canal mining division is Stewart, at the head of Portland canal. A large number of silver-lead-zinc properties occur in the Salmon River, Marmot River, Bear River, and Georgia River sections. An auto road leads from Stewart up Salmon River valley to the Premier and B.C. Silver mines, a distance of 17 miles. This is continued as a wide trail to the upper valley of Salmon river, branch trails making all parts of the valley accessible. Bear River valley has a wagon-road from tide-water to the junction of American creek, a distance of 14 miles. A wagon-road leads up Marmot River valley for a distance of 3½ miles from tide-water to the forks and above this point pack-trails have been built up both forks of the valley. Georgia river empties into Portland canal on the east side about 18 miles south from Stewart. There is a trail for about 10 miles up the river from its mouth. Of the numerous claims which have been taken up in these districts, those of more importance from the point of view of their lead and zinc possibilities will be mentioned.

(3) SALMON RIVER SECTION

Premier Gold Mines

References

Schofield, S. J., and Hanson, G.: Geol. Surv., Canada, Mem. 132, p. 50.
Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1919, p. 74; 1921, p. 69; 1923, p. 79; 1924, p. 72.

The property of the Premier Gold Mining Company is on the western slope of Bear River ridge, on Cascade river just north of the boundary between Alaska and British Columbia. It is easily accessible by motor road from Stewart and Hyder.

The company was incorporated in 1919, being a reorganization of the former Salmon-Bear River Mining Company, Limited. The property had been previously explored with unsatisfactory results. Work was started in the upper tunnel and in a comparatively short distance the shoot of high-grade gold-silver was struck that brought the property into prominence.

The property is primarily a gold and silver mine. In 1923 there was a recovery of lead, however, which increased in 1924 and again in 1925. The production of lead for these three years was, respectively, 62,191, 452,010, and 870,971 pounds. In 1926 it fell off to 492,320 pounds. This production is relatively unimportant when it is considered that during the same years, 1923 to 1926, the production of gold was 117,294, 139,288, 119,725, and 126,329 ounces and that of silver 2,746,551, 3,015,382, 2,559,192, and 3,187,618 ounces respectively.

The region round the Premier mine is underlain by a series of greenish or purplish tuffs, usually very fine grained and intruded, along their bedding planes, by sills of quartz porphyry. The tuffs are the younger members of the Bear River formation of Jurassic age. Their strike is variable, ranging from north 80 degrees east to almost north and south. Their general dip is westerly and southwesterly at angles from 45 to 70 degrees. The rocks are highly sheared, especially near the ore-bodies. Cutting the above rocks are quartz diorite dykes which strike northwesterly and which have been found cutting the primary ore-bodies in other properties in the district. The youngest intrusives in the Premier are lamprophyre dykes which cut the primary ore-bodies. They are usually narrow and dark in colour. The ore-bodies consist of mineralization along shear zones. They occur at or near the contact of a quartz-porphyry sill and tuffs, both of which are highly sheared in the immediate vicinity of the ore-body. The general trend of the shoots is north 80 degrees east and the dip is northerly at angles of 70 to 80 degrees. In general the mineralization has penetrated, and in part replaced, the wall-rock on both sides of the ore-body, so that the walls of the latter are not sharp.

The minerals present are pyrite, sphalerite, chalcopyrite, galena, tetrahedrite, freibergite, polybasite, pyrargyrite, argentite, and native silver. The chief gangue mineral is quartz. Most of the ore is a heavy sulphide, but some of it consists of quartz with isolated patches of sphalerite, tetrahedrite, and silver minerals. The wall-rocks have been extensively silicified.

The ore-bearing zone is crossed almost at right angles by faults that have displaced portions of the ore-bodies, so that the deposit appears irregular and broken.

Big Missouri

References

Schofield, S. J., and Hanson, G.: Geol. Surv., Canada, Mem. 132, p. 45.
Clothier, G. A.: Ann. Repts., Minister of Mines, B.C., 1918-20, 1922, 1923, 1925, 1926.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 101.

The Big Missouri group is on the summit and both flanks of Big Missouri ridge about 20 miles from Stewart. The claims are readily reached by road and trail.

Options on the property have been taken five or six times and a considerable amount of exploration work, including surface trenching, underground work, and diamond-drilling, has been done. In July, 1925, it was bonded by the Big Missouri Mining Company, Limited, a subsidiary of the Standard Mining Corporation of Tacoma, and work was carried out during 1925 and 1926. In September, 1927, the Buena Vista Mining Company, Limited, the controlling interest in which is owned by the Consolidated Mining and Smelting Company of Canada, was incorporated to take over the Big Missouri group, and immediately proceeded with development work.

The rocks on the claims consist of sheared tuffs of the Bear River formation, of Jurassic age, intruded locally by sills of quartz porphyry. The latter are cut in places by lamprophyre dykes.

There is a great deal of evidence of mineralization on the claims. On the Big Missouri claim the sheared tuffs have been locally impregnated by pyrite, galena, and zinc blende. On the Province claim the ore zones are certain bands of the tuffs and the fine, interbedded conglomerates that have been mineralized with pyrite, sphalerite, galena, chalcopyrite, and quartz. On the E. Pluribus the ore-bodies are of two kinds: low-grade, consisting of sphalerite and galena with low gold and silver values, and bodies, probably of secondary origin, that are associated with faults and slips in the bedrock where they intersect the veins. The ores in the latter variety consist of argentite and tetrahedrite, variable amounts of ruby silver, and native silver.

Silver Tip

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 103; 1926, p. 99.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, pp. 101-103.

The Silver Tip group, owned by the Silver Tip Mining Company, Limited, comprises five Crown-granted claims on Silver creek in upper Salmon valley. They are reached by road and trail from Stewart. The rocks consist of agglomerates and tuffs, conglomerates and slates, and the whole intruded by dykes of porphyry. The deposits follow as a rule the hanging-wall side of the acidic dykes. The ore occurs chiefly in the dykes as fairly solid but narrow lenses, or as reticulating stringers. In places the sulphides are disseminated through the dykes and in many cases the hanging-wall rocks are pyritized for a few feet from the ore zone.

What is known as Clegg No. 1 vein is a lens of high-grade silver-lead ore striking east and lying along a quartz porphyry dyke. The high-grade section of this lens is 18 inches wide and stringers penetrate into the dyke for another 2 or 3 feet. A lump of heavy sulphide assayed: gold, trace; silver, 0·83 ounce to the ton; lead, 23 per cent; zinc, 19 per cent. No. 2 vein lies 300 feet north of No. 1. It follows a quartz porphyry dyke, has a width of from 1½ to 4 feet, but does not carry a high percentage of sulphides. Two other east-west veins are exposed on the property, and also one striking north. Two other veins known as the Morkill and May P.J. carry galena and sphalerite with quartz.

Silver Crest Mines, Limited

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1920, p. 64; 1924, p. 73; 1925, p. 104; 1926, p. 99.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 103.

The property of this company consists of eleven claims on the south-east slope of mount Dilworth at the head of Salmon River valley.

The rocks on the property are argillites cut by a series of northwesterly trending dykes. The deposits consist of sulphides occurring either by themselves in small, discontinued stringers or in small quartz stringers, in some places cutting across the containing dyke and in other places paralleling the wall of the dyke. The ore minerals are zinc blende, galena, chalcopyrite, and silver sulphides.

Indian Mines Corporation, Limited

References

Schofield, S. J., and Hanson, G.: Geol. Surv., Canada, Mem. 132, p. 45.
Clothier, G. A.: Ann. Repts., Minister of Mines, B.C., 1922, 1923, 1924, 1925.

The group of claims owned by this company lies on the west side of Cascade creek about 3½ miles by trail from the Premier wagon road at Thirteenmile.

The property was worked in the early days of Portland Canal region before there was a horse-trail up Salmon river and when supplies were taken in winter by dog team from Ninemile crossing Salmon river at the foot of the glacier, by climbing along the east side of the glacier to Indian lake, from which point they were packed by men to the camp at the mine.

In 1911 the Indian Mines, Limited, company was incorporated with a capitalization of $1,000,000 divided in 1,000,000 shares. In 1923 the company was reorganized under the name Indian Mines Corporation, Limited. In 1925, 37 tons of ore were shipped to Belgium, assaying 0·12 ounce in gold, 13 ounces silver, 33 per cent lead, and 18 per cent zinc.

The country rock in the immediate vicinity of the deposit is a quartz porphyry which intrudes tuffs and tuff conglomerates. Numerous lamprophyre dykes cut the porphyry. The ore occurs in a sheared and brecciated zone which closely follows a lamprophyre dyke. This zone is of variable width and is mineralized with quartz, pyrite, sphalerite, galena, and chalcopyrite. In several places in the zone, bodies of solid sulphide up to 15 feet occur, consisting chiefly of galena and sphalerite.

Development work consists of open-cuts, underground work, and diamond-drilling. Up to the end of 1924 about 5,700 feet of underground work and 7,000 feet of diamond-drilling had been carried out. In the upper or No. 1 tunnel six ore-bodies totalling 630 feet in length had been drifted through, showing a width varying up to 20 feet. The No. 3 tunnel about 200 feet vertically below No. 1 was driven 1,400 feet, from which over 500 feet of crosscutting and several thousand feet of diamond-drilling were done without encountering any ore of importance.

(4) MARMOT RIVER SECTION

Marmot Metals Mining Company, Limited

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 81; 1926, p. 88.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 82.

The property of this company consists of the Montana group of five claims and the Horseshoe, all situated on the north side of the south fork of Marmot river, about 5 miles from tide-water. There is a good horse-trail from the shore to the foot of the hill below the workings. From here a foot-trail leads to the camp and to the different workings on the property, a distance of about 3 miles.

The rocks on the claims consist of volcanics and limestone intruded by granite of the Coast Range batholith.

James reports:

"The showings which have received the most attention during the past two or three years are a group of zinc veins in a faulted block of limestone on the Horseshoe claim. The block of limestone is probably 300 feet wide and outcrops at the end of the mountain between 3,600 feet and something more than 4,000 feet elevation. Other fault-blocks of the same band of limestone are to be seen lower down, and north of this..........

Within about 100 feet of the north side of the limestone rock are three fairly continuous veins and a number of small lenses of zinc ore. The northerly vein is very close to the north contact and can be traced from the bottom of the limestone block at 3,600 feet elevation to about 4,000 feet, with the exception of about 100 feet in the middle, which is apparently cut out by the adjoining igneous rocks. The vein is from 3 to 12 feet wide and will assay from 2·5 to 12 per cent zinc. The other two veins are about 50 and 100 feet south of the one just described and are similar to it in every way except that they are only about half as long. Widths run from 1 to 13 feet and values from less than 2 to 13 per cent zinc. An odd speck of galena and some pyrite can be found, but the dominant and only mineral of importance is sphalerite. Silver and gold values are unfortunately very low and the ore is, therefore, a straight zinc ore."

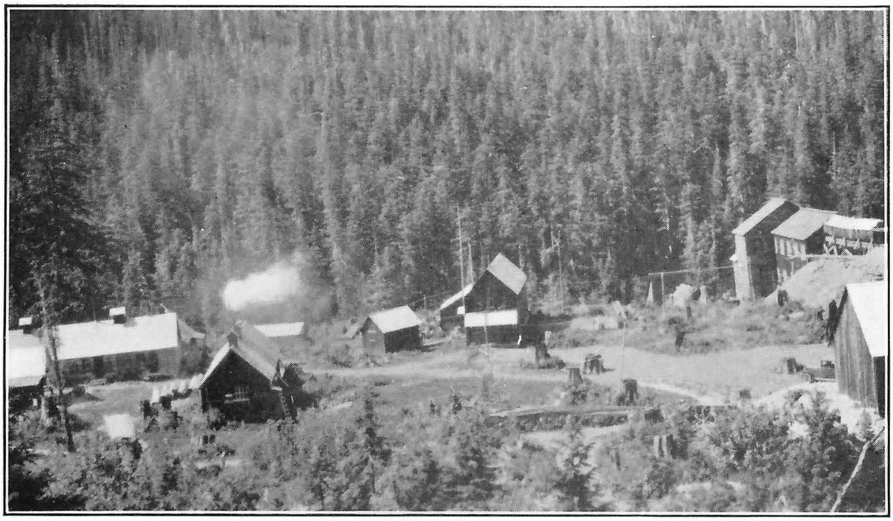
Bayview Mining Company, Limited

References

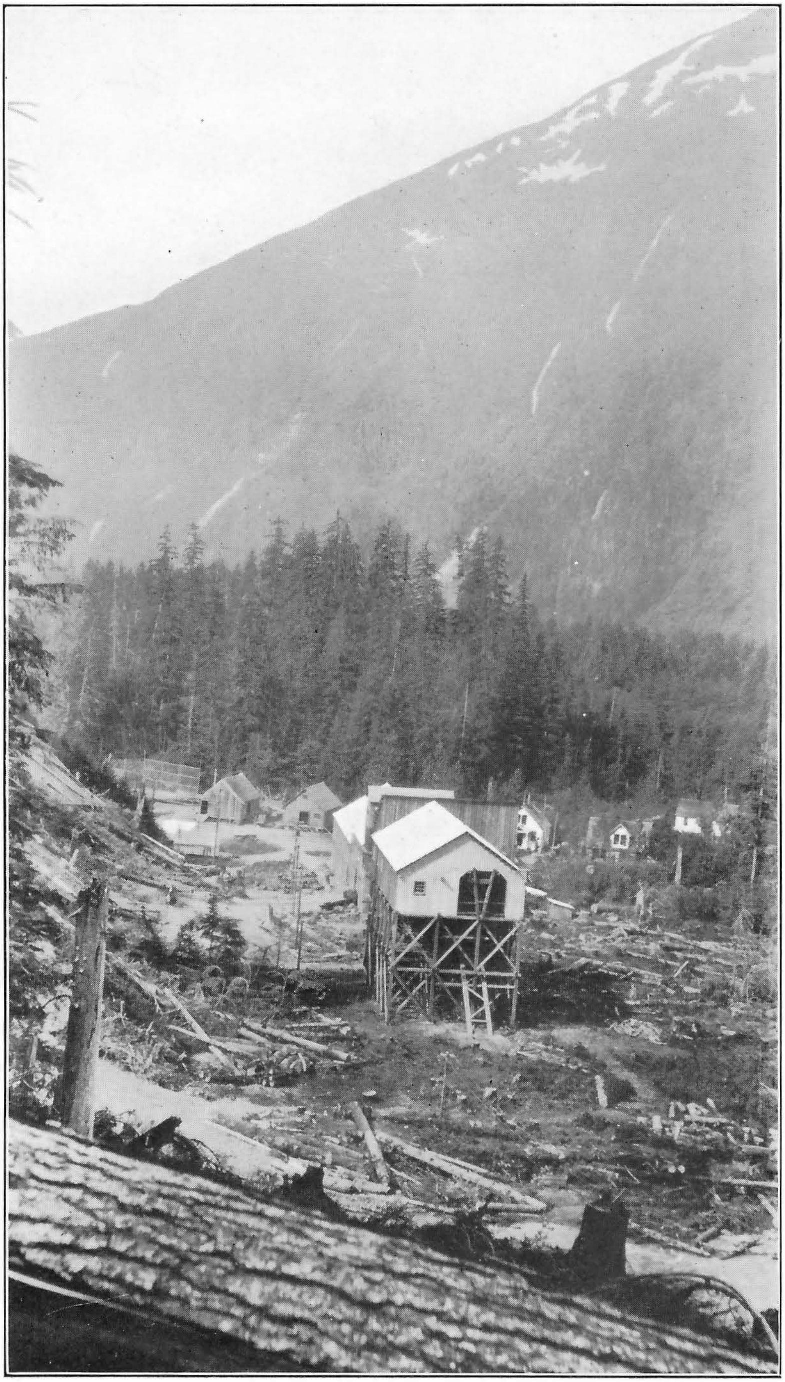
Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1925, p. 99.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 87.

The property of this company is located on mount Dolly, about 2 miles north of Stewart, on the west side of Bear river, and consists of fourteen claims. The rocks are a complex of volcanics of the Bear River for-

A. Porter-Idaho, Marmot river, Portland Canal mining division, B.C.



B. Cork province, Kaslo, Ainsworth mining division, B.C.



Dunwell mine, Portland Canal mining division, B.C.

mation of Jurassic age with interbedded sediments and the whole cut by granodiorite of the Coast Range batholith.

The deposits are veins and mineralized zones carrying sphalerite and galena with high values in silver. On the original Bayview group one vein follows the contact of granodiorite with metamorphosed rocks and a second lies above it within the intruded rocks about 500 feet from the contact.

On the Lucille No. 1 claim of the Thompson group two mineralized zones have been discovered. One has been exposed for a length of 150 feet and varies in width from 2 to 5 feet. It consists of a number of both parallel and irregular stringers of massive sulphides, which coalesce in places, forming large masses of ore in a well-defined zone in the granodiorite. Towards the west end the ore zone is just about on the contact between the granodiorite and the volcanics. The second mineralized zone outcrops 100 feet in elevation above the first and lies entirely within the volcanics. At one place it shows a width of 3 feet of lead-zinc ore said to run as high as $200 to the ton in gold, silver, lead, and zinc.

Porter-Idaho Mining Company, Limited

References

Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1925, p. 81.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 84.

This company owns seven claims, Gem of the Mountains, Lucille, Slide, Nettie L, Prickly Pear, Sunday, and Never Sweat, forming a group to the west of the glacier at the head of the north fork of Marmot river. A pack trail leads from the beach to the mine, a distance of 8 miles.

The deposits consist of veins and mineralized sheared and brecciated zones traversing volcanic breccias and tuffs of the Bear River series.

The mineralized zones vary in width from a few inches to several feet, and are irregular in attitude and distribution. The primary vein minerals consist of quartz, galena, sphalerite, tetrahedrite, and probably other silver minerals. The high-grade ore occurs as lenses of massive sulphides from a few inches wide and several feet long to lenses 2 or 3 feet wide and 60 feet long. The deposits are deeply oxidized. The rusty oxidized ore contains high-grade silver values and masses of galena.

Considerable development work has been done, consisting of sinking, crosscutting, raising, and drifting on the veins.

In 1924, 147 tons of ore were shipped and in the summer of 1925, 177 tons. The chief values were in silver and lead amounting to about $128 per ton. Shipments were also made in 1926 and 1927.

Prosperity

References

Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1926, p. 87.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 85.

The Prosperity group of seven claims is situated above and adjoining the Porter-Idaho ground. An ore-shoot discovered on the latter property was found to extend into Prosperity territory. An option was taken by the Premier Gold Mining Company late in 1926 and development operations commenced.

The showing is a 5 to 6-foot vein of massive sulphides, chiefly galena, with some zinc blende, argentiferous tetrahedrite, and probably other silver minerals. It strikes north 20 degrees west, magnetic, and dips 60 degrees westerly. A tunnel driven to cut the vein at a depth of 80 feet found a considerable amount of oxidized material, although the ore-shoot on the surface is quite solid and fresh.

(5) BEAR RIVER SECTION

Dunwell

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C., 1922, 1923, 1924, 1925, 1926.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 96.

The Dunwell lies about 5 miles north of Stewart. The road leaves the Bear River road about 4 miles from Stewart and follows a switchback course for about another 3 miles to the mine.

The general rock formation is a series of Jurassic age, called by McConnell the " Bitter Creek formation ", consisting of argillites, some tuffaceous beds, and occasional bands of limestone. Their general structure is northwest-southeast with a prevailing dip to the west of about 45 degrees.

The deposits consist of veins or mineralized shear zones. The main or Dunwell vein occupies a well-defined shear in the argillite. It strikes south 80 degrees east, magnetic, and dips flatly to the south at angles varying from 40 degrees to 45 degrees. In the lower underground workings the ore-body follows a narrow, dark-coloured dyke. In general the ore follows the foot-wall side of the dyke, but in places it occurs also on the hanging-wall side. The dyke was apparently a line of weakness along which shearing and subsequent mineralization took place. The ore consists of galena, zinc blende, and pyrite, with a quartz gangue. The mineralized zone varies in width up to 7 feet. Other veins trending in a north direction have been opened up on the property.

The main vein has been opened up on four levels. A 100-ton mill, erected in 1926, commenced operations in the early summer of 1927, treating 140 tons of ore per day. After treating some 27,067 tons of ore, all the known reserves in the mines were exhausted and the mill closed down in late September.

On the Sunbeam claim, which is the most northerly of the group, another vein was exposed by open-cuts and stripping for a distance of 800 feet. The vein has a width from 1 to 6 feet, showing in places native silver. A crosscut tunnel 45 feet long was driven to cut it at a depth of about 200 feet. The vein here was found to be small and low grade.

Red Top

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1920, p. 56; 1925, p. 95.

The Red Top group of claims is situated on the north side of Bear river about 7 miles up from the end of the Bear River wagon-road. Two types of deposits occur, irregular copper deposits, and veins of lead-zinc ore.

At elevation 3,850 feet an open-cut shows a quartz-calcite vein 5 to 8 feet wide, heavily mineralized with pyrite and galena averaging about 20 per cent lead. A second vein 1 to 2 feet wide, heavily mineralized with galena, zinc blende, and some chalcopyrite has been found east of this vein.

Silverado Mines, Limited

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 83; 1926, p. 89.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 85.

The Silverado Mines, Limited, hold nineteen Crown-granted claims at the head of Portland canal on the east side overlooking the town of Stewart.

Work was carried out over a number of years in an attempt to find commercial ore-bodies in a series of relatively flat veins on the Silverado property, but the results were not encouraging. In 1927 a new series of veins was discovered outcropping immediately below the tip of a small glacier extending down a steep snowslide gulch and creek canyon to about 3,500 feet above sea-level. The veins occur in a series of volcanic rocks within a short distance of the main contact of the Coast Range batholith. They consist of a series of more or less parallel shear-zones from a few inches to several feet wide, mineralized with lead and zinc sulphides and silver minerals. The sulphides occur as disseminations throughout the vein and as lenses of massive sulphides. The general strike is north 70 degrees west and the dip varies from 60 degrees to 75 degrees to the southwest. Four veins in this series have been located.

L. and L. Consolidated Mines, Limited

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1922, 1923, 1924, 1925, 1926.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 89.

This company represents a consolidation of the L. and L. Glacier Creek Mines, Limited, and Rush Columbia Mines, Limited. The property controlled consists of some twelve claims extending from the middle to the north fork of Glacier creek, about 8 miles from Stewart. The main deposits consist of narrow veins traversing greenstone rocks. Small shipments of silver-lead ore have been made, the chief values being in the silver. On the old Rush Columbia claims a vein up to 6 feet in width has been traced for several hundred feet. It consists of quartz and calcite with a few inches of iron and zinc sulphides on either wall. In places pyrrhotite is a conspicuous vein mineral and at other points bunches of galena are found.

Ruth and Francis

References

Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1926, p. 92.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 88.

This property, consisting of ten claims, is situated on the north fork of Glacier creek, about 7 miles from Stewart, on the east side of Bear river.

The deposits are veins traversing argillites. The gangue is quartz and the ore minerals are pyrite, galena, jamesonite, and sphalerite with values in silver. Of the three veins exposed, two average less than a foot in width; the third in one place shows a width of 6 feet.

Ore Mountain Mining Company, Limited

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 93; 1926, p. 93.

This company holds six claims situated north of the mouth of Bitter creek, extending from Bear lake up the hill to an elevation of 4,750 feet. A good horse-trail leads from the main wagon-road to the camp, a distance of about 3 miles.

The general country rock consists of volcanics of the Bear River formation. The deposits are veins with a general strike of about north 60 degrees west. There are probably ten of these veins ranging from a few inches to an oxidized width on the surface of from 5 to 6 feet. The sulphides consist of pyrite and galena carrying good values in gold and silver.

(6) GEORGIA RIVER SECTION

North Country Mining Company, Limited

References

Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1926, p. 86.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 80.

The holdings of this company consist of fourteen claims and two fractions covering the mountain that lies in the angle between Bulldog creek and Georgia river.

The country rock is a quartz diorite and the deposits are mineralized breccia zones striking northwesterly and dipping at steep angles. These zones are up to 25 feet in width and are said to have a very considerable length. The sulphide contents are not high and consist dominantly of pyrite with small amounts of sphalerite and galena. One zone carries some chalcopyrite; another has a higher proportion of sphalerite, and a third is reported to carry gold values in places. Four tunnels have been driven on the property.

(7) Nass River Mining Division

References

Clothier, G. A.: Ann. Repts., Minister of Mines, B.C.: 1918, p. 69; 1925, p. 73; 1926, p. 78.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, pp. 65-78.

The Nass River mining division extends from the mouth of Portland inlet north to the head of Kitsault river, a distance of 70 miles. The two chief mining centres are Anyox and Alice Arm. This division is the second largest metal producer of the province, due to the large copper output of the Granby Company at Anyox. In the Kitsault River section are a number of silver properties on which galena and sphalerite commonly accompany the silver ores, but not in amounts to be commercial sources of lead and zinc.

On McGrath mountain, in the Illiance River section, zinc showings have attracted considerable attention, particularly the Standard and the Sunrise groups. The mountain is underlain largely by argillites with a few interbedded bands of limestone and conglomerate and some volcanic material. A large, basaltic dyke several hundred feet wide crosses the mountain in a north-south direction cutting the argillites and related rocks. There are also a number of small, basic dykes and a few outcrops of felsitic rocks.

The deposits are veins or vein zones carrying amber-coloured sphalerite associated with quartz, calcite, and a little barite. A small amount of galena is usually present, but in only a few places is it at all conspicuous. Pyrite likewise occurs only sparingly and gold and silver values are low. Most of the mineral showings are in argillites, but they also occur in light-coloured, dense, felsitic rocks, in the volcanic material, and in the conglomerate. A similar type of mineralization is found on the Devlin zinc property to the northwest of McGrath mountain on the east fork of Kitsault river.

On the Sunrise the most important vein is known as the "Banded" vein. It has an indicated length of at least 1,200 feet and a width up to at least 15 feet. A 10-foot sample across a cut where the grade of ore is poorer than the average gave 8·8 per cent zinc.

(8) Skeena Mining Division

Reference

Hanson, G.: "Reconnaissance between Skeena River and Stewart, B.C."; Geol. Surv., Canada, Sum. Rept. 1923, pt. A.

In the northern and western part of Kitsumgallum district are a few properties showing silver-lead-zinc occurrences. Most of the mineral deposits are, however, gold-bearing quartz veins some of which carry sphalerite and galena. The district is reached from Terrace, on the Canadian National railway.

The region lies along the eastern contact of the Coast Range batholith and is part of the great mineral belt that flanks the batholith throughout its length. The chief rocks containing the ore-bodies are fragmental volcanic rocks, quartzite, and argillites.

(9) Bella Coola Mining Division

References

Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1926, p. 68.
James, H. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 59.

Bella Coola mining division embraces an area of about 125 miles square on the Pacific slope of the Coast range. The eastern contact of the Coast Range batholith enters it at the extreme northeastern corner and follows a southeasterly course to the head of Bella Coola river. Most of the area along the contact, however, is covered by glacial drift or Tertiary lavas and is not a favourable area for prospecting.

A number of claims staked on Smitley river, about 7 miles up from South Bentinck arm, are reported to have silver-lead showings. A specimen of ore assayed $2.40 in gold, 26 ounces in silver to the ton, 3 per cent copper, 12 per cent lead, and 10 per cent zinc.

(10-17) Omineca Mining Division

Omineca mining division covers a large area in the north-central part of the province. It lies east of the Coast Range batholith and its deposits are largely of the silver-lead type. Mining and prospecting have been conducted at numerous localities, particularly in the general region around Hazelton and Smithers. The discovery of what appear to be large deposits of lead-zinc ore on Ingenika river in the northeastern part of the mining division has aroused considerable interest.

(10) SKEENA SECTION

Seven Sisters Group

References

Lay, D.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 130; 1927, p. 126.

This group, consisting of six claims, is 8 miles by pack-trail from Cedarvale, a small settlement on the Canadian National railway about 40 miles west of Hazelton. The property lies on the upper western flanks of Seven Sisters mountain overlooking Skeena river. Work in 1927 was carried out under option by the D. W. Mines, Limited.

The rocks include argillites and quartzites of the Hazelton series, of late Jurassic age, intruded by granite and by dykes of andesite porphyry. Not far from the contact of the granite with the intruded sediments is a mineralized zone which can be traced for over a mile. The strike is north 10 degrees west and the dip is about 30 degrees easterly into the mountain. The surface exposures lie between elevations of 4,300 and 4,500 feet above sea-level.

The mineralization consists largely of pyrrhotite, sphalerite, galena, and pyrite. Silver values appear to vary considerably, but some of the galena lenses containing grey copper show quite high silver values, carrying from 3 to 4 ounces to the unit of lead. The mineralization is a replacement following the bedding-planes of the enclosing sedimentary rocks. It is probable that a belt of country about 300 feet in width will be found to contain parallel ore-lenses.

(11) HAZELTON SECTION

Silver Standard

References

O'Neill, J. J.: Geol. Surv., Canada, Mem. 110, p. 27.
Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1920, p. 84; 1923, p. 105.

The Silver Standard mine is on the northwest side of Glen mountain, about 6 miles by road north of New Hazelton station. The Silver Standard Mining Company purchased the property from the original locators, Long and McBain, in 1910, and steady development was carried on, with interruptions, until 1919. Shipments over the railroad were commenced in 1913. In 1915, the mine was reopened and mining and shipping were continued until the latter part of 1917 when the mine was again closed down. Work was carried on again during parts of the years 1918, 1919, 1920, and 1922. It has not been worked since.

The total tonnage of ore mined and milled was about 14,500 tons, which contained 1,100 ounces gold, 626,000 ounces silver, 1,225,000 pounds lead, and 1,400,000 pounds zinc, with a gross value of about $500,000. Prior to 1918 the ore shipments consisted of hand-sorted ore, but after that practically all the ore was milled and lead and zinc concentrates were shipped. These concentrates were high grade, the lead running from 200 to 225 ounces silver to the ton, and the zinc concentrates from 80 to 120 ounces to the ton.

The rocks on the claims consist of members of the Hazelton series which here are chiefly sedimentary tuffs. One small stock of granodiorite porphyry intrusive into the tuffs, is also exposed on the property. The general strike of the tuffs is northeast and the dip southeast.

The deposits are lode fissures traversing the tuffs. Nine veins have been opened, but only two have been important producers. Some of the others, however, are known to contain high-grade ore, as well as the low-grade which is common to all the veins. The strikes vary in detail, partly due to faulting, but the veins are roughly parallel, striking north 20 degrees to 35 degrees east (magnetic) with steep dips to the southeast. The veins vary from a few inches up to 6 feet in width.

The important minerals are galena, zinc blende, and freibergite. Arsenopyrite, pyrrhotite, pyrite, chalcopyrite, and jamesonite are also present. Free gold is associated with the arsenopyrite. The chief gangue mineral is quartz, but calcite is almost as abundant.

A description of the various veins and the development work carried out on them is given in Memoir 110 of the Geological Survey and in the Annual Reports of the Minister of Mines. On the two main veins most of the ore from the 250-foot level to the surface has been worked out, but there is evidence that the ore-shoots continue downwards as shown by the shaft on the main vein which is down 450 feet.

Silver Cup

References

O'Neill, J. J.: Geol. Surv., Canada, Mem. 110, p. 34.
Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1914, p. 201.
Lay, D.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 134; 1926, p. 130.

This group is on Ninemile mountain, about 6 miles in an air-line northeast of Hazelton, but about twice that distance by wagon-road. The claims were staked in 1909 and have been worked on several occasions by different owners and leasers. In 1927, the property was operated by the Duke Mining Company, Limited.

The rocks of the claims consist of heavily bedded quartzites and argillites of the Hazelton series in places having a high angle of dip. A large area of intrusive granodiorite lies to the west and north, and has been responsible for the fracturing and mineralization. The deposits are quartz-filled fissure veins of which there are two or three on the property.

In 1917 the development as described by O'Neill was as follows:

"There are four main drift tunnels giving a vertical range of over 1,000 feet, although it is not certain that the lowest occurrence is on the same vein as the upper ones. The upper tunnel at about 5,000 feet altitude is 200 feet long on a vein 6 inches to 2 feet in width, averaging 10 inches, and in ore all the way.

A sample across 6-inch paystreak gave: gold, 0·02 ounce; silver, 45·4 ounces; lead, 33 per cent; zinc, 22 per cent.

The second tunnel, about 150 feet lower, is 100 feet long and shows 20 to 24 inches of mineralized vein throughout its length. At 40 feet a stope was made for a height of 25 feet, all in ore. A sample assayed: gold, trace; silver, 116 ounces; lead, 41·6 per cent; zinc, 12·4 per cent. Selected solid sulphide assayed: silver, 150-250 ounces; lead, 50-70 per cent.

The lowest tunnel, the Duchess, was driven 140 feet, but after 100 feet the vein fingered out; the strike here is at about 45 degrees to that in the upper tunnels and it is probably one of another system of veins.

The vein is 6 to 8 inches in width, with disseminated sulphides, mostly arsenopyrite, for 6 inches in the sedimentary tuffs on either side. The gangue is quartz and a sample across 18 inches gave: gold, 0·06 ounce; silver, 92·2 ounces; lead, 14·9 per cent; zinc, 11·16 per cent."

In 1925 work consisted in mining and shipping ore exposed on the surface above No. 1 tunnel and from No. 1 tunnel itself. Fifty-two tons of ore were shipped. The ore consists of galena, zinc blende, and jamesonite and good silver value associated with copper.

Sunrise Group

References

O'Neill, J. J.: Geol. Surv., Canada, Mem. 110, p. 34.
Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1919, p. 204; 1920.
Lay, D.: Ann. Repts., Minister of Mines, B.C.: 1924, p. 94; 1927, p. 131.

The Sunrise group is on Ninemile mountain about one-half mile northeast of the Silver Cup group of claims. They are reached by wagon-road from Hazelton, a distance of about 12 miles.

The deposits traverse granodiorite, and are of the nature of replacements along shear zones. The mineralization consists of galena, jamesonite, stibnite, zinc blende, and small amounts of pyrite and grey copper. The principal value is in silver with subsidiary values in lead and zinc. There are two main veins on the property. The lower is at 9,950 feet elevation; it strikes north 10 degrees east and dips 45 degrees southeast. The shear zone is 20 feet in width and contains a clean vein 1 foot in width. The upper zone is at 5,050 feet elevation; it is 6 to 8 feet wide and is highly mineralized throughout, chiefly with galena and jamesonite. It strikes north 60 degrees east and dips 40 degrees southeast.

The deposits have been opened by tunnels and surface working. Work progressed in 1924 and 1925, but no shipments of ore were made. Further work was carried out in 1927.

American Boy

References

O'Neill, J. J.: Geol. Surv., Canada, Mem. 110, p 32.
Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1914, p. 197; 1917, p. 104.
Lay, D.: Ann. Rept., Minister of Mines, B.C., 1927, p. 131.

This property is on the southwest slope of Ninemile mountain, about 6 miles from New Hazelton. It is reached by a good wagon road and trail, the former passing about 1,100 feet below the property.

The deposits are in the form of veins 6 inches to 3 feet in width traversing rocks of the Hazelton series consisting largely of volcanic tuffs. The veins strike roughly north 30 to 40 degrees east, and dip 40 to 70 degrees southeast. They are offset by a series of small faults, but not to an extent to cause inconvenience in development. The mineralization consists of galena and zinc blende with lesser amounts of jamesonite, tetrahedrite, pyrite, and chalcopyrite in a gangue of quartz.

Early development of three veins on the property is described in the Annual Report of the Minister of Mines for 1914. In 1926 and 1927 operation in a small way was carried out.

Brunswick Group

References

Lay, D.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 134; 1926, p. 126.

This group is situated on Rocher Déboulé near Hazelton. A good trail leads to it from the Rocher Déboulé wagon-road, following the north bank of Balsam creek.

Lay states:

"This group is just below the Red Rose group and is situated in the sedimentary rocks of the Hazelton group in the near vicinity of the contact with granodiorite. The vein, striking north 20 degrees east (magnetic) and dipping westerly at a steep angle of about 75 degrees, is opened up by two drift tunnels on the vein, about 75 feet vertically apart. The hillside being covered with a thickness of about 10 feet of cemented drift at this point, the first 25 feet or so of each tunnel is in the nature of a crosscut.

No. 1 tunnel, at an elevation of 4,350 feet, has been run a distance of 65 feet; the last 20 feet of this disclosed a width of 2 feet of mixed quartz, galena, and zinc blende, with small amounts of chalcopyrite, and in this distance a tonnage of perhaps 10 tons of selected ore was obtained. A grab sample from the pile of ore assayed: gold, 0·16 ounce; silver, 57 ounces to the ton; lead, 11·2 per cent; zinc, 24 per cent. In the face the bottom of the tunnel showed a width of about 9 inches of sulphides.

No. 2 tunnel, at an elevation of 4,275 feet, was run to meet the downward extension of the ore met with in No. 1 tunnel. The length is 170 feet, of which the last 140 feet showed a width of between 1½ and 2 feet of slightly mineralized quartz."

Brian Boru Group

References

Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1914, p. 191.
Lay, D.: Ann. Rept., Minister of Mines, B.C., 1926, p. 127.

The Brian Boru group is at the head of Brian Boru creek. The mineralization consists of small veins and stringers cutting volcanics and sediments of the Hazelton series. The minerals are zinc blende, pyrrhotite, and pyrite, with or without quartz.

True Fissure

Reference

Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1921, p. 98.

This property is on the western side of Thoen basin, about 31 miles northeast of Hazelton. The route from Hazelton is along Babine trail which follows Bulkley river for a few miles after leaving Hazelton and then continues up Suskwa river, a tributary of the Bulkley, to its head, and then down to Babine lake. One of the tributaries of Suskwa river is Thirtyonemile creek, so named because Thirtyonemile post on Babine trail is situated where the trail crosses the creek. The country at the head of Thirtyonemile creek is known as Thoen basin. From the main trail to the head of the basin there is a branch trail 3 miles long.

Galloway states:

"The rock formations exposed on and near the property consist of quartzites, argillites, and tuffaceous rocks of the Hazelton formation, which are intruded by a small boss of granite. This intrusive rock is a light-coloured, medium-grained biotite granite and has considerably affected by metamorphic action the sedimentary measures near the contact. Dioritic dykes also cut the formation, these dykes are characterized by long crystals of feldspar.

The main ore-showing on the property is a fairly well-defined replacement fissure type of vein which is well exposed, cropping at different points up and down the mountain side. The vein has evidently been more of a sheared zone than an open fissure and in places the ore is "frozen" to the walls. The vein strikes northeast (magnetic) and dips 55 degrees to the northwest. The sulphide minerals found in this vein are galena, zinc blende, pyrite, and small amounts of grey copper. The gangue is mostly altered wall-rock, but some quartz occurs in places. The ore in places is a brecciated mass of sulphides and fragments of more or less silicified wall-rock. The wall-rock is of variable character, depending on the particular sedimentary bed through which the vein cuts, but is generally argillitic in composition. Zinc blende is present in considerable quantity in the ore and there is but little solid galena free from blende.

The vein, which has a width of from 1 to 2 feet, is fairly well mineralized, but, as is customary, the ore runs in shoots and parts of the vein are only slightly mineralized. Where the vein is well mineralized the sulphides are in many places confined to a band of nearly solid mineral (generally mixture of galena and zinc blende); these bands vary from a few inches up to a foot in width.

The principal value in the ore is in the high silver content, although the lead and zinc contents are appreciable.

Assays of sample show silver values varying from 20·5 to 203·4 ounces per ton.

There is very little work done on the property. A few open-cuts have been made and at an elevation of 6,200 feet a tunnel has been started and faced up. But the vein is naturally exposed at a number of places up and down the mountain side. Above the tunnel there is a good cropping of the vein on a ridge, but it is practically inaccessible. The highest showings on the vein contain the best ore, and it is reasonable to expect that a drift tunnel going in on the vein would show up some good shoots of ore. The silver values in the selected ore make it a reasonable speculation to explore this vein to see whether or not it contains a sufficient quantity of this class of ore to pay to mine it."

(12) SMITHERS SECTION

Henderson Mine

References

Jones, R. H. B.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 130.
Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1922, p. 109; 1923, p. 108; 1924, p. 94; 1925, p. 135; 1926, p. 129; 1927, p. 134.

The Henderson mine is at an elevation of 3,600 feet on the western slope of Hudson Bay mountain, about 15 miles by motor road from Smithers on the Canadian National railway. The following quotations are from the report by Jones.

"The property was staked many years ago by Boyd and Ashman. Early exploration consisted mainly of test pits and stripping, on what is known as the Ashman vein. In 1921 the Henderson vein was discovered about 200 feet southeast of the Ashman vein. Stripping of the Henderson vein disclosed high silver values and the property was bonded by J. F. Duthie in July, 1922. Development work on the Henderson vein was performed under the supervision of Mr. John R. Turner and in 1923 the property was purchased. In August, 1923, the Federal Mining and Smelting Company obtained a 55 per cent interest in the properties held by Mr. Duthie and a company termed Duthie Mines, Limited, was organized. Options were carried by the Federal Mining and Smelting Company until August, 1924, when all work was stopped. Work was resumed by Mr. Duthie in July, 1925."

In 1927 the property was taken over by the Atlas Exploration Company.

"The area around the mine is underlain by the Upper Volcanic division of the Hazelton series. Rhyolite predominates with a subordinate amount of andesite in the upper levels, but in depth the amount of andesite increases. A series of dykes cut these rocks and strike in general about north-south. The largest dyke is of medium-grained diorite and is about 50 feet wide. Near the Henderson vein it is intensely altered and silicified and is sparingly mineralized with small veinlets of ore. It appears to be pre-mineralization in age. The other dykes are not greatly altered and no mineralization was observed in them; where seen underground these dykes offset the vein and the part of the vein east of each dyke has been displaced to the south. One of the dykes which crosses the Ashman vein is sheared at the surface parallel to the vein. In general the dykes with a north-south trend, other than the large dyke, appear to be post-mineralization in age."

The deposits consist of veins that occupy shear zones striking about south 65 degrees east and dipping steeply southwest. The ore in places shows banding caused by the filling of open cavities. Replacement, however, has also given rise to mineralization beyond the fissure walls and fragments of country rock enclosed in ore have also been partly replaced.

The minerals of the vein zone consist of galena, sphalerite, arsenopyrite, chalcopyrite, pyrite, tetrahedrite, covellite, and quartz. Native silver and ruby silver occur as secondary products of enrichment.

Development on the Henderson vein consists of three drift tunnels, known as the Thompson, McPherson, and Compressor tunnels, an intermediate level, raises, slopes, and surface stripping. The vein is exposed on the surface for a distance of over 1,000 feet.

Previous to August, 1923, 297 tons of ore was shipped; from August, 1923, to August, 1924, 1,625 tons; and during 1925, 950 tons. These shipments averaged from 116 to 185 ounces of silver to the ton and from 16 to 26 per cent lead.

In 1926, the Henderson was a steady shipper of high-grade silver-lead-zinc ore and the only property operating on any appreciable scale in the district. In 1927 a flotation mill was erected which commenced operations in July.

Victory Group

References

Jones, R. H. B.: Geol. Surv., Canada, Sum. Rept., 1925, pt. A, p. 134.
Galloway, J. D.: B.C. Bureau of Mines, Bull. No. 4, pp. 50-51 (1915).
Ann. Repts., Minister of Mines, B.C.: 1914, p. 216; 1922, p. 111; 1923, p. 109; 1925, p. 136.

The Victory group lies on the western flank of Hudson Bay mountain about a mile northwest of the Henderson mine. A wagon-road from the property joins the Smithers-Henderson road below the Henderson mine.

Galloway's description of the property is as follows:

"This property lies to the west of the Coronado group and consists of the Victory, Standard, and Triumph claims. It is owned by Donald C. Simpson, who staked it some ten years ago, and since then has, single-handed, done a considerable amount of development work. The three claims are staked up and down the hill, or roughly in a north-south direction. The victory is the central claim and on this the greater part of the work has been done. Several veins have been found on the property, but as yet only the No. 1 vein has been developed to any great extent. These veins are all developed in sheared zones, and probably connected more or less directly with intrusive dykes; as a rule, the mineralization has been by means of replacement, accompanied by silicification of the wall-rock.

No. 1 Vein. This vein has a strike of north 62 degrees east and dips to the southeast at 80 degrees. It runs roughly up and down the hill, and is, therefore, well situated for the driving of drift-tunnels along the course of the vein. The lowest, or No. 1, tunnel has a length, including the approach, of 90 feet. This working shows a good shoot of ore from the portal of the tunnel inwards for about 25 feet; the width of the vein in this section being from 1 to 2 feet. Beyond this the vein is split up and seems to go into both walls, while at the face there is some mineralization, with iron sulphides, but no ore. From this tunnel about 10 tons of sorted ore has been taken out, a sample intended to represent an average of this assayed: gold, 0·18 ounce; silver, 78·1 ounces; lead, 52·8 per cent; zinc, 11·3 per cent. The whole shoot of ore exposed in the beginning of the tunnel would not assay quite as well as this sample, as the latter was taken from sorted ore.

Above the tunnel the vein has been stripped on the surface for some distance, where it can be seen that the mineralization is spotted and irregular. At a point which would only be a short distance beyond the face of the tunnel, but on the surface, there is another shoot of ore from 15 to 20 feet long and from 12 to 15 inches wide. A sample taken across 14 inches here assayed: gold, 0·13 ounce; silver, 33·7 ounces; copper, 1·5 per cent; lead, 23·6 per cent; zinc, 36·6 per cent.

A short distance above is the No. 2 tunnel, which is 10 feet long. The face shows several seams of mineral scattered across a width of 4 to 5 feet. A sample was chipped out across 4 feet 6 inches which returned on assay: gold, 0·30 ounce; silver, 16·3 ounces; lead, 9 per cent; zinc, 12·4 per cent. Above the No. 2 tunnel there are a series of open-cuts extending up the hill to the No. 3 tunnel, which disclose irregular mineralization along the vein.

No. 3 tunnel has an approach of 15 feet and only a few feet of actual tunnel under cover. At this place there are narrow stringers of mineral disseminated across 7 to 8 feet. A sample taken across 6 feet at this place assayed: gold, 0·10 ounce; silver, 2·5 ounces; lead, 1·6 per cent; zinc, 5·3 per cent. The dump from this tunnel seems to be fairly well mineralized and would probably average slightly better than the above sample.

No. 4 tunnel has a long open-cut approach, but is hardly under cover as yet. This working shows more solid ore than in the Nos. 2 and 3 tunnels. At one section, 5 feet from the face, there are two parallel streaks of ore 12 and 8 inches wide respectively, separated by a strip of waste. A sample of this ore assayed: gold, 0·44 ounce; silver, 15·4 ounces; lead, 12·6 per cent; zinc, 13·8 per cent. A few tons of good-looking ore has been saved from this working, while the waste-dump contains a fair percentage of mineral. Open-cuts and stripping between tunnels Nos. 3 and 4 also show a fair amount of mineralization. Above No. 4 there is one more exposure of the vein, but it is unimportant. From No. 1 tunnel to this uppermost cut is about 1,500 feet, and it may be said, therefore, that the continuity of the vein is proved for this distance.

No. 2 vein lies about 300 feet east of No. 1 and is roughly parallel; this is really a dyke about 1 foot wide, altered to some extent by iron- and silica-bearing solutions, no ore is visible in this vein and no work of importance has been done on it.

No. 3 vein lies 50 feet to the east of the No. 2 vein. An open-cut 24 feet long, with a 12-foot face, shows a small fissure from 6 to 12 inches wide which has a core of 3 inches of galena and on either side red oxidized material. A sample across 10 inches, including the 3 inches of galena, assayed: gold, 0·16 ounce; silver, 53·9 ounces; lead, 33·2 per cent; zinc, 4·3 per cent.

Two or three other veins or slightly mineralized dykes are known, but as yet they have not been developed to any extent: one of these, containing only arsenical iron, is said by the owner to carry fair gold values."

Coronado Group

References

Jones, R. H. B.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 132.
Galloway, J. D.: B.C. Bureau of Mines, Bull. 14, p. 48 (1915).

The Coronado group lies about one-half mile northwest of the Henderson mine, on the western flank of Hudson Bay mountain. It is reached by road from Smithers.

The following is Galloway's description of the property.

"The Coronado group of claims lies up the hill a short distance above the flat and only half a mile from the main trail. The property consists of two claims and a fraction, and is owned by R. J. McDonell, James Halley, and others. The claims are all below the timber-line at elevations from 3,000 to 3,500 feet. A comfortable camp with cookhouse and bunkhouses has been erected.

The main vein on this property has been traced on the surface for at least 800 feet, and is developed by means of adit drift-tunnels and surface cuts. It strikes about northeast and dips at about 85 degrees to the northwest and is apparently a replacement vein, the wall-rock consisting largely of volcanic breccia, but, in places, it changes to diabase, felsite, and porphyrite. The main valuable mineral is galena, which carries fair values in silver, but in addition there are found sulphides of iron and zinc, occurring in a gangue which is mainly silicified wall-rock. The gold values in the ore of this property are a good deal higher than usual throughout the district.

No. 1 tunnel, which is the lowest on the hill, is in 155 feet, and has a winze down 12 feet below the floor-level; this working shows the vein to be mineralized in rather irregular bunches and to vary in width from 1 to 2 inches up to 2 feet. The best paystreak of ore seen was at a point 110 feet in the tunnel, where there is a width of 10 inches of good-looking ore. A sample across this assayed: gold, 0·45 ounce; silver, 129·4 ounces; lead, 38·1 per cent; zinc, 14·4 per cent.

The ore taken out in the driving of this tunnel has been roughly sorted into two grades, of which there is about 25 tons of first-class ore; a sample representing an average of this assayed: gold, 0·20 ounce; silver, 46 ounces; lead, 23·5 per cent; zinc, 15·4 per cent. The winze was full of water, but it is said to have a showing of good ore at the bottom.

One hundred feet up the hill a cut 50 feet long has been made on the vein, and from the end of this the No. 2 tunnel is driven in 35 feet. There is a nice shoot of ore exposed in this tunnel; at the entrance the paystreak is 2 feet wide, being nearly continuous for the length of the tunnel, and has a width of 10 inches at the face. An average sample taken at the face assayed: gold, 0·30 ounce; silver, 16·5 ounces; lead, 4·8 per cent; zinc, 45·3 per cent.

About 30 tons of first-class ore has been sorted out of the material taken out from this working, and there is another dump of second-class ore containing about 30 tons. Average samples of these dumps assayed as follows: first-class gold, 0·24 ounce; silver, 51·4 ounces; lead, 27 per cent; zinc, 21·6 per cent. Second-class—gold, 0·20 ounce; silver, 6 ounces; lead, 2·2 per cent; zinc, 16·5 per cent.

A short distance farther to the hill is the No. 3 tunnel which is 20 feet long. This tunnel has apparently been driven in on one side of the main vein, as what appears to be the vein is cropping on one side at the mouth of the tunnel and then passes into the foot-wall. The only mineral showing in the working is a little arsenical iron pyrites which occurs along fracture-planes, but this is of no importance.

One hundred and fifty feet farther up the hill a surface cut shows what is probably the same vein, and with a width of 10 inches, the mineralization here consisting of zinc blende and arsenopyrite.

A sample across the full width assayed: gold, 0·76 ounce; silver, 4·9 ounces; lead, 0·8 per cent; zinc, 19·2 per cent. This assay is worthy of particular note, inasmuch as the gold content is much higher than any other sample. This sample contained zinc blende and arsenopyrite as the main minerals, with only a slight amount of galena.

From this point up the hill for another 800 feet, attempts have been made by stripping, etc., to find the vein, and in two or three places fractured seams containing some mineral have been found, which may be extensions of the main vein. The cut, which is highest up the hill, 1,200 feet or more from the No. 1 tunnel, shows a rather poorly defined vein about 2 feet in width, and carrying a little galena and zinc blende. No sample was taken here, but to judge by the eye the values would be low.

No. 2 Vein. Near the eastern boundary of the Coronado, on the west bank of Sloan creek, another vein has been developed to some extent. This vein is also of the replacement type, having been formed in a fractured dyke. An open-cut 15 feet long forms the approach to a 60-foot tunnel driven on the vein, which strikes about north 60 degrees east, and dips quite steeply to the northwest. The tunnel was commenced on a seam showing some nice galena, but after a short distance this stringer apparently goes into the foot-wall, and another seam is followed to the face. A crosscut to the northwest 12 feet long has been made at the face, but did not find anything; if the crosscut had been made in the opposite direction it might have picked up the seam on which the tunnel was started, and which lies in the foot-wall. A few tons of ore has been taken out of this working, which will assay about 0·40 ounce gold, 57·2 ounces silver, 30·2 per cent lead, and 18 per cent zinc.

A shaft has also been sunk on this vein to a depth of 15 feet, which shows ore up to 18 inches in width for 10 feet down from the top. Below this the shaft was filled with water, so that it was impossible to see what the vein looked like there. A few surface cuts also show the vein in different places, one of these showing 6 inches of galena and most of the others just disseminated mineral.

It will be of some advantage to consider the assays of the different samples taken from this property, and for this purpose they are now tabulated as follows:

No.	Description	Gold	Silver	Lead	Zinc
		Oz.	Oz.	Per cent	Per cent
1	No. 1 tunnel, sample across 10 inches	0·45	129·4	38·1	14·4
2	No. 2 tunnel, average vein at face	0·30	16·5	4·8	45·3
3	Open-cut, vein 10 inches wide	0·76	4·9	0·8	19·2
4	First-class ore-dump, No. 2 tunnel	0·24	51·4	27·0	21·6
5	Ore dump, No. 1 tunnel	0·20	46·0	23·5	15·4
6	Second-class ore dump, No. 2 tunnel	0·20	6·0	2·2	16·5

From a comparison of these results it will be seen that the silver content is dependent on the lead content, varying from about 2 to 3·4 ounces of silver to the unit of lead. By comparing Nos. 1 and 2, and 5 and 6, it can be seen that the silver is in no way related to, and is evidently not contained in, the zinc. Turning to the gold content, it is not so evident what relationship, if any, exists between it and the other metals. The gold does not vary proportionately with the silver, lead, nor zinc, and, in fact, seems to be quite independent of these. The writer believes, though, that the gold occurs in association with the arsenopyrite which is found in the ore. To some extent this is proved by No. 3 sample, which consisted almost entirely of arsenopyrite, zinc blende, and siliceous gangue; it will be noted that this sample contained a good deal more gold than the others, and, as it also contained a higher percentage of arsenopyrite, it is reasonable to assume that the gold is carried in this mineral. As a rule, this arsenical iron has been considered as of only slight value in this district, but it is quite possible that in many instances it carries good gold values, and that in rejecting it from samples, as is generally done, the prospector is unintentionally throwing away the best of the ore."

Later work has been described by Jones as follows:

"Since the above report on the property was written additional work has been done. Early in 1919 the Skeena Mining and Milling Company was organized to develop the Victory and Coronado groups. The company started operations in the spring, but stopped work during the summer. A start was made again in October, but shortly thereafter work was again stopped. The lower tunnel on No. 1 vein has been driven a total distance of 240 feet. No. 2 tunnel is driven 90 feet. The tunnel on No. 2 vein has been driven an additional 10 feet. There are about 8 inches of galena and sphalerite on the foot-wall side of the tunnel, below a slip dipping 70 to 80 degrees northwestward. If the ore stays below this slip the tunnel is now on the hanging-wall side of the ore."

Silver Creek Group

Reference

Jones, R. H. B.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 138.

This group, formerly known as the Iron Vault group, and commonly called the Schufer property, is situated at an elevation of 5,600 feet to 5,900 feet on the northwest slope of Hudson Bay mountain overlooking the pass between Silver and Toboggan creeks. It is easily reached by a pack trail about 9 miles from lake Kathlyn, or 12 miles from Smithers.

The property is owned by Peter Schufer, of Smithers, and partners. In the autumn of 1910 it was bonded to the Hudson Bay Mining Company, who carried on development work in 1912, 1913, and 1914, dropping their option in 1914. In 1917 the owners shipped 5½ tons of hand-sorted silver-lead ore to the Trail smelter. In 1918, 30 tons of silver-lead ore was shipped to the Silver Standard concentrator at New Hazelton. Exploration has continued on the property each year. In 1925 the property was bonded by the British Canadian Silver Corporation, a subsidiary of the British Columbia Silver Mines, Limited, of Premier, B.C. Development was carried out during the summer of 1926 by this company.

The country rock consists of andesitic flows, tuffs, and breccias, with which is interbedded a limestone bed about 60 feet thick. A stock of granodiorite cuts the series.

Mineralization occurs in the flows and limestone. The granodiorite stock is mineralized at a number of places by fissure veins. Three types of ore occur on the property: (1) galena-silver type; (2) pyrrhotite-sphalerite type; (3) arsenopyrite type.

The galena-silver type is represented by a vein striking north 85 degrees east and dipping south 53 degrees, cutting across andesite flows and limestone and extending into a series of tuffs. Mineralization in the vein where it cuts the flows consists of galena, sphalerite, pyrite, tetrahedrite, and chalcopyrite. The vein varies in width, reaching a maximum of about 18 inches. Where the vein cuts the limestone, mineralization extends over a width of 10 feet and consists of pyrrhotite, sphalerite, pyrite, galena, and minor amounts of chalcopyrite. The vein extends through the limestone into tuffaceous rocks. Development consists of three short drift tunnels and surface stripping.

The second or pyrrhotite-sphalerite type of mineralization is largely confined to the limestone band. Lenses of ore occur in the band, but work in 1926 showed that the mineralization is not continuous. The ore in places shows gradational contacts with the limestone, but other lenses of massive sulphides have sharp contacts with it.

The third or arsenopyrite type consists of mineralization of arsenopyrite, sphalerite, and galena in a few shear zones in the granodiorite. This type of mineralization does not appear to be extensive.

Victoria Group

Reference

Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 32.

This group is situated in Driftwood Creek map-area, Babine mountains, east of Smithers.

Hanson's description of this group is as follows:

"This property, owned by P. Higgins, is situated near the head of Higgins creek. Development consists of adits, shafts, numerous trenches, and open-cuts. The country rock is argillite of the sedimentary division of the Hazelton group, intruded by rhyolite and quartz porphyry dykes. At the time of the writer's visit, most of the trenches and open-cuts had caved, and the shafts were full of water, consequently little was to be seen. During the past summer work was being concentrated on the upper adit. Here the vein is closely associated with a rhyolite dyke which contains numerous gashes of quartz and a good deal of disseminated pyrite. The vein lies between this dyke and one of quartz porphyry. Several veins are present on the property and veins are exposed in a zone fully half a mile long, but no single vein has been shown to have this length. The main vein is 3 feet wide in the upper adit, and contains galena and sphalerite in a gangue of quartz, ankerite, and slate. Tetrahedrite and pyrite are present in small amounts. Several tons of selected ore containing a good deal of silver have been shipped."

Babine Bonanza Mining and Milling Company

(Cronin's Mine)

References

Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 30.
Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1920, p. 87.

This property is in Driftwood Creek map-area about 15 miles east of Smithers. The claims lie north of Cronin creek on the eastern slope of Cronin mountain, 5,000 feet above sea-level.

The country rock is argillite and graphitic schist of the sedimentary division of the Hazelton group, intruded by a small stock of rhyolite and quartz porphyry. The intrusive rock contains several large, irregular inclusions of sedimentary rock. The geology is further complicated by the presence of quartz porphyry, quartz diorite, and lamprophyre dykes.

The following description of the deposits is given by Hanson.

"Two main veins have been explored by tunnels, raises, and shafts. A shaft has been sunk on what is perhaps a third vein. Many other smaller veins were encountered in the tunnels, but were not drifted on to any extent. Two inclined shafts, their mouths about 450 feet vertically above the lowest tunnel, have been sunk on what appear to be two distinct veins, but which, possibly, are one and the same. No. 1 vein, exposed in No. 2 shaft, has an easterly course and dips north. Adit A, 120 feet below shaft No. 2, crosscuts No. 1 vein near the face of the adit, and an inclined raise has been driven on the vein. This adit also crosscuts, 120 feet north of No. 1, another vein. Adit B, 150 feet below shaft No. 2, encounters No. 2 vein and continues as a drift along it. A large surface cut, about 180 feet below shaft No. 2, exposes No. 2 vein. Adit C, 225 feet below shaft No. 2, crosscuts No. 2 vein at the face of the adit. Adit No. 1, 225 feet below shaft No. 2, begins as a drift on No. 1 vein on which two raises have been driven. At the westerly end of this adit, some quartz which may represent No. 2 vein was encountered. From a point midway in this adit a long crosscut to the north encountered No. 2 vein about 160 feet northwest of No. 1 vein. The vein was drifted on to the northeast and southwest and inclined raises were put up. Adit No. 2, 450 feet below shaft No. 2, encounters No. 2 vein, 675 feet from the portal. The vein has been drifted on for some distance. Seven other smaller veins containing sulphides were crosscut by this adit.

The vein appearing in shaft No. 1 varies in width from 6 inches to 3 feet, being widest at the bottom of the shaft. Further development might prove this to be the same as No. 1 vein. It contains much sulphide in a quartz gangue. Galena, sphalerite, and tetrahedrite are the principal sulphides.

No. 1 vein is exposed for a depth of 50 feet along the dip of the vein in shaft No. 2. It varies from 1 to 6 feet in width and consists of quartz, galena, sphalerite, and tetrahedrite. The vein is narrowest at the bottom of the shaft. In adit A it is exposed for a length of 20 feet and has a width of 1½ feet. At the top of a raise driven from adit A the vein is 6 feet wide. Finally, in adit No. 1, the vein is exposed for a length of 360 feet. For the first 240 feet from the portal it contains very little visible sulphide and varies in width from 6 inches to 2 feet. It then widens and for the next 75 feet of length varies from 4 to 6 feet and consists almost entirely of galena and sphalerite. For the next 45 feet the vein is again less than 2 feet wide and consists chiefly of quartz. A raise driven on the sulphide lens shows that the vein narrows rapidly with height. Evidently it pinches and swells within short distances along its strike and dip. The lenses may pinch out entirely and be succeeded along the strike or dip by other lenses. Tetrahedrite is more plentiful near the surface of the vein than it is at the depth of adit No. 1. This vein, where exposed by the mine workings, lies entirely in rhyolite, where splintery and irregular discontinuous fractures might be expected.

No. 2 vein is crosscut by adit A, 50 feet from the portal. At this point it varies from 1½ to 2½ feet in width within a length of 4 feet. The foot-wall here is a hard, fine-grained, grey, quartz porphyry dyke, and the hanging-wall is rhyolite. In adit B the vein is 3 feet wide and is exposed for a length of 40 feet. Here it has a hanging-wall of rhyolite and a foot-wall consisting in part of argillite. Adit C crosscuts this vein, which is 3 feet wide on one side of the adit and 8 feet wide on the other. The hanging-wall is argillite and the foot-wall rhyolite. The vein is not very strong on No. 1 adit level. For a distance of 50 feet it is a mere stringer and for a farther distance of 50 feet it varies in width from 4 inches to 3 feet. In a raise, along the vein driven from this adit, it varies from 1 to 3 feet. The hanging-wall is argillite in some places and rhyolite in others. The foot-wall is rhyolite. In adit No. 2 the vein is first encountered 670 feet from the portal. For 120 feet the vein varies in width from a few inches to 2 feet. For the next 50 feet the width varies from 3 to 7 feet. Here the vein appears to make an abrupt turn and continues in a drift to the southwest for a distance of 190 feet, the width varying from 1½ to 4 feet. At the southwestern end of this drift it divides into two branches, one of which pinches out. Almost the whole of the vein striking southwest has argillite on both walls. Most of the westerly striking part of the vein has rhyolite on both walls. The part striking southwest appears to be the downward extension of No. 2 vein from upper adits. The westerly striking part appears to have been deposited in a pre-mineral fault. The wider parts of the vein on this level consist of practically solid sulphide. In many places zinc blende is very common and there is also a notable amount of tetrahedrite. The westerly extension of the adit crosscuts five other quartz sulphide veins.

Vein No. 2, like vein No. 1, pinches and swells abruptly, but it is further complicated and its continuity is made less certain because the line of fracture in which the ore was deposited passes not only through rhyolite but also through relatively large inclusions of argillite and graphitic schist. The presence of dykes also tends to make the continuity less certain. For these reasons estimation of the quantity of probable ore in this vein is even less certain than in No. 1 vein, but more and wider individual shoots of ore are to be expected.

The workings described above are on the Bonanza claim. On the Homestake claim, adjoining the Bonanza on the southwest, are other veins. One of these, 4 feet wide in some places, has been developed by several short adits, shaft winzes, and open-cuts. The vein strikes northeast and dips north, and has been traced almost to the shafts on the Bonanza claim. One-quarter mile from the Bonanza shafts the vein consists chiefly of quartz, but farther northeast it contains a good deal of galena, zinc blende, and tetrahedrite. The vein passes from sedimentary rock on the west into rhyolite on the east."

Silver King

Reference

Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 35.

Hanson states:

"This property is situated near the head of Driftwood creek. The country rock is sheared tuff. The development work consists of several adits making a total length of 370 feet. Two of the longer adits are crosscuts which have not penetrated the veins. Here a zone of quartz veins extends over an horizontal distance of 1,500 feet. Individual veins are lens-shaped and discontinuous, varying from an inch to 8 feet in width, and are usually less than 200 feet long, but although individual veins pinch out and disappear other similar veins come in along the strike. The veins contain variable amounts of galena, tetrahedrite, chalcopyrite, and sphalerite, in a gangue of quartz. The tetrahedrite contains a good deal of silver."

Hyland Basin

Reference

Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 32.

This property is situated in the Driftwood Creek map-area, Babine mountains, east of Smithers. Hanson's description of the property is as follows:

"This property is situated near the head of Cronin creek. Development consists of numerous open-cuts and two adits 190 and 25 feet long. The country rock is sheared argillite of the upper part of the sedimenary series, intruded by several dykes and perhaps sills of rhyolite parallel to the shearing of the sediments. The vein consists of galena and some tetrahedrite in a quartz gangue. It follows closely the contact between the argillites and a dyke of rhyolite. The open-cuts were caved at the time of the writer's visit, so the actual dip of the vein was not ascertained, but the strike is south 80 degrees west and is parallel to the shearing in the sediments. The long adit has been driven parallel to the vein at a distance of 20 feet to the north of it, and no attempt has been made to crosscut the vein from the adit. Small shipments have been made of selected ore containing a high silver content."

Debenture

Reference

Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 32.

This group is located on Debenture creek in Driftwood Creek map-area, Babine mountains, east of Smithers.

Hanson's description is as follows:

"The mineral showings on this group are located on Debenture creek. Development work consists of a 400-foot crosscut adit, a short drift adit, and surface strippings. The country rock is stratified tuff and rhyolite, of the upper volcanic division. The rocks are severely sheared and weathered. A narrow, steep, rock shoulder projects from the mountain south of the property, and the ore zone or vein crosses this shoulder, is exposed on the summit and down the two opposite slopes, thus being exposed on two sides of a triangle. The mineral deposit contains galena in a gangue of quartz and country rock and is as much as 6 feet wide in a few places. The long crosscut adit has been driven into the shoulder of the mountain, but although it has penetrated beyond the point where the vein should have been intersected, the vein was not found. Probably it is cut off by an horizontal fault, and the adit was driven below this fault."

(13) TELKWA SECTION

Cassiar-Crown

References

MacKenzie, J. D.: Geol. Surv., Canada, Sum. Rept. 1915, p. 62.

Ann. Repts., Minister of Mines, B.C.: 1916, p. 126; 1917, p. 111; 1920, p. 90; 1923, p. 113; 1926, p. 135; 1927, p. 138.

The claims owned by the Cassiar-Crown Mining Company are located on Grouse mountain. A good auto road connects Telkwa on the Canadian

National railway with Lowe's ranch, on the east side of Bulkley valley, a distance of about 15 miles. From Lowe's ranch the railway station of Walcott lies on the opposite side of the valley about 2 miles distant and the mining claims are about the same distance to the east on Grouse mountain. A wagon-road leads to the camp which is at an elevation of about 4,600 feet.

The first ore showings on the property were discovered in 1914 by Louis Shorn and Samuel Bush. Active development was undertaken in 1916 and about 3,000 feet of work performed and five claims Crown-granted. The property was closed down in 1922. In 1926 work was started again by the Marsh Mines Consolidated of Spokane, but the property was closed down in the early summer of 1927.

The rocks of the area consist of fine, slaty tuffs and coarse tuffs of the Hazelton formation intruded by diorite and coarse feldspar porphyry known as the Bulkley intrusives. The sediments dip southeastward at low angles, are much jointed, and also in places rendered schistose along lines approximately parallel to the dykes.

The following is MacKenzie's description of the deposits.

"The ore deposits are mostly located on a low ridge running along the north side of a little lake. They have been prospected at various places for a distance of about 3,200 feet in length, the width of the ore-bearing zone varying up to 100 feet, though this width is not all ore. The prospect openings consist of shallow open-cuts, trenches, and shafts, none extending completely across the possible ore zone, and none over 10 feet deep.

The metallic minerals, which are chalcopyrite and zinc blende, are localized in a sheeted zone, which is in general parallel to the strike of the sediments, and nearly vertical. The joints (sheets) of the zone show little or no slickensiding, and are spaced from a fraction of an inch to several inches apart. The ore minerals are found in narrow fissure veins, representing filling of the openings in the sheeted zone, and also as irregular replacement veins and masses throughout the zone. There is a little quartz gangue associated with the sulphides. Well-defined walls were not observed for the deposit as a whole, though they are present locally. This ore-bearing, sheeted zone has been broken by post-mineral faults, usually of only a few feet displacement and nearly vertical. Those observed are roughly parallel to the strike of the dykes and the direction of the schistosity in the sediments. Proceeding east along the zone, it can be seen to be offset to the north along the faults, and from the areal distribution of the ore minerals it is thought that the western portion of the zone may be affected by faults of greater displacement than those observed elsewhere.

With respect to the tenor of the ore but little definite information is available, as no systematic exploration nor assaying has been done. The following descriptions of some of the prospect openings will serve to give an idea of the character of the more highly mineralized portions of the deposit.

At the initial post of the Copper Crown claim a sheeted zone 12 feet wide is made of closely spaced joints from ½ to 4 inches apart, most of which can be traced on the surface for 10 feet, and in some cases two or three times that far. Chalcopyrite occurs in the fissure in this zone, forming lenticular and irregular veinlets of the solid mineral, the largest seen being 3 inches thick, by 16 inches long. A shoot in the zone, 3 feet thick and 10 feet long, contained about 20 per cent chalcopyrite, and other, less rich shoots also occurred. Twenty-two feet east of the place just described, a 2-foot pit shows a shoot 4 feet thick visible for 10 feet, which contains about 25 per cent chalcopyrite, and a 10-inch vein in the middle of the shoot, exposed for 5 feet, is nearly pure chalcopyrite. At a distance of 190 feet from the initial post mentioned, the continuation of the same zone is 35 feet wide, prospected by a shaft on the south side of the zone and a trench on the north side. The shaft is 5 by 6 by 8 feet deep, and exposes a 5-foot shoot that may run 20 per cent chalcopyrite. The rest of the 35 feet is lower grade ore, except for one or two small shoots, up to 18 inches thick.

Eastward from here for a distance of about 100 feet are many short veinlets of chalcopyrite from ½ inch to 4 inches thick.

At the east end of Coppermine lake, on the Eureka claim, a shaft 6 by 5 by 8 feet deep and some trenching expose a 10-foot mineralized zone in greenish tuffs, which is probably the continuation of the one just described. The zone strikes north 80 degrees east and dips about 75 degrees north. Following is a section of the zone, from the hanging-wall to the foot-wall:

Chalcopyrite, pyrite, and quartz	6 inches
Rock, slightly and irregularly mineralized	6 "
Ore-shoot, about 25 per cent chalcopyrite	2 feet
Rock, slightly and irregularly mineralized	2 "
Ore-shoot, about 25 per cent chalcopyrite	5 "

The stated amounts of chalcopyrite were in all cases estimated by eye, the mean of two independent estimates by different observers being taken."

(14) OWEN LAKE SECTION

Silver Queen Group

References

Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1916, p. 160; 1923, p. 114; 1924, p. 99.

This group is situated in the Owen Lake district which is 26 miles by trail from Houston on the Canadian National railway. The group, consisting of five Crown-granted claims, is situated on Wrinch creek about a mile north of Owen lake.

In the neighbourhood of Owen lake the country rock consists largely of intrusive rocks such as granite, gabbro, diorite, and gabbro porphyrites. Remnants of an older, altered series of sedimentary rocks are seen in places.

The deposits consist of mineralized zones running in a general direction of north 60 degrees west, magnetic. These zones are not well-defined fissures with clean-cut walls, but in most cases they are definite enough to follow and the mineralization is apparently continuous and strongly defined. The largest or No. 4 vein is irregularly mineralized over a width of 20 feet.

The minerals present include pyrite, chalcopyrite, sphalerite, and galena. In the different vein zones these minerals occur in varying amounts, in some cases one mineral predominating and in some cases others. Gold is present only in traces, but the silver content is in many cases important. Of the base metals copper is most important, but zinc might possibly be a by-product of milling operations.

Four or possibly five vein zones are present on the property. No. 3 has been traced for a length of 400 feet in a northwesterly direction by means of open-cuts. No. 4 is somewhat of the nature of a sheeted zone with parallel stringers outside the main fracture. No. 1 and No. 2 were not developed on account of the higher percentage of zinc blende and less chalcopyrite than the others.

Most of the work has been carried out on No. 4 vein. A crosscut tunnel was driven to it and entered the vein 22 feet from the portal. The tunnel was then turned and driven as a drift for 15 feet. The face showed 2 feet of material mineralized with disseminated pyrite and chalcopyrite and 2 feet of high-grade ore, mostly chalcopyrite, with a little galena and zinc blende. A crosscut 113 feet long was driven to the hanging-wall side. The first 8 feet showed disseminated, low-grade ore and the remaining 5 feet high-grade ore with no hanging-wall in sight.

Diamond Belle Group

References

Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1916, p. 159; 1923, p. 116.

This group lies a short distance northeast of the Silver Queen group in Owen Lake district. It is about 28 miles southwest of Houston on the Canadian National railway; 16 miles of this is a motor-road and the remaining 12 miles a sleigh-road.

The country rock in which the deposits occur is a granite porphyry, somewhat decomposed. Galloway states:

"The showings on these claims are similar in character to those of the Silver Queen group. There are at least three veins on it which are more or less parallel and are separated by distances of a few hundred feet. Mineralization is apparent across widths of from 2 to 5 feet and the veins may be wider. The same minerals are found as in the Silver Queen veins, but less chalcopyrite and more zinc blende is found in the showings than in the latter property. Small specks of grey copper were noticed in one specimen. The silver values may be somewhat lower, as it is evident that the zinc blende carries little or no silver. One sample showed $3.20 in gold to the ton.

The three veins are developed by open-cuts and shafts, the deepest of which is about 15 feet deep. On the surface the veins have been exposed at intervals for distances of from 200 to 400 feet. The outcrops of the veins are in country which is more or less level, with slight undulations, so that development will of necessity be shaft-sinking."

(15) BURNS LAKE SECTION

Taltapin Mining Company

References

Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1920, p. 92.
Lay, D.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 143; 1926, p. 145; 1927, p. 150.

The property of this company, consisting of the Silver Fox and six other adjoining claims, is situated 25 miles in a northerly direction from Burns lake. The rough wagon-road from Burns lake to Babine lake is followed for 12 miles to a point known as the Half-way. From this point a sleigh-road is followed for the remaining 13 miles. The principal showings are on the Silver Fox claim and they outcrop along the wall of a canyon formed by Anderson creek. The elevation of the property is 2,600 feet, or only slightly above Burns lake which stands at 2,300 feet.

The rock exposures in the canyon of Anderson creek consist of volcanics, chiefly a light-coloured, greyish green andesite considerably altered. A large, intrusive mass occurs on the east side of the creek which seems to mark the southern edge of the batholithic rock. Numerous injection tongues run from the intrusive mass into the volcanics.

The deposits consist of quartz veins exposed in the canyon of Anderson creek.

"In a distance of 800 feet up and down the canyon there are half a dozen or more stringers and veins of quartz which vary in width from a few inches up to 6 feet. These veins have a general strike of northeast and dip at angles of 30 to 60 degrees to the northwest. They are broken up somewhat by small faults and slips. The metallic minerals noted in the veins are galena, sphalerite, chalcopyrite, arsenopyrite, pyrite, and tetrahedrite. In most places these minerals only occur in small amounts, the total percentage of metallic minerals to quartz being quite low. Surface oxidation is apparent in places, but is an important feature.

The most important showing on the property is what is known as the 'High-grade vein.' This vein, where it is exposed on the east side of the canyon, has a strike of north 30 degrees east, and dips at 60 degrees to the northwest. It also outcrops in the bed of the creek and at the foot of a vertical bluff on the west bank of the creek.. .. ..

On the east bank of the creek the High-grade vein shows from 6 inches to 2 feet of quartz which is very sparingly mineralized with galena and pyrite.. .. .. ..

At a point about 200 feet down the creek from the outcrop of the High-grade vein there are three bands of quartz or veins which strike northeasterly and dip at an angle of 30 degrees to 45 degrees to the northwest. These three bands are separated from one another by from 10 to 20 feet of rock-matter and vary in width from 1 to 4 feet. They are very sparingly mineralized with galena, sphalerite, and arsenopyrite, and some oxidation products therefrom."[1]

(16) SIBOLA SECTION

Emerald Group

References

Galloway, J. D.: Ann. Repts., Minister of Mines, B.C.: 1916, p. 164; 1919, p. 104.
Lay, D.: Ann. Rept., Minister of Mines, B.C., 1927, p. 154.

This group is situated on Sweeney mountain in the Sibola section, a term used to designate an area of country to the southwest of Houston on the Canadian National railway. The route to Sweeney mountain is by trail from Houston past Owen lake. The distance is about 50 miles.

In the 1919 Annual Report, Mr. Galloway states:

"The most important property in the district is the Emerald group, situated on Sweeney mountain and owned by Sweeney, Benson, and partners. The showing consists of a vein varying from 10 to 20 feet in width and mineralized with galena, together with subsidiary amounts of zinc blende, pyrite, and chalcopyrite. The percentage of galena to gangue is high, sufficiently so as to make good milling ore, and in many places there are bands of clean galena from 1 to 3 feet in width. The showing is a remarkable one, and now the vein has been traced for 1,000 to 1,500 feet in length and showing values everywhere. The group was staked in 1915 and would not have remained undeveloped but for its distance from a railroad. The transportation problem is admittedly a difficult one for this property and district generally but is by no means insurmountable..........Without question, the surface showings on the property warrant much more extended development than has yet been given to them."

Galena and sphalerite are also found in shear zones on the Glacier and Stanley claims on Sweeney mountain.

[1] Ann. Rept., Minister of Mines, B.C., 1925.

(17) FORT GRAHAME SECTION

Ferguson Group

Reference

Lay, D.: Ann. Rept., Minister of Mines, B.C., 1926, p. 155.

The Ferguson group consisting of five claims is situated on Ingenika river, about 45 miles distant from Fort Grahame and about 20 miles from the confluence of the Ingenika with Finlay river. The claims are on the south side of the river and distant from it about 1½ miles by good trail.

The geology of the region is described by G. A. Young in "Geology and Economic Minerals of Canada," Geological Survey, Canada, as follows:

"Along the Finlay and Omineca rivers in and near the Rocky Mountain trench are considerable areas of gneissic and schistose rocks accompanied by crystalline limestone. Some of the rocks are deformed igneous rocks, but the bulk of the strata are of sedimentary origin, are in large part evenly bedded, and conform in dip with overlying much less metamorphosed sediments. The overlying younger beds consist of slates and quartzites with a basal conglomerate, and in places have a thickness of 4,000 feet. These are succeeded upwards by a thick limestone group, which in places rests directly on the much metamorphosed lowest assemblage. The gneissic and schistose rocks have been correlated with the Shuswap strata of southern British Columbia and as such were considered to be of early Precambrian age. The overlying limestone strata are presumed to be of Cambrian and perhaps later age. The clastic beds beneath may be Cambrian or late Precambrian or possibly contain representatives of both ages."

Regarding the lead-zinc deposits Lay states:

"On an elevated plateau-like surface, some 500 feet vertically above and south of the Ingenika river, occur several knolls which rise between 200 and 300 feet above the plateau. The whole region has been subjected to intense glaciation and the Ingenika river in this region has evidently cut down through a valley filled with glacial drift; terraces of re-sorted gravel, which might be worth prospecting for placer gold, occur some hundreds of feet above the present river-bed.

On one of the knolls referred to, which is composed of limestone, is situated the Ferguson group. The size of the top of this knoll, which is fairly flat and covered with much vegetation, is approximately 220 yards by 45 yards. The limestone beds strike northwesterly and dip northeasterly in general at angles varying between 25 degrees and 35 degrees. At one point the limestone beds dip in the opposite direction to this, which suggests folding and the development of a synclinal-anticlinal structure. Bands of the limestone up to 25 feet in width as measured on the surface are mineralized very heavily in places with galena, a small amount of zinc blende, a little copper pyrites, and a heavy stain of ferric oxide. There are certainly three such bands, possibly four, and in addition one less heavily mineralized. A very severe handicap to examination, especially if one is pressed for time, is the fact that very little has been done in the way of open-cutting to expose critical points. These bands appear generally to conform with the bedding-planes of limestone, although one or more exposures may be fissures which cut across the limestone beds. The heavy strain of ferric oxide mentioned also tends, in the absence of further development, to mask matters. These exposures are on top of the knoll and extend down one side to some extent, the difference between the highest and lowest exposure, as determined by aneroid barometer, being about 100 feet. The distance apart of these bands on the surface is between 75 and 88 feet. Assuming a dip of 30 degrees, therefore, the actual width of the bands would be about 12 feet and their distances apart about 40 feet. This is on the assumption that all are interbedded. Should this not be the case, the true width may more nearly approach 25 feet and the distance apart will be greater than 40 feet. It is to be noted that one band and the containing limestone dip in the opposite direction to the others. Assuming more or less intense folding with the development of an anticlinal structure, this band and one of the others might be one and the same.

The scanty exposure and limited time rendered it impossible for the writer to form anything like an accurate idea of the length of the more leady portions of the bands. At present such lengths are limited and determined by the size of the knoll. Further, the difference in elevation between the point of highest and lowest exposure is small, only 100 feet approximately. There were said to be no exposures at the base of the knoll, but a close examination of the region more immediately surrounding the base of the knoll is regarded as being of much importance, with a view to picking up the continuation of a band or bands on the plateau. After some preliminary surface prospecting, diamond-drilling could be undertaken with advantage both on the knoll and at the base. There seems every likelihood that a very considerable tonnage of lead ore of low silver grade is contained in the knoll itself and there may be underlying beds of ore not exposed on the surface. But in the nature of things, the knoll not being large, the tonnage therein is limited. Consequently much depends upon proving existence of ore beyond the confines of the base of the knoll and in depth.

It is apparent that glory-hole or quarrying methods of mining, could be applied to the knoll itself, and, further, that if in the future the question of smelting in situ is a matter of consideration a self-fluxing mixture is available and a low zinc content.

There appear to be sound grounds for entertaining the idea of the likelihood of the existence of an ore-body of magnitude in this region owing to the points of resemblance to the East Kootenay region containing the famous Sullivan mine. There is geographic, geologic, and topographic relationship. Mineralogically, however, there is no similarity between this ore and the Sullivan ore. The former shows no pyrrhotite and crystallization is comparatively coarse; it is, therefore, an ore which would probably be amenable to water-concentration. It has certain points of resemblance to the North Star ore, a neighbour of the Sullivan. It is perhaps not foreign to the matter to state that the writer some twenty-seven years ago inspected the Sullivan mine, having at that time to report upon the smelting and concentrating possibilities. The Ferguson group merits the most careful and searching scrutiny with a view to determining the advisability of a little immediate surface work, followed by diamond-drilling. The costs of operation in this region have been fully dealt with in the preface to this section.

The property is 20 miles distant from the Finlay river. Under existing conditions —in fact, unless a railway is constructed connecting Finlay Forks or Hudson Hope with existing railway lines—actual production from this property can hardly be considered. Hope in any immediate diamond-drilling lies in proving the existence of ore-bodies of such dimensions that this fact, considered in conjunction with other factors affecting the question, would be considered sufficient to justify the construction of a railway running through this northern country.

The elevation of the Ingenika river immediately below the claims was found by aneroid to be 2,450 feet; that of the base of the knoll 2,950 feet; that of the summit of the knoll 3,150 feet.

The following sample was taken across what appeared to be the best exposure of ore and represents a surface width of 25 feet: gold, trace; silver, 8 ounces to the ton; lead, 16 per cent; zinc, 4 per cent. A sample taken across a width of 3 feet of the portion containing most galena assayed: gold, trace; silver, 12·2 ounces to the ton; lead, 32 per cent; zinc, 3 per cent.

The following samples were shown to the Resident Engineer by the owner as being a number taken by the engineer of an important operating company who examined the deposit a few years ago and who is well known to the writer. These samples represent various exposures, but give an excellent general idea of the showings.

Description	Gold	Silver	Lead	Zinc
	Oz.	Oz.	Per cent	Per cent
Across 10 feet	Trace	14·0	26·1	7·7
Across 17 feet	"	8·6	25·0	8·0
Across 2·5 feet	"	21·4	52·8	2·1
Across 9 feet	"	Trace	....	13·6
Cube galena	"	25·0	75·2	1·5"

(18) Cariboo Mining Division

Reference

Lay, D.: Ann. Rept., Minister of Mines, B.C., 1925, p. 149.

The chief mining activity in Cariboo mining division is for placer gold. In Cunningham Creek district are a number of claims containing lead-zinc showings. They are located at the head of the south fork of Cunningham creek about 18 miles from Barkerville. The first 12 miles is by wagon-road and the remainder of the distance is by trail. On the Homestake group showings are found on both sides of the creek. Lay states:

"At an elevation of 4,930 feet there is exposed on both sides of the creek a broad mineralized zone about 30 feet in width striking parallel with the schist country rock—that is, northwesterly—and dipping at about 65 degrees northeasterly. On the west side of the creek the schists contain a band of limestone, the full width of which is indeterminate from the exposure, but which seems to be not less than 4 or 5 feet, possibly more. In this lime there is exposed at one point a width of 4 feet of solid sulphides of galena, pyrrhotite, and zinc blende—quite an impressive showing and evidently a replacement deposit of the lime by the mineralization mentioned. Unfortunately, samples only indicate very low precious metal values. A sample across the 4 feet assayed: gold, trace; silver, 9 ounces to the ton; lead, 32 per cent; zinc, 1 per cent. At another point a sample taken across 2 feet assayed: gold, trace; silver, 5·5 ounces to the ton; lead, 24 per cent; zinc, 8 per cent. On the east side of the creek mineralization is not so heavy and only about a foot of the mixed sulphides is exposed.

About 300 feet downstream, that is north of the above mineralization, there is exposed some quartz showing a noticeable amount of galena and pyrite, striking in the same direction. A sample of the most heavily mineralized portion was taken primarily with the view to ascertain the grade of the sulphides in precious metals. The sample assayed: gold, trace; silver, 1·4 ounces to the ton; lead, 0·5 per cent. . . .

At a point some 450 feet above the first exposure mentioned there is another wide, mineralized, bedded zone. Very little galena shows at this point, mineralization being mainly pyrite and siderite in quartz. A sample taken at the most promising point across 5 feet assayed: gold, 0·28 ounce; silver, 0·1 ounce to the ton."

(19) Quesnel Mining Division

Reference

Lay, D.: Ann. Rept., Minister of Mines, B.C., 1926, p. 177.

The principal metal production of Quesnel mining division is placer gold. Interest, however, has been taken in galena-bearing veins on Black Bear creek, situated about 9 miles by road and trail from Likely. The nearest point on the railway is Williams Lake on the Pacific Great Eastern which is connected with Likely by a road 65 miles long.

The deposits are quartz veins in sericite schists and shales. The veins are large, showing widths up to at least 50 feet. Galena occurs as lenses and bunches in the veins, so that quantities varying from a few hundred pounds to several tons can be selected by hand to give a product high in lead. No appreciable gold values have been reported. The most work has been done on four claims, Black Bear No. 1 to No. 4; a number of other groups have been taken up in the district.

In the Keithley section, close to the Likely-Keithley road and about $2\frac{1}{2}$ miles from Keithley, galena and sphalerite are found on the Peacock claim on Duck creek. At an elevation of 3,100 feet there are exposed in silicified quartz schist on the banks of the creek several quartz veins not exceeding 2 or 3 feet in width slightly mineralized with galena, zinc blende, and iron pyrites. They strike north 10 degrees east magnetic and dip east at a steep angle. A sample of picked pieces assayed: gold, 0·2 ounce; silver, 24 ounces to the ton; lead, 42 per cent; zinc, 6 per cent.

(20-23) Kamloops Mining Division

Kamloops mining division is drained principally by North Thompson river. The chief districts that have shown metalliferous deposits are Barriere, Chu Chua, Seymour River, Sicamous, Kamloops, and Adams Lake sections.

(20) BARRIERE SECTION

Prospecting has been carried on over an area of about 60 square miles of heavily timbered and hilly country lying to the south and west of North lake at the head of Barriere river. The rocks are schists with interbedded bands of limestone and dolomite, affording favourable conditions for replacement deposits of the silver-lead-zinc type. The district lies along the border of a large, intrusive mass known as the Baldie granite.

Silver Mineral Group

Reference

Nichols, H. G.: Ann. Rept., Minister of Mines, B.C., 1925, p. 170.

This group is reached from Barriere, on the Canadian National railway, by a wagon-road to the junction of the north and east forks of Barriere river, a distance of 12 miles, and from there by trail 5 miles up the north fork. Nichols states:

"Prospecting has been carried out around an area where there appears to be an intersection between two series of fissures in an altered schist formation, both of which appear to be trending towards a zone of shearing in a band of limestone which can be traced across the hill for a considerable distance in a general north-south direction. Open-cuts in this shear-zone, at a vertical height of about 1,400 feet above the creek-level, show a width of 12 feet, over which the limestone has been greatly crushed and altered, with 2 feet of quartz on the hanging-wall. Galena is found scattered through the quartz and also in fractures and cross-seams passing through the body of the limestone. About 200 feet higher up the hill there is a series of five seams paralleling one another in a general northeast and southwest direction. On one of these seams a considerable amount of prospecting has been done and some heavy bodies of galena have been exposed in an open-cut near the intersection with an east-west zone of shearing. At this point an 8-inch seam of quartz, fairly well mineralized with galena, is also exposed. Mineralization in the northeast and southwest seam appears to die out at a distance of about 150 feet from the intersection, but, under the conditions of snowfall obtaining at the time of the examination, it was not possible to determine this point definitely, or in fact to do fair justice to the occurrence in general. The massive nature of the bodies of galena, which at one point were 2 feet wide, and the possibilities in connexion with the wide zone of shearing above mentioned, in which also mineralization is noted, afford encouragement for developing the property at farther depth. . . . A sample of the galena above referred to, taken from a point 75 feet from the east-west zone of shearing, and across a width of 2 feet, assayed: gold, 0·02 ounce; silver, 27 ounces to the ton; lead, 50 per cent."

Silver-lead ore occurs in quartz veins on the White Rock claims situated on Bunker hill north of the Silver Mineral. On the Wahwah on the north side of North Barriere lake two shear zones in the greenstone formation near its contact with granite are mineralized with pyrrhotite, chalcopyrite, and sphalerite.

(21) CHU CHUA SECTION

Queen Bess

References

Uglow, W. L.: Geol. Surv., Canada, Sum. Rept., 1921, pt. A, p. 102.
Nichols, H. G.: Ann. Rept., Minister of Mines, B.C., 1924, p. 153.

This property is located on the steep eastern slope of North Thompson valley about 600 yards east and 720 feet above Auldgirth (Blackpool) station on the Canadian National railways.

The country rock consists of greenish pillow lavas of the Fennell formation of early Palæozoic or Precambrian age. These rocks are traversed by east-west, buff-coloured shear zones, locally called dykes, highly charged with ankerite and limonite. These zones are of irregular width and show transitional contacts with the greenstone. Uglow states:

"Two main veins, the Cameron and Bigelow, occur on levels Nos. 2 and 3. The Cameron strikes north 45 degrees to 50 degrees east and dips 50 degrees to 70 degrees northwest. The Bigelow, 130 feet to 200 feet southeast of the Cameron, strikes north 20 degrees to 30 degrees east and dips from 80 degrees northwest to vertical. The veins have in most cases definite walls. The fissures in which the vein material occurs maintain a fairly uniform trend in the unaltered greenstone, but where they enter the shear zone of ankerite greenstone or ferrodolomite, they break up into a network of branching fractures. The veins vary in width from 1 inch to 5 feet, but average probably not over 12 to 15 inches. Where they traverse the greenstone, they are as a rule bordered by 2 to 6 inches of hard, buff-coloured rock of similar origin to the main zones of ferrodolomite.

Tabular to lenticular masses of nearly solid sphalerite and galena occur within the veins. The sphalerite is a beautiful, coarse-grained, resin variety mixed with a much smaller amount of fine- to medium-grained galena. Minor amounts of tetrahedrite occur. Lean parts of the veins contained disseminated particles of the sulphides in a quartz and quartz-dolomite gangue. In one stope a tabular mass of solid sulphides, up to 38 inches in thickness, was encountered. Minor amounts of these sulphides occur disseminated through the larger ferrodolomite masses near the positions of some of the vein fissures.

In the upper workings, several well-mineralized veins contain chiefly the oxidized minerals of zinc, lead, and copper. Cerargyrite is reported from these workings, but the writer did not recognize any in the field. No recent development has been carried on above level No. 2, so that little can be said regarding these oxidized zones.

The material mined as ore is said to average about 5 per cent of lead and 6 ounces of silver per ton. The first mill run of approximately 720 tons is reported to have given the following concentrates: 27 tons of lead concentrates assaying 40 to 50 per cent Pb, 12 per cent Zn, and 48 ounces Ag per ton; and 78 tons of zinc concentrates assaying 48 per cent Zn, 7 to 8 per cent Pb, and 14 ounces Ag per ton.

The only suggestion that can at present be offered regarding the origin of the veins is that they are genetically related to bodies of intrusive rock which cut the Fennell formation to the east. This occurrence is similar to that at the Gold Hill prospect.

The veins have been explored on three levels. The lower or No. 3 level, 720 feet above the railway, is 600 feet long, and enters the hill in an easterly direction. At 180 feet it cuts the Cameron vein which has been followed for about 80 feet on either side of the crosscut. From the southwest drift, a winze was sunk 100 feet on the vein, and at the 50-foot level in this winze an intermediate level was driven on the vein and the ore was stoped. The Bigelow vein, which the crosscut intersects at 300 feet, was drifted on for about 100 feet, beyond which the vein becomes a mere fissure or else anastomoses. Considerable stoping has been done on each of these veins.

No. 2 level is 300 feet above No. 3. The Bigelow vein on this level has been drifted on for over 100 feet, and a small amount of stoping has been done. The minerals are both sulphides and carbonates."

(22) SEYMOUR RIVER SECTION

Cotton Belt

References

Davis, A. W.: Ann. Rept., Minister of Mines, B.C., 1922, p. 150.
Nicols, H. G.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 171; 1926, p. 188; 1927, p. 195.

This group of claims is situated at an elevation of about 6,000 feet on the hills south of Deep creek, a tributary of Seymour river, and at a distance of about 18 miles from the head of Seymour arm, Shuswap lake.

The rocks belong to a complex of Precambrian age consisting of schist, quartzite, and limestone. The main ore zone parallels a belt of crystalline limestone that dips northeast at an angle of 35 degrees. Along this zone the ore, which consists of lead and zinc minerals with low values in silver, occurs in a series of lenses. Mineralization has been traced for a distance of over 2,000 feet on the surface, with widths up to 12 feet. The ore zone has been followed underground by a tunnel for a distance of 800 feet, the width averaging between 18 and 24 inches. Immediately below a large surface exposure there is a section about 100 feet long showing ore with a width of from 3 to 4 feet.

A second ore zone, known as the Complex vein, has been traced by open-cuts for a distance of 1,000 feet. A short tunnel driven on this ore-body shows a width of 7 feet consisting largely of magnetite, but carrying values in lead, zinc, and copper.

(23) SICAMOUS SECTION

Victory

Reference

Nichols, H. G.: Ann. Rept., Minister of Mines, B.C., 1927, p. 197.

This group of five claims is on the west side of Mara lake. The rocks are Precambrian sediments of the Shuswap series. The mineralization consists of sphalerite in a silicified zone about 9 feet wide in garnetiferous gneiss. The zone strikes across Black point, a promontory about $1\frac{1}{4}$ miles in length that projects into the lake on the west side. A tunnel was driven for 28 feet from a point at the south end of the promontory and about 10 feet above the level of the lake, following a well-defined hanging-wall which has a northerly strike and a dip to the west. At a distance of a few feet from the portal zinc blende is said to have been distributed in small quantities fairly well through the whole width of the zone exposed in the tunnel and a shipment of about 41 tons of this material was made to the Trail smelter.

(24) Nicola Mining Division

Zinc and lead occur in the region of Stump lake and on Iron mountain east of Merritt.

Stump Lake

References

Nichols, H. G.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 182; 1926, p. 199.

The deposits in the region of Stump lake are veins carrying sphalerite and galena and values in gold, silver, and copper. None of the properties is apparently big enough to be worked separately, but the area as a whole is considered to be worth exploration. A great deal of work was done many years ago in this locality.

On the Star property work was carried out in 1925 and 1926 by Planet Mines, Limited. The shaft was extended to a depth of 230 feet and drifts run on the 200-foot level. The vein on this level averages 2 feet in width, in places swelling to 5 feet. It is fairly well mineralized with galena and sphalerite, with some grey copper.

On the Azela, situated about $1\frac{1}{2}$ miles east of the highway between Stump lake and Nicola lake, at an elevation of about 3,000 feet, two series of well-defined quartz veins, cutting a diabase formation, range from 6 inches to 4 feet in width. A sample from the dump of an old shaft gave 9 per cent zinc.

Iron Mountain

Reference

Nichols, H. G.: Ann Rept., Minister of Mines, B.C., 1927, p. 212.

Iron mountain, situated about 4 miles east of Merritt, receives its name from the occurrence of a number of veins of specular hematite which traverse the altered volcanic rocks of the region in different directions. In

1927 silver-lead ore was discovered on the Leadville group of claims. The mineralization is along a zone of crushing and shearing in which there are considerable quantities of barite. Galena is the most abundant sulphide, but sphalerite is present in small quantities. The zone has been traced for several hundred feet with widths up to at least 10 feet.

(25) Yale Mining Division

References

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept., 1923, p. 68.
Nichols, H. G.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 180; 1927, p. 210.

In the southern section of Yale mining division, tributary to Silver creek and Skagit river, occurs silver-lead-zinc mineralization. The rocks are sedimentaries and volcanics intruded by granodiorite and quartz diorite. The principal types of ore occurrence include: (1) veins and stringers of zinc blende and galena in fracture zones in a granitic rock, intrusive into limestone, and possibly affected by later quartz diorite intrusions; (2) bodies of pyrrhotite, with chalcopyrite and traces of nickel occurring as lenses associated with belts of lime-rock intruded by granodiorite; (3) veins and stringers of pyrrhotite, with zinc blende, chalcopyrite, stibnite, and arsenopyrite in fractured volcanic and sedimenary rocks, apparently related to massive bodies of solid sulphides which have been introduced in a molten condition.

On the Silver Daisy silver-lead-zinc ore occurs in a narrow quartz vein intersecting a chert formation. On the Mammoth the mineralization occurs along a direction of shearing that parallels the border of a stock of granodiorite at a distance from it of about half a mile. Pyrrhotite is the principal mineral and associated with it are sphalerite and some scheelite. The formation is a lime-silicate rock. On the Rainbow are three mineralized zones occupying fractures in silicified limestone.

(26) Lillooet Mining Division

PEMBERTON AREA

Silver-lead-zinc deposits occur in Pemberton area, Lillooet mining division. The following are some of the more important properties.

Crown Group

Reference

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept., 1924, pt. A, p. 93.

The Crown group occupies the summit of Crown mountain on the divide between Lillooet river and Tenquille creek. The rocks of the district are Upper Triassic volcanics and sediments intruded by granodiorite, quartz diorite, and related rocks. The volcanics consist of andesitic flows, pyroclastic rocks, and tuffaceous sediments and the sediments consist of limestone and conglomerate, chlorite, sericite, and talc schists.

The mineralization lies above a zone of shearing which is closely parallel to the average trend of deformation of the rocks in the district. The shear zone dips steeply northeast across one or possibly two beds or lenses of altered limestone whose aggregate width does not exceed 50 feet. The latter underlies a series of fragmental, green, tuffaceous sediments, and overlies a dense white, felsitic rock of probable volcanic origin which is intersected by dykes of quartz porphyry. Where intersected by the shear zone the original limestone bands altered to a magnetite-garnet rock containing also some epidote and minor amounts of pyrite, sphalerite, galena, hematite, pyrolusite, chalcopyrite, and limonite. The main values lie in a brecciated zone about 40 inches wide, which has been impregnated with galena, sphalerite, and pyrite. The values may occur in part as native silver, as some fine specimens were found near the surface. The minerals of the silver-bearing zone are thought to belong to a later period of mineralization than that which produced the magnetite-garnet rock, but both are consequent on the shearing that first affected the rocks.

Two shafts, 40 and 70 feet deep respectively, were sunk on the shear zone and intersect the deposits. Sampling has revealed high values in silver. A sample of 100 pounds of ore representing about 5 tons of ore mined in the deeper shaft gave an average return from two assays of 141·31 ounces in silver, 4·1 per cent lead, and 3·2 per cent zinc.

Silver Bell Group

References

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 96.
Nichols, H. G.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 178; 1926, p. 193.

The Silver Bell group is on the steep hillside about a mile east of Maud lake. The country rock, which is massive to slightly schistose, is probably a volcanic tuff or tuffaceous sandstone. Cutting across it is a comparatively soft, basic dyke 4 feet wide, striking northwest, and dipping 85 degrees southwest.

The mineral deposit occupies a fracture zone running at an angle of about 25 degrees with the dyke and pitching at a high angle to the northeast. The minerals are sulphides of iron, copper, zinc, and lead in a quartz gangue, associated with a large proportion of silicified and otherwise altered country rock. The width of the mineralized zone at the surface is about 5 feet.

Copper Mountain Group

Reference

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 95.

The Copper Mountain group, consisting of four claims, lies in the Pemberton area on Copper mound, a somewhat conical-shaped peak rising over 7,000 feet or about 1,700 feet above the pass between the heads of Tenquille and Wolverine creeks.

Cairnes states:

"The peak of this hill is composed of a faulted series of volcanic and sedimentary rocks intersected by several quartz-porphyry sills and dykes and surrounded by quartz porphyry and more basic intrusive batholithic rocks. Viewed from hills to the southeast the centre of this peak appears to be traversed by a fault following a northwest-southeast direction along a nearly perpendicular plane. The rocks to the northeast of this fault have a massive appearance and dark colour. Those on the other side of the fault have a bedded structure and more variegated appearance. This fault was not precisely located owing, possibly, to the cliffy topography of the hill precluding examination along other than special routes where the contact was not exposed. The northeast side of the hill is composed chiefly of dark green, andesitic rocks including fragmental types such as tuffs, breccias, and agglomerates. The southwest flank of this hill, on the other hand, is composed chiefly of well-bedded rocks including thick beds of limestone. These strata are traversed by a number of faults striking in a general northwesterly direction and showing displacements of 200 feet or more. The sediments, and particularly the limestone, are notably fossiliferous.

Mineralization is evident at a number of localities on Copper mound and especially so at certain showings on the slope overlooking the head of Wolverine creek and about 300 feet above the creek. Here, a thick bed of limestone runs nearly parallel with Wolverine creek, and dips at a low angle to the northeast under a massive, greenish rock resembling an andesite flow, but possibly fragmental in origin. Within the limestone belt and at three closely adjoining localities heavy ore mineralization has been exposed. The three showings cover a vertical range of about 75 feet and may represent a single broad zone of mineralization. At the upper showing and across a width of about 20 feet a deposit composed chiefly of pyrrhotite and magnetite and containing only a little gangue has been exposed over a length of several yards. The intermediate showing is of similar character, except that the percentage of magnetite is higher. The lower showing contains a considerable percentage of sphalerite as well as magnetite. A little chalcopyrite is present in all three showings. Veinlets of pyrite cut across the zinc and magnetite ore, and crystals of calamine were observed along fractures in the ore-body. A sample obtained by Davis from this lower showing gave an assay return of 8 per cent in zinc. Low assays in gold and copper are said to have been obtained from these showings, but no systematic sampling has as yet been attempted.

At a number of smaller showings on this property, and chiefly as a result of the replacement of limestone, other ore minerals—galena, arsenopyrite, pyrite, and chalcopyrite—occur, but in none of these showings is the concentration of ore minerals very pronounced. The hill as a whole is deserving of further prospecting and more careful sampling of such mineral deposits as have been discovered."

Li-Li-Kel Group

References

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 98.
Nichols, H. G.: Ann. Repts., Minister of Mines, B.C.: 1922, p. 167; 1925, p. 177.

The Li-Li-Kel group of eight claims is situated in Pemberton area, Lillooet district, adjoining the Gold King group to the east, and running in a southwesterly direction towards the summit of Tenquille Creek valley.

Cairnes states:

"The prevailing rocks on this property are massive to schistose greenstones of volcanic origin. Included with them are belts of porphyritic, grey and reddish, volcanic flows. Intercalated with these volcanic rocks are sediments, including, chiefly, argillaceous types and limestone beds. The structure is rendered complex by deformation accompanied by abundant faulting and shearing. The general trend, however, appears to be from north 30 degrees to north 40 degrees west with an average dip of 40 degrees northeast.

The mineral deposits are principally of the vein type with an abundant quartz gangue and holding a suite of ore minerals including pyrite, arsenopyrite, galena, sphalerite, and chalcopyrite. In all, thirty-three veins are reported to have been found, but many are very small and doubtless of little economic interest."

A description of the occurrences is given by Cairnes in the report cited above. The chief values are in silver, but small amounts of galena and, locally, a little sphalerite are present.

Gold King Group

References

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 97.
Nichols, H. G.; Ann. Repts., Minister of Mines, B.C.: 1925, p. 178; 1926, p. 193; 1927, p. 219.

This group of four claims lies in the region of Tenquille creek. The lowest and largest deposit occurs a short distance above the junction of two small tributaries of Tenquille creek at an elevation of about 6,000 feet.

Cairnes states:

"The rocks near the lower showing are well-bedded sediments striking north 15 degrees west and dipping 45 degrees to the northeast. They include dense, cherty types, others more arenaceous in appearance, and some limestone. The ore minerals occupy a fractured or fissured zone in these rocks and at the lower showing enclose a horse of country rock several feet wide, which has been silicified and impregnated by the mineralizing solutions and is capped by a porous aggregate of quartz crystals coated with iron oxide. Adjoining this horse to the southwest the mineralized zone has a width of about 9 feet and on the other side of the horse is about 1 foot wide. The ore minerals include an abundance of pyrrhotite, considerable zinc blende and pyrite, and some chalcopyrite. In the wider part of the showing there are bunches of ore minerals containing a fair quantity of galena. Crystalline quartz is an abundant gangue mineral and the drusy character of the ore suggests that it was deposited in a partly open and highly fractured zone. A sample taken by Davis across the zone to the southwest of the horse gave an assay return of: gold, trace; silver, 1·6 ounces to the ton; lead, nil; zinc, 5 per cent. Another sample across 2 feet of vein material in an open-cut about 100 feet farther up the gulch gave: gold, 0·06 ounce; silver, 1·2 ounces to the ton; lead, nil; zinc, 5 per cent.

Ore mineralization is exposed at other points farther up the hill over a distance of about two claims' length. It is uncertain whether there is any direct connexion between these showings and the lower ones, although they are all, apparently, located on the same, or closely parallel, lines of fracturing. Below the lowest showing the formation is obscured by an overburden of soil and rock talus. Mineralization is likely to be more pronounced in this direction than farther up the hill."

(27) Similkameen Mining Division

Similkameen mining division is noted principally for its copper properties at Allenby mountain, 13 miles from Princeton. Occurrences of silver-lead-zinc ore are known in the Siwash Creek section, in the Upper Similkameen River section, and in the Whipsaw section. Those that have attracted most attention as possible sources of lead and zinc occur at Summit camp, Tulameen.

(27) Summit Camp

References

Cairnes, C. E.: Geol. Surv., Canada, Sum. Rept. 1922, pt. A, p. 100.
Freeland, P. B.: Ann. Repts., Minister of Mines, B.C.: 1926, p. 223; 1927, p. 254.

Summit camp is situated near the headwaters of Amberty creek which flows into Tulameen river. The properties are reached by wagon-road and trail from Tulameen, a distance of some 22 miles.

The oldest claim in the district is the Eureka and was staked in 1894. In the following year outcrops of ore were found about 2 miles away and in 1896 F. Sutter and John Amberty staked the Vigo, Lube, Sutter, and Skyline claims for Indiana capital. In 1906 A. Jensen staked the Silver Chief, or what is now known as the Mary E.

In 1909 or 1910 William Dornberg formed a company called the Treasure Mountain Mining Company, of Spokane, Washington, and work, consisting in the driving of two tunnels, was carried out until 1912. From that time until 1915 nothing but assessment-work was done. Later, the claims were restaked and in 1922-23 W. Dornberg and C. Loeb financed some developments in the lower tunnel. In 1925 the Mary E. Mining Company was organized. In 1926 the C. C. Julian Company took over the Mary E. Mining Company, forming the Cascade Consolidated Silver Mining Company. It also took over the holdings of the Capital Mining Company, owning the Blue Bell in the same group.

The rocks of Treasure mountain consist of Cretaceous conglomerates, arkose, and shale, underlain by Jurassic tuffaceous, fossiliferous strata (Dewdney series), and cut by granitic and porphyritic intrusives. Cairnes describes the ore deposits as follows:

"The ore-deposits at Summit camp occur at a number of widely separate points and under a variety of geological associations. There is, however, a rather remarkable uniformity in the character of the ore-bodies at the different showings, a uniformity embracing not only their physical but also their mineralogical characteristics. At each property the ore occurs in veins rarely over a few inches wide, but which may fall within a wider and more sparsely mineralized zone containing other such veins. The entire zone of mineralization constitutes the potential ore-body. It may have a width of several feet, and the whole of it, in at least certain cases, constitutes concentrating-ore. On examination it is found that the mineralized veins are following either lines of fracture or of movement, and that, depending upon the character of the rock traversed, there is some replacement of the wall-rock by mineralizing solutions. The most abundant ore-minerals are galena and sphalerite. They commonly occur in nearly equal proportions, but either may be present almost to the exclusion of the other. The galena is commonly coarsely crystalline and assay of the pure sulphide runs from 150 to 600 ounces in silver. Polished specimens of the galena show that the silver values occur as argentite minutely disseminated through the lead sulphide. No argentite or other silver mineral was observed in the sphalerite. This zinc sulphide is dark, lustrous, and either coarsely crystalline or massive, and, underground, is sometimes difficult to distinguish from the lead sulphide. Following these minerals, pyrite is probably the most abundant metallic constituent and with it may be associated the small gold values, usually under a dollar to the ton.

The ore veins extend indifferently across the strike of both Lower Cretaceous and the Dewdney series. They also follow lines of fracturing or faulting involving the basic hornblende lamprophyre sills that intersect the Dewdney rocks, and consequently belong to a later period than these intrusives—a deduction which supports the view that these sills are Pre-Lower Cretaceous, for they have nowhere been observed to intersect those sediments assigned to this period. The ore-bearing fissures, however, do not appear to cross the feldspar-porphyry dykes which include the Lower Cretaceous rocks, but may, as in the case of the ore-showings on the Silver Chief claim, follow either wall of these dykes. The dykes appear, in certain cases at least, either to follow lines of weakness in the sediments they intrude or to be themselves the immediate cause of the fracturing of the rocks in their vicinity. The ore is regarded as being derived either from the great body of Eagle granodiorite to the east of Treasure mountain or from the smaller bodies of quartz diorite occurring near the main divide at the head of Amberty and Sutter creeks and also near the headwaters of Dewdney creek on the western slope of the divide. The greater abundance of ore veins in the direction of this divide, rather than towards the east, favours this quartz diorite as being the principal source of the ore, a theory strengthened by observation of the very noticeable pyritic mineralization of the older formations almost everywhere in the vicinity of this intrusive.

The order of deposition of the ore and gangue minerals is to some extent variable. The gangue is commonly composed of quartz and calcite, but ankerite and stilbite have been observed. These gangue minerals tend to form along the walls of the fissures, leaving the more central portion to be filled, subsequently, chiefly by the ore-minerals, of which the most important are galena and sphalerite. Chalcopyrite is sometimes a conspicuous vein-mineral and appears to have been the last sulphide precipitated. Pyrrhotite and pyrite also are locally abundant, and not only occur within the fissure deposits, but commonly impregnate the wall-rock on either side or may be found disseminated through the rock formation far from any fissure deposit. Both of these iron sulphides precede the galena and chalcopyrite, but in one instance at least the zinc blende was observed to be intersected by veinlets of pyrite. Arsenopyrite is noticeably abundant in certain of the properties and appears to precede the lead and copper sulphides. Its order with respect to the iron sulphides is less certain. There is, probably, however, much overlapping of all the ore-minerals, but the order in which they each begin to precipitate seems to be pyrrhotite, pyrite, sphalerite, arsenopyrite, tetrahedrite, galena, chalcopyrite.

The association of ore and gangue minerals at Summit camp and the character of the ore-deposits suggest that the solutions from which these minerals were precipitated were of intermediate, or in the case of some of the properties possibly of high, temperature, and that, consequently, the source of these solutions was at no great distance from the ore-bodies. It has been shown that the quartz-diorite intrusive bodies near the main divide afford the most likely source for the mineralizing solutions, and in this connexion it is of interest to note that near these intrusives, and within the zone of contact metamorphism, the older formation is heavily impregnated with pyrite and. to a less extent, pyrrhotite and magnetite, but does not include the other ore-minerals so common in the fissure-veins at a greater distance from the intrusives."

(28) Greenwood Mining Division

A small number of prospects such as the Providence, Elkhorn Fraction, Spotted Horse, and Strathmore near Greenwood have produced small quantities of lead and zinc ore. The ores occur in veins whose chief values lie in their gold and silver content. Some of them may possibly in the future produce further small amounts of lead and zinc.

Lead and zinc values have also been recovered in ores from Wallace mountain.

Wallace Mountain

References

Reinecke, L.: Geol. Surv., Canada, Mem. 79.

Freeland, P. B.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 204; 1926, p. 206; 1927, p. 232.

Wallace mountain is situated near Beaverdell on Westkettle river, in southern British Columbia. Beaverdell is on the Kettle Valley railway between Midway and Penticton.

Prospecting in the district began in 1889, but the more important claims on Wallace mountain were located in 1896 and 1897. During the next four years development work was carried out on a number of claims, but from then until 1911 little was done. During the past ten years a number of properties have shipped ore. Most of the values have been in silver, but small amounts of zinc and lead have also been recovered. The two chief properties are the Bell and Sally mines. The ore shipped carries from 5 per cent to 10 per cent lead and from 5 per cent to 20 per cent zinc. Other producers include the Wellington, Beaver, Bounty, Rambler, and Standard Fraction.

The rocks of the region consist of a series known as the Wallace group, two batholithic intrusives known respectively as the Westkettle batholith and the Beaverdell batholith, numerous dyke rocks, and a younger series of tuffs and conglomerates known as the Curry Creek series.

The Wallace group ground consists largely of metamorphosed igneous rocks, chiefly lavas and tuffs with some sediments at their base. The basal portion may possibly be of Carboniferous age, but most of the series is usually correlated with the Triassic-Jurassic Nicola series of Kamloops area. The Westkettle batholith consists of quartz diorite which along its borders is commonly gneissic. It is considered to be of Jurassic age. The Beaverdell batholith consists of quartz monzonite; it is unfoliated and is believed to be Eocene. Dykes accompany both batholiths and a large intrusion of augite syenite porphyry holds inclusions of Beaverdell quartz monzonite, but is cut by apophyses of that batholith and is accordingly considered to be contemporaneous with it. The Curry Creek series consists of tuffs and conglomerates of Oligocene age.

The chief ore deposits are of the nature of mineralized shear zones. In nearly every case the country rock is quartz diorite. Dykes of andesite and aplite are found in the shear zones and these were intruded prior to the formation of the ore. The shear zones are from 1 to 10 feet wide, strike east and west, and dip south at angles varying from 50 degrees to vertical. They consist of partly replaced fragments of country rock, quartz, and the ore minerals lying between two well-defined walls. The ore minerals consist of galena, sphalerite, pyrite, tetrahedrite, and pyrite. Native silver, calcite, chlorite, and kaolin are secondary.

The ore-bodies were formed by hot ascending solutions from the magma of the Beaverdell quartz monzonite. The shearing of the quartz monzonite into well-defined fractures allowed the solutions to pass freely through it and the ore minerals to be deposited within cavities in the shear zone.

The two most important producing properties have been the Sally and the Bell. The former consists of a group of thirteen claims. In 1924, 690 tons of ore was shipped to the Trail smelter, averaging 358 ounces of silver to the ton as well as some lead. The Bell in 1924 shipped 384 tons of silver-lead ore and in 1924, 584 tons. Other properties include the Beaver, Tiger, Highland Chief, Wellington, etc.

(29) Grand Forks Mining Division

Occurrences of galena and sphalerite are found in a number of districts of Grand Forks mining division, including Franklin camp, Granby River section, Lightning Peak section, and Paulson section.

BONANZA FRACTION GROUP

Reference

Freeland, P. B.: Ann. Rept., Minister of Mines, B.C., 1925, p. 192.

This group is situated along Granby river on its east side adjoining the wagon-road at a distance of about 10 miles upstream from Grand Forks. The rocks of the claims are tuffs and limestones intruded by porphyry dykes. The latter are considered to be apophyses of a granodiorite mass which outcrops to the northeast, and which is probably also responsible for the mineralization.

The deposit is a replacement in the volcanic tuffs. The strike of the ore zone is north and the dip is about 45 degrees to the west. There is no sharp boundary between the ore zone and the unmineralized country rock. The ore minerals are galena, zinc blende, pyrite, marcasite, and pyrrhotite, carrying gold and silver values, in a gangue of quartz and calcite. The deposit, as developed in 1925, had a surface width of 12 feet.

PAULSON SECTION

References

Freeland, P. B.: Ann. Repts., Minister of Mines, B.C.: 1926, p. 205; 1927, p. 226.

About 4 miles northeast of Paulson, on the Canadian Pacific railway, are several prospects containing lead and zinc mineralization. On the Enterprise the ore-bodies occur as lenses in schist close to the contact with granite. The ore consists of galena, sphalerite, chalcopyrite, pyrite, and pyrrhotite.

On the Halifax group, situated about 3½ miles southwest of Paulson, is a mineralized zone which has been traced for a length of 500 feet. The rocks are limestones, volcanic tuffs, and andesites intruded by diorite and later alkali syenite dykes. The mineralization is in the limestone and consists of galena, zinc blende, and pyrite in a gangue of quartz in the upper zone, and chalcopyrite and pyrite in the lower.

(30) Arrow Lake Mining Division

Big Ledge

References

Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1923, p. 235; 1927, p. 330.

Langley states:

"An extensive deposit of sulphides known as the 'Big Ledge' occurs on Bald mountain, west of Pingston creek, some 6 miles back from the Upper Arrow lake, opposite St. Leon hot springs. The old workings, which vary from about 5,500 to 7,000 feet in elevation, are reached by an old, disused road 7 miles in length from the mouth of Pingston creek. From the end of the road a trail 1 mile in length leads to the cabin which was built for some of the claims at the lower end. About twenty-five years ago there were as many as twenty-three claims staked on the 'Big Ledge.' Later a number of these were abandoned, but a few are still held, including those in which Walter Scott and A. E. Fowler, of Nakusp, are interested.

The mineralization consists of pyrite, pyrrhotite, and sphalerite, with which are associated small amounts of galena and chalcopyrite in places. The iron sulphides evidently predominate, but there is considerable zinc blende in evidence, graduating from the disseminated variety, which is the most abundant, to 'solid' ore, which, judging from assays made for the owners, would assay about 40 per cent in zinc. No other values are associated with the zinc blende. The lead and copper contents of the deposit appear to be negligible.

The old workings, chiefly open-cuts and trenches, with some short tunnels, trace the 'ledge' for several miles in a westerly direction up the gentle slope of the mountain. At the lower (or easterly) end the workings are in the timber, which extends to about 6,000 feet elevation.

The deposit lies on the hillsides like a blanket and is apparently of the bedded type, erosion having taken place in the plane of the hanging-wall of the 'ledge,' thus exposing the sulphides at intervals for several miles easterly and westerly and for from 50 to 300 feet northerly and southerly.

Judging from the numerous holes penetrating into the foot-wall, which is quartzite or siliceous schist, the width of the sulphides is from 2 to 6 feet. It would appear from old reports, which refer to the great width of the 'ledge,' that the superficial extent northerly and southerly was mistaken for the true width, giving rise to a belief that the deposit was one of vast size.

The limestone hanging-wall, which was eroded off the sulphides, is well exposed in the bluffs above Empress lake, near the summit. In these bluffs the strata can be seen in their original relations, dipping at from 35 degrees to 40 degrees. A short tunnel driven into the bluffs at the top of a rock-slide exposes a width of 6 feet of mixed iron and zinc sulphides, the iron predominating."

In the autumn of 1926 the property, consisting of some thirty claims, was acquired by the Butler interests of Los Angeles and Duluth, and diamond drilling operations were carried out.

(31) Revelstoke Mining Division

There are a number of zinc-lead occurrences in Revelstoke mining division, but at present there are no producing properties.

Woolsey Group

References

Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1919, p. 140; 1926, p. 270; 1927, p. 289.

This property is situated on Silver creek, about 6 miles from the Canadian Pacific railway at Albert Canyon.

Work was carried out on this property in 1918. In 1925 the Bernier Metals Corporation of Vancouver undertook mining operations.

The main deposit is a vein in carbonaceous slate, to whose bedding planes it conforms in dip and strike. The vein consists of quartz and is remarkable for its width and continuity. Cutting the hillside at an oblique angle, it can be easily traced for thousands of feet from near the summit on the west side to that on the east side.

A tunnel was driven at an elevation of 5,100 feet on the west side of the creek along the foot-wall, and parallel to the strike of the vein. At a distance of 74 feet from the portal a crosscut has been driven showing the vein to have a width of 23 feet. On the foot-wall the mineralization is slight, but increases towards the hanging-wall. A sample across a width of 9·5 feet adjacent to the hanging-wall ran: silver, 6·6 ounces; lead, 6 per cent; zinc, 6 per cent.

In the 1919 annual reports Langley states:

"Immediately above the tunnel galena outcrops on the surface and at an elevation of 5,375 feet an old drift has been driven for a distance of 90 feet but discloses nothing of importance. The vein here is exposed in a series of jagged bluffs and can be seen continuing towards the summit. At an elevation of 5,900 feet the vein shows a width of about 9 feet along the face of a bluff. . . . . Here several shallow diggings on the foot-wall side of the vein expose some nice showings of galena, a sample across 10 inches of which ran: silver, 49·4 ounces; lead, 58 per cent; zinc, 4 per cent.

Proceeding from the new tunnel down the hill, the east fork of Silver creek is crossed at an elevation of about 4,300 feet and a good trail is followed to the showing on the east side of the creek, where at an elevation of 4,650 feet the vein has been uncovered from overburden and an open-cut exposes a width of 9·5 feet. The vein-filling of massive quartz is mineralized with galena in streaks and bunches, and with which is associated iron pyrites and zinc blende. . . . .

The ore occurs in lenses and barren spots are found to be more or less frequent. The future of the property depends on the development of a large tonnage and the ultimate erection of a concentrator."

Other quartz veins carrying sphalerite and galena occur on the property.

Similar deposits occur on the adjacent Snowflake property.

Lanark

References

Ann. Repts., Minister of Mines, B.C., 1915-1925.

The Lanark is situated at Laurie on the main line of the Canadian Pacific railway. It was worked in 1896 and within recent years has made small shipments of silver-lead ore. Diamond-drilling operations were carried out in 1924 and 1925 by W. B. Dornberg, but the results were discouraging and the plant was dismantled and the tram removed. The deposit is a quartz vein cutting argillites.

J and L Group

Reference

Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1922, p. 215.

This property is on the southern side of the east fork of Carnes creek, half a mile above its intersection with the main creek. Carnes creek joins Columbia river at a point about 24 miles northerly from Revelstoke. The trail, 9 miles in length from the Columbia to the mine cabin, gains in that distance an elevation of 1,050 feet above the river, or a total elevation of 2,650 feet above sea-level.

The property is owned by E. McBean of Revelstoke. An option held on it by the Porcupine Goldfields Development and Finance Company was dropped in 1926.

Langley reports:

"The formation, consisting of schist and limestone, shows uniformity. The strike is north 65 degrees west and dips from 30 degrees to 50 degrees to the north-east. The vein, conforming to the stratification of the enclosing rocks, follows a contact between schist and limestone, cutting diagonally up and around a shoulder of the mountain in a southeasterly direction from the creek. The hanging-wall of the vein is schist and the foot-wall is limestone. The vein, 4 to 10 feet in width, is apparently of the bedded-fissure type, being well defined, with, in places, distinct gouges on both walls.

The ore is a complex mixture of iron, zinc, and lead sulphides, carrying gold and silver values. The solid sulphide ore occurs in the vein in bands from a few inches up to 3 feet in width, but in places the vein is entirely decomposed. The gold values are apparently associated with the iron sulphides, which predominate in the ore, the silver probably being chiefly associated with galena. In two places assays of samples gave from 0·5 to 0·8 per cent copper in addition to gold, silver, lead, and zinc. Numerous other samples, however, did not contain any copper.

The vein was first encountered at the creek, but little work was done at this point. The highest workings are 1,800 feet above the creek. Commencing at the highest point near where the vein crosses the summit of the ridge, and gradually descending towards the creek and going around the mountain towards the north, the development and ore-showings examined are as follows:

Near the summit of the ridge, or 1,800 feet above the creek, the vein is 5 feet wide where exposed in an open-cut. Some 800 feet northwesterly along the outcrop and 1,700 feet above the creek an open-cut shows 6 feet of ledge-matter, with, towards the hanging-wall side, a band of solid ore 8 to 10 inches wide. A sample across 8 inches gave: gold, 0·8 ounce; silver, 0·8 ounce; copper, nil; lead, nil; zinc, 4 per cent. The earthy, decomposed ledge-matter on each side of the solid ore gave but negligible results upon assay.

At 1,600 feet above the creek and 170 feet northwesterly 2 feet of solid ore is exposed in an open-cut. A sample across 2 feet gave: gold, 0·36 ounce; silver, 2 ounces; copper, nil; lead, nil; zinc, 3 per cent.

At 1,550 feet above the creek and 575 feet farther northwesterly an open-cut shows 8 feet of solid ore and disseminated mineral in decomposed ledge-matter. The solid ore is in two bands, each 18 inches wide on hanging-wall and foot-wall respectively. A sample across the 8 feet gave: gold, 0·24 ounce; silver, 4·5 ounces; copper, nil; lead, 2 per cent; zinc, 2 per cent.

At 1,500 feet above the creek and 175 feet farther to the northwest an open-cut shows the vein to be nearly 9 feet wide, with bands of solid ore on foot-wall and hanging-wall, samples of which gave as follows: across 2½ feet on hanging-wall side: gold, 0·3 ounce; silver, 2 ounces; copper, nil; lead, nil; zinc, 5 per cent. Across 1 foot on foot-wall side: gold 0·26 ounce; silver, 1·2 ounces; copper, nil; lead, trace; zinc, 3 per cent. Upon assay the 5½ feet of parting proved to contain no values. The ore, however, would break freely from the waste.

At 1,220 feet above the creek and 1,000 feet farther to the northwest there is a tunnel 90 feet long which crosscuts the vein at a depth of 60 feet below the outcrop. From the end of this crosscut a winze has been sunk 125 feet on the vein, which is here from 5 to 6 feet wide, much crushed and decomposed. Throughout the lower 80 feet of the winze there is a band of solid ore, 6 to 20 inches wide, close to the hanging-wall. A sample across 6 feet at the bottom of the winze gave: gold, 0·32 ounce; silver, 3 ounces; copper, nil; lead, 3 per cent; zinc, 2·5 per cent.

At the top of the winze the vein was drifted on 80 feet southeasterly. The vein in this drift is soft and entirely decomposed for a width of from 4½ to 6 feet. A sample across 4½ feet gave: gold, 0·6 ounce; silver, 6 ounces; copper, nil; lead, 8 per cent; zinc, 2 per cent.

At about 1,100 feet above the creek and 760 feet horizontally around the hill to the north there is an open-cut which shows 2 feet of solid ore against the hanging-wall, with some oxidized ledge-matter below it. A sample across the 2 feet gave: gold, 0·30 ounce; silver, 0·8 ounce; copper, nil; lead, nil; zinc, 2 per cent.

At 970 feet above the creek and 675 feet farther round the hill towards the north an incline shaft has been sunk 135 feet on the vein, which is 4 feet wide. Throughout the lower 75 feet of the shaft there is a band of solid ore from 1½ to 2 feet wide along the foot-wall, the schistose ledge-matter on the hanging-wall being crushed and stained from oxidation. The upper part of the shaft contains streaks of solid ore in decomposed ledge-matter. Assays from the incline gave the following results: across 1½ feet of ore from bottom of shaft: gold, 0·42 ounce; silver, 9 ounces; copper, nil; lead, 8 per cent; zinc, 6 per cent. Across 2 feet of ore 50 feet up from bottom of shaft: gold, 0·26 ounce; silver, 8 ounces; copper, 0·5 per cent; lead, 4 per cent; zinc, 7 per cent.

At about 610 feet above the creek and 665 northerly around the hill there is 2½ feet of solid ore exposed in a short tunnel, an average sample of which gave: gold, 1·14 ounces; silver, 1·5 ounces; copper, nil; lead, 1 per cent; zinc, 9 per cent.

At 510 feet above the creek and 160 feet northerly along the outcrop there is a tunnel 217 feet in length. The first 100 feet of this tunnel, having been driven in the limestone foot-wall, does not expose the vein, but a change of direction just beyond this point brought the vein into the tunnel, showing an average width of about 2 feet of ore containing considerable zinc blende. A sample across 2 feet, 160 feet from the portal of the tunnel, gave: gold, 0·39 ounce; silver, 7 ounces; copper, nil; lead, 9 per cent; zinc, 20 per cent. A grab sample from a large pile of ore outside the portal of this tunnel gave: gold, 0·62 ounce; silver, 8 ounces; copper, 0·7 per cent; lead, 8 per cent; zinc, 14 per cent.

In addition to the workings along the section of the outcrop above described, there are a number of other open-cuts which, together with the workings mentioned, trace the vein at short intervals for over 5,000 lineal feet. In these open-cuts, which have been omitted in the description, the vein shows much the same characteristics as noted above, the mineralization being remarkably persistent, indicating ore-bodies of great length. The average width sampled was 32 inches, but milling values would probably extend over a good stoping width in many places. The average in gold and silver (taken at 65 cents per ounce) gave $10.90. Owing to lack of time an examination of the workings between the lower tunnel and the creek (750 lineal feet) could not be made, but the writer was informed that the vein was traced throughout by open-cuts and stripping, with good ore-showings in places.

Transportation would not present a difficult problem, as the country traversed between the Columbia river and the property is of the easiest description for wagon-road construction, with only two short-span bridges required in the entire distance. As the elevation of the cabin is only 1,050 feet above the river a very easy grade is obtainable.

Adequate waterpower for mining and milling could probably be developed economically at the intersection of the east fork and Carnes creek, half a mile below the property. There is an abundant supply of mining-timber on the claims.

Providing a satisfactory solution of the treatment of the ore can be made, the J and L group would seem to have the makings of a mine with some life in it."

(32) Golden Mining Division

A considerable number of properties in Golden mining division carry lead and zinc minerals. On the Monarch and Kicking Horse important tonnages of ore have been blocked out and production is assured. On others such as the Giant and Ruth-Vermont it is also expected that a production will be made.

Monarch

References

Allan, J. A.: Geol. Surv., Canada, Memoir 55, p. 215.
Rayson, H. C.: Ann. Rept., Minister of Mines, B.C., 1912, p. 139.
Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1915, p. 80.
Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1925, p. 220. Can. Min. and Met. Bull., Jan., 1929, p. 24.

The Monarch mine is situated on the precipitous face of mount Stephen in the heart of the Rocky mountains about 3 miles east of Field. It stands about 1,000 feet directly above the track of the main line of the Canadian Pacific railway. Its peculiar position on the face of a cliff has made access and the disposal of ore and waste serious problems.

The property was located as early as 1885 and was one of the first mines opened and worked in British Columbia. It has changed hands many times and has been worked intermittently since that date. Late in the autumn of 1925 it was taken under option by the Pacific Mines Development and Petroleum Company. Early in 1929 it was acquired by Base Metals, Limited, a new company, 35 per cent of whose stock is held by the Mining Corporation of Canada and the balance by Goldfields Consolidated Mines Company, and a 350-ton mill has been erected.

Regarding the deposit, Allan states:

"The ore-body occurs in a band of bluish grey limestone about 300 feet thick, which has, on the weathered surface, a slightly pinkish colour. The limestone belongs to the Cathedral formation which is at the base of the Middle Cambrian. The rock is fissured nearly vertically by a major fissure which strikes approximately south 10 degrees east. There are a series of cross fractures which strike nearly east and west.

There is a well-marked zone of sheared rock which can be readily seen from the opposite side of the valley or from the floor of the Kicking Horse river. This zone in its widest portion is approximately 500 feet wide, but it is not possible to examine it close at hand, as it occurs on the vertical face of mount Stephen. It cuts diagonally across the bedding of the Cathedral limestones and finally pinches out on the southwest side of the mountain about 800 feet higher up, and close to the base of the Stephen formation. In the mine workings, the zone where exposed consists of a shattered mass of rock. The fragments are cemented together by calcite or by ore, so that in some places the limestone band appears as a typical shatter breccia. The blocks vary from a few inches in diameter to several feet. The ore minerals, which are essentially galena, sphalerite, and pyrite, occur on and near the major and cross fissures, and also in the cementing material about these shattered blocks.

When the fragments of limestone are small the ore minerals may form the larger part of the cement or may frequently impregnate the blocks themselves. In some cases, but not always, there is an enrichment of ore at the junction of two fissures. In other places there is a replacement of the carbonate rock by the ore minerals, and pockets of almost pure mineral, principally galena, occur; some of these pockets already opened up are over 10 feet in diameter. It is difficult to outline the form of the deposit as it is now developed, because a large "horse" of the shattered limestone sometimes displaces the ore-body several feet in any direction. The main north-south fissure which has been followed for about 250 feet seems to branch into several smaller ones at the inner (south) end. A fault with small apparent displacement has cut off the ore-body at this end. The upthrow has been on the south side of this break which strikes nearly east-west. The floor of the ore-body consists of a much more massive block of siliceous dolomitic limestone, which has been less shattered about the fissure and which contains very little ore. A zone of pyrite seems to mark the lateral extent of the ore-enriched rock. The sphalerite occurs usually intimately associated with the galena, although it is occasionally found alone in certain parts of the deposit. The sides of the larger fissures are usually highly oxidized and some contain from 2 to 5 inches of gouge clay. Assays show that the galena carries a maximum of 5 ounces of silver to the ton, but the sphalerite does not contain any of this metal.

In general it may be said that the ore occurs along and about a series of cross fractures, sometimes replacing the limestone and cementing together fragments of the shattered rocks. The ore solutions have also spread out along the bedding plane on top of the more impervious underlying dolomitic limestone, giving the deposit the general appearance of a blanket lode.

The ore solutions have come up through the fissures and spread out into and replaced the shattered limestone in the sheared zone. It seems possible that the ore enrichment will continue in the same irregular manner so far as the shattered zone extends both laterally and vertically."

It is probable that the source of the mineralizing solution was an underlying intrusive mass which is not exposed at the surface. A syenite mass outcrops in the Ice River field about 15 miles to the south of the property and it is probable that it is but a cupola of a much more widely extending mass below.

The property consists of two parts, the east Monarch, or Monarch proper, and the New or West Monarch, formerly known as the Couverapee, situated about 700 feet to the west.

The workings on the East Monarch consisted in 1926 of a chamber about 340 feet long and from 40 to 128 feet in width. The average elevation of its floor is about 5,150 feet. It is reached by a tunnel at an elevation of 4,998 feet and a raise.

The West Monarch was formerly reached through the Old Monarch by a difficult trail round the steep cliffs. Its workings consist of a chamber and several drifts, at an average elevation of about 5,341 feet.

Recent work has consisted in driving an incline up the dip of the beds from the East Monarch to the West Monarch. This tunnel, after penetrating a barren zone, encountered a large ore-body whose dimensions as outlined in 1928 were as follows: length 125 feet, width 65 feet, and thickness 25 feet, with ore still in the face. The average of numerous samples indicates the following values: lead, 35 per cent; zinc, 10 per cent; silver, 2·5 ounces per ton.

In the West Monarch the length of the ore-body is about 600 feet with a width of 130 feet and a thickness of 23 feet. The average values indicated are: lead, 15 per cent; zinc, 10 per cent; silver, 1 ounce per ton.

Kicking Horse

References

Allan, J. A.: Geol. Surv., Canada, Mem. 55, p. 221.
Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1925, p. 221.

This property, formerly known as the Black Prince, is situated on the north side of Kicking Horse river opposite the Monarch mine. The mine workings are in the face of a bluff at an elevation of approximately 1,000 feet above the river, or 5,050 feet above sea-level. The property, along with the Monarch, is held by the Base Metals, Limited.

Regarding the deposit Allan states:

> "The mode of occurrence of the ore is quite similar to that of the Monarch on mount Stephen. The ore lies along a fissure which varies in width from a few inches up to 6 feet. The rock is a bluish grey, siliceous limestone of the Cathedral formation, that has been badly shattered along a zone which cuts across the bedding and pinches out in the southwest slope of mount Field. This country rock and sheared zone are a continuation of that in which the Monarch ore occurs. The floor is the same hard, siliceous, dolomitic limestone band that forms the floor of the Monarch mine. The ore minerals are galena, sphalerite with some pyrite, and a very small amount of reddish coating on weathered surfaces which suggests mimetite. The ore-bearing solutions have replaced some of the rock and have cemented some of the broken fragments in the sheared zone about the fissure."

Four tunnels have been driven in from the side of the mountain on the mineralized horizon. The best showings of ore are in what are known as

No. 2 and No. 3 tunnels. In No. 2 an average of nine samples gave 9·6 per cent zinc and in No. 3 an average of twenty-eight samples gave 16 per cent zinc and 5 per cent lead. No. 1 tunnel shows a small amount of ore, but No. 4, which is higher up the cliff to the west, does not show ore. It has been estimated that there is in sight a possible ore reserve of 50,000 tons.

Giant

References

Walker, J. F.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 228.
Evans, C. S.: Geol. Surv., Canada, Sum. Rept. 1926, pt. A, p. 55.
Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1923, p. 195; 1927, p. 261.

This property is situated at an elevation of 3,520 feet on the northwest slope of Spillimacheen mountain, and is about 6½ miles by road from Spillimacheen on the Canadian Pacific railway, Kootenay Central branch.

The deposit is a barite vein which cuts the Ottertail limestone of Upper Cambrian age. The workings are close to the contact of the Ottertail with the overlying Goodsir formation of Cambro-Ordovician age. In an open-cut the vein is 30 feet wide, strikes north 60 degrees west, dips 54 degrees southwest, and outcrops for several hundred feet up the hillside. The sulphide is fine-grained galena and occurs in scattered bunches in the barite.

Regarding the mineralization of this region Evans states:

> "Most of the mineralization of the Jubilee and Lead Mountains area appears to be confined to the Ottertail magnesian limestone in which occur numerous veins and bedding replacements of barite. The sulphides, galena, sphalerite, and in some places chalcopyrite and chalcocite, occur as scattered replacements or as small pockets of richer ore, in the barite and limestone. No large body of ore has been developed, but it seems reasonable to suppose that in this area where the total amount of visible sulphide is great, though scattered, conditions favouring the local deposition of workable bodies of ore should have existed. The area is close to rail transportation."

Ruth-Vermont

References

Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1926, p. 237; 1927, p. 263.

The Ruth-Vermont property is on Vermont creek, a tributary of Spillimacheen river, at a distance of 35 miles from Spillimacheen on the Kootenay Central railway. The property is owned by the Galena Syndicate, of London.

The rocks are argillites and limestones, probably belonging to the Mount Nelson formation of the Windermere series, of late Precambrian age. The main ore showings occur in a zone, apparently from 30 to 50 feet wide, conforming to the strike and dip of the formation. In this zone the sulphide ore has replaced the more easily soluble beds with the result that the ore occurs in parallel bands and streaks separated by layers of sparsely mineralized country rock. In the old Nelson tunnel, which was driven on the foot-wall side of the ore zone, a crosscut 25 feet from the portal shows a width of 4 feet of massive sulphide ore assaying as follows: gold, 0·02 ounce to the ton; silver, 26·01 ounces to the ton; lead, 24·8 per cent; zinc, 25·7 per cent. A 50-foot raise connects this tunnel with an upper tunnel which has been driven for 30 feet on a parallel band of ore, with fairly heavy sulphate mineralization in either wall. The best grade of ore was apparently confined to a width of about 30 inches, across which lead assayed 14·3 per cent and zinc 20·6 per cent. Besides this there is possibly a considerable quantity of lower-grade material.

On other parts of the property a considerable amount of development work and prospecting has been carried out on a series of small fissure veins that cut the formation and from which some high-grade ore has been extracted.

(33) Windermere Mining Division

At present, the most important property in Windermere mining division is the Paradise mine, but there are a number of other prospects some of which have produced small tonnages of ore. Descriptions of these appear in the annual reports of the Minister of Mines of British Columbia and in Memoir 148 of the Geological Survey. The deposits are chiefly veins carrying galena, some silver, and also, in places, some zinc ore. They include the Bald Eagle, the Delphine group, the Kootenay Queen, the Hot Punch group, the Dominion, the Silver Spray, the Mineral King, Larrabee's prospect of the Leadville group, the Nip and Tuck, the Ptarmigan mine, the Phoenix group, the Outcrop and Outlet, the Steele group, the Dragon, the Grotto group, the Puzzle group, the Relief group, the Isaac, the Bear group, the Bunyan, and others.

Paradise Mine

References

Walker, J. F.: Geol. Surv., Canada, Mem. 148, p. 46.
Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1915, p. 88.
Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 221; 1927, p. 264.

The Paradise mine lies at an elevation of 8,000 feet on the side of the basin at the head of Spring creek, a tributary of Toby creek. The property may be reached by automobile from either Invermere or Wilmer on the Canadian Pacific railway, a distance of about 18 miles. The difference of elevation between the mine and the railway is about 5,000 feet.

The property was staked in the summer of 1899 and was taken over by H. C. Hammond of Toronto, in 1900. Development work was carried on until 1904, the total amount up to this date being approximately 4,733 feet. Shipments of ore continued to 1906, the total production amounting to 1,996 tons. In 1915 the property was reopened by R. Randolph Bruce and since that date it has been a steady producer. In 1926 the mine was purchased by the Victoria Syndicate of London, England. In 1927 the erection of a 50-ton concentrator was commenced. The rocks of the vicinity are sediments of late Precambrian age, consisting of quartzites, slates, magnesian limestones, and conglomerate. They comprise two formations separated by an unconformity. The older is the Mount Nelson formation made up of the following horizons in the order from oldest to youngest: magnesian limestone and slate, quartzite, magnesian limestone, slate. The younger is the Windermere and consists of two divisions, a lower known as the Toby conglomerate and an upper known as the Horsethief formation consisting of grey, green, and purplish slate, with lenticular beds of coarse quartzite and pebble conglomerate and numerous thin interbeds of blue-grey, crystalline limestone. The ore-body is in a grey, siliceous, magnesian limestone lying beneath the upper white quartzite of the Mount Nelson formation. The limestone is shattered and lies in a small, closed, anticlinal fold on the eastern limb of a major fold. The minor fold is broken on the west by a fault with a downthrow to the west.

The ore is of two types, primary and secondary. Up to date it has been the secondary variety that has been mined chiefly. It consists largely of lead carbonate, but in places it contains original fragments of galena. This type of ore is commonly called "sand carbonates." The primary ore consists of galena, sphalerite, and pyrite. A good shoot of such ore was opened up on the 4th level. At one place between the 3rd and 4th levels, a transition zone between the secondary and primary type can be observed. The ore of both types occurs in isolated pockets and lenses, in bedded veins, and in fissures. Development work consists in searching for these shoots.

The deposits originated largely by replacement, but probably partly also by deposition along open channels. The source of the mineralizing solutions was undoubtedly the intrusive granite of late Jurassic age, a large mass of which is exposed 16 miles to the northwest and probably extends beneath the property. The deposits were later subjected to the action of surface waters which in places leached out the zinc, most of the iron, and left as a residue the "sand carbonate" ore.

Total smelter shipments up to the year 1924 amounted to between 22,000 and 24,000 tons. The ore shipped averaged about 95 per cent carbonates and 5 per cent sulphides and ran from 40 to 45 per cent lead with 45 ounces of silver to the ton.

The future of the property depends on the amount of primary ore available and the present indications are that a considerable tonnage of such ore will be developed.

White Cat Group

References

Walker, J. F.: Geol. Surv., Canada, Mem. 148, p. 47.
Langley, A. C.: Ann. Rept., Minister of Mines, B.C., 1923, p. 199.

This property, consisting of four Crown-granted claims, the Ground Floor, Heavenly Twins No. 1, Heavenly Twins No. 2, and the White Cat, is situated on Slade creek about 24 miles from Wilmer on the Canadian Pacific railway. Its elevation is 7,250 feet. A road leads up Slade creek to the property.

Work was carried out on the property about 1900 and some ore was shipped. Difficulty of access hampered work in the early days, and work was discontinued. In 1924 work was renewed on the property. The road up Slade creek was improved, a certain amount of surface work carried out, and a shipment of ore made to Trail. In 1925 work was continued and 81 tons of silver-lead ore was hauled to the railway.

The rocks of the vicinity are sediments of the Mount Nelson formation of late Precambrian age, consisting of slate, limestone, and quartzite. The general strike of the series on the property is from north to 10 degrees west of north, and the dip is variable to the east.

The deposit is a vein striking 35 degrees to 40 degrees east of north and dipping from 65 degrees to 80 degrees to the northwest. The vein outcrops for a distance of 250 feet and varies in width from 20 inches to 8 feet. The ore, which consists of galena, occurs in a gangue of slaty gouge and quartz. The best showing of ore occurs in an open-cut where a lens of clean ore near the hanging-wall shows a width of 20 inches and another near the foot-wall a width of 4 inches. The length of these lenses is about 10 feet on the surface. At other points along the vein the ore pinches to practically nothing and swells to several inches in width.

The development work consists of open-cuts and an old tunnel driven for a distance of 90 feet along the strike of the vein. The tunnel is about 600 feet above the creek bottom. The first 40 feet of it shows ore, the remaining 50 feet to the face is barren, but the vein shows well-defined walls and other lenses of ore may occur farther along the vein.

A shipment in 1924 gave the following smelter returns: dry weight, 60,390 pounds; lead, 74·75 per cent; silver, 32·3 ounces per ton; zinc, 1·4 per cent; SiO_2, 3·9 per cent; S, 12·4 per cent; Fe, 1·6 per cent; Ca, 0·6 per cent. Another shipment of 5 tons gave 75·6 per cent lead and 44·6 ounces silver to the ton.

(34) Fort Steele Mining Division

Fort Steele mining division occupies the extreme southeastern portion of British Columbia. It is by far the largest producer of both lead and zinc in the province, due to the fact that in it is situated the Sullivan mine.

Sullivan Mine

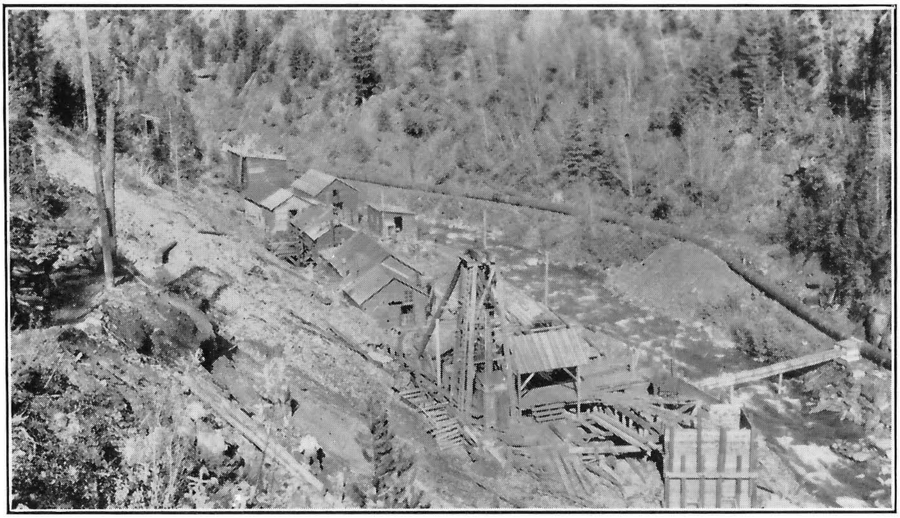
Reference

"The Development of the Sullivan Mine and Processes for the Treatment of Its Ores"; Trans. Can. Inst. Min. and Met., vol. XXVII, (1924).

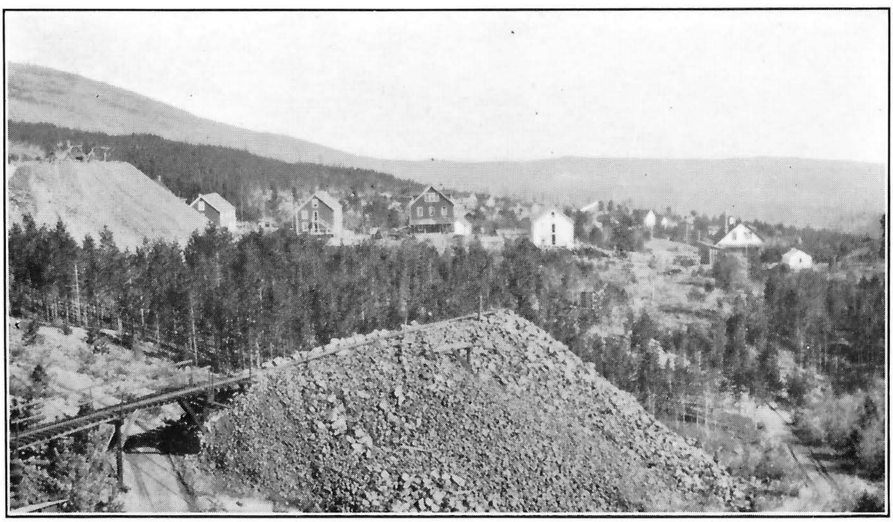
The Sullivan mine is situated at Kimberley which is 19 miles by rail from Cranbrook on the Crow's Nest line of the Canadian Pacific railway. It is easily reached from Cranbrook by train or motor-bus.

The deposit was staked in the summer of 1892. From 1896 to 1899 some surface stripping was done and several small shafts were sunk. In 1900 systematic development was begun and the first shipments of ore made to the Hall Mines smelter at Nelson and to the Canadian Smelting Works at Trail.

In 1903 construction was commenced of a smelter and power plant at Marysville, 5 miles below Kimberley, on Mark creek. Many metallurgical difficulties were encountered and in 1907 the mine and smelter



A. Stemwinder, Fort Steele mining division, B.C.



B. Sullivan mine, upper workings, Fort Steele mining division, B.C.

were closed down. In 1909, the bond holders and the creditors of the company reorganized the company under the name of the Fort Steele Mining and Smelting Company, the control being vested in the Federal Mining and Smelting Company. In December, 1909, The Consolidated Mining and Smelting Company of Canada, Limited, took a lease and bond on the Federal Mining and Smelting Company's holdings in the Fort Steele Mining and Smelting Company. Underground development and diamond-drilling were carried out with the result that towards the close of 1910 the option on the stock of the Federal Mining and Smelting Company and on that of some of the other shareholders was exercised and the control passed into the hands of the Consolidated Mining and Smelting Company of Canada. Other claims were acquired by the company and in 1911 the metallurgical problem was attacked in earnest. Continuous shipments of ore to Trail have been made since 1910.

The Sullivan deposit lies in what is known as the Aldridge formation of quartzites and argillites of late Precambrian age. In the vicinity of the mine the beds strike approximately north and dip east at angles averaging about 23 degrees. The Aldridge formation is intruded by several large sills of gabbro, but none of these occurs in the immediate vicinity of the mine. To the north of the deposit the strata are intruded by granite presumably of late Jurassic age.

The deposit consists of massive sulphides occupying a definite zone in the sedimentary series. Though there are irregularities in the foot-wall and hanging-wall, in general the deposit is conformable to the beds, forming a lens striking north and south and dipping at an angle of 23 degrees to the east. The lens has a maximum thickness of 272 feet, and a length on the lower level of over 6,000 feet, with a rake to the north.

The ore lens consists of pyrite, pyrrhotite, sphalerite, and argentiferous galena. Small amounts of other minerals such as garnet, cassiterite, and tourmaline also occur. Of the iron sulphides, pyrite is dominant in the upper working, whereas in the lower working pyrrhotite predominates. The sphalerite is of the iron-bearing variety known as marmatite. The ore is commonly a fine-grained mixture of the four common sulphides. In places it shows a banded structure, and the bands may either be straight or contorted.

The deposit was formed by replacement of sediments of the Aldridge formation. The banding of the ore probably corresponds to original bedding planes of the replaced strata. Deposition clearly took place under conditions of high temperature approaching that of contact metamorphism. The source of the solutions is believed to be an underlying mass of granite which is exposed at the surface to the north of the deposit.

The lens is mined from two adits, an upper known as the 4,600-foot level and a lower, called the 3,900-foot level, these figures approximately representing their respective elevations above sea-level. There are two connexions between the upper and lower workings. In both levels there are two ore-shoots, known respectively as the north ore-body and the south ore-body.

In the upper workings, stoping in the south ore-body is being carried on over a length of 2,000 feet. The ore is lead and zinc in a gangue of pyrite. In the north ore-body stoping on the same level is being carried on over a length of 1,200 feet. This zone contains more zinc than lead. Between these two zones is a barren zone of massive pyrite 700 feet long. Work is also being carried out on the 4,500-foot and 4,400-foot levels, but the ore from these is sent down to the 3,900-foot level to be hauled to the surface.

The lower, or 3,900-foot tunnel, had a length in 1926 of over 13,000 feet. At a distance of 7,100 feet from the portal, the ore lens is reached. The south ore-body on this level consists of sphalerite in a gangue of pyrrhotite. The amount of galena is small. Stoping is carried on over a length of 900 feet. Between the south and north ore-bodies there is a zone of pyrrhotite with only low values of zinc and lead, and about 1,100 feet long. In the north ore-body stoping is being carried on over a length of 1,200 feet. Though the ratios of lead and zinc vary considerably, lead is here uniformly in greater amounts than zinc. The greatest thickness of the ore lens is 272 feet.

The 3,900-foot tunnel bears north 2 degrees east for the first 9,000 feet from the portal. At this point it swings to the west until its direction is north 40 degrees west. In the south and north ore-bodies it follows the foot-wall, but north of the north body the lens is so irregular that the drift, being straight, is sometimes in the foot-wall and sometimes in the hanging-wall. The average width of the lens in this continuation of the north ore-body is 30 feet and it has been followed for over 4,000 feet beyond the north ore-body. It carries here an excellent grade of ore with high values both of zinc and lead.

The capacity of the Sullivan mill was increased in 1927 from 3,000 tons to 4,000 tons daily. The ore is treated by flotation, and the lead concentrates and the zinc concentrates shipped to Trail for treatment.

At the present rate of mining the reserves in sight will certainly last for many years. Little is as yet known of the depth to which the ore lens extends below the 3,900-foot level, but its thickness and its great length suggest the probability that there is as much ore below this level as there is above.

St. Eugene

References

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 118.
Robertson, W. F.: Ann. Rept., Minister of Mines, B.C., 1904, p. 104.

The property consists of 1,050 acres situated near Moyie, on the east side of Moyie lake. It was located in 1893 by James Cronin, a mining engineer, who had been told by an Indian of the discovery of galena ore at this place. Development work was carried out under the management of Mr. Cronin and later the Moyie and Lake Shore group of claims lying between the St. Eugene and Moyie lake were purchased and the St. Eugene Consolidated Mining Company formed. The property subsequently became the largest producer of lead in Canada. In 1905 it was taken over by the Consolidated Mining and Smelting Company of Canada. In 1910 there was a falling off in production, but operations were continued with several interruptions until 1923. In 1925 a 600-ton concentrator was erected by the Consolidated Mining and Smelting Company to treat the tailings from the old St. Eugene concentrator, in order to recover the zinc blende which the old concentrator discarded.

The surrounding rocks are sediments of the Aldridge formation consisting of dark grey, argillaceous quartzites in beds to one foot in thickness, and dark grey, siliceous argillites usually not exceeding 2 inches in thickness. These rocks commonly weather rusty brown.

The deposit is a lode fissure formed by replacement along a zone of fissuring in the quartzites. This zone has a general east and west strike and in it are two important fissures both of which strike east and dip 70 degrees to the south. On the 1,000-foot level, the two fissures are 600 feet apart and converge downward and to the west. Joining these two main fissures is a system of connecting fissures that usually meet the main fissure at a low angle. Most of the important ore-bodies occurred at or near such junctions.

The ore consisted of coarse-grained galena with minor amounts of zinc blende, pyrite, pyrrhotite, magnetite, and a little chalcopyrite. The gangue material was small in amount and consisted of pink garnet, actinolite, quartz, and some calcite. The garnet, actinolite, and quartz are more abundant in the transition zone of the ore and country rock and in places the fissured quartzite near the vein is heavily charged with these minerals.

The deposit had an origin similar to that of the Sullivan, except that the solutions that caused the replacement travelled along a fracture zone instead of along bedding planes of the strata. As at the Sullivan the solutions that produced the replacement were evidently at high temperatures. The order of formation of the minerals was first magnetite, next the gangue minerals, and lastly the sulphides.

The St. Eugene was one of the large mines of British Columbia. Up to September 30, 1913, the total amount of underground development work amounted to 19·79 miles. The production up to this time was 1,017,106 tons of ore containing 5,365,232 ounces of silver and 229,305,721 pounds of lead, having a total given value of $10,626,608. At present no ore is being mined, but the dump from the old concentrator is being reclaimed from Moyie lake by a suction dredge and is being treated in a recently-erected modern flotation plant; provision is also being made for the crushing and concentration of the old mine dump.

North Star

References

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 133.
Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1923, p. 204.

The North Star mine is on the east slope of the North Star hill at an elevation of 5,260 feet above sea-level or about 1,500 feet above Kimberley, almost due south of and opposite to the Sullivan on the other side of Mark creek. The property was located in 1914 by Bourgeois and Langill who bonded the claims to Woods Brothers of Quebec; the latter transferred four-fifths of their interest to D. P. Mann, of Montreal, in

1893. Later, the North Star Mining Company was organized. In 1895, 62 tons of ore, valued at $68.70 a ton, was shipped to the United States. In 1900 the railway from Cranbrook to Kimberley was completed and an aerial tram built to join the mine with the railway. During the same year 16,000 tons of ore, averaging 50 to 55 per cent lead and 20 to 25 ounces of silver, was shipped. In 1904 the mine was reported to have been worked out, but the cleaning up of the deposit lasted until 1908, in which year 3,000 tons were shipped.

In 1918 a lease was taken on the property by O. C. Thompson and associates and between that year and 1920 over 16,000 tons of lead-carbonate was shipped from the dumps and shallow surface diggings.

In 1924 the property was acquired under option by the Porcupine Goldfields Development and Finance Company, Limited, of London, England, and a certain amount of diamond-drill exploration carried out.

The country rocks are argillaceous quartzites of the Aldridge formation of late Precambrian age, forming part of the eastern limb of the Kimberley anticline. In the vicinity of the mine small anticlines and synclines modify this general structure. The general strike of the quartzites is north and the dip is to the east at various angles. In the immediate vicinity of the ore-bodies the quartzites are bleached to a greyish white colour.

There are two main ore-bodies apparently lying in synclinal basins formed of argillaceous quartzites and separated by an anticline. The longer axes of these ore-bodies are parallel, both striking a little east of north. The western had a length of 400 feet, a width of 70 feet, and a depth of 50 feet; the eastern had a length of 180 feet and a depth of 40 feet.

The ore was primarily a very clean, solid, argentiferous galena, rather fine-grained and with only a small amount of sphalerite. The assay value from smelter return was: silver, 23·50 to 43·3 ounces to the ton; lead, 53 to 68 per cent.

The upper part of the ore-shoot was composed of a reddish brown, black, and yellow mixture of oxides and carbonates of iron and lead, with specimens of wire silver, crystals of cerussite, and sulphides of iron. Most of this secondary material carried a higher silver value than the crude galena. The values from smelter returns of this carbonate ore are: silver, 52 to 60 ounces per ton; lead 49 to 57 per cent.

The original ore-body was a replacement deposit, similar to the Sullivan, occupying a definite zone in the Aldridge quartzites. During subsequent erosion most of the ore zone was removed, leaving only the lower portions in the two synclines. The exposure to surface agencies altered the original ore, forming carbonates and removing the zinc.

The main bulk of the tonnage was mined by glory-hole methods and taken out by an adit-tunnel in the foot-wall at a depth of 60 feet below the surface, and thousands of feet of tunnelling and numerous small shafts were sunk to prospect and prove the content of the ore-bodies.

Regarding future possibilities, Langley states:

"Conditions would seem to warrant further exploratory work by diamond-drilling at some distance down the mountain side. Besides a large tonnage of low-grade carbonate ore being available, there is also a considerable tonnage of good milling grade of sulphide ore similar in character to some of that at the Stemwinder. A sample taken of this ore ran: silver, 9 ounces to the ton; lead, 12·1 per cent; zinc, 17·9 per cent.

On the northerly end of the property a good deal of exploratory work has been done on strong showings of iron sulphides, but it is understood the values were too low to constitute ore. One shaft named the 'Kellogg' is down 200 feet."

Stemwinder

Reference

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 135.

The Stemwinder is situated near Kimberley, on Mark creek about half a mile to the west of the portal of the Sullivan tunnel. It is readily reached either by train or by bus from Cranbrook on the Crow's Nest line of the Canadian Pacific railway.

The property was originally owned by the Mackenzie and Mann interests. In 1923 it was bonded by O. C. Thompson who in 1924 interested the Porcupine Goldfields Development and Finance Company. Work was carried out in 1925 and 1926, but early in 1927 work was discontinued and the option dropped.

The country rock consists of argillaceous quartzites of the Aldridge formation of late Precambrian age, intruded by several sills of hornblende gabbro, one of which outcrops a short distance to the east of the workings.

The ore-body is a lens of massive sulphides entirely enclosed by the quartzites. The lens consists largely of pyrrhotite, strikes nearly north, and dips at an angle of about 75 degrees to the west. It is difficult to see its relations to the country rock, for the contacts are not well exposed in the workings. The thickness of the sulphide zone is about 200 feet.

The ore zone lies along the foot-wall side of the sulphide lens. It consists of a fine-grained mixture of galena and sphalerite passing into a fine-grained mixture of pyrrhotite, pyrite, and zinc blende. The ore zone has a width of about 20 feet. It is separated from the normal quartzite by a cherty layer.

The origin is considered to be similar to that of the Sullivan, i.e. replacement of the quartzite under conditions of high temperature by solutions given off from the underlying granite.

A shaft was sunk to a depth of 250 feet and drifts run from it on the 80, 125, 200, and 250-foot levels. This work and a certain amount of diamond-drill exploration have disclosed the extent of the ore zone. The latter has apparently a length of 260 feet and a width from 15 to 30 feet. The average values are reported to be 20 per cent zinc, 1 per cent lead, and 1 ounce in silver to the ton.

Considering the size of the sulphide lens, it might reasonably be expected that other ore-shoots of zinc and lead might be found in it.

Diamond-drill exploration up to the time of the writer's visit in the autumn of 1926, however, had failed to discover any such shoot other than the one on which mining operations were being conducted.

Society Girl

References

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 127.
Robertson, W. F.: Ann. Rept., Minister of Mines, B.C., 1909, p. 92.
Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1911, pp. 121-122; 1922, p. 188.

This group comprises seven Crown-granted claims situated about 2 miles east of Moyie at an elevation of 5,000 feet and adjoining the eastern boundary of the St. Eugene. Work was carried out on the property between the years 1908 and 1914. Small, irregular shipments of ore were made, but there was no steady production.

The formation in which the deposits occur is the oldest subdivision of the Purcell series called the Aldridge formation, which here strikes north with a dip of 25 degrees to the east.

The deposit is a vein that strikes north 60 degrees west and dips 60 degrees to the south. The vein is narrow where it traverses the thin-bedded, argillaceous quartzites and widens in the heavier-bedded quartzites. The ore is essentially galena carrying about one-half ounce of silver to the per cent of lead, occurring in a quartz gangue, and with it is associated some zinc blende.

In the upper workings the ore is oxidized, consisting of cerussite and pyromorphite, both massive and in beautiful crystals. The cerussite is commonly embedded in dense masses of limonite.

The workings consists of open-cuts, prospect shafts, and several tunnels.

Aurora

Reference

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 123.

The Aurora group is on the west side of Lower Moyie lake opposite the town of Moyie, from which it is reached by motor road. The group was originally operated by the Aurora Mining and Milling Company of Moyie. About 1,500 feet of workings, mostly in the form of tunnels, constituted the development work. In 1925 the property was taken over by the Aurora Mines Syndicate and work was recommenced. The ore is hand-picked, shipped by motor truck to Moyie, and by train to Trail.

The country rock in the vicinity of the deposit is the Aldridge formation of late Precambrian age, consisting of thin-bedded argillaceous quartzites and massive, purer quartzites, which here strike northeast with a dip of 50 degrees northwest.

The deposit is a fissure vein or veins striking easterly across the quartzite series. The vein varies up to 6 feet in thickness. The ore is massive sulphides, chiefly zinc blende with minor amounts of galena. In places the sulphides are deposited around fragments of brecciated country rock, and in places there is evidence of replacement, the sulphides extending into the wall-rock.

Mineralization has clearly taken place along fracture or shear zones. The deposit is chiefly of the nature of a fissure vein, but a certain amount of replacement has taken place. The source of the mineralizing solutions was probably an underlying mass of granite. The probability that such an intrusive mass underlies the region is suggested by the outcrop of a number of granite stocks along a north and south line in the district.

The upper workings are reached from No. 1 shaft and the lower from No. 2 tunnel. The latter enters on the 200-foot level. It shows a main fissure zone and a parallel one called the Sullivan vein. In the stopes above this level there is a definite ore zone about 2 feet wide showing sharp contacts with the country rock.

The 100-foot level is reached from the shaft. It shows a nearly vertical vein about 1 foot wide. The ore zone rakes to the west, the lower showings coming out to the surface. This low, westerly rake is parallel to the bedding of the quartzites and suggests that certain beds have been more influential than others in precipitating ore. The more argillaceous beds seem to be better ore-making horizons than the massive blue quartzites.

No. 1 tunnel was driven to the south of the ore-body and it gradually swings to the south away from it. Future work here will be crosscutting to the north to pick up the lower extension of the vein.

The amount of ore in sight is not large, being less than 2,000 tons. The average content is, however, good. It contains zinc, 18·4 per cent; lead, 8·7 per cent; and silver to the amount of 2·5 ounces to the ton. With low mining and transportation costs, this should prove profitable. Future work may, in addition, prove up a substantial increase in the ore reserves. In 1927, 612 tons of ore were shipped to Trail.

Guindon Group

References

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 125.
Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1917, p. 150; 1923, p. 206.

This property is on the south side of Moyie lake, adjoining the Aurora group to the north. The rocks of the vicinity are argillaceous quartzites of the Aldridge formation which here have a northeasterly strike and a dip of about 20 degrees to the northwest.

The deposits are in the form of veins of which there are two on the property. No. 1, on which most work has been done, strikes south 44 degrees east and dips 60 degrees to the southwest. No. 2 vein, which shows a width up 5 feet, is exposed at an elevation of about 800 feet above the lake, strikes almost due east, and dips 60 degrees to the south. The ore consists of galena, zinc blende, and some pyrite.

In 1927, 21 tons of ore were shipped to Trail.

Cambrian and Mabelle

References

Schofield, S. J.: Geol. Surv., Canada, Mem. 76, p. 125.
Robertson, W. F.: Ann. Rept., Minister of Mines, B.C., 1909, p. 94.

The Cambrian and Mabelle Crown-granted claims embrace the territory between the St. Eugene property and the Aurora and thus for the most part lie under the waters of Lower Moyie lake. The Cambrian occupies 51 acres of which only $\frac{3}{4}$ acre is land area. The Mabelle is located on a sandy spit on the western side of the lake. The zone of shearing on which the St. Eugene and Aurora are located is believed to continue across these intervening claims, and it is quite probable that ore-bodies occur on them.

The property was operated by the Canadian Mining Company, Limited, of Moyie, B.C. In 1907 and 1908 an attempt was made to develop the property. The land area on the Cambrian was not thought large enough on which to sink a shaft, so a caisson was sunk at a distance of about 200 feet from the shore. No definite results were, however, obtained. The sounding of the lake reveals the maximum depth of water on the claims to be 140 feet and in addition 90 feet of blue clay and hard pan cover the bottom.

Victor

References

Langley, A. G.: Ann. Repts., Minister of Mines, B.C.: 1917, p. 148; 1921, p. 128.

This property, consisting of three claims, is situated at the headwaters of Maus creek, at a distance of 9 miles from Fort Steele. A wagon road connects the property with Steele. Development work was carried out intermittently on the property from about 1908 to 1922. A 50-ton concentrator was erected in 1921.

The country rock consists of shale, the strike of which is north. The deposit is a vein striking south 15 degrees west and with a vertical dip. The gangue is massive quartz. The ore minerals are argentiferous galena and zinc blende with some iron pyrite, which are irregularly distributed as small lenses, streaks, and disseminations. At only a few places is a workable width visible. Much of the ore is an intimate mixture of galena and zinc blende.

The vein is exposed in a steep bluff on the side of Maus creek and in this bluff three drifts were run. The portal of the No. 1 or uppermost is about 1,000 feet below the summit of the ridge and was driven along the veins for a distance of 387 feet. No. 2 is vertically below No. 1 and was driven for 427 feet. No. 3 was started in the rock slide at the base of the bluff, 100 feet vertically below No. 2.

A mixed carload of ore and concentrates was shipped in the autumn of 1921.

Park Group

Reference

Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1921, p. 128.

This group, consisting of the Hercules, Park, and Bee Line claims, is 1 mile from the railway at Marysville. A motor car can be driven to within a short distance of the workings.

The rocks of the vicinity are quartzites of late Precambrian age intruded by diorite sills and dykes. The deposit is a vein traversing diorite and striking in a direction north 80 degrees west. The width is about 5 feet. The ore is galena in a gangue of quartz and calcite. The galena is free from zinc and carries low silver values. It occurs irregularly distributed over a length of about 200 feet along the strike of the vein.

The property has been systematically prospected by trenches and open-cuts. The strongest surface exposure examined showed a width of 30 inches, across which a sample was taken; this gave the following results: gold, 0·02 ounce; silver, 3·2 ounces; lead, 18·2 per cent.

Old workings consist of a shaft 60 feet deep, from the bottom of which 70 feet of drifting has been done.

One shipment of ore was made from the property. This amounted to 17 tons and gave the following returns per ton: silver, 6·1 ounces; lead, 48 per cent.

Kootenay King

Reference

Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1925, p. 228.

The property is on Wildhorse creek approximately 6 miles by road and 6 miles by trail from Fort Steele. A considerable amount of development work, extending over a period of years, was carried out by the owner of the property, William Myers of Steele. In 1925 the property was acquired by W. B. Dornberg, W. A. Ainstie, and associates who have carried out some further surface exploration.

The rocks of the vicinity consist of steeply tilted quartzites striking north 7 degrees west. Intrusions of aplite occur, apparently following the bedding planes.

The ore occurs in a shear zone which in one open-cut shows mineralization across a width of 15 feet. The zone strikes north. The ore consists of a finely crystalline mixture of lead, zinc, and iron sulphides. A sample taken across a width of 7 feet gave the following returns: gold, 0·02 ounce; silver, 6·6 ounces to the ton; lead, 19·1 per cent; zinc, 21·9 per cent.

Langley states:

"To explore this outcrop at depth three tunnels have been driven. No. 1 is a crosscut and has been driven for 87 feet at a depth of 35 feet below the outcrops. This tunnel cuts the sheared zone, but the ore is confined to a narrower width than on the surface. A sample taken across a width of 40 inches assayed: gold, 0·01 ounce; silver, 5·1 ounces to the ton; lead, 14·8 per cent; zinc, 18·1 per cent. No. 2 tunnel is also a crosscut and is driven into the hill for 375 feet at a vertical distance of 109 feet below the outcrop. At about 178 feet the sheared zone was cut, showing mineralization in stringers and small bunches, but no ore in commercial quantity. Drifting for 84 feet in a northerly direction has shown little improvement, if any, in mineralization. No. 3 tunnel has been driven from a point 226 feet below the open-cut for 311 feet in a northerly direction and apparently parallel to the sheared zone; no ore has been developed in these workings as yet.

Recent surface diggings indicate the possible extension of the ore to the south of the cut, but at the north end faulting has apparently cut off all traces of the ore-zone."

(35) Slocan, Slocan City, and Ainsworth Mining Divisions

References

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"Notes on the Mining Industry in Slocan District, B.C."; Trans. Can. Inst. Min. and Met., vol. XXX (1922).

Schofield, S. J.: "Geology and Ore Deposits of Ainsworth Mining Camp, British Columbia"; Geol. Surv., Canada, Mem. 117.

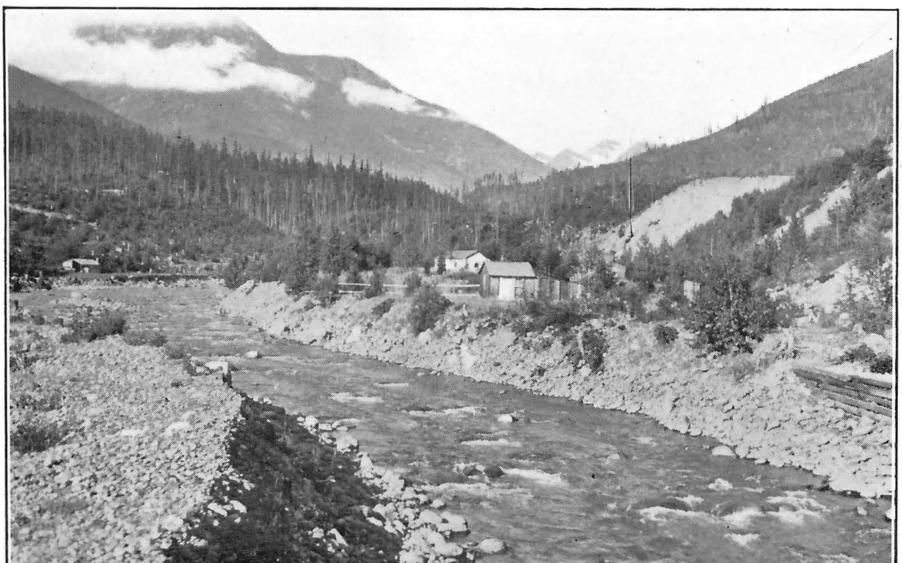
A detailed report is being prepared by C. E. Cairnes, of the Geological Survey, on Slocan mining area, which includes parts of the mining divisions of Slocan and Ainsworth. A detailed description of the numerous silver-lead-zinc properties will be given in this report and, therefore, only a brief reference will here be made to them.

This important mining region lies between Kootenay lake and lower Arrow lake. The larger part of the mineral production has come from a restricted area lying between Kootenay and Slocan lakes and extending for a few miles on either side of the valley traversed by the railway connecting these lakes. The centre of the region is the town of Sandon.

The district lies entirely within the Selkirk Mountain system and has consequently a rugged topography. Elevations range from 1,730 feet, the elevation of Slocan lake, to peaks exceeding 9,000 feet in height. Mountain glaciers occur near the summits of some of the higher mountains. The area, owing to forest fires and early lumbering operations, is sparingly forested and has been rendered easily accessible by a network of roads and trails. The mountain slopes are steep, and snow and landslides are common, so that care in the selection of the location of buildings, tunnel sites, and tramways is required.

The occurrence of lead ore on the site of what is now the Blue Bell mine was known to Indians and Hudson's Bay Company trappers as early as the eighteen-twenties. Active prospecting for lode deposits did not begin in the region, however, until 1865 when the discovery of placer gold in the Big Bend country of Columbia river drew prospectors into the Kootenay. A number of silver-lead deposits were discovered in the vicinity of Ainsworth and Riondel and in 1891 rich silver-lead deposits were located farther north. In that year some eighty locations were taken up, including the Payne, Noble Five, Slocan Star, Antoine, Washington, Freddy Lee, and Utica. In the following year some seven hundred and fifty locations were made including the Whitewater, Lucky Jim, Reco, and Richmond Eureka.

A. Reco mountain, Slocan mining division, B.C.



B. Mouth of Kaslo creek, Ainsworth mining division, B.C., mount Carlyle in the background.

Until 1894 the ore was taken by pack-horses to Nakusp, a distance of 35 miles from Sandon, or by wagon road from Sandon to Kaslo, a distance of 28 miles. The cost of transportation by either of these routes was so great that only the highest grade ores could yield any profits to the operator. In 1894, a branch of the Canadian Pacific railway was constructed from Nakusp to Sandon, and in the following year the Kaslo and Sandon narrow gauge line was completed between Sandon and Kaslo. In 1911 the Canadian Pacific extended its branch line through to Kaslo. The following eight years, including the period of the Great War, were the most prosperous the Slocan has seen, both in point of number of properties operating at one time and their aggregate production.

In his "Notes on the Mining Industry in Slocan District, B.C.," Cairnes states:

"For thirty-five years now the silver-lead and zinc deposits of the Slocan mining area have attracted widespread attention, both on account of the number and richness of the ore-shoots encountered and the success with which many of these have been worked. Up to the end of 1924 this area produced over 38,000,000 ounces of silver, nearly 300,000,000 pounds of lead, and nearly 122,000,000 pounds of zinc. The total value of this production is about $47,000,000. As compared with the total production of lode mines in British Columbia, this area of 280 square miles has, up to the end of 1924, produced over one-third of the silver, over one-fifth of the lead, and nearly one-quarter of the zinc. During this period of thirty-five years one hundred and forty odd properties have, at one time or another, shipped ore. Of these, many have long since been abandoned, others are being held as of potential value although little has been done on them for a number of years, and still others have been incorporated with other adjacent or nearby properties and have lost their original identity under new names and different managements. At the peak of its production in 1918, the area included thirty-six producing mines, of which nineteen shipped over 100 tons. The production for that year alone had a valuation of about $3,500,000. In 1924 there were twenty-six properties shipping from this area, and the aggregate value of their production was about $1,400,000. Last year saw a substantial increase on the year before, witnessed the opening up of a number of the older properties, and gave evidence of an increasing interest in the district, supported by a readier influx of capital, chiefly British, but including also some American. Isolated properties are being grouped together under capable management, and important developments are in progress or under consideration. So, taken by and large, prospects are a little brighter now than they have been for years.

Aside from the question of ore reserves, and sudden increases in production of certain properties due to finding new ore-shoots or taking out newly developed ground, the production and prosperity of the Slocan have been markedly influenced by two important factors, namely, the market price of its metals and improvements in the milling and metallurgical treatment of its ores. The fact that, after twenty years of production, the Slocan district could, in 1912, and for seven years thereafter, suddenly increase its output from a previous yearly average of 45,000 tons to over 180,000 tons, is, in my opinion, good evidence of the ability of the district to respond to the great demand for, and increased market price of, its metals during these years.

Regarding improvements in milling and metallurgical practice, it must be remembered that the ores of the Slocan are complex, most of its silver-lead deposits containing more or less zinc ores, which, until ten or fifteen years ago, was, in the case of most of the properties at least, regarded not only as of no value but as a positive detriment, because smelteries exacted a severe penalty in proportion to the amount of zinc present. Hand-sorted lead ores commonly contained an objectionable proportion of zinc, and methods of water concentration then in vogue eliminated it only at the expense of a serious loss of lead and of any high-grade silver minerals that might be present. As a consequence, many a property was forced to close down as developments encountered an increasing proportion of zinc ore for which, as such, there was no market in the early years.

The advance in milling practice in the last decade or more, including the wide use of flotation and preferential flotation, which enables the operator to separate zinc from lead ore with comparatively small loss; the high market price of spelter, combined with improvements in the metallurgical treatment of zinc ores; and the convenience of the Trail smeltery, have each and all had a marked effect on the development, production, and status of the Slocan.

The rise of the zinc industry affords an interesting chapter in the history of Slocan district. There the industry was practically contemporaneous with its origin in Colorado, from both of which localities the first shipments of zinc ore were made in 1899. Early shipments from the Slocan were chiefly from the Lucky Jim mine, but by the close of 1905 shipments of about 14,000 tons had been made from fifteen properties, of which the Slocan Star, Lucky Jim, Bosun, and Payne were the largest shippers. The Kansas smelteries, to which most of the Canadian zinc ore was sent in these early years of the industry, demanded a high-grade zinc product and paid little or nothing for included lead or silver content, as the treatment of zinc ore, at that time, for silver and lead, resulted either in severe losses of these metals or in a correspondingly high cost of treatment. Only for certain properties, such as the Lucky Jim, where high-grade zinc ore could be readily hand sorted, did the shipments offer any reasonable returns. Where the ore required milling, the methods of water concentration then in use could not eliminate an objectionable high proportion of the commonly associated spathic iron gangue, or of iron pyrites, thereby reducing the grade of the zinc concentrates below the profitable point.

Between 1905 and 1916, and largely as a result of improvements in milling methods, some 20,000 tons of metallic zinc were contained in shipments of zinc ores from the district, a large proportion of these shipments being in the form of concentrates.

It is in the last decade, however, when the price of spelter has been consistently high and properties in the Slocan have been able to take advantage of the big electrolytic-zinc plant of the Consolidated Mining and Smelting Company at Trail, that the zinc industry has reached an importance closely bordering on the returns from lead production. In this period shipments from the Slocan mining area have contained over 40,000 tons of metallic zinc.

This increasing importance of the zinc industry has affected mining operations in the district, as properties are now valued for their zinc as well as silver and lead, and those which formerly were regarded as worthless because of a comparatively high zinc content are today being reconsidered. Old dumps containing the discarded zinc ore are being re-treated for its extraction, and in one case a mill, with a capacity of 100 tons a day, has recently been installed in the valley of Kaslo creek to handle the large tonnage of zinc ore discarded from the Whitewater mine in its earlier years of operation.

The Slocan is now rated as an important producer of zinc as well as silver and lead ores. The relative importance of these three metals to date must not, however, be lost sight of. Nearly all the zinc ore shipped from the district has been produced by some thirty properties located within Slocan mining area. These include most of the larger shippers from the area and their aggregate production, on a basis of valuation, has so far included a much more important content of silver, and a considerably greater content of lead, than of zinc. Even if, in estimating the relative value of these three metals, we include only that production of silver and lead obtaining in years when zinc ore also was shipped, we find that the value of silver production for those years was much greater than, and that of lead somewhat in excess of, that of zinc. The Slocan, then, may still, and probably always will, be entitled to the epithet "silvery," although the value of zinc production in the future may exceed that of the lead.

The rocks of the Slocan district consist of sediments, volcanics, and intrusives. The oldest rocks form a series of schists, quartzite, and crystalline limestone forming a band along the west side of Kootenay lake. These are overlain by slate, limestone, and chert. None of these rocks contains fossils so far as is known, so their age is not definitely established. Schofield places them as Carboniferous or pre-Carboniferous. On these in turn rest flow and fragmental volcanic rocks with some intercalated sediments and some basic intrusive rocks. Younger still is the Slocan series consisting of quartzite, argillite, slate, and limestone. It is this series that contains the greater number of the ore deposits of this area. All these rocks are cut by granite, granodiorite, and quartz diorite, the source of the mineralizing solutions which produced the deposits.

All the formations except the intrusive rocks have a general north to northwesterly trend and prevailing southwesterly dip, complicated, particularly in those formations west of the belt of volcanic rocks, by strong folding in a northwesterly-southeasterly direction and by a remarkable tendency for the strata to be parallel with and dip away from the intrusive granitic bodies, thereby inducing considerable cross-folding with consequent basin- and dome-shaped structures.

No conclusive evidence of any important break or time interval was found in the series of formations that extend west from Kootenay lake to the top of the zone of volcanic rocks, but here it seems that some—although probably not a very considerable—time may have elapsed before deposition of the great series of rocks that extend from there west to Slocan lake and are known as the "Slocan series." Bearing on the age of this series a great number of fossil collections were made from limestone beds which are particularly abundant in a zone about 4 miles wide that lies west of the zone of volcanic rocks. A few collections were also made from the sedimentary formations east of this volcanic zone. These collections have all been referred to the Mesozoic era, although sufficient work has not yet been done on them to fix their age more closely. The granitic rocks, including those shown on the map and a host of minor porphyritic intrusives, intersect all members of the Slocan series and are probably of later Mesozoic age.

.. .. the mineral deposits of the area are mostly located in the Slocan series. This series comprises sediments ranging from limestone to fine conglomerate with intermediate limy, argillaceous, and sandy beds. They range from massive, blocky rocks to others which are notably fissile and slaty. I have sometimes heard the Slocan series referred to as the "Slocan slates"—an unfortunate term, as not only is a large proportion of the series composed of much more massive types, but the slaty formations of the series are undoubtedly the poorest in mineral deposits, and, with rare exceptions, the most treacherous in which to follow vein matter.

The Slocan series, as represented in this area, might be divided into four roughly parallel zones or belts characterized by an abundance of certain rock types. West of the zone of volcanic rocks there is, first of all, a belt up to half a mile or more in width composed almost entirely of black fissile slates. This belt is exceptionally poor in mineral deposits. Adjoining it to the southwest, and overlying it, is a zone with a maximum width of about 4 miles. This zone also contains a large proportion of slaty rocks, but is characterized by a great number of limestone beds varying up to 200 feet or more in thickness. Most of the fossil collections were made from these limestone beds. The zone has comparatively few mineral deposits, although a few important properties are located in it, their ore deposits being characteristically replacements of limestone along series of parallel cross fractures in the limestone. Such ore deposits occur at the Cork-Province, Lucky Jim, and Whitewater Deep properties. The third zone occupies a wide strip through the central portion of the Slocan series and includes the uppermost horizons in that series. It is abundantly mineralized and is characterized partly by a great variety of thinly interbedded rock types including sandy, argillaceous, and limy strata, but more particularly by the great number of associated porphyritic intrusives, most of which trend with the enclosing formations. These "porphyries", as they are generally called, are regarded as of extreme importance, probably not so much from a genetic as from a structural point of view. They have opened channels for rising metalliferous solutions; have bolstered up the ground much after the fashion of reinforcement in concrete, and have thereby preserved the lines of fissuring; and have provided strong confining walls for the ore deposits or furnished good hanging-walls for the mineral deposits to bank against. These minor intrusives are by no means confined to this third zone in the Slocan series, but are particularly characteristic of it and have afforded greater assistance to the formation of ore deposits here than elsewhere in the series. Among the more important properties in this third or "porphyry" zone are the Payne, Surprise, Last Chance, American Boy, Noble Five, Reco, McAllister, and Silver Glance mines. The fourth and broadest zone underlies the third but overlies the second zone, so the rocks composing it also outcrop elsewhere in the area occupied by the Slocan series, as between the second and third zones. They are also overlain within the limits of the fourth zone by rocks identical with those of the third or highest zone. The rock members of the fourth zone, however, are chiefly strong, massive types, including blocky argillites, quartzites, and feldspathic sandstones, all of which may be more or less limy. Some of the largest ore-shoots in the district have been discovered within this zone, including the Standard, Slocan-Star-Silversmith, Ruth-Hope, Queen Bess, Hewitt, Van Roi, and Bosun mines.

In the Slocan region there is a great thickness of folded and cross-folded sediments, invaded to the south by a great body of batholithic intrusives. The northern contact of this batholith apparently plunges at a low angle beneath the rocks of the Slocan series, and its presence at comparatively shallow depths beneath the area now occupied by this series is inferred from the occurrence of numerous, probably satellitic, granitic stocks which erosion has exposed. This great batholith was the source of the hot mineralizing solutions which, in rising towards the surface along fissures or other lines or zones of weakness, deposited their valuable metalliferous load. Since this period of metallization, erosion of a matter of several thousand feet of overlying rocks has exposed the underlying intrusives; has uncovered a great number of the ore deposits; and has, doubtless, swept many others away.

Mineralization is not confined to the members of the Slocan series, but is by all odds of most importance there. As might be expected, the granitic rocks, the source of metallization, also contain a number of valuable deposits, but these, as we shall see later, are mostly somewhat different from those in the sedimentary formations. However, comparatively few ore deposits of considerable size have been found in formations other than the Slocan series and the granitic intrusives. Nothing, for example, of particular account has yet been found in the great zone or belt of metamorphic rocks that borders the west shore of Kootenay lake. Farther south, however, in the Ainsworth mining camp, some important silver-lead deposits have been discovered in these rocks, although, as previously mentioned, they carry comparatively low silver values.

In the overlying belt of sediments, composed largely of slaty rocks, nothing in the line of mineral deposits has yet been found. The adjoining belt of volcanic rocks, however, is more important as a source of mineral wealth. It was in this belt that Jim Brennan in 1891 found rich silver-lead ore on his Ibex property, located just to the north of the area at the headquarters of Lyle creek. Other properties that were staked in the early years, and have since produced some excellent silver-lead ore, include the Beaver and Eureka groups. Another interesting feature of this belt is the variety of ore minerals that have been found in it. Placer gold is reported from Tenmile creek and other tributaries of Kaslo creek, and quartz veins heavily pyritized and carrying good values in gold have been discovered there. Important bodies of manganese ore carrying both the primary silicate of manganese, rhodonite, and the secondary oxide, pyrolusite, have been worked near Zwicky, and shipments of the oxide were made during the war period. At the headwaters of Kane creek, again, and in the same belt of rocks, is the Alps Alturas property, from which some shipments of antimony ore (stibnite) have been made.

The geology of this volcanic belt is extremely interesting. The belt has been variously called the "Kaslo volcanics" because of the abundance of volcanic rocks in it; the "Kaslo schists" because of the marked schistose character of wide portions of it; and also the "Greenstone belt" because of its predominantly greenish colour. As a matter of fact, none of these terms is entirely correct, as the belt is a complex in origin, structure, and colour of its constituent rocks. Its most abundant members are apparently volcanic, but these are intercalated with a minor proportion of sedimentary beds and the whole is invaded and partly digested by a large proportion of rather basic granitic rocks. In spite of the widespread evidence of mineralization, no large ore deposits have yet been found in this belt. This may be partly due to the extremely rugged topography and comparative inaccessibility of the belt, but it seems also the result of a rather sporadic distribution of the valuable minerals, due to the inability of fractures or fissures—offering access to mineralizing solutions—to persist through the comparatively structureless mass for any considerable distance either laterally or in depth.

The mineral deposits of the area may be classified in different ways. According to their mineral composition they fall conveniently into two groups, known as "wet" and "dry" ores. The dry ores include those deposits in which the vein matter is composed largely of quartz and includes only a minor proportion of lead and zinc mineral. Such deposits commonly have an important content of high-grade silver minerals and are worked primarily for this silver. They are mostly located either in the intrusive granitic rock or, if in other formations, adjacent to the granite contact. Typical dry ores occur in the McAllister, Silver Glance, Molly Hughes, Flint, and Mountain Con properties.

The "wet" ores are the predominating type in Slocan district. In these the vein filling, except for included fragments of the wall-rock, is largely lead or zinc minerals. The accompanying gangue forms a much smaller proportion of the vein matter than in the case of the dry ores, and it is commonly spathic iron (siderite).

In some of the wet-ore properties, calcite is the chief gangue mineral, and in many of the more important ore deposits varying proportions of all three gangue minerals—quartz, siderite, and calcite—may be found, their proportions apparently bearing some relation to depth and period of mineralization.

No hard and fast line can be drawn between these wet and dry ores, and no property necessarily produces all wet or all dry ore. There appears to be strong evidence of a zonal arrangement between the two types, both in developments at depth and laterally, with respect to the main batholithic contacts. In other words, as the ores approach the source of mineralization they tend to change in type from typical wet ores to others more characteristic of the dry-ore type, this change bearing relation to the temperature at which the ore minerals were deposited from solution. This implies that the mineral deposits of the dry-ore properties represent the roots of wet ores which once existed at higher points in the vein but which processes of erosion have swept away.

This consideration naturally leads to speculation as to what may be expected as development proceeds from the surface downward, and as to what are the possibilities for development at depth in the district, with special reference, of course, to Slocan mining area. Such speculations involve consideration of a number of facts, conditions, and inferences which a study of mining activities in the area have up to date brought to light. A number of questions present themselves, to which answers based on observation and experience in mining conditions in the Slocan may be applied.

In the first place, what processes have participated in the formation of the mineral deposits? There were two processes, the filling of fissures or zones of fracture and the replacement of the adjoining wall-rock, this replacement being most important in limestone beds or other notably limy strata. In the second place, have these veins any pronounced or general trend or do they run in any direction, and, if so, what is the relative importance of these directions? Experience has shown that the veins strike in all directions, but that they have a dominating northeast-southwest strike and southeasterly dip. Of the thirty-six properties in the area which, in the past, have shipped over 1,000 tons of ore each, the productive veins on nine strike almost exactly northeast-southwest. On twelve others the average strike is within 10 degrees of this direction, and of the remaining twelve only three have developed important veins leading into the opposite quadrants. These three exceptions and two other properties are also the only properties of the thirty-six on which the veins dip other than southeasterly. It appears that, other factors being at all equal, a vein striking northeasterly and dipping southeast has, at the outset of its development, a much better chance of becoming a paying proposition than an equally good looking vein striking or dipping in a contrary direction. This condition is capable of explanation of both regional and local significance. In the first place the dominant northeasterly-southwesterly trend of the fissures is also that of a master system of jointing characteristic not only of the Slocan district but of the entire province of British Columbia and, doubtless, of much greater areas. Under tension, it is reasonable to suppose that fissures would develop more readily along the lines of such joint fractures than across them. Again, these northeasterly-trending veins follow fissures in the true sense of the word in that they cut sharply across the formations and appear to afford straighter and more permanent channels for ore deposition than those which are more nearly parallel to the bedding planes. For it is along these planes that the more pronounced shearing has occurred and where fissures, in consequence, would be more easily destroyed. The importance of the northeasterly strike and southeasterly dip of the fissures may also be partly explained on the assumption that, as this trend is very nearly parallel to the main batholithic contact, and as the southeasterly dip is toward it, the planes of fissuring in this direction afforded a readier egress for mineralizing solutions from the batholithic granitic source than those that strike or dip in a contrary direction.

How far have the fissures in the Slocan been traced? Continuously, underground, in some cases for a mile or more and, on the surface, over several miles. Vertically, several properties have developed their veins over a thousand feet below the outcrop, while on the mountain slopes the stronger fissures or zones of shearing have been traced, with considerable confidence in their continuity, over a range of several thousand feet.

And how do the ore deposits occur in these fissures? It might be supposed that the ore minerals were distributed more or less evenly along the veins, but such is far from being the case. The ore deposits of the Slocan are typically concentrated in shoots, lenses, or pockets, dispersed at irregular intervals along the vein with much barren vein matter between. Commonly a property achieves a reputation on the proceeds from one big ore-shoot, and although smaller ore-shoots may be found close to this, their aggregate production is usually much smaller. Only in exceptional cases, and that after prospecting a long interval of more or less barren vein matter, has a second bonanza ore-shoot been discovered on the same fissure.

It has been common experience in the Slocan to find the richest concentration of lead ore towards the top or along the hanging-wall of ore-shoots, with the percentage of zinc ore increasing at depth. Still farther down spathic gangue may increase at the expense of the zinc, and finally the proportion of quartz increases to the exclusion of most of the other minerals, and the vein matter, as before mentioned, gradually assumes the character of a "dry" ore.

This condition, which represents the normal sequence of ore deposition, is best exemplified in those fissure-vein deposits in which there is evidence of only one period of ore deposition, and is characteristic of the smaller vein deposits in the area. In almost all of the larger veins there is, on the other hand, distinct evidence of strong brecciation of the vein matter and indications of a second or even further incursions of mineral matter into this brecciated material. As a consequence, there may result a successive overlap of ore minerals in which, for example, quartz of the first period of deposition may be associated with lead ore of the second. So, while it may be laid down as something of a rule that in the smaller, more massive vein deposits a second shoot of lead ore is not likely to be found below the first, this rule does not apply in the case of the wider, more brecciated veins.

The deeper developments in the Slocan, extending to a thousand or more feet below the outcrop, have, on a number of properties, shown good lead and zinc ore, while fissures or fissured zones have been traced on the surface over a vertical range of several thousand feet. Equally good ore-shoots have been found on the lower as well as the higher slopes of the hills, and as only the surface has, comparatively speaking, yet been prospected, the possibilities at depth are still relatively large.

The structure and composition of the wall-rock have had much to do with the size of the ore-shoots and their continuity, both laterally and in depth. Attention has already been called to the importance of limestone beds, or other notably limy strata, in the matter of replacement by mineralizing solutions. Generally speaking, too, the fissures are best developed in the more blocky ground, which is the more able to preserve the lines of fractures, and presents firm retaining walls within which ore minerals may be concentrated. Rarely does a fissure persist far into a belt of slaty rocks without serious disruption.

Another extremely important consideration, and one directly related to this tendency of the ore deposits to favour certain character of ground and to be negligibly represented in adjoining ground of another character, must be taken in conjunction with the known presence of an abundance of parallel or nearly parallel fractures or fissures throughout the metallized sections. This association of both favourable ground and the presence of parallel fissures running across it suggest the occurrence of ore zones or potential ore zones, or belts striking more or less at right angles to the course of the veins, and, therefore, presenting possibilities for future development wherever such veins cross them. Bearing on the possibilities of such a relation between fissures and potential ore zones, the occurrence of which seems well demonstrated on certain properties, and groups of properties, it seems to me advisable that property holders should pay particular attention to the character of the ground close to their main ore-shoots, and, instead, of spending so much time and money in trying to pick up or follow their vein where it passes into unfavourable country, should first search diligently for other veins parallel or nearly parallel to their main vein and prospect them at points where they pass through ground similar to that in which their main ore-shoot occurs.

It is discouraging for an operator, after realizing a fair profit from the proceeds of one ore-shoot, to lose it all in an endeavour to find another, and yet this is a condition to which the operator in the Slocan is constantly liable. One of the greatest, if not the greatest, of the handicaps under which this area and the district in general labours is the appalling amount of dead work that has been done and is being done in comparison with the relatively small amount of pay ground that has been discovered. Were it not that the grade of the ores in the Slocan mining area is exceptionally high few of the properties could, for this reason, have paid their way.

The area, too, is handicapped by a comparative lack of reserves. Only on exceptional properties and at exceptional periods in their development have operators been able to "see" ahead for any considerable period of time. Development is rarely kept far ahead of production. Properties are, consequently, purchased on option and on the strength of their past record rather than on the tonnage of ore in sight.

In this area, again, the surface has been rather carefully prospected and most of the outcropping ore-bodies worked out, so that developments of the future must be developments at depth with all its attendant chances and speculative elements. Such development requires boldness alloyed with a strong measure of caution. It requires capital. It requires a knowledge of geological conditions as applied to the particular ore-bodies, and it requires an intelligent and efficient management."

Slocan Mining Division[1]

(Totals of Tonnages and Contents from 1874 to 1926 Inclusive)

Mine	Tons	Period of production (not necessarily continuous)	Gold	Silver	Copper	Lead	Zinc
			Ozs.	Ozs.	Lbs.	Lbs.	Lbs.
Adam group	11	1907	—	1,068	—	10,742	—
Alamo	64	1926	1	2,395	—	3,487	25,981
Alpha Grady group	2,205	1894–95, 1926	—	236,432	—	2,641,947	—
American Boy	4,066	1896–1923	—	265,787	—	2,873,971	9,728
Antoine	1,300	1895–1926	—	256,514	—	1,240,815	3,900
Apex	170	1912–1926	15	16,727	—	9,584	—
Best	52	1918	—	4,960	—	17,000	—
Black Colt	208	1919–1926	—	12,345	—	153,618	28,894
Black Grouse	23	1915–1917	1	2,612	—	—	—
Blue Bird	925	1892–1905	—	118,261	—	1,252,699	—
Bob Fraction	26	1904–1905	—	3,634	—	—	—
Bosun	64,697	1898–1926	32	1,344,081	—	6,775,112	3,806,294
Buck Fraction	3	1914	—	168	—	847	—
Buffalo	94	1905–7, 1915, 1924	—	11,578	—	45,218	8,970
Caledonia	24	—	—	1,350	—	19,200	—
California and Clipper	343	1898–1907	—	30,307	—	355,043	—
Canadian	573	1904–1926	8	42,082	—	392,423	—
Capello	155	1901–3, 1919	38	71,154	—	—	—
Carnation	119	1895. 1922, 1926	1	7,553	—	169,212	—
Chambers	26	1896, 1921	—	2,513	—	36,416	—
Cinderella	236	1904–1924	—	17,626	—	314,904	—
Colonial	230	1906–7, 1913–14, 1926	—	12,912	—	193,499	—
Comstock	342	1904–1920	1	34,214	—	367,273	—
Corinth	47	1906, 1925	—	2,088	—	51.153	—
Daniel	18	1917	—	158	—	—	13,868
Dardanelles	631	1892–1902	—	135,236	—	308,672	—
Dora	2	1926	—	479	—	2,611	—
Dougherty	7	1926	—	432	—	8,820	—
Early Bird	2	1908	—	248	—	3.226	—
Echo	801	1917–1926	1	63,717	—	506,036	221,904
Edison	15	1904	8	—	—	—	—
Elkhorn	67	1907–8, 1916, 1923	—	4,461	—	77,768	..
Emily Edith	886	1898–1907	—	10,281	—	185,828	—
Empire	1	1904	—	154	—	1,215	—
Evening and Jennie	16	1913, 1914	—	1,824	—	5,198	—
Fisher Maiden	636	1894–1910	—	60,004	—	85,234	—

Forget	1	1907	—	52	—	90	—
Freddy Lee	817	1892–93, 1917–21	3	87,128	—	963,934	—
Galena Farm	58,187	1915–1926	1	375,647	—	4,607,231	5,638,855
Gem	59	1917–1923	—	4,764	—	84,828	—
Golden	1	1905	6	—	—	—	—
Goodenough	403	1895–1905	—	71,600	—	28,960	—
Grey Copper	37	1917	—	2,960	—	37,000	—
Hartney	264	1901–1917	—	15,704	—	169,878	—
Hewitt and Lorna Doone	93,117	1900–1926	9	1,282,472	—	1,885,132	3,292,296
Home Rule	2	1915	—	148	—	2,252	—
Idaho-Alamo	24,705	1893–1922	2?	1,100,302	2,861	2,833,233	354,646
Ivanhoe	19,722	1895–1921	—	444,138	—	5,081,853	74,415
Jenny Lind	30	1895	—	6,000	—	36,000	—
Jo Jo	104	1904–1924	2	16,569	—	19,676	—
Last Chance	4,721	1895–1922	—	586,727	—	4,533,940	—
Lone Batchelor	1,068	1905–1923	25	117,570	—	927,038	21,427
Lorna Doone	341	1903–1906	—	45,682	—	27,185	—
Lucky Jim	66,169	1903–1926	36	121,784	—	1,816,408	22,291,469
Lucky Thought	8,129	1914–1925	6	112,426	—	613,564	238,379?
Madison	20	1898	—	—	—	—	—
Majestic and Unexpected	241	1904–1922	—	14,546	—	322,339	—
Mammoth	47	1925–1926	—	3,276	—	9,380	10,347
Margaret	4	1913	—	309	—	590	—
Marion	52	1899, 1905, 1909	—	6,009	—	53,941	—
Mascot	1	1913	—	52	—	612	—
McAllister	6,818	1903–1926	1	337,054	—	5,054	—
Mercury	193	1902–1906, 1925	—	32,205	—	146,595	—
Metallic	94	1909, 1922–1926	1	6,515	—	22,931	4,185
Miller Creek	68	1897–1903	—	7,484	—	79,342	—
Miner Boy	3	1893	—	1,185	—	—	—
Molly Hughes	1,494	1899–1926	428	163,064	—	5,592	—
Monitor and Ajax	3,743	1895–1926	882	347,679	—	2,427,196	369,341
Monte Christo	7	1907	—	364	—	7,615	—
Mountain Boomer	150	1893, 1906	—	14,590	—	22,294	—
Mountain Chief	1,976	1893–96, 1922–26	5	302,707	—	2,821,161	63,497
Mountain Con	484	1899–1922	11	112,609	—	281,600	—
Mowich	92	1902–1925	26	10,139	—	—	—
Native Silver Bell	106	1898–1899	—	20,896	—	140,320	—
Noble Five	1,900	1893–1926	—	190,154	—	1,834,607	419,213
Noonday	971	1894–1923	1	91,218	—	612,195	4,980
Number One	405	1916–1925	—	26,723	—	429,647	—
Ocean	3	1919	—	315	—	3,659	—
Omega	18	1904–5, 1919	—	1,364	—	20,709	—
Payne	91,586	1891–1922	—	688,519	—	7,035,416	—
Queen Bess	18,771	1893–1926	15	1,432,137	—	18,590,443	10,901
Queen Dominion	86	1905–1908	2	9,382	—	102,562	—
Rambler Cariboo	157,046	1895–1926	2	3,116,709	—	21,878,865	4,028,300

[1] Returns in many cases incomplete.

Slocan Mining Division—Continued

Mine	Tons	Period of production (not necessarily continuous)	Gold	Silver	Copper	Lead	Zinc
			Ozs.	Ozs.	Lbs.	Lbs.	Lbs.
Read and Tenderfoot	38	1906	—	3,686	—	33,440	—
Reco	6,716	1893–1919	—	1,055,904	—	6,002,697	55,946
Red Fox	557	1901–1906	—	110,904	—	508,446	—
Redress	8	1920–1921	—	1,900	—	9,620	—
R. E. Lee	247	1895–1906	—	30,213	—	336,820	—
Richmond Eureka	15,146	1896, 1907–26	2	717,885	—	4,544,089	—
Rio	78	1903–1915	—	20,821	181	56,178?	—
Rockland	331	1899 no contents given	—	8,455	—	40,988	—
Ruby Silver	40	1896–1908	—	—	—	—	—
Ruth	23,903	1895–1926	34	1,176,897	—	2,828,207	279,124
Sapphire	128	1899	—	13,300	—	149,500	—
Silver Bell	209	1901–1909	9	17,505	—	235,875	—
Silver Glance	7	1892, 1920	—	376	—	—	—
Silverite	49	1919	—	3,298	—	57,693	—
Silver Nugget	2	1907, 1908	—	454	—	47	—
Silversmith	321,321	1893–1926	1,048	6,798,493	—	67,350,622	14,792,673
Slocan Boy	381	1895–1905	—	44,188	—	491,246	—
Slocan Sovereign	4,472	1898–1926	1	81,700	—	1,222,474	—
Soho	163	1901–2, 1922	—	6,720	—	80,436	—
Standard	373,682	1905–1926	—	6,120,259	—	68,323,561	51,461,429
St. Keverne	16	1902, 1905	—	2,300	—	25,097	—
Sunset	1,869	1902–1911	—	234,448	—	2,559,289	—
Surprise	49,506	1893–1926	3	1,910,349	—	1,521,120	7,756,897
Swansea	6	1905	—	2	—	1,641	—
Trade Dollar	102	1926	—	1,461	—	2,798	81,980
Treasury Vault	20	1898	—	—	—	—	—
Twilight	66	1911, 1912	—	4,319	—	65,557	—
Van Roi	261,992	1893–1926	39	2,160,105	—	13,869,189	10,264,395
Victor	187	1923–1926	10	45,273	—	177,760	—
Victoria	2	1917	—	60	—	1,695	—
Vr ture	583	1899, 1905	—	52,133	—	810,868	—
Wakefield	5,779	1903–1919	—	36,200	—	849,083	—
Washington	8,470	1893–1925	—	426,421	—	4,230,298	—
Wilmer	2	1901	—	197	—	—	—
Wonderful	24,396	1895–1925	171	258,258	—	2,386,082	1,012,648
Yakima	107	1894–1916	—	8,756	—	118,558	—
Total	1,743,858	—	2,887	35,458,472	—	287,512,612	126,646,882

Slocan City Mining Division[1]

(Totals of Tonnages and Contents from 1874 to 1926 Inclusive)

Mine	Tons	Period of production (not necessarily continuous)	Gold	Silver	Copper	Lead	Zinc	Location
			Ozs.	Ozs.	Lbs.	Lbs.	Lbs.	
Alberta	17	1898-1904	21	1,314	—	—	—	Slocan City
Alice S.	16	1915	—	1,324	—	4,899	—	
Anna	128	1912-1925	—	26,322	242	2,400	—	
Arlington	12,795	1897-1922	—	749,819	—	1,227,019	—	
Black Prince	1,608	1899-1922	—	250,493	—	139,361	—	
Bondholder	72	1900-1904	—	7,188	—	4,855	—	
Chapleau	194	1896-1901	929	10,529	—	—	—	
Club	5	1904	2	269	—	—	—	
Cripple Stick	11	1903-1904	1	214	—	—	—	
Colorado	27	1904, 1905, 1915	—	4,223	—	—	—	
Dayton	12	1903	—	16	—	2,218	—	
Duplex	6	1902	7	520	—	—	—	
Eastmont (Westmont)	1,938	1907-1919	58	322,724	—	349,635	—	
Enterprise	7,739	1896-1926	—	840,347	—	2,735,875	430,083	
Exchange	5	1896	5	750	—	—	—	
Evening Star	24	1896-1918	30	8,737	—	—	—	
Graphic Rosebud	6	1905-1906	—	1,531	—	1,402	—	
Hamilton	36	1903-1915	3	3,707	—	4,234	—	
Hampton	92	1900-1922	—	47,588	—	2,663	—	
Happy Medium	13	1905-1906	44	1,944	—	2,230	—	
Highland Light and Victor	11	1904, 1906, 1918	—	2,842	—	—	—	
Howard Fraction	19	1895-1896	17	3,613	—	—	—	
Ibex	10	1906	—	901	—	15,965	—	
Kalispell	16	1896-1897	—	3,848	—	—	—	
Kilo	1,494	1897-1913	595	346	—	—	—	
Kimberley	6	1906	4	287	—	—	—	
Lily B.	38	1913, 1918, 1922	—	2,645	—	10,941	—	
L.T. (Little Tim)	61	1918-1925	—	11,288	—	16,797	—	
Meteor	431	1897-1923	236	102,460	—	—	—	
Midnight	22	1906-1907	14	1,396	—	—	—	
Myrtle	13	1907	1,405	—	—	—	—	
Ottawa	6,191	1903-1926	3	763,905	—	750,540	—	

[1] Returns in many cases incomplete.

Slocan City Mining Division—Continued

Mine	Tons	Period of production (not necessarily continuous)	Gold	Silver	Copper	Lead	Zinc	Location
			Ozs.	Ozs.	Lbs.	Lbs.	Lbs.	
Pay Day	7	1909	—	810	—	2,356	—	
Paystreak	14	1897, 1902	20	615	—	—	—	
Peg Leg (Neepawa)	250	1904–1925	—	55,092	—	19,723	4,720	
Port Hope	11	1904	8	1,966	—	—	—	
Republic	164	1902–1920	76	12,030	—	—	—	
Sapphire	41	1903–1904	33	1,680	—	—	—	
Slocan Bob	1	1896	—	—	—	—	—	
Slocan Chief	4	1900–1923–24	—	576	—	1,047	—	
Speculator	11	1901	—	521	—	12,099	—	
Tamarack	117	1899–1907	—	11,839	—	18,718	—	
Two Friends	125	1896–97, 1900	—	29,000	—	125,000	—	
V and M	12	1901	4	693	—	—	—	
Totals	33,800		3,515	3,287,912	—	5,449,977	434,803	

Ainsworth Mining Division[1]

(Totals of Tonnages and Contents from 1874 to 1926 Inclusive)

Mine	Tons	Period of production (not necessarily continuous)	Gold	Silver	Copper	Lead	Zinc
			Ozs.	Ozs.	Lbs.	Lbs.	Lbs.
Albion	133	1917, 1924–25	—	2,616	—	120,062	14,209
Alpine	4	1915	—	62	—	3,810	—
Ayesha	10	1911	—	500	—	24,000	—
Baltimore	54	1902–1907	1	11,146	—	11,925	—
Bell	1,739	1901, 1916-18	—	83,623	—	32,161	2,356,022
Bismark	1,063	1900–1910	—	108,109	1	318,902	—
Black Bear	5	1922	—	60	—	2,082	—
Blue Bell	501,436	1906–1926	—	631,709	—	46,239,164	—
B.N.A.	3	1909	—	495	—	1,043	—
Bon Ton	13	1917–1919	—	2,765	—	5,897	—
Budweiser	75	1895	—	15,000	—	75,000	—
Caledonia	11	1914, 1921–24	—	761	—	10,267	—
California	3	1896	—	450	—	2,220	—
Charleston	145	1902–1926	4	21,234	—	62,951	38,987
Comfort	500	1916	—	2,500	—	250,000	—
Comstock Virginia	5	1809	—	500	—	6,000	—
Cork-Province	58,715	1903–1926	—	208,051	—	5,545,719	1,045,367
Crescent	28	1916	—	1,100	—	28,000	—
Daybreak	19	1926	—	576	—	15,538	—
Dellie	32	1889, 1895	—	4,320	—	—	—
Early Bird	151	1914–1916	—	1,464	—	130,045	—
Echo	14	1903	—	1,676	—	17,230	—
Emerald Hill	4	1907	—	969	—	2,558	—
Empress	115	1903–1909	3	28,257	—	—	—
Eureka	–	1897	—	—	—	—	—
Fergus	8	1907	—	158	—	6,822	—
Firebrand	16	1924	—	1,832	—	3,460	—
Flint	316	1905–1917	—	10,874	—	139,434	—
Florence	74,781	1912–1924	—	129,047	—	9,755,604	—
Gallagher	230	1889–1919	4	17,615	—	31,863	—
Gibson	14	1895, 1897	—	1,022	—	21,840	—
Glengarry	1		—	—	—	—	—
Gold Cure	20	1909	—	2,000	—	20,000	—
Grant	12	1901–1921	—	4,487	—	1,285	—
Hardie	4	1919	—	215	—	4,824	—
Helena	6	1915	—	1,069	—	7,322	—
Hidden Treasure	5	1896	—	750	—	3,700	—

[1]Returns in many cases incomplete.

Ainsworth Mining Division—Continued

Mine	Tons	Period of production (not necessarily continuous)	Gold	Silver	Copper	Lead	Zinc
			Ozs.	Ozs.	Lbs.	Lbs.	Lbs.
Highland	90,861	1890–1925	1	314,266	—	18,931,296	—
Highlander	17	1895–1896	—	1,590	—	1,200	—
Hillside	—	1900	—	—	—	—	—
Index	11	1909, 1920	—	936	—	15,419	—
Jackson	375	1898	—	75,000	—	450,000	—
Jeanette	11	1926	—	90	—	9,924	—
Jessie Bluebird	172	1907–1921	1	50,947	—	31,207	—
Keno	3	1921	—	150	—	3,000	—
King Solomon	5	1894	—	800	—	4,000	—
Kirby	9	1920	—	243	—	3,919	—
Krao	1,442	1889, 1905-23	—	112,084	—	354,262	—
Lady of the Lake	7	1895	—	700	—	8,400	—
Lake Shore	14	1926	—	106	—	11,801	—
Lavina	99	1900–1902, 1918	—	6,308	—	182,753	—
Libby	12	1907	—	186	—	11,895	—
Liberty Hill	5	1899, 1923, 1925	—	295	—	6,253	—
Lilly May	12	1895	—	1,920	—	—	—
Lincoln	55	1918, 1922	—	2,641	—	57,867	—
Little Donald	625	1889–1908	—	20,112	—	531,530	—
Little Mamie	11	1894, 1921	—	550	—	11,000	—
Little Phil	267	1895, 1917–20	—	5,256	—	262,721	—
London Hill	60	1893–96, 1902, 1912	—	9,694	—	—	—
Lucky Boy	20	1894	—	—	—	—	—
Maestro	2,358	1907–1923	—	36,542	—	1,737,827	—
Martin	59	1915-16, 1924	—	3,268	—	62,582	—
Metals Recovery	16,848	1925–1926	—	38,588	—	9,789	634,870
Mile Point	55	1895–1896	—	4,015	—	11,000	—
Minnie	1	1917	—	60	—	370	—
Mohawk	6	1918–1921	—	926	—	7,213	—
Montezuma	3,362	1899–1918	—	44,976	—	1,088,223	43,343
Mount Vernon	7	1901	—	345	—	1,130	—
Neosho	11	1922	—	411	—	804	—
New Jerusalem	19	1907	—	346	—	19,296	—
Nicollett	10	1916	—	400	—	10,000	—
Northern Belle (Jackson)	1,203	1895–1905	—	64,246	—	839,748	—
No. 1	38,683	1889–1924	237	1,919,102	—	284,964	—
Old Gold	28	1899, 1907, 1916	—	2,535	—	10,245	—

Old Timer	1	1899	—	72	—	—	—
Panama	380	1909–1916	—	47,981	—	4,138	—
Pontiac, Tecumseh	1,368	1898–1905	299	21,221	—	163,282	—
Rainbow	456	1924–1926	1	133	—	1,729	—
Revenue	67	1913–1916	—	5,124	—	72,719	—
Ruth	906	1919–1921	—	10,737	—	—	—
Sailor Boy	8	1923	—	505	—	11,200	—
Silver Bear	108	1919–1923	—	17,206	—	16,131	—
Silver Bell	499	1898–1925	—	72,301	—	173,693	—
Silver Glance	242	1901–1908	6	39,273	—	57	—
Silver Hill	1,663	1901–2, 1917, 1926	—	59,972	58	303,334	—
Silver Hoard	1,967	1883, 1912-1926	—	113,732	—	137,296	4,275
Silver King	3	1916	—	600	—	1,000	—
Silver Queen	26	1917	1	1,870	—	30,439	—
Skyline	3,027	1889–1921	—	218,148	—	4,627	—
Soho	90		—	900	—	64,000	—
Spokane Trinket	2,071	1899–1924	—	39,959	—	2,361,111	—
St. Patrick	21	1919	—	650	—	15,660	10,880
Sun	34	1917	—	2,720	—	27,200	—
Sunset (near Whitewater mine)	52	1901	—	8,318	—	27,607	—
Sunset (Woodbury creek)	60	1909	—	6,000	—	60,000	—
Sunset and Bell	19	1918	—	900	—	13	—
Surprise	125	1893–1894	229	27,900	—	—	—
Surprise (Howser creek)	59	1923	—	3,810	638	—	—
Tam O'Shanter	94	1918–1920	—	1,664	—	—	—
Tariff	320	1896–99, 1918–26	—	5,331	—	236,765	—
Ten Day Man	16	1919	—	2,595	—	21,707	—
True Blue	64	1902	1	109	9,479	—	—
United	837	1906–1924	3	2,754	—	163,164	—
U.S.	180	1913–1914	—	—	—	—	188,800
Utica	5,564	1909–1923	3	716,189	—	1,660,654	247,167
Violet	4	1921	—	1,049	—	1,068	—
Wellington	666	1892–1915	—	111,900	—	447,557	—
Whitewater	96,437	1892–1926	761	3,027,886	—	22,090,253	4,827,905
	913,867		1,555	8,586,155	10,176	115,968,770	8,411,825

(36) Lardeau and Trout Lake Mining Divisions

Deposits similar to those mined in Slocan region occur in Lardeau and Trout Lake mining divisions. Development work has been carried out on a large number of properties in the past and recently renewed interest has been taken in the region and a number of properties developed. The ores are of silver-lead and zinc carrying a small gold value, and gold-bearing quartz carrying a very small quantity of sulphides. The deposits are related to intrusives of Mesozoic or post-Mesozoic age. They were formed in fissure veins, cross fractures, stockworks, chimneys, and through the replacement of limestones cut by fissures along which the ore-bearing solutions travelled.

Properties on which work has been carried out in recent years include the Paymaster, Multiplex, Teddy Glacier, Lead Star, Eclipse, etc., in Lardeau mining division, and Zinc Fissure, Cromwell, Mohican, Surprise, Molly Mae, Abbot, Magnet, and others in Trout Lake mining division.

(37) Nelson Mining Division

In Nelson mining division are a large number of properties carrying lead and zinc minerals, and during recent years there has been considerable activity in developing properties in a number of districts including Ymir, Sheep Creek, Pend d'Oreille, and other camps. In Ymir district the deposits are chiefly veins carrying auriferous pyrite, and sphalerite and galena. In the Sheep Creek camp and the region to the south of Salmo, the deposits are of two types, gold-bearing quartz veins and zinc-lead replacement deposits in limestone. Deposits of the latter type occur also in the Pend d'Oreille section.

Yankee Girl

References

Drysdale, C. W.: Geol. Surv., Canada, Mem. 94, p. 112.
O'Grady, B. T.: Ann. Repts., Minister of Mines, B.C.: 1926, p. 275; 1927, p. 297.

The Yankee Girl is situated about 2 miles by road from Ymir on the eastern side of Salmo River valley. The elevation of the lower tunnel is a little over 1,200 feet above the railway at Ymir. The property is primarily a gold producer and was reopened in 1926 after having been idle since 1920.

The rocks on the property consist of Pend d'Oreille schists of Palæozoic (post-Cambrian) age, cut by granitic tongues from the Nelson batholith. Cutting diagonally across the strike of the schists there is a zone of fracturing, forming vein systems rather than simple veins. The ore is found in the various fractures and in some cases between them. The general strike of the veins is northeast by east with steep northwesterly dips. The ore-bodies are localized at or near acute-angled intersections of the fissure veins with the granitic tongues, the rake of the ore-shoots being apparently nearly vertical. The ore consists of auriferous pyrite, accompanied by galena and zinc blende in a gangue of quartz and altered wall-rock.

The Yankee Girl fissure, on which most of the work has been done, includes a hanging-wall vein and a foot-wall vein which are up to 20 feet apart but which sometimes come together locally, forming wide ore-bodies. A small amount of work has been done on spur veins that branch off from the Yankee Girl vein and on the Lakeview vein which cuts the Yankee Girl vein at an acute angle. Over 2½ miles of underground workings have been opened up. There are three main ore-shoots known respectively as the Hobson, McDowell, and Yukon. The bulk of the total production of the mine, amounting to 71,126 tons up to 1927, has gone to smelters as silver-lead ore, but since late in 1926 most of the tonnage has been shipped to the flotation mill at Trail. The average gross value of all shipped to the end of 1927 is estimated at between $15 and $18 a ton.

Recent work has developed 125,000 tons of ore and 500,000 tons of probable ore.

Goodenough

References

Drysdale, C. W.: Geol. Surv., Canada, Mem. 94, p. 95.
O'Grady, B. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 301.

The Goodenough property is situated on the northwestern side of Ymir creek about 4½ miles from Ymir. The property was staked in 1898.

O'Grady states:

"The ore consists of auriferous pyrite accompanied by zinc blende and galena in a highly siliceous gangue, the principal values being in gold. The formation is composed of Pend d'Oreille schists intruded by granitic tongues from the Nelson batholith. Cutting diagonally across the country-rocks, the fissure-veins strike northeasterly, with steep dips to the northwest. The original shallow surface workings indicated two distinct veins, about 90 feet apart, which converged towards the southwest.

In the underground workings, however, there appears to be a shear-zone 30 to 40 feet wide, in which numerous cross-veins branch out at intervals from the two main quartz-filled fractures which are situated on the hanging and foot-wall sides of the shear-zone. Granite is in evidence at numerous points in the two tunnels and the better-grade ore-shoots are apparently localized at or near the granitic intersections. Faulting in the plane of the vein has taken place on more than one occasion as evidenced by various fractures and gouge zones, offsetting of dykes, slickensides, and the elongated, lenticular shape of the ore-shoots.

At least four ore-shoots, from 40 to 100 feet long, are indicated in the underground workings and another shoot may possibly be developed when the workings reach the expected downward continuation of ore said to be exposed in one of the two shafts on the surface which are caved and inaccessible. . . . . .

The lenticular ore-bodies, which vary in width from a few inches to 7 feet, are intersected by numerous faults, generally causing small offsets. Movement on the east of the faults has been to the northward. Lamprophyre dykes interrupt the continuity of the mineralization in places, but their influence is only local and the veins are not materially affected. The only appreciable throw is caused by a fault which has displaced the western part of the veins in the tunnels.

Development work consists of surface cuts, two shafts, and three tunnels.

Up to the end of 1927 shipments amounted to 1,306 dry tons, which netted $23,413.68 after paying freight and treatment. The total metal content of this ore was as follows: gold, 923 ounces; silver, 6,523 ounces; lead, 86,500; zinc, 88,945."

Hunter V

Reference

O'Grady, B. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 303.

The Hunter V, owned by the Consolidated Mining and Smelting Company, is in Ymir district, on the divide between Porcupine and Hidden creeks, at an elevation of 5,700 feet, and is reached by means of a switchback trail from the Porcupine wagon-road.

The deposits consist of replacements of limestone in which the fine-grained sulphides, galena, sphalerite, and pyrite, carrying values in silver and a little gold, occur disseminated in a carbonate gangue. Occasional native silver is found in small flakes. The limestone, which is limited on the east and west by belts of Nelson granite, belongs to the Pend d'Oreille group and has a general north trend. The deposits, which are low grade and fluctuate considerably in value, are chiefly valuable for fluxing purposes.

Porcupine

References

O'Grady, B. T.: Ann. Repts., Minister of Mines, B.C.: 1925, p. 249; 1926, p. 276.

The Porcupine is in Ymir district, on the southern side of Porcupine creek, about 1½ miles by road from the railroad. It is the oldest claim in the immediate district, having been staked in 1895. Work was carried out on it during 1925 and 1926.

O'Grady reports:

"The area covered by the claims is underlain by rocks of the Pend d'Oreille group, which have been intruded by granitic tongues of the Nelson batholith. The ore deposition occurs in the zone of contact between the igneous and sedimentary rocks. Several open-cuts have exposed promising showings, but not enough work has been done to establish their relation to one another or to throw much light on the continuity of the ore in any one direction. The geology is decidedly complex.

The ore is a mixture of galena, zinc blende, and pyrite in a siliceous gangue. Samples from a few sacks of sorted ore taken from the open-cuts gave the following average values: gold, 0·09 ounce; silver, 14·4 ounces to the ton; lead, 18·9 per cent; zinc, 2·4 per cent."

Dewey

References

O'Grady, B.T.: Ann. Repts., Minister of Mines, B.C.: 1926, p. 276; 1927, p. 303.

The Dewey property, consisting of four claims, is situated on the northern side of Porcupine creek about a mile from the Great Northern railway. The property is owned by the Chloride Mining and Milling Company, of Waverley, Washington.

The rocks on the property are metamorphosed sediments of the Pend d'Oreille group near the contact with the Nelson granite, which lies a short distance to the east. The ore, which consists of disseminated sulphides of iron, lead, and zinc with occasional copper sulphides, occurs in a silicified band of altered limestone. In the workings the width of the mineralization is from 3 to 4 feet.

Howard

References

O'Grady, B. T.; Ann. Repts., Minister of Mines, B.C.: 1926, p. 276; 1927, p. 303.

The Howard group is situated on the eastern slope of the south fork of Porcupine creek at a distance of 6 miles by road from the Great Northern railway at Porcupine siding. The elevation of the lower tunnel and mine cabins is 5,383 feet, or about 3,000 feet above the railway. The property was formerly known as the Union Jack group, and was worked in 1902.

The rocks of the region consist of schists, quartzites, and argillites, intruded by tongues and stocks of the Nelson granite batholith.

On the Prince Charlie claim the old workings were on two well-defined quartz veins in granite, the mineralization consisting largely of pyrite carrying gold values. On the Howard claim to the southeast, work was also carried out, in the form of trenches, open-cuts, a shaft, and two tunnels, on two parallel veins, about 30 feet apart, striking northeasterly. In 1927 work consisting of crosscutting in the old upper and lower tunnels opened up replacement ore in quartzite running at right angles to the fissure veins. The ore consists of pyrite, pyrrhotite, galena, and zinc blende with occasional chalcopyrite.

Alice

References

Robertson, W. F.: Ann. Rept., Minister of Mines, B.C., 1904, p. 133.
Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1925, p. 249.

Langley reports:

"This group, consisting of three claims, the Alice, Alice Fraction, and Morning Star, is situated on the Crow's Nest branch of the Canadian Pacific railway at a distance of 2 miles north of Creston and at an elevation of about 1,500 feet above the railway. The property was previously operated some twenty years ago when an aerial tramway and concentrator were erected; milling was started in September, 1904, and continued through 1905, since which time there is no record in the Annual Reports of continuous operations. The old mill is now dismantled and the tramway no longer exists. During the year the property was acquired by the Porcupine Goldfield Development and Finance Company under the terms of a lease and bond. The old upper workings, which were inaccessible when the property was visited in June, are described in the Annual Report for 1904.

Surface work during the early part of the year disclosed a quartz vein lying apparently 80 feet to the west of the vein already developed. This vein was well mineralized in places with galena and the exposures appeared sufficiently promising to warrant further exploration at depth, so it was decided to explore its downward continuation by crosscutting from the lowest of the old workings, situated at about 180 feet farther down the hill. Several old open-cuts and a shallow shaft bear evidence that this occurrence was not unknown in earlier days. The lowest level of the old workings consists of a 500-foot crosscut from the surface and a considerable amount of drifting. The vein, having a width of about 4 feet, cuts a slate and quartzite formation, of which foldings and slips are a pronounced feature of the structural conditions. The ore, consisting of galena in a white quartz gangue, appeared to be "bunchy" in occurrence, but conditions appeared to be sufficiently favourable to warrant further development. A sample of sorted ore gave the following returns: gold, trace; silver, 16·9 ounces to the ton; lead, 42·2 per cent; zinc, 0·6 per cent."

H. B. Group

References

Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1915, p. 160.
O'Grady, B. T.: Ann. Repts., Minister of Mines, B.C.: 1926, p. 278; 1927, p. 309.

The H.B. property is on Deer creek, a tributary of Sheep creek, which in turn joins Salmo river at the town of Salmo. The property was an important producer of zinc during the war and in 1925 was reopened by the Victoria Syndicate. In 1927 it was purchased by the Consolidated Mining and Smelting Company.

The deposits are replacements in a belt of limestone. There are several ore-bodies which strike with the formation in a general north and south direction and have widths up to 30 feet. These lie wholly within the limestone and would seem to be a replacement along a particular stratum. The ores were deposited as sulphides, but oxidation has nearly everywhere altered them. The zinc minerals are mainly carbonates and oxides, but in places there is a considerable development of calamine. The ore-bodies are cut by a number of basic dykes. In the summer of 1927 some fifteen carloads of lead carbonates were shipped to Trail.

Emerald

Reference

Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1915, p. 162.

The Emerald lies on the south side of Sheep creek across from the H.B., at a point near the divide between Sheep creek and a branch of Lost creek. It is about 6 miles from Salmo. It lies in the continuation of the limestone belt in which the H.B. occurs.

The deposits are replacement bodies in limestone bands, resembling those in the H.B., excepting that lead minerals predominate instead of those of zinc, and oxidation has not proceeded as far as on that property. The ore consists of galena and lead carbonates with silver values practically negligible. The average zinc content of the ore is about 6 per cent.

The property was staked in 1895 and commenced shipment in 1906. Production was maintained over a period of years.

In the same region similar replacement deposits occur on the Aspen, Mona, Black Jack, and Lucky Boy properties.

Molly Gibson

References

Ann. Repts., Minister of Mines, B.C., 1899-1927.
Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1922, p. 206.

The Molly Gibson is situated on the headwaters of Kokanee creek on the north side of Kootenay outlet. The elevation of the camp is 7,200 feet above sea-level.

Work was begun in 1899 by the Molly Gibson Mining Company and continued until 1902. From 1905 to 1907 the property was operated by the La Plata Mining Company. Underground work up to this time amounted to 5,277 feet, the two longest of the five drifts each having a length of 2,000 feet. In 1910 the property was acquired by the Consolidated Mining and Smelting Company and operated by them until 1915. During recent years it has been worked under lease.

The property lies within the Nelson granite batholith. The deposit is a fissure vein which is persistent in dip and strike, having been drifted on for over 2,000 feet and developed to a depth of 1,000 feet below the outcrop. It strikes northwest and dips at an angle of 75 degrees to the southwest. In places the walls of the vein are composed of disintegrated granite. Besides the main vein there is a smaller parallel vein upon which considerable work has been done.

The chief values are in silver with lead as the second most important metal. In places, however, the ore is high in zinc and gold values are also present. The ore zones vary greatly in width and value.

Reeves-McDonald

References

O'Grady, B. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 315.
Langley, A. G.: Can. Min. and Met. Bull., Jan., 1929, p. 24.

The Reeves-McDonald property is in the triangular area between Pend-d'Oreille and Salmo rivers. It is reached by a branch road connecting with the Nelson-Spokane highway near the International Boundary. The portal of the Reeves tunnel is about 60 feet above the level of Pend-d'Oreille river and the Reeves workings are located some 4,000 feet to the northeast.

The deposit is a replacement in limestone of the Pend d'Oreille group. On the Reeves claim drifting and crosscutting in 1928 outlined an orebody 640 feet long with an average width of 30 feet. The ore is of uniform grade and will be readily treated by flotation methods. The metallic contents are about 7 per cent zinc, 2 per cent lead, and 0·5 ounce silver. The chances of there being other important ore-bodies in this zone might be considered highly favourable. On the opposite side of the river and in the continuation of this mineralized belt, showings of oxidized and leached material carrying values in silver, lead, and zinc occur on the Red Bird property.

Silver Reef

Reference

O'Grady, B. T.: Ann. Rept., Minister of Mines, B.C., 1927, p. 315.

This group, consisting of three claims, is situated in the angle between the forks of Anderson creek just east of the Fairview district of the city of Nelson.

The rock formation is granodiorite of the Nelson batholith. The deposits are two fissure veins cutting the granodiorite. Lamprophyre dykes closely follow the veins along the lines of fissuring which strike northwesterly and dip steeply northeast.

The workings on the Rover vein, on which most of the development has been done, are south of the creek. Four tunnels, three of which are short, develop the vein through a vertical range of 150 feet and for a length of some 350 feet. Stoping has been carried out at points roughly 100 feet and 250 feet in from the portal of the main tunnel. In these the vein, including quartz and gouge, is up to 5 feet in width. The ore consists of alternate bands of galena, zinc blende, and pyrite, with some chalcopyrite, in a gangue composed of quartz, with some calcite and siderite. Lead carbonates occur in oxidized material in the upper part of No. 1 raise south. Towards the face of the main tunnel the vein is split by a lamprophyre dyke and the tunnel branches into two parts, each following quartz.

The Silver Reef vein workings are on the northern side of the creek. At an elevation of about 3,300 feet above sea-level there is a crosscut tunnel from which a short drift extends northwesterly along the foot-wall side of a wide sheared and silicified zone in the granite. This zone, of an estimated width of 40 feet, strikes north 450 degrees west and dips 57 degrees northeast. Bands of quartz are developed on both walls of the zone and in its central portion there is a wide lamprophyre dyke in which are inclusions of country rock and quartz. In the short drift is exposed a width of 5 feet of mineralization, consisting chiefly of a fine-grained mixture of lead, zinc, and iron sulphides in a gangue of altered country rock. A sample across 5 feet assayed: silver, 1·9 ounces to the ton; lead, 10·4 per cent; zinc, 8·6 per cent.

(38) Vancouver Mining Division

Zinc-lead showings occur in a number of areas in Vancouver mining division, including Lynn Creek Valley section, the section along the Pacific Great Eastern railway, and the Jarvis Inlet section. The Pacific Great Eastern section is on the western slope of the Coast range, the summit of the range being near Green lake on the northeastern border of the division. This section of country has many belts and masses of altered sedimentary rocks overlying and included in the granodiorite of the Coast Range batholith and many mineral occurrences have been discovered, the only one of importance as yet, however, being the large copper deposit at Britannia.

Lynn Creek

References

Brewer, W. M.: Ann. Repts., Minister of Mines, B.C.: 1917, p. 280; 1926, p. 333.
Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1913, p. 307.
LeRoy, O. E.: Geol. Surv., Canada, Pub. No. 996, p. 29.

The Lynn Creek camp is situated about 15 miles from North Vancouver, on the west fork of Lynn creek. An automobile can be driven up to the forks of the creek and from there a trail about one mile long leads to the property. The whole region is very rugged and the narrow valleys are bounded by very steep slopes, with the hills rising to heights of 3,000 to 4,000 feet above the valley bottoms. In 1926 an option on the property was taken by the Porcupine Goldfields Development and Finance Company.

The rocks of the area consist of a series of sediments surrounded by granites of the Coast Range batholith. The sediments consist of quartzites and limestone, the latter altered in places to lime-silicate rock. Black lamprophyre dykes cut across all the rocks.

The ores consist of zinc blende, chalcopyrite, pyrite, pyrrhotite, molybdenite, and magnetite, occurring as irregular bodies along fracture zones in the intruded strata. They are apparently of contact metamorphic origin, produced by the intrusion of the granodiorite into the sediments.

Development work consists of four tunnels, surface trenching, open-cuts, and diamond-drill holes. Small, irregularly shaped bodies of ore have been opened up, in places showing good values in zinc and lead with silver values. No large, continuous mass of ore has as yet, however, been proved.

The future of the property depends on finding larger bodies of ore than have been discovered at present. Though good values have been obtained, the ore masses discovered so far have proved to be small and irregular. It remains to be seen whether systematic exploration will open up larger bodies.

BRANDYWINE RIVER SECTION

References

Brewer, W. M.: Ann. Repts., Minister of Mines, B.C.: 1924, p. 243; 1925, p. 300; 1926, p. 330.
Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1927, p. 364.
Camsell, C.: Geol. Surv., Canada, Sum. Rept. 1917, pt. B, p. 12.

In the Brandywine River section are several groups of claims showing silver-lead-zinc mineralization. The chief groups are the Blue Jack, the Brandywine, the Astra, and the Elinor. The Blue Jack group is reached by trail from McGuire on the Pacific Great Eastern. The Astra group lies to the north on the ridge between Brandywine river and Callaghan creek. The Brandywine group is situated about 2 miles west of Brew (Brandywine Station) and the Elinor lies south from it.

The rocks of the region consist of sediments and volcanics of Jura-Triassic age intruded by granodiorite. The intruded rocks consist of conglomerates, sandstones, schist, and limestone. To the south and east they pass underneath basalt surface flows. The ore deposits consist of mineralization along shear zones. Within these zones vein material consisting of sulphides in a gangue of quartz, occurs. The ore minerals are pyrite, galena, and sphalerite, and gold and silver values are usually present.

Development work on the claims consists largely of open-cuts. On the Blue Jack and Brandywine groups short adits have been driven. As a result of his examination, Mr. Brewer states:

> "The conclusions drawn after the examination of the Brandywine River section are that it is an excellent prospecting ground on which systematic prospecting will result in the exposing of ore-bodies carrying commercial values in silver, lead, and zinc."

Fitzsimmons Group

Reference

Camsell, C.: Geol. Surv., Canada, Sum. Rept. 1917, pt. B, p. 20.

The Fitzsimmons group of claims is situated about 3 miles south of Green lake on the northeast side of Fitzsimmons creek at an elevation of about 700 feet above the Pacific Great Eastern railway.

Camsell states:

"Nothing has been done on the claims for some years and what development there is consists of stripping the surface and open-cuts. The rocks, as exposed in a number of steep bluffs, consist of limestone altered by the development of garnet and epidote in it and cut by a number of narrow, irregular, quartz porphyry and granite porphyry dykes. The ore appears to be the result of the intrusion of the dykes and occurs in the altered limestone in indefinite bunches up to 20 feet in width and of unknown length. The mineralization is by copper and iron sulphides, zinc blende, and some magnetite. At the lower workings a dump of about 20 tons of broken ore might average 3 per cent in copper. At the upper workings much blende is associated with pyrite and there is less chalcopyrite. The gold content, however, is said to run about $20 to the ton."

(39) Clayoquot Mining Division

Clayoquot mining division extends along the west coast of Vancouver island for a distance of about 100 miles. Considerable prospecting has been carried out in it, but there are no producing properties. Most of the prospects are quartz veins carrying gold and silver values. In the Hesquiat Lake section zinc ore occurs.

Hesquiat

References

Brewer, W. M.: Ann. Repts., Minister of Mines, B.C.: 1916, p. 337; 1925, p. 272.

The Hesquiat group, consisting of four claims, is situated near the south shore of Hesquiat lake, a short distance from the narrows at the outlet of the lake. The property is reached by steamer from Victoria. These claims were staked in 1925 and cover practically the same ground as the old Brown Jug group. Brewer states:

"A wide shear-zone in trap-rock is traceable for about 1,500 feet in a northerly direction on the Brown Jug and Brown Jug No. 2 claims. In many places this rock is so much altered, crushed, and sheared that it is serpentinized and talcose for considerable widths. There are fractures and fissures occurring in the zone, which are filled with quartz mineralized with iron pyrites, sphalerite, and some chalcopyrite. These fissures appear to be lenticular in form, and vary very much in width. Although prospecting work has been done to some considerable extent, the development is not sufficient to determine many material facts relative to the possibilities of the property."

In the 1925 report Mr. Brewer states:

"The presence of zinc in the ore was a great handicap when the old claims were held, and that, added to poor transportation facilities, was mainly responsible for the abandonment of the Brown Jug group after considerable prospecting had been done. Under present conditions with regard to zinc and the perfection of the oil-flotation method of concentration, it may prove to be worth while to further prospect systematically these ore-deposits, as the transportation of concentrates could be done with much less difficulty and expense than transporting ore."

(40) Quatsino Mining Division

Quatsino Mining division occupies the northwestern portion of Vancouver island. The chief zinc-lead occurrences are in the southeast arm section of Quatsino sound.

Alice Lake Group

References

Brewer, W. M.: Ann. Repts., Minister of Mines, B.C.: 1924, p. 228; 1925, p. 273; 1926, p. 305.
Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1927, p. 346.

The Alice Lake group, consisting of seven claims, is situated about 5 miles east of June Landing on the east side of the southeast arm of Quatsino sound, on the easterly slope of the mountains overlooking Alice lake.

The rocks of the area belong to the Triassic Vancouver series consisting chiefly of volcanics, but with a belt of limestone 3 to 4 miles in width which has been intruded by felsite porphyry and other igneous rocks.

Deposits of sphalerite have been found about 2 miles to the southwest of the claims near Victoria lake and also about 12 miles to the northwest near Quatse lake.

On the Alice Lake group the ore occurrences belong to the contact-metamorphic type, with limestone on the hanging-wall and felsite porphyry on the foot-wall. The ore minerals present are sphalerite and galena. An ore zone with widths up to 20 inches was followed for a length of 150 feet. The ore assays: lead, 10 per cent; zinc, 14 per cent; silver, 7 ounces to the ton; gold, $10 to $20 to the ton.

(41) Nanaimo Mining Division

Nanaimo mining division includes part of the mainland of British Columbia underlain largely by the Coast Range batholith, the eastern half of Vancouver island, and the islands between it and the mainland. In the Buttle Lake section on Vancouver island galena and sphalerite occur in small veins and bunches in schists of the Vancouver group of Triassic age. In the Horne Lake section to the southeast, zinc showings have been found in limestone of the Vancouver series. Work has been carried out on zinc occurrences on Thurlow island and near Powell river on the mainland.

Constitution

Reference

Brewer, W. M.: Ann. Rept., Minister of Mines, B. C., 1925, p. 280.

The Constitution claim lies at the northern end of upper Thurlow island near the beacon one mile east of Vere cove. The rocks consist of volcanics and limestone of the Vancouver series. At the contact between the limestone and the volcanics there is a deposit in which the mineralization is largely sphalerite. The values along the strike are, however, very irregular.

Malaspina Mines, Limited

References

Brewer, W. M.: Ann. Repts., Minister of Mines, B.C.: 1917, p. 256; 1922, p. 234; 1924, p. 247; 1925, p. 290; 1926, p. 310.
Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1927, p. 356.

The claims of the Malaspina Mines, Limited, a company which was incorporated in 1925, lie on and near the shore of the mainland between Powell river and Lund. A motor road 5 miles in length connects the property with Lund.

The rocks of the region consist of dark-coloured volcanics and limestone of Triassic or Jurassic age cut by porphyry dykes and granodiorite related to the Coast Range batholith. Along the contact of the granodiorite and the limestone, the latter is altered to a garnet-epidote rock. In places the granodiorite is cut by narrow black dykes from 1 to 2 feet wide.

The ore minerals are chalcopyrite, bornite, and sphalerite in a gangue of garnet, epidote, and magnetite. The ore occurs along the contact of the altered limestone with the granodiorite and in isolated masses in the limestone away from the contact.

Development work on the property consists of stripping, open-cuts, pits, some 500 feet of underground work, and several diamond-drill holes put in at right angles to the contact where the main mineral showings were located.

The deposit is of contact metamorphic origin and it is to be expected that the ore-bodies will be of irregular size and shape.

John Bull Group

Reference

Brewer, W. M.: Ann. Rept., Minister of Mines, B.C., 1926, p. 312.

This group of three claims adjoins the claims of the Malaspina Mines on the north. The rocks are similar, consisting of limestone, volcanics, granodiorite, and dykes. The chief ore mineral is sphalerite, a light yellow, resinous variety, which occurs disseminated and as large masses in the limestone, commonly associated with garnet. At one point a considerable amount of magnetite occurs. A dyke of fresh, massive, dark grey porphyry cuts across the mineralized zone. The mineralization is irregular and patchy, making it difficult, without considerable development work, to estimate the amount of ore available.

CHAPTER VI

FOREIGN OCCURRENCES

NORTH AMERICA

Alaska

A lead-silver-gold area lies between the north slope of Wrangel mountains and the Alaska range in the upper part of Copper River valley. Silver-lead outcrops occur over a region extending for 25 miles from Chistochina river over a width of from 4 to 5 miles. The deposits are veins in which the principal ore mineral is galena, though in some, grey copper is present. A few miles east of Nabesna river is a large lead-silver-zinc deposit. It occupies a zone that has a width of 800 feet and is traceable for 4,000 feet. A large tonnage of commercial ore can apparently be developed in this district.[1]

Mexico

Mexico ranks second to the United States among the lead producers of the world and its production of zinc ore has greatly increased during recent years. The deposits contain rich silver values and many of them have been worked since the days of the Spaniards. They are widely spread throughout many states of which the more important are Chihuahua, Zacatecas, Saltillo, Coahuila, Nuevo Léon, San Luis Potosi, and Jalisco.

Mexico is underlain largely by Mesozoic strata and Tertiary sediments and volcanics. Intrusions of syenite and diorite of late Cretaceous or early Tertiary age occur in some districts. The most widespread rocks and the most important producers of zinc and lead ores are limestones of Cretaceous age which in the average section vary from 3,000 to 5,000 feet in thickness. These are underlain by sandstones and slates of Jurassic age.

The zinc and lead ores occur in veins traversing Tertiary volcanics and underlying rocks and as replacements in Cretaceous limestones. Many of the rich silver-bearing veins for which Mexico has been famous have become, with the deepening of the workings, important sources of lead. In the deeper zones sulphides of copper and iron are associated with galena and sphalerite.

The replacement type supplies at the present time the bulk of the smelting tonnage of Mexico. Prescott[2] describes the characteristics of this variety of deposit. They follow certain favourable beds of limestone and are continuous from the point of entrance, at depth, into the

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[1]Mineral Industry during 1926, p. 404.

[2]Prescott, Basil: "The Underlying Principles of the Limestone Replacement Deposits of the Mexico Province"; Eng. and Min. Jour.-Press, vol. 122, pp. 246, 289 (1926).

favourable beds, to the surface or to the point of egress from the favourable beds or until they gradually become attenuated. The progress of the mineralizer was nearly always upward from the source. The ore-bodies are essentially chimneys or pipes, whether they lie vertically, are inclined, or are horizontal, forming the so-called " mantos." The course of a single ore-body is controlled by such factors as selective action of certain limestones, variation in composition of the sedimentaries, structure of the limestone, attitude of the beds, and pre-mineral fissures. Though in many districts the deposits occur where igneous intrusive rocks are lacking, it is generally conceded that they owe their origin to underlying intrusive masses.

Above the level of groundwater the ore is oxidized and consists commonly of anglesite and cerussite lying on the floor and along the sides of caves. These caves were formed by descending surface waters which oxidized the sulphides to sulphates, oxides, and resulting carbonates and attacked the limestone above and below the mantos. They are commonly of huge size and have produced immense tonnages of silver-lead ore. In some mines calamine and smithsonite are found as alteration products of sphalerite. Cores of galena surrounded by concentric anglesite indicate the primary lead mineral. Examples of this type of deposit are the Ahumada[1], in Lamentos mountains, Chihuahua, and El Potosi[2], in Santa Eulalia district of the same state.

Newfoundland

Large deposits of zinc-lead ores have been developed in Newfoundland about 5 miles north of Red Indian lake[3] by Buchans Mining Company, Limited, a subsidiary of the American Smelting and Refining Company. The property is reached by a railroad, 22 miles long, branching from the Anglo-Newfoundland Development Company's Millertown branch, at a point 15 miles west of Millertown Junction.

The ore-bodies occur along a zone that has been opened for a distance of about 2 miles. The associated rocks are andesites, andesite porphyries, tuffs, and quartz porphyry. The ore is a fine-grained sulphide complex, varying at different points along the zone and with an average content as follows:

Gold	Silver	Copper	Lead	Zinc
Oz.	Ozs.	Per cent	Per cent	Per cent
0·03	3·0	2·0	7·0	16·0

Barite forms a considerable portion of the gangue. Over 3,000,000 tons of ore have been indicated by diamond drilling.

[1]Richard, T. A.: "The Ahumada Lead Mine and the Ore Deposits of the Los Lamentos Range, in Mexico"; Eng. and Min. Jour.-Press, Sept. 6, 1924, p. 365.
[2]Walker, H. A.: "Diamond Drilling in El Potosi Mine"; Eng. and Min. Jour.-Press, Nov. 18, 1922, p. 896.
[3]Davies, D. J.: "A Pamphlet on the Mineral Deposits of Newfoundland."

Silver-lead-zinc ores also occur at Placentia bay. At the Silver Cliff mine and the La Manche lead mine the deposits are veins cutting Precambrian sediments. Lead ores are known to occur also at Notre Dame bay and Port au Port bay on the west coast.

United States

The United States holds the premier position in the world as a producer both of zinc and of lead. In 1927 it produced 613,548 tons of zinc or nearly 42 per cent of the world's total production for that year and 673,000 tons of lead, over 36 per cent of the world's total lead production.

The zinc-lead producing districts of the United States may be conveniently grouped in three general regions: the Atlantic coast, the Mississippi valley, and the Rocky mountains and Pacific coast.

ATLANTIC COAST

In the Atlantic Coast region occur the zinc ores of New Jersey, the zinc-lead ores of New York state, and the zinc-lead deposits of Virginia and Tennessee. Minor deposits occur also in New England, Pennsylvania, and North Carolina. In New Jersey,[1] two important deposits, Sterling Hill and Minehill, occur near Ogdensburg and Franklin Furnace respectively. Both deposits form canoe-shaped zones in Precambrian limestone. The ores comprise zincite, willemite, and franklinite. Calcite is an important gangue and a great number of other minerals, such as tephroite, zinc pyroxene, zinc spinel, manganese, garnet, axinite, apatite, scapolite, rhodocrosite, fluorite, sphalerite, galena, arsenopyrite, chalcopyrite, and löllingite are also present. At Minehill the ore mass, which varies in thickness from 12 to 100 feet, is flanked along its west side by gneiss. The deposit is believed to be due to contact metamorphism resulting from the intrusion of the gneiss into the limestone and later regional metamorphism has further complicated the relations.

In New York, several zinc properties occur near Edwards, St. Lawrence county, of which the chief is the Brown mine.[2] The deposits are of magmatic, high-temperature origin occurring along a belt of Precambrian limestone near its contact with gneiss. The ore carries pyrite and sphalerite, with some galena, pyrrhotite, and chalcopyrite. The occurrence resembles the Tetreault, at Notre-Dame-des-Anges, Quebec.

Galena-bearing calcite veins similar to those of eastern Ontario occur at various places in New York state and have been mined at different periods.

Zinc and lead deposits occur in a number of counties in southwest Virginia, the most important in Wythe county. The ores occur in breccia zones in the Shenandoah limestone of Cambro-Ordovician age. They consist of sphalerite, galena, and pyrite, with locally chalcopyrite, and secondary calamine, smithsonite, and cerussite. The oxidized ores are

[1]Spencer, A. C.: U.S. Geol. Surv., Franklin Furnace Folio, pp. 24, 25.
[2]Wade, W. R., and Wandke, A.: "A Big Zinc Mine in New York State"; Eng. and Min. Jour.-Press, July 21, 1923.

commonly concentrated in massive form in large, irregular masses, principally at and near the bottom of the residual clay closely following the irregular weathered surface of the limestone.

In Tennessee zinc and lead ores occur in a number of districts. At the Mascot and Roseberry mines, in Knox county, the ore-bodies occur in lenses of varying size and in breccias following certain recognized zones in the Knox dolomite. The ore is light-coloured sphalerite.

MISSISSIPPI VALLEY[1]

Zinc and lead ores occur over a wide area in Mississippi Valley region, being found in the states of Missouri, Arkansas, Oklahoma, Kansas, Illinois, Iowa, and Wisconsin. The chief active mining regions are:

(1) Southeastern Missouri
(2) Southwestern Missouri, with the adjacent portions of Kansas and Oklahoma
(3) Wisconsin-Iowa-Illinois district

Southeastern Missouri and southwestern Missouri, with the neighbouring parts of Kansas and Oklahoma, form what is sometimes spoken of as the Ozark region. The former, however, is essentially a lead producer, whereas the latter, which is known as Joplin district, is predominantly a zinc producer.

The deposits occur in nearly horizontal Palæozoic limestones ranging in age from Cambrian to Mississippian. They occur as gash veins in the limestones, along joints, faults, and crevices, in brecciated zones, in sheet-like masses along bedding planes, and as disseminations in the sediments. They hence include two types of deposits, those formed by replacement and those formed by cavity filling.

The ore minerals are galena and sphalerite. The latter is more abundant in the deeper zones. Locally the galena carries a little silver, but as a rule it is non-argentiferous. Pyrite and marcasite are usually associated with the ore minerals and sometimes a little chalcopyrite is present.

The origin of these ores has been the subject of much controversy. The theory most widely accepted is that favoured by Siebenthal, that the deposits were segregated from disseminated zinc and lead minerals in the Cambrian and Ordovician rocks of the Ozark uplift by artesian-circulating, alkaline-saline, sulphuretted waters.

The lead deposits of southeastern Missouri occur in Cambrian strata, at two horizons. The lower, which is the more important, is the Bonneterre dolomite which rests on the basal LaMotte sandstone. The second and less important is the Potosi dolomite at the top of the Cambrian sequence. In the Potosi the ore occurs as gash veins and along joints and bedding planes. In the Bonneterre the ores are chiefly disseminated occurring as grains or crystals formed by the replacement of the dolomite. They also, however, occur as horizontal sheets along bedding planes, generally along the upper side of thin shale beds, and along joint-planes and in cavities or vugs.

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[1]Siebenthal, C. E.: U.S. Geol. Surv., Bull. 606, "Origin of the Zinc and Lead Deposits of the Joplin Region."

In Joplin region the deposits occur chiefly in the Boone formation of Mississippian age and to a less extent in the overlying Chester and Cherokee formations, and in the underlying Kinderhook. The surface of the Boone contains numerous sink-holes and caves and near the surface the ore-bodies are irregular masses in this "broken ground"; below at depths of from 150 to 300 feet they occur as "blanket deposits" or "sheet ground" in a chert member of the Boone formation.

The region was first mined for lead, but in 1870 zinc ore was produced and since that time has become increasingly predominate.

The Wisconsin-Iowa-Illinois district is commonly referred to as the Upper Mississippi valley. The most important districts are in Wisconsin. The deposits occur in almost horizontal Ordovician strata. Though both zinc and lead are produced, the former is produced in greater quantities. Lead occurs most abundantly in the southern part of the district near Galena, Illinois, and Dubuque, Iowa, whereas zinc ore is more important in the northeast where the lower ore-bearing horizons are chiefly exposed.

ROCKY MOUNTAINS AND PACIFIC COAST[1]

The Rocky Mountain and Pacific Coast region was affected by two periods of igneous activity, both of which were followed by epochs of intense mineralization. The first of these periods of intrusion was during the late Jurassic extending into early Cretaceous time. Reference to the great Coast Range batholith of British Columbia has already been made; the great batholith of the Sierra Nevada was also intruded at this time and along the margins of these great masses innumerable intrusions of smaller volume broke through the crust. The ore deposits formed during this period of intrusion are chiefly of gold and copper. In the Pacific Coast region where the intruded sediments contain but little limestone there is very little lead; in the interior, however, where the intrusives cut Palæozoic limestone, as for example in Nevada and Arizona, lead and zinc ores appear, and silver accompanies the lead.

The second great metallogenetic epoch was during the early Tertiary. Intrusions, largely in the form of laccoliths, took place in great numbers. They were of intermediate composition and crystallized as granular or porphyritic rocks. They extend from British Columbia, through Montana, Utah, Nevada, Colorado, New Mexico, eastern Arizona, and attain their maximum development in eastern Mexico. These intrusions produced along their margins a great number of veins and contact metamorphic deposits. The characteristic metals are gold, silver, lead, and zinc, the latter two being chiefly important where the intrusions cut limestones.

The production of zinc and lead in this western region has become increasingly important through the introduction of flotation methods of separation. In 1927 the relative order of importance for lead production among the states was Utah, Idaho, Colorado, Montana, Nevada, New Mexico, Arizona, California, and Washington, whereas for zinc during the same year the order was Montana, Utah, Colorado, New Mexico, Idaho, California, Nevada, Arizona, and Washington.

[1]Lindgren, W.: "Mineral Deposits," pp. 920-921. Mineral Industry during 1926, pp. 405-411 and 704-715.

The main zinc-lead districts of Utah are Bingham, Park City, and Tintic. At Bingham the deposits are largely veins carrying argentiferous lead. They traverse all the rocks of the region which consist of sediments of Upper Carboniferous age cut by intrusives whose age is between Carboniferous and late Tertiary. The largest veins are in limestone and they are most numerous in the vicinity of intrusives. A large amount of secondary lead was mined in the upper part of the deposits. The Park City deposits consist of veins and bedded deposits in sedimentary rocks with the former types occurring also in the intrusives. In Tintic region occur veins and replacements, commonly along contacts of igneous rocks and intruded sediments.

The important area of Montana is that around Butte. The deposits are fissure veins traversing a quartz monzonite batholithic intrusive. The chief ores are of copper and silver, but with both of these are associated sphalerite and galena. At the present time nearly all the zinc and lead produced in the state comes from ores mined by the Butte and Superior, Butte Copper and Zinc, Anaconda, Angellica, Elm Orlu, Silver Dyke, Moulton, and Poser mines.

The zinc-lead deposits of Colorado are scattered through many counties. The types are fissure veins and replacements. At Leadville the deposits, consisting of galena, sphalerite, and pyrite, with subordinate chalcopyrite and a notable amount of gold and silver, are replacements at the contact of Carboniferous limestone with intrusive porphyry. Large quantities of secondary zinc ore consisting of calamine and smithsonite have been mined.

The Coeur d'Alene district of Idaho is a large producer of lead, silver, and zinc. The deposits are veins and replacements in sericitic quartzites and shales of Precambrian age which have been faulted, folded, and intruded by monzonite.

In Nevada a large production of lead has been made in Eureka district from large replacement ore-bodies in limestone along its faulted contact with quartzite. Other important districts are Pioche of Lincoln county and Yellow Pine of Clark county. In the latter district the country rock is mainly Carboniferous limestone cut by porphyry dykes and capped by andesite flows. The zinc-lead deposits occur as replacements in the limestones, which are folded and extensively faulted. A great deal of secondary smithsonite, cerussite, anglesite, calamine, hydrozincite, and pyromorphite have been mined.

In California the chief production of lead has been from Inyo county and from Darwin district in Fresno county. In the former the ores are contained in steeply dipping veins traversing slate and limestone which are cut by various intrusives. In the latter the veins are in limestone and carry lead carbonate and galena. Zinc-lead deposits occur also in Santa Catalina islands.

In New Mexico, zinc-lead ores occur in a number of districts. In Magdalena district the deposits occur in Carboniferous limestone at the contact of a granite-porphyry. The ore-bodies are lenticular, following the bedding planes of the limestone, and in places have a thickness of 40 feet.

Five horizons of the limestones are mineralized, but only one is important. In the oxidized zone the main production was lead and silver, but at depth large bodies of sphalerite were encountered.

SOUTH AMERICA

Argentina, Bolivia, Brazil, Chile, and Peru all contain silver-lead deposits.

In northern Argentina a production of lead is maintained in the district close to Pumahuasi. In Bolivia lead-ore production comes from vein deposits scattered widely over the country, but particularly from the district bordering on the Peruvian northern frontier and from the region near the south frontier of Argentina. In Brazil, lead ore has been produced in the southern part of the state of Sao Paulo, from pockets and veins on the contact between granite and limestone. Peru is a large producer of silver-lead ores. The famous mines of Cerro de Paso, discovered in 1630, are veins in Jurassic and Cretaceous limestones, conglomerates, slates, and sandstones, often metamorphosed by intrusives. Bed and pocket-like deposits in limestone rocks also occur. Sphalerite occurs in deposits in the Mowcocha and Casapalco districts, in the department of Junin.

EUROPE

Austria

The chief deposits of zinc and lead in Austria are situated in southern Carinthia, Styria, and the Austrian Tyrol.

The Carinthian ores occur along a belt of country on the south slope of the Alps forming part of a larger lead-zinc region including part of northern Italy. The principal Austrian occurrences are at Bleiberg, Kreuth, Kappel, Mieres, and Schwarzenberg. The deposits are in Triassic limestones and dolomites and occur as gash veins and irregular deposits resulting from fillings and replacements closely related to the faulting and jointing of the beds. The mineralization, which appears to be quite independent of igneous activity, is similar to that of Missouri. These deposits have yielded large quantities of lead ore in the form of galena and cerussite, but the zinc ore consisting of sphalerite and smithsonite is now more important. Calamine and hydrozincite occur in minor amounts. Wulfenite has been found in large quantities. Marcasite, pyrite, and chalcopyrite occur with the ores and the important gangue minerals are commonly calcite and barite.

At Gratz, in Styria, veins carry galena and sphalerite with sulphides of copper and iron. The gangue minerals include quartz, barite, witherite, and carbonates of iron and lime.

Mines early worked for lead in Tyrol were reopened in 1866 as zinc mines. The veins vary up to 50 feet in width and carry galena, sphalerite, and small quantities of pyrite. At Schneeberg deposits of galena and sphalerite in large veins traversing mica schist have been worked.

Belgium

Belgium ranks second among the world's producer's of zinc, being exceeded only by the United States. Only a very small amount of the ore smelted, however, is of domestic production. Large amounts of ore are imported from Mexico, United States, Canada, India, Australia, Italy, Netherlands, Great Britain, Spain, Sweden, Algeria, and other countries. Its lead production is also from imported ores, a large part of it being derived by the Belgium lead smelters from zinc-distilling residues.

Belgium lies on the northern side of an ancient, denuded mountain range, remnants of which rise to the surface in the Ardennes. The rocks of the range are of Palæozoic age, the youngest beds which were involved in the folding being Carboniferous Coal Measures. On the northern margin lie nearly undisturbed Cretaceous and Tertiary strata which, except for the Ardennes, cover the greater part of Belgium.

The zinc and lead deposits occur in the Palæozoic strata of the Ardennes. The most famous district is that of Morisnet,[1] comprising about 1,400 acres at the Prussian border, which has been mined since the fifteenth century. The deposits are owned by the Vieille-Montagne Zinc Company which was organized in 1837. Since 1882 the production has been small. The ore-bodies occur in Carboniferous limestone and resemble in many ways those of Missouri. They show no association with any igneous rocks, but are dependent on a set of fractures trending northwest. The deposits are replacements of limestone and occur chiefly along the contacts of shale beds and also along fault fissures. The ores are chiefly carbonates, but galena and sphalerite, in many cases intimately intergrown, occur at depth. Enormous masses of smithsonite have been mined. Calamine and willemite are also important ores. Zinc ores have also been mined at Welkenrodt, Nouvelle Montagne, Corphalie near Liège, and Phillippeville.

At Bleyberg large quantities of sphalerite and galena have been mined from veins cutting Carboniferous limestones and overlying Coal Measure shales. Other deposits of a similar character occur near Liège and Verviers.

Bulgaria

Zinc ore has been mined from the Sedmolchisleniza mine about 6 miles southwest of Vratza. The ore-bodies occur as bands and lenses from 2 to 7 feet thick along the bedding planes of Triassic limestone. The ore minerals are sphalerite, smithsonite, and galena. Lead and zinc ores have also been mined at Roupio and from the Blagodat mine near Keustendil. Deposits also occur over an area of between 4 and 5 square miles in Rhodope mountains in southern Bulgaria. The deposits contain both lead and zinc ores. The latter are said to occur in a bed more than a metre thick, near the surface of the soil.[2]

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[1]Timmerhans, Ch.: "Les gites metalliferes de la region de Morisnet" Liège, 1905.
Boscheron, L.: "The Zinc Industry of the Liège District"; Jour. Inst. Metals, No. 2, vol. XXXVI, pp. 21-26 (1926).

[2]Mineral Industry, 1926, p. 718.

Czecho-Slovakia

Lead has been mined in several places in Bohemia, the most important localities being those of Pribram[1], near Prague. About forty veins have been worked in a narrow area about 5 miles in length and some have been followed to depths of from 3,000 to 4,000 feet. They occur in folded and faulted Lower Palæozoic sediments intruded by diorite and basic dykes. The ores consist of galena and sphalerite with pyrite and chalcopyrite, in a gangue of calcite, siderite, and quartz. The proportion of sphalerite increased with depth.

Veins carrying lead and zinc ores have been worked near Pilsen, and other localities include Kuttenberg, east of Prague, and Budivers in southern Bohemia.

France

Deposits of lead and zinc occur at many places in France. The more important are found in the metamorphic and associated igneous rocks of the Auvergne, in the Jurassic limestones and other rocks to the south of that region, in the Hautes and Basses Pyrenees, in the Alpine region of Provence, and in Brittany. Most of the production of both lead and zinc at the present time is from imported ores.

The department of Vosges on the eastern border of France was, in the past, the scene of extensive mining, the operations beginning as early as the fourteenth century. Of the numerous argentiferous deposits of this district, the most important was the Lacroix lode which was worked along its strike for a distance of 2½ miles. The deposits traverse gneiss, are nearly vertical, and have a thickness up to 60 feet. Through the ore zone, argeniferous galena and various silver ores occur in stringers, veins, and stockworks.

The plateau of central France embracing the country between the Alps and the Pyrenees has supplied most of the zinc ore and much of the lead ore of France. Veins, carrying argentiferous galena and traversing granite and metamorphic rocks, occur at numerous localities in the departments of Puy-de-Dome, Cantal, and Haut-Loire. To the south of Auvergne district, zinc and lead ores occur in the departments of Gard, Lozère, and Lot. At Les Malines, in Gard, there are two classes of deposits. The first variety, which supplies most of the ore, occurs in dolomite of Middle Jurassic age, in and along crevices, in caves, or in large masses which in some cases enclose partly unaltered masses of rock. The ore minerals are calamine, smithsonite, sphalerite, hydrozincite, galena, anglesite, and pyromorphite. The second type consists of vein deposits traversing limestone, the ore minerals being sphalerite and galena with pyrite in a gangue of barite.

In almost all the departments of the Pyrenees lead or zinc ores have been worked. Numerous veins carrying sphalerite and galena occur in the Haute-Garonne. At the Senterin mine, in Ariège, argentiferous galena, sphalerite, cerussite, smithsonite, and anglesite have been mined from a deposit in Lower Carboniferous limestone.

In Brittany are numerous veins that have been important producers of argentiferous lead ore. They traverse granite and Palæozoic sediments.

[1]Phillips, J. A.: "A Treatise of the Deposits," p. 318.

Germany

Deposits of zinc and lead occur in Germany in Upper Silesia, Rhenish Prussia, Westphalia, Saxony, Hanover, Nassau, and Baden. By the plebiscite in 1921 Germany lost to Poland the greater part of the Upper Silesian deposits, including about 85 per cent of the producing mines.

The mines of Prussia and Westphalia are within a district about 100 miles long from east to west and about 50 miles broad, north and south, all south of the latitude of Cologne and traversed about midway by the Rhine. The deposits consist of veins cutting Palæozoic slates and of replacements in limestone. In the Iserlohn and Brilon districts of Westphalia are metasomatic deposits in limestone of Middle Devonian age. The ores are galena and sphalerite, with their oxidation products, with which are associated considerable amounts of pyrite.

At Mechernich and Commern about 30 miles southwest of Cologne, lead ore occurs in Triassic sandstone in the form of nodules from the size of a pin's head to that of an apple, somewhat irregularly distributed. The nodules are composed in part of quartz grains cemented by galena and in some cases by cerussite. The rocks are traversed by numerous faults and the ore is supposed to be due to impregnating solutions which advanced along these fissures. Similar deposits are found in other parts of Germany.

The deposits of Saxony are in the Erzgebirge mountains which form the boundary between Saxony and Bohemia. Lead and zinc deposits occur on both sides of the range. In the neighbourhood of Freiberg a complicated system of fissure veins cut biotite gneiss and other metamorphic rocks. Mining has been carried out in this region for a period of over 700 years and depths of over 2,000 feet have been obtained in the workings. The veins are supposed to be related to the post-Carboniferous granites of the Erzgebirge; they have been classified into a number of types grouped into two series known respectively as the older and the younger. The older include rich silver-quartz veins, tin veins, pyritic lead veins, and rich silver-lead veins. The younger comprises barite-lead veins. The pyrite lead veins carry argentiferous galena, sphalerite, pyrite, pyrrhotite, arsenopyrite, and chalcopyrite in a quartz gangue. The silver-lead veins carry argentiferous galena and sulpho-salts of silver in a gangue composed chiefly of ankerite and rhodochrosite. In the younger series of veins, the galena is low in silver and the gangue consists of barite, fluorite, calcite, and quartz. These veins in many places reach a considerable width and in places carry cobalt and nickel minerals.

The lead-zinc deposits of Hanover are in Harz mountains. The veins of the Clausthal plateau, which have been mined since the thirteenth century, form ten parallel series of lodes extending over an area 15 miles long and 5 miles wide, and traversing a folded complex of Devonian and Carboniferous strata. The deposits have been worked to depths of 3,000 feet. The chief ore is galena; in places sphalerite is more abundant and usually increases in proportion with depth. Other sulphides, including marcasite, pyrite, chalcopyrite, and tetrahedrite, also occur and the gangue consists of quartz, calcite, barite, and siderite.

An important deposit in the Harz is that of Rammelsberg, near Goslar, which has been worked for copper ores since the tenth century. The ore-body lies in Lower Devonian shales and slates with which it is more or less conformable and dips at a steep angle to the north. It has been worked for a distance of about $1\frac{1}{2}$ miles and has a thickness of about 10 feet, swelling in places, however, to as much as 120 feet. The ore is an intimate mixture of sphalerite, galena, pyrite, chalcopyrite, and barite.

In Nassau, deposits, known as the Ems and the Holzappel veins, occur in the valley of the Lahn. They traverse Lower Devonian slates. The Ems series of veins extends from Braubach to Deerbach. They carry argentiferous galena, sphalerite, chalcopyrite, and pyrite in a gangue of quartz, siderite, and calcite. The Holzappel series of veins extends from St. Goar to Holzappel, a distance of nearly 8 miles. They contain a mineralization similar to that of the Ems veins.

In Baden, deposits of zinc and lead of the Missouri type have been mined at Weisloch, from limestones and dolomites of Lower Triassic age. In Kinzig valley, in the northern part of the Black Forest, is an assemblage of veins of varied composition and age. They traverse gneissic rock but also extend into overlying Permian and Triassic sandstones. The various types of veins have been grouped into two series, to the younger of which belong those carrying argentiferous galena. Deposits of galena are also known in Wurtemberg and Bavaria.

Great Britain[1]

Lead and zinc ores occur in a large number of districts in the British Isles. They are found in various formations ranging in age from Pre-cambrian to Triassic. There are two groups of occurrences: (1) veins in the older Palæozoic rocks; and (2) cavity-fillings and metasomatic replacements in Carboniferous limestone and associated rocks. The former occur in Cornwall and Devon, Wales, Shropshire, the Lake District of Cumberland and Westmorland, Isle of Man, the Leadhills region of Lanarkshire, Scotland, and county Wicklow, Ireland. The latter variety is found over an extensive area in the north of England, known as the Pennine region, in Derbyshire, Flintshire, and Denbighshire, and the Mendip hills.

In Cornwall and Devon veins carrying galena and sphalerite cut Ordovician and Devonian slates. These veins are younger than the tin-copper veins, usually trend north and south normal to the older veins, and are situated at a greater distance from the granite which supplied the mineralizing solutions. The ore is argentiferous galena accompanied by sphalerite in a gangue of quartz, calcite, fluorite, siderite, and some barite.

In Mendip hills, of Somerset, lead and zinc ores occupy fissures and cavities in Carboniferous limestone and overlying Triassic dolomitic conglomerate. Mining was carried on here at a very early date; pigs of lead bearing Roman inscriptions are evidence of the activity of the Romans. The locality is notable for the occurrence of the rare oxychlorite of lead, mendipite.

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[1]Hall, J. C. F.: "Lead Ores"; Imp. Inst. Mon., London, 1921. "Zinc Ores"; Imp. Inst. Mon., London, 1917.

In Derbyshire the deposits occur in Carboniferous limestone as cavity fillings and replacements. The various forms which the deposits take are given names. Rakes are more or less vertical deposits in enlarged joints or faults, and similar occurrences in small cracks or fissures are called scrins. Flats are deposits in horizontal cavities formed along bedding planes; one or more generally occur in association with a fissure filling, giving rise to a pipe. The term "pocket" is sometimes applied to deposits in chamber-like cavities on the side of a rake.

The Pennine region, including contiguous parts of the counties of Durham, Northumberland, Cumberland, Westmorland, and York, is marked by an extensive outcrop of Carboniferous strata composed of limestone, cherts, sandstones, and shales. The ore occurs chiefly in the limestones and cherts, in places extending into the overlying Millstone Grit. The ore-bodies are chiefly fillings of fissures, commonly faults, but there is also a good deal of replacement of the limestone, particularly at the junction with some impervious bed. The ore minerals are galena and sphalerite; the relative abundance of the two ores is subject to considerable variation. Several properties, such as the Nenthead mine near Alston, have been important producers of zinc ore.

In the lake district of Cumberland and Westmorland, the older Palæozoic rocks contain many veins. The principal ore is galena which carries appreciable quantities of silver, up to 25 to 30 ounces to the ton. Zinc blende and chalcopyrite are also commonly present and in the upper parts of the veins oxidized ores have been of common occurrence.

In Shropshire and the adjacent parts of Montgomeryshire, galena-bearing veins are contained in Ordovician strata. Sphalerite accompanies the galena in many of the veins and increases with depth. Barite forms a gangue in many of the veins and in places is mined.

In the neighbourhood of Macclesfield, Cheshire, some of the Triassic sandstones, in addition to their ores of copper, have yielded lead ore in the form of cerussite, galena, pyromorphite, and vanadinite. These deposits resemble those at Mechernich and Commern in Germany, but attempts to work them for their lead content have never been a commercial success.

The Carboniferous rocks of Flintshire and Denbighshire contain a number of veins carrying ores of lead and zinc which have been of commercial importance. The Halkyn deposits near Holywell in Flintshire consist of two sets of veins traversing Carboniferous limestone and overlying chert beds of the Millstone Grit. Those that have an east and west trend and appear to be the older carry argentiferous galena and sphalerite, whereas the north and south or cross veins, which are later, carry practically no sphalerite and the galena is much poorer in silver.

Veins carrying ores of lead and zinc occur in the older Palæozoic rocks of Carnarvonshire, Wales. Lead veins, traversing slaty Palæozoic rocks, occur over a large part of central Wales, principally in the county of Cardiganshire, and were at one time actively mined. In south Wales occurrences of galena in the Carboniferous and overlying Triassic rocks have been noted in many places but as yet have not proved of commercial importance.

In the Isle of Man veins traversing Cambrian slates and associated granite carry argentiferous galena and zinc blende in a gangue of quartz and calcite. The largest production of ore has been from the Foxdale and Great Laxey mines. At the former, the main vein was traced for a distance of between 2 and 3 miles, had a width in places of 40 feet, and was followed to a depth of 2,000 feet.

The most important lead districts in Scotland are Leadhills and Wanlockhead, which adjoin one another, the former being in Lanarkshire and the latter in Dumfriesshire. The deposits are veins that extend over a tract of country measuring roughly 2 miles north and south and 3 miles east and west. The veins traverse slaty rocks of Ordovician age and carry both galena and sphalerite, the latter having so far been found in subordinate amounts. The chief gangue mineral is calcite, but barite also occurs. The upper parts of the veins formerly yielded a great variety of oxidized products. Cerussite, anglesite, and pyromorphite have all been mined as ores.

At Strontian in Argyllshire galena-bearing veins traverse gneissic rocks near a granite outcrop. The associated minerals are calcite and barite; strontianite, celestite, harmotone, and brewsterite also occur.

About 80 per cent of the lead production of Ireland has come from the Luganure mines in county Wicklow, which were operating up to about 1892. The ore occurs in veins in a belt of mineralized granite. Ores of lead have occasionally been mined in the Carboniferous limestone and older rocks of other parts of Ireland, as in Galway, Sligo, Clare, etc., but the output has never been large.

Greece

Zinc and lead ores occur as replacement deposits in limestone at many localities in Greece, the most important of which are those in Lauirium[1] district, 25 miles southeast of Athens. These mines are of great antiquity, having been in operation as early as 560 B.C. The ore occurs principally in limestone of Cretaceous age near its contacts with shale horizons. The sedimentary rocks are cut by dykes of granite and gabbro. There are three formations of limestone, known respectively as the Upper, Middle, and Lower, separated by two horizons of shale. The upper ore-bearing zone occurs at the base of the Upper limestone. Much of it has been removed by erosion, but along the portions that remain are the places where the earliest mining was done because there the ore appeared at the surface. Beneath the Upper limestone, veins of ore were found extending downward through the shale which, when followed, led to the discovery of more ore at the top of the Middle limestone. Later, larger deposits were found at the top of the Lower limestone. Along these contacts, particularly the third, the ore had the form of tabular masses as much as 35 feet in thickness, whereas in the shale it filled fissures of irregular shape. The ore mined by the Athenians was chiefly galena which contained silver ranging from 30 to 300 ounces per ton. With the galena were associated both

[1]Richard, T. A.: "Notes on Ancient and Primitive Mining and Metallurgical Methods-III"; Eng. and Min. Jour., Oct. 23, 1926, p. 649.

pyrite and sphalerite in small amounts. In the upper parts of the deposits occur secondary cerussite, smithsonite, hematite, and gypsum. During modern days, the mines have been exploited by various French companies chiefly for the zinc ore which is more plentiful in the deeper workings. Over 2,000 shafts were sunk by the ancients, one of which is 386 feet deep. It is estimated that from the sixth to the third century B.C., the mines of Laurium yielded 2,100,000 tons of argentiferous lead. A feature of interest today is the presence of oxychlorides of lead formed by the action of seawater on the ancient slag heaps.

Of the other occurrences of Greece may be mentioned mount Hymettus where zinc ore occurs in irregular masses in limestone. Argentiferous lead ores have also been worked in the islands of Milos, Pharos, and Santorin in the Ægean sea. These deposits are associated with volcanic rocks and carry galena, sphalerite, chalcopyrite, and pyrite, with commonly barite as a gangue.

Hungary

In Carpathian mountains, northern Hungary, occur an assemblage of veins associated with Tertiary volcanic rocks. The ore minerals include gold tellurides, silver ores, galena, sphalerite, pyrite, marcasite, chalcopyrite, tetrahedrite, bournonite, jamesonite, stibnite, and cinnabar, with calcite and other carbonates, barite, fluorite, and zeolites as gangues. In certain veins galena predominates among the ore minerals. The chief mining districts are Schemnitz-Kremnitz, Nagy-Banya-Felsöbanya-Kapnik. The Johann and Spitaler veins of Schemnitz-Kremnitz district have been mined for their galena content. At Felsöbanya and Kapnik argentiferous galena, accompanied by sphalerite, is the important ore.

Italy

The chief deposits of zinc and lead in Italy are in Sardinia. They have been known from a very early date and were worked by the Phoenicians, Carthaginians, and Romans. Other deposits occur in Venetia, Lombardy, Piedmont, and Tuscany.

Sardinia consists of two hilly regions composed of pre-Tertiary rocks separated by a broad depression filled with Tertiary deposits. Both to the east and west of the depression the Precambrian and Palæozoic rocks which form the greater part of the island are strongly folded, with the exception of the uppermost beds which are Permian. In the eastern region there was a later period of deformation which involved Jurassic and Cretaceous strata. The Mesozoic rocks of the western region, comprising strata from Triassic to Cretaceous in age, and the Tertiary rocks throughout the island lie nearly horizontal.

The chief zinc and lead deposits of Sardinia are in the neighbourhood of Iglesias in the southwest part of the island. They consist of veins traversing granite and Palæozoic strata, and replacement deposits in Palæozoic limestones. At Monteponi near Iglesias the deposits are large, irregular replacements in limestone occurring along contacts with slates. The primary ores are galena and sphalerite, the former being more abundant in the upper zone. Near the surface are large deposits of secondary smithsonite and calamine. Similar deposits occur at Malfatano, about 8 miles northwest of Iglesias. At the San Giovanni mines about 2 miles southwest of Iglesias, irregular, nearly vertical lode fissure deposits yielding argentiferous galena and sphalerite are found in limestone. At Nebida near the west coast of Iglesias carbonate and silicate zinc ores occur in limestone in pipes in some cases 60 feet in diameter. At Montevecchio are veins and lode fissures varying from narrow stringers to masses 50 to 100 feet in width, carrying argentiferous galena, zinc blende, and sulphides of copper and iron. The secondary minerals include cerussite, pyromorphite, crocoite, and siderite, with native silver, ruby silver, and argentite. Cinnabar and compounds of arsenic, antimony, nickel, and cobalt also occur. The gangue minerals are chiefly quartz and calcite, but barite, fluorite, and zeolites are also found.

In the Campiglia Marittima of Tuscany, veins traversing Palæozoic slates carry argentiferous galena, zinc blende, chalcopyrite, and antimonial lead ores, together with small quantities of cassiterite and compounds of cobalt and bismuth in a gangue of quartz, calcite, and siderite. In connexion with the Austrian deposits reference has been made to the important zinc and lead ores of northern Italy, the most important of which are localized at Raibl and Auronzo. Near Trent and other places in the Tyrol occur many zinc and lead-bearing veins. Zinc ore has also been mined at Argenticra near Auronzo, and in the Valle Seriana district of Milan, in Lombardy; also in Tuscany at Bottino, and in the Aupanian Alps, east of Carrara.

Norway

Sphalerite and galena occur widely spread in Norway, the former usually in predominate amounts, but on account of the complexity of the ores the production has formerly been small. Recently the development of flotation and leaching processes has created an interest in the zinc deposits, some of which are now under development. During recent years there has been an annual production of from 5,000 to 6,000 tons of refined zinc from foreign ores, cheap waterpower playing an important part in establishing the industry.

The zinc-lead deposits of Norway may be divided into three main groups, according to their age: (1) those related to the eruptives of Oslo region, and probably Devonian in age; (2) those related to the intrusives of the Caledonian Mountain chain of Ordovician-Silurian age; (3) those of the Archæan rocks.

The ores of Oslo region are contact-metamorphic deposits in Cambrian-Silurian limestones on the contact with granites and quartz-syenites.

The zinc-bearing ores of the Caledonian Mountain chain are of two types: (1) zinc ores with galena and subordinate amounts of iron sulphides; and (2) zinc ores in pyrite and chalcopyrite deposits. The former occur as lenses and impregnations in regionally metamorphosed mica schists and marbles. They are related to granitic intrusives and are at least partly of metasomatic origin. The gangue minerals are mainly quartz with some calcite and barite. These deposits occur for the most part in northern Norway[1]. In many of the pyrite and chalcopyrite deposits of Norway zinc is present in amounts varying from 2 to 5 per cent. These deposits occur in metamorphic mica schists and greenstones in connexion with intrusions of gabbro and granite. These sulphide deposits are of huge size and though the zinc may be only a by-product they form the largest reserve of zinc in the country.[2]

The zinc and lead ores of the Archæan belong to several types, are less known, and are of less importance.

Poland

The important zinc-producing region of Upper Silesia is now largely Polish territory. Lead ores also occur in the region but in subordinate quantities. Lead mining was commenced as early as the twelfth century and the mining of the zinc ore for the manufacture of brass in the sixteenth century.

The deposits occur in Triassic limestones and dolomites which are underlain unconformably by Carboniferous measures carrying important seams of coal. The association of the metallic ores and the coal is very important from the view of smelting low-grade ores. The ores occur at two horizons; in the upper, galena and oxidized zinc ore predominate; in the lower, sphalerite is the most important ore mineral and is accompanied by galena and marcasite. The upper commonly lies from 40 to 80 feet above the lower and forms sheet-like bodies varying from a few inches to a foot or more in thickness. The lower or zinc zone lies at depths from 200 to 375 feet below the surface. The deposits here are regular, extensive, and nearly horizontal. Pipes and irregular cavities filled with ore are also found. There has been much dispute concerning the origin of these ores, but it is now generally attributed to the action of ascending hydrothermal solutions. The formation of the oxidized ores from the original sulphides was later accomplished by the action of circulating surface waters.

Portugal

Veins carrying argentiferous galena have been worked in the southwestern part of Portugal, but the country is not at present a source of either lead or zinc.

Roumania

In the Transylvanian Erzgebirge, principally noted for its gold tellurides, are subordinate amounts of lead ores.

Russia

Zinc and lead ores occur in many places throughout Russia, the more important occurrences being in the Caucasus mountains and in Siberia. The Tyuticha mine near Olga bay, 200 miles northeast of Vladivostock,

[1]Torgersen, J. C.: "Zinc and Lead Deposits in Helgeland, Northern Norway"; Geol. Surv., Norway, No. 131, pp. 70-79.

[2]Foslie, S.: "Pyrite Resources of Norway"; in Les Reserves Mondiales en Pyrite, Int. Geol. Cong., Madrid, vol. I, pp. 159-241 (1926).

has considerable reserves of zinc-lead ore. Another large deposit occurs at the Ridder mine in Semipalatinsk district, southwestern Siberia. In the province of Irkutsk, at Nertchinsk, a large number of silver-lead deposits occur as stockworks and as lenses in limestone. These deposits were formerly worked for silver. Deposits are also known to occur in the eastern Kirghiz steppes. In the western extension of the Altai mountains are veins and lenses carrying argentiferous galena, and sphalerite. They occur in Silurian, Devonian, and Carboniferous rocks, and rarely in crystalline schists.

Spain

Spain is the largest producer of lead in Europe and it is also an important producer of zinc ore. The chief lead-producing districts are in the province of Murcia and in the Sierra Morena in the provinces of Jaén and Cordova. The chief zinc-producing regions are the Cantabrian mountains in the northern provinces of Santander and Asturias, and in the province of Lérida in the northeast and in Murcia in the southeast.

In the Sierra Morena, lead deposits occur along both the northern and the southern border and also in the centre of the range. The most important district is the Linares-Carolina[1] on the south side. The deposits are veins cutting Precambrian granite and Silurian slates and quartzites. The deposits are genetically related to intrusions of quartz porphyry and syenitic granite of late Palæozoic age. The veins are due to the mineralization of definite sets of fracture. Their average width is about one metre. The important ore mineral is galena which in some veins is argentiferous but which in the majority of cases carries very little silver. Cerussite occurs in the oxidized zone. The gangue is chiefly quartz, with small amounts of calcite, barite, and siderite. The ore-shoots are irregular in direction and depth, rich pockets and barren zones alternating.

In Murcia the deposits are veins traversing slates and replacements in Permian limestone. The important district is that of Cartagena-Mazarrón. The galena is associated with sphalerite and pyrite and is richly argentiferous.

The zinc ores of the Cantabrian mountains of Santander are replacements in limestone, consisting of pockets and irregular masses. They occur at two horizons, Carboniferous and Cretaceous. The most extensive deposits are found in the former. The ore is largely zinc carbonate and in few cases contains lead or copper minerals.

Sweden

Deposits of zinc blende occur about 8 miles from Ammeberg in Nerika province, at the northern end of lake Wetter. The ore, consisting of sphalerite, galena, and pyrite, occurs in lenses of considerable size in a folded and contorted gneiss of Precambrian age.

At Sala, north of Stockholm, a deposit of lead and zinc ore occurs as replacements in a metamorphosed dolomitic limestone which forms lenses in Precambrian crystalline schists. The chief ore mineral is galena, containing high silver values, with sphalerite and pyrite in subordinate amounts.

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[1]Hereza, J., and de Alvarado, A.: "The Metalliferous Deposits of Linares and Huelva"; Instituto Geologico de Espana, 1926.

Yugoslavia

Lead ores have been mined near Belgrade at Cerveni Brey and Kosmaj, at Babe, 5 miles from the Ralja railway station, and in the northern part of the province of Slavonia at the Mejica mine near Pliberg and the Letija mine, north of Ljubljana.

In Bosnia lead ores occur in veins associated with andesitic lavas, slates, and quartzites. The ores consist of argentiferous galena, with blende and pyrite, and compounds of copper and antimony.

At Laibach and Carniola ores of zinc and lead, accompanied by cinnabar and barite, occur in fissure breccias in Carboniferous sandstones and shales.

AFRICA

Algeria

Lead and zinc ores occur in a number of localities in Algeria, and important quantities have been shipped to France. The two ores are commonly associated, sphalerite in many cases predominating. Many of the deposits consist of replacements of the nummulitic limestone of Tertiary age which is well developed in the region of Atlas mountains. Others are in the form of veins cutting Cretaceous marls and limestones. The ore commonly consists of carbonates above water-level and sphalerite and galena below it.

Rhodesia[1]

Lead and zinc deposits occur in different parts of Rhodesia, but the main occurrence is that of Broken Hill in northwestern Rhodesia, about 300 miles to the northeast of Victoria falls. The discovery was made in 1902. The ore-bodies are iregular masses and impregnations in crystalline limestone. The principal occurrences outcrop as low hills or kopjes which stand above the surrounding flat country, the largest being about 90 feet in height. These kopjes consist almost entirely of oxidized ore. Kopje No. 1, which formerly rose almost perpendicularly to a height of 65 feet, has been replaced by a deep excavation covering over 200,000 square feet. At No. 19 the ore-body has been mined to a depth of 215 feet and diamond drilling has proved it to a depth of 350 feet. The primary ore consists of galena and sphalerite in intimate association. The oxidized ore consists of calamine and cerussite with variable amounts of interspersed limonite. An interesting feature is the presence of the zinc phosphates, hopeite and tarbuttite, and the vanadium mineral, descloizite.[2]

Until recently the ore presented many metallurgical difficulties, but the production of electrolytic zinc has now proved a success and a plant with a daily production of 40 tons of metallic zinc has been erected. It is estimated that the known reserves will last fifteen years. These include 800,000 tons of oxidized ore with a zinc content varying from 27 to 33 per

[1] Mineral Industry during 1926, p. 726.

[2] Spencer, L. J.: "On Hopeite and Other Zinc Phosphates and Associated Minerals from the Broken Hill Mines, North-Western Rhodesia"; Min. Mag., vol. 15, pp. 1-38 (1908-10).

cent, 38,000 tons of vanadium ores with a zinc content of 8 to 15 per cent, 109,600 tons of sulphide ores with a zinc content of 30 to 42 per cent, and a slag dump with the zinc content estimated at 18 per cent.

Tunis

Tunis is an important source of ores of both zinc and lead. The mines consist of small, scattered units. The deposits are principally metasomatic replacements in nummulitic limestone along the contacts of schists and quartzites. The primary ore consists of galena and associated sphalerite. The galena is seldom argentiferous. Cerussite and smithsonite are of common occurrence and form important ores. At Laghouat, 35 miles south of Tunis, are deposits of zinc ore in which the silicate, calamine, predominates.

Union of South Africa

Lead and zinc ores occur in many places in the Union of South Africa[1] in the limestones and dolomites of the older geological formations. Near Ottos Hoop, Malmani district, western Transvaal, zinc and lead ores occur in pipe-like deposits and impregnations in dolomite. The primary ores consist of galena and sphalerite, with secondary calamine, smithsonite, and copper carbonates in the oxidized zone. In Pretoria, Rustenburg, and Marico districts, of the Transvaal, there occur deposits consisting of veins containing argentiferous lead associated with ores of gold, silver, copper, and cobalt. At Leeuwkloof, Pretoria district, a deposit of galena occurs as a replacement deposit in dolomite at the contact with overlying shales. A similar deposit has been worked at Rhenosterhoek. Deposits are known to occur at many other localities in the Transvaal. In the Cape Province, pockets of galena are found at Banghoek, Knysna, and Richmond and in the districts of Beaufort West, Victoria West, Caledon, and Swellendam. In Southwest Africa argentiferous galena is found at Pomona, at Aiais, and in other localities.

ASIA

Asia Minor

Silver-lead-zinc deposits are found in a number of districts of Asia Minor.[2] At Balia-Karaidin Brusa the deposits are veins, 1 to 35 feet thick, occupying fissures in augite-andesite near its contact with Carboniferous limestone. The ores are argentiferous galena and sphalerite. At Bulgar-Maden in Konia the deposits are the result of contact action of micro-granulites which have been intruded into Palæozoic limestones. In Angora, silver-bearing lead ore is found in various mines which are state-controlled. Near Smyrna lead ores are associated with those of zinc.

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[1] "Lead in South Africa"; Min. Mag., Dec. 1919, p. 372.
[2] Penzer, N. M.: "The Minerals of Anatolia"; Min. Mag., vol. 21, p. 76 (1919).

China

The largest zinc and lead mine in China is the Shui-Ko-Shan[1] in Hu-nan province, which has been worked spasmodically for the past three hundred years. The deposit occurs in what is known as the "Great Limestone" formation of probable Carboniferous age which is overlain by red sandstones and shales of Cretaceous or Tertiary age. An intrusion of syenite, apparently in the form of a laccolith, has tilted both formations, producing an anticline, the crest of which has been denuded exposing the intrusive and a contact breccia. The ore-bodies are large, irregular-shaped masses composed of zinc blende and galena with iron and copper pyrites, developed in the limestone at or near the contact with the syenite. Other lead-zinc properties have also been operated in Hu-nan.

Veins carrying lead and zinc ores, with which are associated silver minerals and compounds of arsenic have been mined in the province of Chi-li.

India and Indo-China

Galena and sphalerite are known to occur in many parts of India, but the only deposits worked on a large scale are those of Bawdwin, in Tawngpeng state, one of the northern Shan states of Upper Burma. The deposits comprise an area of 2,500 acres. The ore zone has been traced for a length of 8,000 feet and varies from 350 to 500 feet in width. The deposits are enormous replacements occurring along a nearly vertical zone of combined faulting and shearing. The strike of the thickest part of the sulphide zone is north 25 degrees west and the dip is 70 to 80 degrees west. The hanging-wall consists of feldspathic grits, belonging to what is known as the Bawdwin series; the foot-wall usually consists of rhyolite tuffs. The ore-shoots are confined to the tuffs and do not occur in the feldspathic grits. The hanging-wall is fairly regular, but the foot-wall is less clearly defined, commonly a gradation existing between the solid sulphide zone and the unaltered rhyolite tuffs, the gradational zone consisting of tuffs mineralized with silica and containing nests and stringers of sulphides which gradually diminish in amount as one passes out from the ore-body. The ore is complex in character. The property is operated by the Burma Corporation organized in 1919.

Ore similar to that at the Bawdwin mines is reported to occur at the Mohochang mines, about 20 miles to the north. Zinc ores are stated to occur also at Jawar in Udaipur state, Rajputana. Here the ore consists of smithsonite in veins 3 or 4 inches wide traversing quartzite. Sphalerite is found associated with galena, chalcopyrite, and pyrrhotite in Sikkim and near the Shigri glacier in Lahaul sphalerite occurs associated with antimony ore.

Rich deposits of zinc ore occur in Annam and Tongking. The important ore mineral is smithsonite. The largest production is from Cho-dien where operations began in 1914. Smithsonite has also been mined near Trang-da and at the Lang-hit mine near Thai-Nguyen.

[1]Wheler, A. S., and Li, s. Y.: "The Shui-Ko-Shan Zinc and Lead Mine, in Hunan, Central China"; Min. Mag., vol. 16, p. 91 (1917).

Galena and sphalerite have been produced from the Quan-Son deposit in the province of Thanh-Hoa from Triassic limestone near the contact with schists and from the old Chinese mine at Moa-Ha, in the province of Vinh.

Japan

The chief zinc-lead producing district in Japan is the province of Hida. The most important property is the Kamioka owned by the Mitsui Mining Company. The ore consists of argentiferous galena and sphalerite and contains from 10 to 16 per cent zinc. It is a contact deposit occurring at the margin of a quartz porphyry intrusive into gneiss. The Osaka Mining Company in addition to operating in the province of Hida has produced about 15,000 tons of ore annually from Korea. Japan imports zinc ore from Siberia, China, Tongking, and Australia.

Argentiferous galena occurs in veins in the island of Sado at Akita and similar deposits are found near Tokio.

AUSTRALASIA

New South Wales

Australia is the largest producer of zinc-lead ores in the British Empire. The main producing district is Broken Hill, New South Wales.

The rocks of Broken Hill[1] consist of a complex of presumably Precambrian age, including gneisses and schists of many varieties. They were formed by the metamorphism of a series of argillaceous and sandy sediments intruded by sills and dykes of acid and basic composition. The sedimentary members include sillimanite gneiss, and mica, chloritoid, staurolite, sericite, and quartzite schists: the igneous members include augen gneisses, amphibolite, pegmatite, aplite, granite, serpentine, and dolerite.

The ore deposits are of replacement origin, formed under conditions of high temperature. The main deposit has a length of $3\frac{1}{2}$ miles and varies in width from a few feet to as much as 200 feet. In plan it forms two broad curves, the main trend being northeasterly. The dips, though variable, are generally high to the west and northwest. In cross-section the deposit consists mainly of two portions, a more or less persistent zone known as the "Foot-wall lode" which apparently follows a fault-plane and large, bulging masses of ore which occur along the hanging-wall side of this lode and which follow the structural planes of the enclosing rocks, often in the form of "saddles."

The upper part of the deposit[2] contained great quantities of secondary ore. Beneath the gossan outcrop zone was an oxidized zone consisting of carbonate ore, dry, high-grade ore, and dry, low-grade ore. The carbonate ore was made up of a loose aggregation of cerussite and a gangue composed of siliceous and aluminous material impregnated more or less

[1]Andrews, C. C.: "The Geology of the Broken Hill District"; Geol. Surv., New South Wales, Mem. No. 8.
[2]Kenny, E. J.: "Silver, Lead, Zinc"; Bull. No. 2, Geol. Surv., New South Wales (1923).

with manganiferous iron oxide. Silver in the native form and as haloids ran from 5 to 80 ounces to the ton. The dry, high-grade ore consisted of kaolin with some garnets and quartz with native silver and haloids of silver, giving silver values of from 4 to 300 ounces to the ton. The dry, low-grade ores differed from the carbonate ore only in containing a much smaller quantity of cerussite with a larger proportion of gangue. It yielded 5 to 40 ounces of silver to the ton.

Between the oxidized and sulphide ore was a thin layer of secondary sulphides 3 inches to 3 feet in thickness, representing ordinary sulphide ore that had been enriched by descending surface waters. It contained a maximum of 250 ounces of silver per ton and, in many places, as much as 12 per cent copper.

The ores of the primary sulphide zone are an intimate mixture of galena and sphalerite, with chalcopyrite, pyrite, and pyrrhotite in a gangue of rhodonite, garnet, calcite, pegmatite, with green feldspar, apatite, fluorspar, quartz, and silicified country rock. The higher grade of sulphide ores are medium-grained aggregates of galena and blende with very little gangue. The sulphide ores are divisible into two broad classes, the rhodonitic and the calcite, depending on whether rhodonite or calcite is the more abundant gangue mineral. The rhodonitic ores are developed chiefly in the central part of the deposit; the calcitic type is more abundant near the ends of the lode.

Lead and zinc minerals are known to occur at many other localities throughout New South Wales.[1] A small production of lead has been made from numerous silver-mining districts such as Yerranderie, Sunny Corner, Condobolin, Leadville, Rivertree, Yass, Tingha, Hillgrove, Goulburn, Glen Innes, and others.

Queensland

A silver-lead field was discovered in 1923 in Queensland at mount Isa[2] on the western branch of Leichardt river, about 60 miles westerly from Cloncurry. The main deposits are in a zone 5 miles long and 1 mile wide.

The rocks are altered sediments of the Cloncurry series, considered to be of Silurian age. They consist of finely banded quartzites, porous beds of clay and ironstone, contorted and much altered shales, irregular masses of ironstone more or less stained with manganese, and finely stratified beds of magnesite, dolomite, and limestone. Away from mount Isa similar belts of rocks are to be seen in all directions, alternating with quartzites which have been formed by metamorphism from coarse-grained sandstones and cut by granite intrusions and pegmatite dykes.

The ore deposits are replacements along bedding planes; ore-bodies formed in the spaces produced by the folding, rolling, and separation of the stratified bands. The thickness of the individual ore bands varies from a mere fraction of an inch to several feet. In some outcrops quite a number of fine, regular bands of ore are to be observed separated by bands of ironstone, clay, or ribbonstone in the width of a foot; other occurrences show bands of ore a foot or more thick and massed together

[1] Kenny, E. J.: "Silver, Lead, Zinc"; Bull. No. 2, Geol. Surv., New South Wales (1923).
[2] Dunstan, B.: "Mount Isa Silver-Lead Deposits"; Queensland Government Jour., June 14, 1924, p. 200.

to make up a formation in places 12 or 15 feet thick; in still other showings, heavy beds, as much as a foot in thickness, are separated from one another by several feet of barren rock; or numberless small bands of ore may be spread out over a section of perhaps 50 feet. At the surface the ore is carbonate, but it grades into primary sulphides below. In the primary zone sphalerite also occurs.

Zinc and lead ores have also been mined in Burketown district in the northwest corner of Queensland, from the Mount Barker silver-lead mine in the Eungella goldfield, and from other districts.

West Australia

In West Australia the chief lead occurrences are in Northampton district. The deposits are veins that occur in garnetiferous granite in association with parallel basic dykes, in many cases along their contacts with the granite. The veins are usually small but of considerable length. The main ore is high-grade galena which commonly occurs in shoots of from 500 to 1,000 feet in length.

Tasmania

Lead-zinc deposits occur in several districts of Tasmania, the most important of which are on the west coast in the neighbourhood of Zeehan.[1] The Mount Read group is situated about 17 miles from Zeehan, the Rosebery deposits about 11 miles, and a number of others are located close to Zeehan itself.

The deposits are in a complex of rocks of Pre-Silurian age. They consist of a conformable series of sediments, tuffs, and lava flows which have suffered intense compression and metamorphism during which they were thrown into a complex series of folds and changed into schistose rocks.

The zinc-lead deposits are metasomatic replacements of metamorphosed calcareous beds in this series. The horizon carrying these calcareous beds is approximately 200 feet thick, varying, however, in different parts of the field. The ores have a banded structure, some consisting dominantly of sphalerite, in others galena is more abundant, and in still others pyrite predominates. This banded structure is considered to be the result of selective precipitation from the mineralizing solutions due to the varying composition of the replaced rock. The greatest width of the ore-bodies is about 55 feet, and all gradations from this figure to a few inches are observable. Ore-bodies have been exposed continuously over a length of 850 feet.

In Waratah[2] district veins carrying argentiferous galena and sphalerite have been operated.

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[1]Hills, Loftus: "Preliminary Report on the Zinc-lead Sulphide Deposits of the Rosebery District"; Tasmania Dept. of Mines, Geol. Surv., Rept. No. 7.

[2]Ward, L. K.: "The Silver-Lead Lodes of the Waratah District, Tasmania"; Dept. of Mines, Geol. Surv., Rept. No. 2.

New Zealand

Lead and zinc ores occur in many places in New Zealand, but little has been done to develop them commercially. Hauraki peninsula, in North island, contains an assemblage of veins connected with Tertiary volcanic rocks. Some of the deposits have been worked for their gold content and it is probable that zinc, lead, and copper ores may some day be mined with success.

CHAPTER VII

Statistics

World's Production of Zinc 1916-1927 [1]

(In short tons—2,000 lbs.)

Country	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
United States	679,833	682,225	525,349	471,684	479,669	215,614	373,678	531,202	535,846	590,928	638,533	613,548
Mexico	—	—	—	—	—	—	—	—	—	1,406	6,550	7,089
Canada	2,973	9,982	12,571	12,323	18,508	26,494	27,782	30,025	27,443	38,481	61,727	73,528
Belgium	25,269	11,340	10,188	21,891	92,880	72,917	123,777	162,082	178,242	188,339	209,674	222,686
Czecho-Slovakia	—	—	—	3,121	2,254	3,549	2,254	2,418	7,603	3,307	3,527	4,079
France	22,324	25,268	20,218	11,902	22,140	26,640	43,779	54,381	63,614	74,693	80,969	91,105
Germany (Upper Silesia excluded)	61,206	63,567	68,606	21,359	17,695	29,839	38,360	35,467	45,745	64,620	75,361	92,706
Upper Silesia	135,020	142,012	135,540	81,596	89,740	69,368	83,345	92,425	85,615	108,192	117,103	143,112
Great Britain	57,997	57,214	42,990	42,137	27,550	6,515	20,529	35,033	43,098	42,726	20,148	46,893
Italy	284	404	1,309	1,413	1,297	427	2,901	4,060	6,569	7,141	8,417	8,148
Austria-Hungary	12,783	13,885	13,224	—	—	—	—	—	—	—	—	—
Yugoslavia	—	—	—	1,300	4,350	463	1,163	2,146	2,343	2,460	2,619	3,511
Netherlands	13,335	4,473	750	—	2,238	7,060	14,327	18,126	20,051	23,277	27,333	28,955
Norway	2,019	1,931	2,044	3,731	2,024	2,205	2,039	4,170	5,538	7,503	5,907	6,614
Poland (Upper Silesia excluded)	8,234	9,184	5,392	4,868	5,909	7,745	10,031	13,546	16,999	17,846	19,290	22,643
Russia	—	—	—	—	—	—	—	—	661	1,653	2,059	2,568
Spain	9,395	11,194	17,527	17,983	10,634	7,427	6,910	12,039	14,084	16,669	17,739	18,346
Sweden	11,020	8,816	4,753	2,648	6,458	3,858	1,757	1,420	3,881	5,233	5,291	5,071
Australia	5,318	4,032	10,023	9,128	10,825	1,883	26,339	46,091	52,205	51,280	52,942	54,438
Japan	42,970	60,299	43,990	21,843	17,356	11,435	13,806	15,190	15,508	18,684	18,739	18,739
French Indo-China	—	—	—	—	—	—	—	—	143	1,276	1,102	1,291
Totals	1,089,980	1,105,826	914,474	728,927	811,537	493,439	792,777	1,039,821	1,125,188	1,265,714	1,375,030	1,465,070

[1] Slab zinc produced in the several countries, unallocated according to the origin of the ore. Year Book of the American Bureau of Metal Statistics, 1927, p. 65.

World's Production of Lead 1917-1927

(In short tons—2,000 lbs.)

Country	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
United States	581,557	556,233	454,797	476,125	402,479	470,000	530,000	590,000	662,500	696,000	673,000
Canada	16,283	25,692	21,903	18,187	34,381	45,842	53,899	86,583	126,994	141,386	155,845
Mexico	51,366	97,530	86,667	93,925	66,581	133,180	184,242	177,697	205,159	220,879	274,025
Total North America	649,206	679,455	563,367	588,237	503,711	649,022	768,141	854,280	994,653	1,058,265	1,102,870
Argentina	3,023	3,786	4,369	3,857	2,756	3,986(?)	4,000(?)	5,000	8,488	9,370	8,598
Other, South America[1]	1,548	1,482	2,865	3,047	2,385	2,561	1,600	7,900	4,700	10,100	7,500
Total South America	4,571	5,268	7,234	6,904	5,141	6,547	5,600	12,900	13,188	19,470	16,098
Austria-Hungary[2]	37,909	36,366	1,944	4,379	3,689	4,106	4,690	5,494	5,961	7,141	8,913
Belgium	25,065	22,734	4,656	17,681	32,793	48,032	56,328	64,286	72,278	68,080	72,203
Czecho-Slovakia	—	—	3,266	2,211	2,632	2,456	2,702	2,496	2,260	2,464	2,639
France	23,401	14,081	12,043	16,600	17,058	15,370	19,194	20,811	22,641	21,495	27,447
Germany (excluding Upper Silesia)	58,110	56,161	36,208	45,186	67,527	65,146	35,163	55,335	77,712	84,034	90,168
Great Britain	12,596	12,213	11,506	12,275	2,727	5,551	7,512	5,938	5,303	4,777	6,759
Upper Silesia[3]	36,913	26,070	20,545	19,850	15,149	15,886	18,796	22,130	30,146	30,648	31,839
Greece	1,567	4,510	4,233	5,547	6,140	4,853	4,667	5,628	5,914	5,622	5,291
Italy	17,893	20,202	18,216	17,578	13,763	11,960	18,885	24,318	26,979	26,003	26,279
Yugoslavia	—	—	6,397	5,462	5,322	9,365	10,207	12,662	12,070	10,812	11,764
Poland (Upper Silesia excluded)	—	—	661	1,653	1,113	110	—	—	—	—	—
Russia	—	—	—	—	—	—	—	709	1,067	1,479	2,039
Spain	190,546	187,019	138,545	193,118	149,760	131,394	140,559	147,708	152,338	162,470	153,278
Sweden	3,586	2,525	1,004	991	616	418	338	740	901	621	364
Total Europe	407,586	381,881	259,224	342,531	318,289	314,647	319,041	368,255	415,570	425,646	438,983
Turkey	3,306	2,755	1,102	1,102	9,199	5,952	1,543	5,626	5,276	6,629	8,655
Indo-China	18,885	21,357	20,747	26,679	37,737	43,919	51,239	57,969	52,945	60,849	73,883
Japan	17,418	11,774	6,360	4,607	3,459	3,570	2,976	3,242	3,678	4,409	4,409
Total Asia	39,609	35,886	28,209	32,388	50,395	53,441	55,758	66,837	61,899	71,887	86,947

Australia	164,592	186,729	92,654	7,642	63,071	118,064	137,364	140,645	165,364	170,412	184,710
Rhodesia	4,278	10,257	14,171	16,353	19,808	22,962	12,343	7,003	3,674	4,292	6,561
Tunis	20,492	18,224	11,380	12,574	13,911	14,457	15,754	17,345	15,070	20,262	20,272
Total Africa	24,770	28,481	25,551	28,927	33,719	37,419	28,097	24,348	18,744	24,554	26,833
Grand Totals	1,290,334	1,317,700	976,239	1,006,629	974,326	1,179,140	1,314,001	1,467,265	1,669,688	1,770,234	1,856,441

[1]Does not include lead produced from South American ore exported to European countries, principally Belgium and Germany.

[2]After 1918 figures are for Austria alone.

[3]The statistics of lead production in Polish Silesia have been changed so that they are now given in terms of base bullion, which conforms to the practice in respect of most of the other countries. This change has been made retrospectively beginning 1922.

Year Book American Bureau of Metal Statistics, 1927, p. 45.

Production of Lead from Canadian Ores, 1887-1927 1

Year	Quebec		Ontario		British Columbia		Yukon		Totals		Cents per pound	Year
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
		$		$		$		$		$		
1887	—	—	—	—	204,800	9,216	—	—	204,800	9,216	5·400	1887
1888	—	—	—	—	674,500	29,813	—	—	674,500	29,812	4·420	1888
1889	—	—	—	—	165,100	6,488	—	—	165,100	6,488	3·930	1889
1890	105,000	4,704	—	—	—	—	—	—	105,000	4,704	4·480	1890
1891	88,665	3,857	—	—	—	—	—	—	88,665	3,857	4·350	1891
1892	—	—	—	—	808,420	33,064	—	—	808,420	33,064	4·090	1892
1893	3,931	146	—	—	2,131,092	79,490	—	—	2,135,023	79,636	3·730	1893
1894	—	—	—	—	5,703,222	187,636	—	—	5,703,222	187,636	3·290	1894
1895	—	—	—	—	16,461,794	531,716	—	—	16,461,794	531,716	3·230	1895
1896	—	—	—	—	24,199,977	721,159	—	—	24,199,977	721,159	2·980	1896
1897	177,084	6,340	—	—	38,841,135	1,390,513	—	—	39,018,219	1,396,853	3·580	1897
1898	221,760	8,382	—	—	31,693,559	1,198,017	—	—	31,915,319	1,206,399	3·780	1898
1899	—	—	—	—	21,862,436	977,250	—	—	21,862,436	977,250	4·470	1899
1900	11,200	490	—	—	63,158,621	2,760,031	—	—	63,169,821	2,760,521	4·370	1900
1901	318,052	13,784	—	—	51,582,906	2,235,603	—	—	51,900,958	2,249,387	4·334	1901
1902	420,000	17,090	—	—	22,536,381	917,005	—	—	22,956,381	934,095	4·069	1902
1903	—	—	50,000	2,119	18,089,283	766,443	—	—	18,139,283	768,562	4·237	1903
1904	—	—	885,000	38,135	36,646,244	1,579,086	—	—	37,531,244	1,617,221	4·309	1904
1905	—	—	284,212	13,378	56,580,703	2,663,254	—	—	56,864,915	2,676,632	4·707	1905
1906	—	—	2,200,000	124,454	52,408,217	2,964,733	—	—	54,608,217	3,089,187	5·657	1906
1907	—	—	—	—	47,738,703	2,542,086	—	—	47,738,703	2,542,086	5·325	1907
1908	—	—	—	—	43,195,733	1,814,221	—	—	43,195,733	1,814,221	4·200	1908
1909	—	—	—	—	45,857,424	1,692,139	—	—	45,857,424	1,692,139	3·690	1909
1910	—	—	—	—	32,987,508	1,216,249	—	—	32,987,508	1,216,249	3·687	1910
1911	—	—	—	—	23,784,969	827,717	—	—	23,784,969	827,717	3·480	1911
1912	—	—	—	—	35,763,476	1,597,554	—	—	35,763,476	1,597,554	4·467	1912
1913	—	—	33,000	1.537	37,626,899	1,753,037	2,804	131	37,662,703	1,754,705	4·659	1913
1914	—	—	—	—	36,289,845	1,625,422	47,920	2,146	36,337,765	1,627,568	4·479	1914
1915	40,401	2,262	88,985	4,983	45,377,064	2,541,116	810,000	45,360	46,316,450	2,593,721	5·600	1915
1916	698,760	59,485	685,932	58,393	39,157,701	3,333,496	955,222	81,318	41,497,615	3,532,692	8·513	1916
1917	1,378,001	153,468	1,586,711	176,712	29,483,725	3,283,602	127,844	14,238	32.576,281	3,628,020	11·137	1917
1918	2,110,059	195,180	1,684,366	155,804	47,594,328	4,402,475	9,249	856	51,398,002	4,754,315	9·250	1918
1919	2,280,000	158,825	1,487,586	103,625	40,060,113	2,790,587	—	—	43,827,699	3,053,037	6·966	1919
1920	905,472	80,949	2,255,520	201,643	32,792,725	2,931,670	—	—	35,953,717	3,214,262	8·940	1920
1921	595,881	34,215	3,312,493	190,203	60,298,603	3,462,346	2,472,615	141,978	66,679,592	3,828,742	5·742	1921
1922	—	—	2.890,397	180,216	87,093,266	5,430,265	3,323,508	207,221	93,307,171	5,817,702	6·235	1922

1923..........	520,041	37,334	4,401,494	315,983	99,541,818	7,146,107	6,771,113	486,098	111,234,466	7,985,522	7·179	1923
1924..........	1,058,983	85,820	5,055,368	409,687	168,467,628	13,652,617	903,520	73,221	175,485.499	14,221,345	8·104	1924
1925..........	2,051,100	187,060	7,209,534	657,510	242,454,502	22,111,850	1,875,442	171,040	253,590,578	23,127,460	9·120	1925
1926..........	3,729,636	251,788	7,398,795	580,730	266,812,461	18,012,509	5,860,373	395,634	283,801,265	19,240,661	—	1926
1927..........	6,496,577	341,461	7,990,709	528,729	292,770,544	15,388.020	4,165,331	218,929	311,423,161	16,477,139	—	1927
Total....	23,210,603	1,642,640	49,500,102	3,743,841	2,198,897,425	136,605,602	27,324,941	1,838,170	2,298,933,071	143,830,252	—	

[1]Dominion Bureau of Statistics (1926-1927, personal communication). Previous to 1913 the figures reported show the metal content of the shipments and are somewhat in excess of the actual amount recovered. Since 1912 the data given represent the quantity of lead produced in Canada from domestic ores, together with the estimated lead recovery from lead ores and concentrates exported. From 1887 to 1908, average prices at New York; 1909 and 1910, average prices at Toronto; from 1911 to 1919, average prices in Montreal were used in making up the values shown. In 1926 and 1927 the average yearly price at London was used.

Production of Zinc in Canada, 1911-1927

(Figures supplied by the Dominion Bureau of Statistics)

Year	Pounds[1]	Total value	Average price per pound
		$	Cents
1911	1,877,479	108,105	5·758
1912	4,283,760	297,421	6·943
1913	5,640,195	318,558	5·648
1914	7,246,063	377,737	5·213
1915	9,771,651	1,292,789	13·230
1916	23,364,760	2,991,623	12·804
1917	29,668,764	2,640,817	8·901
1918	35,083,175	2,862,436	8·159
1919	32,194,707	2,362,448	7·338
1920	39,863,912	3,057,961	7·671
1921	53,089,356	2,471,310	4·655
1922	56,290,000	3,217,536	5·716
1923	60,416,240	3,991,701	6·607
1924	98,909,077	6,274,791	6·344
1925	109,268,511	8,328,446	7·622
1926	149,938,105	11,110,413	7·410
1927	165,495,525	10,250,793	6·194

[1]Estimated smelter recoveries, including the actual zinc recovered at Trail, B.C., for years 1916 to 1925.

Production, Imports, Exports, and Consumption of Pig Lead, Canada, 1917-1927

(In metric tons)

—	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Production pig lead.........	14,565	14,318	15,569	13,449	27,752	39,550	45,528	75,660	104,271	121,832	135,651
Imports, pig and scrap......	5,220	4,988	4,790	12,083	800	876	1.221	341	220	347	184
Totals.............	19,785	19,306	20,359	25,532	28,552	40,426	46,749	76,001	104,491	122,179	135,835
Exports, pig...............	455	3,384	5,136	8	10,787	18,816	21,384	55,200	80,492	91,859	108,494
Consumption[1].............	19,330	15,922	15,223	25,500	17,800	21,600	25,365	20,801	23,999	30,320	27,300
Exports, ore, concentrates, etc., lead contents.......	6,081	10,287	5,960	3,424	2,837	4,964	3,606	5,919	17,005	6,189	5,910

[1]Year Book of the American Bureau of Metal Statistics, 1927, pp. 56 and 59.

INDEX

TO

PERSONS, PLACES, PROPERTIES, AND MINERALS

(NOTE: m = mine, claim, or prospect. Names in brackets are those of mining divisions.)