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THE MINERALOGRAPHY OF THE RAINBOW M.C.
SUMALLOW RIVER BRITISH COLUMBIA

600392

An essay submitted in partial
fulfillment of the requirements of the
Course of Fourth year Applied Science
in Geological Engineering of the University
of British Columbia

G. D. McCORD

THE UNIVERSITY OF BRITISH COLUMBIA

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FOREWORD

This report was written in partial fulfillment of the requirements of the Mineralography Course (Geology 409), of the University of British Columbia.

The facilities provided in the Mineralography laboratory, at this university, were employed to ascertain the information recorded in this report. The author wishes to acknowledge the willing assistance given to him by Dr. R.M.Thompson and J. Gower, both of the department of Geology and Geography of the University of British Columbia.

ABSTRACT

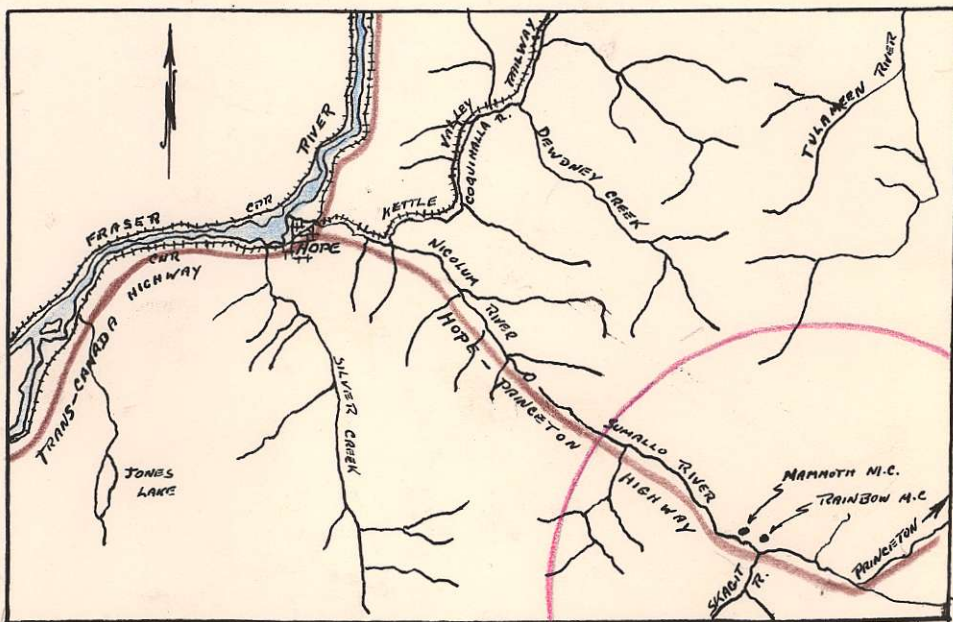
The Rainbow Mineral Suite is composed of one massive, metallic specimen and eleven siderite-jamesonite specimens. These samples were collected randomly from the property, which is reported, by C.E. Cairnes, to have both contact metamorphic and vein type mineral deposits. Jamesonite, the most abundant sulphide mineral, occurs as prismatic crystals, oriented in accordance with a radiating, colloform growth of siderite crystals. The structure in most of the specimens appears to have resulted from solidification (crystal growth), of ^{thin} ~~their~~ coatings of a colloidal solution that was deposited from hydrothermal solutions. The banding was intermittent and was characterized by a variable chemical composition.

The other sulphides present, in order of their abundance are: Pyrrhotite, Arsenopyrite, Sphalerite, Chalcopyrite, Pyrite and Galena. The paragenesis of these minerals is illustrated on page 12 .

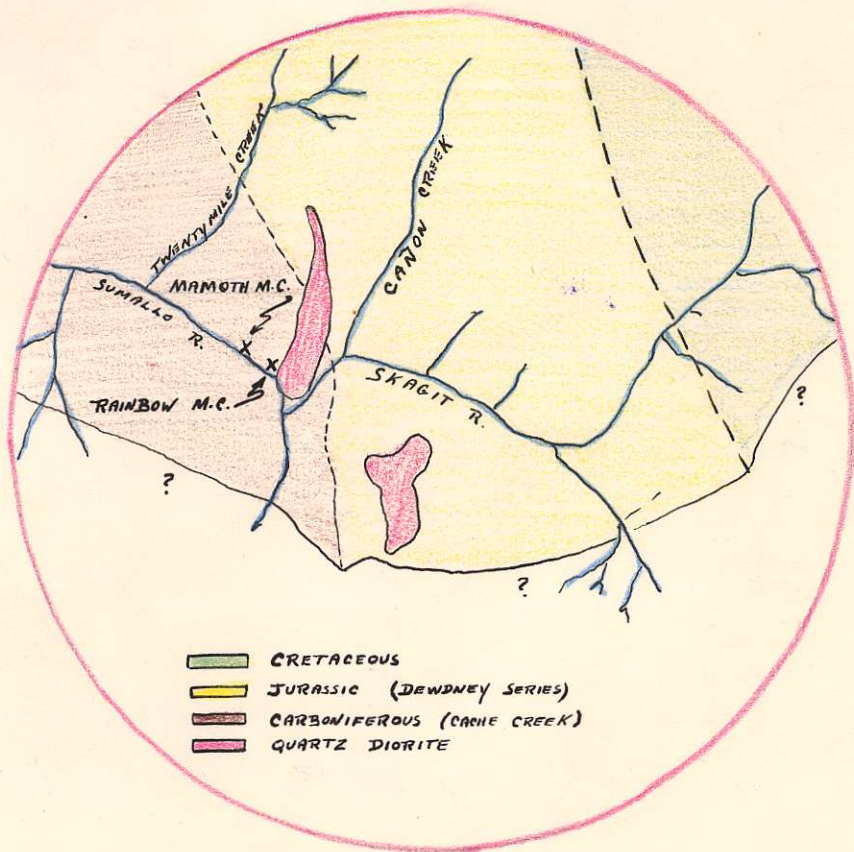
The gold and silver content of this mineral deposit is not represented by gold or silver minerals in the ^{polished} ~~thin~~ sections. It was shown microchemically that gold was contained in arsenopyrite, and silver in tetrahedrite.

Material for the tests was taken from hand specimen #7.

The mineralization occurred in post lower Cretaceous^e time under conditions ranging from mesothermal to epithermal. The source of the mineralizing fluids is believed to have been a quartz diorite intrusive, exposed immediately east of the Rainbow Mineral Claim.



Location



Geology

THE MINERALOGRAPHY OF THE RAINBOW M.C.
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Introduction

This is a report on the microscopic study of a group of mineral specimens collected by Dr. H.V. Warren at the Rainbow Mineral Claim on the Summalow River, British Columbia. The river runs south easterly, parallel to the Hope-Princeton Highway, to join the Skagit River which flows southerly into the State of Washington. The claim is 22 miles south east of Hope, British Columbia.

The mineral deposits in this area are generally low grade Pb, Zn, Cu, Sb, Fe Sulphide deposits that carry some gold and silver. Generally the mineral deposits fall under two groups:

(1) Contact metamorphic and high temperature replacement deposits chiefly in limestone, whose principle values are in gold and copper;

(2) Lead-silver vein deposits.

The Rainbow group consists of both types.¹

The deposits are in Carboniferous rocks that contain banded chert, argillites and lime silicate rock

¹ Cairnes, C.E. Geological Explorations in Yale & Similkameen Mining Divisions, Government of Canada Department of Mines, Summary Report, (Part A) for 1922.

members. They are characterized by an abundance of jamesonite associated with siderite. Jamesonite is reported in the 7th Edition of Dana, 1942, as also occurring at: "Slat Creek and MacKey, Custer County and elsewhere in Idaho; in British Columbia in the East Kootenay and other districts; also near Frederickton, New Brunswick and in dolomite near Barrie, Frontenac County, Ontario." *& elsewhere.*

Reports by the mine recorders of the Yale Mining Division give information on the development of the properties in this area. A summary report in 1923 by C.E. Cairnes, of the Geological Survey of Canada, contains the ore minerals present, the geology of the country rock, some information on the development, and a brief theorization on the formation of the deposits. "Mineralogical Notes" by H.V. Warren on "Ore Minerals from Western Canada" give *Ref?* results of spectographic analyses of the jamesonite in this mineral deposit.

The Rainbow Mineral Claim, Sumallow River B.C.

Mineralization and Geology

The mineral bodies of the Rainbow Group are generally low-grade with high pay streaks. The minerals present include galena, sphalerite, calccopyrite, pyrite, pyrrhotite and arsenopyrite. Sulphantimonide (jamesonite

and berthierite) and sulpharsenide salts of lead and copper
 are present in minor proportions. Quartz is the chief ~~gangue~~^{gangue}
 mineral. Gold and silver have been shown to be present in
 a smelter report from Trail, B.C. A spectographic analysis,
 at the University of Toronto, showed traces of Ag, Cu, and
 ? As present in jamesonite in addition to the main constituents
 of the mineral ($4\text{PbS} \cdot \text{FeS} \cdot 3\text{Sb}_2\text{S}_3$).

The Rainbow Group occurs in Carboniferous rocks.
 These are chiefly banded cherts and argillite, with small
 portions of greenstone. To the east of this property is the
 area of quartz diorite which together with a number of
 porphyry dykes, that are probably off-shoots from the larger
 intrusive, is regarded as the particular source of the
 metamorphism and mineralization of the group. Shortly before
 intrusion of quartz diorite and dykes, the formations were
 subjected to considerable fracturing and deformation; the
 ascending hot solutions followed the resultant lines of
 weakness. The veins are mostly less than half a foot wide.
 They strike 60° east with a steep dip and they are generally
 parallel. "On the whole the vein deposits have well-
 defined walls, but the ore deposits may occupy a zone of
 fracturing along which mineralization occurs, and on either
 side of which the rocks are impregnated for a variable
 distance without limiting walls."²

2 Cairnes C.E. Summary Report, 1922.

"These deposits are invariably low grade and depend for their economic importance on their bulk, which is in certain cases large, and on transportation facilities, which up to the present, have been poor. If a transprovincial highway were built through this section, an impetus would doubtless be given to both prospecting and development work." The highway has now been constructed.²

History and Development Work

1914: The first actual shipment to Trail of ore from the Yale mining Division was made. Twenty tons were shipped from the Rainbow Group. (The Rainbow Group was comprised of four mineral claims; the Rainbow, Keno, Wonder, and Wonder #2). The owner was Canada-States Mining Development Corporation Ltd. The assays of the shipment of ore were as follows:

Au - 0.6 oz/ton (0.0002%)
 Ag - 15.7 oz/ton (0.05%)
 Cu - 0.7%
 Zn - 2.8%

1920: No work was being done on the property.

1923: The development work to this time consisted of a number of open cuts and two short adits on a series of narrow veins and on less regular replacement deposits.

1929: Under the option of Hope Holdings, Ltd., plans were made to drill a cross cut to intercept ore thought to be indicated by a surface exposure in which some scanty

mineralization was found. The operations were suspended pending further surface prospect work.

1951: Apparently no work has been done on these claims since 1929. There was no activity at the time Dr. Warren collected these specimens in 1948.

Mineralographic Study

Megascopic Examination

There are twelve specimens comprising this mineralography problem. The specimens are essentially all the same structure and mineralogy. They all have a vuggy nature on their surfaces and some times at considerable depth below the surfaces. The structure of these specimens will be considered later; ⁱ In general the open spaces and comb structure of quartz and siderite suggest free growth of minerals outward from a quartz area. Yellow and brown ^{spherules} ~~sphericals~~ in the dark mineralized siderite are characteristic of the specimens. The specimens vary somewhat in the degree of siderite and jamesonite mineralization. Mostly jamesonite occurs as unsupported prismatic crystals, but in specimen #9 it is massive and fills all spaces not occupied by siderite spherulites.

One specimen^e in the suite of ores, (#6), is unique in that it is almost entirely composed of massive Fe, Zn, Cu, As sulphides. Quartz and limonite occur sparsely as the

gangue. This specimen^e exhibits a rough banding of the four most abundant minerals. The order is quartz, sphalerite, quartz, arsenopyrite, pyrrhotite and pyrite, and then sphalerite once more. This structure represents a series of depositions, presumably in a vein.

All the minerals present in the specimens are apparent megascopically, but not all could be identified. Those identified were talc^t, quartz, limonite, calcite, siderite, arsenopyrite, pyrrhotite, sphalerite and tetrahedrite. Also present were prismatic black or blue crystals (jamesonite) and prismatic yellow crystals (anglesite).

Fresh surfaces of the siderite-jamesonite specimens are greenish white to cream colored, due to the abundance of quartz and talc. Mineralized portions are dark due to jamesonite in the siderite. On the weathered surface the secondary minerals, limonite and anglesite are brownish reds and yellow.

The specimens were collected at random and no record of their original structural location is available.

Microscopic Examination

The minerals identified in the polished sections are listed below with their distinguishing characteristics.

Arsenopyrite - The prismatic crystal shapes, the silvery white color and hardness of F indicated arsenopyrite, microscopically as well as megascopically. The mineral was distinguished from white pyrite by its anisotropic nature and from ~~leucopyrite~~ by its negative reaction to an HNO_3 etch test. Microchemical tests were positive for gold in this mineral. ?

Chalcopyrite - The brass yellow color, hardness C, and brittleness are characteristic. The mineral was slightly anisotropic changing from darkness to a brown. A microchemical test proved the presence of copper and was negative for nickel, indicating that pentlandite, a common associate, (and very similar to chalcopyrite) was not present. ??

Galena - The more obvious characteristics; hardness B, galena white color, parallel triangular cleavage pits, and brittleness^o were used to identify the mineral. Isotropism and the HNO_3 etch test verified the identification.

Pyrite - The mineral was distinguished from marcasite by its isotropic nature. It can easily be determined in polished section by its pale yellow color, poor polish, square outline and hardness of E.

Pyrrhotite - This mineral is highly magnetic and isotropic. Its creamy gray color and hardness of D were also of use, but etch tests were employed to identify the mineral; KOH stained brown, KCl formed a brown halo on the mineral and the drop turned yellow, HNO_3 effervesced and slightly stained brown, and HgCl_2 , KCN, FeCl_3 were negative. If this mineral is nickeliferous it is only slightly so; only three or four indistinct black spheres were present in the microchemical test.

Sphalerite - The resinous lustre and internal reflection suggested this mineral. Microchemical tests were positive for Zn, Fe and Cu (Cu was from an intergrowth with chalcopyrite). The gray color, hardness from B to C, cleavages, (megoscopic), and isotropism were helpful in confirming the identification.

Jamesonite - This mineral had a hardness of B and was anisotropic with blue, gray, and brown interference colors. It was grouped by etch tests and identified by microchemical tests (positive for Sb, Fe and Pb.). The etch tests were: KOH, iridescent; HCl, poor to negative; HNO_3 , brown to blue colored stain with no effervescence; aqua regia, effervescence with a brown stain. HgCl_2 , KCN and FeCl_3 were negative. The mineral was identified from berthierite by its hardness of B, (berthierite has a hardness of D).

A positive micro-chemical test for silver was obtained from an area, in specimen #7, believed to be massive jamesonite. Dr. Thompson suggested that this mineral was ^ttetrahedrite. Formerly, chemical tests for Cu, Pb, Sb and Fe were proven positive for this mineral; (the copper was believed to have come from chalcopyrite). A conchoidal fracture is present that is characteristic of ^ttetrahedrite and not of jamesonite. Also, straight sides meeting at a well defined 60 degree angle bound the mineral, suggesting a tetrahedral crystal ~~structure~~^{form}. No tetrahedrite was identified in the polished sections, but on the strength of: X-ray identification of jamesonite ($4\text{PbS} \cdot \text{FeS} \cdot 3\text{Sb}_2 \text{S}_3$) and not owyheeite ($8\text{PbS} \cdot 2\text{Ag}_2\text{S} \cdot 5\text{Sb}_2 \text{S}_3$); the positive test for Cu and Ag in the mineral mass; and the megascopic evidence sighted above; the presence of tetrahedrite is strongly indicated. *I x rayed it & told him it was freibergite!*

Non-metallic minerals were identified by thin sections, X-ray and microchemical tests. Those present in the specimens are listed here.

Siderite - Optic properties, (cleavage, variable relief, pseudouniaxial), indicated a carbon^aite, and X-ray examination proved siderite.

Cerussite - The carbonate characteristics in thin section and the existence of high relief at all times was indicative

of cerussite.

Talc - This mineral was recognized by megascopic examination, (hardness of 2 and green color), and also in thin section where it occurred, apparently, as an alteration product on the boundaries of isolated cerussite crystals. It also occurs as feathery flakes within the quartz areas.

Anglesite - The secondary yellow prisms were identified by X-ray.

Paragenesis

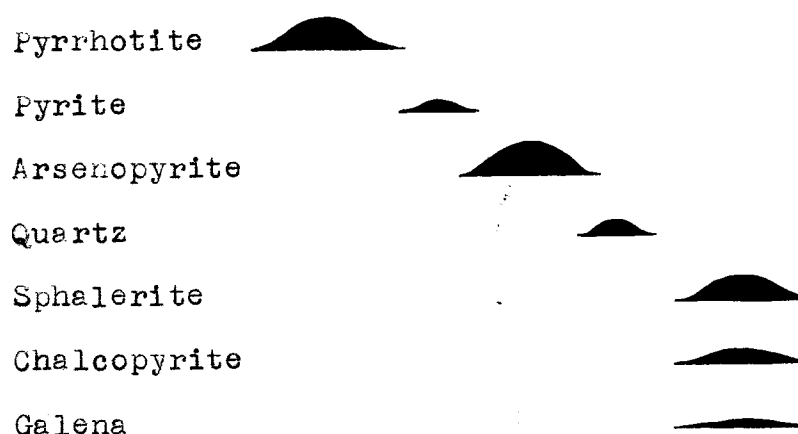
The Metallic Sulphides

The paragenesis of the metallic sulphides is readily obtained from the massive metallic specimen present in the suite. In the polished section it appears that pyrrhotite has been emplaced first. The vein was then sheared, resulting in the development of a twin structure in the pyrrhotite, and finally the zone was fractured and dilated, perhaps by the release of the shearing stresses. First, small quantities of pyrite, and then greater quantities of arsenopyrite, were precipitated in the open spaces and healed them. Quartz was then deposited on the outer surface of the arsenopyrite. Tension appears to have caused dilation in the quartz zone which was then mineralized by sphalerite, chalcopyrite, and galena. Small areas of these three minerals occur throughout the section along

boundaries of the minerals formerly deposited. Presumably some of these latter minerals worked along the mineral boundaries, out from the main zone of deposition. In the hand specimen, sphalerite also occurs adjacent to the original pyrrhotite, paralleling the sphalerite zone on the other end of the specimen. Since the paragenesis of the sulphides has followed the order of deposition, as set out by Lindgren; it is reasonable to believe the sphalerite was all deposited at the same time along two breaks in the vein. Minute veins in the pyrrhotite cut all the minerals in the specimen at places. These veins appear to be filled with quartz and secondary iron oxides.

Any further theorization upon the mode of deposition is impossible, because none of the country rock is recognizable in the specimen. The only relations to structure are; the parallel banding of the minerals, and the surface of the quartz band, which has broken cleanly, suggesting that this is the contact between the wall rock and the mineralized vein. The only replacement texture seen was where chalcopyrite, sphalerite and galena were introduced along mineral boundaries.

Paragenesis of Minerals in Specimen #6:



The paragenesis of these minerals was interpreted by well defined structures. The microscopic structures indicated the same order of deposition as can be interpreted by a megascopic examination of section #6. Illustrations of these microscopic structures would be irrelevant, because there are no unusual characteristics of the depositional cycle that require explaining.

The presence of "mutual boundaries" structure between the sphalerite, chalcopyrite and galena, wherever they occur in the sections, is evidence of contemporaneous deposition of these minerals.

The sulphides listed in order of their abundance in specimen #6 are:

pyrrhotite
arsenopyrite
sphalerite
chalcopyrite
pyrite
galena

(Jamesonite is the most abundant mineral in the suite of specimens).

The Siderite, Jamesonite specimens:

The remainder of the specimens are characterized by quartz, siderite, and jamesonite mineralization. Jamesonite is the only sulphide that occurs in abundance in the siderite province. Occasionally the sphalerite, chalcopyrite, galena intergrowth, arsenopyrite, and tetraehdrite also occur in this zone. The sulphides are more abundant in the quartz province or on the boundaries between the quartz and siderite. The paragenetic relation of jamesonite to the other sulphides is not known except for this sparse evidence. The siderite and jamesonite deposition apparently took place after the greater portion of the sulphides had been deposited. The sphalerite, chalcopyrite, galena, intergrowth that was seen in these specimens was in the form of an irregular glob on the exposed surface of siderite. Jamesonite crystals were not included in this deposit, but they coat its surface, therefore, the sulpho-salts apparently represent a late

stage in a period of siderite crystal growth and the first phase of one of the intermittent periods of jamesonite deposition.

These specimens essentially exhibit open space growth of crystals, therefore they cannot represent replacement in the true sense of the term. The mineralization may have taken place in open vugs in a limestone horizon, or these specimens may be from veins. From the abundance of carbonate minerals in the specimens it would seem that a limestone horizon had a function in the mineralization.

All of these specimens have a fine grained quartz zone upon which well developed comb quartz has grown. On this rough surface colloform siderite has grown. These spherulites are composed of thin, lenticular crystals (typical of the carbonates) that have grown in a radial fashion from each small protrusion on the quartz surface. These spherulites of siderite do not grow beyond 3 to 4 millⁱmetres in diameter, therefore the vuggy mass is made up of an accumulation of spheres. The limitation as to the size of the spheres and the radiating nature of the siderite crystals in these spherulites, suggests that the siderite precipitated from a colloidal coating on the quartz walls. Excess iron present in the solution would form the cream colored halos present in the siderite crystals at a short distance from the original surface of deposition, or from

the centre of a ~~spherical~~^{spherulite} which has formed around an isolated quartz crystal. The rough, comb quartz surfaces caused the yellowish siderite bands bounding the quartz provinces, to be very irregular and cusped.

Stained siderite is mentioned in Dana's Textbook of Mineralogy, fourth edition, and in other mineralogical papers. Dr. Watson mentions a buff colored calcite occurring in the colloform sulphide veins of Port Au Port Peninsula, Newfoundland. Edwards speaks of the fluctuation of the iron content in colloidal solutions from which colloform cassiterite is deposited. "Presumably the iron content of the solutions depositing the cassiterite fluctuated and when it was iron-rich, hematite and ferriferous cassiterite were formed."³

Jamesonite is randomly scattered through the siderite, but it is generally found on the convex side of the cream colored halos. Cusped areas of concentrated jamesonite are found where three or more iron halos show the outline of a restricted open space that was subsequently filled with clear siderite and jamesonite. In some localities alternate black and cream banded halos have formed by the rhythmic formation of jamesonite and stained siderite layers. During the latter stages, at least, jamesonite has grown as isolated crystals on the free surfaces of the siderite ^hspherulites. The structure of the polished sections

³ Edwards, Texture of Ore Minerals, Australian Institute of Mining and Metallurgy, 1947.

indicate that the jamesonite has been deposited in this way throughout an intermittent deposition and crystallization of siderite.

Alternating bands of galena, sphalerite and siderite are reported by Edwards to occur at Mt. Magnet in Tasmania. The structure was believed to have been caused by rhythmic deposition, as ^{a gel} ~~galena~~, of sulphides and non sulphides from the same solution.³

In specimen #9 massive jamesonite is interstitial^t between quartz grains and siderite spherulites. Few cream colored halos are present here, as control for the jamesonite. In other specimens, such as #7, the jamesonite occurs in thin, generally radiati^{ng} ~~ed~~ crystals, controlled by the spherulite boundaries or by crystal boundaries within the spherulites.

In summary, it appears that comb quartz grew on a silicic wall rock, then colloidal solutions containing CO₂ and excess iron, coated the rough quartz surface and solidified. During solidification siderite crystals grew across the colloidal layers without destroying the original composition of each. Subsequently colloidal layers containing antimony, lead and excess iron were deposited and crystallized in the same manner. The latter stages of deposition contain no excess iron and clear siderite and

³ Edwards, Textures of Ore Minerals, Australian Institute of Mining and Metallurgy, 1947.

jamesonite were precipitated. There was a period of FeCO_3 mineralization followed by depositions that contained increasing amounts of iron, (the excess Fe stained the FeCO_3 a cream color). Subsequent depositions contained Pb and Sb which combined with sulphur and the excess iron to form jamesonite.

Cerussite, that was found in thin sections, can be seen megascopically as brown spots within the quartz. This mineral has presumably formed from supergene ^{solutions} enrichment, since the mineralization had taken place.

Secondary Minerals

Limonite, anglesite, cerussite, talc, and perhaps some quartz represent the minerals of these specimens formed by oxidation in place or from supergene solutions.

Limonite - This mineral is evidenced by a brick red coloration of the cream colored siderite bands, and on the surfaces of the sulphides containing iron. Transported limonite has accumulated as massive deposits in some open spaces of the rock. It occurs in both types of specimen.

Anglesite - A yellow coating of prismatic crystals is, in places, the last stage of deposition on the surfaces of the vuggy siderite specimens. This supergene mineral was identified by X-ray.

Cerrussite - This mineral occurs within the quartz areas as isolated pentagonal crystals; it is also believed to be supergene.

Talc - Talc is an alteration product of ultra mafic minerals (e.g. olivine and serpentine). The widespread presence of this mineral with the fine grained quartz of the specimens may indicate the presence of altered portions of the original host rock. |

Origin of the Deposits

Temperature and Age of Mineralization

The presence of two types of specimen in the Rainbow M.C. suite, suggests a transition of temperature of deposition. The lack of open spaces and the abundance of medium temperature sulphides in specimen #6 indicates an initial mesothermal type of mineralization. Later stages resulted in abundant deposition of siderite and jamesonite with minor amounts of the earlier sulphides. These deposits clearly display crustified banding, vugs and cockade structure, commonly regarded as characteristic of the deposits formed at low temperature and pressure.

The quartz diorite intrusive exposed immediately to the east of the Rainbow M.C. extends northerly and is almost identical lithically and structurally with the

quartz diorite at the head of Lewdney Creek. These intrusives intersect Carboniferous sediments, and also sediments regarded as lower Cretaceous. The intrusives were assigned tentatively as late, or post lower Cretaceous, or possible Tertiary age by C.E.Cairnes.

Character of Solutions

The original mesothermal mineralization is believed, by the author, to have formed from hydrothermal solutions. The colloform structure and radial growth of crystals in the second type of mineralization suggests deposition in colloidal form.

Dr. K. De P. Watson lists the following features as diagnostic of contraction upon synthesis; (a condition that is believed to indicate solidification of colloids): Scalloped banding; concentrically banded spherules; banding within a single mineral; and, concentric cracks, radial cracks and cusped pores. All of these features are present in the Rainbow specimens except the radial and concentric cracks. As has been suggested, the minerals of this suite appear to have been deposited by intermittent phases, with only thin films of colloidal material being laid down at one time. This feature may explain the lack of prominent cracks in the structure.

"Colliform textures may result from (1) the transportation of the constituents in true solution and their precipitation as colloids at the site of deposition or (2) the transportation of constituents in a colloidal sol and their flocculation at the site of deposition."⁴
The first method of deposition is at least a very descriptive explanation for the structure of siderite in these specimens.

Source of Solutions

It would seem logical to accept the origin of these mineralizing fluids as being phases of the quartz diorite intrusion that outcrops immediately east of the claims. In regard to the Mammoth M.C. it has been suggested that mineralization resulted from the intrusion from a number of porphyry dykes. The Rainbow M.C. mineralization appears to have been intermittent and to have taken considerable time; a more permanent source of mineralizing fluids would be required than that provided by dykes. The quartz diorite intrusive could meet these requirements.

⁴ Watson, K. De P, Colloform Sulphide Veins of Port Au Port Peninsula Newfoundland, Economic Geology, December 1943, p 621.

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