

*Low x-ray counts needed
Minor English mistakes
Good presentation.
1st class.*

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STUDY OF THE ORE
SPECIMENS FROM RAINBOW MINERAL CLAIMS
YALE DISTRICT, B.C.

A REPORT
PRESENTED TO THE DEPARTMENT OF GEOLOGY
THE UNIVERSITY OF BRITISH COLUMBIA

IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR MINERALOGRAPHY COURSE

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MARCH 1956

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INTRODUCTION

1

The study of the minerals of Rainbow Claim group was done on the samples supplied by Dr. R. M. Thompson, Department of Geology, University of British Columbia. About fifty samples were provided and out of those selected eleven polished sections were made. Some of these sections were used by C. D. McCord in 1951 and prepared by him. More polished sections were prepared by the writer. In addition to polished sections two thin sections were prepared and used.

The minerals were studied and identified with the aid of Binocular Microscope, Mineralographic Microscope, etch tests, microchemical study, Petrographic Microscope. Oil index media was also used.

Representative areas were selected and illustrated by photographs and diagrams drawn with the aid of Camera Lucida.

The writer did not visit the property and has no acquaintance with broad geologic features other than that obtained from meagerly described reports by British Columbia Department of Mines. Hence the conclusions and report are based solely on the specimens supplied.

The writer wishes to thank Dr. R. M. Thompson for the specimens which he supplied and for his valuable assistance which made the preparation of this report possible.

LOCATION¹

The Rainbow group comprising three mineral claims is located in the Yale district of British Columbia. It is one of the properties in the area which is known as 23 Mile Camp. The camp is situated near the junction of Sumallo and Skagit rivers, 23 miles from Hope, on the north-eastern side of Sumallo. Access is most convenient by way of the road from Hope running south-east along Nicolum and Sumallo rivers. Several trails may also be used to reach the area. One of them begins just outside of Hope where Silverhope Creek enters the Fraser River, runs along Silverhope Creek in a south-easterly direction, then north-east along Skagit River. The trails are indicated on the accompanying map of the area. Present condition of the roads and trails is good. (Private commentary of J. Earl who worked in the area in the summer of 1954.)

Limited accomodation was available (up to 1938) for travellers at the cabin of W. H. Robinson, property owner, on the road 22 miles from Hope. Camps and cabins at various other mining properties might also afford shelter providing they are still in a usable condition.

Topography of the area is rugged since the region lies entirely within the limits of the Cascade Mountain system. The highest points in the vicinity of 23 Mile Camp reach an elevation of 6,600' with much higher and glaciated peaks to the south.

a

¹ British Columbia, Annual Report of the Minister of Mines 1938, pp F3.

The general geology of the area is represented on the accompanying map. In the immediate vicinity of the Rainbow mineral claims it can be represented by the following table:

Paleozoic and Mesozoic	-	Hozameen group - chiefly chert, argillite, phyllite, limestone.
Mesozoic	-	Dewdney Creek group - tuffs, agglomerates, sandstone, argillite, conglomerate.
Mesozoic and Cenozoic	-	Intrusive quartz diorite, diorite.

ECONOMIC GEOLOGY¹

The workings on these claims consist of an open-cut about 30 feet long on the outcrop, an adit 43 feet long situated 30 feet below the open-cut with which it is connected by an upraise, a second open-cut 25 feet long made for an approach to a lower adit situated about 100 feet below the upper adit but about 100 feet south of it.

Mineralization is along veins in a rock resembling quartzite but in which occurs considerable epidote. This quartzite is fissured and fissures are filled with sulphides, chiefly arsenical pyrites. Strikes and dips of these veins are nearly parallel (N30°E/70°±NW). The fissures vary from a few inches to 5 feet in width.

In 1914 nine tons of ore were shipped to Trail and returned per ton 0.06 oz. Au, 15.7 oz. Ag, 0.70% Cu, and 2.8% Zn.

¹ W. M. Brewer, M.E., B. C. Annual Report of the Minister of Mines 1915, pp K264-265.

The deposit is classified partially as vein type and partially as Contact Metamorphic type.

MINERALOGY

Out of the eleven polished sections examined only three were found to be suitable for mineral identification other than tetrahedrite and jamesonite. These sections, massive sulphides with practically no gangue, supplied most of the information for the mineral characteristics described on the following pages. Jamesonite and tetrahedrite were more common in the remaining sections and, to a point, were the only important minerals although presence of others especially arsenopyrite and chalcopyrite was apparent.

MEGASCOPIIC

Megascopic examination revealed presence of pyrite, arsenopyrite, sphalerite, fibrous mineral later identified as jamesonite, and chalcopyrite. These formed massive types or were distributed in small amounts in the gangue matrix. The grain size of these minerals varied considerably from lumpy masses to invisible grains. When not of massive type the minerals were in more or less crystalline form, cemented by sugary gangue -- mainly quartz and a carbonate. Colour of the gangue varied from very light to almost black. Often a yellowish coating was present on carbonate-rich portions. In general specimens showed signs of oxidation hence, the yellowish coating might be due to the Fe in the carbonate.

There were several striking textural features which could be observed megascopically or with the aid of the binocular microscope. Most striking was the presence of colloform texture as a series of concentric layers

showing convex curvature. This was even more pronounced viewed on the polished surface. Yellow layers encircled somewhat darker core. This core by later petrographic and mineralographic study showed to be quartz crystals, jamesonite or, less often, tetrahedrite. Yellow concentric layers surrounding the core were of carbonate material. This carbonate material, under petrographic and mineralographic microscope, revealed presence of nest-like bundles of jamesonite. Under oxidizing conditions jamesonite was altered to what appears to be bindheimite -- a yellowish powder. By such alteration jamesonite bundles could be responsible for the postulated origin of the colloform texture.

correct use of term?
 The presence of miarolitic cavities was common. These were occupied by perfectly developed quartz crystals or needle-like crystals of jamesonite. Quartz crystals usually pointed towards the cavity whereas jamesonite crystals intersected at various angles giving a boxwork texture. Quartz and carbonate (siderite?) were sometimes arranged in a comb-like fashion where individual crystals were arranged perpendicularly to the wall of the vug.

Some specimens had thin buffy appearance which suggested alteration, possibly ankerite or dolomite.

MICROSCOPIC

Primary Minerals

Arsenopyrite:

Arsenopyrite showed extreme diversity in size, shape and distribution. It was most commonly massive, measuring up to half an inch across. This could be observed megascopically. Occasional samples showed well developed crystals of same size imbedded in the country rock, however, no such

megascope crystals were observed where arsenopyrite was part of compact samples containing other common sulfides. Massive type arsenopyrite was often fractured and granulated showing microbrecciated texture. During the shearing many fragments had been broken in such a fashion that they showed diamond shaped outlines. Well developed diamond crystals also occurred individually and did not seem to show any evidence that they were once part of the massive type. Commonly the fractures were veined by chalcopyrite and occasionally by sphalerite, when in contact with this mineral. Granulated disarranged fragments varied in size down to a few microns.

Pyrite:

Pyrite occurred as small cubes averaging ≈ 20 microns in size, as larger fractured masses of subhedral cubic outline ≈ 1 mm. in size, or as corroded remnants of fractured masses down to a few microns in size. This mineral showed many features that were typical of arsenopyrite. Like arsenopyrite it showed considerable shearing which occurred because pyrite, very likely, crystallized at the same time or soon after arsenopyrite; but this belief is more postulated since definite evidence is meager. Some grains of pyrite were partially replaced by chalcopyrite and sphalerite but individual pieces, when joined, formed euhedral outline. Pyrite, when crushed and disarranged, was cemented by pyrrhotite or sphalerite; when fractures appeared, these were occupied by chalcopyrite or goethite.

Pyrrhotite:

Pyrrhotite was very plentiful in some sections. Megascopically it showed massive form but, when viewed under microscope, the masses were highly altered to marcasite and goethite. Considerable amount of fracturing must have been present to facilitate oxidizing solution to pass through.

Fractures were often highly obscured because, in many cases, only remnants of pyrrhotite were left as separate islands separated by altered mass, much of which was goethite. The skeletal remnants varied in size ranging from lumpy chunks down to one micron in size and showed orientation and shape typical of herringbone texture. Colloform marcasite, derived from disintegration of pyrrhotite, was scattered throughout the pyrrhotite body but almost invariably was rimmed by a pyrrhotite skeletal-like remnant.

Chalcopyrite:

Only a relatively small amount of chalcopyrite was present. Sphalerite and tetrahedrite were common host minerals of chalcopyrite. In these it appeared as small oriented blebs or worm-like bodies from 30 to a fraction of a micron in size as a result of exsolution. Several megascopic grains a few millimeters in size were noted. These lay in the pyrrhotite and sphalerite neighbourhood. When observed under the microscope such grains showed to be replacing pyrrhotite and commonly showed inclusions of sphalerite averaging 8 microns in size. Euhedral arsenopyrite crystals were often surrounded by a mass of chalcopyrite. Many fractures in massive pyrite and arsenopyrite were veined by chalcopyrite and assumed the shape of the arsenopyrite crystals especially towards the end of the fractures. (Fig. 2).

Sphalerite:

Many of the features of sphalerite have already been mentioned in the description of previous minerals. Next to pyrrhotite it was the most abundant occurring mineral, assuming irregularly formed bodies. Commonly it showed pitted surface with occasional goethite veinlets due to oxidation. It ranged in size from one inch to several microns, the latter size in the form of blebs due to exsolution in chalcopyrite. Perfectly euhedral

crystals of quartz were often surrounded by sphalerite. Caries and mutual boundary textures were typical.

Tetrahedrite (argentiferous)

No tetrahedrite was observed in the sections containing very little gangue. Seeming to be restricted to the specimens rich in carbonate and quartz it occurred as separated nodular bodies. Megascopically it was not fresh but showed irridescent bluish tarnish which might have been a very thin layer of covellite pseudomorphic after tetrahedrite. Microscopically it contained needle-like crystals of jamesonite and exsolution chalcopyrite. (Fig. 3). Size was generally large -- 2 mm[±]. Microchemical tests showed presence of silver in addition to elements comprising tetrahedrite.

Jamesonite:

Although this mineral is similar to boulangierite, zinkenite, semseyite, meneghinite, its validity is supported by Fe presence obtained by qualitative analysis in addition to Pb and Sb. *X ray check previously.*

Jamesonite occurred associated with tetrahedrite in quartz-carbonate gangue mostly in the form of divergent loose bundles of fibres forming nests in many ^{vugs} miarolitic cavities. These were observed under binocular microscope. Jamesonite was also quite abundant in carbonate gangue to which it seemed to be restricted. No jamesonite needles were observed in the quartz occupying part of gangue. Fig. 3 shows a few jamesonite needles found in tetrahedrite which were less common than in the above mentioned cases.

The most abundant secondary product after jamesonite was a yellowish brown mineral which strongly suggested bindheimite. It formed fibrous pseudomorphs after jamesonite and was quite common in some parts especially miarolitic cavities. *but x ray check*

Secondary Minerals

Marcasite:

Marcasite suggested supergene origin derived by disintegration of pyrrhotite. It occurred in colloform bands of different colours entirely restricted to pyrrhotite areas. Two bands of marcasite sometimes were separated by a layer of goethite. Central remnant of pyrrhotite was not uncommon.

Goethite:

Goethite was commonly observed as thin veins criss-crossing highly altered pyrrhotite bodies or as intermediate and irregular bands between two layers of colloform marcasite. Veinlets of goethite were found in some grains of pyrite and arsenopyrite when these were fractured. (Fig. 1). Goethite was probably deposited as amorphous limonite that, in due course, was dehydrated and crystallized as goethite.

Bindheimite:

Bindheimite, seen as pseudomorph coating after jamesonite, was quite common in some parts especially in miarolitic cavities where jamesonite bundles concentrated.

Limonite:

Limonite was derived from oxidation of Fe sulphides and carbonate.

Gangue Minerals

Quartz:

Megascopically two types were observed. One showing well developed crystals up to one-half inch in length occupying miarolitic cavities or, less often, associated with colloform texture as a core. These were stained yellow if in close vicinity of carbonate or jamesonite. Other type was sugary-like and much finer and compact. In thin section, however,

it also showed perfect crystal outlines as porphyroblasts of approximately uniform size. Some quartz grains showed porphyroblastic texture where larger quartz grains contained smaller quartz grains. This, in some grains, graded into ophitic type of texture. In general quartz appeared as porphyroblasts in matrix of carbonate and sulphides which usually lacked crystal outlines.

Carbonate (possibly one of four -- siderite, ankerite, dolomite, calcite)

Fe carbonate mineral was highly suggestive by megascopic and petrographic microscope examination. Its validity was further supported in places where it was altered to limonite. When viewed under binocular microscope it showed well developed wedge-shaped curved crystals forming comb-like texture in some microlitic cavities. Under petrographic microscope it appeared as a very fine cementing material for well developed quartz crystals. In almost every case such cementing portions enclosed the needle-like black opaque mineral jamesonite.

Sericite:

Sericite occurred in minor amounts but was conspicuous megascopically and microscopically. Petrographic examination showed it to be closely connected in time with carbonate. It occurred as minute shreds sometimes showing spherulitic arrangement.

Unknown:

This mineral was a very minor accessory. Its limited abundance did not permit definite identification. However, properties obtained point to zircon.

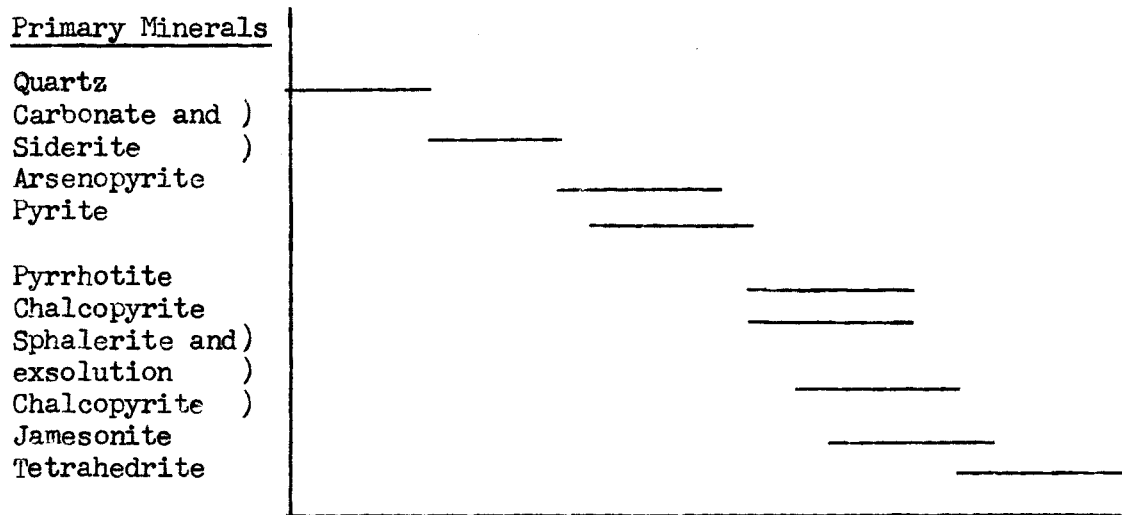
*Occurrence
Properties*

The percentage of the minerals varies with the sections. The difference is especially great when a section is composed almost entirely of sulphides as compared with those with relatively little metallics. The following estimation was based on the over-all occurrence.

Arsenopyrite	-	3%
Pyrite	-	1%
Pyrrhotite	-	3%
Chalcopyrite	-	1%
Sphalerite	-	3%
Tetrahedrite	-	1%
Jamesonite	-	3%
<u>Supergene</u>		
Marcasite	-	1%
Goethite	-	$\frac{1}{2}\%$
Bindheimite	-	1%
Limonite	-	$\frac{1}{2}\%$
<u>Gangue</u>		
Quartz	-)	80%
Carbonate	-)	
Sericite	-	2%
Unknown	-	trace
		<u>100%</u>

PARAGENESIS

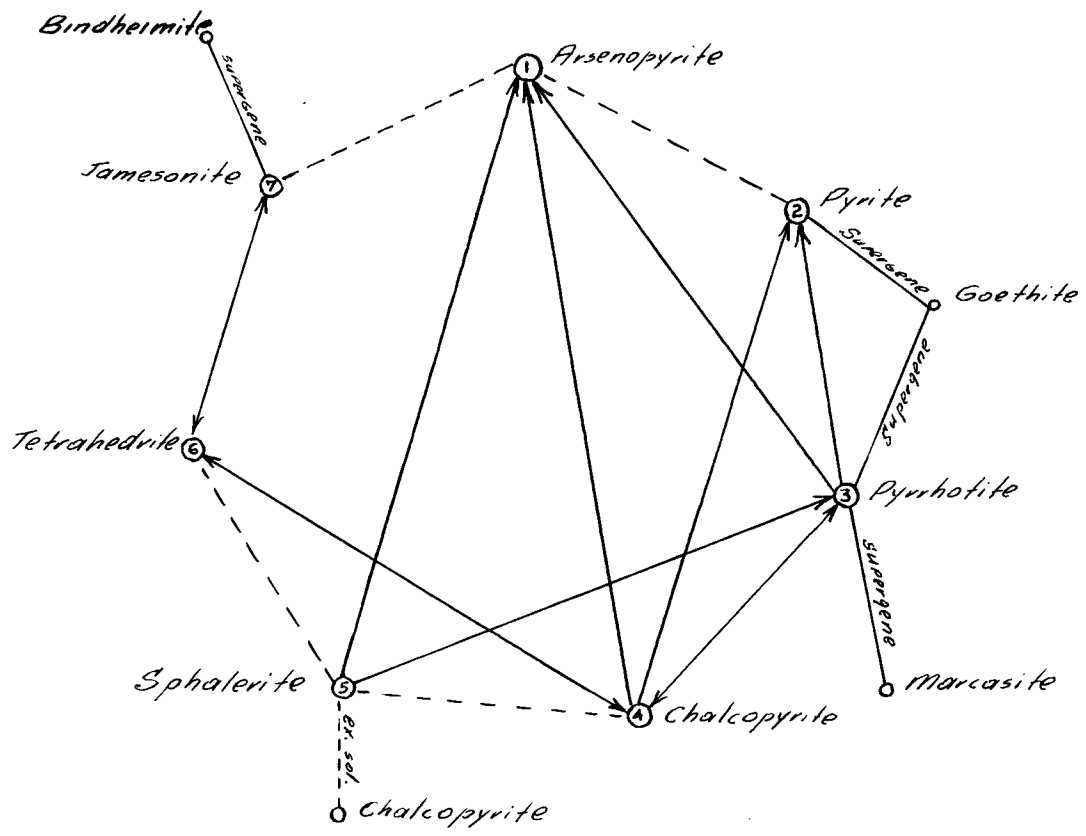
The orderly sequence of mineral formation can be summarized by the following table. Since there is evidence of replacement among the sulphides this is represented by a separate Vandeveer diagram.



Supergene Minerals

- Marcasite
- Goethite
- Bindheimite
- Limonite

Vanderveer Diagram



CONCLUSION

W. M. Brewer¹ classified the deposit as partially vein type and partially Contact Metamorphic type. After examination of the specimens the writer feels that only the first -- vein type -- can be regarded as correct. This conclusion was based solely on the specimens which showed the following:

- (1) Absence of skarn or any of the Contact Metamorphic minerals.
- (2) Presence of open spaces -- vugs.
- (3) Presence of perfectly developed crystals of quartz, jamesonite, pyrite and, to a certain extent, arsenopyrite.
- (4) Asymmetrical crustification (though in a limited amount).
- (5) Suggestive wall rock alteration -- ankerite.

The first two points seem to classify the deposit conclusively as a cavity filling type. Vugs in gangue and deposition of quartz as first crystallizing mineral suggest that the temperature of formation was fairly low, hence, it can be regarded as epithermal vein type or nearly mesothermal because of pyrrhotite and arsenopyrite minerals.

The ore shipped to Trail in 1914 indicates presence of Cu, Zn, Ag, Au metals in quantities mentioned under the heading "Economic Geology". Chalcopyrite, tetrahedrite and sphalerite especially are responsible for Cu and Zn. Presence of Ag is attributed to argentiferous tetrahedrite, therefore, its amount is important from the standpoint of Ag. This mineral is rather limited in the specimens. A. L. Anderson² conducted an

¹ W. M. Brewer, M.E., B. C. Annual Report of the Minister of Mines 1915, pp K264 - 265.

² A. L. Anderson, Economic Geology, Vol. 27, December 1933.

investigation on this and other minerals and concluded that tetrahedrite is one of the early minerals susceptible to weathering and oxidation. This being the case, some tetrahedrite could have been affected nearer the surface and, to a certain extent, might explain its almost complete absence (providing it was present in the first place). That oxidation did occur can be seen by the considerable destruction of pyrrhotite.

Au value is more difficult to explain since no gold minerals were found in the sections. Qualitative microchemical tests also disclosed no gold minerals. Since the value in Au was only 0,06 oz. per ton it could have been restricted to more favourable parts of the minerals or gangue and missed when making qualitative tests.

*Common in Agite + Arseno. Below limit of detection
by micro methods*

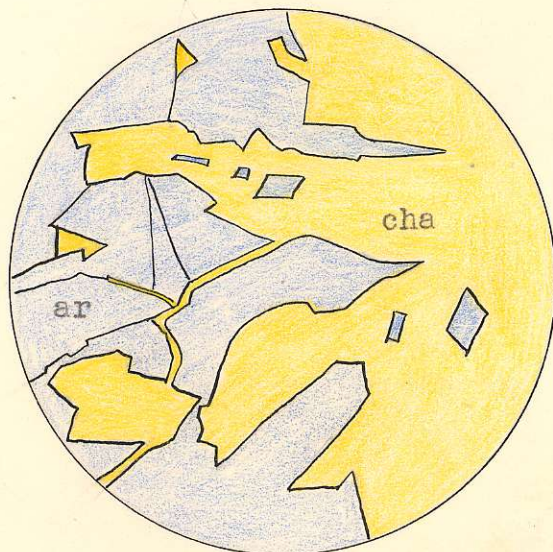
Fig. 1



Colloform banding in marcasite (ma), showing colour zoning. Marcasite formed at expense of pyrrhotite (pyr). Goethite (goe) occurs as veinlets.

51.6 microns

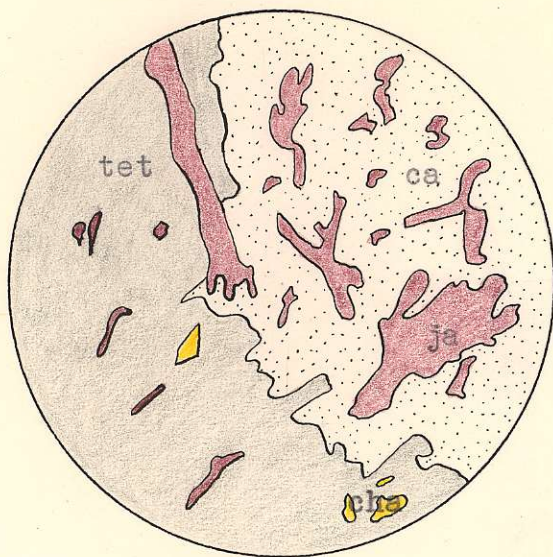
Fig. 2



Fractured and brecciated arsenopyrite (ar) "healed" with chalcopyrite (cha).

245 microns

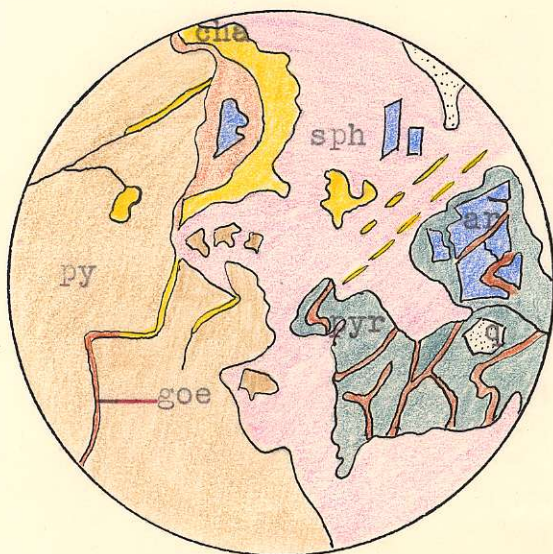
Fig. 3



Jamesonite (ja) needles in carbonate (ca) gangue and tetrahedrite (tet).

245 microns

Fig. 4



Characteristic relationship between chalcopyrite (cha), sphalerite (sph), pyrite (py), pyrrhotite (pyr), arsenopyrite (ar), goethite (goe). Euhedral crystal of quartz (q) in pyrrhotite.

51.6 microns



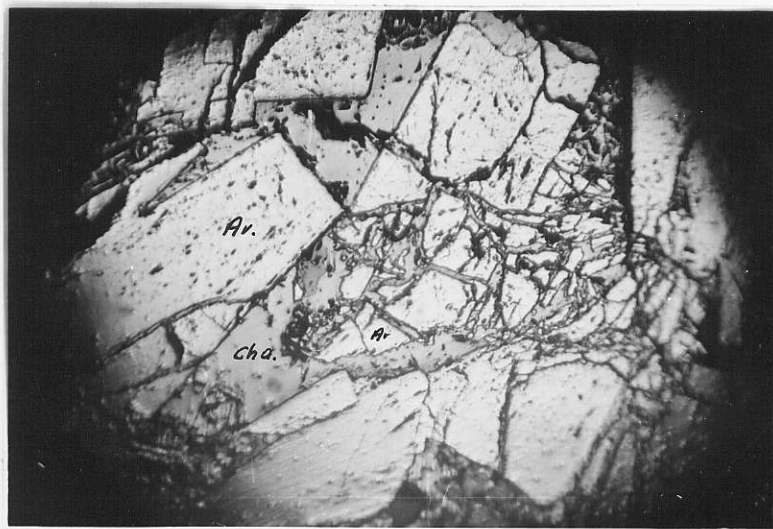
X 2

Colloform texture of carbonate gangue showing series of concentric layers and convex curvature.



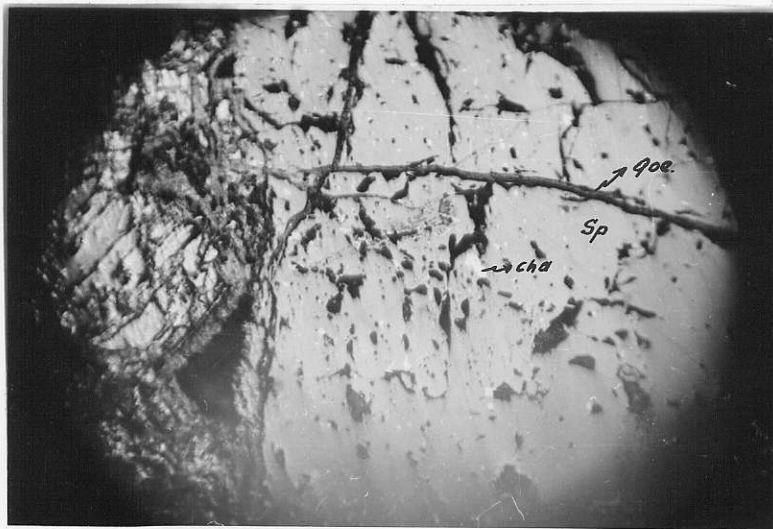
X 2

Miarolitic cavities occupied by nest-like bundles of jamesonite (ja) and crystals of carbonate (ca). (Quartz crystals not seen here.)



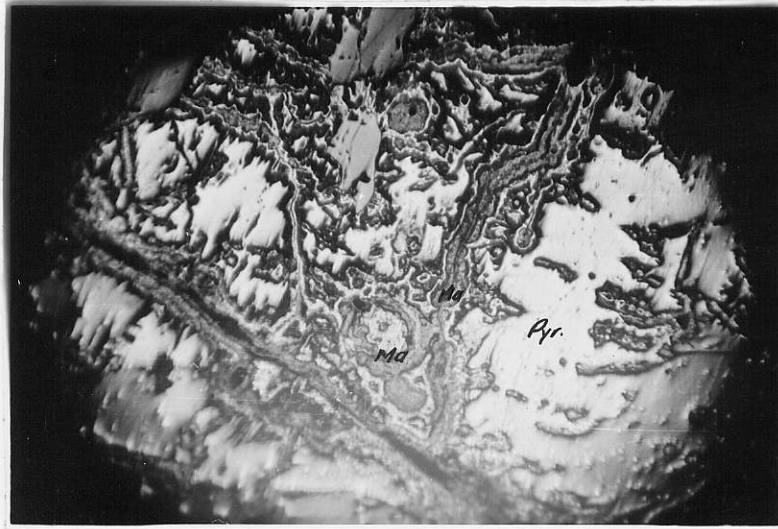
X132

Highly fractured arsenopyrite (ar) replaced and cemented by chalcopyrite (cha).



X 132

Exsolution chalcopyrite (cha) in sphalerite (sp). Irregular veinlets of goethite (goe) criss-cross massive sphalerite.



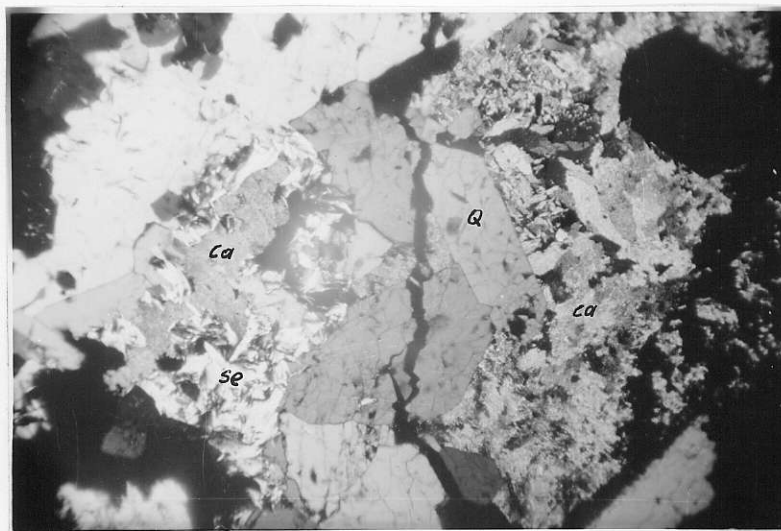
X 132

Highly altered pyrrhotite (pyr)
with secondary marcasite (ma)
formed due to pyrrhotite dis-
integration.



X 132

Jamesonite (ja) needles
scattered in carbonate (ca)
gangue.



X 132

Thin section showing perfectly developed crystals of quartz (q) cemented by carbonate (ca) and sericite (se).

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YALE DISTRICT B.C.

LEGEND:

Cenozoic **COQUIHALLA GROUP** -
basalt, rhyolite, tuff, breccia

PASAYTEN GROUP -
arkose, ss, argillite, congl, tuff

SKAGIT FORMATION -
andesite, tuff, breccia, conglom.

Mesozoic **DEWDNEY CREEK GROUP** -
tuff, aglom. ss, argillite, congl.

JACKASS MIN. FORM. -
congl. ss, argillite

LADNER GROUP -
slate, greywacke, shist, congl.

Paleozoic & Mesozoic **HOZAMEEN GROUP** -
chert, argillite, phyllite, lms.

INTRUSIVE ROCKS

Granite, qrdior, diorite

Mesozoic & Cenozoic Qtz. diorite, diorite

Serpentine

Granite-gneiss, gr. diorite

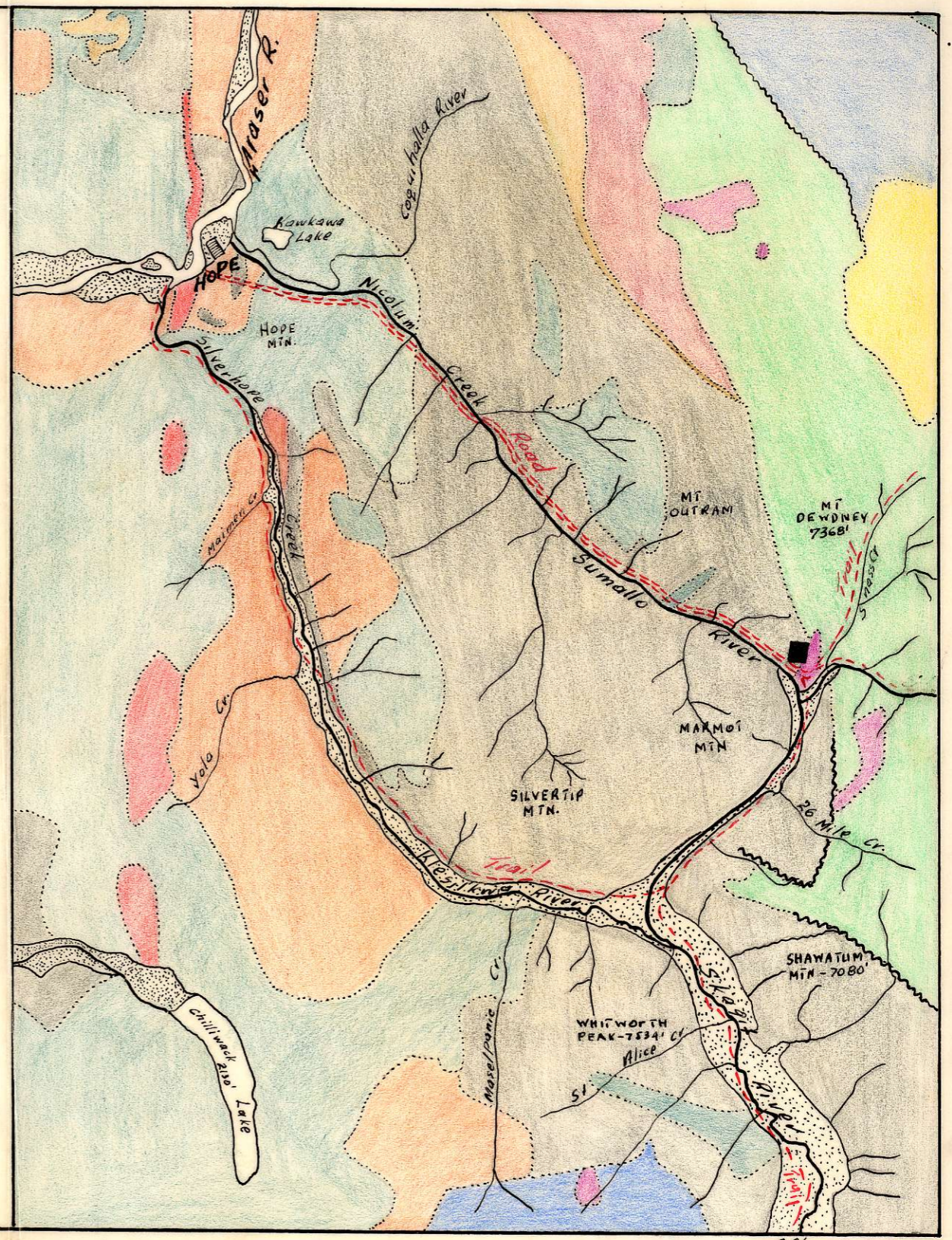
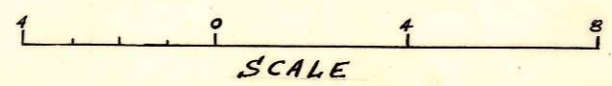
Drift

Fault

Rainbow mineral claims

Road

Trail



After G.S.C.