

A MINERALOGRAPHIC STUDY
OF THE ORE OF
THE TORBRIT MINE, ALICE ARM
BRITISH COLUMBIA

*Location map
'general geology' ?
otherwise 'in class.*

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A report submitted in accordance with the
requirements of the Geology 409 mineralography
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Introduction

A suite of ore samples from the Torbrit Mine have been studied in order to determine the minerals present and the paragenetic sequence.

Since the ore contains an abundance of gangue minerals, including barite, three thin-sections were obtained from the ore samples. These were studied as an aid to determining the history and occurrence of the ore minerals present.

Location

The Torbrit mine is located on the west bank of the Kitsault River approximately 17 miles from Alice Arm. Both mine and mill are situated at an elevation of 1000 feet above sea level near the junction

of the Upper Kitsault valley and Evindsen Creek. The nearest community is Alice Arm located at the mouth of the Kitsault River and at the head of the inlet of the same name. The area, approximately 100 miles north of Prince Rupert, can be reached by air from Prince Rupert or weekly by vessels of the Union Steamship Company.

History

Silver occurrences were discovered in the Alice Arm district soon after the turn of the century. In 1913, a number of claims were staked in the Kitsault valley area and by 1916 exploration by trenching had revealed two main zones of mineralization.

In 1924, the Toric group of four claims including the Toric, Anglo, Moose, and Lamb, were taken under the option of the Consolidated Homestake Mining Company. During the following year, the lower zone of mineralization was explored by adit-level and was found to be about 100 feet wide. In 1927, the name of the company was changed to Toric Mines, Limited. Soon after a mill capable of treating 50 tons a day was built and the milling process was changed from amalgamation and table concentration to flotation.

The Britannia Mining and Smelting Company acquired the mine in 1929 and subsequently organized the Torbrit Mining Company to develop and mine the

mineral deposits. However, the fall in the price of silver curtailed operations and work was suspended in 1930. The property remained idle until 1946 when the Torbrit Silver Mines Company bought the property. The company commenced an active development program and by 1948 had completed a 300 ton mill and power plant. Additional exploration and development has continued to the present time.

By the end of 1955, the production amounted to 151,863 tons of ore. The mining is chiefly by blast hole and shrinkage stopes. In the mill, most of the silver is presently recovered with galena as a flotation concentrate. In addition, native silver is recovered by cyanidation of the flotation tailings. The total silver production to the end of 1955 was 1,819,593 ounces. The lead concentrates amounted to 1,128,833 pounds.

General Geology

The rocks of the area include both sedimentary and volcanic divisions of the Hazelton Group. The Alice Arm district lies on the eastern border of the Coast Range Batholith which has intruded both the volcanic division of Middle Jurassic age and the overlying sedimentary formation of Upper Jurassic and Lower Cretaceous age.

The volcanic division of the Hazelton Group, originally called the Dolly Varden formation has been correlated with the Bear River formation of the Portland Canal area and the Kitsalos formation of the Skeena River

district. In the Alice Arm region, the volcanics form three elongate bodies parallel to each other and oriented with northwesterly trending axis. Surrounding these are sedimentary rocks of the Upper Jurassic and Lower Cretaceous division of the Hazelton Group. Originally, the sediments were included in the Kitsault formation, however now form part of the widespread Bowser formation (Roddick, 1956). In the area, the sediments are conformable on the volcanics, and consist of interbedded argillite, tuffaceous sandstone and greywacke, conglomerate and limey argillite.

The Torbrit Mine lies in the central igneous body of the Hazelton Group, the Kitsault body. The country rock is typically massive and devoid of visible structure. Hanson(1935) believes the area forms the core, plug, or neck of one or more volcanoes. The rock type is a slightly schistose greenstone with green, red, purple, and brown fragments. The colors vary in different places and the change is gradational, not controlled by bedding or any other recognizable structure. There has been considerable shearing of the rocks, obliterating most of the original textures, and there has been much alteration. the greenstones are replaced in part by carbonate, chlorite, and iron oxides. The rocks are extensively weathered and in places are heavily brecciated. Small faults with small displacements are common in the area. Several dykes and stocks are present in the area and range in composition from gabbro to quartz porphyry.

Economic Geology

The silver-lead mineralization occurs as vein-like replacements in the felsitic igneous rocks of the Hazelton Group. Most of the mineralization is located along brecciated and crushed zones where ore matter has partly replaced rock and partly filled open spaces. A few of the smaller deposits are chiefly of the fissure filling type.

The Torbrit Mine consists of a large moderate to low grade deposit roughly 100 feet wide and 300 feet long in places. The main vein strikes northeast and dips steeply to the west. It is characterized by a highly irregular, arcuate outline and a coarse grained, brecciated appearance. The walls are generally parallel to the schistosity of the country rock and the contacts between the deposit and greenstone are gradational, although the gradation is short, extending at places only over a distance of a few inches. The contacts are faulted in part and offset, however, displacement is generally less than twenty feet. The faults are both longitudinal and cross faults that curve and split. The faults in the deposit are chiefly east-west displacements in which the curved ends strike northeast and northwest.

In addition, there are several smaller deposits on the Torbrit property, ranging from small veins to deposits a few feet in width. These are located near the walls of the main deposit and are separated from it by a few feet of

country rock. They are similar mineralogically to the main deposit, although they haven't yet been developed. The large deposit contains numerous masses of country rock, quite distinct in appearance from the vein itself.

The deposit is distinctly banded and the banding is apparently parallel to the contacts of the deposit. The banding ranges from paper thin to several feet in width and consists mainly of alternating jasper, barite, quartz, carbonate, and sulphides. In contrast, a few parts of the deposit consists of unoriented aggregates of minerals.

The ore shoots are those parts of the deposit containing silver-lead minerals, and consist of quartz veins or quartz shoots in barite veins. These are not markedly different in appearance from the rest of the deposit, hence can only be determined by the results of sampling and assaying.

Subsequent to recent exploration of the area, it has been found that the typical silver-barite-jasper mineralization of the main deposit grades to deposits low in silver values and containing higher lead-zinc values to the north of the mine.

The main oreshoots of the Torbrit Mine, similar to those of the adjacent Dolly Varden property, are located in that part of the deposit nearest to the projected extension of the regional synclinal axis. Apparently the ore formation was related to the nearness of this structural axis, a factor that may be useful in locating the higher

grade zones of mineralization.

Mineralogy

Megascopic Examination

The ore is a coarse grained aggregate characterized by a preponderance of gangue minerals as compared to metallic minerals. The appearance varies from a light grey color with a brecciated texture to an aggregate of red, dark grey, and yellow colors. The latter are sometimes complex intergrowths of minerals having a random orientation, although most specimens show distinct banding. Both crustification and colloform banding was observed. The crustified banding is common and in the ore specimens varies from paper thin to approximately one inch in thickness. The bands are either of different minerals alternating throughout the ore or are of the same minerals occurring in layers having different proportions and arrangement, and of different colors.

The major constituents include soft, light colored bands and laths of barite; waxy, light and dark-grey stringers, bands and masses of chalcedonic quartz; red to maroon aggregates of hematite and jasper; and yellowish masses of iron rich carbonate. The metallic minerals include galena, sphalerite, pyrite and various silver minerals.

A few of the specimens have a pronounced brecciated appearance. The light and dark grey quartz is cut by large rectangular laths of barite that are in

general, oriented in a parallel pattern. The sulphides are concentrated near the borders of the barite and quartz forming dark stringers. In addition, sulphides are common as disseminations in fractures throughout the gangue.

The silver minerals are abundant in the sections having a preponderance of red jasper and hematite. These specimens were unoriented intergrowths of minerals or had distinct banded textures. One specimen from the Moose Cut shows distinct colloform banding with concentric layers of chalcedonic quartz, barite, hematite, jasper, pyrite, carbonate, and ore minerals. The bands are of grey, red, yellow and black colors and range from paper thin to one-half inch in thickness. The red jasper-hematite bands are most distinct and contain rectangular laths of barite which are arranged both parallel and perpendicular to the direction of banding.

The sections from the newer prospects contain very little jasper and hematite, and appear as fine grained mixtures of galena and sphalerite. The gangue is predominantly quartz with only minor barite.

Microscopic Examination of Gangue Minerals

Three thin sections of the Torbrit specimens were studied and revealed the following minerals: quartz, barite, siderite, calcite, hematite, (jasper), and sulphides.

Barite, comprising from 30 to 50 percent of the specimens, is present as rectangular grains and prismatic crystals, having high relief and low birefringence.

It has two distinct cleavages and is distributed in large masses and small grains bounded in a groundmass of anhedral quartz. The smaller grains are surrounded by sulphides and hematite grains and the larger masses have numerous fracture fillings of carbonate, jasper and dark quartz containing disseminated sulphides. These stringers and veinlets around and within the barite give rise to the characteristic rectangular, blocky texture.

The quartz is the second, abundant gangue mineral and comprises from 20 to 40 percent of the specimens. It is chalcedonic, and colorless to pale brown in thin section.

It is unaltered, has a distinct aggregate structure and occurs as large anhedral masses and stringers having low relief and mottled extinction. The jasper which is light brown in thin section occurs at the borders of fractures and grain boundaries and contains abundant inclusions of hematite, carbonate and sulphides. It grades outward to the clear colorless variety of chalcedonic quartz. Banding is distinct in places and consists of alternate gradations from dirty quartz clouded with disseminated sulphides to the clearer variety.

The carbonate is plentiful in the sections and consists of two distinct types. Low relief calcite occurs in shreds and irregular aggregates and occurs most commonly within masses of barite and in fractures surrounding pyrite, and disseminated sulphides. A few distinct veinlets entirely of carbonate cross-cut the barite laths. The second variety of carbonate is darker grey in color, and has a somewhat higher relief. The boundaries of the grains are brownish

indicating it is ankeritic in composition. It seems to be mainly of the siderite variety, and occurs chiefly at the quartz-barite grain boundaries.

The opaque minerals including sulphides and some hematite occur as small shreds and disseminated grains along cleavage fractures and at the grain boundaries of the gangue minerals. The occurrence is gradational and the larger distinct grains grade outward from from grain borders to disseminated grains in the gangue. Near the fractures the powdery sulphides are associated with jasper and carbonate. A few distinct bands of of black opaque minerals were seen and consisted of wide layers of sulphides containing small rectangular laths of barite. Hematite grains are common at the borders of the barite laths.

Microscopic Examination of Ore Minerals

Examination of the polished sections of the Torbrit ore revealed the following minerals:

Pyrite (FeS_2). This occurs as large irregular masses and small rounded grains. It occurs in the brecciated fracture zones associated with other sulphides and is often shattered, the fractured grains having been healed with quartz. A few distinct bands of pyrite consisting of thin layers of rounded and irregular grains are contained in the sections from the Moose Cut.

Marcasite (FeS_2) ? A few small grains of lighter color than the remaining pyrite were seen. These had faint

anisotropism and are likely grains of marcasite, although no definite confirmatory properties were observed.

Hematite (Fe_2O_3). This occurs as small, rounded dark-grey grains having a hardness of G, and slight anisotropism. Most specimens yield a red powder, although the common occurrence is in minute, finely disseminated grains. The hematite is associated chiefly with red jasper in fractures and a grain borders of quartz and barite.

Sphalerite (ZnS). The properties, hardness of C, grey color, isotropism, and lack of positive etch reactions for all reagents except aqua regia proved sphalerite. It was confirmed by microchemical tests. Some of the sphalerite shows distinct resin-colored internal reflection, and white powder, whereas in other sections it was darker, lacked internal reflection, and yielded a metallic powder. In general, the iron rich members seem closely associated with the galena and the iron poor ones, with the carbonate-barite-quartz gänge.

Chalcopyrite (CuFeS_2). The chalcopyrite is associated with the sphalerite and occurs as minute blebs and irregular grains in fine grained sphalerite masses, as fracture fillings in pyrite and within fine grained mixtures of galena and sphalerite. It is present mainly in the sections containing abundant galena and sphalerite and rare in the sections containing abundant jasper, barite, ruby silver and sphalerite.

Galena (PbS). The galena shows perfect cleavage with abundant triangular pits and was confirmed by harness and etch tests. The galena occurs as large masses and fine grained mixtures with sphalerite. These form distinct bands alternating with gangue minerals. In addition the galena is disseminated as irregular grains in fractures associated with pyrite, and ruby silver.

Pyrargyrite ($3Ag_2S \cdot Sb_2S_3$) . The ruby silver is bluish-grey, anisotropic, although most grains do not show good anisotropism due to the deep red internal reflection. The mineral was confirmed by etch tests and microchemical test. In hand specimens most ruby silver is dark red to black. Some ruby silver corresponding to the Proustite end member may be present, however the general smallness of grain size prevents confirmation by microchemical tests. The pyrargyrite is distributed as small irregular grains and thin stringers along fractures and grain borders and is associated with jasper, hematite, barite and quartz. In addition, it is intimately associated with the pyrite in the fracture zones occurring as veinlets and stringers throughout and surrounding the pyrite grains. Some of the ruby silver is disseminated through large masses of chalcedonic quartz.

Associated with the ruby silver in fractures are a few very small grains of a white, isotropic mineral. These were too small to allow confirmatory tests and may be finely disseminated galena or possibly native silver. Native silver, if present, is rare in the specimens

examined. Tetrahedrite and other silver minerals, also were not observed.

Textures and Paragenetic Sequence

The textures observed in the polished sections studied are characteristic of a deposit that has been formed by filling and replacement in a brecciated zone. The ore formation and growth of minerals has been closely related to fractures along which hydrothermal solutions circulated. The fractures which control the shape of the deposit originated apparently from shearing attendant upon the intrusion of the Coast Range batholith complex. The distinct banding indicates that the minerals present originated from successive deposition and replacement.

The first stage in the formation of the deposit was likely the deposition of the quartz-barite gangue minerals. The intimate association of barite and chalcedonic quartz and hematite suggests these formed the first stage of deposition. This stage of primary mineralization was followed by replacement of quartz to jasper along fractures, although additional replacement and deposition of chalcedonic quartz likely occurred during later, successive stages of mineralization. Evidence of this is the rhythmic colloform banding seen in some of the sections.

The second major stage in the history of the deposit was the injection of the ore forming minerals and quartz and the replacement of the primary minerals. Most of the metallic minerals are associated with the

quartz in fractures. This is due chiefly to the fact that the quartz is more easily shattered and provided better channels for the penetration of solutions.

Pyrite was likely the first sulphide to crystallize and the shattered appearance and replacement along pyrite fractures of sphalerite, galena, chalcopyrite, pyrargyrite and carbonate indicates successive deposition and replacement by the younger sulphides and sulphosalts. The presence of pyrite in successive layers in some sections indicates that it was not all formed during the earliest stage of ore formation.

The sphalerite is closely associated with pyrite along fracture zones and was likely the next to form. It invariably occurs as wide vein-like zones bordering fractures and in many cases consists of a fine grained mixture of sphalerite and gangue. In one case the sphalerite formed a stringer surrounding a long veinlet of pyrite and was bounded on each side by pyrite stringers. Apparently the original fractures were re-opened, the pyrite shattered and the sphalerite was deposited. The presence of chalcopyrite almost exclusively in the sphalerite as minute, irregular shaped shreds and the smooth boundaries of some blebs suggests the two are contemporaneous and likely the chalcopyrite formed in part by exsolution. The chalcopyrite has replaced both sphalerite along minute fractures and pyrite at the grain boundaries and in fractures.

The galena seems to be nearly contemporaneous in the sequence with sphalerite. In the sections that

consist mainly of galena, sphalerite and gangue minerals, the galena occurs in massive patches with highly irregular borders between it and sphalerite. There has been considerable replacement of sphalerite by galena as indicated by the numerous stringers that extend inward along fractures in the sphalerite. Near the borders the sphalerite remains as small disseminated grains surrounded entirely by a groundmass of galena. The galena surrounds pyrite and has replaced much of the original pyrite mass forming thick stringers around isolated grains. A few of these contain patches of chalcopyrite that have also replaced the pyrite. The galena also forms irregular patches along fractures in the gangue and appears to be replacing it. Generally, the galena is abundant in the sections containing very little pyrargyrite or hematite, and seems to be more closely associated with the quartz rather than barite gangue minerals.

The last stage in the sequence of deposition involves further fracturing and penetration of the silver bearing solutions. The pyrargyrite is distributed along fractures in the hematite-bearing jasper and in fractures of the barite. Under polarized light the sulphosalt stringers are bounded by a ^obrad zone of bright red jasper that grades outward to light grey quartz. The mineralization is closely associated with pyrite stringers in the fractures. The very tiny, isotropic, white flakes were seen associated with pyrargyrite in fractures of this type. The association is suggestive of native silver, although the flakes may well be of finely divided galena in the gangue minerals. The pyrargyrite occurs frequently as rims around pyrite grains

and has replaced much of the original pyrite mass. Subsequent to the last stage of mineralization, there has been considerable alteration and formation of calcite, siderite and ankerite, and iron oxides. The wall rock has also been altered and considerable chlorite, sericite, carbonate and iron oxides have been formed.

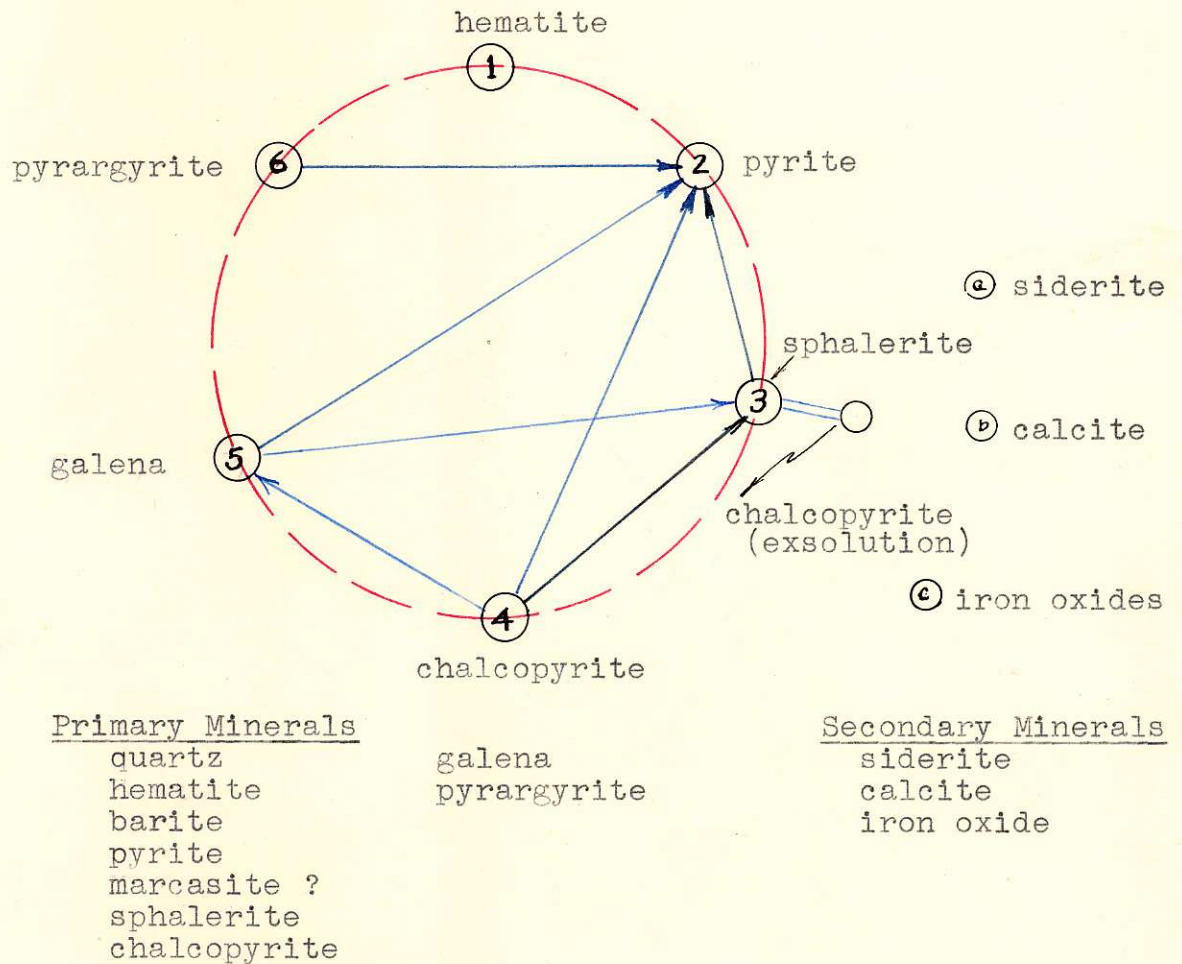


Fig. 1.
Paragenetic Sequence of Torbrit Ore.

Conclusions

The Torbrit silver-barite-jasper deposits are the product of filling and replacement in a sheared, brecciated zone. It has been formed by successive deposition and

replacement caused by hydrothermal activity subsequent to the emplacement of the Coast Range intrusives.

Several criteria can be used to interpret the temperature of formation. The primary stage of hematite, barite, jasper mineralization, likely occurred at temperatures near 500 degrees centigrade. Pyrite formed at successive intervals, but the majority likely crystallized between 450 and 500 degrees. There is some evidence of a sphalerite-chalcopyrite solid solution. This likely unmixed at temperatures in the neighbourhood of 400 to 450 degrees. The galena and pyrargyrite are typically medium to low temperature minerals and probably formed at temperatures between 250 and 350 degrees centigrade. In addition, the general coarse grain size, absence of high temperature silicates, the association of silver-lead-zinc minerals with chalcedonic quartz and barite, the crustification and colloform banding, indicate that the deposit formed at moderate to low temperatures. It is therefore, gradational from Mesothermal to Epithermal.

The deposit is of moderate to low grade and contains a preponderance of gangue minerals as compared to metallic minerals. The silver is associated in the replacement deposits with barite, hematite, and jasper, while the galena is more common in veins containing little silver and having quartz as the main gangue mineral.

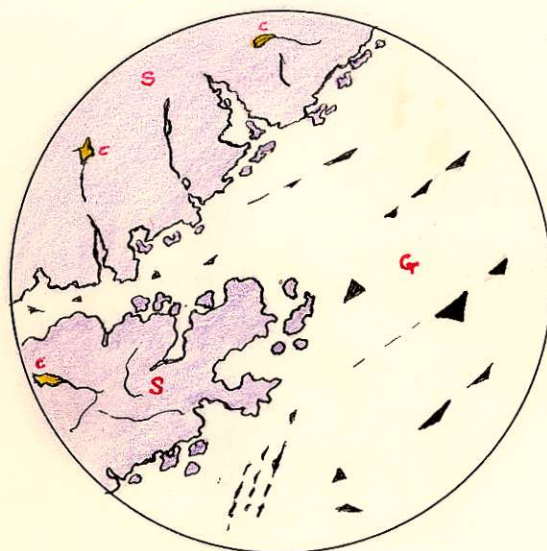


Fig. 2 x(150)

Sphalerite (S) replaced by galena (G)
Chalcopyrite also replacing sphalerite.

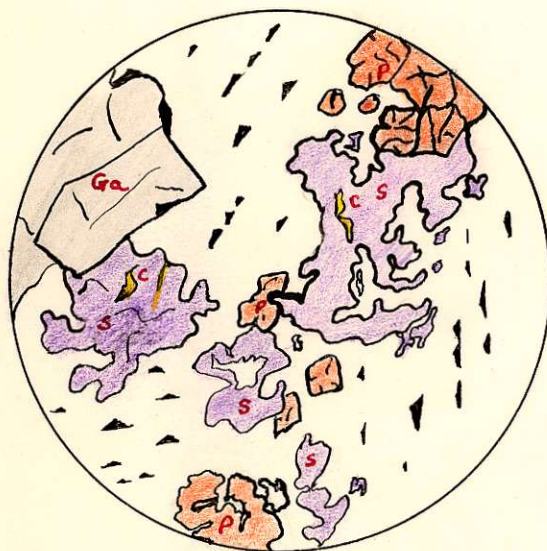


Fig. 3. (x 300)

Sphalerite (S) and Pyrite (P) in groundmass
of Galena. Sphalerite and galena replacing
pyrite. Gangue (Ga) of chalcedonic quartz.

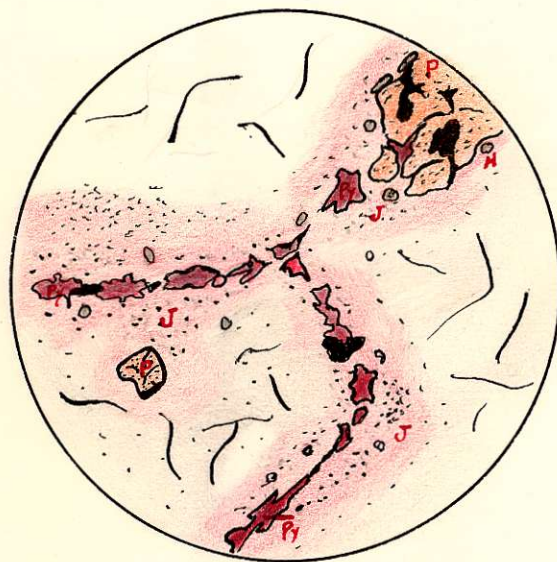


Fig 4. (X'd. Nicols)
x 350

Pyrrargyrite (py) distributed along fractures in broad zones of red jasper. Pyrrargyrite and sphalerite also in fractures of shattered pyrite, replacing it and hematite disseminated in jasper.

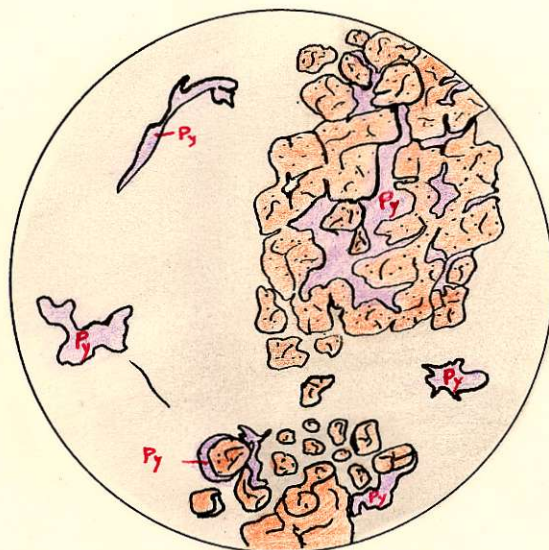


Fig. 5 (x350)

Pyrite, fractured and partially replaced by pyrrargyrite. Pyrrargyrite also distributed in fine grained gangue of barite-jasper-quartz.

BIBLIOGRAPHY

Hanson, George (1921): Upper Kitsault Valley, B. C.;
Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

(1928): Mineral Deposits of Alice
Arm, B. C.; Geol. Surv., Canada, Sum. Rept.
1928, pt. A.

(1935): Portland Canal Area, B. C.,
Geol. Surv., Canada, Mem. 175.

Minister of Mines, British Columbia; Ann. Rept. for
the years, 1925, 1930, 1948, 1951, 1955.