A MINERAGRAPHIC REPORT ON THE THREE HILLS PROPERTY NEAR HAZELTON, B.C.

I hereby submit this report in partial fulfillment of the requirements for Geology 409.

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INTRODUCTION

This is a report based on the mineralogy of the Three Hills property near Hazelton, B.C. The purpose of the study is to determine the mineralogy and paragenesis of the deposit and to classify the deposit as to its mode of emplacement. The samples were chosen, not to represent their typical abundance in the deposit, but to encompass the variability in rock type in order that the various relationships should be represented.

History of the Claims

The property consists of six claims located first by Alfred LeToile in 1951 and relocated by LeToile, D.R. Willemar, and E.H. Harbottle in 1955. The claims, Three Hills Nos. 1 to 6, are between South Hazelton and Skeena Crossing on the east side of Highway No. 16, 2¼ miles south of Seeley Lake. During 1955 and 1956 the property was under option to Silver Standard Mines Limited, which drilled some short diamond-drill holes and did some stripping (Sutherland Brown, 1960).

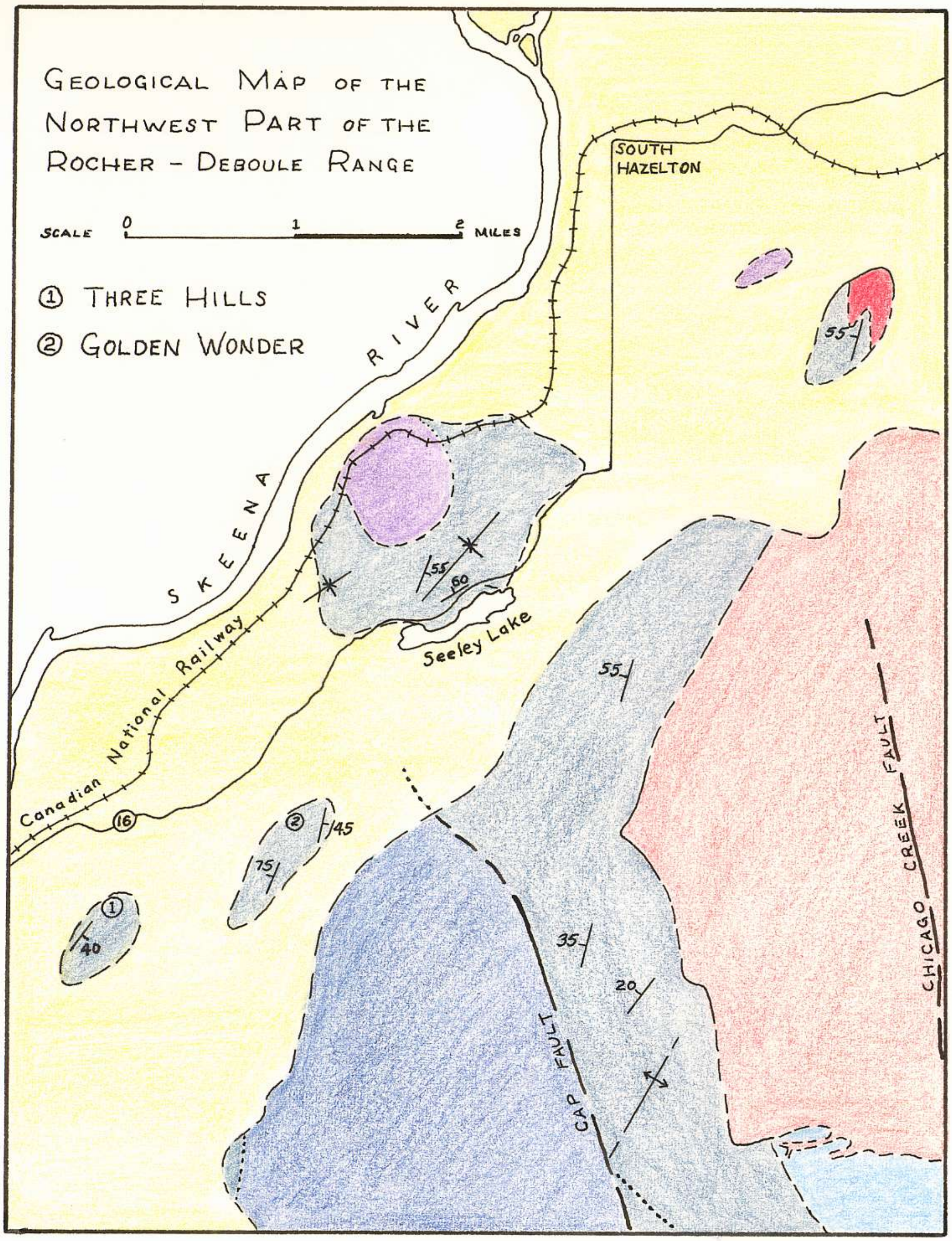
Geology

All geological information was obtained from A. Sutherland Brown's report entitled "Geology of the Rocher Deboule Range" (1960). The terrain surrounding the Three Hills property is flat and drift-covered except for a number of rock drumlins on which the showings are found. The main showing consists of a small rock drumlin about 120 feet wide and about two or three times as long, that rises 25 feet above the adjacent drift-covered area. The rocks are hornfelsic argillite and feldspar porphyry of the Hazelton group. They strike N35°E and dip about 40° north-west. The rocks are fractured by many small joints striking N75° to 90°E and dipping about 60°N. Some joints are filled with small stringers of quartz and chalcopyrite. Two chip samples each taken over 10 feet in the central, better-looking part of the trench assayed as follows:-

Chip Sample	Gold	Silver	Copper
1	tr.	0.3%	0.058%
2	tr.	tr.	0.61%

The Rocher Deboule Range is a fairly homogeneous structural unit with the Rocher Deboule stock occupying the central region of the range. The contact of the stock with Hazelton rocks is about three miles east of the Three Hills showings. Folding is moderate with bedding dips as a rule less than 45 degrees, but details of the pattern are complicated. Folding was completed prior to emplacement of the Rocher Deboule stock. Three large normal faults striking slightly west of north divide the range into four fault blocks of which the center two are raised as a horst. The Three Hills property is on the western down-dropped block.

The lithology of the Three Hills property is mapped as members A and C of the Red Rose formation. These include


GEOLOGICAL MAP OF THE NORTHWEST PART OF THE ROCHER - DEBOULE RANGE
SCALE 0 1 2 MILES
① THREE HILLS
② GOLDEN WONDER
SKEENA RIVER
SOUTH HAZELTON
Canadian National Railway
Seeley Lake
16
55
60
55
55
45
75
40
35
20
CAP FAULT
CHICAGO CREEK FAULT

greywacke, shale, siltstone, and hornfelsic equivalents with occasional beds of conglomerate and coal. Part of the stratigraphy of the area is shown in the map (page 3).

The Hazelton group has been folded as a unit. There appears to have been only one period of folding but the pattern indicates that the folding was not a simple compression. The rocks were thermally metamorphosed during emplacement of the Rocher Deboule stock. An aureole with outwardly decreasing intensity of metamorphism surrounds the stock, and beyond the zone of noticeable metamorphic effects, sedimentary rocks have been generally hardened. Some metasomatism close to the contact is indicated by growth of tourmaline and apatite, widely distributed in all types of rocks in minor amounts. Pyritization occurs about the stock.

Dykes of a number of rock types occur in the area, some within the stock and some beyond it. Five distinct types of dykes are known in the area. These are, in order of older to younger; aplite and pegmatite, granitoid dykes, porphyritic andesite, felsite, and basic dykes. The porphyritic andesites which are found within the stock are purplish dark-grey aphanitic rocks containing about twenty percent tabular andesine phenocrysts and five per cent hornblende phenocrysts in a fine matrix of feldspar laths, biotite, minor quartz, and iron ores. Many of them are trachytic.

Summary

The Three Hills property is a pyrometasomatic deposit containing a suite of sulphides plus scheelite. The sulphides include pyrrhotite, pyrite, arsenopyrite, sphalerite, chalcopyrite and marcasite. The economic possibilities of the deposit are concerned mainly with chalcopyrite and scheelite.

The minerals were emplaced in a porous, brecciated rock in a single event associated with the intrusion of the Rocher Deboule stock. Tourmalinization, silicification and carbonization accompanied mineralization of the rock.

OBSERVATIONS

Hand Specimens

There are four types of rock in the collection. Type 1 is a sample of a porphyritic andesite dyke which is probably identical to the previously mentioned porphyritic andesite. The rock is purplish-brown with about twenty-five per cent feldspar phenocrysts in a fine-grained groundmass. The phenocrysts measure up to one-quarter inch in length. The colouring is probably due to oxidized iron.

Type 2 is a sample of chert breccia with fragments up to one inch long, which has been tourmalinized. Tiny crystals of black tourmaline have impregnated the rock except for a few fragments in a black groundmass. The rock is vuggy with quartz, tourmaline and pyrite crystals lining the cavities.

Type 3 is a sample of grey chert which is cut by a one-half inch stringer of pyrrhotite and by a network of very thin quartz stringers. The rock is tourmalinized in a zone adjacent to the pyrrhotite stringer with irregular blebs and veinlets of chalcopyrite in the tourmaline.

Type 4 is a sample of high grade mineralization containing chalcopyrite, scheelite, tourmaline, limonite and a carbonate which is probably ankerite. The original rock may have been brecciated but it has been entirely replaced. The sample is a coarse-grained rock with angular grains of chalcopyrite up to one inch across often enclosed by ankerite. Euhedral crystals of scheelite up to $1\frac{1}{4}$ inch long are associated with chalcopyrite and ankerite. They show excellent multiple twinning on 001 giving them a pleated appearance. Chalcopyrite occurs as thin films between cleavage planes in some scheelite crystals. Tourmaline has grown as fine-grained, black masses and also as vug linings along with quartz. In places, small euhedral crystals are enclosed by chalcopyrite.

The rock is rusty-brown on the weathered surface due to a limonitic coating. The carbonate is particularly susceptible to weathering and has been leached from the weathered surface leaving a limonite-covered framework of chalcopyrite.

The approximate abundance of minerals in the rock is as follows: chalcopyrite 60%, scheelite 20%, carbonate 15%, tourmaline 5%.

Polished Sections

Optical data by which the metallic minerals were recognized is given below.

1. Chalcopyrite

    Colour: brass-yellow with a greenish cast

    Hardness: C

    Anisotropism: weak

    Etch tests: $HgCl_2$, KOH, KCN, HCl, $FeCl_3$ - negative
    HNO_3 - fumes tarnish

2. Sphalerite

    Colour: grey with a brownish cast against chalcopyrite

    Hardness: D

    Anisotropism: nil

    Internal reflection: present, but not pronounced

3. Pyrrhotite

    Colour: pinkish-cream

    Hardness: D

    Anisotropism: strong

    Twinning: polysynthetic stress twinning (Plate 5)

    Magnetism: distinct

4. Arsenopyrite

    Colour: white

    Hardness: G

    Anisotropism: strong, yellow-brown to violet

    Crystal form: monoclinic rhombs

5. Pyrite

Colour: pale brass yellow

Hardness: F

Anisotropism: nil

Crystal form: cubic

6. Marcasite:

Colour: pale brass yellow

Hardness: E^+

Anisotropism: moderate

Form: concentric banding in some grains

Although one of Sutherland Brown's samples assayed for silver no evidence of a silver mineral was found.

Abundance

The approximate abundance of the metallic minerals in the high grade samples is given as follows:

Mineral	% of metallic minerals
Chalcopyrite	60
Pyrrhotite	25
Marcasite	5
Arsenopyrite	5
Pyrite	3
Sphalerite	2

Significant Textures

Mutual boundary texture. Pyrrhotite and arsenopyrite occur with mutual boundaries with no evidence of one replacing the other. The euhedral outlines of arsenopyrite remain intact.

Banded texture. One specimen shows very irregular crustification banding in fissures within pyrrhotite (Figure 1). A quartz veinlet fills the fissure and has deposited a band of pyrite followed by a discontinuous band of chalcopyrite.

Exsolution texture. Sphalerite is exsolved in chalcopyrite typically as small, star-like grains presumably controlled by the crystallographic axes of chalcopyrite (Figure 2). Chalcopyrite is exsolved in sphalerite as minute, rounded blebs in sub-random orientation (Figure 3).

Cataclastic texture. Arsenopyrite appears fractured and brecciated in many places with either quartz or chalcopyrite filling the fractures(Plate 1). Tourmaline is likewise fractured with either quartz or chalcopyrite filling the breaks (Plate 2).

Colloform texture. Marcasite forms in round to elongate colloform grains due to alteration of pyrrhotite (Plate 3). The colloform banding is concentric usually with discontinuous, alternating bands of carbonate.

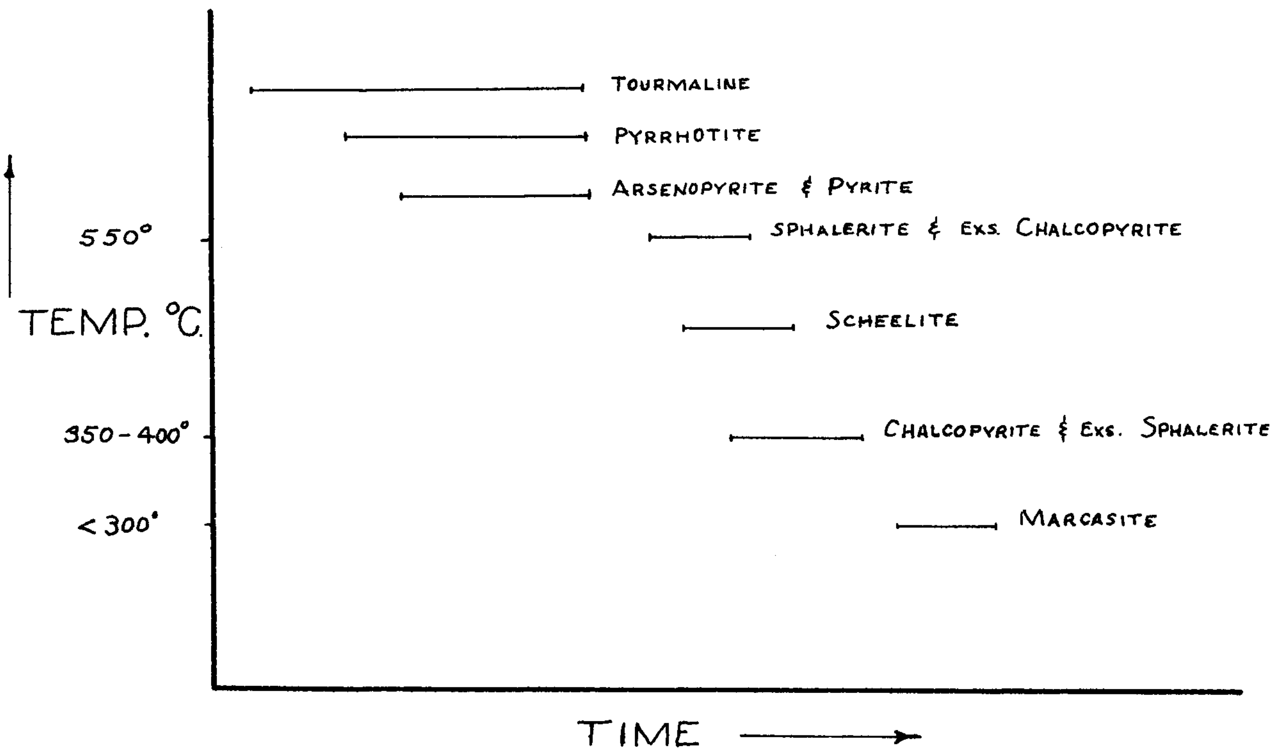
Vug linings. Quartz occurs as inner rims lining cavities (Plate 4). It often gives a reddish reflection under crossed-nicols due to contained iron oxide.

Replacement textures. A patchy, shredded occurrence of pyrrhotite in chalcopyrite indicates wholesale replacement of pyrrhotite by chalcopyrite. The same is indicated by isolated nucleii of pyrrhotite in chalcopyrite. Corroded boundaries of arsenopyrite adjacent to chalcopyrite and irregular blebs of chalcopyrite within arsenopyrite indicate replacement of arsenopyrite by chalcopyrite. Blebs of sphalerite in pyrrhotite indicate replacement by the former.

INTERPRETATION

Paragenesis

The paragenesis of the Three Hills deposit is diagrammatically represented below.



History of Emplacement

The emplacement of this deposit was a single-stage episode which was accompanied by some shearing movement. The original rock was brecciated pre-mineralization providing a favorable host for precipitation of minerals. Hydrothermal solutions charged with volatiles deposited the minerals by replacing the original sedimentary rock. The solutions were at a high temperature, probably greater than 600°C, with the various minerals being deposited as the temperature dropped.

Tourmaline was deposited first, followed closely by pyrrhotite and arsenopyrite. The fracturing of arsenopyrite and tourmaline and the stress twinning in pyrrhotite indicate that some subsequent shearing movement occurred. This could have been due to actual shearing of the rock or to a second influx of hydrothermal fluid exerting pressure on the already formed minerals. A secondary influx of fluid seems feasible since pyrite and arsenopyrite are found in veinlets of quartz which cut pyrrhotite. At approximately 550°C sphalerite with exsolution chalcopyrite was deposited by replacing pyrrhotite. Edwards (page 98) gives information regarding exsolution of sphalerite and chalcopyrite. Scheelite formed next probably accompanied by alpha-quartz. Volatiles in the fluid probably promoted the growth of scheelite resulting in the large, euhedral crystals. At lower temperatures, 350 - 400°C, chalcopyrite with exsolution sphalerite was deposited replacing pyrrhotite and arsenopyrite. Ankerite formed next surrounding scheelite, chalcopyrite and quartz. In the last stage of mineralization vugs were lined with quartz and tourmaline deposited from low-temperature, volatile-rich fluids.

CONCLUSION

The Three Hills deposit is a high temperature pyrometasomatic deposit formed probably at the time of emplacement of the Rocher Deboule stock. The deposit was formed at no great depth. Emanations from the stock were the mineralizing fluids which travelled a distance of three miles. The Golden Wonder property, which is on a similar rock drumlin one mile northeast of Three Hills, has a similar type of mineralization (Sutherland Brown p. 52). It was probably mineralized by the same source at the same time as was the Three Hills property. Each property has a porphyry dyke which is post-mineralization.

Tourmalinization, silicification and carbonization of the host rock occurred in that order during the same metasomatic event. During metasomatism the primary sulphides and scheelite were precipitated from the invading fluid. Marcasite is a supergene replacement of pyrrhotite induced by a late stage invasion of carbonate.

The surface showings of the Three Hills deposit are not extensive. The high grade samples are rich in chalcopyrite and scheelite and would offer no great difficulty in mining or milling were a mine established. It is doubtful, however, that the deposit has much extension underground. If evidence of widespread brecciation or some structural trap was found in the vicinity, it would be feasible to expect that a potential deposit of considerable size exists.

ADDENDUM

Several powdery efflorescent minerals occur on some of the Three Hills samples. X-ray photographs were taken of a blue mineral and a yellow mineral both of which are crystalline. The blue mineral when ground in alcohol gave the x-ray pattern for bonattite ($CuSO_4 \cdot 3H_2O$). When photographed as a powder filling a very thin glass tube it gave a pattern for chalcanthite ($CuSO_4 \cdot 5H_2O$). Therefore, it is presumed that alcohol dehydrates chalcanthite. The yellow mineral was also photographed, once after being ground in alcohol and once as a powder in a tube. Although it gave a fairly distinct pattern it could not be identified. Other powders include a buff pink one and a white one.

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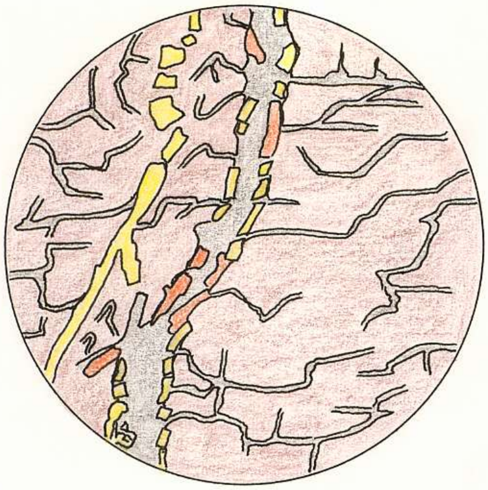

Figure 1. Rough crustification banding of chalcopyrite (orange) and pyrite (yellow) in quartz veinlets (grey) replacing pyrrhotite (brown). X75

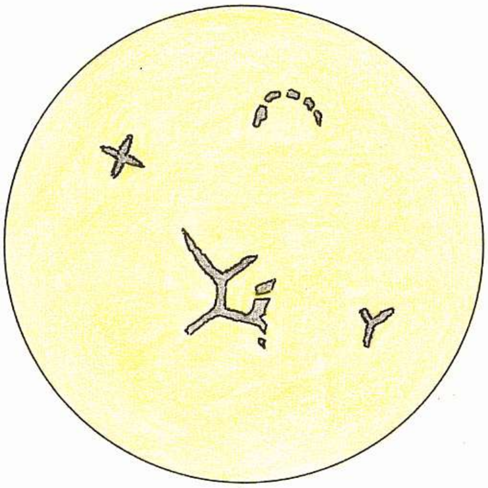

Figure 2. Exsolution of sphalerite (grey) in chalcopyrite (yellow). X300

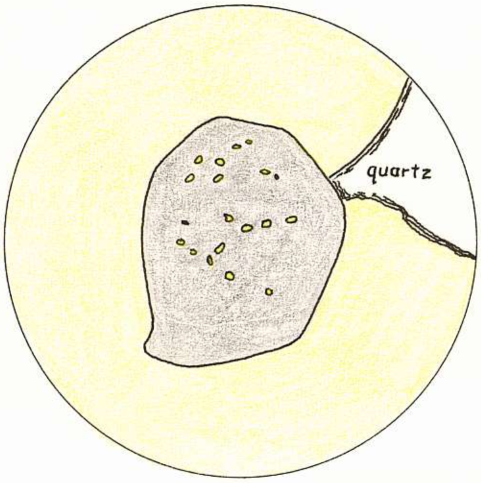

Figure 3. Exsolution of chalcopyrite (yellow) in sphalerite (grey). X 300

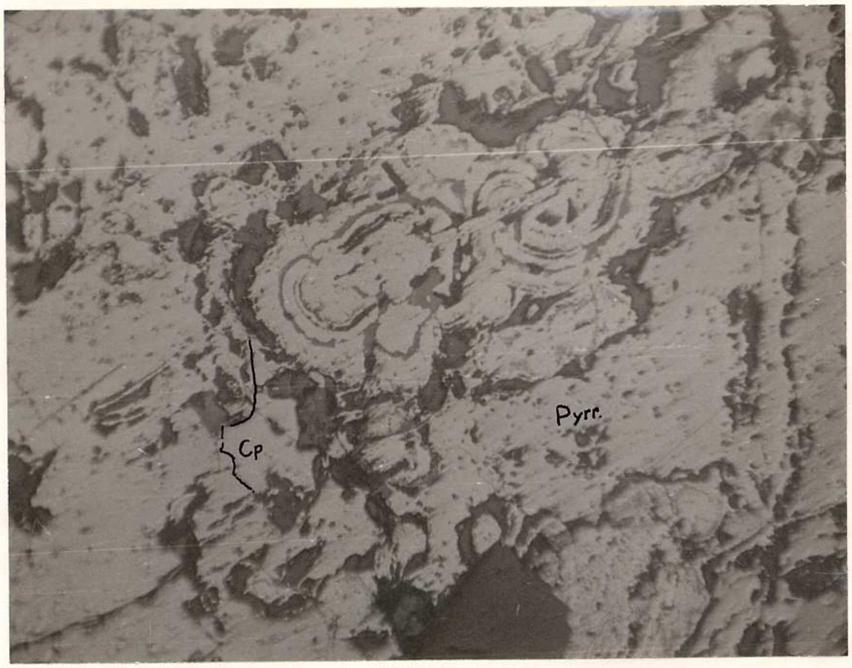

Plate 3. Colloform marcasite in pyrrhotite. X80

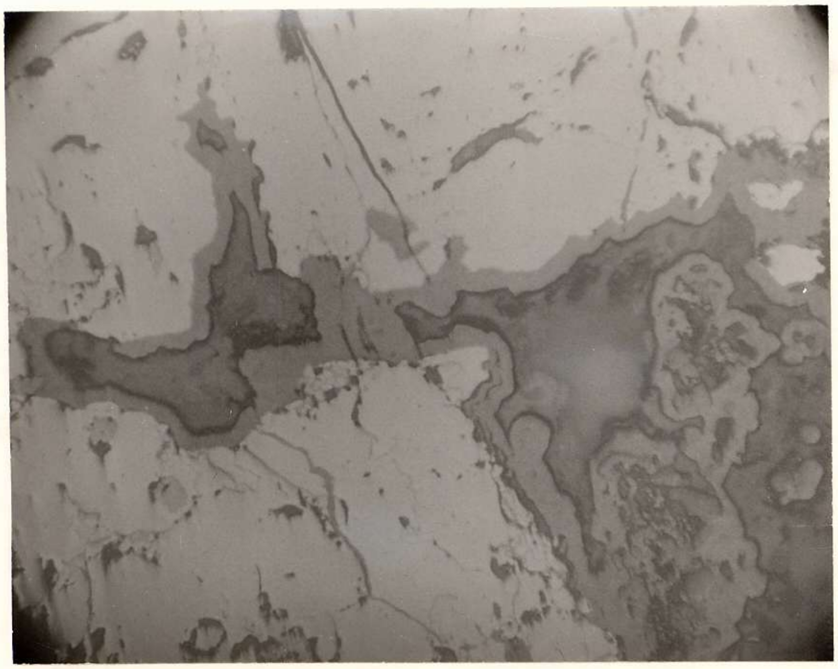

Plate 4. Quartz(dark) lining vugs in chalcopyrite (light). X80

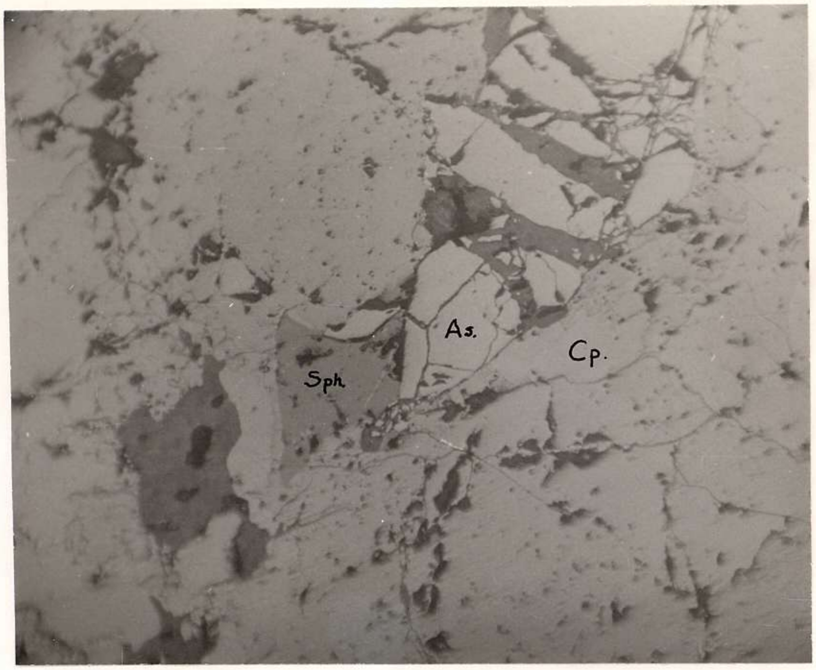

Plate 1. Fractured arsenopyrite crystal with quartz filling fractures. X80

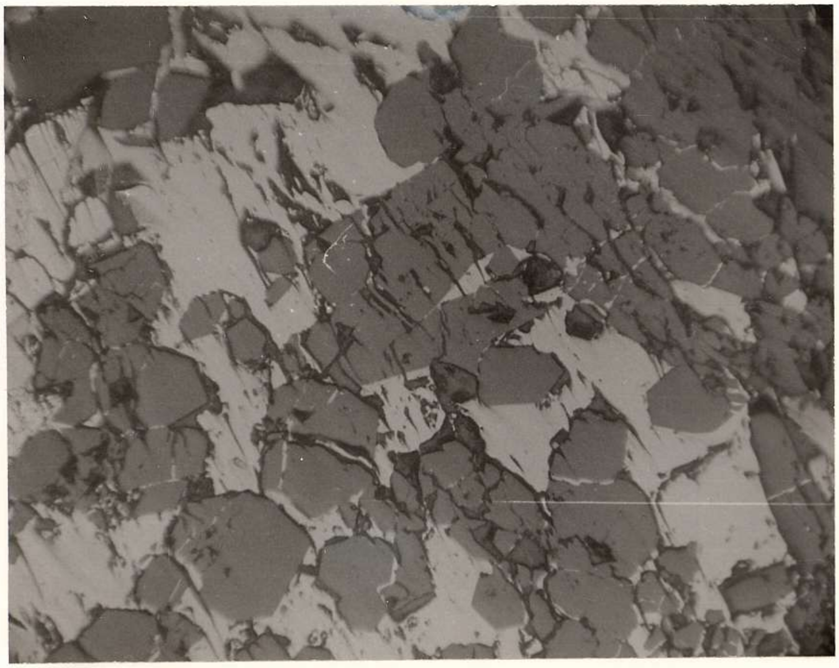

Plate 2. Fractured tourmaline(dark) in chalcopyrite(light) with chalcopyrite filling fractures. X80

Plate 5. Stress twinning in pyrrhotite.
(crossed nicols) X80