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A MICROSCOPIC INVESTIGATION OF ORE FROM THE LITTLE BILLIE MINE, TEXADA ISLAND, B. C.

A report submitted in partial fulfilment of Geology 409 at the University of British Columbia

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Purpose and Scope of this Report

The object of the work summarized in this report was to determine the mode of occurrence of gold, silver and copper in the ore from the Little Billie mine and the size to which it must be ground in order to effect a separation of the valuable constituents.

Previous Work

The Summary Reports of the Geological Survey of Canada and the Reports of the Minister of Mines for British Columbia make several references to Texada Island. The first general survey of the Island was made in 1906 by O. E. Le Roi from the Geological Survey. In 1914 R. C. McConnell's work was published as "Texada Island, B. C.". Dr. V. Dolmage made a detailed study of the Marble Bay mine which was published in "Economic Geology" (1921). The magnetite deposits of the island were investigated by Dr. C. O. Swanson in 1923. Four reports have been compiled at thie university: De Leen in 1946, Carter in 1948, and Smith and Nasmith in 1950. The author has made use of these last four reports in an attempt to present a comprehensive picture.

Location

The Little Billie mine is located one quarter of a mile west of Vananda on Texada Island. The island lies close to seventy miles northwest of Vancouver.

History

In the early nineties bornite was discovered on Texada Island, but it attracted little attention because the ore was of low grade. The ore body of the Marble Bay mine was discovered in 1897. A shaft was sunk to a depth of 500 feet and by 1901 the mine had become the largest on the island. It was worked continuously until 1924. Approximately $25,000,000 in copper, gold and silver ore had been removed.

Work was started about the same time on the Copper Queen and Little Billie mines by the Vananda Copper and Gold Company Limited. A 50 ton copper smelter was built by this company to handle the low grade ore from these mines, which were worked intermittently until abandoned in 1920.

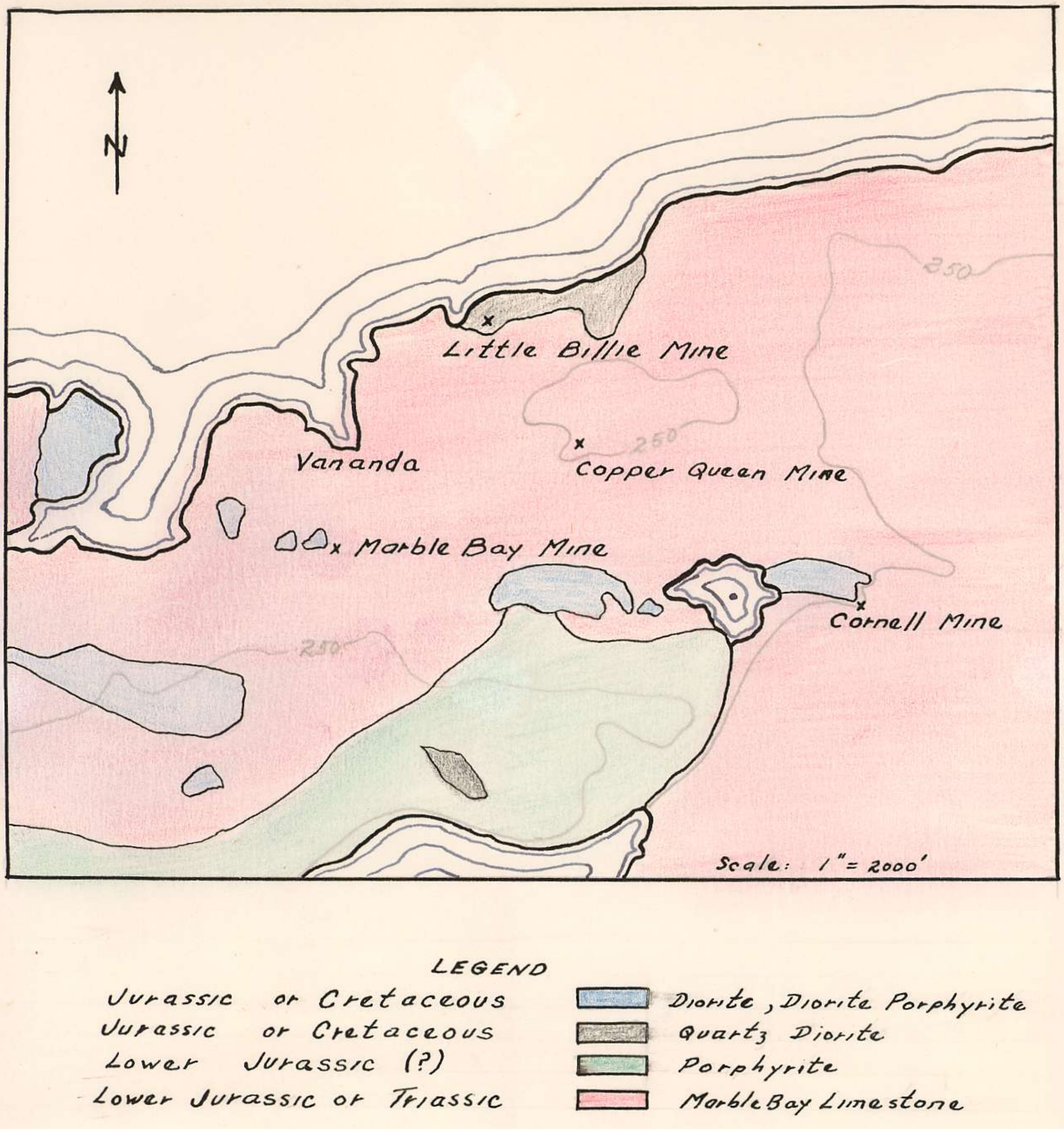
The Industrial Metal Mining Company purchased the mines in 1943 and carried out extensive diamond drilling from the old workings. They succeeded in locating new ore. In 1944 the Little Billie, Cornell and Copper Queen mines were leased by Pioneer Gold Mines Limited, who proceeded to deepen the Little Billie shaft 200 feet and begin work on the 480 foot level.

Carter reports that in 1948, Sheep Creek Gold Mines were building a mill at the Little Billie Mine.

Geology of the Little Billie Mine

The author has not had the privilege of visiting this property, so that the information cited in this section is primarily the work of De Leen.

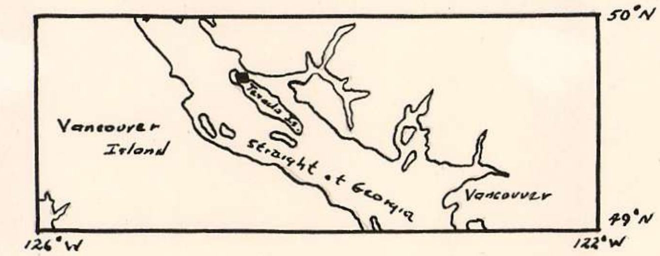
The two main formations at the Little Billie Mine are the Marble Bay limestone and the quartz-diorite. These formations are well illustrated by the map taken from De Leen's report. (Figure 1).



LEGEND

Jurassic or Cretaceous	Diorite, Diorite Porphyrite
Jurassic or Cretaceous	Quartz Diorite
Lower Jurassic (?)	Porphyrite
Lower Jurassic or Triassic	Marble Bay Limestone

Figure 1. MAP SHOWING THE OUTCROP GEOLOGY IN THE VICINITY OF THE LITTLE BILLIE MINE, TEXADA ISLAND, B.C.



The Marble Bay limestone is the oldest formation at the mine and is cut by the quartz-diorite intrusive, alaskite and some andesite dykes. Hand specimens of unaltered limestone are composed of grey calcite crystals up to 10 centimeters in length. The limestone from the contact-metamorphic areas occurs as subhedral crystals, light grey or white in colour and not more than a centimeter in length.

The quartz-diorite outcrops in the Little Billie area as a stock half a mile long and a quarter of a mile wide. It intrudes the Marble Bay limestone and is in turn cut by numerous andesite dykes. Generally, the quartz-diorite is a light grey holocrystalline rock composed of quartz, feldspar, biotite and hornblende. The feldspars are generally subhedral crystals while the quartz is interstitial. Irregular masses of pyrite, chalcopyrite, molybdenite and magnetite are found.

De Leen goes on to say that sections of quartz-diorite taken from the contact zones show that the hornblende and biotite have been altered to chlorite and the feldspars to sericite.

Hand specimens from the Alaskite dykes were composed of feldspar, interstitial quartz and a few shattered grains of biotite. The material had a white watery appearance. No metallic minerals were noted.

The andesite dykes were light to dark green in colour and aphanitic. The dykes are composed largely of plagioclase, hornblende, orthoclase, quartz and biotite. Metallic minerals noted were pyrite, molybdenite and magnetite; and they are found interstitially scattered throughout the specimens..

In general, these dykes seem to have no control over the deposition of the ore.

Ore Types

The intrusion of the quartz-diorite into the limestone has formed areas of skarn up to 100 feet in width. These areas contain the main ore bodies and are classified in two main groups.

1. Bornite - magnetite ore.

This ore occurs in a skarn gangue as a lenticular body about 15 feet wide and running roughly parallel to the quartz-diorite at the east end of the 180 foot level.

Assay:	Copper	1.5%
	Gold	0.05 oz/ton.
	Silver	1.5 oz/ton.

2. Bornite - chalcopyrite ore.

This ore occurs in a fibrous wollastonite gangue in a disseminated state. It is found in the Prosser ore body and ore from the old stopes on the west end of the 180 foot level. It comprises the bulk of the ore.

Assay:	Copper	2%
	Gold	0.2 oz/ton.
	Silver	0.6 oz/ton

The ore is found in limestone and at the margines of the quartz-diorite. It is of contact metamorphic origin.

Mineralogy

By means of etch and microchemical tests and assistance offered by Dr. R. M. Thompson and Mr. Jim McDougall the following ore minerals were noted in the polished sections: magnetite, chalcopyrite, bornite, covellite, chalcocite, molybdenite, sphalerite, pyrite, hessite, linnaeite and an unknown. The unknown mineral was frequently found in association with hessite, but in such small quantities that it was impossible to make positive etch tests. De Leen succeeded in identifying the mineral as wehrlite ($Bi_3 Te_2$). The minerals are described in their probable order of occurrence.

1. Pyrite (FeS_2)

Pyrite was the earliest of the metallic minerals to be deposited. It occurs in cubes and irregular bodies scattered throughout the ore. It was well illustrated in only two polished sections and varied in size from 1.5

centimeters to 2 microns. In places the pyrite has been well veined and replaced by chalcopyrite, bornite and sphalerite. Quartz crystals were noted in the pyrite. In general this mineral was not abundant in the ore.

2. Molybdenite (MoS_2)

Although the age pattern of this mineral is not quite clear from the polished sections it is probable that it preceded most of the metallics. It was not found in contact with pyrite, so no age relationship could be determined. Generally, molybdenite was found in bladed, bent crystals and mostly in the gangue constituents of the ore. In some cases as illustrated, it was found with the metallic minerals.

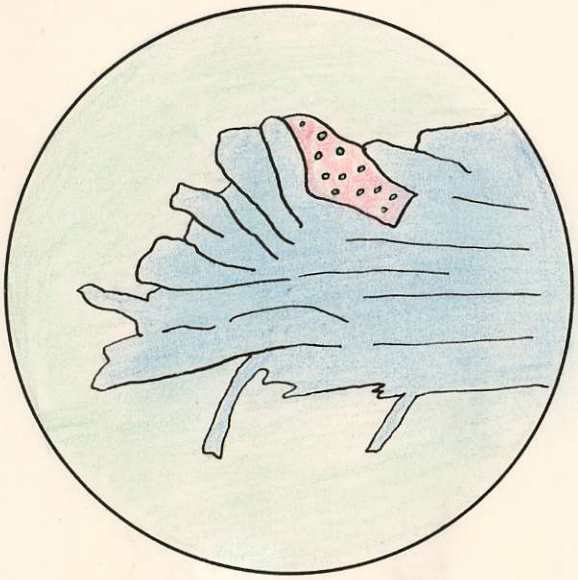


Figure 2. Molybdenite (blue) associated with chalcopyrite (green) and being replaced by sphalerite (red) X 170 (specimen 6)

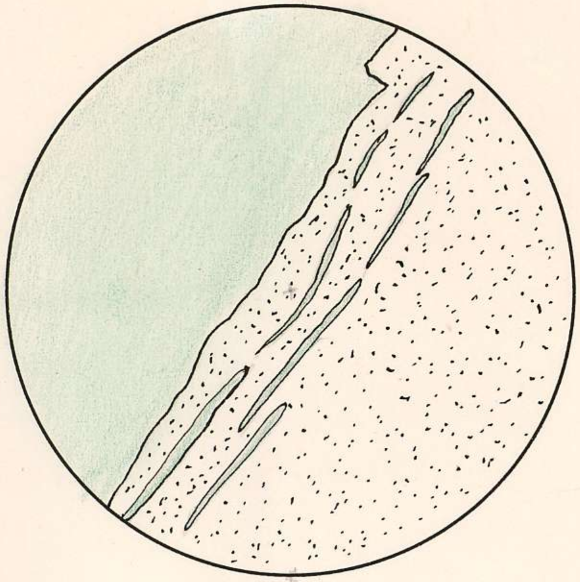


Figure 3. Pyrite (mottled) being replaced by chalcopyrite (green) X 170 (specimen 2)

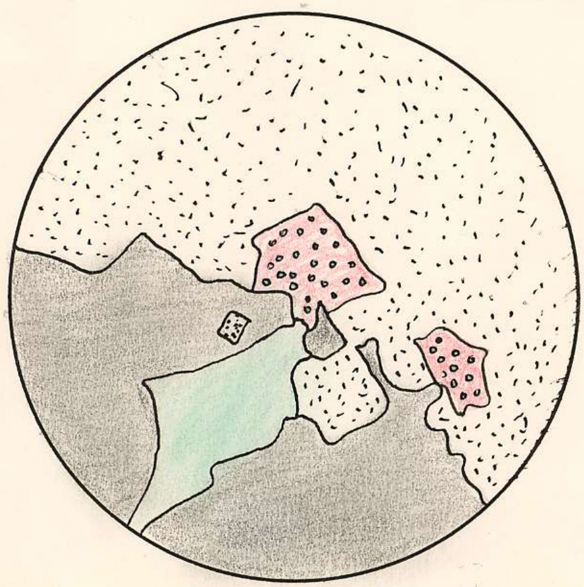


Figure 4. Pyrite (mottled) being replaced by sphalerite (red). Chalcopyrite is green and gangue is black. X 170 (specimen 2)

3. Magnetite ($FeO.Fe_2O_3$)

Figure 5 illustrates clearly that the magnetite has preceded bornite and chalcopyrite. The mineral comprises a fair amount of some sections and occurs as euhedral and anhedral crystals. It is found disseminated throughout the gangue and with bornite and chalcopyrite.

x 300

Figure 5. Magnetite (bright) being replaced by chalcopyrite (light grey) and bornite (dark grey). (Specimen 4)

4. Bornite (Cu_5FeS_4)

Next to chalcopyrite, this mineral is the most abundant metallic in the ore. It is the most important source of copper. Bornite occurs as irregular bodies up to two or three centimeters in size. In some instances small inclusions of covellite and chalcocite were noted. The material had also been replaced by chalcopyrite along fracture planes. It was primarily in the bornite that hessite, linnaeite and the unknown mineral were found.

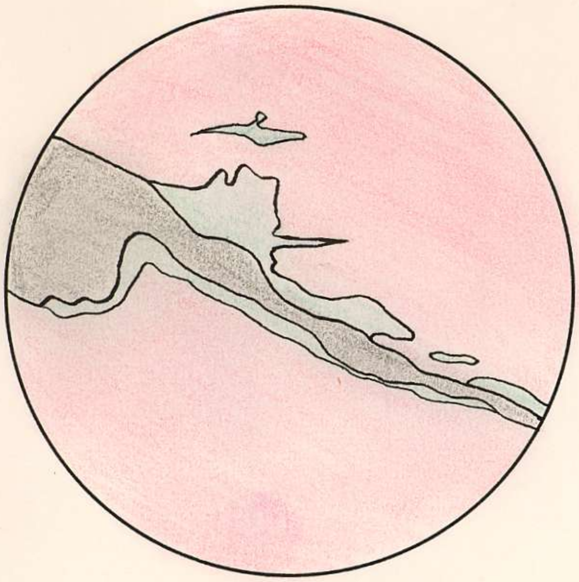


Figure 6. Chalcopyrite (green) replacing bornite (red) wollastonite gangue (black) contact. X 170 (specimen 4)

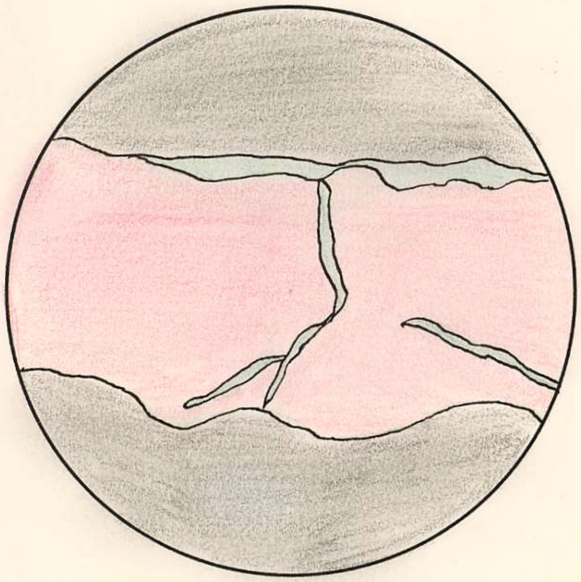


Figure 7. Chalcopyrite (green) in fractures in the bornite (red) and replacing bornite along gangue contact. X170 (specimen 4)

5. Chalcopyrite ($CuFeS_2$)

Chalcopyrite is the second most important copper mineral in the ore of the Little Billie Mine. From figures 5, 6, and 7 it would appear that the chalcopyrite was later than the bornite, although there are indications that they are contemporaneous. Hessite was found in chalcopyrite in one instance, but the unknown telluride was only found in bornite.

6. Sphalerite (ZnS)

Sphalerite occurred with the chalcopyrite in such a way as to suggest they were deposited together. The sphalerite contains a myriad of minute blebs of chalcopyrite dispersed through it. This mottled texture is due to unmixing on cooling of the solution. The mineral is relatively unimportant as it comprises less than one percent of the sections.

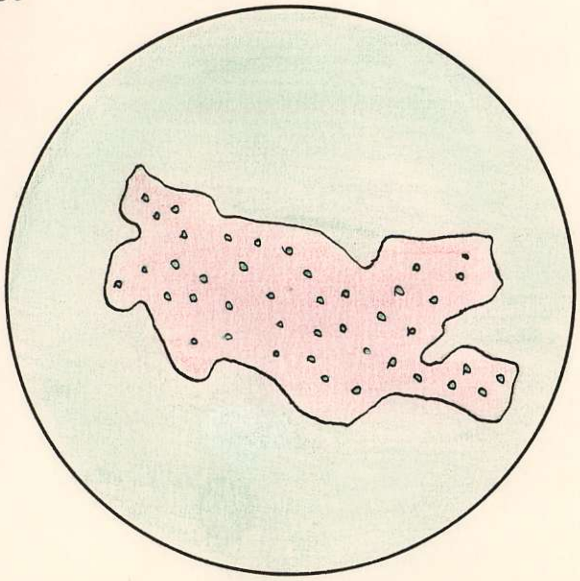


Figure 8. Sphalerite (red) with inclusions of chalcopyrite (green). X 350 (specimen 7)

7. Unknown.

A smooth white mineral occurred in small circular to sub-circular blebs within the bornite. It was quite often associated with hessite, but it was found in such small quantites (less than 10 microns) that identification by etch tests was impossible. Dr. Thompson tentatively identified it as a bismuth telluride and De Leen makes reference to wehrlite (Bi_3Te_2- approx.) occurring in the Little Billie ore. He also states that it assays over two percent silver and is the main silver mineral. Wehrlite is probably contemporaneous with bornite, although, in cases, it appeared to be veining this sulphide.

Doesn't mean anything.

8. Hessite (Ag_2Te)

This mineral was found mostly in bornite and once in Chalcopyrite and always with the unknown bismuth telluride. It generally occurred as blebs around 15 microns in diameter. Its direct association with the unknown suggests they were deposited at the same time. Hessite is another source of silver in the Little Billie Mine.

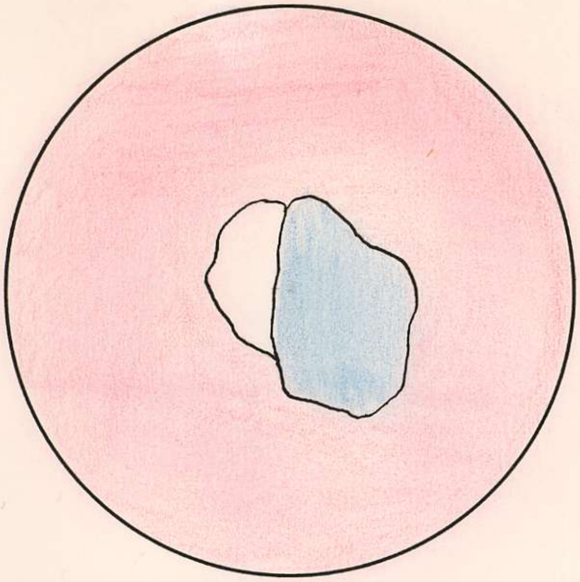


Figure 9. Unknown (white) associated with hessite (blue) in bornite (red). X 1000 (specimen 3)

9. Linnaeite (Co_3S_4)

An isometric, creamy white mineral with good relief was found in bornite in one section. Microchemical tests proved cobalt and a hardness comparison with cobaltite and pyrite suggested that the mineral was linnaeite. Dr. Thompson did some x-ray analyses and identified it as belonging to the linnaeite group. It occurred in cubic and hexagonal forms. The crystals found in this section were about 25 or 30 microns across. Smith states the linnaeite as being replaced by bornite, but no evidence of this was found in the writer's study. However, it was noted that covellite had replaced the mineral.

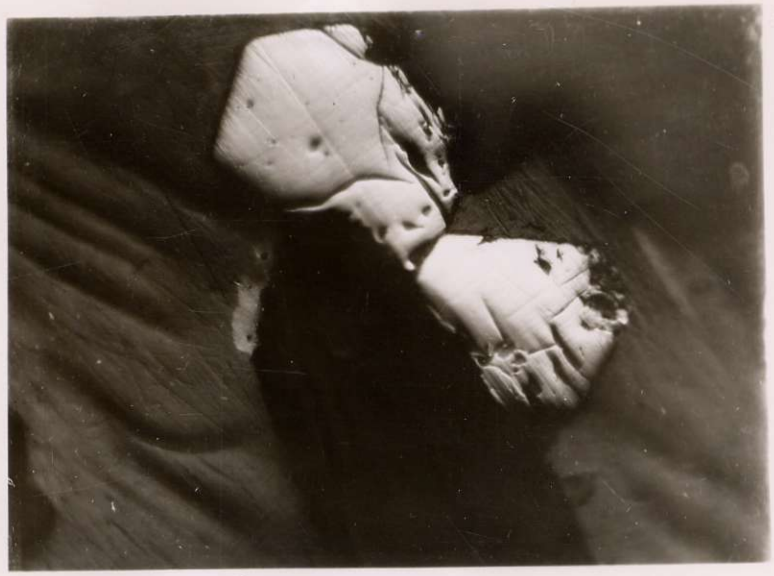


Figure 10. Linnaeite (hexagonal) in bornite (dark grey). Covellite is replacing linnaeite. Chalcocite (light grey) is replacing bornite. (Specimen 3)

10. Chalcocite (Cu_2S)

Chalcocite was found only in small amounts usually associated with bornite. It occurred as small veinlets replacing the bornite.

11. Covellite (CuS)

Covellite was found replacing bornite along fracture cracks and gangue boundaries. It was noted only in small amounts and was probably supergene in origin.

In his study De Leen noted tetrahedrite, native silver and gold in the Little Billie ore. Smith mentions tetrahedrite and also the discovery of one small grain of electrum. Both De Leen and Smith found only one grain of gold each. In the sections the author studied no trace of these minerals was found. Since the ore assays from .05 to .2 ounces per ton gold and .6 to 1.5 ounces per ton silver, it seems likely that these minerals are present. Dolmage also reports the presence of much gold and electrum in polished sections from the neighbouring Marble Bay and Copper Queen mines.

Conclusions

The order of abundance of the minerals found in the polished sections is as follows:

Chalcopyrite
Bornite
Magnetite
Molybdenite
Sphalerite
Pyrite
Chalcocite
Covellite
Linnaeite
Unknown (Wehrlite)
Hessite

This ore could probably be named a pyrometasomatic deposit of copper, gold and silver in a limestone skarn.

The minerals chalcopyrite, magnetite, molybdenite, sphalerite and the tellurides agree with Edward's order of deposition. The ore minerals present indicate a wide temperature range of formation.

Dolmage believes that the covellite and chalcocite are of secondary origin, but De Leen feels they are hypogene. The author tends to agree with Dolmage as far as covellite is concerned, but with De Leen as to chalcocite.

Generally it can be said, the valuable constituents of the ore are hypogene in origin and are found in a pyrometasomatic deposit in a limestone skarn.

The ore is valuable for its copper, gold and silver content. The copper minerals are found in massive particles several hundred microns across. The surfaces are relatively clean and free from oxidation, which would indicate a possible high recovery of copper with a coarse grind and flotation. The chief copper minerals are bornite and chalcopyrite. The finely disseminated particles of sphalerite and molybdenite found in the copper minerals would tend to lower concentrate grade.

In order to free the precious metal minerals from the bornite and chalcopyrite an extremely fine grind would be necessary. These particles appeared no larger than 20 microns. The silver values in the ore can be attributed to wehrlite, hessite and, (by De Leen and Smith) native silver. The gold values come from native gold (again by De Leen and Smith). Bornite, which is a cyanicide, would complicate the recovery of gold by cyanidation.

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