

*Diagrams spoiled by printing  
for bibliography.  
Not a word on previous  
minerals!  
Au - Ag - Hesseite  
Schreibite.  
otherwise a careful study.*

MINERALOGY OF THE LITTLE BILLIE MINE

TEXADA ISLAND, B.C.

600196

A report submitted during the  
Fourth Year of the Course in  
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University of British Columbia

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## MINERALOGY OF THE LITTLE BILLIE MINE

TEXADA ISLAND, B.C.

## Introduction

This report is based on a mineralographic and petrographic study of specimens from the Little Billie Mine on Texada Island. Most of the ore and rock specimens come from the 180 FT LEVEL and a few from the waste dump. The correct location of any of the specimens within the mine could no longer be determined. More than 20 already prepared polished sections existed in the collection most of which could be matched to the ore specimens from which they were made. Three thin-sections of the replacement rock were also studied.

Information about the Little Billie Mine and the general geology of the area was summarized from the following two references:

1. Annual Report, Minister of Mines, B.C. - 1944, pp. 162
2. McConnell, R.G. (1944): Texada Island, B.C. - Geol. Surv., Canada, Mem. 58

Both of these references also contain geologic maps of the area and some of the mine workings.

## Little Billie Mine

### Location

The Little Billie Mines is located on the north coast, north-western end of Texada Island near Vananda Bay. It is in the Nanaimo Mining Division. A road connects the property with Vananda Bay where a dock with loading facilities exists.

### Workings

The workings consist of a 620' deep shaft which serves irregularly spaced levels. In 1951 work was started on a cross-cut which was to intersect the lowest workings of the Copper Queen Mine some 2000 feet in a southerly direction. The levels are generally driven in a southerly direction to explore an irregular limestone and quartz diorite contact. Orebodies are mined by shrinkage stoping.

### History

Outcrops of ore were discovered in 1880 and work has been carried on intermittently since that time. From 1897 to 1916 the Vananda Copper and Gold Mining Company produced 6296 tons of ore. For the next 8 years lessees worked the property. It then lay idle until in 1943 it was acquired, together with adjoining properties, by the Industrial Metals and Mining Company who did considerable development and exploratory work but no stoping. In 1945 the newly formed Vananda Mining Company purchased the property and work has gone on

nearly continuously since then. In 1948 the Vananda Mines Limited was formed. It continued operations until 1951 when stoping was discontinued to allow a connecting cross-cut to the Copper Queen workings to be made. Ore was shipped to Tacoma for smelting.

### General Geology

A geologic map of Texada Island shows Little Billie Mine to lie in an area of limestone, the Lower Jurassic or Triassic Marble Bay Limestone, and near an intrusion of quartz-diorite of Jurassic to Cretaceous age. The Marble Bay formation, which outcrops extensively in the northern part of the island, consists of pure calcareous limestone with some magnesian bands. No siliceous or aluminous beds have been found. The limestone has been more or less crystallized by thermal metamorphism. The quartz-diorite occurs in small stocks and dykes which are found cutting the limestone of the Marble Bay formation as well as the porphyrites of the Texada formation of the southern portion of the island. The quartz-diorites are likely equivalents to, and probably connected at depth with the Coast Range batholith. All major Au-Cu and magnetite deposits of the island occur in the Marble Bay Limestone near contacts with igneous bodies. All these deposits belong to the class of contact metasomatic deposits. Little Billie Mine occurs at or near the contact of the Marble Bay Limestone with a quartz-diorite intrusion, and exists because of it. Many small greenstone dykes of two ages, one pre- and one post-intrusion, occur in the vicinity.

## Detailed Geology

### Petrology

The three main rock types of the mine area include limestone of the Marble Bay formation, the quartz-diorite intrusion outcropping mainly along the nearby coast and numerous greenstone dykes. Specimens of none of these rocks are included in the collection. For a description of them see "Annual Report, Minister of Mines, B.C. - 1944, p 165." The ore mineralization of the property occurs in contact metamorphic and contact metasomatic rocks. These, too, are described in the same reference and some additional specimens from the collection will now be described.

#### Crystalline Limestone

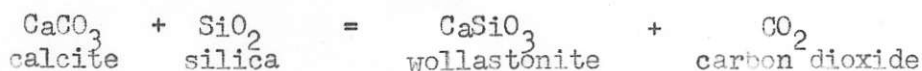
All specimens are medium to coarsely crystalline with some crystals ranging up to 1/2 inch in size. They are white to slightly grey in colour with some buff staining which may be due to the weathering of dolomite or some contained pyrite. Some of the specimens are considerably fractured and even sheared. Many of the specimens are in part replaced by the metallic minerals pyrite, chalcopyrite, molybdenite, bornite and magnetite. The replacement has taken place mostly along the fractures in the carbonate. Pyrite occurs in euhedral to anhedral crystals up to 1/2 inch across, chalcopyrite as disseminated grains and larger irregular masses which at times contain small pyrite crystals, molybdenite as fine grained disseminated specks in the limestone and within chalcopyrite. Some of the limestone grades and

quite suddenly changes into a garnet-rich lime silicate rock. The crystalline limestone was produced by recrystallization and enlargement of crystals due to the thermal metamorphism ( heating under pressure ) of the original Marble Bay Limestone which according to McConnell consists of pure limestone of organic origin which in less metamorphosed areas is dark grey, fine grained to compact and is bedded in layers from one to six feet thick.

#### Wollastonite Marble

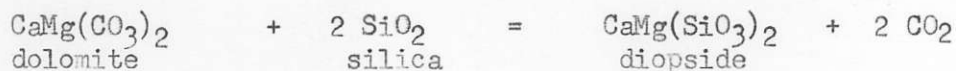
*check*  
This is a white to slightly greenish coarse grained ( crystal up to 2 inches in length ) cleavable to fibrous, silky wollastonite rock containing some carbonate, some quartz and some olive green andradite garnet. A thin section of the specimen showed the rock to consist largely of wollastonite ( colourless, low order white under crossed niccols,  $n = 1.6+$  , nearly parallel extinction, biaxial (-),  $2V$  about  $35^\circ$  ) but also contained considerable calcite, anhedral quartz grains mostly localized in distribution and many small grains of diopside scattered throughout the rest of the minerals.

Wollastonite is formed by the reaction of calcite and silica, the reaction depending on the expulsion of carbon dioxide from the calcite. Since most of the limestone is supposed to be pure (McConnell), free of siliceous bands the silica must have been brought in from elsewhere. Gaseous water readily transports silica in solution. *(reference)*



Limestone is usually quite porous readily allowing diffusion of silica bearing vapours. The localized deposition of quartz may have occurred along fractures along which these vapours could travel even more readily.

In areas which were not sufficiently supplied with  $\text{SiO}_2$ , excessive  $\text{CaCO}_3$  simply recrystallized. The widely scattered small diopside grains may have formed where the limestone was dolomitic in composition.



This reaction occurs under lower temperature-pressure conditions than the formation of wollastonite.

#### Garnetite

A garnetite is a calcic-silicate rock containing garnet. In the rocks from the Little Billie Mine, tan coloured garnets correspond to grossularite  $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_3$  in composition while the olive-green and dark brown garnets correspond to andradite  $\text{Ca}_3\text{Fe}_2(\text{SiO}_4)_3$ . The two types do not occur together. Any <sup>ore</sup>mineralization is associated with the andradite garnet.

Specimen 1. This specimen consists of medium grained, tan coloured, subhedral to anhedral, granular grossularite garnet and contains less than 10% intergranular crystalline calcite. No mineralization is found in specimens containing grossularite.

Specimen 2. Coarse grained, olive-green, euhedral to anhedral andradite garnet crystals and grains intergrown with white coarse to fine grained wollastonite and calcite *make up this specimen.*

Specimen 3. This specimen consists of fine to coarse grained, olive to dark green andradite garnet in a fine grained mass of wollastonite and a little calcite. Some of the garnets form hexagonal crystals 1/2" or more across. Molybdenite lines some of the garnet-wollastonite contacts and is also dispersed in the garnet portion of the rock but not in the wollastonite part. All garnet crystals are fractured.

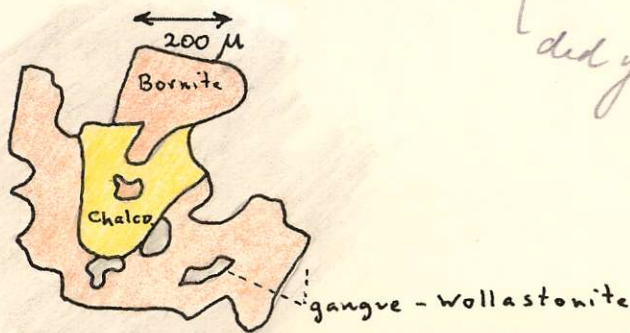


Specimen 4. A green to dark green to brownish, medium to fine grained rock containing olive-green andradite, dark brown andradite, about 10% crystalline intergranular calcite and diopside. In thin section traces of magnetite can also be seen. Still in thin section, the dark brown andradite shows zoning which is due to alternating brown and green colour bands. Interstitial calcite is often replaced by diopside. The magnetite is found mostly along the borders of garnet grains but also within them. The andradite shows anomalous birefringence, which according to Lindgren, is indicative of a temperature of formation below 800°C. Above this temperature isotropic garnet is produced. Other specimens of similar appearance contain finely disseminated chalcopryrite and molybdenite which are seen to replace the calcite and possibly the diopside but not the garnet. Magnetite occurs in specimens of this appearance and so does bornite, both in the form of fine disseminations.

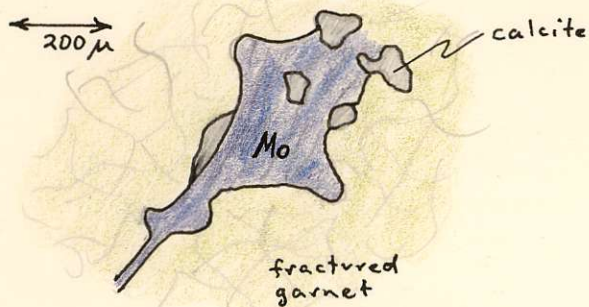
#### Mineralogy

This part of the report will consist of a description in both words and sketches of eleven polished sections from which the paragenetic sequence is to be established.

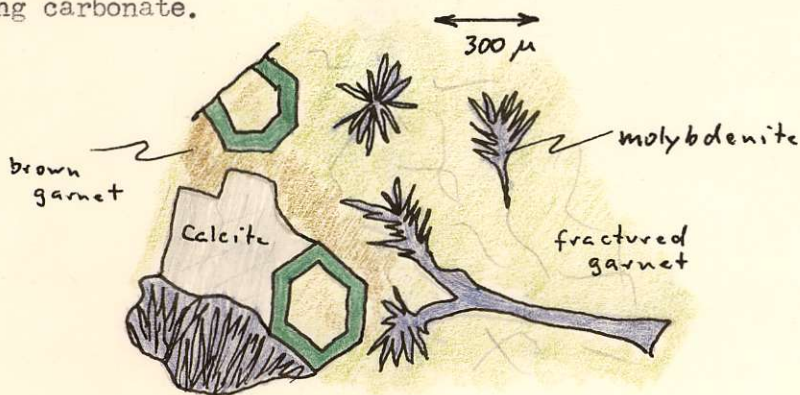
Section 1. Very fine grained bornite and chalcopryrite in wollastonite-andradite skarn. The bornite is being replaced by chalcopryrite.



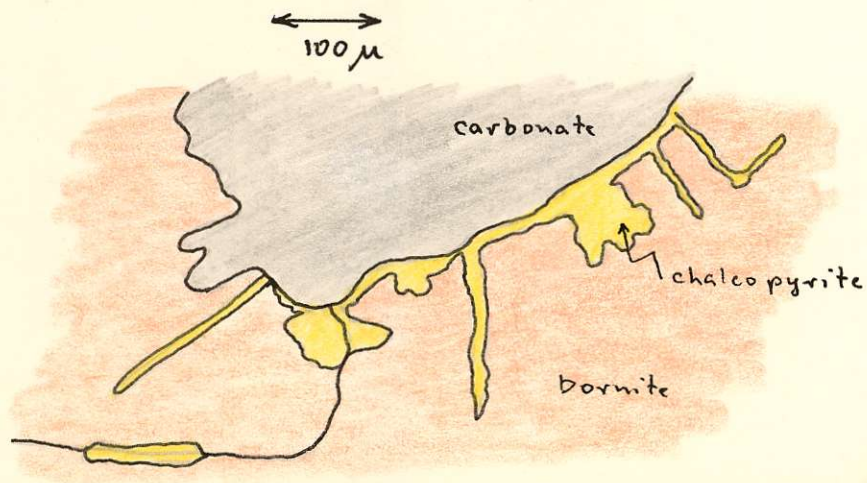
Section 2. Molybdenite in garnetite. The molybdenite formed along some of the major cracks replacing an earlier carbonate filling.



Section 3. Molybdenite in coarse grained garnetite. Fibrous leaf-like blades of molybdenite associated with fractures in the garnet replacing carbonate.

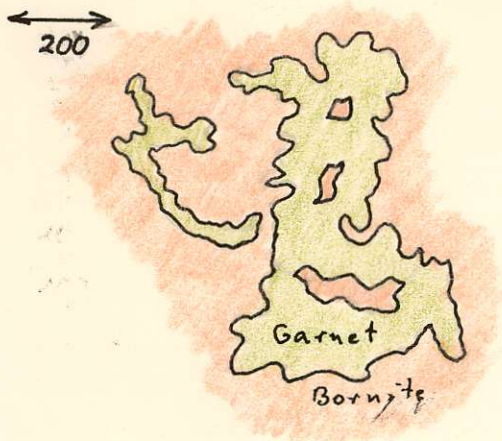


Section 4. High grade bornite ore. The bornite is slightly replaced by chalcopyrite along fractures and especially along bornite-carbonate boundaries. Paragenesis: carbonate, bornite, chalcopyrite.



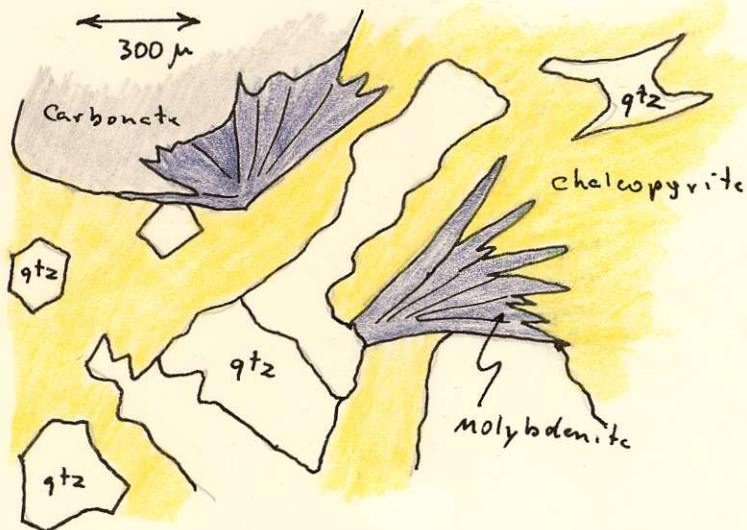


Section 5. High grade bornite ore. The bornite replaces the garnet. Paragenesis: garnet, bornite.

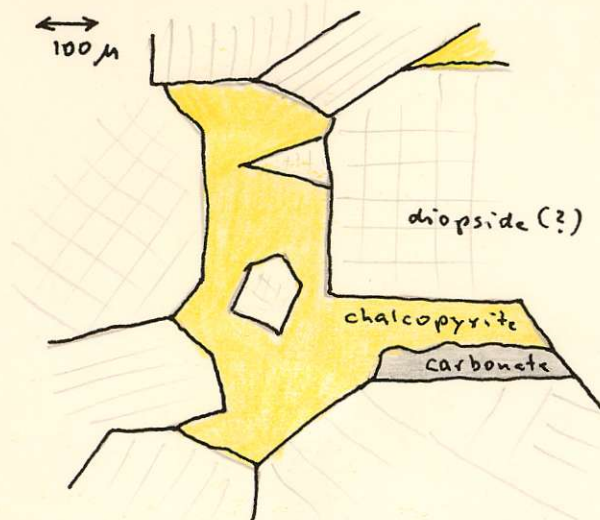


Section 6. This section looks just like the one above except with nearly all of the bornite being replaced by chalcopyrite.

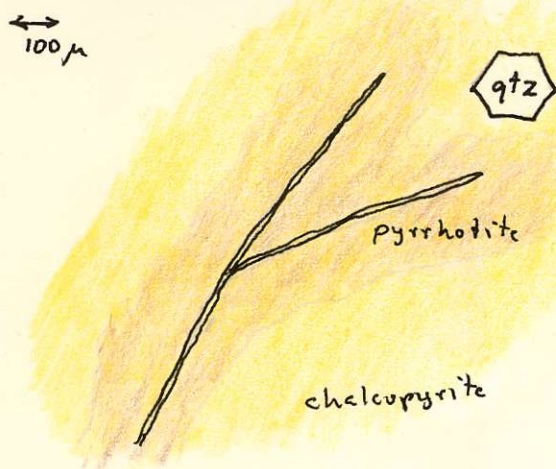
Section 7. Chalcopyrite and molybdenite in siliceous limestone. Paragenesis: quartz, molybdenite, chalcopyrite. The chalcopyrite formed around the molybdenite grains.



Section 8. Chalcopyrite filling intercrystalline space with no replacement. A trace of carbonate is seen in the section and it seems to be replaced by the chalcopyrite, hence it can be assumed that diopside formed first with interstitial carbonate which later was nearly completely replaced by chalcopyrite.



Section 9. Pyrrhotite replacing chalcopyrite along fractures. The chalcopyrite includes early formed euhedral quartz crystals and grains. Paragenesis: quartz, chalcopyrite, pyrrhotite. The boundary is ill defined. *what*



Section 10. Chalcopyrite in magnetite. The magnetite is progressively being replaced by chalcopyrite. ?



#### Paragenesis

The polished section study of the ores from the Little Billie Mine suggests the following paragenesis for the formation of minerals:

1. magnetite
2. molybdenite
3. bornite
4. chalcopyrite and pyrite
5. pyrrhotite

This sequence was preceded by the formation of the silicates for which a likely order is:

1. diopside
2. wollastonite
3. garnet

### Conclusion

The Little Billie Mine is a typical contact metamorphic deposit. The emplacement at depth of the quartz diorite into the pure limestone of the Marble Bay formation first had a thermometa-morphic effect on the limestone, leading to the enlargement of calcite grains. An increase in temperature and pressure and the ascension of silica-and later iron-bearing gaseous water vapour lead to the inter-action of silica and the carbonates to form first diopside, then wollastonite and finally with strongest silicification near the contact also garnet. The iron-bearing vapours also lead to the de-position of magnetite which is always found with or near andradite garnet. This was followed by <sup>the</sup> rising of sulphide bearing vapours and solutions which guided by cracks and fissures <sup>introduced</sup> first molybdenite and bornite, next pyrite and chalcopyrite and finally pyrrhotite. All these sulphides replaced principally carbonates and to a lesser extent garnet and silica. The chalcopyrite replaced magnetite, bornite but not molybdenite and is itself replaced by pyrrhotite.

The whole group of minerals forms a high temperature assemblage. The anomalous extinction of the andradite places an upper limit of 800°C on the temperature of formation of the deposit.

Like other mines of this origin the ore bodies are small, and irregular in outline and distribution.



Little Billy: 092/F/15/E on Ag Au Mo

BCDOM - 6 - BCM 1 #1510

1965 P.224/11 MMAR

1968 p 38-40 GSC paper 68-50

TEXADA ISLAND  
GSC Map 112A, #4

BCDOM/1970, P 282/1/-/GEM.

The Little Billy Mine is a typical contact metamorphic deposit. The replacement at depth of the quartz diorite into the pure limestone of the Harple Bay formation first had a thermometa-morphic effect on the limestone, leading to the enlargement of calcite grains. An increase in temperature and pressure and the ascension of silica and later iron-bearing gaseous water vapour lead to the inter-action of silica and the carbonates to form first diopside, then wollastonite and finally with strongest silicification near the contact also garnet. The iron-bearing vapours also lead to the de-position of magnetite which is always found with or near andradite garnet. This was followed by stages of sulphide bearing vapours and solutions which guided by cracks and fissures first wolfeberite and bornite, next pyrite and chalcopyrite and finally pyrrhotite. All these sulphides replaced principally carbonates and to a lesser extent garnet and silica. The chalcopyrite replaced magnetite, bornite but not wolfeberite and is itself replaced by pyrrhotite.

The whole group of minerals forms a high temperature assemblage. The unusual extinction of the andradite places an upper limit of 800°C on the temperature of formation of the deposit.

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