Microchemical work inconclusive
but general attack sound
and constructive
[illegible]



# A MINERALOGICAL STUDY
# OF
# TWO COBALT ORES

Orval W. Bennett

The University of British Columbia

April, 1944

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## INTRODUCTION

This report is presented in partial fulfilment of the requirements of Geology 9. All work was done in the laboratories of the Dept. of Geology at the University of British Columbia.

The main purpose of the work was to identify the cobalt bearing minerals in the ores studied. A number of microphotographs were taken to show various occurences, associations, and age relations of the minerals.

It is desired to acknowledge with thanks, the assistance of Dr. H.V.Warren, Associate Professor of Geology, under whom this work was carried on. Thanks also goes to Mr. R.M.Thompson, Mr. D.Carlisle, and Mr. J.Donnan for helpful advice and assistance.

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## HAZELTON VIEW

### Location

The Hazelton View property is located in the Omineca Mining Division about 130 miles northeast of Prince Rupert. The camp is on the west face of Roche De Boule mountain.

### General Geology*

The imbedded rocks of the Hazelton district are all of the Hazelton series. Extending across the southern part of the Roche De Boule group of mountains are interbedded flows and coarse, ill-assorted tuffs or tuff-agglomerates. The northern portion is more evenly bedded with well-assorted material, distinctly banded. A determination by Dr. T. W. Stanton, based on marine fossils collected in the area, places the age of this area as upper Jurassic**

The folding of the rocks in this area took place with axes approximately northeast-southwest. This folding was followed by the intrusion of small stocks or batholiths, one

* Preliminary Report on the Economic Geology of Hazelton District, British Columbia.
** Geological Survey, Can. Sum. Report., 1912.

of which now forms the core of Roche De Boule mountain, and by dykes which traverse the mountains and valleys. The intrusions apparently cut through the sediments without causing any appreciable deflexion of the bedding.

The ore occurs in distinct shoots in veins of true-fissure-replacement or shear-zone-replacement type.

Preliminary Work

Four specimens were mounted and polished for the microscopic work.

One minute etch tests with different strengths of nitric acid were first made on known samples of cobalt and arsenic minerals. The object of these tests was to become familiar with and be able to distinguish the arsenide minerals from the sulphide minerals. A summary of the results is given below.

| Mineral | 3:10 $HNO_3$ | 1:1 $HNO_3$ | Conc. $HNO_3$ |
|---|---|---|---|
| Little Gem Saff.-loellingite $(CoFe)As_2$ | Slight brown tinge | Effervesces, grey differential etch remains | Dark grey etch, Transparent octehedrons seen at high power |
| Little Gem Danaite (FeCoAs)S | Neg. | Dark Grey Etch | Dark grey etch but no octehedrons observed |
| Arsenopyrite (FeAs)S | Neg. | Dark grey etch, some irridesence | Dark grey etch, no octehedrons |
| Cobaltite (CoAs)S | Neg. | Neg. | Neg. |

Mineralogy

The metallic minerals identified were, in order of abundance, arsenopyrite, ~~safflorite-loellingite~~, chalcopyrite, cobaltian loellingite & S'Kutterudite two minerals embedded in the chalcopyrite beleived to be bornite and chalcocite, and gold. The chief gangue minerals are quartz and hornblende.

Safflorite-loellingite

Safflorite-loellingite is a little softer than arsenopyrite and takes a smoother higher polish. Arsenopyrite, being harder, shows more relief in the polished section. After some practise it is possible to distinguish between the two by eye under the microscope.

In determining safflorite-loellingite, etch tests with 3:10, 1:1, and concentrated nitric acid were made. 3:10 acid was negative, 1:1 acid gave a grey differential etch and the concentrated acid brought out transparent octehedrons characteristic of arsenides. Subsequent microchemical tests showed the presence of cobalt and a little iron. Due to the small amount of iron showing in the microchemical test it was concluded that the mineral belonged near the safflorite end of the series. The safflorite-loellingite was found chiefly associated with arsenopyrite. Plate III shows safflorite-loellingite veining arsenopyrite.

Arsenopyrite

Etch tests with different strengths of nitric acid corresponded to those run on the standard arsenopyrite sample. Microchemical tests on the mineral gave abundant iron, and arsenic. No cobalt test was obtained and from this it was concluded that the mineral was arsenopyrite and not danaite. More microchemical tests would have to be made from different specimens before it could be definitely concluded that danaite was not present on the property.

Polarized light further confirmed that the mineral was arsenopyrite as it was strongly anisotropic and showed a color change from brown to blue.

Chalcopyrite

Chalcopyrite was observed in all the specimens although some had considerably more than others. In some places it was present as fine veinlets cutting all the minerals and in other places it occured in relatively large pieces.

Chalcopyrite was easily determined by its color, hardness, and negative reaction to all reagents except nitric acid which left a slight tarnish. Microchemical tests showed copper and iron.

Plate II shows chalcopyrite veining safflorite-loellingite.

Two other minerals were observed as inclusions in the chalcopyrite. At first it was thought one of these might be a bismuth mineral or a telluride. Subsequent microchemical tests dismissed this belief as no satisfactory test could be obtained for tellurium or bismuth.

Both of the mineral are soft. One has a purplish tinge suggestive of bornite and the other is light blue. Etch tests on the purplish mineral tended to indicate that it was bornite. Nitric acid (1:1) gave a bright irridesence, KCN darkened the mineral and $FeCl_3$ gave a slightly positive reaction. The other mineral was tarnished bright blue by 1:1 nitric acid and darkened by KCN.

The light blue mineral was also observed in safflorite-loellingite in Section 2. Here it gave a bright blue tarnish with nitric acid and was slightly darkened by KCN. From these tests it was beleived that the mineral might be chalcocite but with the exception of the nitric acid test the tests were not positive enough to be conclusive.

Plate IV shows these two minerals embedded in chalcopyrite.

Gold

Only one speck of gold was observed. It was in an arsenopyrite inclusion in a safflorite-loellingite vein. Plate I shows the gold and the contact of the main masses of the arsenopyrite and safflorite-loellingite.

Age Relations

Examination of the specimens seem to indicate that the arsenopyrite is the oldest metallic mineral present. The safflorite-loellingite is seen in veins cutting the arsenopyrite (PlateIII) and would indicate a later deposition.

Gold found associated with and embedded in the arsenopyrite (Plate I) may have been contemporaneous with it.

Quartz veins cut the arsenopyrite indicating a later deposition. Another kind of quartz was observed which appeared to be older than the arsenopyrite.

Chalcopyrite veins all the minerals, indicating the latest deposition of all.

## Grain Size

The gold observed was about 7 microns across.

The arsenopyrite was mostly coarsely crystalline but some crystals observed in quartz were only about 5 microns in size.

The mineral identified as safflorite-loellingite in Plate II was present in relatively large veins, the smallest being about 60 microns across. In other places the safflorite-loellingite occured as a network with arsenopyrite but not in as fine veinlets as the chalcopyrite shown in PlateII.

From these observations it would appear that a very fine grind would be necessary to free the gold. A normal flotation grind should substantially free the cobalt bearing mineral.

# IDAHO COBALT B. M. & S.

## Location

The specimens used in this work came from the Brown Bear prospect of the Howe Sound Company. The prospect is located in the Blackbird district, Lemhi County, Idaho.

## General Geology*

This area is underlain by a series of thick, considerably metamorphosed, sedimentary strata belonging to the Belt series (pre Cambrian). These strata are composed chiefly of bedded, fine grained quartzites and schists. Basic dikes occur throughout the district. The cobalt ores occur chiefly as very fine to coarse-grained lenses, stringers, and disseminations along fracture or shear zones in quartzite or schist.

## Preliminary Work

Two specimens of the ore were mounted and super polished for the microscopic examination. Two samples of concentrate were also observed. The results of tests on standard known samples , as described earlier in this paper were used.

## Mineralogy

Metallic minerals identified were, in order of abundance, pyrite, arsenopyrite, chalcopyrite, and cobaltite. The chief gangue minerals are quartz and hornblende.

*War Minerals Report 131, U.S. Bureau of Mines.

Pyrite

Pyrite is the most abundant mineral in the sections studied. It is present in its ordinary form as well as in a peculiar coliform structure. This peculiar structure is shown in Plate I. It might be explained as being caused by colloidal deposition of the pyrite.

The pyrite was identified by its color, hardness, and negative reaction to all reagents except nitric acid which gave a differntial stain probably due to different orientation of the grains.

Arsenopyrite

Arsenopyrite occurs associated with the pyrite. Its presence was proved by etch tests with nitric acid and by microchemical tests. The microchemical tests gave good tests for iron and arsenic. It should be noted that microchemical tests on the arsenopyrite gave a good test for nickel. No test for cobalt could be obtained on the arsenopyrite. The mineral also showed strong anisotropism with color changes from brown to blue.

Chalcopyrite

Chalcopyrite occurs mainly in stringers and in quartz veins. Its presence was determined by the same methods as previously described.

Cobaltite

Cobaltite occurs as inclusions in the chalcopyrite and pyrite and also as individual crystals in quartz stringers.

Plate II shows a large cobaltite crystal in quartz and shows quartz cutting the pyrite. Plate III shows cobaltite as an inclusion in chalcopyrite. Plate III also shows the contact of pyrite and arsenopyrite and shows chalcopyrite in the quartz stringer.

In most places the cobaltite appears in well defined pyritehedrons and has a characteristic pink color. It is negative to all etching reagents. Some crystals of cobaltite showed a zoned structure after etching with concentrated nitric acid.

The cobaltite was also observed in small particles in fracture planes in the gangue material.

Age Relations

Observations would tend to show that the cobaltite was the oldest mineral since it occurs as inclusions in the pyrite, chalcopyrite, and quartz.

Plate II shows pyrite being cut by quartz, indicating that the quartz was younger. In other places in the specimen, the pyrite seems to be coming up through the quartz in very fine veinlets, indicating that the quartz was older than the pyrite. These two ages of quartz seem to be borne out in other places where fine quartz veins appeared to be a different color than the main mass of the quartz.

The arsenopyrite appears to be about the aame age as the pyrite.

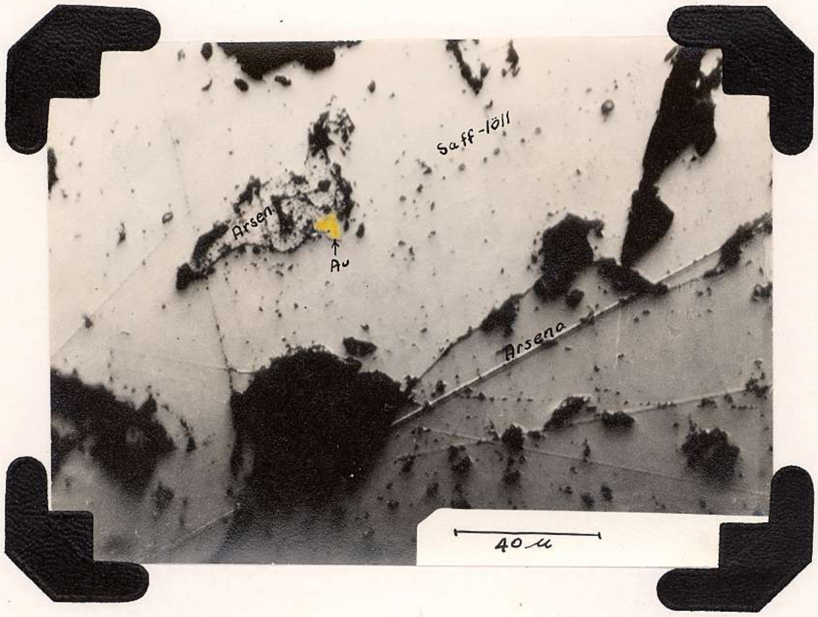
The chalcopyrite in the quartz veins appears to be the latest of all.

## Grain Size

The cobaltite occuring in individual crystals in chalcopyrite and quartz ranges in size from about 225 microns to 30 microns. In other places where the cobaltite is associated with gangue material in fracture planes, it may be as small as 10 microns.

The associated sulphides could be liberated by grinding to normal flotation size, since they occur in relatively large grains. The cobaltite would not be substantially freed unless the ore was ground to pass at least 200 mesh. Even this fine a grind would not free the smallest particles but since the major portion of the cobaltite occurs in the large crystals in chalcopyrite and quartz, this fine a grind might be the most economical when other values were taken into account.

It is not known whether or not the major portion of the cobaltite occurs in relatively large crystals in the chalcopyrite and quartz throughout the whole orebody. On the whole, the proportion in which the types of cobaltite occurence exist in the ore will govern the fineness of the grind.




HAZELTON VIEW

Plate I

Shows gold in arsenopyrite inclusion in safflorite-loellingite vein, also shows contact of arsenopyrite and saff.-loell.

Section 6

Objective 6a

Eyepiece 8x

Magnification X480

Exposure 10 sec.


HAZELTON VIEW

Plate II

Shows chalcopyrite veining safflorite-loellingite.

Section 1

Objective 3b

Eyepiece 8x

Magnification X165

Exposure 12 sec.


HAZELTON VIEW

Plate III

Shows safflorite-loellingite veining arsenopyrite.

Section 5

Objective 3b

Eyepiece 8x

Magnification X165

Exposure 12 sec.


## HAZELTON VIEW

Plate IV

Shows minerals believed to be chalcocite and bornite embedded in chalcopyrite

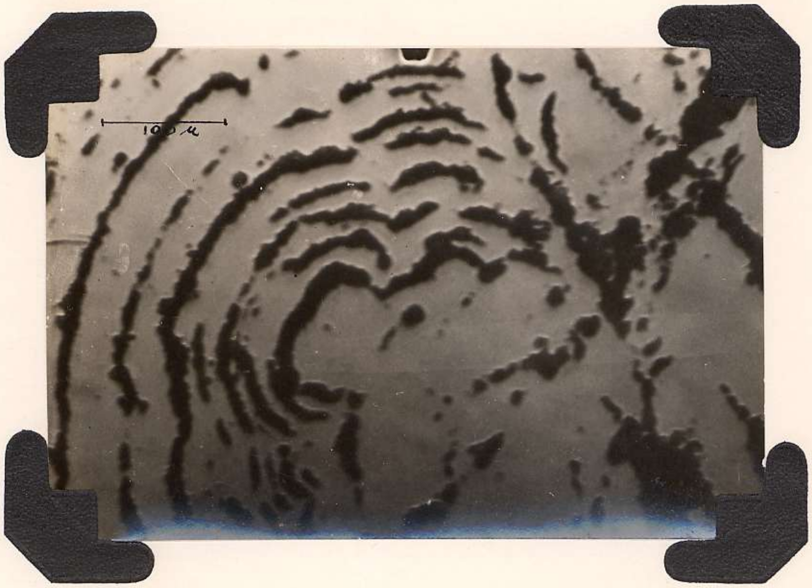
Section 1

Objective 3b

Eyepiece 8x

Magnification X165

Exposure 12 sec.




IDAHO COBALT, B. M. & S.

Plate I

Pyrite showing coliform structure

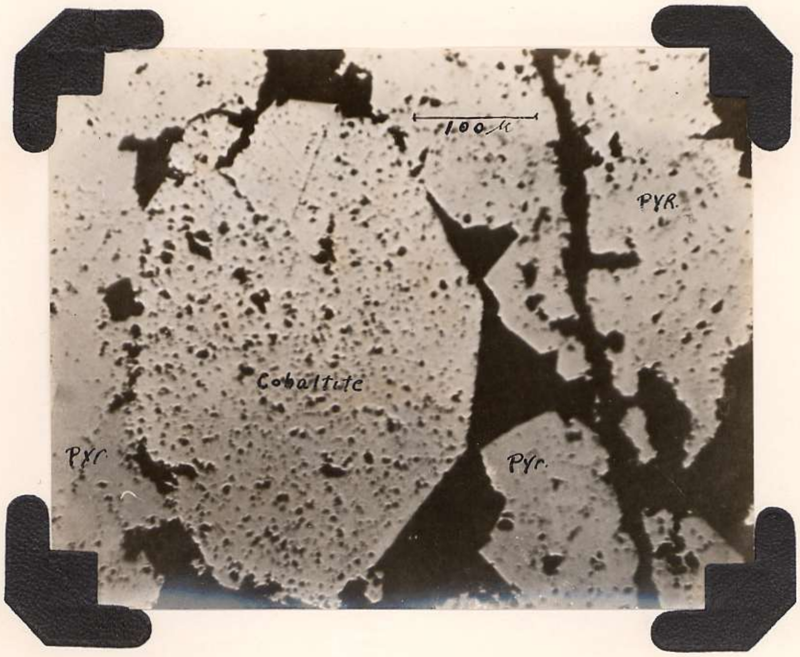
Section 1

Objective 3b

Eyepiece 8x

Magnification X165

Exposure 10 sec.




IDAHO COBALT, B.M. & S.

Plate II

Shows cobaltite crystal in quartz, also quartz cutting pyrite.

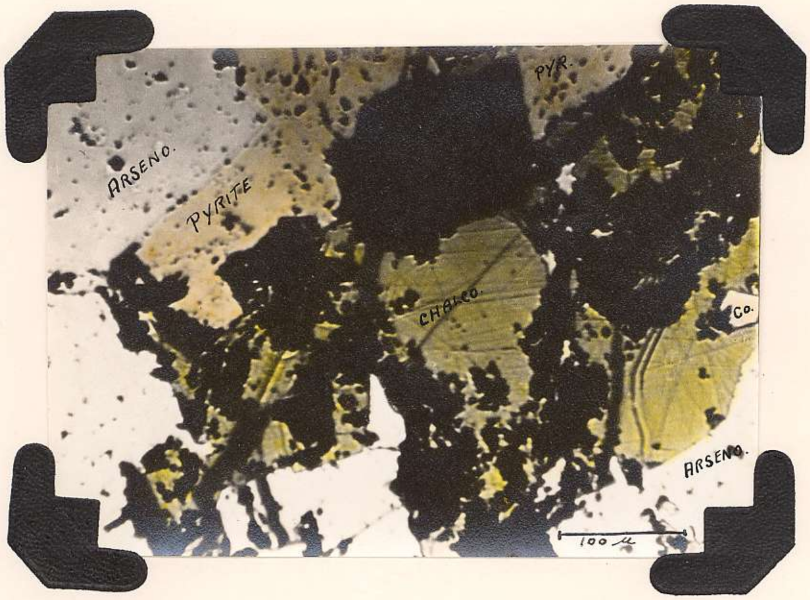
Section 2

Objective 3b

Eyepiece 8x

Magnification X165

Exposure 1 sec.




IDAHO COBALT, B.M. & S.

Plate III

Shows cobaltite inclusion in chalcopyrite and contact of pyrite and arsenopyrite, also shows chalcopyrite in quartz vein.

Section 2

Objective 3b

Eyepiece 8x

Magnification X165

Exposure 12 sec.

## Appendix

Minerals identified in sections

Hazelton View

Section 1. arsenopyrite, safflorite-loellingite, chalcopyrite,(bornite and chalcocite in chalcopyrite)?

Section 2.arsenopyrite, saff.-loell., chalcopyrite,(bornite and chalcocite in chalcopyrite and saff.-loell.)?

Section 3 arsenopyrite, saff.-loell. chalcopyrite, chalcocite

Section 4 arsenopyrite, saff.-loell.

Section 5 saff.-loell. in arsenopyrite

Section 6 gold in saff.-loell. vein in arsenopyrite

Idaho Cobalt, B.M.&S.

Section 1 pyrite, chalcopyrite, arsenopyrite, cobaltite

Section 2 pyrite, chalcopyrite, arsenopyrite, cobaltite

Section 3 concentrate

Section 4 concentrate