PORTLAND CANAL

Geology 409 Skeena

Mineralographic Report #3

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Megascopic

The material examined consists of two polished sections mounted in bakelite and a small hand specimen about 1" × ½" × ¾".

Four minerals can be picked out in the hand specimen. Of these bornite and malachite are easily recognised. A grey sectile mineral showing the iridescent stain characteristic of copper minerals suggests chalcocite. The fourth mineral is a hard, dark grey mineral disseminated through the ore in very fine grains.

The bulk of the ore is composed of a massive intergrowth of bornite and chalcocite. The hard mineral is third in abundance. Malachite occurs in minor amount bordering holes in the ore and is in places intergrown with crystalline calcite. Away from malachite the ore appears quite fresh.

Microscopic.

Bornite (Cu_5FeS_4)

This mineral occurs in graphic intergrowth with chalcocite. The graphic textures are patchy and massive bornite appears in some areas. Bornite appears to be slightly subordinate to chalcocite in the intergrowth.

The mineral shows the typical pinkish brown color, an excellent polish and is isotropic. The following etch tests were observed:

$HgCl_2$	....	brings out anisotropism and grain boundaries.
HCl KOH	...	Negative.
KCN	...	Stains brown
$FeCl_3$	...	stains orange, brings out polygonal pattern of etch cleavage
HNO_3	...	Effervesces, surface stains yellowish brown, brings out cracks and etch cleavage.

Neodigenite : ($4Cu_2S.CuS$)

This mineral occurs in graphic or myrmekitic intergrowth with bornite. Lamellar intergrowths with orthorhombic chalcocite were noted in certain small areas. Under the microscope the mineral is pale blue in color and isotropic. Octahedral cleavage is well developed. Under high magnification the myrmekitic texture is seen to be produced by neodigenite replacing bornite along cracks and cleavage directions. The mineral gave the following etch tests:

$HgCl_2$ ... Stains pale brown, reveals etch cleavage.
KOH, $FeCl_3$ ... Negative.
KCN ... Stains dark grey to black.
HCl ... No stain, reveals etch cleavage.
HNO_3 ... Effervesces; stains blue. brings out etch cleavage and reveals lamellar intergrowth with chalcocite in some areas.

Microchemical tests were positive for copper.

Chalcocite, Cu_2S :

Chalcocite occurs in minor amount in lamellar intergrowth with neodigenite or as aggregates of small grains. Etching with $FeCl_3$ also reveals very thin borders of chalcocite on some neodigenite grains. The mineral is moderately anisotropic in bornite pink and bluish grey. Etch tests are similar to those for neodigenite except that $FeCl_3$ stains faint blue.

Malachite ($Cu_2CO_3(OH)_2$)

This mineral occurs as green crystals showing radial growth and concentric banding. The crystals are prismatic, and coarsely fibrous, and grow across the colloform banding. The mineral effervesces vigorously with HCl.

Under the reflecting microscope the mineral is dark in plain light but shows strong green internal reflection under crossed nicols.

Hematite (Fe_2O_3)

This mineral occurs as granular aggregates or discrete or aggregated crystals embedded in 'chalcocite' and bornite. The crystals show various shapes; usually thin elongate rhombohedrons, sometimes rectangular tablets and sometimes almost square sections are observed. The crystals are very small, generally less than 0.2 mm. The mineral gives a red streak.

Under the microscope the mineral is gray and faintly anisotropic in bluish gray and light gray. It shows a fair polish and a strong red internal reflection.

Etch tests showed the mineral to be negative to all reagents. Micro-chemical tests were strongly positive for iron.

Chalcopyrite ($CuFeS_2$)

Chalcopyrite occurs in exceedingly minute amount in fractures in bornite. It is always accompanied by 'chalcocite' and appears to be a temporary intermediate product formed during replacement of bornite by 'chalcocite'. The mineral appears in section as elongate grains or chain like aggregates partially filling very fine cracks in bornite. Magnification of several hundred diameters is required. The mineral was identified by association and the bright yellow color.

Unknown Minerals A and B.

Included in both bornite and 'chalcocite' are tiny white specks composed of an intergrowth of two minerals. These specks are generally less than 0.1 mm in size and have rounded or irregular shapes with convex boundaries. The main mineral is galena white in color, has a hardness about B; and is apparently isotropic, although the grains are too small to be certain of this. Intergrown with this mineral is a pale grey mineral of approximately equal hardness. This latter mineral is apparently anisotropic though again one cannot be sure.

Etch tests were apparently negative on both minerals for all reagents except HNO_3. After etching with HNO_3 the specks could no longer be located.

COMPOSITION OF THE ORE.

The minerals are arranged in the following table in order of relative abundance in the sections. An estimate of the percentage of each is given.

Primary Minerals		Secondary Minerals	
Neodigenite	33 %	Malachite	3 %
Bornite	30 %	Chalcocite	2 %
Hematite	23 %		
Unknown Minerals A & B	< 1 %		

Gangue 9%

TEXTURES AND PARAGENETIC SEQUENCE.

Hematite often shows a curved linear arrangement of the grains or crystals, often in double rows as if the mineral had replaced the host along fractures. There is no sign of hematite replacing the sulfides hence it may be that the sulfides have replaced the mineral which was

the original host to hematite.

The graphic and myrmekitic textures displayed by ~~hematite~~ bornite and chalcocite are a result of replacement of the former by the latter. These textures represent an intermediate stage in the replacement. Early stages show fine stringers of chalcocite appearing along cracks and cleavage directions in bornite; in later stages the stringers meet and expand leaving isolated remnants of bornite.

Graphic intergrowth is also shown by the Unknown minerals A and B. The lamellar intergrowth of chalcocite and neodigenite is believed to be primary. Small areas of chalcocite, usually fine grained, are believed to be secondary. Rims of chalcocite on neodigenite are also believed formed by supergene processes.

The paragenetic sequence appears to be: Hematite - bornite - chalcopyrite - neodigenite - chalcocite - malachite.

TEMPERATURE OF FORMATION

Since bornite and chalcocite are capable of solid solution above 175° C, one would expect exsolution textures if formation of the ore had occurred above this temperature range. Actually one cannot rule out the possibility that the graphic textures may be a result of exsolution rather than replacement. Consequently the textures shown by bornite and chalcocite do not define the upper temperature limit of formation.

The lower limit of formation is fixed by neodigenite which forms above 91°C. Hematite is generally a high temperature mineral although as noted earlier it may belong to an earlier mineralisation. It is apparent that the ores are of hypogene origin and in view of lack of substantial proof to the contrary the writer feels that they best fit the epithermal class of deposit.

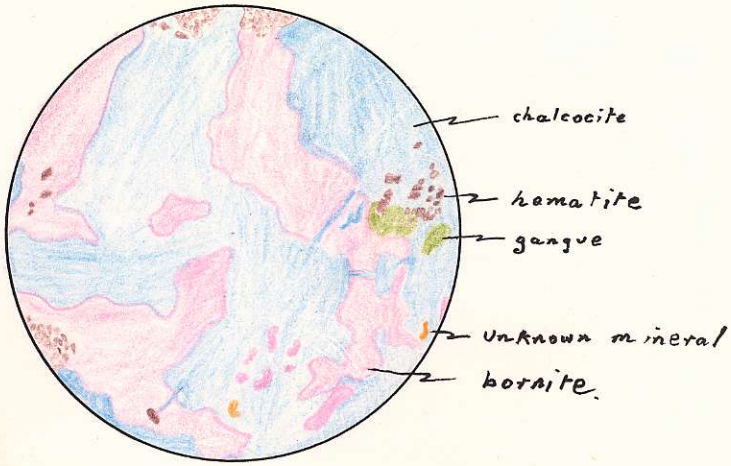

Fig. 1. Typical graphic replacement texture shown by chalcocite and bornite. x 25

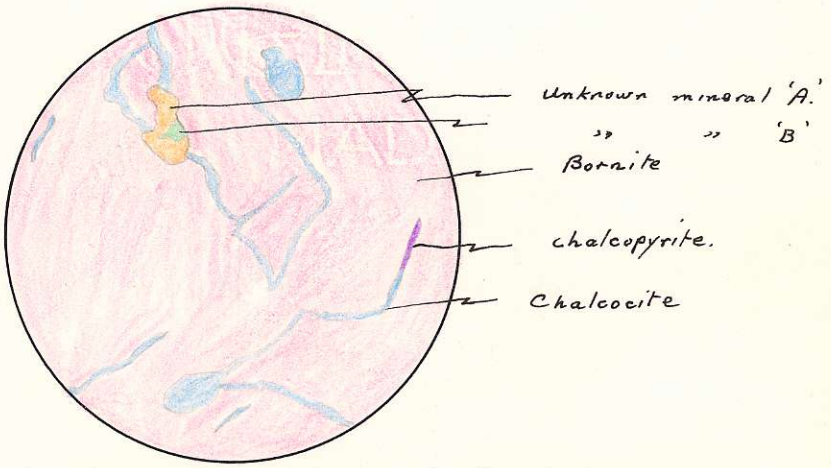

Fig 2. Initial stage of replacement of bornite by chalcocite showing control by fractures and cleavage in bornite. x 1250.

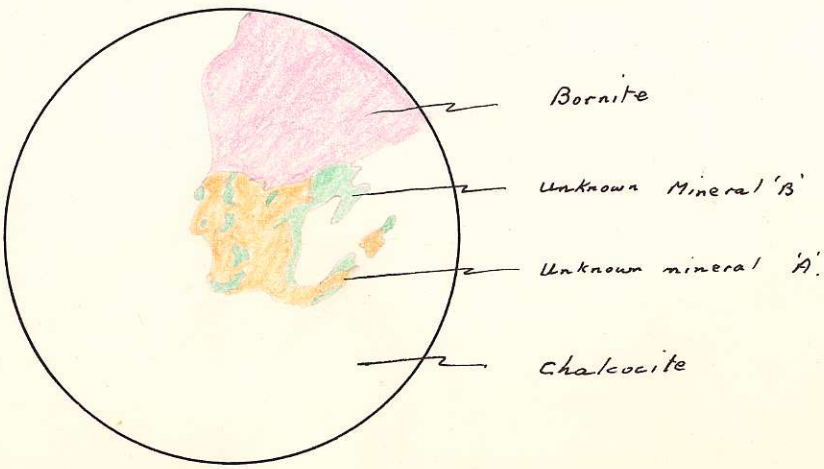

Fig. 3. Graphic intergrowth of unknown minerals A & B x 1634