Geol. 409 Problem III

Oregon Suite (French Mine)

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Geology 409 Problem III

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Megascopic Examination

The suite consists of a skarn assemblage. The most common silicate is a brown garnet. This constitutes about 80 percent of some specimens and about 40 percent of the suite overall. A green pyroxene also occurs in quantity. This is probably diopside. Minor amounts of quartz, wollastonite and late carbonate complete the gangue assemblage.

Metallic minerals make up about 3 percent of the ore. All the metalic minerals were medium to fine grained, in general less than 3 mm. in diameter. The garnet and pyroxene crystals were sometimes as large as 1 cm.. The metalic minerals were usually seen replacing the diopside and carbonates in preferance to the garnet.

Metalic minerals noted in the handspecimen included bournite, chalcopyrite, tellurides, native gold, molybdenite and possibly arsenopyrite.

Microscopic Examination

Thin Section

One thin section was studied to determine the gangue minerals. Results were as follows;

Minerals	Percentages
Garnet	35 %
Diopside	60 %
Opaques (mainly molybdenite)	5 %

The garnet is light brown in thin section and slightly anisotropic. Its index of refraction is about 1.75. It is probably grossularite carrying some of the andradite molecule to account for the higher index. For grossularite n is 1.73. The opaque minerals consisted mainly of molybdenite.

Polished Sections

Thirteen polished sections were studied.

Minerals Identified

Molybdenite - Molybdenite shows well developed lamellae. In some sections it makes up about 15 percent of the

material but in most sections it is scarce or absent. It is seen replacing cobaltite and safflorite and also occurs as unaltered residual lamellae in native bismuth and bismuth telluride (see figure III). Most commonly it replaces gangue.

Bournite - Bournite is also very common in some sections but in most it is entirely absent. It is invariably associated with chalcopyrite.

Chalcopyrite - Chalcopyrite is much more widespread than bournite. It is probably the most widespread and also the most plentiful mineral in the suite. It occurs in two ways; either in association with bournite or separate from it. That which occurs with the bournite appears to be largely derived from it by exsolation. This exsolved chalcopyrite may be retained as inclusions in the bournite or it may migrate to the edge of the bournite grain to form as grains or rims around it.

Chalcocite - This mineral is found in minor amounts as small grains on the outer margins of bournite.

It may have resulted from exsolution from bournite since it seems to be moulded onto, rather than replacing, the bournite.

Covellite - This mineral occurs as a fine irregular replacement of bournite in minor amounts. In the areas where it is found it is particularly common adjacent to fractures.

Arsenopyrite - Arsenopyrite is common although never in large amounts. It has been badly corroded but sometimes still shows subhedral crystal outlines.

Safflorite - This is the commonest of the arsenides. Often as much as 10 percent of a polished section will consist of this mineral. It is generally corroded in appearance. It replaces cobaltite and is replaced by bournite, chalcopyrite and bismuth telluride.

Cobaltite. - This mineral is less common than safflorite. It always shows corroded edges and is replaced by molybdenite, safflorite, chalcopyrite and bournite.

Native Bismuth - Native bismuth is usually seen in

close association with gold and bismuth telluride. In some areas it shows a well developed polysynthetic twinning There are 2 tellurides.

Bismuth Telluride (Joseite B) - This mineral was ~~common~~ usually associated with native bismuth and gold. It commonly occured in large grains, one as large as 1cm. A good basal clevage was often evident, particularly when the mineral was scratched or stressed with the needle. This mineral was X-Rayed and although the pattern was of poor quality it agrees ~~indexed~~ quite closely with joseite B.

Native Gold - Gold was quite widespread in small amounts. It was most commonly associated with native bismuth and joseite B but ~~also~~ was also found with chalcopyrite. It was never noted in association with bournite. When found with joseite B it was usually on the borders of grains indicating that it might be later.

Primary Minerals In Order Of Abundance.

Minerals	Percent
Chalcopyrite	> 1 %
Bournite	1 %
Molybdenite	< 1 %
Safflorite	< 1 %
Arsenopyrite	< 1 %
Joseite B	< ½ %
Cobaltite	< ½ %
Native Bismuth	< ½ %
Chalcocite	< ¼ %
Native Gold	< ¼ %
Covellite	< ¼ %

Skutterudite is present.

Covellite and, less probably chalcocite, may be supergene in origin.

Paragenesis And Significant Textures.

The arsenide group of minerals appears to have been the first to have been deposited. Of these cobaltite was probably the first mineral since it is

Figure I

Exsolution blades of chalcopyrite in bournite.

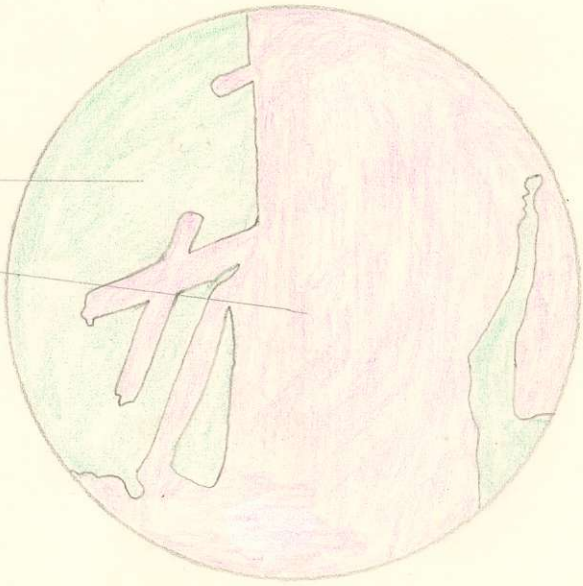
Figure II

Molybdenite replacing cobaltite.

Figure I

X 380

Figure II



X 380

observed to be slightly replaced by safflorite. Arsenopyrite was not seen in contact with cobaltite or safflorite.

The second group to be deposited consisted of molybdenite, bournite and chalcopyrite. These were all ~~observed~~ observed replacing members of the arsenide group. Bournite and chalcopyrite show mutual boundry relationships indicating ~~tha~~ probable simultaneous deposition. Molybdenite is a high temperature mineral and probably formed early in this stage. During the latter part of this stage a second generation of chalcopyrite was produced by exsolution from bournite. Chalcocite occurs as grains on the borders of, but not replacing, bournite indicating that it too may have exsolved from the bournite. There is also the possibility that it is supergene. Covellite occurs in the bournite as small, vaguely defined areas particularly adjacent to fractures. It does not show an exsolution texture and is not evenly distributed throughout the bournite areas in which it occurs. It may have resulted from

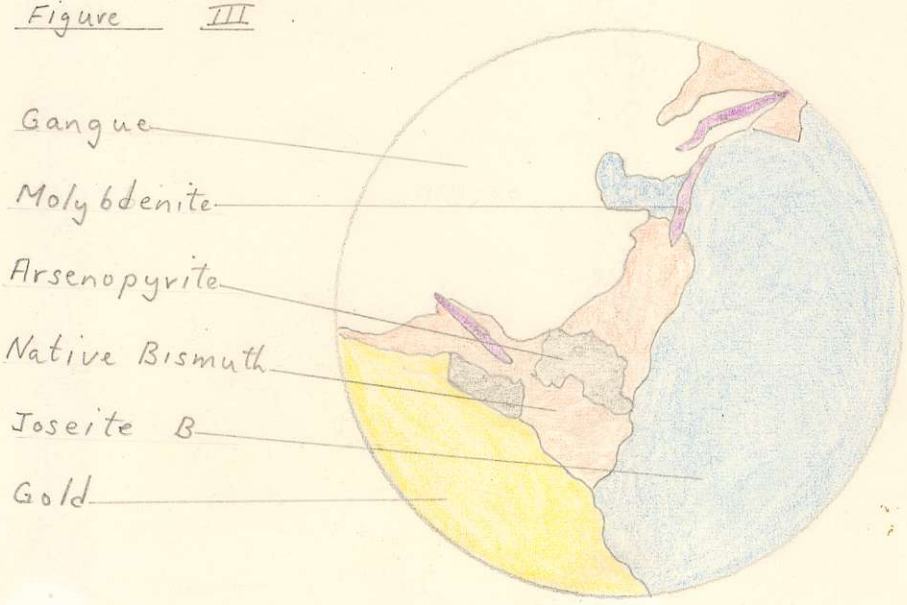
Figure III

Corroded residual of arsenopyrite in native bismuth. and unaltered residuals blades of molybdenite, Native bismuth, gold and joseite B show smooth boundrys.

Figure IV

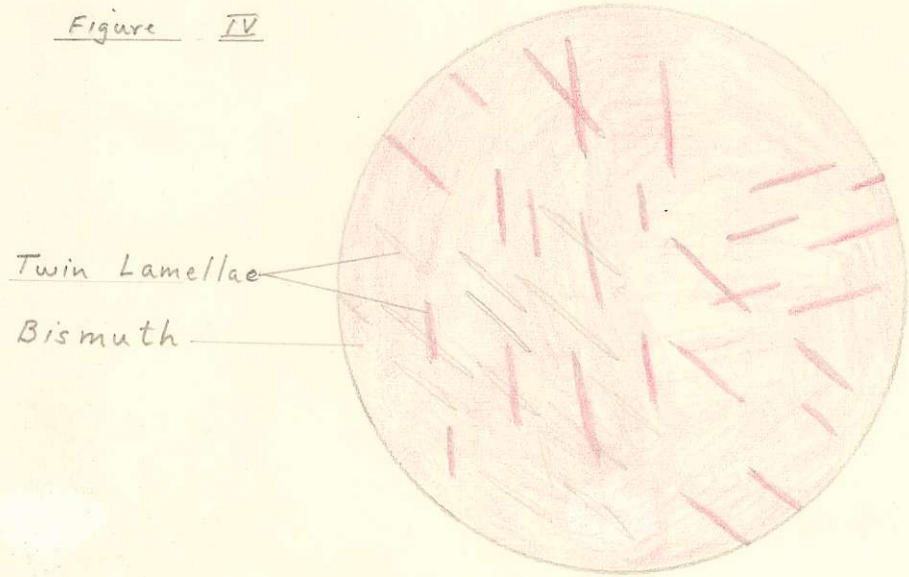
Polysynthetic twinning in native bismuth.

Figure III



X 44

Figure IV



X 380

exsolution but is more likely a supergene mineral.

The third stage of mineralization ~~depo~~ includes native bismuth, ~~f~~ joseite B and native gold. These three minerals show smooth contacts indicating simultaneous deposition or, at least, no replacement. Both native bismuth and native gold occur enclosed in joseite B which, coupled with the above evidence of no replacement, shows that the three were deposited simultaneously. Native bismuth and gold continued to form after joseite and are noted along the outer boundrys of joseite.

Temperature Of Deposition

The arsenide minerals of the first stage were probably deposited considerably above 500 degrees since they pre-date molybdenite which forms above 500 degrees Centigrade (Edwards). Bournite was deposited above 475 degrees since it shows exsolution chalcopyrite. At the lower end of the temperature range, native bismuth ~~which~~ is crystalized at 271 degrees.