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MINERALOGICAL INVESTIGATION OF AN ORE SAMPLE FROM THE MOUNT PLEASANT DEPOSIT IN NEW BRUNSWICK FOR NIGADOO MINES LIMITED

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

A mineralogical investigation was made on a sample of tungsten-molybdenum-tin-bismuth ore from the Mount Pleasant deposit in New Brunswick. The sample contains a wide variety of ore minerals intimately intergrown. The tungsten- and molybdenum-bearing minerals are wolframite and molybdenite respectively. The wolframite is present as rounded grains associated with molybdenite and sulphides, and the molybdenite is present as bundles of crystals in molybdenite-wolframite veinlets and in sulphides. The tin-bearing minerals are stannite and cassiterite. Stannite is the main tin-bearing mineral, and it is intimately intergrown with other sulphides. The bismuth-bearing minerals are native bismuth, bismuthinite, and wittichenite. Native bismuth is the main bismuth mineral, and it occurs as small disseminated grains in gangue and arsenopyrite. Other ore minerals found are sphalerite, tennantite, a silver-bearing tetrahedrite, galena, chalcopyrite, loellingite, and roquesite (?). The non-metallic minerals found in the sample are feldspar quartz, topaz, fluorite, clay minerals, calcite, dolomite, and tourmaline.

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INTRODUCTION

A sample of a tungsten-molybdenum-tin-bismuth ore from the Mount Pleasant deposit in New Brunswick was received from G. Mathieu of the Mineral Processing Division on April 15, 1970. Mr. Mathieu stated that the sample was taken from a 267 shipment of ore submitted to the Mines Branch by Nigadoo Mines Limited for beneficiation tests. The sample received consisted of about 50 chips up to 1/2 inch in size, and 100grams of a head sample crushed to -65 mesh.

METHOD OF INVESTIGATION

The chips were hand picked and 17 pieces were selected for polished sections. The polished sections were studied by ore microscopy, and the ore minerals were identified by microscopical and X-ray diffraction studies. The head sample was separated into fractions by means of heavy liquids having specific gravities of 2.96 and 3.33, and the 3.33 sink fraction was further separated into subfractions by means of a Frantz isodynamic separator. Fractions containing non-metallic minerals were scanned on the X-ray diffractometer and studied by oil immersion methods in order to identify the minerals. Polished sections were prepared from the sub-fractions containing ore minerals, and the minerals were identified by ore microscopy.

RESULTS

General Characteristics of the Ore

Most of the chips received consisted largely of gangue, but in a few the ore minerals predominated. The gangue chips contain small amounts of ore minerals as disseminated grains, and as veinlets up to 1/16 inch wide. The ore mineral chips, hereafter referred to as massive sulphides, are composed of intergrowths of ore minerals and gangue (Fig. 1). The ore minerals identified in the sample are sphalerite, stannite, wolframite, arsenopyrite, loellingite, galena, tennantite, freibergite (tetrahedrite), molybdenite, native bismuth, bismuthinite, wittichenite, chalcopyrite and cassiterite. The gangue minerals are feldspar, quartz, topaz, flourite, clay minerals, calcite, dolomite and tourmaline.

The distribution of the minerals in the head sample, as determined by heavy liquid and magnetic separations, is given in Table 1.

TABLE 1

Distribution of Minerals in Fractions of the Head Sample

Fraction	Wt. %	Minerals Present
2.96 float	75.1	feldspar, quartz and clay minerals
3.33 float	7.6	topaz, feldspar, calcite, flourite, clay minerals, quartz and molybdenite
3.33 sink, non- mag	15.0	topaz, feldspar, flourite, galena, calcite quartz, clay minerals, and molybdenite
3.33 sink, hand- mag	0.3	iron (from crusher)
3.33 sink, 0.2 amp	0.3	not determined (ore minerals)
3.33 sink, 0.4 amp	0.1	wolframite, molybdenite, and traces of pyrite, sphalerite, galena, chalcopyrite and stannite
3.33 sink, 0.6 amp	0.2	wolframite, sphalerite, galena, cassiterite, chalcopyrite, stannite, and traces of molybdenite and arsenides
3.33 sink, 0.8 amp	1.4	mixture of ore minerals including sphalerite, galena, tennantite, tetrahedrite, chalcopyrite, stannite, molybdenite, arsenopyrite, loellingite, and traces of wolframite, cassiterite and rutile.

Detailed Characteristics of the Ore Minerals

Sphalerite (Zns)

Sphalerite is the main ore mineral in the sample. It occurs as irregular grains in the massive sulphides and in veinlets. Some of the grains are free of impurities, some are intergrown with stannite (Fig. 2) and other sulphides (Fig. 3), some contain exsolution globules and lamellae of stannite and chalcopyrite, some contain veinlets and inclusions of galena and tennantite (Fig. 3), and some contain inclusions of wolframite (Fig. 4), cassiterite, and a mineral whose optical properties are similar to those of roquesite ($CuInS_2$). The sphalerite in this ore has a pronounced internal reflection, and appears to have a low reflectivity.

Stannite (Cu_2FeSnS_4)

Stannite was found only in the massive sulphides as inclusions and lamellae in sphalerite, and as intergrowths with sphalerite (Fig. 2). In some places, hair-like veinlets of chalcopyrite are present at the stannite-sphalerite boundaries.

Two varieties of stannite were observed. The main one is shown in reflected light and is isotropic. It probably corresponds to the tetragonal tin- and indium-rich stannite reported by Boorman and Abbot (1). The stannite occurring in minor amounts is rose in reflected light, is anisotropic, and has a higher reflectivity than the isotropic one. It probably corresponds to the hexagonal copper-rich variety reported by Boorman and Abbot (1). The anisotropic stannite is present as irregular grains adjacent to the isotropic variety, and as borders on the isotropic variety.

Cassiterite (SnO_2)

A few grains whose optical properties are similar to those of cassiterite are present in the massive sulphides as small rounded inclusions in the sphalerite and stannite.

Wolframite ((Fe, Mn) WO_4)

Significant amounts of wolframite are present in the ore. It is generally associated with molybdenite, and occurs in wolframite-molybdenite veinlets, and in massive sulphides (Fig. 4). The wolframite is present as rounded grains that vary from about 20 to 200 microns in size.

Arsenopyrite (FeAsS) and loellingite ($FeAs_2$)

Arsenopyrite and loellingite are present as complex arsenide grains and as separate crystals disseminated in sulphides and gangue. The complex grains are composed of loellingite crystals surrounded by arsenopyrite, and the loellingite contains arsenopyrite veinlets (Fig. 5). The separate arsenopyrite crystals contain irregular grains of galena, tetrahedrite, native bismuth, bismuthinite, and wittichenite (Fig. 6).

Galena (PbS)

Galena is present as irregular grains and veinlets in sphalerite, arsenopyrite, and gangue. The irregular grains range from about 10 micron to 1 mm in size.

Tennantite ($(Cu, Fe)_{12}As_4S_{13}$) and freibergite (silver-bearing tetrahedite $(Cu, Ag)_{10}(Fe, Zn)_2Sb_4S_{13}$)

The tennantite and freibergite were identified by X-ray diffraction studies using a 57.3-mm film. It is not known whether the tennantite is silver-bearing, but the X-ray diffraction pattern for the freibergite corresponds to that of silver- bearing tetrahedrite. The tennantite is present in the massive sulphides as irregular grains and veinlets in sphalerite and stannite (Fig. 1 and 3). The freibergite was found in a sulphide veinlet, where it is intergrown with chalcopyrite and native bismuth, and has partly replaced a grain of arsenopyrite (Fig. 7).

Roquesite ($CuInS_2$)

A few grains of a mineral whose optical properties are similar to those of roquesite are present as minute inclusions in the sphalerite. The grains are about 5 microns in size and are too small to identify by X-ray diffraction methods. These grains, however, are similar to those reported as roquesite from the Mount Pleasant deposit, by Sutherland and Boorman (2).

Molybdenite (MOS_2)

Molybdenite is a common mineral in the ore and it generally occurs in association with wolframite. It is present as bundles of crystals and separate crystals in the ore veinlets, in sulphide masses, and in the gangue. Some is also present as inclusions in arsenopyrite and sphalerite.

Native bismuth (Bi)

Native bismuth is the main bismuth mineral in the ore. It is present as disseminated grains in the gangue and in arsenopyrite crystals (Fig. 6). The grains are up to 100 microns in size, and a few are intergrown with bismuthinite, chalcopyrite, and tetrahedrite.

Bismuthinite (Bi_2S_3)

Small amounts of bismuthinite are present in the gangue and in arsenopyrite. It occurs as disseminated grains up to 50 microns in size, and as intergrowths with native bismuth.

Wittichenite (Cu_3BiS_3)

One grain, whose optical properties are similar to those of wittichenite, was found in a large arsenopyrite grain in association with galena, native bismuth, and bismuthinite.

Chalcopyrite ($CuFeS_2$)

Small amounts of chalcopyrite are present in the massive sulphides and in the sulphide veinlets. That in the massive sulphides is present as hair-like veinlets at the boundary between stannite and sphalerite (Fig. 2), and the chalcopyrite in the veinlets is present as an intergrowth with freibergite (Fig. 7).

CONCLUSIONS

The ore from the Mount Pleasant deposit, submitted by Nigadoo Mines Limited, is composed of a wide variety of very fine-grained minerals intimately intergrown; hence it will probably be difficult to liberate and separate most of the minerals. The wolframite and molybdenite, however, are present as rounded grains, and bundles of crystals, respectively, and it is possible that they will be liberated more easily. The bismuth minerals, on the other hand, occur as minute grains in the gangue and arsenopyrite and it is expected that very fine grinding would be required to liberate them. It is further anticipated that, even with very fine grinding, some of the native bismuth may remain locked in the arsenopyrite. The tin-bearing minerals are stannite and cassiterite and they are so intimately intergrown with other sulphides that difficulties might be expected in liberating and separating them from the other sulphides. On the other hand, it may be relatively easy to prepare a bulk sulphide concentrate. Such a concentrate would contain zinc, copper, tin, lead, silver and indium.

REFERENCES

1. R. S. Boorman and D. Abbott, "Indium in co-existing minerals from the Mount Pleasant Tin deposit", Can. Mineral 9, pt. 2, 166-179 (1967).

2. J. K. Sutherland and R. S. Boorman, "A new occurrence of roquesite at Mount Pleasant, New Brunswick", Am. Mineral 54, 1202-1203 (1969).

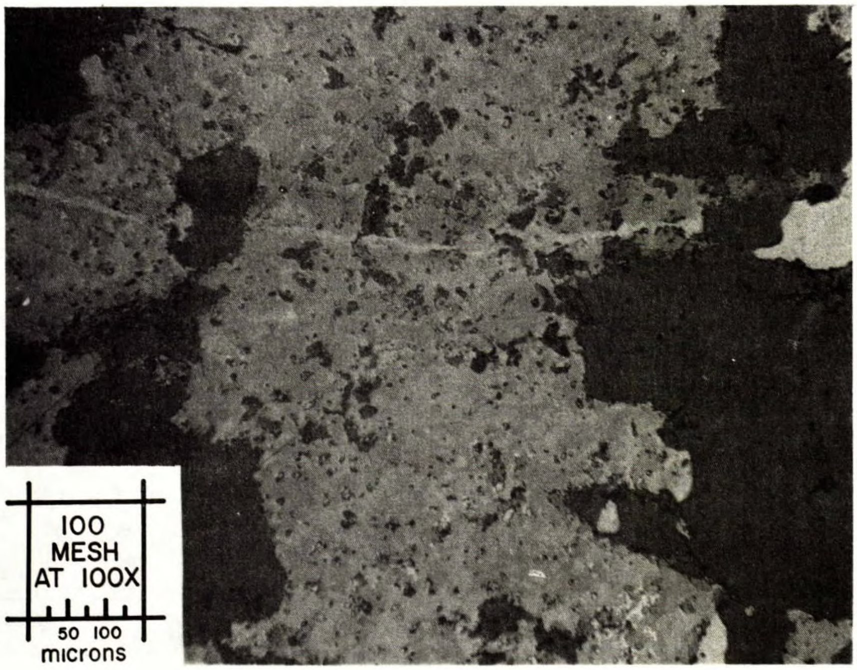

Figure 1. - Photomicrograph of a polished section of an ore mineral chip showing an intergrowth of sulphides in gangue. A tennantite veinlet cuts the intergrowth of sulphides.

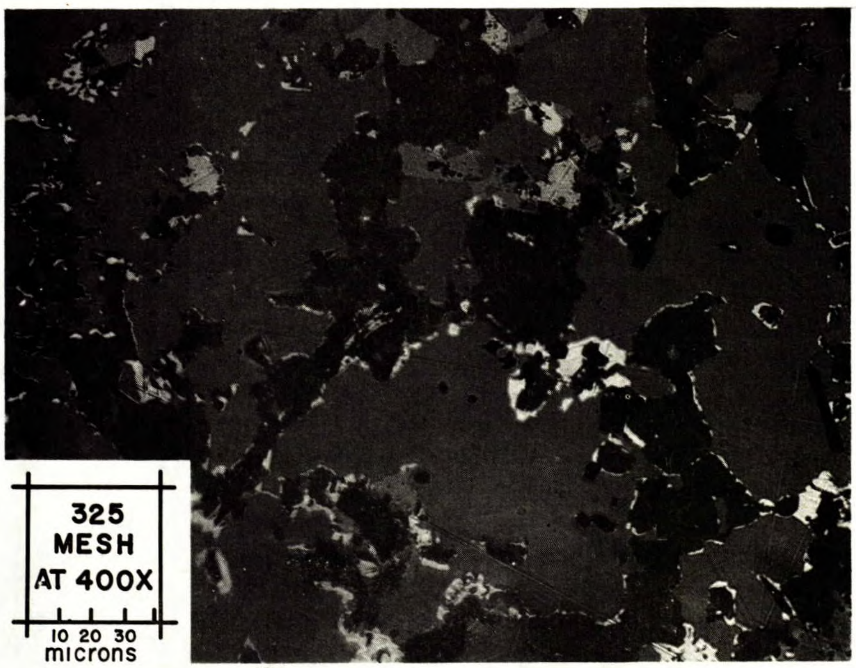

Figure 2. - Photomicrograph showing stannite (grey) intergrown with sphalerite (dark grey). Some chalcopyrite (white) is present at the stannite-sphalerite boundary, and inclusions of galena (white), chalcopyrite (white), and tennantite (grey) are present in the stannite. The sphalerite also contains minute grains of stannite.

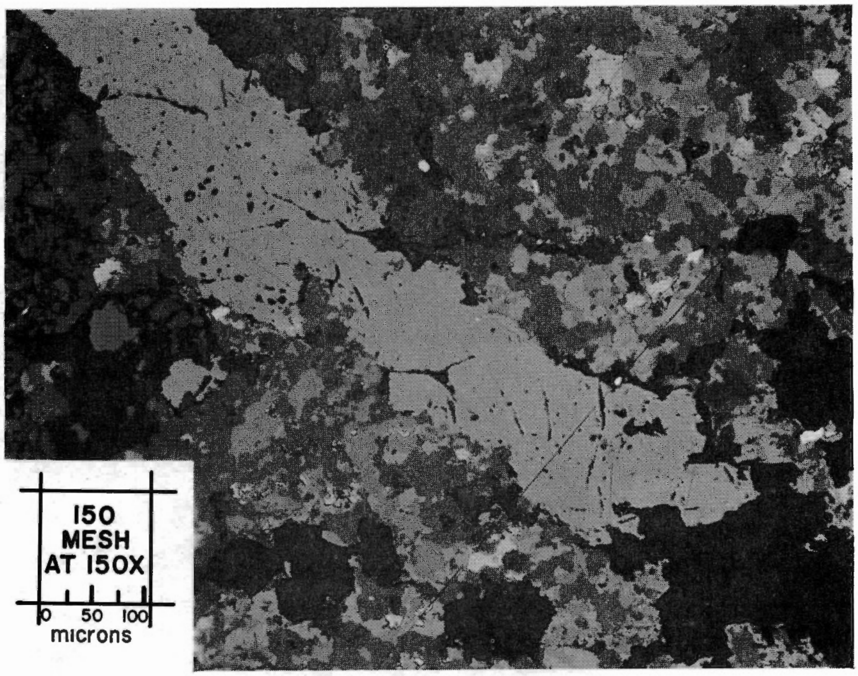

Figure 3. - Photomicrograph of a polished section of an ore mineral chip showing a veinlet of tennantite (light grey) in sulphides. The sulphides are composed of an intergrowth of sphalerite (dark grey), stannite (medium grey) tennantite (light grey), chalcopyrite, and galena. The chalcopyrite and galena are both white on this photograph and cannot be differentiated.

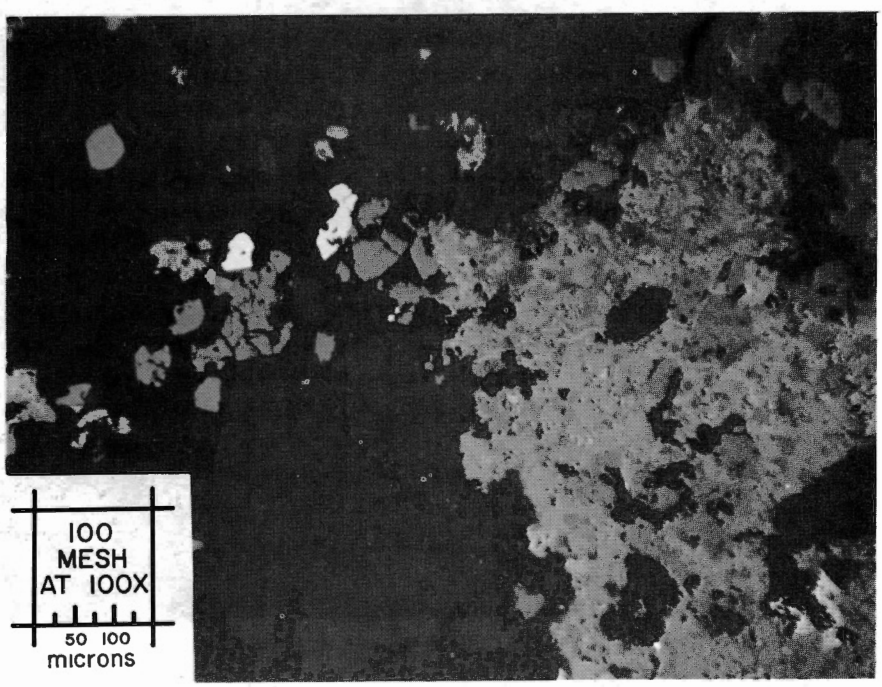

Figure 4. - Photomicrograph showing wolframite grains (rounded grey grains) in gangue and massive sulphides in an ore mineral chip.

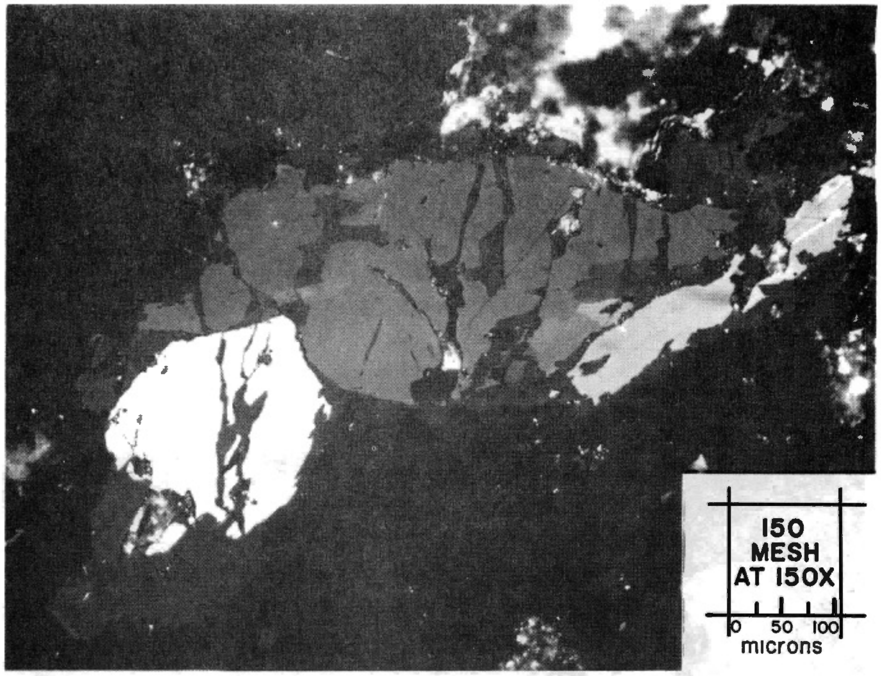

Figure 5. - Photomicrograph of a complex arsenide grain composed of loellingite (white) surrounded and cut by veinlets of arsenopyrite (grey).

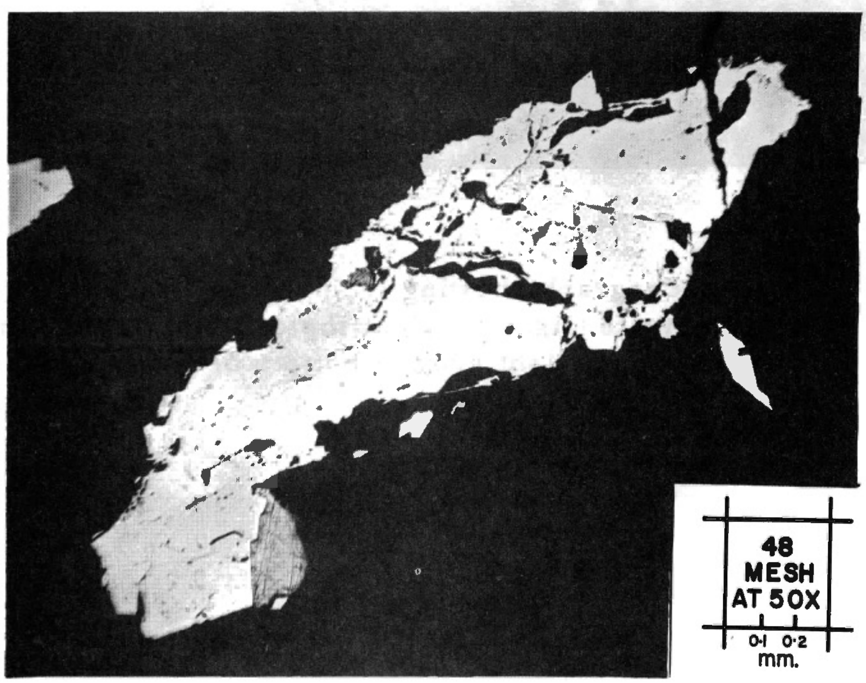

Figure 6. - Photomicrograph of an arsenopyrite grain with inclusions of native bismuth.

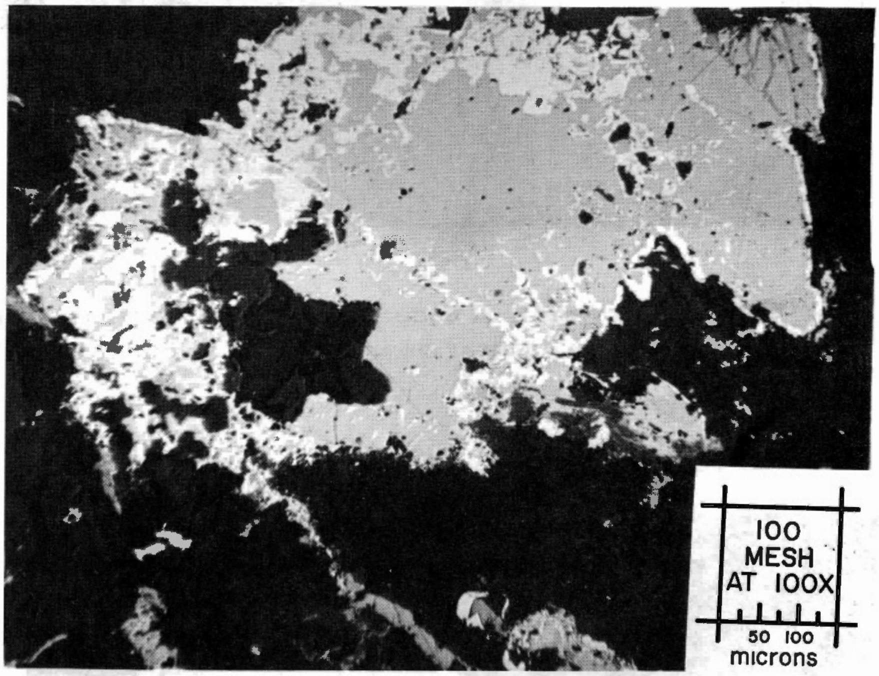

Figure 7. - Photomicrograph showing freibergite (grey) intergrown with chalcopyrite (light grey, at top of photograph), and replacing arsenopyrite (light grey at bottom of photograph).