MR. U. A. HANN

CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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MINERALOGICAL INVESTIGATION OF A SAMPLE OF A TUNGSTEN ORE FROM YORK COUNTY, N. B. ON BEHALF OF BURNT HILL TUNGSTEN AND METALLURGICAL LIMITED

by

D. OWENS

MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

Mineralogical studies made on a sample of tungsten ore from a deposit in York County, N.B., on behalf of Burnt Hill Tungsten and Metallurgical Limited, show that the ore consists of siliceous gangue, in which is disseminated a variety of ore minerals. The tungsten in the ore occurs almost entirely as wolframite, and to a very minor degree, as scheelite. The wolframite occurs mainly as small masses and relatively coarse grains in gangue, while the only scheelite identified consisted of a few grains in the head sample. Small amounts of molybdenum, bismuth and tin also are present in the ore. The molybdenum occurs in the form of molybdenite, the bismuth as native bismuth and bismuthinite, and the tin as cassiterite. Other minerals identified in the ore include pyrite, marcasite, pyrrhotite, sphalerite, arsenopyrite, chalcopyrite, galena, ilmenite, rutile, anatase, goethite, hematite, magnetite, tetrahedrite, quartz, fluorite, chlorite, mica, apatite, dolomite and topaz.

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*Technical Officer, Mineralogy Section, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

INTRODUCTION

A sample of tungsten ore was received from Mr. G. Mathieu of the Mineral Processing Division on January 22, 1969. Mr. Mathieu requested that the sample be examined mineralogically to determine the identity, occurrence and liberation characteristics of the tungsten-bearing minerals in the ore. The sample was reported to be from a deposit in York County, New Brunswick, and that it had originally been submitted to the Mines Branch by Mr. D.F. Porteous, President, Burnt Hill Tungsten and Metallurgical Limited, P.O. Box 210, Victoria, Westmount, Quebec.

SAMPLES

The sample, as received, consisted of 24 small hand specimens, from one to two inches in diameter, and about 100 grams of head sample crushed to minus 10 mesh. The hand specimens were composed essentially of quartz, which contained disseminated grains of a variety of ore minerals. Two of the hand specimens contained pieces of wolframite, each about 20 millimetres in length.

METHOD OF INVESTIGATION

Polished sections were prepared from the hand specimens showing the heaviest ore mineralization, and these were examined microscopically to identify the ore minerals and to determine their grain size, occurrence and liberation characteristics. The 48 to 100 and 100 to 250-mesh fractions were screened from the head sample and separated into sink and float products by means of heavy liquids. One polished section was prepared from each of the sink products and examined microscopically to permit a comparison of the ore minerals in the head sample with those in the hand

specimens. The float products were analysed by X-ray diffractometer to identify their principal gangue minerals.

RESULTS OF INVESTIGATION

General Mineralogy of the Ore

The microscopical examination of the head sample shows that the major heavy minerals are pyrrhotite and wolframite. In addition, the head sample contains slightly smaller amounts of pyrite, marcasite and arsenopyrite, as well as from small quantities to trace amounts of molybdenite, native bismuth, bismuthinite, cassiterite, scheelite, ilmenite, rutile, anatase, chalcopyrite, galena, sphalerite, goethite, hematite, magnetite and tetrahedrite. The major gangue mineral in the ore is quartz. Also present are much smaller amounts of fluorite, chlorite, mica, topaz, apatite, and dolomite.

It should be mentioned that the hand specimens, upon which the textural relationships of the minerals is based, do not appear to be entirely representative of the ore, as shown by the head sample. This fact is illustrated by the presence of a greater amount of pyrrhotite in the head sample than would be expected from its scattered occurrences in the hand specimens. For this reason, and because of the low ratio of heavy minerals to gangue, the associations of the minerals that are discussed in this report may not be entirely typical of the ore.

Detailed Mineralogy of the Ore

Tungsten-bearing minerals

Wolframite [$(Fe, Mn)WO_4$] is the dominant tungsten-bearing mineral in the ore. It occurs essentially as small masses, and as both individual grains and aggregates of elongate grains in gangue (Figures 1 and 2). The small masses vary from about 9 to 25 millimetres in size, while the individual grains and aggregates range from about 75 microns to 4 millimetres.

(The word "size" as used in this report refers to the greatest dimension of the mineral grain being described.) The wolframite contains relatively few inclusions. These consist mainly of rutile (Figure 3) and ilmenite, which range from about 20 to 300 microns in size. The remaining inclusions in the wolframite are composed of a few grains each of pyrrhotite, pyrite (Figure 4) cassiterite (Figure 5), native bismuth, gangue,combined native bismuth and galena, and a few gangue veinlets. These inclusions are from 5 to about 300 microns in size.

Very little scheelite ($CaWO_4$) occurs in the ore. The only scheelite positively identified were a few individual grains in the sink products of the head sample.

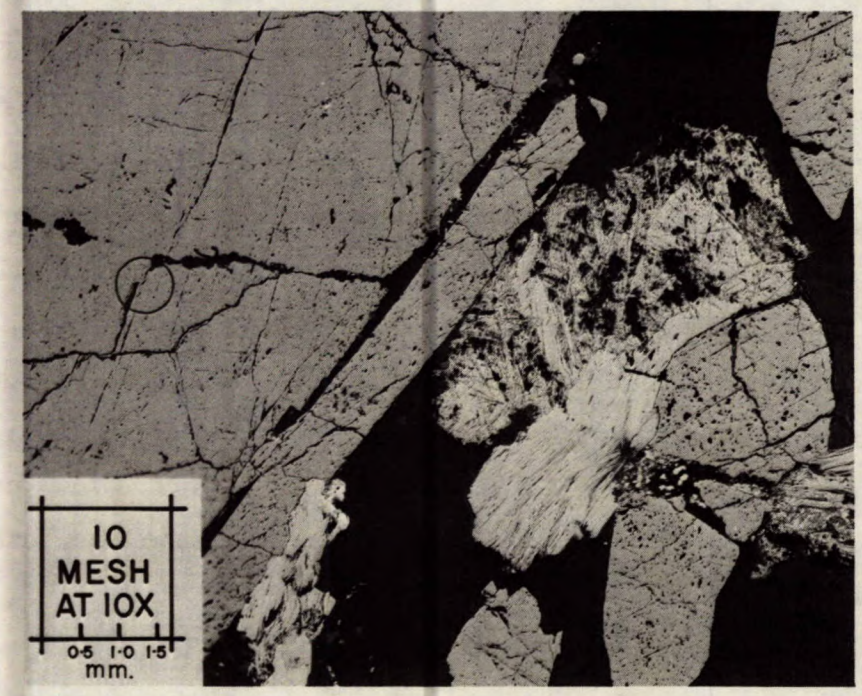

Figure 1. Photomicrograph of a polished section showing part of a small mass, and coarse grains, of wolframite (medium grey), and a few sheaf-like clusters of molybdenite grains (white) in gangue (black).

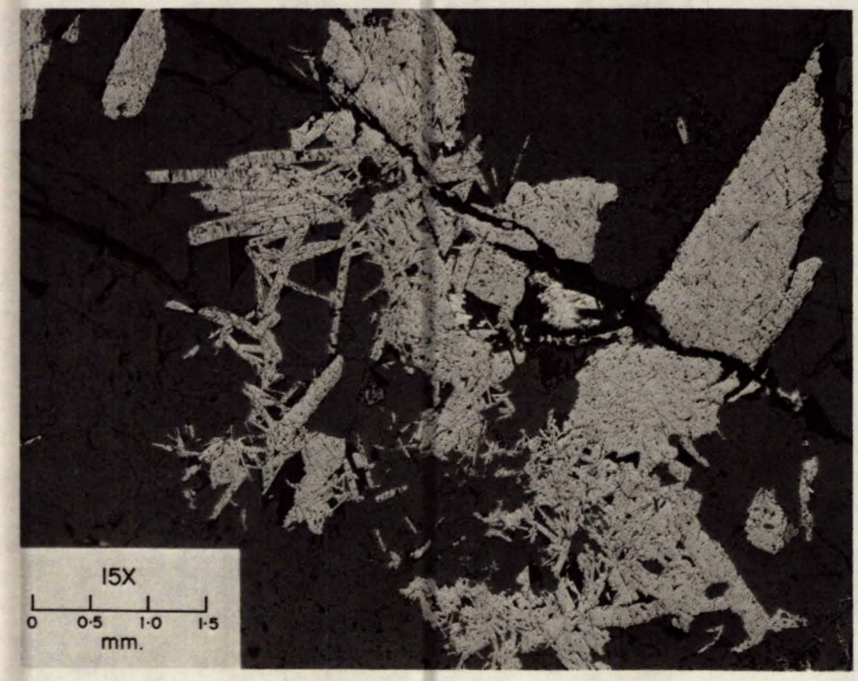

Figure 2. Photomicrograph of a polished section showing both individual grains and aggregates of wolframite grains (medium grey) in gangue (dark grey). A few inclusions of gangue are enclosed within the wolframite.

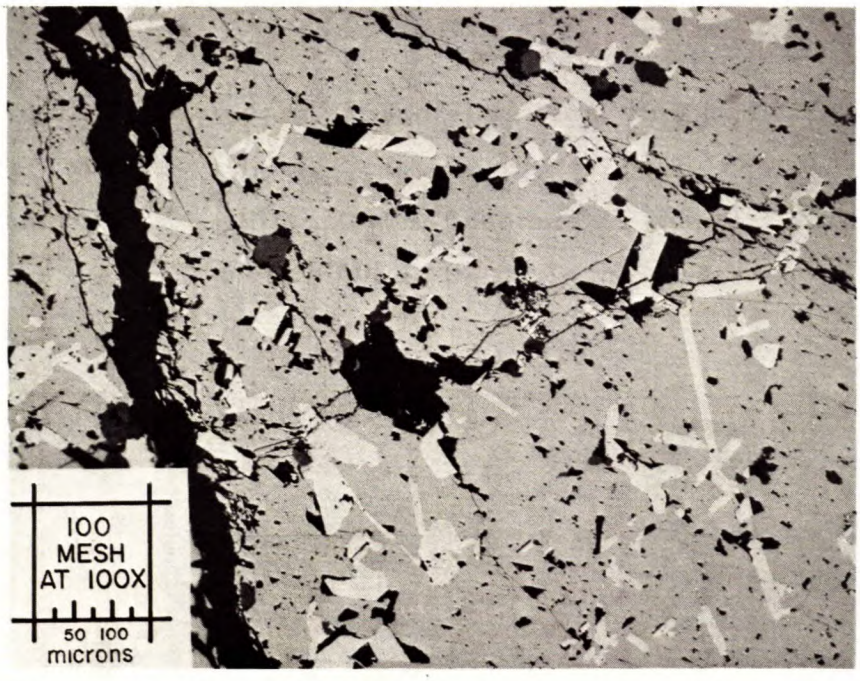

Figure 3. Photomicrograph of a polished section showing a cluster of rutile inclusions (greyish white) in wolframite (medium grey). A few grains of gangue (dark grey) are also present in the wolframite. The black areas are polishing pits and fractures.

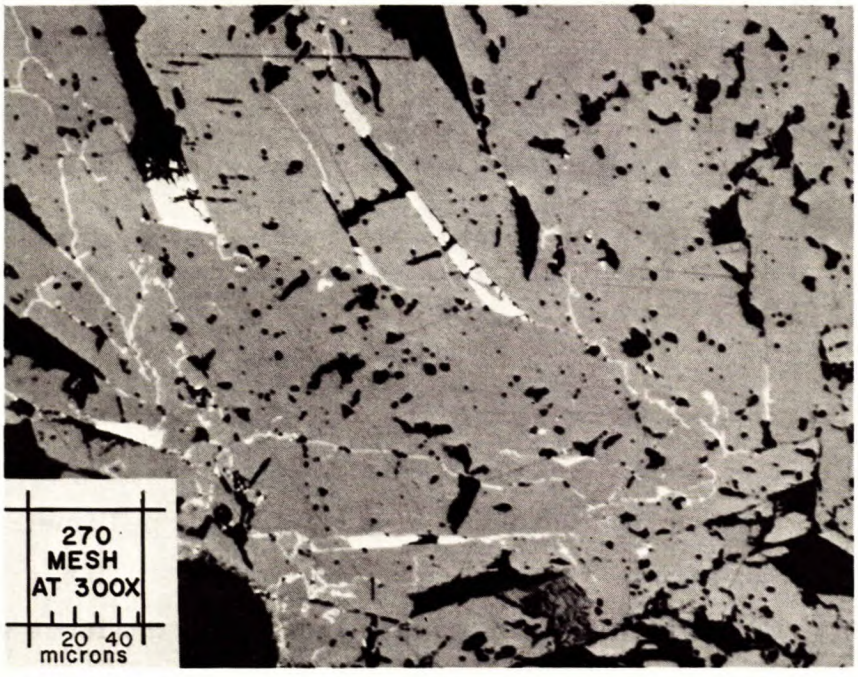

Figure 4. Photomicrograph of a polished section (in oil immersion) showing thin veinlets and small inclusions of pyrite (white) in wolframite (medium grey). The black areas are polishing pits.

Other ore minerals

A small quantity of cassiterite occurs in the ore. It is present largely as inclusions in wolframite (Figure 5) and also in a few gangue grains which are themselves enclosed in wolframite. The grains of cassiterite vary in size from about 20 to 300 microns.

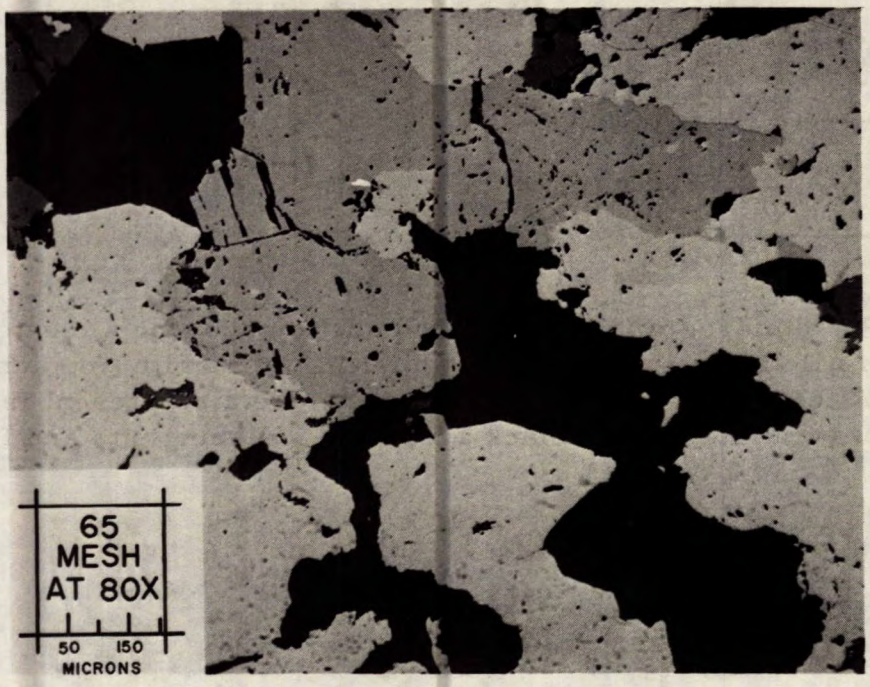

Figure 5. Photomicrograph of a polished section showing grains of cassiterite (medium grey) and gangue (dark grey) in wolframite (light grey).

Molybdenite is also present in the ore. It occurs mainly as individual and aggregates of sheaf-like grains in gangue (Figures 1 and 6). The individual grains vary from about 30 microns to 2 millimetres, while the aggregates range from about 2.5 to 5 millimetres. A few grains of molybdenite are also present as inclusions in some of the large arsenopyrite grains. These inclusions are from about 40 to 450 microns in size. The molybdenite grains themselves contain few inclusions. These are composed

chiefly of gangue, which occurs as thin blade-like grains along the cleavage of the molybdenite. The blade-like gangue inclusions often run the length of the molybdenite grains, whereas the other inclusions are generally smaller, varying from about 10 to 40 microns in size.

Figure 6. Photomicrograph of a polished section showing a few grains of molybdenite (white) in gangue (dark grey).

Small, but significant, amounts of native bismuth and bismuthinite are also present in the ore. The native bismuth occurs as inclusions in gangue (Figures 7 and 8), arsenopyrite, wolframite, bismuthinite (Figure 8) and molybdenite; as combinations with galena in gangue (Figure 7) and in wolframite; and as combinations with bismuthinite in gangue (Figure 9). Of these, the most numerous occurrences are the inclusions of native bismuth in gangue, and its combinations with galena and bismuthinite. The size of the native bismuth is quite small; although the grains range in size from 5 to about 100 microns, most are smaller than

50 microns. A few of the grains of native bismuth contain one or more inclusions of pyrrhotite (Figure 9).

The bismuthinite is present in the ore essentially as grains disseminated in gangue, and as combined grains with marcasite in gangue (Figures 8 and 9). These grains vary in size from 2 to about 50 microns. A number of bismuthinite grains also occur as inclusions in molybdenite, and as combined grains with galena and with native bismuth in gangue (Figure 9). The bismuthinite infrequently contains small inclusions of native bismuth (Figure 8), whose grain size is of the order of 40 microns or less.

Figure 7. Photomicrograph of a polished section showing an area of gangue (black) between wolframite (dark grey) and molybdenite (medium grey and fibrous), in which are disseminated minute grains of native bismuth (white) and larger grains of galena (greyish white). Some of the galena and native bismuth grains are combined.

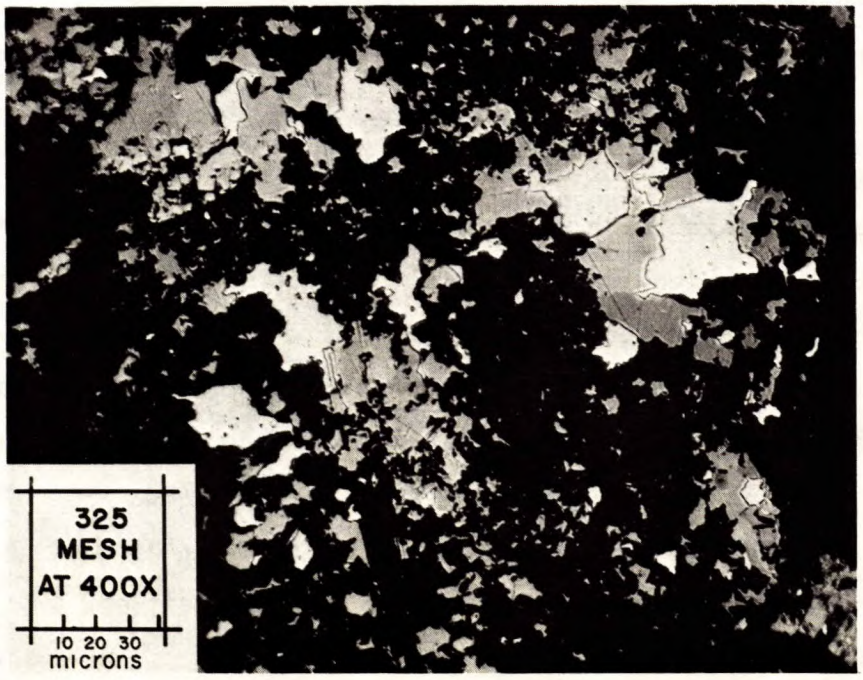

Figure 8. Photomicrograph of a polished section (in oil immersion) showing inclusions of native bismuth (white) in gangue (black) and bismuthinite (grey). A few of the native bismuth grains are combined with bismuthinite. Some of the grains (grey) are marcasite but none of these are in direct contact with the native bismuth.

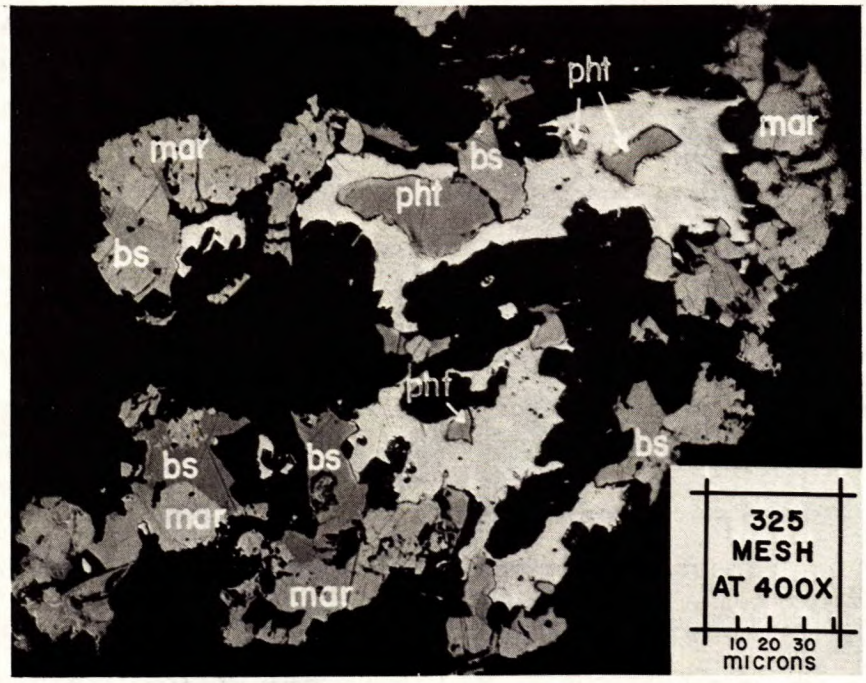

Figure 9. Photomicrograph of a polished section (in oil immersion) showing combined marcasite (mar) and bismuthinite (bs) in association with native bismuth (white) in gangue (black). A few inclusions of pyrrhotite (pht) occur in the native bismuth.

Other minerals in the ore

The other minerals in the ore include pyrite, marcasite, pyrrhotite, sphalerite, arsenopyrite, chalcopyrite, galena, ilmenite, anatase, rutile, goethite, hematite, magnetite and tetrehedrite. Of these, the hematite, magnetite and tetrahedrite were found only in the sink products of the head sample, where in each instance they numbered only a few grains each.

The pyrite and marcasite usually occur in association with each other as disseminations in gangue, although they also occur as separate grains in gangue. The intergrowths of marcasite and pyrite vary from about 0.1 to 4 millimetres in size, while the individual marcasite grains range from 10 to 200 microns, and the pyrite grains attain 260 microns. The inclusions in these two minerals consist mainly of gangue and occasionally of anatase, pyrrhotite, ilmenite and chalcopyrite. These latter inclusions vary from about 5 to 75 microns, whereas the gangue inclusions reach 1.2 millimetres in size. Some association of marcasite with bismuthinite in gangue was also noted (Figure 9).

Although pyrrhotite is one of the major heavy minerals in the head sample, only a few occurrences were found in the hand specimens. In the hand specimens the pyrrhotite is present largely as disseminated grains in gangue. These disseminations generally are from 5 to 120 microns in size. In a few instances slightly coarser pyrrhotite also occurs in association with sphalerite (Figure 10), where it reaches a size of just over one millimetre. A few grains of pyrrhotite also occur as inclusions in sphalerite, pyrite and marcasite, and vary in size from about 10 to 150 microns. In addition, a number of inclusions of sphalerite and chalcopyrite are present in the pyrrhotite, and these vary from 10 to 225 microns in size.

Only a few occurrences of sphalerite were noted in the examination of the hand specimens. In each case the sphalerite is present as fairly large grains in gangue, and is generally found with pyrrhotite (Figure 10). The sphalerite ranges in size from about 75 microns to 3 millimetres. The sphalerite contains a few inclusions of pyrrhotite, chalcopyrite and

gangue, none of which are greater than 150 microns in size. A few grains of sphalerite also occur as inclusions in the pyrrhotite.

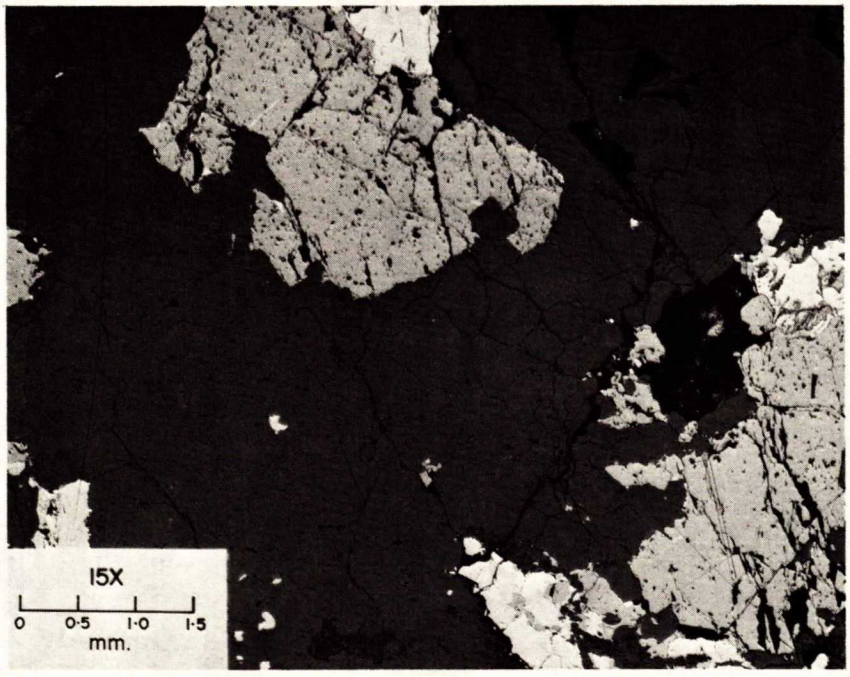

Figure 10. Photomicrograph of a polished section showing small masses and grains of sphalerite (medium grey) in gangue (dark grey). A few small areas of pyrrhotite (white) one of which contains sphalerite inclusions, are associated with the sphalerite.

More arsenopyrite is present in the head sample than was indicated from the examination of the hand specimens. In the hand specimens, the arsenopyrite occurs as a few quite large grains in gangue, which range in size from about 0.1 to 4 millimetres. A few inclusions of native bismuth and of molybdenite occur in these arsenopyrite grains. The native bismuth grains vary from about 5 to 50 microns, while the molybdenite inclusions are as large as 450 microns.

Only minor quantities of both galena and chalcopyrite are present in the ore. The chalcopyrite occurs as inclusions in gangue, sphalerite and pyrrhotite, and varies in size from a few to about 250 microns. The galena is present almost entirely as inclusions in gangue (Figure 7), and occasionally as combined grains with native bismuth in gangue and in

wolframite. The grains of galena vary in size from about 5 to 180 microns. A few grains of galena also contain very small particles of native bismuth, and in a few instances occur in combination with bismuthinite grains in gangue.

Ilmenite occurs essentially as quite small lath-like grains disseminated in gangue and, to a lesser degree, as inclusions in wolframite and pyrite. The grains of ilmenite in gangue are from 5 to 100 microns in size, while those in wolframite and pyrite vary from about 5 to 150 microns. Some of the ilmenite grains are partly replaced or contain inclusions of rutile.

Rutile occurs as inclusions in wolframite (Figure 3) and gangue, and to a small degree as inclusions in, or replacing, ilmenite grains. The grains of rutile are generally lath-shaped, and vary in size from about 20 to 200 microns.

Anatase is also present in the ore. It occurs exclusively as individual and as clusters of grains in gangue. These grains are usually acicular in shape, and range from about 3 to 300 microns in size. A few small grains are also enclosed in pyrite.

Only one occurrence of goethite was found in the ore. It occurs as a thin narrow veinlet in gangue and measures about 40 microns in width.

Gangue minerals

The principal gangue mineral in the ore is quartz; the others, which include fluorite, topaz, mica, chlorite, dolomite and apatite, occur in small, and different, amounts.

CONCLUSIONS

The mineralogical investigation of the ore leads to the following conclusions: Wolframite accounts for nearly all of the tungsten in the ore, and scheelite is present in only trace amounts. The wolframite is generally coarse-grained and should be largely liberated without great difficulty. The

tin in the ore occurs as cassiterite, and although most of it was observed in the wolframite, traces also occur in the gangue minerals. The molybdenite occurs essentially in the gangue; and most of the grains are quite large and a fairly high degree of liberation should be achieved. Native bismuth and bismuthinite, on the other hand, are so fine-grained that they will be hard to liberate.

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