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MINERALOGICAL INVESTIGATION OF A SAMPLE OF A COPPER-MOLYBDENUM ORE FROM KENNCO EXPLORATIONS (WESTERN) LIMITED, BRITISH COLUMBIA

by

D. OWENS

MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

Mineralogical studies made on a sample of a copper-molybdenum ore from Kennco Explorations (Western) Limited show that the ore is composed largely of siliceous gangue, which contains disseminated grains of the ore minerals. The principal copper-bearing mineral is chalcopyrite; digenite, covellite, malachite, azurite and tennantite also occur in small amounts, and bornite, chalcocite and delafossite as trace amounts. The chalcopyrite is frequently rimmed by digenite and covellite. The only molybdenum-bearing mineral found was molybdenite. Other minerals identified include magnetite, ilmenite, hematite, goethite, pyrite, arsenopyrite, pyrrhotite, sphalerite, galena, and a variety of gangue minerals.

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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 a copper-molybdenum ore, designated as "Berg" ore, was received from Mr. G. Mathieu of the Mineral Processing Division on April 4, 1968. Mr. Mathieu requested that the ore be examined to identify its constituent minerals and their textural relationships. The ore was reported to be from a deposit located 60 miles southwest of Houston, in the Omineca Mining Division of British Columbia. The ore had originally been submitted to the Mines Branch by Kennco Explorations (Western) Limited, One Bentall Centre, Suite 730, 505 Burrard Street, Vancouver 1, British Columbia.

SAMPLE

The sample, as received, consisted of 25 very small rock fragments, none larger than $\frac{1}{2}$ in. in size, and about 100 grams of head sample crushed to minus 10 mesh. The sample was reported by Mr. Mathieu to contain 0.5% copper, 0.05% molybdenum and 0.01 ounces of combined silver and gold per ton.

METHOD OF INVESTIGATION

Six polished sections were prepared from the rock fragments that showed the greatest amount of metallic mineralization. These were examined under the ore microscope to identify the metallic minerals and their grain sizes and associations. The 65 to 250-mesh size was screened from the head sample and separated by heavy liquids. One polished section was prepared from the heaviest fraction to check on the metallic minerals in the ore. The gangue constituents were identified by microscopical examination of grain immersion mounts prepared from the products of heavy-liquid separations. X-ray diffraction methods were also employed to assist in the identification of the minerals.

RESULTS OF INVESTIGATION

General Mineralogy of the Ore

The ore sample was found to be composed mainly of gangue minerals in which were disseminated small amounts of metallic minerals. The principal copper-bearing mineral present in the ore is chalcopyrite. Also present are smaller amounts of digenite, covellite, tennantite, malachite and azurite, as well as traces of bornite, chalcocite and delafossite. The only molybdenum-bearing mineral found was molybdenite. Other minerals identified in the ore include pyrite, which is the dominant metallic mineral, lesser amounts of magnetite, and sparse amounts of ilmenite, hematite, goethite, arsenopyrite, pyrrhotite, sphalerite, rutile and galena. The gangue minerals consist chiefly of quartz and dolomite, with small amounts of garnet, mica, amphibole, epidote and chlorite. Except for a few large grains of pyrite, the minerals in the ore are medium- to fine-grained in size. No gold- or silver-bearing minerals were found in the examination of the ore.

It should be noted that the small rock fragments from which the grain size and textural relationships of the metallic minerals were determined do not appear to be representative of the ore. This is borne out by the fact that no tennantite, azurite, chalcocite, delafossite, hematite, galena and arsenopyrite were found in the polished sections of the rock fragments, although these minerals were identified in the head sample.

Detailed Mineralogy of the Ore

Copper-bearing minerals

Chalcopyrite ($CuFeS_2$) is the major copper-bearing mineral in the ore. It occurs as irregularly shaped grains in gangue (Figure 1), as combinations with pyrite, (Figure 1), and occasionally as combinations with magnetite in gangue (Figure 2). The chalcopyrite grains are usually quite small and vary in size from about 2 to 150 microns. (The word "size" as used in this report, refers to the greatest dimension of the mineral grain being described.) A few grains of chalcopyrite also occur as inclusions in pyrite and in magnetite. The inclusions in pyrite range from 6 to 50 microns in size, while those in magnetite are smaller and vary from 2 to 15 microns. Some of the chalcopyrite contains a few pyrite inclusions which vary from 10 to about 20 microns in size.

In some of the sections prepared from the rock fragments, and also in the polished section prepared from the head sample, the chalcopyrite is partly to completely rimmed by either digenite ($Cu_{1.8}S$) (Figure 3) or covellite (CuS), with digenite being the more prevalent. These secondary minerals are presumably formed by the replacement of chalcopyrite, and all stages of replacement are in evidence. Where replacement of the chalcopyrite is complete, the grains of digenite and covellite do not exceed 100 microns in size. In addition, a number of pyrite grains are also bordered by narrow rims, from 4 to 10 microns in width, of either digenite or covellite.

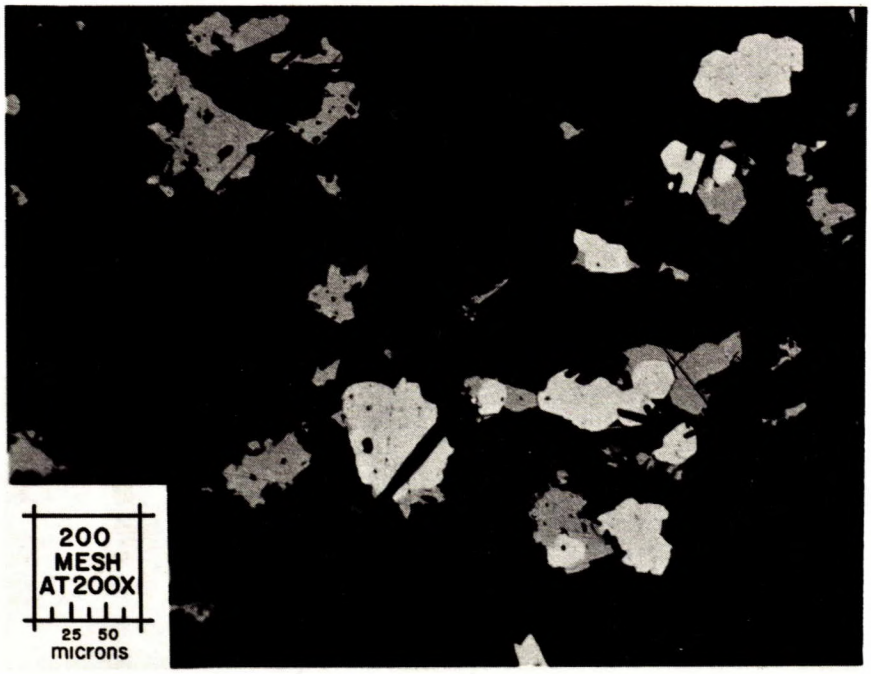

Figure 1. Photomicrograph (in oil immersion) of a polished section showing individual and combined grains of pyrite (white) and chalcopyrite (grey) in gangue (black).

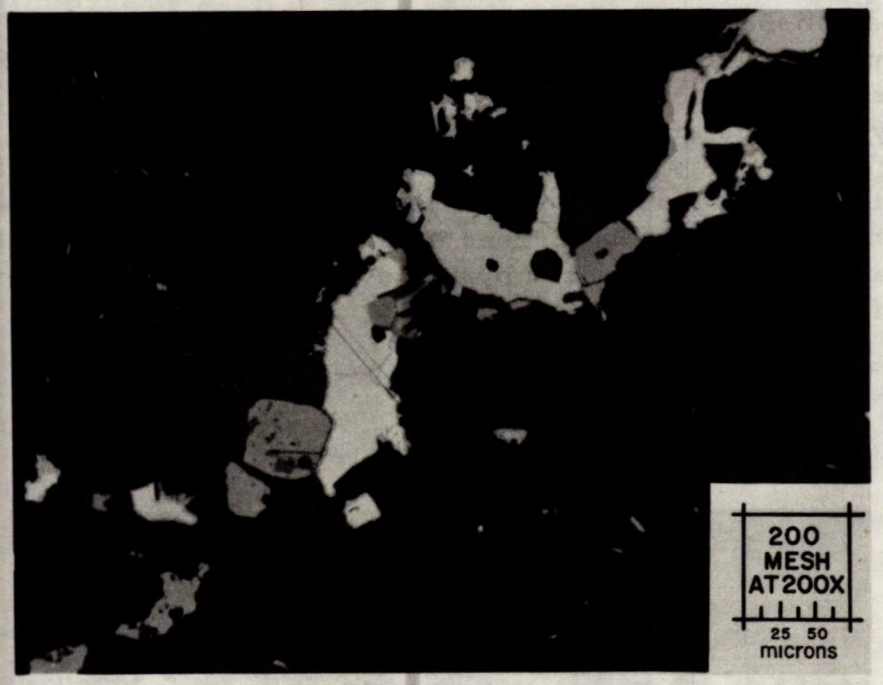

Figure 2. Photomicrograph (in oil immersion) of a polished section showing individual and combined grains of chalcopyrite (white) and magnetite (grey) in gangue (black). The chalcopyrite grains are rimmed by thin borders of digenite.

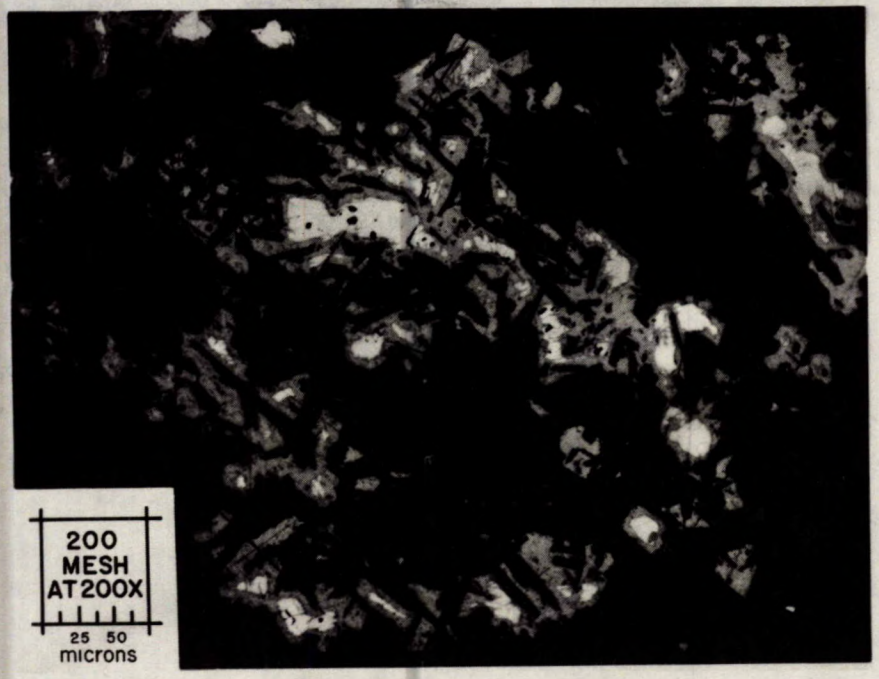

Figure 3. Photomicrograph (in oil immersion) of a polished section showing chalcopyrite (white) partly to completely replaced by digenite (dark grey) in gangue (black).

Fairly numerous grains of malachite ($Cu_2(OH)_2CO_3$) and a lesser number of grains of azurite ($Cu_3(OH)_2(CO_3)_2$) are present in the head sample of the ore. Except for one grain of malachite enclosing a grain of chalcopyrite in gangue, no copper carbonates were found in the examination of the polished rock fragments.

Similarly, although a number of tennantite ($Cu_{12}As_4S_{13}$) grains are present in the head sample, none were found in the polished sections of the rock fragments, and therefore their grain size and textural relationships to the other minerals could not be fully assessed. However, several grains of tennantite in the head sample were found to be veined by covellite. Because of the number of grains in the head sample, and the general mineralogical assemblage of the ore, the tennantite is believed to be a valid constituent in the ore, rather than having been introduced by contamination.

The only bornite (Cu_5FeS_4) found during the examination of the ore consisted of a few inclusions in pyrite. These inclusions are very small and range from 2 to 10 microns in size.

Only a very few grains of chalcocite (Cu_2S) and delafossite ($CuFeO_2$) were found in the head sample. Their presence is consistent with the remainder of the ore assemblage.

Other minerals in the ore

Molybdenite is the only molybdenum-bearing mineral found in the ore. It occurs as flakes, with a lath-shaped cross-section (Figure 4). These grains are all less than 60 microns in length and 20 microns in width.

Pyrite is the dominant metallic mineral present in the ore. It occurs as disseminated grains in gangue (Figures 1 and 4). While a few of these grains are as large as 1.5 millimetres in size, the majority range from 5 to 300 microns. The pyrite grains contain only a few inclusions, and these are composed chiefly of gangue, and minor chalcopyrite, bornite and pyrrhotite. This is the only occurrence of either bornite or pyrrhotite found during the examination of the ore. The inclusions in pyrite are quite small, and vary in size from 5 to about 60 microns. As mentioned earlier in this report, a number of pyrite grains are combined with chalcopyrite in gangue (Figure 1) and occasionally occur as inclusions in chalcopyrite. In addition, a few pyrite grains are rimmed by either digenite or covellite.

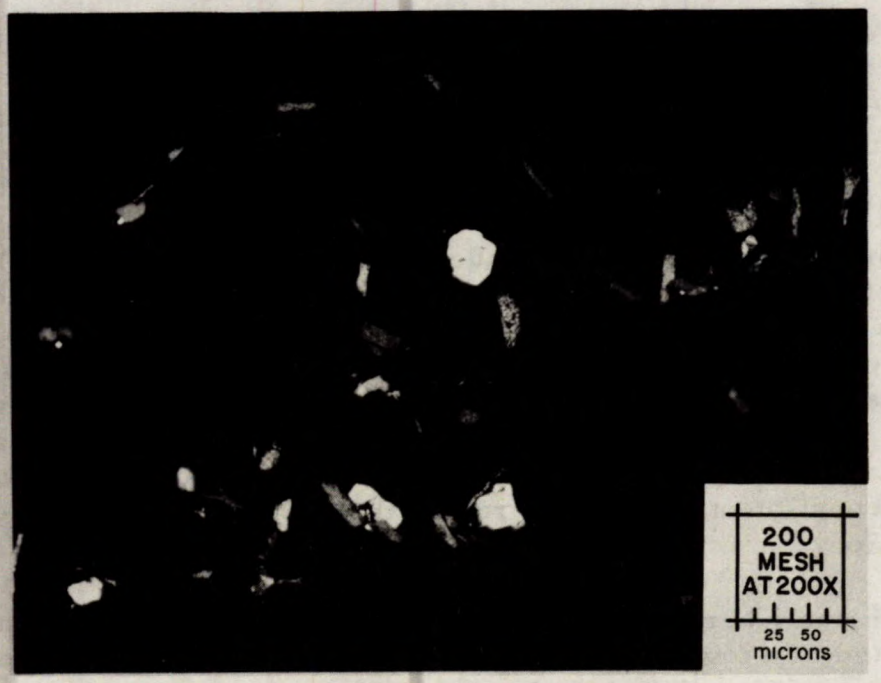

Figure 4. Photomicrograph (in oil immersion) of a polished section showing a few lath-shaped cross-sections of molybdenite flakes (grey) in gangue (black). A few grains of pyrite (white) are also shown.

Fairly numerous grains of magnetite, and a few grains of ilmenite and hematite were found in the ore. The magnetite occurs as medium- to fine-sized grains disseminated in gangue (Figures 2 and 5). These grains vary from 2 to 130 microns in size, but most are smaller than 50 microns. The magnetite grains are sometimes combined with chalcopyrite in gangue (Figure 2) and in a few instances contain small inclusions of chalcopyrite. The only hematite found was in the head sample, where it was observed replacing a few grains of magnetite. The ilmenite in the ore consists of a few grains in gangue, occasionally penetrating magnetite, and having a grain size of 50 microns or less.

Only a few grains each of sphalerite and rutile are present in the ore. They occur as individual grains in gangue, and in general do not exceed 65 microns in size.

No galena, goethite or arsenopyrite were found in the polished sections prepared from the rock fragments, although a few grains of each were found in the polished section of the head sample.

CONCLUSIONS

Conclusions drawn from the mineralogical examination are as follows: Firstly, the rock fragments, upon which the mineralogy, grain size and textural relationships of the minerals of the ore were primarily determined, do not appear to be truly representative of the ore, since some minerals present in significant amounts in the head sample, e.g. tennantite, malachite and azurite, were not found in the rock fragments. Secondly, although chalcopyrite is the principal copper-bearing mineral present in the ore, many of the grains retain borders of covellite or digenite upon being crushed; this same feature also holds true for a few grains of pyrite in the head sample. Thirdly, the molybdenite found in the ore is of a very fine grain size, and difficulty may be encountered in achieving liberation of many of the grains.

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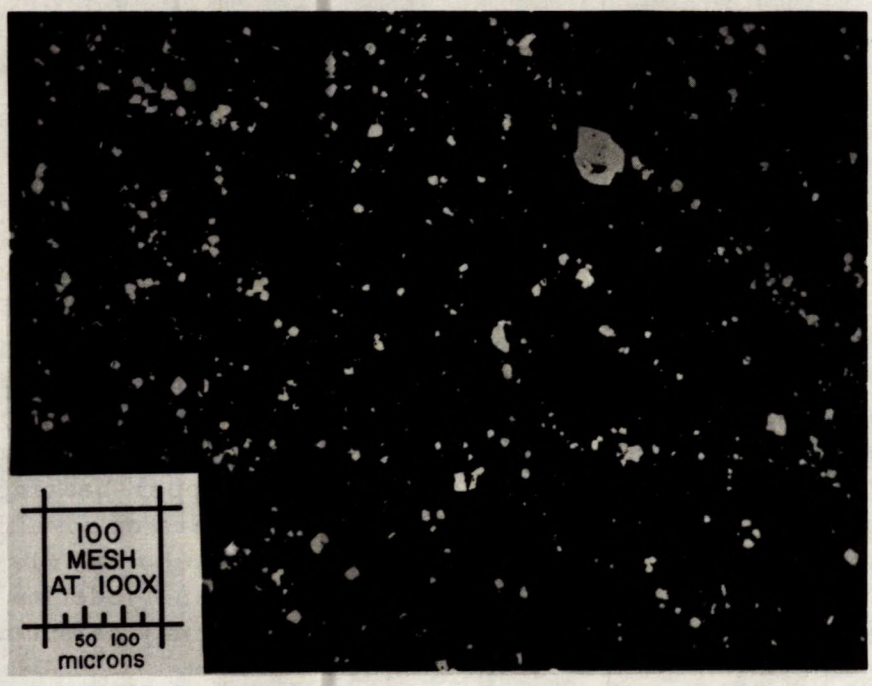

Figure 5. Photomicrograph (in oil immersion) of a polished section showing numerous small grains of magnetite (greyish white) disseminated in gangue (black).

Gangue minerals

No thin sections were made from the rock fragments of the ore because the fragments were rather small; therefore the identification of the gangue minerals was made by the microscopic examination of grain-immersion mounts of the head sample. The gangue consists essentially of quartz and a lesser amount of dolomite. Also present are small amounts of mica and garnet, and traces of chlorite, amphibole and epidote.