Industrial Confidential

Mines Branch Investigation Report IR 68-33

MINERALOGICAL INVESTIGATION OF A SAMPLE OF A SILVER-GOLD ORE FROM MOUNT NANSEN MINES LIMITED, YUKON TERRITORY

by

D. Owens*

- - -

SUMMARY OF RESULTS

Mineralogical studies of a sample of a silver-gold ore from Mount Nansen Mines Limited in the Yukon Territory show that the ore consists of siliceous rock and breccia, which contains disseminated grains of a wide variety of ore minerals. The silver in the ore is present in the form of freibergite, andorite, pyrargyrite and electrum. Electrum is also the only gold-bearing mineral found in the ore. Other minerals in the ore include boulangerite, bournonite, galena, pyrite, arsenopyrite, marcasite, pyrrhotite, sphalerite, chalcopyrite, covellite, goethite, anatase, quartz, jarosite, scorodite, mica, chlorite, feldspar and graphite.

---

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

INTRODUCTION

A sample of a silver-gold ore was received from Mr. T. F. Berry of the Mineral Processing Division on March 18, 1968. Mr. Berry stated that the ore was from a deposit in the Yukon Territory, and that it had originally been submitted to the Mines Branch by Mr. B. S. Imrie, Exploration Manager, Mount Nansen Mines Limited, 420-475 Howe Street, Vancouver 1, British Columbia. Mr. Berry requested that the sample of the ore be examined mineralogically to identify its constituent minerals, and to evaluate their grain sizes and textural relationships.

The samples, as received, consisted of numerous, very small rock fragments from 1/2" to 1" in size, and about 100 grams of head sample crushed to minus 10 mesh. The sample was labelled "composite B ore" and was reported by Mr. Berry to contain 30 ounces of silver and 1/2 ounce of gold per ton.

METHOD OF INVESTIGATION

Ten polished sections were prepared from the small rock fragments and examined under the ore microscope to identify the metallic minerals. The head sample was screened and the 65 to 250-mesh size was removed. This fraction was separated into differing sub-fractions using heavy liquids with specific gravities of 2.96 and 3.30. Two polished sections were prepared from the sink sub-fraction at 3.30 and examined microscopically to check on the metallic minerals in the head sample. Grain-immersion mounts were prepared from each of the float and sink sub-fractions to study the non-metallic minerals. The minerals in the ore were identified by microscopic and X-ray diffraction methods.

RESULTS OF INVESTIGATION

General Mineralogy of the Ore

The ore consists essentially of gangue in which is disseminated a small quantity of metallic minerals. Most of the grains of the metallic minerals, with a few exceptions, are medium- to fine-grained in size. The metallic minerals in the ore consist mainly of pyrite and arsenopyrite; lesser galena, boulangerite and sphalerite; and from small amounts to

a few grains of freibergite, andorite, pyrargyrite, electrum, chalcopyrite, covellite, marcasite, pyrrhotite, anatase, bournonite and goethite. The gangue is composed principally of quartz; lesser jarosite and scorodite; and traces of mica, chlorite, feldspar and graphite.

Detailed Mineralogy of the Ore

Silver- and Gold-Bearing Minerals

The silver-bearing minerals identified in the ore include pyrargyrite [$Ag_3Sb_2S_3$], freibergite [$(Cu,Fe,Ag)_{12}Sb_4S_{13}$], andorite [$(Pb,Ag)Sb_3S_6$] and electrum [Au,Ag]. Freibergite and andorite are the most abundant of the silver-bearing minerals; only a small number of grains of pyrargyrite and a few grains of electrum were found. The electrum contains the only gold found in the ore.

A small number of grains of pyrargyrite are present in the ore, all of which were found in intimate association with galena. The grains of pyrargyrite occur either as inclusions in galena, or as combined grains with galena in gangue (Figure 1). The grains of pyrargyrite are quite small and vary in size from about 8 to 70 microns. (The word "size" as used in this report, refers to the greatest dimension of the mineral grain being described.)

The freibergite in the ore is present largely as inclusions in gangue (Figure 2), galena and boulangerite and occasionally in sphalerite. These grains vary from about 10 to 160 microns in size, but most are less than 70 microns. A number of the larger grains, such as is illustrated in Figure 2, contain a few small inclusions of galena and boulangerite.

Andorite occurs in the ore principally as irregular grains in gangue (Figure 3). These grains vary in size from about 10 to 180 microns. The andorite contains only a small number of inclusions, and these are composed mainly of arsenopyrite as well as a few grains of electrum. These inclusions are usually not larger than 70 microns in size. The amount of andorite in the ore is difficult to determine, since its optical properties in polished section are almost identical to those of boulangerite, which occurs in the ore. In fact the andorite could only be positively distinguished from boulangerite by X-ray-diffraction analysis of grains of the two minerals removed from the polished sections. However, the amount of boulangerite in the ore appears to exceed that of andorite since most of the grains X-rayed proved to be boulangerite.

Two grains of what is also believed to be andorite contain the only gold found in the ore sample. It occurs as inclusions of electrum in the andorite (?) (Figure 4). These inclusions vary from 4 to about 70 microns in size. The grains were identified as electrum by electron-probe

microanalysis of the two largest grains, whicheestablished that the gold: silver ratio is about 3:1. Figures 5 and 6 are X-ray images from the electron probe, of the two largest grains of electrum illustrated in Figure 4. Figure 6 also shows that the andorite (?) contains some silver.

In addition, one other grain of andorite was found which contains 6 very small grains of either native silver or electrum, from 0.5 to 1.5 microns in size. Due to their small grain size it could not be established as to whether they are native silver or electrum.

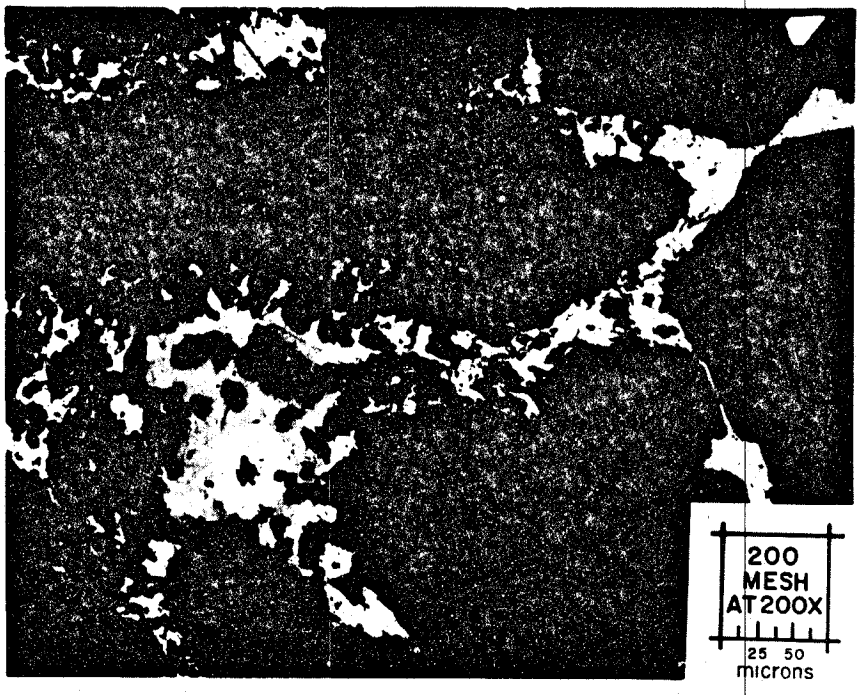


Figure 1. - Photomicrograph (in oil immersion) of a polished section showing galena (white) and pyrargyrite (light grey) combined in gangue (black).

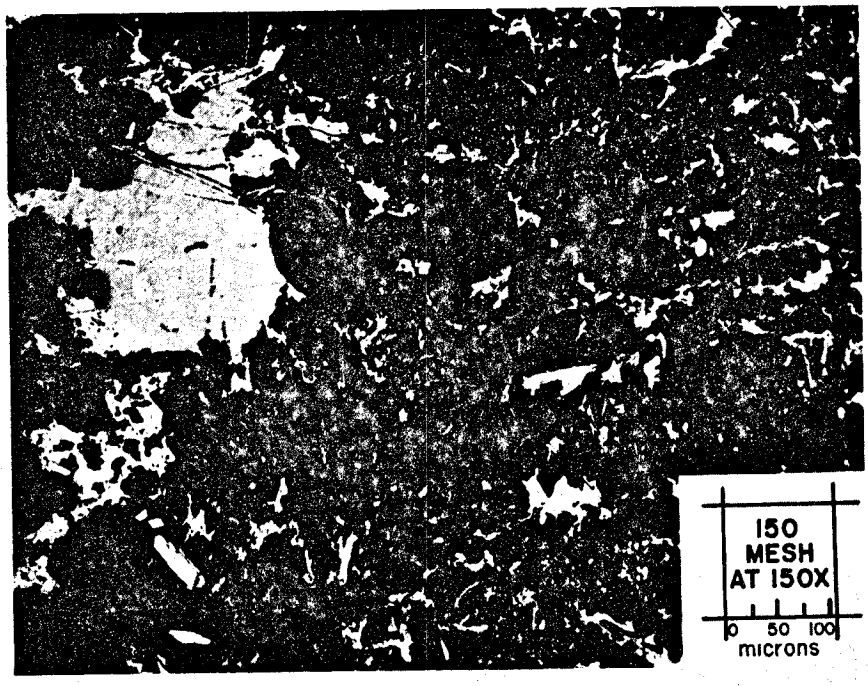


Figure 2. - Photomicrograph (in oil immersion) of a polished section showing numerous small inclusions of boulangerite (greyish white) and a few grains of arsenopyrite (white) in gangue (black). The large grain in the upper left portion of the photomicrograph is freibergite (medium grey), containing inclusions of both galena and boulangerite.

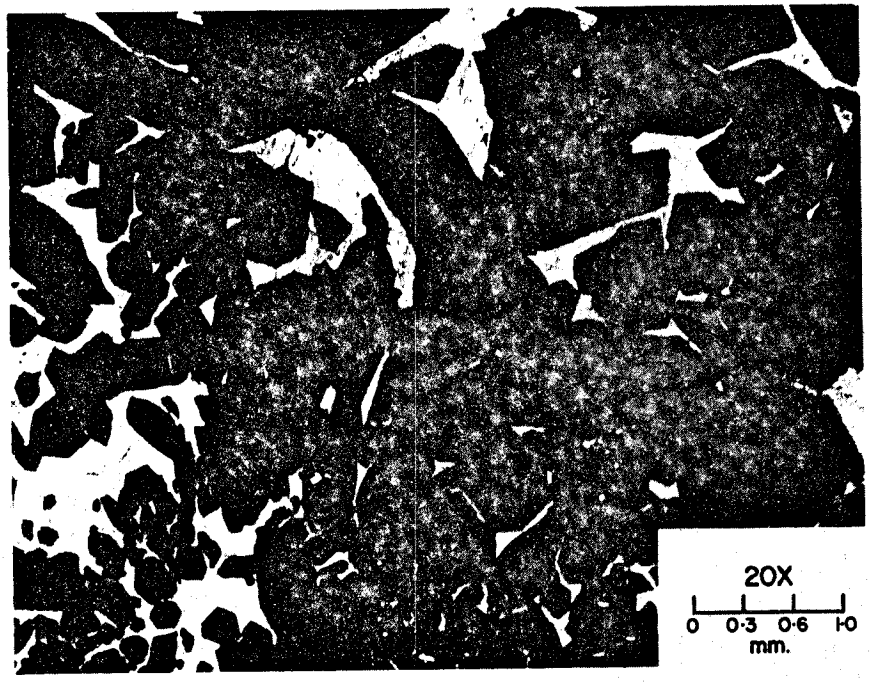


Figure 3. - Photomicrograph of a polished section showing irregular grains of andorite (greyish white) in gangue (grey).

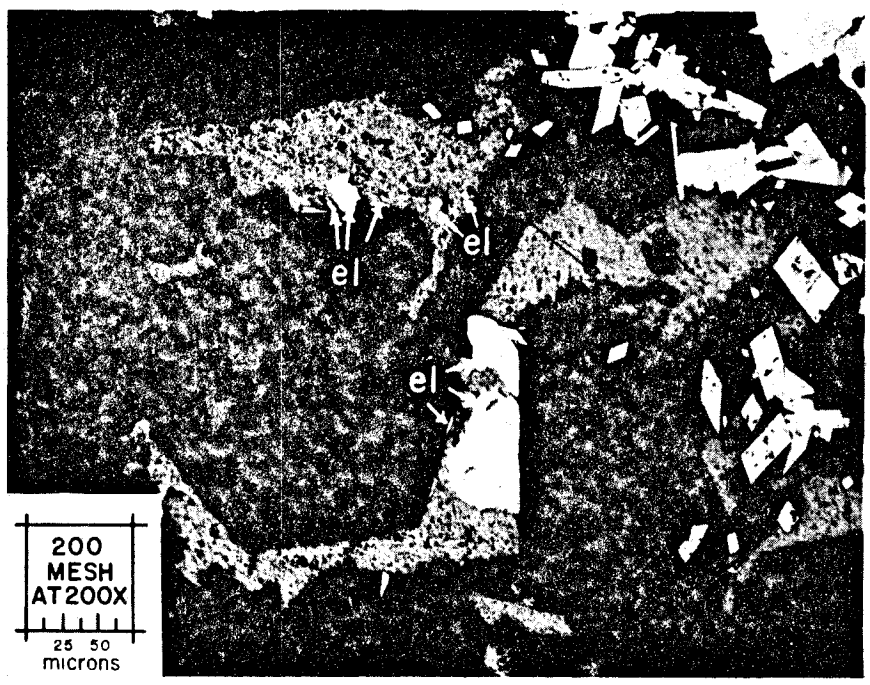
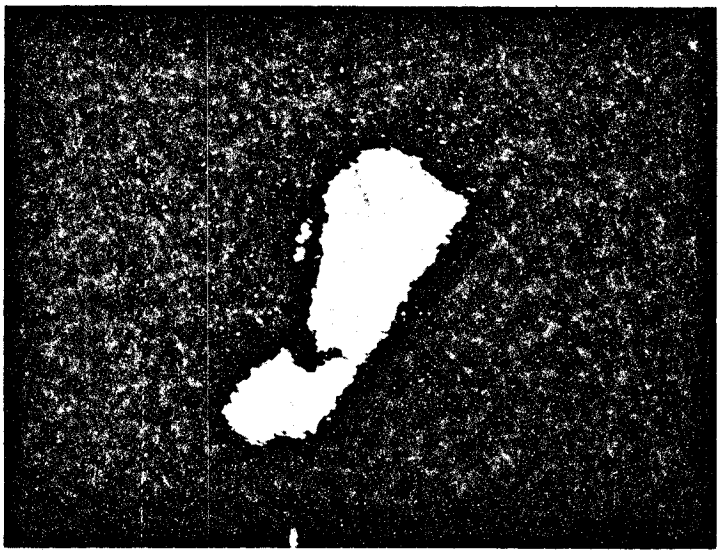
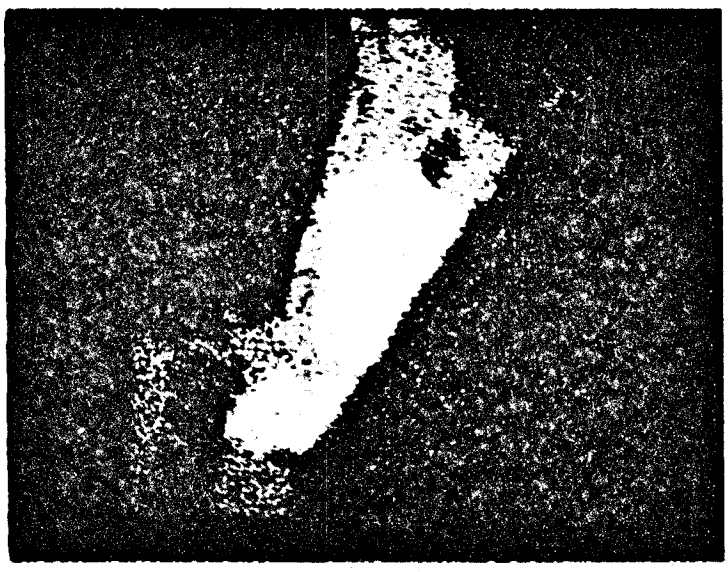


Figure 4. - Photomicrograph (in oil immersion) of a polished section showing a number of grains of andorite (?)(dark grey) in gangue (black). The andorite (?) contains a few grains of electrum (el). The other greyish white grains are arsenopyrite.



Au Mα

Figure 5. - X-ray image of the two larger grains of electrum showing the gold content of the grains (white). The few white specks in the black background are backscatter.



Ag Lα

Figure 6. - X-ray image of the same two grains in andorite (?) showing the silver content of the grains (white). Also visible is the outline of the andorite (?) grain in which the electrum occurs. The less intense image of the andorite (?) indicates its relatively low silver content compared to the electrum. The white specks in the black background are backscatter.

Other Ore Minerals

Boulangerite ($Pb_5Sb_4S_{11}$) occurs in the ore largely as inclusions in gangue (Figure 2) and as interstitial masses around individual grains of gangue (Figure 7). It is found to a lesser degree as inclusions in sphalerite, galena and arsenopyrite. The boulangerite occurs in areas as large as about one millimetre, although most of the grains are between 10 and 300 microns in size. The boulangerite contains a few inclusions of sphalerite, gangue, freibergite, arsenopyrite and pyrite. These inclusions range from 5 to about 200 microns in size. The boulangerite also forms combinations with galena and sphalerite in gangue (Figure 8), and occasionally with arsenopyrite. In a few instances it is also penetrated by very narrow veinlets of covellite, only a few microns in width.

Only traces of bournonite (Pb, Cu, SbS_3) were found during the microscopic examination. The only positively identified bournonite were a few grains in the head sample.

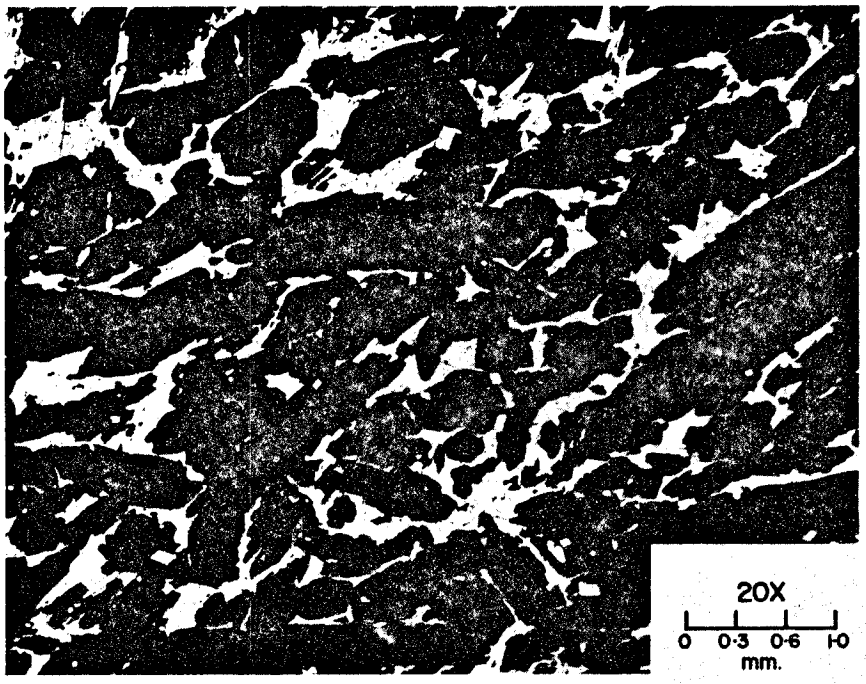


Figure 7. - Photomicrograph of a polished section showing medium- to fine-grained interstitial boulangerite (greyish white) in gangue (grey). A few grains of arsenopyrite (white) occur in boulangerite but are barely visible.

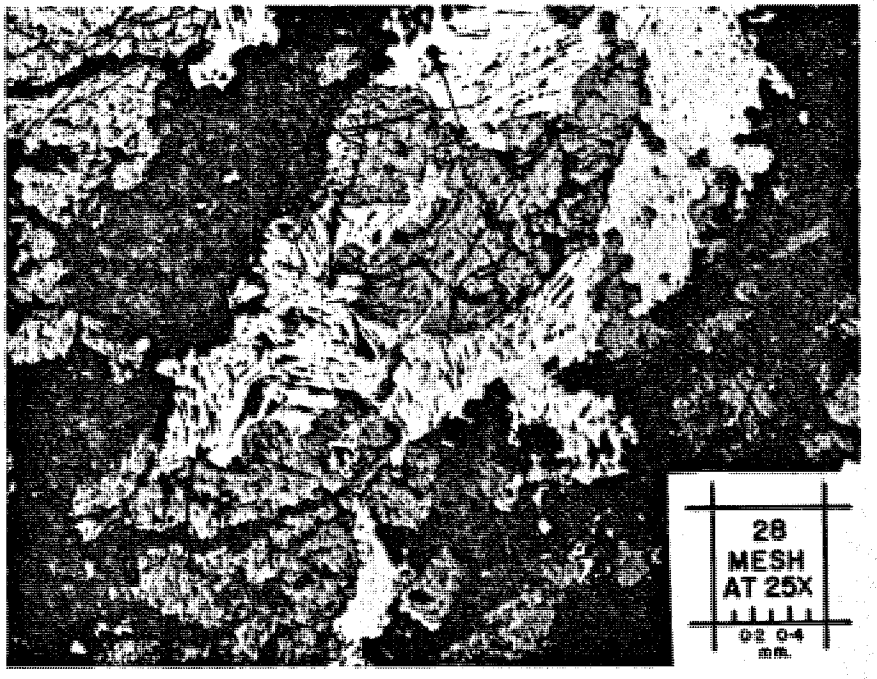


Figure 8. - Photomicrograph of a polished section showing combined sphalerite (medium grey), galena (gn) and boulangerite (blg) in gangue (dark grey). The white line, which is drawn in, marks the approximate division between the heavily pitted galena and the boulangerite. Sphalerite is also present as inclusions in gangue.

The galena in the ore is slightly coarser than the boulangerite. It occurs largely as small masses and grains in gangue (Figure 9), and to a lesser degree as inclusions in sphalerite, pyrite (Figure 10) and occasionally in boulangerite. The galena in gangue attains a maximum size of about 2 millimetres, while the galena in the other minerals varies from about 5 to 300 microns in size. The galena in a few places was found in combination with sphalerite and boulangerite in gangue (Figure 8), and also with pyrargyrite (Figure 1). The galena also contains a few inclusions of pyrite, gangue (Figure 9), sphalerite, freibergite, pyrargyrite and arsenopyrite. These inclusions range from 5 to about 400 microns in size.

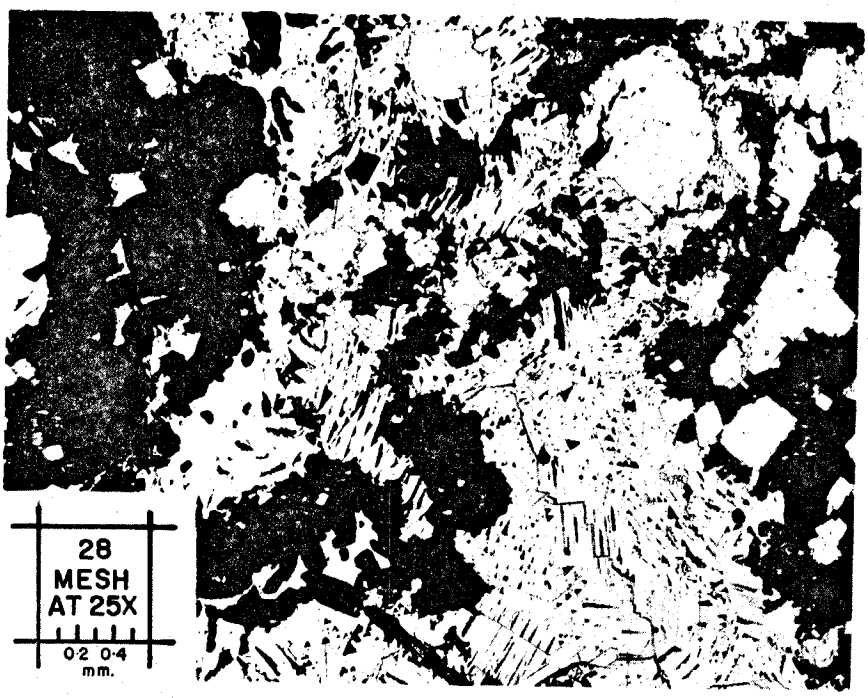


Figure 9. - Photomicrograph of a polished section showing galena (greyish white) and pyrite (white) in gangue (dark grey). The galena also contains inclusions of pyrite and gangue.

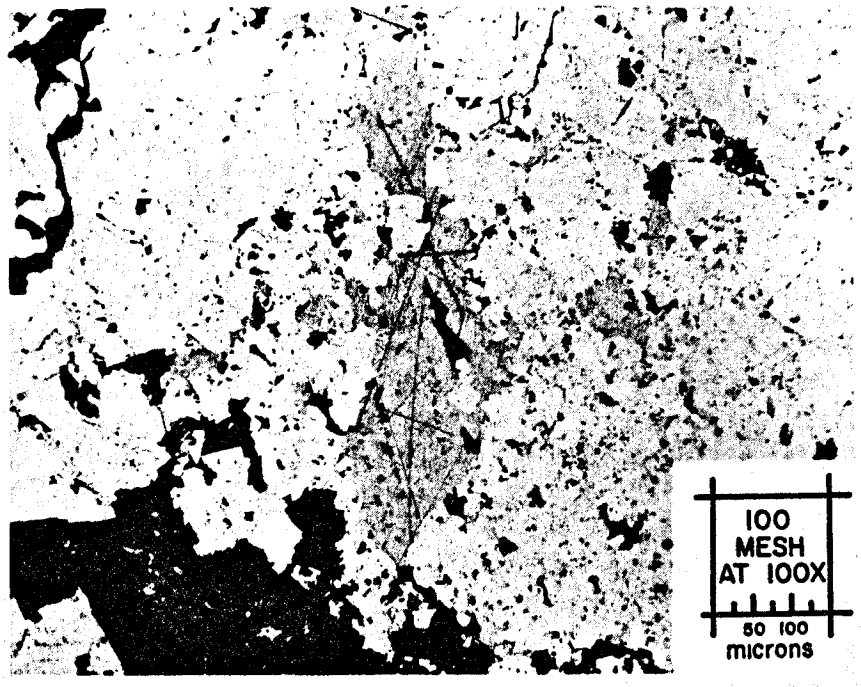


Figure 10. - Photomicrograph (in oil immersion) of a polished section showing pyrite (white) with inclusions of galena (light grey) and sphalerite (dark grey). The black areas are both gangue inclusions and polishing pits.

Pyrite and arsenopyrite are the two major metallic minerals in the ore. The pyrite occurs largely as small masses and grains in gangue (Figure 9), ranging from 0.01 to about 1.5 millimetres in size. Pyrite also occurs as inclusions in galena (Figure 9), sphalerite and arsenopyrite. The inclusions in the latter three minerals vary from about 20 to 500 microns. The pyrite also contains inclusions of galena, sphalerite, gangue (Figure 10) and pyrrhotite. These inclusions range from 10 to about 350 microns in size.

Most of the arsenopyrite is present as disseminated grains in gangue. Although granular aggregates of arsenopyrite up to 1.2 millimetres in size were seen, most of the grains are from 15 to 400 microns. Some arsenopyrite grains also occur as inclusions in boulangerite (Figure 7), andorite (?) (Figure 4), sphalerite and galena. These grains vary from 5 to 150 microns in size. The arsenopyrite contains a few inclusions of sphalerite, gangue (Figure 11), pyrite and boulangerite, and occasionally forms combinations with boulangerite grains in gangue. The inclusions in arsenopyrite are from 5 to about 350 microns in size.

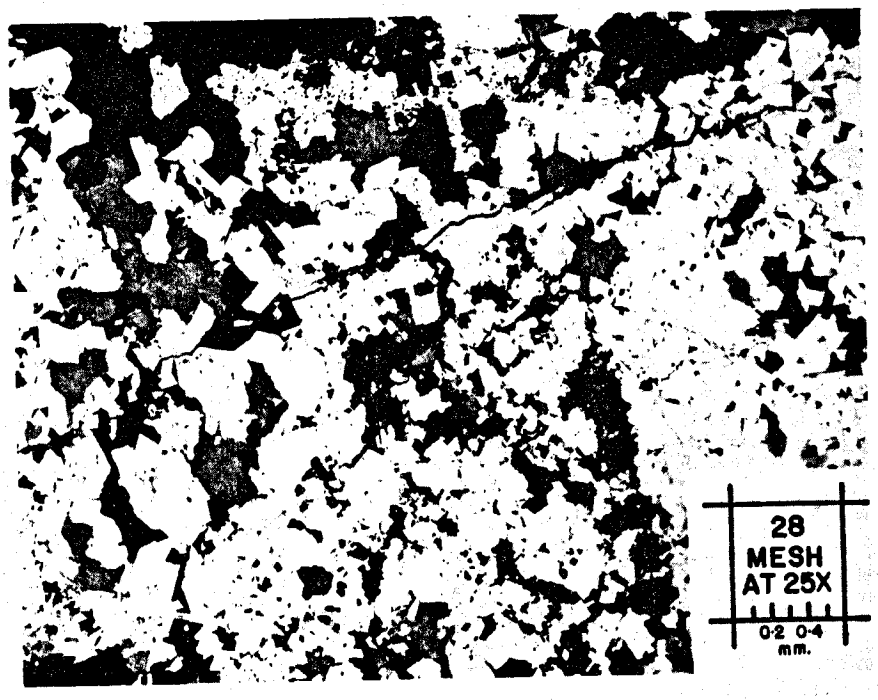


Figure 11. - Photomicrograph of a polished section showing granular arsenopyrite (white) enclosing grains of sphalerite (medium grey) and gangue (dark grey).

Only traces of marcasite and pyrrhotite were seen in the ore. The only pyrrhotite found consisted of a few very small inclusions in a grain of pyrite, while the marcasite is present as a few small grains in gangue, from 10 to 85 microns in size.

A small quantity of sphalerite is also present in the ore. It is present as small masses and grains in gangue, and as inclusions in galena, boulangerite, arsenopyrite and pyrite (Figures 10 and 11). The sphalerite grains and small masses in gangue range from 0.01 to about 2.8 millimetres in size, while those in the other minerals vary from 5 to about 450 microns. Some of the sphalerite contains abundant oriented and unoriented inclusions of chalcopyrite (Figure 12). The inclusions of chalcopyrite are very small, generally less than 20 microns in size. In addition, the sphalerite also contains a few inclusions of freibergite, boulangerite, pyrite and gangue. In a few instances the sphalerite occurs in combination with galena and boulangerite in gangue (Figure 8).

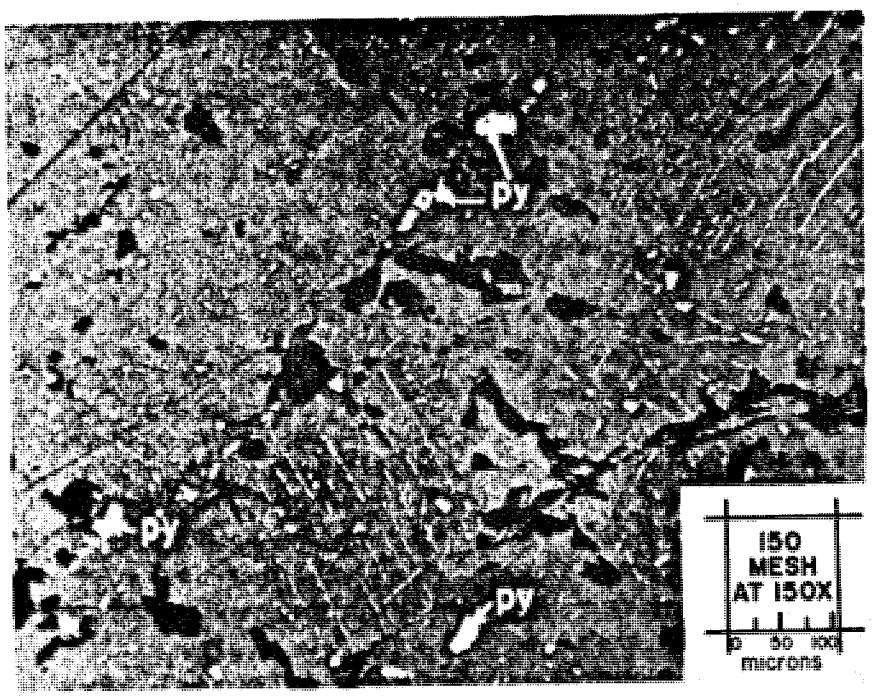


Figure 12. - Photomicrograph (in oil immersion) of a polished section showing sphalerite (medium grey) containing numerous small oriented and unoriented inclusions of chalcopyrite (greyish white). A few slightly larger inclusions of pyrite (py) are also present in the sphalerite. The black areas are polishing pits.

A small amount of chalcopyrite is present in the ore. As mentioned above, it is present almost entirely as very small inclusions in sphalerite (Figure 12), although a few larger free grains, about 100 microns in size, were found in the head sample. The only other occurrence of chalcopyrite noted in the ore, consisted of an inclusion in boulangerite.

Only traces of covellite occur in the ore. It is present as very small grains and stringers in gangue, and occasionally as very thin veinlets in boulangerite. The covellite grains in gangue are all smaller than 30 microns in size.

A few small scattered grains of anatase occur in the ore. All the grains occur in gangue, and in general vary from 5 to 50 microns in size.

Although no goethite was found in the polished sections of the rock fragments, a few grains of goethite, some of which enclose tramp iron, were found in the head sample. They are probably due to contamination of the head sample during grinding.

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 jarosite and scorodite. Also present are small amounts of mica, chlorite, feldspar and graphite.

CONCLUSIONS

The conclusions drawn from the mineralogical investigation are as follows: Firstly, the only gold found in the ore was in the form of electrum, which is quite fine-grained. Secondly, the silver in the ore occurs in a wide variety of minerals, including freibergite, andorite, pyrargyrite and electrum. With the exception of the andorite, which apparently contains a low percentage of silver, the grains of the silver-bearing minerals are also generally quite small, and it is expected that liberation of many of these mineral grains will be difficult to achieve. Thirdly, while the presence of andorite in the ore was established by X-ray diffraction, the amount of it in the ore could not be estimated, because of its similarity in appearance to boulangerite.

DO/pg