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MINERALOGY OF A BISMUTH-COPPER ORE FROM EMPRESA MINERA DE QUECHISLA, TASNA, BOLIVIA FOR PROSPECTION LIMITED

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

The bismuth-copper ore from Empresa Minera de Quechisla, Tasna, Bolivia contains a wide variety of minerals. The bismuth-bearing minerals are bismuthinite, native bismuth and bismutosphaerite, and the copper-bearing minerals are chalcopyrite and stannite. Other minerals in the ore are native gold, galena, sphalerite, pyrite, marcasite, pyrrhotite, arsenopyrite, ferberite, rutile, siderite, quartz, feldspar, tourmaline and chlorite. No silver-bearing minerals were identified but minerals whose optical properties are similar to those of tetrahedrite and acanthite were found.

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INTRODUCTION

Samples of a bismuth-copper ore from the Empresa Minera de Quechisla, Tasna, Bolivia were received from G. O. Hayslip of the Mineral Processing Division, Mines Branch on September 11, 1963. Mr. Hayslip stated that the ore was submitted to the Mines Branch by Prospection Limited, 80 Richmond Street West, Toronto, Ontario, and requested that it be examined mineralogically. The samples as received consisted of a number of hand specimens and one head sample ground to about -10 mesh.

METHOD OF INVESTIGATION

Polished and thin sections were prepared from the hand specimens and the minerals were identified by means of microscopy and X-ray diffraction.

The ground head sample was sized by screening, and the -65+200 mesh fraction was separated into sub-fractions by means of heavy liquids and the Frantz isodynamic separator. The minerals in each sub-fraction were identified and the chalcopyrite and bismuthinite sub-fractions were analysed for Au and Ag. The elements present in the ground head sample were determined spectrographically.

RESULTS OF INVESTIGATION

Spectrographic Analysis

The results of the spectrographic analysis are given in Table 1.

TABLE 1

Elements Present in a Bismuth Ore from Bolivia

Element	Weight per cent*
Si	A
Fe	A
As	B
Al	B
Mg	B
B	B
Bi	B
Cu	B
Na	C
W	C
Ti	C
Sb	C
Pb	C
Ni	D
Ca	D
Co	D
Sn	D
Mn	D
Cr	D
Ga	D
In	D
Mo	D
V	E
Ag	E
Ba	E
Be	tr

Legend

A = +5%
B = 1 to 5%
C = 0.1 to 1%
D = 0.01 to 0.1%
E = 0.001 to 0.01%
tr = trace

*Internal Report SL-63-216 by E. M. Kranck, Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch.

Megascopic Properties of Hand Specimens

The hand specimens show a very fine-grained dark grey rock containing veinlets and masses of metallic minerals and tourmaline. The veinlets are up to $\frac{1}{2}$ inch wide and the masses are up to 1 inch in diameter. Occasionally the metallic mineral veinlets are coated with yellow encrustations of bismutosphaerite.

General Mineralogy

The minerals found microscopically are bismuthinite, chalcopyrite, galena, sphalerite, stannite, pyrite, marcasite, pyrrhotite, arsenopyrite, molybdenite, native gold, native bismuth, ferberite, rutile, goethite, bismutosphaerite, siderite, quartz, feldspar, tourmaline, chlorite, and possibly argentite and tetrahedrite.

Detailed Mineralogy

Bismuthinite (Bi_2S_3)

A significant amount of bismuthinite is present. It occurs as masses (see Figures 1 and 2) and as prismatic crystals in goethite (see Figure 3). The masses of bismuthinite occasionally contain inclusions of native bismuth, chalcopyrite, stannite, and a grey mineral that has the optical properties of acanthite. The inclusions of the last mineral, however, are so small that the mineral cannot be definitely identified.

Native Bismuth (Bi)

Native bismuth was found only as inclusions in bismuthinite. The inclusions range from about 1 to 50 microns in diameter.

Bismutosphaerite ($Bi_2(CO_3)_3 \cdot 2Bi_2O_3$)

Bismutosphaerite is present as the principal constituent of a fine grained yellow encrustation along a bismuthinite veinlet. This encrustation is about $\frac{1}{4}$ inch thick and contains small amounts of siderite, tourmaline and quartz.

Chalcopyrite ($CuFeS_2$)

A significant amount of chalcopyrite is present. It occurs as masses (see Figures 1 and 2) and contains inclusions, veinlets and lamellae of stannite, sphalerite, pyrrhotite, and a light grey mineral that has the optical properties of tetrahedrite, but occurs as grains which are so small that it cannot be positively identified.

Galena (PbS)

A small amount of galena is present as masses and as intergrowths with bismuthinite. It contains inclusions of stannite and a mineral that has the optical properties of acanthite.

Silver-bearing Minerals

No silver-bearing minerals were identified, but chemical analyses show that the ore contains silver* and that chalcopyrite and bismuthinite sub-fractions contain 3.63 and 9.71 ounces silver** per ton respectively. The microscope reveals that the chalcopyrite contains lamellae of a mineral whose optical properties are similar to those of tetrahedrite, and the bismuthinite contains minute inclusions of a mineral whose optical properties are similar to those of acanthite (Ag_2S). Since tetrahedrite is commonly silver-bearing, this mineral, and possibly also acanthite, may be the sources of the silver reported in the sample.

Stannite (Cu_2FeSnS_4)

A small amount of stannite occurs as inclusions, veinlets and lamellae in chalcopyrite. The inclusions are up to 50 microns in size and the veinlets are generally several microns wide. The veinlets frequently occur along chalcopyrite-pyrite and chalcopyrite-arsenopyrite boundaries, and consist of complex mixtures of stannite and sphalerite (see Figure 4).

Sphalerite (ZnS)

A small amount of sphalerite is present in the ore. It occurs as a constituent of narrow stannite-sphalerite veinlets (see Figure 4), and as wider veins along chalcopyrite-goethite boundaries (see Figure 5).

Molybdenite

A trace of molybdenite was found only as individual grains in a gravity sub-fraction.

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*Personal communication, G. O. Hayslip, Mineral Processing Division.

**Chemical analyses by L. Lutes and D. Cumming, Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch, Internal Report MS-AC-64-12.

Pyrite, Arsenopyrite, Marcasite and Pyrrhotite

Pyrite and arsenopyrite occur as masses and are frequently intergrown with each other; the marcasite occurs as small irregular grains in goethite (see Figure 2) and as veinlets in pyrite and chalcopyrite, and the pyrrhotite occurs as minute inclusions in chalcopyrite and pyrite.

Co and Ni - Bearing Minerals

No cobalt- and nickel-bearing minerals were found in the samples studied but the spectrographic analysis of the head sample shows that significant amounts of these elements are present (see Table 1). It is suggested that they may occur as trace elements in the pyrite and arsenopyrite.

Native Gold (Au)

Native gold was found as inclusions in pyrite (see Figure 6), arsenopyrite, chalcopyrite and bismuthinite. Assays of chalcopyrite and bismuthinite concentrates reported 0.23 and 1.82 ounces gold* per ton respectively.

Ferberite ($FeWO_4$)

Ferberite was found only as grains in sub-fractions prepared from a -65+200 mesh fraction of the head sample. These grains are black under the stereomicroscope, are up to 200 microns in size, and are largely free.

Siderite ($FeCO_3$)

Siderite was found as a constituent of the yellow encrustation on a bismuthinite veinlet and as free grains in a sub-fraction prepared from a -65+200 mesh fraction of the head sample. The grains in the sub-fraction are light brown and are in the form of well developed rhombohedral crystals.

Tourmaline ($HgAl_3(B_1OH)_2Si_4O_{19}$)

Tourmaline is present as veins, masses, and crystals in the rock. It is light pink to colorless and occurs in the form of prismatic crystals up to 1 mm long.

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*Internal Report MS-AC-64-12.

Goethite ($Fe_2C_3.H_2O$)

Small masses of goethite are present throughout the ore and some of them contain irregular grains of marcasite and prismatic crystals of bismuthinite (see Figures 2 and 3).

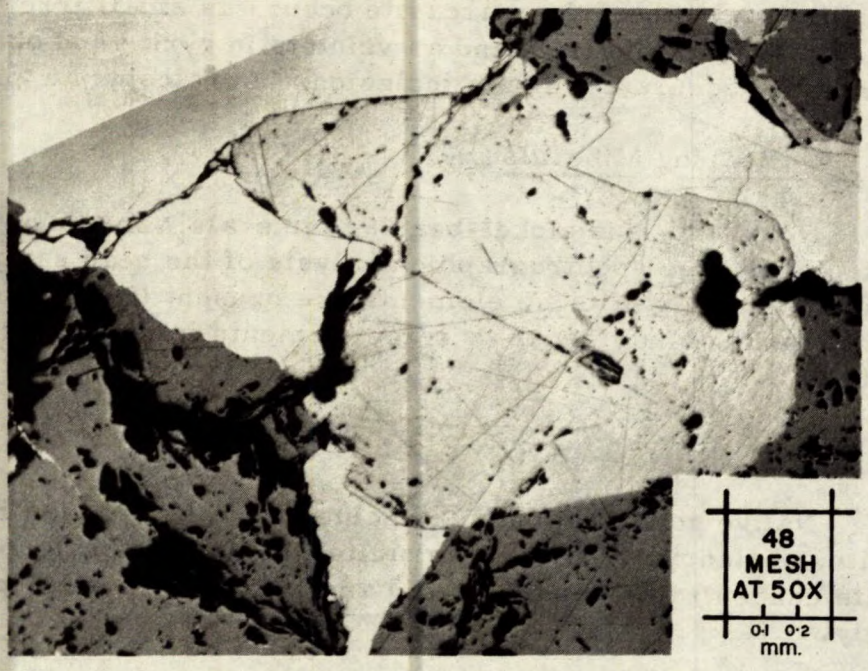

Figure 1. Photomicrograph of a polished section showing bismuthinite (light grey), chalcopyrite (dark grey) and arsenopyrite (white).

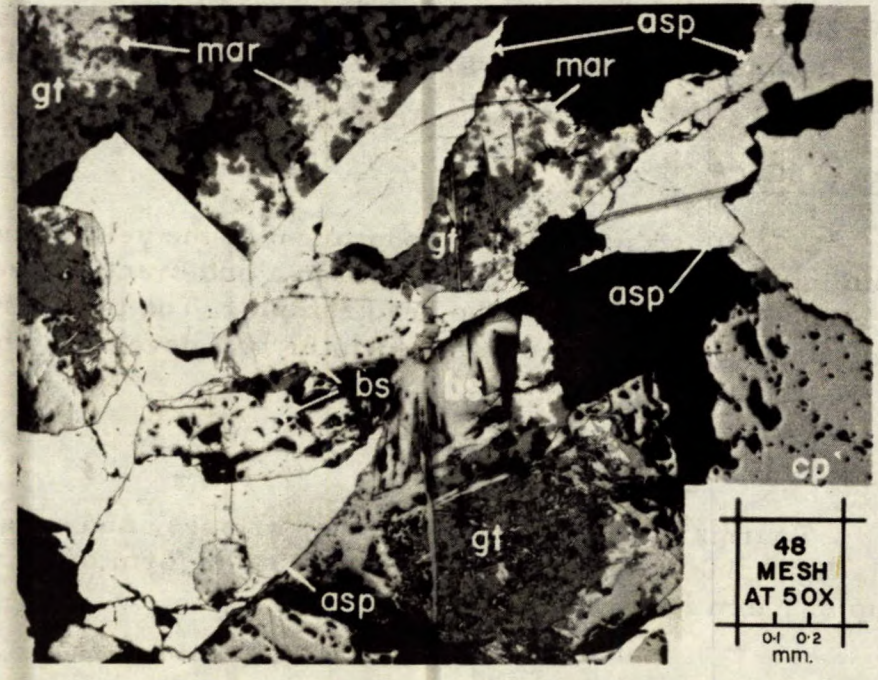

Figure 2. Photomicrograph of a polished section showing bismuthinite (bs), arsenopyrite (asp), chalcopyrite (cp), marcasite (mar) and goethite (gt).

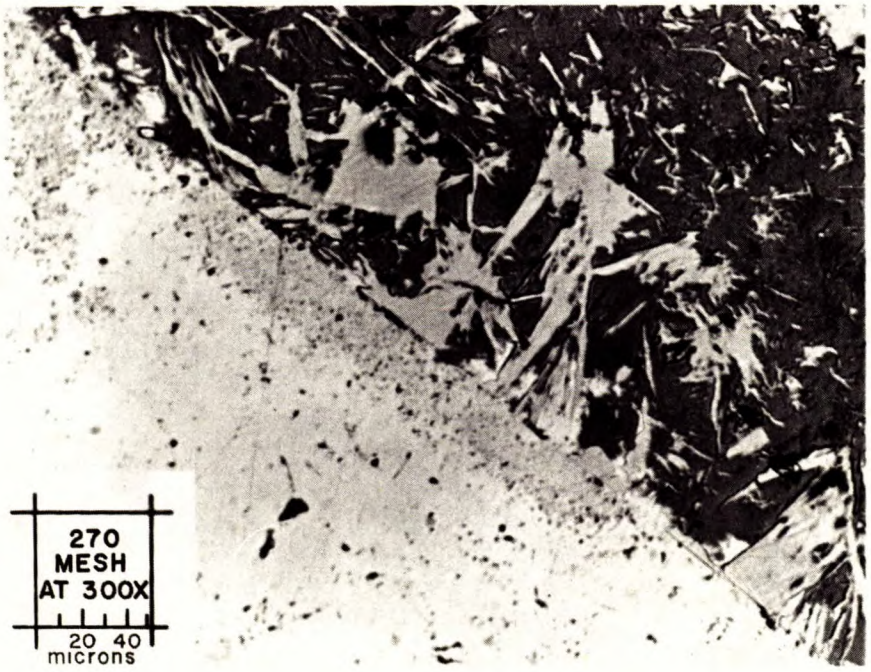

Figure 3. Photomicrograph of a polished section showing the bismuthinite crystals (light grey) in goethite (dark grey). The large grey-white area at the left side of the photograph represents arsenopyrite.

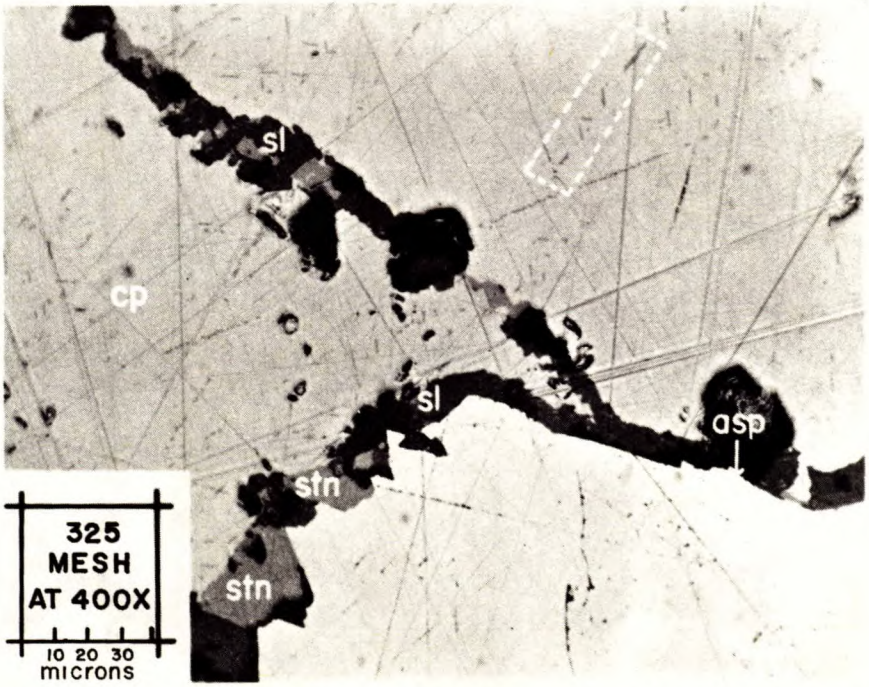

Figure 4. Photomicrograph of a polished section showing a stannite (stn)-sphalerite (sl) veinlet along a chalcopyrite (cp)-arsenopyrite (asp) boundary, and a branch of the veinlet in chalcopyrite. The photograph also shows stannite lamellae in chalcopyrite and an area containing lamellae is indicated by the dashed lines.

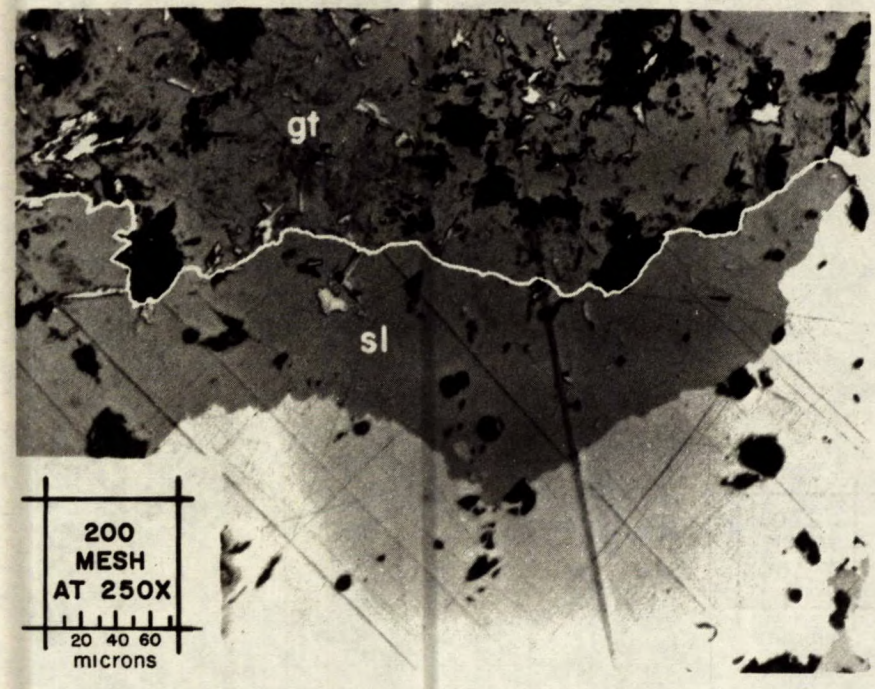

Figure 5. Photomicrograph of a polished section showing sphalerite (sl), goethite (gt) and chalcopyrite (light grey). The sphalerite-goethite grain boundary has been traced for greater clarity.

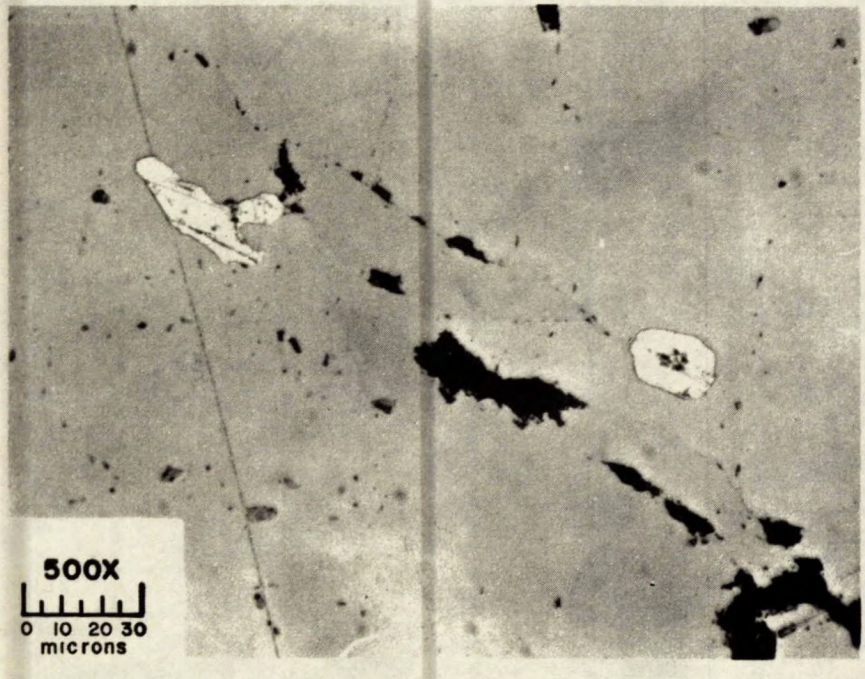

Figure 6. Photomicrograph of a polished section showing inclusions of gold (white) in pyrite (light grey).

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