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MINES BRANCH INVESTIGATION REPORT IR 63-72

MINERALOGY OF AN OXIDE TIN ORE FROM BOLIVIA FOR PROSPECTION LIMITED

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

The oxide tin ore from Bolivia consists of metallic minerals in a weathered rock with the principal tin-bearing mineral being cassiterite. The cassiterite grains range from 2 to 200 microns in size and at least half of those present in -60+200 mesh fractions of the ore are liberated from the gangue. The remaining ones are intergrown with primary and secondary minerals. The principal secondary minerals are jarosite, svanbergite and goethite. The jarosite contains about 0.2% Sn and a trace of Ag.

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INTRODUCTION

Samples of an oxide tin ore from Bolivia were received from G.O. Hayslip of the Mineral Processing Division in April, 1963. Mr. Hayslip stated that the ore was submitted to the Mines Branch by Prospection Limited, 80 Richmond Street West, Toronto, Ontario, and requested a mineralogical investigation.

SAMPLES

The following samples were received from Mr. Hayslip:

(1) about 20 hand specimens;

(2) a head sample ground to about -20 mesh;

(3) a -60+80 mesh cassiterite concentrate, labelled MO series, and containing 20.3% Sn by weight.

METHOD OF INVESTIGATION

The hand specimens (sample 1) were examined under the stereomicroscope and the porous material was selected for X-ray diffraction, X-ray fluorescence and spectrochemical analyses. Thin and polished sections were prepared from the less porous material and the minerals in it were identified.

The head sample (sample 2) was analysed spectrochemically. It was also sized and separated into fractions by means of heavy liquids. The resulting fractions, as well as the cassiterite concentrate (sample 3), were studied by microscopical and X-ray diffraction methods.

RESULTS OF INVESTIGATION

Spectrochemical Analysis

The elements present in the head sample, as determined by a semi-quantitative spectrochemical analysis, are given in Table 1.

TABLE 1

Elements in Head Sample of Oxide Tin Ore from Bolovia*

Element	Amount Present (see Legend)
Fe	A
Si	A
Al	B
Pb	C
Sn	C
Mg	C
Na	C
Ti	C
Sr	C
Ba	D
Mn	D
B	D
Cr	D
Ca	D
Ni	D
Cu	E
Ag	E
V	E
Zr	E
Ga	E
Mo	tr
As	tr
Sb	ND
Bi	ND
Zn	ND
Co	ND

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
ND = not detected

*Analysis by E.M. Kranck, Report SL-63-077, Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch.

Mineralogy

General Mineralogy

The hand specimens of the tin oxide ore are samples of a weathered, vesicular and fragmental, porphyritic rock. The metallic minerals in this ore are cassiterite (SnO_2), pyrite (FeS_2), galena (PbS), boulangerite ($Pb_5Sb_4S_{11}$), magnetite (Fe_3O_4), hematite (Fe_2O_3), sphalerite (ZnS), and pyrrhotite (FeS). The primary non-metallic minerals are quartz (SiO_2), feldspar ($(K,Na)AlSi_3O_8$), chlorite ($(Fe,Mg)_6(Al,Si)_4O_{10}(OH)_8$), fluorite ($CaF_2$), topaz ($(AlF)_2SiO_4$), and tourmaline ($B_3Al_3(AlSi_2O_9)_3(O,OH,F)_4$). The secondary non-metallic minerals are jarosite ($K_2Fe_6(OH)_2(SO_4)_4$), svanbergite ($Sr_2Al_6O_{11}P_2O_5(SO_3)_2.6H_2O$), goethite ($Fe_2O_3.H_2O$) and kaolin ($H_4Al_2Si_2O_9$).

Detailed Mineralogy

Cassiterite

No cassiterite was found in the thin and polished sections of the ore, but it was concentrated from the head sample by means of heavy liquids. It is commonly yellow to buff, but occasionally may be colourless. The grains in the cassiterite concentrate range from about 2 to 200 microns in diameter, and at least half of those in a -100+200 mesh fraction are liberated. The remaining ones are intergrown with jarosite, svanbergite, goethite, hematite, quartz and kaolin.

The -60+80 mesh cassiterite concentrate (sample 3) consists of cassiterite, pyrite, quartz, jarosite, and traces of topaz, chlorite, goethite, hematite, svanbergite, galena, sphalerite, magnetite and pyrrhotite. About half of the cassiterite in this concentrate is liberated (see Figure 1), and the remainder is intergrown with jarosite (see Figure 2), svanbergite, goethite, kaolin, quartz and chlorite. This concentrate was analysed spectrochemically and the results are given in Table 2.

TABLE 2

Semi-Quantitative Spectrochemical Analysis of Sample 3*
(Cassiterite Concentrate)

Element	Weight, per cent (see Legend)
Sn	A
Fe	B
Pb	B
Si	B
As	C
Sb	C
W	C
Al	C
Sr	C
Na	C
Mg	D
Cu	D
Ti	D
Ca	D
Ba	D
Ag	D
B	D
Ga	D
In	D
Ni	E
Zr	E
V	E
Mn	E
Cr	E
Mo	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

* Semi-quantitative spectrochemical analysis by E.M. Kranck, Report SL-63-155, Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch.

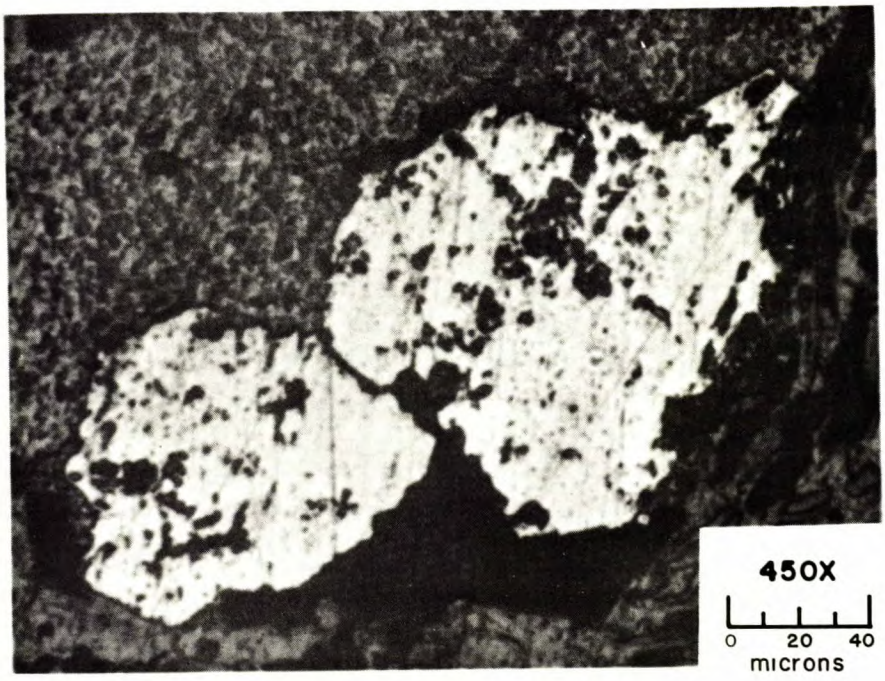

Figure 1. Photomicrograph of a polished section of sample 3 (cassiterite concentrate) showing two freed cassiterite grains. The grey background represents the mounting medium.

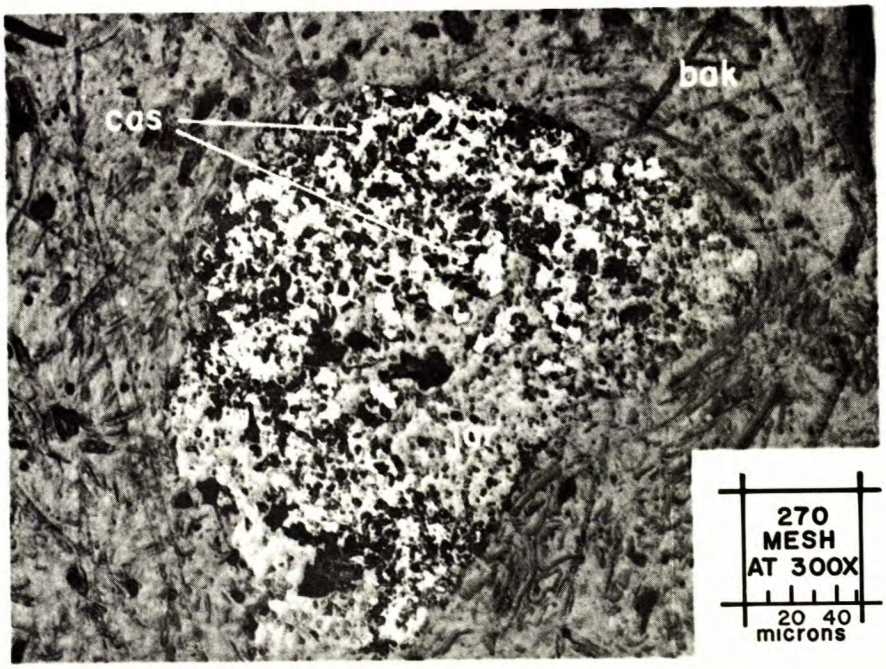

Figure 2. Photomicrograph of a polished section of sample 3 (cassiterite concentrate). It shows cassiterite (cas) intergrown with jarosite (jar). The grey background (bak) represents the mounting medium.

Pyrite, Galena, Boulangerite, Magnetite, Sphalerite and Pyrrhotite

Minute grains of pyrite, galena, boulangerite, magnetite and sphalerite are present in the less porous material. The magnetite and pyrite are partially oxidized to goethite. The sphalerite contains minute exsolutions of pyrrhotite.

Quartz

Quartz is the principal constituent in the fine grained matrix of the rock, but also occurs as phenocrysts, geodes and quartz veins. The quartz in the matrix of the rock contains minute inclusions of iron oxides and kaolin, whereas that in the phenocrysts, geodes, and quartz veins is generally free of impurities.

Feldspar and Kaolin

Feldspar is also a constituent of the fine grained matrix and some of it occurs as phenocrysts. Most of the phenocrysts are altered to kaolin.

Chlorite

Thin sections show that the chlorite is a brown variety that has a very low birefringence. It occurs as small masses (see Figure 3) and occasionally contains some quartz and minute amounts of jarosite.

Fluorite

Variable amounts of fluorite are present throughout the rock.

Topaz and Tourmaline

Small amounts of topaz and tourmaline are present in the rock. The topaz occurs as small grains and the tourmaline as minute radiating crystals (see Figure 4).

Jarosite

The jarosite is a bright yellow mineral that has a yellow streak. It occurs as irregular masses, veinlets and small grains (see Figures 5 and 6). That occurring as irregular masses is intermixed with goethite and hematite, whereas that occurring as veinlets and grains is relatively clean. In some places jarosite forms a coating on quartz grains and under the stereomicroscope these have the appearance of yellow cassiterite.

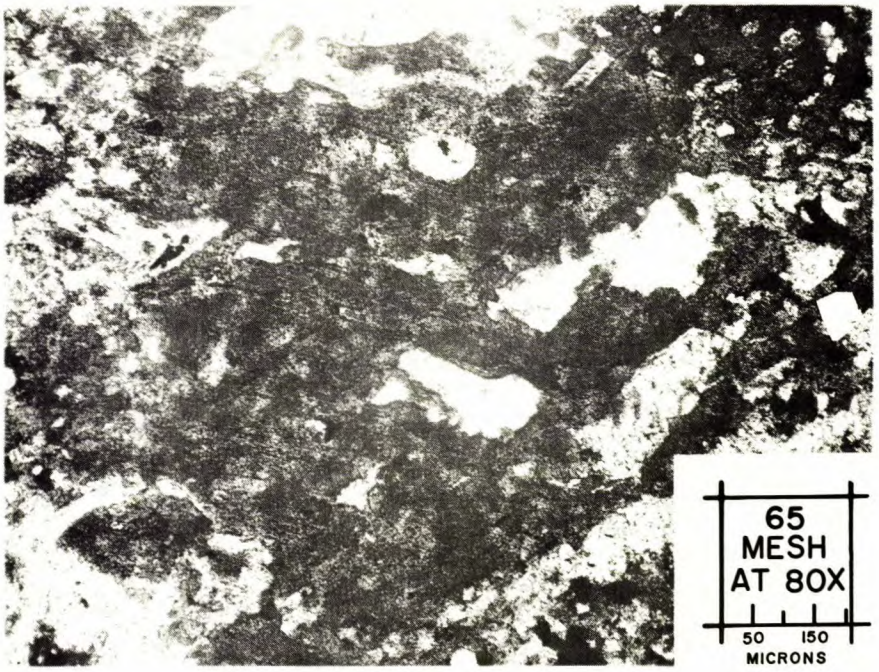

Figure 3. Photomicrograph of a thin section showing a field of massive chlorite (dark grey) and some quartz (white).

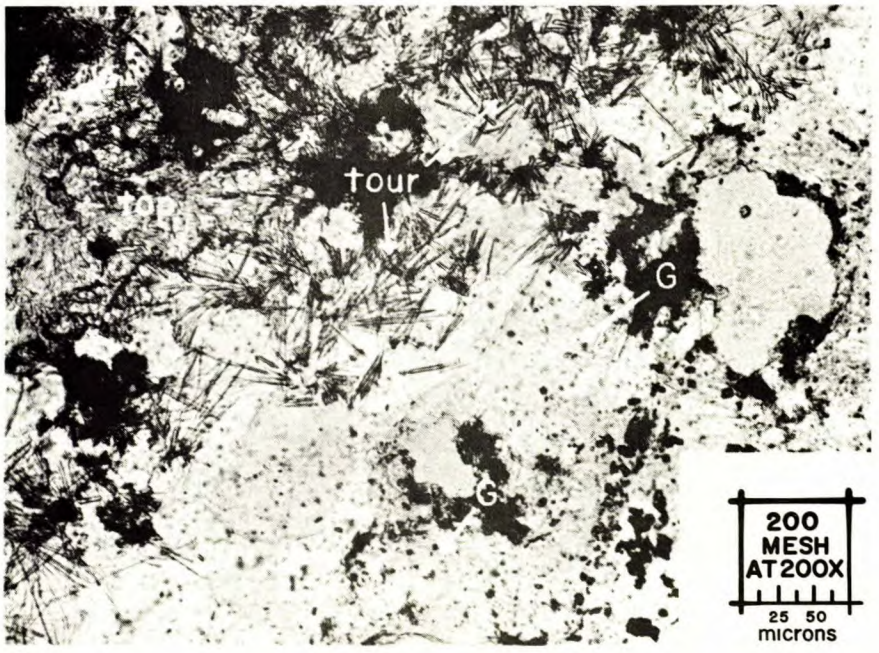

Figure 4. Photomicrograph of a thin section showing (1) topaz (top), (2) minute prismatic crystals of tourmaline (tour) and (3) gangue (G).

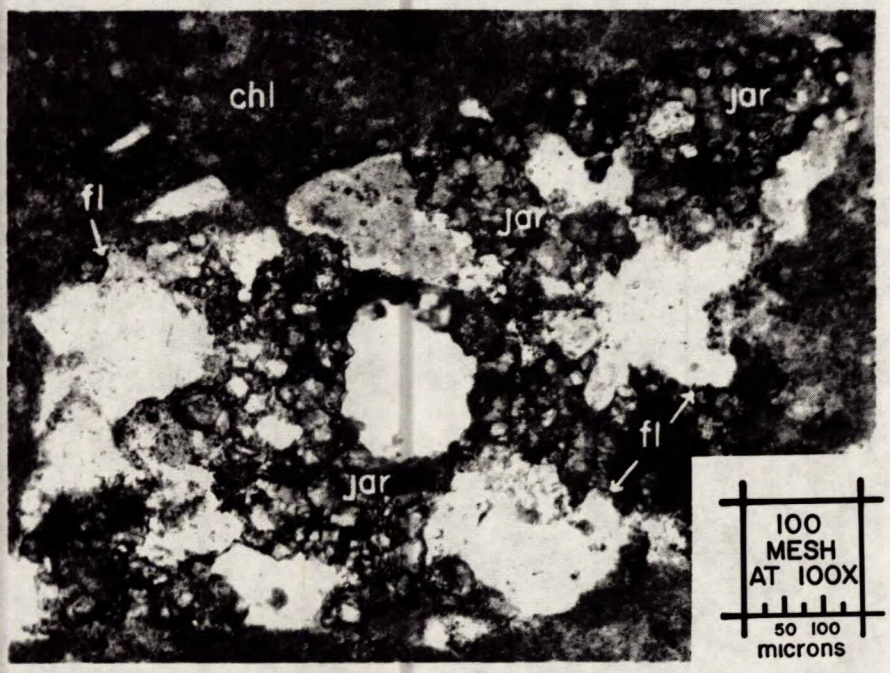

Figure 5. Photomicrograph of a thin section showing jarosite (jar), fluorite (fl) and chlorite (chl) masses.

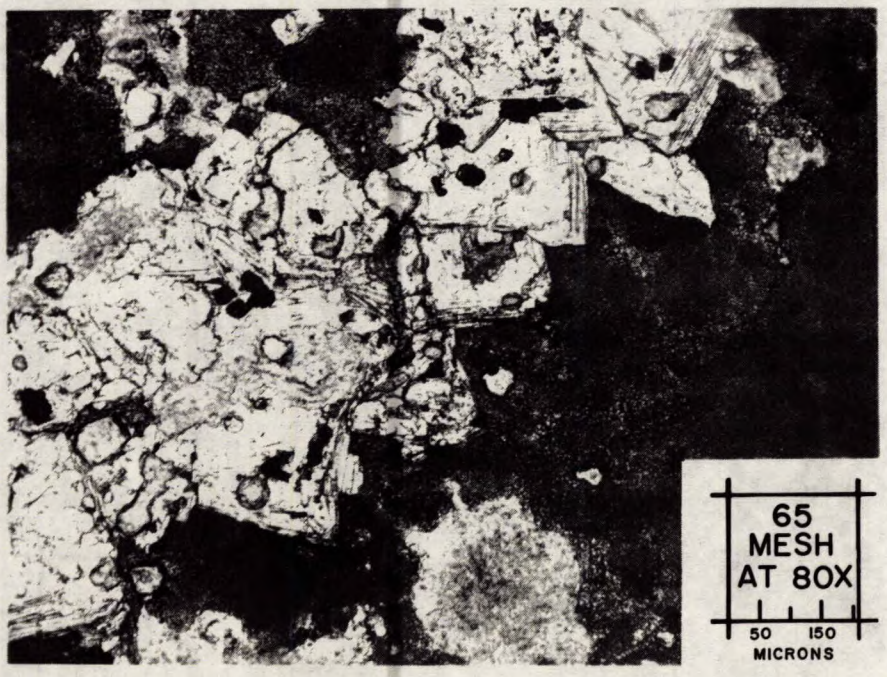

Figure 6. Photomicrograph of a thin section showing massive jarosite (dark grey) and rhombohedral svanbergite crystals (white).

A spectrochemical analysis* of the jarosite shows that it contains Fe, Sn, Ba, As, Pb, and a trace of Ag. X-ray fluorescence** shows that it contains 0.2% Sn, 0.02% Ba and a trace of Ag. Attempts to determine the mode of occurrence of the tin in jarosite proved unsuccessful.

Svanbergite

The svanbergite is a colourless mineral that has a specific gravity of about 3.5. It occurs as well formed rhombohedral crystals and is most abundant in jarosite (see Figure 6).

Goethite

Goethite is a fine grained yellow mineral. In hand specimens its physical properties are similar to those of jarosite and frequently it is difficult to distinguish these minerals. Microscopical studies show that the goethite occurs as masses and veinlets throughout the rock (see Figure 7).

Hematite

A small amount of hematite is occasionally present as a red stain on goethite.

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* Semi-quantitative spectrochemical analysis by E.M. Kranck, Report SL-63-126, Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch.

** Analysis by D.J. Reed, Report SL-63-157, Analytical Chemistry Sub-Division, Mineral Sciences Division, Mines Branch.

Figure 7. Photomicrograph of a thin section showing goethite (black) in gangue (white).

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