Mines Branch Information Circular IC 288

MINERALOGICAL INVESTIGATION OF AN ANTIMONY-ARSENIC ORE FROM THE CARD LAKE COPPER MINES LIMITED, TIMMINS AREA, ONTARIO

by

R. G. Pinard*

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SUMMARY OF RESULTS

A mineralogical study was made on samples from an antimony-arsenic deposit located 35 miles west of Timmins, Ontario and four miles south of Highway 101. The results show that the samples contain antimony and arsenic minerals in silicates. The main antimony mineral is berthierite and the main arsenic mineral is arsenopyrite. The berthierite is present as relatively large grains and the arsenopyrite as clusters of minute grains. Other significant antimony minerals are stibnite, native antimony, and the oxides - valentinite, romeite, and an unidentified oxide. Other minerals found in the samples are pyrrhotite, chalcopyrite, ullmannite, tetrahedrite, tennantite, pyrite, marcasite, covellite, and scorodite. The gangue consists of quartz, chlorite, mica, amphibole, sphene, and dolomite.

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Direction des Mines

Circulaire d'information IC 288

RECHERCHE MINÉRALOGIQUE D'UN MINERAI D'ANTIMOINE-ARSENIC DE " CARD LAKE COPPER MINES LIMITED" DE LA RÉGION DE TIMMINS, ONTARIO

par

R. G. Pinard*

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Résumé des Résultats

L'auteur a fait une étude minéralogique sur les échantillons d'un gisement d'antimoine-arsenic situé à 35 miles à l'ouest de Timmins, Ontario et à 4 miles au sud de la route 101. Les résultats indiquent que les échantillons contiennent des minéraux d'antimoine et d'arsenic dans les silicates. Le minéral principal d'antimoine est la berthiérite et le minéral principal d'arsenic est l'arsénopyrite. La berthiérite est présente sous forme de grains relativement gros et l'arsénopyrite sous forme de groupe de grains minutieux. Les autres minéraux importants d'antimoine sont la stiblite, l'antimoine natif et les oxydes de valentinite et de roméite et un oxyde non identifié. Les autres minéraux trouvés dans les échantillons sont la pyrrohotine, la chalcopyrite, l'ullmannite, la tetraédrite, la tennantite, la pyrite, la marcasite, la covelline et la scorodite. La gangue se compose de quartz, de chlorite, de mica, d'amphibole, de sphène et de dolomite.

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INTRODUCTION

Several hand specimens of mineralized rock were collected from an antimony-arsenic deposit near Timmins, Ontario by Dr. W. Petruk, Group Leader, Mineralogy Group, Mineral Sciences Division, Mines Branch in October, 1971. This deposit, currently being investigated by Card Lake Mines Limited, is located about 35 miles west of Timmins and is about 4 miles south of Highway 101. The mineralization occurs in a shear zone in rhyolite. Hand specimens showing two types of mineralization were taken from this shear zone at surface. Specimens with one type of mineralization are large, irregular, and partly oxidized. The oxidized parts consist of brownish yellow material as layers up to $\frac{1}{2}$ inch thick on sample surfaces and of red films on the ore mineral grains. The ore minerals are present as masses and disseminated grains in a siliceous gangue and are steel grey, bronze, and iridescent on relatively fresh surfaces. Specimens with the other type of mineralization have the appearance of a very fine-grained interlayered schistose rock. Some layers are steel grey and give a black streak when scratched whereas others are light grey. The steel grey layers are coated with red, yellow, and green films in some places.

The specimens were studied by using an ore microscope, X-ray diffraction, and the electron microprobe to identify the minerals and to determine their textural relations. The results are published with the agreement of Mr. A. Wright, President of the Company, to make data on this deposit readily available.

RESULTS OF INVESTIGATION

The specimens contain antimony, arsenic, copper, and iron minerals in non-metallic gangue. The antimony minerals are berthierite, stibnite, native antimony, ullmanite, tetrahedrite, valentinite, romeite, and an unidentified red antimony oxide; the arsenic minerals are arsenopyrite, tennantite, and scorodite; the copper-bearing minerals are chalcopyrite, tetrahedrite, tennantite, and covellite; and the iron-bearing minerals are pyrrhotite, pyrite, and marcasite. The non-metallic gangue minerals are quartz, chlorite, siderite, mica, amphibole, sphene, and dolomite. The most abundant ore minerals are berthierite and arsenopyrite, and the main non-metallic mineral is quartz. The berthierite is generally coarse-grained, and the arsenopyrite is fine-grained.

The large irregular specimens consist of berthierite in quartz and contain some arsenopyrite and the copper and iron sulphides (Figure 1). The steel-grey schistose rock consists largely of arsenopyrite in a quartz-rich gangue and contains some berthierite and other minerals (Figure 2). The brownish yellow oxidized material consists largely of quartz, chlorite, and oxides; the red film is the unidentified antimony oxide; and the green and yellow films are scorodite.

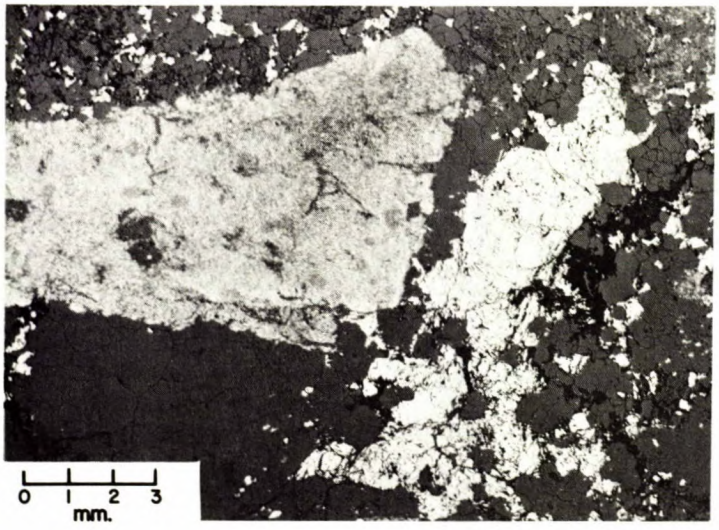

Figure 1. Photomicrograph of a polished section of a large irregular grain showing berthierite (white) and a cluster of fine-grained arsenopyrite (light grey). The matrix is quartz (dark grey) and the black areas are polishing pits.

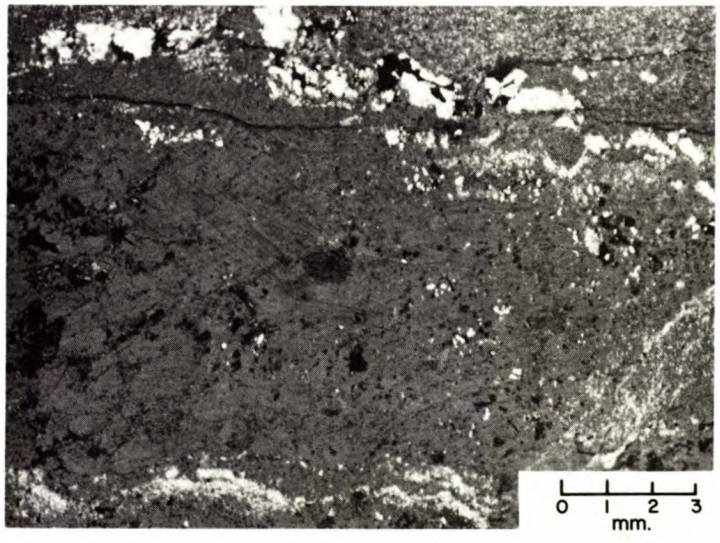

Figure 2. Photomicrograph of a polished section of the schistose rock showing a wide layer of siliceous gangue in the middle and layers of the steel grey material at the top and bottom. The steel grey layers consist largely of fine-grained arsenopyrite (light grey) although the one at the top of the photograph also contains large berthierite grains (white).

Antimony Minerals

(a) Berthierite ($FeSb_2S_4$)

Berthierite is steel grey in hand specimens and is iridescent after tarnishing. It is the main antimony mineral in the samples studied and it occurs as discrete grains between 1 centimetre and 5 microns in diameter (Figure 1). Most of the grains are free of intergrowths and inclusions, although a few contain euhedral arsenopyrite crystals (Figure 3), and some are surrounded and partly replaced by valentinite. It is expected however, that valentinite does not occur below the zone of surface oxidation. Tests with a Frantz isodynamic separator show that the magnetic susceptibility of berthierite is higher than for most of the other minerals in the ore. This factor may be significant for mineral beneficiation.

(b) Stibnite (Sb_2S_3)

A small amount of stibnite is present in specimens containing significant amounts of berthierite. The mineral occurs as prismatic grains, 20 to 200 microns wide, in gangue (Figure 4). Most of the grains are free of inclusions, although a few containing berthierite inclusions were found.

(c) Native Antimony (Sb)

A few small irregular grains of native antimony were found in all specimens that contained berthierite and appeared to be associated with the mineral (Figure 5). Most of the native antimony grains are partly replaced by valentinite.

(d) Ullmannite (NiSbS)

A few ullmannite grains, smaller than 25 microns in diameter, were found as inclusions in pyrrhotite. They were identified by means of the electron microprobe.

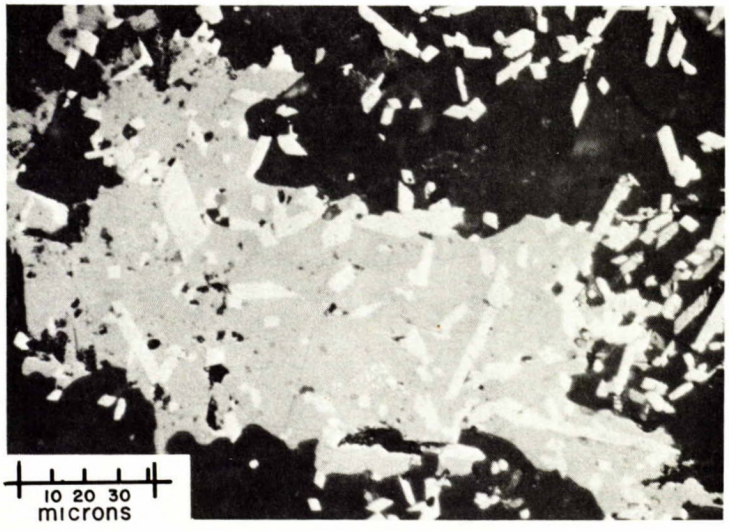

Figure 3. Photomicrograph of a polished section showing arsenopyrite crystals (white) in berthierite (light grey) and quartz (dark grey).

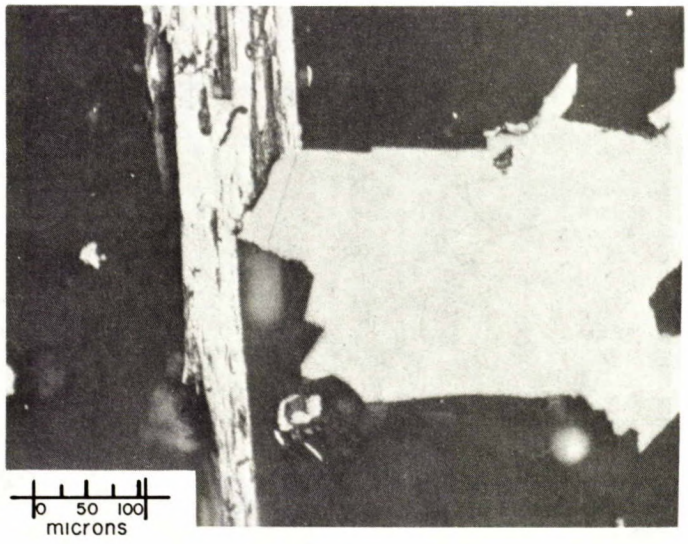

Figure 4. Photomicrograph of a polished section in oil immersion showing two stibnite grains. The elongated grain has small inclusions of berthierite.

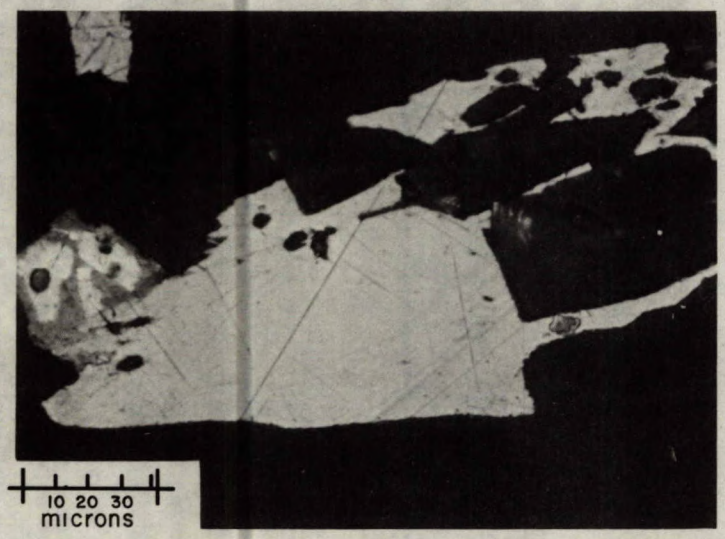

Figure 5. Photomicrograph of a polished section showing remnants of native antimony (white) in valentinite (dark grey). The large grain is berthierite (grey) and the black matrix is quartz.

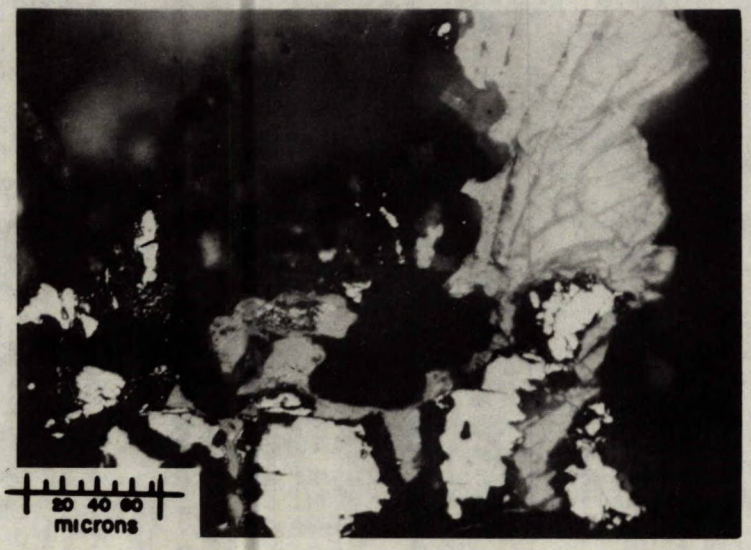

Figure 6. Photomicrograph of a polished section in oil immersion of valentinite (light grey and whitish streaked areas) and berthierite (white). The black area is gangue.

(e) Tetrahedrite $(Cu, Fe, Zn, Ag)_{12}Sb_4S_{13}$ and Tennantite $(Cu, Fe, Zn, Ag_{12}As_4S_{13}$

A few grey grains were found in an ore mineral concentrate that was prepared by crushing some specimens and separating them into fractions by means of heavy liquids. Some grey grains were identified as tetrahedrite by means of the electron microprobe others were identified as tennantite by X-ray diffraction. It is suggested that the tetrahedrite is associated with the antimony minerals and tennantite with arsenopyrite.

(f) Valentinite (Sb_2O_3)

Valentinite is the main antimony oxide mineral found in the partly weathered parts of the specimens. It occurs as replacements of berthierite, stibnite, and native antimony (Figures 5 and 6). The mineral is white in hand specimens. Hand specimens of intensely weathered surfaces are brownish yellow which indicates that the mineral is rare in intensely weathered material.

(g) Romeite $(Ca, Fe, Mn, Na)_2(Sb, Ti)_2O_6(O, OH, F)$

Romeite is yellow in hand specimens. It was found in polished sections of partly weathered specimens as small masses surrounding colloform scorodite grains (Figure 7). It is judged that some romeite may be present in the yellow oxidized coating on the hand specimen although none has been identified.

(h) Unidentified Antimony Oxide

A red antimony oxide is present on partly weathered surfaces of the hand specimens. This mineral was not identified because it was amorphous to X-rays and was unstable when excited by the electron beam of the microprobe. Partial analysis with the electron microprobe, however, indicate that it is an antimony oxide.

Figure 7. Photomicrograph of a polished section in oil immersion of coloform scorodite (white) in romeite (grey). The black areas are gangue and polishing pits.

Figure 8. Photomicrograph of a polished section showing fine-grained euhedral arsenopyrite (white) in gangue (black).

Arsenic Minerals

(a) Arsenopyrite FeAsS

Arsenopyrite is the main arsenic mineral in the samples. It occurs in both the large irregular berthierite-rich specimens (Figure 1) and in the interlayered schistose rock (Figure 2). The mineral is present as clusters of minute euhedral arsenopyrite grains (Figure 8). Most of the arsenopyrite grains are between 5 and 40 microns in diameter and are embedded in a quartz-rich matrix, though a few 200-micron grains were found.

(b) Tennantite $(Cu, Fe, Zn, Ag)_{12}As_4S_{13}$

See tetrahedrite.

(c) Scorodite $FeAsO_4 \cdot 2H_2O$

Scorodite is leaf-green to liver-brown in hand specimens and undoubtedly produces the green and yellow stains. Some was found in polished sections of the oxidized parts of the specimens as colloform grains surrounded by romeite (Figure 7).

Copper Minerals

A few minute grains of chalcopyrite, covellite, tetrahedrite, and tennantite were found in polished sections of the hand specimens and in ore mineral concentrates that were prepared from the samples.

Iron Minerals

(a) Pyrrhotite ($Fe_{1-x}S$)

Some pyrrhotite was found as disseminated grains in gangue. Some of these grains contain ullmannite inclusions.

(b) Pyrite (FeS_2) and Marcasite FeS_2

A few small masses and disseminated grains of pyrite are present in specimens containing berthierite. The pyrite contains irregular grains of marcasite (Figure 9).

RELATIVE PROPORTIONS OF MINERALS IN SPECIMENS STUDIED

The generalized mineralogical composition of the specimens was determined by preparing a series of mineral concentrates and identifying the minerals in each one. Representative pieces sawn from the hand specimens were crushed and screened and the 65 to 200-mesh fraction was separated into sub-fractions by means of heavy liquids (specific gravities of 2.96, 3.33, and 3.70) and a Frantz isodynamic separator (Table 1).

TABLE 1

Results of Heavy Liquid and Magnetic Separations

Sub-fraction	Wt %	Minerals
2.96 float	79.5	quartz, chlorite, mica, dolomite
3.33 float	8.2	middling particles plus amphibole and sphene
3.70 float	1.9	middling particles
3.70 sink, hand magnetic	0.5	pyrrhotite and ullmannite
3.70 sink, 0.4 amps	0.1	oxides
3.70 sink, 0.6 amps	6.2	berthierite
3.70 sink, 0.8 amps	0.8	oxides
3.70 sink, 1.0 amps	0.2	tetrahedrite
3.70 sink, 1.2 amps	0.2	tennantite
3.70 sink, 1.4 amps	0.11	chalcopyrite and oxides
3.70 sink, non-magnetic	2.3	arsenopyrite, pyrite, marcasite, stibnite, and native antimony
Total	100.0	

The results show that the sample contains over 6 per cent berthierite and that the mineral has a relatively high magnetic susceptibility. On the other hand, the arsenopyrite, the other main ore mineral in the sample, is non-magnetic.

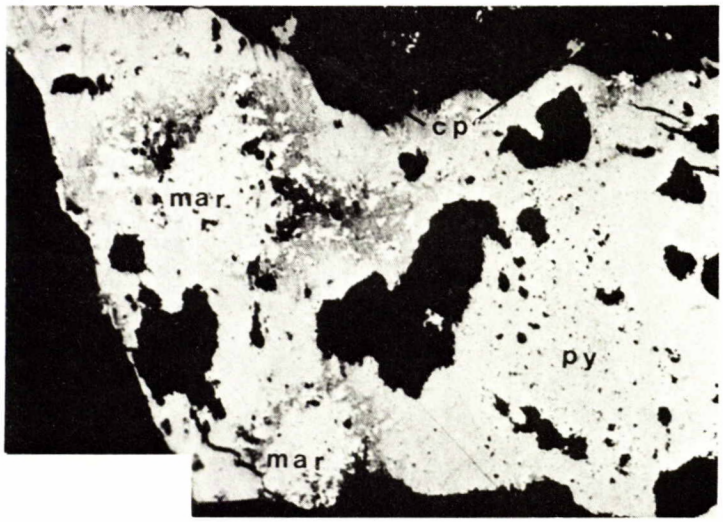

Figure 9. 100X. Photomicrograph of a polished section showing pyrite (light grey) with marcasite inclusions (white) and two small grains of chalcopyrite (dark grey). The black areas are gangue and polishing pits.