The Occurrence of Aurostibite in the Gwanda District, Southern Rhodesia

By H. V. Eales, Ph.D., A.M.I.M.M.

[Plate I]

ABSTRACT

Aurostibite, $AuSb_2$, has been found as minute grains intimately associated with gold in the Lone Hand and Jessie mines in the Gwanda district. In its manner of occurrence, physical properties and etch reactions it closely resembles the type material discovered in the Giant Yellowknife and Chesterville mines, Canada, except that it tarnishes more rapidly. Identification has been confirmed by X-ray and micro-probe analyses, the latter technique having also indicated the presence of an unknown nickel-antimony mineral in the Lone Hand ore.

INTRODUCTION

The first reference to the natural occurrence of the rare mineral aurostibite, $AuSb_2$, was made by Graham and Kaiman (1952), who described its occurrence in the Giant Yellowknife mine, Northwest Territory, and in the Chesterville mine, Ontario. Prior to this, only the artificial compound was known. The manner of occurrence of the mineral, its physical properties, reaction with etch reagents and the crystallography, from X-ray data, were described by these authors.

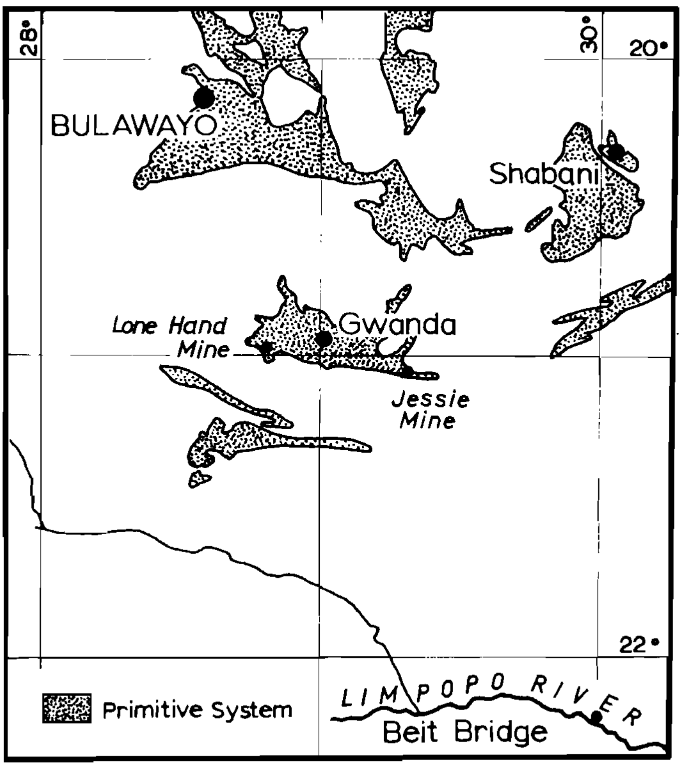


Fig. 1 Map showing location of the Lone Hand and Jessie Mines.

During the present writer's examination of gold ores from the Lone Hand and Jessie mines, Gwanda district, Southern Rhodesia (Eales, 1960), the presence was noted of minute grains of a mineral which corresponds very closely with the material described by Graham and Kaiman. Its finely divided form rendered identification by normal chemical methods impossible. A polished specimen containing this material was subsequently examined by Dr. M. H. Haycock, of the Department of Mines and Technical Surveys, Ottawa, who reported that the X-ray diffraction pattern given by a minute sample drilled from the specimen showed only one definite line which could be attributed to aurostibite and that positive identification could thus not be made.

The subsequent preparation of a number of polished sections failed to reveal any large grains of the suspected aurostibite, but three tiny grains of gold intimately intergrown with the same material were picked out of a polished, mounted concentrate. During the crushing of this tiny sample in a small ball of rubber solution the gold was squeezed out. An X-ray powder photograph of this mount showed sixteen definite lines attributable to aurostibite and gave the cell edge as 6·66 A°, agreeing with the published value of 6·659 A° (Berry and Thompson, 1962).

A micro-probe analysis carried out by the Bureau de Recherches Géologiques et Minierès in Paris finally confirmed the identity of the mineral and showed that the composition of the material from the Lone Hand mine agrees very closely with the theoretical composition, $AuSb_2$.

MANNER OF OCCURRENCE

The Lone Hand deposit is a steeply dipping zone of silicification and sulphide mineralization between three and ten feet wide, occurring in quartz-schist. The better ore is a schistose quartz-sericite rock in which sulphides occur very sparingly and are so fine in grain as to be almost invisible to the naked eye. Individual samples of this have been found to contain up to 18 ounces of gold per ton. Other sections of the reef may consist almost entirely of coarsely crystalline sulphides, but this does not constitute ore for little gold occurs in it. The reef has yielded an average of 6·5 dwt. gold per ton down to the 11th level.

The microscope shows the presence of arsenopyrite, pyrite, abundant pyrrhotite, chalcopyrite (with exsolved lamellae of cubanite), sphalerite and tetrahedrite. The last-named is more common in the richer schistose ore, where it occurs as discrete masses up to 150 microns across, or replacing chalcopyrite or arsenopyrite. Gold occurs sparsely in cracks in the interiors of pyrite crystals in the coarse-grained sulphide ore, in which case it is pale yellow in colour, indicating a high content of silver. Purer gold having a rich yellow colour is abundant in the schistose type of ore, commonly associated with tetrahedrite and aurostibite. The latter, even where present in finely divided form and in minute quantities, is easily detected after immersing the polished specimen in a 20 per cent KOH solution for 10–15 seconds, which has the effect of staining the aurostibite a distinctive reddish-brown. The largest grain found in any of the polished surfaces measured 50×30 microns. Commonly it occurs as vermicular blebs measuring about 5×20 microns, replacing pyrrhotite (Plate I, Fig. 1) or, more rarely, chalcopyrite. Arsenopyrite has in places also been replaced (Plate I, Fig. 2) but its common associate is gold. It is undoubtedly a mineral late in the paragenesis, as it partly rims gold, forming a crust a few microns thick (Plate I, Fig. 3) or replaces gold. Discrete grains are not common.

The occurrence in the Jessie mine is very similar to that in the Lone Hand mine. This deposit is a vein of bluish-grey or black granular quartz in hornblende-schist, and has yielded close on 4 dwt. gold per ton. Specimens collected while development was proceeding on the 17th level show an assemblage of minerals rather similar to that in the Lone Hand mine. Arsenopyrite, pyrite and pyrrhotite are common. The younger sulphides include chalcopyrite with cubanite, sphalerite, galena, tetrahedrite and possibly tiny amounts of pyrargyrite. A few grains of native antimony were found in polished, mounted concentrates but none was detected in the polished ore specimens. In many specimens gold is abundant. Aurostibite occurs only as exceedingly minute grains, invariably in intimate association with the gold. It is significant that some of the purer gold in the ore appears to be younger than the aurostibite, for the latter has been found to occur almost wholly surrounded by gold (Plate I, Fig. 4). Its occurrence in this form has not been recorded at the Giant Yellowknife mine (Coleman, 1957, p. 415) and would appear to refute Coleman's suggestion that aurostibite "has formed by reaction of antimonial solutions with gold that was already in the solid state."

PHYSICAL PROPERTIES

The properties of the type material and that from the Lone Hand mine are compared in Table I.

TABLE I

COMPARISON OF PROPERTIES OF AUROSTIBITE FROM THE LONE HAND MINE AND THE TYPE MATERIAL

Property	Type Material	Lone Hand Material
Colour	galena-white	galena-white
Hardness	C— (slightly harder than gold)	about the same as gold
Anisotropism	not stated	isotropic
Cleavage	no cleavage	no cleavage detected
HNO_3 (1:1)	rapidly acquires iridescent coating	rapidly turns iridescent red-brown
HCl (1:1)	dark brown stain	dark brown stain
$FeCl_3$ (20%)	immediately acquires iridescent coating	immediately acquires iridescent coating
KOH (40%)	slowly acquires light brown coating and polishing scratches are accentuated	rapidly stains reddish-brown
KCN (20%)	no reaction	negative—faint stain after long standing
$HgCl_2$ (5%)	no reaction	negative—faint stain after long standing

No grains were of sufficient size to allow the accurate determination of a value for reflectivity. This value is, however, moderately high. As Graham and Kaiman have pointed out, the behaviour with the standard etch reagents introduces a new category into Short's determinative tables (Short, 1940); no other mineral exhibits a similar combination of reactions. A feature which at first led to some confusion in the case of the Lone Hand material is its extraordinarily rapid rate of tarnish under certain conditions. Specimens polished with ¼-micron diamond grit and cleaned with carbon tetrachloride have been allowed to stand for 3–4 days, during which time no tarnishing of the aurostibite has been detected. Within minutes of burnishing with magnesium oxide and water, the same grains have tarnished to bornite-pink and then reddish-brown. The application to the surface of a drop of the weakly alkaline solution produced by shaking magnesium oxide with water gives the same result. Further experiment showed that even distilled water produces in some grains a patchy tarnish close to contacts with gold. Dr. Haycock (personal communication) has stated that no such tarnish has been observed in any of the type material.

COMPOSITION

A micro-probe analysis of the minerals in the intergrowth shown in Plate I, Fig. 3, was performed at the Bureau de Recherches Géologiques et Minières, and the writer is indebted to Dr. M. Capitant for the following data. The sample analyzed is from the Lone Hand mine.

The composition of the aurostibite forming a thin skin around a grain of gold (Plate I, Fig. 3) was found to be:

Au	$43{\cdot}5 \pm 0{\cdot}5$ per cent
Sb	$55{\cdot}5 \pm 1$ per cent
Ni	of the order of 1 per cent.

This is in close agreement with the theoretical composition of aurostibite (Au 44·7 per cent). Silver was looked for but was not detected. In a second grain analyzed exactly the same ratio of Sb/Au of 1·28 was found.

The gold grain which is partially enclosed by aurostibite (Plate I, Fig. 3) was determined to contain 87 per cent of gold, the remainder being silver and a trace of nickel. This agrees well with the 1000 Au/(Au+Ag) values for gold recovered at the mine and in laboratory samples, in which the fineness ranges from 875 to 985.

The two small patches of an unknown mineral indicated in Plate I, Fig. 3, were shown by the micro-probe to contain only the elements nickel and antimony, but their restricted size rendered a quantitative analysis impossible. The optical properties do not appear to correspond with those of breithauptite and a new species is indicated.

ACKNOWLEDGMENTS

I am sincerely grateful to Dr. C. Guillemin and his colleagues for undertaking the micro-probe analysis and reporting so fully on their findings. I offer my thanks also to Dr. M. H. Haycock for examining the specimen sent to him in 1960, and to Mr. G. S. Woods of the Department of Chemistry at Rhodes

University for preparation of the X-ray powder photographs. Warm thanks are also due to Prof. Edgar D. Mountain for his keen interest and for criticism of this manuscript.

REFERENCES

BERRY, L. G. and THOMPSON, R. M. (1962). 'X-ray powder data for ore minerals: the Peacock atlas'. *Geol. Soc. Amer., Memoir* 85.

COLEMAN, L. C. (1957). 'Mineralogy of the Giant Yellowknife mine'. *Econ. Geol.*, Vol. 52, pp. 400–425.

EALES, H. V. (1960). Unpublished thesis. Rhodes University.

GRAHAM, A. R. and KAIMAN, S. (1952). 'Aurostibite, $AuSb_2$, a new mineral in the pyrite group' . *Amer. Min.*, Vol. 37, pp. 461–469.

SHORT, M. N. (1940). 'Microscopic determination of the ore minerals'. *U.S. Geol. Surv. Bull.* 914.

DEPT. OF GEOLOGY,
RHODES UNIVERSITY, GRAHAMSTOWN, C.P.

Accepted for publication by the Society
on 4th August, 1962.

ADDENDUM

After submitting the manuscript of the paper above, I received a report on the results of an X-ray powder diffraction analysis very kindly carried out at the Department of Mines and Technical Surveys, Ottawa, on a sample supplied by me at an earlier date (J. M. Stewart, 1962). Using a camera of 114·6 mm. radius and exposing for 12 hours with copper radiation, the average value of the cell edge was determined as 6·65A.

STEWART, J. M. (1962). "The X-ray identification of aurostibite from South Africa." *Canada, Dept. Mines, Rept.* IR 62–33.

EXPLANATION OF PLATE I

FIG. 1

Blebs of aurostibite (deeper grey) stained with 20 per cent KOH solution, and tiny grains of gold (white) replacing pyrrhotite (lighter grey) in the centre of the field. The pyrrhotite is in contact with a large grain of chalcopyrite (grey) on one side and gold (white) on the other. Lone Hand mine. x360.

FIG. 2

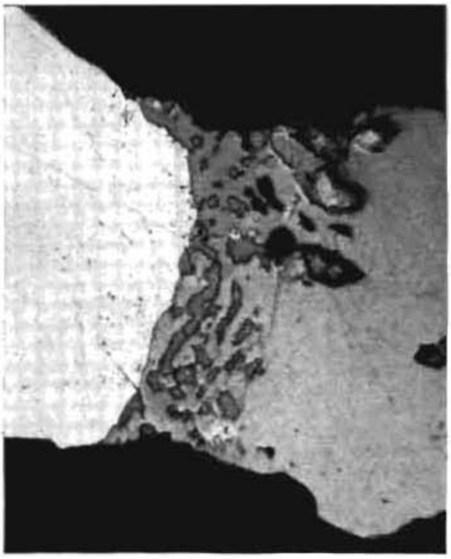
Arsenopyrite crystal (white) partly replaced by aurostibite (grey) stained with 20 per cent KOH solution. Remainder of the field is quartz (black). Lone Hand mine. x360.

FIG. 3

Aurostibite (medium grey, lower left) partly rimming a grain of gold (lighter grey) and enclosing two small grains of an unknown mineral (darker grey) shown by the microprobe to be composed of nickel and antimony. Lone Hand mine. x350.

FIG. 4

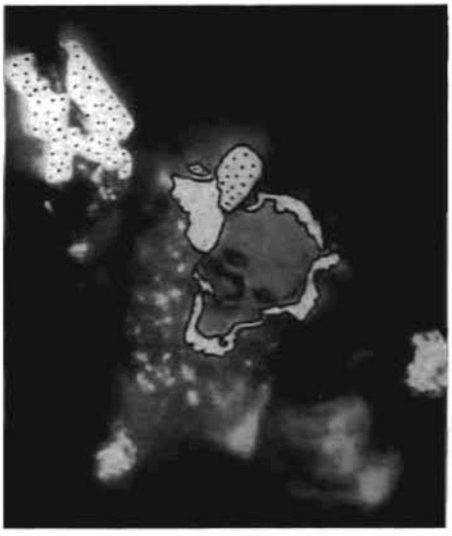
Aurostibite (light grey) in the centre of the field, almost completely rimmed by gold (white). Remainder of the field is arsenopyrite (stippled) and quartz (black). Light-coloured patches in quartz are caused by reflections from minerals a little below the polished surface. Jessie mine. x750.



1

2

3



4