A LABORATORY INVESTIGATION OF SULPHIDE SPECIMENS FROM THE RUBY GROUP OF MINERAL CLAIMS, OMINECA MINING DIVISION BRITISH COLUMBIA

A report submitted in fulfilment of the requirements of Geology 409, part of the course in Geological Engineering leading to the degree of Bachelor of Applied Science at The University of British Columbia

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ABSTRACT

A micro examination of specimens from the Ruby Group was conducted to determine the minerals present, their mutual relationship, paragenesis, and to classify the type of deposit. The minerals in their possible sequence of deposition are molybdenite, sphalerite, pyrite, chalcopyrite, galena, tetrahedrite, arsenopyrite, pyrargyrite, polybasite, and native silver. These minerals and their mode of occurrence indicate a hypogene mesothermal deposit.

INTRODUCTION

The Ruby group of mineral claims, owned by Consolidated Mining and Smelting Company, is on Jimmay Creek, a small tributary of May Creek in the southeast corner of the Aiken Lake map-sheet. The location is approximately 56° 13' North and 125° 10' West. The sheet is within the Omineca Mining Division. The claims were staked in 1944. Exploratory work, consisting mainly of surface stripping by hydraulicking and bulldozing, was done in 1945 and 1946.

Exposed bedrock is mainly quartz-mica schists of the Ruby group of Late Proterozoic age. Stocks and sills of quartz-feldspar porphyry intrude the schists. The mineral showings occur along a zone of intense faulting and shearing that strike north 35° east and dips about 55° southeast. Branch faults or shears trend north 25° west and north 75° east. All the faults and shear planes have slickensided surfaces coated with graphite, and the rocks themselves have been silicified.

Assays are reported to have shown good silver and fair gold content.

MEGASCOPIC EXAMINATION

About 30 lbs. of hand specimens ranging up to four inches and averaging two inches in diameter comprise the "grab" sample of the Ruby group. These specimens were collected by the writer whilst employed in the area by the Geological Survey of Canada during the 1948 field season. They are essentially quartz healed quartzite breccia and quartz-mica-schist breccia, cut by narrow quartz-sulphide veins. The quartz is massive, white to grey, in stringers up to four inches wide. Small amounts of siderite and possibly calcite occur with the quartz. Much of the carbonate, in euhedral crystals, is cut and brecciated by very narrow seams of a greyish-black material.

Many fractures and surfaces are stained or coated by light yellowish-brown to reddish-brown iron oxides. Fragments of schist vary up to several inches, average one inch in diameter.

Sphalerite

Yellow-brown to brown sphalerite may occur as massive sulphide veins up to one half inch wide, but it generally occurs over a width of two inches in narrow branching quartz veinlets. The sphalerite is fine grain, 1/16 inch to ¼ inch in diameter, in places quite pure, but generally it is intimately associated with galena. In vuggy quartz, the sphalerite occurs in pockets ¼ inch in diameter. Near the border of one sphalerite vein is a narrow elongated void crusted with small euhedral quartz crystals, suggesting fracturing and deposition later than the sphalerite.

Galena

Fine grain galena occurs in lenticular masses up to one inch thick and two inches wide, closely associated with the sphalerite. Maximum grain size is about 1/16 inch. Irregular veinlets of galena in the sphalerite average ¼ inch wide.

Tetrahedrite and Ruby silvers

Pockets of tetrahedrite and ruby silver occur in pockets averaging 1/16 inch in diameter more or less along the center of vuggy quartz seams. Euhedral quartz crystals 1/32 to 1/16 inch thick and 1/8 inch long form a comb structure along these quartz seams. Four such seams occur over a distance of three inches. Sphalerite and galena are absent from these specimens.

Pyrite

Pyrite, common in all specimens, occurs as minute cubes and grains, and in veinlets up to 1/8 inch wide. Individual grains are more common with the sphalerite and galena; veinlets with the ruby silvers.

Molybdenite

Molybdenite is intimately associated with narrow crumbly seams and pockets of mica. No other minerals are associated with it other than the pyrite.

Arsenopyrite

Very narrow (1/32 inches or less) veinlets of arsenopyrite and quartz border and cut the sphalerite.

MICRO-EXAMINATION

A total of 14 polished sections were made and examined. Due to the disseminated character of the ruby silvers, most of the sections were of these minerals. But no new minerals, associations, or occurrences ware noted that are not present in the six sections mentioned in this report.

The following minerals, in the possible sequence of deposition, were determined with the microscope; molybdenite, sphalerite, pyrite, chalcopyrite, galena, arsenopyrite, tetrahedrite, pyrargyrite, polybasite. Gangue consists of carbonate and quartz.

Determination

Molybdenite, sphalerite, pyrite, chalcopyrite, galena and arsenopyrite were readily identified by means of their color, etch reactions, habits and hardness.

Tetrahedrite was determined by color: etch reactions, negative to all except HNO_3 by which it stains iridescent, a few times it slightly stained brown with KCN. It was confirmed by X-ray analysis by Dr. R. Thompson. Pyrargyrite was identified by its distinctive bluish-grey color. It was positive, in most cases brown to iridescent, with H_gCl_2, KOH, KCN and HNO_3. It showed moderately strong anisotropism and red internal reflection.

Polybasite etched positive with H_gCl_2(iridescent-grey), KOH (blue-black) and KCN (blue). Most distinctive was its orange to yellowish-green interference colors. A micro-chemical test on polybasite from section five showed a good copper content.

Native silver was best determined by its tarnish on exposure and white precipitate with HNO_3. It is negative to KOH, KCN and H_gCl_2, but quickly stains brown to iridescent with HCl and $FeCl_3$.

DESCRIPTION

Molybdenite

Molybdenite is associated entirely with white mica. Due to its flaky and micaceous habit, polished sections were difficult to finish; section six has an imperfect polish but shows the molybdenite with imperfect pyrite cubes.

Sphalerite

Sphalerite in veins and masses $\frac{1}{4}$ inch across comprise large portions of sections 1, 2, and 3. Minute specs of sphalerite within galena indicates its replacement by that mineral. It has a pitted survace with numerous small euhedral quartz crystals. Quartz, chalcopyrite, and galena vein the sphalerite.

The sphalerite has a light yellowish-brown internal reflection suggesting only a small iron content. A micro-chemical test also only showed a pink color for iron.

Pyrite

Pyrite is common in all sections. It appears earlier than the other minerals but probably overlapped with them. It may be entirely post-sphalerite. Imperfect, pitted cubes averaging 150 - 200 microns, is its common habit. It occurs within and along the borders of sphalerite, rarely within the galena. It is common with euhedral quartz crystals around the periphery of ruby silver and tetrahedrite.

Chalcopyrite

Chalcopyrite occurs in blebs and veins in the sphalerite or along the sphalerite-galena borders. The widths of the veinlets vary from a few microns up to 100 microns, averaging 40 - 50 microns. Most of the chalcopyrite grains between the galena and sphalerite are solid, but masses just within the galena have been invaded and replaced by the galena giving a graphic texture. No chalcopyrite remains within the larger galena masses.

Galena

Galena occurs in irregular masses and veins up to $\frac{1}{4}$ inch wide in the sphalerite. In places, minute triangular pits and cleavages form sinuous strain lines, indicating post-galena stress. A light etch with HCl shows numerous parallel inclusions of tetrahedrite and pyrargyrite within the galena. Sphalerite blebs within the galena are very irregular.

Arsenopyrite

Arsenopyrite occurs in euhedral diamond crystals in narrow quartz veins which cut the sphalerite and, in places, the galena. These crystals average 10 - 20 microns, some prismatic crystals are 50 microns in length. No arsenopyrite occurs with the ruby silver minerals.

Tetrahedrite

Tetrahedrite is best seen in section 4. It occurs in grains up to 1 mm. in diameter, averaging 20 - 30 microns. Minute euhedral quartz crystals and pyrite border these grains. This, as in hand specimens, indicate deposition in vugs. Tetrahedrite also occurs in minute, parallel, elongated particles along fractures or cleavage planes in the galena. Many of these stringers of inclusions are parallel to the galena-sphalerite borders and may suggest replacement along fractures rather than along cleavage planes.

Pyrargyrite

Pyrargyrite occurs in minute blebs averaging 30 microns within the tetrahedrite, or in masses up to 100 microns, filling small fractures along with the tetrahedrite.

Polybasite

Polybasite was not identified in association with tetrahedrite, but occurs in grains up to 1/16 inch across in section 5.

Silver

Silver occurs within the tetrahedrite in very small amount and size, averaging 30 microns, maximum grains about 100 microns.

DESCRIPTION of MICROPHOTOGRAPHS

All of the minerals, occurrences and associations are illustrated in the photographs. An outline diagram of the section and a small circle indicates the relative position of the view represented by the photograph. Scale is indicated by a 500 micron square, or a 100 micron line. Magnification for each photograph is given. All exposures were five seconds with a blue filter, high power objective and 10X ocular. LI microscope was used throughout..

Fig. 1

Chalcopyrite vein filling fracture in sphalerite and terminated by later galena. Clearly shows sequence from sphalerite, chalcopyrite to galena. Euhedral quartz crystals are shown in the galena.

Fig. 2.

Graphic texture of chalcopyrite in galena, showing replacement of the former by the latter. Sphalerite with quartz gangue surrounds the galena. Shows caries texture with galena convex towards the chalcopyrite.

Fig. 3

Contains sphalerite, chalcopyrite, galena, quartz and arsenopyrite. Shows caries texture between sphalerite and chalcopyrite, chalcopyrite and galena, and galena and sphalerite. Galena is advancing from the bottom of the picture, replacing the chalcopyrite, and sphalerite. Some portions of the galena-sphalerite contact are straight, indicating control by fracture or crystallographic plane. Most curved areas are convex to the sphalerite, but a few places the curvature is convex towards the galena. This reverse caries texture is common along replacement borders of galena and sphalerite. (Edwards, p. 107).

A late phase of quartz and arsenopyrite cut across the galena and sphalerite. The arsenopyrite is closely associated with the quartz but was evidently deposited towards the end of the silica phase. This is shown by the narrow limits of the arsenopyrite and absence of it in the large quartz crystals to the side.

Fig. 4.

Contains sphalerite, galena and quartz. The galena is invading the sphalerite through fractures and along all sides, leaving micro-xenoliths of sphalerite within the galena.

Fig. 5.

Shows sequence of deposition from right to left of sphalerite, pyrite, chalcopyrite, galena and carbonate. Graphic texture shown by replacement of chalcopyrite by galena. Note rhomb-shape crystals of carbonate.

Fig. 6.

Chalcopyrite veins cutting sphalerite and terminated by arsenopyrite and calcite vein. Small irregular bleb of galena also within and replacing the sphalerite.

Fig. 7

Shows parallel orientation and replacement along cleavage or minute fractures of tetrahedrite (?) and ruby silvers (?) in the galena.

Fig. 8

Galena lightly etched by 1:1 HCl to show numerous minute inclusions. Most inclusions show parallel orientation; other minute rounded particles may denote exsolution.

Fig. 9.

Irregular grains of pyrargyrite and native silver with tetrahedrite. Largest silver grain is 100 microns in size, average for blebs is 20 microns. Irregular shapes suggest replacement of the tetrahedrite, although much of the texture is reverse of caries. Euhedral with pitted pyrite cubes occur at the edge of the tetrahedrite, suggesting deposition in vuggy quartz.

Fig. 10.

Two grains and numerous minute blebs of native silver in tetrahedrite, showing irregular borders. This habit excludes the possibility of simultaneous deposition of silver and tetrahedrite. Pitted and corroded pyrite cubes occur with euhedral quartz crystals at the edge of the tetrahedrite grain.

Fig. 11.

Irregular contact of quartz and sphalerite, with arsenopyrite occurring towards end of the silica phase and cutting the sphalerite.

Fig. 12.

Quartz and arsenopyrite vein cutting the sphalerite. Note diamond shape arsenopyrite crystals in figures 11 and 12.

Fig. 13

Camera-lucida drawing of small fracture in the quartz gangue of section one, filled with sphalerite, chalcopyrite, galena, tetrahedrite, pyrite and arsenopyrite.

PARAGENESIS

From the examination of the polished sections the following order of deposition is suggested:

Molybdenite
Sphalerite
Pyrite
Chalcopyrite
Galena
Tetrahedrite
Arsenopyrite
Pyrargyrite
Polybasite
Silver

Molybdenite was not found associated with the other minerals. It occurs with the sericite and muscovite flakes. Being a high temperature mineral, it probably was the earliest mineral to be deposited.

Sphalerite, the earliest of the more common sulphides, is veined and replaced by the later minerals. Pyrite veins the sphalerite but not the galena and is definitely earlier than the tetrahedrite and the ruby silvers (figs. 9 & 10).

Chalcopyrite veins the sphalerite (fig. 1 & 6) and is replaced by galena (figs. 2, 3, & 5). No chalcopyrite is found in the galena far removed from the sphalerite. The galena then is capable of entirely removing the chalcopyrite. The relative ages of sphalerite, chalcopyrite and galena are clearly shown in figures 1 to 6. Figure 5 shows the sequence of deposition, from right to left across the picture of sphalerite, pyrite, chalcopyrite, galena and calcite.

Tetrahedrite replaces the galena along minute fractures and cleavages, (figs. 7, 8, & 13). Most of the tetrahedrite occurs separate from the galena and sphalerite, suggesting deposition at quite a later time and distinct phase from the earlier sulphides. Two minute blebs of sphalerite were found within tetrahedrite and probably represents simultaneous deposition of a little zinc with the tetrahedrite.

Arsenopyrite was definitely deposited later than the galena and sphalerite, (figs. 6, 11, & 12). Whether or not it was all deposited later than the tetrahedrite or overlapped with the tetrahedrite is not positively known. Figure 13 suggests that arsenopyrite is later than the tetrahedrite.

Pyrargyrite, polybasite and silver were the last minerals deposited. Their relative position of deposition with one another is not known but most likely they formed simultaneously. Pyrargyrite and silver are found together in tetrahedrites in section four (figs. 9 & 10). Polybasite is found associated but not in contact with the tetrahedrite and pyragyrite in section five. It is possible that polybasite is somewhat later than the pyrargyrite.

Conclusions

The mineral content and mode of occurrence of these specimens indicate a primary mesothermal deposit. Chalcopyrite and tetrahedrite are characteristic mesothermal minerals. The silver bearing minerals are pyrargyrite, polybasite and native silver which are found within the tetrahedrite. As most of the tetrahedrite with these minerals is found in vugs unassociated from the galena and sphalerite, the values will be obtained from treatment of the tetrahedrite concentrates if this property is developed. No doubt, though, the galena will contain some silver value; one micro-chemical test on galena did indicate silver. As arsenopyrite does not occur with the silver minerals it should not present a metallurgical problem.

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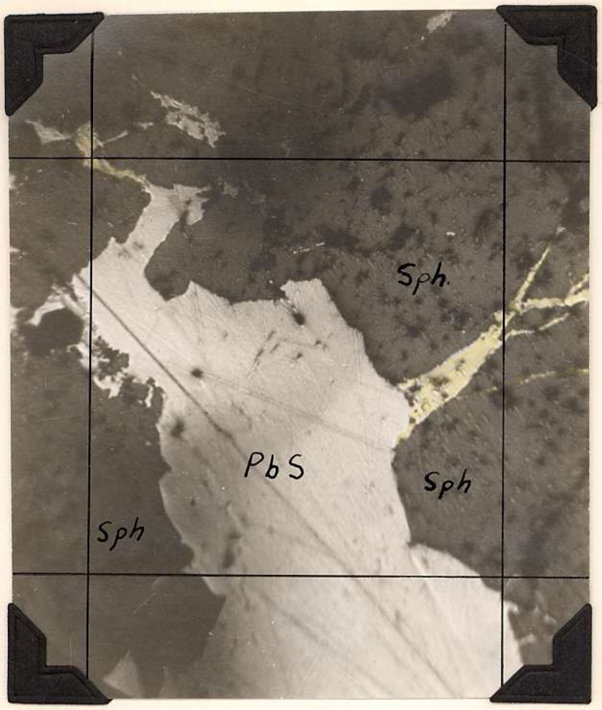
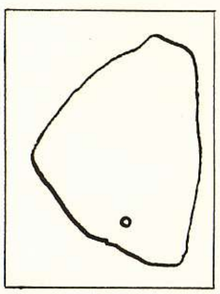


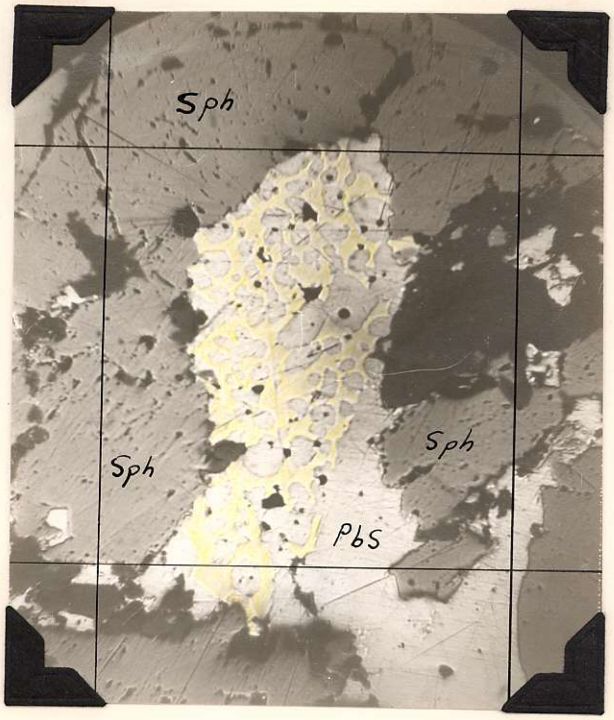
X110

Fig.I



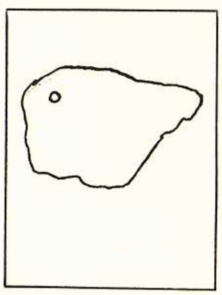
Sect.2

Sph.	Sphalerite
	Chalcopyrite
PbS.	Galena



X110

Fig.2



Sect.3

Sph — Sphalerite

Chalcopyrite

PbS — Galena

Quartz

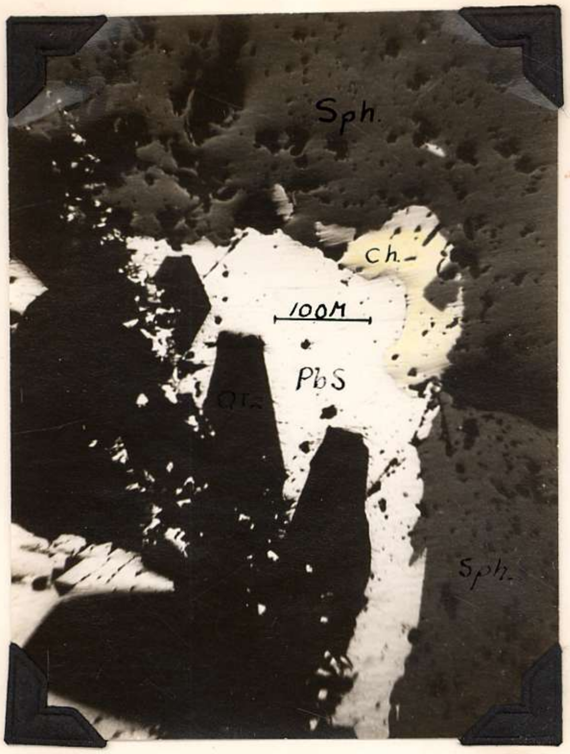
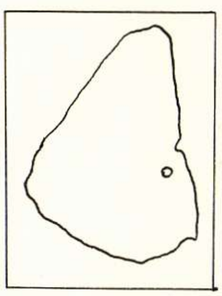


Fig.3



Sect.I

Sph	Sphalerite
Ch.	Chalcopyrite
PbS	Galena
◇	Arsenopyrite
	Quartz

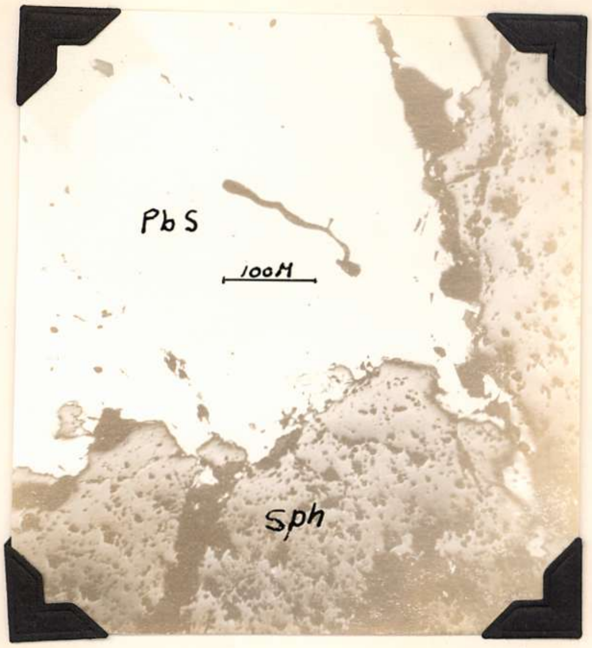
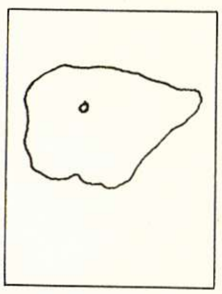
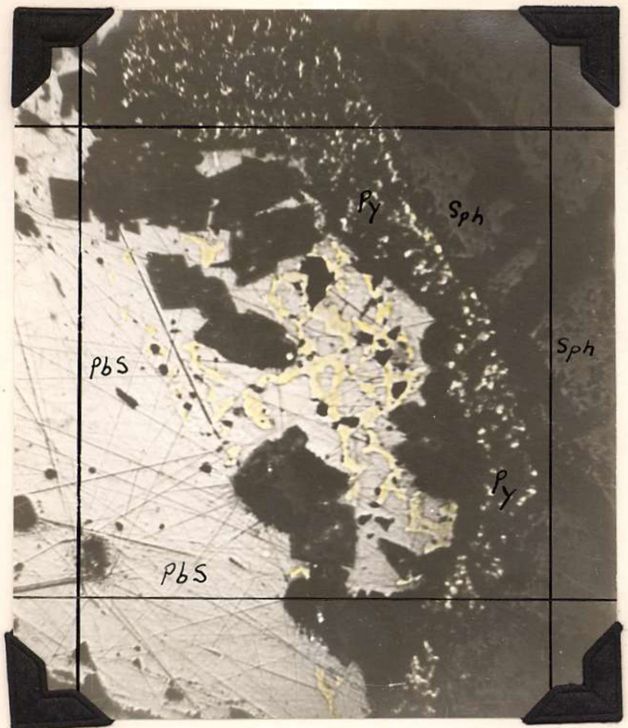


Fig.4



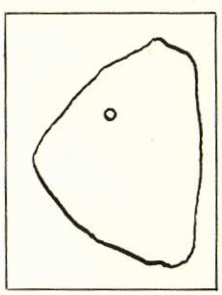
Sect.3

Sph	Sphalerite
PbS	Galena
(shaded)	Quartz



X125

Fig.5

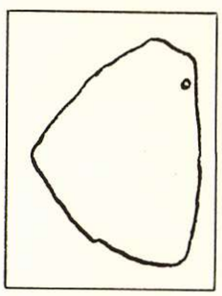


Sect.2

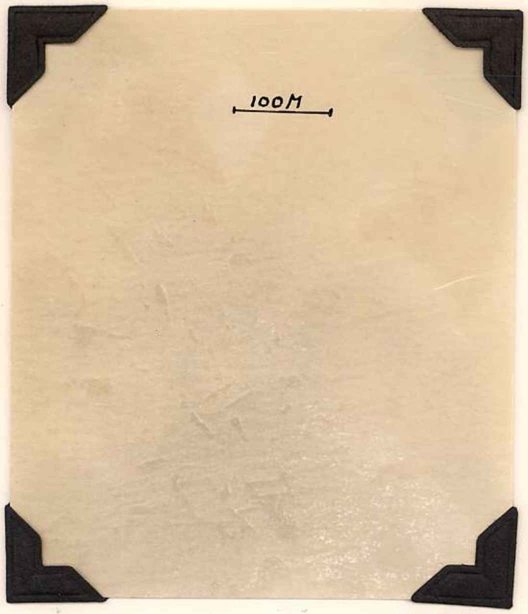
Sph	Sphalerite
Py	Pyrite
	Chalcopyrite
PbS	Galena
	Carbonate¢Calcite?)

X115

Fig.6



Sph	Sphalerite
	Chalcopyrite
PbS	Galena
	Arsenopyrite

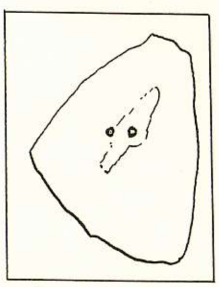


X120

Fig.7

X120

Fig.8

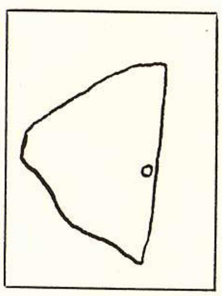


Sect.2

Galena with parallel inclusions.

X125

Fig.9



Sect.4

T Tetrahedrite

P Pyrargyrite

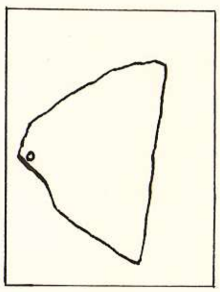
S Silver

Pyrite

Quartz

X95

Fig.IO



Sect.4

T	Tetrahedrite
S	Silver
	Pyrite
	Quartz

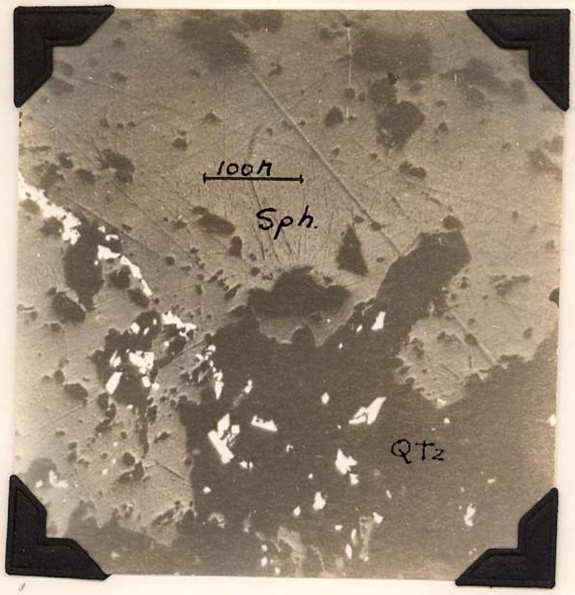


Fig.II X120

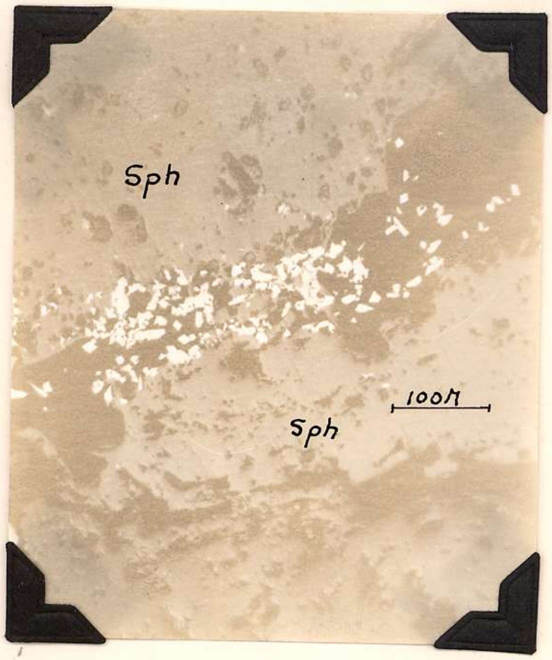
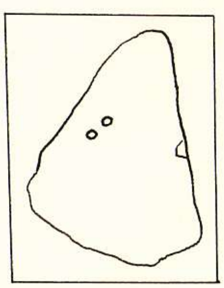


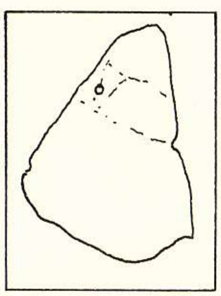
Fig.I2 X120



Sect.I

Sph	Sphalerite
	Chalcopyrite
	Quartz

Fig.I3 X275



Sect.I