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MINERALOGICAL STUDY OF ORE FROM THE GIANT-MASCOT
MINE, BRITISH COLUMBIA

600095

A report
submitted in partial fulfilment of the course
in Geology 409 in the Winter Session 1952-1953 at the
University of British Columbia.

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April 15, 1953

2995 West 34th Avenue,
Vancouver, B.C.

April 15, 1953.

Dr. H.V. Warren, Professor of Mineralogy,
Department of Geology and Geography,
University of British Columbia,
Vancouver, B.C.

Dear Sir:

I have pleasure in submitting this report
MINERALOGICAL STUDY OF ORE FROM THE GIANT-MASCOT MINE,
BRITISH COLUMBIA in partial fulfilment of the course in
Geology 409 in the Winter Session of 1952 - 1953.

Very truly yours,

David H. Brown

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ACKNOWLEDGEMENTS

The writer wishes to thank Dr. R.M. Thompson, Assistant Professor of Geology, under whose supervision this study was made, for advice and assistance in identifying minerals. Thanks are also due to Mr. J.A. Donnan, laboratory technician, and to Mr. E.D. Dodson, laboratory assistant, for valuable assistance.

Summary

A detailed microscopic examination of seventeen ore specimens from the Giant-Mascot Mine is the subject of this report. In addition to the results of the present study, a brief account of history, geological environment, and factors of ore localization of the mine are included.

The suite of specimens studied has been divided into two principal types.

1. Silicified limestone and shale, partially replaced by barite, and containing the ore minerals: pyrite, sphalerite, galena, bournonite, tetrahedrite, pyrargyrite and an unidentified mineral associated with galena and bournonite.

2. Quartz vein material mineralized by pyrite, chalcopyrite, bornite, tetrahedrite, galena, chalcocite, digenite and covellite.

The following conclusions were reached:

(a) Fracturing of the siliceous limestone and shale occurred before the deposition of ore minerals and is also evident post-pyrite and post-sphalerite.

(b) The deposition of ore minerals in siliceous limestone and shale is chiefly fracture filling accompanied by minor replacement.

(c) The temperature of deposition of ore minerals in siliceous limestone and shale, indicated by the predominance of fracture filling and the cryptocrystalline nature of the silica present, ^{classes this deposit as} ~~is~~ epithermal or low mesothermal.

(d) The temperature of deposition of vein minerals, indicated by the

coarse nature of the quartz and the assemblage of metallic minerals ^{classes this deposit as} ~~is~~ probably mesothermal in origin.

(e) The erratic silver assays indicated by Hedley's report (1949) may be due to the sporadic distribution of pyrargyrite in the galena.

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B.C. Min. Mines Ann. Report, 1949.
P. 202

MINERALOGICAL STUDY OF ORE FROM THE GIANT-MASCOT
MINE, BRITISH COLUMBIA

Introduction

Location

The Silver Giant Mine of the Giant-Mascot Co. Ltd., is located on Jubilee Mountain about seven miles by road northwestward from Spillimacheen in the Golden Mining Division.

History of Mining Activities

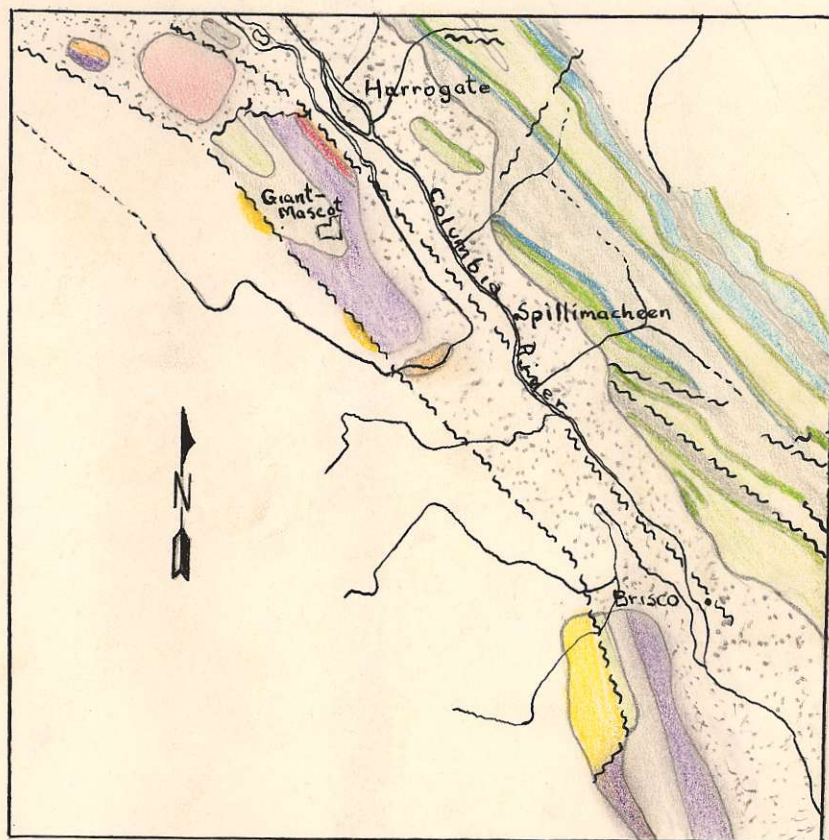
The original discovery on this property was made prior to 1890. However, little work was done until 1907 when Golden Giant Mines, Ltd., did some experimental work in mineral dressing of the ore. Little work was done from this time until 1926 when the property was optioned by Pacific Mines, Ltd. This company carried on diamond drilling and underground development exploration until 1930. The property then lay idle until Silver Giant Mines, Ltd., was organized in 1947 and shipped a small quantity of ore from the dumps.

Late in 1948 Siscoe Gold Mines, Ltd., obtained an option and carried out a sampling and diamond drilling program as well as additional underground development work. The option was dropped in March 1949.

In May, 1951, a merger was effected between Hedley Mascot Gold Mines, Ltd., and Silver Giant Mines, Ltd. After carrying out a development program this new company, Giant-Mascot Mines Ltd., completed a 200 ton mill in February 1951, and started production of February 26, 1951.










PLATE NO. I

Geological Map of the Giant-Mascot Mine Area
Kootenay District, British Columbia



Scale - 1" 4 mi.

LEGEND

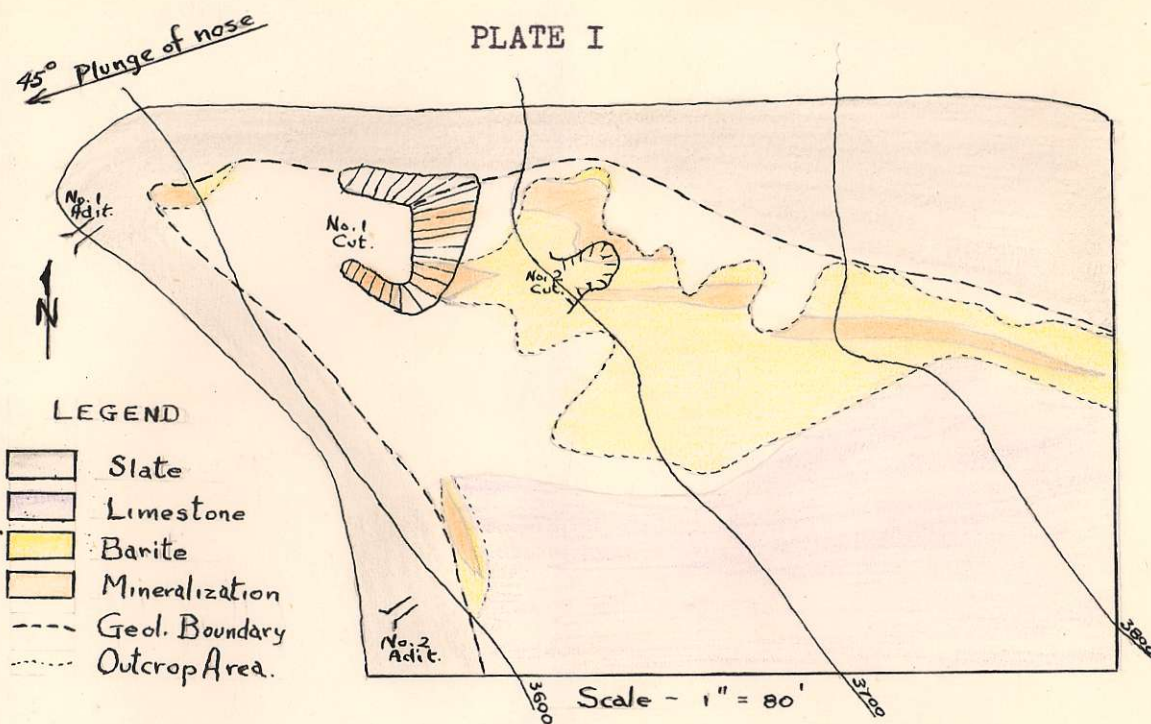
-  Beaverfoot and Brisco
-  Wonah
-  Glenogle
-  McKay
-  Jubilee
-  Donald
-  St. Piran
-  Horsethief Creek
-  Mt. Nelson

At the end of December 1951 the mill was treating about 170 tons per day.

General Geology

Geologically, the Silver Giant Mine occurs in an Upper Cambrian Jubilee limestone near its contact with the overlying McKay slate formation. Regionally, the deposit lies on the western limits of a major syncline but locally the structure is complex. A large regional fault along which Pre-Cambrian Horsethief Creek quartzites, grits, and schists are thrust against Cambrian strata, passes about one-quarter mile west of the mine. A table of formations and a geological map of the immediate area follow:

Age	Formation	Lithology
Ordovician	McKay	- alternating shales and limestones
Upper Cambrian		
Middle Cambrian	Jubilee	- massive-bedded, cliff forming magnesian limestones, gray in color, weathering gray to white, somewhat siliceous
Lower Cambrian	Donald	- interbedded sandstone, slate, with little impure limestone
	St. Piran	- chiefly quartzite
Late Pre Cambrian	Horsethief Creek	- gray-green and purplish slates with some lenticular beds of conglomerate and at different horizons numerous thin beds of crystalline limestones.



Geology of open-cut area
Silver Giant Mine

The mine structure is a plunging, overturned anticlinal nose in which McKay slate is wrapped around Jubilee limestone. In and near the apex there has been replacement of limestone and of slate inclusions by silica and of limestone by barite and in this zone there has been deposition of galena, and sphalerite and in parts, of copper minerals.

Although the general plunge of the nose in the vicinity of the mine is to the northwest, surface exploration seems to indicate a reversal of plunge in the area to the northwest. Local faulting appears to be of normal displacement in spite of the fact that a regional thrust fault lies less than half a mile to the west.

Relations of Mineralogy to Geology and Structure.

Replacement by barite, accompanied by varying amounts of silica, has occurred in limestone at the anticlinal nose, along both limbs, and at

intervals along the lime-slate contact. Fine grained galena with less sphalerite and small amounts of copper minerals occur associated chiefly with silica within the barite.

Ore occurs commonly in conjunction with zones of intense shattering of slate which is more or less silicified within the barite zone. There is also evidence of the barite zone being surrounded by a zone of silicification.

Ill. 2 is a map by M.S. Hedley illustrating his interpretation of the distribution of mineral as known in the open cut area of initial discovery and on No. 6 level of the mine.

Since no more recent geological data is available it can only be suggested that the ore controls include:

1. The structure of the plunging overturned synclinal nose of limestone capped by slate.
2. Erosion and silicification of the slate intrusions within the limestone.
3. The replacement of much of the limestone by barite.
4. The apparent origin of silicification around this barite zone.

Purpose and Scope of this Study.

The examination of the Giant Mascot ore was undertaken with the expectation that some contribution might be made to the known information on the mineralogy and ore deposition at the mine. To the writer's knowledge no previous detailed study of this ore has been undertaken. The specific location in the mine from which the specimens have been taken are not known. Little can be done therefore beyond reporting the minerals present in the specimens and their correlation where such correlation should exist.

Erratic silver values have been reported from samples of the ore (Hedley, 1949) and it is hoped that the reason will be discovered during the examination.

Megascopic Description

In general, the ore is of two types:

1. Massive to disseminated sulphides in silicified limestone and shale which has been partially replaced by barite.

2. Massive to disseminated sulphides in quartz veins.

Type 1.

The specimens that are of this type consist chiefly of silicified limestone partially replaced by barite and mineralized chiefly by pyrite, sphalerite and galena. The mineralization appears to be associated with fracturing of the siliceous material and the dendritic nature of the mineralization seems to indicate filling and replacement from the fractures. The barite is slightly mineralized but does not appear to have been particularly favorable to the deposition of sulphides. Specimen 4, which consists almost entirely of barite with only minor inclusions of silicified material, contains azurite and malachite. The siliceous material in this section shows evidence of recrystallization to quartz. Some specimens exhibit massive sphalerite mineralization containing minor amounts of galena and pyrite. Other specimens consist chiefly of massive galena with minor pyrite and with sphalerite absent or finely disseminated.

The specimens of silicified shale exhibit intense fracturing ~~and~~ and subsequent filling and replacement by coarse grained galena.

Type 2.

The specimens of this type appear to be quartz vein material

mineralized chiefly by pyrite and copper minerals with minor amounts of galena. The quartz vein material appears to have been finely fractured and mineralization has taken place along the fractures.

Specimen 9 appears to be a quartz breccia which has been filled by coarse grained pyrite.

The vein mineralization consists chiefly of quartz, pyrite, bornite, chalcopyrite, galena and chalcocite, with minor quantities of mineral "y", digenite, and covellite.

Microscopic Description.

The following minerals are those identified in polished sections.

Metallic Minerals

- Galena
- Sphalerite
- Pyrite
- Chalcocite
- Chalcopyrite
- Bornite
- Tetrahedrite
- Mineral "y"
- Digenite
- Bournonite
- Mineral "x"
- Pyrargyrite
- Covellite
- Azurite
- Malachite

Gangue Minerals

- Ca Mg carbonate
- Quartz
- Siliceous limestone and shale
- Barite
- Light gray gangue (Sec. 13)

Galena (PbS)

Galena varies in amount from a few grains as in Section 4 to about 90% as in Section 12. It occurs usually in very fine grains but in some cases in coarse grains measuring 4 m.m. on an edge. The galena usually exhibits triangular pits and cubic cleavage which commonly shows evidence of distortion by movements subsequent to crystallization. It is associated with all the minerals listed above.

In Section 8B, galena was identified as veins in pyrite. Its relation with sphalerite is usually smooth contact or exhibiting "island in sea" texture indicating probable simultaneous deposition. Occasionally, however, galena occurs in small elongated masses somewhat resembling veins in massive sphalerite which is suggestive of replacement of sphalerite by galena. Galena replaces bornite and is replaced by mineral "y" (Fig. 1). The relation to bournonite and mineral "x" which occur as blebs in the galena is not known. At one point in Section 3 (Fig. 3) a wedge of chalcopyrite in bornite extends into an area occupied by galena. The galena has apparently replaced the chalcopyrite retaining evidence of the sharp end of the wedge. The galena is apparently later than the chalcopyrite in this case and is probably later than the bornite in which the chalcopyrite occurs.

Microchemical tests revealed no silver content in the galena. If present in the galena, then, it must be in very minor amounts.

Sphalerite (ZnS)

Sphalerite occurs as a dark gray mineral with a pitted surface, in massive form or disseminated in galena. Generally it exhibits moderately high internal reflection and microchemical tests indicate a ^{some} relatively ~~a~~ high iron content. Sphalerite generally occurs in association with

siliceous material and quartz and occasionally is replaced by barite (Fig. 4). It replaces pyrite and is replaced by galena. Its direct relation to other minerals is not indicated.

Pyrite (FeS_2)

Pyrite occurs as individual subhedral to euhedral grains, occasionally exhibiting cubic or pyritohedral forms, and in massive form. It varies in amount from individual disseminated grains to about 80% of a section as in Section 7, where massive pyrite has been fractured and filled with quartz and minor amounts of sphalerite. Individual grains of pyrite have been partly replaced by bornite, tetrahedrite, chalcopyrite, sphalerite, galena and quartz. Textural relations seem to indicate that pyrite was the first formed of the metallic minerals (Fig. 2).

Chalcopyrite (CuFeS_2)

Chalcopyrite occurs in massive form, and as veins, wedges and granular masses in the grain boundaries of bornite. It was only seen to occur in the presence of other copper minerals and pyrite.

Grains of pyrite in a late stage of corrosion are commonly surrounded by chalcopyrite. The common occurrence of wedges or blades of chalcopyrite in bornite seems to indicate exsolution of chalcopyrite in the (111) planes of the bornite.(Fig 3.). Present in the same field, masses of chalcopyrite exhibiting a granular texture are also indicative of exsolution and diffusion to grain boundaries. According to Edwards , however, replacement rims that simulate exsolution of chalcopyrite in bornite do occur and this is considered a more favorable explanation here. This matter will be considered further in conclusion. Fine grained chalcopyrite also occurs in chalcocite in conjunction with the bornite and chalcopyrite reaction rims mentioned above. This combination suggests the

decomposition of the bornite forming chalcocite and chalcopyrite (Uytenbogaardt, p. 73) , and helps to explain the reaction rims in the bornite adjacent to chalcocite. Covellite borders the wedges or blades of chalcopyrite and is intergrown in the granular chalcopyrite rims.

Bornite Cu_5FeS_4

Bornite is the most abundant of the copper minerals present. It has a pinkish brown color and is readily distinguished from the other minerals present. Bornite has replaced pyrite (Fig. 2) and has been replaced by chalcopyrite, galena, chalcocite, digenite and covellite. Its possible relationship with chalcocite and some of the chalcopyrite is suggested above.

Chalcocite Cu_2S

Chalcocite only occurs in the presence of bornite and its origin as a product of decomposition of bornite is suggested as above. Chalcocite was distinguished as a light bluish gray mineral, weakly anisotropic and having polarization colors of steel gray and bornite pink. Etch tests carried out agreed with those considered indicative by Short .

Tetrahedrite $5\text{Cu}_2\text{S} \cdot 2(\text{Cu}, \text{Fe})\text{S} \cdot 2\text{Sb}_2\text{S}_3$

A mineral having the properties of tetrahedrite occurs in Section 6 as blebs averaging 60 microns in length in galena. These blebs were too small to obtain material for a satisfactory microchemical test and its determination as tetrahedrite is only suggested. A mineral having similar etch reactions to tetrahedrite but having a distinctly darker color remains specifically unidentified and has been designated mineral "y".

Mineral "y"

An olive gray mineral having similar optical properties and etch

reactions to tetrahedrite but lacking the brownish or pinkish tints common to tetrahedrite is present in most sections containing copper minerals. This mineral was observed in Section 8 (Fig.6) as veins in bornite and chalcopyrite and is hence later than these minerals. The mineral was also seen as borders around galena as in Fig. 1 which is suggestive of replacement of galena.

Digenite Cu_2S

Digenite appears as a sky blue mineral in polished section. It is isometric and hence isotropic. It has similar etch reactions to chalcocite with the exception of the FeCl_3 reaction which in this case is negative. The mineral replaced covellite and was replaced by that mineral, indicated by cross-cutting veins of these minerals in bornite. Since the covellite is thought to be supergene in origin, digenite is probably also supergene. Digenite is most commonly seen rimmed by chalcocite and in association with bornite. (Fig. 3, 8). This may be due to inversion of orthorhombic chalcocite at a temperature above 91°C and failure to revert because of high covellite content or it may be due to supergene replacement.

Bournonite $2\text{PbS} \cdot \text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$

This is a grayish white mineral with a distinct bluish green tint. It is anisotropic, having polarization colors: greenish gray, dark brown to purple. Its etch reactions to HCl , KCN , FeCl_3 , KOH and HgCl_2 are negative. HNO_3 slowly fumes the mineral dark brown. Bournonite occurs as minute blebs averaging 60 microns in length in galena and in association with tetrahedrite and a mauvish gray mineral designated mineral "x". (Fig. 9).

Mineral "x"

This is a mauvish gray mineral that has polarization colors and etch reactions similar to those of bournonite but bearing a distinctly mauvish tint. Distinction between the two minerals was made possible by the presence of an irregular mass of this mineral in a grain of bournonite (Fig. 9). In comparison with bournonite, this mineral has a distinctly higher anisotropism.

Pyrargyrite $3Ag_2S \cdot Sb_2S_3$

This is a bluish gray mineral, strongly anisotropic and exhibiting strong internal reflection. It occurs only as minute "patches" in galena in association with tetrahedrite (Fig. 10). It was observed in only two sections. (Section 1 and the specimen from which it was cut.)

Covellite CuS

Covellite is indigo-blue in color, and is highly anisotropic, exhibiting fiery orange and reddish brown polarization colors. It replaces bornite, chalcopyrite, chalcocite and possibly digenite and was seen in Section 8A veined by digenite. Some of the covellite, at least, is probably of supergene origin.

Azurite $Cu_3(OH)_2(CO_3)_2$ - blue

Malachite $Cu_3(OH)_2(CO_3)_2$ - green

These carbonates occur in massive barite and were identified megascopically only.

Paragenesis

Fracturing	_____	_____	-----
Quartz	_____		
Barite	_____	_____	
Mg-Ca Carbonate	_____	_____	-----
Pyrite	_____		
Chalcopyrite	_____		-----
Sphalerite	_____		
Bornite	_____		
Chalcoocite		_____	
Tetrahedrite		-----	-----
Galena		_____	
Bournonite		-----	
Mineral "x"		-----	
Mineral "y"		_____	-----
Digenite		-----	_____
Pyrargyrite		_____	
Covellite			_____
Azurite			_____
Malachite			_____
		Early	Late

Fracturing of the siliceous limestone and shale and probably of the vein quartz occurred before the deposition of ore minerals and is also evident post-pyrite and post-sphalerite. The siliceous limestone was fractured, filled and replaced by pyrite. Subsequent fracturing brought quartz and sphalerite into the fractured pyrite. Still later fracturing provided channelways through sphalerite which were later filled by barite and probably Mg-Ca-Carbonate. Chalcopyrite is as early as the galena and

may be as late as digenite (Fig. 5). Other minerals filled fractures and replaced preceding minerals in complicated overlapping periods of deposition.

Conclusions

The possibility of exsolution of chalcopyrite from bornite which would indicate temperature of origin above 475°C as might be indicated by the field of Fig. 3, is rendered improbable by the complete absence of diagnostic high temperature minerals and the presence of such low temperature minerals as pyrargyrite. The best temperature indicator available seems to be the presence of chalcocite and digenite together in Section 3 (Fig. 3). The presence of digenite indicates a temperature of formation above 91°C . The upper limit of temperature cannot be conclusively determined. However, the two types of ore: quartz vein and replacement of siliceous limestone and shale seem to indicate two somewhat different temperatures of formation.
















In the case of the quartz vein the relative coarse grained nature of the quartz together with the assemblage of metallic minerals found in the vein seem to indicate a mesothermal origin.

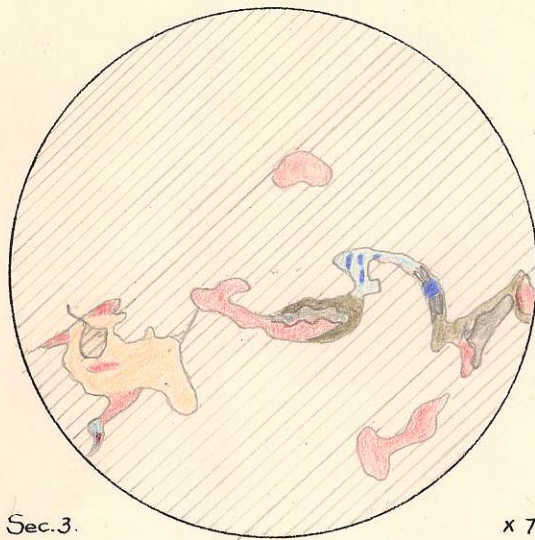
In the case of the mineralized siliceous limestone and shale, the cryptocrystalline nature of the silica and quartz (i.e. calcedonic quartz) and the predominance of fracture filling over actual replacement, together with the assemblage of minerals: pyrite, sphalerite, galena, bournonite and pyrargyrite, seems to indicate lower temperatures of deposition than those of the vein minerals.

The mineralization of the siliceous limestone and shale is probably wholly hypogene. The vein mineralization, although chiefly hypogene has undergone supergene enrichment by digenite and covellite.

The erratic silver assays indicated in Hedley's report (1949) may be due to the sporadic distribution of pyrargyrite in the galena.

Legend for Figures 1 - 10

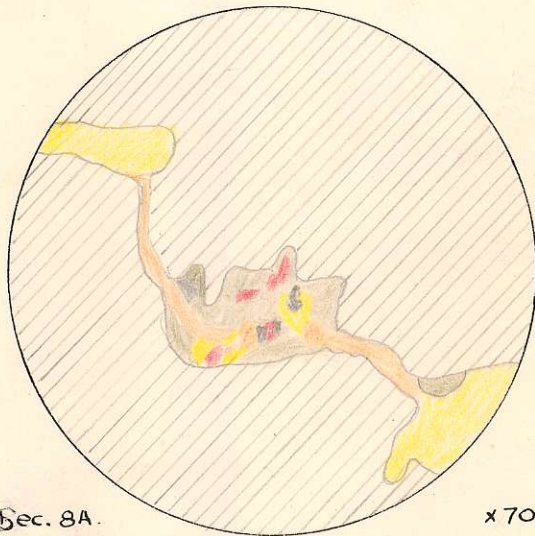
	Quartz
	Barite
	Mg-Ca-Carbonate
	Pyrite
	Chalcopyrite
	Sphalerite
	Bornite
	Chalcocite
	Galena
	Bournonite
	Mineral "x"
	Mineral "y"
	Digenite
	Pyrargyrite
	Covellite



Sec. 3.

x 70

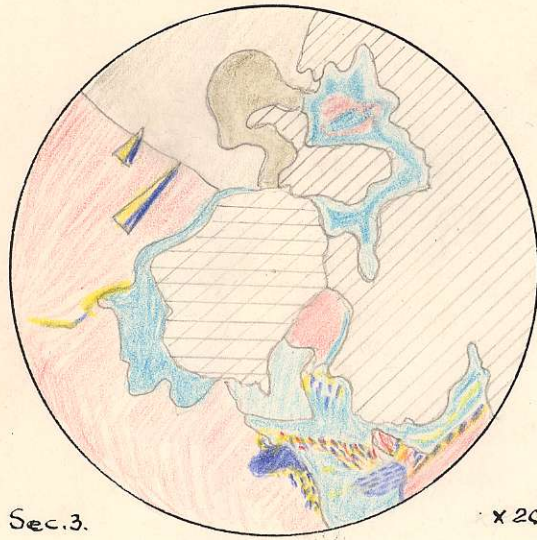
Fig. 1.



Sec. 8A.

x 70

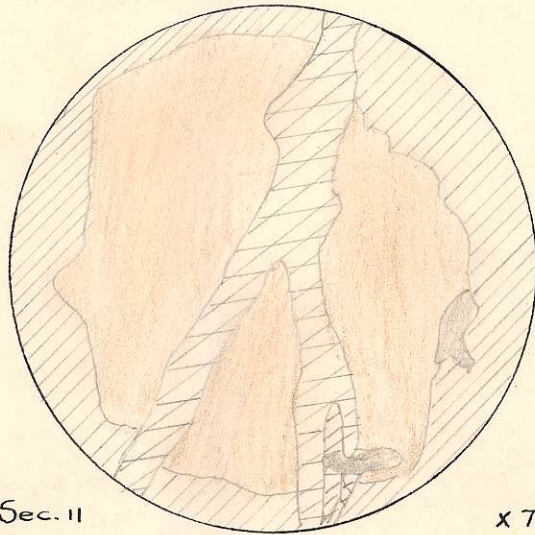
Fig. 2.



Sec. 3.

x 200

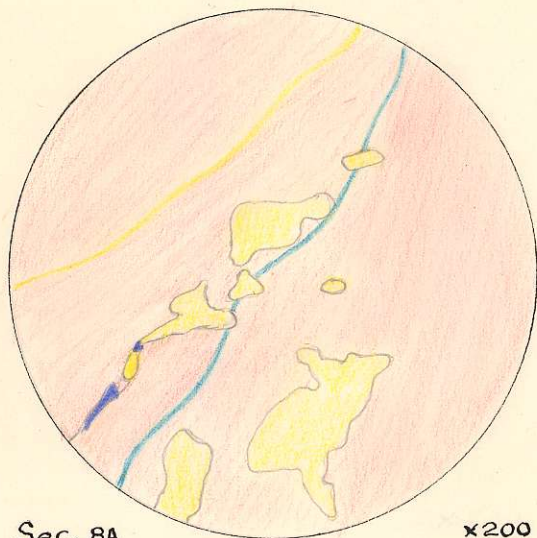
Fig. 3



Sec. 11

x 70

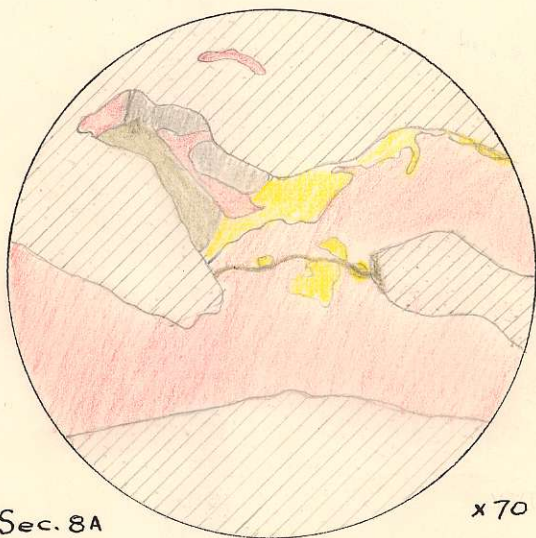
Fig. 4.



Sec. 8A

x200

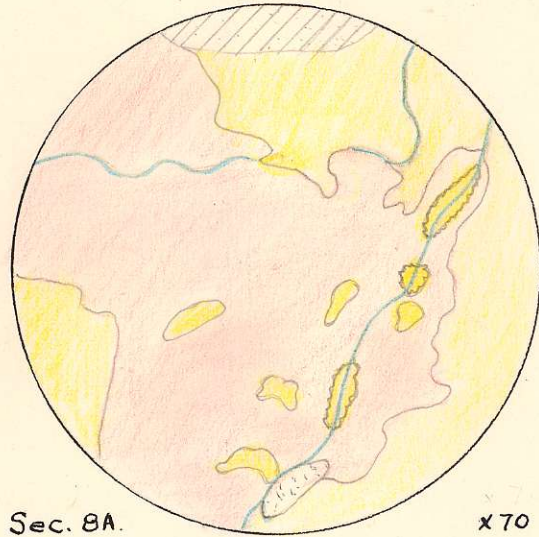
Fig. 5



Sec. 8A

x70

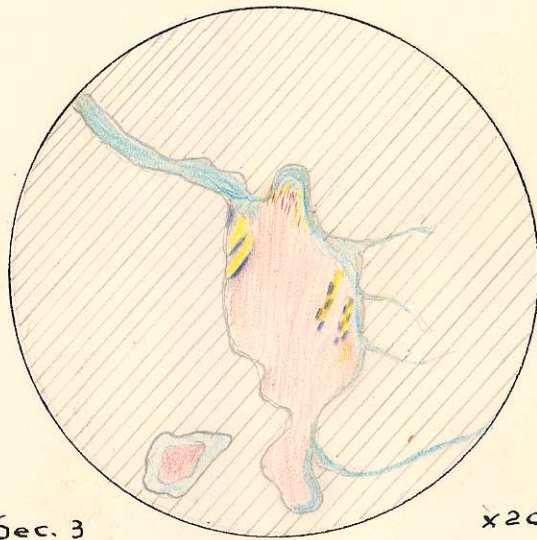
Fig. 6



Sec. 8A.

x70

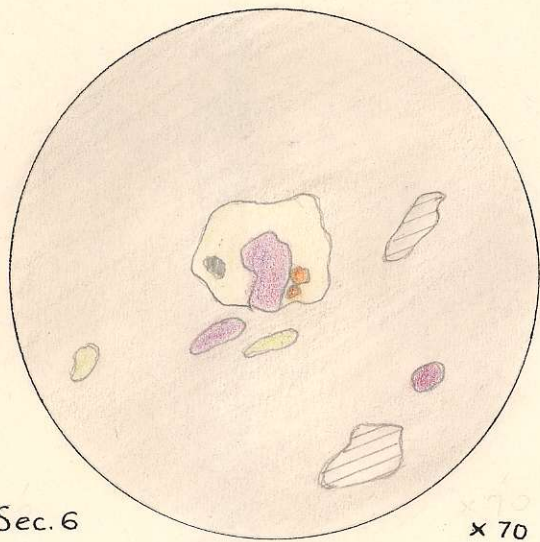
Fig. 7



Sec. 3

x200

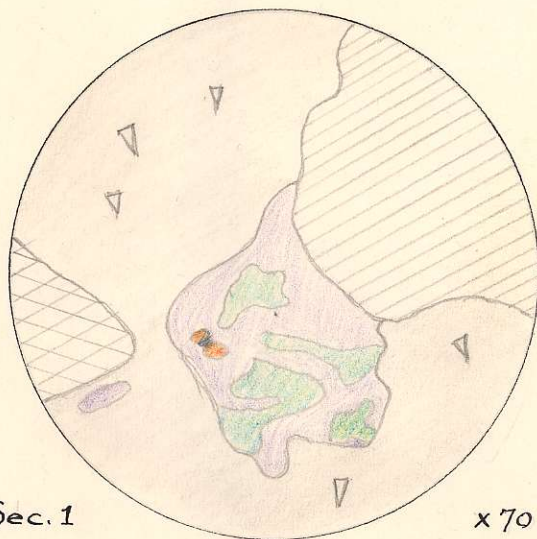
Fig. 8



Sec. 6

x 70

Fig. 9



Sec. 1

x 70

Fig. 10

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