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A REPORT ON THE MICROSCOPIC EXAMINATION OF ORE MINERALS AND MILL SAMPLES FROM SILVER STANDARD MINE

Geology 409

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University of British Columbia

April 8, 1950

University of British Columbia
Vancouver, B. C.
April 8, 1950

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Dear Sir:

I wish to submit herewith A report on the microscopic examination of ore minerals and mill samples from Silver Standard Mine, in partial fulfillment of the requirements of the course in Geology 409 as set forth on page 226 of the 1949-50 Calendar of the University of British Columbia.

Yours truly,

G. A. Noel

G. A. Noel

Acknowledgments

The preparatory work for this paper was carried out in the mineralography laboratories of the University of British Columbia under the supervision of Dr. H. V. Warren and Dr. R. M. Thompson.

The author especially wishes to express his appreciation to Dr. Thompson for X-ray identification of certain unknown minerals. Thanks are also due Mr. J. Donnan for his assistance in preparation of the polished sections.

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A REPORT ON THE MICROSCOPIC EXAMINATION OF ORE MINERALS AND MILL SAMPLES FROM SILVER STANDARD MINE

Introduction

The ore specimens and mill samples for this work were kindly submitted by the management of Silver Standard Mines, Limited. The problem is a two-fold one, the mineralogy of the ores, and attendant milling problems. Thus far, only the first part and the preliminary work for the second part have been completed. The following report therefore treats mainly of the mineralogy and paragenesis of the ore, with a brief qualitative treatment of the mill samples. It is hoped that the milling problems will be investigated shortly and towards this end, certain suggestions for future study have been included herein.

One great difficulty in reaching any general conclusion regarding the ore, is the uncertainty of the representativeness of the samples. However, in this case the samples appear sufficiently diverse to be considered representative of the run-of-mine ore.

The laboratory procedure has been as follows: isolation and tentative identification of the minerals by physical and optical properties, etch reactions, and microchemical and comparative analysis; verification by x-ray analysis. However, if the microscopic methods have given concurrent results, in most cases identification has been considered complete. On the other hand, with the rarer minerals, identification can only be accepted after x-ray analysis. Thus x-ray powder patterns have been made wherever possible. It is regretted that time has permitted neither an analysis into the argentiferous nature of the tetrahedrite nor positive confirmation of the varieties of ruby silver present. However it may be possible to complete this investigation in conjunction with the analysis of the mill samples.

Description of the Property

Location

The Silver Standard mine is about six miles by road northwest of New Hazelton in the Omineca Mining Division of British Columbia. The main workings are on the west side of Glen Mountain between 1200 and 2000 feet elevation.

History

The property was first staked in 1910, and in 1913 the first shipments of ore were made. In 1918 a 50-ton mill was built and the mine operated continuously until 1921. Thereafter operation was intermittent until 1923 when the mine was closed. In 1938 some development of the property was undertaken but no production resulted. In 1946 Silver Standard Mines Limited was formed to operate the property. The mine was reopened in 1947 and development extended over 1947-48. In September 1948, a 50-ton flotation mill was built and by the end of 1948, 3543 tons of ore had been treated.

Mining Practice

From 1911 to 1922 most of the ore mined came from three veins, No. 4, 7, and the hanging-wall vein. At present, mining is by shrinkage stoping mainly in No. 1 and No. 4 veins. The ore is trammed from the main 1300-level to the mill. A lead concentrate containing the galena and most of the minerals rich in silver and gold is floated first, and then the zinc concentrate is floated. The raw concentrates are shipped to the Trail smelter for treatment.

Production

To 1923 total recovery was 1100 oz. gold, 595,000 oz. silver, 1200,000 lb. lead, and 1600,000 lb. zinc, from 14,500 tons of ore. The average grade of the precious metals recovered was .075 oz. gold and 43.2 oz. silver per ton mined. In 1948 a total of 131 tons of lead concentrate and 283 tons of zinc concentrate were produced to give 195 oz. gold, 46,559 oz. silver, 62,805 lb. lead, 255,472 lb. zinc, and 2266 lb. cadmium. What is % Cd in the sphalerite? (.67) 226600 / 255472 = .06+ %

General Geology

Glen mountain is underlain by a thick series of folded sediments, mainly sandstone and greywacke with some tuffs and argillite. On the west slope of the mountain this series forms a low anticline with a north trend. The west limb of the anticline is intruded by two small stocks of porphyritic granodiorite. Numerous quartz veins, striking northeast and dipping 50 to 70 degrees southeast occupy strong fault fissures. The ten largest occur within 2000 feet across the mountain and are sub-parallel, 100 to 400 feet apart. They range from 100 to 1000 feet in length and six inches to eight feet in width. The veins often contain dark septa of wall rock. The wall rock near the veins is sheared and in places gouge is present. Short gash veins strike northerly in the footwall. No. 4 vein is the strongest vein on the property, extending for 1200 feet with an average width of three feet. The vein cuts granodiorite but the sulphide content is reduced in the granodiorite. A fault zone 15 feet wide cuts No. 1 vein and the sphalerite content and vein width are increased to the north of this fault zone.

The ore consists of banded and massive sulphides in milky white quartz with minor carbonate. The sulphides occur in pockets and veinlets generally parallel to the vein walls, but often extending into the walls. Offshoots are generally more common in the hanging wall and sphalerite is notably predominant in these apophyses. The mineral content of the veins varies widely over both length and depth. Numerous samples taken in 1947 and 1948 by the B. C. Dept. of Mines in the 1300 and 1500 foot levels show:

i) the highest gold content occurred on the 1300-level of No. 1 vein; since higher gold values occurred on the 1500 level of No. 4 vein, perhaps better gold values might be expected with depth in No. 1 vein.

ii) generally high gold and silver values are more closely associated with high zinc assays than with high lead values; however since all samples were richer in zinc than in lead, this generalization is probably of little significance.

iii) generally higher precious metal values in the foot wall section of the veins as compared with the hanging wall section.

iv.) an association of higher silver values with higher copper content, that is approaching one percent.

v.) the most significant result of the sampling, which is too limited to draw any quantitative conclusions, is in showing the extreme variability in mineral content and ore width.

Description of mineralogy

General

The ore specimens represented three veins, No.'s 1, 4, and 6 veins, with the largest amount of ore from the latter two. The mineralogy can best be described by treating each vein separately since a very apparent difference in mineralogy and textures occurs from vein to vein.

No. 1 Vein.

The specimens of this vein represented two different forms of ore. The more common variety consists of arsenopyrite, pyrite, chalcopyrite, and sphalerite as fairly uniform replacement veins in occasionally vuggy quartz. The second variety consists of massive sulphides very similar to those of No. 4 vein, that is, a characteristic banding of galena, pyrrhotite, chalcopyrite, sphalerite, and galena. In the hand specimen, galena shows some replacement of both sphalerite and pyrrhotite. Some minor folding is apparent in the bands and all of the minerals except sphalerite have inclusions of quartz. This may indicate that the outer bands were later and the brecciated quartz was originally veined through by sphalerite, or that quartz is more easily replaced by sphalerite. (Figs.(i) and (ii), p. 21)

No. 4 vein

The specimens from this vein exhibit more massive sulphides than the other veins. Galena, tetrahedrite, and sphalerite are the major minerals identifiable in the hand specimens, with smaller amounts of chalcopyrite, pyrrhotite, pyrite, and arsenopyrite. Galena apparently veins through and replaces sphalerite along wide bands. In a few cases, veinlets of galena extend into chalcopyrite and tetrahedrite which lie in bands adjacent to chalcopyrite and sphalerite. (Figs. iii, iv, v, p. 21). Generally quartz occurs in brecciated masses in the massive sulphides; however some clear crystals of quartz are also present. Galena, sphalerite, and tetrahedrite show flow relations around the earlier quartz fragments. (Fig. vi, p. 22).

No. 6 vein

Specimens of No. 6 vein are mainly fine grained banded sphalerite and galena with minor quartz inclusions. In some specimens, sphalerite appears as a very fine grained compact mass which has replaced finely folded sediments. Tiny veinlets of more crystalline sphalerite ramify through the more compact replacement type. Fine grained galena has in part replaced the sphalerite, but usually very little galena occurs in this ore. On the other hand, some of the sphalerite is quite heterogeneous with admixed tetrahedrite, pyrrhotite, and chalcopyrite. A few specimens of No. 6 vein appear to be of the more normal type of ore, with galena, tetrahedrite, sphalerite, and chalcopyrite replacing and brecciating earlier quartz.

Detailed

In addition to the minerals identified megascopically, several more are found in the microscopic examination of polished sections of the ore.

Probably the most outstanding from an economic viewpoint are the ruby silver minerals present. Both pyrargyrite and polybasite can be identified by optical characteristics and etch behaviour, and at least one other member similar to pyrargyrite except darker in color is indicated. As yet, none of these have been identified by x-ray analysis. Pyrargyrite and polybasite almost invariably occur as small disseminated masses in tetrahedrite or galena (Fig. 11, p. 27). The average diameter of the blebs of pyrargyrite is 80 to 100 microns, while polybasite is seldom over 40 microns diameter. All of the ruby silvers except the polybasite exhibit strong internal reflection and are readily detected. The polybasite shows slight internal reflection when scratched. Pyrargyrite occurs in important amounts in massive tetrahedrite, and in isolated blebs in galena. Polybasite on the other hand is much more restricted.

A second mineral located under the microscope and

?

26 PbS. Cu_2S. $7Sb_2S_3$

identified by [an powder photograph] x-ray ~~analysis~~ as meneghinite, occurs in galena and tetrahedrite as lath-like spindles and fibrous masses. It is a lead sulpho-salt (4PbS.Sb_2S_3) which contains about three percent of copper. The mineral is slightly grey-white in color (intermediate between galena and tetrahedrite), shows notable cleavage, is moderately anisotropic from light grey to bluish grey, and is negative to all etches except nitric acid. In masses in galena, the mineral has a mosaic texture with individual grains about 50 microns in diameter. Veinlets of anglesite follow cleavage fractures in the meneghinite. ? how determined?

[formula should be taken from latest Dana.]

A mineral tentatively identified as bournonite occurs in several places in one section as isolated blebs associated with the meneghinite. This mineral is a dirty grey color very similar to tetrahedrite, and is negative to all etch reagents except aqua regia. It is anisotropic but not nearly so strongly as meneghinite. Tho occurrences located were too small to permit positive identification; however if the mineral is bournonite, the sequence of sulpho-salts from tetrahedrite to meneghinite is complete. [ok usual association]

Marcasite is prominent in some sections as irregular composite lamellae replacing pyrrhotite (Edwards, 1947, p. 100). In some specimens the marcasite has entirely replaced pyrrhotite, whereas in others, remnants of pyrrhotite are surrounded by marcasite or by chalcopyrite and sphalerite earlier than the marcasite. (Fig. 2, p. 24).

The secondary minerals, covellite, anglesite, and limonite are present to a minor extent. Covellite occurs as veinlets and small irregular masses in tetrahedrite and meneghinite. Anglesite follows cleavage fractures of galena, tetrahedrite and meneghinite (Fig. 10, p. 27). Limonite forms colloform rims around pyrite extending outward into the enclosing quartz.

Vein No. 1

Galena, tetrahedrite, and meneghinite occur as closely associated masses with some development of covellite and anglesite along cleavage planes. Galena occurs as large coarsely crystalline masses with numerous irregular unsupported islands of tetrahedrite throughout. Tetrahedrite in some places contains numerous small blebs of chalcopyrite of irregular orientation. Fibrous elongate spindles and irregular masses of meneghinite occur at random throughout galena and in places in contact with tetrahedrite. Bournonite occurs in very minor amounts in association with tetrahedrite and meneghinite. Sphalerite commonly veins through quartz, and in some sections replaces arsenopyrite and pyrite to a lesser extent. Chalcopyrite is invariably associated with sphalerite and is generally scattered through the sphalerite as randomly oriented blebs. In some cases, however chalcopyrite occurs as vein-like masses in contact with sphalerite and replacing arsenopyrite. Arsenopyrite and pyrite occur as large euhedral grains, up to two millimeters in diameter, usually showing corrosion and brecciation by later sulphides, principally sphalerite. Small masses of pyrrhotite occur in quartz surrounded by lamellar marcasite. Pyrargyrite and polybasite occur in isolated small masses mainly in galena.

Vein No, 4.

Tetrahedrite occurs in large masses, and with galena replaces sphalerite and chalcopyrite. The tetrahedrite encloses numerous smaller masses of sphalerite, chalcopyrite, pyrargyrite, polybasite, and galena. Polybasite occurs as small oriented blebs in tetrahedrite. Galena and sphalerite also show the typical interstitial texture. Sphalerite has numerous small inclusions of chalcopyrite, and in some cases, these exsolution masses are oriented along cleavage directions (Fig. 9, p. 26). Large masses of tetrahedrite are common in the sphalerite. Relic veinlets of pyrrhotite show notable replacement of arsenopyrite.

Vein No. 6.

Galena and sphalerite occur in banded masses with galena replacing and veining through sphalerite. Sphalerite rarely exhibits exsolution chalcopyrite and the chalcopyrite occurs in veinlets of gangue ramifying through sphalerite in most places. Fairly large relics of unreplaced pyrrhotite are present in the sections representing No. 6 vein.

Paragenesis

From a careful examination of all specimens the general sequence of deposition appears to be:

arsenopyrite
pyrite
quartz
pyrrhotite
marcasite
sphalerite
chalcopyrite
galena
tetrahedrite, bournonite, meneghinite
pyrargyrite, polybasite

supergene: covellite, anglesite, and limonite.

Euhedral grains of arsenopyrite and pyrite are definitely corroded and replaced by later quartz, pyrrhotite, sphalerite, chalcopyrite, galena and tetrahedrite. Chalcopyrite, galena and tetrahedrite also vein through and replace sphalerite although much of the chalcopyrite shows simultaneous deposition textures in sphalerite. Galena shows the usual interstitial texture with sphalerite and also, in some specimens, veins through the sphalerite. Tetrahedrite, bournonite, and meneghinite are apparently members of an almost simultaneous sequence of sulpho-salt deposition showing an increasing Pb/Cu ratio. Ruby silvers are the final hypogene minerals emplaced and may have in part been deposited simultaneously with tetrahedrite since polybasite in places lies along cleavage planes of tetrahedrite. This may be a replacement relation however. The supergene minerals show late deposition along cleavage directions in favorable sulphides.

There appears to be at least two mineralization sequences:

i) deposition of high temperature minerals, such as, pyrrhotite, arsenopyrite, pyrite.

ii) deposition of intermediate and low temperature minerals in a sequence from galena to the ruby silvers.

Sphalerite and chalcopyrite may indicate a third period of mineralization closely following the high temperature sequence.

From the foregoing, the temperature of deposition probably ranged from above 500 degrees to below 250 degrees, Centigrade.

Discussion

9 Ref. The sphalerite though high in iron contains no manganese. This may indicate a persistence of gold values to depth (Warren, 1945, p. 38). Moreover the sphalerite is high in cadmium (Adams, 1948, p. 10), and for the 1948 production averaged 0.6 percent. This cadmium centent is extremely important in that it now amounts to more than 16 dollars per ton of concentrate shipped.

Although no native silver appears in the polished sections examined, anglesite, covellite and limonite indicate sufficient circulation of ground water for supergene silver in the upper parts of the orebody. Indeed, native silver has been reported in an earlier examination of the ores (Adams, 1948, p. 5).

In a similar way, no native gold appears in the sections, even though polished arsenopyrite was examined under magnifications exceeding 600-powers. This is remarkable because the gold assays are high. However it is believed that the arsenopyrite carries the gold in fractions smaller than 10 microns. Whether you see it or not depends largely upon the polish.

Study of Mill Samples

For a complete analysis each of the samples must be sized prior to briquetting. Then a mechanical stage is used to make an accurate count of at least 1500 grains. Each grain is noted as regards size and mineral content, that is, whether free or composite. In making the count traverses are taken across the polished briquette at one millimeter intervals. However, time did not permit such a detailed examination, and since assays are required in conjunction to provide a complete analysis of milling efficiency, it was decided to follow a more simplified procedure.

A representative portion of each of the three mill samples was combined with bakelite powder and converted into a solid briquette. The polished briquettes were examined under the microscope and the minerals present identified by color, hardness, and behaviour under polarized light. In the examination a careful approximation was made of the percentages of the minerals present irrespective of whether as free or composite grains. Further, a measure of maximum, minimum, and average grain sizes, and a description of composite grains was made. It is hoped a complete analysis of sized fractions will be possible at a later date.

The examination was made under high power magnification, that is a field of 0.46 millimeters diameter, and the mineral content was estimated over 10 areas on the polished surface. These areas were selected at random and yet so planned as to cover the section fairly representatively. Moreover, the entire section was examined for the grain size, composite occurrences, and minerals present. It should be noted that observation is possible only on a two-dimensional surface and some error may be involved in considering the size of particles and whether or not composite when the third dimension is not visible. However since the approach has been qualitative throughout, no serious error is involved.

Lead Concentrate

The polished section of lead concentrate shows a variation of grain size from ~~very fines~~ less than 10 microns in diameter to coarse fragments of 160 microns (+ 100 mesh) diameter. Very fine grains considerably outnumber large fragments. The finer material is mainly sphalerite and galena with sphalerite most abundant in the very fine sizes. Ruby silver (unclassified) is present only in these small fragments and is therefore difficult to identify. The average diameter of the fine fragments is about 15 microns.

The approximate distribution of minerals from an average of ten areas over the section is as follows:

Constituents	Percent	Av. size (microns)
galena	70	40
sphalerite	15	10-20
chalcopyrite	6	20
tetrahedrite	6	20
other grains	3	--

Galena occurs as cleavage fragments up to 80 microns square. Many of these grains have sphalerite and tetrahedrite inclusions. In one large grain of galena, sphalerite covered half the area; however the sphalerite inclusions usually occur as many small blebs in the galena. Sphalerite occurs in grains up to 40 microns square, but generally it appears as fine fragments. Tetrahedrite occurs as grains up to 120 by 40 microns, and many of these larger fragments have small inclusions of sphalerite. Tetrahedrite may also appear as very fine grains with sphalerite since it is then difficult to identify. Ruby silver occurs in grains up to 10 microns in diameter and constitutes perhaps one percent of the total mineral in the section of lead concentrate, since fine particles of ruby silver were seen in nearly every area examined. As might be expected the ruby silver occurs as free particles even in the larger sizes. Chalcopyrite occurs as triangular cleavage fragments up to 80 microns across, but the majority of grains are smaller than 30 microns in diameter. The remaining grains are arsenopyrite, pyrrhotite, and minor pyrite and quartz. Pyrrhotite occurs in grains up to 140 by 40 microns and some grains have inclusions of tetrahedrite. Arsenopyrite is present in grains up to 160 microns in diameter and pyrite as euhedral grains up to 80 microns. These three minerals form the largest grains and do not occur in sizes smaller than 40 microns.

Zinc Concentrate

The zinc concentrate shows less overall variation in grain size than the galena concentrate and yet the extremes of variation are as great. Sphalerite shows the maximum variation with grains ranging in diameter from 200 microns to 10 microns. However very little of the total mineral present occurs in the extreme sizes. The finer sizes are mainly chalcopyrite and sphalerite. More gangue is present than in the lead concentrate. The approximate amounts of the various minerals is given below:

Constituents	Percent	Max. diam. (microns)	Av. Size (microns)
sphalerite	80	200	80
galena	1	15	10
tetrahedrite	1	80	40
chalcopyrite	5	80	40
others	13	--	--

A large part of the sphalerite has small inclusions of chalcopyrite, while some sphalerite grains contain ruby silver, for example, one grain 80 by 40 microns has five inclusions of ruby silver each 5 to 8 microns in diameter. Some sphalerite grains also contain small grains of tetrahedrite and meneghinite less than 10 microns in diameter. Quartz present in the section is apparently always attached to sphalerite. Galena is present in small cleavage flakes.

Tailings

This section consists mainly of quartz and arsenopyrite with some pyrite and pyrrhotite. The largest grains present were arsenopyrite up to 80 microns in diameter with the average grain size being about 20 microns.

Discussion

From an examination of the mill samples, the following points have been drawn:

1. Both ruby silvers and sphalerite occur in fine grains in the lead concentrate. This is due to their extreme brittleness and the fines are evidently carried as slimes on galena in the initial flotation.

2. In the massive coarse grained ore, galena occurs as angular grains interstitial to sphalerite, and possibly veining through and replacing sphalerite. Crushing and grinding fragments the galena more readily along cleavage planes than along grain boundaries, and thin selvages and reentrant areas of galena occur with the sphalerite as noted in the lead concentrate.

3. The greater part of the tetrahedrite, which is in all probability silver-bearing, is recovered in the lead concentrate as is desirable. Since the grains occur largely free, tetrahedrite must float with galena.

4. Minor lead and copper sulpho-salts rarely appear in the concentrates, perhaps due to the difficulty in detecting anisotropic qualities under high powers, but probably due to their presence in minor amounts only.

5. Since lead smelters will pay for 80 percent of all zinc in a lead concentrate whereas the zinc treatment plant will pay for only 50 percent of all lead in a zinc concentrate, the high proportion of sphalerite in the lead concentrate and the low proportion of galena in the zinc concentrate is commendable.

6. If arsenopyrite carries gold perhaps preliminary roasting will ensure a higher gold recovery. In

this eventuality, the presence of the arsenopyrite in the tailings is undesirable. *Surely the mill supt. knows.*

Conclusions

1. The mineralogy apparently represents two separate periods of deposition with possibly a third overlapping period. The temperature of deposition ranges from over 500°C. to less than 250°C.
2. Though there are indications that the silver mineralization is epigene, and may be restricted to shoots in the upper parts of the veins, the gold content should persist, since it is apparently associated with the high temperature mineralization. Moreover the lack of manganese in the sphalerite may also be a criterion of continuing gold values. *Reference*
3. Native silver may be expected in the upper parts of the veins.
4. If gold is present in the arsenopyrite, it is as fractions smaller than 10 microns in diameter.
5. Apparently in milling, the ore is now reduced to the finest size desirable and although further crushing might free more sphalerite from galena, it would also greatly increase the proportion of sphalerite fines and result in a zinc-high lead concentrate. Moreover this excessive grinding would increase the loss of ruby silvers by reduction to particles approaching colloidal sizes.

Recommendations for Future Study

i) X-ray analysis of tetrahedrite to determine if it is silver-bearing.

ii) If the tetrahedrite is argentiferous, a silver assay of a pure specimen should be made. 200 mg. required

iii) A spectographic analysis of arsenopyrite to determine if it is gold-bearing. or make a potassium bisulphate fusion on clean arsenopyrite.

iv.) Super-panning the lead and zinc concentrates to determine if free gold is present.

v) Microscopic analysis of sized fractions of mill samples, with special attention to the presence of silver-bearing minerals in the zinc concentrate.

SKETCHES OF ORE SPECIMENS

No. 1 Vein

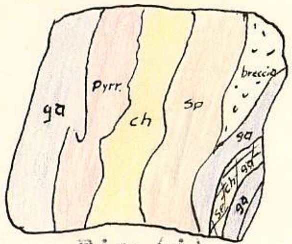


Fig. (i)

Typical banded ore showing some brecciation

X1

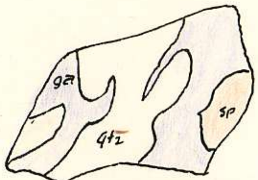


Fig. (ii)

Galena veined through quartz

X1

No. 4 Vein

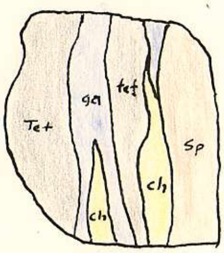


Fig. (iii)

Galena, tetrahedrite, and sphalerite in bands

X1

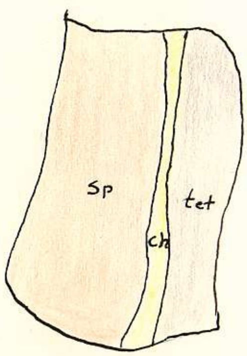


Fig. (iv)

Tetrahedrite band along sphalerite-chalcopyrite contact

X1

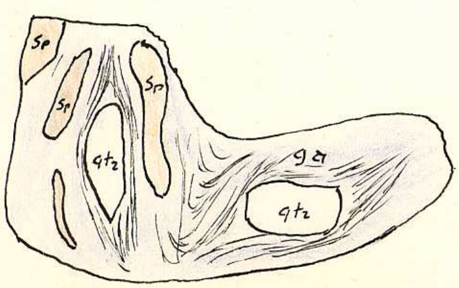


Fig. (v)

Flow of galena and sphalerite around earlier formed quartz

X1

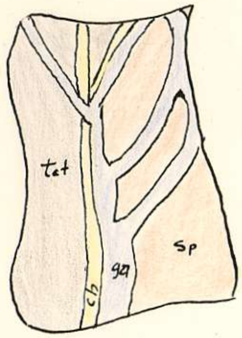


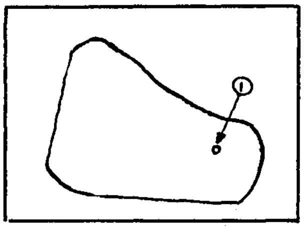
Fig. (vi)

Galena veining through and replacing sphalerite, chalcopyrite, and tetrahedrite.

X1

KEY TO POLISHED SECTION DIAGRAMS

Section 3, No. 1 Vein



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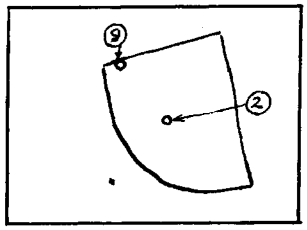

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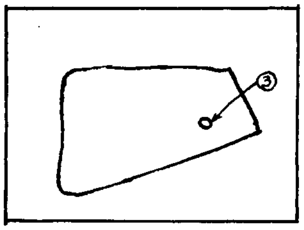

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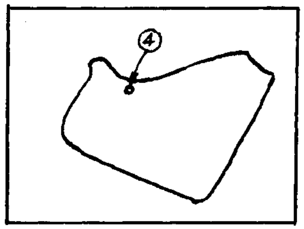

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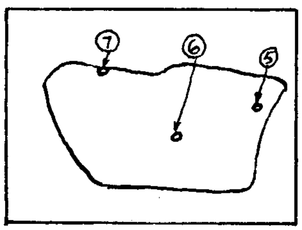

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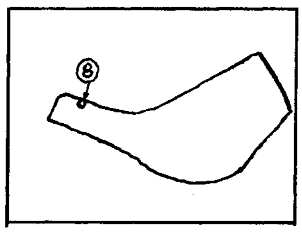

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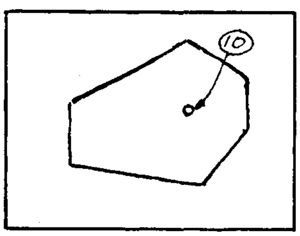

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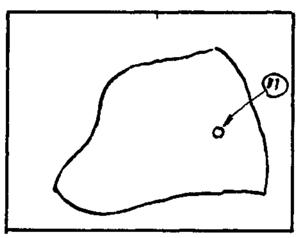


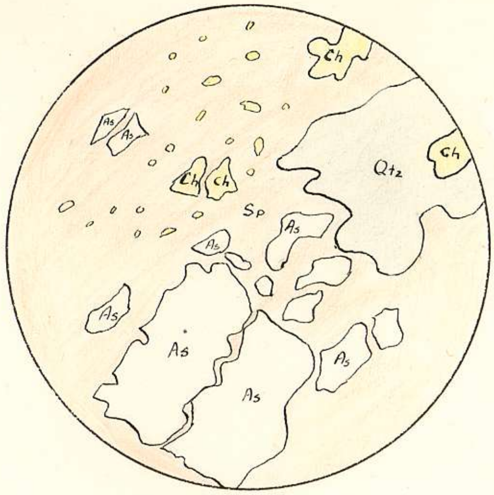


Fig. 1

Brecciation and replacement of arsenopyrite by sphalerite

X60

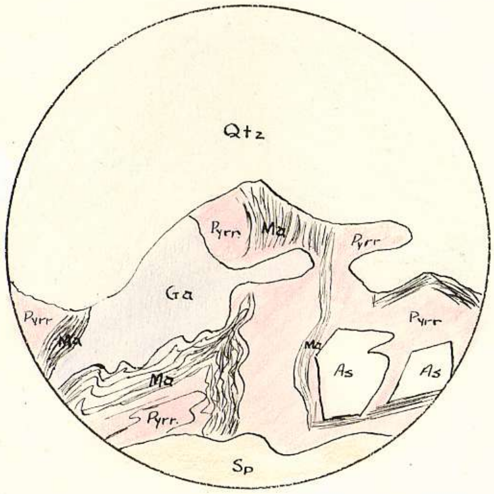


Fig. 2

Lamellar marcasite replacing pyrrhotite which shows earlier replacement of arsenopyrite

X20

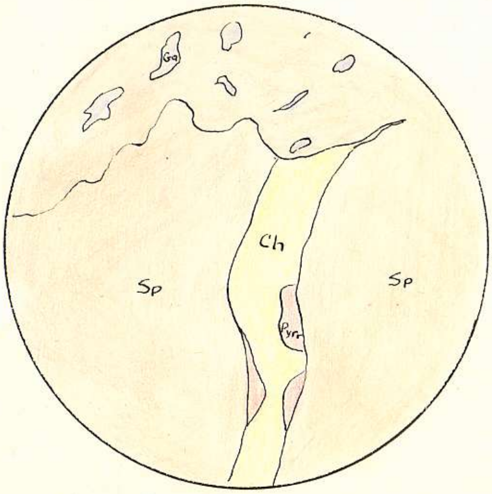


Fig. 3

Chalcopyrite veining through sphalerite

X60

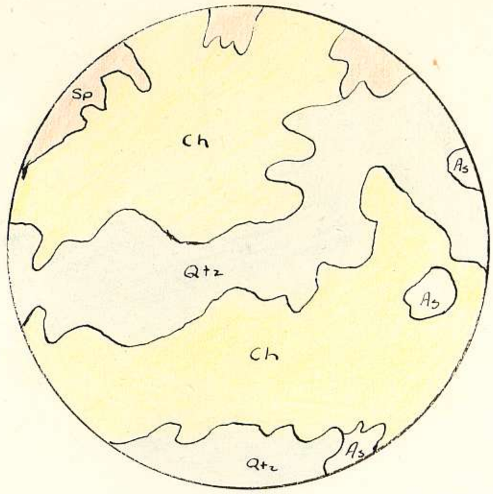


Fig. 4

Chalcopyrite as large masses associated with quartz amd extending into sphalerite. Chalcopyrite and quartz show corrosion of arsenopyrite.

X60

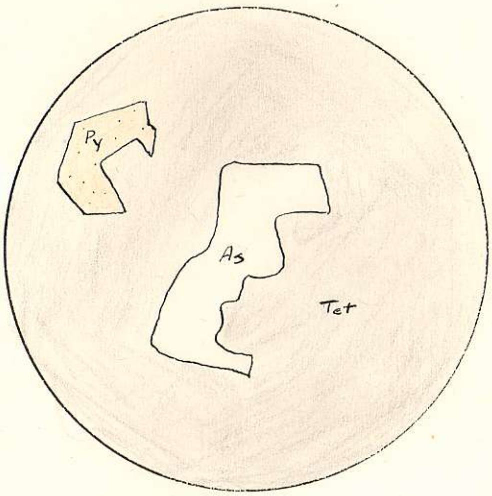


Fig. 5

C orrosion of euhedral arsenopyrite and pyrite by tetrahedrite.

X60

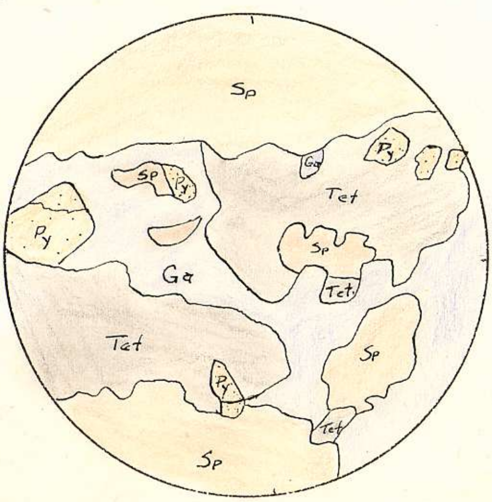
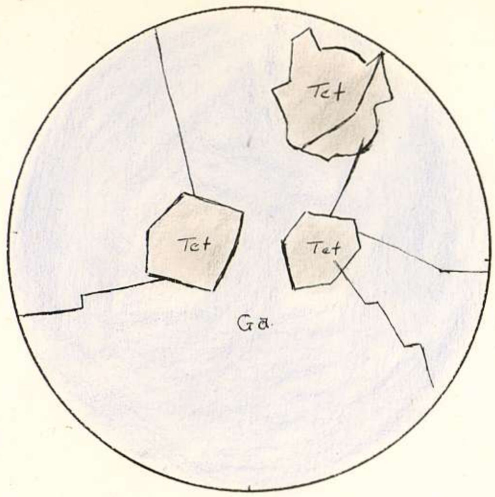


Fig. 6

Galena and associated tetrahedrite veining through sphalerite.

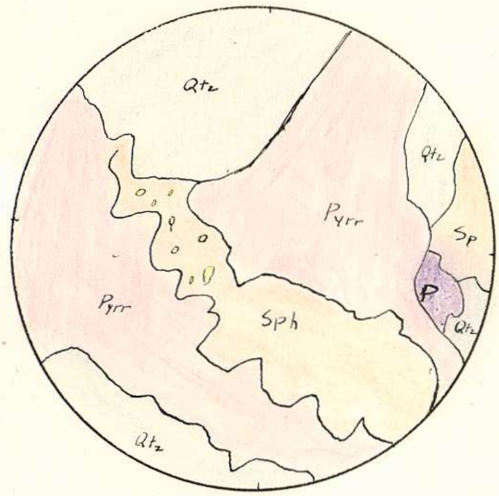
X60



Simultaneous deposition of galena and tetrahedrite or tetrahedrite may be replacing galena along cleavage planes.

X60

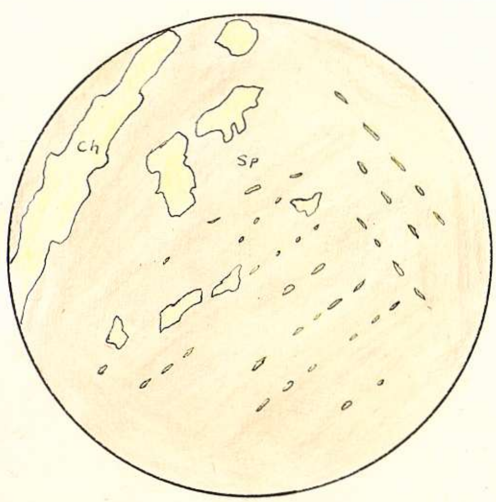
Fig. 7



Sphalerite veining through pyrrhotite

X60

Fig. 8



Exsolution chalcopyrite along crystallographic planes of sphalerite.

X140

Fig. 9

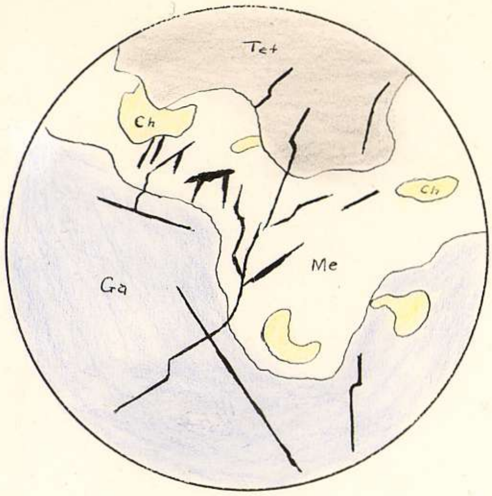


Fig. 10

Anglesite veinlets following cleavage planes in galena, meneghinite, and tetrahedrite.

X60

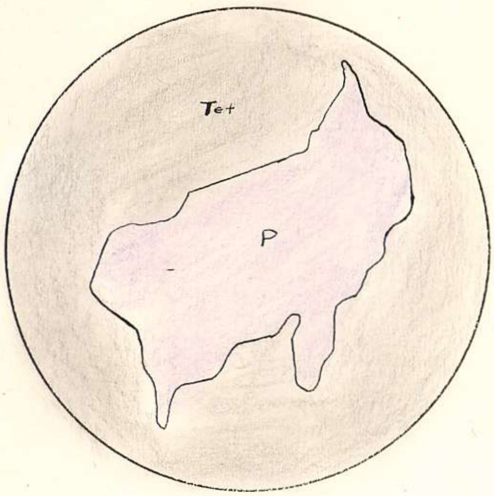


Fig. 11

Pyrargyrite in typical isolated mass in tetrahedrite.

X215

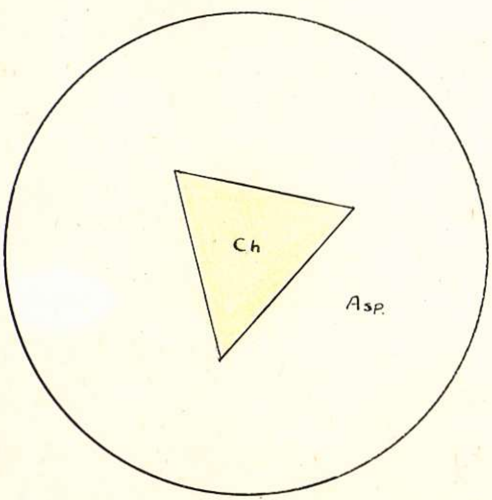
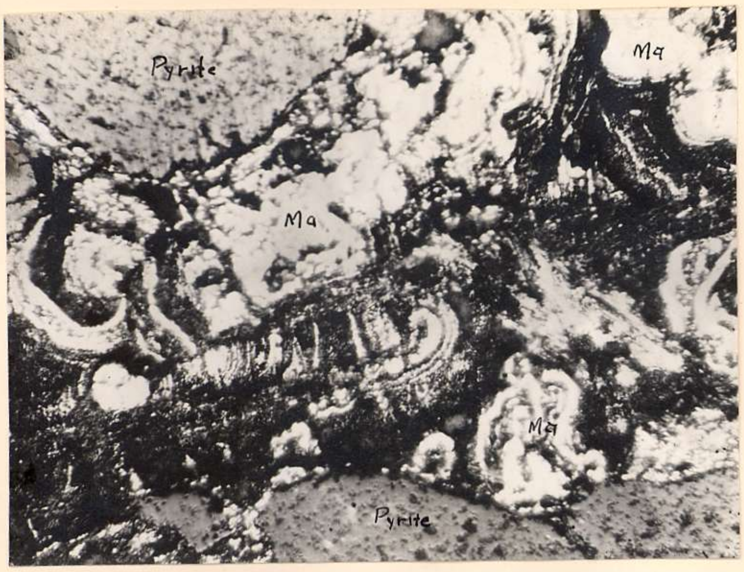


Fig. 12

Idiomorphic chalcopyrite crystal replacing euhedral arsenopyrite grain from core outward.

X625

PHOTOGRAPHS



Irregular composite lamellae of marcasite showing complete replacement of pyrrhotite around pyrite grains.

X215

A

(From Section 4, No. 1 Vein)

Typical mosaic texture of meneghinite in contact with tetrahedrite seen under crossed nicols. Note veinlets of anglesite towards base of photograph.

X215

B

(From Section A, No. 1 Vein)

The above photographs were made with a Leitz microscope and camera assembly. Objective Leitz 3b, Eyepiece 8X

Location and Property Map

(From GSC Memoir 223.)

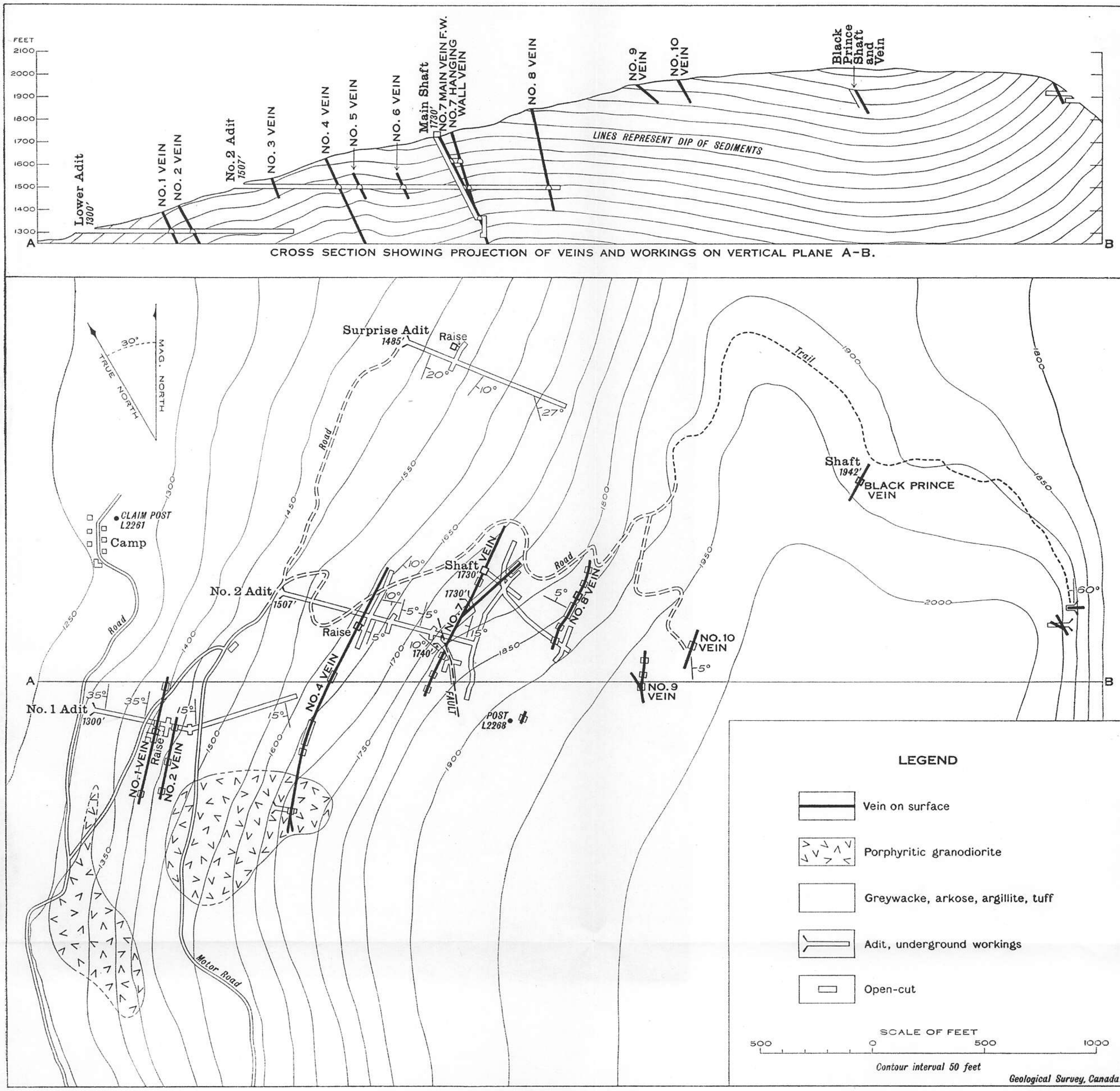


Figure 5. Plan and section of part of the Silver Standard property.

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