A LABORATORY INVESTIGATION OF THE MINERALS
IN THE MISSION GROUP OF CLAIMS
OSOYOOS MINING DIVISION

A report submitted in fulfilment of the requirements of Geology 409

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ACKNOWLEDGMENTS

In the preparation of this report and in the determination of certain minerals I have received assistance from many people. First, to Mr. W.R.Wheeler, who contributed the suite of specimens, I offer sincere thanks and a wish for good luck in the future.

For X-ray spectrometer work I owe thanks to Dr. R.M. Thompson of Toronto and to Dr. S.E. Maddigan and Dr. Batho of the National Research Council. Without their positive identification of the mineral boulangerite, my own work would have been incomplete and almost worthless.

Thanks are also due to J.A.Donnan, for instruction in polishing sections; to J.W. Robinson, for information about the Mission Group of mining claims; to R.H. Seraphim, for advice and general help; and to L.O. Gouin, for his spectrographic work, specific gravity determinations, and various other contributions.

Last but not least I wish to thank the "official helpers", J.G. Fyles and Dr. H.V. Warren, for egging me on to do better work and for showing the right approach to the problems that were encountered.

PURPOSE OF THE INVESTIGATION

Previous workers had listed arsenopyrite, pyrite, sphalerite, chalcopyrite, tetrahedrite, stibnite and an unidentified silver mineral as being the sulphides present in the deposit. The first objective of this work was to determine the silver mineral. As the examination of the specimens progressed, it became evident that the minerals stibnite and tetrahedrite were absent. The mineral for which they were mistaken may also be the "unidentified silver mineral". Most of the work, therefore, has been in the tracking down of this one mineral which proved to be boulangerite.

INTRODUCTION.

LOCATION AND ACCESSIBILITY

The Mission Group of claims lies about three miles west of Hedley, in the Osoyoos Mining Division. There is no road to the property and at the present time all supplies must be taken in by pack-horse along a five mile trail from Hedley. The claims are at elevations of 4,000 to 4,700 feet above sea level on rather steep hillsides. Nearby creeks could supply more than enough water for mining operations and timber is also plentiful.

HISTORY OF THE DEPOSIT

The following table will show the chief events in the history of the deposit:

1860 - The Hedley area was first prospected.

1910 - The main showing on the Mission Group was staked.

1932 - 43 The claims were held jointly by Messrs. Winkler, Walker, and Barnes of Hedley. These men dug several shafts and trenches.

1943 - The claims lapsed.

1944 - W.R. Wheeler restaked the claims. Chas. Ney examined the property and mapped the workings on the main showing to a scale of 1 inch equals 50 feet. The workings at that time consisted of six shafts, five trenches, and 25 test pits.

1946 - W.H.Young and J.W.Robinson, under the direction of A.R.Allen, spent the summer mapping the claims of the Mission Groups, cleaning out caved pits and trenches, and digging new trenches.

REGIONAL GEOLOGY

A thick series of quartzites, argillites, limestone, and pyroclastics presumed to be of Carboniferous age is the oldest group of rocks in the Hedley area. No identifiable fossils have been found in these rocks so the determination of their age is based on a lithological comparison with the Lower Cache Creek Series of the Ashcroft Map-Area. These sedimentary rocks have been divided into four formations. Camsell (1910, p.22) described them as follows:

4. Aberdeen Formation "thin bedded limestone, quartzite, argillite, and volcanic material."
3. Red Mountain Formation "andesitic tuffs and breccias."
2. Nickel Plate Formation "massive limestone at the top and bottom and impure limestone and quartzite between."
1. Red-top Formation "massive limestone, interbedded quartzite siliceous argillite, and volcanic tuff and breccia."

At some time near the end of the Paleozoic, the region was uplifted into a broad anticline whose axis stretched north and south. During the Mesozoic era masses of diorite and gabbro were intruded. Again, in Tertiary times, more plutonic rock was intruded. A large granodiorite batholith of this age virtually isolated the Carboniferous sedimentary rocks.

LOCAL GEOLOGY

The predominant country rock is a brownish-gray, mediumgrained biotite granodiorite. It contains a few roof pendants of argillaceous sedimentary rock and is cut by several andesitic dikes.

Three principal shear zones, entirely within the granodiorite, carry the sulphide mineralization. In these shear zones the granodiorite is altered to a whitish granular material in which quartz, white mica, chlorite, epidote, and calcite can be recognized. The deposits are highly leached and oxidized at the surface. Since they have neither been drifted on nor diamond drilled and since the mineralization has not been explored deeper than ten feet, nothing is known of their depth or the changes in mineralization with depth. The largest mineralized body is that on Mission No. 2 M.C. It has been explored by six shafts and 45 trenches and test pits.

The "weighted average" assay of nine samples taken by Ney in 1944 was:

Gold	0.02 oz/ton
Silver	7.0 oz/ton
Zinc	0.3 per cent.

The "weighted average" assay of 20 samples taken by Young and Robinson in 1946 was:

Gold	0.03 oz/ton
Silver	7.2 oz/ton
Zinc	0.7 per cent

LABORATORY INVESTIGATIONS

DESCRIPTION OF SAMPLES.

MEGASCOPIC EXAMINATION

Sample 1

This sample was taken from No. 1 and No. 2 Shafts and consists of five specimens:

(a) An altered quartz-sericite matrix containing isolated, coarsely crystalline blebs of arsenopyrite, pyrite, and minor sphalerite. Some of the pyrite crystals exceed 1/4 inch in diameter. The specimen is cut in two by an irregular vein, about 1/2 inch wide, containing clear to grayish, glassy quartz and coarse, euhedral arsenopyrite. On weathered surfaces of the specimen sericite flakes show clearly and the quartz has a bleached, white appearance. Yellowish-green oxidation stains seem to come from the arsenopyrite and reddish iron oxide stains surround weathered blebs of pyrite. The specimen contains approximately:

15% arsenopyrite
15% sericite
70% quartz.

(b) A specimen similar to (a) but with the arsenopyrite dispersed in irregular shaped masses throughout the quartz-sericite matrix. Pyrite is more abundant and occurs in larger crystals than in specimen (a). Unleached arsenopyrite appears grayish black on a weathered surface.

The specimen contains approximately:

45% arsenopyrite

5% pyrite

50% quartz-sericite.

(c) A similar quartz-sericite matrix in which fine grains of sphalerite and larger blebs of arsenopyrite are disseminated. The specimen is cut by several irregular veinlets of clear grayish quartz with which the arsenopyrite seems to be associated.

(d) Massive arsenopyrite and sphalerite, split into irregular shapes by pieces of quartz-sericite matrix and by a dark greenish band near one side. This green material may be part of an altered andesite dike. Fine irregular veinlets of arsenopyrite and glassy quartz cut the quartz-sericite matrix. The specimen contains approximately:

65% arsenopyrite

5% sphalerite

30% quartz-sericite.

(e) This specimen is similar to (a) but without the veinlet of quartz and arsenopyrite.

No assays are available for No. 1 and No. 2 shafts from which sample 1 was taken. A sample from near No. 2 shaft assayed o.10 oz/ton gold, 8.40 oz/ton silver and 5.60 % zinc.

Sample 2

Sample 2 consists of four specimens taken from No. 3 and No. 4 pits:

(a) This specimen consists of the quartz-sericite matrix cut by parallel veinlets of clear quartz, pyrite, arsenopyrite, and sphalerite. Pyrite and sphalerite also occur in very coarse grained irregular masses independent of the veins. The specimen contains approximately:

10% arsenopyrite

25% sphalerite

15% pyrite

50% quartz-sericite

(b) Similar to (a)

(c) Apparently this specimen was taken from the edge of a vein. Progressing from the edge to the center the following layers or encrustations are present:

1/8 inch of clear quartz containing some arsenopyrite.

1/2 inch sulphide zone - mixed arsenopyrite, pyrite and sphalerite.

1/2 inch of quartz

a thin irregular band of pyrite

1/2 inch or more of solid sphalerite.

The specimen contains approximately:

5% arsenopyrite

55% sphalerite

10% pyrite

30% quartz.

(d) This specimen is composed of the quartz-sericite matrix with small masses of very coarsely crystalline sphalerite and pyrite. Some arsenopyrite is disseminated through the specimen. It is weathered at the surface to a rusty brown.

The specimen contains approximately:

5% arsenopyrite

10% sphalerite

15% pyrite

60% quartz-sericite.

Assays from No. 3 and No. 4 pits gave up to 0.15 oz/ton gold, 4.40 oz/ton silver, and 9.10 % zinc but other assays showed only negligible amounts.

Sample 3

Three specimens of more or less massive arsenopyrite and pyrite from No. 1 Shaft comprise sample 3. The specimens contain approximately:

80% arsenopyrite

10% pyrite

10% quartz-sericite

Sample 4

This sample is made up of 12 large specimens and several smaller ones that are highly leached and stained by oxidation products. The arsenical parts give a whitish to yellowish green powder that fills a crystal boxwork left from the weathering of arsenopyrite from a quartz matrix. Some specimens show a hard, yellowish green material resembling epidote occurring as fine cherty bands or as very small botryoidal protuberances on coatings inside vugs and boxworks. The sericite shows prominently on freshly broken surfaces of weathered material and as usual, the pyrite weathers to a rusty limonitic powder.

Sample 4 was taken from No. 5 shaft. Other samples taken from the same place assayed 0.12 oz/ton gold, 6.30 oz/ton silver and 0.30% zinc.

Sample 5.

This sample consists of two specimens, one from a weathered and one from an unweathered piece of better grade ore. The weathered specimen appears to be a breccia of siliceous altered granodiorite. The second specimen is a small slab consisting almost entirely of boulangerite which had apparently been taken from a narrow sulphide vein. At one edge of it a fringe of long quartz needles projects into the boulangerite. Perfectly formed pyrite and quartz crystals are completely surrounded by the boulangerite. Tiny fractures make an angle of about 65 degrees with the side of the vein and hair-thin veinlets of quartz follow fractures in the boulangerite parallel to the vein wall. The boulangerite weathers to a dark gray powdery surface. No assays of this type of sample are available.

MICROSCOPIC EXAMINATION

Sections 1A and 1B

In sections 1A and 1B the chief minerals are arsenopyrite and quartz which are present in about equal proportions. A small amount of sericite is found somewhat irregularly mixed with the quartz, particularly in section 1A.

Two ages of quartz are indicated in section 1B. Several crystals of arsenopyrite are severely fractured. Quartz fills these fractures and isolates many small chips of the arsenopyrite. In another part of the section an isolated crystal of arsenopyrite appears precisely at the intersection of two fractures traversing the quartz. Sericite seems to replace the older quartz, the arsenopyrite, and also the younger quartz. Though it is difficult to distinguish between the two types of quartz, the younger quartz usually has a finer grained texture, is less fractured, and consequently takes a smoother polish.

The age sequence is:

1. Quartz
2. Arsenopyrite
3. Qtz
4. Sericite

Section 2A

This section contains arsenopyrite, sphalerite, pyrite, quartz, and small amounts of either calcite or sericite or both. Arsenopyrite and pyrite appear to be the first minerals. Pyrite has been partly replaced by sphalerite and quartz appears to be the latest of all. Under high power, small specks of a soft yellow mineral can be seen in the sphalerite. The particles were too small to permit positive identification but they have been assumed to be chalcopyrite. Thread-like streaks of this pale yellow mineral cut the sphalerite but were not observed in contact with other minerals.

The age sequence is:

1)
) Arsenopyrite and pyrite
2)

3 Sphalerite

4)
) Quartz and chalcopyrite.
5)

Section 2B

Half of this section is quartz and the remainder is made up of pyrite, sphalerite, and a minor amount of arsenopyrite. More small yellow specks were observed in the sphalerite and two grains of a soft white mineral were seen in the pyrite. These grains were both subhedral and roughly triangular. They are probably boulangerite but elsewhere the boulangerite occurs mainly as fine needles in quartz. The age sequence is the same as for section 2A.

Section 3A

Arsenopyrite, quartz, and sericite are the only minerals visible in this section. Much of the arsenopyrite is very coarsely crystallized in sharp euhedral forms.

The age sequence is:

1 Arsenopyrite

2 Quartz

3 Sericite.

Section 3B

This section contains arsenopyrite, pyrite, quartz, and minor amounts of sericite and sphalerite.

The age sequence is:

1)
) Arsenopyrite and pyrite
2)

3 Sphalerite

4 Quartz

5. Sericite.

Section 4A

This section is almost entirely quartz with only a few crystals of arsenopyrite and one or two needles of boulangerite.

Section 4B

This section is composed mostly of quartz but it contains appreciable amounts of arsenopyrite and several bunches of randomly oriented boulangerite needles. None of these needles are longer than one millimeter and most are between 0.1 mm. and 0.5 mm.

The age sequence in sections 4A and 4B is:

1 Quartz

2 Arsenopyrite

3 Quartz

4 Boulangerite.

Section 5A

Boulangerite is the principal mineral in this section but pyrite, arsenopyrite, and quartz are also present. Much of the quartz occurs in large euhedral crystals. The boulangerite intrudes some of the quartz grains and in several instances it occurs as long slender needles projecting inwards in random directions from the crystal surface. The boulangerite also replaces some pyrite but none of the pyrite is seen to replace boulangerite. Although it replaces some quartz, the boulangerite is veined extensively by tiny, dendritic quartz veins which also cut the older quartz crystals. Most of the euhedral quartz crystals have one well shaped rhombohedral termination.

The age sequence is:

1)
) Arsenopyrite and pyrite
2)

3 Quartz

4 Boulangerite

5 Quartz

Section 5B

On the whole, this section is very similar to section 5A. Some of the pyrite crystals that are partly or entirely surrounded by boulangerite contain numerous boulangerite needles that seem to be separated from the main mass by a solid shell of pyrite. The age relations are the same as for section 5A.

MICROCHEMICAL WORK

To supplement the polished section examinations, repeated efforts were made to obtain a silver test by microchemical methods. The plan was to locate the silver by this means and then identify the mineral by some other tests. However, all the silver tests that were made gave negative results. The small amount of silver (one part in 3,400) was not enough to give a convincing test.

DETERMINATION OF BOULANGERITE

MICROCHEMICAL

When etch tests failed to confirm galena, which was suspected from first appearances, microchemical methods were used to help determine the composition of the mineral. The following tests were made:

(a) Method:- Mineral dissolved in 1:1 HNO_3
— leached with 1% HNO_3
Crystal of $(NH_4)_2 Cr_2 O_7$ added.

Result:- The solution turned yellow and numerous small, moss-like clumps began to grow. The fibres of these mossy crystallites gradually straightened out into two sets of dendritic branches roughly at right angles to each other.

Conclusion:- The test gave a negative result for silver.

(b) Method:- Mineral decomposed with 1:1 HNO_3
— evaporated.

Result:- A lead nitrate lattice was formed.

Conclusion:- The mineral contained lead. This fact was confirmed by a Kl test.

(c) Method:- Mineral decomposed with 1:1 HNO_3
— leached with 1:5 HCl
A crystal each of Kl and CsCl added.

Result:- Large clear yellow and orange hexagons appeared.

Conclusion:- The mineral contained antimony.

(d) Method:- Mineral decomposed with 1:1 HNO_3

—leached with 1% HNO_3

Drop of KH_9 $(CNS)_3$ added.

Result:- Long, slender, yellow blades of copper mercuric thiocyanate appeared. Concentrating the solution produced a few moss-like clumps.

Conclusion:- The mineral contained a small amount of copper.

These tests were all repeated at least twice. The properties as determined at this stage fitted jamesonite, boulangerite, meneghinite, or semseyite, but the copper made meneghinite seem the most probable.

ETCH TESTS

Etch tests were given a thorough trial but were found to be inconclusive. A comparison with Short's descriptions of etch reactions for boulangerite is given below:

HNO_3 (Short) "effervesces; surface stains black; action often slow in starting"

(Lab. Test) Well polished, clean surfaces darken immediately and after about five or ten seconds a wave of effervescence sweeps outward from some part of the drop. The final result is a brownish gray stain with a bright iridescent fringe. Irregular patches of otherwise ordinary mineral remain unstained and show distinctly white against the etched part.

HCl (Short) "fumes tarnish slightly some specimens; others negative."

(Lab Test) Almost always negative - sometimes a faint iridescence is produced.

KCN

$FeCl_3$ (Short and lab. tests) negative.

KOH

$Hg\ Cl_2$ (Short) "negative"

(Lab.Test) After about 1-1/2 minutes, a bluish iridescent stain is produced. The reaction sometimes takes longer but in all tests a bright iridescent stain appears just before the drop dries up.

Aqua Regia (lab test) effervesces slowly; stains black; fumes tarnish iridescent.

SPECIFIC GRAVITY

A number of specific gravity determinations were made to prepare a sample pure enough to test by the X-ray spectrometer. The average specific gravity of several fragments was found to be , though individual values ranged from 5.92 - 6.16. The specific gravity of the pure mineral is

SPECTROSCOPE

A spectroscope analysis by Gouin showed the following elements in addition to Pb, Sb, and S;

X-RAY SPECTROMETER

Confirmation of boulangerite came from two X-ray spectrometer tests - one by Thompson at the University of Toronto and the other by Batho of the National Research Council of B.C.

CHEMICAL ANALYSIS

A sample was submitted for chemical analysis but the results were unavailable at the time of writing.

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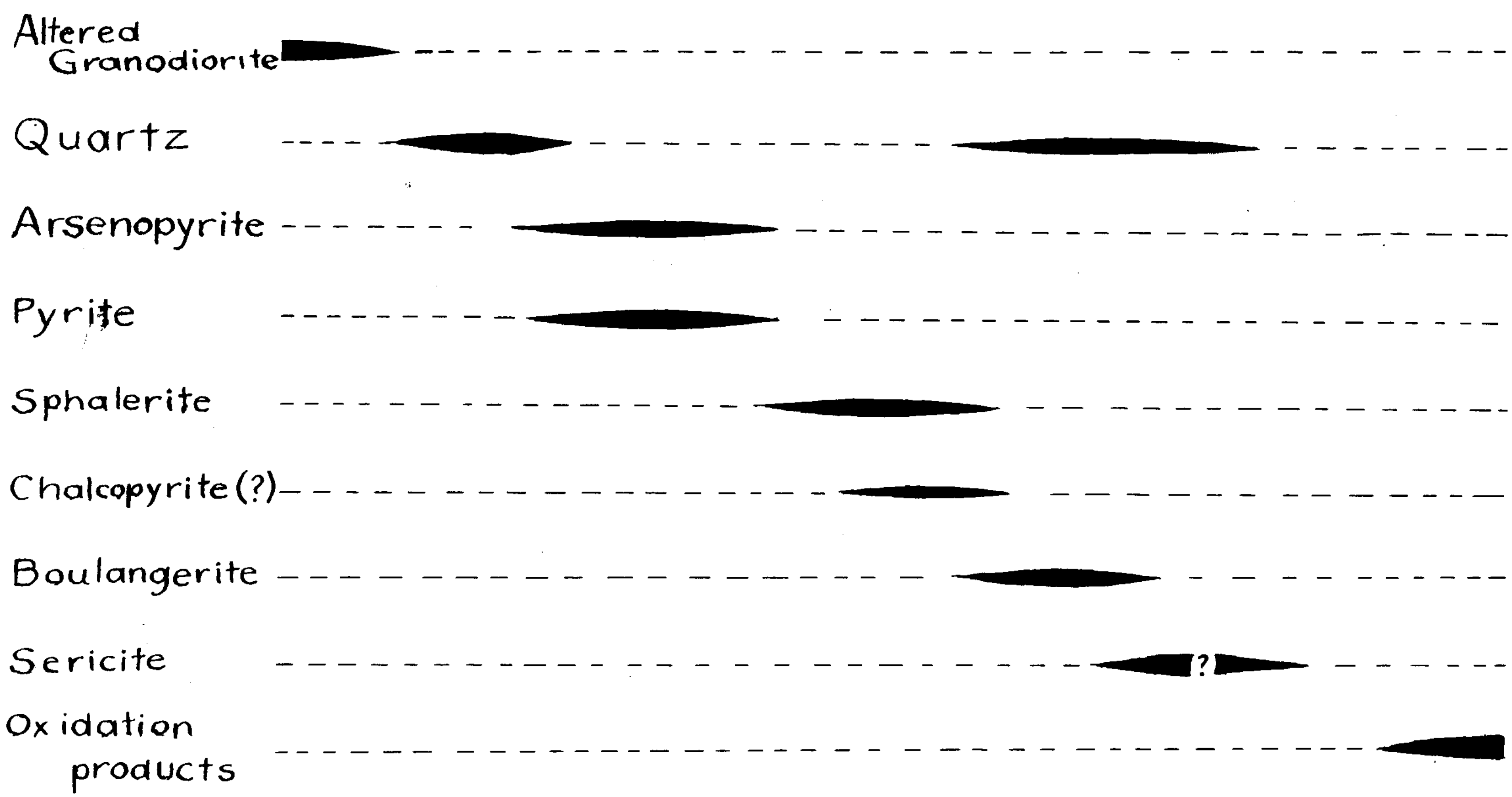
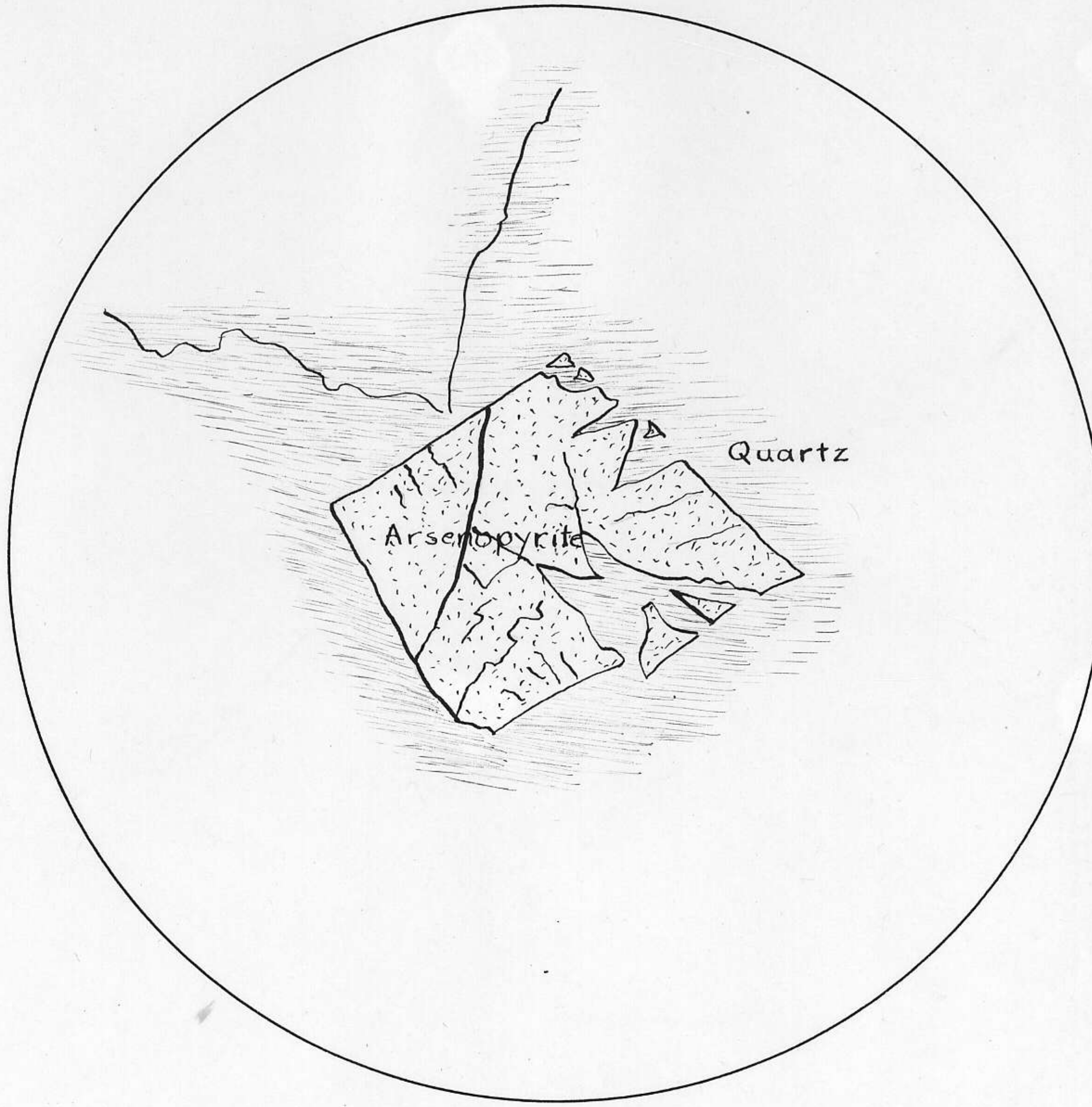
Fig. 1. PARAGENESIS

OF MISSION GROUP MINERALS





X 100

Fig. 2 Sketch showing quartz replacing arsenopyrite.
Section 1B

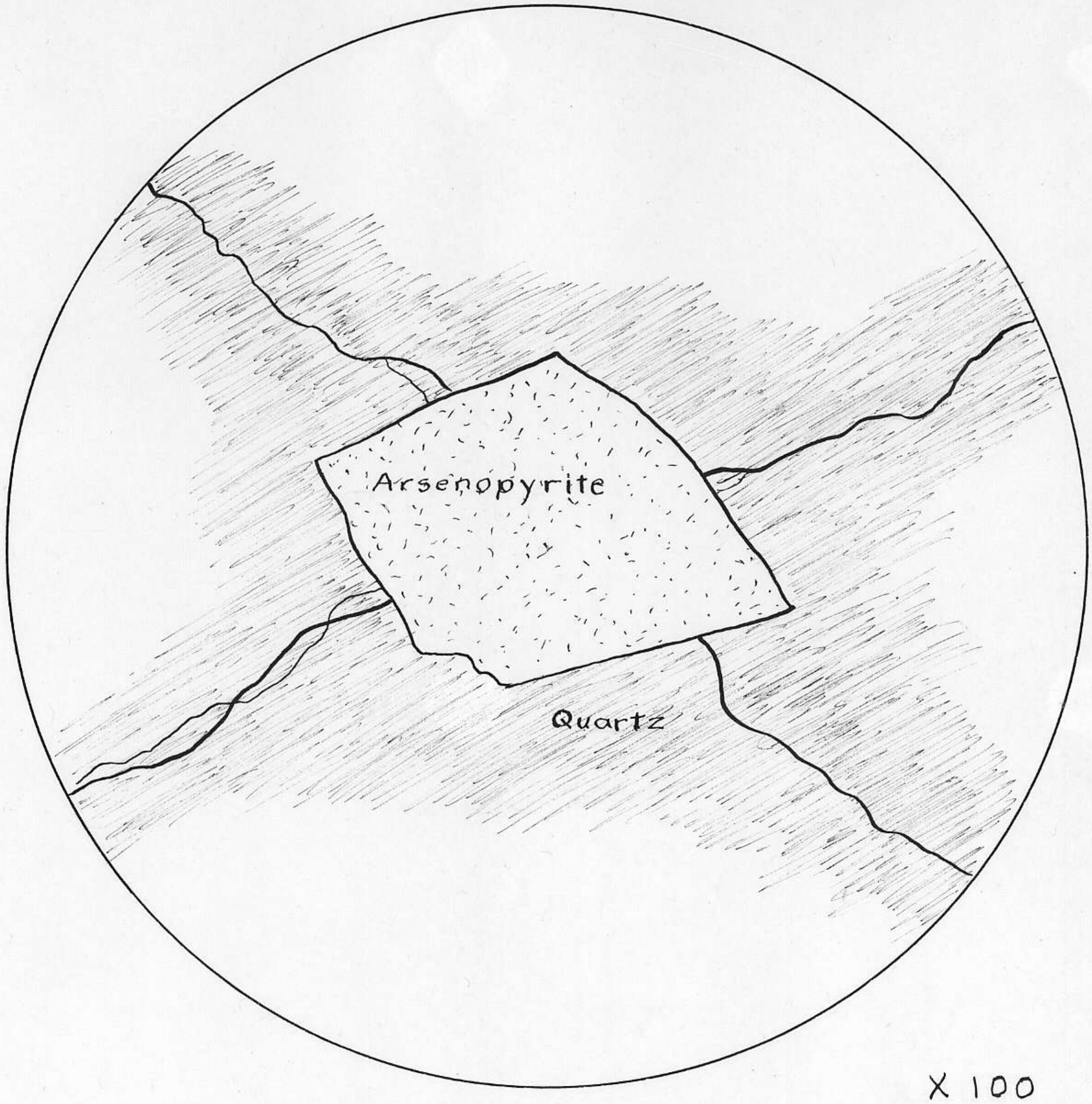
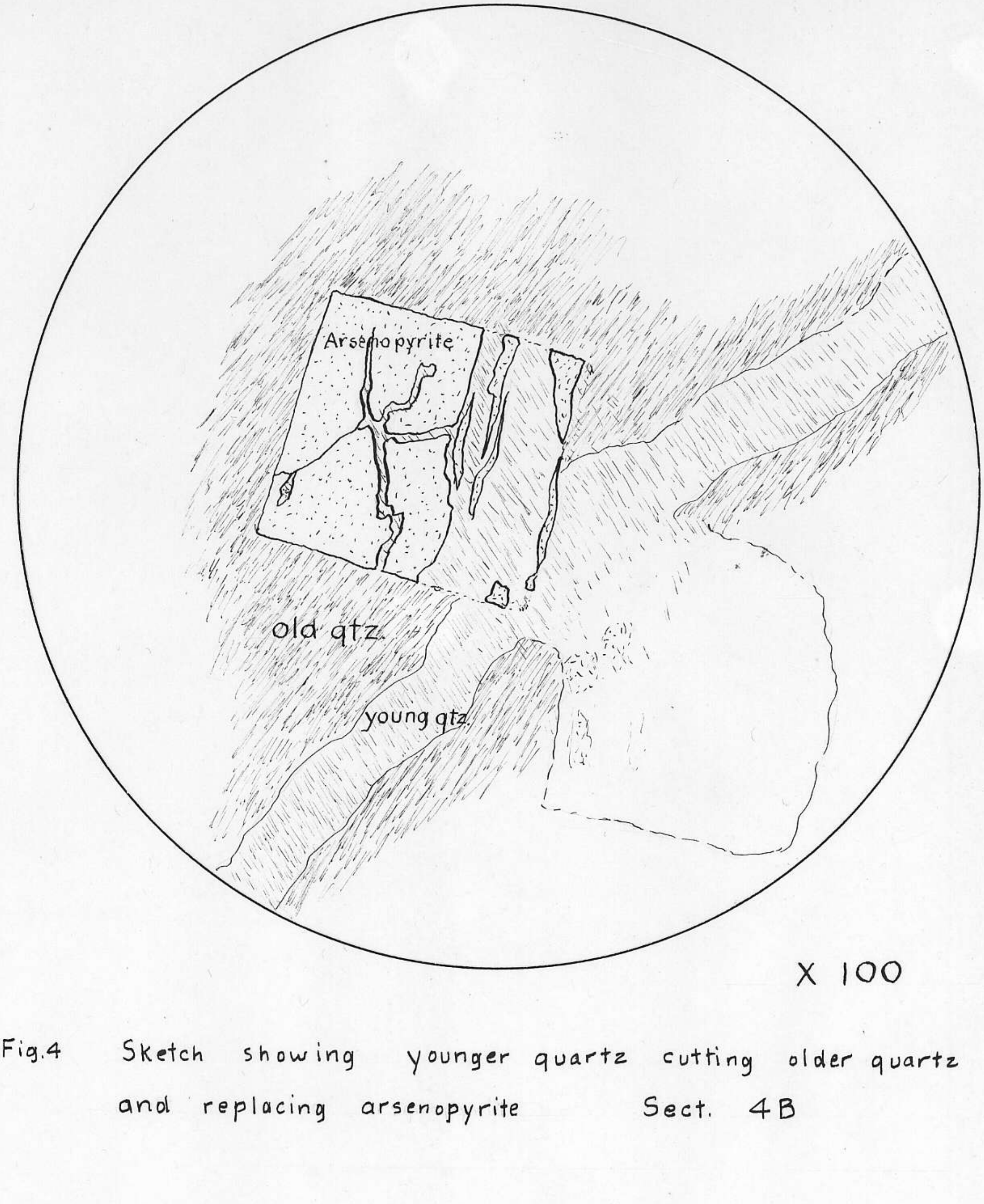
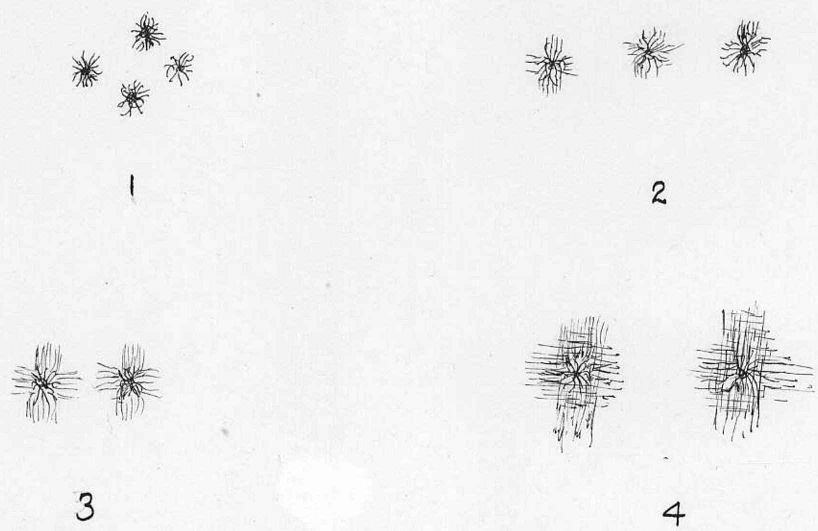


Fig. 3 Sketch showing arsenopyrite that is probably younger than the quartz surrounding it. Section 1B



X 100

Fig.4 Sketch showing younger quartz cutting older quartz and replacing arsenopyrite Sect. 4B



A series of sketches illustrating the growth of the mossy dendrites obtained during the ammonium bichromate test for silver.

Fig. 5.

Microscope 52 Leitz

Ocular No. 4

Objective No. 3

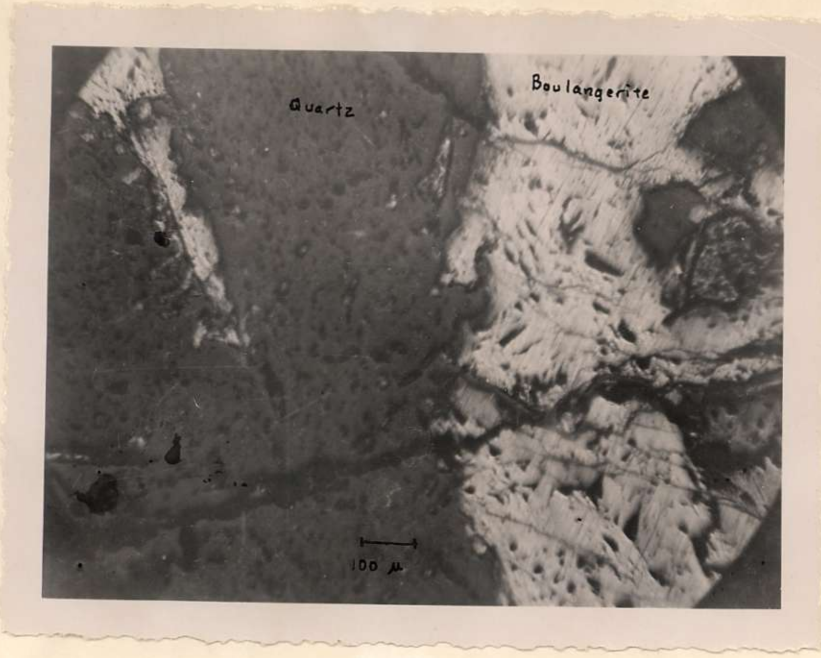
Direct Illumination

Magnification 72 x

Exposure 55 sec.

Shows boulangerite, partly etched with HNO_3, and a small quartz veinlet cutting the boulangerite.

Plate I



Microscope 52 Leitz

Ocular No. 4

Objective No. 3

Direct Illumination

Magnification 72 X

Exposure 45 sec.

Shows boulangerite replacing quartz and a quartz veinlet cutting the boulangerite.

Plate 2

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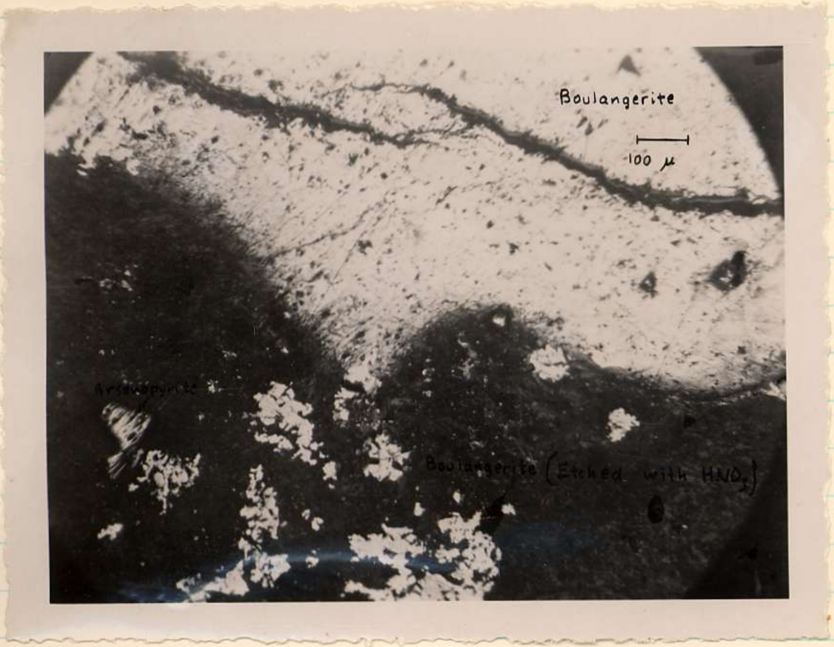

Microscope 52 Leitz

Ocular No. 4
Objective No. 3
Direct Illumination
Magnification 72 X
Exposure 55 sec.

Shows boulangerite, partly etched with HNO_3, and a small quartz veinlet cutting the boulangerite.

Lee, J.W.

Microscope 52 Leitz

Ocular No. 4

Objective No. 3

Direct Illumination

Magnification 72x

Exposure 45 sec

Shows boulangerite replacing quartz and a quartz veinlet cutting the boulangerite.