Report On

AGE RELATIONS OF METALLIC MINERALS IN ORE OF THE BLUE BELL MINE.

By

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5th Year Metallurgy.

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ACKNOWLEDGMENTS

1. The writer wishes to thank Mr. H.S. Fowler for his information regarding some of the rarer minerals in the ore.

2. S.J. Schofield - Memoir 117, "Geology and Ore Deposits of Ainsworth Mining Camp", G.S.C., 1920.

3. J.F. Walker - Summary Report, Part A, G.S.C., 1928 - "Kootenay Lake District".

4. "Criteria of Age Relations" - by Lindgren, Gratton and Short.

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Introduction.

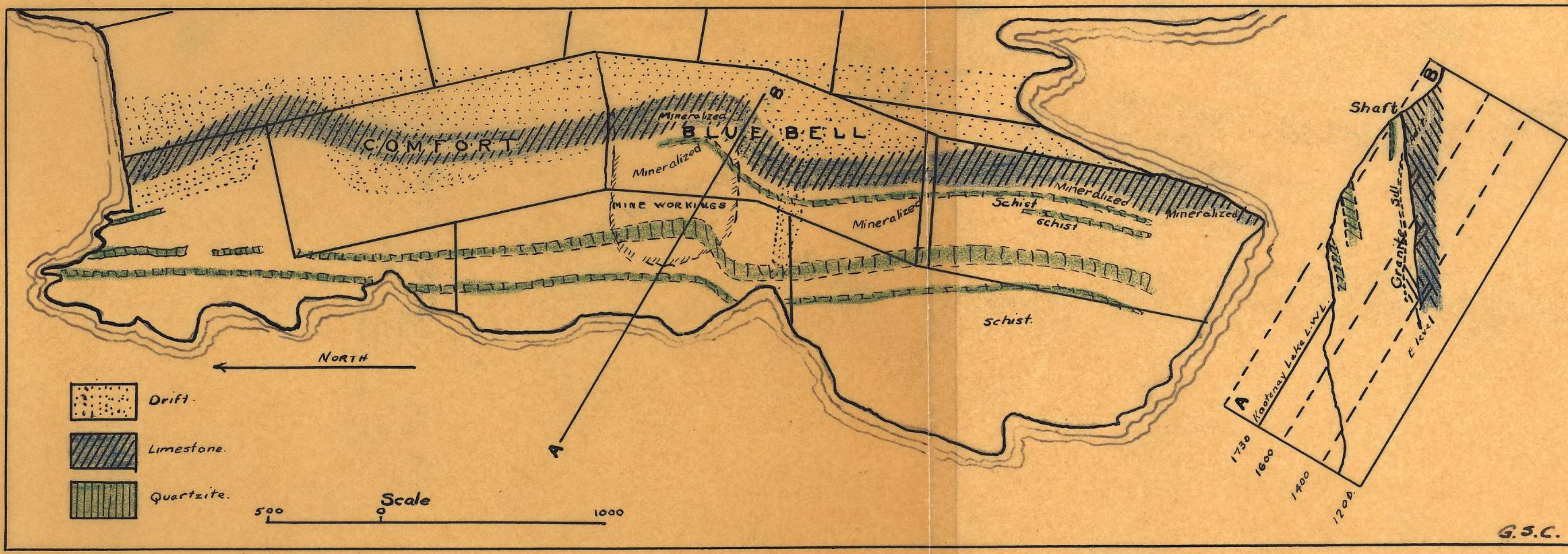
This paper is a report on the investigation of the age relations of the metallic minerals in the ores of the Blue Bell Mine, which was carried out during the spring of 1933 at the University. This work was done in conjunction with an investigation of milling methods for the same ore, made during the same time. The microscopic examination of the polished sections gave some very practical hints for grinding in the milling treatment since it showed the intimate relationship of sphalerite and chalcopyrite.

History.

The Blue Bell mine at Riondel, B.C., on the east side of Kootenay lake, is one of the oldest mining properties in B.C., having been known as far back as 1825. It was not until 1887 that development actually started, when Dr. Hendryx and an American company staked the property and built a mill. The mine produced about 52,000 tons of ore up until 1894.

In 1905, S.S. Fowler in the employ of the Canadian Metal Company, reopened the mine and worked it until 1917, during which time about 320,000 tons of ore were mined. In 1924, S.S. Fowler and B.L. Eastman acquired the mine, renovated the mill with flotation, and until 1927, when the mine was closed down, they mined some 60,000 tons more.

Up to the present the development of the Blue Bell has been confined to the main ore showing in which three irregular ore bodies have been mined out. This means that



BLUE BELL MINE, RIONDEL.

J McCurrie

before mill feed can be maintained, or the mill thoroughly renovated, considerable development must be carried out.

General Geology. (See Plate 1.)

Walker states that the strata in the vicinity of the Blue Bell area belong to the Lardeau series which is a subdivision of the Windermere series and thought to be Pre-Cambrian in age. Schofield believes them to be Palaeozoic; possibly a carboniferous or pre-carboniferous series of their own. Recent work and opinion, however, seems to favor the former classification.

The strata are a series of slates, schists, quartzites and several bands of limestone striking north and dipping on an average 35° west, with a maximum thickness of 15,000 feet. The rocks are variously metamorphosed due to the proximity of the granite rocks of the Nelson batholith, which, Schofield says, ranges in age from Jurassic to Tertiary.

The batholith is chiefly granite and grano-diorite. Numerous tongues of porphyritic granite and pegmatite are injected along the bedding and joint planes of the Lardeau series from Crawford Bay north.

Economic Geology.

The deposit at the Blue Bell is a lead-zinc one, silver only being in very small amounts. Analyses,which I made, showed the following:

Pb	7.4%	Zn	5.3%	Ag	2.8 oz. per ton
Fe	29.6%	S	20.2%	Insoluble	23.2%

The ore is associated with the upper band of limestone which is about 200 feet thick. The deposits occur as irregular pipe-like or square-sectioned replacements in the limestone.[1] The conditions of temperature and pressure were extreme in this deposit and as a result the contact-metamorphic mineral diopside is quite common.[2]

The primary ore minerals in order of decreasing abundance are pyrrhotite (and pyrite ?), galena, sphalerite, arsenopyrite and chalcopyrite. The gangue is chiefly quartz and calcite.

A sill of coarse granite has been intruded along or near the contact between the limestone and the overlying schists. Several small granitic dykes cut the limestone. It is generally believed that these intrusions are pre-mineral and have partly controlled ore deposition. Pronounced joints are present in the limestone and they also have exercised some influence on mineralization. Small rolls along the strike and down the dip appear to have acted both as channels for, and barriers to, the movement of the mineralizing solutions. Some beds in the limestone have not been as favorable to replacement as others.

Apparently the mineralizing solutions emanating from the granite in the pneumatalytic stage of cooling (since

1. Walker, J.F. Summary Rept. G.S.C. 1928, Part A.
2. Schofield, S.J. Memoir 117. G.S.C. 1920.

fluorite is a common gangue mineral in the Ainsworth area[2]) ascending along fractures and bedding planes, found the granite sill and schists an almost impervious barrier and were forced to follow the limestone. The pre-mineral dykes also formed local barriers. The mineralizing solutions working along the joints and bedding planes replased the limestone where conditions were favorable. Some joints appear to have acted as local barriers toward the mineralizing solutions; possibly clay gauge was present and made an impervious layer. There is a suggestion that small rolls along the strike acted as channels tending to confine the mineralizing solutions to structures concave toward the ascending solutiona. There is also a suggestion that small rolls down the dip acted as temporary dams, causing the solutions to precipitate their minerals on the steeper parts of the local structures.

Wall rock alteration was fairly intense, quartz and ankeritic carbonates replacing the limestone. The pre-mineral dykes have been considerably altered, sericite, muscovite, quartz and calcite being present in large quantities. Near the ore, hornblende, bistite and feldspars have changed to chlorite and serpentine.

Oxidation extends to the lowest workings of the mine and has resulted in the leaching of pyrite, pyrrhotite and some sphalerite.

<u>Preparation of Samples.</u>

All the samples used, with the exception of one collected by myself, were collected in 1925 by Jackson. As these samples were from the oxidized zone of the mine and have been in the open for seven years, they are much decrepitated. The result was that the polishing was very difficult and in some cases, very unsatisfactory.

It was found that, for the best results, grinding should be started on the 303 lap. This is preferable over the coarse lap which ruins the structure of the sample. The grind on the 303 lap is followed by a long polish on the glass plate with "Tripoli powder" and a final polish in the usual manner with chrome oxide.

Megascopic Examination of Samples.

B 18. A good grade of lead ore, containing galena, sphalerite, pyrrhotite and arsenopyrite.
The galena was present as large crystals, the pyrrhotite was massive, while the blende, which was brown in color was very "patchy".

B 19. Possibly secondary galena, from above the adit level of the mine. The galena was well crystallized and might be used for assay purposes.

B 20. A sample showing galena and blende interbanded with pre-mineral dyke and quartz. The blende was very dark, probably black-jack. Galena and pyrrhotite were abundant and could be used for assay purposes. A small amount of chalcopyrite could be seen.

B 21. This sample was made up of blende and pyrrhotite, with a small amount of chalcopyrite.

B 22. An ore specimen showing galena, blende, arsenopyrite, pyrrhotite and quartz.

B 23. An ore specimen showing pyrrhotite, calcite, sphalerite, galena, some chalcopyrite and arsenopyrite in quantities large enough for assays.

B 24. A mixture of massive arsenopyrite and pyrrhotite.

X. An intimate mixture of sphalerite and quartz (well crystallized) with a little chalcopyrite and arsenopyrite.

<u>Microscopic Examination</u>.

The specimens examined microscopically were only those showing primary minerals.

<u>B 18</u>.

(a) Shows galena veining pyrrhotite and quartz. The pyrrhotite is embaying on the quartz.

(b) Shows galena embaying on sphalerite.

<u>B 20</u>.

(a) Pyrrhotite present in fractures of quartz.

(b) Sphalerite veining pyrrhotite. Chalcopyrite has replaced the sphalerite.

(c) Shows sphalerite veining pyrrhotite and cutting a vein of pyrite in the sphalerite.

(d) Repetition of (c).

(e) Shows chalcopyrite between sphalerite and pyrrhotite. The chalcopyrite is later than either of the other two since it fills the boundary fissure.

<u>B 21</u>.

(a) Shows remnants of a large quartz crystal which has been partly replaced by galena.

(b) Galena embaying on, and replacing sphalerite. Quartz crystals in the sphalerite being replaced by galena.

(c) Sphalerite in cracks in quartz.

(B 21.)

(d) Sphalerite veining quartz.

(e) Pyrite replacing and veining pyrrhotite. Sphalerite veining both the pyrite and the pyrrhotite.

B 23.

(a) Sphalerite veining arsenopyrite.

(b) Pyrite veining arsenopyrite.

(c) Pyrrhotite and sphalerite replacing quartz.

B 24.

(a) Pyrrhotite replacing arsenopyrite and quartz.

(b) Sphalerite present along boundary of arsenopyrite and quartz. Also sphalerite veining the arsenopyrite. Chalcopyrite cutting both arsenopyrite and sphalerite.

(c) Galena veining and replacing arsenopyrite.

(d) Residual arsenopyrite in sphalerite.

(e) Pyrrhotite veining and replacing arsenopyrite.

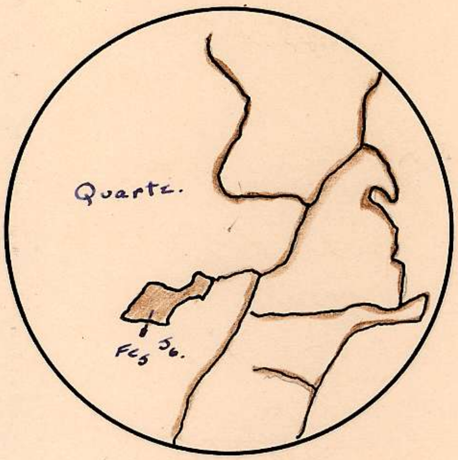
(i) Pyrite along the boundary between quartz and pyrrhotite.

(j) Repetition of (i).

(k) Arsenopyrite embaying on quartz.

X. The groundmass is marmatite - a high iron blende. It contains numerous veins of chalcopyrite which seem to be oriented along the cleavage planes. Small pieces of chalcopyrite are distributed throughout the whole groundmass.

Section 20.



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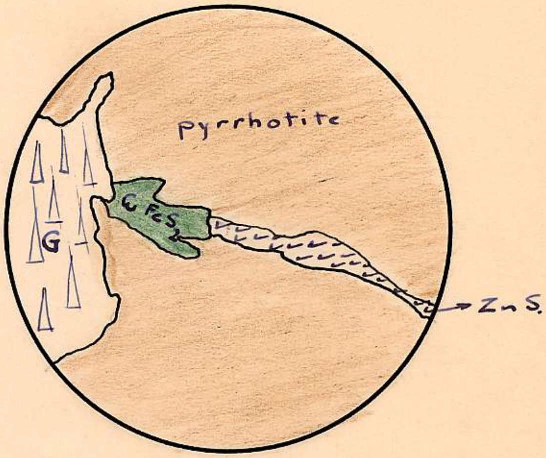

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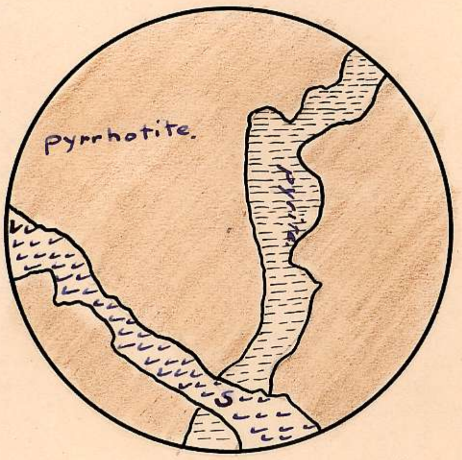

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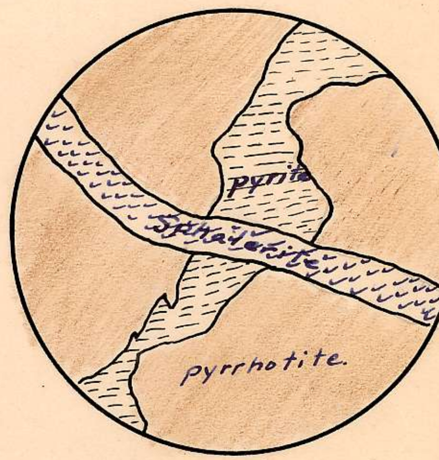

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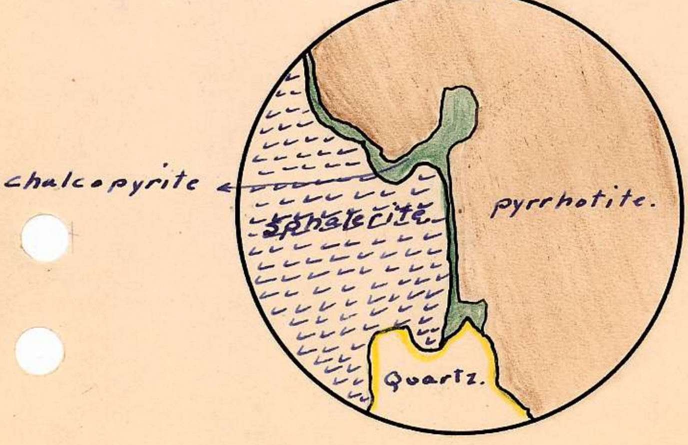

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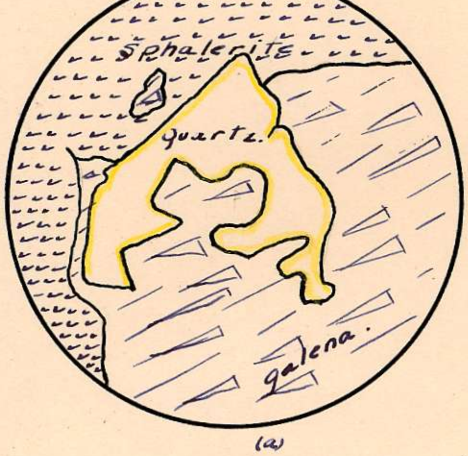

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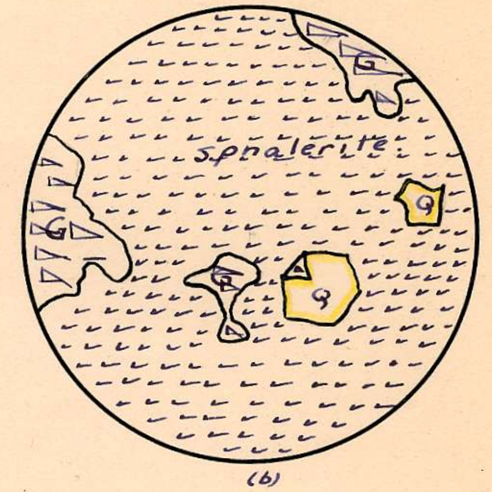

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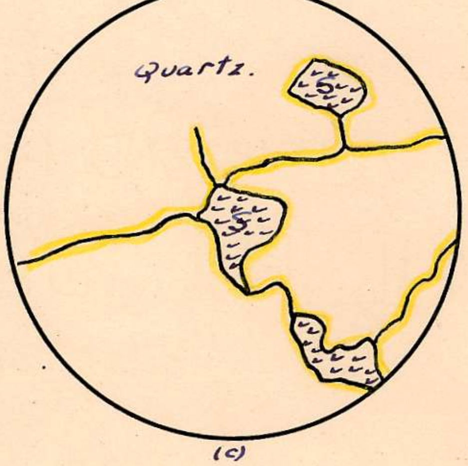

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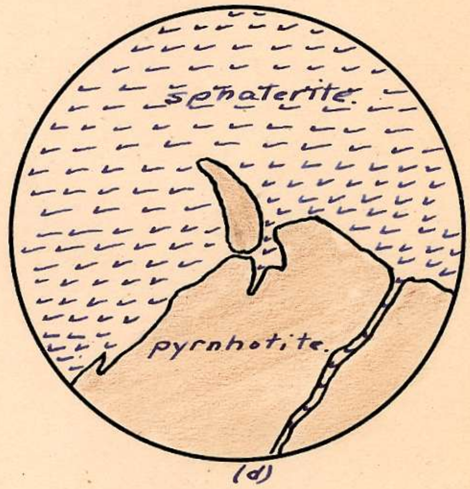

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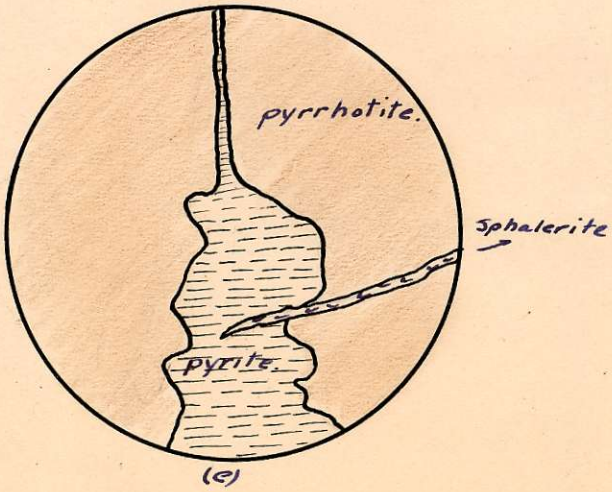

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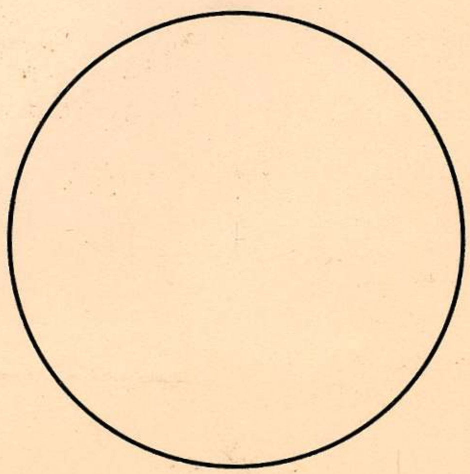

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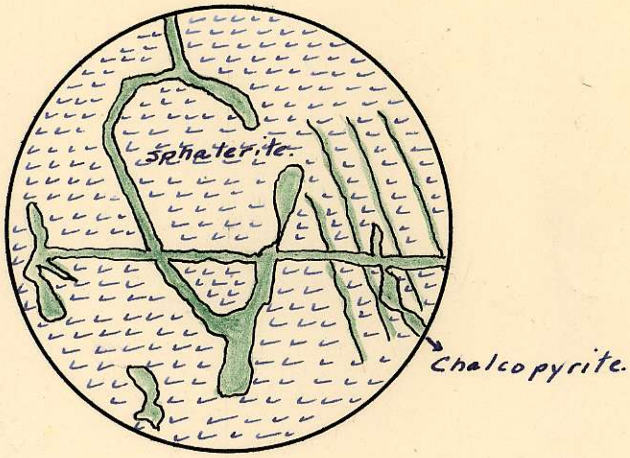

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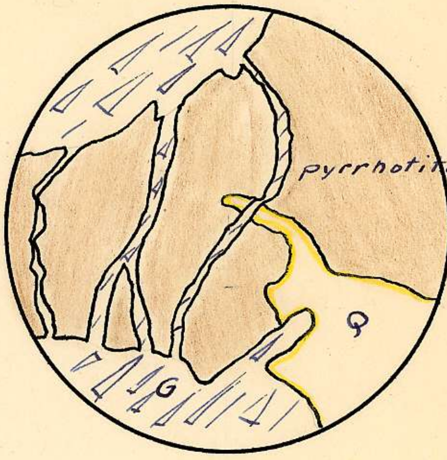

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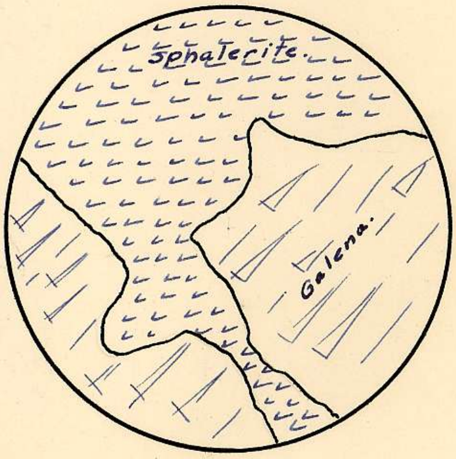

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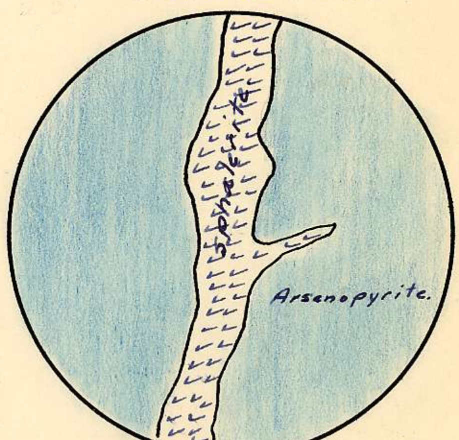

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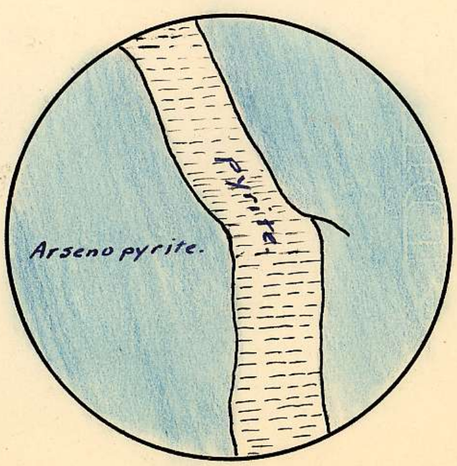

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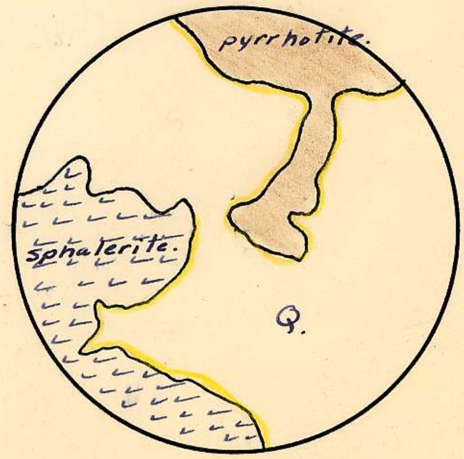

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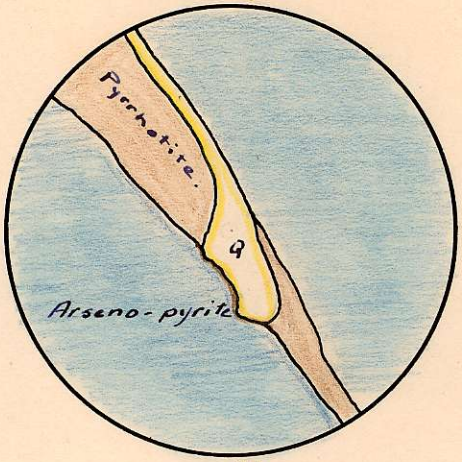

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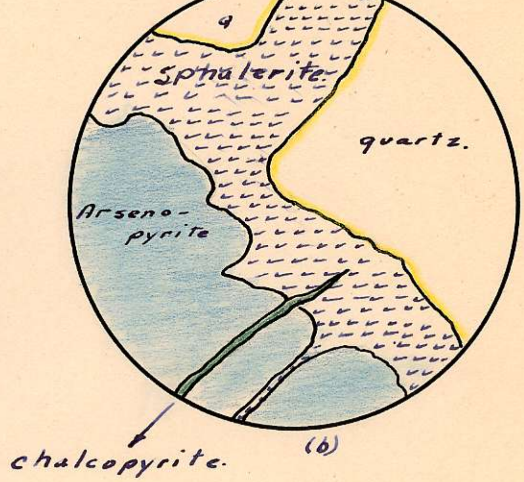

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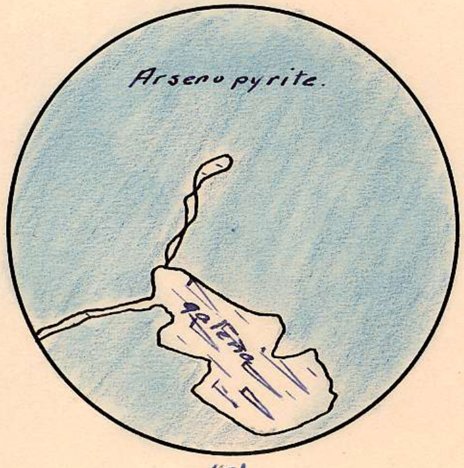

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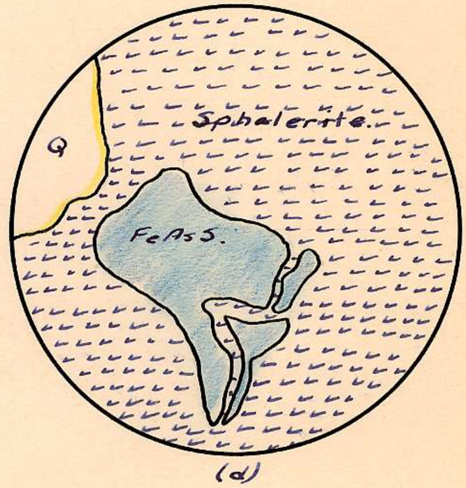

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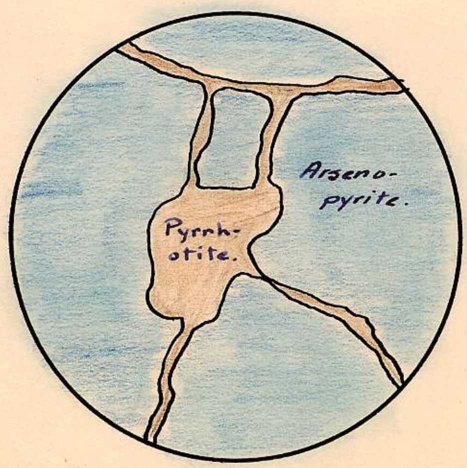

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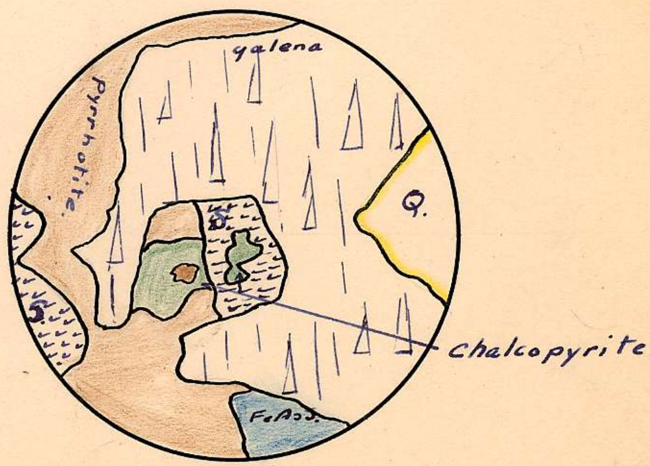

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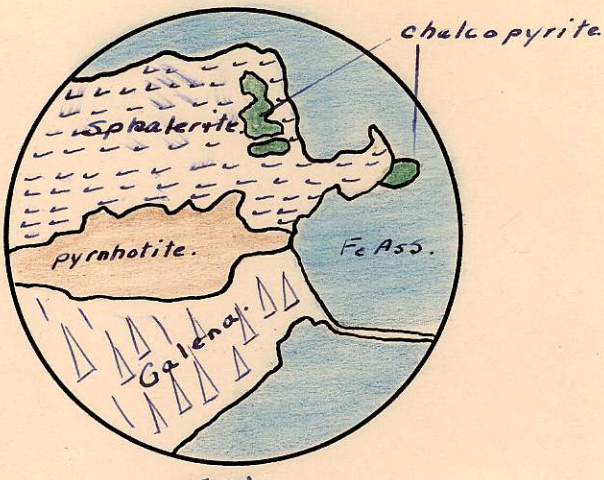

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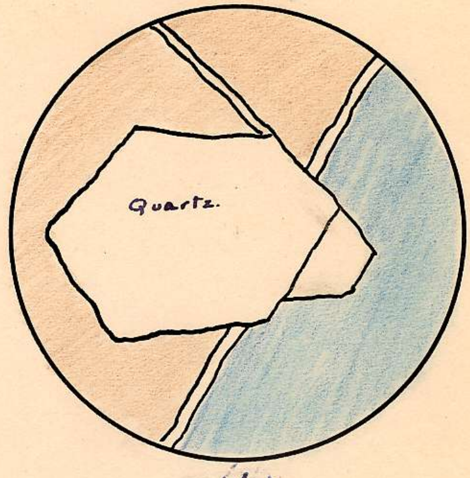

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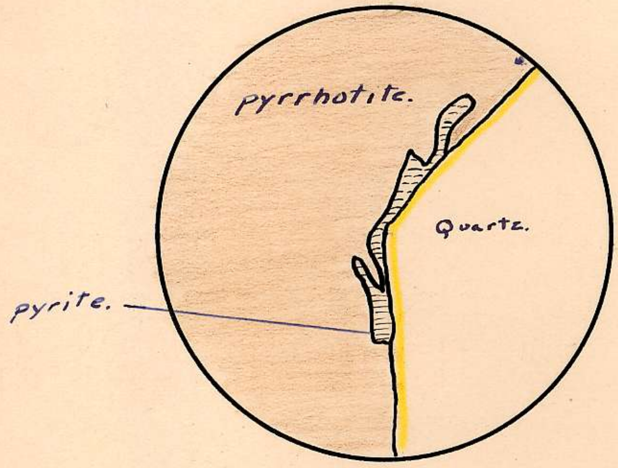

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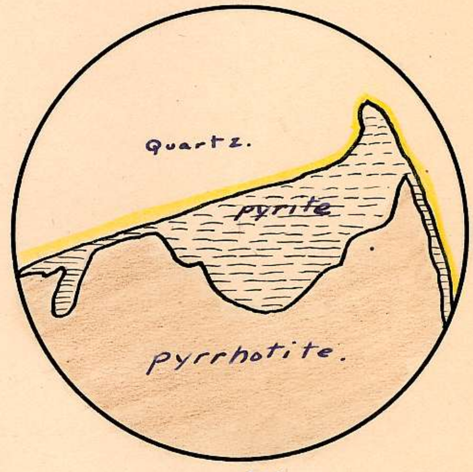

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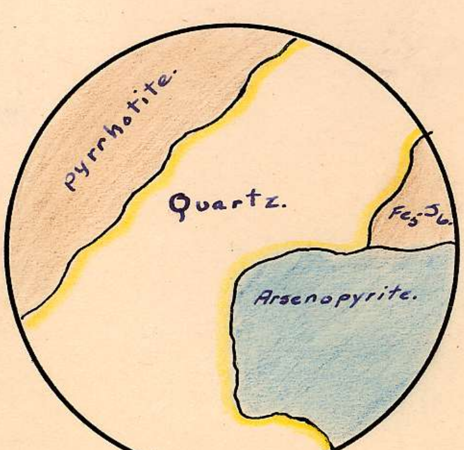

(k)

Paragenesis of the Minerals.

The general order of formation is summarized as follows:

(1) Quartz
(2) Arsenopyrite
(3) Pyrrhotite
(4) Pyrite
(5) Sphalerite and Chalcopyrite
(6) Chalcopyrite
(7) Galena.

(1) Quartz occurs as large masses and as well developed crystals. Its fractures have been found filled with practically all the other minerals. The fact that it is present as well developed crystals proves its early origin. These crystals could not develop by replacement of sulfides and only from a quartz melt or solution.

(2) Arsenopyrite occurs as large masses, often hypidiomorphic. Its fractures have been found filled by practically all the minerals except quartz, upon which it usually embays. It is older than the remaining minerals which is proved by the vein filling and replacement.

(3) Pyrrhotite: the most common mineral of the suite, usually is present as large masses. It is younger than arsenopyrite which it veins and replaces, but is older than the rest of the minerals which have been found veining and

replacing it.

(4) Pyrite is not very plentiful in this suite as it cannot be detected without the aid of a glass. It usually occurs as narrow veins in pyrrhotite or arsenopyrite. It is younger than the pyrrhotite but older than the rest of the minerals, some of which have been found veining it.

(5) Sphalerite and Chalcopyrite. Sphalerite is usually found as masses scattered throughout the sections. It is younger than quartz, arsenopyrite, pyrrhotite and pyrite, but older than some of the chalcopyrite and galena. Chalcopyrite is believed to be contemporaneous with sphalerite since in almost every sample of sphalerite observed it is present as rounded inclusions. These may have been deposited from solid solution.

(6) Chalcopyrite. Chalcopyrite is believed to exist in two generations. The first as above and the second as veins in sphalerite along cleavage planes. In no section was chalcopyrite observed cutting galena.

(7) Galena usually occurs as well crystallized masses. No specimens were observed in which galena actually veined sphalerite. Some embayments were noticed, but it is believed galena began to form with the last of the sphalerite and may have, to a small extent, replaced it.

Determination of Silver Affinities.

The original assay of the ore showed 2.77 ounces of silver per ton. In all the sections examined, no trace of any silver minerals could be found. In an attempt to find out where the silver was, it was decided to assay some samples of galena.

Samples of what seemed to be pure galena from B 19 were broken to pass an 8 mesh screen. With the aid of a glass, cubes of galena with shiny, fresh faces were picked out. These were assayed for lead and silver. The average of four assays made on this sample was: Lead - 84.0%, Silver - 21.65 ounces per ton. This means that 70% of the silver in the ore is associated with the galena. It is believed therefore that at least 70% of the silver in the ore is in solid solution in the galena and cannot be detected by means of a microscope. The remainder of the silver may be present in the sphalerite (which I do not think is very likely) or it might be retained in the oxidation products present in the ore.