THE ATLIN RUFFNER LEAD SILVER MINE.

A REPORT ON MINERALOGRAPHY.

-by-
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A STUDY OF ORE MINERALS FROM POLISHED SECTIONS IN GEOLOGY 9.

DEPARTMENT OF GEOLOGY.

UNIVERSITY OF BRITISH COLUMBIA.
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FOREWORD.

This study was carried on with the coorperation of Mr. V. J. Okulitch. The geological and other information was obtained by personal communication with Mr. Okulitch who collected the specimens during the summer of 1930.

OUTLINE.

THE ATLIN RUFFNER LEAD SILVER MINE.

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The Atlin Ruffner Lead Silver mines are situated on Vaughn Mountain in the Atlin Mining District of British Columbia, about sixteen miles northwest of the town of Atlin. A road has been constructed from the town to the mine.

The country is mountainous, in a mature state of erosion. The elevation of peaks is generally between 6000 and 7000 feet. The timber line is at an elevation of approximately 4000 feet.

Due to snow, cold, and other adverse weather conditions, mining operations in the district usually cease work during the winter months, beginning in May and finishing in October or November.

The country bears strong evidence of glaciation and a tremendous post-glacial water action. The majority of the valleys are steep sided, U-shaped, with glacial debris covering the bottom to a depth of about 60 feet. Terraces found along the valley sides point to submergence of the area immediately after the retreat of the ice. This submergence may have been due to blockades of ice and a consequent 'backing-up' of water.

Vaughn Mountain, and all other mountains in the vicinity, is made up of Coast Range Intrusives, ranging from granite to gabbro. Two main types of granite are found on Vaughn Mountain. One is an ordinary fine-grained grey granite; the other is pink with large and regular crystals of feldspar. The crystals are often 8" long and 1" wide. In spots, volcanics are found: these are probably Tertiary in age and range from andesites to tuffs and breccias.

The Atlin Gold Series, consisting of pyroxenite, greenstone, serpentine, and actinolite schist, is found a few miles to the south

The granite of Vaughn Mountain is intruded by many ~~andesite~~ lamphrophyre dykes, sheared and crushed by subsequent movements. The ore carrying veins are these crushed and sheared dykes which have been mineralized ~~by~~ with galena, sphalerite, and various other metallics. The cementing material is chiefly quartz and calcite. The dykes are from twenty to thirty feet in width and some are over a mile in length. Their strike is in a general north-easterly direction and the dip is around 60 degrees S.E.. Seven dykes carrying metallic bearing veins have been found and explored. From surface work, it seems that #2 and #4 veins are the strongest and best mineralized. But it is quite possible that some of the other veins will show better values at depth.

#2 and #4 veins, on the surface, appear as troughs running up the side of Vaughn Mountain. In the spring and early summer this feature is especially apparent as the troughs are filled with snow and show very distinctly on the dark background of the mountain. The bottoms of the troughs are filled with granite boulders and a considerable amount of float. This float consists mainly of lead carbonate and pyromorphite. Surface trenching is made difficult by the great quantity of debris in the troughs. These veins are about a mile in length and can be traced very easily when found above the timber line.

Some underground work has been done with very gratifying results. On the higher levels the ore is galena with argentite and ruby-silver. Mr. Okulitch states that he has measured sections of solid galena seven feet across. Lower down the pyrargyrite disappears but the silver values appear to be maintained and a small quantity of gold is found in pyrrhotite and arsenopyrite. Sphalerite is found throughout the mine.

In the lower levels, the dykes are crystalline and hard but are crossed by bands of gouge and by veins, making a caving ground which requires strong timbering in the drifts. Near the surface the ground is even worse, due to deep oxidation.

The work of developing this property was started in 1921 by Mr. J.M. Ruffner, the original discoverer. Much preliminary work, covering a wide area, was done; the property was surveyed and mapped, several tunnels were driven to block out ore, and a road was built to Atlin. Recent work consists of driving an adit on #2 vein at depth. From this, cross-cuts will eventually be driven to the other veins. Taking into consideration the length of the veins and the depth already proven, it seems quite probable that there will be sufficient ore discovered to insure success. The abnormally high costs of transportation to and from the property appear to be its greatest handicap at present.

MINERALOGY.

The ore consists of galena, pyrargyrite, sphalerite, and chalcopyrite, in conjunction with pyrite and pyrrhotite, with a gangue of quartz and calcite. Arsenopyrite is found on the lower levels: unfortunately, no specimens containing this mineral were available. Gold is shown in assay values.

Galena.

Coarse grained except where found in conjunction with pyrrhotite. In this case it is disseminated throughout the pyrrhotite in very fine particles. In many cases, ~~it~~ the coarse galena has been badly sheared and cracked; the cracks have been filled with quartz.

Pyrargyrite.

In the upper levels of the mine, pyrargyrite is found replacing the primary sulphides. At greater depths, silver values are found in the assays. This may indicate that silver, possible in the form of argentite, is to be found in conjunction with the galena.

Sphalerite.

This mineral is not found in great quantity. Where found it is in the proximity of galena but is of much finer grain than the lead sulphide.

Chalcopyrite.

This mineral is the second most plentiful commercial mineral in the ore, galena being ~~more~~- found in larger amounts. As a rule it is found in the proximity of pyrite . These two minerals are often mixed together in such a manner that fairly small particles result. In other specimens, the chalcopyrite may be found in large masses.

Pyrite.

Pyrite is found in every specimen and is associated with all of the commercial minerals. It may be massive or in particles in the other sulphides.

Pyrrhotite.

The specimens showing pyrrhotite show it only in conjunction with galena. Its relationships ~~could~~, therefore, could not be worked out.

Quartz.

Crystalline quartz is often found. This was probably the first mineral to enter the veins. A later generation of quartz fills cracks and cavities formed just after the second generation of galena had entered.

Calcite.

Appears to be due to secondary action. Found in cavities and fairly recent cracks.

Marcasite.

This mineral was found only in one specimen. Here it showed a circular form which is often characteristic of this mineral. It was found to be replacing epidote.

Bornite.

This was found only in one place. The specimen was taken near the surface. The bornite was of secondary origin probably due to the enrichment of the primary sulphides from ground water action.

In nearly all cases the minerals had a coarse grain. No microscopic intergrowths were found. The closest relationship to this condition was the dissemination of galena in pyrrhotite. Even here, the grains of galena were by no means microscopic. They could all be discovered under a low power lens.

Descriptions of Illustrations of Polished Specimens.

Fig. 1.

The specimen contains galena, quartz, pyrite, and chalcopyrite. Pyrite is shown to be included in the quartz and chalcopyrite. Chalcopyrite is included i n the quartz.

The probable sequence of mineralization is therefore - 1)Pyrite, 2)Chalcopyrite, 3) Quartz and galena.

Fig. 2.

The specimen contains only quartz and galena. The galena is probably later than the quartz.

Fig. 3and4.

Specimen number four contains galena, marcasite, quartz, epidote, and pyrargyrite. Marcasite and pyrargyrite appear to be the latest minerals, their relative ages may be the same. The latter two minerals are probably secondary fillings in the epidote which appears to have been cut by quartz and galena.

Fig 5.

Specimen No.5. shows quartz, galena, and chalcopyrite. The galena has been badly sheared, and quartz has filled the cracks caused by movements. The quartz is probably of a second generation, as Fig. 2 shows quartz to have been before the galena. Chalcopyrite came before the quartz, as it is entirely surrounded by quartz. There is no relationship shown between the galena and chalcopyrite.

Fig. 6.

In this second figure drawn from specimen no. 5, quartz, galena, chalcopyrite, and pyrite are shown. The pyrite is older than the chalcopyrite which is both cutting and containing it. Galena is later than the pyrite and is probably also cutting the chalcopyrite, showing it to be later than the others. Quartz cuts all the sulphides.

Fig. 7.

This specimen shows pyrite, galena and calcite. Calcite is filling cavities and cracks so is later than both galena and pyrite. Pyrite precedes the galena.

Fig. 8.

Taken from specimen 7. Shows sphalerite, chalcopyrite, pyrite, and calcite. Zinc blende contains chalcopyrite which in turn contains pyrite. Calcite fills cracks although crystals are also found in cavities. The order of mineralization was probably 1)pyrite 2)chalcopyrite 3)sphalerite 4)calcite.

Fig.9.

The illustration shows quartz, pyrite, chalcopyrite, sphalerite, galena, and calcite. The zinc blende contains galena and is cut by pyrite and calcite. Chalcopyrite is later than pyrite. Quartz is of two varieties, crystalline and cavity filling, and is probably of two generations. The order of the minerals was probably 1)crystalline quartz, 2)galena, 3)sphalerite,4)pyrite, 5)chalcopyrite, 6)quartz, 7)calcite.

Fig.10.

Drawn from specimen no.8, shows quartz, calcite, galena, chalcopyrite, and pyrite. Definite relationships between the pyrite and galena were not obtained. The galena was probably older than the other sulphides. The order of mineralization was probably 1)galena, 2)pyrite, 3)chalcopyrite, 4)quartz, 5)calcite.

Fig.11.

Illustrates the relationship between pyrrhotite and galena. The two are probably contemporaneous as the galena is found disseminated throughout the pyrrhotite.

Fig.12.

Chalcopyrite, bornite, and galena are shown. The galena is later than the chalcopyrite. The bornite is due probably to secondary enrichment in the ore body. The order of mineralization was 1)chalcopyrite, 2)galena, 3)bornite.

Fig.13.

Galena is shown to be included in quartz with calcite filling cracks. The order of mineralization was, therefore, 1)galena, 2)quartz, 3)calcite.

Fig.14.

Chalcopyrite, pyrite,and galena are shown. The chalcopyr-ite is evidently earlier than the pyrite which, in turn, was before the galena.

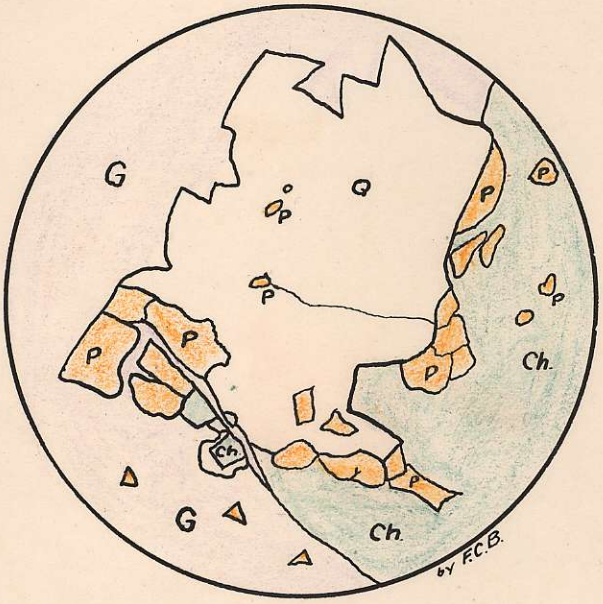

G
Q
P
Ch.
Ch
G
Ch.
by F.C.B.

Fig.1.

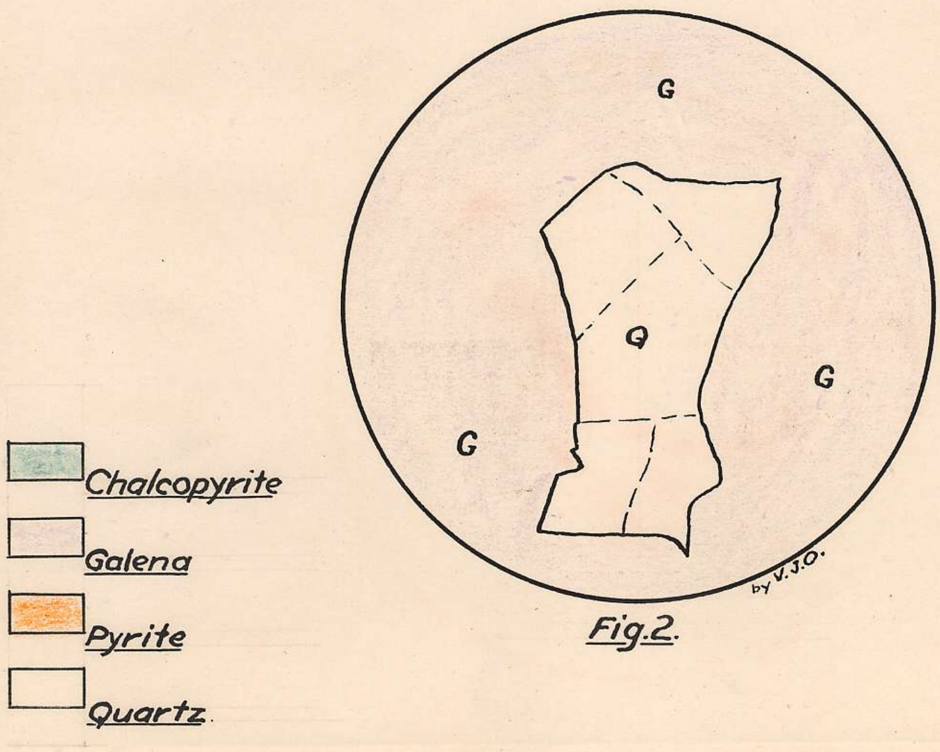

G
Q
G
G
by V.J.O.
Chalcopyrite
Galena
Pyrite
Quartz.

Fig.2.

Fig. 3.

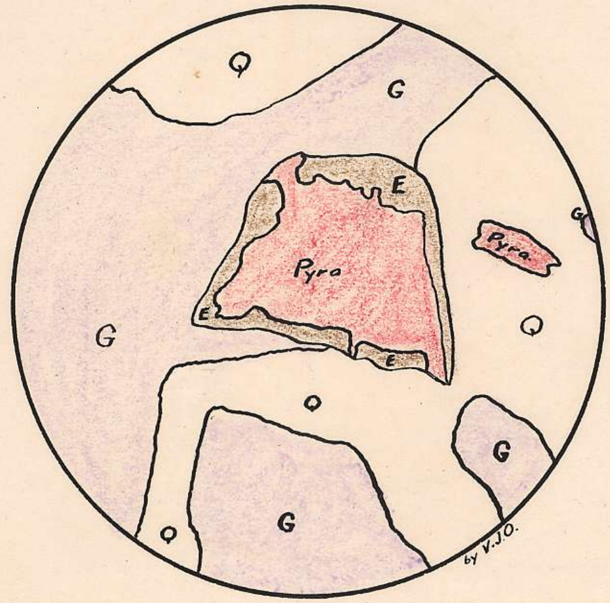
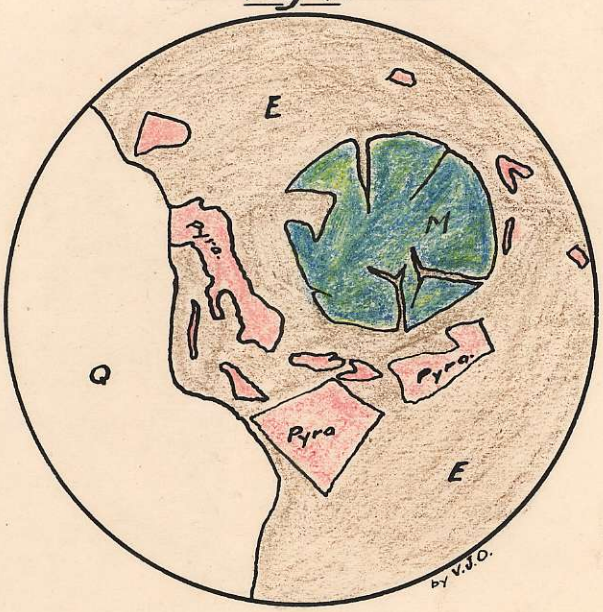

Q
G
E
Pyra
Pyra.
G
E
Q
E
Q
G
Q
G
by V.J.O.

Fig 4.


E
Pyra.
M
Q
Pyra.
Pyra
E
by V.J.O.

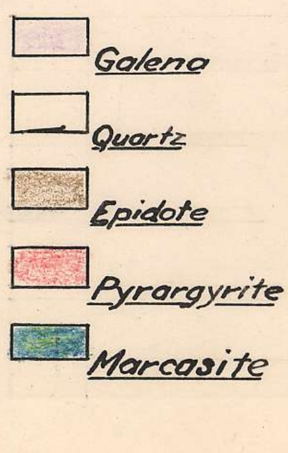

Galena
Quartz
Epidote
Pyrargyrite
Marcasite

FIG. 5

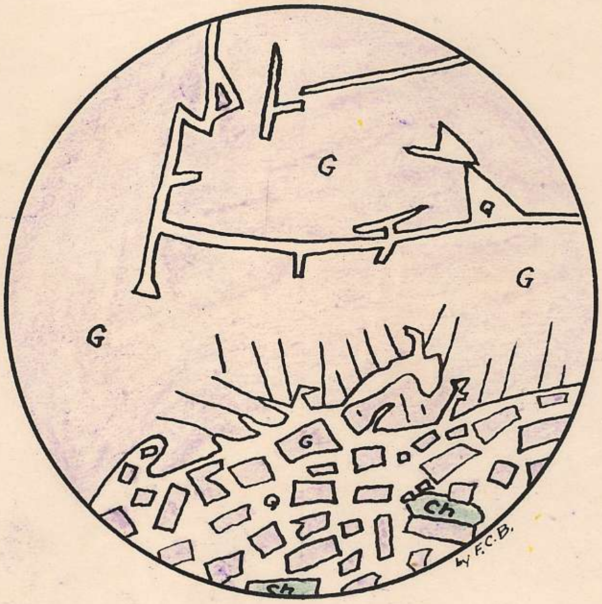


FIG. 6

Quartz

Galena

Chalcopyrite

Pyrite

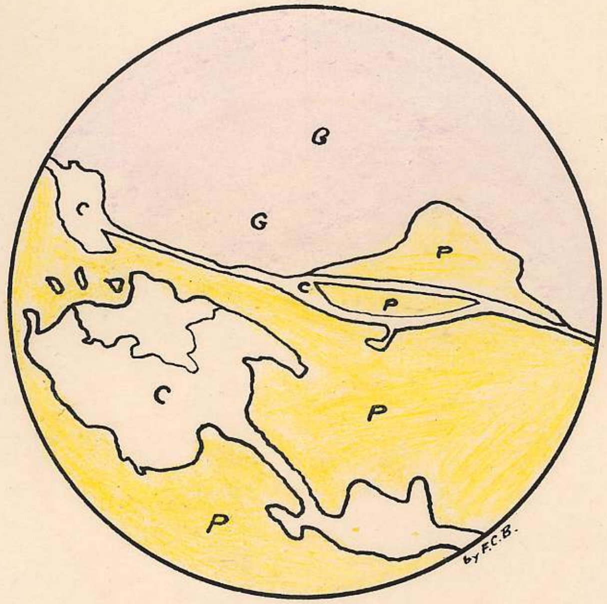

G
G
C
P
C
P
C
P
P
by F.C.B.

FIG. 7.

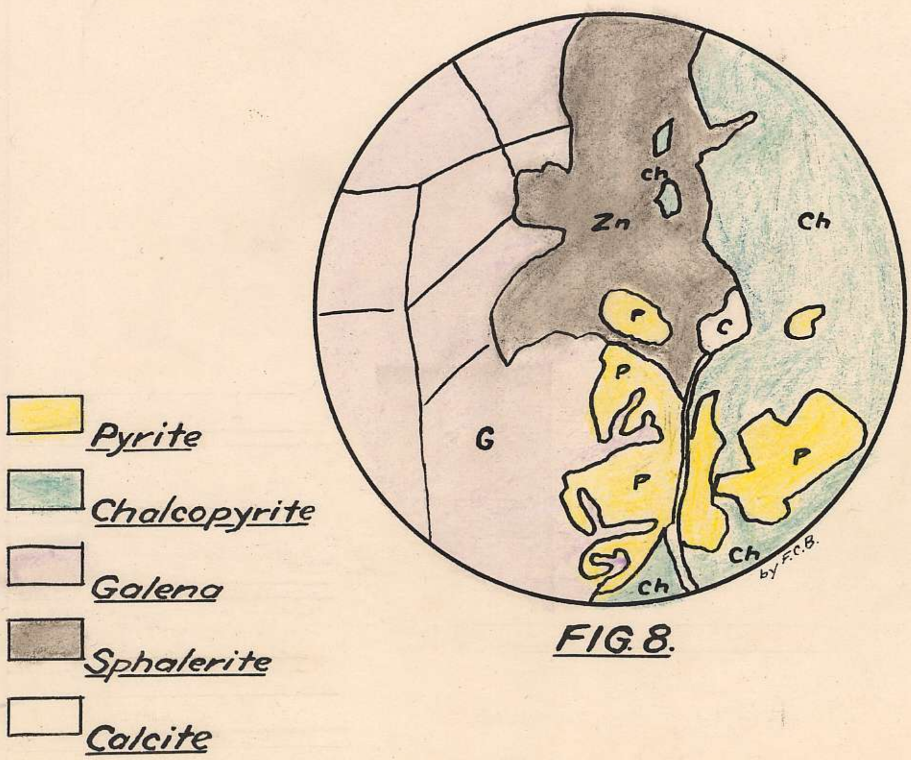
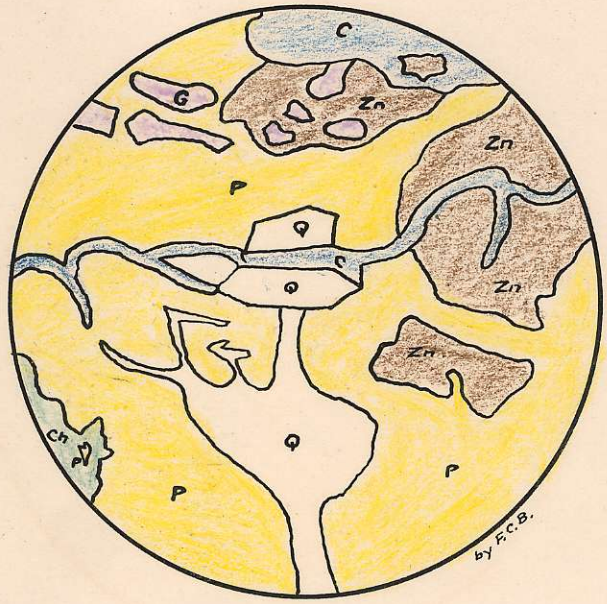

ch
Zn
Ch
P
C
P
G
P
P
Ch
ch
by F.C.B.
Pyrite
Chalcopyrite
Galena
Sphalerite
Calcite

FIG. 8.


C
G
Zn
Zn
P
Q
C
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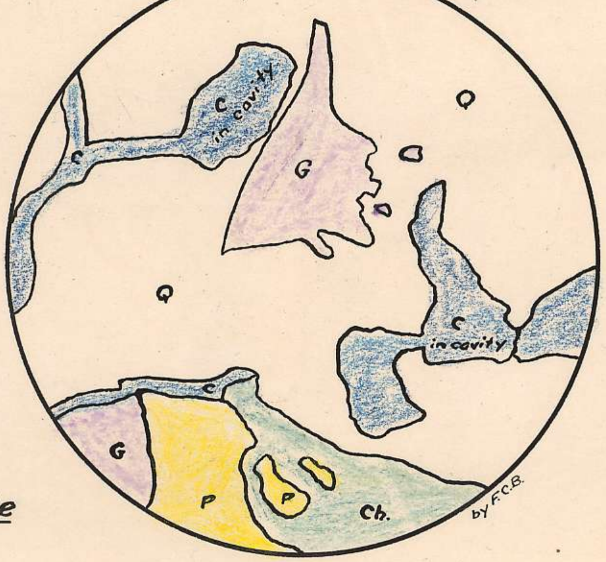
Zn
Zn
Ch
P
Q
P
P
by F.C.B.

Fig. 9.


C
in cavity
Q
G
C
Q
C
in cavity
C
G
P
P
Ch.
by F.C.B.

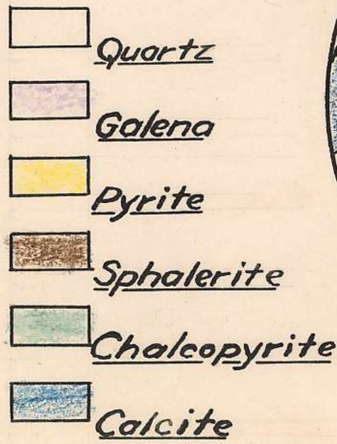

Quartz
Galena
Pyrite
Sphalerite
Chalcopyrite
Calcite

Fig. 10.

Fig. 11.

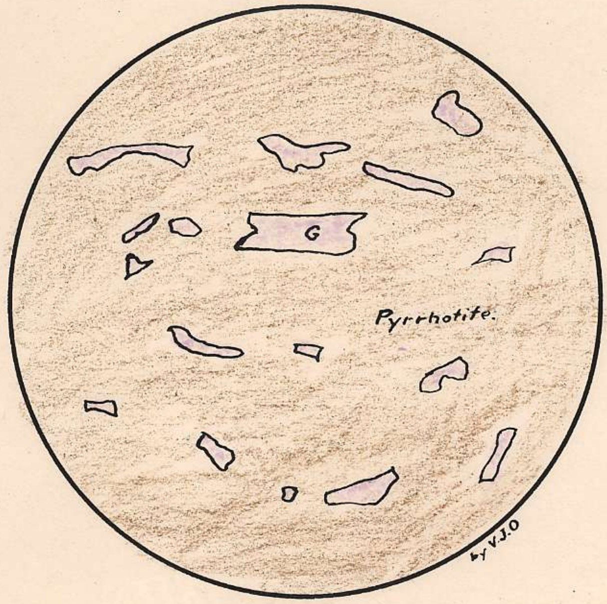
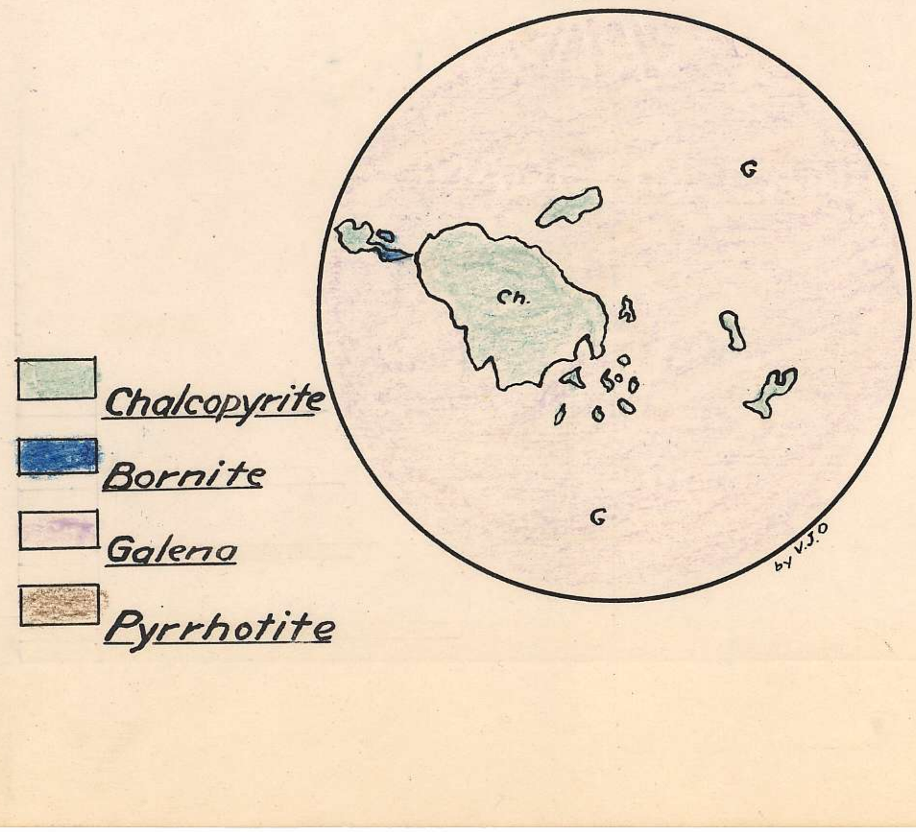
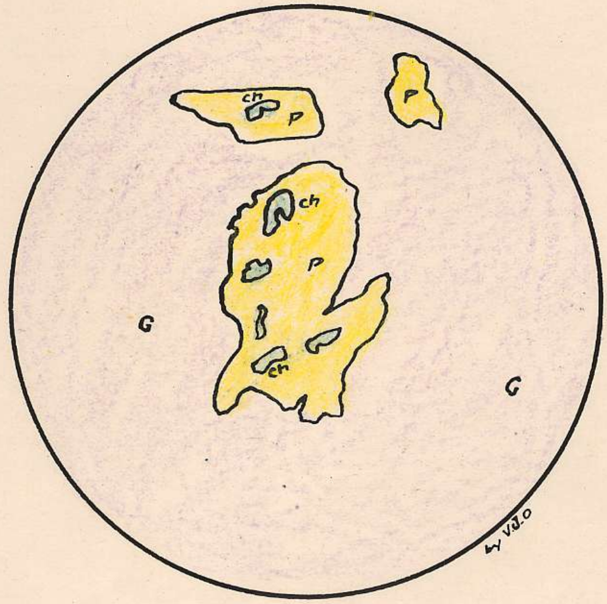

G
Pyrrhotite.
by V.J.O

Fig 12.


G
Ch.
G
by V.J.O
Chalcopyrite
Bornite
Galena
Pyrrhotite


ch
p
ch
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G
G
by V.J.O

Fig. 14.

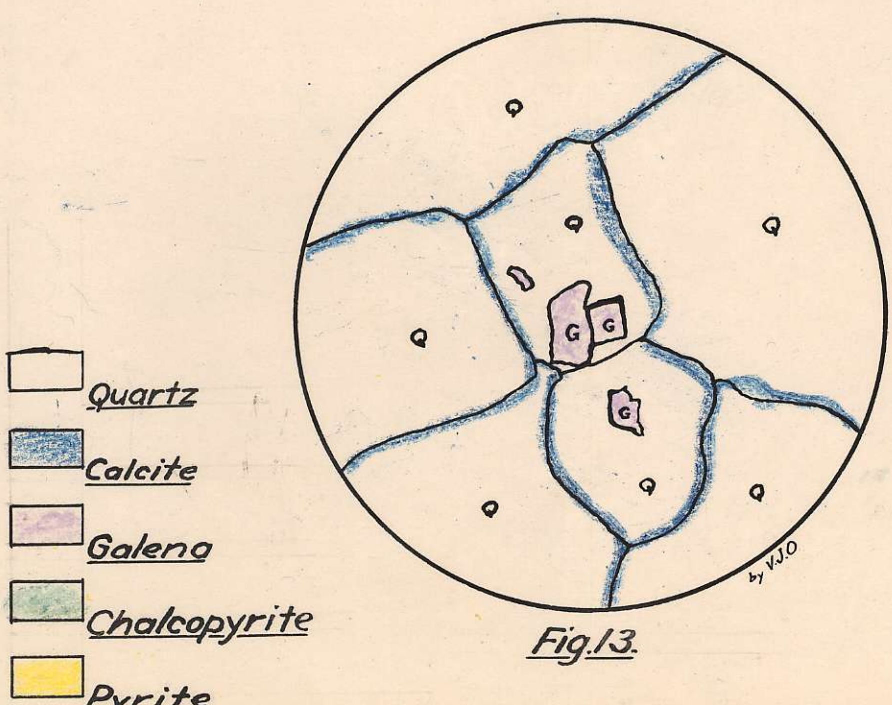
Q
Q
Q
Q
G
G
G
Q
Q
Q
by V.J.O
Quartz
Calcite
Galena
Chalcopyrite
Pyrite

Fig. 13.

Conclusions based on an examination of polished specimens of the ore.

The following table gives the sequence of mineralization as obtained from the Descriptions of Illustrations of Polished Specimens, page 5 . Crosses have been placed after each mineral to denote the figures in which they occur.

Figures	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Crystalline quartz.	-	x	-	-	-	x	-	-	x	-	-	-	-	-
2. Galena.	-	-	-	-	-	-	-	-	x	x	x	-	-	-
3. Sphalerite.	-	-	-	-	-	-	-	x	x	-	-	-	-	-
4. Pyrite	x	-	-	-	-	x	x	x	x	x	-	-	-	x
and Pyrrhotite.	-	-	-	-	-	-	-	-	-	-	x	-	-	-
5. Chalcopyrite.	x	-	-	-	x	x	-	x	x	x	-	x	-	x
6. Galena.	x	x	x	x	x	x	x	-	-	-	-	x	x	x
7. Quartz.	x	-	x	x	x	x	-	-	x	x	-	-	x	-
8. Calcite	-	-	-	-	-	-	x	x	x	x	-	-	x	-
9. Pyrargyrite	-	-	x	x	-	-	-	-	-	-	-	-	-	-
Marcasite	-	-	x	x	-	-	-	-	-	-	-	-	-	-
Bornite.	-	-	-	-	-	-	-	-	-	-	-	x	-	-

There appears to have been three stages of mineralization. After the formation of crystalline quartz, the sulphides of lead, zinc, iron, and copper followed one another in order. Galena then appears for a second time. After this galena was in place the vein was sheared and quartz came in to fill the cracks which resulted. Subsequent mineralization was due to secondary action. The calcite fills cavities rather loosely and is found wherever the quartz has been cracked. Pyrargyrite, marcasite, and bornite are found replacing the other sulphides in specimens which show oxidation and other criteria of secondary action.

The fact that galena and pyrrhotite appear to be contemporaneous (Fig. 11) can be explained by assuming that the pyrrhotite brought up particles of the galena formed in the first generation of the lead sulphide.

There may possibly have been two generations of sphalerite as evidenced by the lateness of this mineral in Fig. 8. In this case it would probably come in again at about the same time as the second generation of galena.

The following table shows the minerals placed in stages of mineralization;

1st. Stage.

a(Crystalline quartz.

b(Galena, sphalerite.

2nd. Stage.

a(Pyrite - pyrrhotite, chalcopyrite, galena.

Shearing.

b(Quartz.

3rd. Stage.

a(Calcite.

b(Pyrargyrite, marcasite, bornite.

The First and Second Stages have been separated because of shearing in the sphalerite before replacement by pyrite. The fact that there are two generations of galena makes it necessary to have two stages. The line is best when drawn where shearing is found. The second generation of quartz might well be placed in a separate stage as very strong shearing forces were active between the incoming of this mineral and the deposition of the second stage of galena.

The relationship of the minerals in the Third Stage could not be determined. The calcite may possible have been later than the minerals in part b. The deposition of these secondary minerals, however, is going on at the present time due to the action of circulating ground waters and to oxidation of the outcrops.