PROBLEM 4

A MINERALOGRAPHIC REPORT ON ORE SPECIMENS FROM TEN MINES OF THE ROSSLAND CAMP, B.C.

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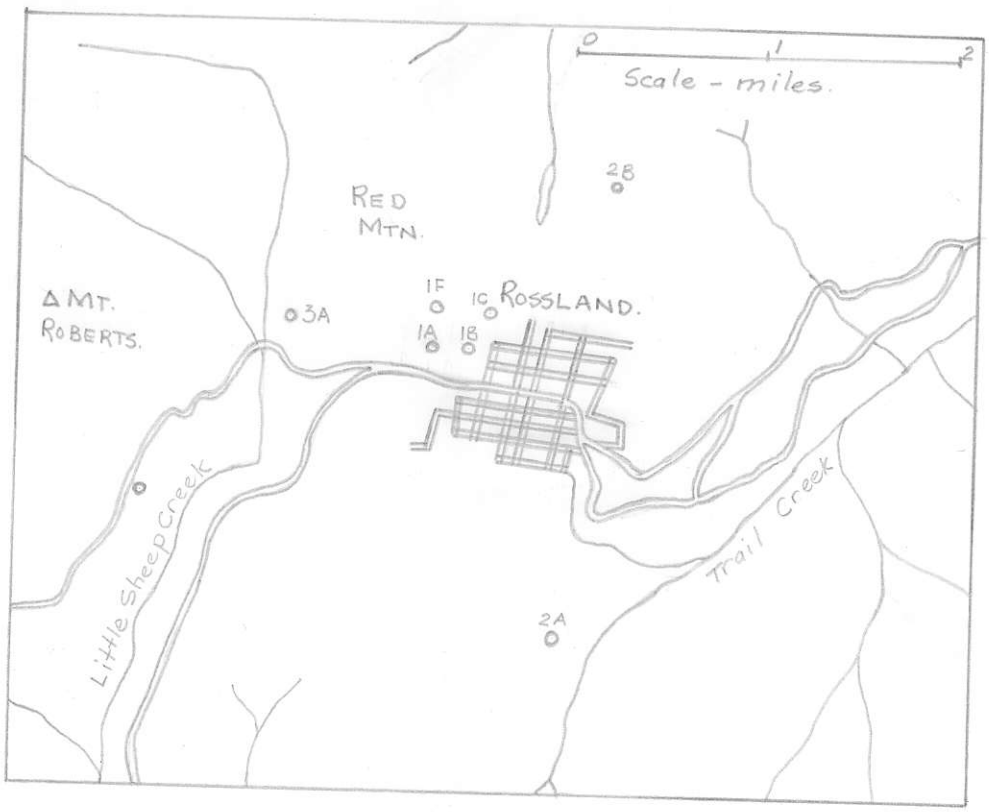
Geology 409

April 3, 1962.

Location Map.



The Rossland Mining Camp.

Group I
- A Le Roi
- B Center Star
- C Josie
- D O K.
- E Bruce
- F War Eagle

Group 2
- A Bluebird
- B Evening Star

Group 3
- A Giant

ORE SPECIMENS FROM THE ROSSLAND CAMP, B.C.

From studying the polished sections from each mine and grouping the mines according to their mineralogy, three groups were set up. These were:

Group I - Pyrrhotite, chalcopyrite, the majority with sphalerite, pyrite and magnetite. One specimen contained 5% pentlandite. Quartz is the main gangue mineral, although some calcite is present in most areas.

The mines in group I are:

War Eagle
Le Roi
Center Star
Josie (959 stope)
O.K.
Bruce

A specimen from "Idaho Shaft" also has this mineralogy

Group 2 - Galena, sphalerite, pyrrhotite, pyrite, one with chalcopyrite. Quartz is the only gangue mineral.

The mines in group 2 are:

Bluebird
Evening Star

Group 3 - Molybdenite, safflorite, pyrrhotite, galena, sphalerite and chalcopyrite with a little magnetite in one or two specimens.

The "Giant" mine comprises this group.

GROUP I

A LE ROI MINE.

The hand specimens are predominantly composed of pyrrhotite which weathers golden brown. This brown coating probably contains some nickel and cobalt. Chalcopyrite and some pyrite are also present. Much of the gangue in this mine is serpentine which is dark green. Other gangue minerals are cloudy white quartz and coarse grained white calcite.

The ore minerals are in blebs and irregular veinlets in the hand specimens. They are replacing the ~~(wall rock and)~~ gangue minerals along fractures.

MICROSCOPIC MINERALS

1 Pyrrhotite $Fe_{1-x}S$. took a moderately good polish and displayed a relatively rough surface. It had a pale brownish cream color and hardness D-. It was strongly anisotropic. The polarization colors were light gray, bluish gray and brown.

Etch Tests:			
	$HgCl_2$	Brown stain	weak ~~rough~~
	KOH	Bluish stain	weak
	KCN	Negative	
	HCl	"	
	$FeCl_3$	"	
	HNO_3	Brown stain	weak

The mineral is distinctly magnetic.

2 Chalcopyrite $CuFeS_2$ - previously met.

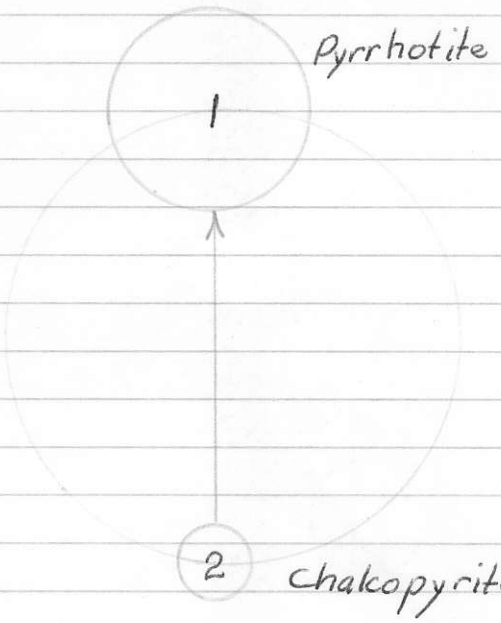
3 Pyrite FeS_2 Took a good polish and had a pale yellow-white color. Other features were normal.

LE ROI MINE

MINERAL PERCENTAGES

Pyrrhotite	75%
Chalcopyrite	15%
Quartz	5%
Calcite	5%.

Paragenetic Sequence.



NOTE FIGURE I

B CENTER STAR MINE did you watch it?

The ore is replacing augite porphyry along fractures. The ore minerals are massive pyrrhotite and chalcopyrite with ragged pyrite crystals and thin streamers of sphalerite. The gangue minerals are medium grained, cloudy white to dull green quartz and coarse grained white calcite.

The distribution of the ore minerals is strongly controlled by fractures in the wall rock and gangue minerals. However, replacement outward from the fractures has occurred.

CENTER STAR MINE

MICROSCOPIC

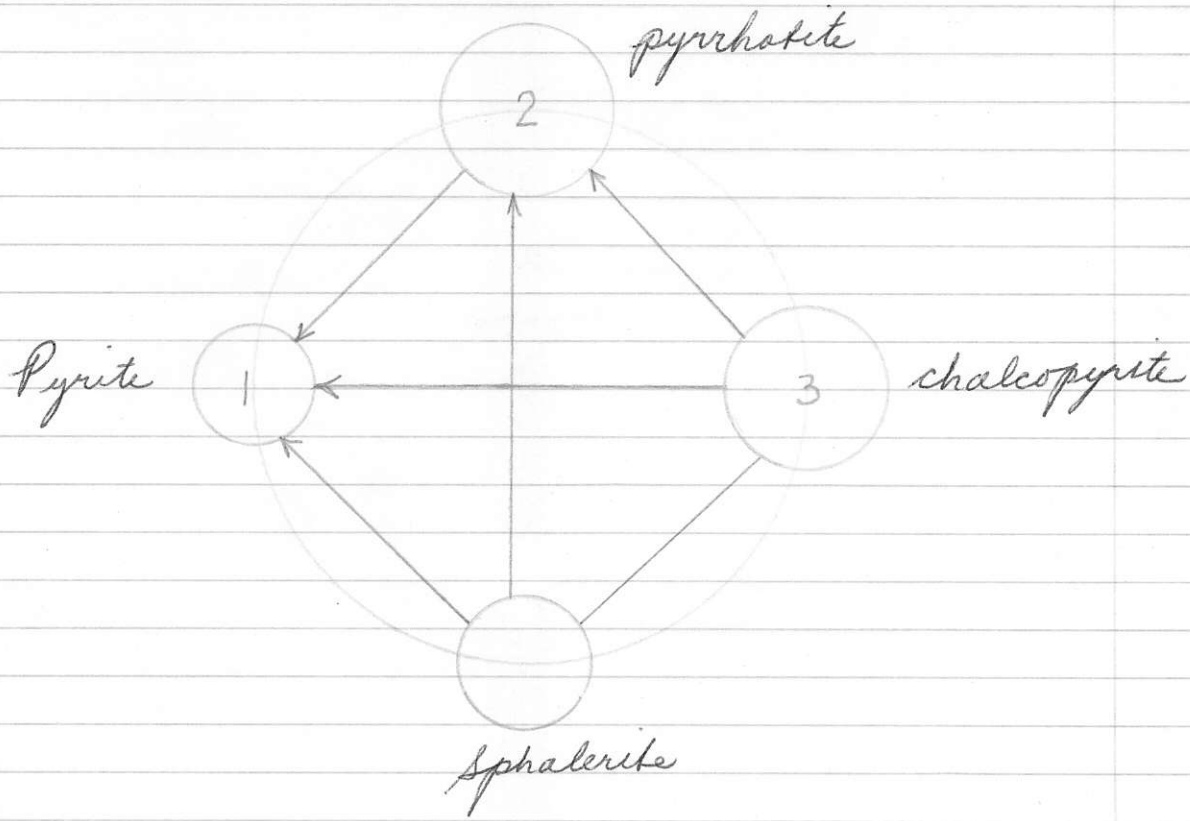
MINERALS

1, Pyrrhotite $Fe_{1-x}S$
2, Chalcopyrite $CuFeS_2$
3, Sphalerite ZnS - described in previous problem.
4, Pyrite FeS_2

MINERAL PERCENTAGES

Polished Section	1	2
Pyrrhotite	25%	20%
chalcopyrite	-	13%
Pyrite	-	7%
Sphalerite	-	10%
Quartz	-	50%
Wall rock	75%	-

Paragenetic Sequence.



C JOSIE MINE (959 STOPE)

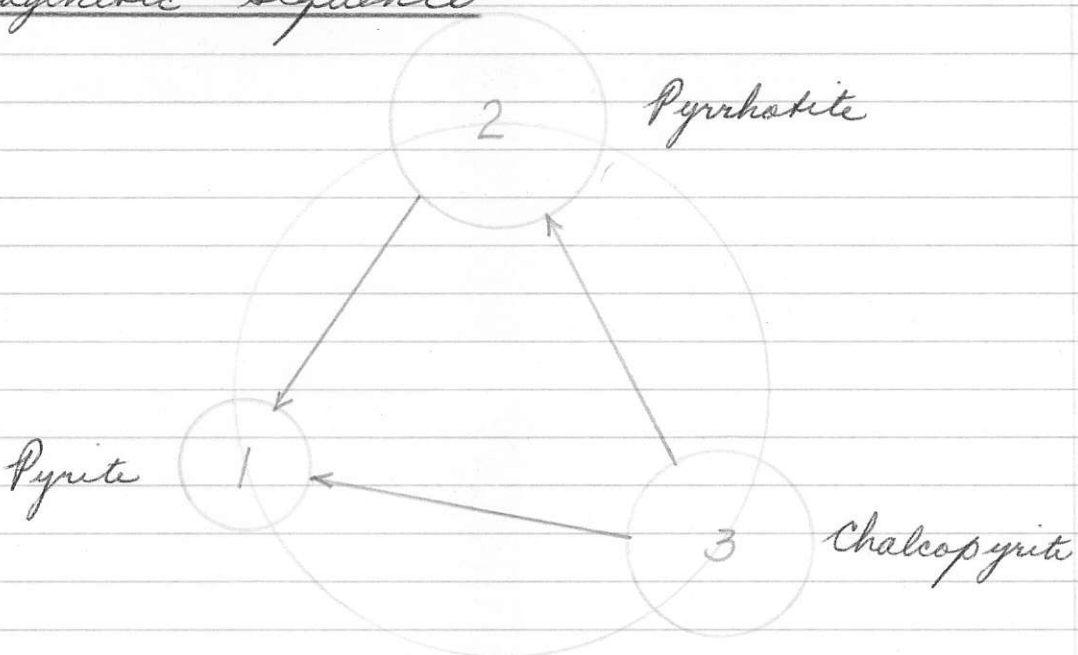
The hand specimen displays a distinct color banding (in the hand specimen) One band is spotily mineralized and is chiefly green augite, biotite lamprophyre. The other band is almost entirely mineralized but contains a few, rounded, partially mineralized lamprophyre fragments. This specimen probaly is an intersection between the ore and the "Josie Dyke." This dyke acted as an impervious barrier to the ore bearing fluids. Pyrrhotite is the main metallic mineral and chalcopyrite and pyrite are also present. The replacement in the rock next to the dyke is almost complete.

MICROSCOPIC

MINERALS AND PERCENTAGES (in the ore zone)

1	Pyrrhotite FeS_{1+x}	62%
2	Chalcopyrite $CuFeS_2$	15%
3	Pyrite FeS_2	8%
4	Dyke remnants	15%

Paragenetic Sequence



D O.K. Mine

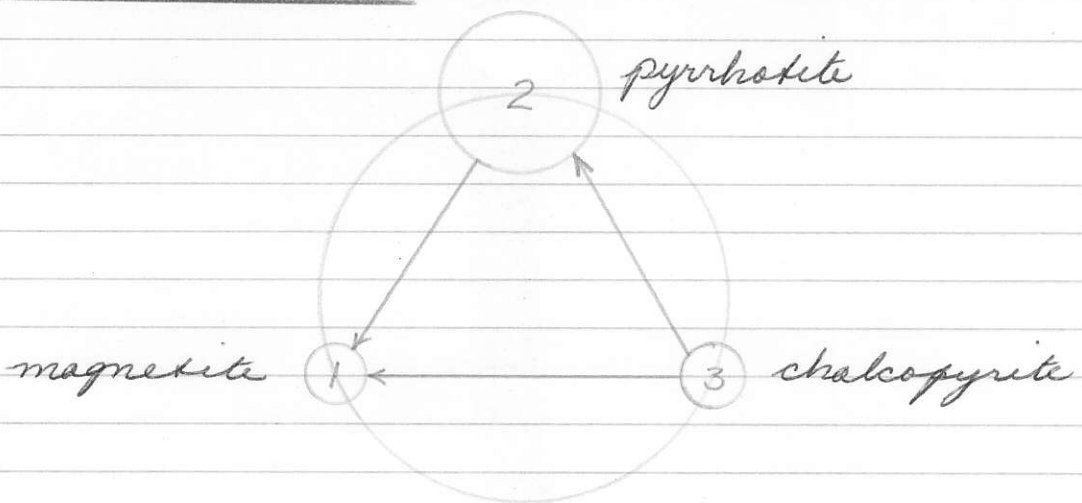
The hand specimen is massive pyrrhotite with minor amounts of chalcopyrite and magnetite. The magnetite is in the form of tiny, eroded crystals and the chalcopyrite occupies tiny fractures in the pyrrhotite.

MICROSCOPIC

MINERALS AND PERCENTAGES

1	Pyrrhotite	FeS_{1+x}	92%
2	Chalcopyrite	$CuFeS_2$	5%
3	magnetite	Fe_3O_4	3%

PARAGENETIC SEQUENCE



E BRUCE MINES

The hand specimens consist of medium grained, subhedral magnetite crystals in a matrix of chalcopyrite and subhedral pyrrhotite crystals. The magnetite crystals give a ~~freshly~~ broken surface a granular appearance. In certain areas the magnetite has formed concentrations with irregular outlines but up to ¼" across. The chalcopyrite forms highly irregular veinlets in the pyrrhotite. Irregular blebs of sphalerite and blebs of pentlandite are also present

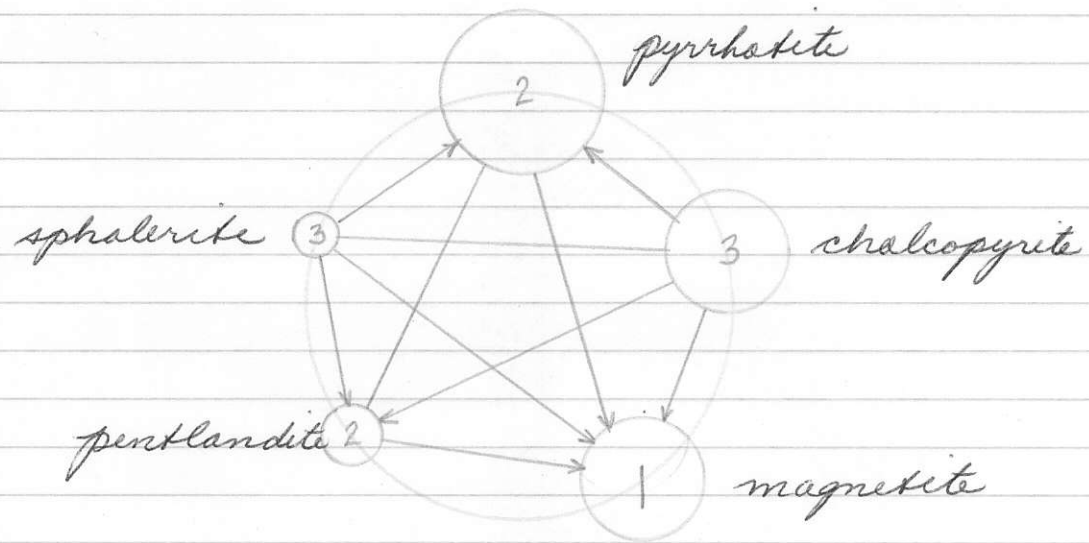
BRUCE MINES

MINERALS AND PERCENTAGES

1	Pyrrhotite	44 %
2	Chalcopyrite	25%
3	magnetite	25%
4	Pentlandite	5% Check.
5	Sphalerite	1%

The cleavage in the pentlandite is not marked and it was negative to all etch reagents.

PARAGENETIC SEQUENCE



F SPECIMEN FROM IDAHO SHAFT.

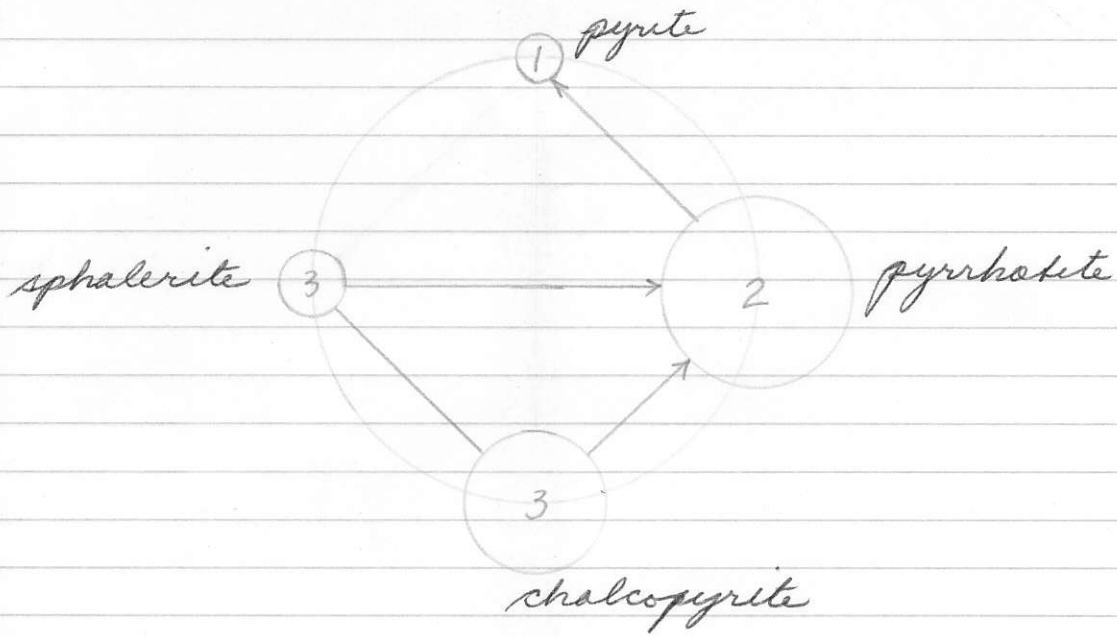
The ore minerals are replacement features along fractures in quartz. The ore minerals are in thin irregular veinlets in a quartz breccia. Two major directions of fracture predominate, they are nearly at right angles.

In the second specimen the quartz is not so markedly brecciated. In this specimen

the replacement is more complete. The main metallic mineral is pyrrhotite.

MINERALS AND PERCENTAGES	SPECIMEN 1	SPECIMEN 2
1 Pyrrhotite	35%	15%
2 Chalcopyrite	3%	20%
3 Sphalerite	-	5%
4 Pyrite	2%	-
5 Quartz	60%	58%

PARAGENETIC SEQUENCE



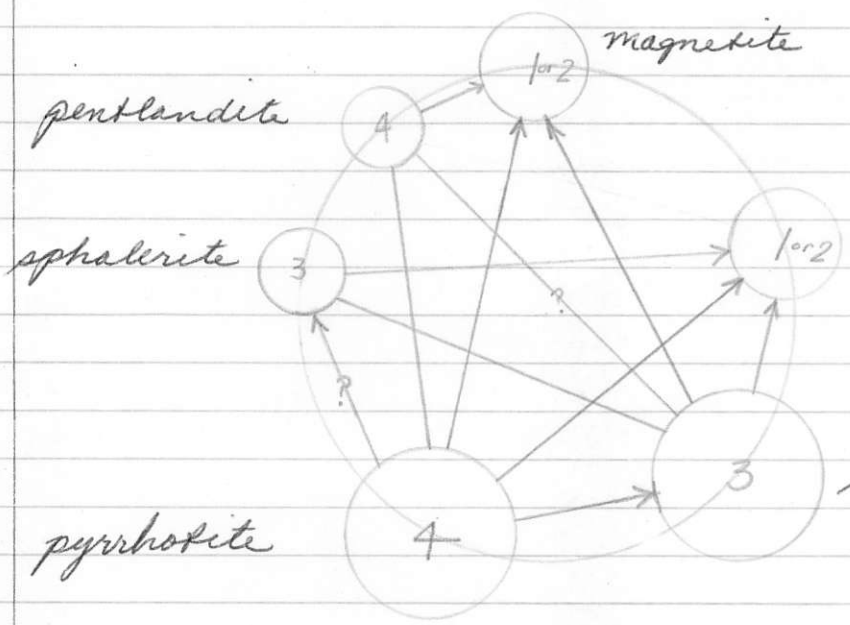
G WAR EAGLE.

Some of the specimens from this mine are very similar to the specimens from the Bruce Mines. Others are massive ~~sulp~~ pyrrhotite, with little else, which weather to yield a honey brown coating. Still other specimens are almost entirely chalcopyrite containing irregular veinlets of ~~chal~~ pyrrhotite. These ore minerals generally replace dark green, contorted serpentine. Calcite and quartz are the main gangue minerals but are present only in minor amounts.

MINERALS AND PERCENTAGES

	Section	1	2	3
1	Pyrrhotite	30%	25%	40%
2	chalcopyrite	40%	35%	20%
3	sphalerite	5%	5%	-
4	pyrite	10%	5%	-
5	quartz	-	-	5%
6	serpentine	15%	30%	-
7	magnetite	-	-	25%
8	Pentlandite	-	-	5%

PARAGENETIC SEQUENCE.



NOTE FIGURES 4 to 7

Summary of Group I.

No minerals containing essential gold were seen in this group of specimens. However, they are essentially gold-copper ores. Chalcopyrite is the copper bearing mineral. The gold is mostly found in the chalcopyrite, pyrite and pyrrhotite. Free gold has been reported in quartz veins in the O.K. Mine and from the 1686 stope of the Star Eagle Mine (memoir 77).

Pyrrhotite is an early-formed mineral in all but the Star Eagle Mine, where it follows chalcopyrite and sphalerite. The geographical position of these mines would suggest that they should all have relatively uniform paragenetic sequences. To my mind this discrepancy indicates that the ore minerals were deposited in a ~~(?)~~ short period of time so that the order could vary from place to place.

The memoir and maps list these mines as producing silver but since the silver is mainly in galena in this camp, and since no galena was seen in this group, this fact has not been definitely established.

The sphalerite is a minor constituent in these ores as a rule so zinc is not likely to be ~~an ore~~ one of the metals produced.

MILLING - The ore would have to be crushed and passed through a magnetic separation unit to remove the magnetite. Then it would be necessary to grind the remaining ~~other~~ ore finely and pass it through a cyanidation circuit to remove the gold and a flotation ~~circuit~~ circuit to remove the copper. The magnetic separation unit could probably be best used to remove both the magnetite

and the pyrrhotite. These could be segregated by using a weak magnet for the magnetite and a stronger one for the pyrrhotite. The pyrrhotite and the remaining ore could then be ~~separated~~ treated separately to minimize the volume of material passing through the copper circuit.

GROUP 2

A BLUEBIRD MINE.

The hand specimen is mineralogically banded into three distinct layers. The first band is:

Pyrite	80%
Sphalerite	17%
Galena	3%

The second band contains:

Pyrite	45%
Sphalerite	30%
Galena	20%
quartz	5%

The third band contains:

Pyrite	20%
Pyrrhotite	10%
sphalerite	20%
galena	5%
quartz	45%

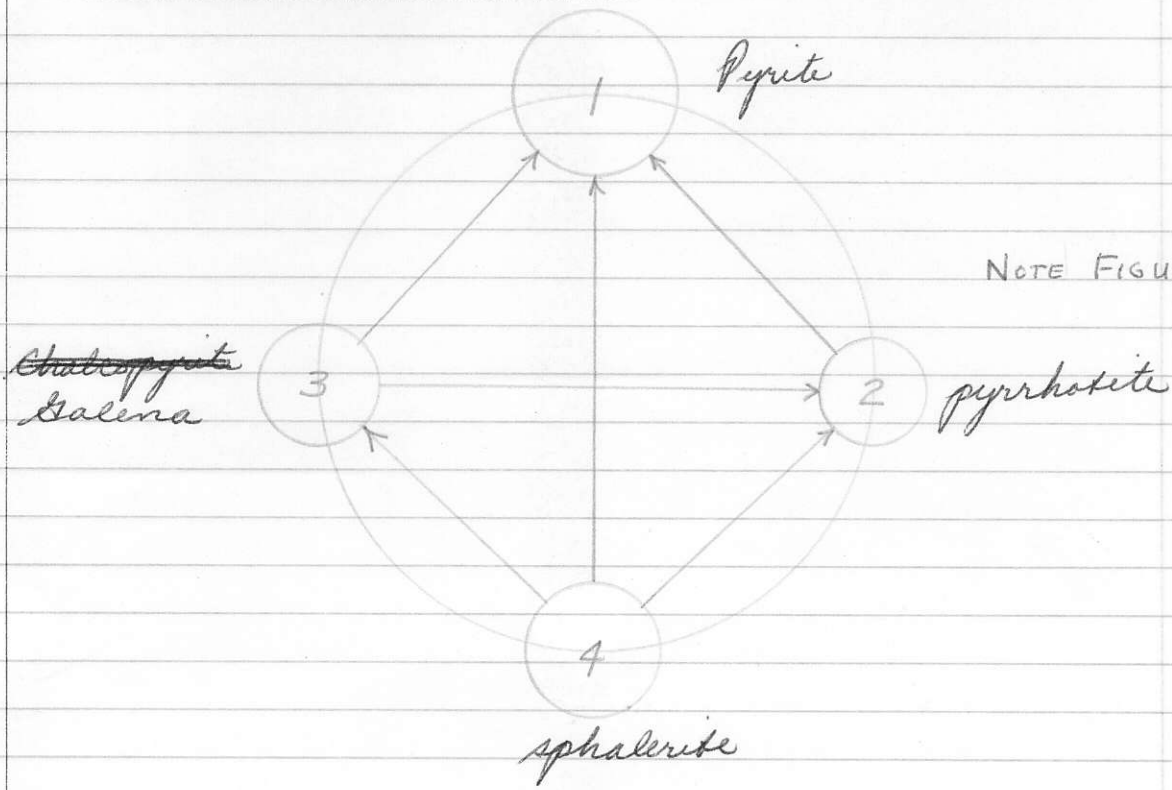
The pyrite is in euhedral to eroded crystals, the quartz is in the form of clear ~~small~~ needles and irregular crystals of relatively large size ranging up to 3/8" across. The other minerals are interstitial.

The central band is 3/4" thick the outer bands are of uncertain width but are greater than 3/4 inches in width.

BLUE BIRD MINE

MICROSCOPIC

PARAGENETIC SEQUENCE



B EVENING STAR MINE.

The hand specimens are quartz breccia with pyrrhotite, galena, sphalerite and chalcopyrite as replacement masses and irregular veinlets along the fractures. The replacement has been more complete in some samples than in others. The quartz is massive cloudy white with iron stained fractures or dark green and massive.

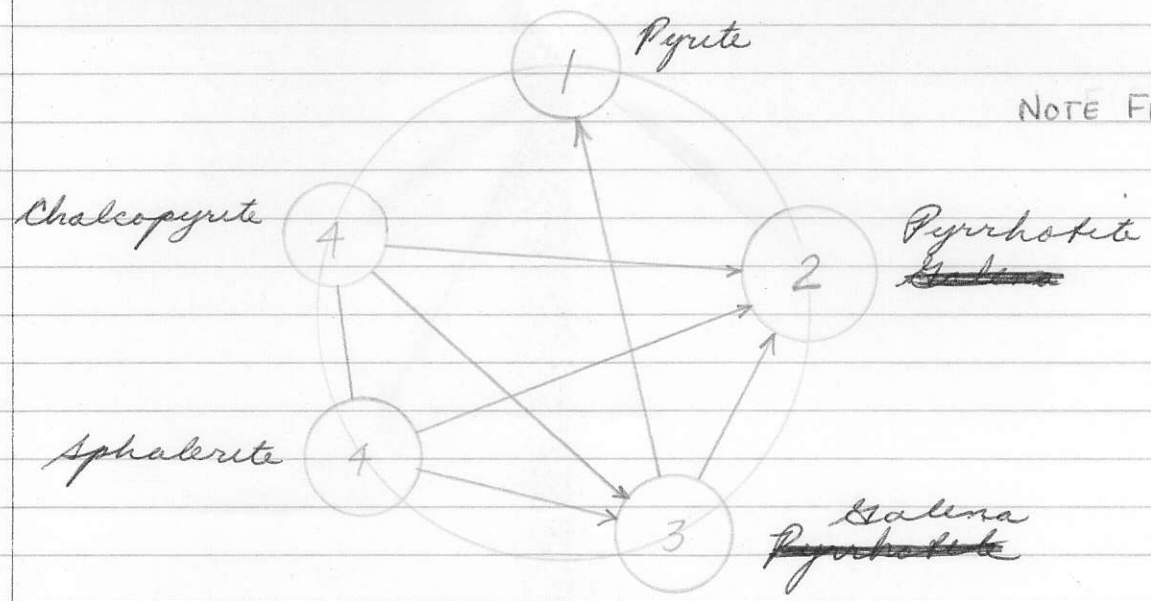
MICROSCOPIC

MINERALS AND PERCENTAGES

Specimen	1	2
1 pyrrhotite	30%	–
2 Galena	4%	20%
3 Sphalerite	1%	10%
4 chalcopyrite	10%	–
5 Pyrite	–	10%
6 Gangue	55%	55%

EVENING STAR MINE

PARAGENETIC SEQUENCE



Summary of Group 2.

This group is noted for producing gold, silver, lead zinc. The gold is in the pyrrhotite, pyrite and chalcopyrite. The galena is argentiferous.

The memoir states that arsenopyrite and stibnite are present in the Bluebird mine. These minerals were not contained within the specimen studied. -D/C

MILLING:-

The ore would have to be crushed then finely ground. A cyanidation circuit would be necessary, then the remaining ore would be passed through a copper-lead-zinc milling circuit. The silver would be concentrated with the lead as is done at Beaverdell.

GROUP 3.

THE GIANT MINE.

One hand specimen contains euhedral magnetite crystals and is similar to ore from the Bruce Mines. A second specimens is very fine grained galena with a little carbonate gangue. A third specimen contains closely meshed blade-like crystals of molybdenite cut by veinlets and blebs of safflorite, pyrrhotite and a little chalcopyrite. A fourth specimen contains sphalerite, galena and a little chalcopyrite replacing serpentine along fractures in the serpentine. The fifth specimen is well crystallized safflorite containing blebs and irregular veinlets of pyrrhotite with a little carbonate gangue. A sample of medium gray phyllite containing a few tiny pyrite crystals is the wall rock.

MICROSCOPIC

MINERALS

1 Galena
2 Pyrrhotite
3 Magnetite
4 Chalcopyrite
5 Molybdenite (MoS_2) - took a poor polish and was pleochroic from white to gray. It was strongly anisotropic with white, light violet and black colors. Four extinctions per revolution were noted. It had perfect basal cleavage and was negative to all reagents. The hand specimen gave a bluish gray streak on paper. The mineral had hardness B+.

GIANT MINE

6 Safflorite $(CoFe)As_2$ The mineral took an excellent polish and displayed a creamy white color. It had hardness F and was anisotropic in dark purple.

Etch Tests

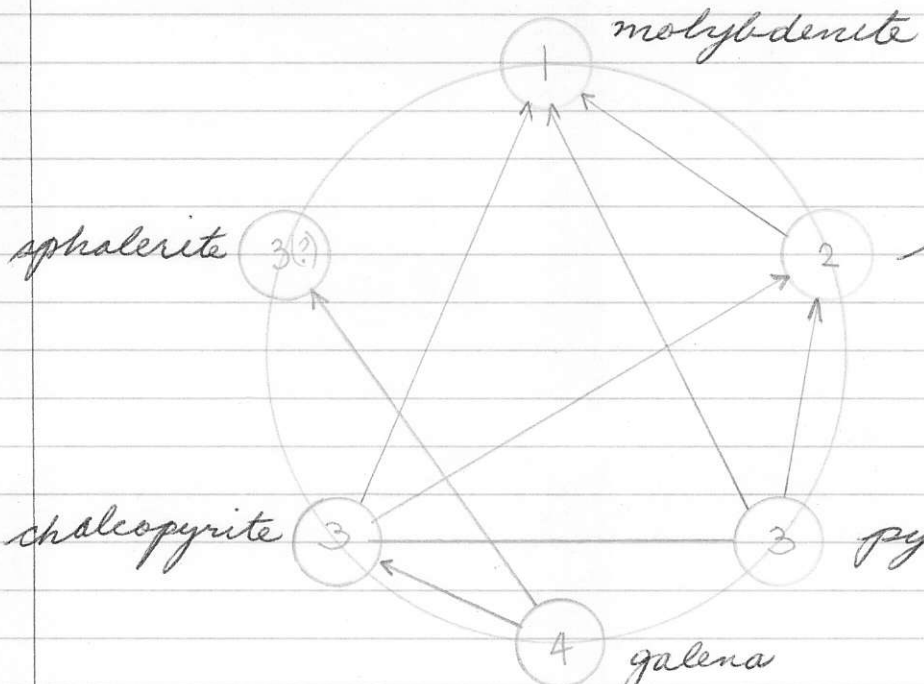
$HgCl_2$	stained light brown, differentially.
KOH	negative
KCN	negative
HCl	negative
$FeCl_3$	brown stain, differentially
HNO_3	effervesced slowly, stained black (note FIGURE 12).

Microchemical Tests

Strong, positive arsenic, cobalt tests

The mineral percentages were exceedingly variable.

PARAGENETIC SEQUENCE :-



NOTE FIGURES 10 to 13.

No magnetite was seen in the polished sections. It is probably the earliest metallic mineral.

Summary.

The minerals found in the sections suggest that the Giant mine might produce gold, silver, lead, zinc, molybdenite and cobalt. According to the memoir (memoir 77) this mine produced gold, copper and a little silver.

I can only conclude then that the sections studied by me are not representative. It is reasonable to assume that no molybdenite could be used commercially since molybdenum ores must be low in copper content. They can be sporadic.

MILLING:- The mill would need gold, copper and lead circuits. If these are typical

Le Roi

Figure 1 In general, chalcopyrite replaces pyrrhotite along fractures. In this example the reverse seems to be true. This fact seems to indicate that the pyrrhotite is both replaced by and replacing the chalcopyrite. The majority of the pyrrhotite is earlier.

Evening Star

Figure 2 The chalcopyrite has replaced the pyrrhotite. Pyrrhotite has been left as an "island" at one point.

Sphalerite replaces pyrrhotite and has smooth borders it is contemporaneous with the chalcopyrite.

Figure 3 Chalcopyrite replaces pyrrhotite and galena. These ore minerals are replacing quartz along fractures in the quartz.

LE ROI

X100

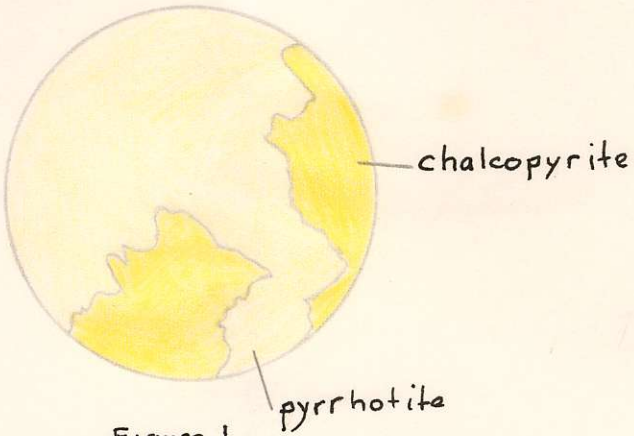


Figure 1

EVENING STAR

x100

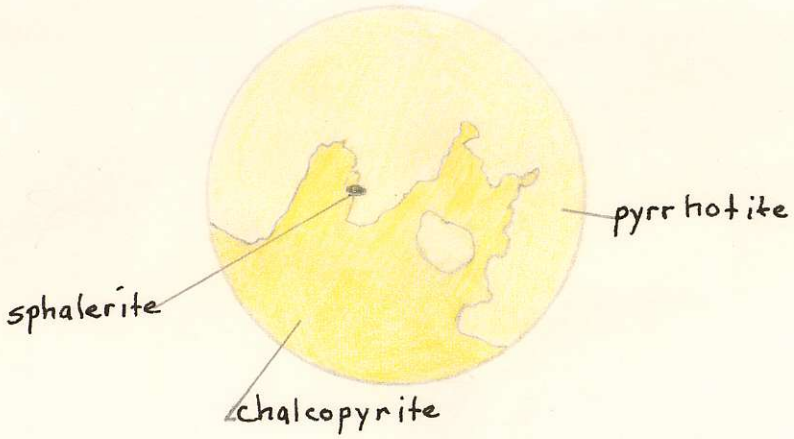


Figure 2.

x100

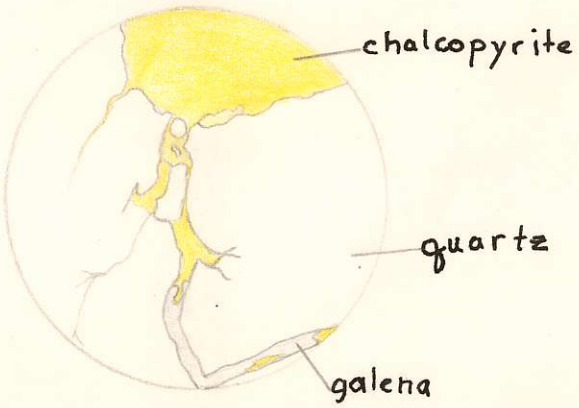


Figure 3

Near Eagle Mine

Figure 4 to Figure 7

These pictures are designed to show that all the metallic minerals replace the gangue mineral (serpentine mainly) along fractures. Pyrrhotite appears to be later than the chalcopyrite and sphalerite in this mine. Pyrite and magnetite are the earliest formed metallic minerals.

WAR EAGLE MINE.

x100

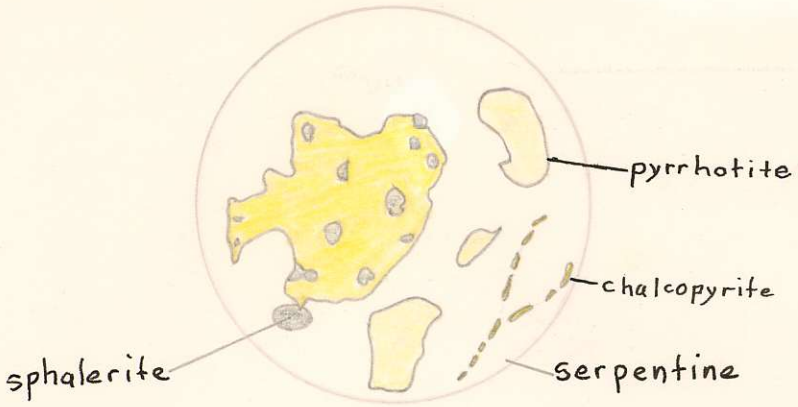


Figure 4

x100

Figure 5

x 100

Figure 6

WAR EAGLE

x 40

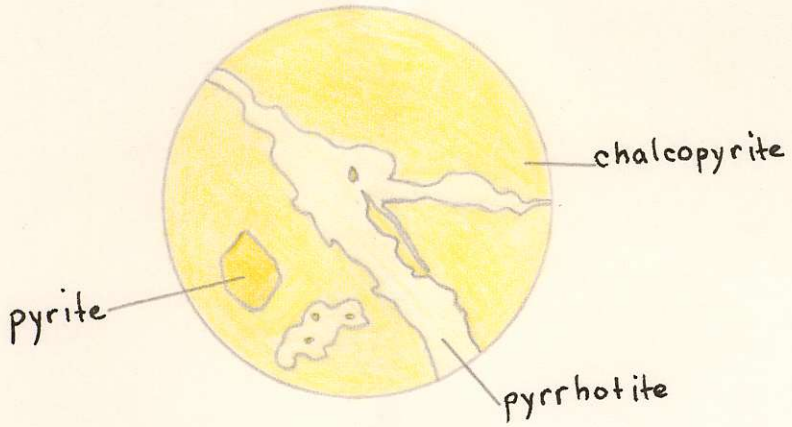


Figure 7

Blue Bird Mine

FIGURE 8 This drawing is designed to show the texture of the specimen. From this drawing it is evident that pyrite is replaced by sphalerite and galena and that sphalerite replaces galena.

FIGURE 9 Galena replaces pyrrhotite. Pyrrhotite replaces pyrite. The quartz crystals seem to be replacing pyrrhotite and ~~are~~ represent probably a second period during which quartz was introduced.

BLUE BIRD

x100

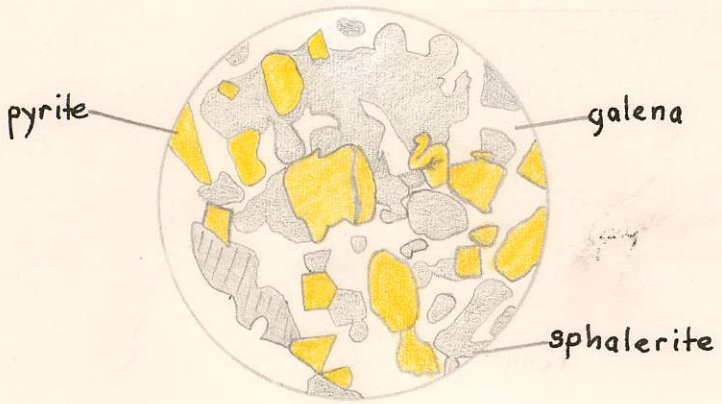


Figure 8

x150

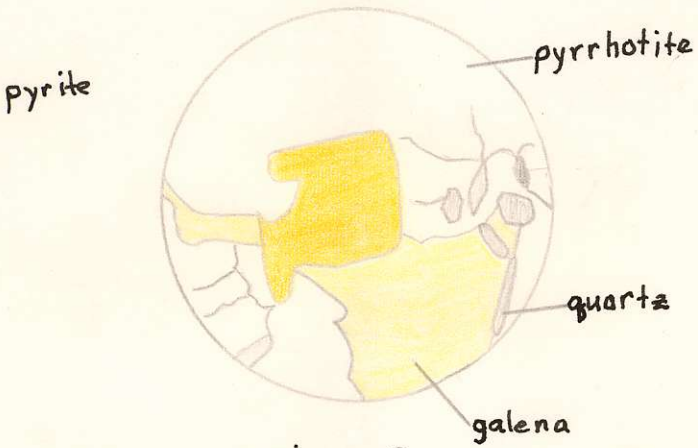


Figure 9

Giant Mine

FIGURE 10 Chalcopyrite replaces safflorite along fractures in the safflorite.

FIGURE 11 An irregular replacement vein of safflorite, which is in turn replaced by pyrrhotite, cutting molybdenite. Pyrrhotite and chalcopyrite are contemporaneous.

FIGURE 12 Safflorite etched with $FeCl_3$ or HNO_3 did not react where it was in contact with pyrrhotite or chalcopyrite.

GIANT.

x150

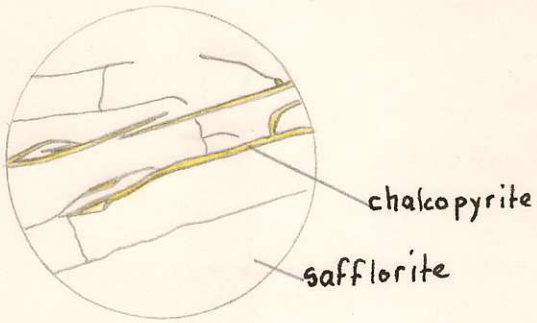


Figure 10

x100

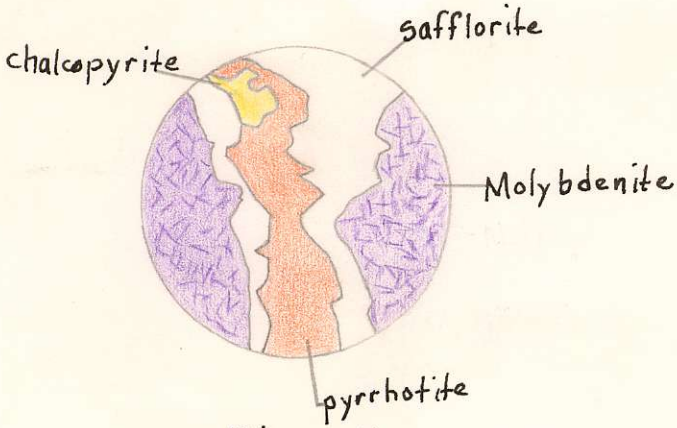


Figure 11

x150

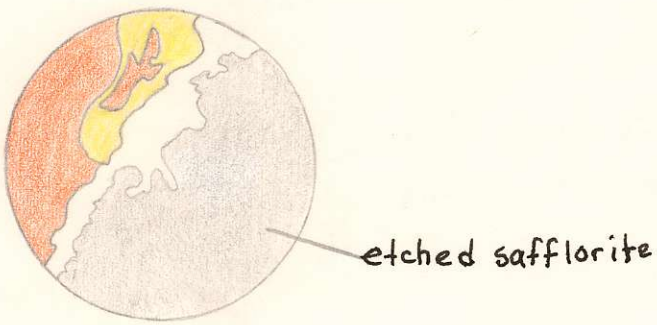


Figure 12

Grant

FIGURE 13 Galena replaces sphalerite and chalcopyrite.

GIANT

x100

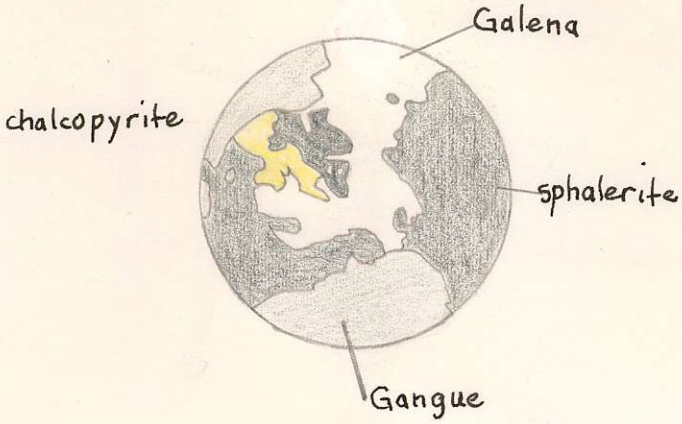


Figure 13.