600313

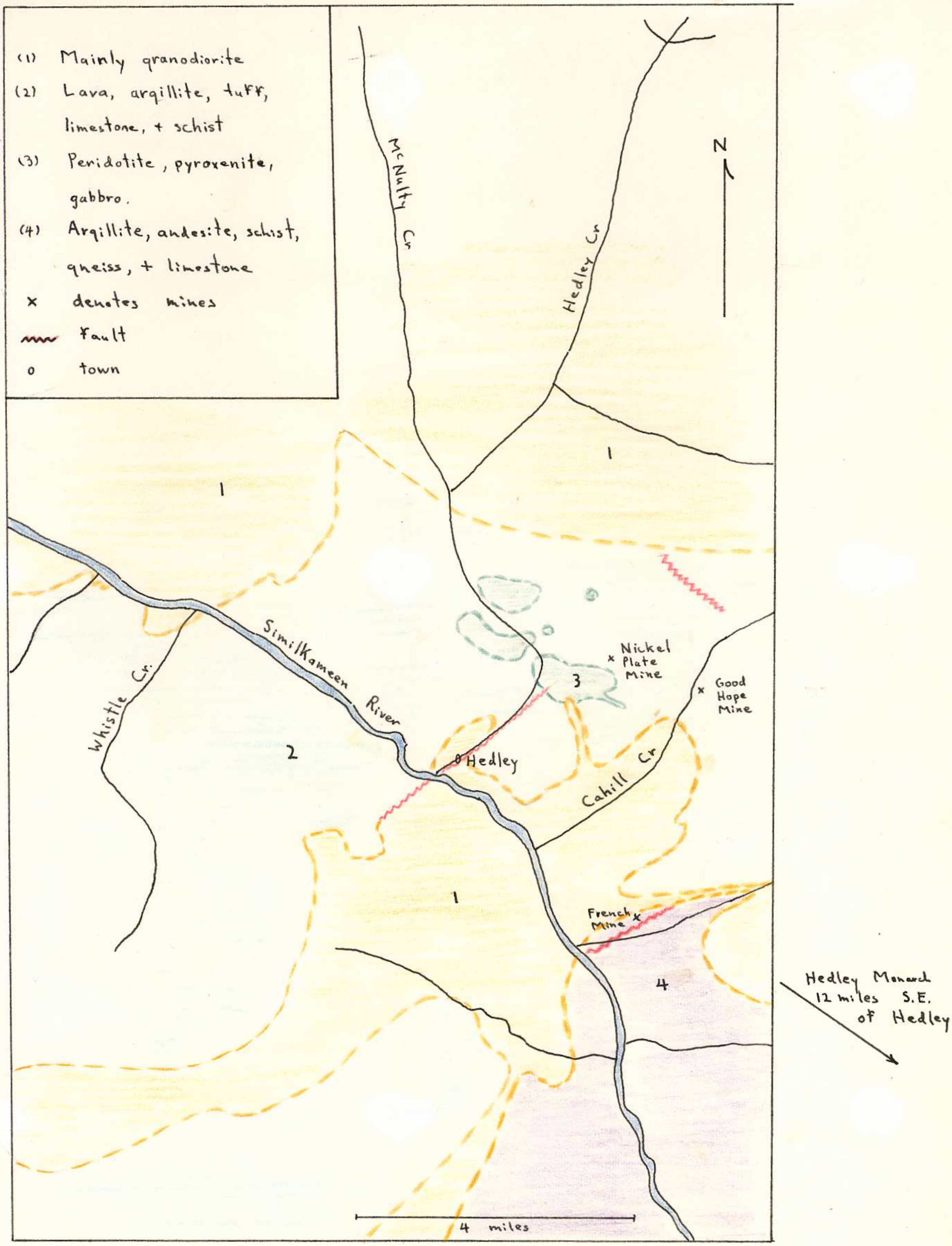
MINERALOGICAL REPORT ON THE FRENCH, GOOD HOPE, AND HEDLEY MONARCH MINES.

R. J. Nethery

March 15th/67

CONTENTS

Location Map



Introduction

This report deals primarily with the mineralogy of the French, Good Hope, and Hedley Monarch mines all of which are located in or near the Hedley area. An analysis of each mine is given which consists of the minerals present and their relative amounts, significant mineral textures of the ore, a paragenesis, and a classification of the deposit and its possible temperature of formation. The study of these mines is based almost solely on a polished section analysis of the ore.

Conclusion

The mineralogy and mode of formation are relatively the same for both the French and the Good Hope mines. Both deposits are related to a granodiorite intrusion, both occur in skarn, and both have relatively the same paragenetic sequence. Although these two contact metasomatic deposits are 4 miles apart, they have similar mineral assemblages. The Good Hope mineralogy is less complex, but none the less all the minerals found at this deposit are also present at the French Mine.

The Hedley Monarch deposit does not appear to be of the contact metasomatic variety. The ore for the most part occurs in quartz veins and in many different types of rock. It is therefore thought that the Hedley Monarch deposit is of hydrothermal origin.

Minerals found at the Good Hope, Oregon, French, and Monarch mines.

Arsenopyrite ($FeAsS$)

Polish: excellent
Color: white with a faint creamy or pinkish tint
Hardness: F
Anisotr: strong; blue, green, reddish brown-yellow

Cobaltite ($(Co,Fe)AsS$)

Polish: poor
Color: white with a distinct pinkish tint
Hardness: G
Anisotr: weak
Etch test: negative to all standard reagents

Molybdenite (MoS_2)

Polish: fair to good
Color: white with purple tint
Hardness: B
Anisotr: very strong; white with pinkish tint, to dark blue
Etch test: negative to all reagents

Gold (Au)

Polish: fair with scratches
Color: bright or "golden" yellow
Hardness: B
Isotropic: no complete extinction but typical greenish color
Etch test: KCN usually etches black

Chalcopyrite ($CuFeS_2$)

Polish: good
Color: brassy yellow
Hardness: C
Anisotr: weak but distinct; grey-blue and greenish yellow

Bornite (Cu_5FeS_4)

Polish: good, smooth surface
Color: pinkish brown to orange
Hardness: B
Isotropic: weak anomalous anisotr
Etch test: HNO_3 stains yellowish brown, KCN stains brown, FeCl stains orange

Tetrahedrite ($CU_{12}Sb_4S_{13}$)

Polish: good, easily
Color: olive grey
Hardness: D
Isotropic: complete extinction
Etch test: CrO_3 plus HCl; develops zonal texture beautifully

Pyrrhotite ($Fe_{1-x}S$)

Polish: excellent
Color: cream with a faint tint of pinkish brown
Hardness: D
Anisotr: very strong; yellow grey, greenish grey or bluish grey
Etch test: HNO_3 stains brown, HCl (-), KOH (≠) tarnishes irid to brown
KCN (-), $FeCl_3$ (-), $HgCl_2$ (-).

Bismuth (Bi)

Polish: fair with scratches
Color: white to creamy white but tarnishes brownish with time
Hardness: A
Anisotr: distinct to strong
Others: usually has distinct polysynthetic twinning
HNO_3 brings out texture, HCl stains slowly black, $FeCl_2$ quickly stains irid to black, KCN (-), KOH (-).

Galena (PbS)

Polish: good
Color: bright white
Hardness: B
Isotropic: a weak anomalous anisotr may rarely occur
Others: perfect cubic cleavage usually visible and triangular pits are found along cleavage traces.

Joseite B ($Bi_{4+x}Te_{2-x}S$)

Polish: good
Color: white with a yellow tint
Hardness: A
Anisotr: moderate to distinct, light brown to brownish dark grey
Etch test: HNO_3, HCl, and $FeCl_3$ are all positive.

Hedleyite (Bi_7Te_3)

Polish: fair but seldom without scratches
Color: white
Hardness: A
Anisotr: distinct ; light grey to dark grey
Etch test: HNO_3 eff. vigorously and quickly turns grey; $FeCl_3$ stains brown, in places irid; HCL, KCN, $HgCl_2$, and KOH are all (-)

Altaite ($PbTe$)

Polish: good
Color: bright white
Hardness: A
Isotropic: never shows complete extinction
Etch test: HNO_3 eff., stains dark grey, HNO_3 conc: stains irid, HCl tarnishes irid or neg., $FeCl_3$ quickly tarnishes irid, may develop granular texture.

Hessite (Ag_2Te)

Polish: poor
Color: grey, commonly with a brown tint
Hardness: A
Anisotr: strong; dark gold-brown to dark blue-grey
Etch test: HNO_3 stains irid to black, HCl slowly stains black, some spec neg; KCN (+), $FeCl_3$ stains irid, $HgCl_2$ stains brown to irid, KOH (-).

Petzite (Ag_3AuTe_2)

Polish: fair
Color: greyish white with a violet or reddish tint
Hardness: A
Isotropic:
Etch test: HNO_3 stains dark brown, brings out texture; HCl some spec stains irid others neg.; KCN (-); $FeCl_3$ stains irid; $HgCl_2$ slowly stains brown; KOH (-).

Pyrite (FeS_2)

Polish: poor
Hardness: F
Color: yellowish white
Isotropic: but not always showing complete extinction

Magnetite (Fe_3O_4)

Polish: poor - pitted
Hardness: F
Color: grey with brownish tint
Isotropic:
Others: magnetic

The French Mine (formerly the Oregon) Hedley, B.C.

Location

The French Mine is on the east side of Cahill Creek, about 5 miles east of Hedley at an elevation of 3,900 feet. The mine is approximately 4 miles south of the old Nickel Plate mine. It lies on the steep eastern slope of the Similkameen River between Cahill and Winters Creeks.

General Geology

The country rock consists of brown tuff, flows, limestone, and cherty formations belonging to the Nicola group of Triassic age. West of and just below the mine is a large mass of granodiorite which is part of the same body that underlies Nickel Plate Mountain. The French Mine lies near the crest of a large northeasterly trending asymmetrical anticline which contains in its gently dipping western limb the Nickel Plate orebodies. The grandiorite body conforms roughly to this shape and seems to occupy the core of the anticline. Sill-like prongs of granodiorite extend upward to the east from the main mass.

The orebody is a relatively flat spread of brown skarn associated with strong brecciation, silicification, and shearing in a predominatly limy member of the Nicola group. The ore has a marked tendency to run in shoots trending southeasterly, perhaps because of the presence of southeasterly trending crinkles or folds in the skarn bed.

Minerals found at the French Mine and an estimation of their relative abundance based on a polished section analysis of the ore.

Primary minerals

Chalcopyrite	21%
Arsenopyrite	15%
Cobaltite	15%
Pyrrhotite	10%
Bornite	10%
Molybdenite	12%
Joesite B	7%
Gold	5%
Bismuth	2%
Tetrahedrite	2%
Hedleyite	1%

Significant mineral textures found at the French Mine.

1. In this section arsenopyrite has partially replaced pyrrhotite. The arsenopyrite appears to have bitten into the pyrrhotite thus giving a good replacement texture.

2. Here arsenopyrite has extensively replaced the cobaltite. The replacement is fracture controlled.

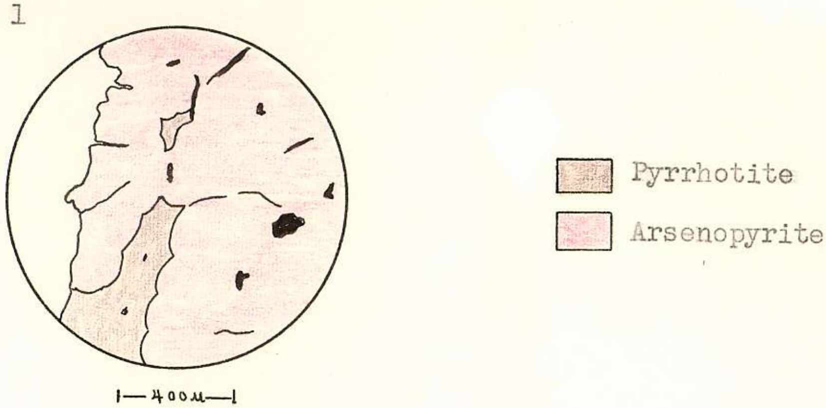
3. In this section chalcopyrite and molybdenite have filled fractures and coated outer surfaces of the cobaltite. From the textures it appears that cobaltite was the first to crystallize followed by chalcopyrite and then molybdenite.

4. This section shows an exsolution intergrowth of chalcopyrite in bornite. The chalcopyrite has exsolved along the (111) crystallographic planes of the bornite. Also in this section it appears as if the tetrahedrite has partially replaced the earlier bornite. The arsenopyrite also appears to have been replaced to a moderate degree by bornite.

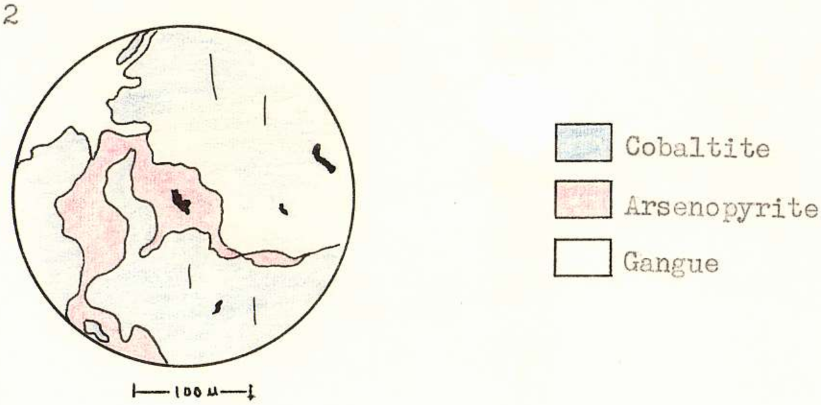
5. In this section joesite B has partially replaced bismuth along its cleavage planes.

6. This section shows molybdenite crystals coating the outside and filling fractures in the arsenopyrite. The texture indicates that arsenopyrite is the earliest mineral.

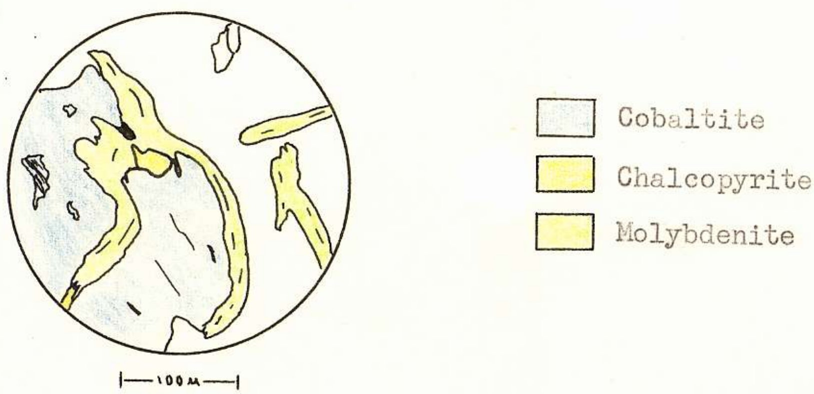
1


Pyrrhotite
Arsenopyrite
400 μ

2


Cobaltite
Arsenopyrite
Gangue
100 μ

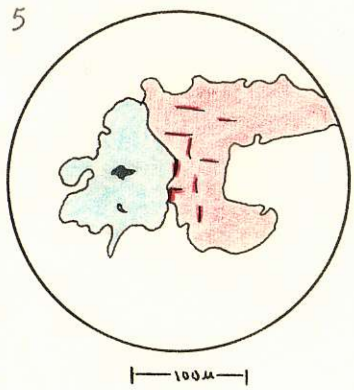
3


Cobaltite
Chalcopyrite
Molybdenite
100 μ

4

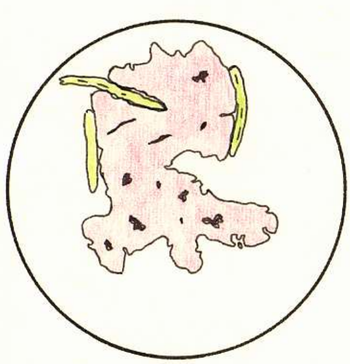
- Arsenopyrite
- Bornite
- Chalcopyrite
- #Tetrahedrite

5



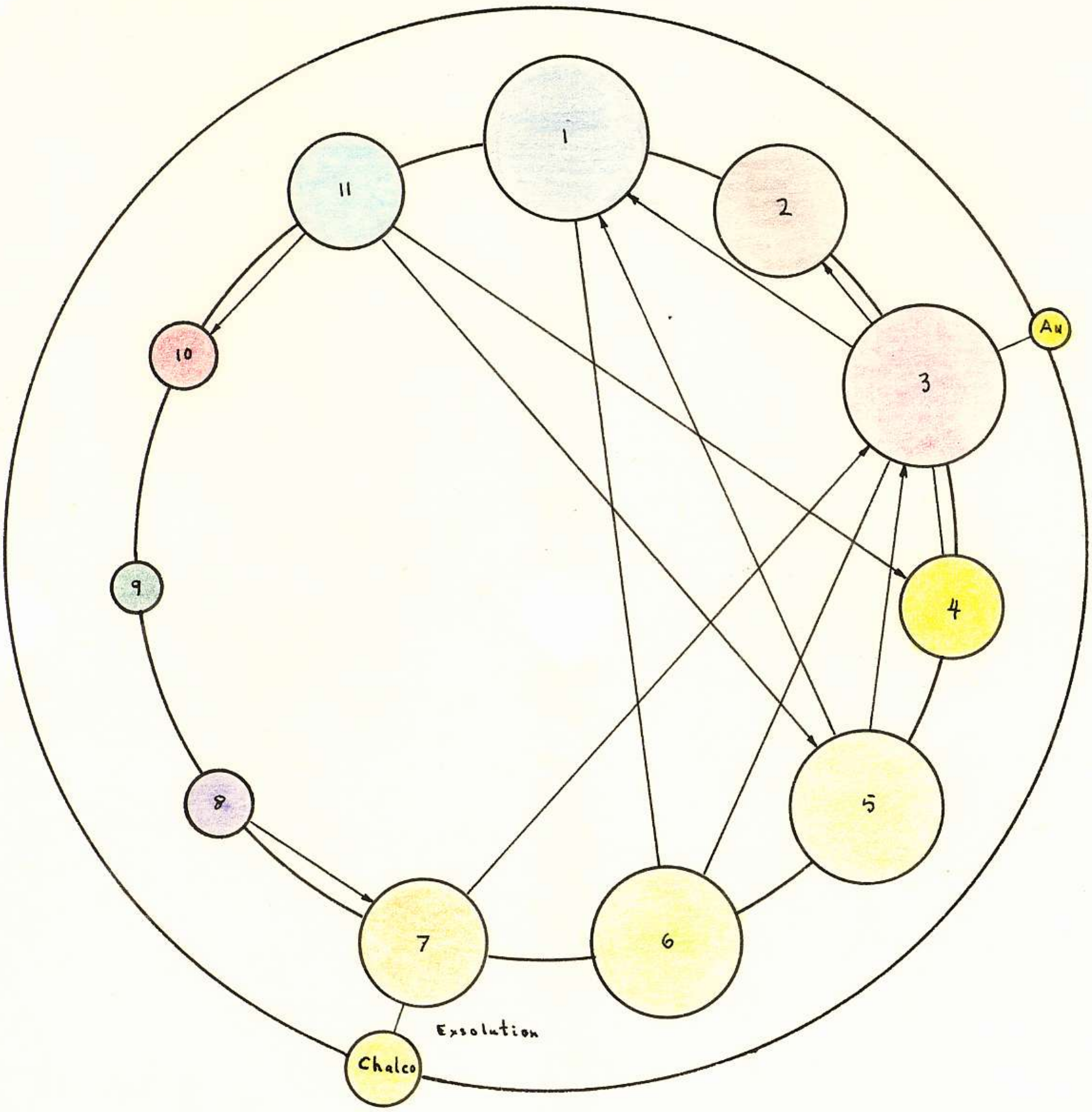
- Bismuth
- Joseite B

6



- Arsenopyrite
- Molybdenite

Van Der Veer diagram showing the paragenetic sequence of the minerals found at the French Mine.



1. Cobaltite
2. Pyrrhotite
3. Arsenopyrite
4. Gold
5. Chalcopyrite
6. Molybdenite
7. Bornite
8. Tetrahedrite
9. Hedleyite
10. Bismuth
11. Joseite B

Paragenetic sequence - French Mine

The paragenesis of this mine is difficult to determine due to the apparent overlapping and simultaneous deposition of the minerals. Also, many of the minerals occur only as unrelated blebs. Cobaltite was probably the first mineral deposited, followed then by pyrrhotite, arsenopyrite, and gold. Minor amounts of gold appear to have been in solid solution with the arsenopyrite but the majority of the gold was deposited after the arsenopyrite. Chalcopyrite was deposited over a fairly wide range. The majority of the chalcopyrite was deposited about the same time as the molybdenite, although it probably started to form before the molybdenite and was still forming after all the molybdenite had crystallized. In the next phase of mineralization minor amounts of chalcopyrite exsolved from bornite. The tetrahedrite is related to this phase of mineralization but appears to have formed just a little later than the chalcopyrite-bornite. The last minerals to be deposited were bismuth and the bismuth tellurides. The exact depositional sequence for these minerals is not too well known but it appears as if hedleyite and bismuth were deposited at relatively the same time, with joesite B forming a little later.

Classification of the deposit and its probable temperature of formation.

French Mine -

The French Mine is a contact metasomatic deposit. The mineralization occurs in an altered limy sediments called skarn. The temperature of formation is fairly high. Minerals like cobaltite, arsenopyrite, pyrrhotite, and molybdenite all indicate a high temperature of formation. An exsolution intergrowth of chalcopyrite in bornite was observed in this deposit and according to Edwards (Textures of the Ore Minerals - A. B. Edwards - 1965) chalcopyrite and bornite form extensive solid solutions at temperatures above 475°C. Therefore it would seem that the temperature of the first mineralizing fluids was around 500°C or higher. With time, slightly cooler mineralized fluids deposited the lower temperature minerals like bismuth and the tellurides.

The Good Hope Property

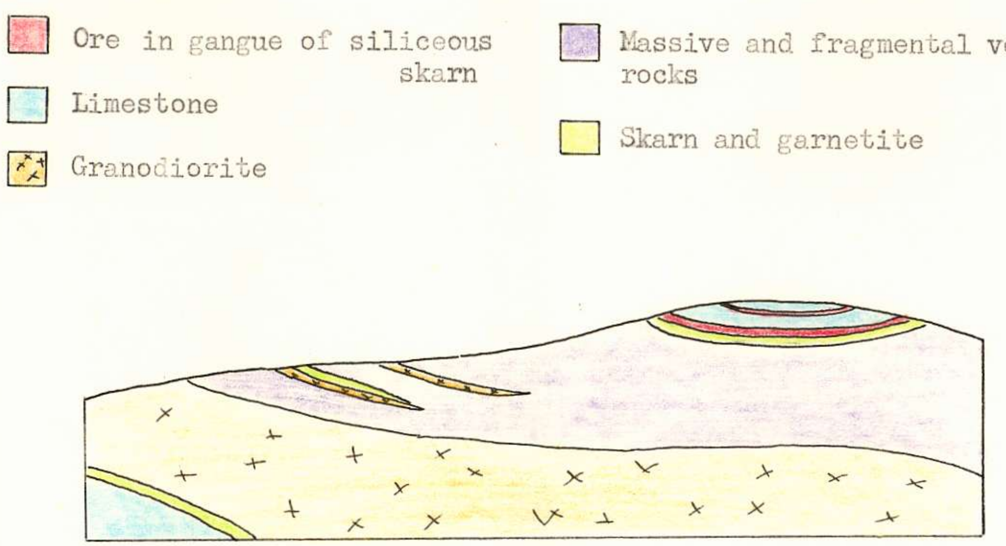
Location

The property is approximately 3 miles southeast of Hedley at an elevation of 5,000 feet, between Cahill and Winters Creeks.

General Geology

The rocks in the vicinity are volcanic flows and fragmentals, with subordinate tuffs, argillite, and limestone, intruded by granodiorite and aplite. Locally the rocks are altered to epidote-pyroxene-garnet-quartz-calcite skarn and garnetite. The limestones are recrystallized and locally may be strongly silicified.

General cross-section of the property area looking directly west.



Minerals found at the Good Hope property and an estimation of their relative abundance based on a polished section analysis of the ore.

Primary minerals

Joesite B	35%
Bismuth	25%
Arsenopyrite	20%
Gold	10%
Molybdenite	5%
Hedleyite	5%

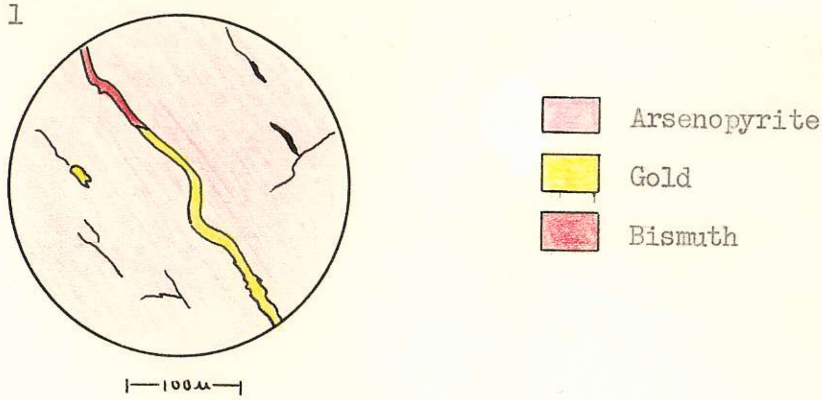
Significant mineral textures of the Good Hope property.

1. In this section gold and bismuth have filled fractures in the arsenopyrite. From this texture it is assumed that both the gold and the bismuth are later than the arsenopyrite.

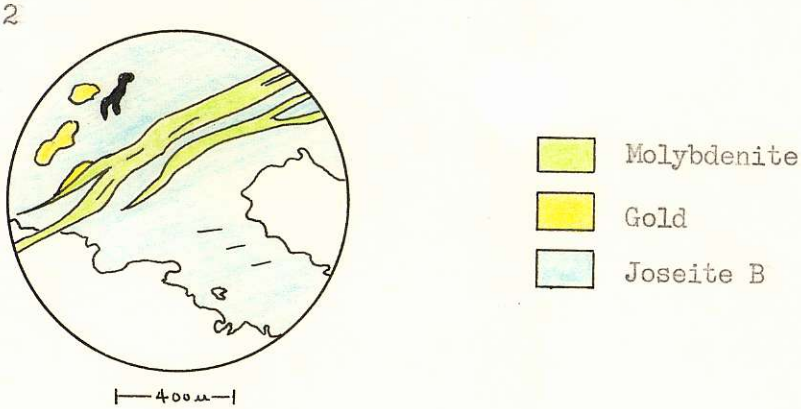
2. Here a bleb of gold has formed along a molybdenite crystal contact. The gold is therefore later than the molybdenite. Joesite B was the last mineral to form and has partially replaced gold.

3. This section shows an intergrowth of hedleyite and bismuth that has been replaced by joesite B. The hedleyite appears in the bismuth as hexagonal plates. From this texture it is assumed that joesite B is later than the hedleyite and bismuth.

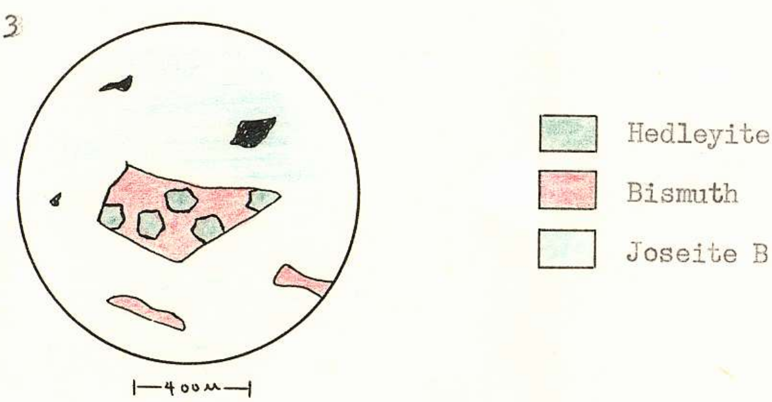
1


Arsenopyrite
Gold
Bismuth
100μ

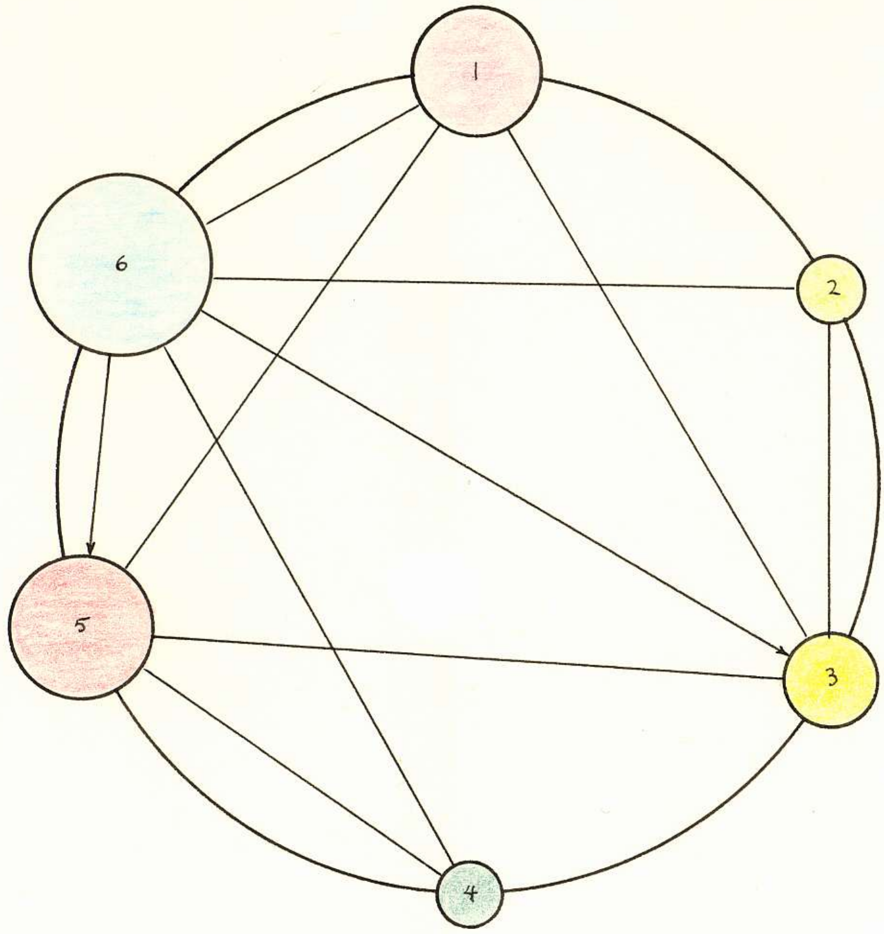
2


Molybdenite
Gold
Joseite B
400μ

3


Hedleyite
Bismuth
Joseite B
400μ

Van Der Veer diagram showing the paragenetic sequence of the minerals found at the Good Hope property.



1. Arsenopyrite
2. Molybdenite
3. Gold
4. Hedleyite
5. Bismuth
6. Joesite B

Paragenetic sequence - Good Hope Mine

The paragenesis of the Good Hope property is similar to that of the French Mine. It appears as if the first two minerals deposited were arsenopyrite and molybdenite. The arsenopyrite is fractured and some of the fractures are filled with gold. It is therefore thought that ore movement occured within the ore body subsequent to the deposition of arsenopyrite, but prior to the deposition of the gold. The last minerals to form were bismuth and the tellurides.

Classification of the deposit and its probable temperature of formation

The deposit is in skarn and has formed as a direct result of contact metasomatism. The temperature of formation is probably similar to that of the French Mine, with the first mineralizing fluids at temperatures of around 500°C, followed by later fluids of cooler temperatures.

The Hedley Monarch Mine.

Location

The property is at Olalla, about 4 miles north of Keremeos. The Keremeos-Penticton Trans-Provincial highway runs right by the property.

General Geology

On the property is a thick sedimentary series which is intruded by pyroxenite, syenite, granite, and some dioritic rock. The sediments include argillite, chert, quartzite, and minor amounts of impure limestone. Some greenstone is intercalated with the sediments. The sediments are found mainly in the southern part of the Hedley Monarch property, and the pyroxenite and other granitic rocks in the central and northern part. A small composite stock of soda granite, syenite, and aplite occurs on the property. This stock is bounded on three sides by proxenite. Mineralization occurs in serveral areas on the property. In one area it occurs in a fault zone in the pyroxenite and in another, in the syenite and soda granite. Mineralization is also found in a carbonate breccia-zone near a pyroxenite contact.

Minerals found at the Monarch Mine and an estimation of their relative abundance based on a polished section analysis of the ore.

Primary minerals

Chalcopyrite	20%
Hessite	20%
Galena	15%
Tetrahedrite	15%
Gold	10%
Altaite	8%
Pyrite	7%
Magnetite	3%
Petzite	2%

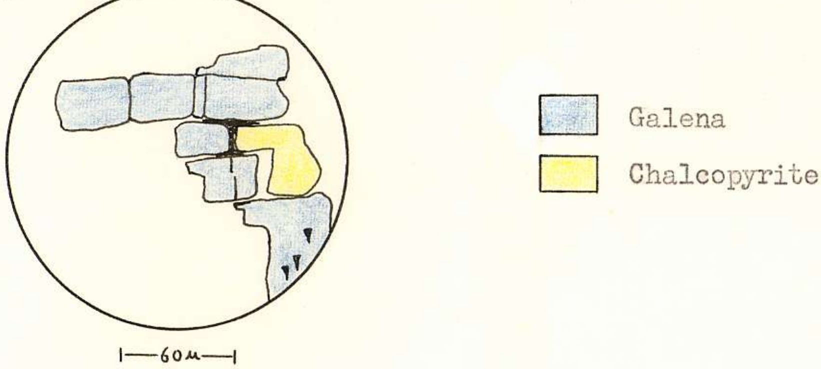
Significant mineral textures of the Hedley Monarch Mine.

1. In this section chalcopyrite has replaced galena. The replacement is crystallographically controlled and has taken place along cleavage planes. The chalcopyrite is therefore definitely later than the galena.

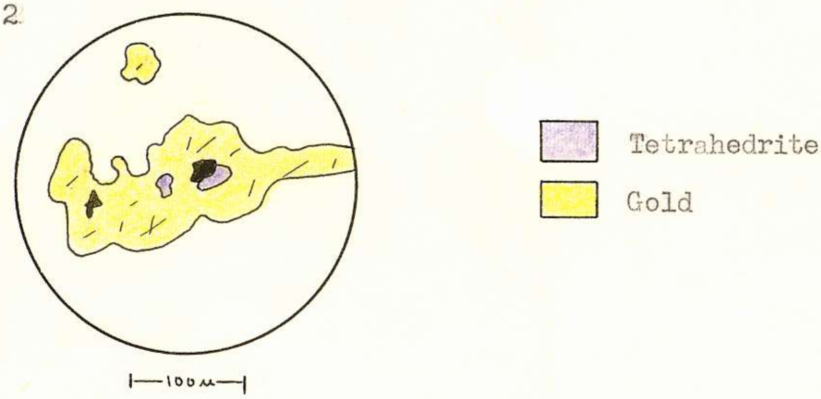
2. This section shows gold having partially replaced the earlier tetrahedrite.

3. Here hessite appears to have partially replaced both the gold and the chalcopyrite. Also, the gold may have replaced some of the chalcopyrite.

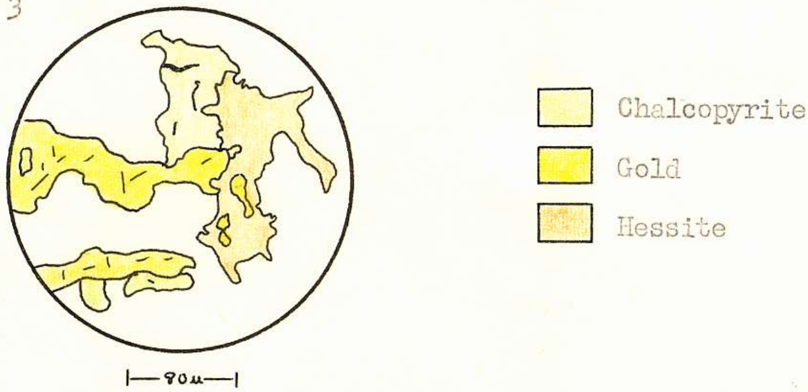
1


Galena
Chalcopyrite
60µ

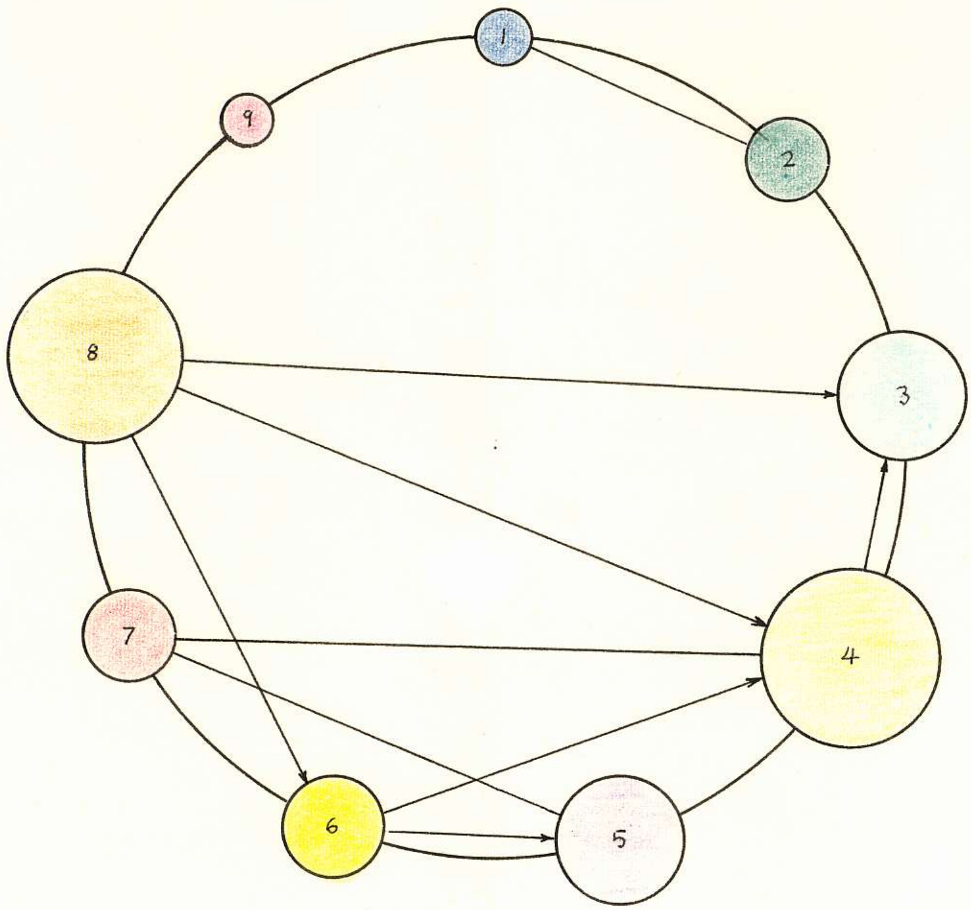
2.


Tetrahedrite
Gold
100µ

3


Chalcopyrite
Gold
Hessite
80µ

Van Der Veer diagram showing the paragenetic sequence of the minerals found at the Hedley Monarch Mine.



1. Magnetite
2. Pyrite
3. Galena
4. Chalcopyrite
5. Tetrahedrite
6. Gold
7. Altaite
8. Hessite
9. Petzite

Paragenetic sequence - Hedley Monarch Mine

The paragenetic sequence of this mine is difficult to ascertain due to the unrelated textures of most minerals. It appears that the first minerals to crystallize were magnetite and pyrite. The pyrite and magnetite are corroded and show no textural relationship to the other minerals. The next minerals to be deposited were galena, chalcopyrite and tetrahedrite, and gold in that order. It should be noted that the chalcopyrite and tetrahedrite appear to have been deposited simultaneously. The tellurides formed last but their exact order of formation is not known, although it appears as if altaite crystallized before hessite and petzite.

Classification of the deposit and its probable temperature of formation.

Hedley Monarch Mine -

The relationship of the mineralization to any intrusive bodies is not known for this property. It is most probable that this deposit is of hydrothermal origin. The mineralogy of the deposit is indicative of moderately high temperatures. The magnetite, pyrite, galena, chalcopyrite, tetrahedrite and gold all were probably deposited by hydrothermal fluids of the 300 - 500°C temperature range. It should be noted that this temperature range is a matter of conjecture on the part of the author as no good temperature indicators were available in the polished sections studied. The tellurides were probably deposited by later low temperature fluids. It is thought that these later solutions were of temperatures under 250°C.

Good Job.
Refs?
A