Reg Olson
266 E. 46th
Van. 15, B.C.

Apr. 20, 1968

Mr. F. A. Lang

Dear sir,

I have enclosed a copy of my report on the Cream Silver deposit.

The information you gave me was appreciated as it was of great assistance in the writing of the report.

Best of luck in your summer exploration.

Yours truly,
Reg A. Olson

A Mineralographic Report on the Cream Silver Deposit

by

Reg Olson

6517621

1968 ?

Abstract:

Petrographic study of specimens from the Cream Silver deposit, a lead-zinc-silver property located in Strathcona Park on Vancouver Island, shows that the major ore minerals are sphalerite, galena, tetrahedrite and owyheeite, in that order of abundance. The mineralogy and textures indicate that the deposit was formed from moderate to low temperature (500°C. to less than 250°C.) hydrothermal solutions which moved up fault zones and shear zones and deposited sulphides in a vein deposit.

Introduction:

The purpose of this study was to ascertain the mineralogy and paragenesis of the Cream Silver deposit.

The Cream Silver deposit is situated approximately six miles south of Buttle Lake, which lies in Strathcona Park on Vancouver Island. Most of the deposit lies in and near the southern end of a northwesterly-trending belt of volcanics with interbedded bands of limestone and argillite. This belt is Permian in age. Along its western and southern edges the belt is in contact with a granitic intrusion, part of the Coast batholithic intrusions of Middle Jurassic age. Along its eastern and northern edges the belt is in contact with Karmutsen volcanics of Triassic age. The region is occupied by the axis of a broad north-west trending anticlinal structure which has been faulted from the south-west. Mineralization in the Cream Vein is closely associated with a thrust fault and associated shear zones. Other veins in the area are also related to faulting and shearing. Ore minerals and gangue were deposited around, and to a limited extent in, fault breccia. Movement has occurred on some of these faults and shears since mineralization, as evidenced by slickensided surfaces on Specimen No. 5. A probable explanation is that ore deposition was closely related to faulting and occurred while movement was in progress.

More detailed information on the above may be found in:

Lang, F.A. and Quinn, H.A.: Prospectus Cream Silver Mines Ltd., (N.P.L.), February 16th, 1967.

Selmser, C.B.: Geological Report Cream and Bear Groups, Buttle Lake Area, British Columbia, September, 1967.

Summary:

1) Purpose: to ascertain the mineralogy and paragenesis of the Cream Silver deposit.

2) Main Minerals:

a)	Sphalerite	- 50%	of total sulphides
b)	Galena	- 22%	" " "
c)	Tetrahedrite	- 17%	" " "
d)	Owyheeite	- 5%	" " "
e)	Arsenopyrite	- 3%	" " "
f)	Pyrite	- 2%	" " "
g)	Pyrargyrite	- <1%	" " "

h) Chalcopyrite - $<1\%$ of total sulphides

3) Paragenesis: earliest to latest

1) Arsenopyrite
2) Pyrite
3) Chalcopyrite
4) Sphalerite
5) Tetrahedrite
6) Galena
7) Exsolution of Chalcopyrite from Sphalerite
8) Pyrargyrite
9) Owyheeite

4) Classification: moderate (under 500°C.) to low (less than 250°C.) temperature, hydrothermal lead-zinc-silver vein deposit.

Description of Specimens

SPECIMEN NO. 1

Hand Specimen: The specimen consists of galena, tetrahedrite, sphalerite and pyrite, abundance given from greatest to least. Galena is silvery-grey in colour and shows good cubic cleavage. Sphalerite is a moderate brown colour and shows a few cleavage faces. Tetrahedrite is a flint-grey colour and has a massive to somewhat granular texture. Pyrite is pale brass-yellow and massive.

Gangue consists of carbonate (siderite and possibly ankerite ?).

Polished Section:

1) Galena: PbS

Colour: White

Hardness: B

Polish: Very good

Reflectivity: Very good -~45

Cleavage: Triangular cleavage pits

Pleochroism: None

Anisotropism: Isotropic

Etch Tests:

HNO_3 - tarnishes black

HCl - tarnishes brown

$FeCl_3$- tarnishes brown (?) to iridescent

KCN - negative

Texture: Irregular masses. Some replacement of pyrite, chalcopyrite, sphalerite and tetrahedrite. In contact with pyrargyrite and owyheeite, age relations unclear.

Galena occupies approximately 27% of the section.

2) Tetrahedrite: $(\underline{Cu}, Fe, Ag, Zn)_{12} (As, Sb)_4 S_{13}$

Colour: Olive-grey (tetrahedrite replacing sphalerite is slightly more greenish-grey -

possibly from reaction with sphalerite?).

Hardness: D >gn, < sph

Polish: Good

Reflectivity: Fair, slightly more than sph, approximately 25-30.

Pleochroism: None

Anisotropism: Isotropic

Texture: Irregular masses. Replaces sphalerite to a large extent. Replaced to a large extent by pyrargyrite and owyheeite. Seems to be in part replaced by galena (small round blebs of td in gn).

Tetrahedrite occupies approximately 20% of the section.

3) Sphalerite: (Zn, Fe) S

Colour: Light grey

Hardness: C ≫gn, > td

Polish: Good - slightly pitted

Reflectivity: Low (< 25)

Pleochroism: None

Anisotropism: Isotropic

Internal Reflection: In plain light shows as light brown areas. Under crossed-nicols is very strong, entire mass shows light to moderate brown colours.

Texture: Irregular masses. Some replacement of arsenopyrite. Replaced by tetrahedrite, galena, and owyheeite. Very small amounts of chalcopyrite occur as oriented inclusions and as rim texture in some masses, (exsolution features).

Light colour of sphalerite both in hand specimen and polished section, coupled with strong light to moderate brown internal reflection indicates a low iron sphalerite. Percent Fe substituting for Zn is probably between 2% to 5%.[1]

Sphalerite occupies approximately 10% of the section.

4) Pyrite: FeS_2

Colour: Pale yellow

Hardness: Very hard

Polish: Poor - surface strongly pitted

Reflectivity: Good to very good - ~50

Pleochroism: None

Anisotropism: Isotropic

Cleavage: None observed

Texture: Irregular to elongated masses. Seems to be replacing arsenopyrite.

Pyrite occupies approximately 5% of the section.

5) Owyheeite: $Pb_5Ag_2Sb_6S_{15}$

Colour: Greyish white to greyish green - lighter green than tetrahedrite - light green next to galena.

---

1. Edwards, Textures of the Ore Minerals, 1960, pp. 84.

Hardness: Low - approximately = to galena, < tetrahedrite

Polish: Very good - as good as galena

Reflectivity: Fair to good - > tetrahedrite < galena - approximately 33 to 35

Pleochroism: None

Anisotropism: Strong to very strong - colours dark grey to light grey (slightly brownish tinge)

Internal Reflection: None

Etch Tests:

HNO_3 - (+) ve - slowly stain brown

HCl - (+) ve - tarnishes brown along fractures

KCN - (-) ve

$FeCl_2$ - (-) ve

KOH - stains slightly after prolonged exposure (? - 3 to 5 min.)

Texture: Occurs as small masses, or acicular crystals. Replaces tetrahedrite and may be replacing pyrite, sphalerite and galena. Seems to occur frequently surrounding pyrite grains in tetrahedrite and galena, and also commonly occurs along galena-tetrahedrite contact. This could be because contacts are zones of weakness and allow easier penetration of fluids. Also occurs in tetrahedrite with pyrargyrite. Caries texture seems to indicate owyheeite replaces pyrargyrite.

Owyheeite occupies approximately 5% of the section.

7) Arsenopyrite: FeAsS

Colour: Silvery

Hardness: G

Polish: Poor in larger grains - pitted, fair in smaller grains. (Specimen was diamond polished)

Reflectivity: High - approximately = to pyrite

Pleochroism: None

Anisoptropism: Strong to very strong (brown to bluish grey)

Texture: Occurs in thin sharp rhombic crystals up to 0.5mm. in length in quartz gangue. Partly replaced by pyrite.

Arsenopyrite occupies approximately 1% or less of the section.

8) Chalcopyrite: $CuFeS_2$

Colour: Bright yellow

Hardness: C - slightly < sphalerite

Polish: Very good

Reflectivity: Good - slightly < galena

Pleochroism: None

Anisotropism: None

Texture: Occurs as a few small oriented inclusions in sphalerite and as small blebs along edge of sphalerite mass (rim texture). Seems to be entirely of secondary origin from exsolution.

Chalcopyrite occupies much less than 1% of the section.

Gangue occupies approximately 30% of the section and consists of carbonate (siderite) and quartz. Quartz is most abundant in the plane of the section, and surrounds most of the sulphides. Massive pyrite on the edge of the section seems to be partly surrounded by a quartz-carbonate mixture. Quartz is of two types, a euhedral variety which seems to occur in comb structure, and a later massive variety that surrounds the euhedral variety as well as the sulphides.

SPECIMEN NO. 2.

No Hand Specimen

Polished Section:

1) Galena: Galena replaces pyrite, chalcopyrite and tetrahedrite. Occupies 95% of the section.

2) Pyrargyrite: Generally occurs as rounded blebs to angular blebs in galena with no particular orientation (?). Some blebs seem definitely younger than galena as they show preferential replacement of galena along fractures and

cleavage, whereas some of the more rounded blebs appear to be relict features. Age relations are therefore uncertain. Pyrargyrite occupies less than 1% of the section.

3) Sphalerite: Generally the same as in Section No. 1 but seems to be a slightly darker grey and shows exsolution of chalcopyrite, as oriented inclusions and as rim texture. Sphalerite occupies 1% of the section.

4) Tetrahedrite: Occurs as irregular blebs and masses. Replaces arsenopyrite and rounded inclusions of chalcopyrite in tetrahedrite indicate tetrahedrite replaces chalcopyrite. Replaced by galena. Tetrahedrite occupies 1% or less of the section.

5) Pyrite: Occurs as euhedral grains, some of which are replaced by galena. Pyrite occupies 1% of the section.

6) No owyheeite was observed.

7) Chalcopyrite: Same distinguishing characteristics as in Section No. 1.

Texture: Occurs as exsolution feature of sphalerite but large irregular masses entirely separated from sphalerite are probably of primary origin. Replaced by tetrahedrite and galena. Seems to flood around euhedral grains of pyrite without actually replacing them -

indicating chalcopyrite is younger than pyrite.

Chalcopyrite occupies 1% of the section.

Gangue composed of irregular masses with light grey colour, brown internal reflection and a low hardness (3-4). It is most likely siderite or possibly ankerite ?. Gangue occupies less than 1% of the section.

SPECIMEN NO. 3

No Hand Specimen

Polished Section: Mineralogy and textures are the same as in Sections No. 1 and 2. Galena definitely replaces sphalerite. Gangue is quartz and calcite.

Mode is:	Sphalerite	- 46%
	Galena	- 3%
	Chalcopyrite	- $<$ 1%
	Pyrite	- $\ll$ 1%
	Gangue	- 50%

SPECIMEN NO. 4

Hand Specimen: Appears to have been part of a vein. Shows breccia fragments (indicates faulting) and some layering or banding of sulphides. Order of deposition of sulphides uncertain. Vugs contain radiating quartz crystals and also small, black, acicular radiating crystals (owyheeite?).

Other sulphides are sphalerite, galena, tetrahedrite, pyrite and arsenopyrite in that order of abundance.

Polished Section: Quartz shows good comb structure. Good euhedral crystals of arsenopyrite are quite noticeable. Arsenopyrite, pyrite and sphalerite were deposited in vein amongst euhedral quartz. Tetrahedrite came in, replacing sphalerite (asp and py?) and filling in more spaces between the quartz. Owyheeite was last mineral to deposit and replaced tetrahedrite.

Mode is:	Sphalerite	- 9%
	Tetrahedrite	- 7%
	Owyheeite	- 2%
	Pyrite	-<< 1%
	Arsenopyrite	- 1%
	Gangue	- 80%

SPECIMEN NO. 5

Mineralogy and texture similar to previous sections.

Mode is:	Sphalerite	- 15%
	Galena	- 10%
	Tetrahedrite	- 10%
	Owyheeite	- 2-3%
	Pyrite	- 1%
	Pyrargyrite	- < 1%
	Arsenopyrite	- < 1%
	Gangue	- 60%

Gangue composed of quartz and limonite stained calcite.

SPECIMENS NO. 6 and 7

Mineralogy is the same as in previous sections. Good acicular crystals of owyheeite occur in tetrahedrite. Sphalerite seems to be replacing pyrite. Galena is replacing arsenopyrite.

Combined Mode is:

Sphalerite	- 20%
Galena	- 5%
Tetrahedrite	- 3%
Owyheeite	- 2%
Pyrargyrite	- $\ll$1%
Arsenopyrite	- 1%
Pyrite	- $<$1%
Gangue	- 68%

SPECIMEN NO. 8

Specimen No. 8 is a large specimen, showing very interesting features. The most noticeable feature is the breccia fragments which are up to 4 inches in length and probably are a result of faulting and shearing. Sulphides are arranged in bands parallel to the walls. Pyrite (?) and arsenopyrite occur as fairly good crystals close to the walls, followed by sphalerite a little farther towards the center. Sphalerite is the major sulphide present (approximate amount is 5 to 10% of total specimen). Small vugs are common into which good euhedral crystals of quartz and owyheeite project. Owyheeite is quite common as filler between quartz grains. Some movement has occurred since deposition (possibly during deposition) as small fractures are observed which have displaced bands of sulphides up to 1/8 inch.

The previous sections were all cut from specimens believed to have been taken only from the Cream Vein. Specimen No. 9 was taken from the Sugar Vein, which is related to the Cream Vein both spatially and probably geologically.

SPECIMEN NO. 9

Generally the specimen seems very similar to those from the Cream Vein. The hand specimen is largely composed of sphalerite with lesser amounts of galena and tetrahedrite. In polish section, owyheeite is particulary noticeable as it has heavily replaced tetrahedrite and to a lesser extent galena. Veins of owyheeite cut through galena.

Mode is:	Sphalerite	- 45%
	Tetrahedrite	- 7%
	Galena	- 6%
	Owyheeite	- 2%
	Pyrargyrite	- $\ll$1%
	Pyrite	- 1% or less
	Arsenopyrite	- 1%
	Gangue	- 40%

Paragenetic Sequence of Sulphides
From Earliest to Latest

1) Contemporaneous deposition of arsenopyrite and pyrite. Some pyrite may be later as evidenced by replacement of small percent of arsenopyrite by pyrite.

2) Deposition of chalcopyrite (?). Seems to be some indication that chalcopyrite was replaced by tetrahedrite and sphalerite. It is definitely replaced by galena. Seems to be earlier than pyrite.

3) Deposition of sphalerite, possibly contemporaneous with chalcopyrite. Shows minor replacement of pyrite and arsenopyrite.

4) Deposition of tetrahedrite, definitely younger than sphalerite as it shows good replacement texture.

5) Deposition of Galena. Possibly partly contemporaneous with tetrahedrite and maybe also sphalerite. Textures indicate galena replaces all earlier minerals to a greater or lesser degree.

6) Deposition of pyrargyrite. Pyrargyrite seems to show strong preferential replacement of tetrahedrite. Age relations with galena uncertain, some blebs seem to indicate relict structure, whereas other exhibit definite replacement features. Probably, for the large part it is younger than galena (?).

7) Deposition of owyheeite. Owyheeite strongly replaces tetrahedrite. Also replaces galena and sphalerite to a limited extent. Seems to show some replacement of pyrargyrite and thus it is the youngest mineral in the paragenetic sequence.

Gangue Minerals

Good euhedral quartz seems to have formed early, probably contemporaneous with or slightly later than arsenopyrite and pyrite, as other minerals enclose euhedral quartz crystals. Massive quartz also seems to have formed early as it occurs close to walls of veins, but it also is later as it surrounds euhedral quartz. Quartz carbonate, siderite, ankerite and calcite seem to be the youngest gangue minerals. Limonite and limonitic quartz are probably a result of secondary weathering. Arsenopyrite, pyrite and sphalerite (?) seem to be more often associated with quartz gangue whereas all other minerals (and some sphalerite) is more often associated with carbonate gangue. Small vugs are common, often with either quartz or owyheeite, or both, projecting into them.

Temperature of Formation

The sulphides were deposited from hydrothermal solutions of moderate to low temperature. Higher moderate temperatures are indicated by arsenopyrite and pyrite.

Galena and tetrahedrite indicate deposition below 500°. Pyrargyrite and siderite indicate deposition below 250°C. Exsolution of chalcopyrite from sphalerite occurs at 350°C. to 400°C. Temperature of deposition therefore probably varied from 500°C. to slightly below 250°C.

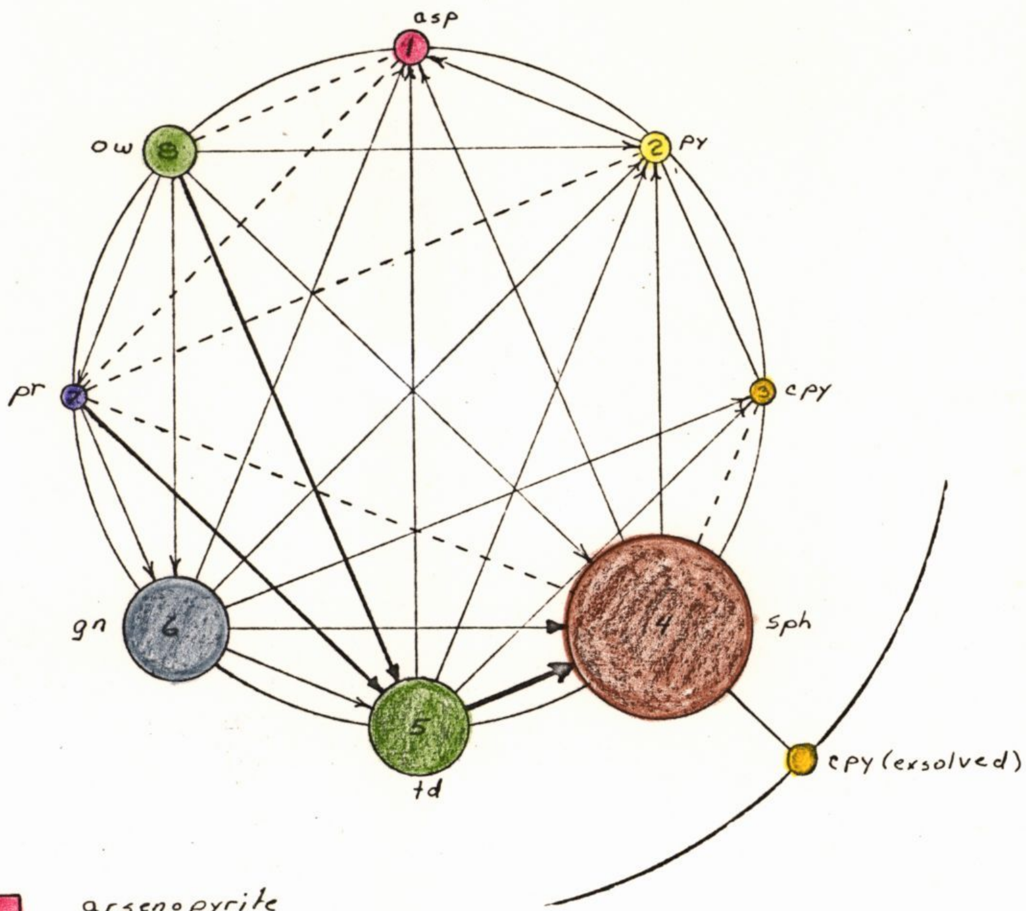
Classification

Deposit is classified as a moderate to low temperate hydrothermal vein deposit of the lead-zinc-silver type.

Graph Showing Relative Abundance of Sulphides and Paragenetic Sequence

Area in colour for each mineral represents relative abundance and distribution in time of each mineral.

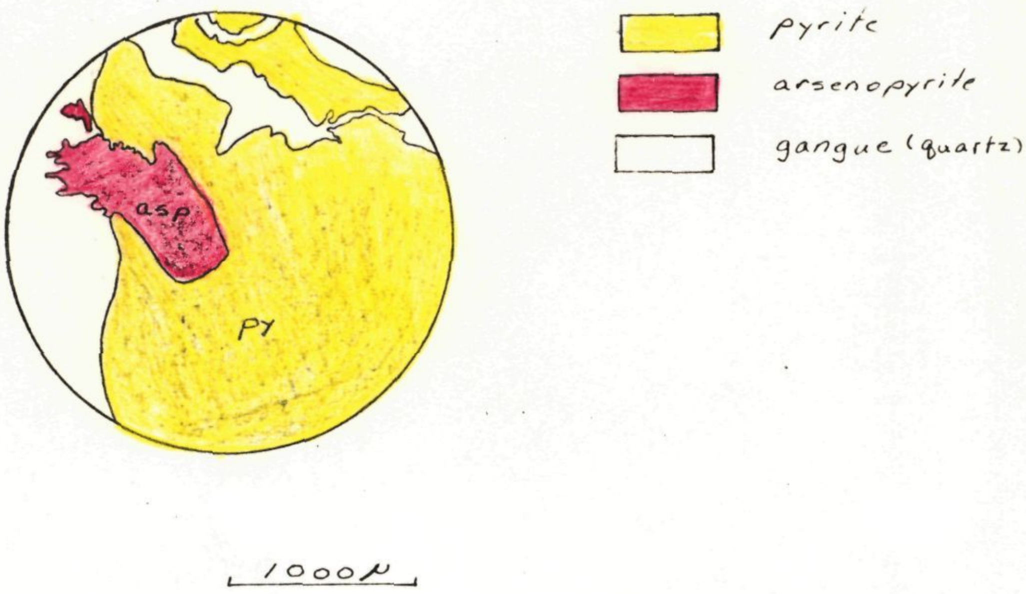
VAN DE VEEN DIAGRAM



1	asp	arsenopyrite
2	py	pyrite
3	cpy	chalcopyrite
4	sph	sphalerite
5	td	tetrahedrite
6	gn	galena
7	pr	pyrargyrite
8	ow	owyheeite

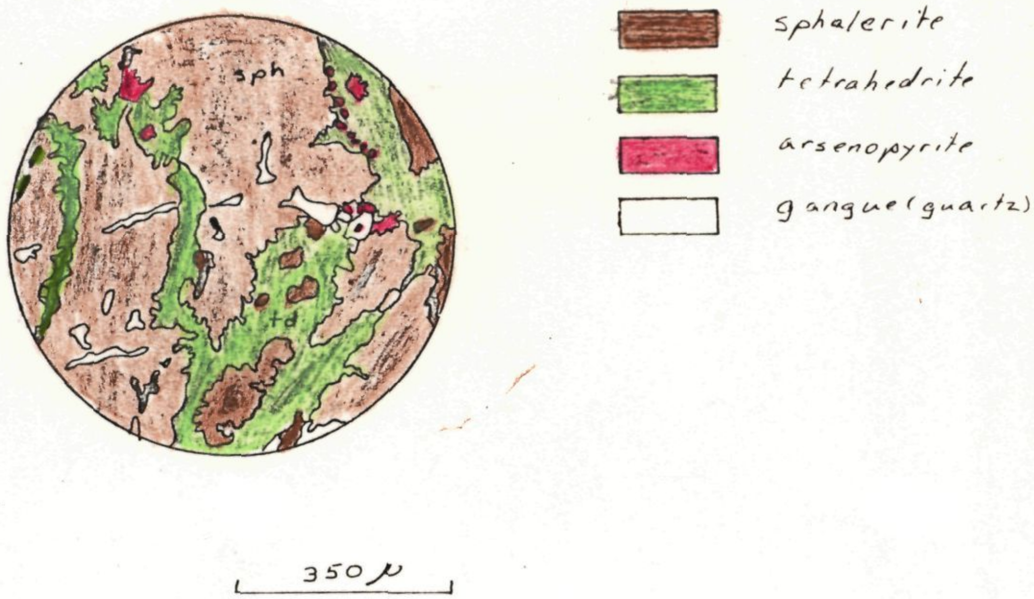
Area of circles represents amounts of each mineral present.

Figure No. 1 - Section No. 1



Drawing illustrates pyrite surrounding and to some extent replacing euhedral arsenopyrite. Thus indicating pyrite is, in part, younger than arsenopyrite.

Figure No. 2 - Section No. 1



Drawing illustrates replacement of sphalerite and arsenopyrite by tetrahedrite. Also illustrated is replacement of arsenopyrite by sphalerite.

Figure No. 3 - Section No. 1

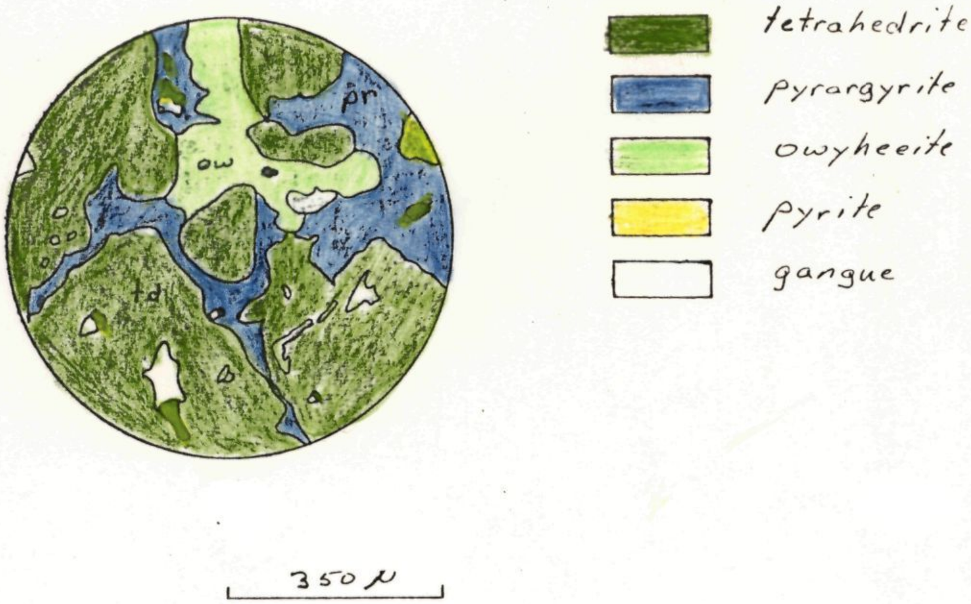
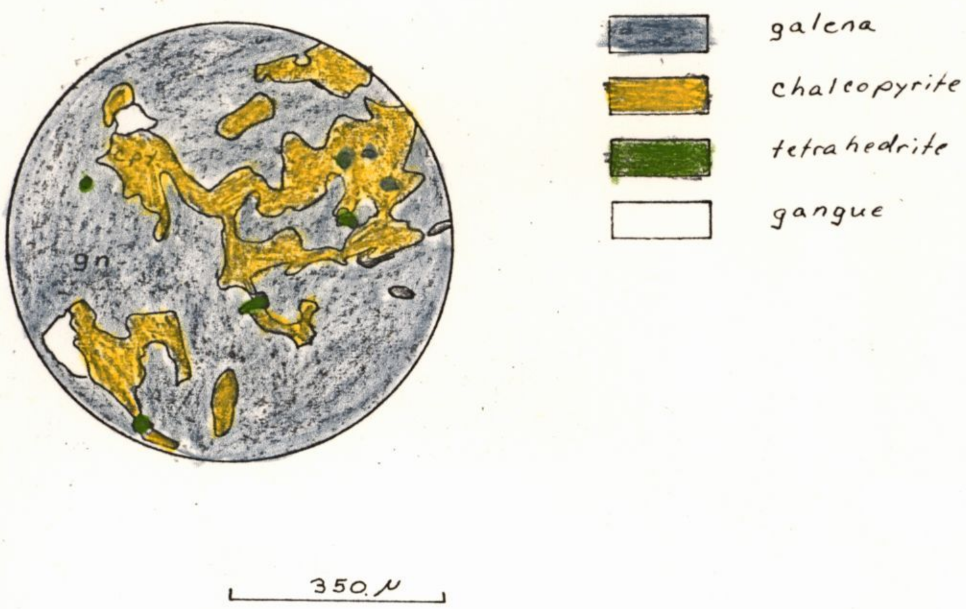


Diagram illustrates replacement of tetrahedrite by pyrargyrite. Also shown is replacement of pyrargyrite by owyheeite.

Figure No. 4 - Section No. 2

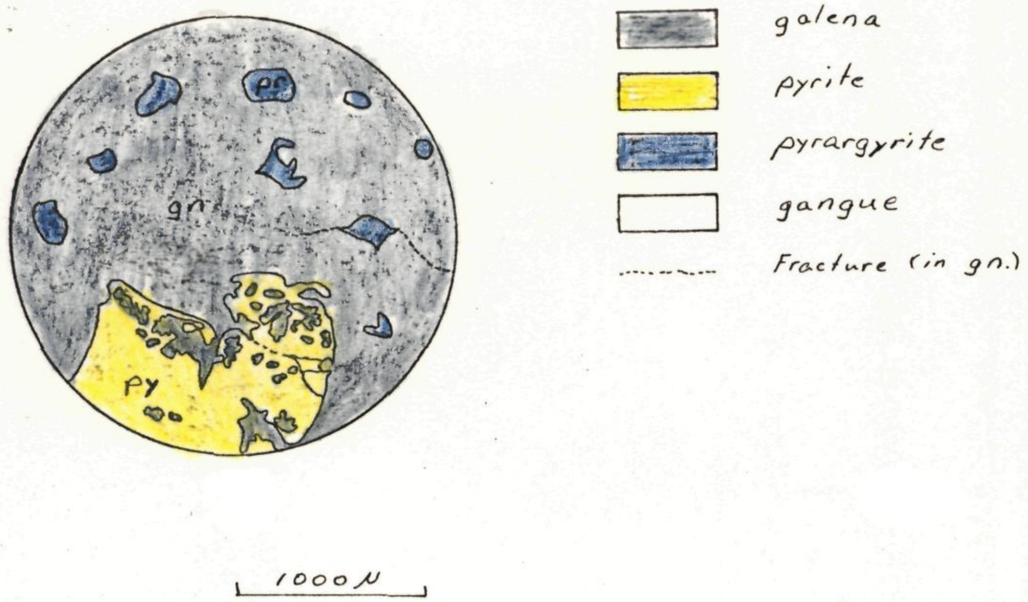
Drawing illustrates chalcopyrite flooding around euhedral grains of pyrite, indicating that chalcopyrite is younger. Also illustrated is the replacement of chalcopyrite, pyrite and tetrahedrite by galena.

Figure No. 5 - Section No. 2



Drawing illustrates galena replacing chalcopyrite.

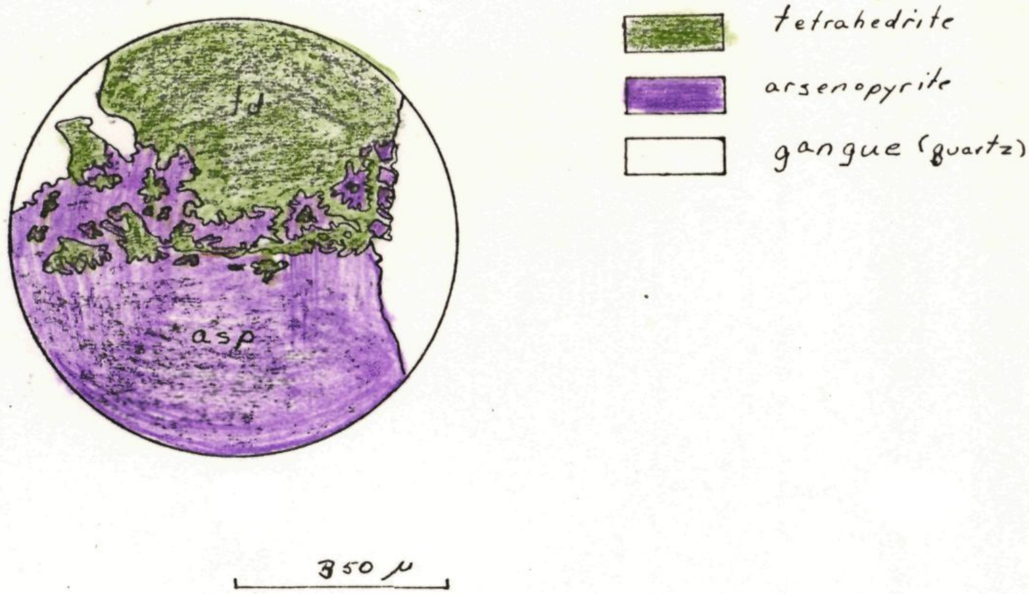
Figure No. 6 - Section No. 2



Drawing illustrates galena replacing pyrite.

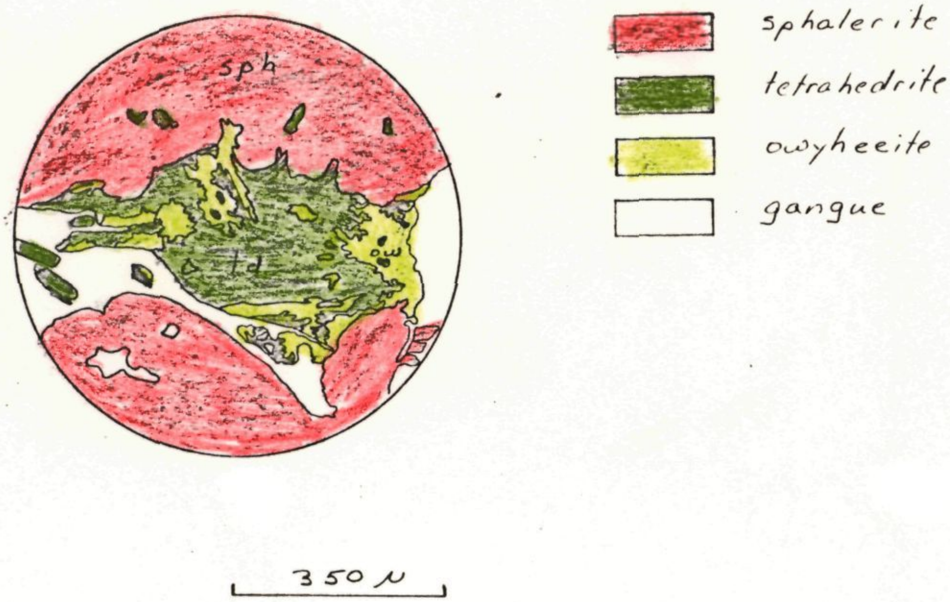
Also shown is replacement of galena by pyrargyrite. (Some blebs appear rounded and thus could represent relief structure, but others seem to be definitely replacing galena - eg. Note bleb occurring along fracture.)

Figure No. 7 - Section No. 4



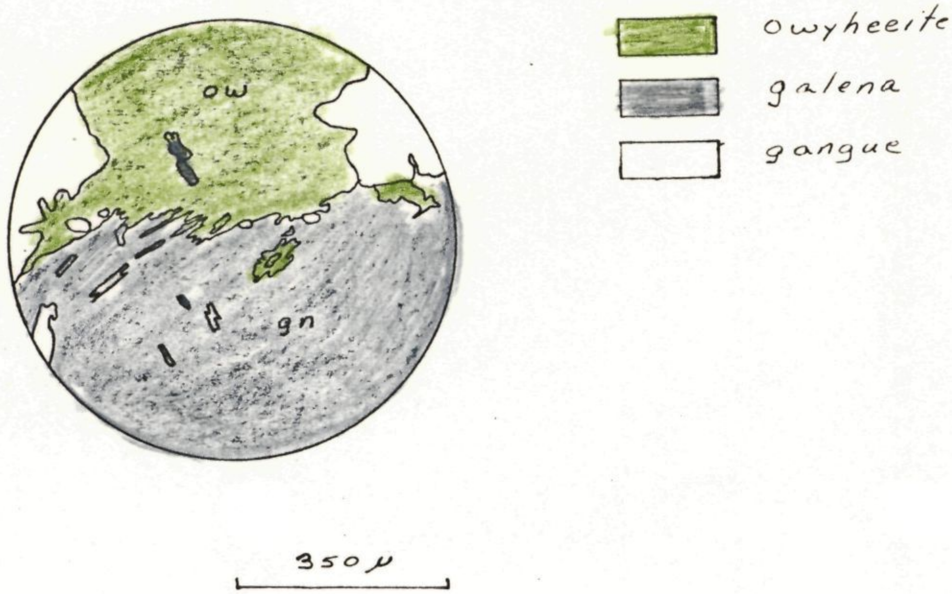
Drawing illustrates replacement of arsenopyrite by tetrahedrite.

Figure No. 8 - Section No. 6



Drawing illustrates replacement of tetrahedrite and sphalerite by owyheeite.

Figure No. 9 - Section No. 7



Drawing illustrates owyheeite replacing galena.

References

1. Lang, F.A. and Quinn, H.A.: Prospectus Cream Silver Mines Ltd., (N.P.L.), February 16th, 1967.

2. Selmser, C.B.: Geological Report Cream and Bear Groups, Buttle Lake Area, British Columbia, September, 1967.

3. Uytenbogaart, W.: Tables for Microscropic Identification of the Ore Minerals, Princeton University Press, 1951.

4. Edwards, A.B.: Textures of the Ore Minerals and Their Significance, The Australian Institute of Mining and Metallurgy, 1960.