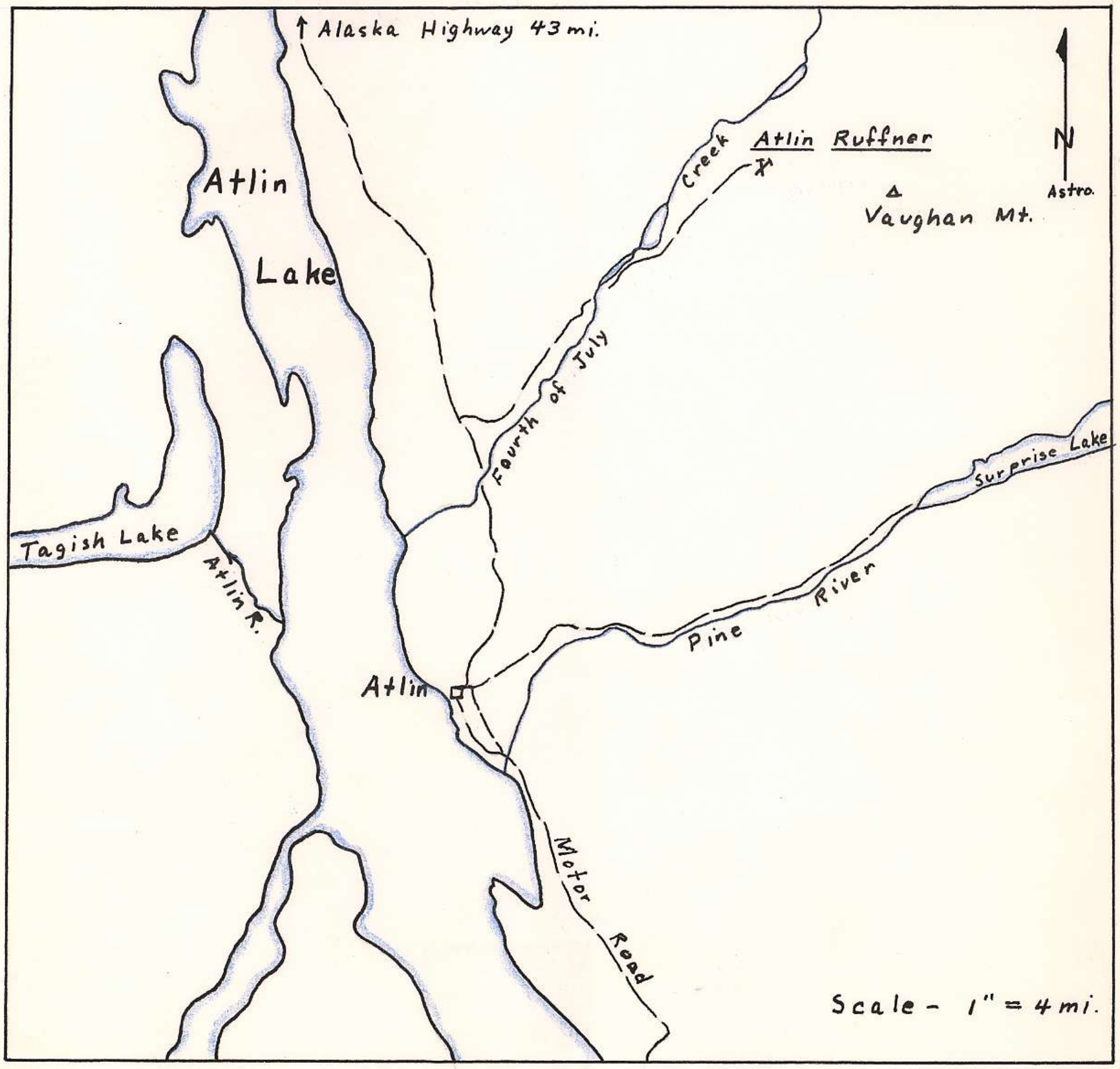
Geology 409

Problem 4

D. Rebagliati

Careful job
Sternbergite needs
checking.

Map
showing the location
of the
Altin Ruffner



April 2, 1962. Geology 409 Douglas Rebagliati

Problem No. 4

The Atlin - Ruffner

Introduction

The suite of specimens examined from the Atlin-Ruffner were collected by Dr. V. J. Okulitch in the 1930's. The suite consisted of thirty handspecimens and eighteen polished sections.

The accompanying map shows the location of the Atlin-Ruffner Mine.

History

The occurrence of silver-lead minerals at Crater Creek, a small tributary of Fourth of July Creek, was known as early as 1901. In 1921 work started in earnest on the Ruffner and Big Canyon groups of claims and continued until 1930, at which time Atlin-Ruffner Mines Ltd., was formed. The company acquired the Ruffner group and developed it for three years, then allowed the property to fall idle. Work started again in 1951. In 1952 the company acquired the adjoining Vulcan and Big Canyon groups and the Saddle Nos. 1 and 2 claims. After 4,000 feet of exploratory drilling had been done to investigate the continuation of the vein zones into the newly acquired ground, the property once more fell idle.

Shipments of sorted ore were:

1922 - 3 tons
1925 - 10 tons
1951 - 44 tons

Silver values varied from 80 to 200 oz/ton.

General Geology

The prevailing rock formation of Vaughan Mountain is a light coloured coarse grained granite. This has been intruded by many dark green andesitic dykes which have followed a roughly parallel series of fractures in the granite, striking N 30°E to N 50°E and dipping at a high angle to the northwest. The dykes have evidently also formed along lines of weakness for they have been intensely sheared and crushed by subsequent movements. Mineral bearing solutions following along these shear zones have filled the fissures, replaced the crushed dyke rock to a great extent, and cemented the rock fragments with quartz and metallic minerals and to a minor extent by calcite and fluorite.

Megascopic Description

Specimens from near-surface parts of the veins are oxidized and leached. They are siliceous and rustly coloured and they contain no metallic minerals.

Specimens from underground workings in the veins are fresh and shown no apparent supergene enrichment These specimens can be classified into three types which are here listed in decreasing order of abundance. In spite of differences in mineralogy, the paragenesis in each type seems to be the same.

1. Vuggy to massive specimens containing andesite breccia which is cemented and replaced by pyrite, arsenopyrite, marcasite, galena, sphalerite, and chalcopyrite.
2. Massive siliceous specimens containing coarsely crystallized quartz with arsenopyrite and sphalerite and lesser amounts of galena, pyrite and chalcopyrite.
3. Andesite dyke material containing relatively persistent siliceous veins which contain galena and sphalerite. Between the siliceous layers there are feldspars altered to clay minerals and there is a soft fibrous silicate mineral.

The following habits were observed for the above mentioned minerals.

Pyrite - fine to medium grained, anhedral to subhedral, disseminated to massive.

Arsenopyrite - very fine disseminated crystals or medium grained subhedral aggregates.

Galena - coarsely crystalline and well crystallized in buggy rock, massive fine to coarse gained aggregates elsewhere.

Sphalerite - dark brown to brownish-black, fine to coarse grained, subhedral to anhedral.

Chalcopyrite - very irregular fine to medium grained grains.

Marcasite - medium grained euhedral crystals, some aggregates show a cockscomb texture.

Microscopic Description

The following data was obtained in determining the minerals present in the suite in polished section. The minerals are arranged in decreasing order of abundance.

Galena PbS

- White colour, hardness B, isotropic, numerous prominent triangular pits.
- Etch tests

$HgCl_2$, KOH, KCN	- negative
HCl	- light black tarnish
$FeCl_3$	- heavy iridescent tarnish
HNO_3	- heavy black tarnish

- Microchemical tests

  Ag - positive

Sphalerite $(Zn, Fe)S$

- Grey colour, hardness C, isotropic, amber internal reflection.
- Etch tests - all negative.

Pyrite FeS_2

- Pale brass yellow colour, hardness F, poor polish, isotropic, square shaped crossections.
- Etch tests - all negative.

Chalcopyrite $CuFeS_2$

- Brass yellow colour, good polish, hardness C, weakly anisotropic grey to greenish-grey.
- Etch tests - all negative.

Marcasite FeS_2

- Pale brass yellow colour, hardness E to F, poor polish, strongly anisotropic green to steel blue to brown, furrowed surface.
- Etch tests

  $HgCl_2$, KOH, KCN, HCl, $FeCl_3$ - negative
  HNO_3 - effervescence, light brown tarnish.

Arsenopyrite FeAsS

- Galena white colour, hardness F to G, poor polish, anisotropic greenish-yellow to brown to violet, diamond shaped crossections.
- Etch tests

  $HgCl_2$, KOH, KCl, HCl, $FeCl_3$ - negative
  HNO_3 - differential iridescent tarnish

Pyrrhotite $Fe_{1-x}S$

- Pinkish-cream colour, hardness D, good polish, strong anisotropism bluish-grey to brown, magnetic.
- Etch tests

  $HgCl_2$, KCN, HCl, $FeCl_3$ - negative
  KOH, HNO_3 - brown tarnish

Proustite $3Ag_2S \cdot As_2S_3$

- Pale grey-blue colour, hardness B, strong red internal reflection, with tennantite.
- Etch tests

$HgCl_2$	- brown tarnish
KOH	- differential grey to black tarnish
KCN	- black tarnish
HCl, $FeCl_3$	- negative
HNO_3	- iridescent tarnish

- Microchemical tests
  As - positive

Tennantite $5Cu_2S \cdot 2(Cu,Fe)S \cdot 2As_2S_3$

- Pale greenish-grey colour, hardness D, isotropic.
- Etch tests

  $HgCl_2$, KOH, KCN, HCl, $FeCl_3$ - negative
  HNO_3 - iridescent tarnish around edges and along cracks.

- Microchemical tests
  As - positive
  Sb - very very weak to negative

Tetrahedrite $5Cu_2S \cdot 2(Cu,Fe)S \cdot 2Sb_2S_3$

- Grey colour, hardness D, isotropic, exsolution from galena.
- Etch tests - all negative.

Argyrodite $4Ag_2S \cdot GeS_2$

- Mauvish-grey colour, hardness C, isotropic, with tennantite, proustite, and galena
- Etch tests

  $HgCl_2$ - quickly gives heavy iridescent tarnish, hard to remove.
  KOH, HCl - negative

KCN — black tarnish
$FeCl_3$ — light black or iridescent tarnish, black tarnish hard to remove.
HNO_3 — heavy iridescent to black tarnish

Sternbergite $Ag_2S \cdot Fe_4S_5$
- This mineral is not positively identified because its reaction to HCl is definitely negative. All other properties are confirmatory. According to Short, HCl is the most characteristic positive reaction for sternbergite. Uytenbogaardt, however, lists the reaction as weak. Uytenbogaardt also lists that sternbergite gives a fast positive reaction under $AgNO_3$.
- Light creamy brown colour, hardness B, faint pleochroism - light creamy brown to light creamy greyish-brown - not present in most grains, very strong anisotropism - grey to mauve to black, mozaic of grains under crossed-nicols, in galena
- Etch tests
  - $HgCl_2$, KCN, HCl — negative
  - KOH — differential iridescent tarnish, usually negative.
  - $FeCl_3$ — very faint darkening tarnish - usually negative
  - HNO_3 — iridescent tarnish or negative
  - Aqua regia — iridescent tarnish
  - $AgNO_3$ — tarnishes quickly black

Covellite CuS
- Blue colour, hardness B, pleochroic blue to mauve, very strong anisotropism - deep red to dark blue, light reddish-

brown internal reflection, replaces tennantite

- Etch tests

  $HgCl_2$, KOH, HCl, $FeCl_3$ - negative

  KCN - heavy black tarnish, hard to remove.

  HNO_3 - black tarnish

Mineral Abundance

Galena	-	40 %
Sphalerite	-	40 %
Pyrite	-	7 %
Chalcopyrite	-	4 %
Marcasite	-	3 %
Arsenopyrite	-	2 %
Pyrrhotite	-	1 %
Proustite	-	1 %
Tennantite	-	1 %
Tetrahedrite	-	<1 %
Argyrodite	-	trace
Sternburgite	-	trace
Covellite	-	trace

Textures and Paragenesis

The paragentic sequence was determined by using simple cross-cutting relationships. Mineralization is believed to have taken place in seven stages as is shown on the Vandorveer diagram.

The exact occurrence of pyrrhotite was not firmly established because few cross-cutting relationships involving pyrrhotite were found. However, by association it was assumed to have been deposited during the same stage of mineralization as arsenopyrite.

Good cross-cutting relationships involving marcasite, except in association with pyrite, were not found. Since it is typically deposited under telethermal ? conditions it was assumed to have been deposited later than the sulphosalts.

Covellite was assumed to have been deposited later than marcasite because it is believed to be a supergene mineral.

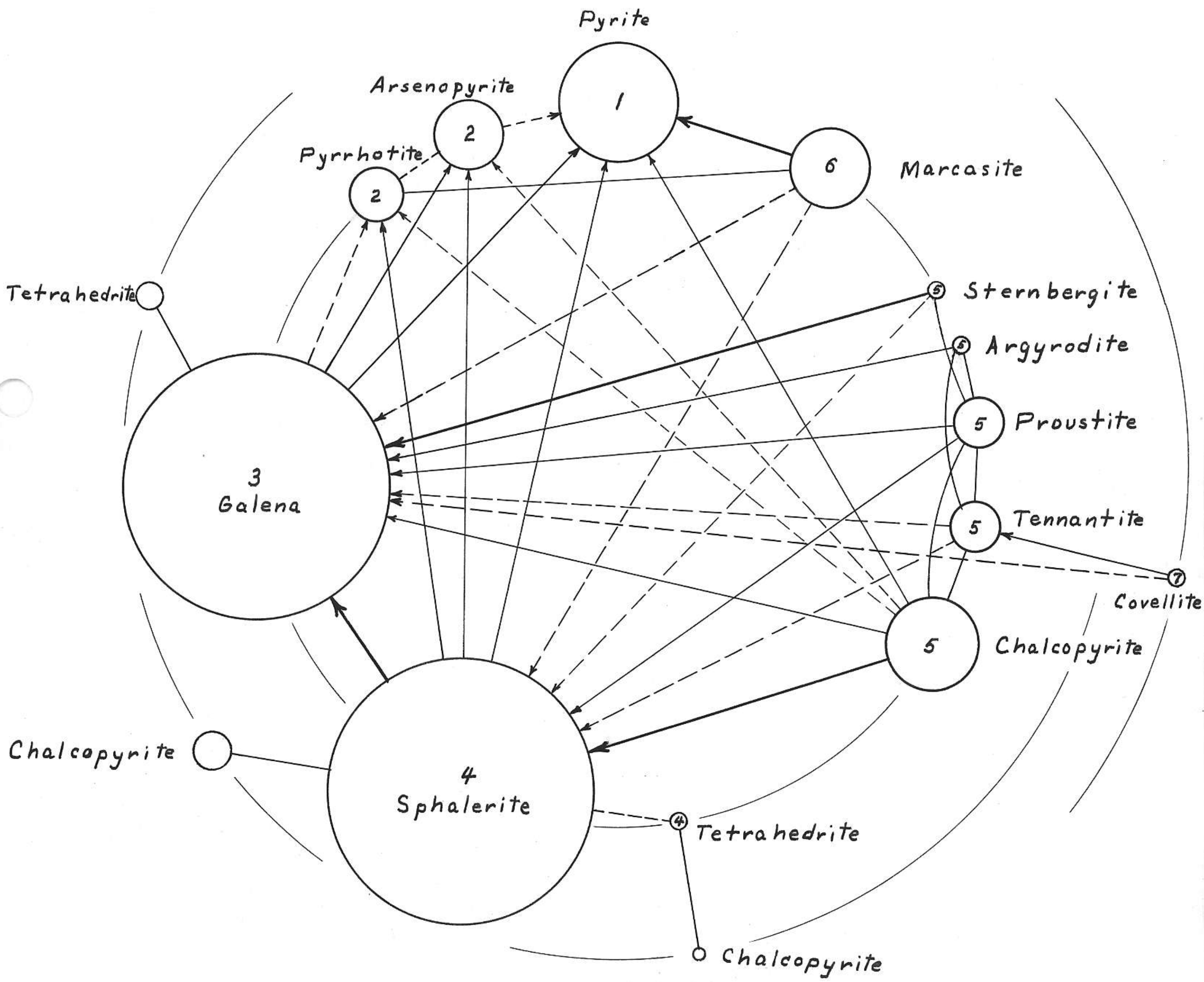
Exsolution — Tetrahedrite is exolved from galena in only about one-third of the galena grains. Exsolved chalcopyrite is ubiquitous in sphalerite where is usually occurs as tiny rounded grains. Chalcopyrite was exsolved from tetrahedrite only where tetrahedrite occurred in sphalerite. Only two or three grains of tetrahedrite in sphalerite were seen.

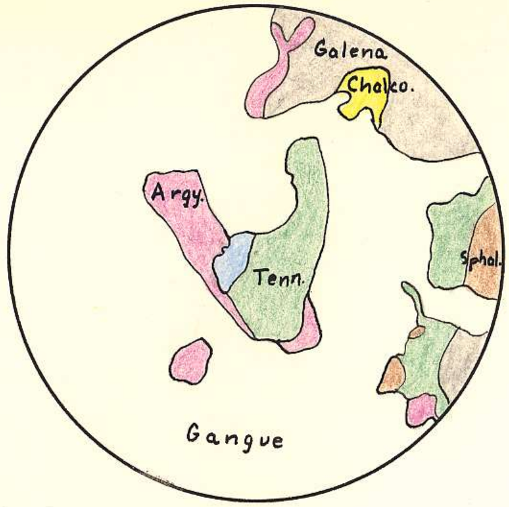
Type of Deposit

The mineral assemblage and paragenises indicate that mineralization took place in stages which were at successively lower temperatures. The minerals can be divided into five temperature types and these are intimately related to the paragenises.

1. Hypothermal - pyrite, arsenopyrite, pyrrhotite
2. Mesothermal - galena, sphalerite, tetrahedrite, chalcopyrite.
3. Low temperature mesothermal - chalcopyrite, proustite, tennentite, sternbergite, argyrodite.
4. Telethermal - marcasite
5. Supergene - covellite.

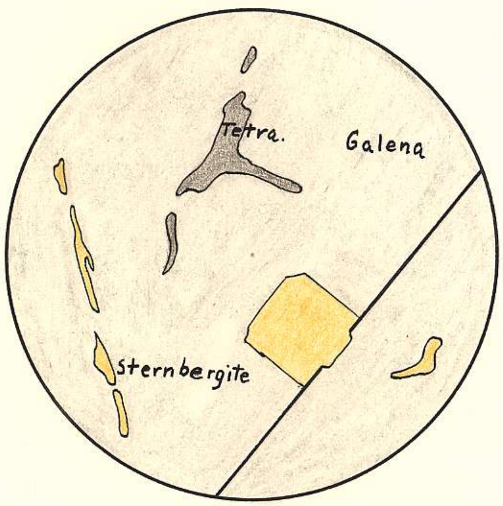
Paragenesis





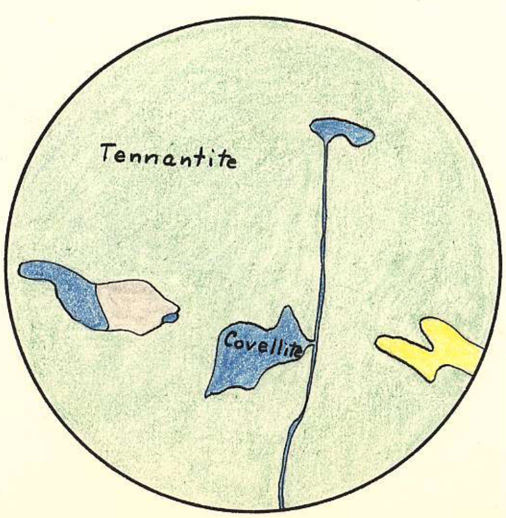
x 80

- the occurrence of argyrodite, has contacts with tennantite, galena, and proustite.



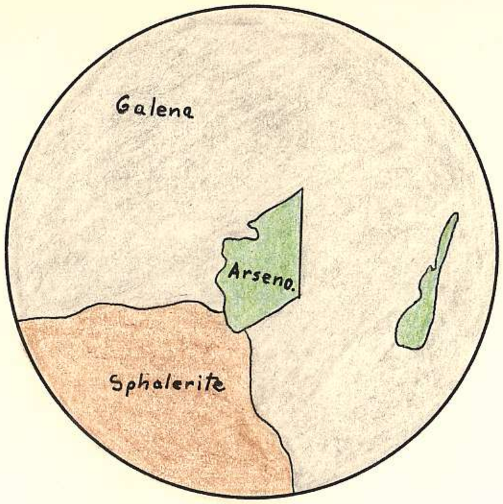
x 320

- the occurrence of sternbergite, in contact with galena as replacement along cleavage planes and as a massive replacement.
- tetrahedrite exsolved from galena.



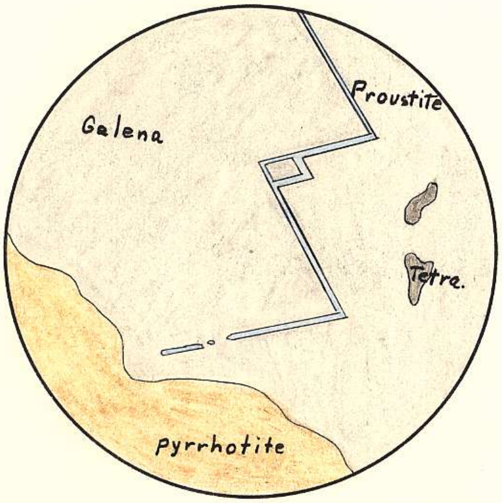
x 320

- the occurrence of covellite, supergene replacement of tennantite and galena.



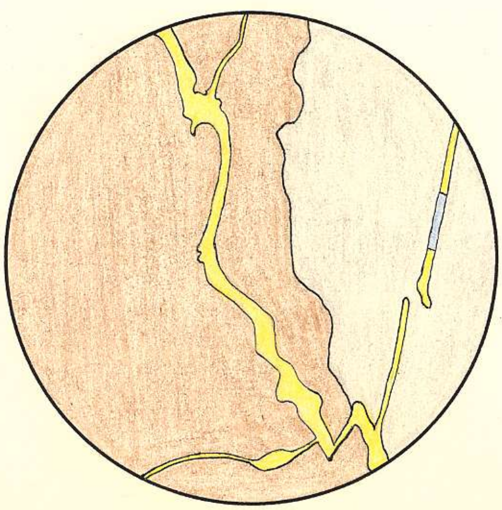
x 80

- arsenopyrite replaced by galena and sphalerite.



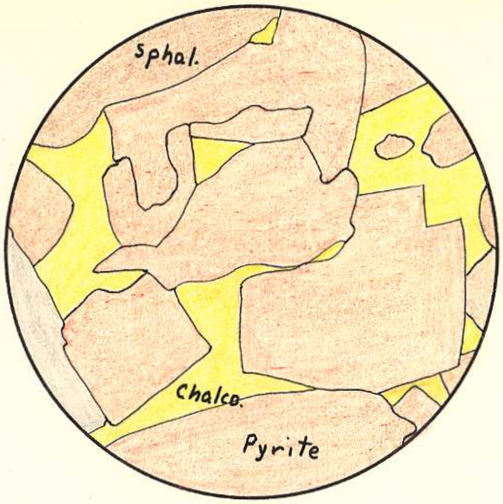
x 80

- galena veined by proustite.
- tetrahedrite exsolved from galena.



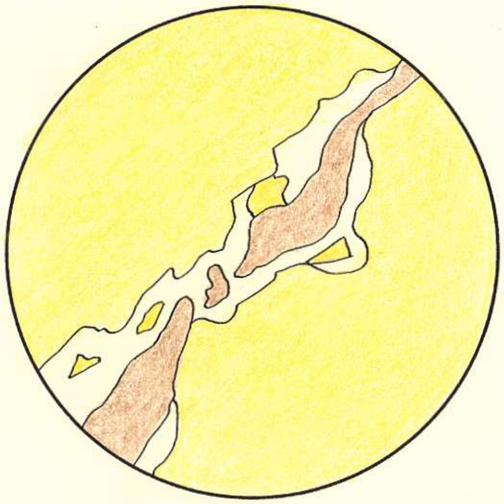
x 80

- sphalerite veined by chalcopyrite.
- galena replaced along cleavage planes by chalcopyrite and pyrargyrite.



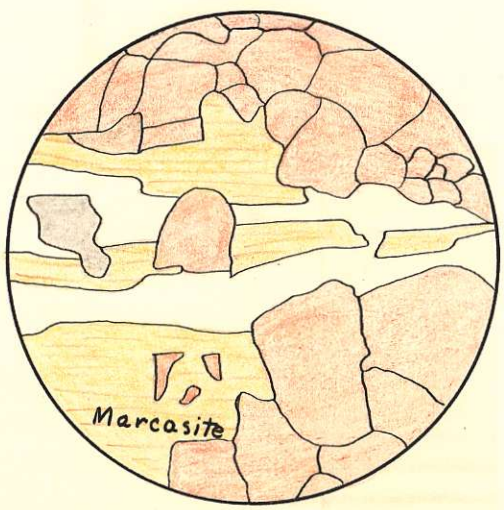
x 20

- open spaces in brecciated pyrite filled by calcoprite.
- pyrite, galena, and sphalerite replaced by chalcopyrite.



x 20

- galena veined and replaced by sphalerite and siliceous gangue.



x 40

- marcasite with siliceous gangue replacing pyrite, and galena and sphalerite.

Bibliography

Aitken, J.D., 1959, Atlin Map-Area, British Columbia, G.S.C. Memoir 307.

Annual Reports of the British Columbia Minister of Mines, 1921-1934, especially 1922 - pages N89 - N91.