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MINERALOGRAPHY
(Geology 409)
PROBLEM No.4.

THE STUDY OF ORE MINERALS
FROM TORBRIT (TORIC) SILVER
MINE, OF PORTLAND CANAL AREA, B.C.

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March, 1960
U.B.C.

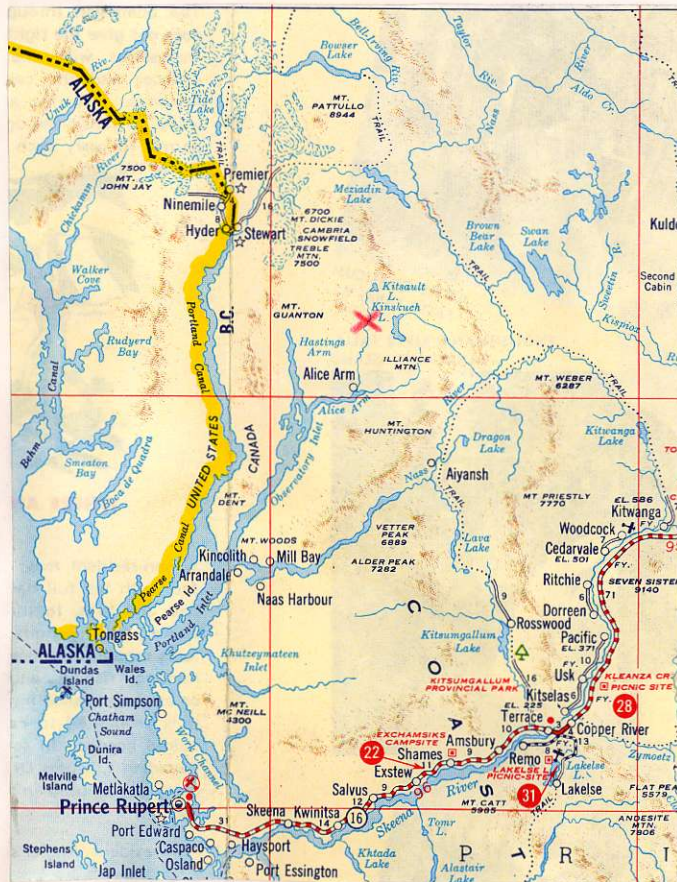
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TORBRIT SILVER MINE, B. C.

I INTRODUCTION

Location:

The Torbrit (Toric) Silver Mine is located in the Portland Canal area, B.C.(near southern end of Alaska Panhandle), about 17 miles upstream on Kitsault River from Alice Arm. It is connected with Alice Arm by a road, and is in a steep-walled valley, at an elevation of slightly over 1000 feet.



Map of B.C. North-West Coastal Area.

Scale: 40 miles to 1 inch.

History:

Starting about 1916 silver occurrences were explored, indicating two main zones of mineralization. In 1924 the consolidated Homestake Mining and Development Company optioned the original Toric claim and started to work on the lower zone, now called level 1150. In 1929 Britannia Mining and Smelting Co. acquired the mine. Due to low silver prices the mine was inactive from 1930 to 1949. In 1946 the Mining Corp. of Canada took over the mine and began production in 1949. By 1957 it was the third largest silver producer in Canada, following United Keno and Sullivan. It was closed about a year ago.

Production:

The estimated average grade of ore treated through 1949-1957 period was 17.2 oz. Ag and 0.42% Pb per ton.

By 1958 ore milled was 135,892 tons. Total concentrates produced amounted to 1,872 tons containing 1,090,846 oz. Ag and 1,506,849 lbs Pb. Total bullion produced was 240,242 fine ounces.

The 420 ton mill consists of a crushing plant, flotation circuit, and cyanidation circuit. 80 % of Ag is covered as flotation concentrate, 20 % as bullion.

The gold-silver ratio is less than 1:100. This is peculiar in this respect that of ten silver producing mines in this general area only Torbrit (and adjacent Dolly Varden) has produced no gold.

The production has ceased now, since the ore has been exhausted. The last shipment out was in October, 1950. 1959 ?

II GEOLOGY

General:

The country rocks of Upper Kitsault area belong to Hazelton group (Jurassic ?), and consist of heterogeneous assemblage of volcanic breccias, tuffs, and flows with poorly defined sediments. They form a syncline that strikes slightly west of north and plunges 30° N. The sequence of Hazelton group is as follows:

Upper Volcanic formation (breccias, tuffs, some local graywacke and shale).

Upper Sedimentary formation (shale, argillite, graywacke, tuff).

Lower Volcanic formation (propylitized volcanic breccia tuff and andesite).

Lower Sedimentary formation (argillites with interbedded graywacke, some conglomerate).


This sequence has been intruded by felspar porphyry (Cretaceous ?) and later by a series of andesite dikes (Tertiary ?)


The felspar porphyry has composition of rhyodacite, it is auto-brecciated and highly altered and pyritized. The aphanitic matrix is completely altered to sericite, chlorite and carbonate. The locus of numerous copper occurrences is along the eastern margin of the felspar porphyry body, accompanied by superimposed chloritization ("greenstone"). This mineralization is cut by quartz-barite veins, and both are cut again by andesite dikes.

This intrusion was controlled by the axial plane of


Geological map of UPPER KITSAULT RIVER.


LEGEND:


 Intrusive bodies, mostly altered felspar porphyry.

 Copper belt intrusive, much pyritized.

Hazelton Group:

 Predominantly shale, also beds of sandstone and greywacke tuff.

 Predominantly volcanic agglomerate and tuff.

 Predominantly shale; few conglomerate beds.

--- Contact assumed

mm Fault

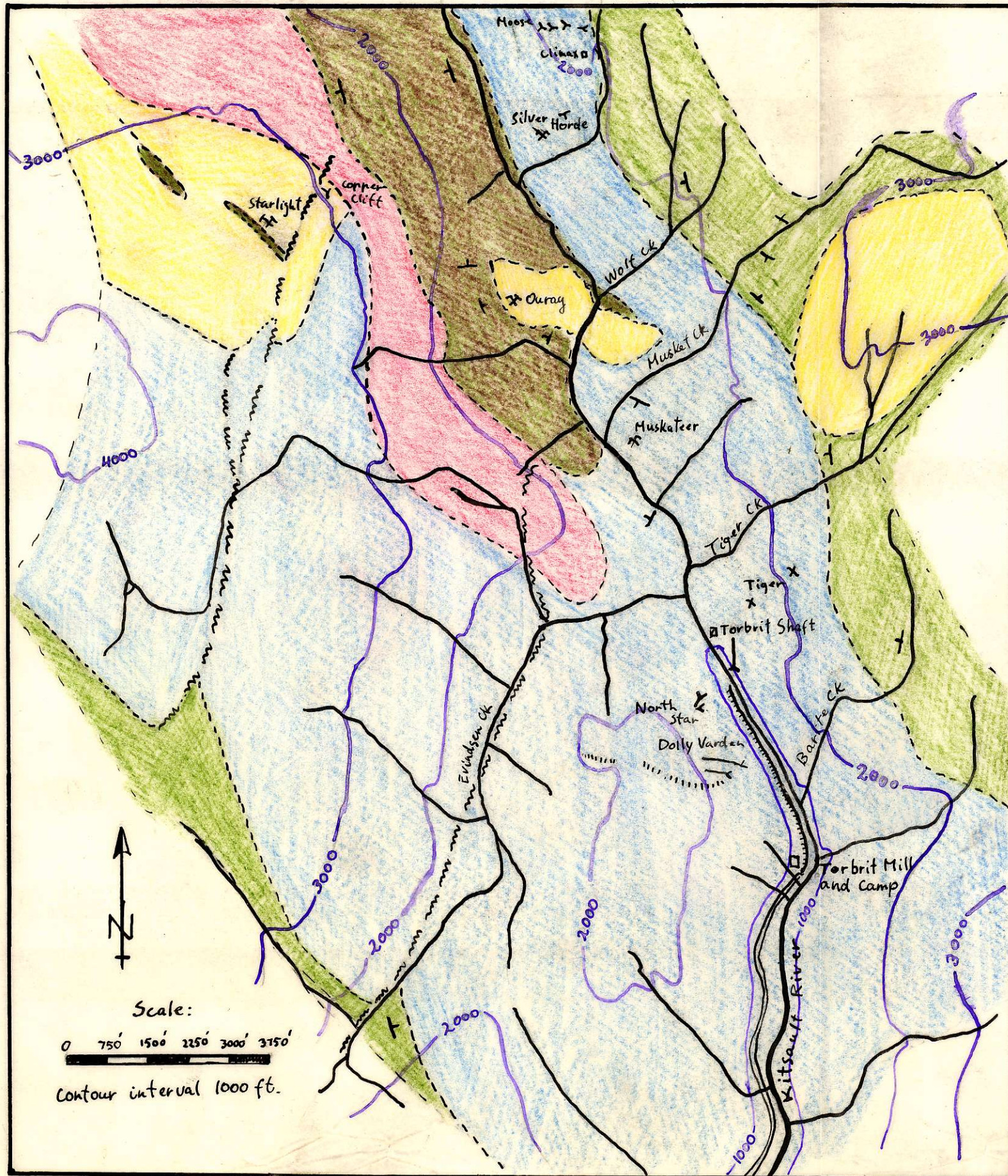
* Prospect

Y Underground working

== Road

≡≡≡ Railroad

┆ Dip and strike of bedding



the syncline, and it spread out in a sill-like body between the lower volcanics and overlying sediments. A zone of weakness near the axial plane of syncline probably gave ingress to the felspar porphyry.

Geology of the mine:

The mine lies entirely in the Lower Volcanic formation near the major synclinal axis. The most common rock type is a slightly schistose greenstone. The original texture and the bedded or intrusive structures have generally been obliterated by shearing or crushing and alteration.

Only the lower of the two known zones of mineralization has been explored and developed. It consists of one large and several small replacement deposits, consisting mainly of hematite, barite, quartz, jasper and carbonates and small amounts of incompletely replaced greenstone. It also includes small proportions of pyrite and galena and other metallic (Ag, Cu, Zn) minerals. Most of the mineralized part consist of narrow crustiform bands, in which the proportion of minerals differs from adjacent bands. In some barite crystals are oriented across the band, in others parallel or nearly so. The growth of minerals was probably related to fractures, possibly shears, along which the solutions circulated.

Parts of the deposit in which the silver content is of economic importance constitute the ore shoots. The principal difference is the concentration of silver,

otherwise there is not much change. The mineralization in the core from the deepest drillhole is similar in appearance to that from near the surface.

The ore has been affected by minor faulting and has been cut by numerous andesite dikes.

III MINERALOGY

Original samples consisted of two sets of numerous large chunks of ore mixed with gangue (mostly barite). These were broken up and the pieces containing more ore were selected and then cut. Of these cuts 5 further specimens were selected and mounted and then polished. A number of remaining smaller specimens were also polished, to be studied under the microscope. Nowhere in these specimens was massive mineralization encountered; the amount of gangue exceeds many times the amount of metallic minerals, even in the most carefully chosen polished sections.

Megascope:

The crustiform banding of some specimens is most striking, and also the general abundance of barite. Color is usually light gray, except in more mineralized parts. Ore seems to lay in thin layers along bands, generally.

In other specimens, however, fracturing has taken place. Ore minerals, especially ruby silver, can be found in these cross-cutting fractures.

Gangue minerals are barite, calcite, quartz and chlorite (in un-replaced greenstone)

Ore minerals recognizable by eye are: rather massive pyrite, in crustiform bands on gangue; galena, often disseminated as smaller grains in the gangue; ruby silver (pyrargyrite) in minute fractures cross-cutting the gangue.

Ore minerals and their percentages:

Ore minerals are following Ag-Pb-Cu-Fe sulfides and sulfosalts (percentage varies considerably from specimen to specimen):

Pyrite	30-40%	
Galena	40-50%	
Tetrahedrite ..	10-15%	
"Ruby silvers" ..	6-8%	
	pyrargyrite ... 5-6%	
	stephanite less than 1%	
	unknown	1-2%
Chalcopyrite(?)	... traces	

Microscopic:

Pyrite (FeS_2):

Polish poor; cannot be scratched. Usually in larger, well developed, but often deeply corroded cubic crystals. Isotropic, nonpleochroic. Often surrounded by galena; other times fractured, with galena (and other minerals) filling fractures. Seems to be the earliest metallic mineral.

Galena (PbS):

Polish fair; color galena-white, hardness B; sectile. Texture: surface mottled and pitted in most specimens, indicating cleavage; caries. (In other specimens, however, have massive looking galena). Seems to cut some quartz grains. Non-pleochroic; isotropic; no twinning. Associations: pyrite, "ruby silvers", tetrahedrite.

Etch tests: HgCl₂, KOH and KCN negative. HCl, FeCl₃ and HNO₃ positive, with iridescence and black coating.

Seems to replace pyrite, and gangue along very irregular fractures, and in certain layers in crustiform bands. Shows mutual boundaries with stephanite.

Tetrahedrite (5Cu₂S·2(Cu,Fe)S·2Sb₂S₃):

Polish poor; color dull grey, hardness B+. Texture massive, mottled surface, caries. Isotropic; non-pleochroic; no twinning; no cleavage.

Associations: pyrite, galena, "ruby silvers".

Etch tests: All reagents negative; only Aqua Regia shows slight brownish staining. Seems to replace galena and pyrite, with embayments into galena.

Pyrargyrite (3AgS·Sb₂S₃):

Polish excellent; color bluish gray; hardness B; streak reddish-brown. Texture massive. Slightly anisotropic; nonpleochroic. Texture under crossed nicols massive. No twinning; no cleavage. Very strong ruby red internal reflection.

Etch tests: HgCl negative (?). KOH tarnishes and brings out striations, surface turns brown. KCN etches. HCl and FeCl₃ negative. HNO₃ etches slightly, with blue stain.

Has mutual boundaries with other "ruby silvers" and sometimes also with galena. Fills minute cracks cross-cutting the gangue. Probably replaces galena, but not to a great extent.

Stephanite (5Ag₂S·Sb₂S₃):

Polish excellent; color light (greenish) grey; hardness C. Texture massive. Nonpleochroic. Anisotropic: *Check this* dark grey to creamy grey. Texture under crossed nicols massive. No twinning, no cleavage. No internal reflection seen.

Associations: galena, other "ruby silvers", tetrahedrite, pyrite.

Etch tests: HgCl stains light brown; turns purple. KOH stains dark brown (to black), brings out striations. HCl, FeCl₃ and HNO₃ tests seemed to be negative; but the results are indefinite and doubtful because of the strong reaction with calcite (effervescence).

No confirmatory microchemical tests were carried out since only minute grains of mineral were seen.

It may be possible that this mineral is not stephanite, but some other "ruby silver". Probably X-ray patterns are needed to confirm this mineral.

It was observed to have mutual boundaries relationship with galena. (see Fig.4)

Unknown "ruby silver" (?):

Polish excellent; color (pinkish) white; hardness B(+).
Texture massive. Nonpleochroic (?). Anisotropic: lighter
and darker pinkish colors (stronger than pyrargyrite).
Texture under crossed nicols massive. No twinning. No
internal reflection seen. No cleavage.

Associations: Pyrargyrite, stephanite, galena, tetra-
hedrite, pyrite.

Etch tests: HgCl_2 negative; KOH negative(?), very
slight pitting. KCN negative. HCl indefinite, slight
etching of striations. FeCl_3 probably positive, grey
coating. HNO_3 indefinite, some pitting(?). N.B. - Test
with HCl, FeCl_3 and HNO_3 are all of doubtful validity,
due to strong reaction of reagents with calcite (effere-
vescence).

This mineral shows mutual boundaries with pyrargyrite,
in which it is seen as small blebs (only in some specimens).

Since this mineral was present in very small
quantities, and since the etch tests were partly masked
by reactions with calcite, it could not be identified
definitely. However, after several checks it could be
assumed with some certainty that this mineral is another
"ruby silver", probably either miarzyrite ($\text{Ag}_2\text{S} \cdot \text{Sb}_2\text{S}_3$)
or freieslebenite ($2\text{Ag}_2\text{S} \cdot 3\text{PbS} \cdot 2\text{Sb}_2\text{S}_3$). (First mineral
is commonly associated with pyrargyrite, while the
second one is a rarer mineral; however, freieslebenite
fits the description more closely than miarzyrite).

Other possibilities: cosalite, aikinite, galenobismuthite,
- all Bismuth sulfosalts of Pb, Ag or Cu.

A X-ray pattern would probably identify this mineral.

*Perhaps. Same unknown as spotted
previously.*

Chalcopyrite (CuFeS_2)(??):

This mineral was only seen as very minute well
polished yellow specks under high power of microscope
and was inferred to be chalcopyrite. No tests were made.

Other minerals, in minor amounts, were reported in
the literature of the mine, such as magnetite, argentite
sphalerite and native Ag. These, however, were not seen
in the specimens involved in this study,

IV PARAGENESIS

Interpretation of textures:

Crustiform banding of gangue and some ore minerals is
indicative of open space or fissure filling. The host is
the volcanic rock, that has been sericitized and propyl-
tized. Parts of the vein are fractured and brecciated.
There were probably several alternating periods of
deposition and fracturing. In such a deposit same
minerals may be easily deposited at different times at
different places. Quartz and barite were deposited first,
with carbonates following (see Fig.1).

Since samples contain galena of two different appear-
ances (see under galena), it appears that the small
grained pitted variety, enclosing grains of pyrite,

was deposited before the carbonates. This would also mean that at least part of the pyrite was deposited even earlier. Since pyrite has a very wide temperature range of deposition, it could have deposited throughout the entire period of mineralization. In general, galena replaces pyrite (see Fig. 5 & 6).

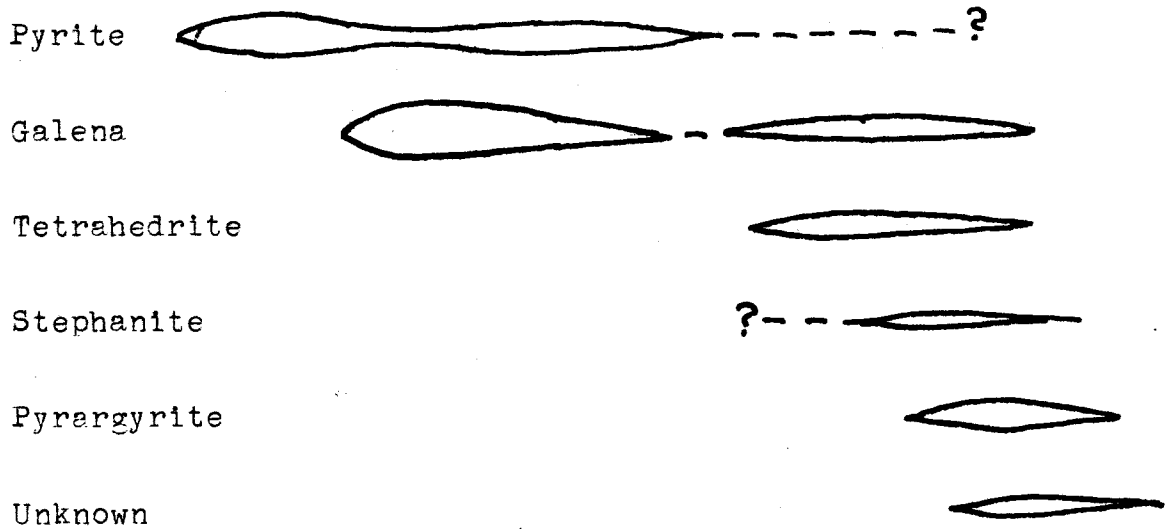
The later minerals (including some galena) lack any significant textures, except mutual boundaries, which indicates that they were deposited more or less simultaneously. This seems to be especially the case with galena and stephanite, which occur together and show straight line mutual boundaries (see Fig.4).

Tetrahedrite replaces galena, as shown by caries texture.

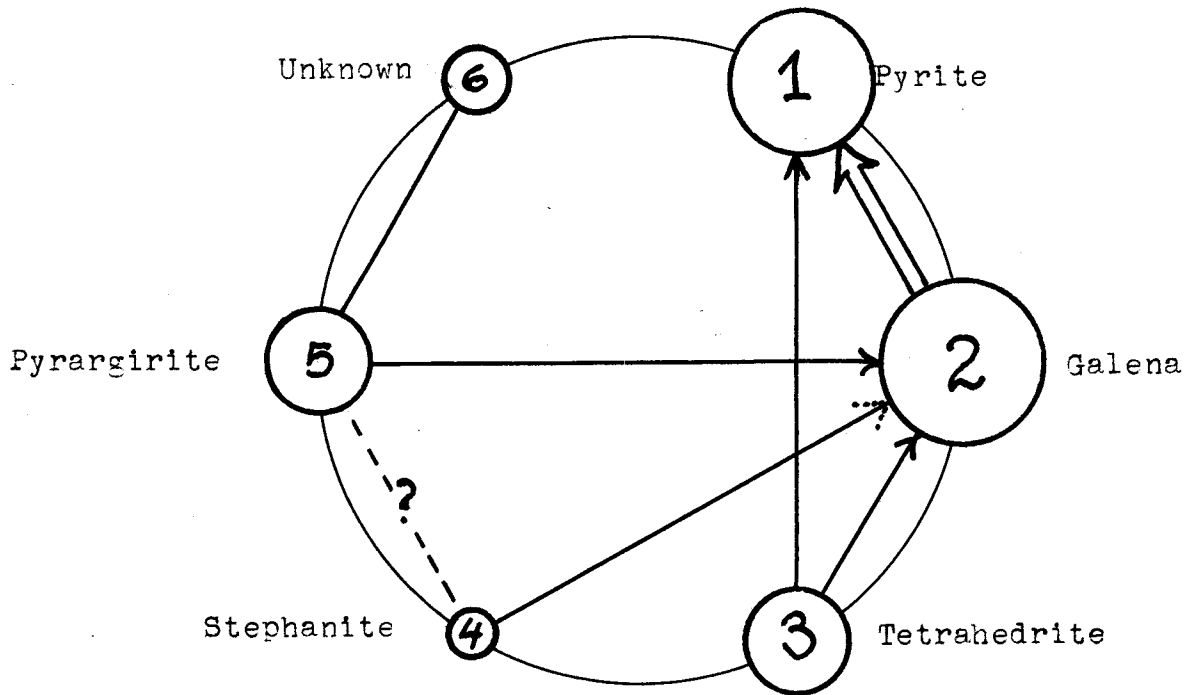
Pyrargyrite (which occurs together with the unknown mineral as ^{an} unmixing product) is the last mineral to be deposited in these specimens. It occupies fractures, and is often seen in contact with galena (see Fig. 3 & 5).

Paragenetic sequence:

1. Quartz and barite deposited as crustiform bands.
2. Some pyrite and galena deposited on quartz and barite.
3. Several fracturings, alternating with carbonate deposition. (Also some quartz as separate crystals)
4. Most of the pyrite deposited, possibly with some further fracturing.
5. Pb-Ag-Cu-Fe ore minerals deposited, almost simultaneously, as shown by following diagram:



Further relationships are indicated by the following Vandever diagram:



Type of deposit:

The Torbrit orebody is clearly of hydrothermal type, deposited from circulating metal-bearing solutions.

The structure must have been fairly open; this and the assemblage of Ag-Pb sulfides and sulfosalts indicates mesothermal setting. However, the crustiform banding and the presence of carbonates indicates epithermal deposits. Pyrargyrite is usually deposited at about 250°C.

Therefore the deposit was formed approximately between intermediate (mesothermal) and low (epithermal) temperature ranges, from 500°C to about 200°C or a little less. Accordingly, the pressures were also low to moderate, which means that the depth of formation was moderate, probably less than 2 miles.

The orebody is later than the felspar porphyry intrusion and probably related to it as a later stage. Both, the intrusion and the mineralization, may, in turn, be related to Coast Range intrusion (batholith), as a last stage. In this respect the orebody would be similar to many others in the western part of North America.

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R.M.T.
April 7/60

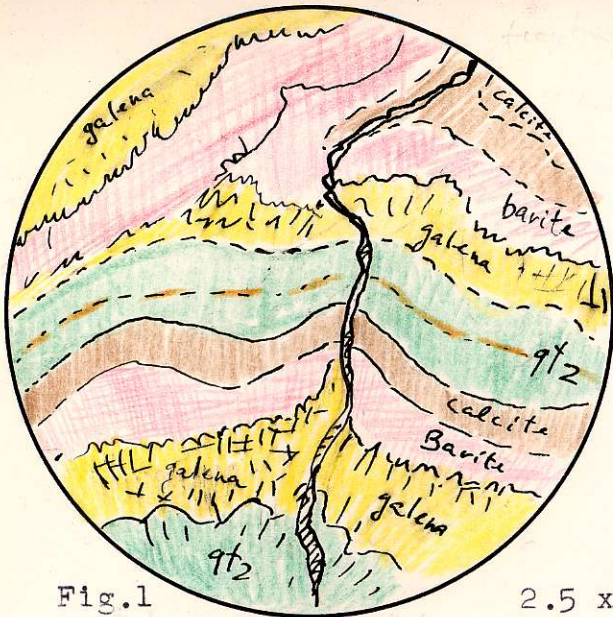


Fig.1

2.5 x

Crustiform banding indicates open space deposition of gangue minerals. Quartz, barite and calcite are deposited, repeatedly, in this order. Quartz has terminated crystals, on which fine grained galena, mixed with barite, is deposited. A later gangue filled fracture cuts across the structure. Quartz contains a mineralized zone (pyrite?).

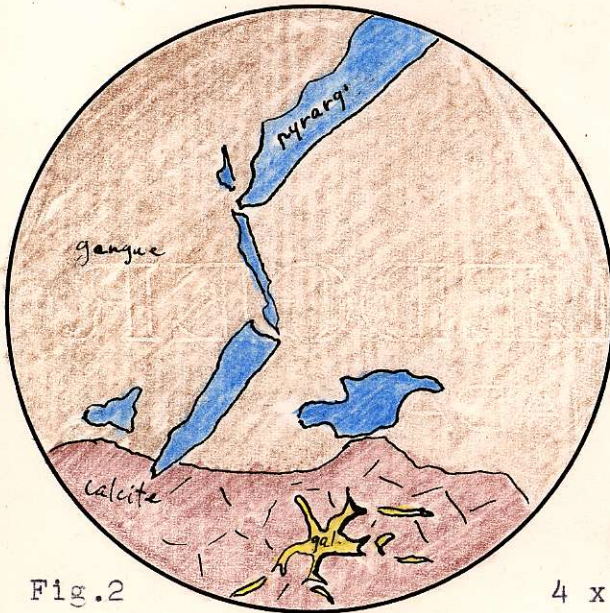


Fig.2

4 x

A displaced veinlet of pyrargyrite cutting across a crustiform band of gangue. Galena filling fractures and grain boundaries in calcite.

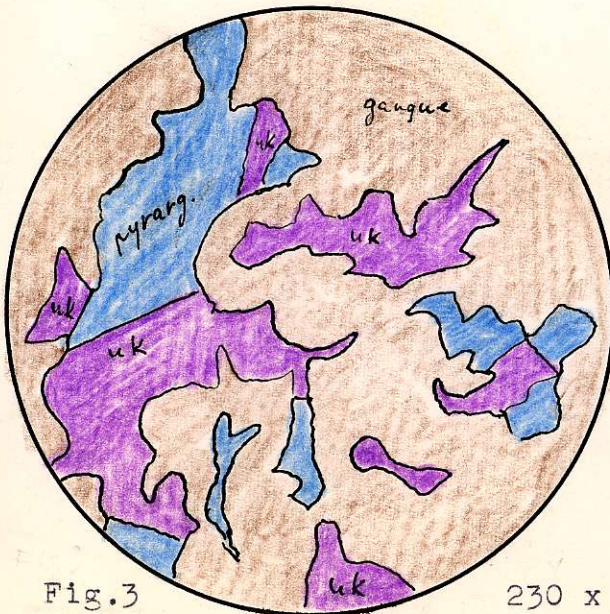


Fig.3

230 x

Pyrargyrite and unknown mineral showing mutual boundaries, indicative of simultaneous deposition. The unknown mineral was probably exsolved from the more abundant pyrargyrite host.

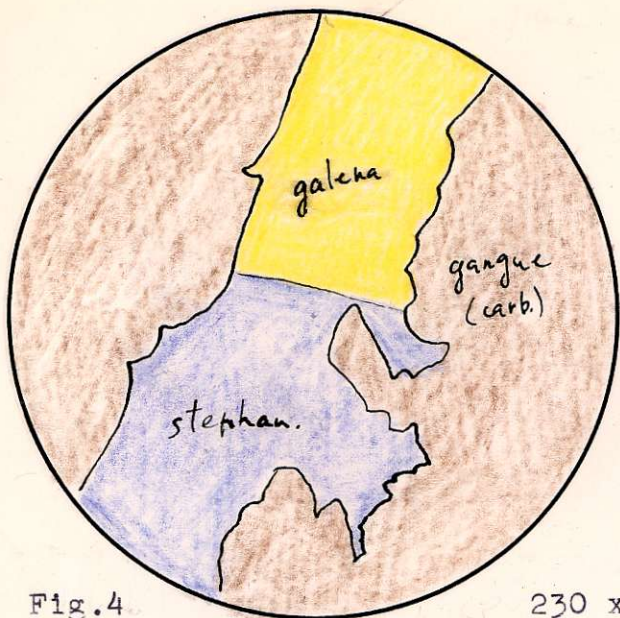


Fig.4

230 x

Galena and stephanite showing mutual boundaries, indicating simultaneous deposition. This is probably a later galena.

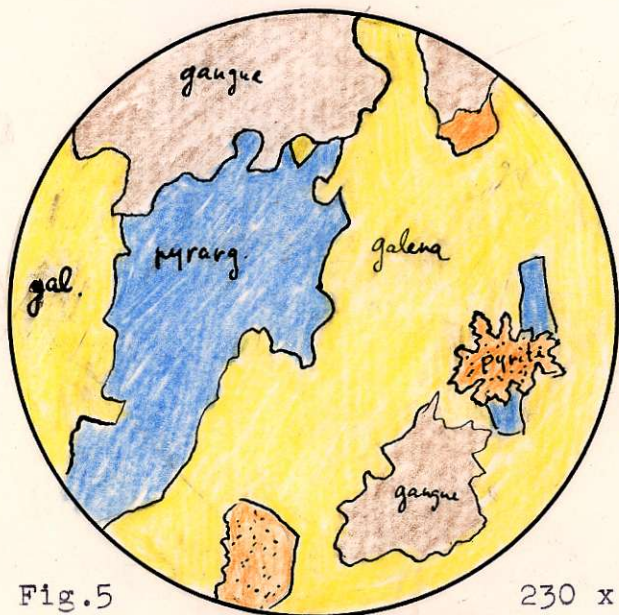


Fig.5

230 x

Pyrrargyrite and galena showing mutual boundaries indicating almost simultaneous deposition. (In places see suggestion of caries texture, with embayments concave toward pyrrargyrite, which indicates that pyrrargyrite may be somewhat later mineral.) Galena is surrounding and replacing highly corroded pyrite crystals.

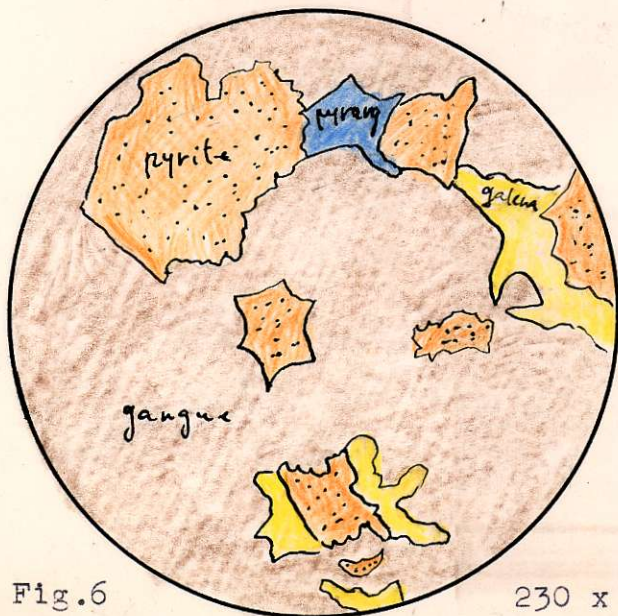


Fig.6

230 x

Pyrite being replaced by galena and pyrrargyrite. Pyrite crystal are highly corroded.

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Any mineralogy?