GEOLOGY 409

600361

Ore Minerals from Torbrit Silver Mine,

Portland Canal, B. C.

March 31, 1962.

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Introduction:

The mineral suite concerned with in this report is from the Torbrit Silver Mine which is situated 18 miles up Kitsault River from Alice Arm in the Portland Canal area of B.C. Mining and milling of lead-silver ore was carried out on the property from 1927 until 1959, when operations ceased. During that period of time more than 18 million ounces of silver and 11 million pounds of lead were extracted from 1.4 million tons of ore. The mineralization occurs in intruded and fragmental members of the Hazelton group which is commonly represented as a schistose greenstone. This rock has been extensively altered and replaced by carbonates, chlorite and iron oxides. The ore is present as replacement bodies arranged approximately parallel to the schistosity of the greenstone. Ore contacts with the wall rocks are gradational and the intensity of replacement is quite uniform throughout the deposit. Indications are, however, that the type of mineralization varies in different parts of the mine with ruby silvers more abundant in some areas than in others. No map of the mine was available for this report so variations in mineralogy, as seen in polished sections, could not be related to the geology of the mine.

The Torbrit property is discussed briefly in the following reports:

Minister of Mines, B.C., Ann. Report, 1925, pp. 76-78.
G.S.C., Summ. Report, 1928, Pt. A, pp. 44-49.
Minister of mines, B.C., Ann. Report, 1948, pp. 75
Minister of Mines, B.C., Ann. Report, 1959, pp. 8.

The material examined in this report consists of numerous hand specimens, ranging up to 10 cm. by 12 cm. by 6 cm. in size, approximately 30 polished sections and three thin sections. The specimens were obtained from most parts of the mine and were apparently collected at various stages in the development of the property.

Megascopic Description of Hand Specimens:

The hand specimens were light to dark grey in colour with the ore mineralization ranging in colour from light reddish brown to black. The chief gangue mineral is light grey barite but extensive alteration to secondary carbonates, in many cases, has resulted in a darker colour in the specimen. Localized quartz is present in some samples where it is closely associated with the ore minerals. Reddish jasper is present as irregular shaped grains and as banded structures with barite, hematite and chalcedonic quartz. Sheared fragments of greenstone wallrock were observed in three specimens where alteration was, however, so intense that the exact nature of the original rock was impossible to determine. In such cases the greenstone was usually associated with quartz. Pyrite was observed in all specimens examined. Shearing movements subsequent to the introduction of the quartz gangue is evident in some areas; in several cases the quartz grains were elongated with some recrystallization. One hand specimen had a porous, leached surface texture with localized limonitic staining. The minerals recognized in hand specimen were as follows:

Barite. This mineral is white to light grey in colour, has a hardness of 3-3½ and constitutes most of the ore gangue. It makes up an average of about 65% of most specimens and often shows excellent development of crystals. In several specimens it was found to be present in a banded texture with chalcedonic quartz, jasper and hematite with minor amounts of pyrite.

Quartz. Quartz is present in two varieties. One type is chalcedonic quartz found in alternating bands with ~~(of)~~ jasper, hematite and barite in two specimens. In such cases it appears to be a low temperature type of vein emplacement with the other minerals. A second type of quartz is a fine to medium grained variety which is sometimes sheared. Both pyrite and galena were found in the quartz gangue.

Megascopic Description.. (contd)

Pyrite: Pyrite is present as pale yellowish equant grains and disseminations throughout most specimens. It is found in ore, barite and quartz alike and may have been formed during different stages of mineralization. It has a hardness of about 6 and is unusually light coloured. In several cases it was found localized (in a banded texture with hematite, jasper and barite. (marcasite??

Galena: This mineral appears in all specimens and is the most abundant ore mineral. It is present as metallic grey black crystals with a hardness of 3, a grey streak and excellent cubic cleavage. The galena is generally present as vein fillings and replacements in barite but is closely associated with crystalline quartz in several specimens. The silver minerals are usually associated with galena.

Sphalerite: Only several areas of sphalerite were seen in hand specimens; it was usually in a quartzose gangue in barite. (It was difficult, in many cases, to determine whether the quartz veined the barite or vice versa.) Sphalerite is brownish grey in colour, has a light streak, very good cleavage and a hardness of 4-5.

Jasper: Jasper was identified, in hand specimens, by its red colour, hardness (6+) and occurrence in a banded texture with hematite and barite. Several isolated fragments of jasper were seen in the barite.

Hematite: This mineral has a red brown streak and was observed banded with jasper and barite in several specimens. Hematite appears to be lamellar, dark grey in colour and has a hardness of about 6.

Pyrargyrite: This silver mineral was found in barite where it appears as blue grey (crystal) disseminations and veinlets ~~(in)~~ closely associated with galena. Pyrargyrite

Megascopic Description. (cont'd)

... has a bright red streak, good cleavage and a hardness of 2-3.

Native Silver: This mineral was found to be present in three hand specimens where it occurs as sectile yellowish grey "flakes" together with pyrargyrite, galena and minor amounts of quartz, in a brecciated barite gangue. The ore minerals, in such cases, were usually present as fracture fillings in the barite.

Microscopic Description:

Although native silver was observed in hand specimens, it was not positively identified in any of the polished sections examined. The other minerals described in hand specimens plus tetrahedrite, chalcopyrite and two unknown minerals were observed under the microscope. They are as follows:

Barite: Barite was by far the most abundant mineral present and it is often associated with lamellar hematite. It is commonly massive, has a light grey colour, a hardness of about C, and exhibits typical internal reflection. It is often fractured, cut by replacement veinlets of galena and/or pyrargyrite and effervesces vigorously when treated by acids. Indications are that the barite is later than the quartz as in several cases it is seen veining the latter (Fig. 5) Barite often shows well developed tabular crystal form; the thin sections show this feature very well.

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Quartz: In several of the polished sections examined quartz was the chief gangue mineral. It is dull grey in colour, has a hardness of F+, exhibits strong internal reflection and is negative to all reagents. It has a poor polish and is commonly associated with sphalerite and galena. "Islands" of rounded quartz grains were often seen in such cases and the reason for this is not clear. The interpretation made was that the quartz and its associated minerals were deposited simultaneously.

Microscopic Description: (cont'd)

... no indications of replacement of quartz by any other mineral were seen.

Pyrite: Pyrite was found to be present in practically all sections examined. It occurs in both quartz and barite as separated and grouped cubic forms. It is sometimes strung out into elongate segregations suggestive of selective deposition. Pyrite has a dull yellowish grey colour, a poor polish, a metallic lustre, a hardness of F+ and is isotropic. (Fig. 3, 4.).

Galena: This mineral is the most abundant ore mineral present and appears to have been introduced in at least two stages. In several specimens it was found as a replacement of sphalerite (and possibly tetrahedrite) in a quartz gangue. (Fig. 4). In other specimens galena veins barite and has inclusions of chalcopyrite, pyrargyrite and other silver minerals. Galena is white in colour, has a hardness of B, shows abundant triangular pits and is isotropic. Strong positive tests for lead confirmed galena.

Sphalerite: Sphalerite was seen in polished section as vein fillings and disseminated bodies in quartz. Several sections showed large areas composed exclusively of quartz, sphalerite and minor amounts of pyrite. In most cases sphalerite appears to have been replaced by galena and was obviously emplaced prior to or contemporaneously with, galena. The sphalerite has a good polish, a hardness of C, a light brown streak and little or no internal reflection. Positive tests for zinc were conclusive for this mineral.

Jasper: Jasper was seen in polished section as a hard mineral having the internal reflection of quartz but with a reddish tint. It was closely associated with barite and fine grained quartz as well as hematite.

Microscopic Description (contd)

Tetrahedrite: This mineral was identfied in only one specimen where it was intergrown with sphalerite. It has a medium grey colour, a hardness of C-D and is isotropic. Positive tests for copper, iron and antimony (~~confirmed~~) confirmed tetrahedrite. A positive test for silver was also obtained but was not strong and may have been due to contamination from silver minerals.

Hematite: This mineral occurs as thin tabular to fibrous aggregates where it accompanys barite as a fracture filling in quartz (?). It is commonly found with its "fibres" parallel to the vein wall and as non-oriented elongate bodies in the barite. (Fig. 5). Some of the hematite was deposited in an alternating manner with quartz, jasper and barite in banded textures seen in several specimens. In many cases the hematite appears to have been introduced later than the barite. Hematite is medium grey in colour, has a hardness of ~ G, and has a red streak and internal reflection. Hematite has a poor polish and was negative to all reagents.

Pyrargyrite: All pyrargyrite seen was as inclusions in galena veinlets or as isolated replacement areas in barite. It (was) bluish grey in colour, had an excellent polish, a hardness of B-C, and had inclusions of chalcopyrite as well as unknown minerals A and B. Pyrargyrite was isotropic, exhibited excellent red internal reflection and had a bright red streak (Fig. 2, 3.). Positive chemical tests for silver and antimony confirmed this mineral.

Chalcopyrite: Only small areas of this mineral were seen in polished section. It was found in veinlets of galena in barite, and in a pyrargyrite veinlet which was also in a barite gangue. Chalcopyrite is brass

Microscopic Description (cont'd)

... yellow in colour, has a hardness of C and is practically isotropic. It was found to be negative to all etch tests that were attempted (Fig. 1, 2.).

Unknown mineral A: This mineral was light grey in colour, had an excellent polish, a hardness of B and weak anisotropism (bluish grey to greyish brown.) This mineral was present, in small amounts, in pyrargyrite, where it exhibited mutual boundaries with that mineral, suggestive of simultaneous deposition of the two. The unknown mineral has a light tan colour relative to that of pyrargyrite and showed no internal reflection. This mineral may be stephanite but etch tests and chemical tests were inconclusive. The mineral is present in exceedingly small amounts.

Unknown mineral B: This mineral accompanied unknown mineral A as small inclusions in pyrargyrite and exhibited similar grain boundary relationships with the silver mineral. It occurs as small isotropic non-oriented blebs which were a darker grey in colour than the enclosing pyrargyrite. It has an excellent polish and appears to be somewhat harder than pyrargyrite. Etch tests were inconclusive and insufficient amounts of the mineral were present for other tests.

Etch Tests: See next page.

Etch Tests:

Mineral:	Reagent: $HgCl_2$	KOH	KCN	HCl	$FeCl_3$	HNO_3	Aq. Reg.
Sphalerite	–	–	–	–	–	brown-black tarnish	brown-black tarnish
Galena	slight irrid tarnish	–	–	light br. tarnish	irrid. tarnish	brown-black tarnish	
Tetrahedrite	–	–	?	–	–	irrid. tarnish	dark brown tarnish
Hematite	–	–	–	–	–	?	–
Chalcopyrite	–	–	–	–	–	–	black brown tarnish
Pyrite	–	–	–	–	–	dark tarnish	dark tornish
Pyrargyrite	brown tarnish	irrid. tarnish	brown black tarnish	–	–	?	?
Unknown A. (Stephanite?)	irrid tarnish	brown black stain	dark grey stain	–	–	?	
Unknown B.	irrid. tarnish	?	? (dark grey)	?	?	?	?

Textures:

Colliform banded textures are shown by barite, hematite, chalcedonic quartz and jasper in several specimens. The banding appears to be in a vein of siliceous material the exact nature of which could not be determined. The barite in such cases often shows excellent comb textures with the crystals tabular, up to 8 mm. in length and radiating from the central part of the structure. Fine grained pyrite is often present and is rudely concentrated in bands parallel to the other banded minerals. Galena is also present, in such cases, as isolated grains and segregations, usually in well defined greyish coloured bands.

Hematite, where present in polished section, exhibits a "fibrous", foliated texture in association with barite.

Textures (contd)

Although isolated elongate "fibres" of hematite occur in the barite it appears to be later than barite, in many cases, and encloses blebs of the latter mineral. The foliated texture of the hematite is usually best seen between the barite vein filling and the quartzose gangue. (Fig. 5).

A type of graphic texture involving chalcopyrite and pyrargyrite was observed in one specimen. The chalcopyrite, in minor amounts, formed an intergrowth with pyrargyrite at one end of a large grain of the latter. This intergrowth was only barely discernible by means of the high power objective of the microscope so exact relationships could not be determined. This texture, together with other boundary relationships between the two minerals, suggest their contemporaneous deposition in galena.

Close relationships between galena, sphalerite and tetrahedrite in quartz are indicated. It appears that all four minerals were deposited at the same time with galena later encroaching the sphalerite to some extent. The galena shows mutual boundaries with both sphalerite and tetrahedrite in many cases but in other instances has obviously replaced sphalerite (Fig. 4). Only small amounts of tetrahedrite were present in one specimen where it exhibited smooth mutual boundaries with both sphalerite and galena. The quartz is present as large irregular bodies and as isolated grains, showing, in many cases, a type of ice cake texture within the other minerals.

The galena was introduced in at least two stages as is evidenced by its mineral associations. In the first instance it is associated with only sphalerite, tetrahedrite and pyrite in quartz; in second instance it has chalcopyrite and silver minerals associated with it and veins barite. The interpretation made is that the barite gangue is later than the quartz and intervenes the two periods of galena mineralization. Later veinlets of barite and/or carbonates transgress all previous mineralization.

Paragenesis:

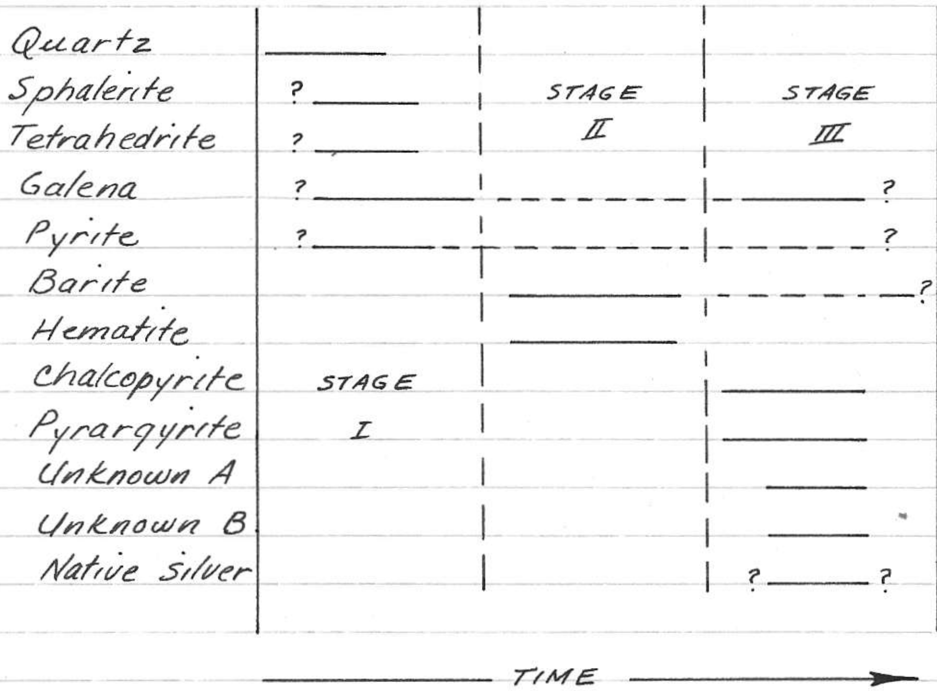
The mineral relationships in this suite can be explained by postulating a paragenetic sequence involving at least three stages of mineralization. The sheared and fractured greenstone fragments are enclosed by quartz which is itself sheared, in many cases, by later movements. The quartz is associated with galena, tetrahedrite and sphalerite which were probably introduced along with it or at a slightly later stage. Pyrite also accompanys the mineralization. Subsequent to this, galena has partially replaced sphalerite; this sequence terminates the first stage of mineralization. (It has been assumed, throughout this study, that all specimens examined contribute equally to one paragenetic sequence; — widely spaced areas in the mine may, however, show diverse mineral assemblages which may not be correlated under any circumstances since they do not necessarily form a related sequence.) At a later date barite was introduced and was seen in several instances to cut the previous minerals (Fig. 5). Hematite was introduced with the barite but the relationships between the two minerals is not too clear. Lamellae of hematite parallel the quartzose walls of the vein containing both barite and hematite, in many cases, and this suggests that hematite was the first deposited mineral. Elongate grains of hematite are found in the barite, however, which indicates probable contemporaneous deposition of the two minerals. In several instances the hematite lamellae appear to surround irregularly shaped grains of barite strongly suggesting later deposition of the iron mineral. Possibly a pulsating type of introduction of the two minerals occurred together with the development of the previously mentioned colloform textures as seen in other specimens. No other minerals besides hematite appear to have accompanied barite in this second stage of mineralization.

A third stage of mineralization involved the introduction of galena with chalcopyrite, pyrargyrite and the two

Paragenesis: (contd)

... unknown minerals. Galena appears as both fracture fillings and replacement veins in barite. Close, mutual boundaries relationships between the introduced minerals indicate simultaneous emplacement. Pyrite is also present in the barite and may have accompanied this later mineralization. Veinlets of barite and/or carbonate material cut previous minerals.

A suggested paragenetic sequence is as follows:



Conclusions:

Torbrit has the characteristics of both mesothermal and epithermal types of deposits. Tetrahedrite, sphalerite, galena and pyrite in a quartz gangue emplaced in a sheared greenstone is very typical for mesothermal deposits. Native silver (assuming it is hypogene) and ruby silvers in a barite gangue together with colloform banding of barite with other minerals suggests epithermal deposition. The deposit may be best termed a leptothermal vein filling and replacement deposit characterized by at least two stages of mineralization. The first stage was mesothermal whereas the second stage was typically epithermal in character. The second epithermal stage may be further

Conclusions (cont'd)

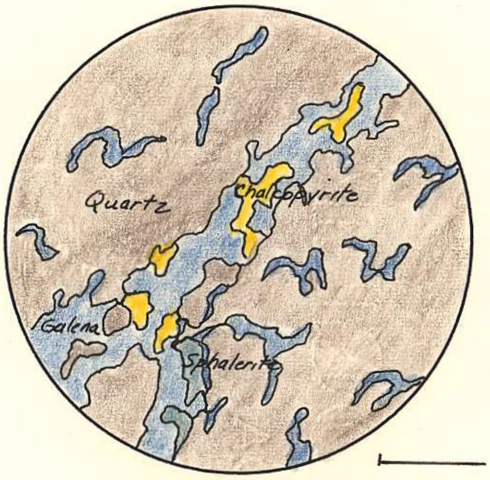
... subdivided into one stage involving the introduction of barite and hematite, and a later stage characterized by the introduction of galena and silver minerals.

It is possible that the native silver present was derived from the alteration of earlier argentiferous tetrahedrite or originated in the galena. At any rate the pyrargyrite is definitely late stage and its presence in a barite gangue indicates that temperatures were quite low when it was introduced. The good crystal form of the barite in the non-deformed colloform structures indicates not only low temperature deposition but also slow cooling of the deposit from the time of introduction onward.

The paragenesis of the silver-lead ores of Yerranderie, N.S.W., Australia show certain similarities to the implied paragenesis at Torbrit. At Yerranderie four stages of mineralization are recognized, - ~~each~~ the stages separated by a period of fracturing and a drop in temperature. Early minerals include pyrite, arsenopyrite, tetrahedrite and sphalerite whereas the late stages included galena, ruby silvers and native silver. (Edwards, pp. 138.).

Successive stages of mineralization in a single deposit may be related to the stability of an area in addition to the availability of mineral fluids. The shearing of the rocks of a mineral deposit, after initial mineralization, provides access for later, possibly diverse, mineralizing fluids to enter and deposit their loads.

— D R A W I N G S —

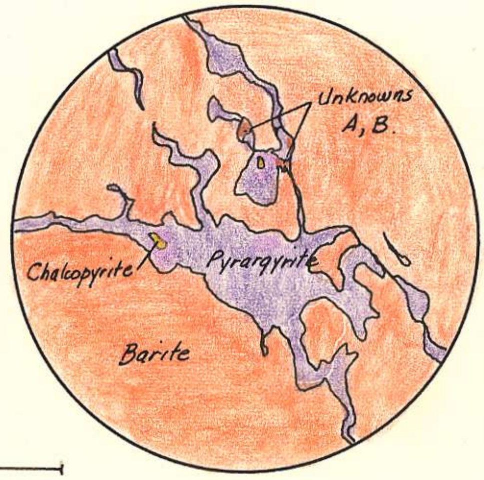


Chalcopyrite inclusions seen in a veinlet of galena which cuts quartz; a small amount of sphalerite present.

500μ

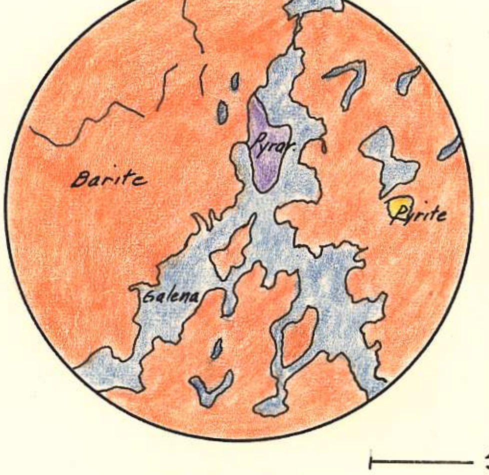
FIG. 1.

Pyrargyrite veining barite; inclusions of chalcopyrite and unknown minerals A and B are seen within the pyrargyrite.



500μ

FIG. 2.



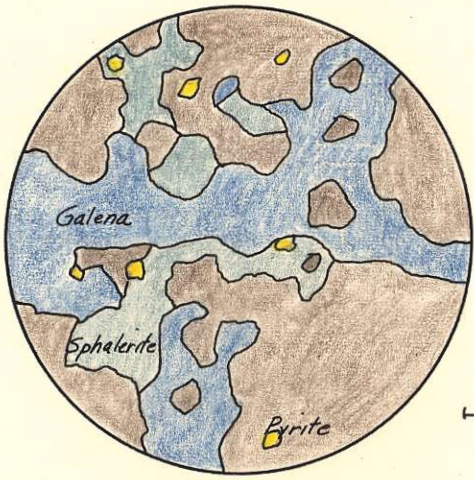
Veinlet of galena within barite gangue; an inclusion of pyrargyrite in the galena correlates the two minerals. Pyrite is seen, also within the barite gangue.

500μ

FIG. 3.

— DRAWINGS —

9025
73oz



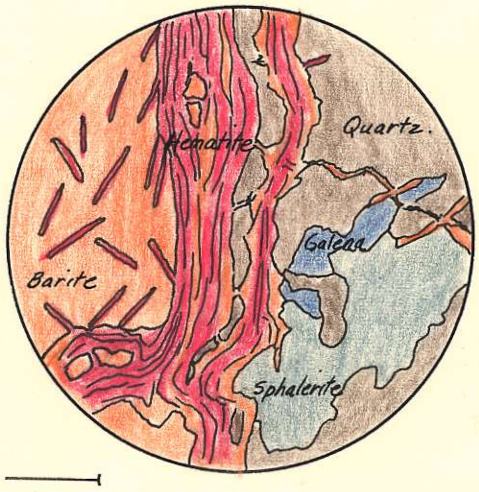
Galena seen replacing an intergrowth of quartz and sphalerite. Pyrite is also present as widely separated equant grains.

500μ

FIG. 4.

M

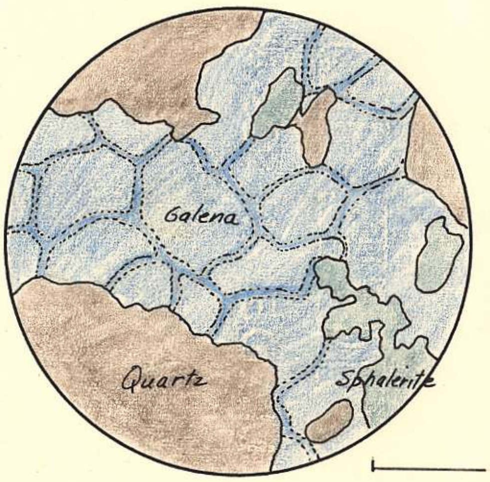
Boundary of a hematite-barite veinlet in quartz gangue. A small veinlet of barite cuts the quartz. The relationship between hematite and barite may have various interpretations. Quartz appears to preceed the barite.



500μ

FIG. 5.

63oz.



Galena, sphalerite, quartz association. Differences in the etching of galena indicate the possibility of two stages of galena mineralization.

210μ

FIG. 6.