A MINERALOGRAPHIC INSPECTION OF ORE SPECIMENS FROM TORBRIT SILVER MINES

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PREFACE

The collection of the specimens and their mineralographic study was made possible through the permission of Mr. R. W. Burton, Manager of Torbrit Silver Mines Ltd. The writer's thanks are hereby acknowledged.

The writer also thanks Dr. R. M. Thompson and Mr. S. Papezyk for their invaluable assistance and guidance in the laboratory and to Mr. J. A. Dennan for his assistance in making up the polished sections.

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Introduction

Purpose

The purpose of this mineralographic study was to identify the minerals in the specimens investigated and to determine the paragenesis of the minerals. Some information regarding the milling characteristics of the ore was also expected to be obtained.

Location

The specimens studied were taken from the workings of the Torbrit Silver Mines Ltd. The mine is located on the east bank of the Kitsault River, seventeen miles from its mouth at Alice Arm, B.C. Access to the mine is by a road which follows the old roadbed of the railway constructed by Taylor Engineering Co. in 1924 to provide access to the neighbouring Dolly Varden Mine which at that time was operating in the area.

History

The property was originally staked as the Toric group in 1914. Early prospecting centred around a lens-shaped outcrop approximately 180 feet long which contained galena, pyrite and native silver. Exploration in the area since the mine has been operating has not revealed any further outcrop of the orebodies other than a few small stringers which show in the walls of the canyon of the Kitsault River.

The property was slow to develop but in 1928 a small mill built by the Homestake Miniag and Development Co. treated 1540 tons of ore from which 18,000 ounces of silver were recovered.

Britannia Mining and Smelting Co. obtained control of the property in 1929 but there was no production from the mine until it was purchased by Mining Corporatinn of Canada who installed a 300-ton mill which commenced operation in February 1949.

The mill has been in continuous operation since then and subsequent expansions have increased its capacity until at the present time the mill treats about 460 tons of ore per day running 16 ounces of silver per ton.

The oreshoots are mined by shrinkage stoping and the silver is recovered as a flotation concentrate which is sacked and shipped to the smelter and as a silver bullinn from cyanidation of the flotation tailings.

Geology

The deposit lies in a series of volcanic breccias and tuffs which form part of the Hazelton series. The brecciated toe of an anticlinal structure which plunges gently to the north along a line striking N65W has been hydrothermally replaced to form a mineralized zone in which the ore shoots are located. This zone contains quartz, calcite, barite, hematite, pyrite, galena, sphalerite, native and ruby silver, and includes masses of unreplaced and partly replaced wall rock. The deposit is wide at depth and branches of it finger out east and west toward the surface. These fingers apex abruptly before reaching the surface.

The walls of the deposit are composed of a slightly schistose massive agglomerate of grey, green, purple, and red tuff.

The ore shoots in the deposit are conformable to the replacement deposit and are arranged in bands of unoriented aggregates from a few inches to several feet in width and also conform to the schistosity in the walls. Mineralization was probably controlled by fractures in the brecciated zones through which the replacing solutions circulated.

Megascopic Examination

Specimen I

Specimen I was taken from the walls of the old lunchroom on the 1000 Level, a location particularly noted for the ocurrence of high grade specimens in which sulphides and ruby silver were abundant. It was a sharply angular fragment about 3" by 2" by 2" in which a slight schistosity was apparent. The groundmass of the fragment was grey tuff which was partially replaced by a number of fine-grained minerals in which a banding was suggested. ~~a banding.~~ The minerals identified with the aid of a hand lens were a white quartz, barite, small grains of galena, the odd speck of pyrite, a brick-red quartz known locally as jasper, and crusts of ruby silver.

Upon standing in air since the specimen was broken, it was noticed that much of the barite had been oxidized and had acquired a soft, crumbly, oxidized coating.

Two polished sections were made from the specimen. One through a zone containing mostly quartz and barite in which a considerable amount of jasper and a number of specks of ruby silver were in evidence. The other section was made through a zone rich in sulphides in which a slight banding was noticed.

Specimen II

Specimen II was selected from the muck broken while taking the first lift in 902 stope. It was a slab approximately 2" by 2" by 1", the largest face of which was polished. At first glance the specimen seemed to be composed of massive fine grained galena but upon closer inspection was found to consist of small grains of quartz in a matrix of sulphides. Two types of quartz were noticed in the specimen, the brick-red quartz containing fine particles of hematite and a milky white quartz which seemed to be deposited after the jaspery quartz. One fragment of jaspery quartz had a vein of barite about 1/8" wide running through it. Metallic minerals identified in this specimen were pyrite and galena.

Specimen III

Specimen III was taken from the wall of 880 sub-level. The hand specimen was a fragment of breccia which had been replaced by quartz and sulphides, subsequently fractured, and a layer of barite deposited on the fractured surfaces. Thin plates of native silver varying in size from 1/4" to 1/16" in diameter were also deposited on these surfaces.

The polished section made from a fragment similar to the hand specimen showed laths of barite replacing the quartz and made up approximately 60% of the polished section area. Galena and pyrite were identified associated with the quartz in the section.

Miscroscopic Examination

Minerals Identified

The metallic minerals identified in specimen I, were galena, pyrargyrite, sphalerite, pyrite, tetrahedrite, chalcopyrite, stephanite, and hematite. All these constitute only about 10% of the volume of the specimen. The remainder of the section was made up of quarts, calcite, and barite.

Galena was identified by its colour, hardness, the presence of triangular pits in its surface, and its etch reactions which are listed in table I of the appendix.

Pyrargyrite ($3Ag_2S.Sb_2S_3$) was identified by its scarlet internal reflection, hardness, (C) and bluish-grey colour. It was moderately anisotropic and the polarization colours changed ~~colour~~ from grey to blue-grey. Microchemical tests for silver and antimony were positive and results of etch tests are listed in figure I of the appendix. It was distinguished from hematite in the section by the colour of its internal reflection, the hematite exhibiting a brick-red internal reflection.

Sphalerite showed a mouse-grey colour in polished sections and its surface contained small triangular pits. It was isotropic and had a honey-coloured internal reflection. Results of etch tests are listed in figure I.

Pyrite was recongnized by its polish, its hardness, its colour, and its lack of anisotropism.

Tetrahedrite was present as small grains in the quartz but had a different polish than the sphalerite and had no internal reflection. It was isotropic, had a hardness of D, and was negative to all etch reagents.

Chalcopyrite was recognized by its characteristic color, its hardness and it showed weak anistropism.

Stephanite, $5\ Ag_2S.Sb_2S_3$, was identified by its colour and the results of etch tests which are listed in figure I, It was associated with pyrargyrite and had a pale brass yellow colour with a pinkish caste. It had a hardness of C and showed no internal reflection. Its polarization colours were from mustard green to purple. It had a good polish but had a few more pits than the pyrargyrite. It was distinguished from pearcite by its etch reactions and from polybasite by its lack of internal reflection.

Two other minerals were noticed under incident light from the carbon arc lamp but were too small to be identified. One which occurred in the quartz as grains about 25 microns in diameter associated with the hematite inclusions and smaller pyrargyrite grains had a red internal reflection. The other unknown mineral occurred as groups of particles in the quartz about 5 microns and less in diameter and had no internal reflection but were a metallic steel grey colour. They could also be seen under crossed nicols but were not visible in plane polarized light. Another mineral, seen once closely associated with chalcopyrite, was steel blue in colour, seemed to be anisotropic, and was a grain about 40 microns in diameter.

The percentage distribution of the minerals over the area of each polished section was estimated and are shown listed in figure 2 of the appendix.

Textures and Grain Size

Galena occurred filling cracks and as inclusions in the jaspery quartz with an average grain size of from 15 to 100 microns and at times as grains as large as 800 microns. No contacts with other minerals were observed when it was associated with the jaspery quartz. When associated with the milky quartz, the galena occurred as small veinlets surrounding corroded grains of the quartz. It was observed that it veined and surrounded corroded particles of the pyrite. When in contact with sphalerite, the galena exhibited mutual boundary relations with it, showed evidence of replacing it and also showed evidence of being replaced by the sphalerite. A photomicrograph illustrating the boundary relations between the quartz, galena, pyrite and sphalerite is shown in figure 4 of the appendix.

The sphalerite occurred as blebs averaging 200 microns in diameter associated with the galena in the milky quartz. Very little sphalerite was observed in specimen I. The sphalerite had the boundary relations with galena mentioned above and was seen to vein and replace pyrite and quartz. In the specimen from the 880 sub-level it was observed to replace barite.

Pyrite was associated with the galena and sphalerite in all specimens and showed an average grain size of 100 microns with a few grains as large as 800 microns.

Most of the pyrargyrite was found as euhedral grains measuring 150 microns, ~~were found~~. However, an estimated 20% of the pyragyrite occurred as inclusions in the jaspery quartz which averaged 20 microns in diameter. Very few of the small inclusions were noted in the milky quartz. Some pyrargyrite was also observed filling cracks in the quartz and in one case was observed to be replacing sphalerite. A large grain of pyrargyrite and several smaller inclusions in the jaspery quartz are shown in the photomicrograph in the appendix, figure 5. It was observed that very little pyrargyrite occurred in the specimens II and III where there was no jaspery quartz. The silver values from this type of ore are likely in the form of native silver occurring as plates "plastered" on fragments of breccia.

The stephanite always occurred closely associated with the pyrargyrite and its boundary relations with it indicate that it was exsolved from solid solution with the pyrargyrite.

Chalcopyrite also was found closely associated with the pyrargyrite but because of its size no conclusion could be drawn from the boundary relations with it. It was also observed as minute inclusions in some of the larger blebs of sphalerite. These may be the result of unmixing of solid solution with the sphalerite or of replacement of the sphalerite by chalcopyrite.

A few blebs of tetrahedrite measuring 25 microns across occurred as inclusions in the jaspery quartz. These showed no contacts with minerals other than the quartz consequently their paragenesis is not definitely established.

Conclusions

Paragenesis

The textures and boundary relations of the minerals observed in the specimens indicate the following paragenesis of the ore minerals.

After brecciation of the volcanic tuffs a quartz containing hematitic inclusions filled the openings in the sheared zone. Continued fracturing of the quartz permitted the deposition of pyrargyrite with stephanite along with galena and tetrahedrite in the cracks in the quartz. Further fracturing of the jasper quartz during which some barite was deposited was followed by the deposition of the milky coloured quartz and pyrite. This was followed by a replacement of the milky quartz and pyrite by sphalerite and galena which was accompanied by more fracturing with the open spaces being filled by the sphalerite and galena.

A graphic illustration of the paragenesis is shown in figure 4 of the appendix.

Classification of Deposit

The minerals occurring in this deposit and their association indicate that replacement occurred at a temperature in the neighborhood of 470°C. Mineralization occurred as fracture filling and hydrothermal replacement of the brecciated zone. The deposit may be classified as a hydrothermal deposit of the epithermal type.

Milling Characteristics of Ore

The grain size of the pyrargyrite in the quartz immediately suggests that a fine grind will be necessary in order to liberate the mineral from the quartz. Since quartz crushes more readily than it grinds, it will be of some advantage to crush the ore as fine as economically possible before attempting to grind it. A rod mill may be employed for primary grinding as comminution by impact is more effective in quartz than the attrition of ball mill grinding. However, grinding will have to be finished in a ball mill in order to attain grind of the required particle size.

The presence of barite in the ore complicates the concentration since grinding the barite will produce slimes which tend to decrease grade and recovery of flotation concentrate and hinder the settling and filtration of the pulps.

Since pyrargyrite was the main silver mineral found in this investigation, the silver values in the ore could be recovered best by flotation since the mineral is refractory to cyanidation. Its association with pyrite however, presents some difficulty in finding a collector which will selectively float the pyrargyrite from the associated pyrite.

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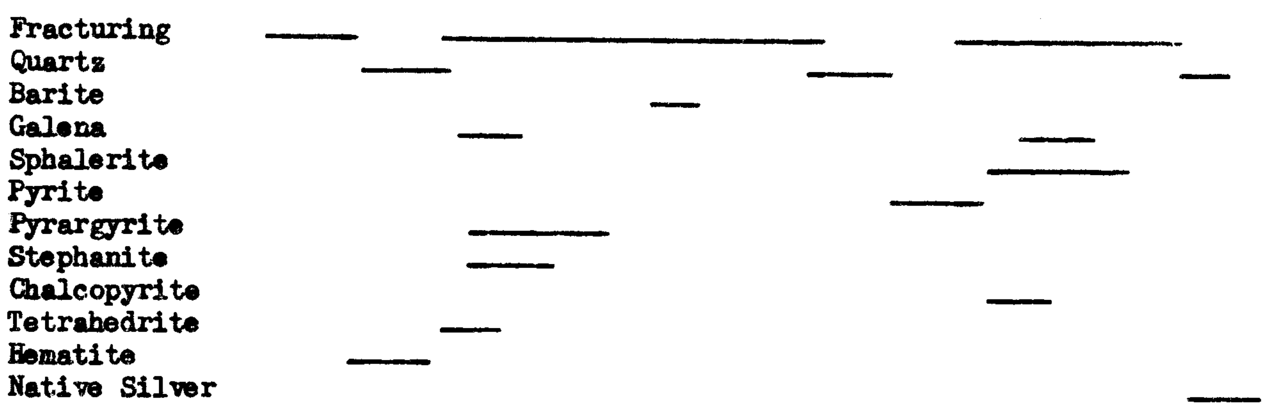
APPENDIX

Reagent	Galena	Sphalerite	Pyrargyrite	Stephanite
$HgCl_2$	neg.	neg.	brown stain	irredescent tarnish
KCN	neg.	neg.	etched - brings out minute cracks	etches - brings out boundary and minute cracks
KOH	neg.	neg.	etched grey	etched dark brown
HCI	irridescent tarnish	neg. ?	neg.	neg. ?
$FeCl_3$	irridescent stain	neg.	neg.	neg.
HNO_3	dark brown	slight tarnish	neg.	neg.
Aqua Regia	—	dark brown stain	—	—

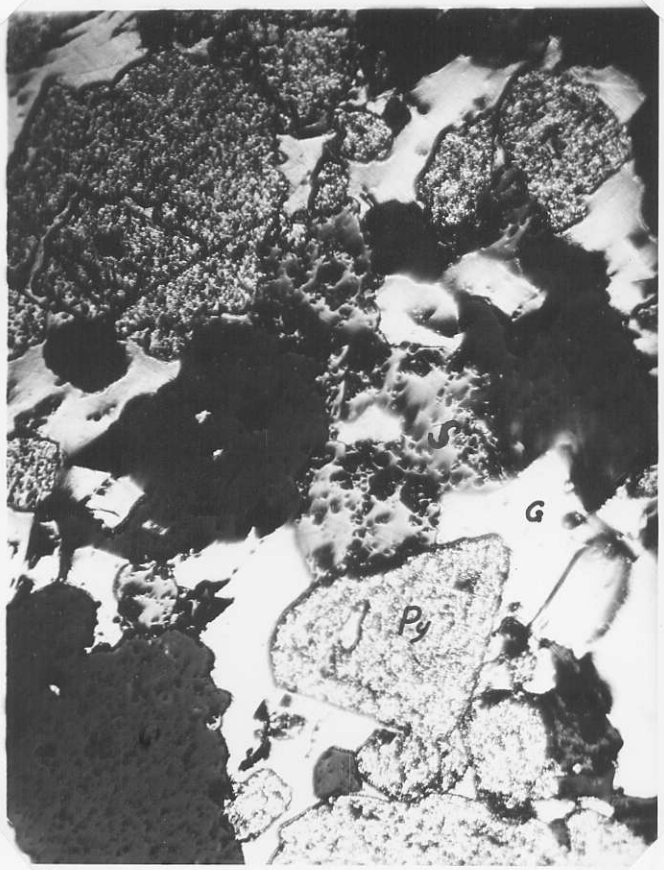
<u>Figure I.</u> Table of Etch Reactions

	Specimen I		Specimen II	Specimen III
	Section 1	Section 2		
Milky quartz	70	50	50	20
Jaspery quartz	15	20	15	--
Barite	10	10	5	60
Calcite	2	1	--	10
Galena	<1	5	15	3
Pyrite	<1	4	5	--
Sphalerite	--	1	5	6
Pyrargyrite	2	3	1	--
Tetrahedrite	--	<1	--	--
Stephanite	--	<1	--	--
Chalcopyrite	--	<1	<1	--

Figure 2. Table showing distribution of minerals in volumetric percent.



<u>Figure 3.</u> Table showing paragenesis



<u>Figure 4.</u> Photomicrograph showing boundary relations between pyrite (P), galena (G), sphalerite (S), and quartz (Q). x165

<u>Figure 5.</u> Photomicrograph showing pyrargyrite (P) in hematic quartz (Q). x165