ORES OF THE SILBAK PREMIER MINE

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SUMMARY AND CONCLUSIONS

A study of about fifty polished sections of ore from the Silbak Premier Mine has shown that the principal metallic minerals in the ore are pyrite, sphalerite, galena, chalcopyrite, tetrahedrite, polybasite, argentite and electrum. Pyrite, sphalerite, and some chalcopyrite were deposited early in the period of mineralization, whereas galena and the silver minerals were deposited late, possibly simultaneously.

Tests using the Haultain Super-Panner were made to find the distribution of silver and gold in several samples, and to obtain pure samples of electrum for analysis.

These studies have lead to the following conclusions.

(1) There is no significant difference between the mineralogy of the hanging-wall orebodies and that of the main ore zone and hence no mineralogical evidence to show that ore does not exist below the present working levels.

(2) Gold is present in the form of electrum which averages 50% silver and 50% gold, the composition being constant throughout the mine.

(3) Silver in addition to that contained in electrum occurs in silver sulfides; polybasite, tetrahedrite, and argentite being important in the upper orebodies, and polybasite and tetrahedrite being important in the lower orebodies.

(4) Geological thermometers indicate that the ores were formed between 180 and 350 deg. C.

ORES OF THE SILBAK PREMIER MINE

The Silbak Premier Mine now owned and operated by the Silbak Premier Mines Limited is in the Portland Canal Mining Division of the coast of Northern British Columbia. The mine camp and workings are on the west slope of Bear River Ridge. They overlook the Salmon River Valley and are connected to the town of Stewart at the head of Portland Canal by a 15 - mile motor road.

Orebodies in the mineralized zones now covered by Silbak Premier holdings have been mined continuously since 1918. Lead has been produced intermittently since 1923 and copper since 1927. Silbak Premier has thus become one of the important silver - gold mines in British Columbia.

GENERAL GEOLOGY

The Silbak Premier orebodies lie near the eastern contact of the Coast Range Batholith and are thought to be genetically related to the batholith.

Two main types of country rock are important in the mine. These are (1) volcanics of the Bear River Series, locally subdivided into greenstones and purple tuffs; and (2) feldspar porphyry which intrudes the volcanics in sill-like tongues. The feldspar porphyry was intruded before the Coast Range Batholith and is thought to be Late Upper Jurassic in age.

The main orebodies are confined to two ore zones, one striking northwest and the other northeast. Both dip steeply to the north. The orebodies lie between elevations of 700 and 2100 ft. above sea level; the northwest zone is 3000 ft. long, while the northeast is 5200 ft. long. The northwest zone is cut off on the west by the steeply dipping surface of Bear River Ridge. At the junction of the two ore zones large orebodies have been mined. In the northeast zone narrower orebodies occur at irregular intervals, but in places they show a well developed enechelon arrangement.

The position and size of these orebodies is controled to some extent by the competency of the country rock. The porphyry holds a fracture well, and hence orebodies are confined to it, or to greenstone - porphyry contacts. The purple tuffs, on the other hand, are very incompetent. They form a blanket overlying the ore zones and somewhat parallel to the slope of the hill. The base of the tuffs generally corresponds to the top of the orebodies except where porphyry has intruded the tuffs and later been fractured and mineralized.

No important orebodies have been found below No. 6 level, at an elevation of 780 ft. above sea level, and only small orebodies have been mined between 5 and 6 level in the main ore zone. Recently, however, important orebodies were discovered about 600 ft. northwest of the main northeast zone, extending from an elevation of 790 to 1200 ft. above sea level. These proved to be in the form of a small crescent similar to that at the junction of the main northeast and northwest zones. Recent mining has been confined mainly to these orebodies. They will be referred to in this report as the hanging-wall orebodies.

LABORATORY STUDIES OF THE MINERALOGY

The mineralogy of the old Premier Mine has been studied by W.D. Burton (2) and that of the northeast ore zone by W.H. White (8). The present study extends this work to include the mineralogy of the hanging-wall orebodies and of the deeper workings of the main ore zone. When originally undertaken, it was thought that this study might show some changes with depth in the minerals or their associations which would explain why good ore has not been found below No. 6 level. It has been found, however, that such changes are largely lacking and there seems to be no mineralogical evidence to suggest that valuable minerals do not extend below the present working levels.

Laboratory work has consisted mainly of a study of polished sections and of tests using the Haultain Super-Panner. Twenty sections from the hanging-wall orebodies, three from 10 L stope, and thirty made by Dr. White of ore from the main ore zone were studied under the microscope. The super-panner was used to obtain pure samples of electrum for analysis, and to show the distribution of silver and gold in picked samples. Several products from the super-panner were mounted for microscopic study.

MINERALOGY AND STUDY OF POLISHED SECTIONS

Hand specimens of ore from the Silbak Premier Mine vary widely in appearance. Some appear to be pure galena while others are high in sphalerite and pyrite. Most typically, pyrite is predominant, and is surrounded with smaller amounts of galena and sphalerite. Chalcopyrite is not abundant but is present in most specimens. Quartz and calcite are the main gangue minerals, but much of the ore grades into altered wall rock. All specimens are medium to fine grained and in most the sulfides are massive.

The following minerals were identified in polished sections.

Pyrite (FeS_2)	Tetrahedrite ($3Cu_2SSb_2S_3$)
Sphalerite (ZnS)	Polybasite ($9Ag_2SSb_2S_3$)
Galena (PbS)	Argentite (Ag_2S)
Chalcopyrite ($CuFeS_2$)	Electrum
	Silver.

Base Metal Sulfides

Grains of pyrite up to four millimeters across are abundant in most sections. These are generally of uniform size and well formed but fractured and replaced by quartz and later sulfides. The extent of the replacement varies, some crystals being relics while others are merely rounded or replaced by a few inclusions of later sulfides. Pyrite grains are most extensively replaced where sulfides are abundant and little replaced where there is much silica. Late sulfides may thus have first replaced silica and later attacked pyrite.

Sphalerite in hand specimens has a light to medium brown color. In polished sections it surrounds pyrite grains and in places appears in fractures in quartz. Intricate feathery contacts between galena and sphalerite show definitely that sphalerite has been replaced by galena. In places sphalerite is obviously fractured and replaced by galena, while in most the replacement has progressed so far as to obliterate the original fracture pattern and leave isolated remnants of sphalerite in galena. Most sphalerite contains rounded and angular blebs of chalcopyrite.

As stated above, galena replaces sphalerite and pyrite but it also occurs as veinlets in quartz. Galena is important as the host for the silver minerals.

The earliest chalcopyrite was introduced with sphalerite. It occurs as minute rounded or angular grains or occasionally as well formed intergrowths with sphalerite. Several sections show chalcopyrite blebs clustered around the borders of sphalerite grains and apparently related to them. Definitely later chalcopyrite occurs as irregular areas in galena, many of which are small, while others are relatively large and occupy positions similar to those occupied by galena. Thus there are two ages of chalcopyrite, one related to sphalerite and the other to galena.

Silver Minerals

The silver minerals include tetrahedrite, polybasite, argentite, electrum and minor amounts of native silver. They all have been deposited late in the period of mineralization, probably with the same solutions which brought in galena.

Tetrahedrite occurs as rounded or irregular grains in galena averaging 0.5 to 1 mm across. Many grains are isolated but more commonly they are in contact with sphalerite or quartz. The intimate association of galena and tetrahedrite indicates simultaneous deposition of these two minerals. The size and association of tetrahedrite grains is strikingly constant in all sections. Those from the upper main ore zone show the same small irregular grains of tetrahedrite in galena as do those from the hanging-wall orebodies, and these in turn are similar to those from 10 L stope. (Fig. 1 & 2)

The exact silver content of tetrahedrite is not known as the grains are too small to analyse, but super-panner tests have shown that tetrahedrite is one of the most important silver-bearing minerals in the ore.

Polybasite has many characteristics in common with tetrahedrite. It always occurs in galena in grains similar to those of tetrahedrite and occasionally is intimately associated with tetrahedrite. (Fig. 3 & 4). However, the grain size of polybasite varies with depth. Grains or rounded areas in galena are as much as 3 mm across in sections from the upper levels, and as much as 1 mm across in sections from No. 4 level. (Fig. 5). But in all sections from the lower levels and the hanging-wall orebodies polybasite grains are less than 50 microns across. These grains in the lower levels are not abundant and it is possible that polybasite decreases in amount as well as in grain size with depth.

Argentite was found in sections taken from above No. 4 level but not in sections taken from below this level. It occurs as relatively large grains in galena. (Fig. 6). One occurrence of argentite with galena and native silver filling persistant late fractures in quartz was noted.

Electrum, the natural alloy of silver and gold occurs in galena, commonly with pyrite. Occasional occurrences of electrum as inclusions in pyrite or as fillings in quartz are fairly common. The average size of electrum grains is about 0.5 mm but grains as large as 1 mm occur in samples from both the upper and the lower levels, and grains as small as 10 microns were found in superpanner tips from the hanging-wall orebodies. The composition of electrum is markedly constant. Picked grains of electrum from the hanging-wall orebodies, (average elevation 900 ft. above sea level) contained an average of 50.8% gold. Dr. White (9) determined the composition of electrum from 15 A stope (elev 1550 ft) to be 47.2% gold and from 1814 drift (elev 1820 ft) to be 50.0% gold. Over a vertical range of nearly 1000 ft. there is thus no appreciable change in the composition of the electrum.

Hence, although polybasite and argentite may decrease in importance with depth, electrum and tetrahedrite are remarkably persistant.

Native silver was identified in only one section where it occupied fractures in quartz. Occasional minute silver-white grains in galena were thought to be native silver but were too small to identify.

Quartz and Calcite

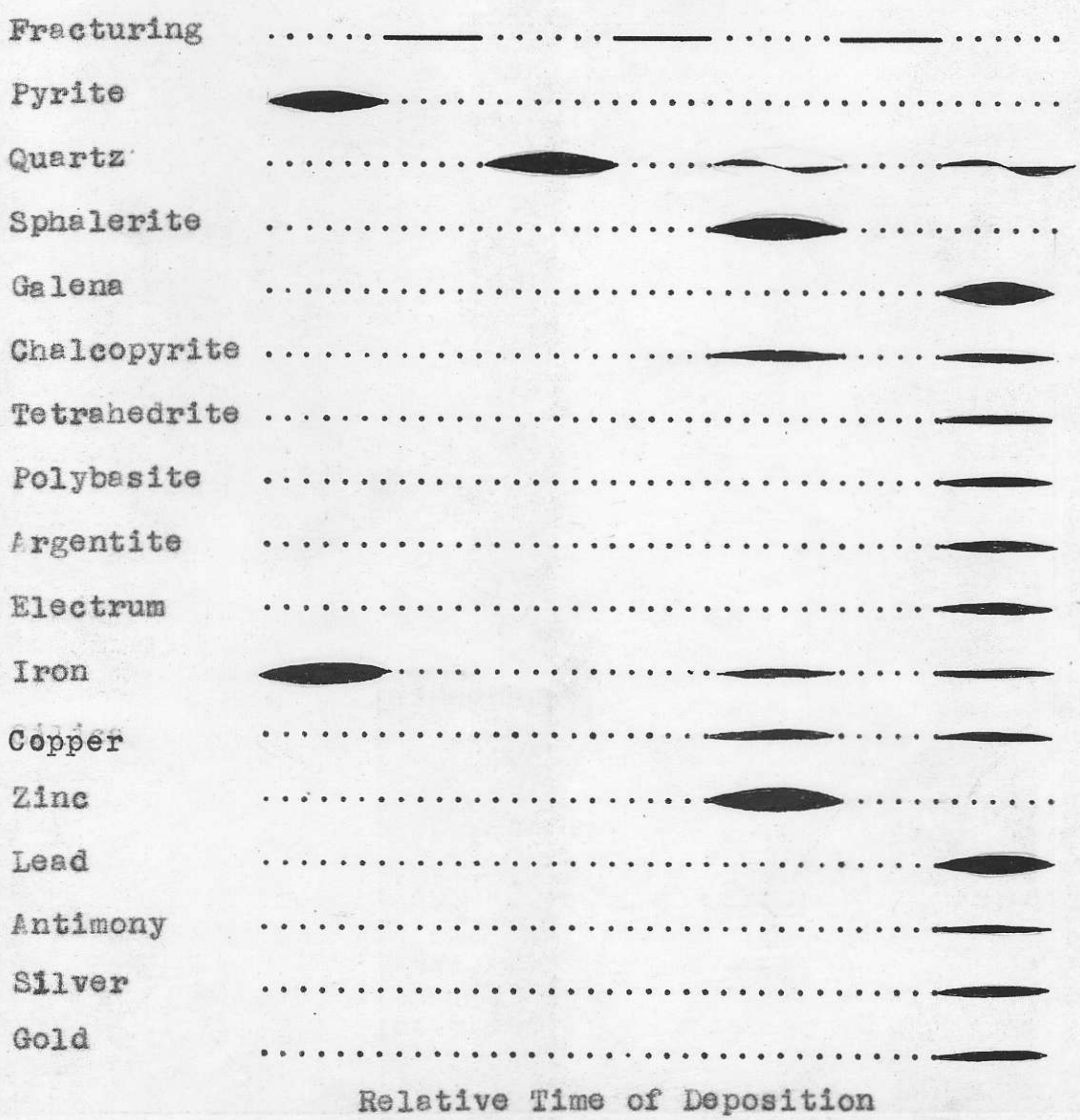
Quartz and calcite are common even in sections containing massive sulfides. Their relative ages were not definitely established but as calcite commonly fills irregular fractures in quartz it is thought to be later than at least some of the quartz. There are, however, several ages of quartz. The oldest seems to have been introduced following the fracturing of pyrite. Very late quartz appears as veinlets cutting all the sulfides including galena. Quartz which probably formed by the recrystallization of original quartz can be distinguished in thin sections. Hence, quartz appears to have been deposited at intervals throughout the deposition of all the sulfides.

Paragenesis

From the study of polished sections a fairly definite sequence of deposition of the main minerals has been worked out. Following the widespread fracturing which formed the ore zones there seem to have been four periods of mineralization each separated by a period of fracturing. The precipitation of pyrite was followed by fracturing and the introduction of quartz. The quartz and pyrite in turn were fractured and sphalerite deposited bringing with it chalcopyrite which formed as inclusions and intergrowths with sphalerite. The deposition of sphalerite was followed by fracturing and the introduction of galena which widely replaced sphalerite and brought with it chalcopyrite, the silver sulfides, and electrum. There is no evidence to show that the silver sulfides, electrum and galena were not deposited simultaneously.

The following table gives the paragenesis of the minerals and elements in diagramatic form.

PARAGENESIS



Temperature Estimates

Two possible indicators of temperature were observed in polished sections of Silbak Premier ore and these are the basis for the following estimates of the temperature of formation of the orebodies.

Small rounded or angular blebs of chalcopyrite in sphalerite have been mentioned previously. The smallest blebs average 5 microns in diameter and are rounded, while larger ones are angular and grade into a coarse, well formed intergrowth. Many blebs show no definite arrangement, while others are aligned possibly along crystallographic planes. It is probable that these blebs of chalcopyrite intimately associated with sphalerite result from the unmixing of the two sulfides, and it seems beyond doubt that such well formed intergrowths as that shown in Fig. 10 are caused by this process of unmixing. Intergrowths of this type are common (8) and are generally attributed to unmixing from solid solution. Work by Beurger (1) indicates that the unmixing temperature of chalcopyrite and sphalerite, where sphalerite is the host, lies between 350 and 400 deg. C.

Argentite is present in several sections. In all places it is isotropic indicating that it is isometric in crystal form. Several writers point out that isometric argentite is a high temperature form crystallizing above 180 deg. C. (3)

These transformation temperatures have been determined at atmospheric pressure but it has been shown that pressure does not change the transformation temperature in solid substances more than 10 or 20 deg. C. for depths of transformation up to 5 miles. (4).

Thus, the temperature of formation of the ores at the ? Silbak Premier mine can be estimated to lie between 180 and 350 deg. C. Error here? - Temp of formation over 350° is indicated by intergrowth. upper limit not known. (J.T.F. 1949)

Super-Panner Tests

The Distribution of Silver and Gold

The study of polished sections shows that the silver values at the Silbak Premier mine are not entirely dependent on the silver content of the electrum. Silver-bearing sulfides, principally polybasite and tetrahedrite are common throughout the mine and argentite is important at least down to No. 4 level. The polished sections also show no marked differences in mineralogy between the ores of the upper and lower levels. In order to substantiate these conclusions a series of tests were run using screen sizing equipment and the Haultain Super-Panner.

Three samples, one from the new hanging-wall ore zone, (elev. 800 ft. in 789 dr.) one from the lower part of the main ore zone, (elev. 1140 ft. in 10 L stope) and one from the upper part of the main ore zone (elev. 1420 ft. in 13 A stope) were crushed and ground to 65 mesh. These samples were then sized into five products having size ranges of +65, -65 + 100, - 100 + 150, -150 + 200, and - 200 mesh in a set of standard screens. Each size was then panned on the superpanner and three products removed. The "tip" appeared to be pure galena with, in some samples, a few grains of electrum. The middling product was principally pyrite with possibly 10% galena and smaller amounts of sphalerite. The tailing product contained mostly sphalerite with some pyrite and the gangue minerals. Each product was weighed and assayed for silver and gold.

The following tables, which are divided into two groups for purposes of comparison, give the results of the tests.

Table 1 shows the distribution of the silver and gold in each sample for various size ranges. Column 5 shows a marked increase in the silver-gold ratio for the -200 mesh material, and a general increase in the silver-gold ratio with a decrease in size. Columns 6 and 7, based on the weight and assay of each sample, show the same trend. In sample A, for example, 35.1% of the silver but only 11.9% of the gold appears in the -200 mesh product. Similar relations hold for the other samples.

TABLE 1

Sample A. (Lower main ore zone elev. 1140 ft. 10 L stope)

(1) Screen Size	(2) Weight Grammes	(3) Au Oz/T	(4) Ag Oz/T	(5) Ag/Au	(6) % Au	(7) % Ag
+65	236.6	3.06	11.12	3.7	21.3	17.2
-65+100	180.0	6.00	17.00	2.8	31.9	20.0
-100+150	140.5	5.58	17.16	3.1	23.2	15.8
-150+200	125.8	3.16	14.52	4.6	11.7	11.9
-200	348.8	1.16	15.32	13.2	11.9	35.1

Sample B. (Hanging-wall orebody elev. 800 ft. in 789 Dr.)

-65+100	106.0	0.20	5.10	25.5	71.8	30.1
-100+150	57.5	0.04	5.56	139.	7.8	17.8
-150+200	47.0	0.04	5.64	141.	6.3	14.7
-200	103.1	0.09	6.52	163.	14.1	37.4

Sample C. (Upper Main Ore Zone elev. 1420 Ft. in 13A stope)

-65+100	124.8	0.94	5.86	6.2	25.4	20.9
-100+150	97.1	1.04	6.10	5.9	22.0	17.0
-150+200	81.0	0.88	5.36	6.1	15.5	12.4
-200	244.9	0.70	7.06	10.0	37.1	49.7

TABLE II

Screen Size	Sample A (1) Au Oz/T	Sample A (2) Ag Oz/T	Sample A (3) Ag/Au	Sample A (4) Ag-Au Oz/T	Sample B (1) Au Oz/T	Sample B (2) Ag Oz/T	Sample B (3) Ag/Au	Sample B (4) Ag-Au Oz/T	Sample C (1) Au Oz/T	Sample C (2) Ag Oz/T	Sample C (3) Ag/Au	Sample C (4) Ag-Au Oz/T
Galena Product												
+65	53.33	78.15	1.6	24.82								
-65+100	42.66	69.50	1.6	16.84	0.01	12.35	1235	12.34	4.75	16.25	3.4	11.50
-100+150	28.55	56.00	2.0	27.45	0.045	4.55	100	4.50	8.97	19.85	2.2	10.88
-150+200	15.96	39.26	2.5	23.30	0.5	8.35	166	8.28	9.51	17.59	1.85	8.08
-200	4.24	28.24	6.7	24.00	0.10	10.94	109	10.84	6.30	18.53	2.9	12.23
Pyrite Product												
+65	10.20	23.40	2.3	13.20								
-65+100	4.64	19.36	4.2	14.72	0.04	6.52	163	6.48	1.08	8.44	7.8	7.36
-100+150	2.00	13.36	6.7	11.36	0.03	5.10	170	5.07	0.82	7.00	8.5	6.18
-150+200	1.08	12.28	11.4	11.20	0.03	5.00	166	4.97	0.58	7.80	13.5	7.22
-200	0.70	16.44	23.5	15.74	0.03	7.12	237	7.09	0.68	11.16	16.5	10.48
Sphalerite Product												
+65	3.12	9.28	3.0	6.16								
-65+100	2.80	9.44	3.4	6.64	0.02	2.94	144	2.92	0.72	5.20	7.2	4.48
-100+150	2.08	9.00	4.3	6.92	0.02	2.86	143	2.84	0.76	5.08	6.7	5.32
-150+200	2.12	10.60	5.0	8.48	0.04	3.00	75	2.96	0.78	4.90	6.3	4.12
-200	0.40	10.96	27.4	10.56	0.02	3.66	183	3.64	0.38	4.70	12.3	4.42

This evidence points to the conclusion that brittle silver minerals are present which break readily and concentrate in the fine sized product, while malleable electrum escapes this concentration. Table I also shows that the same general trends exist for all three samples.

Table II gives the distribution of silver and gold in the super-panner products taken from each sample. For particles of about the same size, the super-panner makes a separation on a specific gravity basis. Hence, minerals of higher specific gravity such as electrum and polybasite tend to concentrate in the galena product while minerals of lower specific gravity such as tetrahedrite remain with the pyrite and sphalerite.

Columns 3 show the same change in the silver-gold ratio with size as similar columns in Table I. Relatively high silver-gold ratios appear in the -200 mesh material showing again the importance of the brittle silver-bearing sulfides.

Columns 4 represent the amount of silver carried by minerals other than electrum. This follows from the fact that previous tests have shown the average composition of the electrum to be about 50% silver and 50% gold. Hence, the difference between the total silver assay and the total gold assay gives the approximate amount of silver carried by the sulfides.

Trends in the values in columns 4 show the relative importance of the high and low specific gravity silver sulfides. The high silver content of the pyrite and sphalerite products compared with that of the galena product points to the importance of tetrahedrite as a silver-bearing mineral. Polished sections show that polybasite and tetrahedrite are intimately associated with galena, and thus the silver content of the galena product can be attributed to polybasite and possibly tetrahedrite in galena (Fig. 3). In sample C argentite may account for some of the silver in the galena product.

The results point, almost without exception, to two main conclusions.

(1) Silver sulfides, occuring as very small grains in samples from the deeper orebodies are important in carrying silver. These were identified in polished sections as mainly polybasite and tetrahedrite with some argentite in the upper levels.

(2) The distribution of silver and gold is the same in each sample regardless of its position in the mine.

The Composition of Electrum

Several samples of pure electrum were obtained on the super-panner. These came from concentrates of ore from the hanging-wall orebodies. Study under the ultrapak and binoculars showed that the grains differed in color but that the colors were not distinctive enough to divide them into separate groups. Two picked samples, however, were obtained, one consisting of smaller lighter grains and the other of larger darker grains. Contrary to expectations, the lighter grains averaged 61% gold while the darker grains assayed 40%

gold. Several other samples picked at random, but containing no visible impurities, gave an average assay of 51.8% gold with no sample differing more than 1% from the average. It was concluded that the color of the grains is dependent on the oxides present on their surfaces even though the grains were ignited before being tested.

Mounted polished sections of electrum show it to have several different colors in section. It may be that these colors depend on the silver content of the electrum but minor impurities may have a greater effect on the color. W.H. Mathews (7) reports that electrum from the Silbak Premier mine contains minor amounts of lead, copper and possibly antimony.

Hence, it may be concluded that gold in the hanging-wall orebodies occurs as electrum having a composition of about 50% silver and 50% gold. Dr. White reports the presence of native gold in the upper main ore zone, but native gold if present in the hanging-wall orebodies is in insignificant amounts.

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APPENDIX A

Photomicrographs

List of Abbreviations

Py	Pyrite
S	Sphalerite
G	Galena
C	Chalcopyrite
T	Tetrahedrite
Po	Polybasite
A	Argentite
E	Electrum

Figl. Tetrahedrite grains in galena with sphalerite and quartz.

Section: 15-37 Log: 077,162

Microscope :Panphot

Objective: 3b Ocular: 12x

Exposure: 10 sec. Daylight Filter

Plate: Kodak M

Magnification: 175x

Fig 2. Tetrahedrite grains in galena with sphalerite.

Section: 20-27 Log: 111,454

Microscope: Leitz No. 305897

Objective: 3b Ocular: 10x

Exposure: 20 sec Illumination: Leitz 6v 6a
Daylight Filter

Plate: Wratten M

Magnification: 175x

TETRAHEDRITE

Fig 1. Elevation 1450 ft

Fig 2. Elevation 800 ft

Showing a uniformity of grain size and association regardless of depth. Inserts 200 mesh

Fig 3. Polybasite and tetrahedrite in a grain of galena from a super-panner concentrate. The area labelled (1) consists of polybasite and tetrahedrite, the polybasite being recognizable only under crossed nicols.

Section: 20-7-T Log: 033,436
Microscope: Panphot
Objective: 8mm oil immersion Ocular: No.2
Exposure: 3 sec. Double Daylight Filter
Plate: Kodak M
Magnification: x135

Fig. 4. Isolated grain of polybasite in galena.

Section: 20-22 Log: 164,537
Microscope: Leitz No. 305897
Objective: 6a oil immersion Ocular: 10x
Exposure: 20 sec. Plate: Kodak M
Illumination: Leitz6v,6a
Magnification: x500

POLYBASITE

Fig 3.

Fig 4.

Showing the intimate association with galena.

Inserts 200 mesh.

Fig. 5. Polybasite in galena with quartz from section of ore from No.4 Level.

Section: 6-37 Log: 200,163

Microscope: Panphot

Objective: 3b Ocular: No2

Exposure: 7 sec.

Plate: Kodak M

Magnification: 57x

Fig 6. Argentite in galena from section of ore from No. 4 Level.

Section: 10-37 Log: 691,079

Microscope: Panphot

Objective: 3b Ocular: No.2

Exposure: 7 sec

Plate: Kodak M

Magnification: 110x

POLYBASITE AND ARGENTITE

Fig 5.

Fig 6.

Showing typical association and grain size in sections from the upper levels. (Elev 1365 ft)

Fig 7. Grains of electrum in galena with quartz and pyrite.

Section: A-37 Log: 144,040

Microscope: Panphot

Objective: 3b Ocular: 12x

Evposure: 3 sec. Daylight Filter

Plate: Kodak M

Magnification: x300

Fig 8. Electrum grains with galena associated with quartz and pyrite.

Section: 18-37 Log: 080,033

Microscope: Panphot.

Objective: 3b Ocular: No.2

Exposure: 3 sec Daylight Filter

Plate: Kodak M

Magnification: x90

ELECTRUM

Fig 7. (Elev 1420)

Fig 8. (Elev 1260)

Showing typical occurrences of electrum in the main ore zone.

Fig 9. Electrum with galena in fractured pyrite, from section of ore from the hanging-wall orebodies.

Section: 20-30-B Log: 071,082

Microscope: Panphot

Objective: 3b Ocular: No.2

Exposure: 3 sec. Double Daylight Filter

Plate: Kodak M

Magnification: x100

Fig 10. Coarse, well formed intergrowth of chalcopyrite in sphalerite.

Section: 10-37 Log: 142,198

Microscope: Panphot

Objective: 8 mm oil immersion Ocular: No.2

Exposure: 10 sec.

Plate: Kodak M

Magnification: x175

Fig 9. (Elev 980)

Fig 10.

APPENDIX B

Notes Describing Polished Sections

1 Super-panner products from table concentrates of ore from the hanging-wall orebodies.

3-2 Estimated to be 75% pyrite, 10% sphalerite, 10% galena, and 5% chalcopyrite. Grains average 100 - 200 microns in diameter.

2-2 Mostly galena with a few pyrite grains and electrum. Two distinct colors of electrum show. Electrum grains are 25 to 240 microns in diameter.

3-1 Mostly electrum showing at least two colors. Grains are 10 to 400 microns across.

4-2 Estimated to be 70% electrum, 30% galena. Electrum is associated with galena. Grains of electrum are 5 to 100 microns across.

4-3 Galena with light colored grains of electrum most of which are less than 50 microns across.

2-3 Mostly galena with some pyrite and electrum grains averaging 100 to 200 microns across.

20-7-T This section was made from a galena tip from sample A (+65 mesh) described in Table 1. Section mostly galena, some pyrite and electrum. Galena contains tetrahedrite and polybasite (Fig.4)

II Sections from specimens collected in 1947.

20-30-A (9c stope, elev. 980 ft.) Large areas of sphalerite containing pyrite crystals 2 mm. across and some isolated grains of galena. Most galena occurs around pyrite grains. Little chalcopyrite, no tetrahedrite or electrum.

20-30-B Equal amounts of sphalerite and pyrite with less galena and quartz.

20-30-C Pyrite grains are less than 1 mm across. Sphalerite is widely replaced by galena. Some sphalerite contains chalcopyrite blebs but late chalcopyrite is also present.

20-30-D Very similar to 20-30-A. Electrum in galena in a fracture in a pyrite crystal occurs at 125, 490.

20-18 (9D stope, elev. 980 ft.). Relatively high quartz and chalcopyrite content. Galena occurs replacing pyrite and sphalerite and in quartz. Galena contains odd grains of tetrahedrite.

20-18-A Similar to 20-18. Chalcopyrite occurs in sphalerite as well as in galena.

20-18-B Pyrite and sphalerite widely replaced by galena. Sections numbered 18 are noticeably similar.

20-27 (789 Dr. elev. 800 ft.). Pyrite and sphalerite replaced by galena. Pyrite grains average 1 mm across.

Galena-sphalerite contacts are irregular or feathery. Late chalcopyrite appears to replace sphalerite.

20-22 (781 stope elev. 900 ft.) Almost pure galena but containing isolated minute grains of chalcopyrite, tetrahedrite and polybasite.

20-21 (781 stope elev. 900 ft.) Many isolated grains of pyrite in galena and sphalerite. Section contains no silver minerals and little chalcopyrite.

20-19 (781 stope elev. 900 ft.) Mainly isolated grains of pyrite in quartz with some sphalerite but little galena.

20-11 (9E stope elev. 980 ft.) Pyrite grains surrounded by quartz which is replaced by sphalerite and this in turn is somewhat replaced by galena. Sphalerite contains many blebs of chalcopyrite.

20-7 (10 L stope elev. 1140 ft.) Contains much chalcopyrite in galena but little in sphalerite. Pyrite is widely replaced by galena, sphalerite, and chalcopyrite which form rounded inclusions in it. Dark electrum (?) occurs in pyrite grains and as odd minute grains in galena with sphalerite.

F-2 (10 L stope elev. 1140 ft.) Pyrite similar to that in 20-7. Section high in sphalerite and relatively high in chalcopyrite. Galena contains abundant tetrahedrite.

<u>III</u> Sections from specimens collected in 1937 and 1938 by Dr. White.

1-37-A Mostly pyrite grains surrounded by quartz and containing small amounts of galena and sphalerite.

1-37 Similar to 1-37-A but contains more galena and chalcopyrite. Galena contains tetrahedrite grains 50 microns across.

5-37 Mostly fractured pyrite grains surrounded by quartz and a little sphalerite.

6-37-A Pyrite replaced by galena and sphalerite and sphalerite replaced by galena. Galena contains grains of polybasite about 0.5 mm. across.

6-37-B One end consists of massive pyrite cut by quartz stringers. The other end shows sphalerite and a little galena surrounding pyrite.

A-37 Relatively high sphalerite content. Sphalerite and galena replace pyrite grains. Many grains of electrum throughout the section. Most grains are in galena but some are in quartz. One quartz veinlet cuts completely across the sulfides.

10-37 Argentite occurs as grains in galena with quartz and sphalerite. Sphalerite and chalcopyrite form coarse intergrowths.

11-37 Similar to 1-37

12-37 Mostly quartz containing few pyrite grains and cut by veinlets of galena sphalerite and chalcopyrite.

15-37 Pyrite widely replaced by galena and sphalerite. Galena contains grains of tetrahedrite.

17-37 Mostly pyrite grains in quartz with little galena, sphalerite, and chalcopyrite.

18-37 Shows a good sequence of deposition. Abundant electrum mostly with galena but some as inclusions in pyrite or in quartz.

20-37 Alternating sphalerite, pyrite and quartz bands. Quartz intricately veined by galena.

21-37 Mostly pyrite grains in quartz with little galena and sphalerite.

22-37 Similar to 21-37. Sphalerite contains large inclusions of chalcopyrite.

25-37-A Large pyrite grains in quartz fractured and filled with galena.

25-37-B Mostly quartz, but galena contains large areas of polybasite and pyrite grains are replaced by electrum.

26-37 This section shows well the sequence of deposition. Pyrite on one side is fractured and surrounded only by quartz.

In other places quartz and pyrite are fractured and surrounded by sphalerite, and in others sphalerite is fractured and replaced by galena.

27-37 Mainly finely broken pyrite in quartz.

28-37 Mostly quartz containing coarse pyrite. The sphalerite which does exist is replaced by many galena veinlets.

29-37-A Mostly quartz with irregular stringers of galena, sphalerite and a little chalcopyrite.

29-37-B Pyrite fractured and surrounded by quartz, sphalerite and galena. Sulfides replace pyrite to some extent.

32-37 Pyrite with abundant galena and sphalerite showing rounded contacts and replacing pyrite. Galena contains tetrahedrite.

8-38 Quartz contains long narrow veinlets of native silver with galena and argentite. Massive sulfides contain some electrum in galena and also native silver.

9-38 Mostly large pyrite grains slightly replaced by galena, a little sphalerite, quartz and in at least one place by electrum.

10-38 Rounded pyrite and fractured quartz grains in galena. Section contains little sphalerite and chalcopyrite but some tetrahedrite.

13-38 Mostly large pyrite grains surrounded by galena and quartz.