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PRELIMINARY REPORT ON THE MINERALOGY
OF THE
SILBAK-PREMIER MINE

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for credit in the
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INTRODUCTION.

This short report is based on the microscopic examination of a suite of Silbak ores, the individual specimens of which are believed to be fairly representative of the ore-bodies from which they were obtained. Below is given data relative to the suite:

No.	Location	Co-ordinates		Elev	AV. Assay		AG Au.	Remarks.
		N	E		AU.	AG.		
15	13-B. st.	6100	5900	1450	0.26	9.36	36	
16	"	"	"	"	-	-	-	From str. with free electrum
12	1304-Dr.	5950	5650	1350	0.56	15.3	27	
20	12-A. st.	6000	5600	1260	0.26	2.73	10	
22	1070 Lev	6000	5500	1070	0.25	1.50	6	only spec from zone in tuffs.
A	13-C. st.	6400	6250	1450	(56	300)	(6)	Shows no free electrum
9	1328-S1 H-Hw X0	"	"	1400	-	-	-	Shows bunches of ruby silver

It may here be noted that specimens of the average ore, that is, Nos. 15, 12, 20, and 22 lie about on a vertical plane over a vertical range of nearly 400 feet.

These specimens and data were obtained thru the courtesy of the Mine Management. Acknowledgment is also made to Dr. H. V. Warren, Department of Geology and Geography, University of British Columbia, for his many helpful suggestions and opinions.

LOCATION:

The property, a consolidation of the former B.C. Silver, Premier, and Sebakwe holdings, comprises some 70 claims

on the westerly slope of the Bear River Ridge, about 15 miles from the town of Stewart at the head of the Portland Canal, in northern British Columbia.

GENERAL GEOLOGY:

The district lies on the Eastern Contact of, and within the Petrographic Province of the Coast Range Batholith. On the Silbak property, the two rock types of economic importance are the tuffaceous member of the Bear River Series, and the Premier Porphyry.

The tuff is a fine-grained fragmental rock of a greenish color, badly altered and sheared so as to obliterate any bedding-planes. It strikes North-westerly and dips 45° S. thus forming the general slope of the ridge.

The premier Porphyry is a greenish-grey intrusive rock of about the composition of a Quartz Diorite. Phenocrysts of an intermediate plagioclase are typical of the unaltered rock, but in the majority of cases this characteristic is not evident.

It is generally considered that the Porphyry intrusion took place in Late Upper Jurassic Time, and hence somewhat antedates the major batholithic intrusion. There is evidence to suggest that intrusion was along bedding-planes of the tuff^I. The Porphyry - Tuff contact is very irregular, striking roughly East of North and dipping 55 to 80 degrees N. Roof pendants of tuff in the porphyry with a general N-W strike are quite common.

LOCALIZATION OF ORE-BODIES:

The ore-zones are of the siliceous replacement type. Replacement took place along two intersecting fracture systems which developed subsequent to the porphyry intrusion and also subsequent to the tilting of the strata. The porphyry, when it fractured, being the more competent rock, afforded easy access to mineralizing liquids. Consequently, the ore-zones are found principally within the porphyry, generally not far from the contact. In the Premier Mine, the ore-bodies were found along both the Northeast and Northwest zones, being particularly productive in the vicinity of the intersection; but much of the Northwest zone has been removed by erosion so that in the present mine, only the Northeast zone is of importance. Here, altho the ore-bodies are localized in the Northeast fracture system, they are offset along the strike of the Northwest set, that is, to the left; and it may be that these fractures exert structural control over localization as did certain pre-mineral dykes in the old Premier workings.

MINERALOGY OF THE ORE:

Silbak-Premier is of the Gold-silver sulphide type, averaging about 15% metallics, with the values varying roughly as the metallic content. The principal sulphides, in order of abundance, are Pyrite, Galena and Sphalerite, with minor amounts of Chalcopyrite and silver sulphides.

PYRITE occurs as irregular fragments, varying in

size from one or two millimeters down to a few microns. Very often the grains are badly fractured with other minerals filling the fractures. In contact with sphalerite, the pyrite usually exhibits corroded borders.

SPHALERITE appears under the microscope as a dark-grey mineral with a pitted surface. In contact with pyrite, the very irregular borders indicate replacement of the latter. Its exact genetic relation to galena is not obvious. Altho it generally shows the mutually rounded borders in contact with galena which are considered evidence of contemporary deposition; some sections of massive sphalerite have minute inclusions of chalcopyrite and galena, while other sections show an apparent veining of sphalerite by galena. It is probable that there was some range in the periods of deposition and hence some overlapping of generations.

GALENA is found healing fractures in pyrite, quartz and calcite. In gangues of quartz and/or calcite, galena occurs, with or without sphalerite, in irregular, rounded, or aborescent forms. This structure is such as to negate any conclusion that all the quartz was deposited prior to the base metallics.

CHALCOPYRITE is present in minor but persistent amounts, occurring as minute, rather euhedral grains in sphalerite, but more commonly, as somewhat larger rounded particles, invariably in very intimate association with galena. In one section, fractures in quartz not over a few microns in width were filled with alternating grains of chalcopyrite and galena.

PYRRARGYRITE was found in only one section. Here it occurs as irregular, rounded masses or as discrete grains, having mutual boundaries with galena and sphalerite in a gangue of quartz and calcite: (Fig.7).

ARGENTITE was observed in several sections as small rounded grains, nearly always intimately associated with galena and generally also in contact with chalcopyrite. This appears to be the characteristic mode of occurrence of argentite.(Fig.6).

ELECTRUM. Microscopic examination of Specimen A (Fig.10) disclosed the presence of electrum. It appeared as a pale yellow mineral, distinguished from chalcopyrite by its mottled surface and by etch tests. A slight effervescence with HCl indicates that its gold content is about 30%. Below are given the typical modes of occurrence of electrum in Silbak ore:

1. As irregular veinlets, filling quite wide fractures (say up to 30 microns in width) in pyrite, if the same fractures are also occupied by a base metal sulphide, notably sphalerite. No example could be found of electrum, alone, filling fractures in pyrite.
2. As irregular, somewhat equi-dimensional grains up to 50 microns in diameter, deposited in fractures between pyrite and quartz, or in quartz alone, but in all cases being closely surrounded by galena and/or sphalerite.
3. As veinlets filling extremely fine fractures in quartz. Here the width of the fractures seems to be a controlling factor, the maximum being of the order of 1 or 2 microns.

GANGUE MINERALS-QUARTZ AND CALCITE: The introduction of ore liquids into a replacement zone already filled with highly siliceous material, must have been accompanied by solution and subsequent re-crystallization of existing silica. It seems improbable that much, if any, additional silica was introduced with the ore liquids.

Consequently, it is not surprising to find that the quartz has an apparent "period of deposition" extending from the first introduction of iron-bearing solutions to after the deposition of the base metal sulphides. What appears to be, in the section, other later generations of quartz, is in reality a re-crystallization of the original zone material; and this process of solution and re-crystallization necessarily paralleled the deposition of the sulphides.

Some sections contained minor amounts of calcite which occurs as irregular, rounded masses and dendritic stringers in the quartz with which it exhibits quite mutual relations. This mode of occurrence strongly suggests residual deposition

(Fig. 7.)

PARAGENESIS OF THE ORE:

To work out completely the paragenesis of a complex sulphide ore requires minute examination of many sections, coupled with other lines of attack. The course of crystallization of any particular mineral may be influenced by various factors; re-working of fractures with consequent large differential pressures, such as undoubtedly occurred in this instance, would tend to cause some over-lapping of the various periods of deposition. In offering the following paragenesis, only the general relations can be established and some idea of the history of the ore deduced therefrom.

1. Solution of original zone material with the deposition of pyrite.
2. Fracturing of the pyrite and filling of the fractures by quartz.
3. Further fracturing of both pyrite and quartz, accompanied by the re-solution of some silica.
4. Deposition of the base metal sulphides and silver sulphides, probably over an appreciable period, accompanied by fluctuating re-solution and re-crystallization of siliceous material.
5. Contemporaneous or slightly later deposition of electrum in fractures in pyrite or quartz.

GENERAL CONCLUSIONS AND OBSERVATIONS:

Type of Deposition:

The ore at Silbak-Premier is entirely of primary origin. Evidence of any supergene enrichment is quite lacking, at least over the range from El. 1450' to 1070'.

Criteria required for the localization of ore-bodies:

1. A major structure which would influence the random mineral-bearing liquids to localize as sulphide bodies. This was provided by the NE - NW fracture system, briefly described under "Localization of ore-bodies."

2. A minor structure which could cause electrum to concentrate within these sulphide bodies. This took the form of repeated fracturing along the strike of the main system which accompanied mineralization. In this connection it is the fracturing after the deposition pyrite which is of greatest importance.

3. The early-formed mineral, that is, pyrite, when fractured had to be of sufficient competency to retain its fractures even when influenced by later deformative strains.

4. The presence of two mineral surfaces in these fractures is necessary. A partial filling of either sphalerite or galena will fulfill this requirement. There is here a strong suggestion that electro-chemical action was instrumental in causing deposition of electrum.

The variation of the Silver-Gold Ratio:

In general, the ratio of silver to gold gradually decreases as greater depth is obtained. This is not because the composition of the electrum is changing; it is because the content of silver sulphides in the ore decreases with depth.

The importance of temperature gradient:

Over a vertical range of 400 feet no change could be detected in the mineral associations. Hence it is believed that, over this range at least, the temperature gradient was quite insignificant. If we accept the hypothesis of the deposition of gold and silver by electro-chemical action from colloidal suspension, we further decrease the importance of temperature; and this hypothesis is certainly deserving of further consideration.

That certain heavy sulphide bodies on the lower levels of the mine are very low-grade, does not prove that temperature conditions were too extreme for the deposition of electrum. Examination of these ores would disclose that, for one reason or another, they had escaped later fracturing and so fail to satisfy the criteria given above.

The silver sulphides have a place in the normal deposition cycle, and on the basis of factual evidence alone, their variation with depth can only be attributed to temperature gradient.

In conclusion, the writer offers his opinion that in the Silbak-Premier Mine, structure is of great importance. If other structures can be located which satisfy the conditions as outlined, whether they be at lower elevations or farther along the strike of the NE zone, such structures will contain commercial ore-bodies.

APPENDIX

Descriptions of sections - Drawings and
Photographs of Mineral Associations

x100

Fig. 1.

Fig. 2.

Spec. #22 - 1070 Level.

Fig. 1. illustrates the early fracturing of Pyrite (yellow), the filling of the fractures by Quartz (white), and the later fracturing of both quartz and pyrite, with galena coming in to fill the later fractures.

Fig. 2. is a section further along the same line of fracture and shows Sphalerite (brown) as well as some galena (blue) invading the later fracture.

x 250

Fig. 3.

Spec. #15 - 13 - B. Stope

This photograph shows a large grain of Pyrite (yellow) being replaced along its boundaries by Sphalerite (brown). It also indicates the mutual boundary relationship of sphalerite and galena (blue).

x 50

Fig. 4.

Spec. #12. - 1304 Drift.

This photograph shows Galena (blue) filling fractures in Pyrite (yellow) and Quartz. This is a typical relationship observed in all sections.

x 120

Fig.5.

Spec. #20 - 12 - A stope.

Showing minute grains of Chalcopyrite (red) in Sphalerite. The grains have rather euhedral outlines and appear to have a similar orientation.

This section also shows an excellent example of replacement of Pyrite by Sphalerite.

x30

Fig. 6.

Spec. #12 - 1304 Drift.

Illustrating the intimate and mutual association of Galena (blue), Chalcopyrite (red), and Argentine (grey), all being later than Pyrite (yellow).

x30

Fig. 7.

Spec. #9 - 1328 sub-level W - Hw. Ic.

Pyrargyrite (red) appears to be contemporaneous with Galena (blue) and Sphalerite (brown). The very irregular grey material is Calcite, which is the same general age as the quartz but has the appearance of being a residual product of the silica crystallization.

x30

Fig. 8.

Spec. #16 - 13-B stope.

This figure is given to illustrate a condition found to a less marked degree, in all sections. It is the existence of a structural pattern to which the ore minerals have a tendency to conform. This figure suggests that the larger structure which controls the localization of ore-bodies, may be repeated within the ore-bodies where it may control the mineral deposition, and hence it may be the deciding factor in the economic possibilities of a given ore-body.

This figure also shows an interesting occurrence of galena and chalcopyrite as minute fissure fillings.

x30

Fig. 9.

Spec. #20 - 12-A stope

Illustrating the mutual relationship of Galena (blue) and Sphalerite (brown) in a gangue of quartz. The sulphides do not appear to be simple fracture fillings; there is a strong suggestion that some of the quartz has been dissolved (by means of the differential pressures of which the fractures are evidence). Then the metallics were deposited and the quartz re-crystallized.

x100

Fig. 10.

Spec. A. 13-C stope.

Photographs illustrate the occurrence of electrum in the normal ore. The electrum occupies fractures in Pyrite and quartz in the left-hand picture and between Galena and Pyrite in the right-hand one. Other sections in the same specimen showed much smaller veins of electrum in Pyrite but always with Sphalerite or Galena. This appears to be its typical association.

In the photographs, the Pyrite is colored yellow, the Galena, blue, the sphalerite, brown, and the electrum yellow outlined in ink.

THE RELATION OF SILVER TO GOLD IN SILBAK-PREMIER ORE

A mechanical investigation, using the Haultain, "Super-Panner" & "Infra-Sizer"

March, 1938

by W. H. White

Object:

It has long been known that the gold at Premier occurs as "Electrum", which is the name given to any natural alloy of gold and silver. Several investigators of the ore occurrences at Premier have noted that the ratio Ag/Au decreased with depth; and they have attributed this to the changing composition of the electrum.

The natural conclusion drawn from this was that ore-deposition was controlled by the temperature of deposition, i.e., at some concentration of gold with respect to silver in the mineralizing "solutions", the "freezing-point" of the alloy would be too high to allow deposition. Such a condition would automatically limit ore-deposition in a vertical direction. A.H.Means, in an early report to the Premier Gold Mining Co., concluded that this "Critical Horizon" was approximately 150' below #4 level, that is, at an elevation of about 1200'. Below this horizon, it was inferred that physico-chemical conditions were such as to prevent deposition of ore, and consequently little prospecting has been done at the lower elevations.

With the aid of the new Haultain equipment it has been possible to mechanically analyse specimens of ore from various elevations and to obtain information as to the relation of silver to gold, and as to the composition of electrum.

Conclusions:

The results of two pairs of analyses are tabulated below. They are so clear-cut and definite, that despite the fact that only four specimens from three elevations were available, this investigator feels no hesitation in setting out the following conclusions:

1. The gold and silver occur in the primary ore:
 - (a) As electrum with a constant composition of about Au 50%, Ag 50%, over the investigated range of 470' vertically.
About 80% of the electrum particles appear to be over 25 microns in size.
 - (b) The remainder of the silver is present as silver sulpho-salts, such as argentite, ruby-silver, and allied minerals.
2. These silver minerals do tend to disappear with depth, and this accounts for the decrease of the Ag/Au ratio with depth.
3. Galena, when pure, carries little, if any, silver. A rough calculation from these results indicates a content of 2.5 Oz. Ag. per ton of pure galena.
4. In the case of the gold alloy, thermal conditions had no significantly different effect at the lower elevations; and there is no apparent physico-chemical reason why deposits containing electrum should not be found at still lower elevations.
5. In the case of the silver sulpho-salts - these may be expected to decrease in quantity at greater depths. Deposition over a short vertical range is the normal mode of occurrence of these minerals.

TEST # 2 - Using - 200 mesh feed for the "Infra-Sizer "

The pair of samples used for comparison in this test were:

SPM #29 - from sill of 15-A Stope - Elevation 1550'
 SPM #31 - 1814 Drift - " 1820'

	Cpt No	Size range in Microns	Wts. Gms.	Total Content Mg		Ag/Au	Distribution %	
				Au	Ag		Au	Ag
FEED SPM #29	-	-73	100	1.42	31.65	22.6	100	100
PRODUCTS SPM #29	1	-73 / 65	19	0.86	5.42	6.3	61	17
	2	-65 / 50	23	0.20	5.17	26.0	14	16
	3	-50 / 40	16	0.12	4.02	34.3	8	12
	4	-40 / 25	10	0.07	3.49	50.0	5	10
	5	-25 / 10	9	0.07	3.69	53.8	5	11
	6	/ -10	12	0.06	4.78	80.0	4	13
	7	-3	11	0.04	3.96	96.5	3	11
FEED SPM #31	-	-73	100	3.73	165.70	45.4	100	100
PRODUCTS SPM #31	1	-73 / 65	9	1.75	32.25	18.4	47	19
	2	-65 / 50	21	0.50	22.55	45.1	13	14
	3	-50 / 40	18	0.40	19.65	49.2	10	12
	4	-40 / 25	13	0.33	20.23	63.3	9	13
	5	-25 / 10	12	0.28	19.70	70.4	8	12
	6	-10	12	0.24	21.31	88.7	7	13
	7	-3	15	0.23	28.00	121.8	6	17

Weighted corrections: #29 Au - 0.03mg Ag -1.22mg
 #31 - 0.28 -5.00

This test reveals the same conditions as did test #1; grinding the ore has resulted in a re-distribution of the silver and electrum, which could not happen if the bulk of the silver were present as the alloy.

CONFIRMATORY TEST FOR THE COMPOSITION OF ELECTRUM

The first three products of each sample were panned. Due to the close sizing obtained by the Infra-Sizer, it was possible to separate pure electrum # . The analyses of these metallic tips were as follows:

SPM		mg. Au	mg. Ag.	Ag/Au
#29	- Electrum from the first three products	0.34	0.38	1.10
#31	- " " " " " "	0.20	0.20	1.00

- Examination of the electrum concentrates disclosed that #31, was very pure, whereas #29 contained a slight amount minute dark grains. It is probable, then, that the ratio 1.00 is more nearly correct.

TEST #1 - Using screen-sized feed for the "Super-Panner"

Feed Analysis

Sample No.	Location	Elev.	Assay - Oz		$\frac{Ag}{Au}$	Screen Sizes of feeds	Content		$\frac{Ag}{Au}$	Distrib. %	
			AU	AG			AU	AG		AU	AG
SPM #1 A B C D	13-E St.	1350	0.94	9.62	10	- 70 +100	16.90	51.0	3.0	39	10
						-100 +150	12.85	80.6	6.2	30	15
						-150 +200	5.57	52.5	9.6	13	11
						-200	8.16	314.	37.8	18	64
SPM #32 B' C' D'	Col 1802 -A Rse.	1820	1.88	100.4	53	-100 +150	7.57	241.	32.0	26	9
						-150 +200	7.64	424.	55.5	26	17
						-200	14.20	1879	130.	48	74

Product Analysis

No	PBS / tip (Elev)			FeS ₂			Conc. FeS ₂ -ZnS Mid			SiO ₂ -sl Sulph			Slimes		Totals		
	Content		$\frac{Ag}{Au}$	Content		$\frac{Ag}{Au}$	Content		$\frac{Ag}{Au}$	Content		$\frac{Ag}{Au}$	Content		$\frac{Ag}{Au}$	AU	AG
	AU	AG		AU	AG		AU	AG		AU	AG		AU	AG			
A	4.70	9.68	2.08	2.25	9.24	3.6	0.29	2.99	10.6	0.12	4.4	36.7				89	99
B	2.45	6.76	2.43	0.80	8.26	10.7	0.19	3.88	20.4	0.14	4.7	34.0				82	88
C	2.02	7.16	3.54	0.50	7.05	14.1	0.13	4.60	35.5	0.03	3.0	100.				88	77
D	1.20	8.62	7.20	0.30	9.10	30.4	-	-	-	0.11	6.3	57.3	0.22	27.0	123	98	92
B'	4.62	10.4	2.25	1.79	33.6	18.8	-	-	-	1.34	141.	105.				85	83
C'	2.00	6.46	3.23	1.34	66.9	50.0	-	-	-	2.04	185.	92.				79	80
D'	1.21	8.90	7.35	1.55	148.	95.5	-	-	-	1.35	151.	111.	4.27	458.	110	77	79

Notes:

The gold and silver are expressed as total content in milligrams
 The position of a particle on the panner surface is a function of its SG &

its surface. The normal position of argentite would be near the tip, but owing to its breaking finer than galena, it tends to collect with the lower density products; hence, the tip, in the coarse feeds, consists of nearly barren galena and electrum. However, in the -200 mesh feeds where the size difference is less the argentite tends to take its proper position, thus increasing the Ag/Au in the higher density (tip) products.

2000

Carrying .014

oz gold per ton, A 10,000 gram representative sample, was first tilled and the concentrate amounting to 1.78% by weight obtained. This concentrate was then supermilled and four products obtained. These ~~were as follows.~~

~~1. Tip~~

Paragraph beginning Table 1.

	of the gold.		
	% Weight of Total Sample.	Gold Content of per ton	% distribution of gold
1) Tip including some silica.	.00(1)	233.3	16.7
2) Clean arsenopyrite.	.05	10.49	37.5
3) Pyrite and a little arsenopyrite.	.20	1.52	21.7
4) Sphalerite, quartz and fine sulfides	1.53	.07	7.6
	<u>1.78</u>		<u>83.5</u>

A 10,000-gram representative sample of the tailing,

carrying 0.014 oz. gold per ton, was treated, and four sulphide products were obtained, ^{and} together with a tailing consisting ^{largely of slimes.} ~~largely of slimes.~~ ^{of considerable quantity of quartz and iron oxides.} ~~of considerable quantity of quartz and iron oxides.~~

Table 1 gives, for each of the four products, its percentage weight of the total sample, its gold content in ounces per ton, and the percentage it contained of the total gold of the original sample, i.e., the percentage distribution of the gold.

calculated from data in first two columns, combined superpanner concentrate carries 3.51 oz. gold per ton, which is impossible

TABLE 1

Superpanner Product	% Weight of Total sample	Gold Content (oz. per ton)	Percentage Distribution of Gold
1. ^{Tip} Largely galena	0.01 .001	27.20	^{233.3} 192-20 11.3 16.7
2. " arsenopyrite ...	0.09 .05	15.20	10.40 57.0 37.5
3. " pyrite	0.41 .20	0.90	1.53 15.3 21.7
4. " sphalerite, with a little quartz ..	0.07 ^{1.53} .07	0.39	.07 1.2 7.6
	0.58 1.78	-	84.8 83.5

This is neglecting 15.2% loss
Taking account of loss, value
is 2.05 oz/t

check Table

16.5

~~Loss~~ losses were thus 15.2 per cent. Calculation will

show that the combined superpanner concentrate carried ~~2.42~~ ^{approximately 66 oz} oz gold per ton.

An error on the table concentrate actually ran 65 oz per ton
The most interesting fact brought out by the test, however, is that the

tip plus

arsenopyrite concentrate, amounting to ~~less than one-tenth~~ ^{about 10th twentieth} of one per cent

of the weight of the original sample, carried nearly ~~sixty~~ ^{forty plus one} per cent of the

gold values.

? omit.
According to
above, infra-
sizer was not
used

Unfortunately

There was not sufficient material available to make super-panner concentrates of the several infrasizer products. It is hoped to undertake this work in the near future.

In another test, a 400-gram sample of Pioneer tailing, carrying 0.015 oz. gold per ton, was sized to plus-200-mesh in a Bell screening machine. The minus-200-mesh material was further sized in the infrasizer and the several products weighed and assayed. The results are shown in Table 2. ✓