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CONCENTRATION AND CYANIDATION TESTS ON A GOLD-SILVER ORE FROM SILBAK PREMIER MINES LTD., PORTLAND CANAL AREA, B. C.

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The valuable constituents of this ore are gold and silver, assaying respectively 0.33 and 24.91 oz/ton. The investigation indicated that these values occur finely disseminated throughout pyrite, the principal metallic gangue mineral present in the ore.

Amalgamation, gravity, flotation and cyanidation tests were run on this ore with the following results:

Test	Procedure	% Recovery	
		Au	Ag
1	Amalgamation	40.1	nil
2	Jigging, flotation and cyanidation of the tailing	97.1	92.2
4	Tabling and flotation	87.6	76.6
	Cyanidation of the concentrates produced	85.6	73.3
6	Flotation	92.2	82.6
	Cyanidation of the concentrate produced	89.0	74.8
14	Straight cyanidation	96.7	93.3

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INTRODUCTION

Shipment and Instructions

A shipment of 60 pounds of gold-silver ore was received on July 21, 1961. It was submitted by Mr. L.P. Starck of Hill, Starck and Associates, P.O. Box 820, Hope, B.C. Mr. Starck indicated that this ore was formerly treated by a cyanidation process, which was later replaced by a combination of flotation and gravity methods.

Location of Property

The property from which this ore originated is the Silbak Premier Mines Ltd., located in the Portland Canal area, B.C.

Sampling and Analysis

The ore received was crushed to minus one inch and a few pieces were selected for mineralogical examination. The remainder was crushed to -10 M and a 2 pound head sample was riffled out by conventional methods for analysis and microscopic examination.

The chemical analysis* gave the following results:

Gold	(Au)	-	0.33 oz/ton
Silver	(Ag)	-	24.91 oz/ton
Iron	(Total Fe)	-	5.09 %
Lead	(Pb)	-	0.12 %
Zinc	(Zn)	-	0.18 %

* From Internal Report MS-61-650 by L. Lutes and H. Lauder, Mineral Sciences Division, Mines Branch, Sept. 7, 1961.

Sulphur	(S)	-	4.94 %
Insoluble		-	73.79 %

A spectrographic analysis* on the head sample detected the following elements listed in their approximate decreasing order of abundance:

I - Si, Ca, Fe, Al.

II - Ba, Mn, Mg.

III - Pb, W, Zn, Na, Ti.

IV - Ag, Mo, Cu, Zr.

MINERALOGICAL EXAMINATION**

A few pieces of the ore and a portion of the head sample were sent to the Mineralogical Section of the Mineral Sciences Division for microscopic examination.

Methods of Examination

A -65 + 200 mesh fraction of the head sample of the ore was separated into fractions by means of heavy liquids and the Frantz isodynamic separator. The resulting fractions were weighed and the minerals comprising them identified by means of microscopical and X-ray diffraction studies.

Seven polished sections of the head sample and the mineral

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* From Internal Report MS-61-491 by A.H. Gillieson, Mineral Sciences Division, Mines Branch, Aug. 30, 1961.

** From Internal Report MS-61-88 by W. Petruk, Mineral Sciences Division, Mines Branch, Sept. 18, 1961.

fractions were prepared and examined under the microscope.

Results

The metallic minerals present in the ore are pyrite, sphalerite, galena and a silver-bearing mineral. The non-metallic minerals are quartz, calcite, chlorite, a clay mineral which is probably illite, and a very small quantity of pyroxene.

Pyrite is the principal metallic mineral and constitutes about 13% of the ore. It occurs as euhedral to subhedral crystals that range between 0.01 mm and 0.7 mm in diameter (see Figure 1) and contains rounded blebs of galena, sphalerite, and the silver-bearing mineral. The galena and sphalerite blebs range up to 30 microns in diameter (see Figure 2), but the blebs of the silver-bearing mineral are only a few microns in diameter and are too small to be positively identified (see Figures 3 and 4). Their optical properties, however, suggest that they may be native silver and/or a silver-gold alloy.

The galena and sphalerite also occur as tiny blebs along the edges of pyrite grains and as irregular shaped grains enclosed in the non-metallic minerals (see Figure 2). These irregular shaped grains range up to 50 microns in diameter.

X-ray diffractometer analysis of the head sample shows that quartz is the predominant non-metallic mineral, but calcite, chlorite, and illite are also present in significant amounts.

No gold was seen in the examination of the polished sections prepared from this ore.

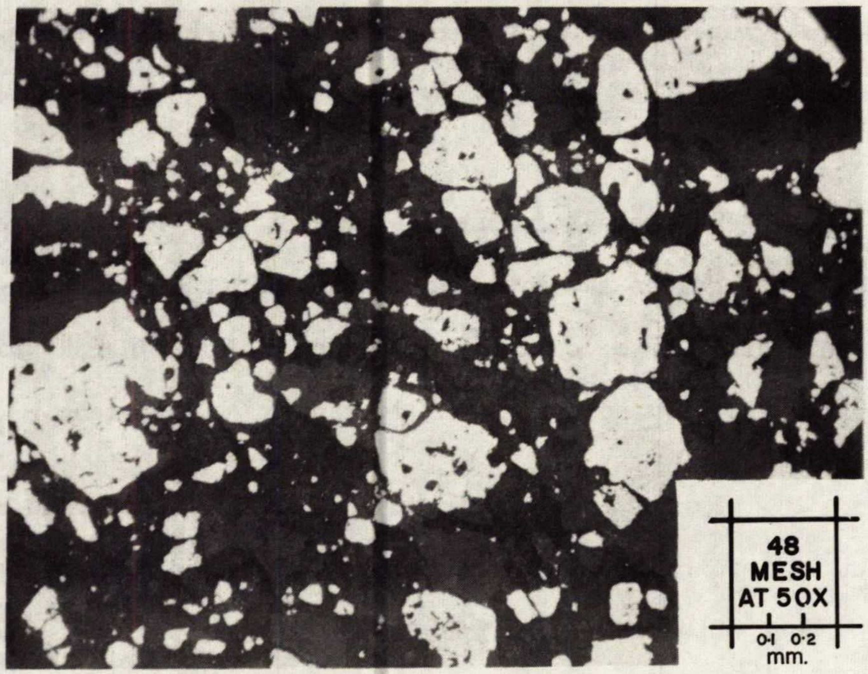

Figure 1. - Photomicrograph of a polished section showing the distribution and grain size of the pyrite.

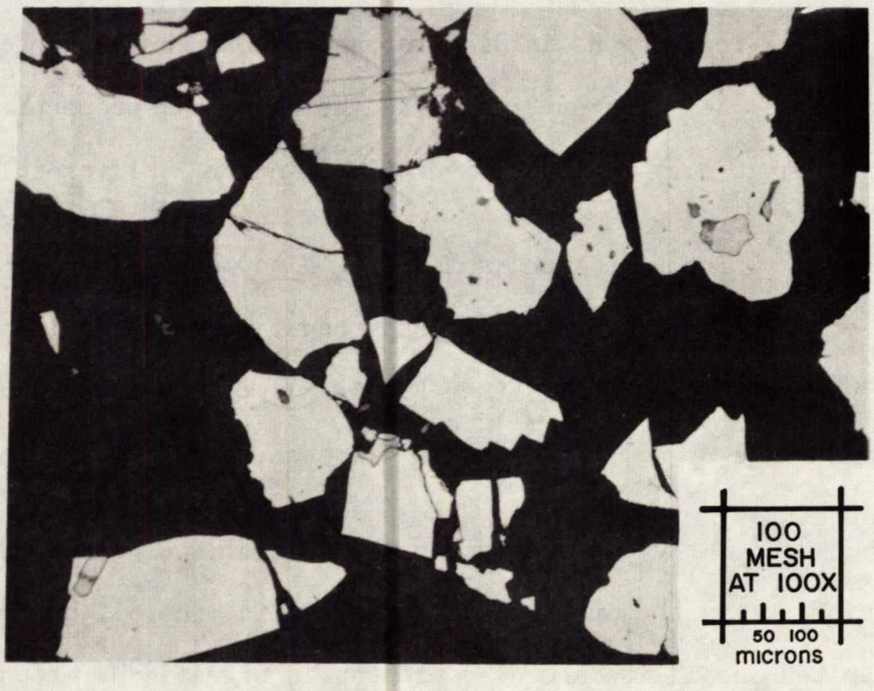

Figure 2. - Photomicrograph of a polished section showing, in addition to free galena, an inclusion of galena in pyrite (right side of photograph) and a few tiny blebs of galena along the edges of the pyrite grains (bottom of photograph).

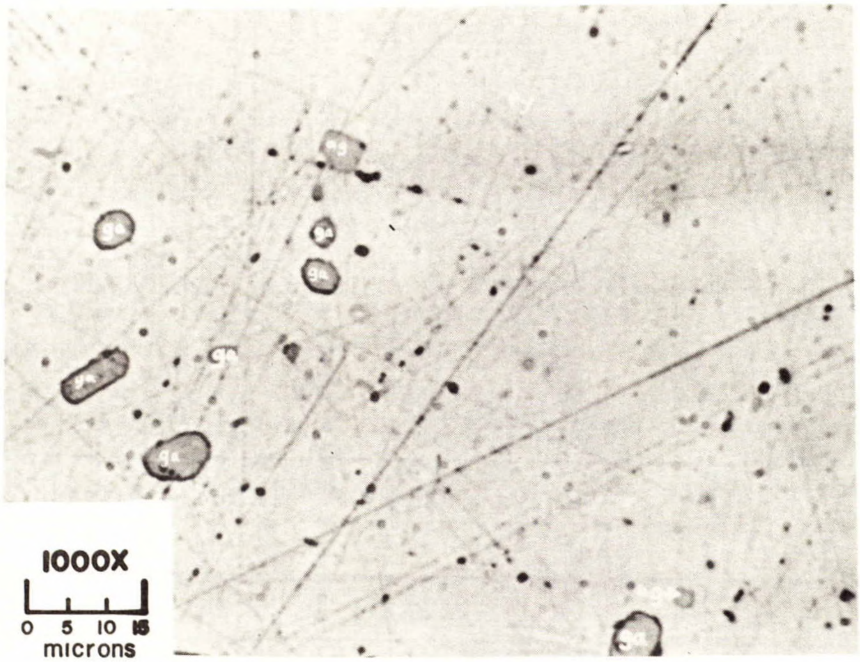

Figure 3. - Photomicrograph of a polished section of pyrite showing inclusions of galena (Ga) and a silver-bearing mineral (Ag).

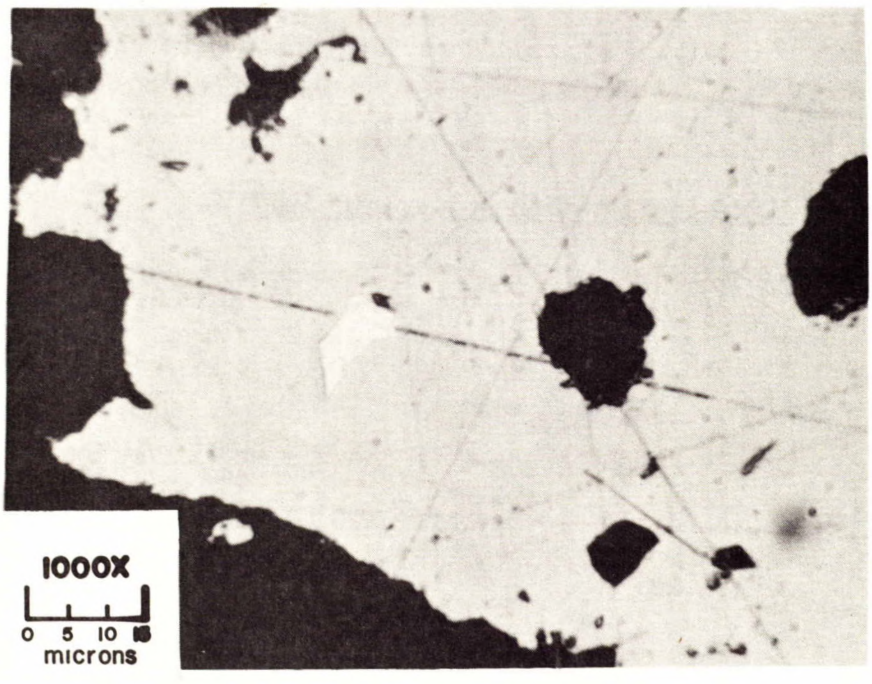

Figure 4. - Photomicrograph of a polished section (white) showing a bleb of silver-bearing mineral in pyrite.

DETAILS OF INVESTIGATION

Test 1, Amalgamation

A 1,000 g sample of ore was ground for 45 minutes to 96% - 200 M and amalgamated with 10 ml of mercury and 1.0 lb of lime per ton.

Results of Test 1

Product	Assays oz/ton		Extraction %	
	Au	Ag	Au	Ag
Residue	0.196	24.53	40.1	nil

This test indicated that at 96% - 200 M only 40.1% of the gold and a negligible amount of silver were free milling. As free milling gold is usually recovered by gravimetric methods in the grinding circuit, jigging and tabling tests were carried out on the ore.

Test 2, Jigging, Flotation and Cyanidation

A 2,000 g sample of ore, crushed to -10 M, was jigged to determine if any free gold could be removed at a coarse size.

To complete the gold and silver extraction, the jig tailing was stage ground to -100 M (74% - 200 M) and floated at natural pH of 8.2 as follows:

Reagents and Conditions

Operation	Reagents lb/ton	Time min
Conditioning	Reagent 301 - 0.10 Aerofloat 208-0.10	3
Flotation	Pine oil - 0.06	10

Results of Jigging and Flotation

Product	Weight %	Assays oz/ton		Distribution %	
		Au	Ag	Au	Ag
Jig conc	3.3	1.60	84.33	16.0	11.1
Jig bed	5.9	0.33	26.33	5.9	6.2
Flotn conc	7.5	2.77	196.04	62.9	58.5
Flotn tailing	83.3	0.06	7.32	15.2	24.2
Feed (calcd)	100.0	0.33	25.14	100.0	100.0

It appears that finer grinding will be necessary to improve the gold recovered by gravity concentration.

The silver contained in the flotation tailing was high enough to justify a cyanidation test. A 1,000 g sample was cut from this tailing and cyanided for 48 hours at a dilution of 2:1, with cyanide and lime strengths of the solution maintained at 1.0 lb/ton and 0.5 lb/ton respectively.

Results of Cyanidation

%-200M	Cyanidation Time hr	CaO Consumption lb/ton ore	NaCN Consumption lb/ton ore	Reducing Power cc $\frac{N}{10}$ $KMnO_4$/l	Residue Assays oz/ton		Extraction %	
					Au	Ag	Au	Ag
74.0	48	2.88	0.80	60	0.01	2.37	83.3	67.6

Overall Extraction of Gold and Silver in Test 2

Procedure	% Au	% Ag
Jigging	21.9	17.3
Flotation	62.9	58.5
Cyanidation of tailing	12.3	16.4
Total	97.1	92.2

Test 3, Tabling and Flotation

A 2,000 g sample, ground to -35 M, was concentrated on a Deister table. The table tailing was stage reground to -100 M and floated at natural pH, using the same procedure as in Test 2.

Results of Test 3

Product	Weight %	Assays, oz/ton		Distribution, %	
		Au	Ag	Au	Ag
Table conc	7.1	2.00	99.24	42.6	27.6
Flotn conc	6.6	2.29	192.38	45.3	49.7
Flotn tailing	86.3	0.047	6.71	12.1	22.7
Feed (calcd)	100.0	0.33	25.53	100.0	100.0

The gold extraction in the table concentrate was 42.6%, but only a small portion of this gold was considered free. The main portion of the gold like the silver, which was not liberated at this fineness of grind, was probably attached to the coarse sulphide particles contained in the table concentrate.

Test 4, Cyanidation of Table and Flotation Concentrates

A table and a flotation concentrate were produced, using the same procedure as in Test 3. The two concentrates were combined.

Results of Tabling and Flotation

Product	Weight %	Assays oz/ton		Distribution %	
		Au	Ag	Au	Ag
Conc	17.5	1.66	107.25	87.6	76.6
Tailing	82.5	0.05	6.95	12.4	23.4
Feed (calcd)	100.0	0.33	24.50	100.0	100.0

Two portions of 100 g were cut from the combined concentrate and each ground to 92.2% - 325 M. The two portions were agitated at a dilution of 5:1 for 48 and 72 hours respectively, with solution strengths of 2.0 lb NaCN/ton and 0.5 lb CaO/ton.

Results of Cyanidation

%-325M	Cyanidation Time hrs	CaO Consumption lb/ton ore	NaCN Consumption lb/ton ore	Reducing Power ccN KMnO4/1 10	Residue Assays oz/ton		Extraction %	
					Au	Ag	Au	Ag
92.2	48	2.17	2.59	280	0.038	5.13	97.7	95.2
92.2	72	2.56	2.80	180	0.038	4.62	97.7	95.7

Overall Extraction of Gold and Silver in Test 4

Procedure	% Au	% Ag
Cyanidation for 48 hrs	85.6	72.9
Cyanidation for 72 hrs	85.6	73.3

Test 5. Straight Flotation

From the tests conducted, it appeared that gravity concentration served no useful purpose in the beneficiation of this ore. To confirm this a 2,000 g sample was ground to -100 M and treated by straight flotation using the same procedure as in Test 2.

Results of Test 5

Product	Weight %	Assays oz/ton		Distribution %	
		Au	Ag	Au	Ag
Flotn conc	12.6	2.32	149.45	85.7	74.2
Flotn tailing	87.4	0.056	7.48	14.3	25.8
Feed (calcd)	100.0	0.34	25.37	100.0	100.0

These results were about the same as was obtained when gravity concentration preceded flotation. Straight flotation using a longer grinding and flotation time might improve the recovery of the gold and silver.

Test 6. Cyanidation of Flotation Concentrate

A 2,000 g sample of ore was ground for 45 minutes to 89% - 200 M and floated at natural pH as follows:

Reagents and Conditions

Operation	Reagents lb/ton	Time min
Conditioning	Reagent 301 - 0.10 Aerofloat 208 - 0.10	5
Flotation	At start: Pine oil - 0.06 After 10 min: Reagent 301 - 0.02 Aerofloat 208 - 0.02	15

Results of Flotation

Product	Weight %	Assays oz/ton		Distribution %	
		Au	Ag	Au	Ag
Flotn conc	17.1	1.72	119.35	92.2	82.6
Flotn tailing	82.9	0.03	5.19	7.8	17.4
Feed (calcd)	100.0	0.32	24.27	100.0	100.0

A 100 g sample was cut from the flotation concentrate and cyanided at a dilution of 5:1 for 48 hours. The solution strength was maintained at 2.0 lb NaCN/ton and 0.5 lb CaO/ton.

Results of Cyanidation

%-200M	Cyanidation Time hrs	CaO Consumption lb/ton ore	NaCN Consumption lb/ton ore	Reducing Power ccN KMnO$_4$/1 10	Residue Assays oz/ton		Extraction %	
					Au	Ag	Au	Ag
89.0	48	0.75	2.24	40	0.06	11.28	96.5	90.6

A regrinding step before the cyanidation should increase the silver extraction over 95%, as in Test 4.

Overall Extraction of Gold and Silver in Test 6

Gold - 89.0%

Silver - 74.8%

Tests 7 to 14, Straight Cyanidation

Eight cyanidation tests were conducted on the ore sample. In each test, a 1,000 g sample of ore was ground in 750 ml of water for periods of 30 to 45 minutes and agitated at a dilution of 2:1 for periods of 48 to 72 hours. Lime and cyanide concentrations were kept at 0.5 lb/ton and 1.0 lb/ton respectively, except in the tests 11 to 14 in which the cyanide concentration was increased to 2.0 lb/ton of solution.

Results of Tests 7 to 14

Test	%-200M	Cyanidation Time hrs	CaO Consumption lb/ton ore	NaCN Consumption lb/ton ore	Reducing Power ccN/10 $KMnO_4$/1	Residue Assays oz/ton		Extraction %	
						Au	Ag	Au	Ag
7	85.5	48	2.40	2.80	80	0.019	3.60	94.2	85.6
8	85.5	72	2.48	3.16	160	0.019	3.12	94.2	87.5
9	96.0	48	2.72	3.36	160	0.015	3.04	95.5	87.8
10	96.0	72	2.84	3.42	140	0.015	2.87	95.5	88.5
11	85.5	48	1.84	3.56	80	0.017	2.83	94.8	88.6
12	85.5	72	2.28	3.56	140	0.017	2.54	94.8	89.8
13	96.0	48	2.44	4.24	180	0.014	2.10	95.8	91.6
14	96.0	72	2.88	4.24	200	0.011	1.67	96.7	93.3

CONCLUSIONS

The ore received consisted of gold and a silver-bearing mineral intimately associated with pyrite (Figures 3-4). Fine grinding will be required to liberate these values from the associated gangue minerals. Barrel amalgamation of the ore, ground to 96% - 200 M, showed that none of the silver and only 40% of the gold was free milling.

A test, in which jigging was followed by flotation, gave gold and silver recoveries of 84.8% and 75.8% respectively (Test 2). The flotation tailing from this test still contained an appreciable amount of gold and silver. Cyanidation of this tailing extracted 83.3% of the gold and 67.6% of the silver.

Tabling followed by flotation gave recoveries of 87.6% of the gold and 76.6% of the silver present in the ore. The tabling and flotation concentrates were combined. Cyanidation of the combined concentrate gave overall gold and silver extractions of 85.6% and 73.3% respectively.

Straight flotation produced a rougher concentrate assaying 1.72 oz Au/ton and 119.35 oz Ag/ton with recoveries of 92.2% and 82.6% respectively (Test 6). This test showed that the gravity concentration step served no useful purpose in the beneficiation of this ore. Cyanidation of the flotation concentrate gave overall extractions of 89.0% of the gold and 74.8% of the silver.

The straight cyanidation appeared the best method for treating this ore. Gold and silver extractions of 96.7% and 93.3% respectively were obtained after 72 hours cyanidation of the ore ground to 96.0% - 200 M.