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INVESTIGATION OF A SAMPLE OF
SILVER-LEAD-ANTIMONY ORE

submitted by

PESO SILVER MINES LTD. (N.P.L.)

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INTRODUCTION

This report describes tests carried out on a bulk sample of ore from the intersection at the junction of 75 west drift and 78 cross cut north, on the Rex vein of Peso Silver Mines Ltd.

The investigation was commenced on July 6 and informal progress reports were issued on August 7, August 11, August 19 and August 28, 1964. Instructions to suspend work were received on October 21, 1964.

SUMMARY

(1) The bulk sample used for testing assayed 30.5 ounces of silver per ton, 6.46% lead, 4.17% antimony, 0.11% copper, 0.73% zinc, and 2.23% arsenic.

(2) After grinding the ore to 80% minus 200 mesh, followed by flotation and two stages of cleaning, a silver-lead-antimony concentrate assaying 0.05 ounces of gold and 160.6 ounces of silver per ton, 31.01% lead, 20.41% antimony, 0.56% copper, 3.25% zinc and 0.75% arsenic was obtained. The silver, lead and antimony recoveries in the final concentrate were 85.1%, 80.8% and 81.8% respectively.

(3) In practice, it is expected that silver, lead and antimony recoveries of at least 92%, 90% and 90% respectively would be obtained in a concentrate assaying about 150 ounces of silver per ton, 30% lead and 19% antimony.

(4) In another test, after grinding the ore to 72% minus 200 mesh, floating the lead, silver and antimony and cleaning the concentrate three times, a separation into a silver and a lead-antimony concentrate was made. The silver concentrate assayed 1215 ounces of silver per ton and the lead-antimony concentrate assayed 25.7 ounces of silver per ton. In practice, allowing for the recirculation of intermediate products, it is expected that 75% of the total silver in the ore could be recovered in a concentrate assaying about 1000 ounces of silver per ton and a further 13% in a concentrate assaying about 27 ounces per ton.

(5) Tests showed that 99% of the antimony in a bulk concentrate could be removed by treatment with sodium sulphide solution. The residue assayed 187.6 ounces of silver per ton, 37.3% lead, 0.27% antimony and 0.78% arsenic. 3.7% of the silver in the concentrate dissolved during leaching, but in practice most of this silver could probably be recovered by a slight modification of the process.

Respectfully submitted,

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ASSAY OF HEAD SAMPLE

Gold	(Au)	0.01 oz. per ton
Silver	(Ag)	30.5 oz. per ton
Lead	(Pb)	6.46%
Antimony	(Sb)	4.17%
Copper	(Cu)	0.11%
Zinc	(Zn)	0.73%
Arsenic	(As)	2.23%
Iron (acid-soluble)	(Fe)	20.93%
Sulphur	(S)	10.77%

DETAILS OF TEST WORK

The work was divided into 3 stages:

- (1) Production of a bulk silver-lead-antimony concentrate.
- (2) Production of separate high-silver and low-silver concentrates.
- (3) Leaching of the bulk concentrate to remove antimony.

(1) Production of a bulk silver-lead-antimony Concentrate.

The best results were obtained in a test (F4) in which the ore was ground in stages to 80% minus 200 mesh, the silver, lead and antimony were floated and the rougher concentrate was cleaned twice.

A scavenger concentrate was taken off from the rougher tailing.

Test results are shown in Table 1.

Table I - Test F4 results

Individual results:

#	Product	Weight %	Assays				Distribution %			
			Oz. per ton Au	Ag	% Pb	% Sb	Au	Ag	Pb	Sb
1	Final concentrate	16.60	0.05	160.6	31.01	20.41*	83.3	85.1	80.8	81.8
2	1st cleaner tailing	5.59	-	15.4	3.71	2.57	-	2.7	3.3	3.5
3	2nd cleaner tailing	4.79	-	53.4	14.67	8.83	-	8.2	11.0	10.2
4	Scavenger concentrate	3.17	-	9.0	2.10	1.69	-	0.9	1.1	1.3
5	Rougher tailing	69.85	-	1.4	0.35	0.19	-	3.1	3.8	3.2
6	Head	100.00	0.01	31.3	6.37	4.14	100.0	100.0	100.0	100.0

* Revised assay.

Cumulative results:

1	Final concentrate	16.60	0.05	160.6	31.01	20.41	83.3	85.1	80.8	81.8
1+3	Concentrate after 1 cleaning	21.39	-	136.6	27.35	17.82	-	93.3	91.8	92.0
1to3	Rougher concentrate	26.98	-	111.5	22.45	14.66	-	96.0	95.1	95.5
1to4	Rougher + scav. concen.	30.15	-	100.7	20.31	13.29	-	96.9	96.2	96.8

Additional assays of final concentrate:

	Recoveries %
Copper	0.56%
Arsenic	0.75%
Zinc	3.25%
Sulphur	18.54%
Total iron	8.96%
Silica	2.23%

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-
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Table 2 - Reagents added:

Point of addition	Pounds per ton of ore				
	Lime (CaO)	NaCN	Z6	Dowfroth 250	Pine Oil
Grind	-	-	-	-	-
Rougher flotation	2.0	0.2	0.22	0.08	0.02
Scavenger Flotation	-	-	0.06	-	0.02
1st cleaning	0.3	-	0.04	-	-
2nd cleaning	0.3	-	0.02	-	-
Total	2.6	0.2	0.34	0.08	0.04

Table 3 - Frothing periods, pH determinations, pulp temperatures and pulp volumes:

Stage	Frothing period- Minutes	pH	Pulp Temperature °C	Pulp volume- Cubic feet per ton of original ore
Rougher flotation	20	9.8-9.1	23	77
Scavenger flotation	5	8.8	24	77
1st cleaning	10	10.0-9.5	21	42
2nd cleaning	10	10.0-9.6	21	42

Comments: High recoveries (95-96%) of the silver, lead and antimony were obtained in rougher flotation. Appreciable losses, however, took place in the second stage of cleaning, due mainly to the presence of middling particles, which would require extremely fine grinding (below 10 microns) for liberation. The sulphide slimes floated slowly and contributed to the losses.

In practice, the scavenger concentrate and cleaner tailings would be recirculated and it is expected that the following results would be obtained when treating similar ore in a full-scale mill:

Anticipated results in full-scale plant:

Weight of concentrate (approx.): 19% of feed

Assay of concentrate (approx.)

Gold	0.05 oz./ton
Silver	150 oz./ton
Lead	30%
Antimony	19%
Copper	0.5%
Arsenic	1%
Zinc	3%
Iron	9%
Silica	3%
Sulphur	18%

Recoveries:

Silver	92% (min.)
Lead	90% (min.)
Antimony	90% (min.)

The chief impurity in the final concentrate was siderite, most of which was intimately associated with jamesonite. Some improvement in the grade might be obtained by regrinding the concentrate before cleaning, but the losses of silver, lead and antimony would tend to increase due to excessive sliming.

(2) Production of separate high-silver and low-silver concentrates.

The best results were given in a test (F7) in which the ore was ground at 65% solids to 72% minus 200 mesh and a bulk silver-lead-antimony rougher concentrate was floated off, followed by a scavenger concentrate. The rougher concentrate was cleaned three times and the cleaned concentrate was conditioned with potassium dichromate in order to depress the galena and jamesonite. Rougher and scavenger silver concentrates were then floated off; the rougher concentrate was cleaned once. Flotation conditions were as follows:

Table 4 - Reagents added:

Point of addition	Lime (CaO)	NaCN	Z6 (1)	Dowfroth 250	Pine Oil	K ₂ Cr ₂ O ₇
Grind	-	-	-	-	-	-
Bulk rougher flotation	2.0	0.2	0.22	0.08	0.02	-
Bulk scavenger flotation	-	-	0.06	-	0.02	-
Bulk 1st cleaning	0.3	-	0.04	-	-	-
Bulk 2nd cleaning	0.4	-	0.04	-	-	-
Bulk 3rd cleaning	0.5	-	0.03	0.01	-	-
Ag rougher flotation	-	-	0.02	-	-	2.0
Ag scavenger flotation	-	-	0.06	0.01	-	-
Ag cleaning	-	-	0.01	-	-	0.5
Total	3.2	0.2	0.48	0.10	0.04	2.5

(1) Potassium amyl xanthate.

Table 5 - Frothing periods, pH determinations, pulp temperatures and pulp volumes:

Stage	Frothing period- Minutes	pH	Pulp temperature C	Pulp volume- Cubic feet per ton of original ore
Bulk rougher flotation	20	9.9-8.9	21	77
Bulk scavenger flotation	5	8.5	21	77
Bulk 1st cleaning	10	9.7-9.0	19	77
Bulk 2nd cleaning	10	9.9-9.1	20	42
Bulk 3rd cleaning	10	10.2-9.7	19	42
Ag rougher flotation	6	8.2-7.5	27	42
Ag scavenger flotation	6	7.8	27	42
Ag cleaning	4	6.9	28	19

Test results are given in Table 6.

Table 6 - Test F7 results

#	Product	Weight %	Ag Assay Oz.per ton	Ag Distribution %
1	Final Ag concentrate	1.65	1215.4	64.6
2	Ag cleaner tailing	0.42	73.6	1.0
3	Ag scavenger concentrate	1.43	85.8	3.9
4	Pb-Sb concentrate	10.83	25.7	9.0
5	3rd cleaner tailing	1.80	91.4	5.3
6	2nd cleaner tailing	3.14	53.0	5.4
7	1st cleaner tailing	11.69	18.2	6.8
8	Scavenger concentrate	9.06	5.1	1.5
9	Scavenger tailing	59.98	1.3	2.5
10	Head (calculated)	100.00	31.1	100.0
10	Head (direct assay)	-	30.5	-

Calculated results:

1+2	Ag concentrate before cleaning	2.07	983.7	65.6
1+2+3	Ag rougher + scavenger conc.	3.50	616.9	69.5
1to4	Bulk concentrate before separation	14.33	170.1	78.5
1to5	Bulk concentrate after 2 cleanings	16.13	161.3	83.8
1to6	Bulk concentrate after 1 cleaning	19.27	143.7	89.2
1to7	Rougher bulk concentrate	30.96	96.3	96.0
1to8	Rougher + scavenger conc.	40.02	75.6	97.5
2+3	Ag cleaner tailing + Ag scavenger concentrates	1.85	83.0	4.9
2to4	Ag cleaner tail.+ scav.conc. + Pb-Sb conc.	12.68	34.1	13.9
3+4	Ag scavenger conc.+Pb-Sb con.	12.26	32.7	12.9

Comments The final silver concentrate assayed 1215 ounces of silver per ton and contained 64.6% of the total silver in the ore. The lead-antimony concentrate (product 4) assayed 25.7 ounces of silver per ton and contained 9.0% of the total silver. The combined intermediate products assayed 27.0 ounces of silver per ton and contained 23.9% of the total silver. Allowing for the recirculation of these products, it is expected that the following results would be obtained when treating similar ore in a full-scale mill:

	<u>Silver concentrate</u>	<u>Lead-antimony concentrate</u>
Weight: % of ore	2.3	14.5
Assay of concentrate: Silver	1000 oz/ton	27 oz/ton
Silver recovery:	75%	13%
Overall silver recovery:		88%
Overall silver assay:		160 oz/ton

Although the results show that a high-grade silver concentrate can be made, it would not be feasible to obtain all of the recoverable silver in this product and the lead-antimony co-product would contain an appreciable quantity of silver.

(3) Leaching of bulk concentrate to remove antimony.

Tests were carried out to determine whether the antimony present in a bulk concentrate could be removed by leaching. Following a preliminary test which showed that the antimony was soluble in alkaline solutions, a test was carried out on a sample of the concentrate from test F4, under the following conditions:

Weight of concentrate taken: 50 grams

Leach solution: 500 ml solution containing 250 grams of sodium sulphide (60-62% Na₂S).

Treatment time: 3 hours

Temperature: Boiling point

Stirring: At intervals, by hand.

Filtration: By vacuum, on Buchner funnel

Washing: Hot water

Filtrate and wash volumes: Filtrate + 1st washes (clear) 600 ml

2nd washes (cloudy) 600 ml

Residue weight (dried): 41.2 grams = 82.4%

Note: Probably due to the finely-divided lead and iron sulphides remaining from the decomposition of jamesonite, the residue ignited spontaneously during drying at 150°F. As a result, its weight would have increased.

Assays of feed and residue:

	<u>Concentrate</u>	<u>Residue</u>
Silver	160.6 oz/ton	187.6 oz/ton
Lead	31.01%	37.31%
Antimony	20.41%	0.27%
Arsenic	0.75%	0.78% (calc.)

The first filtrate and washes assayed 15.88 grams of antimony and 0.09 grams of arsenic per liter.

99% of the antimony present in the concentrate was removed by leaching and 3.7% of the silver also dissolved; the loss of silver could probably be reduced by adding antimony metal to the solution and thereby reprecipitating the silver. The residue assayed 187.6 ounces of silver per ton, 37.31% lead, 0.78% arsenic and only 0.27% antimony.

The recovery of antimony from solution was not investigated. No difficulty is, however, anticipated in recovering it as metal by electrolysis, in the same way as the Sunshine Mining Company formerly recovered antimony derived from tetrahedrite (W.C. Holmes, U.S. Patent No. 2,331,395, October 12, 1943).