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REPORT OF CONCENTRATION TEST ON MONO ORE MILLER RIVER DISTRICT, WASHINGTON

BY

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FELLOW AT SEATTLE STATION, U. S. BUREAU OF MINES.

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The ore for the following test was obtained from the Mono mine, on the Miller River near Berlin, Washington. A description of the property and of the ore is given in my report on the Mono mine.

The tests were made at the School of Mines Mill, University of Washington, in conjunction with the Seattle station of the U.S. Bureau of Mines.

The testing was done to indicate what could be expected from the commercial concentration of this low grade gold, silver-bearing chalcopyrite ore and what process or series of processes promised the best results.

The ore was selected to be as nearly representative of the ore body as possible by the combination of a grab sample broken from the tunnel walls where readily obtainable. While the values may not be taken as being a true average of the exposed ore body, the samples can be depended upon to exhibit the characterization of the ore under concentration treatment. In other words, for purposes of arriving at proper concentration methods for the treatment of the ore body, those samples may be considered representative.

Lot, I is a composite of the samples taken from the upper tunnel, (60") and the lower tunnel, (65") and is representative of the characteristics of the major portion of the exposed ore.

Lot 2, is a sample of the ore occurring in the bottom of a winze from the lower tunnel. The work done with it was to determine if it presented any widely different concentration problems from the other ore represented by Lot 1. Other than being tougher and harder to grind, Lot 2 appeared to act very much as Lot 1 on the tables and in the flotation cell.

All the ore was put through a Sturtevant roll-jaw crusher, and set of rolls and screened over an impact screen to pass 20-mash. The two Lots were then sampled, the assay of the sample being as follows: (page 3)

ASSAYS OF SAMPLES

Samples,	Gold;	Silver;	Copper;	Iron;	Zinc;	Lime;	Sulphur;	Insol.	Alumina	H 2 o.	Manganese	Total less on
	on, per, ton.											
"	Oz.	Oz.	oz.	%	%	%	%	%	%	Igition		Total
Lot I	.04	1.00	1.06	4.60	1.21	1.38	1.39	83.4. Silion				93.8.
Lot 2	.03	1.25	1.61	21.75	1.01	.69	2.55	30.0	32.2	10.0	2.6	102.41.

A tabulation of the results of a screen analysis of the -28. mesh material of Lot I, prepratory to the tabling of the products follows:

Product	Weight	Per cent of total	Per cent Cumulative	Assay % Cu	% of total cu in heads
Heads - 28 mesh	2000"	100	100	1.06	100
-28, " 65 mesh	1025"	51.3	51.3	1.08	52.3
-65, " 150 mesh	359"	17.9	69.2	1.32	22.2
-150 " mesh	605"	30.25	99.45	.80	22.8
Errors and losses by diff.	II"	.55	.55		2.7
Totals	2000"	100.00	100.00		100.00

A preliminary set of tabling tests was run on a laboratory wilfley table to see what could be done with three products -20 mesh unclassified feed, -28, 65 mesh feed, and -65 mesh feed. A tabulation of the results follows:

Products	Weight	Per cent of total weight	Assay % Cu	Per cent of total copper in heads
Heads -28 mesh unclassified	1000 "	100	1.06	100.00
Concentrates	48 "	4.8	10.8	48.9
Tails	750 "	75.6	.52	36.8
Slimes	202 "	20.2	.75	14.3
Total	1000 "	100.0		100.0

Products	Weight	Per cent of Total weight	Assay Per Cent Copper	Per cent of total copper in Heads
Heads -28, 65 mesh	900 "	100	1.08	100.0
Concentrates	40 "	4.4	14.3	58.8
Tails	829 "	92.2	.38	32.4
Slimes by diff.	31 "	3.4	2.72	8.8
Total	900	100.0		100.0

Products	Weight	Per cent of Total weight	Assay % Copper	Per cent of total Copper in head
Heads -65 mesh	800 "	100	1.00	100.0
Concentrates	25 "	3.1	11.56	33.5
Tails	563 "	70.4	.70	45.6
Slimes	212 "	26.5	.84	20.6
Error & losses by diff.				.3
Total	800 "	100.0		100.0

The chalcopyrite slime badly and floats off. Tests were then made on a one-half size Deister Overstrom table with larger amounts of feed to check up these preliminary tests, and to see what recovery could be made by tabling followed by flotation of the slimes. The results for the two sized products from 50 "20, mesh ore are tabulated below:

Lot, I Test I,

Products	Weight Lbs.	Per cent of total weight	Assays Oz. Gold	Assays Per cent Silver	Assays Per cent Copper	Assays Per cent Zinc	Per cent of total metal in heads gold,	Silver	Copper	Zinc
Heads - 28.65 mesh	27.	100	.03	.95	1.00	1.21	100	100	100	100
Concentrates	0.625	2.3	.21	17.79	9.04	16.8	16.2	43.3	20.9	32.8
Middling	1.19	4.4	.03	.99	3.01		4.45	4.6	13.3	
Tails	23.75	87.9	.02	.39	.51		58.65	36.0	44.9	
Slimes	1.43	5.4	.03	1.20	1.53		5.90	7.6	9.7	
Errors & Losses by diff.	.006						14.8	9.5	11.2	
Totals	27.00	100.0					100.0	100.0	100.0	

Flotation test on above slimes

Products		Per cent Weight of total weight	Assays Gold	Oz. Silver	Per cent copper	Oz. sel.	Per cent of total metal in heads Per In- Gold	silver	copper	- zinc
Slimes (above)	600 g	100	.03	1.20	1.83	22.55	100	100	100	
Concentrates	19 g	3.17			12.32					21.4
Middlings	63 g	10.5			1.85					10.6
Tails	514 g	85.6			1.45					68.
Errors & losses by diff.	4	.73								
Totals	600 g	100.00								100.0

The flotation test was made in a small Hoover type laboratory machine designed by Thomas Varley and made of heavy sheet lead. The first agitation was for ten minutes with 5 drops of flotoo No. 1 oil plus 3 drops more after the first five minutes. The first concentrates were then cleaned for 6 minutes with 5 drops flotoo No. 1, giving a cleaned concentrate and middling product.

Lot 1. Test No. 2.

Products	Per cent Weight of total Lbs.	Per cent Weight of total weight	Assays Oz. Gold	Assays Oz. Silver	Assays % copper	Assays % insol.	Per cent of total metal in heads Gold	Silver	Copper
Heads - 65 mesh	23.00	100.00	.03	1.00	1.00		100.00	100.00	100.00
Concentrates	.56	2.80	.23	14.69	10.80	36.12	18.7	35.7	24.4
Middlings	1.94	8.44	.03	.42	2.02		8.4	3.6	15.7
Tails	8.88	29.90	.02	.44	.42		20.0	14.1	11.6
Slimes	13.19	57.40	.02	.81	.91		38.3	46.4	48.0
Losses & errors by diff.	.43	1.46					14.6	.2	.3
Totals	23.00	100.00					100.00	100.00	100.00

Flotation test on above slimes

Heads are a portion of slimes (above)	1000 g	100.0	.02	.01	82.99		100.0	100.0	100.0
Concentrates	65	6.5			10.02	41.45			65.7
Middlings	140	14.0			1.74				24.0
Tails	795	79.5			.13				10.3
Totals	1000	100.0							100.0

The above flotation test was begun like the previous one but a small amount of lime (CaO), less than one grain, was added to the pulp in the cell. This seemed to bring over excessive gangue with the froth. No cleaning was done on the concentrate. The froth for the first seven minutes was taken as the concentrate and the froth for the last three minutes as middling.

Table concentration following crushing does not seem advisable, since the chalcopyrite slimes are rendered difficult to recover after wetting; it is difficult to get a good concentrate because of poor separation of mineral and gangue: and a low tailing cannot be made.

Series of tests were then made, putting the 28 mesh unclassified material of lot I through the flotation machine and then tabling the flotation tails. A tabulation of the results follows:

Products	Wts. A	Percent of total Wt.-G., Grams	Assays Oz. Gold	Oz. Silver	Percent Copper	Percent insol.	Percent of total metal in heads Gold	Silver	Copper
Heads -28 mesh unclassified.	3000 g.	100.00	.04	1.00 (by difference)	1.00	1.05	100.	100.	100.
Concentrated)Flotation(	100 g.	3.33	.185	14.77	19.60	16.30	15.4	49.2	61.6
Tails	2900 g.	95.67	.035	.525	.37	84.6	50.8		33.8
Errors & losses									4.4
Totals	3000 g.	100.0					100.0	100.0	100.0

Laboratory Wilfley table test on portion of above tails.

Heads	2000 g.	100.0	.035	.525 (by difference)	.37		100.0	100.0	100.0
Concentrate	63 g.	3.1	.855	10.58	7.05	26.7	77.0	33.5	60.0
Tails	1400 g.	70.0	.01	.35	.135		20.0	33.3	25.0
Slime	446 g.	22.3	.005	.075	.10		3.0	3.2	6.0
Errors & Losses by difference	91 g.	4.6							
Totals	2000 g.	100.0					100.0	100.0	100.

Flotation test of -28 mesh
Unclassified Feed Lot No. 1

Products		Percent of Total Wt.	Assays Oz. Gold	Oz. Silver	Copper	Insol.	PER CENT of total metal in heads Gold	Silver	Copper
Heads	3000 g.	100.0	.035 (by diff.)	1.00	1.06		100.0	100.0	100.0
Concentrates	95 g.	3.2	.494	11.00	16.00	1600	44.6	36.1	46.4
Tails	2700 g.	92.3	.02	.02	.66	.47	58.7	60.9	41.0
Middlings	70 g.	2.3	.04	1.72	3.50		2.7	4.0	7.7
Errors & losses by diff.	65 g.	2.2							4.9
Totals	3000 g.	100.0					100.0	100.0	100.0

Laboratory Wilfley table test on portion of above tails.

Heads	2000 g.	100.0	.02 (by difference)		.660	.47	100.0	100.0	100.0
Concentrates	72 g.	3.4	.407	13.800	9.00	21.14	73.3	75.2	69.0
Tails	1410 g.	70.5	.005	.185	.125		17.6	15.6	18.7
Slimes	460 g.	23.0	.008	.142	.10		9.1	5.0	4.9
Errors & losses by diff.	56 g.	2.9							7.4
Totals	2000 g.	100.0					100.0	100.0	100.0

The above test show better recoveries of all metals than by tabling and floating the slimes, but the concentrates from the tabled tailings are low and the oil consumption for flotation is high, scouring action on the flotation machines would be bad due to the coarse material in the feed.

The second flotation test was made in acid solution which gave a dirty froth. This froth was then cleaned giving the cleaner tails as a middling product.

Tests were next made on a straight flotation process. The -28 mesh material, Lot I was ground in an iron ball mill until all passed 80 mesh. The -28 mesh material, Lot 2, was ground the same time and about 12 per cent remained on 80 mesh. A small quantity of heavy oil was added to the pulp in the ball mill before grinding. This materially lessened the quantity of oil needed in the flotation machine. A tabulation of the results below:

Product	Wts.	Per cent of total Weights	Oz. Gold	Oz. Silver	Assays Per cent Copper	Zinc	Insol.	Per cent of total metal in heads Gold	Silver	Copper
Heads, Lot I	3000 g.	100.00	.03	.94	.95			100.0	100.0	100.0
Concentrates	121g.	4.03	.32	19.29	18.95	14.45	13.8	43.0	78.4	80.4
Middling	164g.	5.47	.04	1.70	1.58			7.3	9.9	9.9
Tails	2715g.	90.50	.015	.10	.065			45.2	9.6	6.3
Errors & Losses by differences								4.5	2.1	4.4
Totals	3000 g.	100.00						100.0	100.0	100.0
Heads, Lot 2	3000 g.	100.00	.03	1.10	1.42			100.0	100.0	100.0
Concentrates	236 g.	7.86	.12	8.29	13.29	7.00	12.0	31.4	59.3	73.5
Middlings	85 g.	2.94	.04	.74	6.74			3.78	1.9	13.4
Tails	2610 g.	97.00	.02	.39	.186			58.1	30.1	11.4
Errors & Losses by differences	69 g.	2.3						6.72	8.7	1.7
Totals	3000 g.	100.0						100.0	100.0	100.0

The following sets of tests were made by grinding the -28 mesh material in the iron ball mill to pass 80 mesh without the addition of oil. The oil required in the flotation machine was then considerably greater than when the pulp was ground with oils. The copper recoveries were about the same. The last one of the following tests was the only one in which a middling product was made. By skimming the last froth close for a middling product, the tails could have been lowered somewhat.

Different oils were used for the two sets of tests.

A tabulation of the results follows:

Products	wts.	Per cent of total weight	Assays Oz. Gold	Oz. Silver	Per cent Copper	Zinc	Iron	Insol.	Per cents of total metal in Heads Gold	Silver	Copper
Heads, Lot I.	1000 g	100.0	.031	1.20	1.07	1.21			100.0	100.0	100.0
Concentrates	73	7.3	.016	11.68	11.95	8.60	27.80	18.70	37.8	70.8	81.6
Tails	927	92.7	.02	.38	.186	.65			60.0	29.2	16.1
Errors and losses by dif.									2.2		2.3
Totals	1000 g.	100.0							100.0	100.0	100.0
Heads, Lot I	1000 g.	100.0	.03	.94	1.10	1.20			100.0	100.0	100.0
Concentrates	53	5.3	.14	10.56	17.39	10.48	12.20		24.3	59.6	83.7
Tails	947	94.7	.02	.40	.186	.63			65.2	40.4	16.0
Errors & losses by diff.									12.0		.3
Totals	1000 g.	100.0							100.0	100.0	100.0
Heads, Lot 2	1000 g.	100.0	.035	1.83	2.28	1.01			100.0	100.0	100.0
Concentrates	100	10.0	.24	15.76	18.80	3.96	17.70		68.6	86.0	82.5
Tails	900	90.0	.01	.28	.36				25.7	13.8	14.2
Errors & losses by diff.									5.7	.2	3.5
Totals	1000 g.	100.0							100.0	100.0	100.0
Heads, Lot 2	1000 g.	100.0	.06	1.40	2.52	1.01			100.0	100.0	100.0
Concentrates	86	8.6	.20	12.20	23.0	4.59	37.50	10.30	43.0	75.0	85.4
Middlings	12	1.2			3.35	2.32		35.02			1.7
Errors & losses by diff.	.2	.2							12.8	2.5	.3
Tails	900	90.	.02	.36	.526	.48			45.0	23.5	12.6
Totals	1000 g.	100.0							100.0	100.0	100.0

From the foregoing test it would seem that a straight flotation process on this ore followed possibly by fine sand tables, to act as pilots on the flotation work, save any coarse copper minerals that might be in the tails, and also to increase materially the gold and silver recovery, would be about the best floor sheet to adopt. If a small amount of heavy oil, about one pound per ton, is added to the pulp as it enters the tube or ball mill, very little oil is required in the flotation machines, about one-half pound per ton. The ore should all be ground to pass 80 mesh before entering the flotation machine.

Apparently some of the Gold in the ore occurs as free Gold which accounts for the low flotation recovery and the better table recovery of the gold.