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REPORT
of the
ORE DRESSING AND METALLURGICAL LABORATORIES

Test No.168

The concentration of the Antimony Ore from Lake George, N.B.

by C. S. Parsons.

A shipment of 2154 pounds of antimony ore was received in August 1922 from the North America Antimony Smelting Company Limited, Lake George, N.B. This shipment was supposed to be a true and representative sample of the milling ore from the company's mine.

Experimental test work was desired to determine a concentration process, suitable for the treatment of the ore on the basis of 50 to 100 tons daily capacity. The company contemplated the erection of a mill on the results of the experimental work.

The whole shipment was crushed in a jaw crusher to 1¼" size and in rolls to ½" and sampled. The head sample cut out gave an analysis as follows:

Antimony	11.65%
Arsenic	0.37%

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HAND SORTING

The sample received did not contain sufficient lumps of pure stibnite to warrant hand picking.

JIGGING TESTS

Considerable stibnite was freed at ¼" size, and it is possible to obtain a jig product at this size, or finer, by careful manipulation. This concentrate would average about 50% Sb. Jigging, however, would

hardly be practicable owing to the fact that a clean tailing could not be produced, and that a middling product would always be present, which would prevent a high grade concentrate being made. This is based on the results of a test made in a small laboratory Richards jig.

Considering jigging from the stand-point of operation and costs in a small mill, it is quite evident that the use of jigs would not be advisable owing to the necessity of introducing re-crushing machinery for the jig tailing and middling, and would mean a more complexed flow-sheet.

TABLE CONCENTRATION

Crushing in ball mill to tabling size (-14 mesh): The following results were obtained by crushing to 14 mesh and sizing on 24, 35, and 50 mesh. The -50 mesh was not tabled, it being assumed that it would be sent to the flotation machines. The following sizes and weights were obtained:

Product	Weight	Per-cent
-14 +24 mesh	3610 grams	40.94
-24 +35 "	1817 "	20.61
-35 +50 "	647 "	7.34
-50 "	2742 "	31.10

TABLE NO. 1
Tabling -14+24 mesh

Product	Weight gram	% Weight	% Sb.	Content Sb.	% Sb. Recvy	% As.	Content As.	% As. Recvy
Concentrate	337	9.36	54.80	184.60	62.5	0.20	0.67	6.82
Mids from re-run	120	3.33	7.15	8.58	2.9	0.48	0.58	5.91
Middling	509	14.13	7.15	36.40	12.3	0.44	2.24	22.81
Tailing	2636	73.16	2.50	65.90	22.3	0.24	6.33	64.46

Procedure and notes on above test: A concentrate, middling, and tailing were first made. The concentrate was recleaned, using a special cleaner deck on the small table. A second middling product was obtained from the recleaning of the concentrate. The concentrate represents about as high a product as could be expected from this size. The middling posed chiefly of unfreed mineral, and therefore, would have reground in order to recover the antimony content. The t ains most of the stibnite in an unfreed condition. ns were arrived at by the examination of the produ

microscope.

TABLE NO. 2
Tabling -24+35 mesh

Product	Weight grams	% Weight	% Sb.	Content Sb.	% Sb. Recvy	% As.	Content As.	% As. Recvy
Concentrate	165	9.11	57.86	95.37	59.90	0.31	0.51	10.62
Mids from re-run	62	3.42	13.31	8.25	5.17	0.79	0.49	10.21
Tailing	1584	87.46	3.52	55.76	34.93	0.24	3.80	79.16

Procedure and notes on above test: This size tabled more readily than the preceeding one. A concentrate and tailing were made, the middling being returned with the feed, giving two products only from the first pass. The concentrate was recleaned on a special cleaner deck. The recleaning of the concentrate produced a middling product. The concentrate represents practically as high grade a product as can be obtained on this size. Considerable float antimony mineral was observed passing over the table into the tailing. The middling is made up chiefly of unfreed mineral and is, therefore, a true middling, which would have to be recrushed in order to recover the antimony content. The tailing is very dirty, and on examination under the microscope, shows that about half the antimony is there as freed stibnite.

TABLE NO. 3
Tabling -35+50 mesh

Product	Weight grams	% Weight	% Sb.	Content Sb.	% Sb. Recvy	% As.	Content As.	% As. Recvy
Concentrate	63	9.53	58.02	36.55	57.14	0.28	0.18	8.41
Mids from rerun	36	5.45	10.45	3.76	5.88	0.53	0.19	8.88
Tailing	545	82.45	3.74	20.38	31.86	0.31	1.69	78.97
Slimes	17	2.57	19.25	3.27	5.11	0.47	0.08	3.74

Notes on above test: A concentrate and tailing were made from the first pass of the ore, and the concentrate was recleaned on a special cleaner deck.

CONCLUSIONS FROM TABLE TESTS: It is possible to obtain a table concentrate with an analysis of 55% Sb. if careful sizing is resorted to after crushing to 14 mesh, with a recovery of 55% to 60% of the stibnite in the ore. Here again the middling and tailing products would require regrinding to recover the unfreed antimony. Half the loss in the tailing from the -24+35 and -35+50 mesh products

was due to flotation of the antimony when tabling. The finer the ore is crushed for tabling, the greater will be the loss from the antimony mineral floating off on the surface of the water, and reporting in the tailing.

LABORATORY FLOTATION TESTS ON CRUDE ORE
See Table No. 4

Part of the original head sample was used for these tests. The procedure adopyed was to use 1000 grams of ore crushed dry to 20 mesh and then to approximately 65 mesh in a small ball mill, wet.

Screen test of flotation feed

Screen	Weight	Weight %	Weight Acc. %
+65	50	5.2	5.2
-65 +100	204	21.1	26.3
-100+150	137	14.1	40.4
-150+200	168	17.4	57.8
-200	410	42.2	100.0

Test no. 1 1000 grams of ore; mixture of 40% coal tar and 60% coal tar creosote, and pine oil for frothing; neutral pulp

Test no. 2 1000 grams of ore; #1 K.K. oil from Southwestern Engineering Co., and pine oil for frothing; neutral pulp

Test no. 3 1000 grams of ore; #1 K.K. oil and pine oil; pulp alkaline with 4 pounds per ton of soda ash.

Test no. 4 1000 grams of ore; #1 K.K oil and pine oil; pulp alkaline with 4 pounds per ton of lime. Note, no stibnite would float in presence of lime.

Test no. 5 1000 grams of ore; #1 K.K. oil and pine oil; pulp acid with 10 pounds per ton sulphuric acid. Note, this test gave better results.

TABLE NO. 4

Test No.	Product	Weight %	Analysis % Sb.	Analysis % As.	% Recovery Sb.	% Recovery As.	Reagents
1.	Concentrate	16.0	64.24	0.28	86.7		Coal tar mixture
	Middling	2.8	6.38	1.62	1.4		Pine oil
	Tailing	81.2	1.75	0.35	11.9		
2.	Concentrate	17.7	61.80	0.62	81.4	35.6	K.K. oil
	Middling	4.0	4.50	1.04	13.4	13.5	Pine oil
	Tailing	78.3	0.88	0.27	5.2	50.9	
3.	Concentrate	15.3	62.70	1.00	83.6	40.0	Soda Ash
	Middling	4.1	13.10	1.44	4.7	15.4	K.K. oil
	Tailing	80.6	1.65	0.21	11.7	44.5	Pine oil

Test No.	Product	Weight %	Analysis % Sb.	% As.	% Recovery Sb.	As.	Reagents
4.	No flotation						Lime, K.K.Oil Pine oil
5.	Concentrate	17.4	63.36	0.51	95.6	16.4	K.K. Oil
	Middling	4.3	5.94	1.29	2.2	16.7	H_2SO_4
	Tailing	78.3	0.33	0.28	2.2	66.9	Pine oil.

Conclusions: Flotation tests on the crude ore show that by crushing to about 65 mesh, a high grade concentrate 60% to 65% Sb. can be obtained with a recovery up to 95% of the antimony values in the ore. The arsenic content in this concentrate is about 0.3%. If no objectionable feature arises in the handling of this fine concentrate in the subsequent treatment, this would seem to be the simplest and most feasible method of treating the ore. An outline of such a flow sheet would be as follows:

Coarse crushing in breaker and rolls to $\frac{3}{8}$" to $\frac{1}{4}$", and ball mill in closed circuit with classifier of Dorr type, to approximately 65 mesh. The overflow of the classifier would go to flotation machines, say of the Callow type, making a rougher concentrate which would be recleaned on a series of cleaner cells, and a tailing, which would go to roughing tables. These roughing tables are recommended on account of the high grade feed going to cells. They would act as a guard on the operation of the cells. The concentrate from the tables would be fed back to the circuit at the ball mill.

These deductions are based on the results obtained from the sample of ore received, and do not take into consideration any local conditions at the mine, or special market conditions regarding the physical character of the concentrate required for subsequent treatment The process which gave the highest grade concentrate, the highest recovery, with simplicity of operation is recommended.

In the construction of a small concentrator of 100 tons daily capacity, simplicity of design is important. Jigging and tabling followed by flotation would mean extra regrinding, classification, sizing, and thickening units, giving a lower grade final product, but a product much coarser than that obtained by straight flotation, and in this respect may be more suitable for subsequent refining. The

final recovery of antimony values would be about the same in both cases.

LARGE SCALE OR TONNAGE CHECK TESTS.

A large scale, or tonnage check test, was made in a small pilot Callow flotation unit consisting of two rougher cells of the new flat bottom type, and two cleaner cells of the same design. The ore was reduced to ½" in a jaw crusher and rolls, and fed to a Hardinge conical ball mill in closed circuit with a Dorr classifier. The classifier was adjusted to give a -50 mesh product to the flotation cells. The test was made on 1,800 pounds of ore.

The concentrate assayed 58.21% antimony
The tailing assayed 0.94% "

The recovery is figured from the formula $R = \frac{(H - t)C}{(C - T)H} \times 100 = 93.5\%$

That is, 93.5% of the antimony was recovered in a concentrate assaying 58.2% antimony. H = Assay of feed
T = Assay of tailing
C = Assay of concentrate

The reagents used for flotation were a mixture of 20% coal tar and 80% coal tar creosote, from the Dominion Tar and Chemical Co, Sault Ste Marie, Ont., and sufficient steam distilled pine oil to maintain a good froth. Five pounds of sulphuric acid was added per ton of ore just before entering the cell.

Conclusions: The results from this test confirm the results obtained from the small scale laboratory tests. The grade of the concentrate is slightly lower, but this does not mean that a concentrate of higher grade, similar to that obtained in the small tests, cannot be obtained. After the operator becomes familiar with the operation of the flotation unit, better work can be expected. It is difficult to guage the grade of the concentrate being produced, but with training and efficient manipulation, similar results to those of the small tests should easily be obtained.

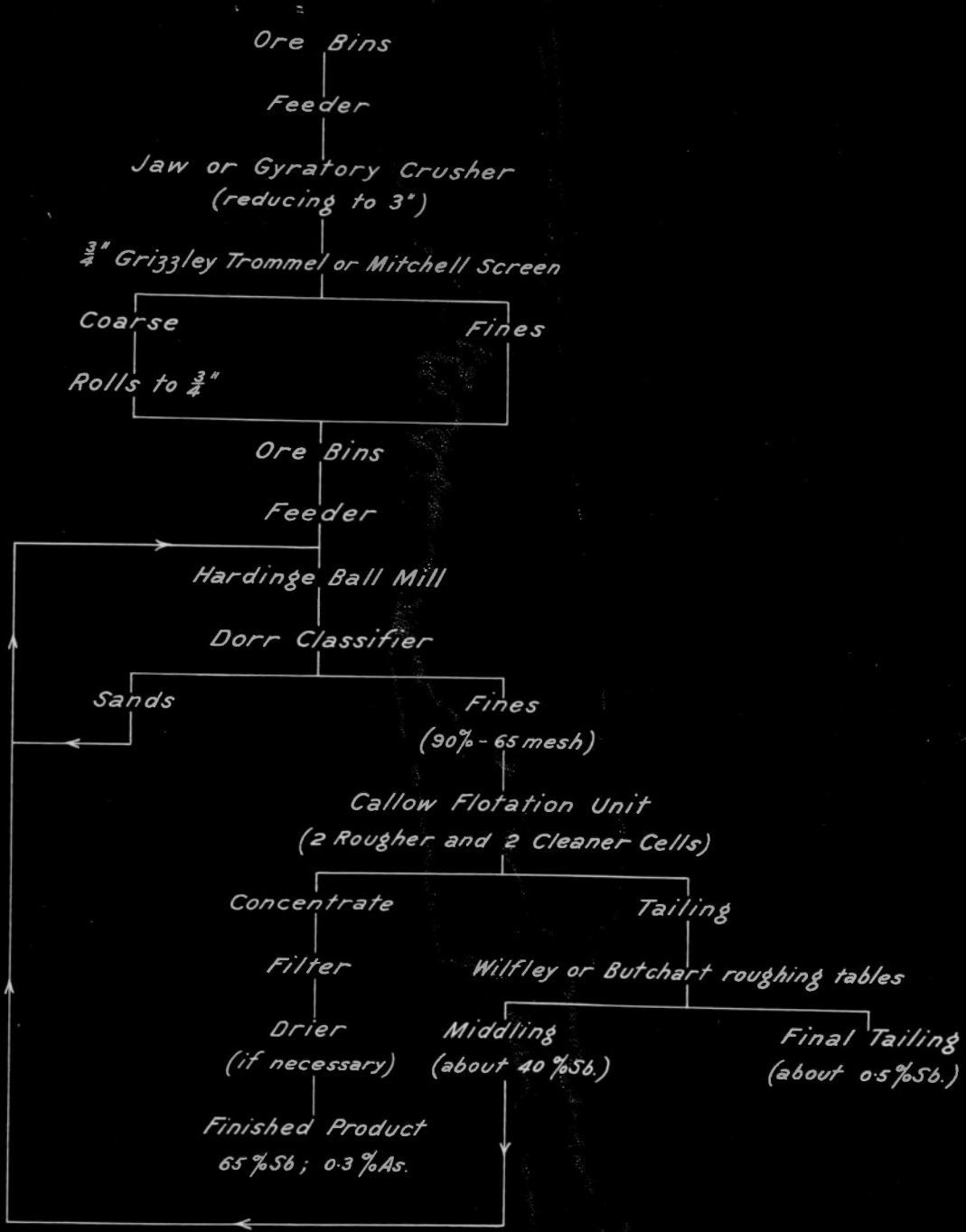

FIG. FLOW SHEET SUGGESTED FOR LAKE GEORGE ANTIMONY ORE