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of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2018.

Laboratory Tests on the Recovery of Silver in a Sample of Tailings from Former Mill Operations at Cobalt, submitted by La Rose-Rouyn Mines Limited, Toronto, Ontario.

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Note:

This report relates essentially to the samples as received. It shall not, nor any correspondence connected therewith, be used in part or in full as publicity or advertising matter for the sale of shares in any promotion.

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BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH
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Laboratory Tests on the Recovery of Silver in a Sample of Tailings from Former Mill Operations at Cobalt, submitted by La Rose-Rouyn Mines Limited, Toronto, Ontario.

Shipment:

A shipment of mill tailings, of a net weight of 99 pounds, was received from La Rose-Rouyn Mines Limited, 112 Yonge Street, Toronto, Ontario, on January 31, 1946.

A covering letter was received from Mr. H. H. Sutherland, Vice-President of the company, giving an approximate assay of the product and stating that the tailings were ground to about 100 mesh.

Mr. Sutherland requested some flotation and treatment tests on the sample, with a view to treatment at a profit, and asked for an estimate of the cost of treatment per ton.

Location of the Property:

The tailings are said to be from a disposal dump at Cobalt, Ontario, from milling operations conducted during the early years of the camp.

Sampling and Analysis:

A sample of the shipment, as received, was taken for the preparation of polished sections for microscopic examination.

The tailings were then riffled in a Jones sampler and a head sample secured for assay and analysis. The remainder was bagged for test purposes.

The analysis made on the head sample gave the following results:

Silver	-	4.69 oz./ton
Cobalt	-	0.06 per cent
Nickel	-	0.01 "
Arsenic	-	0.11 "
Sulphur	-	0.12 "
Insoluble	-	77.36 "

Test Observations:

On a preliminary examination of the tailings, considerable coarse material of a size of about 1/16 inch was observed. As the shipment was said to be ground to about 100 mesh it was thought that this material was perhaps foreign to the tailings proper and might be eliminated as waste by screening. Accordingly, a sample was prepared for screen analysis which gave the following results:

Mesh	Weight, per cent	Assays					Distribution, per cent				
		Oz.T	Per cent								
		Ag	Co	Ni	As	S	Ag	Co	Ni	As	S
				(calc.)	(calc.)						
+20	6.6	5.42	0.04	0.002	0.08	0.09	7.5	4.6	1.0	5.5	4.5
+48	20.85	4.20	0.04	0.002	0.04	0.09	18.3	14.5	2.8	8.7	17.1
+65	10.00	4.90	0.04	0.002	0.04	0.08	10.2	7.1	1.4	4.2	7.3
+100	12.20	4.40	0.08	0.01	0.02	0.06	11.4	17.1	8.4	2.5	6.9
+150	13.93	3.89	0.04	0.01	0.02	0.05	11.3	9.7	9.5	2.9	6.3
+200	11.10	3.52	0.04	0.01	0.06	0.07	8.2	7.5	7.6	7.0	7.1
-200	25.32	6.26	0.09	0.04	0.26	0.22	33.1	39.5	69.3	69.2	50.8
Total	100.00	4.78	0.057	0.014	0.095	0.109	100.0	100.0	100.0	100.0	100.0

(Test Observations, cont'd) -

It is seen that values are distributed more or less evenly through coarse and fine sizes and that nothing can be eliminated as waste by preliminary screening.

Microscopic Examination of Mill Tailings:

Purpose -

For the purpose of learning, if possible, how the silver remains in these tailings, five polished sections were prepared from the sample and examined under a reflecting microscope.

General Description -

The five polished surfaces consist predominantly of irregular fragments of rock, which are distributed unevenly through the mounting medium (bakelite). They range from only a few microns up to three millimetres or more in size and are composed largely of light greenish grey material but some pieces of iron-stained quartz and white carbonate can be distinguished among them.

Metallic minerals are comparatively sparse in the polished sections and are represented by "limonite", cobaltite, chalcopyrite, pyrrhotite, and native silver. These minerals occur as small irregular grains free in bakelite and combined with gangue.

Native silver, the only way in which this metal occurs in the sections, is visible as occasional tiny grains. The largest one seen, about 100 microns (-150 +200 mesh) in size, is intimately associated with a grain of chalcopyrite. The majority of the silver particles observed, however, are either combined with gangue or apparently free in bakelite.

Conclusions:

As in most projects of this kind, dealing with a secondary product, the flotation test work developed into the

(Conclusions, cont'd) -

double problem of making a good-grade concentrate and, also, a satisfactory low tailing and thus a good percentage of extraction.

The additional difficulty of controlling the considerable amount of gangue slime, which floated with the primary concentrate, also appeared. This was readily separated from the higher-grade portion of the concentrate by the addition of sodium silicate at various points in the flotation circuits and by using two or three stages of cleaning, but left a middling product to be considered.

The results in Tests Nos. 2, 5 and 6 show a range of operation from a lower-grade concentrate with a higher recovery of silver to a high-grade concentrate with a lower recovery of silver.

Test No. 2 would appear to represent what might be expected where the accent is not placed on a high-grade concentrate but on a higher recovery. Estimating a recovery of 50 per cent of the silver from the middlings, the overall recovery would reach 84.1 per cent with a grade of concentrate of approximately 160 ounces silver per ton.

In Test No. 5, a third stage of cleaning has increased the grade of concentrate with a higher ratio of concentration and practically the same flotation tailing. The recovery has fallen off, however, and estimating the same percentage of recovery from the middlings as in Test No. 2, the overall recovery would be 79.2 per cent of the silver with a grade of concentrate of 271.4 ounces per ton.

Since the treatment of the cleaner tailings or middlings appears to be a paramount problem in this project, in Test No. 6 an effort was made to control the amount of this product which floated with the rougher concentrate, by the addition of sodium silicate to the rougher cell, to act as a

(Conclusions, cont'd) -

depressant for the gangue slime. This test might represent what can be expected where a high-grade concentrate is desired at a small sacrifice of recovery. Under the same conditions for the middling products as in Tests Nos. 2 and 5, the overall recovery would reach 80.03 per cent with a grade of concentrate of 574.8 ounces silver per ton.

However, the method of procedure to be used, resulting in a high or lower grade concentrate with a lower or a higher recovery of silver, must be decided on an economic basis, largely influenced by shipping and smelter charges.

As to the method of treatment of these cleaner tailings, to return them "in toto" to the primary flotation circuit would eventually result in a build-up of primary flotation products. It was thought that the No. 1 cleaner tailings could be tabled, with the table concentrate being returned to the flotation circuit; or, perhaps, they could be treated in a separate flotation circuit.

In Test No. 4, tabling the cleaner tailings Nos. 1 and 2 was not highly successful; only 21.6 per cent of the 11.7 per cent of the silver in these products was recovered as a concentrate. Plant tabling is one of the most difficult operations to parallel in a laboratory, by reason of the table adjustments to be made during the feeding of the small weight of sample and due, also, to the uneven feeding of the sample.

In Test No. 5, the No. 1 cleaner tailings were refloated separately with somewhat better results, and 74.1 per cent of the 9.9 per cent of the silver in this product was recovered as a concentrate in 23.4 per cent of the weight. It was hoped that the tailing would be sufficiently low in silver to discard, with only the concentrate being returned to the original flotation circuit. There remains, in the tailings of the re-floated No. 1 cleaner tailings, 2.56 per

(Conclusions, cont'd) -

cent of the silver in the original sample (feed).

Cyanidation of the tailings (feed) gave a surprizingly good percentage of recovery on a low-grade product, as in Test No. 3, an extraction of 86.5 per cent of the silver being made. The idea of cyanidation, therefore, cannot be discarded, but the higher extraction, in the case of cyanidation, must be balanced against the higher plant expenditure and the higher cost of operation as compared to flotation.

Progressively finer grinding in the flotation tests gave progressively lower tailings, and grinding should be carried to 90 per cent minus 200 mesh. The oversize particles in the tailings (feed) were quite resistant to grinding, and sufficient grinding capacity should be allowed, in practice, to take care of this feature.

With reference to the cost per ton of operation in this project, there are so many variable factors in connection with it, that an overall cost figure is not possible without further details. The tonnage to be treated per day, the method of getting the tailings to the treatment plant, the shipping charges on the concentrate, the contract with the smelter, and tailings (waste) disposal facilities will all have a bearing on any overall cost figure.

However, in regard to treatment at the plant, it can be said that from the point of entry into the treatment plant to the final disposition of waste, under normal facilities, on a basis of 300 tons of tailings (feed) treated per day, the cost per ton of operation should not be in excess of 50 cents in the case of flotation. Under the conditions which apply in the case of cyanidation, the cost per ton might reach 90 cents. Reagent cost would make up a large part of the difference. On behalf of cyanidation, it must be noted that the silver produced would be in practically a finished state, with only express and mint charges remaining for any further refining.

Cost figures are based on the use of modern equipment and modern plant design.

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RESULTS AND DETAILS OF INVESTIGATIVE TESTS:

Preliminary.

2,000 grams of the product was taken and ground in a laboratory ball mill to 85 per cent minus 200 mesh. The pulp was transferred to a flotation cell.

Reagents Added -

To Grinding		Lb./ton	
Soda ash	-	0.5	
Coal tar creosote	-	0.064	
Aerofloat No. 25	-	0.10	
To Conditioning			
Pot. amyl xanthate	-	0.10	pH, 9.7. 3 mins.
To Flotation			
Pine oil	-	0.025	7 mins.

Results

Product	Weight, per cent	Assay, oz./ton	Distribution of silver, per cent
Flot. conc.	10.6	37.0	84.6
Flot. tailing	89.4	0.8	15.4
Total	100.0	4.63	100.0

Ratio of concentration, 9.4 to 1.

Test No. 1.

2,000 grams of tailings ground to 90.0 per cent minus 200 mesh.

Transferred to a flotation cell and one stage cleaning of concentrate made.

Reagents Added -

To Grinding		Lb./ton
Soda ash	-	0.2
Reagent No. 301	-	0.1
Aerofloat No. 25	-	0.07
Coal tar creosote	-	0.064

(Continued on next page)

(Results and Details of Investigative Tests, cont'd) -

To Conditioning		Lb./ton	
Pot. amyl xanthate	-	0.10	pH, 9.5. 3 mins.
To Flotation			
Pine oil	-	0.05	10 mins.
To Cleaner Cell			
Sodium silicate	-	1.0	4 mins.

Results

Product	Weight, per cent	Assays Oz./ton Ag	Assays Per cent Co	Assays Per cent As	Assays Per cent S	Distribution, per cent Ag	Distribution, per cent Co	Distribution, per cent As	Distribution, per cent S
Cleaner conc.	4.96	73.96	0.29	1.16	1.42	78.9	26.0	49.4	53.1
Cleaner tailing	11.10	3.14	0.04	0.11	0.14	8.1	8.5	11.3	12.6
Flot. tailing	84.30	0.66	0.04 (calc)	0.05 (calc)	0.05 (calc)	13.0	65.5	39.3	34.3
Total	100.00	4.32	0.06	0.108	0.12	100.0	100.0	100.0	100.0

Ratio of concentration, 20.2 to 1.

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Test No. 2.

Same general procedure as in Test No. 1, except that grinding was done to 92.8 per cent minus 200 mesh and two stages of cleaning the concentrate were made.

Reagents Added -

To Grinding		Lb./ton	
Soda ash	-	0.2	
Reagent No. 301	-	0.1	
Aerofloat No. 25	-	0.07	
Coal tar creosote	-	0.064	
To Conditioning			
Pot. amyl xanthate	-	0.10	pH, 9.5 5 mins.
To Flotation			
Pine oil	-	0.05	8 mins.
To Cleaner Cell No. 1			
Sodium silicate	-	1.00	4 mins.

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(Results and Details of Investigative Tests, cont'd) -

To Cleaner Cell No. 2		Lb./ton	
Sodium silicate	-	1.00	4 mins.
Pot. amyl xanthate	-	0.05	
Pine oil	-	0.025	

Results

Product	Weight, per cent	Assays: Oz./ton Ag	Assays: Per cent Co	Assays: Per cent As	Assays: Per cent S	Distribution, per cent Ag	Distribution, per cent Co	Distribution, per cent As	Distribution, per cent S
Clean. conc.	2.1	159.4	0.20	1.91	2.71	78.0	7.8	36.3	45.0
Cleaner Tailing No. 2	4.7	4.72	0.04	0.15	0.06	5.2	3.5	6.3	2.2
Cleaner Tailing No. 1	17.3	1.76	0.01	0.06	0.17	7.1	3.2	9.4	23.1
Flot. tailing	75.9	0.56	0.06 (calc)	0.07 (calc)	0.05 (calc)	9.7	85.5	48.0	29.7
Total	100.0	4.30	0.06	0.11	0.12	100.0	100.0	100.0	100.0

Ratio of concentration, 47.6 to 1.

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Test No. 3.

1,000 grams of tailings (feed) was ground in a laboratory jar mill to 92.8 per cent minus 200 mesh.

Transferred to a bottle agitator and agitated at 2 to 1 dilution with cyanide and lime for 72 hours. Cyanide solution maintained at 2.5 pounds NaCN per ton. Residue filtered and washed.

Results:

Assay feed, oz./ton silver = 4.69
Assay residue, " " = 0.63
Extraction, per cent silver = 86.5

NaCN consumed, lb./ton feed = 2.28
CaO " " " = 8.68
NaCNS = 0.0071 per cent
Reducing power = 150.4 c.c. $\frac{N}{10}KMnO_4$ for 1000 c.c. solution.

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Test No. 4.

2,000 grams of tailings was ground in a laboratory mill to 93.2 per cent minus 200 mesh and transferred to a

(Results and Details of Investigative Tests, cont'd) -

flotation cell.

Procedure the same, with same reagents, as used in Test No. 2.

The test was a repeat test to obtain cleaner tailings products to ascertain whether the values in Cleaner Tailings Nos. 1 and 2 could be recovered effectively by concentration on a Wilfley table in order to avoid returning these cleaner tailings to the flotation circuit and to return the concentrate only from them.

Results:

Product	Weight, per cent	Assay, Ag, oz./ton	Distribution, of silver, per cent
Cleaner conc.	2.4	151.8	76.6
Cleaner Tailing No. 2	4.3	3.05	11.7
Cleaner Tailing No. 1	13.8		
Flot. tailing	79.5	0.70	11.6
Total	100.0	4.75	100.0

Ratio of concentration, 41.6 to 1.

267 grams of combined Cleaner Tailings Nos. 1 and 2 were concentrated on a laboratory Wilfley table.

Results:

Product	Weight, per cent	Assay, Ag, oz./ton	Distribution of silver, per cent
Concentrate	11.1	6.12	21.7
Tailing	88.9	2.76	78.3
Total	100.0	3.13	100.0

(Results and Details of Investigative Tests, cont'd) -

Test No. 5.

2,000 grams of tailings was ground in a laboratory mill to 95.2 per cent minus 200 mesh and transferred to a flotation cell.

Reagents Added -

To Grinding		Lb./ton	
Soda ash	-	0.2	
Reagent No. 301	-	0.1	
Aerofloat No. 25	-	0.07	
Coal tar creosote #4	-	0.064	
To Conditioning			
Pot. amyl xanthate	-	0.10	pH, 9.6. 5 mins.
To Flotation			
Pine oil	-	0.05	9 mins.
To Cleaner Cell No. 1			
Sodium silicate	-	1.00	4 mins.
To Cleaner Cell No. 2			
Sodium silicate	-	1.00	
Pot. amyl xanthate	-	0.05	
Pine oil	-	0.025	4 mins.
To Cleaner Cell No. 3.			
Sodium silicate	-	1.00	
Pot. amyl xanthate	-	0.05	
Pine oil	-	0.025	4 mins.

Results:

Product	Weight, per cent	Assay, Ag, oz./ton	Distribution, of silver, per cent
Cleaner concentrate	1.2	271.4	68.1
Cleaner Tailing No. 3	2.1	12.0	5.3
Cleaner Tailing No. 2	5.3	6.48	7.1
Cleaner Tailing No. 1	13.6	3.47	9.9
Flot. tailing	77.8	0.59	9.6
Total	100.0	4.78	100.0

Ratio of concentration, 83.3 to 1.

(Results and Details of Investigative Tests, cont'd) -

214 grams of Cleaner Tailing No. 1 was ground lightly and floated with the addition of the following reagents:

	Lb./ton of original feed
Aerofloat No. 25 -	0.035
Coal tar creosote -	0.032
Reagent No. 301 -	0.05
Pot. amyl xanthate -	0.05
Sodium silicate -	1.00
Pine oil -	0.025

Results:

Product	Weight, per cent	Assay, Ag. oz./ton	Distribution, of silver, per cent
Flot. conc.	23.4	11.0	74.1
Flot. tailing	76.6	1.18	25.9
Total	100.0	3.47	100.0

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Test No. 6.

2,000 grams of tailing (feed) were ground in the laboratory mill to 96.2 per cent minus 200 mesh. Pulp transferred to 2,000-gram flotation cell.

Reagents Added -

To Grinding	Lb./ton
Soda ash -	0.2
Reagent No. 301 -	0.1
Aerofloat No. 25 -	0.035
Coal tar creosote -	0.064
Sodium silicate -	1.50

Cleaning operations and conditions were the same as in Test No. 5. The same reagents were used in cleaning operations.

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(Results and Details of Investigative Tests, cont'd) -

Results:

Product	Weight, per cent	Assay, Ag, oz./ton	Distribution, of silver, per cent
Cleaner conc.	0.62	574.80	72.43
Cleaner Tailing No. 3	0.98	21.80	4.34
Cleaner Tailing No. 2	3.25	7.52	4.94
Cleaner Tailing No. 1	7.80	3.70	5.86
Flot. tailing	87.35	0.70	12.43
Total	100.00	4.92	100.0

Ratio of concentration, 161.3 to 1.

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