DIVISION OF
ORE DRESSING AND
METALLURGY

DEPARTMENT OF MINES
CANADA

MINES BRANCH

O T T A W A December 10th, 1931.

Inv. 403

REPORT

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ORE DRESSING AND METALLURGICAL LABORATORIES.

Concentration Tests on Samples of Two Mill Products from The Kirkland Lake Gold Mining Company, Limited, Kirkland Lake, Ont.

By

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Shipments:

A shipment consisting of 900 pounds marked B.U. and 1000 pounds marked M.T. was received October 28th, 1931, from the Kirkland Lake Gold Mining Company, Limited, Kirkland Lake, Ontario.

Characteristics of the Products:

The product designated B.U. (Bowl Underflow) is equivalent to the return from the bowl classifier in the grinding circuit of a cyanide mill practising fine grinding

Such a product consists of the coarser sulphides and sands and owing to the concentrating action in the classifiers it is relatively higher in gold bearing sulphides than the original feed though lower in gold value owing to the dissolving action of the cyanide to this stage in the circuit.

The sample of this product contained 16 percent moisture as cyanide solution and as dissolution is continually taking place the relationship between the undissolved and dissolved gold value is a variable one depending upon the time elapsed between the taking of the sample and the commencement of the test work and also between tests.

The following average screen analysis indicates the fineness of grinding to this stage

Mesh	Wt. %
+100	4.8
+200	58.7
-200	36.5

The sample designated M.T. (Mill Tailings), is the final tailing as discharged from the filter. As this product also contained some cyanide solution, a somewhat similar relationship between undissolved and dissolved gold value exists as in the previously described product.

A screen analyses on this product showed that 95 percent was minus 200 mesh.

Purpose of Experimental Tests on Product B.U.

The product B.U. was subjected to three small-scale flotation tests and a medium-sized table test for the purpose of ascertaining if the sulphides could be removed at this stage and subjected to a special grinding and agitation before being re-passed to the main cyanide circuit to be ultimately discharged with the tailing.

Some data on the feed rate to the table was desired in order to estimate the number of tables that would be required to yield results at least equal to those obtained in the table tests and to treat about 150 tons per twenty-four hours.

Summary:

A brief summary of the results is as follows: By flotation on a sample assaying Au 0.18 oz/ton a recovery of 26.6 percent of the gold was obtained in a concentrate assaying Au 1.82 oz/ton with a ratio of concentration of 38.5:1. Also on a sample assaying Au 0.11 oz/ton practising water-washing to remove the cyanide and soluable lime before flotation, a recovery of 48.8 percent of the gold was obtained in a concentrate assaying Au 0.84 oz/ton, with a ratio of concentration of 15.4:1.

By tabling a sample assaying Au 0.156 oz/ton a recovery of 21.6 percent of the gold was obtained in a con-

centrate assaying Au 0.524 oz/ton and with a ratio of concentration of 16.1:1.

Experimental Tests on Product B.U.

Mr. John Dixon, Mill Superintendent for the Kirkland Lake Gold Mining Company, Limited, was present during and, co-operated in, this test work.

Test No. 1 - Flotation

Results:

Product	Wt. %	Assays Au oz/t	% Value Au
Heads	100.0	0.15	100.0
Conc.	0.8	3.30	17.5
Mid.	1.5	0.20	2.0
Tail	97.7	0.124	80.5

A sample of the flotation tailing screened on 200 mesh

+ 200	72.0	0.11	63.8
- 200	28.0	0.16	36.2

Average flotation tailing - Au 0.124 oz/ton

Test No. 2 - Flotation

Results

Product	Wt. %	Assays Aunoz/t	% Value Au
Heads	100.0	0.178	100.0
Conc.	2.6	1.82	26.6
Mid.	1.4	0.90	7.1
Tail	96.0	0.123	66.3

A sample of the flotation tailing screened on 200 mesh

+ 200	68.8	0.11	61.7
- 200	31.2	0.15	38.3

Average flotation tailing Au 0.123 oz/ton.

Test No. 3 - Flotation

In this test the sample was water-washed before flotation:

Results:

Product	Wt. %	Assays Au oz/ton	% Value Au
Heads	100.0	0.11	100.0
Conc.	6.5	0.84	48.8
Mid.	2.1	0.16	3.0
Tail	91.4	0.059	48.2

A sample of the flotation tailing was screened on 200 mesh

+ 200	70.8	0.05	60.2
- 200	29.2	0.08	39.8

Average flotation tailing Au 0.059 oz/ton.

Test No. 4 - Table Test:

For this test a 1/4 deck Wilfley table, fitted with slime riffles was used.

Two products only were taken from the table, namely, a concentrate and a tailing. What would ordinarily be a middling product was allowed to report with the tailing.

The average feed rate was 3098 grams per minute.

Samples of the feed to the table, table concentrate and tailing were taken at 10 minute intervals. All samples were taken wet and filtered before drying to avoid inaccuracies due to dissolved gold.

Results of Screen Analyses on Products:

1. Head sample - Au 0.156 oz/t.

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+100	6.4	0.20	8.2
+200	59.3	0.12	45.7
- 200	34.3	0.21	46.1

2. Table concentrate - Au 0.524 oz/ton

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+100	18.3	0.36	12.6
+200	44.1	0.34	28.6
- 200	37.6	0.82	58.8

3. Table tailing - Au 0.126 oz/ton

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+100	6.3	0.20	10.0
+200	63.0	0.11	55.8
- 200	30.7	0.14	34.2

Summary of Table Test.

Product	Wt. %	Assays Au oz/tn.	% Value Au
Head	100.0	0.156	100.0
Conc.	6.2	0.524	21.6
Tail	93.8	0.126	78.4

Conclusions:

From the preceding tests on this product it is evident that flotation after water-washing would produce the best metallurgical results. From an economic standpoint we are inclined to favour table concentration. As the tabling may be

done in cyanide solution, it eliminates the necessity of filtration and avoids an excess of cyanide solution. While it is true that the recovery by tabling was only 21.6 percent this recovery includes the coarser refractory sulphides,

It is proposed that the table concentrates be subjected to a special regrinding and agitation, then repassed to the main circuit. It is suggested that after regrinding the table concentrates be returned to the table, thus retaining in the grinding circuit any sulphide particle until sufficiently fine to report with the table tailing.

The ratio of concentration of 16:1 might be reduced to say 12:1 thereby including some sulphides unfreed from gangue that would ordinarily be a middling product. The introduction of this step would depend largely on the capacity of the regrinding circuit.

In the table test a feed rate of 3095 grams per minute was maintained. This rate is equivalent to 4.9 tons per day for a quarter sized deck or 19.6 tons per day for a full sized table. Four double deck tables would then be sufficient to take the daily tonnage of 150 tons.

It should be borne in mind that a high recovery was not to be obtained at the expense of capacity because the table tailing is not a final product but was to be reground and agitated in the main circuit.

Purpose of Experimental Tests on Mill Tailing:

The product mill tailing was subjected to three flotation tests for the purpose of ascertaining the percentage of gold remaining in the cyanide tailing that could be recovered by flotation.

As the mill tailing contained some cyanide solution and soluable lime and as both of these reagents have a depressing effect on the pyrite, with which the greater part of the gold is associated, tests were made before and after water-washing to remove these reagents.

Summary of Results:

Small Scale Flotation Tests

On a head sample assaying Au 0.046 oz/ton, a recovery of 44.3 percent of the gold was obtained in a concentrate assaying Au 0.46 oz/ton with a ratio of concentration of 23:1.

On a sample assaying Au 0.049 oz/ton practising water-washing before flotation a recovery of 66.6 percent of the gold was recovered in a concentrate assaying Au 0.68 oz/ton with a ratio of concentration of 21:1.

Medium Scale 100 pounds per hour Flotation Tests

On a sample assaying Au 0.061 oz/ton, a recovery of 57.6 percent of the gold was obtained in the flotation concentrate which assayed Au 0.54 oz/ton, with a ratio of concentration of 15.5:1.

After water-washing before flotation 67.9 percent of the gold was recovered in the concentrate, which assayed Au 0.64 oz/ton with a ratio of concentration of 15.5:1.

Experimental Tests on Mill Tailing:

Mr. John Dixon was present during and co-operated in the following test work.

In order to show the difference in assay value between the washed and unwashed tailing two samples were taken. Each sample is composed of a number of smaller samples taken at 15 minute intervals during one of the tests, No. 1 sample is considered to be representative of 500 pounds; No. 2 of 350 pounds. Both samples were screened on 200 mesh.

Results: - No. 1 sample after water-washing.

Mesh	Wt. %	Assays Au oz/to	% Value Au
+ 200	5.0	0.08	6.5
- 200	95.0	0.06	93.5

Average Assay - Au 0.061 oz/ton

No. 1 sample without water-washing

Mesh	Wt. %	Assays Au oz/tn	% Value Au
+ 200	4.8	0.10	6.7
- 200	95.2	0.07	93.3

Average Assay Au 0.071 oz/ton

The difference between the two samples is au 0.01 oz/ton which is attributed to dissolved gold included in the mill tailing.

Flotation Tests:

Test No. 1. Sample unwashed before flotation..

Results of Flotation

Product	Wt. %	Assays Au oz/t	% Value Au
Head	100.0	0.046	100.0
Conc.	4.4	0.46	44.3
Mid.	3.9	0.015	1.3
Tail	91.7	0.027	54.4

A sample of the flotation tailing was screened on 200 mesh

Results:

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+ 200	4.1	0.07	10.8
- 200	95.9	0.025	89.2

Average assay of flotation tailing - Au 0.027 oz/ton

Test No. 2 - Sample washed before flotation

Results of Flotation

Product	Wt. %	Assays Au oz/tn	% Value Au
Head	100.0	0.049	100.0
Conc.	4.8	0.68	66.6
Mid.	6.7	0.02	2.7
Tail	88.5	0.017	30.7

A sample of the flotation tailing was screened on 200 mesh

Results:

Mesh	Wt. %	Assay Au oz/ton	% Value Au
+ 200	3.8	0.08	17.2
- 200	96.2	0.015	82.8

Average assay of flotation tailing Au 0.017 oz/ton.

Test No. 3

Flotation Test in a Continuous Unit

A flow-sheet of the unit was as follows: The mill tailing was passed through a 4 mesh screen, to break the lumps, then feed to a small contact tank set for about 15 minutes contact. From the contact tank the pulp was pumped to an Akin's classifier. The classifier overflow passed to No. 2 cell of a six-cell Denver flotation machine. A rougher concentrate was taken from cells 2 - 6 inclusive which was cleaned in No. 1 cell. The final concentrate was taken from No. 1 cell. The middling repassed through the other cells.

It was intended that the classifier return be reground in a small rod mill in closed circuit with the classifier, but as the feed was too fine for the classifier no return was made and the rod mill was cut from the circuit.

The test was a comparative one for the purpose of comparing the results obtainable by flotation on tailings after water-washing to remove the soluble lime and cyanide, and on the tailings as received.

Two series of samples were taken during the flotation of the water-washed tailing. The purpose of these samples was to determine whether the use of sodium sulphide as an auxiliary flotation reagent was instrumental in increasing the recovery or not.

The results were as follows:

Head sample; water-washed, screened on 200 mesh

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+ 200	5.0	0.08	6.5
- 200	95.0	0.06	93.5

Average assay - Au 0.061 oz/ton

Head sample; unwashed, screened on 200 mesh

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+ 200	4.8	0.10	6.7
- 200	95.2	0.07	93.3

Average assay Au 0.071 oz/ton

No. 1 series of samples, feed water-washed before flotation

Flotation concentrate Au 0.70 oz/ton
Flotation Tailing Au 0.032 z/ton

A sample of the flotation tailing was screened on 200 mesh.

Results:

Mesh	Wt. %	Assays Au oz/ton	% Value Au
+ 200	3.2	0.08	8.2
- 200	96.8	0.03	91.8

Average assay Au 0.032 oz/ton

No. 2 series of samples - Feed washed before flotation

Flotation concentrate Au 0.64 oz/ton
Flotation tailing Au 0.021 oz/ton

A sample of the flotation tailing was screened on 200 mesh.

Results:

Mesh	Wt. %	Assays Au oz/t	% Value Au
+ 200	1.8	0.08	6.7
- 200	99.2	0.02	93.3

Average assay Au 0.021 oz/ton

No. 3 Series of Samples; Feed not washed before Flotation

Flotation concentrate Au 0.54 oz/ton
Flotation tailing Au 0.028 oz/ton

A sample of the flotation tailing was screened on 200 mesh.

Mesh	Wt. %	Assays Au oz/t	% Value Au
+ 200	3.7	0.11	14.5
- 200	96.3	0.025	85.5

Reagents:

The following reagents were used in their approximate quantities:

Series No. 1. Feed washed before flotation.

Na_2CO_3 3.0 lbs/ton - added to contact tank
$CuSO_4$ 0.75 bs/ton - added to classifier overflow
Sodium Amyl Xanthate - 0.10 lb/ton added to classifier overflow
Pine oil 0.20 lbs/ton -added to classifier overflow

Time of series 2½ hours.

Series No. 2 - Feed water-washed before flotation.

Na_2CO_3, $CuSO_4$, Sodium Amyl Xanthate and Pine oil as in series No. 1.

Na_2S 0.75 lbs/ton added to pump after contact tank. Time of series 2 hours.

Series No. 3 - Feed not washed before flotation.

Reagents as in series No. 2. Time of series 2 hours.

Summary of Results: Head sample Au 0.061 oz/ton

Series No.	Conc. Au oz/ton	Tail Au oz/ton	Recovery %	Ratio of Conc.
1	0.70	0.032	50.0	23:1
2	0.64	0.021	67.9	15.5:1
3	0.54	0.028	57.6	15.5:1

Conclusions:

Using given reagents better and more consistent results will be obtained by water-washing the cyanide tailing before flotation.

From the results of the above tests it is evident that sodium sulphide as a flotation reagent is effective as a means of increasing the recovery. It is probable that it acts as a sulphidizer on the fine particles of pyrite that have been pitted by the action of the cyanide during the cyanidation treatment. It has a tendency to lower the grade of concentrate so that the quantity used should be held within fairly narrow limits.

Samples of the table concentrate and the flotation concentrate were forwarded to Mr. Dixon for further experimental work at Kirkland Lake.