DIVISION OF
ORE DRESSING AND
METALLURGY

DEPARTMENT OF MINES
CANADA

MINES BRANCH

O T T A W A November 7th, 1930.

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REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES

The Recovery of Gold from the Ore of the Night Hawk Lake Mining Co., Night Hawk Lake, Ont.

Alex K. Anderson.

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Shipments: A shipment contained in 36 bags, gross weight 3590 pounds was received by freight at the Ore Dressing and Metallurgical Laboratories on Sept. 6, 1930, consigned by James G. Cameron from Connaught Station, Ontario. The Callinan Flin Flon Mines Limited, Mount Julian P.O. Ont., Jno W. Callinan, President, are also interested. The shipment was made up of two lots #1 and #2, of approximately equal weights.

Characteristics of the Ore: This material consisted of a red porphyry containing small crystals of iron pyrite free from oxidation.

Purpose of Experimental Tests: The shipment was made for the purpose of determining the value of the ore, the amount of free gold present, and the best method to apply for the recovery of the contained values.

Sampling and Analysis: Each lot was crushed to pass $\frac{3}{4}$ inch screen and quartered. One-quarter was then crushed to pass six mesh and again quartered. By further grinding to finer sizes and cutting through a Jones riffle sampler, a representative portion passing 100 mesh was finally secured. Fire assay showed the following:

Lot #1	Gold - 0.17 oz/ton.	Silver 0.07 oz/ton.
Lot #2	Gold - 0.14 oz/ton.	Silver 0.03 oz/ton.

Experimental Tests: Due to the similarity of the two lots, all tests were made on Lot #1. These included amalgamation, amalgamation and concentration by flotation, flotation, cyanidation, and flotation and cyanidation of the flotation concentrate.

The investigation discloses that approximately 80% of the gold is free with a probable recovery of 58% by standard amalgamation practice. Flotation gives a recovery of 94% with fine grinding. Amalgamation followed by flotation recovers 96.7% of the gold. On cyaniding these concentrates, the indicated recovery drops to 81%. Cyanidation of the raw ore gives an extraction of 97% of the gold.

The tests unless otherwise stated were made on representative 1000 gram portions of the ore ground in porcelain mills containing iron balls.

Test #1 Amalgamation

A 1000 gram sample of the ore -14 mesh was ground to pass approximately 94% -200 mesh and amalgamated.

Heads	-0.17 oz. gold
Amalgamation Tailing	-0.035 oz. gold
Recovery	-79.4%

This indicates that over three-quarters of the gold in the sample is free.

Test #2 Amalgamation and Flotation

A 1000gram sample of the ore was ground in water with 4.0 pounds soda ash per ton to pass 94% through 200 mesh and then amalgamated. After removing the amalgam, the pulp was transferred to a laboratory size mechanically agitated flotation machine. A concentrate was removed after adding 0.10 pounds potassium xanthate and 0.04 pounds pine oil.

Product	% Wt.	Assay Au oz/ton	% Values Au
Heads	100.00	0.17	100.0
Flotation conc.	3.13	0.48	8.8
Flotation tail.	96.87	0.01	5.7
Recovered by amalgamation			85.5

These results show that 85.5% of the gold is recovered by amalgamation at this fineness of grinding and an additional 8.8% in a flotation concentrate assaying $9.60 a ton, or a total recovery of 94.3% of the gold. Each 100 tons of feed produces 3.13 tons of flotation concentrate.

Test #3 Flotation

In this test concentration without amalgamation was applied.

A representative 1000 gram portion of the ore -14 mesh was ground in water containing soda ash equivalent to 4.0 pounds per ton of ore. After grinding to 94% -200 mesh, the pulp was transferred to the flotation machine where 0.10

pounds potassium xanthate and 0.04 pounds pine oil per ton were added and a concentrate removed.

Product	% Wt.	Assay Au oz/ton	% Values Au
Heads	100.00	0.168	100.0
Flotation conc.	3.58	4.42	94.2
Flotation tail.	96.42	0.01	5.8

Flotation at this fineness of grinding gives a recovery of 94.2% of the gold in a concentrate assaying 4.42 oz. gold per ton.

A sizing test on the tailing shows:

+100 mesh	-	0.2%
-100+150	-	1.9
-150+200	-	3.8
-200	-	94.1
		100.0

Test #4

Flotation of coarser ground mateiral was then tried. Grinding in this test was:

+65 Mesh	-	1.7%
-65+100	-	8.0
-100+150	-	10.7
-150+200	-	19.0
-200	-	60.6
		100.0

Flotation was conducted as in Test #3

Product	% Wt.	Assay Au oz/ton	% Values Au
Heads	100.00	0.164	100.0
Flotation conc.	3.18	4.10	79.4
Flotation tail.	96.82	0.035	20.6

On this size of material, 60% -200 mesh, the recovery of gold is 79.4% as against 94.2% as in Test #3.

Test #3

This test was made on material even coarser than in Test #4.

Product	% Wt.	Assay Au oz/ton	% Values Au
Heads	100.00	0.188	100.0
Flotation conc.	3.40	4.4	79.5
Flotation tail.	96.60	0.04	20.5

A screen analysis of the tailing was made to note where the unrecovered gold laid.

Mesh	%Wt.	Assay Au oz/ton
+65	10.5	0.19
-65+100	25.1	0.04
-100+150	6.5	0.07
-150+200	14.8	0.02
-200	43.1	0.01
	100.0	

This screen analysis of the tailing shows that the +150 mesh portion is of much higher value than the -150 mesh part. To secure maximum recoveries by flotation it is apparent that the ore should be ground to pass 150 mesh.

Test #6 Cyanidation

In this test, the raw ore was ground to pass 100 mesh and agitated for 48 hours 1:3 dilution with a 2.0 pound KCN solution. Lime at the rate of 2 pounds per ton of ore was added.

The tailing after this treatment had a gold content of 0.005 oz. per ton representing an extraction of 97.0% of the gold. Reagent consumption was 0.54 pounds cyanide and 1.7 pounds lime per ton of ore milled.

Test #7

This test was made on ore ground to pass 150 mesh treated in the same manner as in Test #6

Tailing - 0.005 oz. gold per ton.
Extraction - 97.0%
Consumption - KCN - 0.60 lb. per ton.
CaO - 1.7 lb. per ton.

These tests show that the raw ore is amenable to cyanidation. No benefit is to be derived by grinding finer than 100 mesh.

Test #8 Concentration and Cyanidation

In this test, a flotation concentrate was made as in previous tests. The concentrate was then reground and cyanided.

The ore was ground with water and soda ash equivalent to 4.0 pounds of ore. A concentrate was then removed by the addition of 0.10 pounds potassium xanthate and 0.06 pounds pine oil per ton.

Product	% Wt.	Assay Au oz/ton	% Values Au
Heads	100.00	0.17	100.0
Flotation conc	6.83	2.08	83.6
Tailing	93.17	0.03	16.4

This concentrate with an assay value of 2.08 oz. gold per ton was reground and then agitated for 48 hours, 1:3 dilution with a 2.0 pound KCN solution and 4 pounds lime per ton of ore.

This treatment left a residue containing 0.05 oz. gold per ton representing an extraction of 97.6% of the gold in the concentrate or a recovery of 81.6% on the original feed. A cyanide consumption of 9.0 pounds KCN per ton of concentrate is indicated.

A sample of the concentrate was first amalgamated and then cyanided as above.

By amalgamation the gold in the concentrate was reduced from 2.08 oz. to 0.38 oz. per ton. The residue after cyaniding for 48 hours had a gold content of 0.02 oz. This represents a recovery of 68.3% of the gold in the original feed by amalgamation with an additional 14.4% by cyanidation, a total recovery of 82.7% by this method.

Test #9

In this test approximately 700 pounds of the ore was fed at the rate of 100 pounds per hour to a small rod mill, the discharge of which passed over an amalgamating plate. The pulp after passing the plate was elevated to a classifier the oversize from which was returned to the ball mill. The classifier overflow at approximately 35% solids flowed to a conditioning tank where about 20 minutes contact was obtained and thence to a six cell Denver Sub A flotation machine. Cells No's 2 and 3 were used as rougher cells, the concentrate from these flowing to cell No. 1 where the finished concentrate was removed. Cells No's 4, 5 and 6 were maintained as scavenger cells, the concentrate from these being returned to cell No. 2 together with the middling from cell No. 1.

Soda ash at the rate of 3 pounds per ton was added to the grinding mill, 0.10 pounds amyl xanthate to the conditioning tank and 0.04 pounds pine oil to the flotation machine.

The concentrate was then cyanided in small scale apparatus.

Product	% Wt.	Assay Au oz/ton	% Values Au	
Heads	100.00	0.17	100.0	
Amalgam tail.		0.07	58.8	recovery in amalgam
Flotation conc.	7.96	0.81	37.9	
Flotation tail.	92.04	0.006	3.3	

These results show that amalgamation followed by flotation results in a recovery of 96.7% of the gold in the ore. A concentrate containing 0.81 oz. gold per ton is obtained in a product 7.96% of the weight of ore milled. This concentrate was rather pure pyrite containing 43.8% iron, 46.8% sulphur.

The following screen tests made on the amalgam plate tailing and flotation tailing or classifier overflow are of interest.

Mesh	Plate Tailing	Classifier Overflow
+65	8.6%	0.0%
-65+100	17.7	2.1
-100+150	10.3	1.7
-150+200	22.1	6.7
-200	41.3	89.5
	100.0	100.0

The flotation tailing was filtered and representative 200 gram portions were reground and agitated for 48 hours, 1:3 dilution with a 3 pound per ton KCN solution and lime equivalent to 5 pounds per ton of ore. It was found that the solutions became foul from the presence of soluble sulphides. The addition of 4 pounds lead acetate per ton corrected this condition. Very poor results were obtained however, only 20% of the gold being extracted. It was felt that, owing to oxidation of the concentrate prior to cyaniding and to the possible contamination with carbon from other operations being carried on, these results are not conclusive, especially as in Test #8 no trouble was experienced in securing a good extraction from the concen-

trates. It will be necessary, therefore, to conduct further large scale flotation tests to secure a concentrate for additional cyanide investigations.

Summary and Conclusions: The greater part of the gold in the ore is present as free gold. When ground very fine as in Test #1, approximately 80% of the gold is recovered by amalgamation. However as these conditions would not be duplicated in practice, the result shown in Test #9, 58% recovered by amalgamation is more nearly correct.

Concentration by flotation can be depended on to yield a recovery of well over 90% of the gold in the ore. Fine grinding is necessary to secure this. Amalgamation and flotation as shown in Test #9 gives a recovery of 96.7% of the gold.

Cyanidation of the ore ground to pass 10 mesh results in an extraction of 97% of the gold with a cyanide consumption of 0.60 pounds KCN per ton of ore milled.

Flotation followed by cyanidation of the concentrate results in a recovery of 81.6% of the gold as indicated in Test #8. With a ratio of concentration of 14.6:1, the cyanide consumption of 9 pounds per ton of concentrate figures out to 0.62 pounds per ton of original ore, closely approaching that indicated in the cyanide tests on the raw ore.

Cyanidation of the raw ore gives highest recoveries. However, due to the low gold content of the ore, $3.40 per ton, and the case with which it is concentrated, the deciding factor in the adoption of the method to apply will be largely one of costs, the initial cost of installation and subsequent operation. These can be determined only by a detailed study of each type of mill, cyanide or amalgamation and flotation to determine if a lower final return by flotation will effect the higher costs of a cyanide plant.