DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, December 21, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2153.

Laboratory Experiments on Gold Recovery from a High-Grade Ore from the Property of Thunderhead Gold Mines Limited, Thunder Bay District, Ontario.

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.

(Copy No. 13.)

Bureau of Mines
Mineral Dressing and
Metallurgy Division

CANADA
DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A December 21, 1946.

R E P O R T

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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2153.

Laboratory Experiments on Gold Recovery from a High-Grade Ore from the Property of Thunderhead Gold Mines Limited, Thunder Bay District, Ontario.

Shipment:

On October 26, 1946, a shipment of ore from the above-mentioned property was received under instructions from Mr. Robert Campbell, President, Room 1504, Victory Building, 80 Richmond Street West, Toronto, Ontario. The shipment consisted of two bags of ore, of a total weight of 98 pounds.

Mr. Campbell asked for test work to determine a flow sheet for a 25-ton mill.

Location of Property:

The property of the Thunderhead Gold Mines Limited from which the samples originated is in Gorham township, in the Thunder Bay district, Ontario.

Sampling and Analysis:

The contents of the two bags were combined and crushed to approximately 20 mesh, and a sample was cut out for assay and analysis.

The remaining portion of the ore was then made to pass a 20-mesh screen and bagged for investigative purposes.

Before crushing, some representative samples of the ore were taken for the preparation of polished sections for microscopic examination.

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

Gold	-	1.70 oz./ton
Silver	-	1.28 "
Iron	-	3.13 per cent
Sulphur	-	0.30 "
Insoluble	-	85.56 "

A screen analysis of the head sample showed the values, association and distribution of the gold in the various mesh sizes to be as follows:

Mesh	Weight, per cent	Assays Oz./ton Au	Assays Per Cent Fe	Assays Per Cent S	Distribution, per cent Au	Distribution, per cent Fe	Distribution, per cent S
+28	9.9	1.52	2.86	0.16	8.2	11.4	8.0
+35	21.5	1.65	2.60	0.17	19.5	22.5	18.5
+48	12.5	1.45	2.18	0.17	9.9	11.0	10.7
+65	14.9	1.61	2.03	0.18	13.1	12.2	13.5
+100	10.2	1.59	2.08	0.19	8.9	8.6	10.0
+150	8.7	1.54	1.31	0.25	7.3	5.7	11.1
+200	5.7	3.03	1.72	0.27	9.5	4.0	8.0
-200	16.6	2.60	3.69	0.24	23.6	24.6	20.2
Totals	100.0	1.82	2.48	0.19	100.0	100.0	100.0

Microscopic Examination:

Six polished sections were prepared from the sample and examined under a reflecting microscope for the purpose of determining the character of the ore.

Gangue -

In the polished sections, gangue material consists essentially of milky white quartz with small patches and

(Microscopic Examination, cont'd) -

narrow streaks of soft, dark greenish grey to almost black rock and a small amount of finely disseminated carbonate (calcite). The whole assemblage is transected by a few narrow sinuous fractures and bears local reddish-brown stains of iron oxides. In hand specimens, coatings of rust are abundant and show that the sample has been severely weathered.

Metallic Minerals -

Metallic mineralization is very weak in the polished sections and is represented by pyrite, "limonite", and chalcopyrite. Megascopically, only two of the six polished surfaces appear to contain ore minerals but under the microscope the other four are seen to contain negligible amounts disseminated very sparingly through gangue in very fine grain sizes.

Pyrite, the most abundant metallic, is distributed unevenly through gangue as euhedral to anhedral crystals, many of which are rimmed with "limonite" and contain occasional small inclusions of the same material as well as of gangue. The largest grain observed in the polished surfaces is about 0.5 mm. in diameter and they range from that down to only a few microns but the coarser sizes are predominant.

"Limonite" is comparatively common in gangue as local reddish-brown stains, small irregular grains, and narrow borders around pyrite and chalcopyrite. A practically negligible amount of the latter mineral is visible as small uneven particles scattered sporadically through gangue.

Although each section was carefully traversed under a high-power objective no gold or gold minerals were observed. An examination of several hand specimens under a binocular microscope met with a similar result. Next, some of the

(Microscopic Examination, cont'd) -

head sample was ground in an agate mortar and panned on a watch glass. When the resultant concentrate was examined under the binocular microscope two free flakes of native gold were found. One of them measured approximately 0.1 mm. (-150 +200 Tyler mesh) across, and the other was somewhat smaller in size. Both were more or less equidimensional in shape and normal in colour.

Conclusions:

The ore as represented by the sample received is quite amenable to cyanidation, and the highest extraction on it is obtained by straight cyanidation. For maximum extraction by this process, fine grinding is perhaps necessary, as represented by Test No. 2 where nearly 99 per cent of the gold was extracted. Higher tailing loss at a considerably coarser grind was obtained by cyanidation, as in Test No. 7, but the percentage of extraction was still high. These percentages of extraction are mainly due to the high grade of the ore which offsets a higher tailing loss than might be expected from a normal grade of ore.

The standard flowsheet for a small-scale cyanidation operation could be used, but milling costs would be comparatively high.

Flotation of the ore followed by cyanidation of the concentrate gave a somewhat lower overall recovery of the gold at 94 per cent, as in Test No. 6.

Utilizing this procedure, cost of milling would undoubtedly be lower than in straight cyanidation. Cyanidation would involve treatment of only some 6 per cent of the ore weight, which could be done in batch cyanidation. It is

(Conclusions, cont'd) -

a matter of closer calculation, influenced by local conditions, whether the lesser cost of operation, when flotation and cyanidation are used, would offset the extra extraction by straight cyanidation. Approximately 78 per cent of the silver is also recovered in Test No. 6.

As a means of avoiding cyanidation of the concentrate, where the grade is 27 and 21 ounces gold per ton as in Tests Nos. 3 and 6, the concentrate could be shipped to a smelter for treatment.

Test No. 8 shows the ore to be a good settling one and the thickener area could be reduced to a minimum.

Reagent consumption is comparatively low for an ore of this grade.

TEST DETAILS:

Test No. 1.

1,000 grams of ore ground to 71.6 per cent minus 200 mesh and amalgamated with 7 c.c. mercury, 0.5 gram CaO, 1,000 c.c. water, and 6 small pebbles.

Results:

Assay heads, Au oz./ton	-	1.70
Assay tailing,	-	0.50
Extraction of gold, per cent	-	70.6

Test No. 2.

1,000 grams ore ground to 73.2 per cent minus 200 mesh.

Cyanided for 48 hours at 2 to 1 dilution.

Results:

Assay heads, Au oz./ton	-	1.70
Assay residue, " "	-	0.02
Extraction of gold, per cent	-	98.82
NaCN consumed, lb./ton ore	-	1.08
CaO " " "	-	3.32
Reducing power, c.c. N/10 $KMnO_4$ per litre	-	54
NaCNS, per cent	-	0.001

Test No. 3.

2,000 grams of ore ground to 79.4 per cent minus 200 mesh and transferred to a flotation cell.

(Continued on next page)

(Test Details, cont'd) -

Reagents Added -

To Grinding:		Lb./ton
Soda ash	-	0.5
Reagent No. 301	-	0.1
Reagent No. 208	-	0.2
Aerofloat No. 25	-	0.035
Pot. amyl xanthate	-	0.1

To Conditioning:

Pot. amyl xanthate	-	0.05 (3 mins.) pH, 9.2.

To Flotation:

Pine oil	-	0.025 (7 mins.)

Results:

Products	Weight, per cent	Assays Oz./ton Au	Assays Oz./ton Ag	Assays Per Cent Fe	Assays Per Cent S	Distribution, per cent Au	Distribution, per cent Ag	Distribution, per cent Fe	Distribution, per cent S
Flot. conc.	5.05	27.02	20.6	7.66	3.96	93.0	87.3	16.9	85.4
Flot. tail.	94.95	0.11	0.16	2.00	0.036	7.0	12.7	83.1	14.6
Total	100.00	1.47	1.19	2.28	0.23	100.0	100.0	100.0	100.0

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Test No. 4A.

500 c.c. of solution from Test No. 2 deoxidized for 30 minutes with 0.2 gram $PbNO_3$ in a laboratory precipitation apparatus under vacuum. Precipitated with 0.3 gram zinc dust for 5 minutes under vacuum.

Results:

Assay of pregnant solution, Au oz./ton = 0.834
Assay of barren solution, " " = 0.047

-

Test No. 4B.

500 c.c. of solution from Test No. 2 deoxidized for 30 minutes with 0.2 gram $PbNO_3$ under vacuum. Precipitated with 0.35 gram NaOH and 0.2 gram aluminium dust for 5 minutes under vacuum.

(Continued on next page)

(Test Details, cont'd) -

Results:

Assay of pregnant solution, Au oz./ton = 0.834
Assay of barren solution, " " = 0.006

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Test No. 5.

1,000 grams of ore ground to 58 per cent minus 200 mesh.

Pulp run over a corduroy blanket table at 3 to 1 dilution with a slope of 3 inches per foot to the table.

Results:

Assay heads, Au oz./ton = 1.70
Assay tailing, Au oz./ton = 0.50

Products	Weight, per cent	Assays Oz./ton Au	Assays Per Cent Fe	Assays Per Cent S	Distribution, per cent Au	Distribution, per cent Fe	Distribution, per cent S
Blanket conc.	10.8	9.86	3.28	0.96	70.5	16.8	45.4
Blanket tailing	89.2	0.50	1.97	0.14	29.5	83.2	54.6
Totals	100.0	1.51	2.11	0.23	100.0	100.0	100.0

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Test No. 6.

4,000 grams of ore ground in two lots of 2,000 grams each to 83.6 per cent minus 200 mesh. Floated in two lots with products combined.

Flotation conditions the same as in Test No. 3 but time increased to 10 minutes and pH of pulp 9.0.

Results:

Products	Weight, per cent	Assays Oz./ton Au	Assays Oz./ton Ag	Assays Per Cent Fe	Assays Per Cent S	Distribution, per cent Au	Distribution, per cent Ag	Distribution, per cent Fe	Distribution, per cent S
Flot. conc.	6.1	21.3	17.45	7.0	3.36	94.8	84.7	18.7	90.5
Flot. tail.	93.9	0.075	0.205	1.98	0.023	5.2	15.3	81.3	9.5
Totals	100.0	1.37	1.26	2.28	0.23	100.0	100.0	100.0	100.0

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(Test Details, cont'd) -

150 grams of flotation concentrate cyanided at 3.3 to 1 dilution for 48 hours without regrinding.

Results:

Assay flotation conc.,	Au oz./ton	=	21.3
" " "	Ag "	=	17.45
" cyanide residue,	Au "	=	0.165
" " "	Ag "	=	1.385
Per cent extraction of	gold	=	99.2
" " " "	silver	=	92.0
NaCN consumed, lb./ton	conc.	=	11.7
CaO " "	"	=	7.59
Overall extraction of	gold, per cent	=	94.0
" " "	silver, per cent	=	77.92

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Test No. 7.

1,000 grams of ore ground for 10 minutes to 19.1 per cent minus 200 mesh.

Cyanided at 2 to 1 dilution for 48 hours.

Results:

Cyanide heads, Au oz./ton	=	1.70
Cyanide residue, Au oz./ton	=	0.045
Per cent extraction of gold	=	97.4
NaCN consumed, lb./ton ore	=	1.0
CaO consumed, lb./ton ore	=	2.56

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Test No. 8.

2,000 grams of ore ground to 84.6 per cent minus 200 mesh with 1.0 lb./ton of NaCN and 1.0 lb./ton CaO.

Pulp transferred to a cylinder for settling tests. Dilution raised to 4 to 1. Pulp mixed. Pulp allowed to settle for 10 minutes and measurements of clear solution noted every minute for 10 minutes.

Enough clear solution decanted to bring dilution to 3 to 1 and settlement noted for 10 minutes.

Enough clear solution decanted to bring dilution to 2 to 1 and settlement noted for 10 minutes.

(Continued on next page)

(Test Details, cont'd) -

Results:

4 to 1 dilution, settlement 7½ in. in 10 minutes = 3.75 ft. per hour.

3 to 1 dilution, settlement 4-7/8 in. in 10 minutes = 2.4 ft. per hour.

2 to 1 dilution, settlement 2 in. in 10 minutes = 1.0 ft. per hour.

Settling area required can be ascertained from the formula

$$A = \frac{1,333(F-D)}{R}, \text{ in which}$$

A = thickener area,
F = initial density (parts solution),
D = final density of thickener discharge (parts solution), and
R = settling rate in feet per hour.

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