Ottawa, July 12, 1927

REPORT
of the
ORE DRESSING AND METALLURGICAL LABORATORIES

Report No. 256

Experimental tests on gold ore from the Central Manitoba Mine

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Shipments: Two shipments were received during September 1926, one weighing 25 lbs. and the other 64 lbs. There was no difference in the ore of the two shipments, which came from the Rice Lake district, Manitoba.

Characteristics of the ore: The samples received contained about 0.75 oz/ton gold, about 90 per cent of which is free the remainder being associated with small quantities of the sulphides of iron, copper, and nickel.

Purpose of tests: The purpose of these tests was to compare concentration and cyanidation as means of recovering the gold.

Sampling and Analysis: The head sample of the combined shipments contained

Gold	0.78 oz/ton
Copper	0.40 per cent
lead	nil
Zinc	trace
Iron	1.67 per cent
Nickel	0.009 "
Insol	92.54 "

Test No. 1 - Flotation and tabling

Results:

Product	Weight %	Assay Au oz	Assay Cu %	% values Au	% values Cu
Flot. conc	4.2	7.84	8.36	56.5	92.6
Table "	6.5	3.18	0.16	35.4	2.6
" tail	67.6	0.06	0.02	7.0	3.7
Slimes	21.7	0.03	0.02	1.1	1.1
Head from products		0.58	0.38		

Recovery in concentrates Au 91.9 %
Cu 95.2 %

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Test No. 2 - Flotation and tabling

Product	Weight %	Assays Au oz	Assays Cu %	% values Au	% values Cu
Flot. conc.	3.2	11.13	10.71	54.3	89.4
Table "	8.8	2.70	0.16	36.2	3.6
" tail	59.4	0.09	0.03	8.2	4.7
Slimes	28.6	0.03	0.03	1.3	2.3
Head from products		0.66	0.38		

Recovery in concentrates Au 90.5 % Cu 93.0 %

Test No. 3 - Amalgamation

Screen test on tailings -

Mesh	Weight %	Assay	% values
+48	0.7	0.14	1.0
+65	7.3	0.68	5.5
+100	14.9	0.12	17.0
+150	16.5	0.12	18.8
+200	16.3	0.10	15.5
-200	44.3	0.10	42.2
Average tailing		0.105	

Recovery 85.7 per cent

Test No. 4 - Amalgamation

Screen test on tailings -

+100	1.5	0.12	2.1
+150	9.0	0.11	11.6
+200	21.1	0.09	22.2
-200	68.4	0.08	64.1
Average tailing		0.085	

Recovery 88.5 per cent

Test No. 5 - Amalgamation and tabling

Product	Weight %	Assay Au oz	Assay Cu %	% values Au	% values Cu
Table conc.	8.5	0.68	1.42	53.9	30.0
" tail	63.8	0.06	0.28	35.8	44.5
Slimes	27.7	0.04	0.37	10.3	25.5
Amalgam. tailing		0.107	0.40		
Table tailing screened on 150 mesh					
+150	13.7	0.06	0.06	13.7	3.0
-150	86.3	0.06	0.31	86.3	97.0
Average tailing		0.06	0.28		

Distribution of gold - In amalgam 83.3 per cent
Table conc 7.4
Table tail 4.9
Slimes 1.4

Recovery 93.7 per cent

Test No. 6 - Amalgamation and flotation

Flot. conc	5.3	1.16	6.62	76.5	92.5
" tail	94.7	0.02	0.03	23.5	7.5
Amal. tail from prod.		0.08	0.38		

Distribution of gold - In amalgam 89.7 per cent
flot. conc. 7.9
flot. tail 2.4

Recovery 97.6 per cent

Test No. 7 - Amalgamation, flotation, and tabling

Flot conc.	5.2	1.12	6.96	71.5	93.9
Table "	3.8	0.28	0.09	13.0	0.9
" tail	54.2	0.023	0.01	15.4	1.4
Slimes	36.8	tr	0.04		3.8
Amal tail from prod.		0.081	0.39		
Table tailing screened on 200 mesh					
+200	15.3	0.04	0.01	26.5	15.0
-200	84.7	0.02	0.01	73.5	85.0
Average tail		0.023	0.01		

Distribution of gold -	In Amalgam	90.0	per cent
	Flot. conc.	7.2	"
	Table "	1.4	"
	" tail	1.4	"

Recovery 98.6 per cent

Head sample tests 5-7 Gold 0.78 oz/ton Copper 0.40 %

Test No. 8 - Six-cycle cyanidation test

A six-cycle cyanide test was made to obtain some data on the following points:

1. The cyanide and lime consumption
2. The amount of cyanide soluble copper
3. The effect of the fouling of solution due to presence of copper on the dissolution of gold

The procedure was as follows:
For cycle No. 1 six pebble jars were used for grinding the ore. Each jar was charged with 750 grams of ore at -20 mesh. The grinding was done in 1:1 pulp with lime equivalent to 2 lb/ton added to mill. The ore for cycle No.1 was ground in water, that for all other cycles in solution from previous cycle.
For cycle No. 2 five lots of ore were used and for each succeeding cycle one less lot than for the previous one was used. Thus, for cycle No. 6 one lot of ore was used.

On completion of the grinding the pulp was washed into small glass agitators and agitated for 48 hours in 1:2.5 pulp. The cyanide strength was maintained at 0.075% KCN by additions of cyanide twice each day. The protective alkalinity was kept at approximately 0.02% CaO. Any solution withdrawn was replaced by solution from the previous cycle. After 48 hours agitation the contents of each agitator were combined in a pressure filter and washed. The amount of wash solution used was based on 450 cc for every 750 grams of tailings. The 450 cc consisted of 150 cc 0.05% KCN, 150 cc 0.025% KCN and 150 cc water. The washings were combined with the pregnant solution for the succeeding cycle. Precipitation of the gold was not attempted between cycles. The solutions from each cycle was analysed for copper content. On the completion of cycle No. 1 it was realized that the free gold interfered with the results, as it settled out in the agitators and made the results erratic. It was, however, decided to continue the work to obtain information on points 1 and 2.

Head sample Gold 0.78 oz/ton copper 0.40 %

Cycle	Tailing assay	Extractn %	Reagents used lb/ton KCN	CaO	Cu gm/lt in soltn	
1	0.20	74.46	2.67	3.41	0.1207	
2	0.37	52.6	3.41	2.48	0.2406	Ore 2% +200 mesh
3	0.39	50.0	2.64	2.52	0.3422	" "
4	0.31	60.2	2.77	2.03	0.4180	.7% +200 mesh
5	0.27	65.4	2.90	1.96	0.4810	1.1% +200 mesh
6	0.10	87.2	2.78	2.20	0.5120	

The extent of the interference of free gold is shown by the following results taken from cycle No. 4 as being typical

Cyanide tailing before amalgamation -

Mesh	Weight %	Assay	% values
+200	0.7	15.71	35.6
-200	99.3	0.21	64.4
Average		0.31	

Cyanide tailing after amalgamation - 0.077 oz/ton
Per cent gold amalgamated - 75.2 %

Test No. 9 - Cyanidation tests in winchesters

900 grams of the ore at -20 mesh was ground in a pebble mill with 1 lb/ton lime. The pulp was filtered and divided into three about equal parts. One part was used for a head sample and each of the others put into a winchester bottle and made up to 1:2.5 dilution with the clear filter solutions. The cyanide strength was 0.075 % KCN and strengthened after 24 hours agitation. The protective alkalinity was approximately 0.02% CaO. Time of agitation 48 hours. Results:

1. Head sample after grinding screened on 200 mesh

+200	6.8	2.22	31.0
-200	93.2	0.35	69.0
Average		0.48	

2. Cyanide tailing screened on 200 mesh

+200	6.1	0.12	28.0
-200	93.9	0.02	72.0
Average		0.026	

3. Cyanide tailing screened on 200 mesh

+200	6.7	0.044	13.4
-200	93.3	0.02	86.6
Average		0.022	

Part	Assay Head	tailing	Extraction %	Reagents used lb/ton KCN	CaO
2	0.48	0.026	94.5	1.90	3.5
3	0.48	0.022	95.4	2.27	3.5

Test No. 10 - Amalgamation and cyanidation (three cycles)

Cycle No.1 - Three lots of ore, each 900 grams were ground to about 5% +200 mesh, then amalgamated one hour with 90 grams of mercury in a 1:1 pulp. The amalgamation tailings were dewatered and agitated 48 hours in 0.075% KCN and 1:2 pulp. The washings were not united with the main solution. The tailings from the three agitators were screened on 200 mesh and assayed separately.

Cycle No.2 - Two lots of ore each of 900 grams at -20 mesh were ground and amalgamated as in cycle no. 1 After dewatering the dilution was made up to 1:2 with solution from cycle no. 1. The agitation period and conditions were the same as in no. 1

Cycle No. 3 - One lot of ore of 900 grams was used for this cycle, otherwise procedure was the same as fr no. 2. The solutions from each cycle were analysed for copper and nickel. Results:

Cycle No. 1 - Tailings screened on 200 mesh

Part	Mesh	Weight %	Assay	% values	
A	+200	5.6	0.18	21.2	
	-200	94.4	0.04	78.8	
	Average		0.048		
B	+200	2.9	0.58	30.2	
	-200	97.1	0.04	69.8	
	Average		0.056		
C	+200	3.3	0.04	6.3	
	-200	96.7	0.02	93.7	Average tailing 0.0417 oz/t
	Average		0.021		

Reagent consumption in lbs/ton

Part	KCN	CaO
A	2.60	2.84
B	2.67	3.10
C	2.67	3.00
Averg.	2.65	2.98

Cycle No. 2 - Tailings screened on 200 mesh

Part	Mesh	Weight %	Assay	% values	
A	+200	4.8	0.13	24.6	
	-200	95.2	0.02	75.4	
	Average		0.025		
B	+200	4.8	0.07	17.1	
	-200	95.2	0.01	82.9	Average tailing 0.018 oz/tn
	Average		0.011		

Reagent consumption in lbs/ton

Part	KCN	CaO
A	2.40	3.97
B	2.23	3.45
Averg.	2.31	3.71

Cycle No. 3 - Tailing screened on 200 mesh

Mesh	Weight %	Assay	% values
+200	4.8	0.06	13.1
-200	95.2	0.02	86.9
Average		0.022	

Reagent consumption in lbs/ton

KCN	CaO
2.12	3.64

Summary - Head sample Au 0.78 oz/ton Cu 0.40 % Ni 0.009 %

Cycle	Tailing Av assay	Extractn %	Reagent con. (av) KCN	CaO	Analysis solution Cu gm/lt	Ni gm/lt
1	0.021	97.3	2.65	2.98	0.11	0.0031
2	0.018	97.7	2.31	3.71	0.21	0.0042
3	0.022	97.2	2.12	3.64	0.28	0.0064

CONCLUSIONS:

1. Concentration. Good recoveries were made by floatation and tabling. The ratio of concentration is 1:10. Flotation alone is not sufficient for the gold, as some of it remains in the tailing. A good recovery of this gold is made in table concentrate. The flotation concentrate, uncleaned, contains about 10% copper, which when cleaned would be doubled with an increase in the gold content. This would make a good smelter product. If this method were employed the table concentrate from the flotation could probably be successfully cyanided as its copper content is low, 0.16%

2. Amalgamation. Amalgamation gave very good results on this ore, 85 to 90 per cent being recovered by this treatment.

3. Amalgamation and concentration. Amalgamation followed by tabling recovered 93.7 per cent of gold. The concentrate is low in both gold and copper - only 30 per cent of the copper present is recovered. When amalgamation is followed by flotation, good recoveries in both gold and copper are obtained. The flotation concentrate is higher in gold than that from the table. The grade of this concentrate could be considerably increased by a recleaning operation.

When amalgamation is followed by flotation and tabling, 98.6 per cent gold and 94.8 per cent copper is recovered. The table concentrate is very low in grade.

Cyanidation: 1. Extraction. The extractions in test 8 were very poor, due to presence of free gold. In test 9 where bottles replaced agitators the extractions were greatly improved, 94 to 95 per cent being extracted. In test 10 where amalgamation preceeded cyanidation, 97 per cent gold is recovered. The free gold would not interfere in large scale operations.

2. Reagent consumption. Two to three pounds cyanide was used in all tests. The tests conducted in bottles showed a lower consumption than those in agitators. The ore was overground, which increases the consumption. Copper is the main cyanicide, though some nickel enters the solutions as shown in test 10. Two to nearly four pounds of lime was consumed to maintain a fair protective alkalinity. Good settling was obtained in the agitators when about three pounds per ton was used.

3. Boiling of solution. Where agitators are used

about one tenth of a gram per liter of copper appears after the first cycle, which gradually decreases until in the sixth cycle when three one hundredths gram per liter is the amount dissolved. On the completion of the sixth cycle 0.512 grams per liter copper was present in the solution. This would represent a little more than one pound per ton of solution. Fineness of grainding is a big factor in the amount of soluble copper in a cyanide solution. While nickel enters the solution, it is of secondary importance, the copper being the greater cyanicide. From the above tests, amalgamation followed by flotation appears as the most satisfactory method of treating this ore. The operations would not be effected by a possible increase in the copper content with increase in the depth of mining operations. The problem of the disposal of the concentrate is the chief objection to this method.

The ore is apparently amenable to cyanidation, with a fairly high consumption of cyanide, but there is a possibility of the interference of the copper in the extraction and precipitation operations. Should this occur, running to waste of a certain amount of the solution might be sufficient remedy. At any rate it would prevent indefinite accumulation of the copper.