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June 4, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1883.

Cyanidation and Flotation Tests on a Gold-Silver-Lead
Ore from the Delhi (Temagami) Gold Mines Limited,
in the Temagami District of Northern Ontario.

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Note:

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Shipment:

Five bags of ore, total weight 278 pounds, were received on April 23, 1945, from the Delhi (Temagami) Gold Mines Limited, Toronto, Ontario, per L. J. Lahay, President. A letter, dated April 19, 1945, had been received previously from Mr. Lahay, asking for "the values of the various metals contained in the ore and for a test showing the best method of treatment and recovery which might be expected." Mr. Lahay's letter contained a newspaper summary of a mining engineer's report on the property.

Location of Property:

The shipment was composed of rock said to have been taken from the Delhi (Temagami) Gold Mines property in the Temagami Forest Reserve, in northern Ontario.

Sampling and Analysis:

The contents of the five bags were combined, ground to minus 14 mesh, and a sample was taken by standard methods for assay and analysis.

The remainder was bagged for investigative purposes.

The results of the analysis were as follows:

Lead	-	1.63 per cent
Copper	-	0.03 "
Iron	-	2.85 "
Zinc	-	0.20 "
Sulphur	-	0.27 "
Cobalt	-	Trace.
Nickel	-	Trace.
Insoluble	-	82.40 "
<hr/>		
Silver	-	0.71 oz./ton
Gold	-	0.11 "

Several head samples were cut out and assayed, to establish the above values in gold.

From the above analysis it will be seen that the combined gold, silver and lead values establish an ore which is on the border line of profitable operation at normal tonnages and at present metal prices.

Characteristics of the Ore:

Six polished sections of the ore were prepared and examined microscopically for the purpose of determining the character of the ore. In addition, several hand specimens and a superpanner concentrate were inspected under the binocular microscope, and the findings of all these examinations are incorporated in the following:

Gangue -

Gangue material is a mixture of coarse white quartz

(Characteristics of the Ore, cont'd) -

and medium hard greenish grey rock. The quartz carries carbonate (calcite) as occasional scattered grains up to at least one centimetre in size, and bears local reddish brown stains of iron oxides, especially along fractures. In two or three of the hand specimens the rock constituent exhibits a pink staining of erythrite (cobalt bloom), but a primary cobalt mineral was not found in them or in the polished sections.

Metallic Minerals -

Metallic mineralization is rather sparse in both the hand specimens and the polished sections and, listed in their approximate order of abundance, is represented by galena, pyrite, chalcopyrite, "limonite", sphalerite and covellite.

Galena predominates as small masses and coarse to fine grains scattered through gangue. The largest mass observed covers an area about $1\frac{1}{2}$ centimetres square and contains inclusions of gangue and grains of the other metallics.

Pyrite and chalcopyrite, in almost equal amounts and often in close association, are unevenly disseminated through gangue as small masses and coarse to fine crystals and grains. As already mentioned, both minerals are also visible in lesser amount as small inclusions in galena.

"Limonite" is relatively abundant, as stains in gangue and as veinlets in and rims around pyrite and chalcopyrite.

A very small quantity of sphalerite is visible as occasional small grains, which average about 85 microns in size, in massive galena. Many of the zinc sulphide grains contain tiny dots of chalcopyrite.

Covellite is present in practically negligible amount, as rare minute particles associated with chalcopyrite and sphalerite.

Gold and Silver -

As neither native metals nor gold and silver minerals could be found in polished sections or hand specimens, a super-panner concentrate made from flotation concentrate was carefully examined under the binocular microscope in an effort to learn something as to how these metals occur in the ore sample.

(Continued on next page)

(Characteristics of the Ore, cont'd) -

While no positive information as to the mode of occurrence of silver was gained from this examination, ten or twelve small particles of free gold were observed. The largest is 75 microns (approximately 200-mesh), the smallest about 8 microns (1600-mesh) in size. In shape most are more or less flattened flakes and one appears to have been rolled into a cylindrical form. All are normal in colour.

Next, massive galena in polished sections was etched in several places with 1:1 HNO₃ to see if this would show up a "silver-carrier" oriented along crystallographic directions, as illustrated by Schneiderhöhn.⁶ Since all etch tests were negative in this respect, it can only be said that, if, as is probable, the galena is argentiferous, the silver appears to be present in the lead sulphide in submicroscopic sizes, perhaps in solid solution. Hence, this metal likely will concentrate with galena.

Conclusions from Investigation:

In the treatment of this ore by the various procedures as outlined in the test work, there are several pronounced features:

1. The gold values are very amenable to cyanidation.
2. The silver values are not readily cyanided.
3. A high ratio of concentration is obtained by flotation of the lead, silver and gold values, with high recoveries.
4. Fine grinding is not necessary.

In view of these features and of the grade of the ore as submitted for test work, the best method of treatment must depend on certain local and economic conditions.

The highest recovery of the precious metals and of the lead is had by a combined operation of cyanidation of the

⁶ Schneiderhöhn-Ramdohr: "Lehrbuch der Erzmikroskopie, II Band, 1931, pp. 252-3.

(Conclusions from Investigation, cont'd) -

ore and flotation of the cyanide residue, as in Test No. 3.

The primary treatment by cyanidation gives a tailing of 0.0025 ounce gold per ton and an extraction of 97.7 per cent of the gold but only 16.90 per cent of the silver. The secondary operation of flotation raises these recoveries to approximately 99 per cent of the gold in the ore and 94.5 per cent of the silver. Lead recovery is 87.9 per cent in the cleaner concentrate.

Straight cyanidation of the ore, as carried out in Tests Nos. 1 and 4, corroborates the primary results in Test No. 3 to give a tailing of 0.0025 ounce gold per ton and a recovery of 97.7 per cent of the gold in the ore and approximately 17 per cent of the silver.

These tests emulate processes which in practical operation involve high capital expenditure and higher recovery costs. In Test No. 3, shipment to a smelter of the concentrate would be required for ultimate recoveries. In this regard it is doubtful whether the values remaining would be high enough to warrant smelter treatment.

In Test No. 6, a concentration of the values by flotation, with a secondary treatment of the concentrate by cyanidation, gave a lower overall recovery of the gold, amounting to 92.4 per cent, and a very poor recovery of the silver at 12.37 per cent. Lead recovery was 98.4 per cent.

In so far as the gold recovery is concerned, this procedure would require less capital expenditure and lower operating costs than the processes represented by Test Nos. 1, 3 and 4.

However, inasmuch as ultimate recoveries of the silver and lead values require treatment at a smelter, it would appear that the best procedure would be to recover the gold values in the same operation.

(Conclusions from Investigation, cont'd) -

As in Tests Nos. 2 and 5, a good recovery of gold, silver and lead values could be made comparatively cheaply by flotation with subsequent smelter treatment of the concentrate, if smelter facilities were available under normal contracts.

Capital expenditure and operating costs of the flotation operation should be low and the values confined to a small percentage of the ore weight.

Recoveries are indicated as 93.5 to 95.8 per cent for the gold and 93.5 to 94.3 per cent for the silver. Lead recoveries are 96.7 to 99.3 per cent.

DETAILS OF INVESTIGATIVE TESTS:

Test No. 1.

1,000 grams of ore was ground in a jar mill for 20 minutes to 60.8 per cent minus 200 mesh.
Cyanided at 2 to 1 dilution for 28 hours.

Results:

Assay of head	=	0.11	Au oz./ton
	=	0.71	Ag "
Assay of tailing	=	0.0025	Au "
	=	0.58	Ag "
Extraction of gold	=	97.7	per cent
Extraction of silver	=	18.6	"
NaCN consumed	=	1.04	lb./ton ore
CaO consumed	=	4.60	" "
Reducing power for 1000 cc. of solution	=	80 cc.	$\frac{N}{10}$ KMnO ₄

Test No. 2.

2,000 grams of ore ground to 78 per cent minus 200 mesh.

Reagents Added:

<u>To Grinding -</u>		<u>Lb./ton</u>
Soda ash	-	2.5
Aerofloat No. 31	-	0.07

(Details of Investigative Tests, cont'd) -

To Conditioning -

Pot. amyl xanthate - $\frac{\text{Lb./ton}}{0.10}$ (5 min.)
pH, 7.15.

To Flotation -

Pine oil - - - 0.05 (6 min.)

Results:

Prod- ucts	:Weight, : per : cent	A S S A Y S					Distribution, per cent				
		: Oz./ton : Au	: Ag	: Pb	: Fe	: S	: Au	: Ag	: Pb	: Fe	: S
Flot. conc.	: 3.35	: 2.06	: 20.81	: 43.26	: 4.94	: 7.94	: 93.5	: 93.5	: 96.7	: 7.1	: 96.7
Flot. tail-	:	:	:	:	:	:	:	:	:	:	:
ing	: 96.65	: 0.005	: 0.05	: 0.05	: 2.24	: 0.01	: 6.5	: 6.5	: 3.3	: 92.9	: 3.3
Total	: 100.00	: 0.0738	: 0.745	: 1.497	: 2.33	: 0.275	: 100.0	: 100.0	: 100.0	: 100.0	: 100.0

Ratio of concentration = 29.9 to 1.

Flotation concentrate: 0.60 per cent zinc,
0.35 per cent copper.

Test No. 3.

2,500 grams of ore ground to 78.5 per cent minus 200 mesh. Cyanided for 28 hours at 2 to 1 dilution. Filtered and washed well. Sample cut for assay from moist filter cake.

Results:

Assay of head = 0.11 Au oz./ton
= 0.71 Ag "
Assay of residue = 0.0025 Au "
= 0.59 Ag "
Extraction of gold = 97.7 per cent
Extraction of silver = 16.9 "

Remainder of filter cake repulped and floated.

Reagents Added (lb./ton)

To Conditioning -

(10 min.) pH, 8.0.

Soda ash - 3.0
Aerofloat No. 31 - 0.07
Pot. amyl xanthate - 0.10

To Flotation

(6 min.)

Pine oil - 0.05

To Cleaner -

(5 min.)

Zinc sulphate - 0.10
Sodium cyanide - 0.05

(Details of Investigative Tests, cont'd) -

Results:

Prod- ucts	:Weight, per cent	A S S A Y S					Distribution,				
		Oz./ton		Per Cent			per cent				
		Au	Ag	Pb	Fe	S	Au	Ag	Pb	Fe	S
Cleaner conc.	2.1	0.04	25.68	57.77	3.30	10.64	37.5	89.2	87.9	2.9	90.4
Cleaner tail- ing	2.2	0.02	1.23	3.21	4.73	0.66	19.7	4.5	5.1	4.4	5.8
Flot. tail- ing	95.7	0.001	0.04	0.10	2.29	0.01	42.8	6.3	7.0	92.7	3.8
Total	100.0	.00223	0.604	1.38	2.36	0.247	100.0	100.0	100.0	100.0	100.0

Ratio of concentration = 23.3 to 1.

Cleaner concentrate: 0.45 per cent zinc,
0.77 per cent copper.

Overall extraction: 99.1 gold per cent,
94.4 silver per cent.

Test No. 4.

1,000 grams of ore ground to 89.2 per cent minus
200 mesh. Cyanided at 2 to 1 dilution for 28 hours.

Results:

Assay of head = 0.11 Au oz./ton
= 0.71 Ag "
Assay of residue = 0.0025 Au "
= 0.595 Ag "
Extraction of gold = 97.7 per cent
Extraction of silver = 16.2 "

NaCN consumed,
lb./ton ore = 1.04
CaO consumed,
lb./ton ore = 5.0

Reducing power for
1,000 cc. solution = 100 cc. $\frac{N}{10}$ KMnO₄.

Test No. 5.

2,000 grams ore ground to 78.4 per cent minus
200 mesh.

Reagents added:

<u>To Grinding</u> -	<u>Lb./ton</u>
Soda ash -	3.0
Aerofloat No. 31 -	0.07

(Continued on next page)

(Details of Investigative Tests, cont'd) -

To Conditioning - Lb./ton
 Pot. amyl. xanthate - 0.10 (5 min.) pH 8.9.

To Flotation -
 Pine oil - 0.05 (6 min.)

Results:

Prod-ucts	:Weight, per cent	A S S A Y S					Distribution, per cent					
		: Oz./ton	: Per Cent	: Au	: Ag	: Pb	: Fe	: S	: Au	: Ag	: Pb	: Fe
Flot. conc.	3.2	3.44	22.22	45.40	6.46	8.42	95.8	94.3	99.3	8.1	96.6	
Flot. tail-				trace								
ing	96.8	0.005	0.045	0.001	2.44	0.01	4.2	5.7	0.7	91.9	3.4	
Total	100.0	0.115	0.754	1.46	2.56	0.279	100.0	100.0	100.0	100.0	100.0	

Ratio of concentration = 31.2 to 1.

Flotation concentrate: 0.55 per cent zinc,
 0.48 per cent copper.

Test No. 6.

8,000 grams of ore ground to 79.2 per cent minus 200 mesh. Floated with same reagent combinations as in Test No. 5.

Results:

Prod-ucts	:Weight, per cent	A S S A Y S					Distribution, per cent					
		: Oz./ton	: Per Cent	: Au	: Ag	: Pb	: Fe	: S	: Au	: Ag	: Pb	: Fe
Flot. conc.	4.9	1.86	14.31	30.03	6.51	5.73	95.0	96.7	98.4	12.5	96.6	
Flot. tail-												
ing	95.1	0.005	0.025	0.02	2.34	0.01	5.0	3.3	1.6	87.5	3.4	
Totals	100.0	0.0950	0.725	1.49	2.54	0.29	100.0	100.0	100.0	100.0	100.0	

Ratio of concentration = 20.4 to 1.

Flotation concentrate: 0.55 per cent zinc,
 0.29 per cent copper.

235 grams of flotation concentrates cyanided at 4 to 1 dilution for 48 hours without regrinding.

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(Details of Investigative Tests, cont'd) -

Results:

Assay of flotation concentrate	= 1.86 Au oz./ton
	= 14.31 Ag "
Assay of residue	= 0.05 Au "
	= 12.48 Ag "
Extraction of gold	= 97.3 per cent
Extraction of silver	= 12.8 "
NaCN consumed, lb./ton concentrate	= 7.04 "
CaO consumed, lb./ton concentrate	= 15.92 "
Reducing power for 1,000 cc. solution	= 800 cc. N KMnO ₄ . 10
Overall recovery:	= 92.43 gold per cent, = 12.37 silver per cent

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