O T T A W A June 3rd, 1944.

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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES

Investigation No. 1643.

Amalgamation and Concentration Tests on an Oxidized Gold Ore from the Michipicoten Area, Algoma District, Ontario.

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Bureau of Mines
Division of Metallic
Minerals
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Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Shipment:

A shipment of two sacks of ore, total weight 210 pounds, was received on March 14th, 1944. The ore was taken from Claim No. 9074, Township 29, Range 24, in the district of Algoma, Ontario, and was submitted by J. N. Morrison, of Wawa, Ontario.

Purpose of the Investigation:

The owners propose to treat the ore in a 5-ton Gibson mill and use a Deister table to make a shipping grade of concentrate if amalgamation proves unsatisfactory. Information was requested as to the disposal of the concentrate to a mill or smelter for treatment.

Sampling and Analysis:

The ore was crushed and sampled by standard methods and was found to contain:

Gold	-	0.175 oz./ton.
Silver	-	0.225 "
Arsenic	-	7.36 per cent
Iron		25.8 "

Results of Experimental Tests:

Amalgamation during grind in ball mill resulted in practically no recovery.

Barrel amalgamation recovered $1.92 and consumed approximately 125 pounds of lime, per ton of ore. The mercury is subject to flouring and fouling due to arsenopyrite.

Table and blanket concentration, followed by amalgamation of the concentrates, recovered 13.7 per cent of the gold, or 92 cents per ton of ore.

Separation of pyrite from arsenopyrite shows that the arsenopyrite carries more gold than does pyrite.

Character of the Ore:

A microscopic examination of polished sections made from selected pieces of ore showed the following:

Gangue:

The ore is so badly oxidized that it is friable, and the polished sections were made with difficulty. The gangue material appears to be mostly coarse white quartz. It is extensively stained and coated with rusty brown iron oxides.

Metallic Minerals:

Metallization is heavy in the polished surfaces and is represented very largely by pyrite and arsenopyrite. These two sulphides are present in almost equal amounts as medium coarse admixtures in gangue. Both minerals are shattered and

(Metallic Minerals, cont'd) -

contain numerous inclusions and veinlets of gangue.

"Limonite" is abundantly visible, rimming and veining sulphides, as well as stains and grains in gangue. Very small quantities of chalcopyrite and pyrrhotite occur as occasional to rare tiny particles in pyrite.

Neither native gold nor gold minerals are visible in the polished sections. The mode of occurrence of gold was not determined.

Investigative Procedure:

The investigation included the following:

1. Amalgamation in the ball mill.
2. Amalgamation by barrel amalgamation without sufficient lime to make an alkaline pulp.
3. Amalgamation in alkaline pulp.
4. Table concentration at various grinds.
5. Table and blanket concentration, with amalgamation of concentrates.
6. Table concentration of a sized feed, with separation of pyrite from arsenopyrite.

EXPERIMENTAL TESTS:

Test No. 1. - Amalgamation.

In this test mercury was added to the ball mill during the grind. No lime was added to the ore.

The sample of ore was ground to 72 per cent -200 mesh in a ball mill, at a dilution of four parts ore to three parts water. Mercury was added to the ore at the rate of 10 per cent of the weight of the charge of ore.

No lime was added to the ball mill. This condition is known as a natural pulp. The water showed a fairly strong acid action after grinding.

The mercury was dispersed in the ore in very tiny particles and only about one-half of it was recovered. When

(Experimental Tests, cont'd) -

in this condition the mercury is said to be floured. Part of it was coated with sulphides (arsenopyrite) and could not be coalesced into a liquid form. The arsenopyrite tends to react with mercury and prevent amalgamation. The mercury in this condition is said to be fouled.

After separating the mercury the ore was sampled and assayed for gold. Assuming the head assay of the sample as 0.175 ounce per ton, the amalgamation tailing assayed 0.170 ounce per ton. The results indicate practically no recovery of gold in this test.

Test No. 2. - Amalgamation.

In this test the ore was ground 72 per cent -200 mesh and then barrel-amalgamated, with lime added to the ground ore in the amalgam barrel.

The ore was ground, without mercury, in the ball mill. Mercury was then added to the amalgam barrel (10 per cent of the weight of the ore) with lime at the rate of 20 pounds of lime per ton of ore.

At the end, the mercury showed considerable flouring, some fouling, and did not coalesce completely. After separation of the mercury the tailing was assayed.

Results:

Assays, Au oz./ton		Recovery of gold, per cent	Reagents used, lb./ ton-ore
Feed	Tailing		CaO
0.175	0.145	17.1	20.0

The water showed acidity after the amalgamation, indicating that the lime was consumed.

Assuming the value of gold at $38.50 per ounce, the value of the gold in the feed is $6.75 approximately and the

(Experimental Tests, cont'd) -

recovery, 17.1 per cent, is $1.55 per ton.

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Test No. 3 - Amalgamation.

In this test lime was added to the pulp until it remained alkaline.

The ore was ground in water to 72 per cent -200 mesh. The water from the pulp had a pH of 4.2. The ground ore was placed in an amalgam barrel and lime was added at intervals until the pH remained at 8.2 (alkaline). This required lime at the rate of 120 pounds lime per ton of ore. Mercury was then added to the ore (10 per cent of weight of the ore) and the amalgamation was completed. Additional lime had to be added during the amalgamation, to hold up the alkalinity of the pulp.

Results:

Assays, Au oz./ton		Recovery of gold, per cent	Reagents used, lb./ton ore
Feed	Tailing		CaO
0.175	0.125	28.6	125

The mercury was fairly clean, only a little floured mercury being seen.

The recovery was 28.6 per cent, or $1.92 per ton.

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Test No. 4. - Table Concentration.

The following tests were made to note the effect of grinding, to various degrees of fineness, on the grade of concentrate and recovery of gold. Samples of ore were ground in a ball mill at a dilution of four parts ore to three parts water, for various periods of time. The pulps were concentrated on a Wilfley table. The products of each test included a concentrate, tailing and slimes tailing. A screen test was

(Experimental Tests, cont'd) -

made on each to show the degree of grinding.

Results:

Products	Weight, per cent	Assays: Au, Oz./ton	Assays: As, per cent	Distribution of gold, per cent	Ratio of concentration	Grind per cent minus 200 mesh
Feed	100.0	0.18	--	100.0		45
Concentrate	8.9	0.54	13.5	26.8	11.2:1	--
Tailing	68.7	0.13	--	49.6	--	--
Slimes	22.4	0.19	--	23.6	--	--
Feed	100.0	0.18	--	100.0	--	60
Concentrate	6.8	0.62	10.90	23.2	14.6:1	--
Tailing	61.3	0.135	--	45.3	--	--
Slimes	31.9	0.18	--	31.5	--	--
Feed	100.0	0.17	--	100.0	--	70
Concentrate	5.2	0.56	7.71	16.7	19.3:1	--
Tailing	50.3	0.13	--	37.4	--	--
Slimes	44.5	0.18	--	45.9	--	--
Feed	100.0	0.18	--	100.0	--	83
Concentrate	9.6	0.51	10.9	27.5	10.4:1	--
Tailing	55.0	0.125	--	38.7	--	--
Slimes	35.4	0.170	--	33 8	--	--
Feed	100.0	0.18	--	100.0	--	92
Concentrate	3.5	0.75	13.4	14.7	28.6:1	--
Tailing	60.2	0.145	--	48.8	--	--
Slimes	36.3	0.18	--	36.5	--	--

The results show that as the grind becomes finer, more gold is lost in the tailings and more slime product is made which carries gold.

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Test No. 5. - Amalgamation of Table and Blanket Sulphide Concentrates.

This test was made to determine the recovery of gold by amalgamation of the sulphide concentrates obtained from table and blanket concentration.

A sample of ore was ground 70 per cent -200 mesh and concentrated on a Wilfley table. The table tailings were passed over corduroy blankets sloping 1½ inches in 12 inches. A blanket concentrate was recovered. Each concentrate was examined under a microscope for free gold, but none could be

(Experimental Tests, cont'd) -

found.

These concentrates were reground to 99 per cent through 325 mesh and then barrel-amalgamated separately. The mercury showed some fouling and flouring. Lime was used for the amalgamation.

Both the amalgamated concentrates and the mercury were assayed, and a screen analysis of the blanket tailing was made to show the distribution of gold in the various-sized portions of the blanket tailing.

Results:

Table Concentration.

Products	Weight, per cent	Assay Au oz./ton	Distribution of gold, per cent	Ratio of concentration
Feed	100.0	0.19	100.0	--
Table conc.	9.3	0.53	25.4	1.1:1
Table tailing	90.7	0.16	74.6	--

Blanket Concentration.

Products	Weight, per cent	Assay Au oz./ton	Distribution of gold, per cent	Ratio of concentration
Blanket feed	90.7	0.16	100.0	--
Blanket conc.	3.6	0.56	14.1	25.5:1
Blanket tailing	87.1	0.14	85.9	--

Amalgamation of the Concentrates.

Products	Assays, Au oz./ton Feed	Assays, Au oz./ton Tailing	Recovery of gold, per cent	Recovery in terms of feed, per cent	
Table conc.	0.53	0.40	24.53	6.24	= 13.73
Blanket conc.	0.56	0.16	71.43	7.49	

	Per cent
Gold recovered as bullion -	- 13.73
Gold left in blanket tailing -	- 64.10
Gold left in amalgamated table concentrate -	19.18
Gold left in amalgamated blanket concentrate -	2.99
	100.00

(Continued on next page)

(Experimental Tests, cont'd) -

Value of gold recovered from the ore -

Assuming gold at $38.50 per ounce, the head assay of the shipment was 0.175 ounces, or $6.75 per ton; and 13.73 per cent of the gold was recovered, or 92 cents per ton.

Screen Analysis of the Blanket Tailing -

A sample of the blanket tailing was screened on 48-, 65-, 100-, 150-, and 200-mesh screens. Each fraction was assayed and the distribution of the gold was calculated in terms of the contents of the blanket tailing and of the original feed used in the test.

Mesh No.	Weight, per cent	Assays: Au oz./ton	Distribution of gold, per cent: In Tailing	In Original Feed
Feed	100.0	0.14	100.0	64.1
+48	--	--	--	--
-48+65	2.8	0.281	5.6	3.6
-65+100	--	--	--	--
-100+150	8.6	0.065	4.0	2.5
-150+200	14.1	0.09	9.0	5.7
-200	74.5	0.155	81.4	52.3

This test shows that 52.3 per cent of the gold in the original feed remains in the -200 mesh portion of the final tailing.

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Test No. 6. - Table Concentration of Sized Feed.

This test was made to determine the recovery of gold when a sized-feed is concentrated. A portion of the sulphide concentrates was used to make a separation of pyrite from arsenopyrite to determine the gold content of each.

A sample of the ore was ground to pass 14 mesh and then screened on the following screens, 20, 48, 100, 150 and 200 mesh, from which the following products were obtained: -14+20, -20+48, -48+100, -100+150, -150+200, and -200. From each size an assay sample was cut out and the balance was

(Experimental Tests, cont'd) -

concentrated on a Wilfley table. The +100 mesh table tailings were reground to -100 mesh and reconcentrated. A portion of the minus 100 mesh sulphide concentrate, so obtained, was then reconcentrated on a Haultain superpanner to make a separation of pyrite from arsenopyrite.

The various table concentrates were examined microscopically for free gold, but none could be seen in the samples. A sample of each concentrate was assayed. From these results, the value of the combined concentrates was calculated.

The combined tailing included the original -100 mesh tailing together with the tailing from the reground ore from the +100 mesh table middlings and tailings.

The results of the test are tabulated as follows:

Results:

Analysis of Sized Products.

Product	Weight, per cent	Assay, Au oz./ton	Distribution of gold, per cent
Feed (calc.)	100.0	0.22	100.0
-14+20 mesh	13.6	0.13	8.0
-20+48 "	37.0	0.15	25.0
-48+100 "	15.5	0.15	10.5
-100+150 mesh	5.8	0.165	4.3
-150+200 "	5.4	1.145	28.0
-200 "	22.7	0.24	24.2

Table Concentration of Sized Products.

Product	Weight, per cent	Assay, Au oz./ton	Distribution of gold, per cent	Ratio of concentration
Feed	100.00	0.15	100.00	--
-14+20 mesh conc.	0.77	0.42	2.15	130:1
-20+48 " "	3.65	0.36	8.73	27:1
-48+100 " "	0.98	0.50	3.26	102:1
-100 mesh conc.	3.64	0.55	13.33	27:1
Combined conc.	9.04	0.46	27.47	11:1
" tailing.	90.96	0.12	72.53	--

(Continued on next page)

(Experimental Tests, cont'd) -

Separation of Pyrite from Arsenopyrite.

Products	Weight, per cent		Assays,	Distribution, per cent		Ratio of
	In test	In orig. feed	Au oz./ton	In test	In orig. feed	concentration
Feed (-100 mesh conc.)	100.0	9.04	0.57	100.0	27.47	--
-100 mesh pyrite	85.4	7.72	0.38	57.0	15.65	1.2:1
-100 mesh arsenopyrite	14.6	1.32	1.678	43.0	11.82	6.8:1

Distribution of Gold in Test -

Feed - 0.15 oz. at $38.50 = $5.78 per ton of ore.
Combined concentrate - 27.47 x .15 x 38.50 = $1.59 " " " "
Combined tailing - 72.53 x .15 x 38.50 = $4.19 " " " "

Assuming the sample to be the same as the deposit, the concentrate recovered from one ton of ore would be worth $1.59.

The results indicate that from 100 tons of ore similar in grade to that of the shipment, 9.0 tons of concentrate would be obtained. Of this amount, approximately 7.7 tons would be pyrite and 1.3 tons would be arsenopyrite. The assay of the combined concentrates would likely be approximately one-half ounce of gold per ton of concentrate.

Microscopic Examination of Concentrates:

The microscopic examination of the concentrates showed the following:

-14+20 Mesh Concentrate -

A portion of the particles appeared to be solid sulphide, but a large number of the particles appeared to contain mixtures made up of both arsenopyrite, pyrite, and gangue; while others showed gangue attached to sulphides, indicating that the concentrate should be ground finer to liberate the sulphides from gangue or from arsenopyrite and pyrite.

-20+48 Mesh Concentrate -

The same conditions were observed in this concentrate

(Experimental Tests, cont'd) -

as occurred in the -14+20 mesh concentrate. The amount of gangue-attached sulphides was relatively less, however.

-48+100 Mesh Concentrate -

This concentrate was relatively free of gangue-attached sulphides. A few particles of free quartz were noticed in the concentrate.

-100 Mesh Concentrate -

This concentrate appeared to be free of gangue.

-100 Mesh Pyrite Concentrate -

This concentrate was free of gangue but a few particles of arsenopyrite appeared to be present; the amount was small.

-100 Mesh Arsenopyrite Concentrate -

This concentrate was free of gangue but contained some rusty-looking particles among the clean bright arsenopyrite. A few particles of pyrite were also seen in the concentrate.

No free gold was seen in any of the products.

CONCLUSIONS:

The sample of ore submitted for the investigation is low grade, containing $6.75 in gold.

The highest amount recovered by direct barrel amalgamation of the ore was $1.92.

Concentrating the ore, regrinding the concentrate to -325 mesh, and barrel-amalgamating this concentrate, did not increase the recovery of gold. Only 92 cents in gold was recovered by this method. Over 52 per cent of the gold remaining in the tailing was reported in the -200 mesh portion of the tailing.

Concentrating and separating the sulphides indicated

(Conclusions, cont'd) -

that 11.8 per cent of the gold in the sulphides is carried in the arsenopyrite and could not be recovered by amalgamation.

Ore similar in character to this shipment would be difficult to treat by amalgamation, as fouling of the mercury may be expected. Although no free gold could be found, the amount recovered by amalgamation was 0.05 ounce per ton, or 28.6 per cent of the gold in the ore.

It is evident that amalgamation would prove unprofitable on ore of this type and grade.

Table concentration is best carried out with a sized feed. In practice, the ball mill discharge is sized in a hydraulic classifier having several sorting columns. The spigot discharge from each is fed to a separate table. The slimes go to a settling cone, the underflow of the cone is then concentrated on a slimes table, and the cone overflow is run to the tailing. Facilities for regrinding the coarse table middling and tailing are generally provided and the reground ore is recirculated through the classifier.

The concentrate recovered by table concentration would carry up to 13 per cent arsenic and would most likely require roasting prior to cyanidation.

Enquiry should be made of various mills in the neighbouring mining camps which now utilize the roasting-and-cyanidation process, whether they would buy such a concentrate.

The concentrate appears to be too low grade to be able to carry high freight or treatment charges.

The ore as represented by the sample furnished, is too low grade and too refractory to yield a profit if treated by the proposed method of table concentration and amalgamation.

The results of this investigation can only apply to the type of ore received in the shipment.

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