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INVESTIGATION OF A GOLD ORE FROM SAPAWE GOLD MINES LIMITED, SAPAWE, ONTARIO

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The sample of ore contained free-milling gold with a head analysis of 0.463 oz Au/ton.

Straight amalgamation of the ore ground to 50.1% -200 m gave a gold recovery of 77.9%. When this was followed by the cyanidation of the amalgamation residue a recovery of 96.9% of the gold was obtained.

Straight cyanidation of the ground ore (50.1% -200 m) for 24 hr, 48 hr and 72 hr gave a recovery of 95.7%, 96.1% and 97.0% respectively.

In Test 10 the amalgamation of a jig concentrate followed by cyanidation of the amalgamation residue and a sulphide flotation concentrate gave an overall gold recovery of 92.5%.

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INTRODUCTION

The Sapawe Gold Mines Limited, formerly Lindsay Exploration Limited is a gold prospect located in McCaul township, 15 miles east of Atikokan in northwestern Ontario. Grant and Oja Limited, Suite 2, Phoenix Bldg., Port Arthur, Ontario, a firm of consulting engineers for the company, asked the Mines Branch in Ottawa to do a series of tests on a sample of the gold ore from this property to determine the ore dressing method best suited to maximum gold recovery. A previous investigation by Technical Service Laboratories at Swastika, Ontario, indicated that the free-milling gold in the ore made jig concentration and amalgamation, flotation and cyanidation necessary for maximum gold recovery.

Shipment

On December 21, 1962, a sample of 5 burlap bags containing 378 lb of -1/2 in. ore was received at the Mines Branch.

Sampling and Analysis

Several specimens representative of the ore were selected for a mineralogical examination and the remainder of the shipment was crushed to -10 m. A head sample was carefully riffled from the crushed ore for a spectrographic and a chemical analysis. The remainder of the shipment was then riffled into 2 parts one of which was split into 2000 g test samples for the investigation. The remainder of the crushed ore was bagged for future use.

The semi-quantitative spectrographic analysis showed that apart from gold which was not determined there were no elements in the ore in economic amounts.

The results of the chemical analysis are shown in Table 1.

TABLE 1

Chemical Analysis* of Head Sample

Element	
Gold (Au)	0.463 oz/ton
Silver (Ag)	0.140 " "
Iron (Soluble Fe)	1.81 %
Sulphur (Total S)	0.40 %

* From Internal Report MS-AC-63-227

MINERALOGICAL EXAMINATION*

Method of Examination

Four polished sections were prepared and studied microscopically.

Results of Examination

The metallic minerals present are pyrite, chalcopyrite, pyrrhotite, goethite and gold. The non metallic mineral is quartz.

Pyrite, which occurs as isolated grains, ranging in size from 1 to 1500 microns in diameter, contains inclusions of gold (see Figure 1). chalcopyrite and pyrrhotite. The gold inclusions vary in size from nearly sub-microscopic sizes to about 20 microns in diameter. The chalcopyrite and pyrrhotite inclusions range from about 1 to 25 microns in diameter. Chalcopyrite also occurs in quartz.

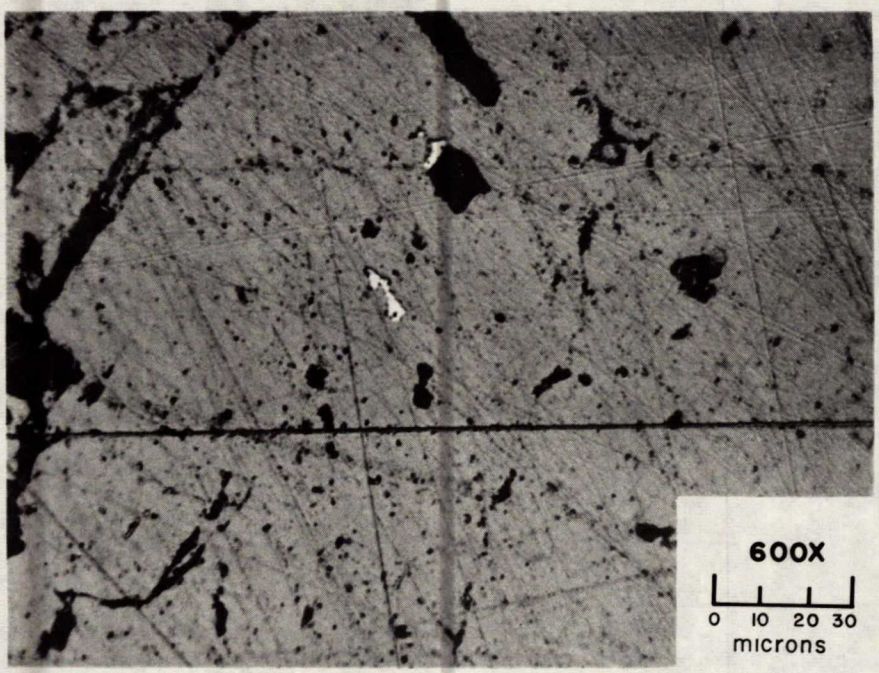

Figure 1 - Photomicrograph of a polished section showing gold inclusions (white) in pyrite (grey).

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* From Mines Branch Test Report M-63-11 by Dr. W. Petruk, March 14, 1963.

Conclusion

As no coarse free gold was seen the most significant mineral relationship that might affect the treatment of this ore is the occurrence of all of the gold observed as comparatively tiny grains enclosed within pyrite.

DETAILS OF INVESTIGATION

Test 1

A 1000 g sample of the -10 m ore was ground to 50.1% -200 m and was amalgamated for 2 hr with 15 ml Hg and 2.0 lb lime/ton. The amalgam and the amalgamation residue were analysed for gold.

TABLE 2

Results* of Amalgamation of Ground Ore

Hg - Amalgam	0.377 oz/ton
Amalgamation residue	0.107 " "
Head (calcl)	0.484 " "
Extraction %, Au	77.9

* From Internal Report MS-AC-63-201

Test 2

This test duplicated Test 1 as far as the amalgamation stage was concerned. The amalgamation residue was cyanided for 48 hr at a solution strength of 0.5 lb NaCN and 0.5 lb CaO/ton. The consumption of these elements during cyanidation was 0.08 lb NaCN and 0.72 lb CaO/ton ore.

The results of this test is shown in Table 3.

TABLE 3

Results* of Amalgamation and Cyanidation of Ground Ore

** Head	0.484 oz/ton
Hg-Amalgam	0.370 " "
Extraction %, Au	76.4
Cyanidation head	0.114 oz/ton
Cyanidation residue	0.015 " "
*** Extraction %, Au	86.8

* From Internal Report MS-AC-63-201

** Head assay used is that calculated for Test 1

*** Calculated by difference.

The overall recovery of gold in this test was as follows:

By amalgamation - 76.4 %
By cyanidation - 20.5 %

Total recovery - 96.9 %

Tests 3, 4, and 5

Three 1000 g samples of -10 m ore were ground to about 50% -200 m and were cyanided for 24 hr, 48 hr and 72 hr at a dilution of 2:1 and a solution strength of 0.5 lb NaCN and 0.5 lb CaO/ton. The results of these straight cyanidation tests on the ore are shown in the following table.

TABLE 4

Results* of Straight Cyanidation of Ground Ore

Test No	3	4	5
Agitation time, hr	24	48	72
Reagent consumption lb/ton ore, NaCN	0.20	0.32	0.40
CaO	1.20	1.60	1.76
Reducing power of solutions, ml N/10 $KMnO_4$/l	negligible		
Cyanidation residue, oz/ton Au	0.02	0.018	0.014
** Extraction %, Au	95.7	96.1	97.0

* From Internal Report MS-AC-63-251

** Extraction was calculated by difference from a head analysis of 0.463 oz Au/ton.

Test 6

About 4000 g of -10 m ore was ground to 28.1% -200 m and was jigged in a Denver laboratory jig. The jig concentrate which included the jig bed, was ground and was amalgamated for 1 hr with 15 ml Hg and 0.5 g lime. The amalgam and the amalgamation residue were analysed for gold. The jig tailing was ground to 53.1% -200 m, and was floated using the following flotation scheme.

To grinding	-	$CuSO_4$	- 0.25 lb/ton
		Aero Xanthate 301	- 0.10 " "
		Aerofloat 208	- 0.10 " "
To conditioning (2 min)	-	Aero Xanthate 301	- 0.02 " "
		Aerofloat 208	- 0.02 " "
		Aerofloat 15	- 0.02 " "
To flotation (3 min)	-	pine oil	- 0.02 " "
To conditioning (1 min)	-	Aero Xanthate 301	- 0.02 " "
		Aerofloat 208	- 0.02 " "
To flotation (1 min)	-	pine oil	- 0.02 " "

The rougher concentrate obtained was cleaned once with no additional reagents and the flotation tailing was cyanided for 24 hr at a dilution of 2:1 and a solution strength of 0.5 lb NaCN and 0.5 lb CaO/ton. The results of this test may be seen in Tables 5A, 5B and 5C.

TABLE 5-A

Results of Jigging and Amalgamation - Test 6

Product	Weight %	Analysis * oz/ton Au	Distribution % Au
Amalgam	----	3.844 **	35.4
Amalgamation residue	4.9	0.445	4.1
Jig tailing	95.1	0.340	60.5
Head (calcd)	100.0	0.534	100.0

* From Internal Report MS-AC-63-201

** Amalgam assay expressed in oz/ton of jig concentrate.

The amalgamation recovery was 89.6 % of the gold contained in the jig concentrate.

TABLE 5-B

Results of Flotation - Test 6

Product	Weight %	Analysis* oz/ton Au	Distribution % Au
Sulphide cl conc	1.0	26.870	80.3
Sulphide cl tail	2.7	0.655	5.3
Flotation tail	96.3	0.050	14.4
Head (calcd)	100.0	0.334	100.0

* From Internal Report MS-AC-63-262

TABLE 5-C

Results of Cyanidation - Test 6

Reagent Consumption lb/ton Ore		Residue* oz/ton Au	Extraction** % Au
NaCN	CaO		
0.12	0.68	0.013	74.0

* From Internal Report MS-AC-63-262

** Extraction was calculated by difference from a head analysis of 0.050 oz Au/ton.

A summary of the overall recovery of gold in Test 6 follows:

By amalgamation	-	35.4 %
By rougher flotation *	-	54.9 %
By cyanidation	-	6.4 %
Total recovery	-	96.7 %

* It has been assumed that 80% of the gold contained in the amalgamation residue would be recovered by flotation.

Test 7

About 4000 g of -10 m ore was ground to 47.7% -200 m. This test differed from Test 6 in that a finer grind was used and only half the quantity of flotation reagents were used with no Aerofloat 15. The results may be seen in the following tables.

TABLE 6-A

Results of Jigging and Amalgamation - Test 7

Product	Weight %	Analysis * oz/ton Au	Distribution % Au
Amalgam	----	3.846**	30.2
Amalgamation residue	3.9	0.175	1.4
Jig tailing	96.1	0.355	68.4
Head (calcd)	100.0	0.498	100.0

* From Internal Report MS-AC-63-251

** Amalgam assay expressed in oz/ton of jig concentrate

The amalgamation recovery was 95.6 per cent of the gold contained in the jig concentrate.

TABLE 6-B

Results of Flotation - Test 7

Product	Weight %	Analysis * oz/ton Au	Distribution % Au
Sulphide rougher conc	5.0	4.750	67.6
Sulphide " tail	95.0	0.120	32.4
Head (calcd)	100.0	0.352	100.0

* From Internal Report MS-AC-63-251

TABLE 6-C

Results of Cyanidation Test 7

Reagent Consumption lb/ton Ore		Residue*	Extraction**
NaCN	CaO	oz/ton Au	% Au
0.12	0.68	0.015	87.5

* From Internal Report MS-AC-63-262

** Extraction was calculated by difference from a head analysis of 0.120 oz Au/ton.

The overall recovery of gold in Test 7 follows:

By amalgamation	-	30.2%
By rougher flotation*	-	47.0%
By cyanidation	-	18.3%
Total recovery	-	95.5%

* It has been assumed that 60% of the gold contained in the amalgamation residue would be recovered by flotation.

Test 8

To determine whether finer grinding and increased flotation reagents and time would result in an increased gold recovery, 2000 g of -10 m ore was ground to 68.3% -200 m and without prior jigging the ground pulp was floated using the same reagents used in Test 7. The quantities of these reagents were increased slightly ie (Aero Xanthate 301 - 0.14 to 0.16 lb/ton). (Aerofloat 208 - 0.14 to 0.16 lb/ton) and (Aerofloat 15 - 0.02 to 0.04 lb/ton). The main feature of this test however was the finer grind and the increased flotation time of 10 min. There were no reagents used in the two cleaner stages. The results of this test are shown in Table 7.

TABLE 7

Results of Flotation Test 8

Product	Weight %	Analysis* oz/ton Au	Distribution % Au
Sulphide recl conc	0.4	67.72	61.5
Sulphide recl tail	0.7	4.08	6.5
Sulphide cl tail	5.8	1.465	19.3
Flotation tail	93.1	0.06	12.7**
Head (calcl)	100.0	0.440	100.0

* From Internal Report MS-AC-63-262

** The absence of jigging in this test undoubtedly accounted for a large percentage of the gold in the flotation tailing.

Test 9

A 2000 g sample of -10 m ore was ground to about 28% -200 m and jigged in a Denver laboratory jig. The jig conc was combined with the jig bed and was ground and amalgamated for 1 hr with 10 ml Hg and 0.5 g lime. The jig tailing was then reground and floated similarily to Test 8. The sulphide rougher concentrate was cleaned once with no additional reagents. The flotation tailing was cyanided for 24 hr at a dilution of 2:1 and a solution strength of 0.5 lb NaCN and 0.5 lb CaO/ton.

The results of this test are shown in the following tables.

TABLE 7-A

Results of Amalgamation and Flotation Test 9

Product	Weight %	Analysis* oz/ton Au	Distribution % Au
Amalgam	---	2.470**	29.2
Amalgamation residue	5.4	0.150	1.8
Sulphide cl conc	1.2	22.150	57.6
Sulphide cl tail	4.8	0.495	5.1
Flotation tail	88.6	0.033	6.3
Head (calcd)	100.0	0.462	100.0

* From Internal Report MS-AC-63-392

** Amalgam assay is expressed in oz/ton of jig concentrate.

The amalgamation recovery was 94.3 per cent of the gold contained in the jig concentrate.

TABLE 7-B

Results of Cyanidation Test 9

Reagent Consumption lb/ton Ore		Residue*	Extraction **
NaCN	CaO	oz/ton Au	% Au
0.2	0.8	0.005	84.8

* From Internal Report MS-AC-63-392

** Extraction was calculated by difference from a head analysis of 0.033 oz Au/ton.

The overall recovery of gold in Test 9 follows:

By amalgamation of jig concentrate	- 29.2%
By rougher flotation *	- 63.8%
By cyanidation of flotation tailing	- 5.3%
Total recovery	- 98.3%

* It has been assumed that 60% of the gold contained in the amalgamation residue would be recovered by flotation.

Test 10

About 8000 g of -10 m ore was riffled from the shipment and was ground to about 28% -200 m. The sample was jigged in a Denver laboratory jig and the jig concentrate plus the bed was ground and amalgamated for 1 hr with 10 ml Hg and 0.5 g lime. The amalgam and the residue were analysed for gold and a portion of the latter was cyanided for 24 hr at 5:1 dilution and a solution strength of 1.0 lb NaCN/ton and 1.0 lb CaO/ton.

The jig tailing was ground to 70.1% -200 m and the sulphides were floated for 10 min using the same reagents which were used in Test 8. This concentrate was cleaned once.

The sulphide cleaner concentrate was split into two fractions. One of these was cyanided directly for 48 hr at a dilution of 5:1 and a solution strength of 1.0 lb NaCN/ton and 1.0 lb CaO/ton. The other fraction was amalgamated for 1 hr with 10 ml Hg and 0.5 g lime. The amalgam and the residue were analysed for gold and a portion of the latter was cyanided for 24 hr at a dilution of 5:1 and a solution strength of 1.0 lb NaCN/ton and 1.0 lb CaO/ton.

Table 8-A and 8-B show the results which were obtained in this test.

TABLE 8-A

Results of Amalgamation and Flotation - Test 10

Product	Weight %	Analysis* oz/ton Au	Distribution % Au
** Amalgam from jig conc	--	3.73	29.8
Amalgamation residue	3.8	0.18	1.4
Jig conc and bed (calcd)	3.8	3.91	31.2
** Amalgam from Sulphide cl conc	--	8.34***	47.4
Amalgamation residue	2.7	2.55	14.5
Sulphide cl conc (calcd)	2.7	10.89	61.9
Sulphide cl tail	6.4	0.105	1.4
Flotation tail	87.1	0.03	5.5
Head (calcd)	100.0	0.475	100.0

* From Internal Report MS-AC-63-392

** Amalgam assays expressed in oz/ton of amalgamation residue - 95.4% and 76.8% of the gold in the jig and the sulphide cl conc respectively was recovered by amalgamation.

*** For purposes of calculating the metallurgical balance it was assumed that all of the sulphide cl conc was amalgamated. Actually 100 g of this was cyanided directly.

TABLE 8-B

Results of Cyanidation Test 10

Product	Reagent Consumption lb/ton ore		Feed Au oz/ton	Residue* Au oz/ton	Recovery** Au %
	NaCN	CaO			
Amalgamation residue from jig conc	0.08	0.36	0.18	0.015	91.7
Amalgamation residue from flot cl conc	0.28	0.32	2.55	0.125	95.1
Flotation cl conc	1.10	1.52	10.89	0.140	98.7

* From Internal Report MS-AC-63-392

** Calculated by difference.

The several treatment combinations gave the following overall recoveries of the gold:

1.	Amalgamation of jig concentrate and bed	-	29.8%
	Amalgamation of sulphide cleaner concentrate	-	47.4%
	Total recovery	-	77.2%
2.	Amalgamation of jig concentrate and bed	-	29.8%
	Cyanidation of amalgamation residue (91.7% recovery)	-	1.3%
	Cyanidation of sulphide cleaner concentrate (98.7% recovery)	-	60.1%
	Assume 90% cyanide recovery of gold in sulphide cleaner tailing	-	1.3%
	Total recovery	-	92.5%
3.	Amalgamation of jig concentrate and bed	-	29.8%
	Cyanidation of amalgamation residue (91.7% recovery)	-	1.3%
	Amalgamation of sulphide cleaner concentrate	-	47.4%
	Cyanidation of amalgamation residue (95.1% recovery)	-	13.8%
	Assume 90% cyanide recovery of gold in sulphide cleaner tailing	-	1.3%
	Total recovery	-	93.6%

CONCLUSIONS

The gold in this ore is readily recoverable by straight cyanidation or by amalgamation followed by cyanidation. The test work shows that between 95% and 97% of the gold can be recovered by this method.

Approximately 75% of the gold is free-milling at a relatively coarse grind and therefore the flowsheet should include some method of recovering this free-milling gold as soon after liberation as possible. This is normally done by placing a jig between the ball mill and the classifier.

If management is considering a low capital cost plant, the flowsheet outlined in Test 10-2 might be suitable. In this test 92.5% of the gold was recovered by the amalgamation of a jig concentrate followed by the cyanidation of a sulphide flotation concentrate and the amalgamation residue. In this test the 3.8% of the feed recovered as a jig concentrate was considerably higher than that which would be obtained in a full sized plant. Based on a 100 ton per day operation, batch cyanidation of a jig-amalgamation residue and a flotation concentrate would entail the cyanidation of between 6 or 7 tons of material daily.

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TFD:EPH