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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINES BRANCH INVESTIGATION REPORT IR 62-90

INVESTIGATION OF A COMPOSITE SAMPLE FROM THREE NEW ORE ZONES AT MADSEN RED LAKE GOLD MINES LIMITED, MADSEN, ONTARIO

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

This Madsen composite sample of ore contained 0.70 oz Au/ton. Approximately 35% of the gold was free milling and most of the remainder was associated with sulphide minerals.

The procedures used in testing the ore and the results obtained are summarized in the following table.

TABLE 1

Procedures and Results

Test	Procedures	Overall Recovery % Au
1A	Jigging, flotation, roasting of flotation concentrate, cyanidation of calcine and flotation tailing	91.8
1B	Jigging, flotation, roasting of flotation concentrate, treatment of flotation tailing with SO_2, cyanidation of calcine and flotation tailing	93.0
1C	Jigging, cyanidation, desliming, flotation: (i) regrinding and cyanidation of flotation concentrate (ii) roasting, regrinding and cyanidation of flotation concentrate	93.1 - 93.3 94.5

CONTENTS

INTRODUCTION

Location of Property

Madsen Red Lake Gold Mines Limited is a gold producer operating a mine in the Red Lake district, near Madsen, Ontario.

Shipment

A sample weighing 404 lb was received on June 27, 1962, from Madsen Red Lake Gold Mines Limited. The material was described as a composite sample of ore, representing some of the future ore to be mined from three zones, namely, South Austin, No. 3 and No. 4.

Instructions

Mr. A. A. McCloskey, P.Eng., Madsen Red Lake Gold Mines Limited, Suite 1109, 55 Yonge Street, Toronto 1, Ontario, consultant for the company, requested this investigation. He suggested a jig test on the ore sample to recover the free milling gold, amalgamation of the jig concentrate and then the following series of tests to be carried out on the jig tailing:

A - Flotation, roasting of flotation concentrate, cyanidation of calcine and flotation tailing;

B - Flotation, roasting of flotation concentrate, treatment of flotation tailing with SO_2, cyanidation of calcine and flotation tailing;

C - Cyanidation, desliming, flotation, regrinding and cyanidation of the flotation concentrate with and without roasting.

Mr. McCloskey also wished to know the specific gravity and the settling rate of a flotation concentrate, and some infrasizer analyses of the tailings after different stages of treatment.

Sampling and Analysis

All the sample was crushed to $-\frac{1}{2}$ in. and a few representative pieces were selected for mineralogical examination. The remainder was divided into two portions. One of these portions was crushed to -10 m and a one lb head sample was riffled out by conventional methods.

Chemical analysis of the head sample gave the following results:

TABLE 2

Chemical Analysis*

Gold (Au)	-	0.70 oz/ton
Silver (Ag)	-	0.16 "
Arsenic (As)	-	1.21 %
Sulphur (S)	-	2.15 %

* Gold and silver assays from Internal Report MS-AC-62-900, arsenic and sulphur analyses from Certificate of Analysis No. 1677.

A semi-quantitative spectrographic analysis on a portion of the head sample detected the following elements listed in their approximate decreasing order of abundance.

TABLE 3

Semi-Quantitative Spectrographic Analysis*

I	-	Si, Fe
II	-	Al, Ca, Mg, As
III	-	Na, Mn, Cu, Cr
IV	-	Ni, Ba, Zr, Co

* From Internal Report MS-AC-62-881 by E. Kranck, Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch, August 17, 1962.

MINERALOGICAL EXAMINATION*

Microscopic examination of four polished sections indicates that the current sample of ore from the Madsen Red Lake property appears similar to that examined in 1953 (Report M-1318-E, August 19, 1953). This report is inserted in the Mineral Dressing and Process Metallurgy Division Investigation Report No. MD 3001.

The gangue consists of rather fine textured quartz with interstitial crystals and grains of softer minerals probably largely carbonate, chlorite and epidote.

The metallic mineral content is relatively small. Pyrrhotite, the most abundant ore mineral, occurs as large to small irregular masses in the quartz, occasionally associated with coarse grains of pyrite and rare chalcopyrite. Pyrite and arsenopyrite are present in lesser quantities as disseminated grains and crystals, and small grains of magnetite are scattered throughout the quartz.

No native gold or gold minerals (such as tellurides) were observed.

* From Test Report M-62-25 by Dr.M.H.Haycock, Mineralogy Section, Mineral Sciences Division, Mines Branch, August 2, 1962.

DETAILS OF INVESTIGATION

Test 1

Jigging

A 15,000 g sample of ore crushed -10 m was fed to a jig to remove the free milling gold. The results obtained are shown in Table 4.

Table 4

Results of Jigging

Product	Weight %	Assays* oz/ton Au	Distribution % Au
Jig conc	0.5	54.33**	35.3
Jig tail	99.5	0.50	64.7
Feed (calcd)	100.0	0.77	100.0

* From Internal Report MS-AC-62-993

** Calculated from results of amalgamation (see Table 6).

A screen and infrasizer analysis on the jig tailing gave the following results:

TABLE 5

Screen and Infrasizer Analysis

Size	Weight %	Assays* oz/ton Au	Distribution % Au
+200 m	20.4	0.38	15.2
-200 m +40μ	23.7	1.06	49.2
-40μ +28μ	17.2	0.34	11.4
-28μ +20μ	12.6	0.36	8.9
-20μ +10μ	13.8	0.35	9.5
-10μ	12.3	0.24	5.8
Feed (calcd)	100.0	0.51	100.0

* From Internal Report MS-AC-62-993

Amalgamation

The jig concentrate was amalgamated for 1 hr with 10 cc of new mercury and 1 g of lime. The amalgamation gave the following results:

TABLE 6

Results of Amalgamation

Product	Assays* oz/ton Au	Distribution % Au
Amalgam**	53.60	98.7
Residue	0.73	1.3
Feed (calcd)	54.33	100.0

* From Internal Report MS-AC-62-993

** Amalgam assay expressed in terms of amalgamation feed.

Part A

Flotation

A 2,000 g sample, cut from the jig tailing of Test 1, was ground for 20 min to 84% -200 m and floated under the conditions shown in Table 7.

TABLE 7

Reagents and Conditions

Operation	Reagents	lb/ton	Time min	pH
Grinding			20	
Conditioning	$CuSO_4$	1.0	5	6.5 - 7.0
	H_2SO_4	1.0		
	R-301	0.05	5	
	R-208	0.05		
Flotation	At start:		25	7.0 - 7.8
	Pine oil	0.04		
	After 15 min			
	H_2SO_4	0.5		
	R-301	0.05		
	R-208	0.05		
	Pine oil	0.02		

The flotation test gave the following results:

TABLE 8

Results of Flotation

Product	Weight %	Assays*			Distribution %		
		oz/ton	%				
		Au	As	S	Au	As	S
Flotn conc	11.0	2.86	3.05	5.04	65.0	31.2	27.1
Flotn tail	89.0	0.19	0.83	1.68	35.0	68.8	72.9
Feed (calcd)	100.0	0.48	1.07	2.05	100.0	100.0	100.0

* From Internal Report MS-AC-62-940

Roasting

A 160 g sample was cut from the flotation concentrate and roasted for 1 hr at 600°C. The calcine was weighed and a portion of it was assayed with the following results:

TABLE 9

Results of Roasting

Product	Weight lost %	Assays*		
		oz/ton Au	% As	% S
Calcine	7.1	2.90	1.75	0.47

* Gold assay from Internal Report MS-AC-62-940, arsenic and sulphur assay from Certificate of Analysis No. 1677.

Cyanidation

A sample, consisting of 100 g of calcine and 900 g of flotation tailing, was cyanided for 48 hrs at a dilution of 2:1 and at a concentration of 1.0 lb NaCN/ton and 0.2 lb CaO/ton of solution. The results of the cyanidation are summarized in Table 10.

TABLE 10

Results of Cyanidation

Reagent Consumption lb/ton of feed		pH	Reducing Power cc $\frac{N}{10}$ $KMnO_4$/l	Residue Assay* oz/ton Au	Extraction** % Au	Overall*** Recovery % Au
NaCN	CaO					
0.8	2.0	11.5	80	0.058	87.4	91.8

* From Internal Report MS-AC-62-993.
** Calculated by difference.
*** Including jigging and cyanidation.

A screen and infrasizer analysis on a sample of the cyanidation residue showed the following gold distribution:

TABLE 11

Screen and Infrasizer Analysis of the Cyanide Residue

Size	Weight %	Assays* oz/ton Au	Distribution % Au
+200 m	18.4	0.06	19.8
-200 m + 40μ	27.0	0.07	34.0
-40μ + 28μ	17.2	0.04	12.4
-28μ + 20μ	12.1	0.04	8.6
-20μ + 10μ	13.5	0.06	14.6
-10μ	11.8	0.05	10.6
Feed (calcd)	100.0	0.056	100.0

* From Internal Report MS-AC-62-993

Part B

Flotation

A 2,000 g sample, cut from the jig tailing (Test 1) was ground and floated using the same procedure as shown in Table 7.

TABLE 12

Results of Flotation

Product	Weight %	Assays*			Distribution %		
		oz/ton Au	%				
			As	S	Au	As	S
Flotn conc	11.0	3.77	6.40	8.25	80.9	60.3	44.4
Flotn tail	89.0	0.11	0.52	1.29	19.1	39.7	55.6
Feed (calcd)	100.0	0.51	1.17	2.07	100.0	100.0	100.0

* Gold assay from Internal Report MS-AC-62-940, arsenic and sulphur analyses from Certificate of Analysis No. 1677.

The flotation concentrate has a specific gravity of 3.26, a final density of 0.61:1 in parts water to solids by weight, and a settling rate of 0.95, 0.42 and 0.15 ft/hr at dilution of 4:1, 3:1 and 2:1 respectively.

Roasting

A 160 g sample was cut from the flotation concentrate and roasted for 1 hr at 600°C. The calcine was weighed and a portion of it was assayed with the following results:

TABLE 13

Results of Roasting

Product	Weight lost %	Assays*		
		oz/ton Au	%	
			As	S
Calcine	9.7	3.95	2.45	0.63

* Gold assay from Internal Report MS-AC-62-940, arsenic and sulphur analyses from Certificate of Analysis No. 1677.

Treatment with SO_2

A 900 g sample was cut from the flotation tailing and agitated for 2 hrs with SO_2. The material was then thoroughly washed and mixed with 100 g of calcine for cyanidation.

Cyanidation

The combined product was cyanided for 48 hrs at a dilution of 2:1 and at a concentration of 1.0 lb NaCN/ton and 0.2 lb CaO/ton of solution. The following results were obtained.

TABLE 14

Results of Cyanidation

Reagent Consumption lb/ton of feed		pH	Reducing Power cc $\frac{N}{10}$ $KMnO_4$/1	Residue Assay* oz/ton Au	Extraction** % Au	Overall*** Recovery % Au
NaCN	CaO					
1.8	3.6	12.0	108	0.053	89.2	93.0

* From Internal Report MS-AC-62-993
** Calculated by difference
*** Including jigging and cyanidation

A screen and infrasizer analysis on a sample of the cyanide residue showed the following gold distribution:

TABLE 15

Screen and Infrasizer Analysis of the Cyanide Residue

Size	Weight %	Assays* oz/ton Au	Distribution % Au
+200 m	18.4	0.06	22.7
-200 m +40μ	24.9	0.05	25.6
-40μ +28μ	17.3	0.04	14.2
-28μ +20μ	12.9	0.04	10.6
-20μ +10μ	14.0	0.04	11.5
-10μ	12.5	0.06	15.4
Feed (calcd)	100.0	0.049	100.0

* From Internal Report MS-AC-62-993

Part C

Cyanidation

Ten 1,000 g samples, cut from the jig tailing of Test 1, were cyanided for 48 hrs at a dilution of 2:1 and at a concentration of 1.0 lb NaCN/ton and 0.2 lb CaO/ton of solution. The cyanide residues were combined for assay. The results of this test are shown in Table 16.

TABLE 16

Results of Cyanidation

Reagent Consumption lb/ton of feed		pH	Reducing Power cc $\frac{N}{10}$ $KMnO_4$/1	Residue Assay* oz/ton Au	Extraction** % Au	Overall*** Recovery % Au
NaCN	CaO					
1.2	2.8	11.8	240	0.060	88.0	92.2

* From Internal Report MS-AC-62-993
** Calculated by difference
*** Including jigging and cyanidation

Desliming

The combined cyanide residue was deslimed in a cyclone with the following results:

TABLE 17

Results of Desliming

Product	Weight %	Assays*			Distribution %		
		oz/ton Au	%				
			As	S	Au	As	S
O'flow	47.2	0.04	1.05	2.25	30.9	53.3	56.7
U'flow	52.8	0.08	1.03	1.92	69.1	46.7	43.3
Feed (calcd)	100.0	0.06	1.04	2.09	100.0	100.0	100.0

* Gold assays from Internal Report MS-AC-62-940, arsenic and sulphur analyses from Certificate of Analysis No. 1677.

A screen and infrasizer analysis on the above products showed the following gold distribution:

TABLE 18

Screen and Infrasizer Analysis

Size	O'flow			U'flow		
	Weight %	Assays* oz/ton Au	Distribution % Au	Weight %	Assays* oz/ton Au	Distribution % Au
+200 m	-	-	-	33.2	0.07	30.5
-200 m +40 μ	10.0	0.05	10.5	40.3	0.08	42.4
-40 μ +28 μ	20.0	0.04	16.8	16.2	0.06	12.8
-28 μ +20 μ	23.9	0.03	15.1	6.4	0.09	7.6
-20 μ +10 μ	21.9	0.07	32.2	3.9	0.13	6.7
-10 μ	24.2	0.05	25.4	-	-	-
Feed (calcd)	100.0	0.048	100.0	100.0	0.076	100.0

* From Internal Report MS-AC-62-1136

Flotation

Two 2,000 g samples, cut from the U'flow, were ground for 20 min to 84% -200 m and floated separately. The products were combined for assays. Table 19 shows the conditions during the flotation test.

TABLE 19

Reagents and Conditions

Operation	Reagent	lb/ton	Time min	pH
Grinding			20	
Conditioning	$CuSO_4$	1.0	5	8.9
	Na_2CO_3	1.0		
	R-301	0.1		
	R-208	0.1		
Flotation	Pine oil	0.04	15	
Conditioning	H_2SO_4	2.0	5	6.9
	R-301	0.05		
	R-208	0.05		
Flotation	Pine oil	0.02	10	

The flotation results are shown in Table 20.

TABLE 20

Results of Flotation

Product	Weight %	Assays*			Distribution %		
		oz/ton Au	%				
			As	S	Au	As	S
Flotn conc	10.2	0.48	8.50	14.5	60.9	75.7	64.4
Flotn tail	89.8	0.035	0.31	0.91	39.1	24.3	35.6
Feed (calcd)	100.0	0.080	1.14	2.30	100.0	100.0	100.0

* Gold assays from Internal Report MS-AC-62-940, arsenic and sulphur analyses from Certificate of Analysis No. 1677.

A screen and infrasizer analysis on the flotation tailing showed the following gold distribution.

TABLE 21

Screen and Infrasizer Analysis of Flotation Tailing

Size	Weight %	Assays* oz/ton Au	Distribution % Au
+200 m	15.4	0.05	25.1
-200 m +40 μ	45.0	0.03	44.0
-40 μ +28 μ	20.6	0.02	13.4
-28 μ +20 μ	9.4	0.03	9.1
-20 μ +10 μ	6.5	0.03	6.5
-10 μ	3.1	0.02	1.9
Feed (calcd)	100.0	0.031	100.0

* From Internal Report MS-AC-1136

(i) Regrinding and Cyanidation of Flotation Concentrate

Three 100 g samples were cut from the flotation concentrate and ground for 10, 20 and 30 min to 94.6%, 97.6% and 98.5% -325 m. Each sample was cyanided for 48 hrs at a dilution of 5:1 and at a concentration of 1.0 lb NaCN/ton and 0.05 to 0.15 lb CaO/ton of solution. The following results were obtained in this test.

TABLE 22

Results of Regrinding and Cyanidation

Grind		Reagent Consumption lb/ton of flotn conc		pH	Reducing Power cc $\frac{N}{10}$ $KMnO_4$/1	Residue Assays* oz/ton Au	Extraction** % Au	Overall*** Recovery % Au
Time min	Fineness % -325 m	NaCN	CaO					
10	94.6	8.0	9.6	11.1	540	0.35	27.0	93.1
20	97.6	13.5	14.5	11.3	720	0.33	31.2	93.2
30	98.5	18.2	18.2	11.5	1080	0.32	33.3	93.3

* From Internal Report MS-AC-62-993

** Calculated by difference

*** Including jigging, cyanidation of jig tailing and flotation concentrate

(ii) Roasting, Regrinding and Cyanidation of Flotation Concentrate

A 50 g sample, cut from the flotation concentrate, was roasted for 1 hr at 600°C and reground for 5 min to 92.7% -325 m. The calcine was cyanided for 48 hrs at a dilution of 10:1 and at a concentration of 1.0 lb NaCN/ton and 0.1 lb CaO/ton of solution. The following table summarizes the results of this test.

TABLE 23

Results of Roasting, Regrinding and Cyanidation

Grind		Reagent Consumption lb/ton of flotn conc		pH	Reducing Power cc $\frac{N}{10}$ $KMnO_4$/1	Residue Assay* oz/ton Au	Extraction** % Au	Overall Recovery*** % Au
Time min	Fineness % -325 m	NaCN	CaO					
5	92.7	2.8	6.8	12.0	40	0.15	68.9	94.5

* From Internal Report MS-AC-62-1136
** Calculated by difference
*** Including jigging, cyanidation of jig tailing and flotation concentrate

CONCLUSIONS

The Madsen composite sample of ore contained approximately 0.7 oz Au/ton of which about 35% was free milling. Most of the remainder was associated with sulphide minerals, arsenopyrite in particular.

A jig test, run on 15,000 g of ore, recovered 35.3% of the gold. Amalgamation extracted 98.7% of the gold in the jig concentrate.

Straight cyanidation of the jig tailing resulted in an overall gold recovery of 92.2%. No significant increase in this recovery was obtained when the jig tailing was floated, the flotation concentrate roasted and the calcine recombined with the flotation tailing before cyanidation. After it was learned that the company had abandoned the idea of roasting, no attempt was made to improve the flotation technique used in these tests.

When straight cyanidation of the jig tailing was followed by desliming, flotation of the deslimed fraction, regrinding and cyanidation of the flotation concentrate, the overall gold recovery was increased by 0.9% to 1.1%. The increase attained 2.3% when the flotation concentrate was roasted prior to regrinding and cyanidation.

The additional amount of gold recovered by these treatments seems insufficient to justify the installation of regrinding or roasting facilities. However, it might be worthwhile to reclean the flotation concentrate obtained from the cyanide tailing and then to sell this upgraded concentrate to a company operating a roaster in the Red Lake area.

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