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MINES BRANCH INVESTIGATION REPORT IR 67-50

INVESTIGATION OF A GOLD-SILVER ORE FROM THE LYNN LAKE MANITOBA PROPERTY OF AGASSIZ MINES LTD.

by

G. I. MATHIEU

MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The drill core sample submitted for investigation contained 0.48 oz Au/ton and 1.67 oz Ag/ton.

Amalgamation at a coarse grind (-20 mesh) showed that about 35% of the precious metals were free milling. Of the remaining gold (fine grains of native metal), 95% was readily extracted by cyanidation. On the other hand, part of the residual silver was present as freibergite which was particularly resistant to cyanidation, thus limiting the silver extraction to 57%.

Treatment of the ore by jigging, amalgamation, flotation and cyanidation gave gold and silver recoveries of 94.0% and 68.7% respectively. In a modification of this method using direct cyanidation of the jig tailing and amalgamation residue (without flotation), overall recoveries of 96.3% and 69.1% were achieved.

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INTRODUCTION

Property

Agassiz Mines Ltd. holds a group of 12 claims located in Lynn Lake area, Northern Manitoba. On the basis of 20,000 ft of diamond drilling, ore reserves are said to be about one million tons averaging 0.3 oz Au/ton and 1.1 oz Ag/ton. Plans are now underway for sinking a 3- compartment shaft.

Purpose of Investigation

Preliminary metallurgical tests were required to indicate a possible flowsheet and recoveries of gold and silver which might be expected. Mr. H.J. Bergmann, P.Eng., Mining Engineer, 3518 Vendome Avenue, Montreal 28, Quebec, authorized as consultant for the company, expressed particular interest in cyanidation of either the whole ore or a flotation concentrate.

Shipment

A 35 lb. sample of minus one-inch core rejects was received on January 7, 1967 from Warnock Hersey Ltd., Calgary Alberta. The sample was said to be representative of the Lyn Lake orebody.

Sampling and Analysis

A few pieces were selected from the core rejects for mineralogical examination. The remainder was crushed to -20 mesh from which a head sample was riffled out for chemical analysis.

TABLE 1

Chemical Analysis* of Head Sample

Gold (Au)	-	0.48 oz/ton
Silver (Ag)	-	1.67 "
Iron (Fe)	-	9.06 %
Arsenic (As)	-	2.74 "
Sulphur (S)	-	4.70 "
Insoluble	-	57.28 "

* From Internal Reports MS-AC-67-180, 201 and 344.

A spectrographic analysis on a portion of the head sample indicated the presence of the following elements listed in their approximate order of decreasing abundance:

TABLE 2

Spectrographic Analysis* of Head Sample

I - Mg, Fe, Ca, Al, Si (1.0%)

II - Zn, Pb, Cr, Ti, Mn (1.0 - 0.1%)

III- V, Mo, Ni, Cu, Zr, Ag (0.1%)

* From Internal Report MS-AC-67-27.

Mineralogical Examination*

The pieces selected from the drill core and a portion of the head sample were sent to the Mineralogy Section of the Mineral Sciences for examination.

By microscopic examination of several polished sections and X-ray diffraction studies, the following minerals were identified:

TABLE 3

Minerals Contained in Lynn Lake Ore

Metallic		Non-Metallic
Pyrrhotite	Galena	Amphibole
Arsenopyrite	Pentlandite	Quartz
Pyrite	Marcassite	Peroxene
Sphalerite	Covellite	Dolomite
Ilmenite	Magnesite	Feldspar
Rutile	Native silver	Chlorite
Chalcopyrite	Freibergite	Biotite
Hematite	Native gold	Anatase

* From Internal Reports MS-AC-67-51 and 62, by D. Owens.

The ore consists largely of gangue minerals with only disseminated metallic minerals. A few grains of free gold, about 40 microns in diameter, were observed in the polished sections.

Silver occurs as native metal and as freibergite. The latter mineral accounts for at least 30% of the total silver. Both minerals are partly free and partly as inclusions in galena and arsenopyrite. A few grains of freibergite were also found intimately associated with gangue. The silver inclusions were usually less than 15 microns in diameter.

OUTLINE OF INVESTIGATION PROCEDURE

The investigation on the Lynn Lake ore was conducted along the following lines:

1. Direct amalgamation of the ore to estimate the free-milling gold and silver content;

2. Straight cyanidation of the ore to assess the effect of grinding and contact time on the extraction of gold and silver;

3. Jigging and amalgamation to recover the free-milling precious metals, and treatment of the tailing by either direct cyanidation or flotation and cyanidation to recover the remaining values.

Finally, microscopic studies were made to determine the cause of the low silver extraction. When this was attributed to the presence of freibergite, preliminary tests were carried out in an attempt to dissolve the silver from this refractory mineral.

DETAILS OF INVESTIGATION

Amalgamation, Test 1

A 500 g sample of crushed ore was amalgamated for 1 hr with 10 cc of mercury and 1 g of lime.

TABLE 4

Results of Amalgamation

Product	Assays* oz/ton		Distribution %	
	Au	Ag	Au	Ag
Amalgam**	0.16	0.60	32.7	36.8
Residue	0.33	1.03	67.3	63.2
Feed (calcd)	0.49	1.63	100.0	100.0

* From Internal Reports MS-AC-67-216 and 476.
** Amalgam assay expressed on the basis of amalgamation feed.

Straight Cyanidation, Tests 2-10

Lots of 500g of ore were ground for periods of 20 to 45 minutes and agitated at a dilution of 2:1 for 24 to 72 hours. In each test, lime and cyanide concentrations were maintained at 1.0 lb/ton of solution.

TABLE 5

Results of Straight Cyanidation

Test	Grinding		Cyanidation Time hrs	Reagents Consumed lb/ton of ore		Residue Assays* oz/ton		Extraction** %	
	Time min	% -200m		NaCN	CaO	Au	Ag	Au	Ag
2	20	80.2	24	1.6	10.4	0.13	0.73	72.9	56.3
3			48	2.3	10.9	0.10	0.71	79.2	57.5
4			72	2.5	11.5	0.09	0.68	81.3	59.3
5	30	84.9	24	1.8	10.3	0.08	0.66	83.3	60.5
6			48	2.1	10.5	0.05	0.61	89.6	63.5
7			72	2.5	11.2	0.05	0.58	89.6	65.3
8	40	90.1	24	2.2	12.4	0.05	0.67	89.6	59.9
9			48	2.6	12.8	0.03	0.62	93.8	63.9
10			72	2.8	14.0	0.03	0.51	93.8	69.5

* From Internal Reports MS-AC-67-197, 344 and 476.
** Calculated by difference.

Jigging and Amalgamation, Test 11

A 8000g sample of crushed ore (-20 mesh) was fed to a laboratory jig to recover the free milling gold and silver. The jig concentrate was ground for 15 min to 71% -200 mesh and amalgamated for 1 hr with 20 cc of mercury and 2g of lime.

TABLE 6

Results of Jigging and Amalgamation

Product	Weight %	Assays* oz/ton		Distribution %	
		Au	Ag	Au	Ag
Jig conc	9.9	1.65	8.84	34.8	49.0
Tailing	90.1	0.34	1.01	65.2	51.0
Feed (calcd)	100.0	0.47	1.78	100.0	100.0
Amalgam	-	1.20	5.05	72.7	57.1
Amalgamation tailing	-	0.45	3.79	27.3	42.9
Feed (calcd)	-	1.65	8.84	100.0	100.0
Overall Recovery (Jigging, Amalgamation)				25.3	28.0

* From Internal Reports 216 and 395.

i) Flotation of Jig Tailing and Cyanidation of Concentrate, Test 12

The flotation test was carried out on a 1000g sample cut from the Jig Tailing and ground for 20 min to 80% -200 mesh. The procedure followed and the results obtained are shown in Tables 7 and 8.

TABLE 7

Reagents and Conditions

Operation	Time min	Reagent	lb/ton	pH
Conditioning	3	Copper sulphate	1.00	8.3
		Xanthate 301	0.10	
		Dowfroth 250	0.02	
Rougher flotation	15	Copper sulphate	0.50	8.1
		Xanthate 301	0.05	
		Dowfroth 250	0.04	

TABLE 8

Results of Flotation

Product	Weight %	Assays* oz/ton		Distribution %	
		Au	Ag	Au	Ag
Flot conc Flot tailing	31.8 68.2	0.98 0.03	3.17 0.09	93.8 6.2	94.3 5.7
Feed (calcd)	100.0	0.33	1.07	100.0	100.0
Overall Recovery (Jigging and Flotation)				96.0	97.1

* From Internal Report MS-AC-67-216.

A 100g sample was prepared using proportional amounts of the flotation concentrate and amalgamation tailing. After grinding for 5 min to 88% -200 mesh, the product was cyanided for 48 hrs at a dilution of 3.1, with the solution strengths of 1.5 lb NaCN/per ton and 0.7 lb CaO/ton. The results of the cyanidation are shown in the following table.

TABLE 9

Results of Cyanidation of Flotation Concentrate

Reagents Consumed lb/ton of ore		Residue Assays* oz/ton		Extraction** %	
NaCN	CaO	Au	Ag	Au	Ag
0.6	1.6	0.022	1.85	98.1	60.0
Overall Recovery (Jigging, Amal., Flotation, Cyanidation)				94.0	68.7

* From Internal Reports MS-AC-67-350 and 559.
** Calculated by difference.

ii) Cyanidation of Jig Tailing, Test 13

A 500g sample was prepared using proportional quantities of jig and amalgamation tailings. The mixed product was then ground for 30 min to 89% -200 mesh and cyanided for 48 hrs at a dilution of 2:1. Lime and cyanide concentrations were maintained at 1.0 lb/ton and 0.7 lb/ton respectively.

TABLE 10

Results of Cyanidation of Jig Tailing

Reagents Consumed lb/ton of ore		Residue Assays* oz/ton		Extraction** %	
NaCN	CaO	Au	Ag	Au	Ag
3.6	12.4	0.017	0.51	95.1	57.1
Overall Recovery (Jigging, Amal., Cyanidation)				96.3	69.1

* From Internal Report MS-AC-67-350.

To determine the cause of the low silver recovery, a portion of the cyanide residue was upgraded to about 10 oz Ag/ton by flotation and sent to the Mineral Sciences Division for examination. The results of the mineralogical studies can be summarized as follows:

"No native silver was found in the microscopic examination of the polished sections of the silver concentrate. The only silver-bearing mineral identified was freibergite. It occurs as both free grains and combined grains with galena and gangue, and a few were found to contain minute blebs of chalcopyrite.

From the examination of the concentrate, it is probable that the reported silver content is due to the presence of the grains of freibergite."*

To determine if additional silver could be extracted from the freibergite by finer grinding and longer cyanidation, a portion of the upgraded residue was ground for 5 min to 96% -325 mesh and agitated in a solution maintained at 1.5 lb NaCN/ton and 0.7 lb CaO/ton. Since only 15% of the silver was dissolved after a 48-hour agitation, it was obvious that freibergite would not be amenable to such a treatment.

Another attempt was made to recover the silver from the freibergite by roasting a portion of the flotation concentrate and cyaniding the calcine, but the high silver loss (45%) by volatilization during the roasting stage precludes the application of this technique. Furthermore, practically none of the remaining silver could be extracted by cyanidation. This might be attributed to the formation of insoluble silver compound during the roasting treatment.

* From Internal Report MS-AC-67-62, by D. Owens.

Additional studies would be necessary to find a process to extract the silver from the refractory freibergite. Unfortunately, the small lot of ore received was insufficient to pursue the investigation further.

SUMMARY AND CONCLUSIONS

Analysis of a head sample cut from the ore shipment gave 0.48 oz Au/ton and 1.67 oz Ag/ton. Microscopic examination showed that all the gold and a portion of the silver were present as native metal. The remainder of the silver occurred as freibergite, a complex copper, iron, silver, antimony sulphide.

At a relatively coarse grind of -20 mesh, barrel amalgamation indicated that about 35% of the precious metals were free milling. Straight cyanidation at various fineness of grinding and agitation periods showed that grinding to about 90% -200 mesh and a 48-hour contact time was necessary to achieve near maximum gold extraction (93.8%). Although only 56.3% to 69.5% of the silver was extracted in these tests, the best results were also found with finer grinding and longer agitation period. This was attributed to the presence of freibergite which is very refractory to normal cyanidation.

Most of the free milling precious metals were recovered by jigging of the ore and amalgamation of the concentrate. This practice should be included in the flowsheet for the commercial treatment of the Lynn Lake ore.

To complete the gold and silver recovery, the jig tailing and amalgamation residue were cyanided either with or without pre-concentration by flotation. A comparison of the results from the two methods is shown below.

TABLE 11

Comparative Results

Procedure	Average Grinding % -200 m	Reagents Consumed lb/ton of ore					Overall Recovery, %	
		CaO	NaCN	$CuSO_4$	R-301	R-250	Au	Ag
Jigging, Amal., Flotation and Cyanidation	83	1.6	0.6	1.5*	0.15*	0.15*	94.0	68.7
Jigging, Amal. and Cyanidation	89	12.4	3.6	-	-	-	96.3	69.1

* These consumptions should be reduced by about 50% in a plant circuit.

To determine the best procedure for the treatment of the Lynn Lake ore, a careful economic study using the "cost plus tailing" method will be necessary. Of particular interest are the reduction of grinding and cyanidation feed when using the flotation stage, on the one hand, and the higher overall recovery in its absence on the other hand.

The low silver recovery was attributed to the presence of refractory freibergite. Preliminary testwork indicated that the silver contained in this mineral could not be extracted by cyanidation after fine grinding and even after roasting. Although further studies would have been necessary to find a method to recover the silver from freibergite, these were not undertaken because of the lack of ore.

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