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AMALGAMATION, CONCENTRATION AND CYANIDATION TESTS ON A GOLD ORE, FROM HANNA GOLD MINES LTD. (N. P. L.), CASSIAR, B. C.

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The ore submitted contained approximately 1.2 oz Au/ton of which over 90% was free milling.

The procedure used to treat the ore and the results obtained are summarized in Table 1.

Table 1

Procedures and Results

Test	Procedure	Recovery, % Au
1-4	Barrel amalgamation	74.8 - 91.6
5-7	Jigging and flotation	93.5 - 94.8
8	Jigging and tabling	90.3
9	Jigging, tabling and flotation	97.8
10-13	Straight cyanidation	81.5 - 98.3

Amalgamation and cyanidation tests of the concentrates produced in Test 9 gave an overall recovery of 97.3% of the gold.

CONTENTS

INTRODUCTION

Location of Property

The property from which the ore originated is the Hanna Gold Mines Ltd. (N.P.L.), comprising seventy-seven claims located in the Liard district, approximately six miles east of Cassiar in northern British Columbia.

Shipment and Instructions

A shipment of three boxes of gold ore of a net weight of 579 lb was received on April 13, 1962. It was submitted by Mr. Craigie Hood Jr., Managing Director, Hanna Gold Mines Ltd., Box 166, Cassiar, B.C. Mr. Hood requested an investigation to determine the most efficient procedure for recovering the gold.

Sampling and Analysis*

The sample received was crushed to -1/2 in. and a few representative pieces were selected for mineralogical examination. The remainder was crushed to -10m and a 2 lb head sample was riffled out by conventional methods for chemical analysis and mineralogical studies.

The results of the chemical analysis of the head sample are shown in Table 2.

Table 2

Chemical Analysis

Gold (Au)**	1.19	oz/ton
Silver (Ag)	0.23	"
Iron (total Fe)	7.83	%
Iron (soluble Fe)	7.64	"
Sulphur (S)	1.14	"
Insoluble	74.07	"

*Head sample analysis from Internal Report MS-AC-62-630, all test work assays from Internal Report MS-AC-62-821.

**Because of the amount of free milling gold in the sample and the resultant erratic assays, the gold assay was calculated from an amalgamation test on a 1,000 g sample of the ore.

MINERALOGICAL EXAMINATION*

Methods of Investigation

Four polished sections were prepared from the hand specimens and examined under the microscope. A -100 + 200 mesh portion of the head sample was separated into fractions by means of heavy liquids and the Frantz Isodynamic Separator. The minerals in each fraction were identified by microscopical and X-ray diffraction studies.

Results of Investigation

Examinations of the hand specimens show that they are samples of a dolomitic rock and vein quartz. The dolomitic rock is composed of dolomite, sericite and quartz, and contains pyritohedral pyrite crystals, narrow chalcopyrite veinlets, and a few very minute grains of an amorphous iron oxide.

The vein quartz contains amorphous iron oxide, sericite, pyritohedral pyrite crystals (see Figure 1) and small amounts of hematite, pyrrhotite and native gold. The pyrite crystals range between 0.1 mm and several millimetres in diameter and a few are partially altered to an amorphous iron oxide.

The native gold occurs as discontinuous veinlets in quartz and pyrite (see Figures 2 and 3). The veinlets range between about 0.1 microns and 100 microns in width. The widest ones appear to follow grain boundaries, and the very narrow ones appear to occur only in pyrite.

The approximate mineral content of the -100 + 200 mesh portion of the head sample was determined by separating it into fractions. The results are given in Table 3.

*From Investigation Report IR 62-32 by W. Petruk, Mineralogy Section, Mineral Sciences Division, Mines Branch, May 30, 1962.

Table 3

Mineral Content of the -100 + 200 Mesh Portion of the Head Sample

Mineral	Weight per cent
Quartz, amorphous iron oxides, and sericite	97.0
Pyrite	2.5
Hematite, pyrrhotite, chalcopyrite	0.5
Gold	observed in pyrite fraction

It is noted that, although dolomitic rock was observed in the hand specimens, no appreciable amounts of dolomite were found in the head sample. This suggests that the dolomitic rock is a minor component in the ore, and that the hand samples were not fully representative.

Conclusions

The samples studied show that native gold occurs as veinlets in quartz and pyrite. The width of the veinlets indicates that much of the gold would be liberated at grind of about -200 mesh. The gold present as minute veinlets in pyrite, however, can probably not be liberated by mechanical means.

Figure 1. Photomicrograph showing pyrite crystals (white) in vein quartz.

Figure 2. Photomicrograph showing gold (light grey) along boundary between pyrite (white) and quartz (dark grey). Note that some gold is also present in pyrite and in fractures in quartz.

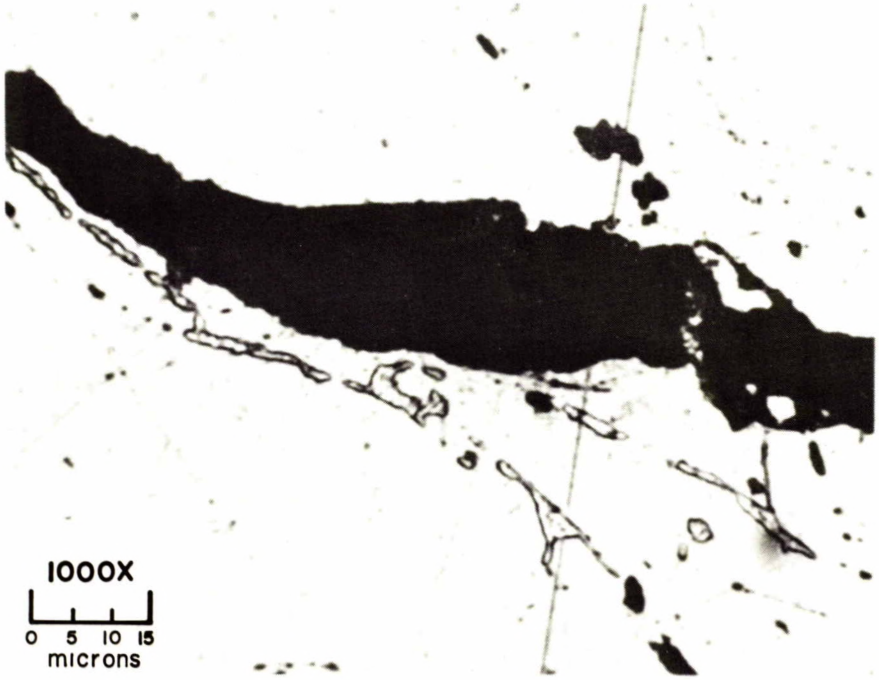

Figure 3. Photomicrograph showing very narrow discontinuous gold veinlets (white areas with black rims) in pyrite. The completely black areas on the photograph are fractures in the pyrite grains.

DETAILS OF INVESTIGATION

Barrel Amalgamation

Tests 1-4

Four amalgamation tests were carried out on the ore to determine the amount of free milling gold recovered at different degrees of fineness. In each test, a 1,000 g sample of ore was amalgamated with 10 cc of mercury and 1 g of lime. The results of these tests are shown in Table 4.

Table 4

Results of Amalgamation Tests 1-4

Test	Grinding Time min	Fineness % -200m	Assays oz/ton Au		Recovery % Au
			Amalgam	Residue	
1	-	14	.89*	0.30	74.8
2	10	43	-	0.17	85.7**
3	20	70	-	0.12	89.9**
4	30	86	-	0.10	91.6**

*Amalgam assay expressed in terms of original feed.
**Calculated by difference.

Concentration

Test 5 (Jigging and Flotation)

A 2,000 g sample of ore crushed to -10m was fed to a jig using a 1/8 in. stroke and fitted with a 20m screen. The thickness of the shot bed was approximately 1 in. The jig bed and concentrate were retained and the tailing was ground for 20 min to 73% -200m and floated under the conditions described in Table 5.

Table 5

Reagents and Conditions of Flotation

Operation	Reagents lb/ton		Time min	pH
Grinding			20	
Conditioning	Cu SO_4	1.0	5	8.5
	R-301	0.08		
	R-208	0.08		
Flotation	R-250	0.02	15	
	Pine oil	0.02		

The results of this test are shown in Table 6.

Table 6

Results of Jigging and Flotation Test 5

Product	Weight %	Assays oz/ton Au	Distribution % Au
Jig conc	1.4	38.38	44.2
Jig bed	5.7	4.10	19.3
Flotn conc	4.7	7.75	30.0
Flotn tail	88.2	0.09	6.5
Feed (calcd)	100.0	1.21	100.0

Test 6 (Jigging and Flotation)

A 2,000 g sample of ore was fed to a jig using a 1/8 in. stroke and a 14 mesh screen. The tailing was ground for 40 min to 88% -200m and floated using the procedure described in Table 5. The results of this test are summarized in Table 7.

Table 7

Results of Jigging and Flotation Test 6

Product	Weight %	Assays oz/ton Au	Distribution % Au
Jig conc	1.9	46.30	54.7
Jig bed	6.2	4.33	16.7
Flotn conc	5.8	6.44	23.2
Flotn tail	86.1	0.10	5.4
Feed (calcd)	100.0	1.61	100.0

Test 7 (Jigging and Flotation)

A 2,000 g sample of ore was fed to a jig using a 1/8 in. stroke and a 10m screen. The tailing was ground for 40 min and floated using the procedure described in Table 5, except that 0.04 lb of Reagent 404 per ton of ore was added to the conditioning stage. Table 8 shows the results of this test.

Table 8

Results of Jigging and Flotation Test 7

Product	Weight %	Assays oz/ton Au	Distribution % Au
Jig conc	3.0	17.73	36.2
Jig bed	6.2	8.53	36.0
Flotn conc	6.9	4.82	22.6
Flotn tail	83.9	0.09	5.2
Feed (calcd)	100.0	1.47	100.0

Test 8 (Jigging and Tabling)

A 4,000 g sample of ore was fed to a jig using a 1/8 in. stroke and a 10m screen. The tailing was ground to -28m and divided into three fractions, -28 + 48m, -48 + 100m, and -100m. The two coarser fractions were tabled separately to produce a concentrate, a middling, and a tailing. Each middling was ground to -100m and added to the fine fraction (-100m) which was also tabled. Only a concentrate and a tailing were produced in this tabling operation. All the tailings were combined for assay. Table 9 summarizes the results of this test.

Table 9

Results of Jigging and Tabling Test 8

Product	Weight %	Assays oz/ton Au	Distribution % Au
Jig conc	2.3	24.66	38.1
Jig bed	3.4	14.44	32.9
Table conc -28 + 48 m	1.4	3.51	3.3
" " -48 + 100m	1.1	6.65	4.9
" " -100m	1.5	11.01	11.1
Table tail	90.3	0.16	9.7
Feed (calcd)	100.0	1.49	100.0

Test 9 (Jigging, Tabling and Flotation, Amalgamation and Cyanidation of Concentrates)

Jigging, Tabling and Flotation:

A 2,000 g sample of ore was fed to a jig using a 1/8 in. stroke and a 10m screen. The jig tailing, after a 40 min grind, was tabled and the table tailing was floated using the procedure described in Table 5.

Table 10 shows the results of this test.

Table 10

Results of Jigging, Tabling, and Flotation Test 9

Product	Weight %	Assays oz/ton Au	Distribution % Au
Gravity conc*	14.5	8.87**	94.1
Flotn conc	3.9	1.30	3.7
Flotn tail	81.6	0.035	2.2
Feed (calcd)	100.0	1.37	100.0

*Jig bed, jig concentrate and table concentrate combined. **Calculated.

Amalgamation:

The jig bed and concentrate, after a 20 min grind to 87% -200m, were combined with the table concentrate and amalgamated for one hour with 10 cc of new mercury and 1 g of lime.

The results of the amalgamation are summarized in Table 11.

Table 11

Results of Amalgamation Test 9

Product	Assays oz/ton Au	Distribution % Au
Amalgam	8.53*	96.2
Residue	0.34	3.8
Feed (calcd)	8.87	100.0

*Amalgam assay expressed in terms of amalgamation feed.

Cyanidation:

The flotation concentrate and the amalgam residue were combined and ground for 10 min to 96% -200m. The ground material was diluted to 4:1 and agitated for 48 hrs in a solution maintained at approximately 1 lb of NaCN/ton and 0.5 lb of CaO/ton.

The results of this test are summarized in Table 12.

Table 12

Results of Cyanidation Test 9

Consumption lb/ton of ore		Reducing Power cc $\frac{N}{10}$ KMnO /l	Assays oz/ton Au		Recovery % Au
CaO	NaCN		Solution	Residue	
1.20	0.36	120	0.51*	0.034	93.8

*Solution assay expressed in terms of cyanidation feed.

The overall recovery of gold in Test 9 was 97.3% (90.5% by amalgamation and 6.8% by cyanidation).

Straight Cyanidation

Tests 10-13

Four cyanidation tests were conducted on the ore. In each test, a 1,000 g sample of ore was ground for periods of 20 to 30 min and agitated at a dilution of 2:1 for periods of 24 to 48 hrs. Lime and cyanide concentrations of the solutions were kept at 0.5 lb/ton and 1.0 lb/ton respectively. The results of these tests are summarized in Table 13.

Table 13

Results of Cyanidation Tests 10-13

Test	Grinding Time min	Fineness % -200m	Cyanidation Time hrs	Consumption lb/ton of ore CaO	NaCN	Reducing Power cc N/10 $KMnO_4$/l	Residue Assays oz/ton Au	Extraction* % Au
10	20	70	24	9.0	0.76	36	0.22	81.5
11	20	70	48	11.1	0.84	40	0.15	87.4
12	30	86	24	9.1	1.08	40	0.02	98.3
13	30	86	48	11.2	1.32	40	0.02	98.3

*Calculated by difference.

CONCLUSIONS

The sample of ore contained approximately 1.2 oz Au/ton, which occurred mostly as coarse veinlets along the quartz and pyrite boundary and, to a lesser amount, as minute veinlets in pyrite grains (Figures 2-3).

Barrel amalgamation tests determined that 75% to 92% of the gold was free milling and could be recovered when the fineness varied from 14% to 86% -200m (Tests 1-4). The results of these tests indicated that any flowsheet for treating this ore must include a method of recovering this free milling gold as soon as it is liberated. This can be conveniently done by placing a jig in the grinding circuit between the ball mill and the classifier.

This would prevent what is commonly called "absorption" which is a lag between gold coming into the mill and the recovery, and is common in the grinding circuit with ores containing "free milling" gold.

Jigging followed by tabling or flotation recovered from 90% to 95% of the gold, but failed to produce a final tailing containing less than 0.09 oz Au/ton (Tests 5-8). However, a treatment consisting of jigging, tabling and flotation reduced the tailing to 0.035 oz Au/ton (Test 9).

Amalgamation and cyanidation of the concentrates produced in this test gave an overall recovery of gold of 97.3%.

Straight cyanidation tests were also made on the ore. The gold recovery attained 98.3% in the best cyanidation test.

Although straight cyanidation gave the highest recovery, concentration by jigging, tabling and flotation followed by amalgamation and cyanidation of the concentrates would probably be more practical for the treatment of a small tonnage of this high grade ore.

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