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R.682. Gold recovery from old tailing, Mathinna dump.

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A sample of tailings said to have been *in situ* on the surface of a Mathinna dump for many years was submitted by H. Moses for gold recovery tests. Mr Moses said that most of the gold was present in the material coarser than 600 µm.

The sample consisted of free running sand and cemented aggregates of sand and sulphide, up to 100 mm in diameter. The discrete grains were relatively free from sulphides and the aggregates have resulted from the cementing action of oxidation products in areas or pockets rich in sulphides. The sulphide present was mainly arsenopyrite.

SIZING

The total sample of 6.213 kg was dry screened on 1.00 mm, 600 µm and 355 µm, care being taken not to break down the aggregates more than necessary. The undersize of each screen was sampled and assayed. The purpose of this exercise was to gain information on whether any of the undersize material was barren enough to discard as a tailing and at what size this occurred.

The -600 µm material was relatively low in gold content and was excluded from the test sample which was made up as a composite from the +600 µm and +1.00 mm fractions. From the assay of this composite and the undersize fractions assayed previously an overall sizing analysis and head assay was calculated.

Sizing and assay results

Fraction	*% Mass*	*Au (g/t)*	*% Au distribution*
+1.0 mm	29.2	127	91.0
-1.0 mm +600 µm	6.7	12.9	2.1
-600 µm +355 µm	19.6	3.4	1.6
-355 µm	44.5	4.9	5.3
Composite Head	100.0	40.9	100.0

Assay of composite for gold extraction tests

Composite +600 µm fractions (106 g/t Au)

As	5.0%
Cu	0.08%
S	4.6%

GOLD EXTRACTION TESTS

The composite sample was jaw and roll crushed to approximately -2 mm for sampling. The material was fairly friable and could possibly be broken down in a dolly pot.

Test samples were obtained by riffling.

Test N1. Mortar amalgamation of roll crushed ore

A sample of the -2 mm ore was ground for 15 minutes in a Wedgwood

mortar in a pulp of 70% solids in the presence of mercury. Mercury addition was approximately 150 kg/t. The mercury was recovered from the ground pulp by panning.

Result

	%
Gold recovery in amalgam	34.6
Gold loss in amalgam tailing	65.4

(N1. Composite head: 98 g/t Au*)*

Notes: After a short period of grinding the mercury became floured and tarnished as a result of its contact with the arsenopyrite present. Extreme difficulty was experienced in getting the mercury droplets to coalesce and the addition of reagents such as nitric acid or caustic soda had little effect. Panning of the many small droplets of mercury from the ground pulp was very difficult.

Test N2. Flotation, calcination and amalgamation of concentrate

A sample of -2 mm ore was ball mill ground for 5 minutes and a sulphide concentrate removed by froth flotation.

Flotation conditions

Reagent	
Sulphuric acid	to pH 5.0
Sodium ethyl xanthate	500 g/t
Potassium amyl xanthate	500 g/t
Kerosene	100 g/t
Pine oil	20 g/t
Conditioning time	5 minutes
Flotation time	15 minutes

The flotation concentrate was dried, roasted to eliminate arsenic and sulphur, and the calcine subjected to mortar amalgamation by grinding in a Wedgwood mortar in a pulp of 70% solids in the presence of mercury added to the extent of 250 kg/t.

The mercury was recovered after the grind by panning. A comparatively minor amount of flouring or non coalescence of mercury globules occurred as a result of contact with the very small amount of sulphides material not oxidised during the calcining.

Result

Product	*% Mass*	*% Au distribution*
Calcined FC/amalgam		78.0
Calcined FC/amalgam tailing		21.2
FC	27.9	99.2
FT	72.1	0.8
Total	100.0	100.0

(N2. Composite head: 98 g/t Au*)*

Test N3. Gravity concentration, flotation concentration, amalgamation of concentrates followed by calcination and amalgamation

This test was designed to show the increase in gold recovery obtainable by progressing from relatively simple to somewhat more sophisticated methods of treatment.

The steps carried out were as follows:

(1) The ore was ball mill ground as in test N2.

(2) A gravity concentrate was made by panning the ground material.

(3) The pan concentrate from (2) was subjected to mortar amalgamation, and the amalgam removed for assay.

(4) The amalgamation tailing from (3) was calcined and the calcine again amalgamated by mortar amalgamation. The amalgam from this operation was also removed for assay.

(5) A flotation concentrate was made from the pan tailings from (2).

(6) The FC from (5) was subjected to mortar amalgamation and the amalgam removed for assay.

(7) The amalgamation tailing from (6) was calcined and the calcine again amalgamated by mortar amalgamation. The amalgam from this operation was removed for assay.

All tailing products were assayed for gold.

Results

A. Gravity concentration of ground ore	*% Au Distribution*
Amalgam from pan concentrate as produced	34.0
Amalgam from pan concentrate after calcining	1.5
Calcined pan concentrate/amalgamation tailing	0.9
Total pan concentrate	36.4
B. Flotation concentration of pan tailing	
Amalgam from flotation concentrate as produced	36.6
Amalgam from flotation concentrate after calcining	5.1
Calcined flotation concentrate/amalgamation tailing	18.3
Total flotation concentrate	60.0
Flotation tailing	3.6
Total	100.0

(*N3. Composite Head:* 113 g/t Au)

Notes: As in test N1 difficulty was encountered in recovering the mercury, floured as a result of grinding in contact with the sulphide concentrates. The problem occurred in only minor degree in the amalgamation of the calcined products.

GOLD RECOVERY BY CYANIDATION

This method of recovery was not investigated, because of the small quantity of sample available. However, the unusual nature of the deposit, in which fairly coarse aggregates resulting from oxidation of sulphides contain most of the gold may lend itself ideally to this type of treatment. A sulphide concentrate produced as in N2 would contain about 90% of the gold from the original material while representing only about 10% by weight.

A concentrate such as this could be calcined, ground and cyanided, the gold being extracted from the pregnant solution by passing through a bed of activated carbon.

The process could be conducted at low cost and high efficiency, the cyanide solution being recycled and the end product being gold as bullion obtained by burning off the carbon.

COMMENT ON TEST RESULTS

The material, as received contained 40.9 g/t of gold.

A coarse fraction consisting of aggregates caused by oxidation of sulphides was obtained by screening on 600 µm. This fraction amounted to 36% by mass, contained 93% of the gold and assayed 106 g/t.

In any projected treatment it would therefore be economically advisable to screen on 600 µm and exclude the undersize, assaying 4.4 g/t from further treatment.

The +600 µm aggregates require crushing before further treatment. In the test work, this was accomplished by passing through crushing rolls to a maximum size of about 2 mm.

Mortar amalgamation of the crushed aggregate gave a poor gold recovery in the amalgam amounting to 34.6%. The hand grinding in the mortar was probably not sufficient to release gold locked with sulphides and the recovery is thought to represent the free gold present in the material. Non coalescence of mercury proved to be a considerable problem in its recovery from the pulp. This was caused by contact with the arsenopyrite, which makes up the greater part of the sulphides present.

Pan concentration (N3) of ball mill ground -2 mm material (to approximately -300 µm) followed by amalgamation of the concentrate gave a similar result and encountered the same difficulties in recovery of the mercury. It is reasonable to assume that a similar recovery would be obtained in the field by streaming and amalgamation techniques.

Ball mill grinding to approximately -300 µm followed by froth flotation produced a concentrate amounting to 28% by mass and containing 99% of the gold (Test N2).

Calcining of this concentrate to remove sulphur and arsenic, followed by mortar and amalgamation gave a recovery of 78%.

'Flouring' or 'sickening' of the mercury was also not apparent.

SUMMARY AND CONCLUSION

The gold content of the material is mainly associated with the sulphides

present and as such is not recoverable by the comparatively simple methods of streaming and amalgamation. The gold and sulphides are concentrated in coarse aggregates and the material lends itself readily to a simple preliminary concentration by screening on 600 µm.

The preliminary coarse concentrate requires crushing and grinding to reduce the aggregates to discrete particles. This will, in part, liberate the gold, some 30-40% of which could then be recovered by amalgamation. The difficulty of recovering 'sickened' mercury from the sulphides should not be overlooked in assessing whether this method should be adopted.

Gold recovery would be increased and amalgamation difficulties mostly overcome by calcining before amalgamation. The amalgamation should be performed in either case by grinding batchwise in a steel amalgamation barrel.

Froth flotation of sulphides from ground aggregates affords a ready method of concentrating practically all the gold in a low bulk concentrate amounting to about 10% of the original material. This concentrate would also require calcining before amalgamation.

However, it is recommended that calcination of preliminary concentrate take place before amalgamation or cyanidation is undertaken.

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