CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
3550 N. Central Ave, 2nd floor
Phoenix, AZ, 85012
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the West Oatman Project mining collection

PREPARED FOR:

BILLITON MINERALS U.S.A., INC.

CYANIDE LEACH TESTS AND MINERALOGICAL CHARACTERIZATION OF GOLD ORE SAMPLES FROM THE MOSS MINE PROJECT

By

Wolfgang Baum & Louis W. Lherbier, Jr.

Project O M 33

December 17, 1990

The bulk XRD analysis represents crystallized minerals present in concentrations above 2%. Extremely fine-grained, poorly crystalline and/or amorphous mineral phases such as alteration products and clay minerals may not be detectable or may be under-represented.

Concentration Ranges:	Major = 20 - >50%
	Minor = 5 - 20%
	Trace = <5%

Representative split portions of each sample were subjected to optical microscopy with modal analysis in order to quantify pertinent mineralogical characteristics. The results of the modal analysis are summarized in Table 5.

Table 5

Microscopic Modal Analysis of Head Samples

Mineral	Sample 444-1-2	Sample 444-3
Silica/Feldspar Groundmass	49% vol.	63% vol.
Carbonates	41	20
Clay Minerals	7	15
Opaque Minerals	3	2

Gold Mineralogy

The gold mineralization in the Moss Mine samples is characterized by the presence of mostly silver-rich native gold which frequently may approach electrum composition. The silver content in this gold shows an average concentration of 27% according to semiquantitative SEM-EDX analyses. Intimately associated with the silver-rich gold is native gold with extremely low silver concentrations (<5%).

The gold is primarily associated with siliceous gangue and hydrous iron oxides. These iron oxide minerals represent alteration products of gold-bearing pyrite and/or are the result of hydrothermal iron mobilization and reprecipitation. Minor amounts of the gold are associated with small concentrations of pyrite, some of which occurs as the spheroidal variety. Approximately 20 - 30% of the total pyrite mineralization consists of spheroidal fine-grained iron sulfides. The spheroidal pyrite exhibits particles sizes of <1 to 50 micron in diameter.

In addition to the iron sulfides there are minor to trace amounts of sphalerite, chalcopyrite, bornite and galena. Most of these sulfide minerals occur as inclusions in the pyrite.

Some of the liberated gold particles observed in these samples exhibit surface coatings of (hydrous) iron oxides and/or silica clay slimes. Approximately 30% of the gold displays rapid surface tarnishing. In composite sample 444-1-2, 64% of the gold is associated with hydrous iron oxides. Most of the remaining gold (30%) is intergrown with silica gangue. Minor amounts of gold (<10%) occur as refractory gold associated with pyrite. Many pores and fractures in the gangue particles are filled with silica-carbonate-clay slimes.

As indicated by the microscopic analysis of the head samples, the gold mineralogy in the composite 444-1-2 differs distinctly from sample 444-3 with regard to particle size and mineralogical residence:

1. The gold in the PMET cyanide leach composite contains distinctly more fine-grained (-25 micron) gold than sample 444-3.

2. In the cyanide leach composite, the majority (64%) of the gold is locked with hydrous iron oxides; whereas in sample 444-3, gold association with silica gangue is dominating.

The gold particle sizes range from <1 micron to 300 micron with the majority of the gold occurring in the coarser (+400 mesh) sizes. The microscopic work indicates that the native gold present in sample 444-3 shows distinctly coarser particle sizes than the gold observed in composite 444-1-2. Table 6 summarizes a microscopic gold particle size analysis for both samples.

Table 6

Microscopic Gold Particle Size Analysis of Moss Mine Samples

Size of Gold Particles (Approximate Diameter)

Size(micron)	Samples 444-1-2	Samples 444-3
< 5	60%	21%
5 - 20	21%	15%
> 20 - 50	10%	24%
> 50 - 100	7%	22%
>100	2%	18%
	100%	100%

Both samples contain noticeable amounts of tramp iron shavings (from drilling?) and fragments of copper wire. Trace concentrations of organic/carbonaceous material were observed in sample 444-1-2.

Gravity Separation Tests

The gravity testwork was performed on 800-gram splits from samples 444-1-2 and 444-3 by way of heavy liquid separation at a S.G. of 2.95. Prior to separation, the samples were carefully stage-crushed to -48 mesh and deslimed at 400 mesh.

- The gravity separation tests confirmed the conclusions made from the optical microscope analysis, i.e. that the gold mineralogy of composite 444-1-2 and sample 444-3 exhibits significant differences in particle size and gold occurrence. Both of these factors will impact gold ore processing and precious metal recovery.

- In composite 444-1-2, almost half of the gold reported to the -400 mesh slimes fraction. This fraction represents 30% of the sample weight. Less than one third (26.8% distribution) of the gold was recovered in an extremely small (0.12% of the weight) gravity concentrate assaying 38 oz/ton gold. The remainder (28.7% distribution) of the gold occurred in the gravity tailings (float fraction) due to encapsulation in (light) silica gangue. The gravity tailings account for the majority of the sample weight (69%).

- In sample 444-3, the majority of the contained gold (69.4% distribution) was recovered in a high-grade (71.8 oz/ton Au) gravity concentrate which represents 0.29% of the sample weight. Eighteen percent of the gold reported to the float fraction. This fraction accounts for 75% of the sample weight. Only 12% of the gold occurred in the -400 mesh slimes.

  The reasons for the high gold recovery by gravity methods in this particular sample are a) distinctly coarse gold particle sizes and b) good liberation of gold at the 48 mesh grind.

The results of the gravity separation tests are summarized in Table 7 and Figure 1.

CONCLUSIONS

- The Moss Mine gold ore samples examined during this study contain a fine- to coarse-grained mineralization of silver-rich native gold some of which may be equivalent to electrum. Minor amounts of gold with low silver contents are also present. It is indicated that the ore may contain a bimodal occurrence (mineralogical residence) of gold as well as a bimodal gold particle size distribution:

  1. In the composited samples MM-8-46/48, the majority of the gold is associated with iron oxidation minerals and the gold is primarily of ultrafine particle size.

  2. In the MM-1-49 sample, most of the gold is associated with siliceous gangue and exhibits distinctly coarse particle sizes.

- The characteristics of the gold mineralogy described above have a distinct impact on ore processing and gold recovery. The fine gold intergrown/encapsulated by iron oxides will require a sufficiently fine grind to become amenable to direct cyanidation. The coarser gold mineralization found in sample MM-1-49, however, showed a good response to gravity concentration, i.e. almost 70% of this gold can be recovered into a small-volume, high-grade concentrate by physical preconcentration.

- The bottle roll cyanidation tests and subsequent mineralogical analyses of a leach residue confirmed the mineralogical characteristics identified in the head samples. The leach tests revealed a particle size-dependent refractoriness to direct leaching. Based upon the recent work, it is also concluded that in ore samples similar to the composite MM-8-46/48, 10-15% of the gold occurs encapsulated in pyrite and may require oxidation prior to cyanidation.

- It is concluded that losses encountered during cyanide leaching are primarily due to partial or complete locking (encapsulation) of gold in iron oxidation minerals, siliceous gangue and/or middlings particles of these minerals.

- The very coarse gold particle sizes observed in sample MM-1-49 could become troublesome in sampling, sample preparation and assaying by causing severe nugget effects. In addition, extremely coarse gold may not be entirely leached during short bottle roll tests. The resultant poor gold extraction could be erroneously interpreted as being caused by locking. Routine gravity separation tests are therefore of critical importance during further development work.

- Due to the presence of spheroidal pyrite, sorptive clay minerals, and traces of carbonaceous matter, the ore may exhibit minor preg-robbing effects. Considerably more follow-up work is required to confirm these conclusions.

- Increased cyanide consumption is caused by cyanicides such as soluble iron oxidation products, spheroidal pyrite, tramp iron and copper wire contamination and cyanide-consuming ferruginous gangue in the slimes fraction.

RECOMMENDATIONS

1. The ore samples analyzed during this study indicate differences in gold mineralogy and particle size distribution. Therefore potential variations in metallurgical amenability within the ore body can be anticipated. It is recommended that future assessment work should continue to monitor the mode of occurrence of gold as well as its particle size characteristics.

2. Bottle roll leach tests should be performed on several size fractions of a test sample (e.g. as-is, -10 mesh, -100 mesh).

3. Routine gravity separation tests are recommended in order to assess the preconcentration potential of the gold and control nugget effects.

4. The alteration minerals (specifically iron oxidation phases) and the clay mineralogy warrant further attention.

5. Representative ore zone samples should be subjected to periodic Total Carbon and Organic Carbon analyses.

WB/mkf

Figure 7 Photomicrograph showing the presence of silver-rich (A) and silver-poor (B) gold particles both of which are encapsulated by hydrous iron oxides.
Scale = ⌴ 50 micron

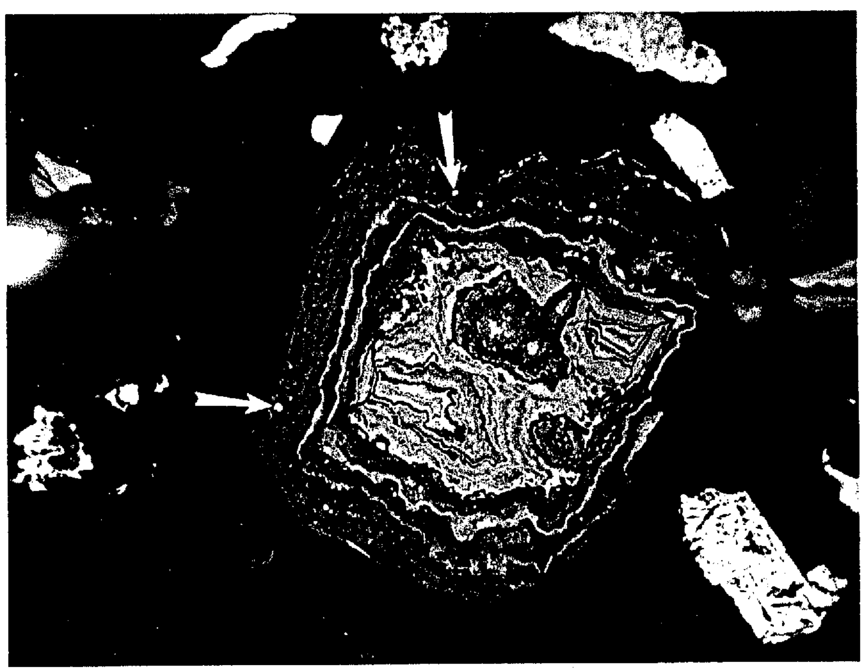

Figure 8 Photomicrograph showing rhythmic iron precipitation with ultrafine gold formation (see arrows). It is tentatively concluded that this gold has been remobilized from a primary mineralization during alteration and was thereafter co-precipitated with the iron.
Scale = ⌴ 50 micron

McCLELLAND LABORATORIES, INC.

1016 Greg Street, Sparks, Nevada 89431 702 / 356-1300
FAX 702 / 356-8917

January 29, 1992

Mr. Mark Sander
MAGMA COPPER COMPANY (602) 575 5600
7400 North Oracle Road - Ste 200
Tucson, AZ 85704

Dear Mark:

Enclosed is our report concerning metallurgical results obtained from direct agitated cyanidation tests conducted on the Moss cuttings intervals submitted by Mr. Richard Jeanne.

Enclosed also is our final invoice (MLI Job No. 1727/1957) for the testwork.

Thank you for allowing us another opportunity to serve you.

Sincerely,

Frank A. Macy
Project Manager

FAM:aak
Enclosure

McCLELLAND LABORATORIES, INC.

1016 Greg Street, Sparks, Nevada 89431 702 / 356-1300
FAX 702 / 356-8917

January 29, 1992

Mr. Richard Jeanne
888 Keele Drive
Reno, NV 89509

Dear Richard:

Enclosed is our report concerning metallurgical results obtained from direct agitated cyanidation tests conducted on the Moss cuttings intervals, which you submitted.

Enclosed also is our invoice (MLI Job No. 1727/1958) for testwork conducted on cuttings interval MC-4 (37).

Thank you for allowing us another opportunity to serve you.

Sincerely,

Frank A. Macy
Project Manager

FAM:aak
Enclosure

McCLELLAND LABORATORIES, INC.

1016 Greg Street, Sparks, Nevada 89431 702 / 356-1300
FAX 702 / 356-8917

Report
on
Direct Agitated Cyanidation Testwork - Moss Cuttings Intervals
MLI Job No. 1727
January 29, 1992

for

Mr. Mark Sander
Magma Copper Company
7400 North Oracle Road - Ste 200
Tucson, AZ 85704

TABLE OF CONTENTS

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 26
To DR. DouglAS JINKS	From RAY IRWIN
Co.	Co.
Dept.	Phone #
Fax #	Fax #

McCLELLAND LABORATORIES, INC.

1016 Greg Street, Sparks, Nevada 89431 702 / 356-1300
FAX 702 / 356-8917

Report
on
Preliminary Direct Agitated Cyanidation Testwork - Moss Cuttings Intervals
MLI Job No. 1727
January 29, 1992

for

Mr. Mark Sander
Magma Copper Company
7400 North Oracle Road - Ste 200
Tucson, AZ 85704

EXECUTIVE SUMMARY

Direct agitated cyanidation (bottle roll) tests were conducted on two Moss cuttings intervals at the as received (nominal 10 mesh) feed size to determine precious metal recovery, recovery rate, and reagent requirements.

Metallurgical results show that Moss cuttings intervals were amenable to direct agitated cyanidation treatment at the as recieved feed size. Gold recoveries of 87.9 and 78.7 percent were achieved from intervals MC-6 (56) and MC-14 (28), respectively, in 96 hours of leaching. Respective silver recoveries were 70.0 and 59.4 percent. Gold recovery rates were fairly rapid and extraction was substantially complete in 24 hours. Additional gold values were extracted between 24 and 96 hours, but at a very slow rate. Reagent requirements were low.

SAMPLE PREPARATION AND HEAD ASSAYS

Two cuttings intervals from the Moss project were received for the preliminary testing program. Each interval was thoroughly blended and split to obtain one kilogram for a bottle roll test, and a sample for single direct head assay.

Head samples were assayed directly using conventional fire assay fusion procedures to determine precious metal content. Head assay results are provided with overall metallurgical results from bottle roll tests later in this report.

DIRECT AGITATED CYANIDATION TEST PROCEDURES AND RESULTS

Direct agitated cyanidation (bottle roll) tests were conducted on two Moss cuttings intervals at the as received (nominal 10 mesh) feed size to determine precious metal recovery, recovery rate, and reagent requirements. Ore charges were mixed with water to achieve 40 weight percent solids. Natural pulp pHs were measured. Lime was added to adjust the pH of the pulps to 11.0 before adding the cyanide. Sodium cyanide, equivalent to 2.0 pounds per ton of solution, was added to the alkaline pulps.

Leaching was conducted by rolling the pulps in bottles on the laboratory rolls for 96 hours. Rolling was suspended briefly after 2, 6, 24, 48, and 72 hours to allow the pulps to settle so samples of pregnant solution could be taken for gold and silver analysis using A.A. methods. Pregnant solution volumes were measured and sampled. Cyanide concentration and pH were determined for each pregnant solution. Make-up water, equivalent to that withdrawn, was added to the pulps. Cyanide concentrations were restored to initial levels. Lime was added, when necessary, to maintain the leaching pH at between 10.8 and 11.2. Rolling was then resumed.

After 96 hours, the pulps were filtered to separate liquids and solids. Final pregnant solution volumes were measured and sampled for analysis. Final pH and cyanide concentrations were determined. Leached residues were washed, dried, weighed, and assayed in triplicate to determine residual precious metal content.

Overall metallurgical results for the bottle roll tests are provided in Table 1. Gold leach rate profiles are shown graphically in Figure 1. Triplicate tail assay results are provided in Table 2.

Figure 1. – Gold Leach Rate Profiles,

Bottle Roll Tests, As Rec'd Feeds

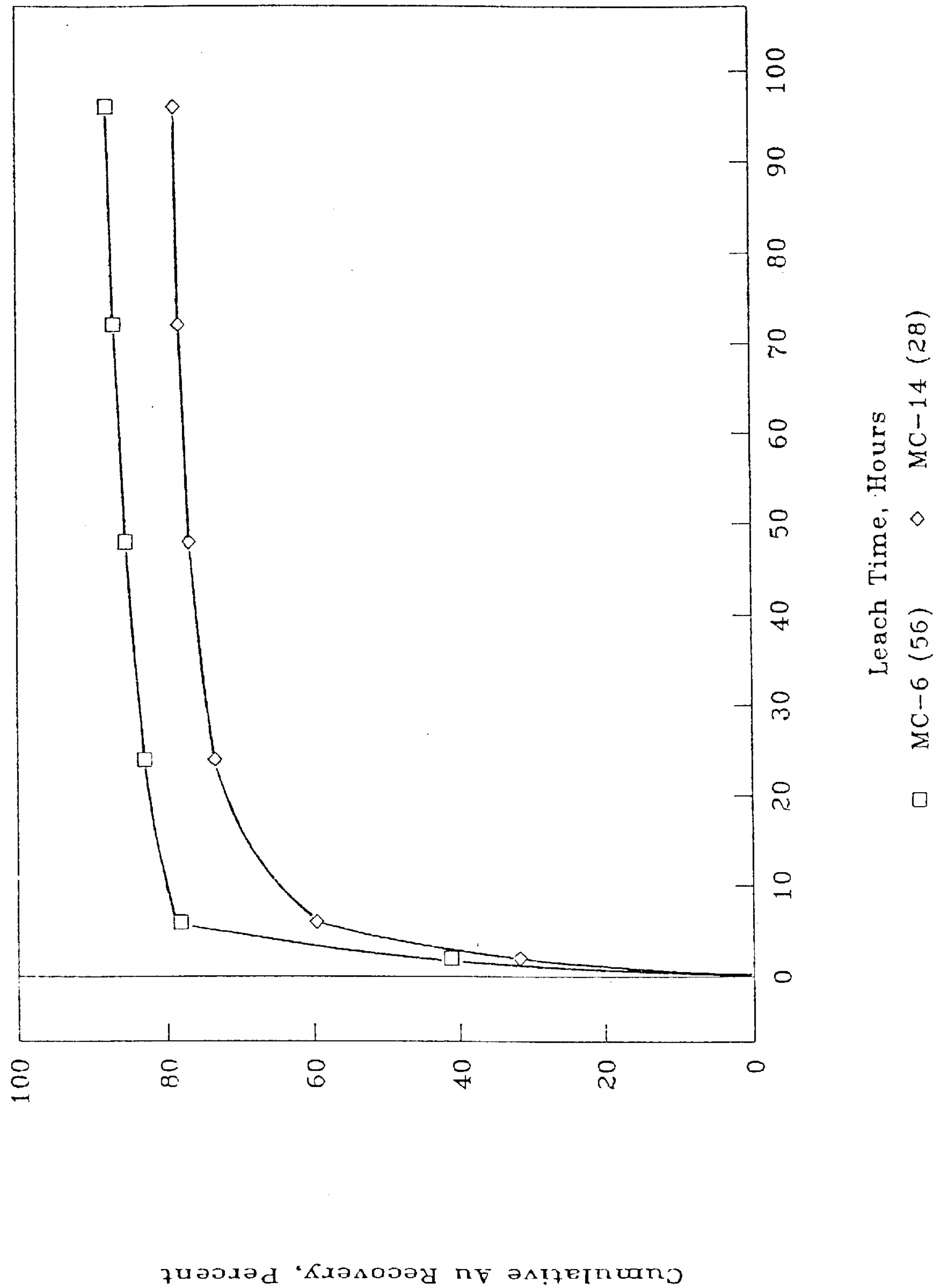

Table 1. - Overall Metallurgical Results, Bottle Roll Tests, Moss Cuttings Intervals, As Received Feeds

Metallurgical Results	Sample MC-6 (56) Au	Sample MC-6 (56) Ag	Sample MC-14 (28) Au	Sample MC-14 (28) Ag
Extraction, pct. of total				
in 2 hours	41.2	35.0	31.7	15.2
in 6 hours	78.2	50.0	59.6	26.8
in 24 hours	83.0	62.0	73.4	43.6
in 48 hours	85.5	67.0	76.8	51.3
in 72 hours	87.0	69.0	78.1	55.8
in 96 hours	87.9	70.0	78.7	59.4
Extracted, oz/ton ore	0.029	0.07	0.037	0.41
Tail Assay, oz/ton*	0.004	0.03	0.010	0.28
Calculated Head, oz/ton ore	0.033	0.10	0.047	0.69
Assayed Head, oz/ton ore	0.034	0.13	0.051	0.56
Cyanide Consumed, lb/ton ore	0.58		0.46	
Lime Added, lb/ton ore	2.8		3.7	
Final Solution pH	11.1		11.0	
Natural pH (40% solids)	8.4		8.4	

* Average of three.

Table 2. - Tail Assay Results, Bottle Leached Residues, Moss Cuttings Intervals, As Received Feeds

	Tail Assays, oz/ton			
	MC-6 (56)		MC-14 (28)	
	Au	Ag	Au	Ag
Initial	0.004	0.03	0.011	0.24
Duplicate	0.004	0.03	0.010	0.45
Triplicate	0.003	0.03	0.010	0.15
Average	0.004	0.03	0.010	0.28

Metallurgical results show that the Moss cuttings intervals were amenble to direct agitated cyanidation treatment at the as received (nominal 10 mesh) feed size. Gold recoveries of 87.9 and 78.7 percent were achieved from intervals MC-6 (56) and MC-14 (28), respectively, in 96 hours of leaching. Respective silver recoveries were 70.0 and 59.4 percent. Gold recovery rates were fairly rapid and extraction was substantially complete in 24 hours. Additional gold values were extracted between 24 and 96 hours, but at a very slow rate.

Cyanide consumptions were low for both intervals and averaged 0.52 pounds per ton of ore. Consumption rates tended to increase slightly after 48 hours of leaching. Lime requirements were low for both intervals and averaged about 3.3 pounds per ton of ore. Controlling pH was not difficult for either interval even though lime was added to interval MC-14 (28) at various sampling intervals to maintain leaching pH at between 10.8 and 11.2. About 80.0 percent of the total lime required for that interval was added during initial pH adjustment procedures. The remaining 20.0 percent was added during leaching.

CONCLUSIONS

- The Moss cuttings intervals were amenable to direct agitated cyanidation treatment at the as received (nominal 10 mesh) feed size.

- Gold recovery rates were fairly rapid.

- Reagent requirements were low.

RECOMMENDATIONS

We recommend that additional testwork be conducted on representative cuttings composites from various areas of the Moss ore deposit to determine if these metallurgical results are representative of the entire mineable ore body. We recommend also that column percolation leach tests be conducted on representative core or bulk ore composites to determine gold recovery, recovery rate, and reagent requirements under simulated heap leaching conditions.

Frank A. Macy
Project Manager

McCLELLAND LABORATORIES, INC.

1016 Greg Street, Sparks, Nevada 89431 702 / 356-1300
FAX 702 / 356-8917

Report
on
Direct Agitated Cyanidation Testwork -
Moss Bulk Ore and Cuttings Samples
MLI Job No. 1567
May 29, 1991

for

Mr. Mark Sander
Magma Copper Company
7400 North Oracle Road
Suite 200
Tucson, AZ 85704

TABLE OF CONTENTS

Report
on
Direct Agitated Cyanidation Testwork
Moss Bulk Ore and Cuttings Samples
MLI Job No. 1567
May 29, 1991

for

Mr. Mark Sander
Magma Copper Company
7400 North Oracle Road
Suite 200
Tucson, AZ 85704

EXECUTIVE SUMMARY

Direct agitated cyanidation (bottle roll) tests were conducted on 1 bulk ore sample, and 14 cuttings intervals from the Moss project to determine gold recovery, recovery rate, and reagent requirements. The bulk ore sample was evaluated at a 100 percent minus 1 inch feed size. Cuttings intervals were evaluated at the as received feed size.

Metallurgical results show that the bulk ore sample was not readily amenable to direct agitated cyanidation treatment at a minus 1 inch feed size. A gold recovery of 42.1 percent was achieved in 96 hours of leaching. Gold recovery rate was fairly slow and extraction was progressing at a slower, but fairly constant rate, when leaching was terminated at 96 hours. Reagent requirements were low.

Metallurgical results show that the cuttings intervals were amenable to direct agitated cyanidation treatment at the as received feed size. Gold recoveries ranged from 51.9 to 78.1 percent, and averaged 62.4 percent in 96 hours of leaching. Gold recovery rates were fairly rapid and extraction was substantially complete in from 6 to 24 hours. Additional gold was extracted after 24 hours, but at a slow rate. Cyanide and lime requirements were low to moderate.

SAMPLE PREPARATION AND HEAD ASSAYS

One bulk ore sample, and 14 cuttings intervals from the Moss project were received for the testing program. The bulk ore sample was stage crushed to 100 percent minus 1 inch in size, and was thoroughly blended and split to obtain 3 kilograms for a bottle roll test, and samples for triplicate direct head assay. Cuttings intervals were thoroughly blended and split to obtain 1 kilogram for a bottle roll test. Cuttings intervals from hole MM-2 were split further to obtain a 300 gram sample for direct head assay.

Head samples were assayed directly using conventional fire assay fusion procedures to determine gold content. Head assay results and head grade comparisons for the bulk ore sample are provided in Table 1. Head assay results for cuttings intervals are provided with overall metallurgical results from the bottle roll tests later in this report.

Table 1. - Head Assay Results and Head Grade Comparisons, Moss Bulk Ore Sample

Determination Method	Head Grade, ozAu/ton
Direct Assay: Initial	0.250
Duplicate	0.254
Triplicate	0.325
Calculated, Bottle Test	0.214
Arithmetic Average	0.261
Maximum Deviation from Average	0.064
Precision, percent	80.3

Head grades determined by the various methods did not agree closely. Gold occurrence was somewhat "spotty". The cause of "spottiness" was not established. The calculated head grade determined from the bottle roll test is considered more reliable than direct head assays because of the quantity of sample evaluated.

DIRECT AGITATED CYANIDATION TEST PROCEDURES AND RESULTS

Direct agitated cyanidation (bottle roll) tests were conducted on 1 bulk ore sample, and 14 cuttings intervals from the Moss project to determine gold recovery, recovery rate, and reagent requirements. The bulk ore sample was evaluated at a 100 percent minus 1 inch feed size. Cuttings intervals were evaluated at the as received feed size. Ore charges were mixed with water to achieve 40 weight percent solids. Natural pulp pHs were measured. Lime was added to adjust the pH of the pulps to 11.0 before adding the cyanide. Sodium cyanide, equivalent to 2.0 pounds per ton of solution, was added to the alkaline pulps.

Leaching was conducted by rolling the pulps in bottles on the laboratory rolls for 96 hours. Rolling was suspended briefly after 2, 6, 24, 48, and 72 hours to allow the pulps to settle so samples of pregnant solution could be taken for analysis by A.A. methods. Pregnant solution volumes were measured and sampled. Cyanide concentration and pH were determined for each pregnant solution. Make-up water, equivalent to that withdrawn, was added to the pulps. Cyanide concentrations were restored to initial levels. Lime was added, if necessary, to maintain the leaching pH at between 10.8 and 11.2. Rolling was then resumed.

After 96 hours, the pulps were filtered to separate liquids and solids. Final pregnant solution volumes were measured and sampled for analysis. Final pH and cyanide concentrations were determined. Leached residues were washed, dried, weighed, and assayed in triplicate to determine residual gold content.

Overall metallurgical results for the bottle roll tests are provided in Tables 2 through 7. Gold leach rate profiles are shown graphically in Figures 1 through 6. Triplicate gold tail assay results for the cuttings intervals are provided in Table 8. A summary of bottle roll test results conducted on the cuttings intervals is provided in Table 9.

Table 2. - Overall Metallurgical Results, Bottle Roll Test, Moss Bulk Ore Sample

Metallurgical Results	Feed Size
Extraction: pct. total Au	-1"
in 2 hours	10.2
in 6 hours	18.4
in 24 hours	29.0
in 48 hours	34.7
in 72 hours	38.6
in 96 hours	42.1
Extracted, ozAu/ton ore	0.090
Tail Grade, ozAu/ton[1)]	0.261
Calculated Head, ozAu/ton ore	0.214
Head Grade, ozAu/ton ore[2)]	0.261
Cyanide Consumed, lb/ton ore	0.15
Lime Added, lb/ton ore	3.4
Final Solution pH	11.0
Natural pH (40% solids)	7.1

1) Average of three (0.132, 0.119, and 0.121 ounce gold per ton).
2) Average of all head grade determinations.

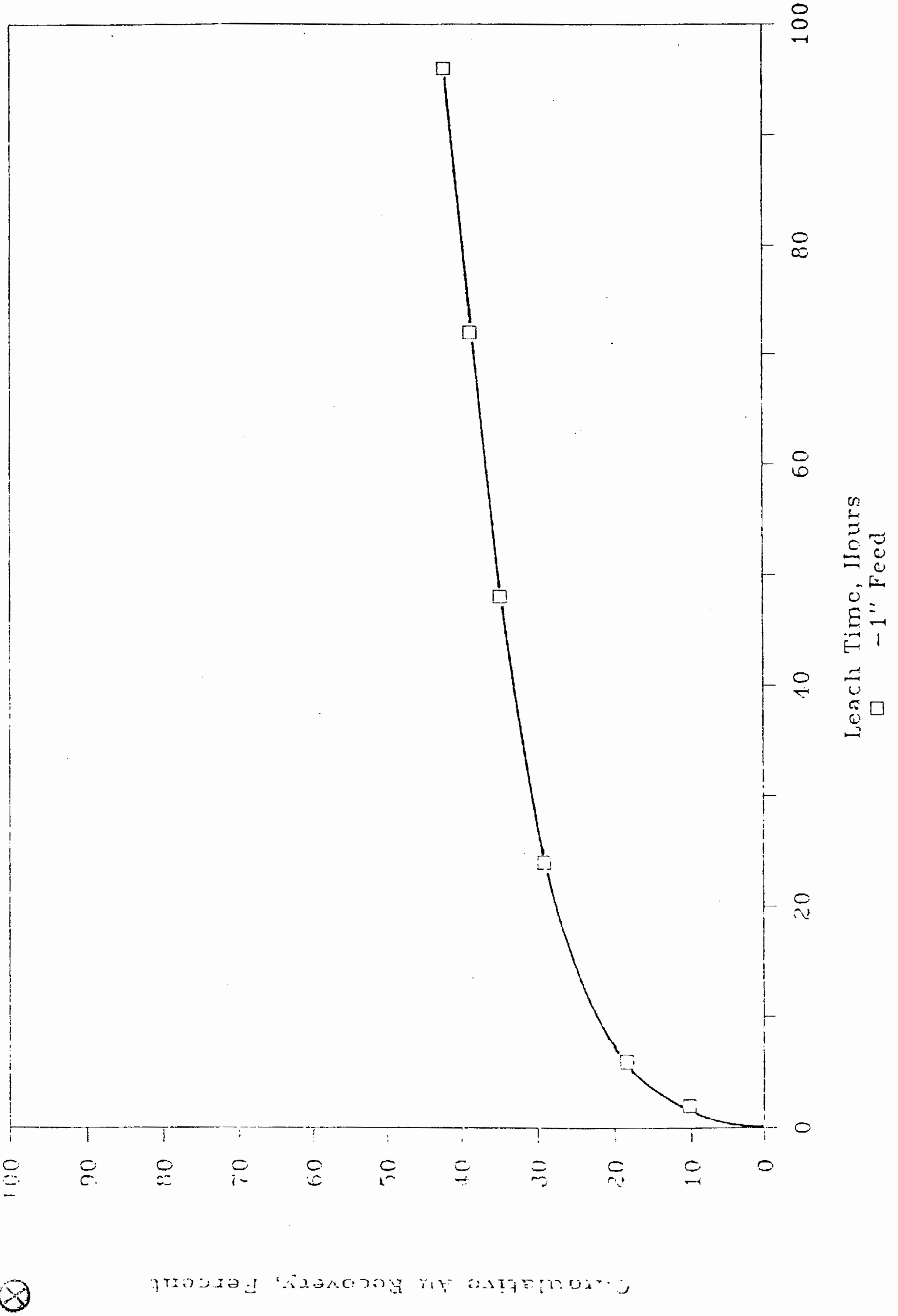

Figure 1. - Gold Leach Rate Profile,
Bottle Roll Test, Moss Bulk Ore Sample

Metallurgical results show that the bulk ore sample was not readily amenable to direct agitated cyanidation treatment at a 100 percent minus 1 inch feed size. A gold recovery of 42.1 percent was achieved in 96 hours of leaching. Gold recovery rate was fairly slow and extraction was progressing at a slower, but fairly constant rate, when leaching was terminated at 96 hours. Additional gold values would be extracted with a leaching cycle longer than 96 hours, but at a slow rate.

Cyanide consumption was low at 0.15 pounds per ton of ore. The lime requirement was low at 3.4 pounds per ton of ore.

Table 3. - Overall Metallurgical Results, Bottle Roll Tests, Moss Cuttings Intervals, As Received Feeds

Metallurgical Results	Sample	
Extraction: pct total Au	MM-1-30	MM-1-64
in 2 hours	20.0	13.3
in 6 hours	38.0	33.9
in 24 hours	49.7	63.3
in 48 hours	54.9	71.7
in 72 hours	57.4	74.7
in 96 hours	60.0	75.0
Extracted, ozAu/ton ore	0.021	0.027
Tail Assay, ozAu/ton[1)]	0.014	0.009
Calculated Head, ozAu/ton ore	0.035	0.036
Predicted Head, ozAu/ton ore[2)]	0.029	0.046
Cyanide Consumed, lb/ton ore	0.24	0.10
Lime Added, lb/ton ore	4.3	5.9
Final Solution pH	11.1	11.1
Natural pH (40% solids)	7.8	7.8

1) Average of three.
2) Provided by Magma Copper personnel.

Figure 2. - Gold Leach Rate Profiles,
Bottle Tests, Moss Cuttings Intervals

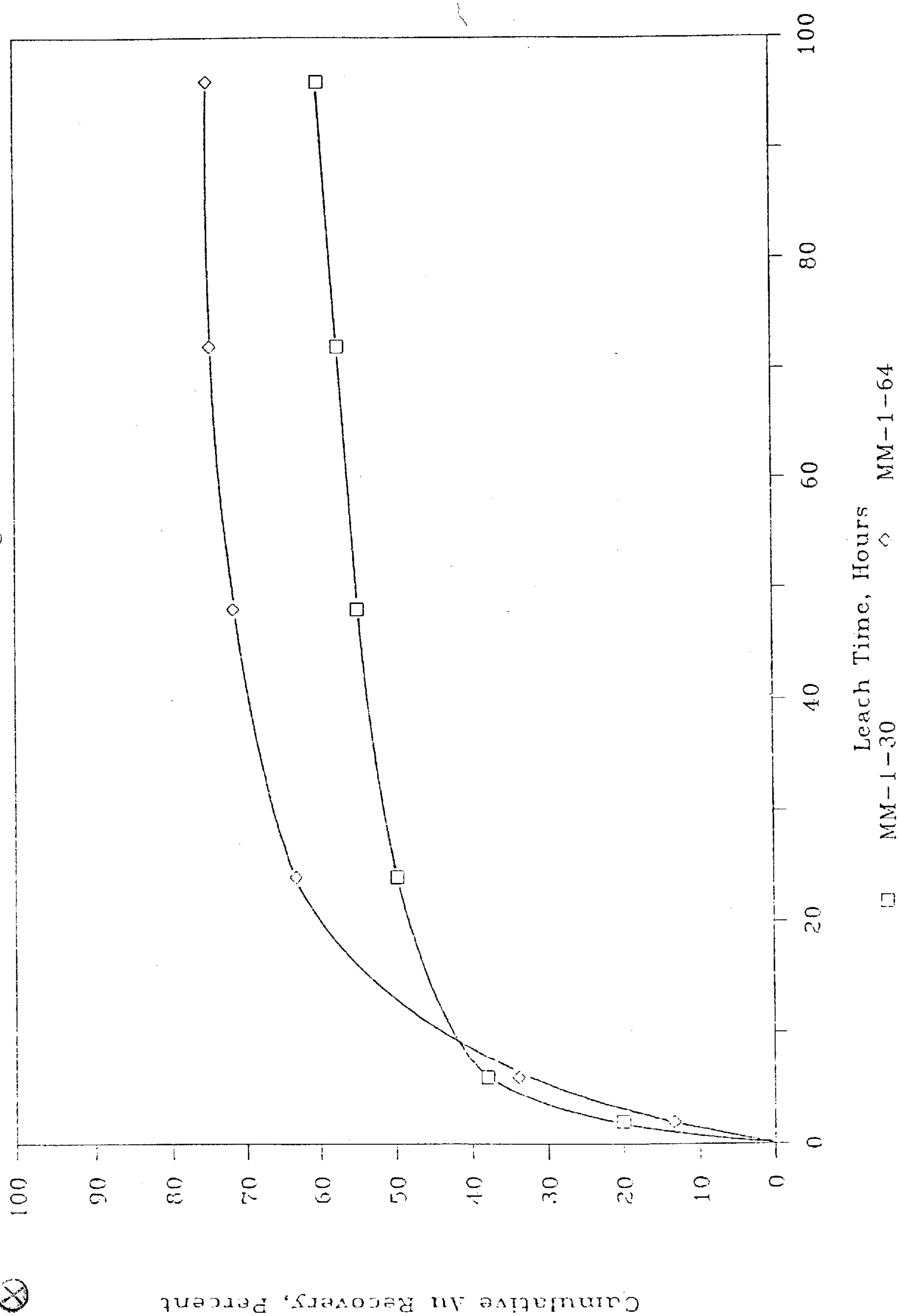

Table 4. - Overall Metallurgical Results, Bottle Roll Tests, Moss Cuttings Intervals, As Received Feeds

Metallurgical Results	Sample		
Extraction: pct total Au	MM-2-22	MM-2-23	MM-2-31
in 2 hours	22.6	28.2	19.4
in 6 hours	39.3	42.5	33.1
in 24 hours	47.4	54.3	45.0
in 48 hours	49.3	58.9	50.0
in 72 hours	51.1	61.8	52.7
in 96 hours	51.9	64.3	53.8
Extracted, ozAu/ton ore	0.014	0.018	0.028
Tail Assay, ozAu/ton[1)]	0.013	0.010	0.024
Calculated Head, ozAu/ton ore	0.027	0.028	0.052
Head Assay, ozAu/ton ore	0.028	0.026	0.046
Predicted Head, ozAu/ton ore[2)]	0.052	0.032	0.055
Cyanide Consumed, lb/ton ore	0.14	0.27	1.29
Lime Added, lb/ton ore	5.9	4.6	5.1
Final Solution pH	10.9	10.8	10.9
Natural pH (40% solids)	7.8	7.6	7.7

1) Average of three.
2) Provided by Magma Copper personnel.

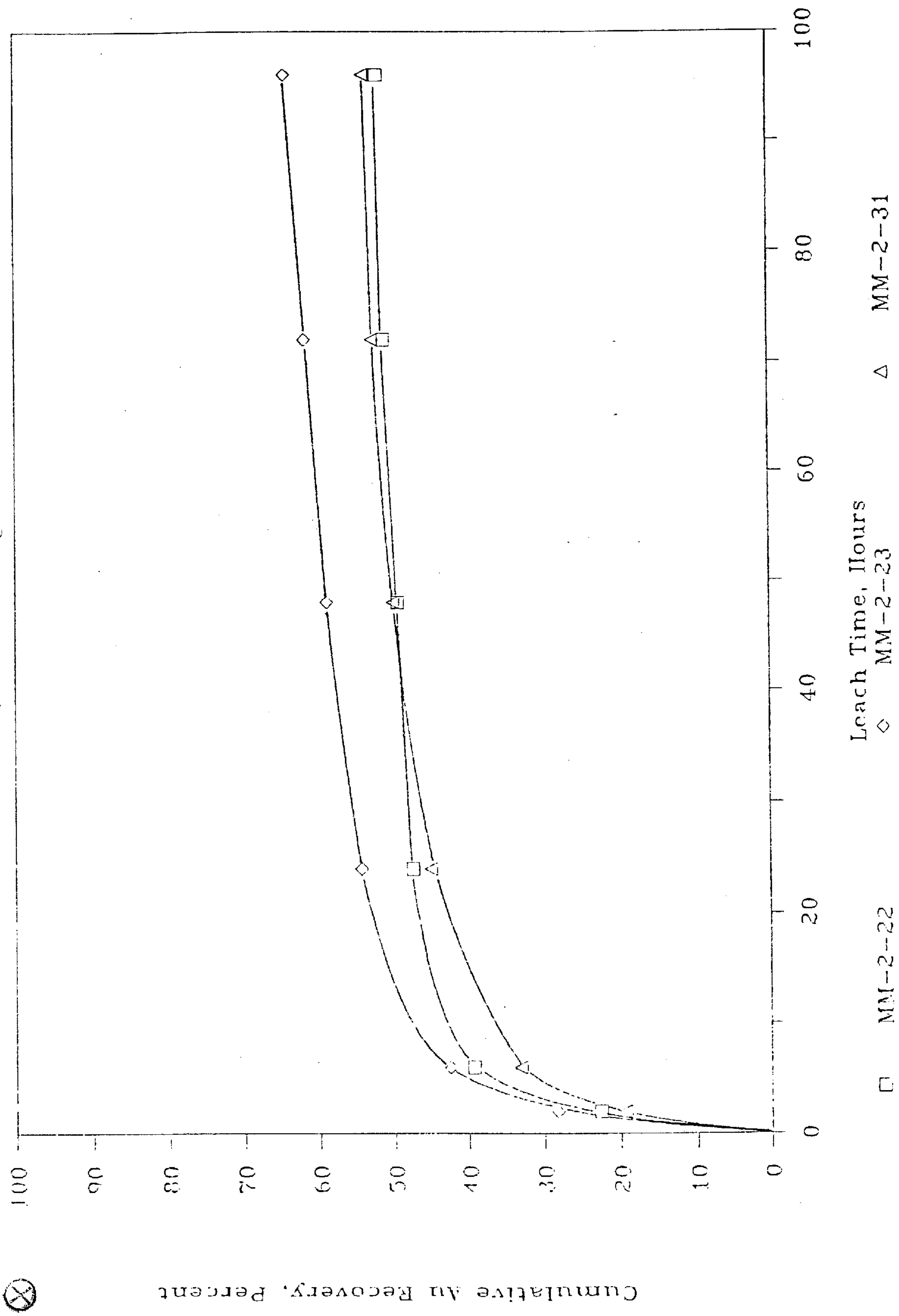

Figure 3. - Gold Leach Rate Profiles,
Bottle Tests, Moss Cuttings Intervals

Table 5. - Overall Metallurgical Results, Bottle Roll Tests, Moss Cuttings Intervals, As Received Feeds

Metallurgical Results	Sample		
Extraction: pct total Au	MM-2-33	MM-2-36	MM-2-37
in 2 hours	38.4	29.5	27.1
in 6 hours	52.0	41.2	38.1
in 24 hours	59.0	50.2	47.9
in 48 hours	63.0	54.4	52.6
in 72 hours	63.9	55.8	54.5
in 96 hours	64.6	58.1	57.1
Extracted, ozAu/ton ore	0.053	0.025	0.024
Tail Assay, ozAu/ton1)	0.029	0.018	0.018
Calculated Head, ozAu/ton ore	0.082	0.043	0.042
Head Assay, ozAu/ton ore	0.093	0.038	0.038
Predicted Head, ozAu/ton ore2)	0.071	0.038	0.039
Cyanide Consumed, lb/ton ore	0.86	0.46	0.32
Lime Added, lb/ton ore	4.6	4.2	3.9
Final Solution pH	10.9	10.9	10.8
Natural pH (40% solids)	7.7	7.7	7.7

1) Average of three.
2) Provided by Magma Copper personnel.

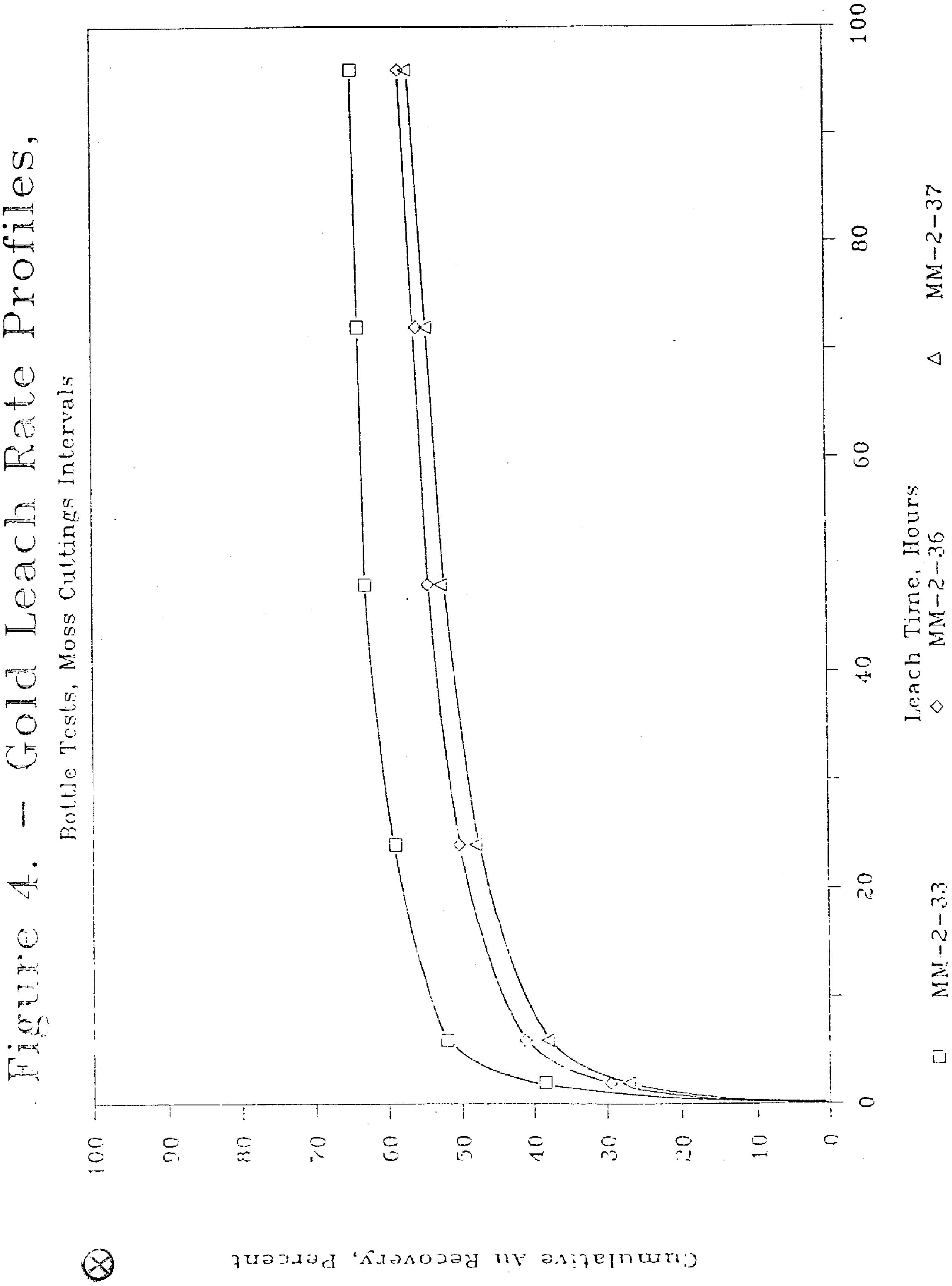

Figure 4. - Gold Leach Rate Profiles,

Table 6. - Overall Metallurgical Results, Bottle Roll Tests, Moss Cuttings Intervals, As Received Feeds

Metallurgical Results	Sample			
Extraction: pct total Au	MM-4-18	MM-8-30	MM-8-49	MM-8-56
in 2 hours	20.3	21.0	23.3	36.9
in 6 hours	33.3	39.5	38.7	57.8
in 24 hours	44.1	52.9	54.3	70.3
in 48 hours	48.8	59.5	61.0	72.5
in 72 hours	51.4	63.8	64.5	74.7
in 96 hours	53.4	66.7	66.5	78.1
Extracted, ozAu/ton ore	0.031	0.014	0.125	0.025
Tail Assay, ozAu/ton[1)]	0.027	0.007	0.063	0.007
Calculated Head, ozAu/ton ore	0.058	0.021	0.188	0.032
Predicted Head, ozAu/ton ore[2)]	0.056	0.016	0.185	0.028
Cyanide Consumed, lb/ton ore	0.47	0.28	0.73	0.75
Lime Added, lb/ton ore	3.8	4.3	3.6	5.0
Final Solution pH	10.7	10.8	10.8	10.9
Natural pH (40% solids)	8.0	8.2	8.1	8.3

1) Average of three.
2) Provided by Magma Copper personnel.

Figure 5. - Gold Leach Rate Profiles,

Bottle Tests, Moss Cuttings Intervals

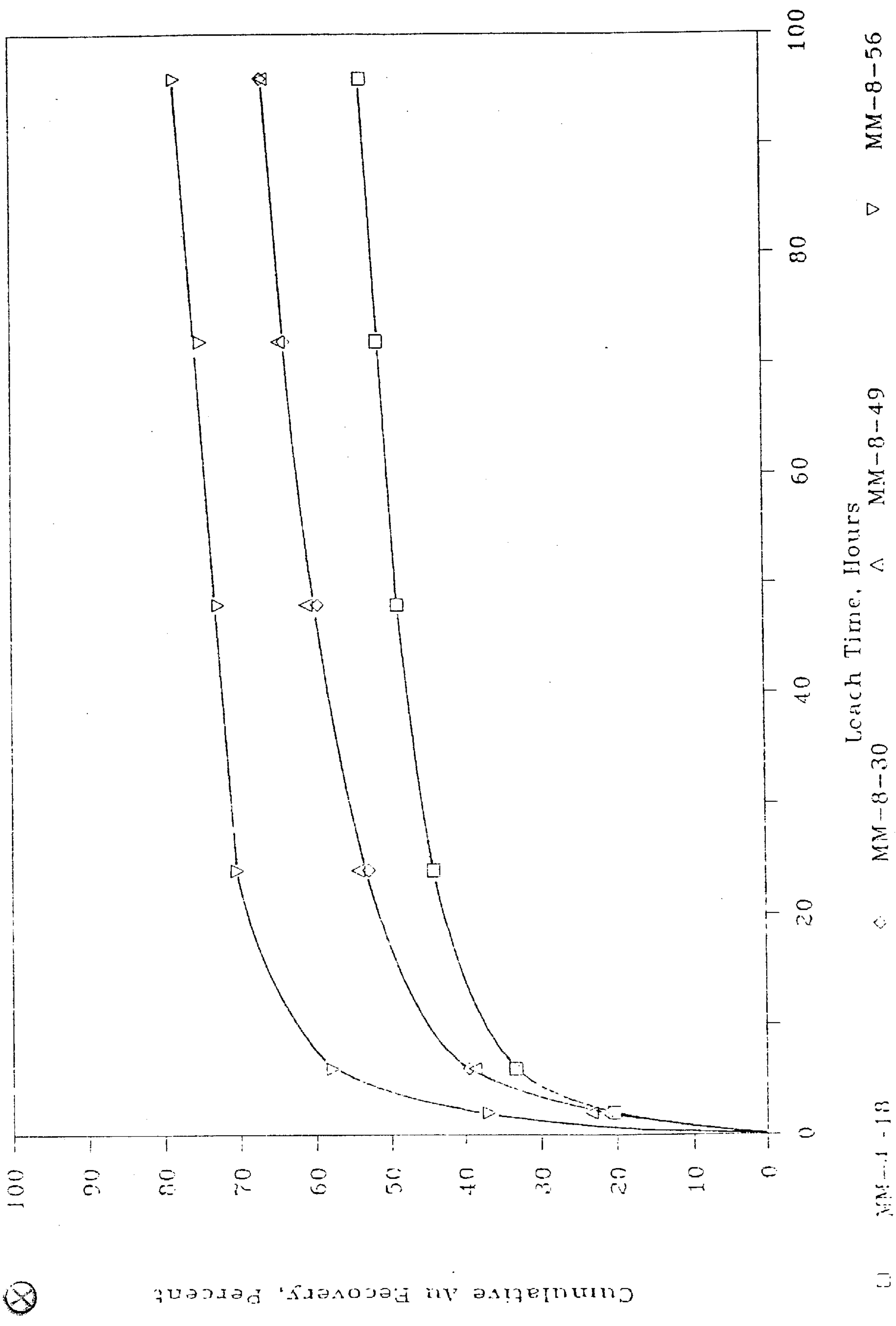

Table 7. - Overall Metallurgical Results, Bottle Roll Tests, Moss Cuttings Intervals, As Received Feeds

Metallurgical Results	Sample	
Extraction: pct total Au	MM-14-72	MM-18-58
in 2 hours	14.8	22.2
in 6 hours	29.4	40.4
in 24 hours	45.4	55.7
in 48 hours	51.5	61.2
in 72 hours	54.6	64.4
in 96 hours	57.5	66.4
Extracted, ozAu/ton ore	0.046	0.089
Tail Assay, ozAu/ton[1)]	0.034	0.045
Calculated Head, ozAu/ton ore	0.080	0.134
Predicted Head, ozAu/ton ore[2)]	0.077	0.127
Cyanide Consumed, lb/ton ore	0.61	0.44
Lime Added, lb/ton ore	5.0	3.9
Final Solution pH	11.1	10.9
Natural pH (40% solids)	8.3	8.4

1) Average of three.
2) Provided by Magma Copper personnel.

Figure 6. – Gold Leach Rate Profiles,

Bottle Tests, Moss Cuttings Intervals

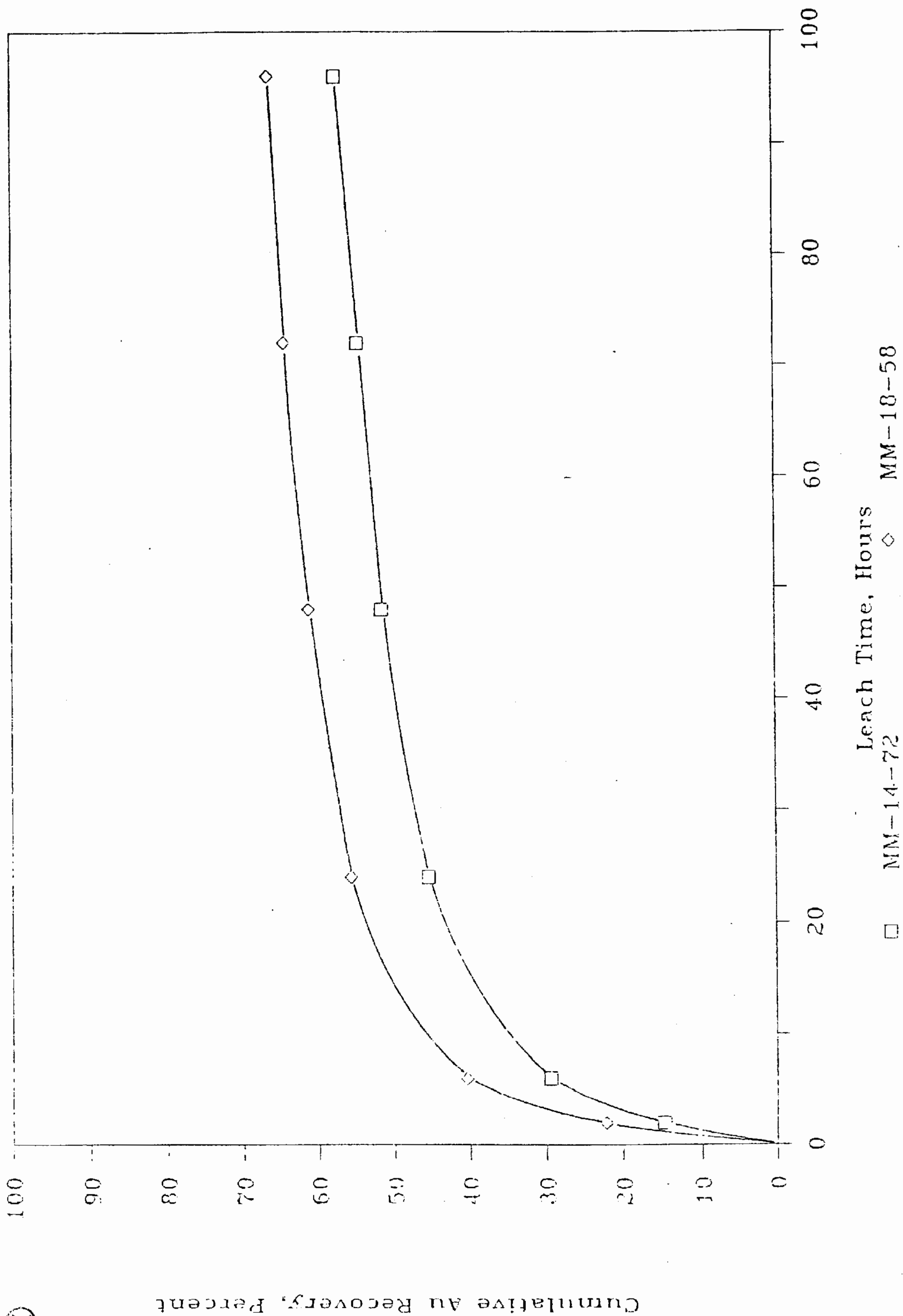

Table 8. - Tail Assay Results, Bottle Leached Residues, Moss Cuttings Intervals, As Received Feeds

	Tail Assays, ozAu/ton			
Interval	Initial	Duplicate	Triplicate	Average
MM-1-30	0.013	0.015	0.014	0.014
MM-1-64	0.012	0.010	0.006	0.009
MM-2-22	0.014	0.009	0.015	0.013
MM-2-23	0.008	0.008	0.014	0.010
MM-2-31	0.028	0.027	0.018	0.024
MM-2-33	0.030	0.027	0.030	0.029
MM-2-36	0.018	0.019	0.018	0.018
MM-2-37	0.018	0.018	0.018	0.018
MM-4-18	0.029	0.025	0.028	0.027
MM-8-30	0.007	0.008	0.007	0.007
MM-8-49	0.063	0.070	0.057	0.063
MM-8-56	0.006	0.007	0.009	0.007
MM-14-72	0.035	0.031	0.036	0.034
MM-18-58	0.047	0.044	0.045	0.045

Table 9. - Summary of Bottle Roll Test Results, Moss Cuttings Intervals, As Received Feeds

Interval	Extracted, ozAu/ton	Calculated Head, ozAu/ton	Au Recovery, percent	Cyanide Consumed, lb/ton	Lime Added, lb/ton
MM-1-30	0.021	0.035	60.0	0.24	4.3
MM-1-64	0.027	0.036	75.0	0.10	5.9
MM-2-22	0.014	0.027	51.9	0.14	5.9
MM-2-23	0.018	0.028	64.3	0.27	4.6
MM-2-31	0.028	0.052	53.8	1.29	5.1
MM-2-33	0.053	0.082	64.6	0.86	4.6
MM-2-36	0.025	0.043	58.1	0.46	4.2
MM-2-37	0.024	0.042	57.1	0.32	3.9
MM-4-18	0.031	0.058	53.4	0.47	3.8
MM-8-30	0.014	0.021	66.7	0.28	4.3
MM-8-49	0.125	0.188	66.5	0.73	3.6
MM-8-56	0.025	0.032	78.1	0.75	5.0
MM-14-72	0.046	0.080	57.5	0.61	5.0
MM-18-58	0.089	0.134	66.4	0.44	3.9

Metallurgical results show that the Moss cuttings intervals were amenable to direct cyanidation treatment at the as received (cuttings) feed size. Gold recoveries ranged from 51.9 (MM-2-22) to 78.1 (MM-8-56) percent, and averaged 62.4 percent in 96 hours of leaching. Gold recovery rates were fairly rapid and extraction was substantially complete in from 6 to 24 hours. Additional gold values were extracted between 24 and 96 hours, but at a slow rate.

Cyanide consumptions were low to moderate and ranged from 0.10 (MM-1-64) to 1.29 (MM-2-31) pounds per ton of ore. Consumption rates were more rapid early in the leaching cycles. Lime requirements were low to moderate and ranged from 3.4 to 5.9 pounds per ton of ore. Controlling pH was not difficult even though lime addition was required at various sampling intervals to maintain leaching pH at between 10.8 and 11.2. An average of 82.5 percent of the total lime required was added during initial pH adjustment procedures. The remaining 17.5 percent was added during the leaching cycles.

CONCLUSIONS

- The Moss bulk ore sample was not readily amenable to direct agitated cyanidation treatment at a 100 percent minus 1 inch feed size.
- Gold recovery rate was fairly slow. Additional gold values would be extracted with a longer leach cycle, but at a very slow rate.
- The Moss cuttings intervals were amenable to direct cyanidation treatment at the as received feed size.
- Gold recovery rates were fairly rapid.
- Reagent requirements were low to moderate.

RECOMMENDATIONS

We recommend that column percolation leach tests be conducted on core or representative bulk ore samples from the Moss project to determine gold recovery, recovery rate, reagent requirements, and sensitivity to feed size under simulated heap leaching conditions.

Frank A. Macy
Project Manager