9-13-79 21600528 WESTERN STATES MINERALS

PRELIMINARY RESULTS

DIABLO MINE SERVICES' GOLDFIELD, NEVADA PROPERTY

On August 20, 1979, one drum of ore was received from Goldfield, Nevada. The drum contained a bulk ore sample of approximately 400 pounds and four individual smaller samples. The four individual samples were identified as DMS 1 through 4. The four samples were pulverized and analyzed for total gold, silver and sulfur. The gold and silver were analyzed by fire assay at Skyline Labs. The results of the analysis are as follows:

SAMPLE NUMBER	Au oz/ton	Ag oz/ton	S %
DMS #1	0.030	<.01	1.19
DMS #2	0.026	<.01	3.72
DMS #3	0.040	<.01	0.48
DMS #4	0.029	<.01	2.89

The bulk sample was blended and quartered (pieces larger than 6" were reduced in size). One quarter of the bulk sample was crushed to less than ¼", blended, and split for the bottle leach testing. Part of the crushed ore was carefully split into 500 gram portions for the bottle leach tests. Fire assay of the sample splits averaged 0.091 oz/ton gold, and less than 0.01 oz/ton silver.

These bottle leach tests were completed at different pH levels using a leach solution containing 1.00 lb/ton NaCN. The bottle leach tests were run for 24 hours using 500 grams of ore and 500 ml of leach solution. A summary of the results is as follows:

TEST	pH	NaCN CONSUMPTION lb/ton	NaOH CONSUMPTION lb/ton	TOTAL GOLD EXTRACTED %
65	10.0	0.29	3	46.5
66	11.0	0.16	4.5	45.2
67	12.0	0.12	9	45.2

Rate extraction curves are shown on the attached sheets (Figures 1-3).

The data indicates that pH does not noticeably effect the % gold extracted. The data also shows that the consumption of NaCN is greater at lower pH levels. (Both these trends are consistent with the Goldstrike test program.)

Agitation of the ore in the bottle leach produced a slurry which was found to be impossible to filter on a scale larger than a few ml. The difficulties encountered with filtration of the leached sample means that a good sample of the leached ore cannot be obtained and consequently the percent extractions cannot be based on a calculated head. The above gold extractions are therefore based on head assays of the crushed ore blend. Despite this fact, they seem to be consistent.

The remaining bulk ore sample was blended and quartered, with one quarter (83.82 pounds) placed in column #1. Twenty-five liters of leach solution containing 0.25 lb/ton NaCN was prepared. On day one of the column leach test, approximately one liter of leach solution was pumped onto the column before it was noticed that the solution was not percolating. The leach solution sat on the ore column for 4 hours with only about 2" of ore being penetrated during that period. At four hours, a hole was poked through the top part of the column and the leach solution found a channel and quickly trickled about 2/3 of the way down the column before plugging off. Subsequent administrations of leach solution plugged off at various points in the column. After five days, no leach

solution had reached the bottom of the column. Penetration along the initial channel has only reached 2 or 3 inches and dry ore pockets remain in the column.

BOTTLE LEACH TEST 65

Sample 9820-5

Parameters:
Test pH 10.0
Initial NaCN 1.00 lb/ton
Additive

Gold 0.091 oz/ton

Consumption:
NaCN 0.29 lb/ton
NaOH 3 lb/ton

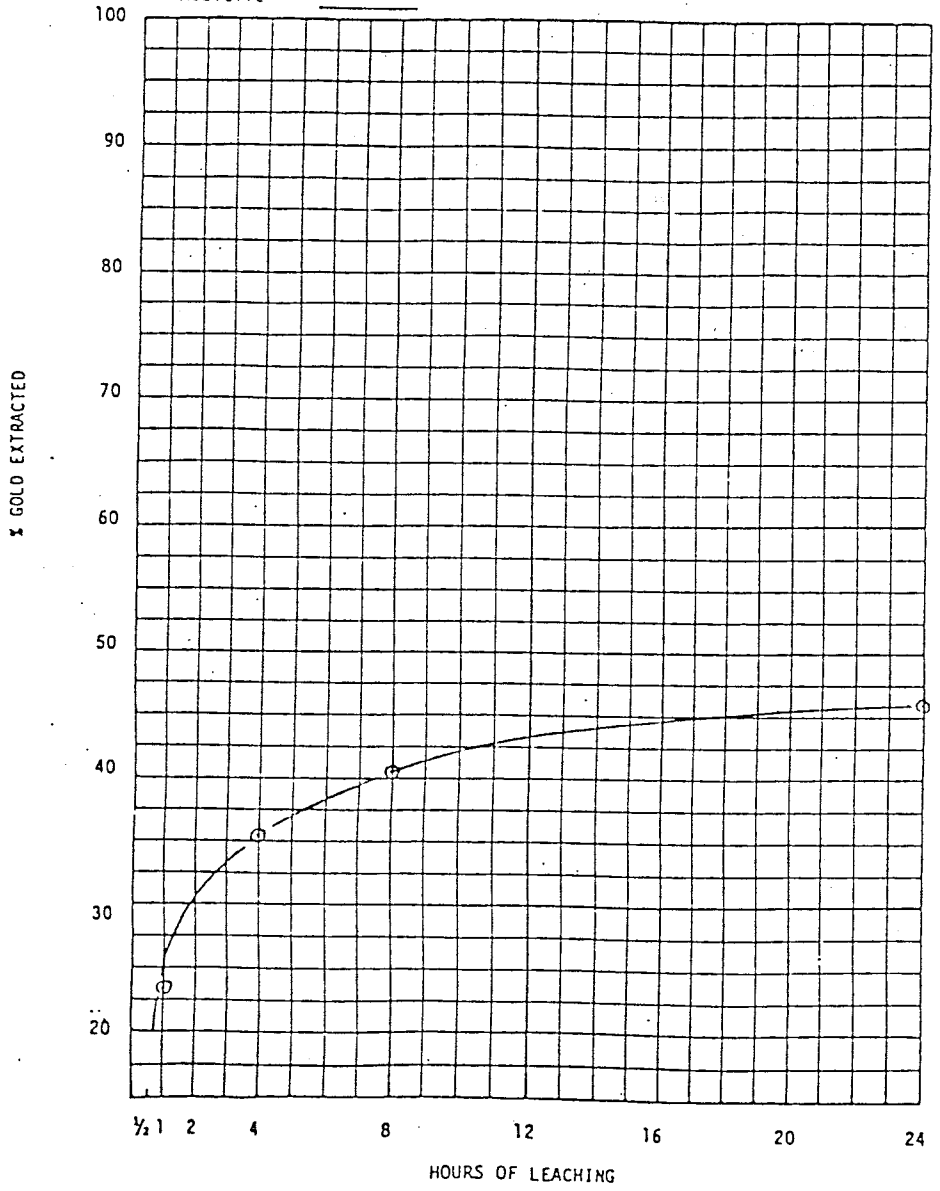


FIG 1

BOTTLE LEACH TEST 66

Sample 9820-5

Parameters:
Test pH 11.0
Initial NaCN 1.00 lb/ton
Additive

Gold 0.091 oz/ton

Consumption:
NaCN 0.16 lb/ton
NaOH 4.5 lb/ton

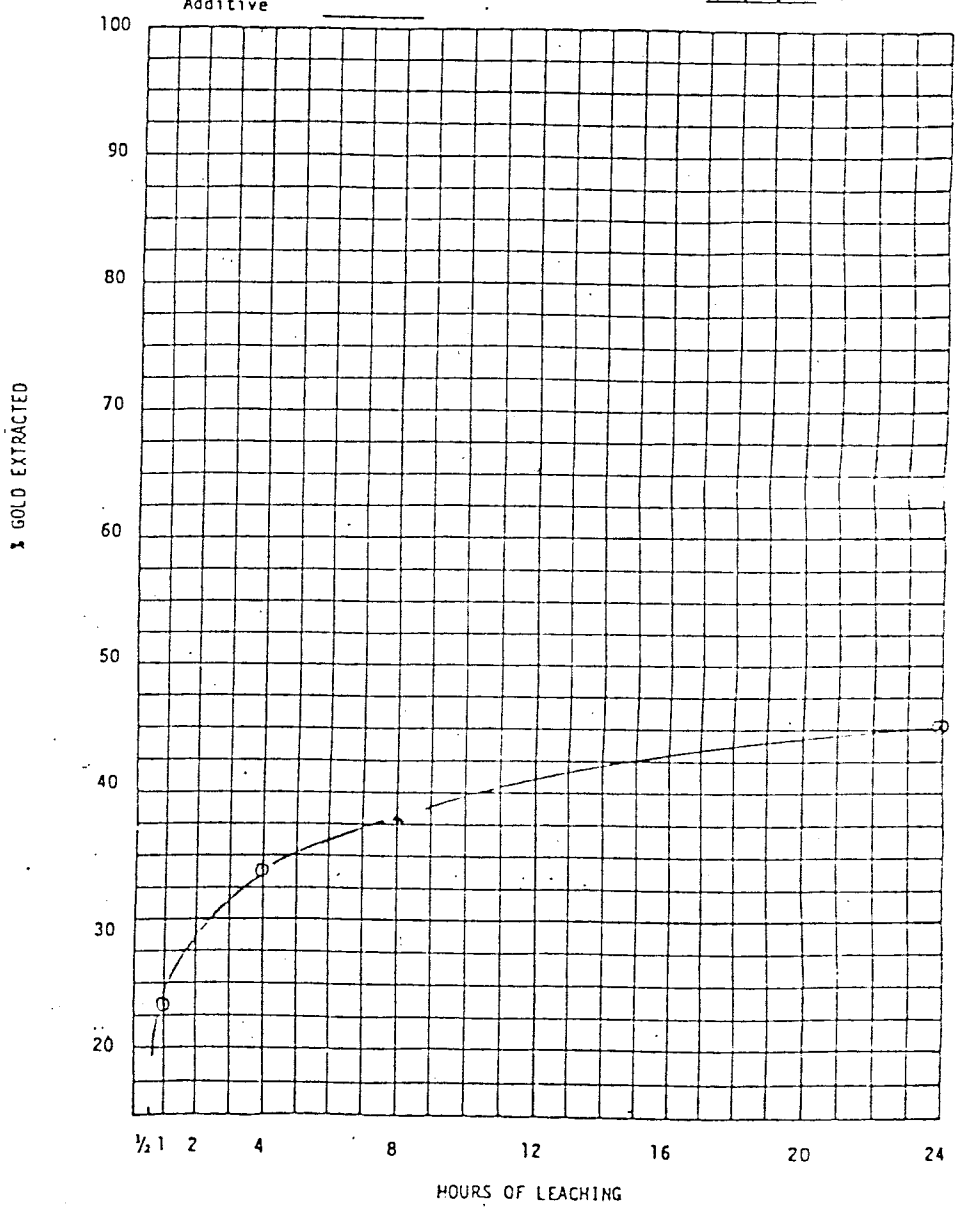


FIG 2

BOTTLE LEACH TEST 67

Sample 9820-5

Parameters:
Test pH 12.0
Initial NaCN 1.00 lb/ton
Additive

Gold 0.091 oz/ton
Consumption:
NaCN 0.12 lb/ton
9 lb/ton

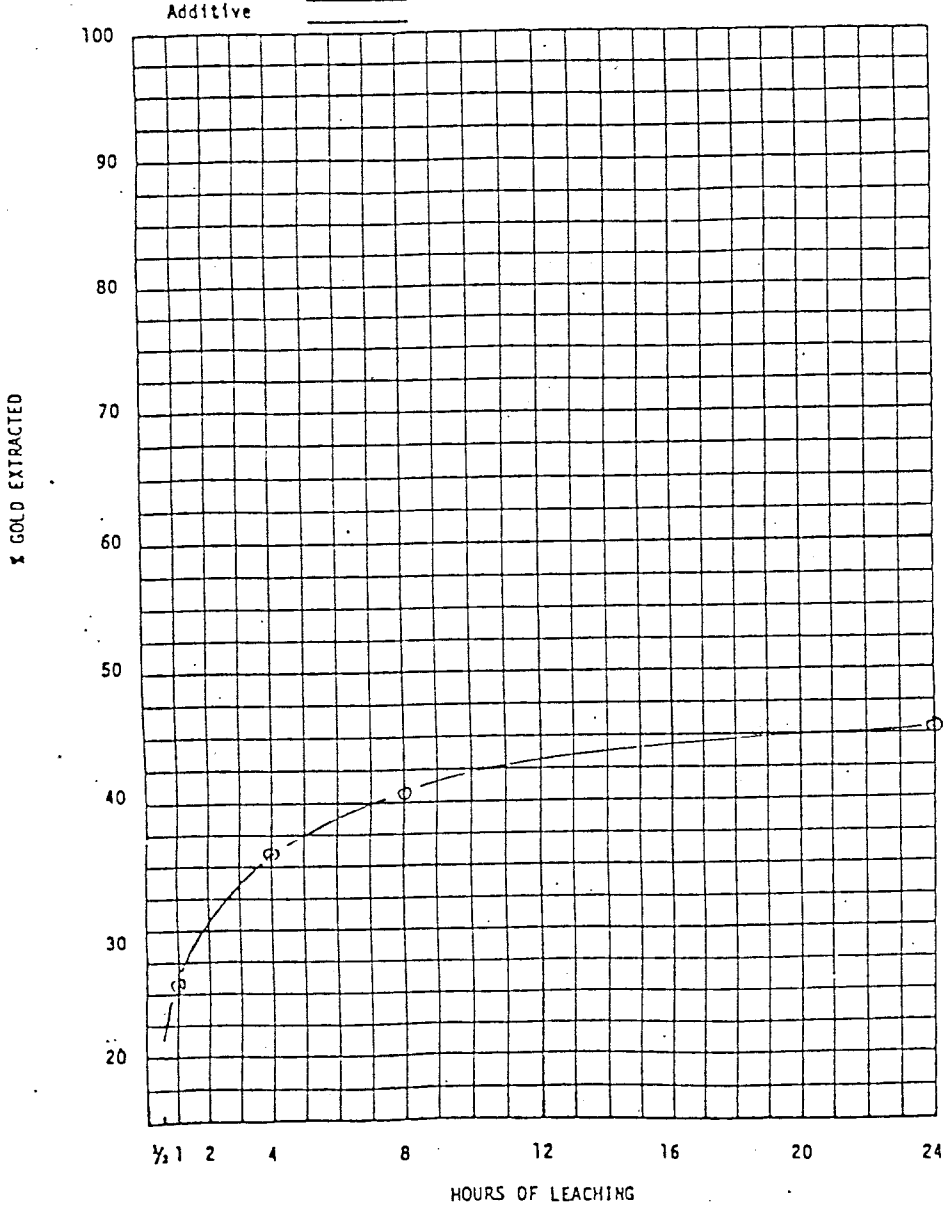
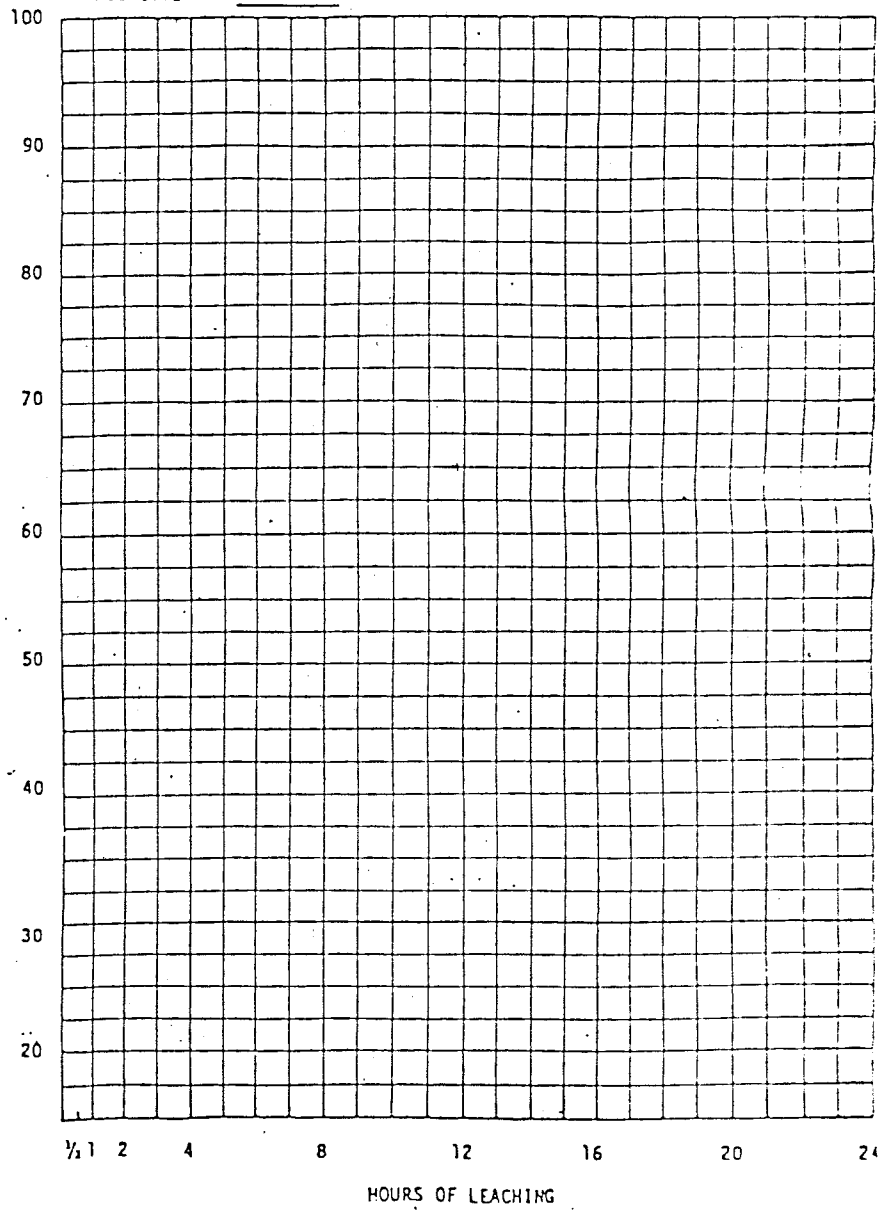


FIG 3

BOTTLE LEACH TEST

Sample
Parameters:
Test pH
Initial NaCN lb/ton
Additive

Gold oz/ton
Consumption:
NaCN lb/ton
CaO lb/ton



9

EEN ANALYSIS (SPLIT OF BULK SAMPLE) 10575 g − 1250 = TOTAL 9327 g

MPLE		SIZE	WEIGHT g	WT %	CUM %
-64	-1	+2"	3377	36.1	36.1
	-2	2 × 3/4	1663	17.8	53.9
	-3	3/4 × 1/4	1230	13.2	67.1
	-4	1/4 × 8M	930	10.0	77.1
	-5	8 × 30	991	10.6	87.7
	-6	30 × 100	717	7.7	95.4
	-7	−100M	428	4.6	100.0
			9330 g	100.0	

	OZ/TON AU	PPM AU	GRAMS AU	% IN FRACTION	CUM GOLD
-64 -1	.078	2.68	.009033	42.60	42.60
-2	.076	2.61	.004934	20.47	63.07
-3	.034	1.17	.000144	6.79	69.86
-4	.056	1.92	.000179	8.44	78.30
-5	.056	1.92	.000190	8.96	87.26
-6	.056	1.92	.000138	6.51	93.77
-7	.090	3.09	.000132	6.23	100.00
	.066 OZ/TON	2.27	.021205		

.066 OZ/TON

Continued on Page

Read and Understood By

Signed

Date

DMS **Diablo Mine Services Company**

A DILLINGHAM COMPANY

Inter-Office Correspondence

TO: File **DATE:** September 10, 1979

FROM: Earl M. Woodward **INITIAL:** EMW/ekb

SUBJECT: Goldfield Ore - Interim Lab Test Results **REFERENCE:**

Preliminary results of ore testing presently in progress at Western Testing Lab in Reno, Nevada indicate the following:

1. "Run of mine" ore, i.e. ore produced by drilling and blasting or ripping without intermediate processing, is not amenable to leaching in heaps for the following primary causes:

   a. Solutions sprinkled on the heaps are "channeling" through the heaps and, therefore, not coming into contact with the ore in general.

   b. Fines within the heaps contains a clay which tends to coat and, therefore, protect the gold contained within the fines from contact by leach solution.

   c. Coarse rocks within the heap are relatively hard and dense; therefore, precluding the leach solution from contacting and dissolving gold on other than their exterior surfaces.

The above is consistent with the poor results we have been getting from the 10,000 ton heap at Goldfield. This heap has been under sprinkling since July 20th at a circulation rate of solution averaging 150 tons of solution/day. The pregnant solution emanating from the heap has been assaying between .004 and .006 oz Au/ton of solution. This figure has varied very little since leaching began. Thus, the approximately 1000 oz of Au contained in the heap is being returned at 150 x .005 = .75 oz of gold/day. If this rate were maintained, it would require $\frac{1000}{.75}$ = approximately 1330 days for recovery of the contained gold. This, of course, is not economically viable.

Western Testing Labs are currently running two column tests on the second lot of ore shipped to them.

These tests should be complete about September 15th. The procedure being tested consists of the following:

1. Ore was screened on a 1" screen giving the following:

   Plus 1" = 32% by weight
   Minus 1" = 68% by weight

2. Head Assay (by Chitty Test)

   Minus 1" = .043 oz gold/ton
   Plus 1" = .031 oz gold/ton

3. This ore was then re-combined and two each samples of 140# each were cut.

4. One sample of the crushed ore was placed in a 6" diameter x 12' column for leaching.

5. The second sample was mixed with Portland Cement at the ratio of 10# cement per ton of ore and a moisture content of 12% by wt. This mixing together causes a "balling" up of the fines (clay) to marble size and thus large air interstices between balls. It then was placed in a column similar to #4 above. The process of mixing with cement is called "agglomeration".

6. These columns were started leaching on Monday, September 3rd.

7. Leach solution required almost 5 full days to reach the bottom of the un-agglomerated ore column, while the agglomerated required less than one day, and had a total gold recovery of 40% of the contained gold by the end of 3 days.

8. These tests are continuing at the present. Results, however, to date indicate the solution to leaching Goldfield ore will require the following:

   a. Ore will require crushing.

   b. For reasonable recovery it will also require agglomerating with cement.

I have requested Western Testing to write a report on the results of testing to date, and their recommendations as to treatment of our ore for recovery of the gold. This will be done after completion of the column tests.

After review of their recommendations, I propose to ship a sufficiently large ore sample to their Reno Lab and run a pilot size heap leach conforming exactly to their recommended ore processing.

Following this, it will be necessary to run a complete cost analysis for the operation. This will include all applicable costs, such as:

Exploration
Stripping
Drill, Load and Blast
Load and Haul Waste
Load and Haul Ore
Crush Ore
Agglomeration of Ore
Haul to and Construct Heaps
Leach
Other

EMW:lhb

DMS **Diablo Mine Services Company**

A DILLINGHAM COMPANY

Inter-Office Correspondence

TO: File DATE: October 15, 1979

FROM: Earl Woodward INITIAL: E. M. W.

SUBJECT: Western Testing Laboratory REFERENCE:
Report of Testing dated 10-11-79

Attached herewith is a copy of lab report for work performed on column testing up to this date. Additional test work is continuing, and reports will be sent as they become available.

EMW:mls

cc: Gordon A. Coats
Walt Hogan
Oscar Margraf
Mac Forbes (For Mr. Davis)
Western Crude Oil
G. W. Bayne
K. L. & L. Enterprises
Geo Exp. Co.

WESTERN TESTING LABORATORIES
1080 LINDA WAY, #3
SPARKS, NEVADA 89431
TELEPHONE: (702) 331-3600

REPORT OF ANALYSIS

SUBMITTED BY: Diablo Mine Services Co.
P.O. Box 798
Alamo, California 94507
Attn: Earl Woodward

DATE: October 11, 1979

LABORATORY NUMBER: 243-5

ANALYTICAL METHOD: Leach Test
Screen Analysis

REPORT ON: Au

YOUR ORDER NUMBER:
Invoice No. A392-1

SAMPLE MARK:

Note: See Report on COLUMN CYANIDE LEACH TESTS (15 pages, including 6 Tables) for the full report of analysis on Lab. No. 243-5. The report is dated October 11, 1979, and signed by Harold Heinen.

PPM = Parts per million
PERCENT = Parts per hundred
1 OZ/TON = 34.286 ppm
1.0% = 20 pounds/ton

OZ/TON = Troy ounces per ton of 2000 pounds avoirdupois
FINENESS = Parts per thousand
1 PPM = 0.0001% = 0.029167 oz/ton
Read + as "greater than." Read – as "less than."

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

COLUMN CYANIDE LEACH TESTS
(Laboratory No. 243-5)

to

Earl M. Woodward
Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013
(October 11, 1979)

SUMMARY

Column percolation leach tests were conducted on two 160-pound charges of a clayey gold ore crushed to minus 1 inch. A 12-foot bed of ore was stacked in a 5-inch I.D. upright PVC column. One charge of ore was leached directly with a dilute cyanide solution. The other charge was agglomerated with 10 pounds of portland cement per ton of ore, and 12 weight-percent solution containing sodium cyanide and sodium hydroxide equivalent to two pounds each per ton of ore. The agglomerated feed was cured at ambient conditions for 96 hours prior to leaching.

The percolation flow through the untreated ore was too slow to be practical for heap leaching. However, the agglomerated pre-treatment rendered this ore amenable to percolation treatment. The application rate of the leach solution onto the surface of the agglomerated material was approximately 10 gal/day/ft^2. Extraction achieved in a 2-week period of treatment was 79 percent of the total

gold from heads containing 0.033 ounce of gold per ton.

SAMPLE PREPARATION

The entire sample, as received, approximately 600 pounds, was sized dry on a 1-inch screen. Each fraction was weighted, sampled, and assayed to determine the gold distribution prior to crushing the oversize fraction. Results were:

Feed Size	Weight (Percent)	Gold Assay (Oz/Ton)
+1 Inch	34.6	0.031
-1 Inch	65.4	0.043
Composite	100.0	0.039

Although a slight enrichment of gold occurred in the undersize fraction, the plus 1-inch portion still carried too much value for discard. Therefore, the oversize portion was crushed to minus 1 inch and blended into the primary undersize fraction by cone and quartering. Then, a head sample was split from the minus 1-inch feed, using a Jones riffle sampler. This portion was pulverized to minus 80 mesh and mixed thoroughly by rolling on a plastic sheet. The pulverized material was used as the head sample for fire assay and the bottle cyanidation test. The minus 1-inch reject was split into two 160-pound charges for the column leach tests.

FIRE ASSAY

The fire-assay technique was employed for the determination of the gold and silver contents of the submitted sample of ore. Assay results were:

Gold	0.035 Troy Ounce/Ton of Ore
Silver	Less than 0.1 Troy Ounce/Ton of Ore

BOTTLE CYANIDATION TEST

The bottle cyanidation test was conducted on a 200-gram of sample split from the minus 80-mesh feed. The charge was pulped with 600 grams of water. Lime was added to adjust the pH of the pulp to about 11. Then, cyanide was added to produce an initial solution strength of 2.0 pounds of sodium cyanide per ton. Cyanidation was conducted by agitation of the pulp in an open bottle by rolling on the laboratory rolls for a period of 24 hours. The object was to compare the gold recovery from finely ground ore with that obtained with percolation leaching of 1-inch feed material.

Upon completion of the leach period, the cyanide pulp was filtered, and the tailings were washed thoroughly. Then, the test products were assayed for gold. Pertinent results of the bottle cyanidation test are shown in Table 1.

The results of the bottle cyanide leach test show that the gold contents of this ore are readily leachable, when liberated or exposed to permit contact with the leach solution. The cyanidation treatment of minus 80-mesh feed achieved 85.9 percent gold recovery in 24 hours.

TABLE 1

GOLD RECOVERY FROM MINUS 80-MESH FEED

RESULTS	GOLD
Assay of Tailings, Ounce per Ton	0.004
Extraction, Percent Based on Assays Of Solution and Tailings	85.9
Calculated Heads, Ounce per Ton	0.035

PREPARATION OF ORE FOR COLUMN LEACH STUDY

One charge of 160 pounds of minus 1-inch crushed ore was leached without any pretreatment. This charge was placed in a 5-inch (inside diameter) PVC column to make a bed approximately 12 feet thick.

The second 160-pound charge of minus 1-inch crushed ore was subjected to an agglomeration pretreatment to enhance percolation flow. The 160-pound charge of ore, which contained 3 weight-percent moisture, was mixed with 363 grams of portland cement (Type II) in a small cement mixer. After a few minutes of mixing, the batch of ore, while revolving, was wetted thoroughly and uniformly with 14.4 pounds of solution (6.54 liters) containing 72.64 grams each of sodium hydroxide and sodium cyanide. The whole pretreatment requires less than 5 minutes time.

The amounts of reagents employed in the agglomeration step are equivalent to 2.0 pounds each of sodium hydroxide and sodium cyanide per ton of ore, 10 pounds of portland cement per ton of ore, and a total of 12-weight-percent moisture. The sodium cyanide used in the column leach tests was a granulated commercial-grade reagent that contained 90 percent NaCN.

The agglomerated feed was discharged from the cement mixer into plastic trays and allowed to cure at ambient temperature for 96 hours before being transferred manually to the upright leach column. It made a bed 12 feet thick.

COLUMN PERCOLATION CYANIDATION

The untreated ore sample was leached with a cyanide solution containing 2.0 pounds of sodium cyanide per ton. Since the agglomerated charge of ore had been pretreated with caustic soda and sodium cyanide, it was leached with a solution containing only 1.0 pound of NaCN per ton. For both tests, the leach liquor was applied to the top of the bed of ore from an overhead reservoir (a 10-liter plastic container). The solution outlet line was plumbed into the side of the reservoir. Consequently, the initial volume of leach solution had to be increased to compensate for the amount that could not be drained from the reservoir. The leach solution dripped onto a burlap disk covering the charge of ore to disperse the solution to obtain uniform flow onto the surface of the ore. The application rate was approximately 10 gal/day/ft^2 of surface area, which amounted to 5.15 liters per day in these experiments.

Solution flow was regulated by means of a stopcock and a screw-type pinch clamp in the line. The pregnant effluents were collected in plastic containers underneath the leach column. Each day the volume of solution collected was measured, analyzed for free cyanide contents, and assayed for gold--using the Chiddy-fire assay method. No attempt was made to produce barren cyanide solutions for recycle for leaching.

Upon completion of the leach period, the bed of ore lay dormant for a few days; and, then, it was washed with tap water for six days at an application rate of 10 gal/day/ft^2 of surface area. The tailings were analyzed for gold via conventional fire assay techniques.

A screen analysis was conducted on the leached agglomerated feed to determine the distribution of the residual gold values. The tailings from the test conducted on the untreated ore was neither assayed nor sized, because the laboratory results indicated that the untreated ore crushed to 1 inch is not amenable to percolation leaching due to its poor percolation flow characteristics.

The daily logs, showing the volume of leach and wash solutions applied and effluents collected for the two tests, are shown in Tables 2 and 3.

TABLE 2

LOG FOR LEACHING UNTREATED ORE
(Test No. DMS #2)

TIME		LEACH SOLUTION		PREGNANT EFFLUENT		
Day	Hour	Volume Added (Liters)	NaCN Added (Grams)	Solution Number	Volume Collected (Liters	NaCN Contents (Lbs NaCN/Ton)
9-4	1 PM	7.5	7.5	-	0	-
9-5	9 AM	5.15	5.15	-	0	-
9-6	11 AM	5.15	5.15	-	0	-
9-7	3 PM	0	0	-	0	-
9-8	11 AM	5.15	5.15	1	3.67	0.1
9-9	12 PM	5.15	5.15	2	3.30	0.2
9-10	12 PM	5.15	5.15	3	3.08	0.2
9-11	8 AM	5.15	5.15	4	2.70	0.2
9-13	3 PM	0	0	5	7.90	0.1
		WASH SOLUTION				
9-13	3 PM	5.15	0	-	0	-
9-14	3 PM	5.15	0	1	2.92	0.1
9-17	11 AM	5.15	0	2	5.92	0.1
9-18	3 PM	5.15	0	3	1.20	Trace
9-19	3 PM	5.15	0	4	4.55	Trace
9-20	3 PM	5.15	0	5	3.82	Trace

Note: Ponding occurred at start and continued throughout test. Column of ore settled about 3 feet.

TABLE 3

LOG FOR LEACHING AGGLOMERATED ORE
(Test No. DMS #3)

TIME		LEACH SOLUTION		PREGNANT EFFLUENT		
Day	Hour	Volume Added (Liters)	NaCN Added (Grams)	Solution Number	Volume Collected (Liters)	NaCN Contents (Lbs NaCN/Ton)
9-4	1 PM	7.5	3.75	-	0	-
9-5	9 AM	5.15	2.575	1	0.825	8.6
9-6	11 AM	5.15	2.575	2	4.83	7.5[a]
9-8	11 AM	5.15	2.575	3	4.48	2.5
9-9	12 PM	5.15	2.575	4	3.80	1.0
9-10	12 PM	5.15	2.575	5	4.20	0.9[b]
9-11	8 AM	0	0	6	4.80	0.7
		WASH SOLUTION				
9-11	8 AM	5.15	0	-	0	-
9-13	3 PM	5.15	0	1	6.34	0.7
9-14	3 PM	5.15	0	2	3.80	0.4
9-17	3 PM	5.15	0	3	5.90	0.1
9-18	3 PM	5.15	0	4	3.59	Trace
9-19	3 PM	5.15	0	5	4.60	Trace
9-20	3 PM	0	0	6	4.60	Trace

Note: a) 12-foot bed of ore settled about 1 foot.
b) Bed of ore settled about 2 feet. Ponding occurred temporarily when application rate exceeded 10 gal/day/ft^2 of surface area.

EXPERIMENTAL RESULTS

Pregnant liquor commenced to drip from the bottom of the 12-foot bed of agglomerated ore, crushed to inch, about 16 hours after start-up of the percolation leach. No ponding of solution on top of the ore column was observed. Percolation flow through the unagglomerated or raw ore crushed to inch was, however, unsatisfactory for a heap leach operation. Ponding of solution on top of the bed of ore occurred almost from the start of the leaching test. The bed of ore compacted about 3 feet upon being wetted. It required at least 72 hours before the bed of ore was completely wetted and solution began to come through at the bottom of the column of ore.

In our laboratory experiment, the leach solution had no place to go but down through the bed of ore. However, in heap leaching this ore, the leach solution would not penetrate the heap to any extent. Even with an extremely slow application rate, the solution would take the path of least resistance--resulting in run off or channeling. This experiment proves conclusively that the crushed ore is just not suitable or amenable to heap leaching. However, if the crushed ore is pretreated with portland cement, as described, the ore becomes amenable to percolation leaching.

The amount of gold recovered by percolation leaching was determined from the assays obtained on 600-ml aliquots of pregnant and wash solutions using the Chiddy-fire assay procedure. The extraction results are summarized in Tables 4 and 5.

TABLE 4

GOLD RECOVERY FROM 1-INCH CRUSHED ORE
(Test No. DMS #2)

SOLUTION NUMBER	CHIDDY ASSAY (600 ml) Mgs Au	EFFLUENT Total Volume Liters	EXTRACTION Equivalent to Ounce Gold/Ton of Ore
Preg-1	5.776	3.67	0.0141
Preg-2	3.132	3.30	0.0069
Preg-3	0.594	3.08	0.0012
Preg-4	0.450	2.70	0.0008
Preg-5	0.394	7.90	0.0021
		Total	0.0251
Wash-1	0.182	2.92	0.0004
Wash-2	0.172	5.92	0.0007
Wash-3	0.163	1.20	0.0001
Wash-4	0.152	4.55	0.0005
Wash-5	0.084	3.82	0.0002
		Total	0.0019
		Grand Total	0.0270

TABLE 5

GOLD RECOVERY FROM AGGLOMERATED ORE
(Test No. DMS #3)

SOLUTION NUMBER	CHIDDY ASSAY (600 ml) Mgs Au	EFFLUENT Total Volume Liters	EXTRACTION Equivalent to Ounce Gold/Ton of Ore
Preg-1	6.212	0.825	0.00342
Preg-2	4.767	4.83	0.01534
Preg-3	1.493	4.48	0.00446
Preg-4	0.422	3.80	0.00107
Preg-5	0.161	4.20	0.00045
Preg-6	0.137	4.80	0.00044
			Total 0.0252
Wash-1	0.097	6.34	0.0004
Wash-2	0.083	3.80	0.0002
Wash-3	0.057	5.90	0.0002
Wash-4	0.045	3.59	0.0001
Wash-5	0.025	4.60	0.0001
Wash-6	0.019	4.60	0.0001
			Total 0.0011
			Grand Total 0.0263

Cyanide Tails, Ounce Au/Ton 0.007
Calculated Heads, Ounce Au/Ton 0.0333
Gold Extraction = 79.0 Percent

The laboratory results presented in Table 5 show that 79.0 percent of the total gold, equivalent to 0.026 ounce of gold per ton of ore, can be recovered by percolation cyanidation treatment from one-inch feed material that had been agglomerated with portland cement. The tails assayed 0.007 ounce of gold per ton.

It is interesting to note in Table 4 that the gold extraction from the raw ore crushed to inch verified the above recovery, even though the percolation flow through the ore was impractical for heap leaching. The cyanide consumption for test number DMS #3 was equivalent to 1.4 pounds NaCN per ton of ore.

The residual gold in the tailings occurred mainly in the minus 1/2-inch plus 10-mesh fraction, as shown in Table 6. This indicates that crushing the ore finer than 1 inch would not improve the gold recovery significantly. This conclusion is further substantiated by the results of the bottle cyanidation test, which achieved only 86 percent gold extraction from minus 80-mesh feed, leaving 0.004 ounce of gold per ton in the tailings.

TABLE 6

SCREEN ANALYSIS OF CYANIDE TAILS
(Test No. DMS #3)

PRODUCT SIZE	WEIGHT (Percent)	GOLD		
		Ounce/Ton	Unit	Percent of Total
+1/2"	14.2	0.006	0.0009	10.1
-1/2" +1/4"	19.2	0.011	0.0021	23.6
-1/4" +10 Mesh	27.6	0.015	0.0041	46.1
-10 +20	8.6	0.005	0.0004	4.4
-20 +35	5.2	0.005	0.0003	3.4
-35 +200	9.7	0.008	0.0008	9.0
-200 Slimes	15.5	0.002	0.0003	3.4
Composite	100.0		0.0089	100.0

CONCLUSIONS

The raw ore, crushed to 1 inch, is not amenable to heap leaching; because it contains excessive quantity of clays, which prevents satisfactory percolation flow of the cyanide leach solution. Agglomeration of the crushed ore with portland cement and alkaline cyanide solution markedly improved the percolation flow of the cyanide solution. Gold recovery from ore containing 0.035 ounce of gold per ton was 79 percent.

RECOMMENDATIONS

The initial agglomeration-percolation leach test gave very promising results regarding percolation flow and gold recovery. However, I feel that the conditions for agglomerating the crushed ore must be optimized to eliminate the slumping or compaction of the bed of ore experienced in our initial test. The slumping of the ore during heap or vat leaching could have a very deleterious effect on the economic success of the commercial operation.

I suggest an additional percolation cyanide leach test be conducted on 1-inch feed agglomerated with more portland cement, specifically 15 pounds per ton of ore, and reducing the moisture contents from 12 to 9 or 10 percent. Based on my experience with agglomerating other clayey ores, I believe the initial conditions selected for your ore can be improved to give better percolation flow of the leach solution through a bed of your ore.

Harold Heinen

Harold Heinen
Projects Manager

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 • Sparks, Nevada 89431 • (702) 331-3600

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

BARREL TEST
(Lab No. 213-2)

to

Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013
(August 21, 1979)

SAMPLE PREPARATION

A sample of approximately 700 pounds of ore was received in gunny sacks. The entire sample was dumped onto a plastic sheet and mixed with a shovel to make a homogenous sample.

The homogenous sample was loaded into a 25-inch diameter steel barrel, with care being taken to take material from all places on the homogenous sample of coned material. As the barrel was being loaded, a sample was cut for a head assay and bottle test.

HEAD ASSAY AND BOTTLE TEST

The head sample, consisting of approximately 8 pounds, was crushed to -10 mesh and then pulverized to -80 mesh. The sample was rolled and split on the Jones riffle to provide a one assay-ton head sample and a 200-gram sample for the bottle test.

The bottle test produced a 97.3% recovery on the gold values and resulted in a calculated head assay of 0.307 ounce per ton of gold. The fire assay gave a head assay of 0.292 ounce per ton of gold.

BARREL CYANIDE LEACH TEST

The 500-pound charge of mine run ore (sizes up to 8 inches in diameter) was leached with a cyanide solution, which contained 1.0 pound of sodium cyanide per ton of solution, for 15 consecutive days. Sodium hydroxide was employed to maintain the pH of the leach solution between 10 and 11.

The experiment was conducted in a 25-inch diameter steel barrel. The ore measured a depth of 20 inches. To insure a uniform wetting of the ore bed with cyanide solution, a layer of burlap was placed on top of the ore for dispersion of the leach solution that was sprayed directly onto the burlap covering.

Cyanide solution was applied on top of the ore bed at a rate of 1.4 gallon/hour/foot^2 of cross-sectional area. The effluent from the barrel was collected in a tray. A small sump pump (stationed in the tray) pumped the pregnant solution through carbon absorption columns, containing 6x16-mesh activated carbon. The activated carbon removed the gold from solution; the resulting barrens were recycled to the top of the ore bed for further leaching. Whenever necessary, the solution was fortified with sodium cyanide and sodium hydroxide to maintain cyanide strength and a pH betwen 10 and 11.

The loaded carbons were replaced periodically (i.e., 1st, 2nd, 3rd, 5th, 7th, 9th, 12th, and 16th day of test) with fresh carbon and assayed for gold content. See Figure 1, Total Gold Recovery vs Days of Leaching.

CONCLUSION

At the end of the leach period (16 days), 0.136 ounce per ton of gold was extracted. Depending on what is assumed as a head assay (0.292 or 0.306 ounce per ton of gold), either 46.5% or 44.4% of the contained gold was recovered.

It is obvious from the graph (Figure 1) showing the gold recovery versus days of leaching that the leach was not conducted for enough days. Solution assays were showing a slight decrease in gold; thus, it can be assumed that the curve was beginning to level out.

Reagent consumption during the 16-day test was 0.8 pound of cyanide and 2.3 pounds of sodium hydroxide per ton of ore.

B. M. Clem
General Manager

Lab No. 213-2

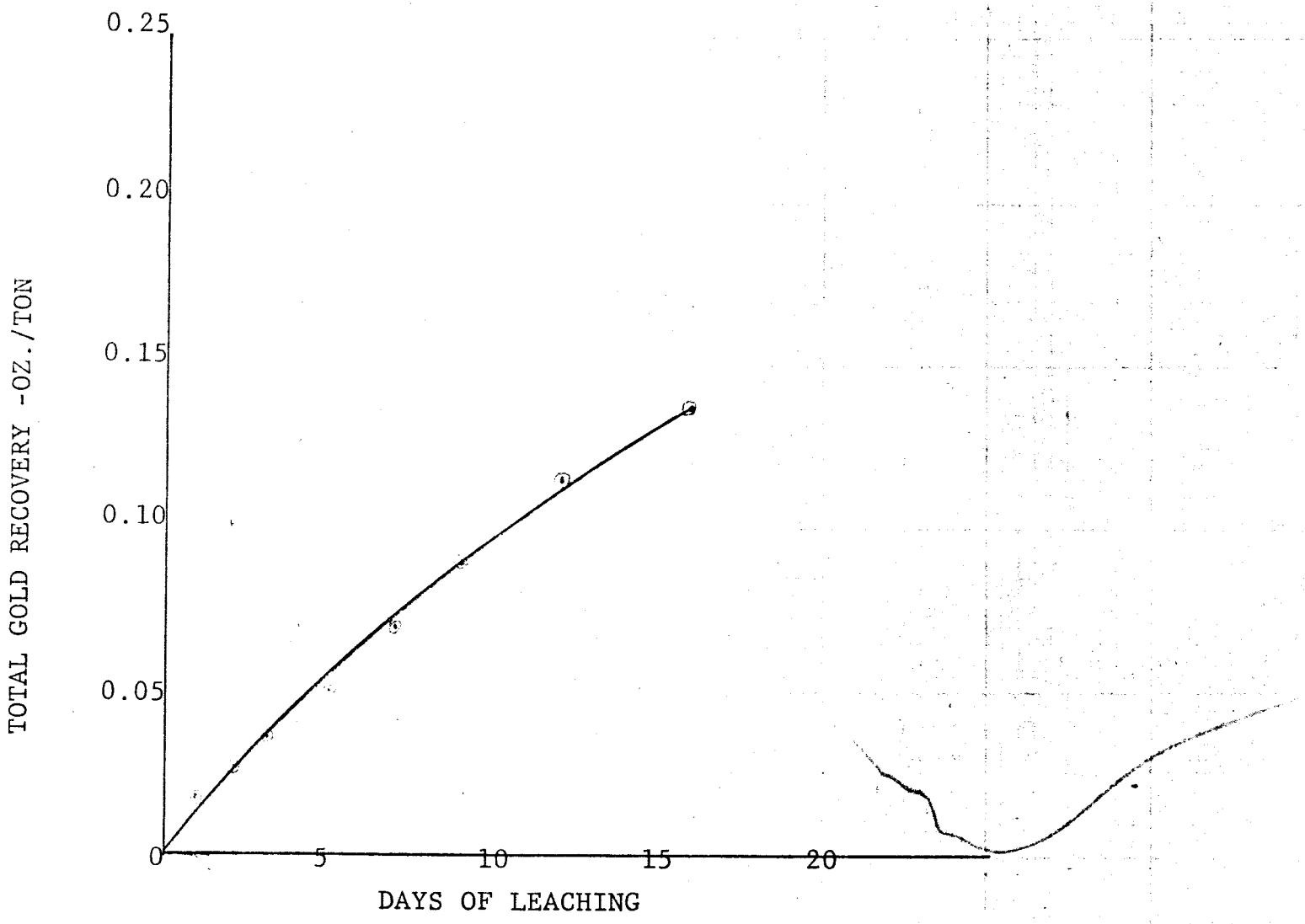


Figure 1. Total Gold Recovery vs Days of Leaching

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

BOTTLE TEST, Lab No. 213-2

to

Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013

SAMPLE PREPARATION

A sample of approximately 700 pounds of ore was received from Diablo Mine Services in "gunny" sacks. The entire sample was dumped onto a plastic sheet. The ore was mixed with a shovel to make a homogeneous sample. Since the sample was also to have a barrel test, 500 pounds of the ore was loaded into a barrel for leach testing.

As the material was being loaded into the barrel, a sample was being cut from the ore for a head assay and bottle test. The sample cut for a head assay and bottle test was crushed and split; approximately 1500 grams were pulverized to -80 mesh.

BOTTLE CYANIDATION TEST

A bottle-agitation cyanidation test was performed on the ore that was ground to -80 mesh. This test was performed to obtain (1) information regarding amounts of reagents required, and (2) to what extent the gold can be extracted from this particular ore. A 200-gram portion of the ground ore was pulped with 600 grams of

tap water. An equivalent of 4 pounds of sodium hydroxide per ton of ore and an equivalent of 2 pounds of cyanide per ton of solution were added to the water, prior to mixing with the ore. The bottle-agitation cyanidation test was conducted for 72 hours, consecutively.

Upon completion of the bottle leaching test, the pulp was filtered and the residue was thoroughly washed with warm tap water. The pregnant solution was assayed by using the chiddy method, and the tailings were fire assayed for gold. Results indicated that 97.3% of the gold was extracted from material containing 0.306 ounce of gold per ton. The tailings assayed 0.008 ounce of gold per ton. Reagent consumptions were 3.0 pounds of sodium hydroxide and 1.4 pounds of sodium cyanide per ton or ore.

CONCLUSION

The ore submitted for this bottle test is very amenable to cyanidation, and the reagent consumption is minimal.

B. M. Clem
General Manager

WESTERN TESTING LABORATORIES
1080 LINDA WAY, #3
SPARKS, NEVADA 89431
TELEPHONE: (702) 331-3600

REPORT OF ANALYSIS

SUBMITTED BY: Diablo Mine Services
P.O. Box 798
Alamo, CA 94507
Attn: Earl Woodward

DATE: August 20, 1979

LABORATORY NUMBER: 213-2

ANALYTICAL METHOD: Bottle Cyanidation Test & Barrel Test

REPORT ON: Gold

YOUR ORDER NUMBER: Invoice No. A332

SAMPLE MARK:

See Attached Report on Bottle Test, Lab No. 213-2, dated August 20, 1979.

The Report on Barrel Test will be available August 21, 1979.

B. M. Clem
General Manager

PPM = Parts per million
PERCENT = Parts per hundred
1 OZ/TON = 34.286 ppm
1.0% = 20 pounds/ton

OZ/TON = Troy ounces per ton of 2000 pounds avoirdupois
FINENESS = Parts per thousand
1 PPM = 0.0001% = 0.029167 oz/ton
Read + as "greater than." Read — as "less than."

Mr. Davis

DMS Diablo Mine Services Company

A DILLINGHAM COMPANY

Inter-Office Correspondence

TO: File DATE: October 15, 1979

FROM: Earl Woodward INITIAL: EMW

SUBJECT: Western Testing Laboratory REFERENCE:
Report of Testing dated 10-11-79

Attached herewith is a copy of lab report for work performed on column testing up to this date. Additional test work is continuing, and reports will be sent as they become available.

EMW:mls

cc: Gordon A. Coats
Walt Hogan
Oscar Margraf
Mac Forbes (For Mr. Davis)
Western Crude Oil
G. W. Bayne
K. L. & L. Enterprises
Geo Exp. Co.

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

COLUMN CYANIDE LEACH TESTS
(Laboratory No. 243-5)

to

Earl M. Woodward
Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013
(October 11, 1979)

SUMMARY

Column percolation leach tests were conducted on two 160-pound charges of a clayey gold ore crushed to minus 1 inch. A 12-foot bed of ore was stacked in a 5-inch I.D. upright PVC column. One charge of ore was leached directly with a dilute cyanide solution. The other charge was agglomerated with 10 pounds of portland cement per ton of ore, and 12 weight-percent solution containing sodium cyanide and sodium hydroxide equivalent to two pounds each per ton of ore. The agglomerated feed was cured at ambient conditions for 96 hours prior to leaching.

The percolation flow through the untreated ore was too slow to be practical for heap leaching. However, the agglomerated pre-treatment rendered this ore amenable to percolation treatment. The application rate of the leach solution onto the surface of the agglomerated material was approximately 10 gal/day/ft^2. Extraction achieved in a 2-week period of treatment was 79 percent of the total

gold from heads containing 0.033 ounce of gold per ton.

SAMPLE PREPARATION

The entire sample, as received, approximately 600 pounds, was sized dry on a 1-inch screen. Each fraction was weighted, sampled, and assayed to determine the gold distribution prior to crushing the oversize fraction. Results were:

Feed Size	Weight (Percent)	Gold Assay (Oz/Ton)
+1 Inch	34.6	0.031
-1 Inch	65.4	0.043
Composite	100.0	0.039

Although a slight enrichment of gold occurred in the undersize fraction, the plus 1-inch portion still carried too much value for discard. Therefore, the oversize portion was crushed to minus 1 inch and blended into the primary undersize fraction by cone and quartering. Then, a head sample was split from the minus 1-inch feed, using a Jones riffle sampler. This portion was pulverized to minus 80 mesh and mixed thoroughly by rolling on a plastic sheet. The pulverized material was used as the head sample for fire assay and the bottle cyanidation test. The minus 1-inch reject was split into two 160-pound charges for the column leach tests.

FIRE ASSAY

The fire-assay technique was employed for the determination of the gold and silver contents of the submitted sample of ore. Assay results were:

Gold	0.035 Troy Ounce/Ton of Ore
Silver	Less than 0.1 Troy Ounce/Ton of Ore

BOTTLE CYANIDATION TEST

The bottle cyanidation test was conducted on a 200-gram of sample split from the minus 80-mesh feed. The charge was pulped with 600 grams of water. Lime was added to adjust the pH of the pulp to about 11. Then, cyanide was added to produce an initial solution strength of 2.0 pounds of sodium cyanide per ton. Cyanidation was conducted by agitation of the pulp in an open bottle by rolling on the laboratory rolls for a period of 24 hours. The object was to compare the gold recovery from finely ground ore with that obtained with percolation leaching of 1-inch feed material.

Upon completion of the leach period, the cyanide pulp was filtered, and the tailings were washed thoroughly. Then, the test products were assayed for gold. Pertinent results of the bottle cyanidation test are shown in Table 1.

The results of the bottle cyanide leach test show that the gold contents of this ore are readily leachable, when liberated or exposed to permit contact with the leach solution. The cyanidation treatment of minus 80-mesh feed achieved 85.9 percent gold recovery in 24 hours.

TABLE 1

GOLD RECOVERY FROM MINUS 80-MESH FEED

RESULTS	GOLD
Assay of Tailings, Ounce per Ton	0.004
Extraction, Percent Based on Assays Of Solution and Tailings	85.9
Calculated Heads, Ounce per Ton	0.035

PREPARATION OF ORE FOR COLUMN LEACH STUDY

One charge of 160 pounds of minus 1-inch crushed ore was leached without any pretreatment. This charge was placed in a 5-inch (inside diameter) PVC column to make a bed approximately 12 feet thick.

The second 160-pound charge of minus 1-inch crushed ore was subjected to an agglomeration pretreatment to enhance percolation flow. The 160-pound charge of ore, which contained 3 weight-percent moisture, was mixed with 363 grams of portland cement (Type II) in a small cement mixer. After a few minutes of mixing, the batch of ore, while revolving, was wetted thoroughly and uniformly with 14.4 pounds of solution (6.54 liters) containing 72.64 grams each of sodium hydroxide and sodium cyanide. The whole pretreatment requires less than 5 minutes time.

The amounts of reagents employed in the agglomeration step are equivalent to 2.0 pounds each of sodium hydroxide and sodium cyanide per ton of ore, 10 pounds of portland cement per ton of ore, and a total of 12-weight-percent moisture. The sodium cyanide used in the column leach tests was a granulated commercial-grade reagent that contained 90 percent NaCN.

The agglomerated feed was discharged from the cement mixer into plastic trays and allowed to cure at ambient temperature for 96 hours before being transferred manually to the upright leach column. It made a bed 12 feet thick.

COLUMN PERCOLATION CYANIDATION

The untreated ore sample was leached with a cyanide solution containing 2.0 pounds of sodium cyanide per ton. Since the agglomerated charge of ore had been pretreated with caustic soda and sodium cyanide, it was leached with a solution containing only 1.0 pound of NaCN per ton. For both tests, the leach liquor was applied to the top of the bed of ore from an overhead reservoir (a 10-liter plastic container). The solution outlet line was plumbed into the side of the reservoir. Consequently, the initial volume of leach solution had to be increased to compensate for the amount that could not be drained from the reservoir. The leach solution dripped onto a burlap disk covering the charge of ore to disperse the solution to obtain uniform flow onto the surface of the ore. The application rate was approximately 10 gal/day/ft^2 of surface area, which amounted to 5.15 liters per day in these experiments.

Solution flow was regulated by means of a stopcock and a screw-type pinch clamp in the line. The pregnant effluents were collected in plastic containers underneath the leach column. Each day the volume of solution collected was measured, analyzed for free cyanide contents, and assayed for gold--using the Chiddy-fire assay method. No attempt was made to produce barren cyanide solutions for recycle for leaching.

Upon completion of the leach period, the bed of ore lay dormant for a few days; and, then, it was washed with tap water for six days at an application rate of 10 gal/day/ft^2 of surface area. The tailings were analyzed for gold via conventional fire assay techniques.

A screen analysis was conducted on the leached agglomerated feed to determine the distribution of the residual gold values. The tailings from the test conducted on the untreated ore was neither assayed nor sized, because the laboratory results indicated that the untreated ore crushed to 1 inch is not amenable to percolation leaching due to its poor percolation flow characteristics.

The daily logs, showing the volume of leach and wash solutions applied and effluents collected for the two tests, are shown in Tables 2 and 3.

TABLE 2

LOG FOR LEACHING UNTREATED ORE
(Test No. DMS #2)

TIME		LEACH SOLUTION		PREGNANT EFFLUENT		
Day	Hour	Volume Added (Liters)	NaCN Added (Grams)	Solution Number	Volume Collected (Liters	NaCN Contents (Lbs NaCN/Ton)
9-4	1 PM	7.5	7.5	-	0	-
9-5	9 AM	5.15	5.15	-	0	-
9-6	11 AM	5.15	5.15	-	0	-
9-7	3 PM	0	0	-	0	-
9-8	11 AM	5.15	5.15	1	3.67	0.1
9-9	12 PM	5.15	5.15	2	3.30	0.2
9-10	12 PM	5.15	5.15	3	3.08	0.2
9-11	8 AM	5.15	5.15	4	2.70	0.2
9-13	3 PM	0	0	5	7.90	0.1
		WASH SOLUTION				
9-13	3 PM	5.15	0	-	0	-
9-14	3 PM	5.15	0	1	2.92	0.1
9-17	11 AM	5.15	0	2	5.92	0.1
9-18	3 PM	5.15	0	3	1.20	Trace
9-19	3 PM	5.15	0	4	4.55	Trace
9-20	3 PM	5.15	0	5	3.82	Trace

Note: Ponding occurred at start and continued throughout test. Column of ore settled about 3 feet.

TABLE 3

LOG FOR LEACHING AGGLOMERATED ORE
(Test No. DMS #3)

TIME		LEACH SOLUTION		PREGNANT EFFLUENT		
Day	Hour	Volume Added (Liters)	NaCN Added (Grams)	Solution Number	Volume Collected (Liters)	NaCN Contents (Lbs NaCN/Ton)
9-4	1 PM	7.5	3.75	-	0	-
9-5	9 AM	5.15	2.575	1	0.825	8.6
9-6	11 AM	5.15	2.575	2	4.83	7.5[a]
9-8	11 AM	5.15	2.575	3	4.48	2.5
9-9	12 PM	5.15	2.575	4	3.80	1.0
9-10	12 PM	5.15	2.575	5	4.20	0.9[b]
9-11	8 AM	0	0	6	4.80	0.7
		WASH SOLUTION				
9-11	8 AM	5.15	0	-	0	-
9-13	3 PM	5.15	0	1	6.34	0.7
9-14	3 PM	5.15	0	2	3.80	0.4
9-17	3 PM	5.15	0	3	5.90	0.1
9-18	3 PM	5.15	0	4	3.59	Trace
9-19	3 PM	5.15	0	5	4.60	Trace
9-20	3 PM	0	0	6	4.60	Trace

Note: a) 12-foot bed of ore settled about 1 foot.
b) Bed of ore settled about 2 feet. Ponding occurred temporarily when application rate exceeded 10 gal/day/ft^2 of surface area.

EXPERIMENTAL RESULTS

Pregnant liquor commenced to drip from the bottom of the 12-foot bed of agglomerated ore, crushed to inch, about 16 hours after start-up of the percolation leach. No ponding of solution on top of the ore column was observed. Percolation flow through the unagglomerated or raw ore crushed to inch was, however, unsatisfactory for a heap leach operation. Ponding of solution on top of the bed of ore occurred almost from the start of the leaching test. The bed of ore compacted about 3 feet upon being wetted. It required at least 72 hours before the bed of ore was completely wetted and solution began to come through at the bottom of the column of ore.

In our laboratory experiment, the leach solution had no place to go but down through the bed of ore. However, in heap leaching this ore, the leach solution would not penetrate the heap to any extent. Even with an extremely slow application rate, the solution would take the path of least resistance--resulting in run off or channeling. This experiment proves conclusively that the crushed ore is just not suitable or amenable to heap leaching. However, if the crushed ore is pretreated with portland cement, as described, the ore becomes amenable to percolation leaching.

The amount of gold recovered by percolation leaching was determined from the assays obtained on 600-ml aliquots of pregnant and wash solutions using the Chiddy-fire assay procedure. The extraction results are summarized in Tables 4 and 5.

TABLE 4

GOLD RECOVERY FROM 1-INCH CRUSHED ORE
(Test No. DMS #2)

SOLUTION NUMBER	CHIDDY ASSAY (600 ml) Mgs Au	EFFLUENT Total Volume Liters	EXTRACTION Equivalent to Ounce Gold/Ton of Ore
Preg-1	5.776	3.67	0.0141
Preg-2	3.132	3.30	0.0069
Preg-3	0.594	3.08	0.0012
Preg-4	0.450	2.70	0.0008
Preg-5	0.394	7.90	0.0021
		Total	0.0251
Wash-1	0.182	2.92	0.0004
Wash-2	0.172	5.92	0.0007
Wash-3	0.163	1.20	0.0001
Wash-4	0.152	4.55	0.0005
Wash-5	0.084	3.82	0.0002
		Total	0.0019
		Grand Total	0.0270

TABLE 5

GOLD RECOVERY FROM AGGLOMERATED ORE
(Test No. DMS #3)

SOLUTION NUMBER	CHIDDY ASSAY (600 ml) Mgs Au	EFFLUENT Total Volume Liters	EXTRACTION Equivalent to Ounce Gold/Ton of Ore
Preg-1	6.212	0.825	0.00342
Preg-2	4.767	4.83	0.01534
Preg-3	1.493	4.48	0.00446
Preg-4	0.422	3.80	0.00107
Preg-5	0.161	4.20	0.00045
Preg-6	0.137	4.80	0.00044
			Total 0.0252
Wash-1	0.097	6.34	0.0004
Wash-2	0.083	3.80	0.0002
Wash-3	0.057	5.90	0.0002
Wash-4	0.045	3.59	0.0001
Wash-5	0.025	4.60	0.0001
Wash-6	0.019	4.60	0.0001
			Total 0.0011
			Grand Total 0.0263

Cyanide Tails, Ounce Au/Ton 0.007
Calculated Heads, Ounce Au/Ton 0.0333
Gold Extraction = 79.0 Percent

The laboratory results presented in Table 5 show that 79.0 percent of the total gold, equivalent to 0.026 ounce of gold per ton of ore, can be recovered by percolation cyanidation treatment from one-inch feed material that had been agglomerated with portland cement. The tails assayed 0.007 ounce of gold per ton.

It is interesting to note in Table 4 that the gold extraction from the raw ore crushed to inch verified the above recovery, even though the percolation flow through the ore was impractical for heap leaching. The cyanide consumption for test number DMS #3 was equivalent to 1.4 pounds NaCN per ton of ore.

The residual gold in the tailings occurred mainly in the minus 1/2-inch plus 10-mesh fraction, as shown in Table 6. This indicates that crushing the ore finer than 1 inch would not improve the gold recovery significantly. This conclusion is further substantiated by the results of the bottle cyanidation test, which achieved only 86 percent gold extraction from minus 80-mesh feed, leaving 0.004 ounce of gold per ton in the tailings.

TABLE 6

SCREEN ANALYSIS OF CYANIDE TAILS
(Test No. DMS #3)

PRODUCT SIZE	WEIGHT (Percent)	GOLD		
		Ounce/Ton	Unit	Percent of Total
+1/2"	14.2	0.006	0.0009	10.1
-1/2" +1/4"	19.2	0.011	0.0021	23.6
-1/4" +10 Mesh	27.6	0.015	0.0041	46.1
-10 +20	8.6	0.005	0.0004	4.4
-20 +35	5.2	0.005	0.0003	3.4
-35 +200	9.7	0.008	0.0008	9.0
-200 Slimes	15.5	0.002	0.0003	3.4
Composite	100.0		0.0089	100.0

CONCLUSIONS

The raw ore, crushed to 1 inch, is not amenable to heap leaching; because it contains excessive quantity of clays, which prevents satisfactory percolation flow of the cyanide leach solution. Agglomeration of the crushed ore with portland cement and alkaline cyanide solution markedly improved the percolation flow of the cyanide solution. Gold recovery from ore containing 0.035 ounce of gold per ton was 79 percent.

RECOMMENDATIONS

The initial agglomeration-percolation leach test gave very promising results regarding percolation flow and gold recovery. However, I feel that the conditions for agglomerating the crushed ore must be optimized to eliminate the slumping or compaction of the bed of ore experienced in our initial test. The slumping of the ore during heap or vat leaching could have a very deleterious effect on the economic success of the commercial operation.

I suggest an additional percolation cyanide leach test be conducted on 1-inch feed agglomerated with more portland cement, specifically 15 pounds per ton of ore, and reducing the moisture contents from 12 to 9 or 10 percent. Based on my experience with agglomerating other clayey ores, I believe the initial conditions selected for your ore can be improved to give better percolation flow of the leach solution through a bed of your ore.

Harold Heinen

Harold Heinen
Projects Manager

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 • Sparks, Nevada 89431 • (702) 331-3600

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

BARREL TEST
(Lab No. 213-2)

to

Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013
(August 21, 1979)

SAMPLE PREPARATION

A sample of approximately 700 pounds of ore was received in gunny sacks. The entire sample was dumped onto a plastic sheet and mixed with a shovel to make a homogenous sample.

The homogenous sample was loaded into a 25-inch diameter steel barrel, with care being taken to take material from all places on the homogenous sample of coned material. As the barrel was being loaded, a sample was cut for a head assay and bottle test.

HEAD ASSAY AND BOTTLE TEST

The head sample, consisting of approximately 8 pounds, was crushed to -10 mesh and then pulverized to -80 mesh. The sample was rolled and split on the Jones riffle to provide a one assay-ton head sample and a 200-gram sample for the bottle test.

The bottle test produced a 97.3% recovery on the gold values and resulted in a calculated head assay of 0.307 ounce per ton of gold. The fire assay gave a head assay of 0.292 ounce per ton of gold.

BARREL CYANIDE LEACH TEST

The 500-pound charge of mine run ore (sizes up to 8 inches in diameter) was leached with a cyanide solution, which contained 1.0 pound of sodium cyanide per ton of solution, for 15 consecutive days. Sodium hydroxide was employed to maintain the pH of the leach solution between 10 and 11.

The experiment was conducted in a 25-inch diameter steel barrel. The ore measured a depth of 20 inches. To insure a uniform wetting of the ore bed with cyanide solution, a layer of burlap was placed on top of the ore for dispersion of the leach solution that was sprayed directly onto the burlap covering.

Cyanide solution was applied on top of the ore bed at a rate of 1.4 gallon/hour/foot^2 of cross-sectional area. The effluent from the barrel was collected in a tray. A small sump pump (stationed in the tray) pumped the pregnant solution through carbon absorption columns, containing 6x16-mesh activated carbon. The activated carbon removed the gold from solution; the resulting barrens were recycled to the top of the ore bed for further leaching. Whenever necessary, the solution was fortified with sodium cyanide and sodium hydroxide to maintain cyanide strength and a pH betwen 10 and 11.

The loaded carbons were replaced periodically (i.e., 1st, 2nd, 3rd, 5th, 7th, 9th, 12th, and 16th day of test) with fresh carbon and assayed for gold content. See Figure 1, Total Gold Recovery vs Days of Leaching.

CONCLUSION

At the end of the leach period (16 days), 0.136 ounce per ton of gold was extracted. Depending on what is assumed as a head assay (0.292 or 0.306 ounce per ton of gold), either 46.5% or 44.4% of the contained gold was recovered.

It is obvious from the graph (Figure 1) showing the gold recovery versus days of leaching that the leach was not conducted for enough days. Solution assays were showing a slight decrease in gold; thus, it can be assumed that the curve was beginning to level out.

Reagent consumption during the 16-day test was 0.8 pound of cyanide and 2.3 pounds of sodium hydroxide per ton of ore.

B. M. Clem
General Manager

Lab No. 213-2

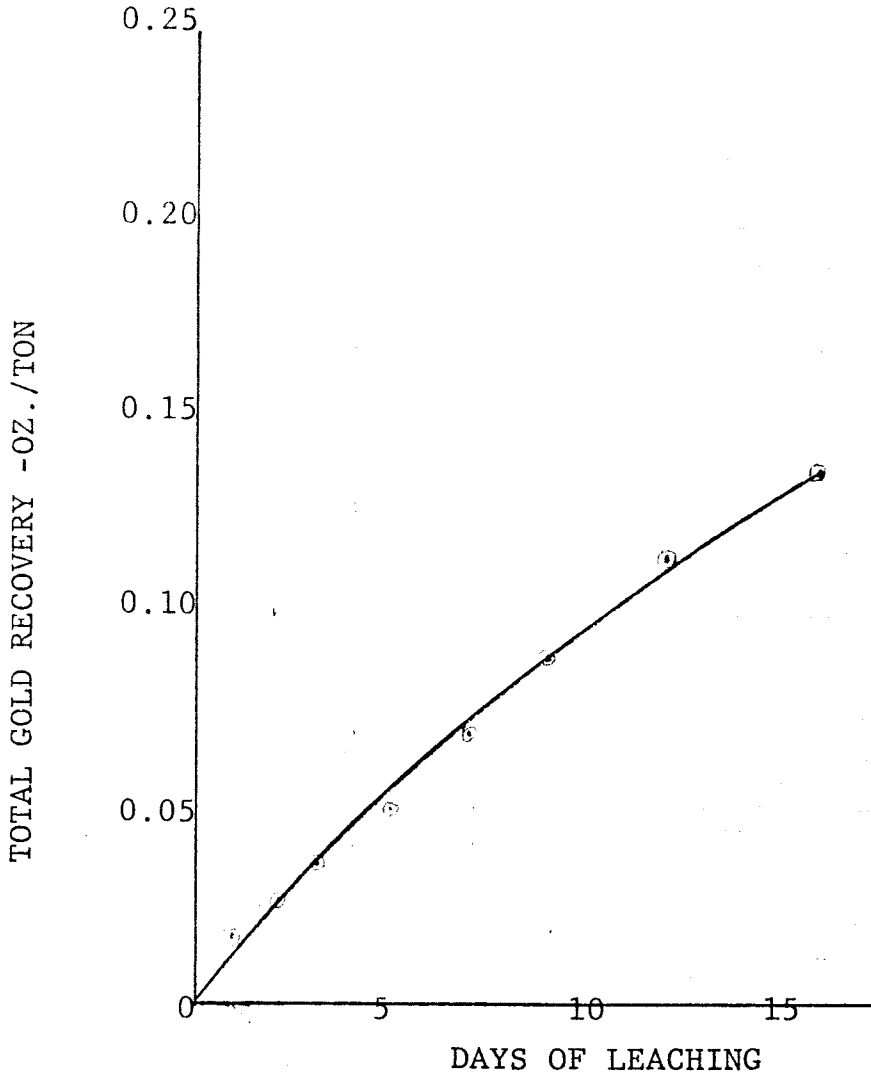


Figure 1. Total Gold Recovery vs Days of Leaching

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

BOTTLE TEST, Lab No. 213-2

to

Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013

SAMPLE PREPARATION

A sample of approximately 700 pounds of ore was received from Diablo Mine Services in "gunny" sacks. The entire sample was dumped onto a plastic sheet. The ore was mixed with a shovel to make a homogeneous sample. Since the sample was also to have a barrel test, 500 pounds of the ore was loaded into a barrel for leach testing.

As the material was being loaded into the barrel, a sample was being cut from the ore for a head assay and bottle test. The sample cut for a head assay and bottle test was crushed and split; approximately 1500 grams were pulverized to -80 mesh.

BOTTLE CYANIDATION TEST

A bottle-agitation cyanidation test was performed on the ore that was ground to -80 mesh. This test was performed to obtain (1) information regarding amounts of reagents required, and (2) to what extent the gold can be extracted from this particular ore. A 200-gram portion of the ground ore was pulped with 600 grams of

tap water. An equivalent of 4 pounds of sodium hydroxide per ton of ore and an equivalent of 2 pounds of cyanide per ton of solution were added to the water, prior to mixing with the ore. The bottle-agitation cyanidation test was conducted for 72 hours, consecutively.

Upon completion of the bottle leaching test, the pulp was filtered and the residue was thoroughly washed with warm tap water. The pregnant solution was assayed by using the chiddy method, and the tailings were fire assayed for gold. Results indicated that 97.3% of the gold was extracted from material containing 0.306 ounce of gold per ton. The tailings assayed 0.008 ounce of gold per ton. Reagent consumptions were 3.0 pounds of sodium hydroxide and 1.4 pounds of sodium cyanide per ton or ore.

CONCLUSION

The ore submitted for this bottle test is very amenable to cyanidation, and the reagent consumption is minimal.

B. M. Clem
General Manager

WESTERN TESTING LABORATORIES
1080 LINDA WAY, #3
SPARKS, NEVADA 89431
TELEPHONE: (702) 331-3600

REPORT OF ANALYSIS

SUBMITTED BY: Diablo Mine Services
P.O. Box 798
Alamo, CA 94507
Attn: Earl Woodward

DATE: August 20, 1979

LABORATORY NUMBER: 213-2

ANALYTICAL METHOD: Bottle Cyanidation Test & Barrel Test

REPORT ON: Gold

YOUR ORDER NUMBER: Invoice No. A332

SAMPLE MARK:

See Attached Report on Bottle Test, Lab No. 213-2, dated August 20, 1979.

The Report on Barrel Test will be available August 21, 1979.

B. M. Clem
General Manager

PPM = Parts per million
PERCENT = Parts per hundred
1 OZ/TON = 34.286 ppm
1.0% = 20 pounds/ton

OZ/TON = Troy ounces per ton of 2000 pounds avoirdupois
FINENESS = Parts per thousand
1 PPM = 0.0001% = 0.029167 oz/ton
Read + as "greater than." Read — as "less than."

DMS Diablo Mine Services Company

November 2, 1979

Mr. Ralph E. Davis, Jr.
P. O. Box 534
Vail, CO 81657

Dear Mr. Davis:

As you are aware from our recent phone conversation, our attempt at heap leaching of mine-run ore from the January pit at Goldfield was unsuccessful. As soon as it became apparent (July 30, 1979), we embarked on a laboratory test program to hopefully determine a method to successfully extract the values in the high clay content ores.

We now believe we have progressed to the point where a feasible method of leaching the Goldfield oxide ore is available to us. The test program is not as yet complete, but has progressed sufficiently to the point wherein we desire to continue the test program to pilot size and thereafter to full scale operation. We have therefore visited with Mountain States Engineers' of Tucson, Arizona, with the intent of having them prepare a Preliminary Feasibility and Mine Plan Report to be followed later by an actual mine plan.

In order to proceed on a businesslike and workmanlike manner, we feel it essential to restructure our service agreement with Goldfield, Ltd. We have therefore requested a meeting to be held in our office in Danville for Monday, November 19, at 2:00 p.m., to both report on progress to date and to explore suitable alternative business relationships, which would be the benefit of all concerned.

We therefore extend to you an invitation to attend this meeting. You are welcome to bring with you, or to send in your place a representative to attend with you, or on your behalf.

Please indicate your intent to attend, or not to attend on the enclosed copy of this letter to be returned to us in the enclosed self-addressed, stamped envelope.

Very truly yours,

DIABLO MINE SERVICES COMPANY

By Earl M Woodward
Earl M. Woodward, President

EMW:mls

cc: J. McLaren Forbes

P.O. BOX 798, ALAMO, CALIFORNIA 94507 TELEPHONE (415) 837-0581

WESTERN TESTING LABORATORIES
1080 Linda Way, No. 3 Sparks, Nevada 89431
Telephone: (702) 331-3600

REPORT

on

AGGLOMERATION AND COLUMN CYANIDE-LEACH TEST
(Laboratory No. 264-1)

to

Earl M. Woodward
Diablo Mine Services
P.O. Box 535
Goldfield, Nevada 89013
(November 16, 1979)

SUMMARY

A column percolation-leach test was conducted on 123-pound charge of Goldfield ore that was pretreated to agglomerate the clayey constituents. One of the key factors governing the production of a stable porous agglomerated feed is the amount of portland cement and solution applied during the pelletizing step. Under optimum agglomeration conditions, this clayey gold ore was converted from a difficult leachable ore to a product with excellent percolation characteristics. Gold extraction achieved in a simulated heap leach test on agglomerated ore was 86 percent from heads containing 0.107 ounce of gold per ton.

ORE SAMPLE PREPARATION

Four barrels of surface ore from Goldfield, Nevada were submitted for further simulated heap leach testing. A four-hundred pound charge of the bulk ore sample was split out for the current investigation. Based on the knowledge gained from a recent start-up of a pilot heap leach operation at Goldfield and preliminary column leach tests conducted at Western Testing Laboratories, it was decided to utilize minus 1-inch feed material for the current study. The bulk ore sample was sized dry on a one-inch screen. The two sized fractions were weighed, sampled, and assayed for gold. Results were:

FEED SIZE	WEIGHT (Percent)	GOLD	
		Assay Oz/Ton of Ore	Percent of Total
+1 Inch	21.9	0.053	9.2
-1 Inch	78.1	0.153	90.8
Composite	100.0	0.130	100.0

These results show that the gold contents of the Goldfield ore tend to concentrate in the fines. The plus 1-inch fraction was crushed to minus 1 inch and recombined with the primary undersize material. The crushed feed was blended by cone and quartering. Then, a 175-pound charge was split out of the crushed ore, using a Jones riffle sampler. A head sample was taken from the 175-pound charge and pulverized to minus 80 mesh. This pulverized material was used for analyses and the bottle cyanidation test. A five-pound sample of the minus 1-inch feed was taken for the determination of the moisture content. The remainder of the minus 1-inch feed, 165 pounds,

was used for the column leach test.

ANALYSES OF THE HEAD SAMPLE

The precious metal contents of the ore sample were determined by the conventional fire-assay technique. Assay results were:

Gold	0.078	Ounce/Ton of Ore
Silver	0.13	Ounce/Ton of Ore

The moisture contents of the ore were determined by drying a five-pound sample at 100 ^{o}C for 24 hours. Results showed that the feed material contained 3.4 weight-percent moisture.

BOTTLE CYANIDATION TEST

A standard bottle agitation cyanide-leach test was made on a 400-gram charge of pulverized heads. Dilution ratio was 3-to-1 of solids. Lime was added to the pulp to provide alkalinity. Cyanide was added equivalent to 2.0 pounds NaCN per ton of solution. Cyanidation was carried out by agitating in a bottle on the laboratory rolls for 24 hours. This test was made to obtain information regarding gold recovery by cyanidation of finely ground material for comparison with the extractions obtained by percolation leaching of 1-inch feed. Results of this test are tabulated in Table 1.

TABLE 1

GOLD RECOVERY FROM MINUS 80-MESH FEED

RESULTS	GOLD
Assay of Tailings, Ounce per Ton	0.002
Extraction, Percent Based on Assays Of Solution and Tailings	97.4
Calculated Heads, Ounce per Ton	0.078

These results indicate that excellent gold extractions can be achieved by fine grinding of the Goldfield ore. Reagent consumption was 5 pounds of lime and 5.4 pounds of sodium cyanide per ton of ore. The cyanide consumption is rather high; however, in plant practise the consumption may be only half of that amount. The results of this investigation have shown that 97 percent of the gold ore can be recovered by cyanidation of minus 80-mesh feed. The insoluble gold loss in the tailings is exceptionally low (0.002 ounce per ton) and is in close agreement with the results of the previous bottle cyanidation test conducted on the first ore sample. The amount of silver extracted was minimal, i.e. about 0.06 ounce per ton of ore.

PREPARATION OF ORE FOR COLUMN-LEACH STUDY

The recovery of gold from the Goldfield ore by conventional heap leaching practices has been shown to be highly ineffective, because the clayey constituents present in the ore prevents efficient percolation of the cyanide leach solution. The U.S. Bureau of Mines has developed an agglomeration technique, using a small amount of portland cement as a binder that converts clayey ore into porous feed materials, which are then amenable to percolation cyanidation.

Preliminary column leach tests conducted previously by Western Testing Laboratories (Report October 11, 1979) indicated that this new agglomeration technique was applicable to the Goldfield ore. The conditions for agglomeration in this initial test, however, was not optimized. It was believed that considerable improvements could be made by adjustments in the amounts of portland cement and solution employed to insure the production of agglomerates that can successfully withstand percolation leaching and minimize ore compaction and short circuiting of the leach solution.

The procedure for agglomerating the ore in the present study was as follows. One-hundred and sixty-six pounds of minus 1-inch feed (dry weight equals 160 pounds) and 545 grams of portland cement was mixed dry in a cement mixer. Resulting mixture was moistened and agglomerated, using 5.7 liters of solution containing 72.64 grams each of sodium hydroxide and sodium cyanide. This represents 10 weight-percent moisture. The amount of reagents employed is equivalent to 2.0 pounds each per ton of ore. The agglomeration was carried out

by mixing in the cement mixer until the feed was uniformily moistened and practically balled up. The agglomerated feed was discharged, after about 5 minutes of mixing, onto a plastic sheet and allowed to cure at ambient laboratory conditions for 96 hours.

After the curing was completed, the semi-dry product was transferred manually to an upright 5-inch (inside diameter) plexiglas pipe 10 feet high. A total of 123 pounds of ore (dry weight) was placed in the column. This amount made a bed approximately 10 feet thick.

COLUMN PERCOLATION LEACH EXPERIMENT

The bed of agglomerated ore in the column was leached with a solution containing 0.5 pound of NaCN per ton. The leaching procedure was essentially the same as that described in our previous report of October 11, 1979. As before, the leach solution was introduced on top of the bed of ore, and the leaching was accomplished by downward percolation.

The leach solution was applied at a rate of approximately 10 gal/day/ft^2 of surface area. The bed of ore could have endured a much faster flow rate; however, we chose an application rate that was similar to that used in some commercial operations. The ore charge was leached for 7 days and washed for 5 days. (This test was dormant during the weekend.)

Each day the volume of effluent collected was measured, analyzed for free NaCN, and assayed for gold--using the Chiddy fire-assay and atomic absorption methods. The pregnant effluent was replaced each day with 5.15 liters of fresh cyanide solution and finally water. Upon completion of the leaching, the tailings were

analyzed for gold via conventional fire assay techniques. A wet-screen analysis test was also conducted on a portion of the tailings to determine the distribution of the residual gold in the sized fractions.

The daily log of this experiment, showing the volume of leach and wash solutions applied and effluents collected, is shown in Table 2.

EXPERIMENTAL RESULTS

The time required for the leach solution to percolate through the bed of ore was not established, because the stopcock became plugged during the first night, when the leach column was unattended. No ponding of solution on top of the bed of ore was observed at any time. At completion of the leach period, the 10-foot bed of ore had compacted only 10.5 inches.

The amount of gold extracted was determined daily from the assays obtained on 600-ml aliquots of effluents, using the Chiddy fire-assay procedure. The results are summarized in Table 3.

TABLE 2

DAILY LOG
FOR LEACHING AGGLOMERATED ORE

TIME	LEACH SOLUTION		SOLUTION	PREGNANT EFFLUENT	
Day	Volume Added (Liters)	NaCN Added (Grams)	NUMBER	Volume Collected (Liters)	NaCN Contents (Lbs NaCN/Ton)
10-16	7.5	1.88	-	0	0
10-17	5.15	1.29	-	0	0
10-18	5.15	1.29	1	4.46	1.1
10-19	5.15	1.29	2	5.04	0.8
10-22	5.15	1.29	3	5.15	0.3
10-23	5.15	1.29	4	4.47	0.2
10-24	5.15	1.29	5	5.15	0.2
10-26	5.15	1.29	6	5.10	0.2
10-27	-	-	7	4.90	0.1
	WASH SOLUTION				
10-29	5.15	0	-	-	-
10-30	5.15	0	1	4.30	Trace
10-31	5.15	0	2	4.32	Trace
11-1	5.15	0	3	4.85	Trace
11-2	5.15	0	4	4.67	Trace
11-3	-	-	5	5.80	Trace

TABLE 3

DAILY GOLD RECOVERY

SOLUTION NUMBER	CHIDDY ASSAY 600 ml Mgs Au	EFFLUENT Total Volume Liters	EXTRACTION Equivalent To Oz Gold/Ton of Ore
Preg-1	14.760	4.46	0.0575
Preg-2	4.133	5.04	0.0182
Preg-3	1.625	5.15	0.0073
Preg-4	0.904	4.47	0.0035
Preg-5	0.518	5.15	0.0023
Preg-6	0.235	5.10	0.0010
Preg-7	0.196	4.90	0.0008
		Total	0.0906
Wash-1	0.171	4.30	0.0006
Wash-2	0.148	4.32	0.0006
Wash-3	0.039	4.85	0.0002
Wash-4	0.055	4.67	0.0002
Wash-5	0.029	5.80	0.0001
		Total	0.0017
		Grand Total	0.0923
Cyanide Tails, Ounce Au/Ton			0.015
Calculated Heads, Ounce Au/Ton			0.107
Gold Extraction = 86.3 Percent			

This column leach experiment demonstrated the technical feasibility of heap or vat leaching the Goldfield ore that has undergone the agglomeration pretreatment. Gold recovery from 0.1 ounce gold per ton feed crushed to minus one inch and agglomerated was 86 percent. The tails assayed 0.015 ounce of gold per ton. Results of the screen analysis are shown in Table 4. These results show that the residual gold in the tailings occurred mainly in the plus 10-mesh fraction. Finer crushing undoubtedly would expose more gold for leaching. However, it would also create more fines which very likely would preclude percolation leaching.

Results of the bottle cyanidation test described earlier in this report show that an additional 0.01 ounce of gold per ton of ore can be extracted by fine grinding and agitation leaching. This conclusion can also be derived by examination of the screen analysis data shown in Table 4. Before any decision is made as to which process is best, additional data should be obtained from pilot-scale tests and economic feasibility studies.

Another observation made during the screen analysis was the occurrence of small balls of portland cement in the sand fractions. Apparently, maximum utilization of the cement had not occurred during the agglomeration step. The presence of excessive moisture in the feed material is believed to have an adverse effect on the uniform mixing of cement and the crushed ore.

Reagent consumption for the column leach test on the agglomerated feed was 15 pounds portland cement, 2.03 pounds sodium hydroxide, and 2.1 pounds of sodium cyanide per ton of ore.

TABLE 4

SCREEN ANALYSIS OF CYANIDE TAILS

PRODUCT SIZE	WEIGHT (Percent)	GOLD		
		Ounce/Ton	Unit	Percent of Total
+1/2"	7.8	0.024	0.0019	13.1
-1/2" +1/4"	21.9	0.022	0.0048	33.1
-1/4" +10 Mesh	22.4	0.021	0.0047	32.4
-10 +20	11.7	0.008	0.0009	6.2
-20 +35	5.9	0.008	0.0005	3.4
-35 +200	7.2	0.006	0.0004	2.8
-200 Slimes	23.1	0.004	0.0013	9.0
Composite	100.0	0.015	0.0145	100.0

CONCLUSIONS

The agglomeration of the ore, crushed to 1 inch , with 15 pounds of portland cement per ton and 10 weight-percent cyanide solution, produced a porous mill feed that was more stable than the agglomerated feed produced in our earlier tests. Gold recovery from ore containing 0.107 ounce of gold per ton was 86 percent. Cyanide consumption was 2.1 pounds of NaCN per ton of ore.

RECOMMENDATIONS

The laboratory-scale percolation leach studies have demonstrated that an agglomeration pretreatment of the Goldfield ore with portland cement will render this clayey ore amenable to percolation leaching practices. Gold recovery of better than 80 percent was achieved in the simulated heap leach tests conducted on minus 1-inch crushed ore.

From these studies, it is suggested that pilot-scale percolation tests be made to obtain the engineering data needed for the selection of a specific process (heap, vat, or agitation leaching) for the treatment of Goldfield ore. The agglomeration pretreatment of clayey ores has not yet been tried on a commercial scale. Therefore, it is strongly recommended that pilot-scale work be conducted to determine whether agglomeration via a drum or disk pelletizer is the best technique.

Harold Heinen

Harold Heinen
Project Manager