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AMERICAN SMELTING AND REFINING COMPANY
UNITED STATES MINING DEPARTMENT
P. O. BOX 5795, TUCSON, ARIZONA 85703

January 10, 1969

J. H. C.
JAN 9 1969

G. W. BOSSARD
MILLING ENGINEER

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

Mr. E. R. Marble
Central Research Laboratories
American Smelting and Refining Company
South Plainfield, N.J. 07080

Lakeshore Project

Dear Sir:

Under separate cover from the Galigher Company in Salt Lake City you will be receiving two sample envelopes containing approximately 50 gms each of Lakeshore copper concentrate. These samples are from the duplicate testing of a general Lakeshore drill hole composite and should be representative of the material tested to date by Galigher. Please furnish me with a copy of your spectographic analyses from these samples.

Yours truly,

G. W. BOSSARD
Milling Engineer

GWB/mg

cc: CENelson
JSSmart
KDLoughridge
BJDiSanto
TASnedden
JHCourtright
RBMeen

1/10/69
221

Box 5912
Tucson, Arizona
85703
Phone 623-5045
Area code 602

METCON =====
===== LABORATORY

please copy for 6W13

January 6, 1969

J. H. C.

JAN 9 1969

El Paso Natural Gas Company
Box 1492
El Paso, Texas

ATTENTION: Mr. J. R. Reynolds, Superintendent of Exploration

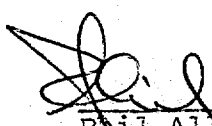
Dear John:

The enclosed material is a revision of data included in my original report.

While the accountability is lower generally, I believe these figures may more nearly reflect what actually took place.

All other pertinent data including APPENDIX III and re-run of samples P-69 (989-1020), P-69 (1020-1040), P-73 (870-988), and P-73 (1124-1187) will follow as soon as possible.

Very cordially,



Phil Allen, Director
METCON Laboratory

IMC

Enclosure

METCON LABORATORY

PROJECT EP-36

FOR

EL PASO NATURAL GAS

This short report is a recompilation of statistics based on essentially new data. All dry samples and final pregnant liquors from Project EP-36 were assayed again and while the accountability is lower it appears we can be confident the actual assay must fall between the two.

The intermediate pregnant liquors could not be re-assayed since the small portion taken for samples was nearly exhausted during the initial assaying.

The "EL PASO LEACH TEST RESULTS" may be placed in the report on page 2, to be compared with the earlier page 2.

EL PASO LEACH TEST RESULTS

<u>HOLES</u>	<u>INTERCEPTS</u>	<u>COPPER</u>		<u>%</u>	<u>ACCOUNT-</u>	<u>Lbs Cu</u>	<u>ACID PER *</u>
		<u>TOTAL N.S.</u>		<u>RECOVERY</u>	<u>ABILITY</u>	<u>RECOV.</u>	<u>Lb COPPER</u>
P- 4	768- 882	0.53	0.38	71.86	91.89	7.60	13.02
P- 5	200- 384	0.40	0.30	61.16	81.75	4.84	30.35
P-66	1040-1226	0.45	0.34	67.14	92.66	6.04	44.22
P-69	989-1020	0.33	0.21	25.32	83.73	1.67	44.43
P-69	1020-1040	0.73	0.54	35.33	81.42	5.16	14.38
P-69	1040-1072	0.84	0.58	45.17	86.96	7.59	9.78
P-69	1072-1124	1.80	1.76	89.75	103.90	32.31	3.98
P-70	810- 930	1.72	1.72	83.38	103.21	28.68	5.00
P-73	870- 988	0.27	0.18	13.21	84.07	0.71	69.68
P-73	988-1124	0.47	0.37	39.50	86.25	3.70	17.38
P-73	1124-1187	0.64	0.52	45.21	89.92	5.79	19.65
P-73	1187-1227	0.82	0.64	51.14	88.23	8.39	8.84
P-73	1227-1340	0.85	0.65	37.82	96.42	6.43	18.85

For method of computation see Appendix sheet number 1.

* Adjusted to 247.35 grams per liter for H₂SO₄ added.

El Paso Natural Gas Company

J. H. C.
JAN 4 1969

El Paso, Texas 79999
December 30, 1968

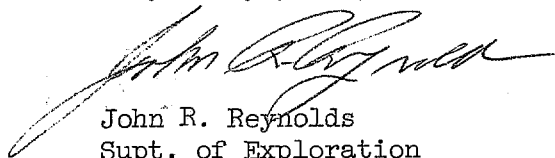
Mr. J. H. Courtright
Chief Geologist
Southwestern Exploration Dept.
American Smelting & Refining Company
1150 North 7th Avenue
Tucson, Arizona

Dear Mr. Courtright:

I am enclosing a copy of a report from Metcon Laboratories in Tucson describing the results of some leaching tests conducted by Metcon on 13 samples from the oxide zone of our Lakeshore ore body. All of these samples were composited from crusher rejects of split diamond drill cores.

Some of the assay results appear questionable to me, so I have requested that Metcon submit duplicate head and tail samples to another assay office for confirmation. These assay reports will be forwarded to you as soon as they are available.

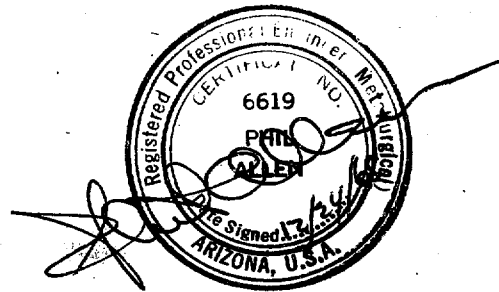
Very truly yours,



John R. Reynolds
Supt. of Exploration
Mining Division

JRR:mp
Enclosure

PROJECT EP-36
FOR
EL PASO NATURAL GAS



December 24, 1968
METCON LABORATORY
Box 5912
1796 W. Grant Road
Tucson, Arizona
85703

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METCON LABORATORY

PROJECT EP-36

FOR

EL PASO NATURAL GAS

SUMMARY

The results of Project EP-36 were extremely variable, sulfuric acid consumption per pound of copper extracted varying from a high of 82.5 pounds to a low of 4.4 pounds. Copper extraction based on total copper in the heads varied from a high of 88.5% to a low of 12.5%.

The following table presents a summary of results and a comparison by holes of the samples leached.

EL PASO LEACH TEST RESULTS

HOLES	INTERCEPTS	COPPER		% RECOVERY	ACCOUNT- ABILITY	Lbs Cu RECOV.	ACID PER * Lb COPPER
		TOTAL	N.S.				
An P-4	768- 882	0.43	0.32	70.8	109.0	6.1	16.20
An P-5	200- 384	0.35	0.26	54.6	92.6	3.8	39.06
An P-66	1040-1226	0.40	0.31	62.4	91.0	4.9	54.53
An P-69	989-1020	0.30	0.13	15.1	96.3	0.9	82.47
Por P-69	1020-1040	0.65	0.35	29.8	95.0	3.9	19.03
Por P-69	1040-1072	0.76	0.45	43.0	99.2	6.5	11.42
Por P-69	1072-1124	1.67	1.49	88.5	109.2	29.2	4.41
Por P-70	810- 930	1.60	1.41	83.0	108.4	26.6	5.39
An P-73	870- 988	0.25	0.10	12.5	99.0	0.6	82.47
Por P-73	988-1124	0.42	0.28	84.4	84.4	3.5	18.38
Por P-73	1124-1187	0.62	0.44	45.4	99.1	6.6	17.24
Por P-73	1187-1227	0.77	0.50	49.1	100.3	7.6	9.77
An + Por P-73	1227-1340	0.90	0.49	37.4	90.4	6.7	18.09

$$10 \sqrt{8.22} \quad 10 \sqrt{59.34}$$

0.82 % Cu 59.3 % Cu

$$10 \sqrt{174.5}$$

17.5 lbs / 16 Cu

0.12.6 x 17.5 = 2.1 lbs / ton

For method of computation see Appendix sheet number 1.

* Adjusted to 247.35 grams per liter for H₂SO₄ added.

PROCEDURE

All thirteen samples were treated by the following method which was detailed to METCON Laboratory by Dr. A. W. Last of Kennecott Copper Corporation Research Center.

Initially two sulfuric acid solutions were prepared.

- (1) A large volume containing 5 grams of H_2SO_4 per liter of water
- (2) A smaller volume of solution containing 250 grams of H_2SO_4 per liter for acid makeup additions.

Both solutions were accurately assayed for H_2SO_4 content by Hawley & Hawley Assayers.

The pH of the dilute solution was determined to be 1.4 and a volume was retained as a reference standard for future pH determinations. All pH determinations of pregnant liquor were made by first standardizing pH meter with dilute acid to 1.4 pH, then taking a reading of the pregnant liquor followed by a reading of dilute standard acid. If any drift was noticed the meter was re-adjusted and all three readings taken again.

TEST PROCEDURE

200 grams of crushed ore (reduced in size to all minus 9 mesh)
1 liter of dilute sulfuric acid.

Agitation was provided by rolling gallon bottles within a rotating frame.

At the end of each 24 hour period the 13 bottles were removed and allowed to settle after which a small sample was withdrawn

for pH determination, filtered and 10 ml sent to Hawley & Hawley for copper assay.

A sufficient volume of the 250g/l sulfuric acid solution was added to bring the pH back to 1.4 (the starting pH)

Total volume was kept constant in the bottles.

All bottles were continued on the rolls for 96 hours, at which time the pH was very carefully adjusted to the same value as the reference solution and volume likewise checked to original amount. In no case was it necessary to add liquid other than the acid makeup liquor.

A number of options are possible in this procedure.

(1) Time interval for sampling: This can be 6, 12, or 24 hours, in fact any other exponential time interval. We selected a 24 hour period in order to minimize the effect of allowing the bottles to remain quiescent while pipetting and adjusting pH.

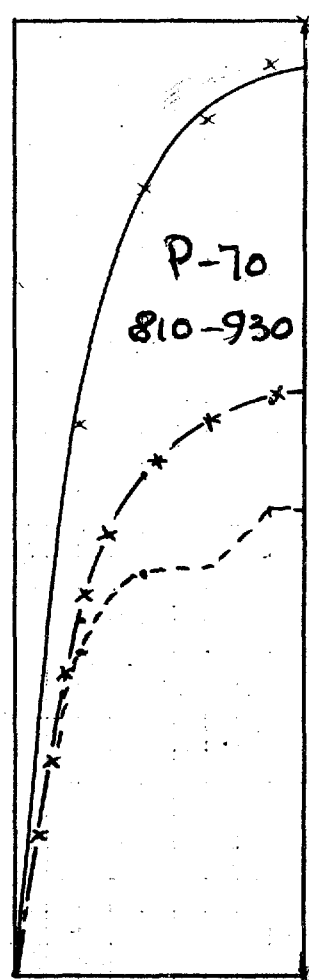
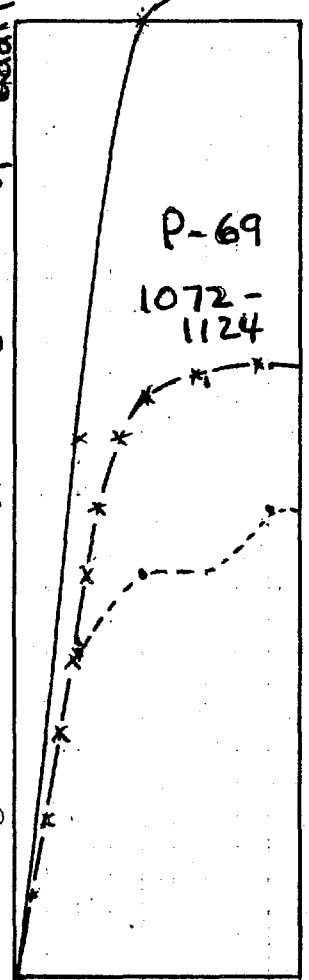
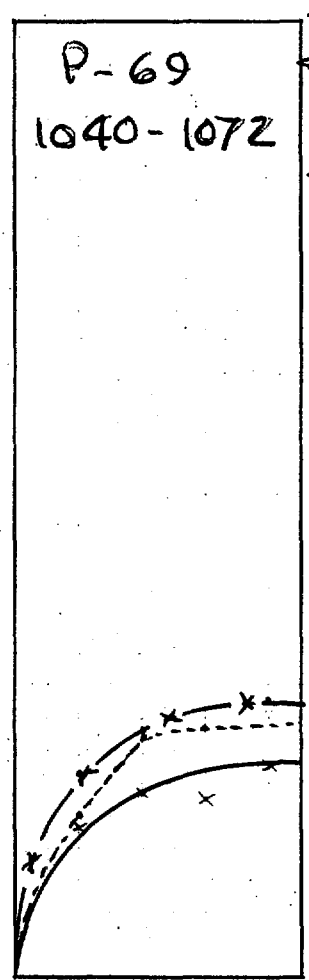
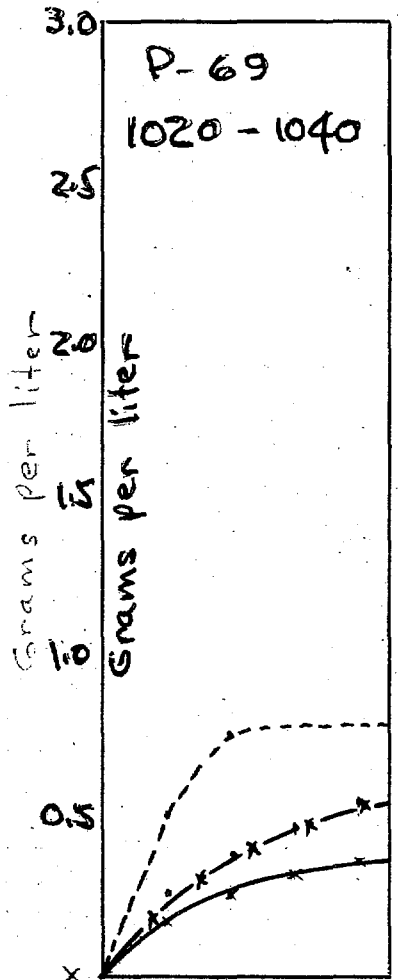
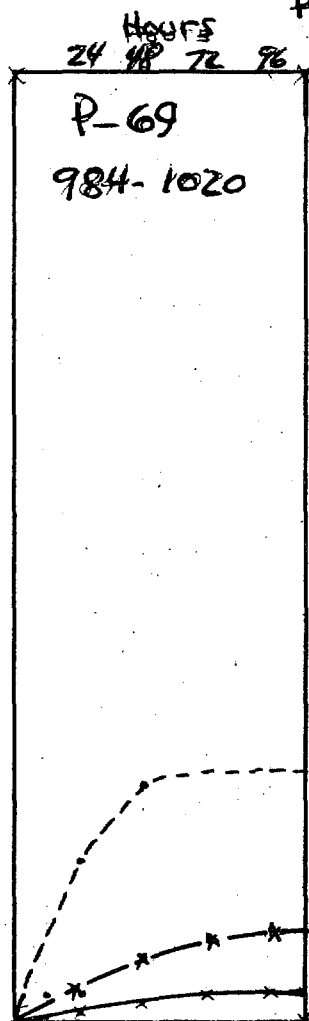
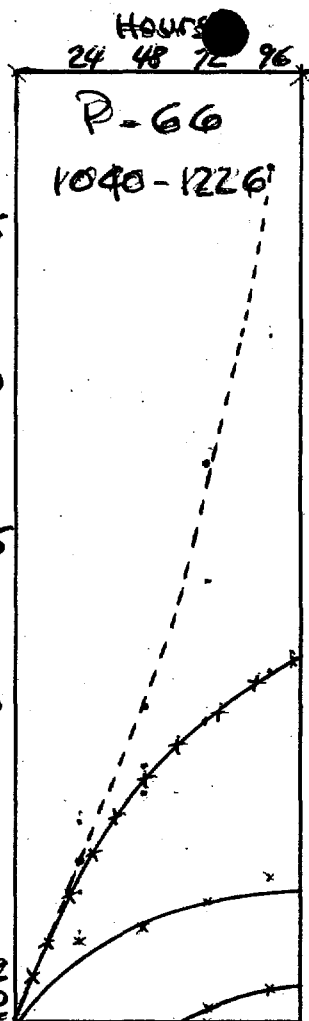
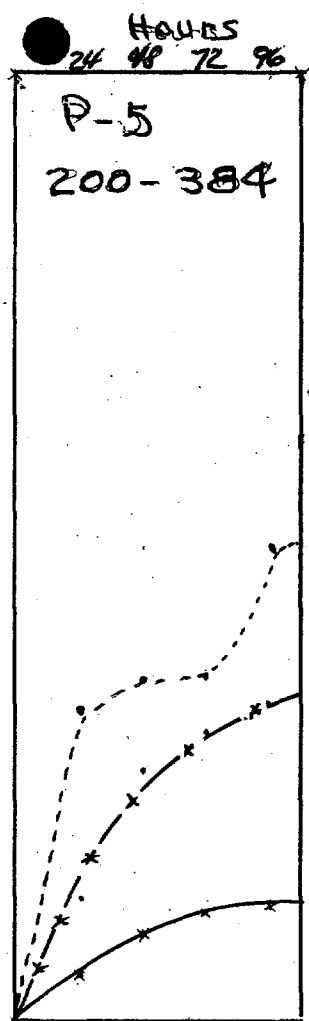
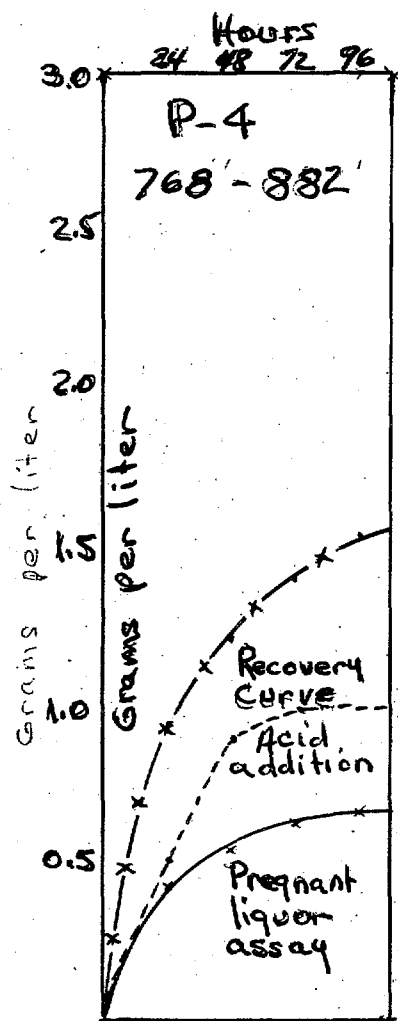
(2) Particle size: Inasmuch as the several samples (13) were not uniform in sizing it seemed desirable to reduce them to a common maximum screen (all minus 9 mesh) so a direct relationship based on particle size could be established (see appendix II).

(3) Volume of sample recovered for assaying: We removed only the exact amount requested by the assayer for copper determination. In this case 10 ml was accurately pipetted into a small bottle. No accounting was made of the copper removed from total leach solution by this sample pipetting as the total effect on copper extraction and acid consumption is negligible.

It is quite evident there must have been strong buffering action in several of the samples. The most intense buffer action occurred with sample p-66 (1040'-1226' interval) where at the end of 96 hours a total of 108 ml of strong (250g/l) H_2SO_4 had been added to maintain the pH at 1.4. This would be 27 grams of commercial H_2SO_4 (95%-98%).

CHARTS

The following charts show 3 graphs for each sample. The solid line represents the assay of the pregnant liquor, the scale being on the left side of the paper in grams per liter. The broken line with crosses at small intervals is the recovery curve in percent, the scale being on the extreme right hand side of the page. The plain broken line shows acid additions on a accumulative bases. The scale is in the center vertical space and is in total grams of commercial acid.

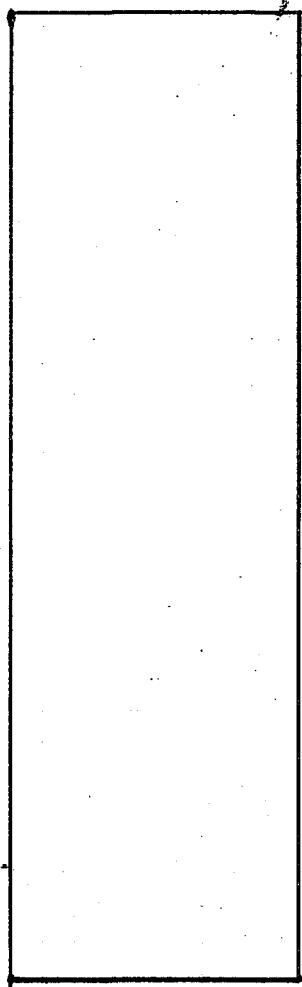
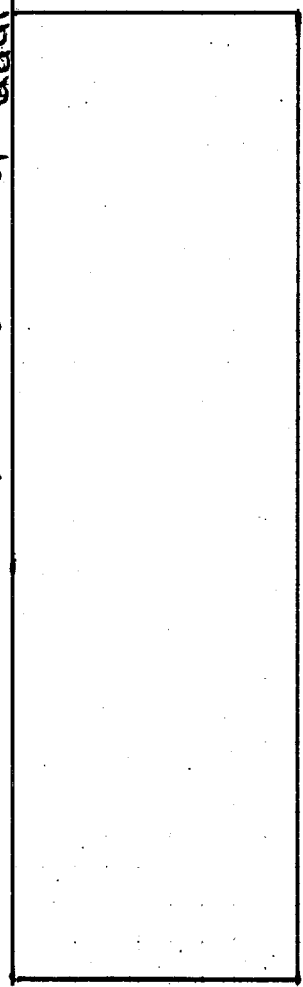
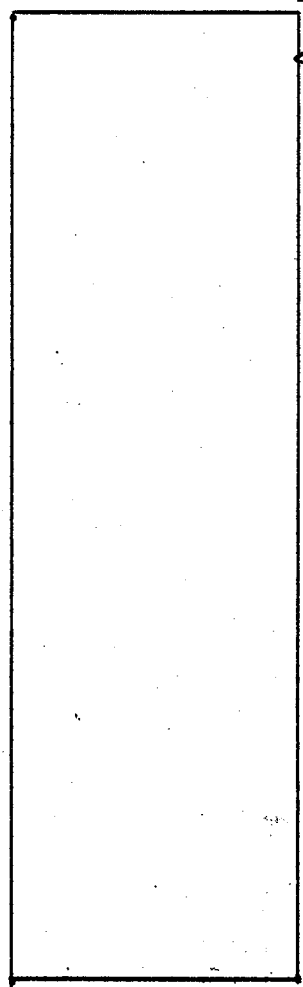
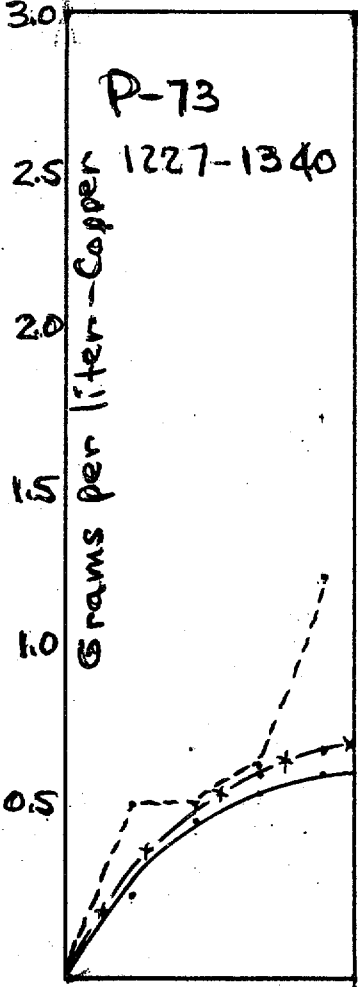
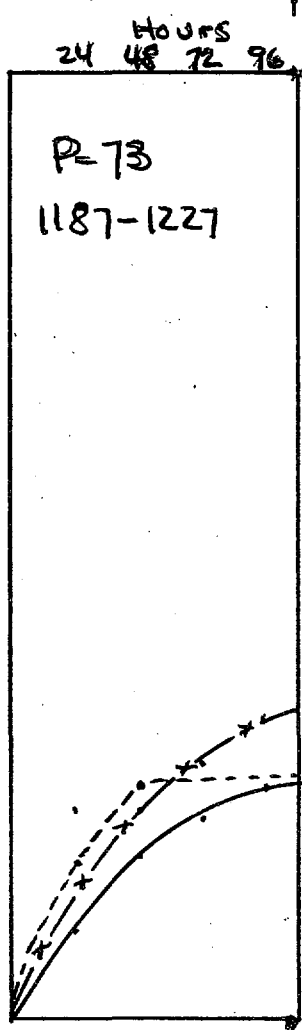
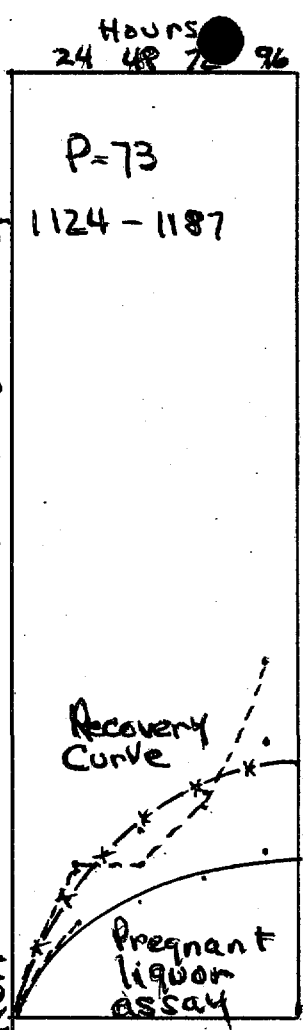
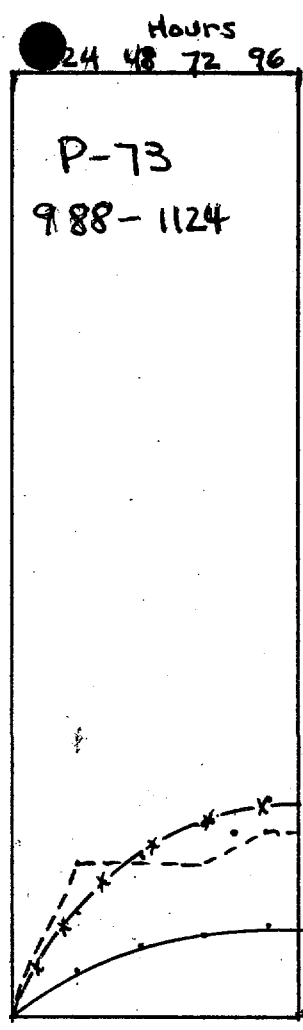
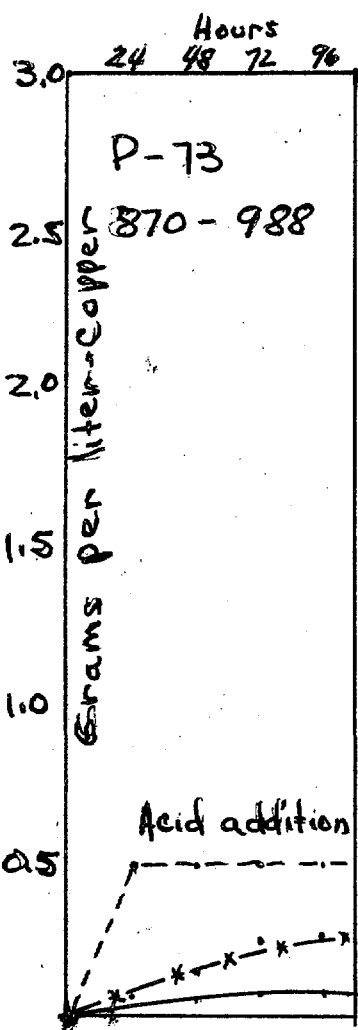


100
98
80
70
60
50
40
30
20
10
Percent recovery

100
90
80
70
60
50
40
30
20
10
Percent recovery

Acid addition ↑

↓ Acid addition



DISCUSSION

Recovery figures calculated from the pregnant liquors do not check with the recovery figures on page 2 because only two assays were used for each and accountability (showing assay deviation) was not considered. These figures do, however, show a sufficient relationship within themselves to justify plotting curves on this basis; in fact no other method could be used since no tailing assays were obtainable. The recoveries shown in the tailing column are based solely on head and tailing assay and do not consider the copper in the pregnant liquor.

Inasmuch as the calculations on page 2 reflect all three products, heads, pregnant liquor and tailing, it is taken to be a more meaningful figure on which to calculate acid consumption even though our accountability figures show a rather wide deviation.

Several of the samples might have had better end results if they had been rolled for an additional 24 hours, also probably less total acid would have been consumed if a somewhat higher pH had been used, since less gangue material would be attacked by the acid at this higher pH. The resulting pregnant liquor would be a much better feed for a liquid ion exchange plant, if this were considered.

In the event recipitation on shredded tin cans or sponge iron were contemplated a lower consumption of this commodity would be probable.

COMMENT

It would appear desirable to do further test work at a slightly

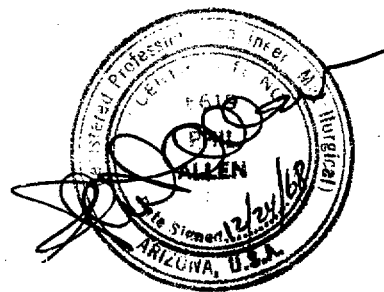
elevated pH. Possibly around 1.9 or a pH of 1.9 - 2.2. The acid would not attack gangue material as readily but might require additional leach time to attain optimum results.

It is difficult to project results at one particle size to results for altogether different screen sizes. Heap leaching could probably achieve better than 80% of the results achieved here but over a considerably longer period of time.

It is also possible to do as well in tank leaching with only slightly longer leach time but with a greatly increased capital cost.

ADDENDA

Since the accountability (assay deviation) in several of the samples was greater than the usually acceptable $\pm 5\%$, the heads and tailing assays will be rerun and at least 4 of the leach tests will be repeated. This will be reported out as an attachment to this report.



December 24, 1968

PA/pa

Phil Allen, Director
METCON Laboratory

Method of computation using sample P-5 as an example.

A - Grams copper per liter in final pregnant liquor - 0.354

B - Weight of residue - 195.7

C - Assay of residue - 0.15

D - Copper in residue plus copper extracted - $B \times C + A = 0.648$

E - $D \div$ copper in heads (head assay \times 200 grams) - $0.648/0.700$

E = Accountability = 92.6

F - Pounds of copper in ton = 7.0

G - Percent extraction = $A/D = 54.6$

H - Extraction \times total copper in ton of ore = $7.0 \times 54.6 = 3.8\#s$
copper extracted.

I - 60 ml of *247.35 g/l acid added (consumed) = 14.84 grams commercial
acid @ 95%-98% H_2SO_4

J - 14.84 grams H_2SO_4 per 200 grams = 148.40#s/ton

K - Therefor $148.40/3.8 = 39.06\#s$ acid required per pound of copper extracted.

*Acid made up at 250 grams per liter but assayed 247.35 grams per liter.

S C R E E N A N A L Y S I S

--MESH SIZE--

<u>Hole</u> <u>No.</u>	<u>Footage</u>	+20	+35	+48	+65	+100	+150	+200	-200
P- 4 (768.0- 882.0)		30.79	20.79	5.514	4.76	4.93	4.5	4.66	24.10
P- 5 (200.0- 384.0)		29.31	19.82	5.26	4.40	4.60	3.9	4.6	28.10
P-66 (1040.0-1226.0)		35.88	24.28	6.44	5.50	4.60	2.0	3.4	17.90
P-69 (989.0-1020.0)		30.66	23.16	6.23	5.60	4.93	3.5	3.8	22.12
P-69 (1020.0-1040.0)		30.39	20.56	5.45	5.40	5.10	4.4	4.9	23.80
P-69 (1040.0-1072.0)		34.54	23.36	6.20	5.60	4.90	4.0	4.5	16.90
P-79 (1072.0-1124.0)		35.68	24.14	6.40	5.26	4.60	3.3	3.8	16.90
P-70 (810.0- 930.0)		37.61	25.44	6.75	5.10	4.10	2.7	3.3	15.00
P-73 (870.0- 988.0)		35.67	24.13	6.40	5.60	5.20	3.2	4.0	15.80
P-73 (988.0-1124.0)		37.45	25.33	6.72	5.30	4.60	2.6	3.1	14.90
P-73 (1124.0-1187.0)		38.47	26.03	6.91	5.40	4.40	2.6	2.8	13.40
P-73 (1187.0-1227.0)		37.72	25.51	6.77	5.90	4.50	3.1	3.2	13.30
P-73 (1227.0-1314.0)		36.96	25.00	6.63	4.90	4.50	2.9	3.3	15.80

1st 24 HOUR LEACH

APPENDIX I (A)

<u>pH</u>	<u>ml ACID CONSUMED</u>	<u>ASSAY Cu g/l</u>	<u>RECOVERY</u>
2.4	20	0.408	47.44
3.2	40	0.137	19.57
2.5	20	0.267	33.38
2.4	20	0.024	4.00
2.3	20	0.164	12.62
2.4	20	0.466	30.66
3.5	40	1.690	50.60
3.8	40	1.730	55.00
2.3	20	0.025	5.00
2.4	20	0.147	17.50
2.6	20	0.307	24.75
2.6	20	0.280	18.18
2.6	20	0.210	11.67

2nd 24 HOUR LEACH

<u>pH</u>	<u>ml ACID CONSUMED</u>	<u>ASSAY Cu 1g/l</u>	<u>RECOVERY</u>
1.70	15	0.534	62.09
1.45	5	0.280	40.00
2.60	20	0.282	35.25
1.52	10	0.061	10.17
1.51	10	0.250	19.33
1.50	10	0.570	37.50
1.52	10	3.050	91.32
1.55	10	2.480	77.50
1.40	--	0.038	7.60
1.40	--	0.216	25.72
1.40	--	0.374	30.16
1.50	10	0.530	34.42
1.40	--	0.446	24.78

3rd 24 HOUR LEACH

<u>pH</u>	<u>ml ACID CONSUMED</u>	<u>ASSAY Cu g/l</u>	<u>RECOVERY</u>
1.45	5	0.608	70.70
1.40	--	0.326	46.57
1.70	30	0.384	48.00
1.40	--	0.076	12.67
1.40	--	0.306	23.54
1.40	--	0.550	36.18
1.40	--	3.120	93.41
1.40	--	2.780	86.87
1.40	--	0.064	12.80
1.41	--	0.270	32.14
1.48	8	0.464	37.42
1.40	--	0.646	41.95
1.48	5	0.534	29.67

4th 24 HOUR LEACH

<u>pH</u>	<u>ml ACID CONSUMED</u>	<u>ASSAY Cu g/l</u>	<u>RECOVERY</u>
1.40	-5	0.662	76.98
1.45	15	0.354	50.57
1.55	38	0.454	56.75
1.40	--	0.087	14.50
1.40	--	0.368	28.31
1.40	--	0.648	42.63
1.42	2	3.230	96.71
1.50	8	2.880	90.00
1.40	--	0.062	12.40
1.48	6	0.298	35.48
1.50	18	0.558	45.00
1.40	--	0.760	49.35
1.50	24	0.608	33.78

Hd ASSAY

<u>WEIGHT</u>	<u>TAILING</u>		<u>RECOVERY</u>	<u>ACID CONS*</u>	<u>SAMPLE No.</u>	<u>Hd ASSAY</u>	
	<u>ASSAY</u>	<u>ASSAY</u>				<u>TOTAL</u>	<u>N.S.</u>
	<u>T Cu</u>	<u>N.S.</u>				<u>Cu</u>	<u>N.S.</u>
195.5	0.14	0.07	68.17	40 ml	P-4 (768- 882)	0.43	0.32
195.7	0.15	0.09	41.94	60 ml	P-5 (200- 384)	0.35	0.26
195.7	0.14	0.10	63.31	108 ml	P-66 (1040-1226)	0.40	0.31
196.5	0.25	0.11	18.13	30 ml	P-69 (989-1020)	0.30	0.13
197.1	0.49	0.23	33.29	30 ml	P-69 (1020-1040)	0.65	0.35
195.4	0.44	0.19	43.47	30 ml	P-69 (1040-1072)	0.76	0.45
191.7	0.44	0.12	87.37	52 ml	P-69 (1072-1124)	1.67	1.49
190.5	0.31	0.16	81.55	58 ml	P-70 (810- 930)	1.60	1.41
197.0	0.22	0.09	13.32	20 ml	P-73 (870- 988)	0.25	0.10
196.3	0.28	0.13	34.56	26 ml	P-73 (988-1124)	0.42	0.28
197.2	0.34	0.23	45.93	46 ml	P-73 (1124-1187)	0.62	0.49
196.4	0.40	0.21	48.98	30 ml	P-73 (1187-1227)	0.77	0.50
196.0	0.52	0.34	43.37	49 ml	P-73 (1227-1314)	0.90	0.49

To: HAWLEY & HAWLEY
Assayers and Chemists, Inc.

622.4836

(For Customer's Use)

From: ASARCO
Tucson Unit

Run for Total Cu
& Non Sul Cu

Save pulps
Return rejects

- Single Analysis
- Verified Analysis*
- Geochemical Analysis
- Spectrographic Analysis

*Verified Analysis will be run unless otherwise specified

Att RD Karvinen

Nov 28 1968

Page 1 of 1 pages

Silver Bull Mission Total NS

Interval	Sample No.	Au	Ag	Pb	Cu	NS Cu	Mo T _{Cu}	NS		
846-1031	P-1 A				0.48	0.11	.510	.046	.505	.115
850-968	P-30				0.35	0.23	.326	.146	.310	.268
968-1064	P-30				0.67	0.22	.772	.070	1.772	.252
962-1038	P-55				0.65	0.10	.756	.028	.751	.100
1058-1145	P-55				0.66	0.05	.762	.060	.757	.059
070-758	P-56				1.36	0.16	1.540	.016	1.56	.168
758-940	P-56				0.53	0.06	.848	.006	.639	.069
876-930	P-64				1.60	0.63	1.902	.042	1.89	.642
068-1158	P-68				0.37	0.04	.426	.010	.417	.031
158-1322	P-68				0.49	0.04	.548	.006	.573	.039
1124-1290	P-69				1.22	0.08	1.442	.016	1.43	.121
					.76	.15	.39	.045		

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 13, 1968

Mr. J.J. Collins, Chief Geologist
ASARCO - New York Office

LAKESHORE LEACH TESTS

Dear sir:

Enclosed is Mr. Bossard's covering letter and Mr. Crowell's report on vat leach tests conducted on Lakeshore copper oxide material.

The samples submitted for this work were crushed core rejects from the few holes that were diamond drilled through the oxide zone. The majority of holes were rotary drilled through the oxide zone and the rejects discarded. Therefore, it is to be understood that the results may not represent the average to be expected from the entire oxide zone.

The results indicate an average of around 70% recovery in a 6-day leach period with consumption of 70-80 lbs of acid per ton. Our preliminary calculations (not checked) indicate something over 80 million tons (overlying the proposed block-cave sulfide zone) of 0.65% copper, as oxide, using a 0.4% copper cutoff. Thus, acid consumption would amount to around 9 lbs/lb of copper on a 0.65% head.

We expect to complete a block-cave ore reserve and supporting cross sections within two weeks.

Yours very truly,

J.H. Courtright
J.H. Courtright

JHC:lzb
Encl.

cc: JJCcollins, 1 extra
TASnedden, no encl.
RBMeen " "
WGBossard " "
DECrowell " "

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 11, 1968

Mr. J. H. Courtright, Supervisor
Exploration Department
Southwestern United States Division
Building

Lakeshore Project Metallurgical
Test Results

Dear Sir:

I am enclosing two copies of Mr. Crowell's memorandum discussing the leach test results from the 18 Lakeshore Project samples evaluated at the Mission Unit Testing Laboratory. The two procedures used to evaluate these samples indicate the following results should be obtained from the Lakeshore orebody if a vat leach process (six-day leach period) is used for the higher grade material:

<u>Composite Ore Type</u>	<u>Copper Recovery</u>	<u>Sulfuric Acid Consumption</u>
Andesite	65-67 percent	80 lbs sulfuric acid per ton ore
Porphyry	70-73 "	80 lbs sulfuric acid per ton ore
Mixed Andesite, Quartzite and Porphyry	71-74 "	65 lbs sulfuric acid per ton ore
Overall Recovery	69-71	75 lbs sulfuric acid per ton ore

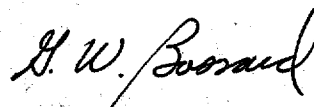
J. M. Crowell

The sampling instructions for the three composites (andesite, porphyry and mixed) were furnished to Mr. Crowell by Mr. Karvinen in his memorandum dated November 29. The over all recovery estimate is based on the arithmetical average of the results from the three separate composites.

If dump leaching is considered for lower-grade material not vat-leached then total acid consumption, over an extended period of say 20-30 years, will not materially decrease and will be in the range of

60-70 pounds per ton. However copper recovery will be lower since it will not be possible to leach with as concentrated solutions as used with vat leaching, an assumption confirmed by the test work. I would estimate that no more than 40 percent of the copper would be recovered by dump leaching in the first 10-year active leaching period. Similar assumptions with regard to acid consumption and copper recovery could also be used for a leaching-in-place scheme.

Yours truly,



G. W. BOSSARD
Milling Engineer

GWB/mg
enclosures

cc: CENelson - w/copy encl.
TASnedden - " "
TBMeen - " "
TDHenderson - " "

FOUR STAR BOND
SOUTHWORTH, CALIF.
25% COTTON FIBER

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 11, 1968

Memorandum To: Mr. G. W. Bossard

Results of Leaching Tests on Lakeshore
Oxide Ore Samples

This memorandum outlines the results of the metallurgical test program on the 18 Lakeshore oxide ore samples collected November 15-16 at the Lakeshore property. The complete analysis of each sample is given in Table No. 1.

The first results indicated that this ore would require strong acid solutions and/or long leaching times in order to obtain reasonable recoveries. It was decided, therefore, to test each of the samples under strong leaching conditions (minus 10 mesh ore and leach solution strength of 57.5 gram per liter H_2SO_4) in order to quickly determine the amount of leachable copper present and to obtain an approximate idea of the acid consumption. The results of this phase of the test program are given in Table No. 2.

Three composite samples, A, B and C were then made up from the 18 samples on the basis of rock type and amount of leachable copper present. The composition of these samples is discussed in a memorandum from Mr. R. D. Karvinen dated November 29, 1968. Composite A represents andesitic rock, Composite C represents porphyritic rock, and Composite B represents a mixture of the two types. The composition and assays of the three composite samples are given in Table No. 3.

The three composite samples were then tested under conditions approximating vat leach conditions. Each composite was leached for seven days with leach solution strengths maintained at 10 and 20 gram per liter sulfuric acid for the first three days and then without further acid addition. The size of the material was minus one-quarter inch. The tests were run in open-mouth bottles rotated on laboratory rolls since sufficient sample for column leach tests was not available. The results of the six leach tests are given in Table No. 4. Complete results of each test are given in the attached sheets in the form of curves showing copper recovery and acid consumption plotted against leaching time.

In general, these tests indicate from the samples tested that reasonable recoveries (70% plus or minus 3%) can be obtained by vat leaching this ore using sufficient time (approximately six days leaching) with moderately strong leaching solutions. In actual practice, varying strength leaching

solutions would be applied to the ore at different times during the leaching cycle; the 10 and 20 gram per liter acid strengths used in the test work are only rough approximations of actual conditions. The tests indicate that the data obtained with the 10 gram per liter solutions should approach actual results more closely than data obtained from the 20 gram per liter solutions.

Previous experience has shown that actual copper recoveries from vat leach operations will be lower than recoveries obtained in laboratory bottle leach tests, so the recoveries listed in the table should be reduced somewhat. The following paragraphs present a short discussion of the test results from each ore type tested.

Andesite (Composite A) This sample was of low grade and contained more sulfide copper than the other samples. Also, the copper in this sample went into solution more slowly than with the other ore types. If this sample is typical of the andesite ore, only 65 to 67 percent recovery can be expected with this ore type with acid consumption of about 80 pounds of sulfuric acid per ton of ore.

Mixed Type (Composite B) This sample gave better results than either of the other samples but since only two drill holes are represented these results may not be too significant. Copper recovery should be 71 to 74 percent and acid consumption about 65 pounds of sulfuric acid per ton of ore.

Porphyritic (Composite C) The grade of this sample is considerably higher than that indicated for the orebody so the copper recoveries obtained from these tests are probably higher than could be expected in practice. Copper recovery should be 70 to 73 percent and acid consumption approximately 80 pounds sulfuric acid per ton of ore. The acid consumption seems high considering that this sample contains less than one-half as much acid-soluble CaO as Composite A, but all of the tests confirm this high acid consumption. This consumption would be less if the copper assay of the feed was lower but would not change the acid consumption figure by more than 10 percent. The acid is apparently being consumed by some other constituent in the ore besides CaO, possibly by the dissolution of alumina. The cause of this acid consumption can be determined by further test work if this information is desired.

The results that could be expected from heap leaching this ore are estimated as follows: 40 percent copper recovery over 10-15 years and an acid consumption of at least 75 pounds H_2SO_4 per ton of ore.

The above estimates of copper recovery and acid consumption are the most accurate that we can make based on the samples tested. These estimates should be accurate to within plus or minus 10 percent assuming that the samples accurately represent the orebody. If more detailed and accurate information is desired we would need enough coarse (plus 1/2 inch) sample to permit column leach tests. This would require a minimum of 500 pounds and we should have two or three times that quantity to permit several tests.

D. E. Crowell
D. E. CROWELL

Table No. 1Lake Shore Sample Assays

<u>Lake Shore Hole No.</u>	<u>Total Cu</u>	<u>N.S. Cu</u>	<u>Total CaO</u>	<u>Acid Soluble CaO</u>	<u>Total MgO</u>	<u>SiO₂</u>	<u>Fe</u>	<u>S</u>	<u>Al₂O₃</u>
P- 3	.61	.23	7.6	2.0	1.95	62.3	3.4	.40	3.63
P- 4	.32	.28	6.2	1.6	0.68	62.0	2.5	.04	3.80
P-27	.47	.40	7.2	1.7	1.01	63.3	2.9	.25	3.38
P-33	.57	.03	7.6	2.8	1.73	62.8	3.1	.90	2.14
P-39	.52	.35	6.2	2.3	0.94	62.8	3.2	Nil	3.80
P-40	.27	.24	5.0	1.2	1.73	62.0	2.9	.80	3.80
P-43	.48	.39	3.5	2.0	1.23	62.1	2.9	.25	3.46
P-45	.34	.30	4.5	2.0	1.01	61.8	3.0	Nil	3.23
P-51	.27	.19	2.4	0.9	0.65	62.8	4.1	.05	3.82
P-55	.68	.60	2.2	0.9	0.21	63.4	4.5	.20	3.82
P-56	1.80	1.58	1.0	0.5	0.21	66.6	3.1	.02	2.72
P-59	.70	.63	2.3	0.6	1.12	64.0	3.0	.47	3.78
P-62	.79	.74	1.1	0.9	0.29	64.2	2.6	.03	3.84
P-64	.95	.87	0.9	0.6	0.40	64.3	2.4	.09	2.97
P-68	.69	.62	0.8	0.6	0.43	64.6	3.9	.07	2.83
P-69	.70	.60	1.4	1.1	0.65	62.8	3.6	.09	3.84
P-70	.95	.81	1.3	1.1	0.86	63.4	3.4	.28	3.63
P-73	.34	.22	0.9	0.8	0.86	63.0	5.1	tr	3.38

Table No. 2

Lake Shore Test Results - Strong Leaching Conditions

<u>Lake Shore Hole No.</u>	<u>Head Assay</u>		<u>Cu Recovery</u>	<u>Acid Consumption - Pounds of H₂SO₄</u>					
	<u>Total Cu</u>	<u>N.S. Cu</u>							
P - 3	.61	.23	36%	143#/ton ore - 32##/## Cu recovered					
4	.32	.28	75	170	"	"	36	"	"
27	.47	.40	*77	155	"	"	21	"	"
33	.57	.03	NO TEST - ALL SULFIDE						
39	.52	.35	59	142	"	"	23	"	"
40	.27	.24	84	132	"	"	29	"	"
43	.48	.39	77	87	"	"	12	"	"
45	.34	.30	82	113	"	"	20	"	"
51	.27	.19	34	122	"	"	67	"	"
55	.68	.60	*67	125	"	"	14	"	"
56	1.80	1.58	78	119	"	"	4	"	"
59	.70	.63	77	132	"	"	12	"	"
62	.79	.74	77	129	"	"	11	"	"
64	.95	.87	84	78	"	"	5	"	"
68	.69	.62	78	121	"	"	11	"	"
69	.70	.60	*72	132	"	"	13	"	"
70	.95	.81	75	-			-		
73	.34	.22	37	107	"	"	42	"	"

* - 40 hour leach only

Leach Conditions: 200 gm - 10 mesh ore leached 48 hours in 57.5 gpl acid solution at 20% solids. Leaching done in one gallon bottles rotated on rolls.

Table No. 3

Composition and Assays of Lake Shore Composite Samples

<u>Composite</u>	<u>Rock Type</u>	<u>Lake Shore DDH Hole Nos.</u>	<u>Total Cu</u>	<u>Assay</u>		<u>Acid Soluble CaO</u>
				<u>N.S. Cu</u>	<u>Fe</u>	
A	Andesitic	P-4, P-27, P-39 P-43, P-45	0.49	0.33	3.10	1.80
B	Mixed Rock Types	P-64, P-69	0.81	0.72	3.50	0.70
C	Porphyritic	P-55, P-56, P-62 P-68, P-70	1.04	0.92	4.00	0.70

Composites were made up of equal amounts of sample from the holes listed except that hole P-45 is represented by only one-half the weight of the other samples in this composite. This is because we did not have a sufficient amount of this sample to make an equally weighted composite.

Hole No. P-59 was listed by Mr. Karvinen as belonging to the B Composite but it was decided to leave this sample out as it consists wholly of hammer cuttings while all of the other samples in the composites are diamond drill core crushed to minus one-quarter inch.

Table No. 4

Summary of Leach Test Results

With 10 and 20 gpl Acid Leach Solutions

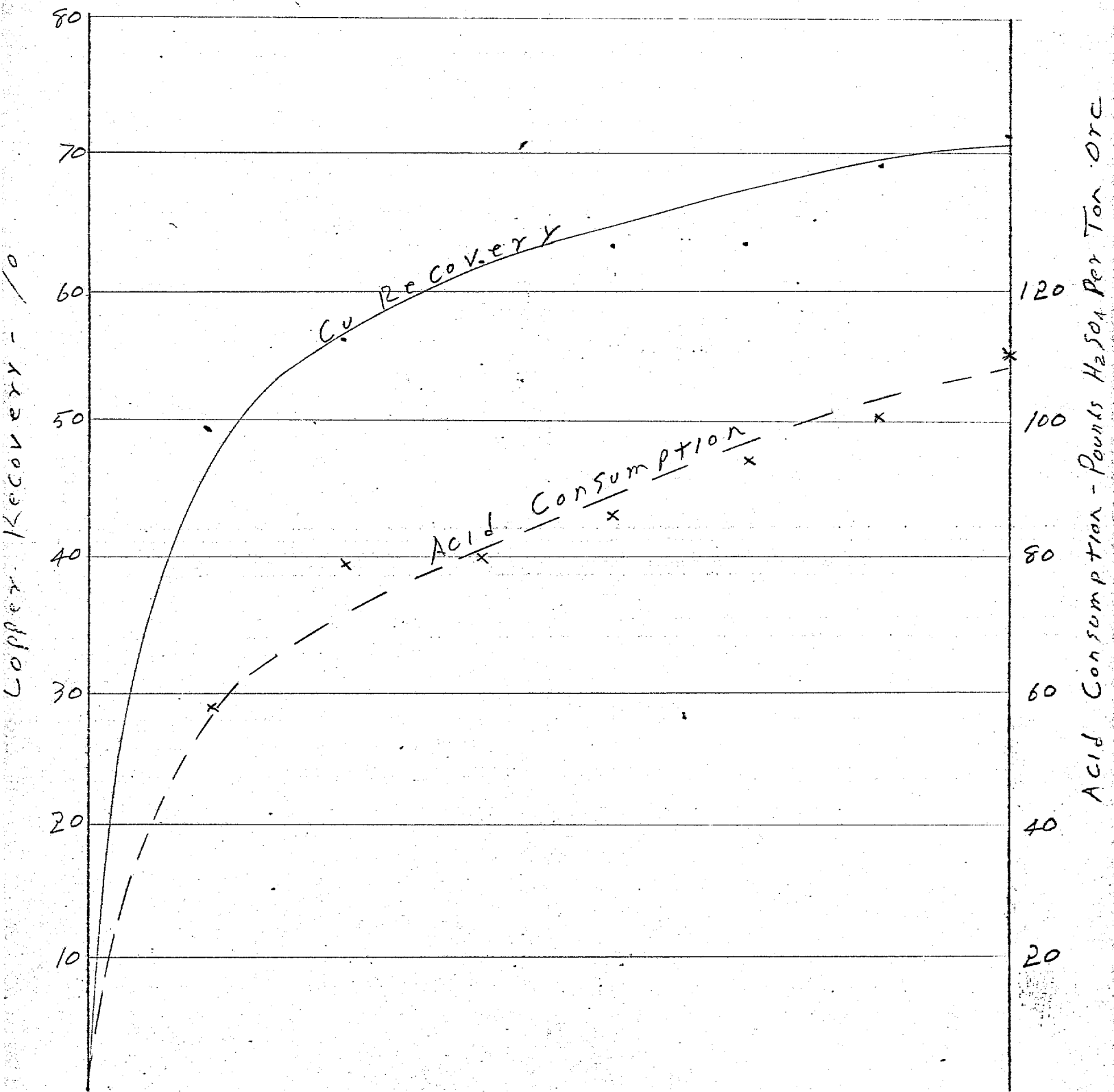
Test No.	Sample	Solution Strength gpl H ₂ SO ₄	Third Day			Seventh Day		
			Total Cu Recovery	Acid Consumption lbs/ton	Acid Consumption lbs/lb Cu	Total Cu Recovery	Acid Consumption lbs/ton	Acid Consumption lbs/lb Cu
30	A (Andesite)	10	56%	64.9	13.6	68.8%	83.1	14.1
31	A (Andesite)	20	63%	78.9	14.6	71.9%	110.8	17.9
32	B (Mixed)	10	72%	58.4	4.9	77.4%	66.6	5.2
33	B (Mixed)	20	76%	64.7	5.1	77.7%	80.6	6.2
34	C (Porphyry)	10	68%	65.0	5.0	75.8%	83.1	5.7
35	C (Porphyry)	20	74%	73.6	5.0	78.8%	101.5	6.5

These tests were done in one-gallon bottles rotated on rolls. Leach solution strengths were held at the indicated value (10 or 20 gpl H₂SO₄) for 72 hours then allowed to fall as the acid was consumed. The sample was all minus one-quarter inch in size. The ratio of solution to solids was held at 2:1 by weight. All leaching was done at room temperature.

Daily copper recovery and acid consumption figures are given on the following pages along with final solution assays for H₂SO₄ and copper.

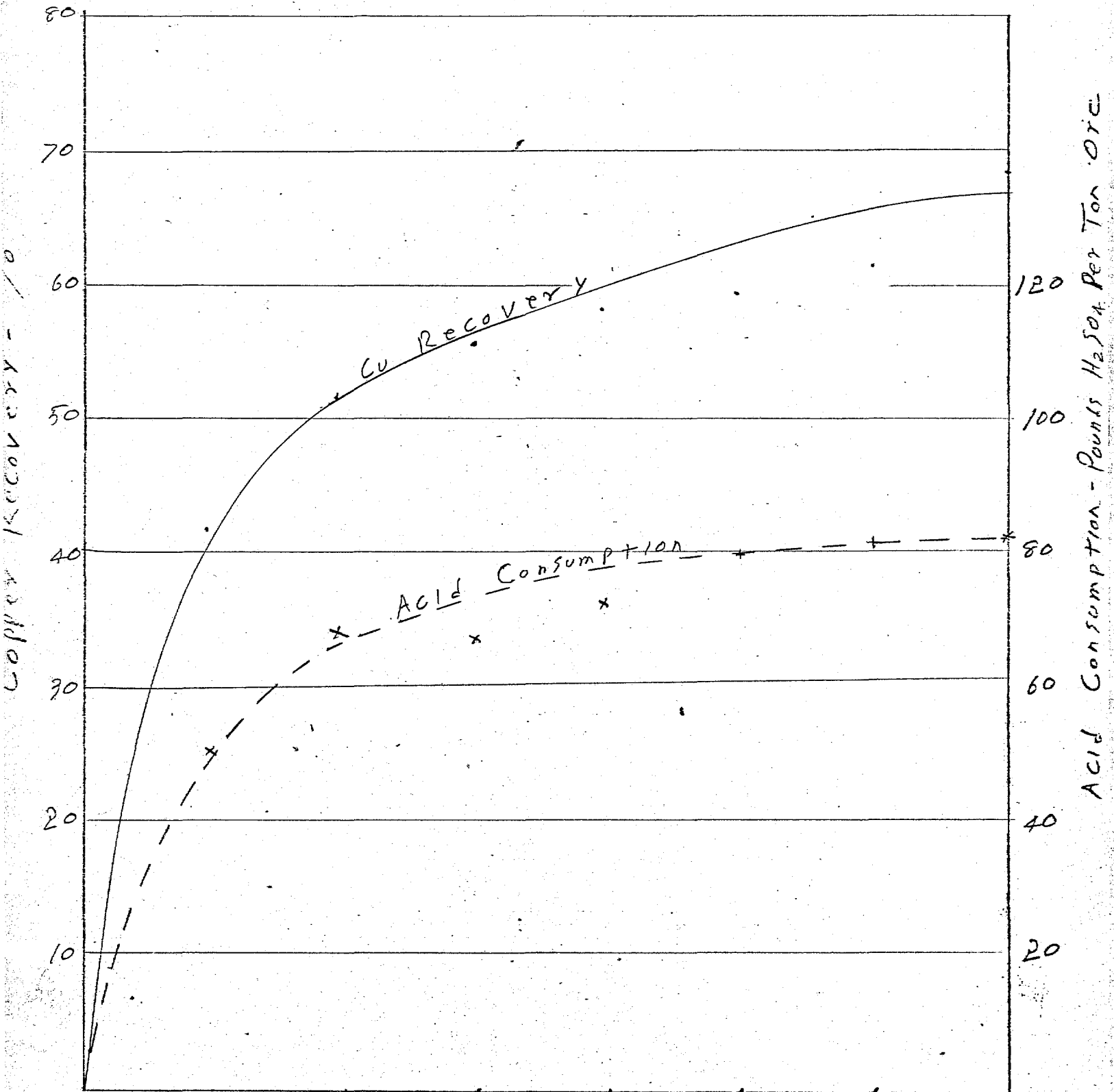
Test No. 31 - Sample A

Leach solution maintained at 20 gpl H_2SO_4 for three days then allowed to drop as acid was consumed. Final solution strength was 11.3 gpl H_2SO_4 and 1.4 gpl Cu.



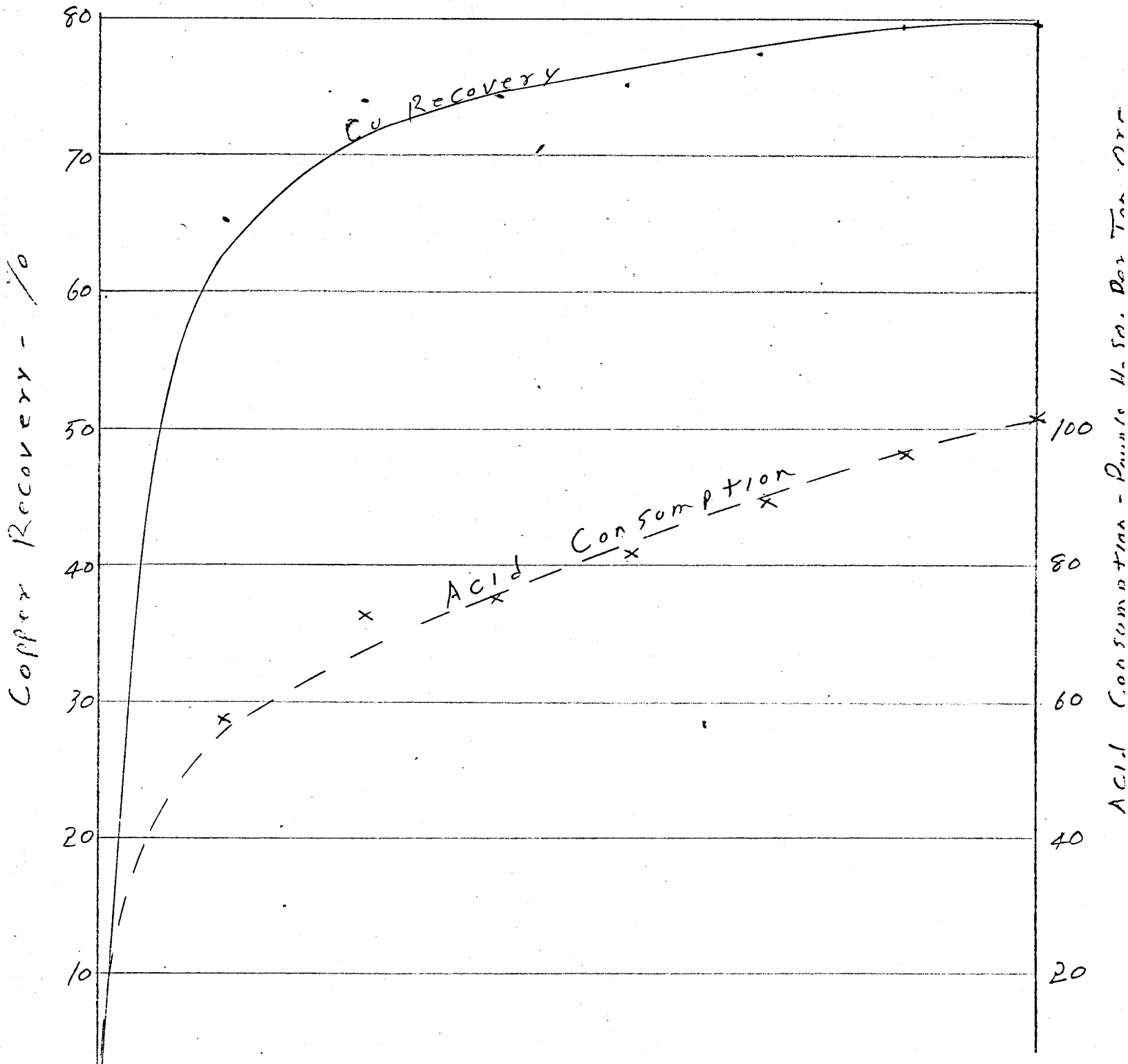
Test No. 30 - Sample A

Leach solution maintained at 10 gpl H_2SO_4 for three days then allowed to drop as acid was consumed. Final solution strength was 5.5 gpl H_2SO_4 and 1.3 gpl Cu.



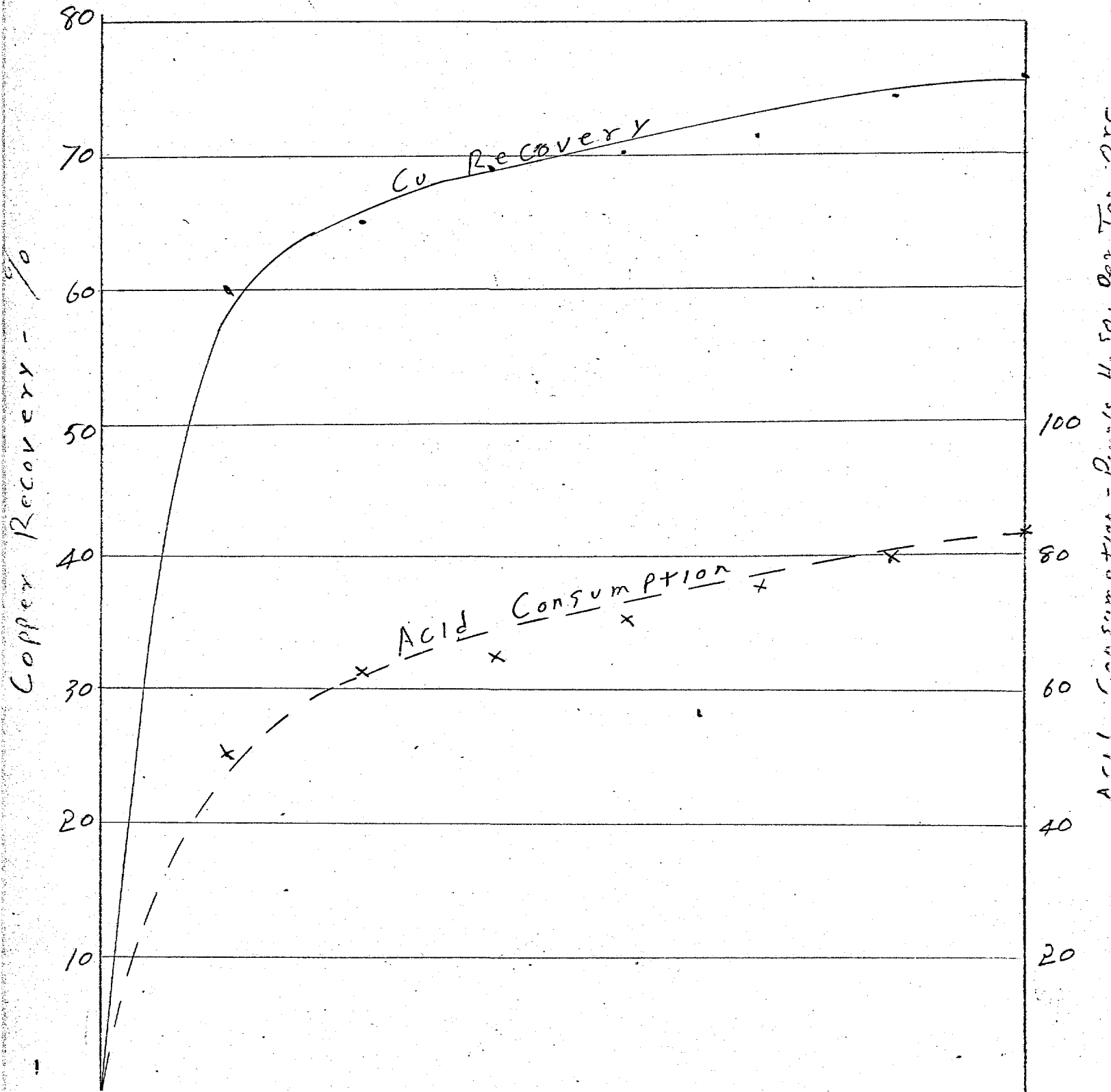
Test No. 35 - Sample C

Leach solution maintained at 20 gpl H_2SO_4 for three days then allowed to drop as acid was consumed. Final solution strength was 12.8 gpl H_2SO_4 and 3.5 gpl Cu.



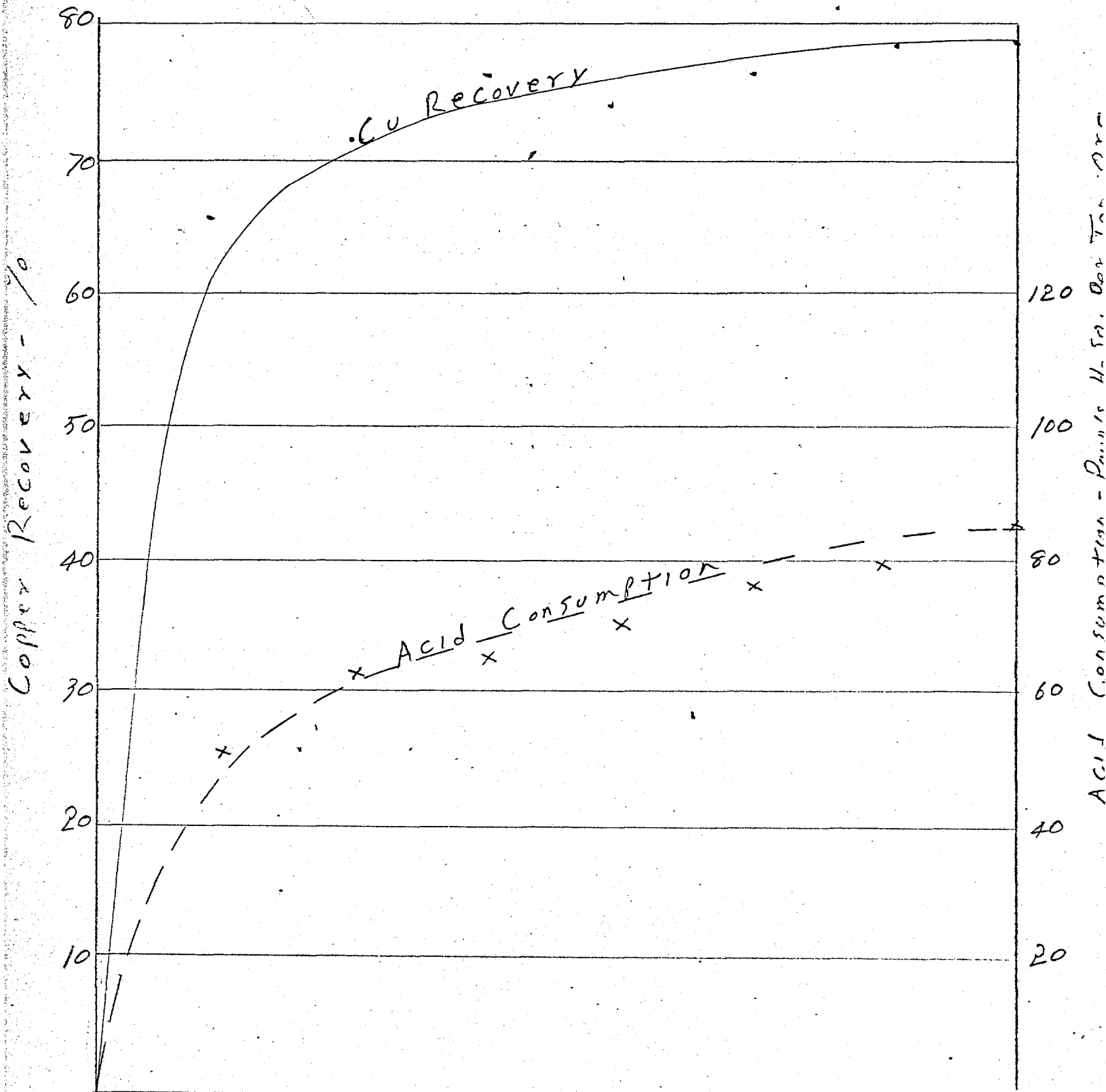
Test No. 34 - Sample C

Leach solution maintained at 10 gpl H_2SO_4 for three days then allowed to drop as acid was consumed. Final solution strength was 6.1 gpl H_2SO_4 and 3.2 gpl Cu.



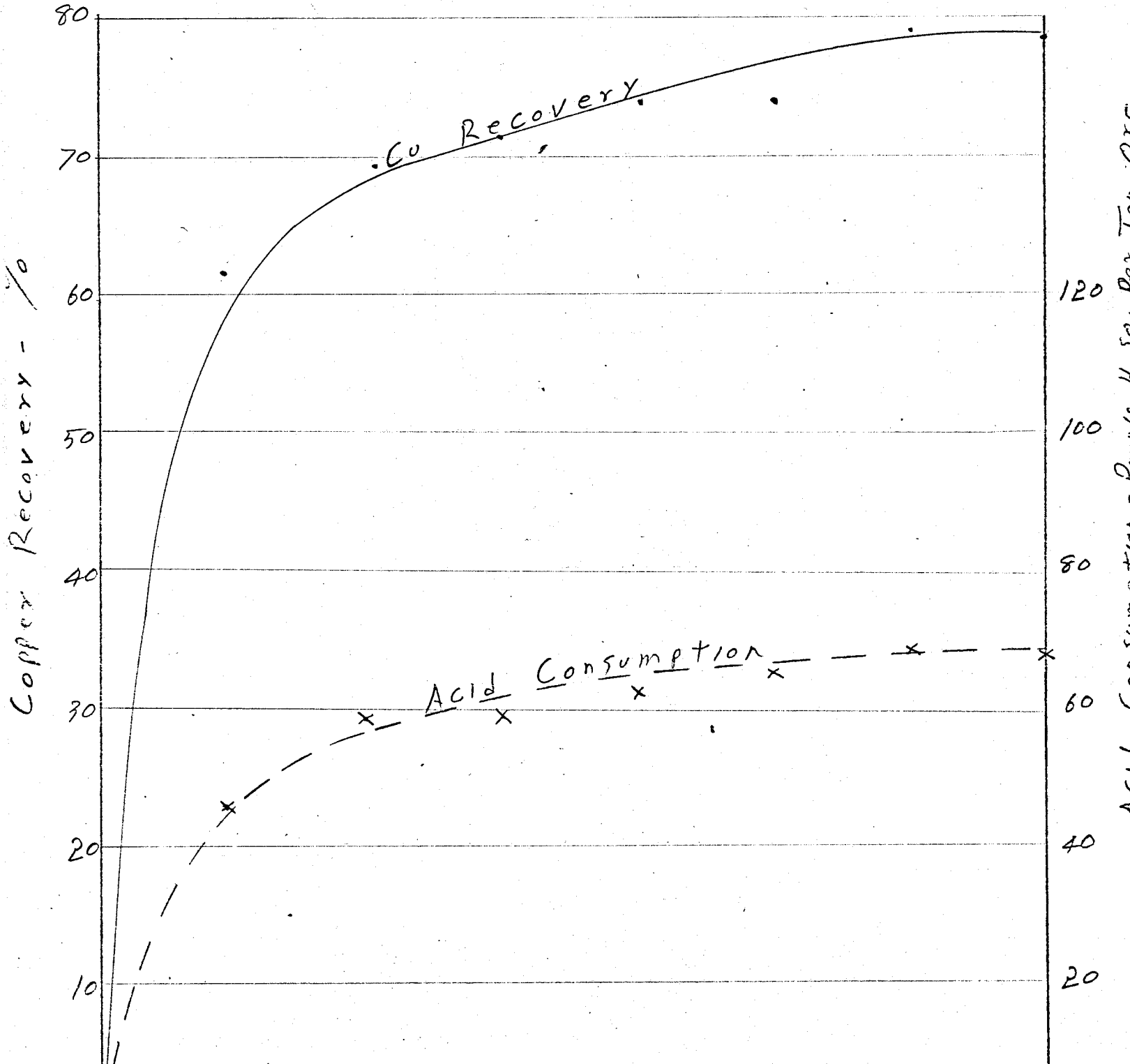
Test No. 33 - Sample B

Leach solution maintained at 20 gpl H_2SO_4 for three days then allowed to drop as acid was consumed. Final solution strength was 15.8 gpl H_2SO_4 and 3.0 gpl Cu.



Test No. 32 - Sample B

Leach solution maintained at 10 gpl H_2SO_4 for three days then allowed to drop as acid was consumed. Final solution strength was 7.5 gpl H_2SO_4 and 2.8 gpl Cu.



File Copy

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 11, 1968

Mr. J. H. Courtright, Supervisor
Exploration Department
Southwestern United States Division
Building

Lakeshore Project Metallurgical
Test Results

Dear Sir:

I am enclosing two copies of Mr. Crowell's memorandum discussing the leach test results from the 18 Lakeshore Project samples evaluated at the Mission Unit Testing Laboratory. The two procedures used to evaluate these samples indicate the following results should be obtained from the Lakeshore orebody if a vat leach process (six-day leach period) is used for the higher grade material:

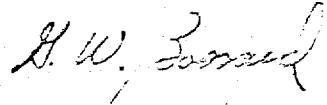
<u>Composite Ore Type</u>	<u>Copper Recovery</u>	<u>Sulfuric Acid Consumption</u>
Andesite	65-67 percent	80 lbs sulfuric acid per ton ore
Porphyry	70-73 "	80 lbs sulfuric acid per ton ore
Mixed Andesite and Porphyry	71-74 "	65 lbs sulfuric acid per ton ore
Overall Recovery	69-71	75 lbs sulfuric acid per ton ore

The sampling instructions for the three composites (andesite, porphyry and mixed) were furnished to Mr. Crowell by Mr. Karvinen in his memorandum dated November 29. The over all recovery estimate is based on the arithmetical average of the results from the three separate composites.

If dump leaching is considered for lower-grade material not vat-leached then total acid consumption, over an extended period of say 20-30 years, will not materially decrease and will be in the range of

60-70 pounds per ton. However copper recovery will be lower since it will not be possible to leach with as concentrated solutions as used with vat leaching, an assumption confirmed by the test work. I would estimate that no more than 40 percent of the copper would be recovered by dump leaching in the first 10-year active leaching period. Similar assumptions with regard to acid consumption and copper recovery could also be used for a leaching-in-place scheme.

Yours truly,



G. W. BOSSARD
Milling Engineer

GWB/mg
enclosures

cc: CENelson - w/copy encl.
TASnedden - " "
TBMeen - " "
TDHenderson - " "

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 9, 1968

Mr. D.R. Jameson
ASARCO - Silver Bell Unit

LAKESHORE MINE

Dear Sir:

Enclosed is a list of samples assayed by Hawley & Hawley I mentioned to you on the phone today. Please run the pulps which will be delivered to you today for total and non-sulphide copper.

Yours very truly,

J.H. Courtright

JHC:lzb
Encl.

To: HAWLEY & HAWLE
Assayers and Chemists, Inc.

622.4836

(For Customer's Use)

From: ASARCO
Tucson Unit

Run for Total Cu
& Non Sul Cu

Save pulps
Return rejects

- Single Analysis
- Verified Analysis*
- Geochemical Analysis
- Spectrographic Analysis

*Verified Analysis will be run unless otherwise specified

Att. RD Kerwin

Nov 28 1963

Page 1 of 1 pages

Interval	Sample No.	Au	Ag	Pb	Cu	NS Cu	Mo		
846-1031	P-1 A				0.48	0.11			
850-968	P-30				0.35	0.23			
968-1064	P-30				0.67	0.22			
962-1038	P-55				0.65	0.10			
1058-1145	P-55				0.66	0.05			
650-758	P-56				1.36	0.16			
758-940	P-56				0.53	0.06			
876-930	P-64				1.60	0.63			
068-1158	P-68				0.37	0.04			
1158-1379	P-68				0.49	0.04			
1124-1290	P-69				1.22	0.08			
				11	8.38	1.72			
						20.5%			

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 12, 1968

Memorandum To: Mr. G. W. Bossard

Lakeshore Property Samples For Metallurgical Test Work

On Friday, November 8, I visited the Lakeshore property of El Paso Natural Gas Company with Messrs. Courtright, Saegart, Bowditch, Kinnison, Karvinen, Sell and Wojcik in order to assist in the collection of samples for metallurgical tests. These samples are from oxide ore intercepts of diamond drill and rotary drill holes in the Lakeshore ore body.

There are 18 samples in all; 13 consist of crushed diamond drill core, two consist of rotary drill cuttings and three are mixed crushed core and rotary cuttings. A complete list of the hole numbers, intercept footage, type of sample, and approximate sample weight is attached.

These samples are too small for any detailed test work but this is all the El Paso personnel would allow us to take as they had to keep enough sample on hand for other companies who are investigating the project.

The physical condition of these samples is very poor; the fines have been washed out of the rotary drill cuttings and the diamond drill core has been crushed too finely for any column leach tests. In addition, pulverized assay sample reject has been returned to some of the crushed core samples. The two samples consisting entirely of rotary drill cuttings (hole nos. 51 and 59) were collected from piles of cuttings which were left out in the field and exposed to the weather for some time so most of the fines (if any fine material had been collected) have been washed away and the material will have weathered to some extent.

In discussions with Mr. Courtright I said that these samples would be adequate for a rough determination of acid consumption and copper recovery but that we would not be able to run percolation tests or other detailed test work on them.

D. E. Crowell
D. E. CROWELL

DEC/mg
attachment

cc: JHCourtright - w/o attachment
TASnedden - " "
RBMeen - " "