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inquiries@azgs.az.gov

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~~43-43A~~
~~61~~
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~~69-69D~~
~~10~~
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Footage Barrel No.

7 10-50 HDS-51 (also 7A) 7A 90-535 ; 370-580 HDS-52 (7A) 783-887 HDS-72 & -94 & 95 - 694
9 10-180 HDS-49 190-390 HDS-50 10-335 HDS-70
10 10-440 HDS-49 & -90 & -91 335-395 HDS-71 & 93
15 10-150 HDS-41 (15A) duplicate HDS-83 & -88
16 10-280 HDS-41 & HDS-84
18 10-420 HDS-42 Duplicate HDS-78 10-420 HDS-82
19 10-260 HDS-43 20-260 duplicate HDS-81
22 10-430 HDS-44 440-525 HDS-22 10-525 HDS-76 & -77
23 10-370 HDS-46 Duplicate HDS-77 ~~10~~-370 HDS-78
25 10-510 HDS-32 duplicate HDS-80
31 310-550 HDS-31 10-300 HDS-33 duplicate HDS-31
43-43A 10-450 10-95 HDS-23 duplicate HDS-61 & 62
44 10-30 HDS-24 ;
52 10-280 HDS-20 285-445 HDS-~~21~~
55 0-465 HDS-17 also HDS-13
54 0-435 HDS-16
58 0-435 HDS-9
61 0-330 HDS-2 also HDS-~~13~~
63 0-425 HDS-10
64 0-475 HDS-8
68 Selective interval HDS-38 also HDS-89 & HDS-103
69-69D HDS-39 & HDS-40
74 0-380 HDS-3
75 0-370 HDS-1

57 0-335 HDS-11

Hardshell

Map of Hardshell waste outline.

Holes as outlined by WLK, if used.

Tabulation of hole, sample footage, ~~weight~~, ~~recovery~~, assay, weight, note on recovery factor, sample number.

Telex to Brown 1st, ask if other needed

Note. All of sample sent. No material left in Tucson

FRK
1/26/84

HARDSHELL MET SAMPLES FOR CENTRAL RESEARCH

Samples should be from
within these intervals ±

HDS-83: 365-425 97#

HDS-82: 280-~~365~~ 360 150#

(A) HDS-~~81~~ 81B: 320-340 29#

(B) HDS-81A: 390-420 63#

or

450-550

HDS-80: 380-430 124#

HDS-77: 115-150 120-125 = 16# 145-150 = 12#

HDS-73: 230-280 69#

HDS-72: 120-180 55#

HDS-67: ~~350-420~~ 380 - 385 12#

HDS-60: ~~120~~ 130 -190 84#

HDS-62: ~~245~~ 260 -360 60#

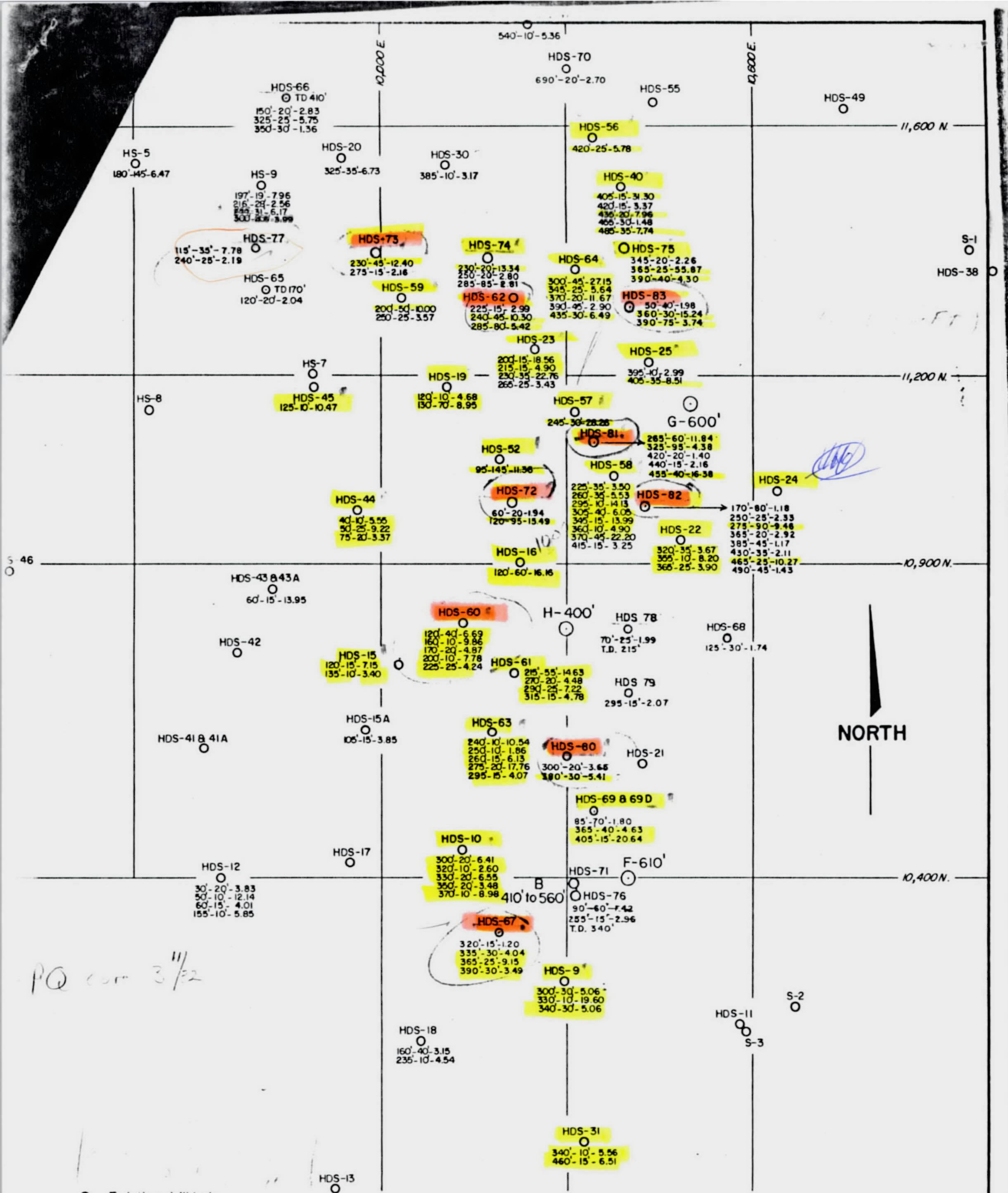
- Record weight of each sample used with identity for each composite.
- Mark bucket by Hole # & (MET-CR) - Example HDS-83 (MET-CR)
- Also for HDS-81 - Make up sample from 450-550' (HDS-81B (MET-HAZ) and 320-340' (HDS-81A (MET-NAZ) for each. only 34# total left.

  For Hazen-Denver, Pack each in separate marked double plastic bag and put in 5 gal. bucket.
- Best if complete sequence makes up composite.
- ~~Because of erratic high grade/low grade sequences do not use more than 10 pounds from any interval - use at least 5 samples for 50 lbs.~~

FROM: W. L. KURTZ

To:

On this map
I'd say the
intercepts marked
in yellow



Existing drill hole

H-400'
Proposed drill hole & depth

ASSAY DATA KEY

Depth—Length—Oz Ag
245' — 30' — 28.26

HARDSHELL PROJECT

PATAGONIA MOUNTAINS
SANTA CRUZ CO., ARIZONA

1" = 200'

ASARCO

Southwestern Exploration Division

October 18, 1983

To: J. D. Sell

From: F. R. Koutz

+ map + inventory

Estimated Costs
Large Diameter Coring Program
Hardshell Project
Santa Cruz County, AZ

As requested in your note of Oct. 14 the following are very roughly estimated costs of a large diameter coring program at Hardshell to provide samples for metallurgical and geomechanical testing. Drilling cost figures were obtained from Russ Beddow, Longyear (Phoenix, 258-6543) and Clark Hirschi, Boyles Bros. (Phoenix, 944-1731). Joy apparently does no coring over NC (2.4")diameter. It is also suggested that we contact Shelton Drilling who did the coring at Sacaton and who has core drilled (DDH S-6) at Hardshell.

I have consulted N. P. Whaley's (8-30-79) estimates for 6" coring at Hardshell (basement files), A. Dalla Vista's (5-28-70) report on Sacaton 6" coring, and B. E. Kilpatrick's (Nov. 1970, p. 83) La Caridad report to help prepare these estimates.

The major uncertainty is rate of coring and bit life in the jasperoids and vuggy jasperoids. I suspect that we will not get a footage bid from anyone, although Longyear would like to look at our previous core and the site with out-cropping jasperoid before deciding. All have suggested that PQ (3.345") core, if suitable, would be much preferable as it is wireline compared to conventional for 6" (5.97") core. As R. L. Brown has phoned (Oct. 17) that 50 pounds per interval will be sufficient for metallurgical tests, PQ core may be suitable as it would produce 210 pounds/20 feet of core.

Rig-time estimates were \$100/hr. although Boyles would give us a Longyear 44 Hydrostat. which could handle PQ to 500-600' for \$70/hour. I also believe that due to the probable difficulty in getting through the massive jasperoid caprock to the manto with core drilling we should hammer-drill to just above the manto and case and then core drill. A rig capable of doing both hammer/ rotary top-holing might be slightly more than \$100/hr. but we might be better off having 2 separate rigs and/or contractors for top holes and core.

Drilling rate is estimated at a maximum of 2 ft./hr. as Sacaton drilling averaged 2-4'/hr. (actual drilling time). The rate could be <u>considerably</u> less. Diamond impregnated bits will probably give better penetration than set bits but apparently will have to be special ordered for 6" bits. Boyles indicated that a common 6" set bit contained 76 carats (115 carat bits were used at Sacaton) which, with using \$25/carat diamonds and a \$646 setting charge would be \$2546/bit. Diamond recovery should be about 50% (it was 70% at Sacaton but with more diamonds) which would put bit costs @ \$1596 each.

Boyles estimated that a 6" impregnated bit would cost only slightly less than a set bit and would last longer but would have no diamond salvage value. Standard PQ impregnated bits are $1200 each. Bit life is estimated at 100 feet of drilling (Sacaton averaged 220 ft.) but could be considerably less. In 1972 Mettler Bros. consumed 18 NQ set bits drilling 253' and 4 BQ set bits drilling 115' at Hardshell. With larger diameter core bit life (especially impregnated bits) should be better.

Most of the manganese oxide manto zone at Hardshell ranges from 60-150' thickness; 120' is used for an average core intercept to allow a little rock above and below the zone to be cored. For the 8 proposed holes this would be 960 feet of coring. At 2'/hr. this would take 480 hours of actual coring or about 2 month's time on a 10 hr./day x 6 day week. Average top-hole hammer drilling would probably be about 250 feet per hole and should take a week for 8 holes.

Total estimated costs are about 50% more for 6" vs. PQ coring and the advantages of over 3 times the sample volume may not overweigh the problems with conventional vs. wireline coring and the larger equipment, casing, etc. needed for 6" core. In any case the drilling procedure, logging, photographing, geomechanical testing, splitting (?), crushing and assaying need to be discussed before a large diameter coring proposal is finalized. Most of the 8 holes should also be located so that they can be deepened by smaller-diameter diamond drilling to test for sulfide limestone replacement deposits which have a good potential of being underneath Hardshell.,

Fleetwood R. Koutz

FRK/cg

Attachment

cc: SAAnzalone (w/attachment)

F. R. Koutz
18 Oct. 1983

Rough Estimates - Hardshell Large Diameter Core Drilling

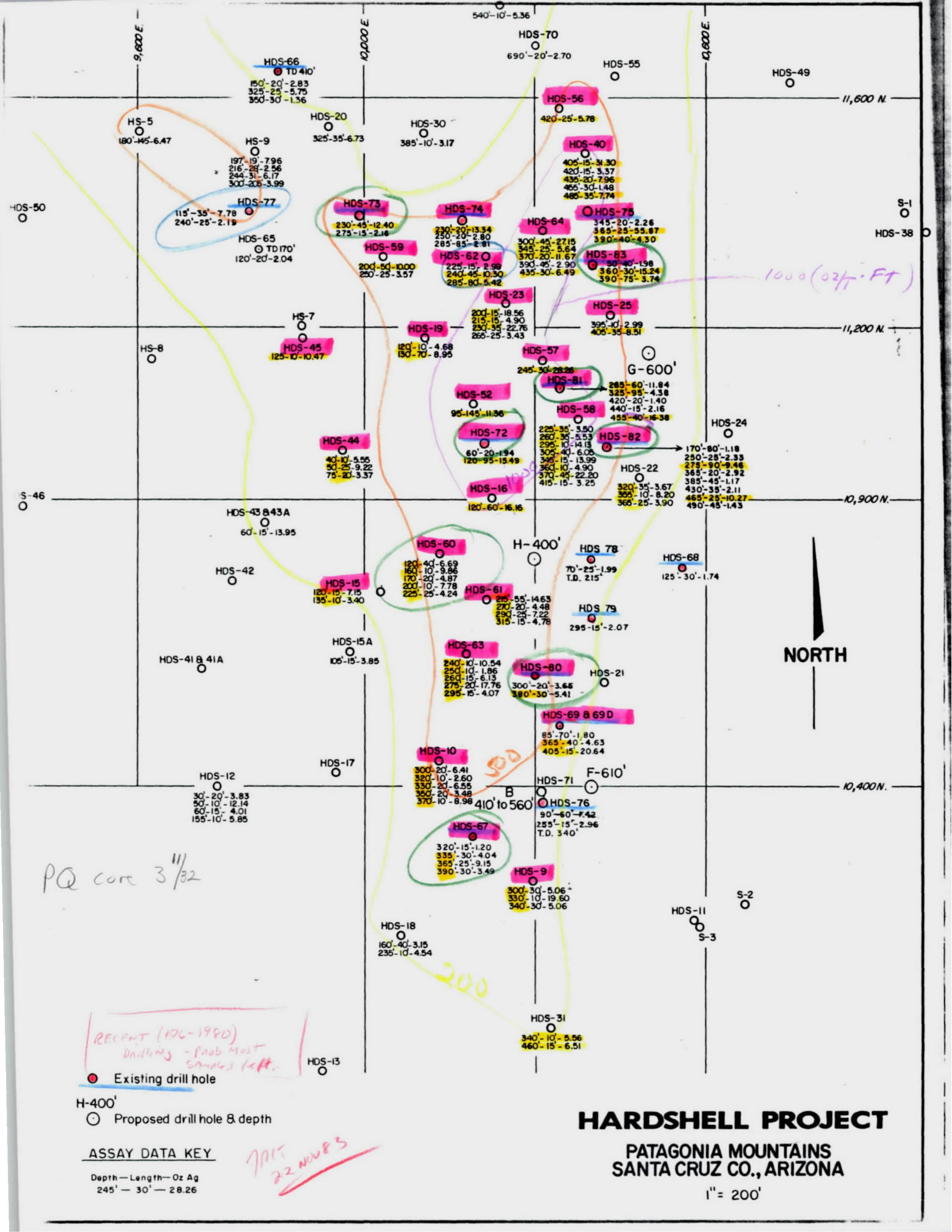
MnOxide manto:60-150' thickness - say 120 feet average
8 holes x 120' = 960' core = 48 x 20' samples.

at density of 2.8 gm/cc

6" core (5.97") = 33.8 lbs./ft. = 676 lbs/20 ft. = 16.2 tons/960'
PQ core (3.345") = 10.5 lbs./ft. = 212 lbs/20 ft. = 5.1 tons/960'
HQ core (2.50") = 5.9 lbs./ft. = 118 lbs/20 ft. = 2.8 tons/960'

	6" core	3" core
At 2'/hr. drilling (2'-4'/hr. @ Sacaton) = 480 hours for 960'	$ 100/hr.	$ 70/hr.
Drilling time rig cost	48,000	33,600
Plus 20% other rig time: moving, rigging, mixing mud, etc. (1.76'/hr. was overall drilling rate at Sacaton)	9,600	6,720
Total Rig Cost	$ 57,600	$ 40,320
Mud, additives, cement(!), water, boxes, drums, etc.	12,000	8,000
Bits (10 x 100' each) - Impregnated	25,000	12,000
Diamond Drilling Total	$ 94,600	$ 60,320
(Sacaton was $23.98, 1970): Cost/Ft.	98.54	62.83
250' x 8 holes = 2000' hammer drilling (including bit additives)	@ $12/ft. (9 7/8")	@ $10/ft. (7")
Hammer Drilling Total	$ 24,000	$ 20,000
Casing (2000') (some will be salvageable) Escalated from N.P.Whaley 1979 figures	8 5/8" $ 7/ft.	6" $ 5/ft.
	$ 14,000	$ 10,000
Top Hole Cost	$ 38,000	$ 30,000
Misc.; Salaries and labor supervision, logging: (2 months)	$ 8,000	$ 7,000
Road and Site Work (no major new roads)	2,000	2,000
Shipping to N.J. @ $8.97/100 lbs.	2,900	915
GRAND TOTAL COSTS	$145,500	$100,235
Cost/Ft. of Core	$ 151.56	$ 104.41

(Sacaton was $41.62/ft. actual coring - 1970)



540'-10'-5.36
HDS-70
690'-20'-2.70
9,600 E.
10,000 E.
10,600 E.
HDS-66
TD 410'
150'-20'-2.83
325'-25'-5.75
350'-30'-1.36
HDS-55
HDS-49
HDS-56
420'-25'-5.78
11,600 N.
HS-5
180'-145'-6.47
HDS-20
325'-35'-6.73
HDS-30
385'-10'-3.17
HS-9
197'-19'-7.96
216'-28'-2.56
244'-31'-6.17
300'-205'-3.99
HDS-40
405'-15'-31.30
420'-15'-3.37
435'-20'-7.96
455'-30'-1.48
485'-35'-7.74
HDS-50
HDS-77
115'-35'-7.78
240'-25'-2.19
HDS-73
230'-45'-12.40
275'-15'-2.16
HDS-74
230'-20'-13.34
250'-20'-2.80
285'-85'-2.81
HDS-75
345'-20'-2.26
365'-25'-55.87
390'-40'-4.30
S-1
HDS-38
HDS-65
TD 170'
120'-20'-2.04
HDS-64
300'-45'-27.15
345'-25'-5.64
370'-20'-11.67
390'-45'-2.90
435'-30'-6.49
HDS-59
200'-50'-10.00
250'-25'-3.57
HDS-62
225'-15'-2.99
240'-45'-10.30
285'-80'-5.42
HDS-83
350'-40'-1.98
360'-30'-15.24
390'-75'-3.74
1000 (oz/T · Ft)
HDS-23
200'-15'-18.56
215'-15'-4.90
230'-35'-22.76
265'-25'-3.43
HDS-25
395'-10'-2.99
405'-35'-8.51
HS-7
HS-8
HDS-45
125'-10'-10.47
HDS-19
120'-10'-4.68
130'-70'-8.95
11,200 N.
HDS-57
245'-30'-28.26
G-600'
HDS-81
265'-60'-11.84
325'-95'-4.38
420'-20'-1.40
440'-15'-2.16
455'-40'-16.38
HDS-52
95'-145'-11.36
HDS-58
225'-35'-3.50
260'-35'-5.53
295'-10'-14.13
305'-40'-6.05
345'-15'-13.99
360'-10'-4.90
370'-45'-22.20
415'-15'-3.25
HDS-72
60'-20'-1.94
120'-95'-15.49
HDS-82
170'-80'-1.18
250'-25'-2.33
275'-90'-9.48
365'-20'-2.92
385'-45'-1.17
430'-35'-2.11
465'-25'-10.27
490'-45'-1.43
HDS-24
HDS-44
40'-10'-5.55
50'-25'-9.22
75'-20'-3.37
HDS-22
320'-35'-3.67
355'-10'-8.20
365'-25'-3.90
HDS-16
120'-60'-16.16
S-46
10,900 N.
HDS-43 & 43A
60'-15'-13.95
HDS-60
120'-40'-6.69
160'-10'-9.86
170'-20'-4.87
200'-10'-7.78
225'-25'-4.24
H-400'
HDS 78
70'-25'-1.99
T.D. 215'
HDS-68
125'-30'-1.74
HDS-42
HDS-15
120'-15'-7.15
135'-10'-3.40
HDS-61
215'-55'-14.63
270'-20'-4.48
290'-25'-7.22
315'-15'-4.78
HDS 79
295'-15'-2.07
HDS-15A
105'-15'-3.85
HDS-41 & 41A
HDS-63
240'-10'-10.54
250'-10'-1.86
260'-15'-6.13
275'-20'-17.76
295'-15'-4.07
HDS-80
300'-20'-3.65
380'-30'-5.41
HDS-21
NORTH
HDS-69 & 69D
85'-70'-1.80
365'-40'-4.63
405'-15'-20.64
HDS-10
300'-20'-6.41
320'-10'-2.60
330'-20'-6.55
350'-20'-3.48
370'-10'-8.98
500
HDS-17
HDS-12
30'-20'-3.83
50'-10'-12.14
60'-15'-4.01
155'-10'-5.85
B
410' to 560'
HDS-71
F-610'
HDS-76
90'-60'-7.42
255'-15'-2.96
T.D. 340'
10,400 N.
HDS-67
320'-15'-1.20
335'-30'-4.04
365'-25'-9.15
390'-30'-3.49
PQ core 3 11/32
HDS-9
300'-30'-5.06
330'-10'-19.60
340'-30'-5.06
S-2
HDS-11
S-3
HDS-18
160'-40'-3.15
235'-10'-4.54
200
HDS-31
340'-10'-5.56
460'-15'-6.51
RECENT (1976-1980) Drilling - Prob Most Samples left.
HDS-13
Existing drill hole
H-400'
Proposed drill hole & depth
ASSAY DATA KEY
Depth—Length—Oz Ag
245' — 30' — 28.26
22 NOV 83
HARDSHELL PROJECT
PATAGONIA MOUNTAINS
SANTA CRUZ CO., ARIZONA
1" = 200'

ASARCO

March 28, 1980

Hardshell Rejects

Hardshell project rejects stored in 55-gallon drums, Ventura Street warehouse.

20882

Barrel No.	Hole No.	Interval
HDS-1	HDS-76	0-150
	HDS-75	0-370
HDS-2	HDS-61	0-330
HDS-3	HDS-74	0-380
	HDS-73	0-100
HDS-4	HDS-60	0-255
HDS-5	HDS-73	100-340
	HDS-72	0-210
HDS-6	HDS-59	0-335
HDS-7	HDS-72	210-245
	HDS-71	50-310
HDS-8	HDS-64	0-475
HDS-9	HDS-58	0-435
HDS-10	HDS-63	0-425
HDS-11	HDS-57	0-335
	HDS-57	Duplicate
	HDS-56	Duplicate
HDS-12	HDS-62	0-385
HDS-13	HDS-54	500-TD(?)
	HDS-55	Duplicate
	HDS-61	Misc.
	HDS-62	Misc.
	HDS-70	Misc.
HDS-14	HDS-70	
HDS-15	HDS-54	0-500
HDS-16	HDS-56	0-435

continued. . .

Barrel No.	Hole No.	Interval
HDS-17	HDS-55	0-465
HDS-18	HDS-49	10-525
HDS-19	HDS-50	10-435
	HDS-51	10-110
HDS-20	HDS-51	115-254
	HDS-52	10-280
HDS-21	HDS-52	285-445
	HDS-38	10-250
	HDS-39	10-200
HDS-22	HDS-39	210-480
	HDS-40	10-310
	HDS-41	5-35
HDS-23	HDS-40	320-380
	HDS-41	10-60
	HDS-41	5-40
	HDS-42	45-105
	HDS-43	10-45
	HDS-43A	10-95
HDS-24	HDS-44	10-30
	HDS-45	10-230
	HDS-46	10-125
HDS-25	HDS-47	10-540
HDS-26	HDS-47	540-590
	HDS-48	10-125
	HDS-48	20-125
HDS-27	HDS-35	120-190
	HDS-S36	10-150
	HDS-37	10-75
	HDS-38	470-550
HDS-28	HDS-35A	10-50
	HDS-38	260-460
	HDS-S35	10-110
HDS-29	HDS-36	10-150
	HDS-32	10-310
	HDS-32	566-575
	HDS-33	10-200
HDS-30	HDS-34	10-50
	HDS-35	10-190
	HDS-33	420-580

continued. . .

Barrel No.	Hole No.	Interval
HDS-31	HDS-31	310-550
	HDS-32	320-550
	HDS-33	210-410
HDS-32	HDS-26	10-200
	HDS-25	10-510
HDS-33	HDS-30	10-410
	HDS-31	10-300
HDS-34	HDS-28	10-490
	HDS-29	10-150
HDS-35	HDS-27	10-585
HDS-36	HDS-66	6-5, 10-150; 190-175; 180-285; 295-325; 380-390; 395-405; 410-TD
HDS-37	HDS-67	Selective Interval
HDS-38	HDS-68	Selective Interval
HDS-39	HDS-68+69 (1/3 Barrell)	
HDS-40	HDS-69+65	Selective Interval
HDS-41	HDS-15A	10-210
	HDS-15	10-150
	HDS-16	10-280
HDS-42	HDS-18	10-420
	HDS-17	10-320
HDS-43	HDS-19 ✓	10-260
	HDS-20	10-387
	HDS-21	10-250
HDS-44	HDS-21	250-510
	HDS-22	10-430
HDS-45	HDS-24	20-590
HDS-46	HDS-22	440-525
	HDS-23 ✓	10-370
	HDS-13	10-340
HDS-47	HDS-14	10-444
	HDS-12	20-240
HDS-48	HDS-11	10-600

continued. . .

Barrel No.	Hole No.	Interval
HDS-49	HDS-10	10-440
	HDS-9	10-180
HDS-50	HDS-9	190-390
	HDS-8	180-410
HDS-51	HDS-7A	90-360
	HDS-7	10-50
	HDS-8	10-170; 480-570
HDS-52	HDS-7A	90-535; 370-580
HDS-53	HDS-79	200-520
HDS-54	?	
HDS-55	HDS-80	455-490
	HDS-79	335-340; 385-390;410-420; 435-440; 445-450; 460-490
	HDS-78	170-215
	HDS-76	240-340
HDS-56	HDS-76	
	HDS-77	
HDS-57	HDS-49	
	HDS-47	140-70
HDS-58	HDS-50	
	HDS-49	250-TD
HDS-59	HDS-47	Box #1
	HDS-46	0-TD
	HDS-45	205-230
HDS-60	HDS-45	Duplicate
	HDS-45	Box #1 & 2
	HDS-44	65-100
HDS-61	HDS-44	
	HDS-44	Duplicate
	HDS-43	
HDS-62	HDS-43A	
	HDS-43A	Duplicate
	HDS-42	Duplicate
HDS-63	HDS-42	
	HDS-41	
	HDS-41	Duplicate

Continued . .

Barrel No.	Hole No.	Interval
HDS-64	HDS-40	270-TD
HDS-65	HDS-40	10-270
	HDS-40	Duplicate
HDS-66	HDS-47	525-575
	HDS-50	120-330
	HDS-49	10-130
HDS-67	HDS-39	
HDS-68	HDS-38	Duplicate
HDS-69	S-6	5-422.9
HDS-70	HDS-8	581-792
	HS-9	10-335
HDS-71	HS-9	335-395
	S-11	606-853
HDS-72	HDS-24	607-840.3
	HDS-7A	783-887
HDS-73	HDS-31	Duplicate
	HDS-30	Duplicate
	HDS-34	0-50
	HDS-37	0-75
HDS-74	HDS-21	10-580
HDS-75	HDS-20	10-387
	HDS-21	Duplicate
HDS-76	HDS-22	10-525
HDS-77	HDS-22	Duplicate
	HDS-23 ✓	Duplicate
HDS-78	HDS-18	Duplicate
	HDS-23 ✓	10-370
HDS-79	HDS-24	10-590
HDS-80	HDS-25 ✓	Duplicate
	HDS-20	Duplicate
HDS-81	HDS-19	20-260
	HDS-19	Duplicate
HDS-82	HDS-18	10-420
HDS-83	HDS-17	20-320
	HDS-17	Duplicate
	HDS-15A	Duplicate

continued

Barrel No.	Hole No.	Interval
HDS-84	HDS-16	10-280
	HDS-16	Duplicate
HDS-85	HDS-7A	594-783
	F-2	10-130
HDS-86	HDS-12	Duplicate
	HDS-12	175-240
	HDS-13	30-210
HDS-87	HDS-13	220-340
	HDS-14	10-444
HDS-88	HDS-15	Duplicate
	HDS-15	30-160
	HDS-15A	10-220
HDS-89	HDS-11	320-600
	HDS-12	10-170
HDS-90	HDS-10	Duplicate
	HDS-11	20-310
HDS-91	HDS-10	10-440
HDS-92	HDS-9	20-390
	HDS-9	Duplicate
HDS-93	HDS-8	260-573
HDS-94	HDS-7A	490-570
	HDS-8	10-250
HDS-95	HDS-7	10-83
	HDS-7A	10-290
HDS-96	HDS-7A	300-480
HDS-97	HDS-77	
HDS-98	HDS-76	
HDS-99	HDS-79	
HDS-100	HDS-78	
HDS-101	HDS-80	
HDS-102	HDS-80	
	HDS-79	

Barrel No.	Hole No.	Interval No.
HDS-103	HDS-81	175-500 Missing intervals: 205-220; 225-230; 260-265
	HDS-68	285-290
	HDS-69	155-160 295-300 385-390 410-415
	HDS-80	90-100
HDS-104	HDS-83	0-475 Missing intervals: 110-120; 260-265; 450-455
HDS-105	HDS-82	500-560 Missing intervals: 510-515; 515-520
HDS-106	HDS-82	500-560 Missing intervals: 90-100; 470-475

ASARCO Southwestern Mining Department

June 15, 1984

FILE MEMO

HARDSHELL PROJECT
Central Research Project 3103

Apparently, Harold Stone will inventory and separate the reject samples that are available for the holes and intervals listed on the "Hardshell Project - Zone 3 Intervals For Drill Holes" memo dated June 15, 1984.

From a review of the holes selected and intervals shipped to Central Research, letter, James D. Sell to Dr. M. El Tawil, February 27, 1984, these holes are representative of the Zone 3 mineralized area. The only intervals that do not represent Zone 3 are: HDS-81-A intervals 390-420, and HDS-82 intervals 280-290.

It would appear that the only additional Central Research testing that would be required at this time would be to selectively test several intervals in the five holes not yet tested, according to the May 22, 1984 Progress Report.

David F. Skidmore

DFS/mck
cc: RJKupsch - all w/attach.
TEScartaccini
RLBrown
WLKurtz
HMStone
DECrowell

ASARCO

Southwestern Mining Department

June 15, 1984

FILE MEMO

HARDSHELL PROJECT - Zone-3 Intervals for Drill Holes

Hole No.	From	To	+3 oz (From-to, intervals)	
HS -5	180	330	Except	180-190 208-217 227-233 278-284 299-302 311.5-313
HS -7	126	161	Only	126-130 138-147.5
HS -8	137	207	Only	194-198
HS -9	194	242	Only	197-229
HDS-9	290	390	Only	300-370
HDS-10	290	380	Except	290-300 320-330
HDS-12	50	195	Only	50- 75 155-165
HDS-15	120	160	Only	120-145
HDS-16	120	180	All	
HDS-17	220	240	None	
HDS-18	180	380	Only	180-190, 235-255
HDS-19	110	230	Except	110-120, 205-230
HDS-20	285	375	Only	295-300, 325-360
HDS-22	320	415	Except	350-355, 370-380 390-410

HARDSHELL PROJECT
Page 2

Hole No.	From	To	+3 oz (From-to, intervals)	
HDS-23	200	315	Except	290-315
HDS-25	395	485	Only	395-400, 405-440
HDS-30	360	420	Only	360-365, 385-390
HDS-31	456	553	Only	460-475
HDS-40	400	560	Except	430-435, 460-485 525-560
HDS-41A	0	65	Only	0- 10, 15- 20
HDS-42	0	90	Only	5- 20
HDS-43A	55	85	Only	55- 80
HDS-44	50	90	All	
HDS-45	125	155	Only	125-130
HDS-46	75	120	None	
HDS-47	510	590	Only	510-515, 540-550
HDS-50	410	435	None	
HDS-52	90	215	Except	90- 95
HDS-56	420	455	Except	445-455
HDS-57	245	340	Only	245-275
HDS-58	275	435	Except	425-435
HDS-59	210	335	Only	210-250, 255-275
HDS-60	120	255	Only	120-190, 200-210, 225-250
HDS-61	220	330	All	
HDS-62	220	385	Except	220-225, 365-385
HDS-63	240	410	Only	240-250, 260-310, 320-330
HDS-64	295	465	Except	295-300, 395-405 430-435
HDS-65	125	170	Only	125-130

Hole No.	From	To	+3 Oz (From-to, intervals)	
HDS-66	325	410	Only	325-350
HDS-67	305	440	Only	340-400, 405-410, 415-420
HDS-69	405	475	Only	405-420
HDS-70	505	650	None	
HDS-72	120	210	All	
HDS-73	230	300	Except	260-270, 275-285, 290-300
HDS-74	220	380	Only	230-240, 245-250, 260-270, 295-310, 320-325, 340-360
HDS-75	350	430	Only	355-430
HDS-77	115	155	Only	115-135
HDS-79	370	390	None	
HDS-80	295	435	Only	310-315, 385-400
HDS-81	270	370	Except	365-370
HDS-82	290	500	Only	290-375, 460-490
HDS-83	355	465	Only	360-395, 405-425, 435-450

The following holes did not indicate a zone-3 through the geological logging or stopped short of hitting zone-3.

S- 2	Zone-1 only
S- 3	Zone-1 only
S- 6	Zone-1 only
HDS-13	No Zone-3
HDS-15A	No Zone-3
HDS-68	Zone-1 only
HDS-71	Into Zone-2 only
HDS-78	Zone-1 only
HDS- 21	No Zone-3
HDS- 24	" " "
HDS-38	Zone-1 only
HDS-49	Zone-1 only
HDS-55	Into Zone-2 only

D. F. Skidmore
June 15, 1984

DFS/mkc

ASARCO

Mineral Beneficiation Department

June 19, 1984

File Memorandum: Misc 11A

Subject: Hardshell Drill Hole Samples taken from Drums in Warehouse Yard - June 19, 1984

HDS 20-340
20-335
20-355

HDS 19-170D
19-180D
19-185D
19-200D

HDS 15-135D
15-140D

HDS 44-65
44-70
44-75
44-80
44-85

HDS 45-130

HDS 67-340-345
345-350
350-355
355-360

T. D. Henderson, Jr.

T. D. Henderson, Jr.

TDH/ab

cc: DFSkidmore
WLKurtz
HMStone
DECrowell/File Copy

ASARCO Southwestern Exploration Division

September 28, 1981

To: T. D. Henderson

From: F. R. Koutz

Hermosa Metallurgical Sample
Hardshell Project
Santa Cruz County, Arizona

I have composited a 75 pound metallurgical sample from the Hermosa Mine at the Hardshell Project. This sample is composed of crusher reject material from chip samples cut by F. Michel and D. Martinez in August. The sample should be fairly representative of low-manganese ores such as were mined 100 years ago (4.26 oz Ag/T, 0.79% Pb). I also have a 5 pound sack of higher-grade material (25.7 oz Ag/T, 2.24 % Pb) which can be used as a character sample or for special tests.

We would like to see if you can improve on the 48-55% Ag recovery by cyanidation reported on similar ores from Hermosa (April 1968, report of Proj. M103, EPOTL, H. F. Keeler, Sample No. 3) with some minor additional treatment, possibly to remove deleterious Sb or As. A 31 ton lot of Hermosa ore shipped in 1950 ran: Ag: 41 oz/T, 1.7% Pb, 0.5% Cu, 2.7% Fe + Mn, 59% SiO_2, 3.1% Al_2O_3 0.41% As, 2.8% Sb. The 75 pound sample should be well mixed before use. Please cut out a 5-10 pound representitive sample for possible future mineralogic work. The heads should be assayed for at least Ag, Au, Cu, Pb, Zn, Fe, Mn, Sb, As, Ba, Bi, SiO_2, Al_2O_3.

Much of the silver in Hermosa ores is contained in silver halides: Ag(Br, Cl). A minor amount may be in cryptomelane-group minerals as is found in the main Mn-oxide rich manto: (K, Pb, Ag, Ba) Mn_8O_{16}, but manganese content should be low - less than 1%. A minor amount of the silver may be as silver sulfide in iron oxides as at Rochester or in plumbojarosite-type minerals. Much of the lead is contained in pyromorphite-mimetite: $Pb_5(PO_4, AsO_4)_3Cl$, cerussite: $PbCO_3$ or beudanite-hidalgoite: $Pb(Fe,Al_3)(SO_4)(AsO_4)(OH)$ Bindheimite $Pb_5Sb_2O_6$ (O,OH) has also been identified. Major gangue minerals are orthoclase, quartz, sericite, kaolinite, hematite, and goethite. I am not sure what the magnetitic material reported by Keeler was: possibly an iron or manganese oxide.

Most of the silver halides and lead minerals are closely associated with hematitic clays or goethite-rich former sulfide vugs so I expect that the finer-grind sizes will contain higher values. The silver halides also have a wax-like texture so their recovery may be related to grinding.

Of historical interest is the reported 87-90% Ag recovery by amalgamation with silver bullion 0.998 Fine. There are at least several hundred thousand tons with potential up to 1-2 million tons of shallow Hermosa-type ores in the east Hardshell area and considerable tonnages of low-manganese ores (e.g. samples 1 & 2 of project M103) overlie the manganese-rich Hardshell main manto ores. Perhaps this testing will improve recoveries of low-manganese ores at Hardshell.

F.R. Koutz

F. R. Koutz

FRK/sk
cc: WDPayne
DECrowell

T. D. Henderson September 28, 1981

Hermose Mine (underground)
Metallurgical Samples
Marked: ERM-81-MET

Sample No.	Weight: lbs	Ag: oz/T	Pb %
ERM A-1	9.9	3.03	1.02
A-2	5.4	2.04	0.09
A-4	5.8	2.50	1.02
B-1	6.4	3.54	0.64
B-4	10.7	10.45	1.10
B-5	6.0	9.89	1.02
B-6	6.8	1.36	0.52
BC-1	8.4	4.29	0.68
BC-3	15.8	1.64	0.36
	75.2	4.26	0.79
Composite:	Total	Weighted	Means
ERM B-3	5.3	25.69	2.24

1 sack High-grade character sample

cc: WDPayne
File/DEC/BWA/ARR

ASARCO

Mineral Beneficiation Department

October 30, 1981

Memorandum to: Mr. F. R. Koutz

Subject: Metallurgical Testing of Hermosa Mine Samples

Several cyanide leach tests have been run on the two samples of Hermosa Mine ore which you gave me the end of September. These samples are described in your memorandum of September 28th.

The objective of this test program was to determine (1) the silver extractions attainable by conventional cyanide leaching of fine ground raw ore and (2) possible means of improving the silver extraction.

Introduction:

Leach tests were run on a sample of Hermosa mine ore in 1968 by Mr. H. F. Keeler at the El Paso Ore Testing Laboratory (reported April 1968, Project No. M103). This sample (No. 3 in the report) contained 3.27 oz. Ag per ton. Keeler investigated the effects of lime alkalinity, cyanide solution strength, leach time and fineness of grind on silver extraction by cyanidation of fine ground ore. He concluded that fineness of grind affected silver recovery somewhat, but the other three factors had little effect. He also found that some of the silver is apparently associated with manganese, because a preleach with sulfurous acid to dissolve manganese improved silver extraction by subsequent cyanide leaching. Improvement was from about 53 percent silver extraction without SO_2 preleach to 63 percent with preleach.

Description of Samples:

The larger composite sample on which most of the test work was done (ERM-81), assayed as follows:

oz/T		Percent					
Au	Ag	Mn	SiO_2	Al_2O_3	Total CaO*	Ba	Pb
.008	4.03	0.3	62.6	17.4	0.21	0.10	0.5

Zn	As	Sb	Cu	Fe	Bi
0.07	0.28	0.103	.026	2.3	ND

Sulfide S	Available* $CaCO_3$
0.11	4.6

* Total CaO is a total calcium determination reported as CaO; "Available CaO" is a determination of acid consumption by leaching the sample. It is reported as percent $CaCO_3$. This value is too high in relation to the total CaO to be all due to calcium carbonate.

The smaller higher grade sample (ERM B-3) was assayed only for silver, gold and manganese:

oz/T		Percent
Au	Ag	Mn
.004	23.44	1.5

Three series of cyanide leach tests were run on Sample ERM-81.

The first tests were a grind series to determine the effect of fineness of grind on silver extraction by cyanide leaching. On the basis of Keeler's previous work a cyanide solution strength of 3.0 lbs. NaCN per ton solution was used, along with a rather high lime dosage ($\pm$ 10 lbs. CaO per ton of solution) since lime consumption from previous test work was high. The bottle leaches were agitated for 43 hours at a solution to solids ratio of about 2:1 (33% solids). Results of these tests are shown below. Silver recoveries are based on the silver assay of the heads sample from the lot of ore tested (4.03 oz. Ag per ton) and the individual tailing assays:

Test No.	Grind % Passing 200-Mesh	Leach pH	Tails Assay oz/T Ag	% Ag Extraction	Consumptions lbs/T NaCN	Consumptions lbs/T Ore CaO
1	55.2	12.2	1.68	58.3	0.85	16.4
2	70.5	12.3	1.44	64.3	0.83	16.6
3	81.6	12.3	1.28	68.2	0.94	16.6
4	92.5	12.3	1.16	71.2	1.05	16.8

These results show a steady improvement in silver recovery from 58 to 71 percent as the fineness of grind is increased from 55 to 93 percent passing 200-mesh (74 micron). Cyanide consumptions increased slightly at finer grinds.

The next tests investigated the effects of longer leach time on silver extractions. These used 3.0 lb. NaCN and 10 lb. CaO per ton of leach solution and approximately 33 percent leach solids, the same as tests 1-4. However the leach time was extended to 70 hours. One test (No. 5) used a grind of 81.6% passing 200-mesh and the other (No. 6) was ground to 92.5% passing 200-mesh. Results are shown below:

Test No.	Grind % Passing 200-Mesh	Leach pH	Tails Assay oz/T Ag	% Ag Extraction	Consumptions lbs/T NaCN	Consumptions lbs/T Ore CaO
5	81.6	12.2	0.98	75.7	1.11	17.2
6	92.5	12.3	1.04	74.2	1.13	16.7

Silver extractions were improved in both cases by extending the leach time to 70 hours. At the 81.6% minus 200-mesh grind the recovery increased from 68.2 to 75.7 percent; at 92.5% passing 200-mesh the recovery increased from 71.2% to 74.2%. As would be expected cyanide consumption was also somewhat higher with the longer leach time (1.1 lb. NaCN per ton ore compared to 1.0 lb. at 43 hours).

Further tests were then run to determine what effect various pretreatments or additives during leaching might have on silver recovery. Test L-1 used aeration during agitation with lime for 15 hours as a pretreatment. It is known that some sulfide minerals, particularly those of arsenic and antimony, decompose in alkaline cyanide leach solutions to form reducing agents, which interfere with cyanide leaching be consuming oxygen from the solution. The preaeration treatment should oxidize these compounds and neutralize their harmful effects on the cyanide leach. It might also be possible to achieve this by an oxidizing roast of the ore prior to cyanidation but this was not considered economically feasible for this grade of ore.

Test L-2 used a SO_2-H_2SO_4 preleach (at pH 1.2 for 22 hours) to dissolve manganese. This is the standard method for breaking down refractory manganese-silver minerals to render the silver amenable to cyanidation. Silver is not dissolved by the SO_2 leach. The manganese content of the acid leach solution indicated that most of the Mn in the ore was dissolved by this preleach. After the preleach, the pulp was filtered and washed on the filter to remove the acid manganese leach solution. It was then repulped with water and lime was added to make the pulp alkaline before cyanide leaching.

In test L-3 a cyanide leach was run with addition of lead acetate to the lime-cyanide leach solution. The amount added was equivalent to one lb. of lead per ton of ore. Addition of a soluble lead salt to cyanide leach solutions is a recognized method of combating soluble sulfide minerals which interfere with cyanidation by forming sulfide in solution which precipitates the silver. It is often useful for ores containing As and Sb, and has been found to be beneficial for cyaniding the Rochester ore.

Test L-4 was a standard cyanide test run as a control using the same conditions of grind, cyanide strength, and leach time.

All four of these tests were run in agitated beakers. After pretreatments, cyanide was added, and the cyanide leaches were agitated for 64 hours. The grind used in all four of these tests was 81.6% passing 200-mesh.

Results of these tests are summarized on the following page:

Test No.	Special Treatment	Leach pH	Tails Assay oz/T Ag	% Ag Extracted	Consumptions lbs/T Ore NaCN	CaO
L-1	Aeration with lime 15 hours	11.2	1.20	70.2	4.75	6.5
L-2	Preleach with SO_2-H_2SO_4 22 hours	11.4	0.82	79.6	4.38	10.1*
L-3	Lead acetate to leach, 1 lb. Pb per ton	11.3	1.10	72.7	4.24	6.6
L-4	None	11.3	1.14	71.7	2.92	6.6

* 50% more lime added to this leach to be sure acid leach residue was made alkaline. Therefore CaO consumption was higher.

The only treatment that showed a significant improvement was the SO_2 preleach before cyanidation. This increased the silver extraction from 72 to 80 percent which would indicate that roughly one-third of the silver not dissolved by straight cyanidation is tied up with manganese.

Test on High Grade Sample:

One leach test was run on ERM-B3. It was leached for 70 hours with a solution containing 2.6 lbs. NaCN and 8.7 lbs. CaO per ton at 30% percent solids. The grind was not determined but the grinding time used should have given about 80% passing 200-mesh.

Silver extraction on this sample, assaying 23.44 oz. Ag/T, was 83.4% based on the leach tailing assay of 3.90 oz. Ag per ton.

Cyanide consumption was 2.2 lbs. per ton ore; CaO consumption was 16.2 lbs. per ton.

It was noted that both samples of Hermosa ore were quite sticky, but this higher grade sample was extremely so. It required grinding at lower solids to get the ore out of the mill. Both ore types would present settling or filtration problems in a cyanide leach plant.

Conclusions:

The Hermosa Mine sample ERM-81 gave 72 percent silver extraction using a 64-hour leach with 3.0 lb. NaCN per ton solution.

The only pretreatment that significantly improved recovery (to 80%) was an SO_2 preleach.

Both finer grinding and longer leach times improve silver extraction, grinding having the greater effect.

T. D. Henderson

T. D. Henderson, Jr.

TDH/ab

ASARCO

Mineral Beneficiation Department

November 4, 1981

File Memorandum: Misc 11A

Subject: Discrepancies in Calculated Heads and Silver Recoveries of Hermosa Mine Ore Leach Tests

During the recently reported (memorandum TDH to F. R. Koutz, October 30, 1981) cyanide leach tests on Hermosa Mine samples, there were serious differences between assay heads and heads calculated from leach residue and solution weights and silver assays. I originally intended to calculate heads on all tests and base silver recoveries on the calculated heads. The heads sample and leach residues were fire assayed at Mountain States. The first set of leach solutions (Tests 1-4) were assayed for silver by AA at Copper States. When these assays were used the calculated heads were consistently lower than the assay heads. Therefore the solutions were reassayed by AA at Mountain States, resulting in much higher silver values and calculated heads which were higher then the assay heads. It was for this reason that the leach residue and heads fire assays were used to determine silver recoveries.

There is insufficient sample left to run a fire assay (Chiddy method or similar type) on the solutions. On future tests this will be done to compare results with direct AA silver analyses of the solutions. Also both sets of solution assays will be used along with leach residue fire assays, to calculate heads and compare these with fire assays of the heads sample. Apparently the direct AA assays of solutions for silver is not giving reliable results.

As a further check I have requested Hazen to send the heads sample and residues from tests 1-4 to Skyline for reassay (by fire assay) to check Mountain States original fire assay results.

Assays, calculated heads and silver recoveries by the various sets of data are shown in the attached table.

If we are not able to get good checks on calculated vs. assay heads in future silver or gold leach test work using local assay lab results, I would recommend that test products be sent either to the Asarco Umpire Lab in El Paso or the Central Research Department for analysis.

T D Henderson

T. D. Henderson, Jr.

TDH/ab
Attachment (table)

cc: FRKoutz
WDPayne
File/DEC/ARR/BWA

Hermosa Sample Leach Tests
Comparison of Assays and Calculated Heads
by Different Assay Lab Results

Test No.	Ratio Solution to Solids	Mountain States Tails Assay* oz Ag/T	Copper State Solution** Assay oz/T	Copper State Calc. Heads oz/T	Mountain States Solution** Assays oz/T	Mountain States Calc. Heads oz/T
1	2.033	1.68	.916	3.54	1.458	4.64
2	2.078	1.44	1.073	3.67	2.100	5.80
3	2.038	1.28	.962	3.24	1.633	4.61
4	2.050	1.16	.878	2.96	1.429	4.09
Heads Sample		4.03*				

* All assays of solid samples were fire assays run by Mountain States.

** All solutions silver assays were direct AA assays of pregnant solutions.

Comparison of Silver Recoveries
from Different Sets of Assay Data

Test No.	MS Tails Assays, CS Solution Assays	MS Tails Assays MS Solution Assays	MS Tails Assays* MS Heads Assay
1	52.6	63.8	58.3
2	60.8	75.1	64.3
3	60.5	72.2	68.2
4	60.8	71.6	71.2

* These results were reported in metallurgical report.

ASARCO

Southwestern Exploration Division

February 8, 1984

R. L. Brown
New York Office

Rotary Cuttings Rejects
Hardshell Samples
Santa Cruz County, AZ

Rotary cuttings rejects have been separated out for Hardshell drill hole numbers 60, 62, 67, 72, 73, 77, 80, 81, 82, and 83.

The sample interval, weight of sample, and the silver assay for each hole is listed on 4 of the six pages telecopied to you.

The Hardshell drilling map is the fifth page and shows an outline of the +5 ounce silver manto as generally expressed by Pickard on his reserve estimate.

Please advise on the person-place to send these samples which are the first run of the metallurgical research.

Please advise on further samples which are desired for continued research.

Also to be forwarded to Central Research will be a copy of the available SWED assays for these intervals. All samples were assayed for silver but not all for copper, lead, zinc, manganese, and silica.

The Mission Unit X-Ray Fluorescence data being accumulated by Al Raihl is presently available for hole numbers 60, 72, 73, 80, 82, and 83.

Jim
James D. Sell

JDS/cg

Al_2O_3
SiO_2
S
CaO —
Ti
V_2O_5
Mn —
Fe
Cu —
Zn —
Mo
Sb
Ba
Pb —

Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-60	130-135	11	4.14
	135-140	6	6.13
	140-145	10	5.68
	145-150	9	5.62
	150-155	9	3.78
	155-160	4	4.61
	160-165	10	6.03
	> 170-175	10½	4.75
	175-180	10	4.55
	> 185-190	5 84#	3.22
HDS-62	260-265	7½	3.39
	> 285-290	3	4.70
	290-295	3	3.38
	295-300	2	4.74
	300-305	3	6.67
	305-310	5	6.90
	310-315	3	6.82
	315-320	2	4.69
	320-325	5½	6.31
	325-330	2	6.29
	330-335	6	6.91
	335-340	5½	5.55
	340-345	5½	3.81
	345-350	2½	5.20
	350-355	5	6.61
	355-360	5 65#	4.86
HDS-67	380-385	12 12#	6.31

> = gap in sequence.

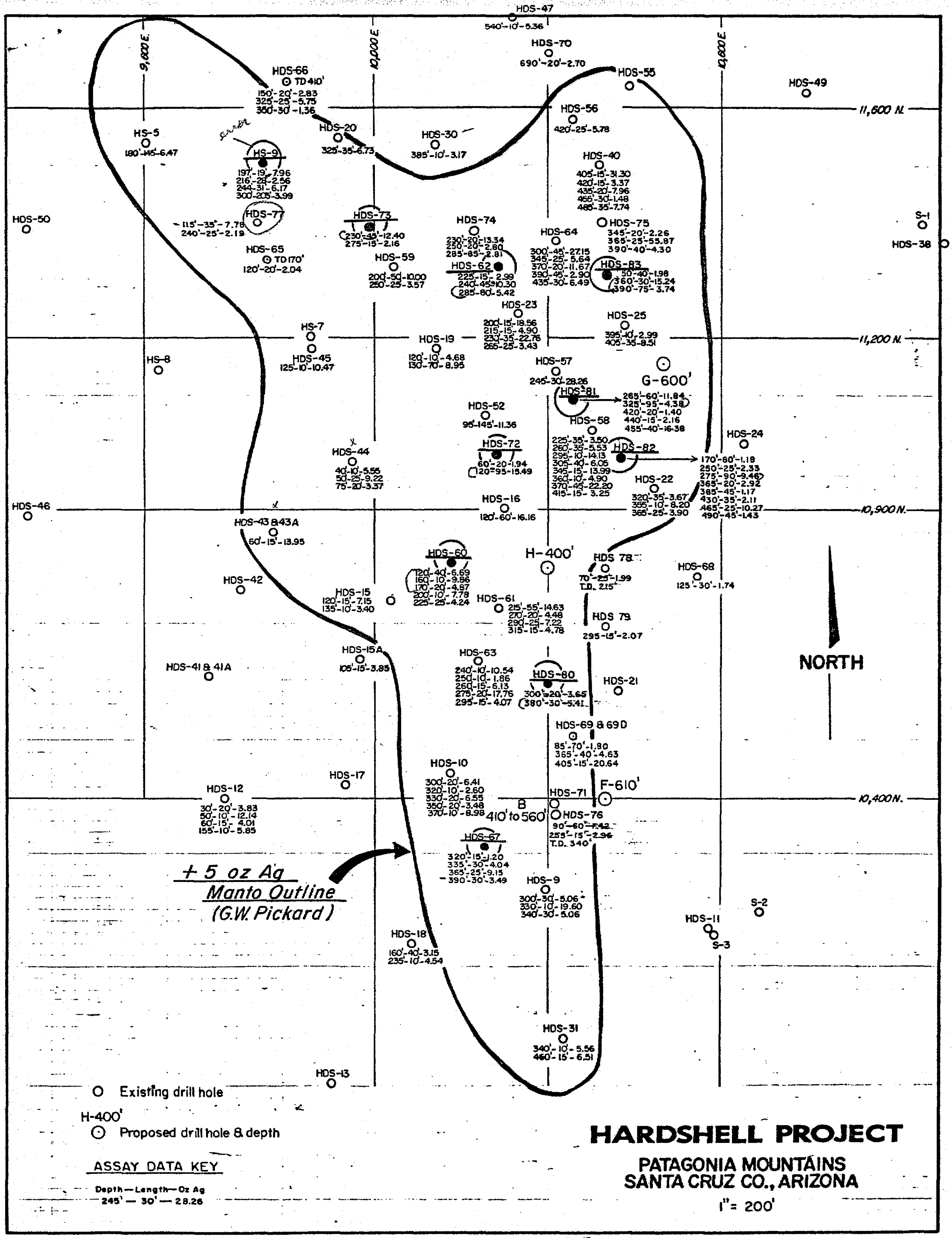
Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-72	120-125	5	62.74
	125-130	5½	52.26
	130-135	3	8.63
	135-140	3	3.57
	140-145	3½	7.94
	145-150	4	9.70
	150-155	2	6.90
	155-160	3	18.46
	160-165	4½	18.08
	165-170	3	15.57
	170-175	8	5.89
	175-180	11 55#	11.11
HDS-73	230-235	5	9.25
	235-240	5	22.22
	240-245	7½	10.75
	245-250	3½	23.22
	250-255	5	12.36
	255-260	6	17.57
	260-265	9	2.64
	265-270	10	2.72
	270-275	9	10.83
	275-280	9½ 69#	1.61
HDS-77	120-125	16	27.92
	> 145-150	12	2.07
HDS-80	380-385	14	2.04
	385-390	14½	15.15
	390-395	13	8.35
	395-400	13	3.35
	400-405	11½	1.73

Cont. on page 3

> = gap in sequence.

Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-80 Cont.	405-410	10	1.82
	410-415	12½	0.83
	415-420	11	0.86
	420-425	10½	0.68
	425-430	13½ 123#	0.30
HDS-81-A	390-395	8	9.54
	395-400	11½	5.14
	400-405	11½	4.63
	405-410	14	3.13
	410-415	12	3.69
	415-420	7 64#	2.11
HDS-81-B	320-325	11	8.91
	325-330	7½	6.56
	330-335	10½	6.52
	335-340	5 34#	3.91
HDS-82	280-285	12	4.91
	285-290	12	5.04
	290-295	6	8.80
	295-300	5½	13.65
	300-305	9½	10.22
	305-310	9½	4.91
	310-315	11	6.30
	315-320	11½	11.33
	320-325	13	11.61
	325-330	10	18.79
	330-335	11	5.99
	335-340	8	8.86
	340-345	6½	10.50
	345-350	9½	16.25
	350-355	10	12.18
	355-360	6½	10.13
	360-365	8 159#	6.07

Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-83	365-370	10	26.05
	370-375	8	23.93
	375-380	7½	12.44
	380-385	7	7.55
	385-390	13	14.30
	390-395	10	3.57
	395-400	11	2.82
	400-405	4	1.98
	405-410	9½	3.55
	410-415	6½	7.34
	415-420	8	4.83
	420-425	4 98#	3.18



HDS-47
540'-10'-5.36
HDS-70
690'-20'-2.70
9,600 E.
10,000 E.
10,600 E.
HDS-66
TD 410'
150'-20'-2.83
325-25-5.75
350-30-1.36
HDS-55
HDS-49
11,600 N.
HDS-56
420'-25'-5.78
HS-5
180'-145'-6.47
HDS-20
325-35-6.73
HDS-30
385'-10'-3.17
HS-9
197-19-7.96
216-28-2.56
244-31-6.17
300-205-3.99
HDS-40
405-15-31.30
420-15-3.37
435-20-7.96
465-30-1.48
485-35-7.74
HDS-50
HDS-77
115'-35'-7.76
240'-25'-2.19
HDS-73
230'-45'-12.40
275'-15'-2.16
HDS-74
230-20-13.34
250-20-2.80
285-85-2.81
HDS-75
345-20-2.26
365-25-55.87
390-40-4.30
S-1
HDS-38
HDS-64
300-45-27.15
345-25-5.64
370-20-11.67
390-45-2.90
435-30-6.49
HDS-65
TD 170'
120'-20'-2.04
HDS-59
200-50-10.00
250-25-3.57
HDS-62
225-15-2.99
240-45-10.30
285-80-5.42
HDS-83
350-40-1.98
360-30-15.24
390-75-3.74
HDS-23
200-15-18.56
215-15-4.90
230-35-22.76
265-25-3.43
HDS-25
395-10-2.99
405-35-8.51
HS-7
HDS-45
125-10-10.47
HS-8
HDS-19
120'-10'-4.68
130-70-8.95
11,200 N.
HDS-57
245-30-28.26
G-600'
HDS-81
265'-60'-11.84
325-95-4.38
420-20-1.40
440-15-2.16
455-40-16.38
HDS-52
95-145'-11.36
HDS-58
225-35-3.50
260-35-5.53
295-10-14.13
305-40-6.06
345-15-13.99
360-10-4.90
370-45-22.20
415-15-3.25
HDS-82
HDS-24
170'-80'-1.18
250'-25'-2.33
275'-90'-9.46
365'-20'-2.92
385'-45'-1.17
430'-35'-2.11
465'-25'-10.27
490'-45'-1.43
HDS-44
40-10-5.55
50-25-9.22
75-20-3.37
HDS-72
60'-20'-1.94
120'-95-15.49
HDS-22
320-35-3.67
355-10-8.20
365-25-3.90
HDS-46
HDS-16
120'-60'-16.16
10,900 N.
HDS-43 & 43A
60'-15'-13.95
HDS-60
120-40-6.69
160-10-9.86
170-20-4.87
200-10-7.78
225-25-4.24
H-400'
HDS 78
70'-25'-1.99
T.D. 215'
HDS-68
125'-30'-1.74
HDS-42
HDS-15
120-15-7.15
135-10-3.40
HDS-61
215'-55'-14.63
270-20-4.48
290-25-7.22
315-15-4.78
HDS 79
295'-15'-2.07
HDS-15A
105'-15'-3.85
HDS-63
240-10-10.54
250-10-1.86
260-15-6.13
275-20-17.76
295-15-4.07
HDS-80
300'-20-3.65
380'-30'-5.41
HDS-21
NORTH
HDS-41 & 41A
HDS-69 & 69D
85'-70'-1.80
365'-40'-4.63
405'-15'-20.64
HDS-10
300-20-6.41
320-10-2.60
330-20-6.55
350-20-3.48
370-10-8.98
HDS-17
HDS-12
30'-20'-3.83
50'-10'-12.14
60'-15'-4.01
155'-10'-5.85
HDS-71
F-610'
B
410' to 560'
HDS-76
90'-60'-7.42
255'-15'-2.96
T.D. 340'
10,400 N.
HDS-67
320'-15'-1.20
335'-30'-4.04
365'-25'-9.15
390'-30'-3.49
+ 5 oz Ag
Manto Outline
(G.W. Pickard)
HDS-9
300-30-5.06
330-10-19.60
340-30-5.06
S-2
HDS-11
S-3
HDS-18
160'-40'-3.15
235'-10'-4.54
HDS-31
340'-10'-5.56
460'-15'-6.51
HDS-13
Existing drill hole
H-400'
Proposed drill hole & depth
ASSAY DATA KEY
Depth—Length—Oz Ag
245' — 30' — 28.26
HARDSHELL PROJECT
PATAGONIA MOUNTAINS
SANTA CRUZ CO., ARIZONA
1"= 200'

JDS

ASARCO

Mineral Beneficiation Department

July 6, 1984

File Memorandum: Misc 11A

Subject: Kerley Process and Standard Cyanide Leach Tests of Hardshell Ore Composite

A composite was made from nineteen drill hole intervals of Hardshell ore representing six holes (HDS 15, 19, 20, 44, 45 and 67). All of the intervals were from intercepts assaying more than 3 opt Ag in Zone 3. Duplicate heads samples were cut from the composite and assayed. Results were as follows:

oz/T			
Au	Ag	%Mn	%Cu
.013*	6.36*	10.6	0.17

* Average of one assay on each heads sample.

Grinding tests were run by CEC on 500-gram charges of 10-mesh composite. A 20-minute grind gave a product size of 1.5% +65 and 70.1% -200 mesh, and this grind was used in the leach tests.

Two tests were run, a standard cyanide leach on the raw ore and a leach using the Kerley process of ammonium thiosulfate-ammonium sulfite with a copper catalyst.

Standard Cyanide Leach:

Ore ground to 70 percent passing 200-mesh was leached at room temperature (20°C) and 34 percent solids with a leach solution containing 4.1 lbs. NaCN per ton and lime added to a pH of 11.5. Leaching was done with agitation and addition of 1 cu. ft. per hour of air for 24 hours. At the end of the leach the pH was 10.5.

Leach pulp was filtered and the filter cake was given two water washes of 100 ml. each. Preg and wash solution assayed 0.199 opt Ag and tails assayed 5.99 opt Ag. On this basis the calculated heads assay was 6.397 opt Ag and the silver extraction was 6.4 percent.

Calculated cyanide consumption was 4.1 lbs. NaCN per ton ore; lime consumption was 10.9 lbs. (100% CaO) per ton ore.

Kerley Leach Process:

A 500-gram charge of ore was ground to 70 percent passing 200-mesh. The ground ore was washed into a 2000 ml. beaker, allowed to settle and decanted to give an initial pulp weight of 1306 grams (500 grams solids and 806 grams water). To this was added 170 grams at ammonium sulfite, 150 grams of ammonium thiosulfate and 16 grams of $CuSO_4.5H_2O$. This made a leach solution of the following composition by weight:

Ammonium Sulfite	14.9%
Ammonium Thiosulfate	13.1%
Copper	0.35%

The pH of the leach solution was 8.8 so it was not necessary to add ammonium hydroxide. The pulp was heated with agitation to 53°C and leaching was continued for five hours at temperatures ranging from 51-54°C. During this time the pH of the solution decreased from 8.8 to 8.0 at the end of the five-hour leach.

The pulp was filtered and the leach tails given two water washes of 100 ml. each. The preg and wash solution contained 0.718 opt Ag and 1.08% Mn. An SO_3 analysis showed 0.55 mg. per liter of sulfite ion remaining. This assay is probably low in view of the weight of manganese dissolved during the leach. The preg and wash solution contained 12.9 grams of Mn. This should have consumed 54.6 grams of ammonium sulfite compared to 170 g. added to the leach solution, leaving a residual SO_3 content of 6.7 percent. The leach tail assayed 4.66 opt Ag and 9.69% Mn.

On the basis of these assays the calculated head silver assay was 6.159 opt and the silver extraction was 27.8. The calculated head for manganese was 11.82% Mn and manganese extraction by the leach was 21.8 percent.

Conclusions:

This composite of Hardshell ore was refractory to cyanidation. A standard cyanide leach for 24 hours gave only 6.4 percent silver extraction.

The Kerley process leach at 50-55°C for five hours gave only 27.8 percent silver extraction which agrees pretty much with previous Kerley process leaches done on Hardshell ore at Central Research (12.5-30.8 percent silver extractions).

T. D. Henderson, Jr.

T. D. Henderson, Jr.

TDH/ab
Attachment

cc: WLKurtz, with attach.
DFSkidmore, " "
DECrowell/File

Metallurgical Calculations

Cyanide Leach:

Tons P&W per ton feed = $\frac{1032.1}{504.8}$ = 2.045

Silver content of P&W = 2.045 x 0.199 oz/T = 0.407 oz.

Tons tails per ton feed = 1.0

Silver content of tails = 1 x 5.99 = 5.99

Total = 6.397 oz

Silver extraction = $\frac{100 \times .407}{6.397}$ = 6.4%

Kerley Process Leach:

Tons P&W per ton feed = $\frac{1193.2}{500}$ = 2.386

Tons tails per ton feed = $\frac{477}{500}$ = 0.954

Assays

Product	Weight	opt Ag	%Mn	Contents Ag	Contents Mn	Distribution Ag	Distribution Mn
P&W	2.386	.718	1.08	1.713	.0258	27.8	21.8
Leach Tails	0.954	4.66	9.69	4.446	.0924	72.2	78.2
Calc Heads				6.159	11.82%	100.0	100.0

TO: ASARCO
P.O. BOX 5747
Tucson, AZ 85703

ATTN: TOM HENDERSON

MINERAL
JUL 6 1984
BENEFICIATION DEPT

DATE: 6/29/84

REPORT NO: 513

84-451

ASSAY REPORT

CEC CONTROL NO.	CLIENT SAMPLE NO.	DESCRIPTION	ASSAY Ag T.Oz/t	Mn %	NaCn Lb/ton	CaO Lb/ton	SO_3 Mg/l	Wt g	pH
6165	HS-1	pregnant solution	0.199	-	1.85	0.10	-	1032.1	10.50
6166	HS-1	tails	5.99	-	-	-	-	504.8	-
6167	HS-2	pregnant solution	0.718	1.08	-	-	0.55	1193.2	6.90
6168	HS-2	tails	4.66	9.69	-	-	-	477.0	-

APPROVED BY: R. Nelson / lm

P.O. BOX 36446
TUCSON ARIZONA 85740

Cimetta Engineering & Construction Co., Inc.

(602) 297-7231

TO: ASARCO Incorporated
P. O. Box 5747
Tucson, AZ 85703

84-451

MINERAL
JUL 5 1984
BENEFICIATION DEPT

DATE: 6/22/84

REPORT NO: 512

ASSAY REPORT

CEC CONTROL NO.	CLIENT SAMPLE NO.	DESCRIPTION	ASSAY Au T.Oz/T	Ag T.Oz/T	Mn %	Cu %			
6163 1	x	Leach head	0.009	6.39	13.4	0.17			
6163 2	x	Leach head	0.017	6.34					
		Check assay			10.6				

x Sample run in duplicate

APPROVED BY: ____________

6701 S. WILMOT RD.
TUCSON, ARIZONA 85706

Cimetta Engineering & Construction Co., Inc.

(602) 889-8220

DATE: 6/22/84

NAME:

[illegible]

SAMPLE: ASARCO-1

PROJECT: 84-431

Wet SCREEN ANALYSIS					
SCREEN SIZE	WEIGHT RETAINED	PERCENT RETAINED	CUMULATIVE PERCENT RETAINED	CUMULATIVE PERCENT PASSING	
+65	41.5	8.3	8.3	91.7	
+100	39.5	7.9	16.2	75.5	
+150	62.1	12.4	28.6	46.9	
+200	68.5	13.7	42.3	4.6	
-200	288.4	57.7	100	—	
Tot	500.0	100%	—	—	

ball charge = 9626 g

Cimetta Engineering & Construction Co., Inc.

20 min.

DATE: 6/22/84

NAME:

SAMPLE: ASARCO-[illegible]

PROJECT: 84-151

Wet SCREEN ANALYSIS

SCREEN SIZE	WEIGHT RETAINED	PERCENT RETAINED	CUMULATIVE PERCENT RETAINED	CUMULATIVE PERCENT PASSING	
+65	7.7	1.5	1.5	98.5	
+100	20.4	4.1	5.6	94.4	
+150	45.9	9.2	14.8	85.2	
+200	75.7	15.1	29.9	70.1	
-200	350.3	70.1	100.0	—	
total	500	100	—	—	

ball mill charge = 9626g

Cimella Engineering & Construction Co., Inc.

WPK J. D. Sell

JDS

ASARCO

Central Research Department
South Plainfield, N.J. 07080

July 6, 1984
Ref: 3103

Dr. V. Kudryk
B U I L D I N G

Hardshell Test Work

Some problem areas have been encountered in the on-going reduction roast-cyanide leach test program. High silver contents of leach residues from ore samples of very high grade (30-75 oz/t) are being experienced. Although silver extractions exceeding 80% are being obtained from these samples, the silver contents of the leach residues remain unacceptably high (7-15 oz/t). Electron microprobe examination of the high-silver leach residues and a comparison of total vs. non-refractory silver analyses indicate that most of the silver is contained in the manganese minerals and not encapsulated in the silica. This leads to the conclusion that the reduction-roast and/or cyanide leach conditions for those samples still have to be optimized.

The test program has so far consisted in running the samples obtained from the Exploration Department under a single set of conditions; namely, reduction roasting with propane at 550°C for 20 minutes followed by leaching at 33% solids in 5 g/l NaCN solution for 48 hours. Those are the optimum conditions for the Upper Manto sample used in past studies. While those conditions give very favorable results with most of the samples being tested, some optimization work appears to be necessary with the exceptionally high grade samples.

Factors that may be affecting silver extraction from high grade samples include roasting time and temperature, particle size and silver concentration limitations in solution; i.e., at high silver concentrations in solution the leaching rate may be adversely affected. This can be rectified by leaching at lower percent solids or using multistage leach techniques.

From the standpoint of plant design, it has so far been assumed that both preheating and reduction would be carried out in an indirect fired rotary kiln. Significant energy savings could be realized, however, if it were feasible to preheat the ore in a direct fired kiln then transfer the hot ore to the indirect fired kiln for reduction and cooling. Test work will be required in order to determine the feasibility of this approach.

RECEIVED

JUL 9 1984

EXPLORATION DEPARTMENT

In light of the large number of samples that must be treated in this test program it would be highly desirable to prepare composites of samples with chemical or mineralogical similarities or based on an established mining plan. This would save a great deal of time in arriving at the optimum conditions for each ore type or zone.

It will still be necessary to test the intervals from each hole separately. However, more useful information would be gained by testing each sample under the conditions that were arrived at for its particular category from the optimization work done on the composites.

M. El Tawil

M. El Tawil

MET/ds

cc: R. L. Brown
D. E. Crowell
F. T. Graybeal
R. J. Kupsch
T. C. Osborne
W. P. Roe
T. E. Scartaccini
J. D. Sell

ASARCO

Southwestern Exploration Division

~~WLK~~ JDS

June 26, 1984

To: J. D. Sell

From: F. R. Koutz

Central Research-Hardshell
Assay Comparisons
Hardshell Project
Santa Cruz County, AZ

W. L. Kurtz passed a copy to me of M. El Tawil's note of June 11 to F. T. Graybeal, noting 4 Ag assay values in the 8-28 opt range that were 15-60% lower in our values than the check samples sent to El Paso. This is not surprising since they are not assaying the same sample. I would not trust what crusher reject samples that remain after shipping, multiple handling and splitting numerous times for previous metallurgical samples to provide a replicate assay of the original pulp.

I agree that it would be a good idea to check assay the higher grade Ag intervals but the pulps rather than old rejects should be used. You will note the rather high (at least these days) Au assays which itself is a reason for a reassay program. I have spoken to D. F. Skidmore and apparently a Ag-Au check assay program will take place in the near future.

You also might note that I did a check assay program on composite intervals in 1980 (April 10, 1981 memo) for Au and Ag after American Analytical provided us with a number of high Au assays on HDS 81, 82 and 83. The Ag values were quite similar between AARL and Hunter Labs (Reno).

As mentioned to you previously I would like to run the previous Hermosa area drilling and underground and surface sampling pulps for Au as soon as someone comes up with the assay money. The Au content may add considerably to the Ag heap leach value of the low Mn oxide Hermosa mineralization.

F. R. Koutz

FRK/cg

cc: DEC/ARR

Need to check exactly what Tunil assayed — he mentioned screening the samples. Also assay method.
Supposedly FTG checking

Make sure we get this resolved.

May want to check our pulps

ASARCO

Central Research Department
South Plainfield, N.J. 07080

May 22, 1984
Ref: 3103

Dr. V. Kudryk
B U I L D I N G

Evaluation of Hardshell Drill Samples
A Progress Report

Rotary drill cuttings from the Hardshell deposit were received at Central Research on March 7, 1984. Sixty of the 5-foot interval samples assay 5 oz/t silver or more. These are being subjected to reduction roasting-cyanidation to determine the quantity of silver that can be extracted from the ore using the reduction roasting-cyanidation process.

Reduction of the - 1/2 inch ore is carried out in an indirectly heated tube furnace in the presence of propane at 550°C for 20 minutes. The total contact time with propane is 75 minutes; 55 minutes for heat-up from ambient temperature, then maintaining 550°C for 20 minutes. The roasted ore is then cooled in an inert nitrogen atmosphere to prevent reoxidation. This is followed by dry grinding the ore to -65 mesh and leaching with sodium cyanide solution containing 5 g/l NaCN. Silver extractions are calculated from Ag assays of the pregnant solutions and leach residues.

Results from 15 of the five-foot drill samples from holes HDS-60, HDS-77, HDS-80, HDS-82 and HDS-83 are given in Table I.

The analytical results available at this time indicate the following:

1. The silver assays of most of the samples, according to assays performed at Central Research, are substantially higher than the assays reported by the Exploration Department (see Table II). This raises a question about boarder-line samples which are reported to contain 4-5 oz/t Ag. Those will be reassayed at Central Research and the ones that show 5 oz/t will be processed.

2. Approximately 72-88 % of the silver is extracted from the ore using the 550°C-20 min. propane reduction process followed by cyanidation.

3. There are substantial variations in the quantity of silver remaining in the leach residues, ranging from 0.99 to 7.32 oz/t. Available data indicate that the quantity of unextractable silver increases with increasing silver assays of the ore.

4. There was little or no difference in silver extraction between leach times of 24 and 48 hours. All leaches were carried out for 48 hours with intermediate solution samples taken at 4 and 24 hours.

5. An increase in reduction time from 20 to 40 minutes resulted in no improvement in recovery. An increase in reduction temperature from 550 to 675°C resulted in some improvement in recovery. In the case of sample

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MAY 29 1984

EXPLORATION DEPARTMENT

HDS-77 (120-125), the increase in temperature reduced the residue assay from 7.32 to 5.55 oz/t. This will be further investigated at the end of this test program. Also, leaching tests on -1/2 inch roasted ore will be conducted without prior grinding. Previous tests on upper and lower manto and higher grade ores have revealed that leaching of the -1/2 inch ore gives the same Ag extraction as leaching of the ground ore, but longer leaching times are required.

V. Puskar

V. Puskar

M. El Tawil

M. El Tawil

VP/MET/ds

Encs.

cc: R.L. Brown
D.E. Crowell
F.T. Graybeal
W.P. Roe
J.D. Sell

Table I

Silver Extraction from Various Hardshell Samples

Roast Conditions:

Particle size	- 1/2 inch	Temp.	550^oC
Time at Temp.	20 min.	Red. Gas	Propane

Leach Conditions:

Particle Size	- 65 mesh	% Solids	25
Sol. strength	5 g/l NaCN	Leach time	48 hours

Hole	Footage	Reported Assays		Results of Cyanide Leading			
		Ag oz/t	Mn %	Calc.Hd oz/t	Residue oz/t	Ag Extraction oz/t	Ag Extraction %
HDS-60	135-140	6.13	9.0	6.85	1.9	4.95	72.3
	140-145	5.68	10.7	5.93	1.43	4.50	75.9
	145-150	5.62	10.1	5.99	1.55	4.44	74.1
	160-165	6.03	19.2	6.72	1.26	5.46	81.3
HDS-77	120-125	27.92	14.3	37.95	7.32	30.63	80.7
HDS-80	385-390	15.15	25.0	26.71	4.70	22.01	82.4
	390-395	8.35	14.4	13.73	2.37	11.36	82.8
HDS-82	290-295	8.80	6.0	12.60	2.19	10.41	82.5
HDS-83	365-370	26.05	23.0	32.62	4.30	28.32	86.8
	370-375	23.93	27.7	30.09	3.42	26.67	88.6
	375-380	12.44	27.2	17.03	2.54	14.49	85.1
	380-385	7.55	26.5	10.69	1.99	8.70	81.4
	385-390	14.30	28.1	20.45	3.27	17.18	84.0
	410-415	7.34	27.6	8.58	1.61	6.97	81.3
	415-420	4.83	22.4	5.85	0.99	4.86	83.2

Table II

Assay Comparisons for Selected Hardshell Samples

Hole	Interval	Silver Assay, oz/t	
		Exploration Dept.	Central Research
HDS-60	145-150	5.62	6.25
HDS-60	160-165	6.03	7.13
HDS-77	120-125	27.92	35.9
HDS-80	385-390	15.15	25.4
HDS-80	390-395	8.35	12.7
HDS-83	365-370	26.05	30.0

ASARCO

Exploration Department
Western USA

June 13, 1984

Note to Carol

Please get in touch with Harold Stone and tell him that he will need to work on Hardshell samples next week. He should be able to do this and also take care of Superior East drilling.

We will need the Hardshell information--his instructions will come from Dave Skidmore--by next Thursday night.

W. L. Kurtz

WLK/cg

xc: DFSkidmore
JDSell

JDS—
I contacted HMS. He sees no problems. Will come in office on June 18 or 19 & do as Skidmore wants.

ASARCO

Mineral Beneficiation Department

July 12, 1984

File Memorandum: Misc 11A

Subject: Hardshell Zone 3 Composite

The 10-mesh reject of a composite of Hardshell Zone 3 ore is stored at the Ventura Warehouse in a white 5-gallon pail marked "Hardshell Zone 3 Composite June 1984". This was the composite made up from nineteen drill hole intervals in six holes. The test work using the Kerley process vs. cyanidation (ref. TDH memo of July 6, 1984) was done on this sample which assayed:

oz/T			
Au	Ag	% Mn	% Cu
.013	6.36	10.6	0.17

It is a good sample of refractory Hardshell ore. Standard cyanide leaching (4 lb. NaCN/T solution, 24 hours, 70% passing 200 mesh grind) gave only 6 percent silver extraction.

There are 33 plastic bags each containing about 500 grams of 10-mesh ore (16.5 Kg. total).

T. D. Henderson Jr.

T. D. Henderson, Jr.

TDH/ab

cc: WLKurtz
DFSkidmore
File/DEC/ARR

xc: JDS
FRK

ASARCO

Exploration Department
Western USA

March 6, 1984

R. L. Brown
New York Office

Hardshell Metallurgy

Mr. Sell has verbally informed Mr. Tawil to conduct tests only on those 5' samples that contain 5 ounces or more silver.

Mr. Sell will also determine what other rejects containing +5 ounces are available.

W. L. Kurtz

W. L. Kurtz

WLK/cg

cc: M. Tawil
J. D. Sell

JDS

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

March 2, 1984

Mr. J. D. Sell, Manager
Southwestern Exploration Dept.
Tucson, Arizona

Hardshell Metallurgical Samples
Arizona

Dear Mr. Sell:

Your letter of February 27th to Dr. El Tawil indicates that all samples listed on pages 1-4 will be sent to Central Research. There are approximately 100 samples listed and at one sample per day it will take about 100 days to complete the work. I note that at least 20 of these samples are significantly below the 5 oz. Ag cut-off utilized by Mr. Pickard in his ore reserve study and that most or all of these samples are in continuous zones of low grade mineralization. I question whether these low grade samples should be evaluated at this time and suggest that samples from other drill holes, including some outlying holes such as HDS-40, 44, 56, HS-5, and some of the other interspaced intersections might not be better choices for this rather extensive metallurgical program.

Please discuss this with Mr. Kurtz and if you agree, advise Dr. El Tawil to defer work on the low grade isolated samples at the present time. Also, I suggest that you contact Dr. El Tawil every month or so to determine his progress and whether additional samples are required, rather than wait for him to advise you.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

cc: W. L. Kurtz

RECEIVED
MAR - 5 1984
S. W. U. S. EXPL. DIV.

JDS

FROM: J. D. SELL 3/5/84

TO: F T Grayhead

Hardshell Metal.

Your note of 3/2 had been verbally passed on to me by WLK and I called May & ~~[illegible]~~ informed him not to run anything less than 5 oz — but to hold all til job is finished.

Will get other samples as the work gets going & they (Central Research) see the need.

Thanks.

Jim

(201) 756-4800

March 2, 1984 JDS

~~JDS~~ → WLK
Tucson Office

Hardshell

You should call Max Tavel and tell him That we do not want ~~any sam~~ to run any samples That assay less than ~~four~~ five ounces. If necessary ~~He~~ can combine two adjacent samples to get enough weight for the kiln.

You should have a search made for any other five foot samples that assay plus five ounces and send them to Central Research.

WLK

cc FTGraybeal

3/21 Telephone to Max. Samples have not arrived, but they will run only ~~the~~ plus 5 oz runs at present. Will hold all pulps the until further notice.

Jim

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

March 2, 1984

Dr. M. El Tawil
Section Head, Mineral Science
Central Research Department

Hardshell Metallurgy

Dear Dr. El Tawil:

Individual 5' drill samples from the Hardshell deposit are being forwarded to you from the Southwestern Exploration Division by Mr. J. D. Sell. Some of the intervals are relatively low grade (less than about 4 oz. Ag) and it is questionable whether reduction roast tests should be performed on these samples. I have asked Mr. Sell and Mr. Kurtz to consider whether only the higher grade samples should be tested and they will advise you.

I also have your memo of February 29th regarding the reduction-roast process. My review of your previous summary of this work indicated that there was a background of unrecoverable silver in the range of 0.7-2.0 oz. Ag which had no relationship to position within the deposit. I concluded that recoveries were simply a function of grade, that there is only one ore type, and reference to position of mineralization in upper or lower manto areas was irrelevant. This new test program should further clarify these points.

I also note in your memo of February 29th that you estimated capital costs for a heap leach plant using the Alligator Ridge model. These costs are higher by 2-3x (in constant dollars on per ton basis) than any other large or small heap leach operation built in the Western United States over the past 7 years. I realize that your estimate was only approximate and subject to major revision, but I anticipate Asarco would substantially underrun the costs incurred at Alligator Ridge.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

RECEIVED
MAR - 5 1984
S. W. U. S. EXPL. DIV.

cc: W. L. Kurtz w/att
J. D. Sell

F. T. G.

MAR 2 1984

ASARCO

Central Research Department
South Plainfield, N.J. 07080

RECEIVED

MAR 2 1984

EXPLORATION DEPT.

February 29, 1984
Re: 3103

Dr. V. Kudryk
B U I L D I N G

Silver Recovery from Hardshell By the Reduction-Roast Process

Laboratory investigations carried out at Central Research showed that reduction roasting followed by cyanidation is the preferred process for treating Hardshell ores because of its high recovery and simplicity with respect to metallurgy and tailings disposal.

The process consists of crushing the ore to minus 1/2 inch, roasting with propane gas or coal in an indirect-heated rotary kiln at 500-600 C, cooling and cyanidation using conventional heap leaching. Propane reduction was found to give silver extractions of 80-85% with the upper manto ore and about 70% with the lower manto. Test work with coal reduction has so far indicated 10-15% lower silver recoveries and hence the process requires further investigation. If recoveries were to be improved to the level attained by propane reduction then coal reduction would be the more economical approach. Cooling of the roasted ore is then carried out in an indirect rotary cooler since heap leaching is to be used in the cyanidation step. (Water quenching would be acceptable if grinding-agitation leaching is used in cyanidation).

Recoveries a function of grade, not U or L manto.

Indirect-heat kiln roasting, although offers lower thermal efficiency, enables the use of much less reducing gas (propane) to maintain the reducing atmosphere without interference from combustion gases. Furthermore, a much simpler, less costly dust collection system will be required with indirect-heat kilns. It should be noted that the manganese minerals in the ore are very friable and a considerable amount of fines is to be expected even in a fairly coarse (1/2 inch) crushed product.

Figure I illustrates the flowsheet for reduction-roasting and heap leaching. A general depiction of the reduction roasting installation is shown in Figure II.

A preliminary estimate of the capital and direct operating costs of the process is presented in Tables 1 and 2. Those costs are based on the results obtained from test work carried out with samples of upper and lower manto ores. A test program will begin shortly in which the process will be applied to numerous samples which encompass the entire range of silver assays and are geographically spread throughout the deposit both laterally and vertically. Upon completion of this test work, it will be possible to carry out a complete economic evaluation using realistic recoveries.

M. El Tawil

M. El Tawil

MET/jh

cc: R.L. Brown, D.E. Crowell, F.T. Graybeal, T.C. Osborne, W.P. Roe

Capital Investment

Basis 2000 TPD	Million Dollars
Kilns (Two 10'D x 110' long) @$1.25 MM each	7.5 (1)
Heap leach plant	24.0 (2)
Mine Investment	7.5 (3)
Total Capital Investment	39.0

(1) Using a factor of 300% to include installation, cooler and accessory equipment such as bins, conveyors, etc. (Verbal quotation from Bartlett - Snow on Feb. 24, 1984).

Far and away the costliest of all the heap leach plants.

(2) Using cost of the heap leach operation at Amselco's Alligator Ridge Operation (Ely, Nev.).

(3) Re: Report by Mr. A.R. Raihl dated July 22, 1979 and adding 50% escalation (10% per year).

Plant

Direct Operating Costs

A - Propane Reduction

Operating Labor - 34 persons @ $25,000/person		$850,000
Supervision - 15% of operating labor		$127,500
Maintenance:	Material - 15% of equipment cost[1]	$1,575,000
	Labor - 10% of equipment cost	$1,050,000
Utilities:	Power - $0.78/t	$546,000
	Fuel[2] - $8.07/t	$5,650,000
Reagents:	Reducing gas - $2.25/t	
	Lime - $0.60/t	
	NaCN - $1.04/t	
	Zn dust - $0.30/t	
	Total - $4.19/t	$2,933,000
Total Direct Costs		$12,731,500/yr.
		or about $18.00/t

B - Coal Reduction

With coal reduction all costs will remain the same except for the reducing gas cost of $2.25/t being replaced by the cost of coal at $1.35/t. This results in a decrease in total direct operating cost to $12,101,500/year or $17.30/t.

---

(1) Purchase cost of 2 kilns ($2.5MM) plus 1/3 of heap leach plant cost ($8.00MM)

(2) Using heat requirement of 565,000 BTU/Ton and 35% thermal efficiency. Energy cost - $5.00/MM BTU

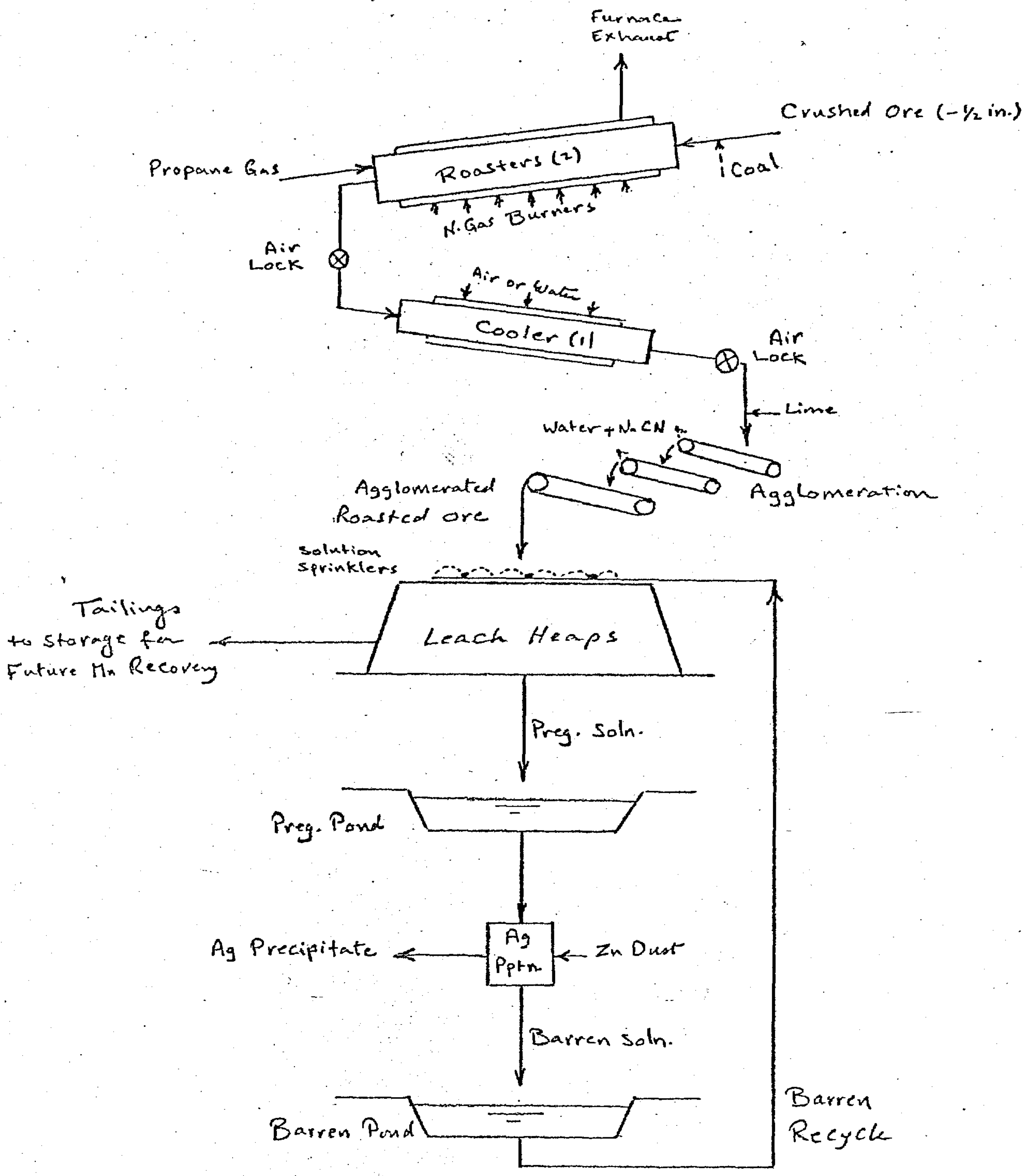

Figure I

Flowsheet for the Reduction-Roast, Heap-Leach Process

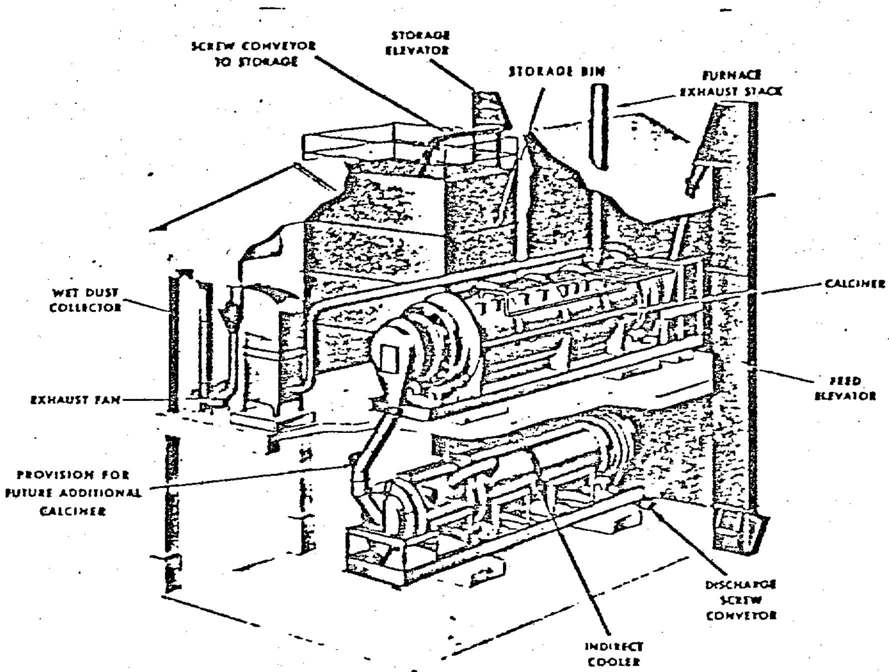

Figure II

Indirect-Heat Calciner-Cooler

Installation

HDS. MET SAMPLES JDS

CUSTOMER COUNTER

SHIPPING RECORD

RECEIVED FROM (PLEASE USE STAMP OR PRINT)	
NAME H M STONE / ASARCO	DATE 2/28/84
STREET Bx 5747	
CITY TUC, AZ STATE ZIP 85703	

SHIPPER RECEIPT — WHITE
UPS COPY — CANARY

United Parcel Service

FOR UPS USE ONLY

PACKAGE	SEND TO ADDRESS	C.O.D. AMOUNT	DECLARED VALUE	UPS ZONE	TYPE CHARGE	CUSTOMER COUNTER	DATE	TRANS	CHARGES AMOUNT
1	NAME ASARCO, INC	$.			C.O.D.	Rock Samples			
	STREET 101 OAK TREE RD		$100.	5?	EXCESS VALUATION	RP			
	CITY SO PLAINVIEW STATE NJ ZIP 07080			18	PACKAGE				20.74
2	NAME	$.			C.O.D.				
	STREET Same		$.	6?	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				2151
3	NAME	$.			C.O.D.				
	STREET Same		$.	6?	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				[illegible]
4	NAME	$.			C.O.D.				
	STREET Same		$.	6?	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				2005
5	NAME	$.			C.O.D.				
	STREET Same		$.	6?	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				2115

SHIPPER COMPLETE ALL INFORMATION SHOWN ABOVE

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TOTAL CHARGES

UNLESS A GREATER VALUE IS DECLARED IN WRITING ON THIS RECEIPT, THE SHIPPER HEREBY DECLARES AND AGREES THAT THE RELEASED VALUE OF EACH PACKAGE OR ARTICLE NOT ENCLOSED IN A PACKAGE COVERED BY THIS RECEIPT IS $100, WHICH IS A REASONABLE VALUE UNDER THE CIRCUMSTANCES SURROUNDING THE TRANSPORTATION. THE ENTRY OF A C.O.D. AMOUNT IS NOT A DECLARATION OF VALUE. IN ADDITION, THE MAXIMUM VALUE FOR AN AIR SERVICE SHIPMENT IS $5,000 AND THE MAXIMUM CARRIER LIABILITY IS $5,000. CLAIMS NOT MADE TO CARRIER WITHIN 9 MONTHS OF SHIPMENT DATE ARE WAIVED. CUSTOMER'S CHECK ACCEPTED AT SHIPPER'S RISK UNLESS OTHERWISE NOTED ON C.O.D. TAG.

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PACKAGE	SEND TO ADDRESS	C.O.D. AMOUNT	DECLARED VALUE	UPS ZONE	TYPE CHARGE	CUSTOMER COUNTER	DATE	TRANS	CHARGES AMOUNT
1	NAME ASARCO, INC	$.			C.O.D.	Rock samples			
	STREET 901 OAK TREE RD		$100.	5	EXCESS VALUATION		NB		
	CITY SO PLAINVIEW STATE NJ ZIP 07080			7/8	PACKAGE				2094
2	NAME	$.			C.O.D.				
	STREET SAME		$.	5	EXCESS VALUATION				
	CITY STATE ZIP			7/8	PACKAGE				2094
3	NAME	$.			C.O.D.				
	STREET SAME		$.	5	EXCESS VALUATION				
	CITY STATE ZIP			7/8	PACKAGE				2055
4	NAME	$.			C.O.D.				
	STREET SAME		$.	5	EXCESS VALUATION				
	CITY STATE ZIP			7/8	PACKAGE				2055
5	NAME	$.			C.O.D.				
	STREET SAME		$.	6	EXCESS VALUATION				
	CITY STATE ZIP			7/8	PACKAGE				2228

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CUSTOMER COUNTER

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NAME H M STONE / ASARCO	DATE 2/28/84
STREET BX 5747	
CITY TUC, AZ STATE ZIP 85703	

SHIPPER RECEIPT — WHITE
UPS COPY — CANAR

UPS United Parcel Servic

FOR UPS USE ONLY

PACKAGE	SEND TO ADDRESS	C.O.D. AMOUNT	DECLARED VALUE	UPS ZONE	TYPE CHARGE	CUSTOMER COUNTER	DATE	TRANS	CHARGES AMOUNT
1	NAME ASARCO INC.	$.		109	C.O.D.	Rock Sampling			
	STREET 901 OAK TREE RD		$100.–		EXCESS VALUATION	NR			
	CITY SO PLAINVIEW STATE NJ ZIP 07050			18	PACKAGE				21.42
2	NAME	$.			C.O.D.				
	STREET Same		$.	44	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				1737
3	NAME	$.			C.O.D.				
	STREET		$.	54	EXCESS VALUATION				
	CITY Same STATE ZIP			18	PACKAGE				2054
4	NAME	$.			C.O.D.				
	STREET Same		$.	45	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				1853
5	NAME	$.			C.O.D.				
	STREET Same		$.	38	EXCESS VALUATION				
	CITY STATE ZIP			18	PACKAGE				1583

SHIPPER COMPLETE ALL INFORMATION SHOWN ABOVE

A DUPLICATE ADDRESS LABEL MUST BE ENCLOSED IN EACH PACKAGE LISTED ABOVE

TOTAL CHARGES 90

UNLESS A GREATER VALUE IS DECLARED IN WRITING ON THIS RECEIPT, THE SHIPPER HEREBY DECLARES AND AGREES THAT THE RELEASED VALUE OF EACH PACKAGE OR ARTICLE NOT ENCLOSED IN A PACKAGE COVERED BY THIS RECEIPT IS $100, WHICH IS A REASONABLE VALUE UNDER THE CIRCUMSTANCES SURROUNDING THE TRANSPORTATION. THE ENTRY OF A C.O.D. AMOUNT IS NOT A DECLARATION OF VALUE. IN ADDITION, THE MAXIMUM VALUE FOR AN AIR SERVICE SHIPMENT IS $5,000 AND THE MAXIMUM CARRIER LIABILITY IS $5,000. CLAIMS NOT MADE TO CARRIER WITHIN 9 MONTHS OF SHIPMENT DATE ARE WAIVED. CUSTOMER'S CHECK ACCEPTED AT SHIPPER'S RISK UNLESS OTHERWISE NOTED ON C.O.D. TAG.

Thank You For Using

United Parcel Service

U1227TC5 REV 8-81

JDS

ASARCO

Exploration Department
Southwestern United States Division
James D. Sell
Manager

February 27, 1984

Dr. M. El Tawil
ASARCO Incorporated
Central Research Department
901 Oak Tree Road
South Plainfield, NJ 07080

Hardshell Metallurgical
Samples - Arizona

Dear Dr. El Tawil:

In accordance with your instructions by telephone (2/27/84) I am shipping the Hardshell metallurgical samples per F. T. Graybeal's letter of 2/21/84.

The shipment, in plastic pails, will be sent to the attention of Engineer Victor Puskar and will be transported by UPS.

Attached is a list of the drill holes, sample footages, approximate pounds, and our silver assay for the interval, along with my letter to R. L. Brown dated 2/8/84.

Additional samples are available from the deposit and can be secured and sent to you. Please give us some lead time if additional sampling is needed.

See you in Tucson soon.

Sincerely,

James D. Sell

James D. Sell

JDS/cg
Attachments

cc: Eng. V. Puskar, CRD
RLBrown/FTGraybeal
DECrowell
WLKurtz
FRKoutz
TCBenavidez) also separate letter of
HMStone) instruction to them.

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

February 8, 1984

R. L. Brown
New York Office

Rotary Cuttings Rejects
Hardshell Samples
Santa Cruz County, AZ

Rotary cuttings rejects have been separated out for Hardshell drill hole numbers 60, 62, 67, 72, 73, 77, 80, 81, 82, and 83.

The sample interval, weight of sample, and the silver assay for each hole is listed on 4 of the six pages telecopied to you.

The Hardshell drilling map is the fifth page and shows an outline of the +5 ounce silver manto as generally expressed by Pickard on his reserve estimate.

Please advise on the person-place to send these samples which are the first run of the metallurgical research.

Please advise on further samples which are desired for continued research.

Also to be forwarded to Central Research will be a copy of the available SWED assays for these intervals. All samples were assayed for silver but not all for copper, lead, zinc, manganese, and silica.

The Mission Unit X-Ray Fluorescence data being accumulated by Al Raihl is presently available for hole numbers 60, 72, 73, 80, 82, and 83.

Jim

James D. Sell

JDS/cg

Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-60	130-135	11	4.14
	135-140	6	6.13
	140-145	10	5.68
	145-150	9	5.62
	150-155	9	3.78
	155-160	4	4.61
	160-165	10	6.03
	> 170-175	10½	4.75
	175-180	10	4.55
	> 185-190	5	3.22
HDS-62	260-265	7½	3.39
	> 285-290	3	4.70
	290-295	3	3.38
	295-300	2	4.74
	300-305	3	6.67
	305-310	5	6.90
	310-315	3	6.82
	315-320	2	4.69
	320-325	5½	6.31
	325-330	2	6.29
	330-335	6	6.91
	335-340	5½	5.55
	340-345	5½	3.81
	345-350	2½	5.20
	350-355	5	6.61
	355-360	5	4.86
HDS-67	380-385	12	6.31

> = gap in sequence.

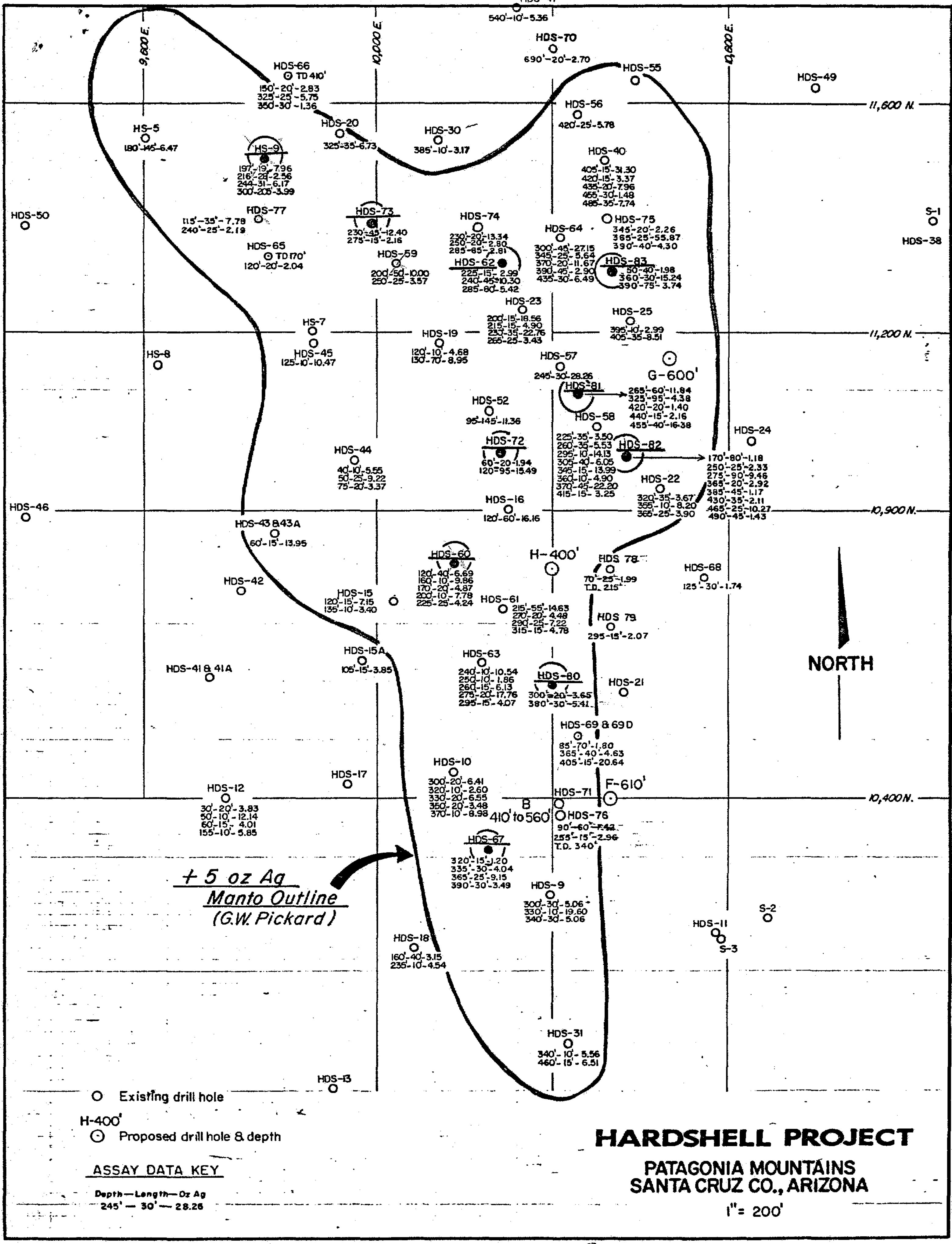
Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-72	120-125	5	62.74
	125-130	5½	52.26
	130-135	3	8.63
	135-140	3	3.57
	140-145	3½	7.94
	145-150	4	9.70
	150-155	2	6.90
	155-160	3	18.46
	160-165	4½	18.08
	165-170	3	15.57
	170-175	8	5.89
	175-180	11	11.11
HDS-73	230-235	5	9.25
	235-240	5	22.22
	240-245	7½	10.75
	245-250	3½	23.22
	250-255	5	12.36
	255-260	6	17.57
	260-265	9	2.64
	265-270	10	2.72
	270-275	9	10.83
	275-280	9½	1.61
HDS-77	120-125	16	27.92
	> 145-150	12	2.07
HDS-80	380-385	14	2.04
	385-390	14½	15.15
	390-395	13	8.35
	395-400	13	3.35
	400-405	11½	1.73

Cont. on page 3

> = gap in sequence.

Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-80 Cont.	405-410	10	1.82
	410-415	12½	0.83
	415-420	11	0.86
	420-425	10½	0.68
	425-430	13½	0.30
HDS-81-A	390-395	8	9.54
	395-400	11½	5.14
	400-405	11½	4.63
	405-410	14	3.13
	410-415	12	3.69
	415-420	7	2.11
HDS-81-B	320-325	11	8.91
	325-330	7½	6.56
	330-335	10½	6.52
	335-340	5	3.91
HDS-82	280-285	12	4.91
	285-290	12	5.04
	290-295	6	8.80
	295-300	5½	13.65
	300-305	9½	10.22
	305-310	9½	4.91
	310-315	11	6.30
	315-320	11½	11.33
	320-325	13	11.61
	325-330	10	18.79
	330-335	11	5.99
	335-340	8	8.86
	340-345	6½	10.50
	345-350	9½	16.25
	350-355	10	12.18
	355-360	6½	10.13
	360-365	8	6.07

Hole No.	Footage	Weight (Lbs.)	Assay Ag (opt)
HDS-83	365-370	10	26.05
	370-375	8	23.93
	375-380	7½	12.44
	380-385	7	7.55
	385-390	13	14.30
	390-395	10	3.57
	395-400	11	2.82
	400-405	4	1.98
	405-410	9½	3.55
	410-415	6½	7.34
	415-420	8	4.83
	420-425	4	3.18


HDS-47
540'-10'-5.36
HDS-70
690'-20'-2.70
9,600 E.
10,000 E.
10,800 E.
HDS-66
TD 410'
150'-20'-2.83
325-25-5.75
350-30'-1.36
HDS-55
HDS-49
11,600 N.
HDS-56
420'-25'-5.78
HS-5
180'-145'-6.47
HDS-20
325'-35'-6.73
HDS-30
385'-10'-3.17
HS-9
197'-19'-7.96
216'-28'-2.56
244-31-6.17
300'-205'-3.99
HDS-40
405'-15'-31.30
420'-15'-3.37
435'-20'-7.96
455'-30'-1.48
485'-35'-7.74
HDS-50
HDS-77
115'-35'-7.78
240'-25'-2.19
HDS-73
230'-45'-12.40
275'-15'-2.16
HDS-74
230'-20'-13.34
250'-20'-2.80
285'-85'-2.81
HDS-64
300'-45'-27.15
345-25-5.64
370-20'-11.67
390-45'-2.90
435-30'-6.49
HDS-75
345'-20'-2.26
365'-25'-55.87
390'-40'-4.30
S-1
HDS-38
HDS-65
TD 170'
120'-20'-2.04
HDS-59
200'-50'-10.00
250-25-3.57
HDS-62
225'-15'-2.99
240'-45'-10.30
285-60'-5.42
HDS-83
350'-40'-1.98
360'-30'-15.24
390'-75'-3.74
HDS-23
200'-15'-18.56
215-15'-4.90
230-35'-22.76
265-25-3.43
HDS-25
395'-10'-2.99
405'-35-8.51
HS-7
HDS-19
120'-10'-4.68
130-70'-8.95
11,200 N.
HS-8
HDS-45
125'-10'-10.47
HDS-57
245'-30'-28.26
G-600'
HDS-81
265'-60'-11.84
325'-95'-4.38
420'-20'-1.40
440'-15'-2.16
455'-40'-16.38
HDS-52
95'-145'-11.36
HDS-58
225'-35'-3.50
260'-35'-5.53
295'-10'-14.13
305'-40'-6.05
345'-15'-13.99
360'-10'-4.90
370'-45'-22.20
415'-15'-3.25
HDS-82
170'-80'-1.18
250'-25'-2.33
275'-90'-9.46
365'-20'-2.92
385'-45'-1.17
430'-35'-2.11
465'-25'-10.27
490'-45'-1.43
HDS-24
HDS-72
60'-20'-1.94
120'-95'-15.49
HDS-44
40'-10'-5.55
50'-25'-9.22
75'-20'-3.37
HDS-22
320'-35'-3.67
355'-10'-8.20
365'-25'-3.90
HDS-46
HDS-16
120'-60'-16.16
10,900 N.
HDS-43 & 43A
60'-15'-13.95
HDS-60
120'-40'-6.69
160'-10'-9.86
170'-20'-4.87
200'-10'-7.78
225'-25'-4.24
H-400'
HDS 78
70'-25'-1.99
T.D. 215'
HDS-68
125'-30'-1.74
HDS-42
HDS-15
120'-15'-7.15
135'-10'-3.40
HDS-61
215'-55'-14.63
270'-20'-4.48
290'-25'-7.22
315'-15'-4.78
HDS 79
295'-15'-2.07
NORTH
HDS-15A
105'-15'-3.85
HDS-41 & 41A
HDS-63
240'-10'-10.54
250'-10'-1.86
260'-15'-6.13
275'-20'-17.76
295'-15'-4.07
HDS-80
300'-20'-3.65
380'-30'-5.41
HDS-21
HDS-69 & 69D
85'-70'-1.80
365'-40'-4.63
405'-15'-20.64
HDS-10
300'-20'-6.41
320'-10'-2.60
330'-20'-6.55
350'-20'-3.48
370'-10'-8.98
HDS-17
HDS-12
30'-20'-3.83
50'-10'-12.14
60'-15'-4.01
155'-10'-5.85
B
410' to 560'
HDS-71
F-610'
10,400 N.
HDS-76
90'-60'-7.43
255'-15'-2.96
T.D. 340'
HDS-67
320'-15'-1.20
335'-30'-4.04
365'-25'-9.15
390'-30'-3.49
+5 oz Ag
Manto Outline
(G.W. Pickard)
HDS-9
300'-30'-5.06
330'-10'-19.60
340'-30'-5.06
S-2
HDS-11
S-3
HDS-18
160'-40'-3.15
235'-10'-4.54
HDS-31
340'-10'-5.56
460'-15'-6.51
HDS-13
Existing drill hole
H-400'
Proposed drill hole & depth
ASSAY DATA KEY
Depth—Length—Oz Ag
245' — 30' — 28.26
HARDSHELL PROJECT
PATAGONIA MOUNTAINS
SANTA CRUZ CO., ARIZONA
1" = 200'

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

JDS

February 21, 1984

Mr. J. D. Sell, Manager
Southwestern Exploration Division
Tucson, Arizona

Hardshell Metallurgical Samples
Arizona

Dear Mr. Sell:

Dr. M. El Tawil advises that the sample kiln at Central Research which is used to run bench scale reduction-roast tests on Hardshell silver ore is now available. He notes that each test will require approximately 2½ lbs. of sample material with additional needed for assay work. It would appear that 4 to 5 lbs. per sample would be a reasonable minimum weight. Each test takes about 1 day.

I suggest you send Dr. El Tawil about 50 samples, each weighing no more than 5 lbs., which encompass the entire range of silver assays and are geographically spread throughout the deposit, both laterally and vertically. To simplify sample preparation, I suggest that only individual 5' assay intervals be sent, even though these intervals are less than a minimum mining height.

The purpose of this work would be to look for variations in metallurgical response which might not be related to obvious geological characteristics. Please send the samples to Dr. El Tawil and mark me for a copy of your transmittal letter. The research will be conducted using identical test parameters so that if future modifications are made in the reduction-roast flow sheet, non-uniform behavior of the

RECEIVED

FEB 27 1984

EXPLORATION DEPARTMENT

Hardshell ore would be known and could be retested. If you have any questions, please call me or Dr. El Tawil. Remember, that it is Mr. Brown's desire to keep the kiln turning until we have a better feeling for the presence or absence of variable metallurgical response of Hardshell ores.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

cc: Dr. M. El Tawil
D. R. Crowell
W. L. Kurtz

Salcedo

5	(225)	✓	
66	(380)	✓	
9	(505)	✓	
77	(265)	✓	
65	(150)	✓	
73	290)	✓	
59	(275)	✓	
45	(135)	✓	sent prev. (130-190)
19	(200)	✓	
44	(95)	✓	
43-43A	(80)	✓	
15	(145)	✓	(120-150)
60	(250)	✓	

5 not tested
9 — samples 200 – 230 2 1/2 oz
15 None
19 None
43-43A None
44 None
45 None
59 250 → 275 3 1/2 oz
60 230-235 & 240-245 4 oz
65 None
66 None
73 285 – 290
77 230 – 360 2 oz

JDS

ASARCO

Southwestern Exploration Division

July 16, 1984

To: H. M. Stone

From: J. D. Sell

Additional Samples Available?
Hardshell Samples
Santa Cruz County, AZ

Dr. M. El Tawil called on 7/13/84 and asked if we had samples below the last footages listed below. The holes and last footages he has received are:

Hole	Last Footage Sample
HDS-60	185-190
-62	355-360
-72	175-180
-73	275-280
-82	360-365
-83	420-425

If you do, please call Dr. El Tawil and tell him. He will probably ask that they be sent.

Has the list of the remainder of the Hardshell samples been sent to him?

James D. Sell

James D. Sell

JDS/cg

cc: FRKoutz

JDS

ASARCO

Southwestern Exploration Division

July 16, 1984

To: H. M. Stone

From: J. D. Sell

Hardshell Project
Santa Cruz County, AZ

According to your inventory of July 11 the following samples are available for shipment to Central Research as requested by Max El Tawil on July 13, 1984:

Hole No.	Footage
HDS-60	230-235
	240-245
HDS-62	360-365
HDS-72	180-185
	185-190
	190-195
	195-200
	200-205
	205-210
HDS-73	285-290

Hole No.	Footage
HDS-82	365-370
	460-465
	465-470
	475-480
	480-485
	485-490
HDS-83	435-440
	440-445
	445-450

Please prepare all these samples for shipment by UPS to: M. El Tawil, ASARCO Incorporated, Central Research Department, 901 Oak Tree Road, South Plainfield, NJ 07080.

James D. Sell

James D. Sell

JDS/cg

cc: RLB
DEC/ARR
FRK
RJK
TES/DFS
WLK
MElT

ASARCO

Southwestern Exploration Division

JDS

July 12, 1984

To: RLBrown
DECrowell
FRKoutz
RJKupsch
WLKurtz
ARRaihl
TEScartaccini
DFSkidmore
HMStone

From: JDSell

Hardshell Project
Santa Cruz County, AZ

Attached is the inventory prepared by H. M. Stone of the reject samples available on the Hardshell Project. These are stored in the Ventura warehouse.

James D. Sell
James D. Sell

JDS/cg

Attachment

HMStone
7/11/84

HARDSHELL PROJECT

(Central Research Project #3103)

Reject samples are available for the holes & intervals listed below.

Barrel No.	Hole No.	Footage	Lbs.
HDS-51	HDS-7A	120-130	3
		130-140	5
		140-150	4
HDS-51	HDS-8	190-200	9
HDS-50	HDS-9	200-210	6
		210-220	6
		220-230	5
HDS-49	HDS-10		No Samples
HDS-89	HDS-12		No Samples
HDS-88	HDS-15		No Samples
HDS-84	HDS-16		No Samples
HDS-83	HDS-17		No Samples
HDS-78	HDS-18		No Samples
HDS-81	HDS-19		No Samples
HDS-80	HDS-20		No Samples
HDS-75	HDS-21		No Samples
HDS-76	HDS-22		No Samples
HDS-78	HDS-23	195-200	2
		200-205	1
		205-210	0
		210-215	0
		215-220	½
		220-225	0
		225-230	0
		230-235	½
		235-240	½
		240-245	0
		245-250	0
		250-255	0
		255-260	0
		260-265	1
		265-270	½
		270-275	0
		275-280	1
		280-285	½
		285-290	2

Barrel No.	Hole No.	Footage	Lbs.
HDS-80	HDS-25	395-400	1
		400-405	0
		405-410	½
		410-415	1
		415-420	4
		420-425	½
		425-430	0
		430-435	0
		435-440	0
HDS-73	HDS-30	360-365	2
		385-390	0
HDS-73	HDS-31	460-465	1
		465-470	½
		470-475	0
HDS-64	HDS-40	400-405	0
		405-410	¼
		410-415	½
		415-420	½
		420-425	2
		425-430	½
		435-440	¼
		440-445	2
		445-450	1
		450-455	¼
		455-460	½
		485-490	½
		490-495	½
		495-500	1
		500-505	1½
		505-510	2
		510-515	½
		515-520	1
		520-525	¼
HDS-23	HDS-41A	0- 10	No Samples
		15- 20	No Samples
HDS-23	HDS-42	0- 5	No Samples
		5- 10	No Samples
		10- 15	No Samples
		15- 20	No Samples

Barrel No.	Hole No.	Footage	Lbs.
HDS-23	HDS-43A	55- 60	No Samples
		60- 65	No Samples
		65- 70	No Samples
		70- 75	No Samples
		75- 80	No Samples
HDS-24	HDS-44	45- 50	No Samples
		50- 55	No Samples
		55- 60	No Samples
		60- 65	No Samples
		65- 70	No Samples
		70- 75	No Samples
		75- 80	No Samples
		80- 85	No Samples
		85- 90	No Samples
HDS-24	HDS-45	125-130	No Samples
HDS-24	HDS-46	70- 75	No Samples
		75- 80	No Samples
		80- 85	No Samples
		85- 90	No Samples
		90- 95	No Samples
		95-100	No Samples
		100-105	No Samples
		105-110	No Samples
		110-115	No Samples
		115-120	No Samples
HDS-25	HDS-47	510-515	7
		540-545	3
		545-550	3
HDS-26	HDS-50	405-410	1
		410-415	2
		415-420	6
		420-425	7
		425-430	6
		430-435	2

Barrel No.	Hole No.	Footage	Lbs.
HDS-20 & HDS-21	HDS-52	95-100	5
		100-105	No Sample
		105-110	0
		110-115	0
		115-120	6
		120-125	2
		125-130	0
		130-135	0
		135-140	No Sample
		140-145	0
		145-150	3
		150-155	4
		155-160	0
		160-165	6
		165-170	0
		170-175	0
		175-180	0
		180-185	0
		185-190	0
		190-195	5
		195-200	0
		200-205	0
		205-210	0
		210-215	0
HDS-16	HDS-56	415-420	4
		420-425	4
		425-430	3
		430-435	9
		435-440	4
		440-445	4
HDS-11	HDS-57	245-250	7
		250-255	6
		255-260	2
		260-265	6
		265-270	½
		270-275	2

Barrel No.	Hole No.	Footage	Lbs.
HDS-9	HDS-58	275-280	9
		280-285	5
		285-290	5
		290-295	11
		295-300	0
		300-305	0
		305-310	5
		310-315	2
		315-320	7
		320-325	3
		325-330	0
		330-335	0
		335-340	0
		340-345	3
		345-350	0
		350-355	0
		355-360	0
		360-365	5
		365-370	4
		370-375	3
		375-380	0
		380-385	2
		385-390	4
		390-395	3
		395-400	No Sample
		400-405	0
		405-410	0
		410-415	2
		415-420	3
		420-425	½
HDS-6	HDS-59	210-215	0
		215-220	2
		220-225	0
		225-230	0
		230-235	0
		235-240	2
		240-245	2
		245-250	0
		250-255	1½
		255-260	3
		260-265	5
		265-270	2½
		270-275	3

Barrel No.	Hole No.	Footage	Lbs.
HDS-4	HDS-60	120-125	No Samples
		125-130	No Samples
		130-135	No Samples
		135-140	No Samples
		140-145	No Samples
		145-150	No Samples
		150-155	No Samples
		155-160	No Samples
		160-165	No Samples
		165-170	No Samples
		170-175	No Samples
		175-180	No Samples
		180-185	No Samples
		185-190	No Samples
		200-205	No Samples
		205-210	No Samples
		225-230	No Samples
		230-235	3
		235-240	No Samples
		240-245	3
		245-250	No Samples
HDS-2	HDS-61	220-225	No Samples
		225-230	3
		230-235	5
		235-240	No Samples
		240-245	5
		245-250	No Samples
		250-255	No Samples
		255-260	No Samples
		260-265	No Samples
		265-270	No Samples
		270-275	3
		275-280	2
		280-285	3
		285-290	No Samples
		290-295	6
		295-300	No Samples
		300-305	No Samples
		305-310	2
		310-315	No Samples
		315-320	No Samples
		320-325	7
		325-330	No Samples

Barrel No.	Hole No.	Footage	Lbs.
HDS-12	HDS-62	225-230	5
		230-235	7
		235-240	4
		240-245	2
		245-250	No Samples
		250-255	No Samples
		255-260	No Samples
		260-265	No Samples
		265-270	No Samples
		270-275	No Samples
		275-280	No Samples
		280-285	No Samples
		285-290	No Samples
		290-295	No Samples
		295-300	No Samples
		300-305	No Samples
		305-310	No Samples
		310-315	No Samples
		315-320	No Samples
		320-325	No Samples
		325-330	No Samples
		330-335	No Samples
		335-340	No Samples
		340-345	No Samples
		345-350	No Samples
		350-355	No Samples
		355-360	No Samples
		360-365	6
HDS-10	HDS-63	240-245	No Samples
		245-250	5
		260-265	7
		265-270	1½
		270-275	1
		275-280	No Samples
		280-285	8
		285-290	No Samples
		290-295	No Samples
		295-300	1
		300-305	7
		305-310	2
		320-325	6
		325-330	3

Barrel No.	Hole No.	Footage	Lbs.
HDS-8	HDS-64	300-305	1
		305-310	3
		310-315	No Samples
		315-320	No Samples
		320-325	No Samples
		325-330	No Samples
		330-335	No Samples
		335-340	No Samples
		340-345	7
		345-350	2
		350-355	2
		355-360	4
		360-365	No Samples
		365-370	3
		370-375	No Samples
		375-380	No Samples
		380-385	No Samples
		385-390	No Samples
		390-395	2
		405-410	No Samples
		410-415	5
		415-420	No Samples
		420-425	2
		425-430	4
		435-440	1
		440-445	1
		445-450	No Samples
		450-455	No Samples
		455-460	No Samples
		460-465	2
HDS-40	HDS-65	125-130	No Samples
HDS-36	HDS-66	325-330	No Samples
		330-335	No Samples
		335-340	No Samples
		340-345	No Samples
		345-350	No Samples

Barrel No.	Hole No.	Footage	Lbs.
HDS-37	HDS-67	360-365	No Samples
		365-370	No Samples
		370-375	No Samples
		375-380	No Samples
		380-385	No Samples
		385-390	No Samples
		390-395	No Samples
		395-400	No Samples
		405-410	No Samples
		415-420	No Samples
HDS-39	HDS-69	405-410	No Samples
		410-415	No Samples
		415-420	No Samples
HDS-5	HDS-72	120-125	No Samples
		125-130	No Samples
		130-135	No Samples
		135-140	No Samples
		140-145	No Samples
		145-150	No Samples
		150-155	No Samples
		155-160	No Samples
		160-165	No Samples
		165-170	No Samples
		170-175	No Samples
		175-180	No Samples
		180-185	7
		185-190	5
		190-195	3
		195-200	9
		200-205	6
		205-210	8
HDS-5	HDS-73	230-235	No Samples
		235-240	No Samples
		240-245	No Samples
		245-250	No Samples
		250-255	No Samples
		255-260	No Samples
		270-275	No Samples
		285-290	7

Barrel No.	Hole No.	Footage	Lbs.
HDS-3	HDS-74	230-235	2
		235-240	4
		245-250	3
		260-265	No Samples
		265-270	10
		295-300	5
		300-305	7
		305-310	7
		320-325	6
		340-345	8
		345-350	7
		350-355	6
		355-360	6
HDS-1	HDS-75	355-360	6
		360-365	5
		365-370	5
		370-375	No Samples
		375-380	No Samples
		380-385	No Samples
		385-390	No Samples
		390-395	No Samples
		395-400	No Samples
		400-405	No Samples
		405-410	No Samples
		410-415	No Samples
		415-420	No Samples
		420-425	No Samples
		425-430	No Samples
HDS-56	HDS-77	115-120	No Samples
		120-125	No Samples
		125-130	No Samples
		130-135	No Samples
101-102	HDS-80	310-315	12
		385-390	No Samples
		390-395	No Samples
		395-400	12

Barrel No.	Hole No.	Footage	Lbs.
HDS-103	HDS-81	270-275	3
		275-280	3
		280-285	No Samples
		285-290	8
		290-295	3
		295-300	12
		300-305	11
		305-310	13
		310-315	12
		315-320	11
		320-325	No Samples
		325-330	No Samples
		330-335	No Samples
		335-340	No Samples
		340-345	10
		345-350	11
		350-355	No Samples
		355-360	4
		360-365	8
HDS-106	HDS-82	290-295	No Samples
		295-300	No Samples
		300-305	No Samples
		305-310	No Samples
		310-315	No Samples
		315-320	No Samples
		320-325	No Samples
		325-330	No Samples
		330-335	No Samples
		335-340	No Samples
		340-345	No Samples
		345-350	No Samples
		350-355	No Samples
		355-360	No Samples
		360-365	No Samples
		365-370	6
		370-375	No Samples
		460-465	9
		465-470	10
		470-475	No Samples
		475-480	9
		480-485	7
		485-490	9

Barrel No.	Hole No.	Footage	Lbs.
HDS-104	HDS-83	360-365	No Samples
		365-370	No Samples
		370-375	No Samples
		375-380	No Samples
		380-385	No Samples
		385-390	No Samples
		390-395	No Samples
		405-410	No Samples
		410-415	No Samples
		415-420	No Samples
		420-425	No Samples
		435-440	8
		440-445	11
		445-450	4