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AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
February 2, 1959

MEMORANDUM FOR K. E. RICHARD

MISSION PROJECT
Screen Analysis of Crushed
Sample Reject

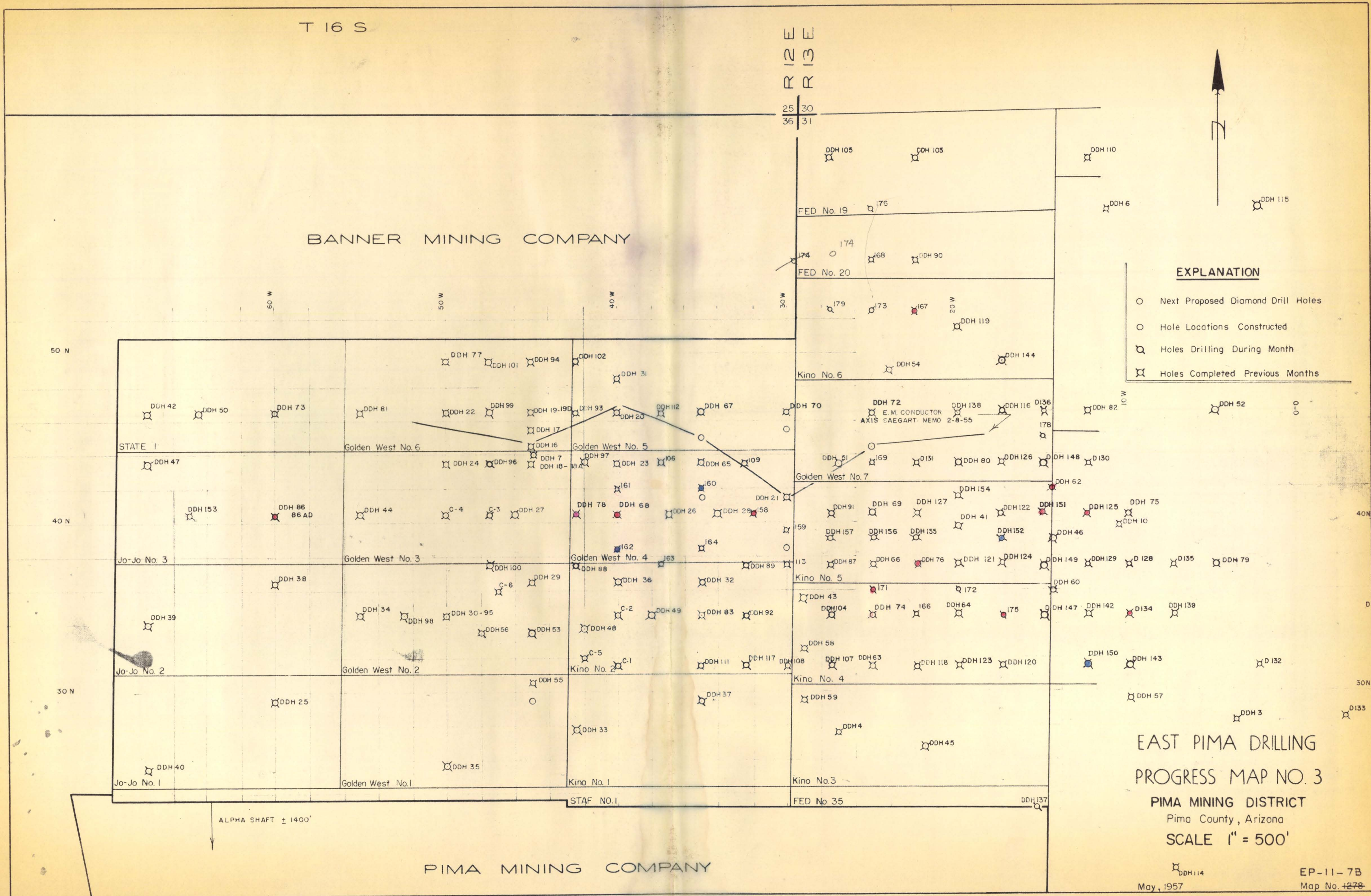
A screen analysis was made of several crushed core samples in storage at the Mission laboratory by passing the rejects through screen sizes of 1/2", 1/4" and 10-mesh. The samples selected for analysis consisted of eleven intercepts of argillite, four of hornfels, and six of tactite.

The following is a tabulation of these data:

Hole Number	Interval (Ft.)	Wght(lbs) of Sample Reject	+1/2" (%)	-1/2" +1/4" (%)	-1/4" +10 Mesh (%)	-10 Mesh (%)
	ARGILLITE					
48	287.9 - 294.9	3.03	0	17	46	37
68	254.2 - 263.9	2.69	0	21	49	30
68	270.1 - 281.3	2.99	0	22	43	35
78	320.6 - 331.7	3.05	0	35	40	25
83	296.8 - 309.4	3.04	0	14	53	33
88	348.5 - 358.2	2.73	0	37	38	25
88	385.1 - 397.6	2.82	0	30	47	23
92	320.9 - 325.9	2.24	2	37	39	22
111	455.9 - 465.0	3.13	0	19	45	36
153	269.2 - 279.4	2.86	0	34	41	25
163	348.0 - 355.0	2.50	0	20	45	35
		Weighted Average	0	26	44	30
	HORNFELS					
49	597.2 - 607.9	3.27	0	9	37	54
68	400.0 - 407.6	2.77	0	13	50	37
111	620.7 - 630.8	3.28	0	9	40	51
148	332.7 - 343.0	3.15	1	38	37	24
		Weighted Average	0	18	40	42
	TACTITE					
128	246.3 - 252.2	3.95	0	13	47	40
128	459.2 - 469.4	3.07	0	25	52	23
129	430.5 - 438.6	3.15	0	20	54	26
136	362.0 - 369.7	3.41	0	15	50	35
142	261.5 - 271.6	3.65	0	18	51	31
178	304.6 - 314.1	3.62	0	28	43	29
		Weighted Average	0	20	49	31

SCF/ds SAMUEL C. FALL

cc: JHCourtright
JEKinnison



T 16 S
R 12 E
R 13 E
25
30
36
31
BANNER MINING COMPANY
EXPLANATION
Next Proposed Diamond Drill Holes
Hole Locations Constructed
Holes Drilling During Month
Holes Completed Previous Months
60 W
50 W
40 W
30 W
20 W
10 W
0-0
50 N
40 N
30 N
FED No. 19
FED No. 20
Kino No. 6
STATE 1
Golden West No. 6
Golden West No. 5
Golden West No. 7
E.M. CONDUCTOR AXIS SAEGART MEMO 2-8-55
Jo-Jo No. 3
Golden West No. 3
Golden West No. 4
Kino No. 5
Jo-Jo No. 2
Golden West No. 2
Kino No. 2
Kino No. 4
Jo-Jo No. 1
Golden West No. 1
Kino No. 1
Kino No. 3
STAF NO. 1
FED No 35
ALPHA SHAFT ± 1400'
PIMA MINING COMPANY
EAST PIMA DRILLING
PROGRESS MAP NO. 3
PIMA MINING DISTRICT
Pima County, Arizona
SCALE 1" = 500'
May, 1957
EP-11-7B
Map No. 1278

PROPERTY East Pima

Megascopic: Tactite. Coarse-grained fibrous wollastonite, and garnet. dissem-inated chalcopyrite

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical Study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 32 @ 541 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

32-541'

PROPERTY East Pima

Megascopic: (Sample SB 56) Brown even-textured sandy argillite. Disseminated pyrite and chalcopyrite.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study.

Microscopic by: Date

Petrographic Rock Name:

Formation: Papago

DDH No. 45 @ 450 ft. Depth

Sent for: T.S. ✓ P.S.

Date: —

Other Location:

For additional comments use/see reverse

45-450'

PROPERTY East Pima

Megascopic: Pore, slightly translucent, medium-grained quartzite. Veins of chalcopyrite

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 49 @ 555 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

49-555'

PROPERTY East Pima

Megascopic: Yellow-tan argillite colored brown along veinlets and near clusters of sulfides.

By: J.E.K. Date 1/31/58

Purpose: sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Papago

DDH No. 88 @ 298 ft. Depth

Sent for: T.S. ✓ P.S.

Date: —

Other Location:

For additional comments use/see reverse

88 - 298'

PROPERTY East Pima

Megascopic: Brown even-textured argillite. Thin quartz veins with weak bleaching adjacent.

By: J. E. K. Date ~~1-58~~ 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Papago

DDH No. 88 @ 317 ft. Depth

Sent for: T.S. ✓ P.S.

Date: —

Other Location:

For additional comments use/see reverse

88-317'

PROPERTY East Pima

Megascopic: Soft varety of hornfels, but cut by quartz veins. Very heavy pyrite and chalcopyrite. Molybdenite may be present in small quantities.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 89 @ 284 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

89-284'

PROPERTY East Pima

Megascopic: Abundant feldspar phenocrysts set in a "quartzy" groundmass. Quartz veins present. Feldspar altered? Disseminated pyrite and chalcopyrite

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Metaporphyry

DDH No. 101 @ 336 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other location:

For additional comments use/see reverse

101 - 336'

PROPERTY East Pima

Megascopic: Hard variety of hornfels. Grey-green, fine-grained, slightly fibroos. Pyrite and chalcopyrite in veins and disseminations.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallorgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 113 @ 314 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

113-314'

PROPERTY East Pima

Megascopic: Tactite. Brown and red-brown fine grained garnet. Hematite and chalcopyrite heavy.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 113 @ 374 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

113 - 374'

PROPERTY East Pima

Megascopic: Hard variety of hornfels (marble ?). white, fine-grained. Abundant disseminated chalcopyrite and hematite

By: J.E.K. Date 1/31/58

Purpose: sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 113 @ 383 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

113 - 383'

PROPERTY East Pima

Megascopic: Feldspar rock. Coarse-grained pink feldspar disseminated chalcopyrite. Minor disseminated molybdenite.

By: J. E. K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 130 @ 327 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

130 - 327

PROPERTY East Pima

Megascopic: Soft variety of hornfels. This sample represents the very soft and pulverent type. white, fine-grained.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 138 @ 301 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

138 - 301'

PROPERTY East Pima

Megascopic: Tactite. Euhedral garnet with some admixed soft material. Disseminated pyrite and chalcopyrite.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 151 @ 284 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

151 - 284'

PROPERTY East Pima

Megascopic: Tactite. Garnet with admixed soft white material.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 151 @ 313 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

151 - 313'

PROPERTY East Pima

Megascopic: Hornfels, ~~Tactite.~~ ~~Garnet~~ heavily mixed with soft diopside. Sparsely disseminated pyrite and chalcopyrite.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 151 @ 313 A ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other location:

For additional comments use/see reverse

151 - 313'A

PROPERTY East Pima

Megascopic: Soft variety of hornfels. white, fine-grained, granular. Chalcopyrite disseminated in large blebs.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study.

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 151 @ 344 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

151 - 344'

PROPERTY East Pima

Megascopic: Soft variety of hornfels. White, fine-grained, granular. Very heavy chalcopyrite disseminated in large blebs.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study.

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 151 @ 370 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

151 - 370'

PROPERTY East Pima

Megascopic: Soft variety of hornfels. white, fine-grained, granular. Heavily dissemmated chalcopyrite.

By: J.E.K. Date 1/31/58

Purpose: Sample for metallurgical study

Microscopic by: Date

Petrographic Rock Name:

Formation: Pima

DDH No. 151 @ 380 ft. Depth

Sent for: T.S. ✓ P.S.

Date: 1/31/58

Other Location:

For additional comments use/see reverse

151 @ 380'

See file Aa 16.16.20A

PIMA HOLES

Hole	Co-ord	Elev. Collar	Depths Bedrock	Depths Total
A-50		3302	210	350
A-93		3295	198	693
A-92		3287	207	723
A-78		3285	195	474
A-79		3289	205±	593
A-52		3285	?	313
A-90		3278	202'	946'
A-89		3271	215'	1006'
A-84		3281	198	938
A-91		3265	215	918
A-87		3268	225	782
A-58		3246	213?	495
A-67		3243	190?	404
A-68		3234	220?	411?

PIMA MINE LOGS

(Loged By J. Journey) - Summarized for use on East Pima Sections.

A-89 Bedrock @ 215'

215-393 Ark̄(?) [log Pyroclastic) feld. development. Prob. equiv. to Papago fm.

299-300 felsite Porphyry.

393-640 Argillite (?) black w/ light colored patches and veining. [Log. Pyroclastic]

633-640, Epidote & chl, limy w/ qtz veins, strong Sulf.

640-723 Argillite(?) - cinamon colored. (corresponds to a horizon noted in A-87)

723-855 Qtzt. (also penetrated in A-87)

855-885 Hornfels [log Diopside Hf].

885-893 Pale brown, fn-grained limy material w/qtz veins.

893-917 Hornfels [log. Diopside Hf]

917-957 Tactite [log Garnet Hf]

957-967 Hornfels [log Diopside Hf]

967-979 Tactite [log garnet Hf]

979-982 Arg??

982-990 Porphyry ? (felsite)

990-1006 Qtzt or sand Arg.

BOTTOM

A-93 Bedrock @ 227'

227-409 Arg (?) [log pyroclastic]

409-429 Felsite porphyry (??) [log siliceous quartzose (watery) matrix with scattered anhedral feldspar.

429-537 Arg (?) [log pyroclastic]

537-554 Felsite porphyry [log Rhyolite]

554-562 "Hornfels (?) w/ Felsite Porphry. [log. silicified material w/ porphyry]

562-583 Tactite [log Garnet Hf]

583-597 Hornfels (?) [log quartzose material w/ trace of Hf.]

597-607 Felsite porphyry
607-611 Hornfels [log Diopside Hf]
611-621 Felsite porphyry
621-629 Hornfels
629-639 Hornfels (?) w/ porphyry
639-693 Ark or Arg w/ intercepts of Felsite porphyry.

BOTTOM

PIMA MINE LOGS

A-90 Bedrock @ 202

202 - 282 Arg(?) [log. Pyroclastic] w/ bleaching.

282 - 289 Porphyry w/ short streethes of Arg(?)

289 - 751 Arg (?) [log. Pyroclastic]

751 - 760 Tactite [log Garnet Hf]

760 - 765 Felsite porphyry

765 - 789 Hornfels [log diopside Hf]

770 - 770-772 sheared quartzose material.

789 - 802 Brown siliceous material, some garnet and other limesilicate

802 - 811 Tactite. Heavy sulf.

811 - 820 As 789-802, some garnet.

820 - 853 Sandy Argillite, dark brown.

853 - 872 Hornfels. Gypsum.

872 - 927 Arg or porphyry. light-colored w/ fine white feld.?

927 - 932 Hornfels [log. diopside Hf]

932 - 946 Siliceous material like 872-927. [log pyroclastic?]

BOTTOM

A-50 Bedrock @ 245

245-350 Arg (?) [log. Pyroclastic]

BOTTOM

A-78 Bedrock @ 203-210

210- 393 Arg (?) [log Pyroclastic]
w/ bleaching? veinlets.

393- 399 Felsite porphyry (?)

399-474 Arg (?) dark.
[log Pyroclastic - probably
footwall series]

BOTTOM

A-79 Bedrock @ 205 ± (Est.)

205-225 No Core

225- 593 Arg (?) [logged Pyroclastic] with high-degree of alt.
or bleaching. Much veining by
feldspathic? material.

339-395 Extensive shattering

BOTTOM

PIMA MINE LOGS

A-87 Bedrock @ 225 (?)

225-651 Arg? and/or Ark [log pyroclastic] w/ abundant blebs and veining of feldspathic? material

651-672 Arg (?) w/ cinnamon color (see DDH A-89)

672-782 Qtzite.

BOTTOM

A-84 Bedrock @ 201

201-938 Arg(?) [log pyroclastic] Much feldspathic? veining (or bleaching)

636-917 Breccia material with siliceous cement. (Pima logs continually refer to "crushed" or "shattered" material throughout most "Pyroclastic" (Papago Fm equivalent) intercepts. this reference to Breccia is, however, uncommon). Epidote throughout in small spots.

BOTTOM

A-91 Bedrock @ 215

215 - 677 Arg(?) and ark(?)
[log pyroclastic]

677 - 806 [log. Siliceous quartzose material - marker above hornf] Is this the hangingwall Rhyolite of Pima Mine?

806 - 814 Hornfels.

814 - 918 Marble

BOTTOM

A-92 Bedrock @ 228

228 - 358 Arg(?) [log Pyroclastic]

358 - 379 Felsite porphyry

379 - 433 Qtzt
Felsite porph 395-401

433 - 441 Mixed Felsite porphyry and Arg(?).

441 - 537 Felsite porphyry

537 - 565 Arg(?)

565 - 604 Felsite Porphyry [log Rhyolite] prob. Hanging wall rhyolite of Pima Mine

604 - 610 Hornfels, w/ magnetite.

610 - 625 Felsite porphyry [log rhyolite]

625 - 658 Hornfels and Tactite mixed.

658 - 675 Hornfels [log silicified or possibly silty or qtzitic]

675 - 679 Tactite

679 - 723 Siliceous. sugary texture. like 677-806 in DDH A-90

BOTTOM

DDH 82 — 30+99 W, 52+12 N, 3211'
Bedrock @ 217.5

217.5 - 371 Sandy Arg
371 - 380 Gg
380 - 408 limey Arg w/ garnet.
408 - 423 Qtzt, white light-grey
423 - 617 Tactite
617 - 680.5 Marble

BOTTOM

DDH 84 — 52+05 N, 44+30 W, 3238'
Bedrock @ 206'

206 - 226 Ark? leached
226 - 231 45° premin. fault.
231 - 384 Ark, coarse-gr.
384 - 408 Meta porphyry
408 - 517 Coarse ark to sandy Arg.
517 - 518 Gouge
518 - 579.5 Light grey-white qtzt.

BOTTOM

DDH 89 — 52+02 N, 57+45 W, 3251'
Bedrock @ 197

197 - 262 Metaporphyry - leached to 224.
262 - 625 Metaporphyry(?)
Gyp veinlets noted from 430-625

BOTTOM

DDH 91 — 3235', 56+44 N, 46+37 W
Bedrock @ 213

213 - 286 Ark or Qtzt
286 - 288 Metaporphyry
288 - 745 Ark & Qtzt. No data 450' to 724'
1½' Gg @ 301
314-318 Mp(?)
1' flt @ 350
406 - 440 Mo dissem
738 - 745 Mp.

745 - 770 Hornfels
770 - 822 Qtzt. Grey-white core broken to small pieces.

822 - 902 Tactite & Hornfels interbedded.
902 - 917 Marble w/ wollastonite
917 - 966 Tactite
966 - 1001 Marble

BOTTOM

DDH 92 — 54+20 N, 45+30 W, 3231'
Bedrock @ 204

204 - 370 Ark.
247-252 Mp?
370 - 382 Mp.
382 - 537 Ark
537 - 582 Mp.
582 - 602 Ark. (596-602 white to Brown Qtzt)
602 - 615 Hornfels (Serpentine & qtz)
615 - 590 Qtzt, grey white

DDH 93 — 46+47 N, 69+85 W, 3271'
Bedrock @ 169

169 - 362 Ark. pink, grey, and green. May be some Mp
362 - 388 Mp
388 - 420 Ark. May be some Mp
420 - 430 Grey qtzt(?) with garnet at beginning(?)
430 - 448 Hornfels
448 - 516 Tactite
516 - 520 Felsite porph. or meta porphyry. (assay .05)
520 - 530 Hornfels
530 - 579 Tactite w/ magnetite
579 - 605 Qtzt, grey-white
605 - 636 Tactite, with a few short areas of alt. limestone or marble.
636 - 647 Marble, yellow-grey
647 - 682 Marble.

BOTTOM

DDH 95 — 3233', 54+23 N, 43+00 W (+29 Listed in book)
Bedrock @ 204

204 - 687 Ark & qtzt
Gg 334-339
Flt zone 478-482
Mp ? 643-646
Local Hf(?) below 610

BOTTOM

DDH 98 — 3243', 52+03 N, 48+73 W.
Bedrock @ 203

203 - 280 Metaporph.
280 - 383 Hornf. (arkosic?)
383 - 390 Metaporph.
Fault 384-385
390 - 400 Gg and Hf.
400 - 415 Hornfels
415 - 495 Metaporphyry 485-95 w/ Hf.
495 - 502 Hornfels.
502 - 522 Qtzt, grey white.
522 - 537 Metaporph.
537 - 600 Qtzt, grey white
600 - 625 Hornfels
625 - 661 Qtzt, grey-white
661 - 682 Hornf.
682 - 716 Tactite
716 - 722 Hornf?
722 - 731 Tactite
731 - 809 Marble
809 - 830 Slightly altered Marble
830 - 888 Marble
888 - 900 Hornf.
900 - 994 Marble

BOTTOM

BANNER MINE
DDH GEOL
By McKenzie
Abstract by JEK
TR.MK. REG. U.S. PAT. OFF.

DDH 104

3242'
59+28 N
47+58 W

Bedrock @ 210

210 - 558 Ark & Qtzt
529-558 Possibly Mp
558 - 602 Hornfels
602 - 646 Metaporph — Faultzones 621 & 646
646 - 649 Hornfels
649 - 665 Metaporph.
665 - 732 Qtzt, grey white
732 - 774 Hornfels
774 - 778 Qtzt, grey-white
778 - 808 Tactite. Marble near top
808 - 821 Hornfels
821 - 866 Tactite
866 - 878 Marble

107

3273'
69+84 W
44+44 N

Bedrock @ 178

178 - 410 Metaporph
410 - 444 Qtzt, grey-white
444 - 454 Tactite
454 - 470 Hornfels
470 - 475 Qtzt, grey-white (Frags, No Core)
475 - 490 No Core
490 - 510 Tactite
510 - 532 Hornfels
532 - 540 Tactite
540 - 592 Marble

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
October 3, 1963

MEMO FOR MR. T. A. SNEDDEN:

MISSION ARGILLITE

Since the first of the year, the Mission mill averaged just over 20,000 tpd on a feed averaging about 23% argillite. As I understand it, this rate is 10-12% higher than indicated by grindability indices of around 12 for tactite-hornfels and 16 for argillite (based on a test of Pima argillite). In addition, day to day fluctuations of the argillite content --- say from zero to 75% --- have not shown corresponding fluctuations in the grinding rate, indicating that either (1) the argillite mined recently is softer than the average for the Mission, or (2) the Pima sample was harder (in terms of grindability) than the Mission average.

Mr. Kinnison and I visited the Mission pit September 30. Mr. Anzalone showed us the areas which produced most of the argillite mined in the past few months --- the south end of the 2770 bench and the southwest part of the 2890 bench. With the exception of very minor amounts of tactite and andesite dike rock, the material exposed is composed entirely of essentially typical argillite. In our opinion it is representative of 80 to 90% of the rock so classified in the Mission ore reserve; accordingly it is concluded that the difference in mill capacity between the predicted and actual is at least in part due to a somewhat higher degree of metamorphism in the Pima argillite than existing in the Mission argillite.

It is our conclusion that the past 9 months milling experience for argillite can be used in forecasting production rates --- with the reservation that something like 10% of the remaining argillite may be somewhat more difficult to grind, say equivalent to the Pima argillite with an index of 16+.

Original signed by
J. H. Courtright

J. H. COURTRIGHT

JHC/jk
cc: NWeiss
RBMeen
JDVincent
KERichard
JEKinnison

Metallurgical Samples

Lot No. 1 7/10/58

Tactite. Friable, partly euhedral, garnet; with some admixed soft diopside. The rock as mined is highly fragmented and contains a high proportion of fines. Pyrite and chalcopyrite are disseminated throughout, in more or less equal amounts. The fines contain considerable sulfides, and may contain a higher proportion of soft diopside than the rock fragments. A minor amount of gypsum is present.

Lot 2
Metallurgical samples
7/11/58

Tactite. Massive euhedral friable garnet, with a variable (zero to abundant) amount of soft diopside. Pyrite and chalcopyrite are disseminated throughout in fine to coarse grains, and occur both individually and as interlocked grains. A trace of hematite is present. Sulfides are locally associated with calcite. The rock as mined is highly fragmented and contains a high proportion of fines. Sulfides are abundant in the fine material.

Metallurgical Samples
Lot No. 3
7/14/58

Tactite. Massive garnet, both euhedral and structureless aggregates. Some diopside associated. Also a minor amount of diopside hornfels and a soft dense hornfels which is probably fine-grained diopside. Pyrite disseminated principally as small cubes, and chalcopyrite is heavily disseminated in large and small grains and as thin stringers. Trace of Molybdenite and sphalerite. Minor amount of heavy chalcopyrite in quartz gangue. The rock as mined is well broken with a high proportion of fines, which contain considerable sulfides.

Metallurgical Samples
Lot No 4

Tactite. Principally euhedral medium-grained garnet, with small and variable amount of diopside. Pyrite is weakly disseminated in grains and thin veinlets. Chalcopyrite is present but in less quantity than pyrite. The rock as mined is well broken and contains a high proportion of fines.

Metallurgical Samples
Lot No 5

Tactite. Massive structurless and euhedral garnet, with a moderate to locally heavy amount of soft diopside. Pyrite and chalcopyrite are heavily disseminated in about equal amounts, and vary from fine grains to large masses. Calcite is present, often associated with the sulfides, in small and large masses. A trace of sphalerite is present. Hematite is prevelent as fracture coating. Some quartz is interlocked with the sulfides. The rock as mined is highly fragmented and contains a high proportion of fines, which contain considerable sulfides.

Lot No 6

Metallurgical Samples

Tactite. Mostly structurless garnet with fairly abundant diopside, quantity somewhat variable. Pyrite and chalcopyrite disseminated in about equal amounts. Concentration of sulfides is spotty, the heavier dissemination generally occuring as large blebs. Some of the chalcopyrite is tarnished. Calcite fairly common, associated with sulfides. Hematite coats fractures. Rock as mined is well fragmented with a high proportion of fines containing considerable sulfides.

Lot No 7
Metallurgical samples.

Hornfels. Fine-grained soft diopside hornfels. Cpy is well disseminated in medium to large blebs and as thin veinlets. Py is occurs in minor quantities. Some of the vein cpy is well tarnished. Sphalerite occurs in minor amount along some cpy veins. The rock as mined is well fragmented, but contains more coarse material and fewer fines than did previous lots consisting of tactite. The fines contain some sulfides, but less than the tactite fines.

Metallurgical Samples
Lot No 10

Hornfels. White, soft diopside, mostly fine-grained granular, but partly as bladed or fibrous (probably hedenbergite molecule present), fine-grained aggregates. Chalcopyrite is the principal sulfide, and occurs as small to large heavily disseminated blebs and in short discontinous stringers. Pyrite is present as disseminated blebs. The rock as mined is well fragmented and contains a high proportion of fines, in about the same quantity as previous lots of hornfels. The fines contain some sulfides.

Metallurgical Samples
Lot No. 8

Hornfels. Fine-grained soft diopside. The principal sulfide is chalcopyrite, heavily disseminated in blebs and stringers. Pyrite is present but in a lesser quantity. The rock as mined is well fragmented, and contains a high proportion of fines, but in lesser amount than the previous lots of tactite. The fines contain a slightly greater amount of sulfides than the fines of lot No. 7.

METALLURGICAL SAMPLES

Hanging wall rock from Pima Mine pit — Lots 11

Argillite and sandy argillite.-- Light to dark brown, dense, very hard highly recrystallized argillite with local concentrations of small round quartz grains. The rock is quite hard to break with a geology pick, and breaks to a semi-conchoidal uneven fracture. Sulfides are disseminated moderately throughout the rock, but occur in equal abundance as thin vein fillings. Sulfides are mainly pyrite and chalcopyrite in about equal amounts, but either one may locally exceed the other. Individual disseminated sulfide grains are usually 1/2 to 2 mm. in size. The chalcopyrite shows prevalent tarnish, but some small amount of the tarnished sulfide may be bornite. Epidote and chlorite are frequently associated with the sulfide grains. Chlorite is also present as thin films on fracture surfaces. A trace of galena and sphalerite is present. The rock as brought from the Pima pit contains many large fragments, exceeding one foot, but no boulders. A small percentage of fines are present.

This sample contains rocks essentially identical ~~comparable~~ to ~~at least~~ a substantial part of the argillite rocks at East Pima which will be milled. It ~~does, however,~~ compares to the hardest type which will be encountered. ~~and~~ Possibly a large portion of the East Pima argillite is somewhat softer, at least from a crushing standpoint. The ratio of pyrite to chalcopyrite from this lot (about 1:1) is not representative, however, of most of the East Pima argillite. ~~The~~ At East Pima the ratio of pyrite to chalcopyrite will normally exceed 1:1, and may at times be several times greater. The sulfides at East Pima will be principally disseminated, and contain fewer sulfide veinlets, in contrast to this sample.

— Met. Samples —

Lot No 1 - 17D 69.3-74.1 S.D.

2 - 23D 83.9-88.8 S.D

3 - 31D 106.8-112.0 S.D

4 - 53D 154.3-158.8 S.D

5 - Slab, West wall S.D.
100.0-104.0

6 - Slab, west wall S.D.
96.0-100.0

7 - Slab, So. wall E.D.
81.3-86.8

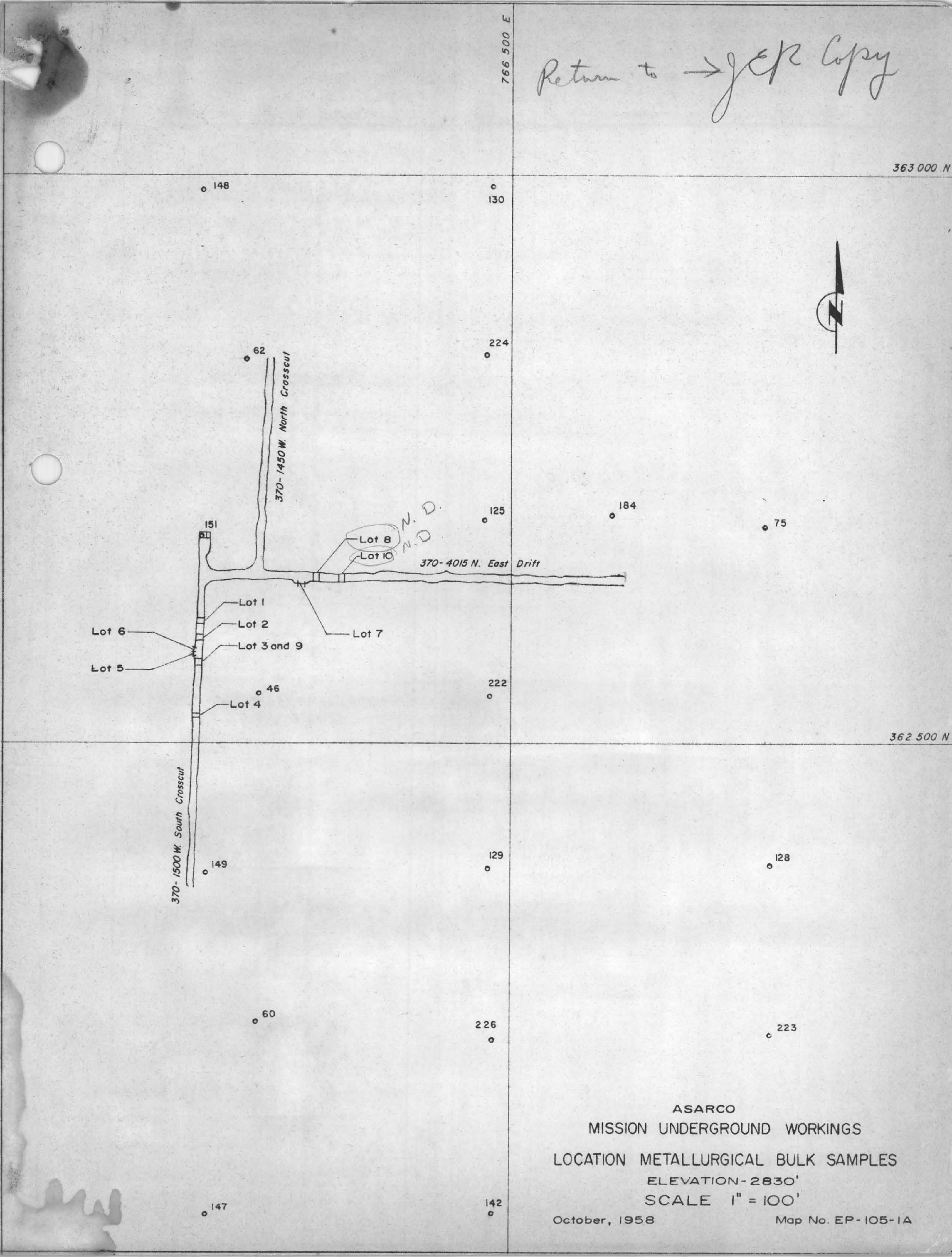
— 8 - 97D 95.0-100.0 N.D.

9 - (Same as Lot 3)
31D 106.8-112.0

— 10 - 109D -117.3-122.7 N.D.

11 - Pima Pit

Lots Numbered past 11
are composites of the
above.



ASARCO

MISSION UNDERGROUND WORKINGS

LOCATION METALLURGICAL BULK SAMPLES

ELEVATION-2830'

SCALE 1" = 100'

October, 1958

Map No. EP-105-1A

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
July 8, 1958

FILE MEMORANDUM

EAST PIMA
Pilot Mill Samples

It is planned that Mr. Kinnison will carefully inspect each batch of material before it is transported to the pilot mill. He will make a note-form mineralogical description of this material. A penciled copy of this description will be handed to Mr. Romney by the truck driver as the material arrives at the mill. Subsequently the description will be typed, with copies going to those listed below.

The first batch being crushed July 8, preparatory to transportation to the mill, is described as follows by Mr. Kinnison:

> Tactite; massive structureless garnet, some soft diopside. Chalcopyrite in 1/4" disseminated blebs. Pyrite-chalcopyrite ranges down in size, disseminated throughout in fair quantity. Maybe a trace of moly as pin point disseminated grains. Rock well broken.

Normally the exact location the material come from will be recorded with the description, but at the time the description was made for this first batch the location had not been measured.

Any suggestions regarding a change in this procedure, or in the character of the descriptions, will be welcome.

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
cc: ACHall
WCWaidler
NWeiss
JDVincent
ABRomney
bc: KERichard
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
July 17, 1958

FILE MEMORANDUM

MISSION - LOT 1
Metallurgical Samples

Description - 7/10/58

Tactite. Friable, partly euhedral, garnet, with some admixed soft diopside. The rock as mined is highly fragmented and contains a high proportion of fines. Pyrite and chalcopyrite are disseminated throughout, in more or less equal amounts. The fines contain considerable sulphides, and may contain a higher proportion of soft diopside than the rock fragments. A minor amount of gypsum is present.

Original Signed By
K. Richard

KENYON RICHARD

JEK/ds
cc: ACHall
WCWaidler
NWeiss
JDVincent
ABRomney
bc: KERichard
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
July 17, 1958

FILE MEMORANDUM

MISSION - LOT 2
Metallurgical Samples

Description - 7/11/58

Tactite. Massive euhedral friable garnet, with a variable (zero to abundant) amount of soft diopside. Pyrite and chalcopyrite are disseminated throughout in fine to coarse grains, and occur both individually and as interlocked grains. A trace of hematite is present. Sulphides are locally associated with calcite. The rock as mined is highly fragmented and contains a high proportion of fines. Sulphides are abundant in the fine material.

Original Signed By
K. Richard

KENYON RICHARD

JEK/ds
cc: ACHall
WCWaidler
NWeiss
JDVincent
ABRomney

bc: KERichard
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
July 17, 1958

FILE MEMORANDUM

MISSION - LOT 3
Metallurgical Samples

Description - 7/14/58

Tactite. Massive garnet, both as euhedral and structureless aggregates. Some diopside associated. Also a minor amount of diopside hornfels and a soft dense hornfels which is probably fine-grained diopside. Pyrite disseminated principally as small cubes, and chalcopyrite is heavily disseminated in large and small grains and as thin stringers. Trace of molybdenite and sphalerite. Minor amount of heavy chalcopyrite in quartz gangue. The rock as mined is well broken with a high proportion of fines, which contain considerable sulphides.

Original Signed By
K. Richard

KENYON RICHARD

JEK/ds
cc: ACHall
WCWaidler
NWeiss
JDVincent
ABRomney
bc: KERichard
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
July 28, 1958

FILE MEMORANDUM

MISSION - LOT 4
Metallurgical Samples

Tactite. Principally euhedral medium-grained garnet, with a small and variable amount of diopside. Pyrite is weakly disseminated in grains and thin veinlets. Chalcopyrite is present but in less quantity than pyrite. The rock as mined is well broken and contains a high proportion of fines.

JOHN E. KINNISON

JEK/ds
cc: ACHall
WCWaidler
NWeiss
JDVincent
ABRomney

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
July 28, 1958

FILE MEMORANDUM

MISSION - LOT 5
Metallurgical Samples

Tactite. Massive structureless and euhedral garnet, with a moderate to locally heavy amount of soft diopside. Pyrite and chalcopyrite are heavily disseminated in about equal amounts, and vary from fine grains to large masses. Calcite is present, often associated with the sulphides, in small and large masses. A trace of sphalerite is present. Hematite is prevalent as fracture coating. Some quartz is interlocked with the sulphides. The rock as mined is highly fragmented and contains a high proportion of fines, which contain considerable sulphides.

JOHN E. KINNISON

JEK/ds
cc: ACHall
WCWaidler
HWeiss
JDVincent
ABRomney

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 4, 1958

FILE MEMORANDUM

MISSION - Lot 6
Metallurgical Samples

Tactite. Mostly structureless garnet with fairly abundant diopside, quantity somewhat variable. Pyrite and chalcopyrite disseminated in about equal amounts. Concentration of sulphides is spotty, the heavier dissemination generally occurring as large blebs. Some of the chalcopyrite is tarnished. Calcite fairly common, associated with sulphides. Hematite coats fractures. Rock as mined is well fragmented with a high proportion of fines containing considerable sulphides.

JOHN E. KINNISON

JEK/ds
cc: ACHall
WCWaidler
KRichard
NWeiss
JDVincent
ABRomney

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 6, 1958

FILE MEMORANDUM

MISSION - Lot 7
Metallurgical Samples

Hornfels. Fine-grained soft diopside hornfels. Cpy is well disseminated in medium to large blebs and as thin veinlets. Py occurs in minor quantities. Some of the vein cpy is well tarnished. Sphalerite occurs in minor amount along some cpy veins. The rock as mined is well fragmented, but contains more coarse material and fewer fines than did previous lots consisting of tactite. The fines contain some sulphides, but less than the tactite fines.

JOHN E. KINNISON

JEK/ds
cc: ACHall
WCMaidler
KRichard
NWeiss
JDVincent
ARRomney

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 11, 1958

FILE MEMORANDUM

MISSION - Lot 8
Metallurgical Samples

Hornfels. Fine-grained soft diopside. The principal sulfide is chalcopyrite, heavily disseminated in blebs and stringers. Pyrite is present but in a lesser quantity. The rock as mined is well fragmented, and contains a high proportion of fines, but in lesser amount than previous lots of tactite. The fines contain a slightly greater amount of sulfides than the fines of Lot No. 7.

JOHN E. KINNISON

JEK/z
cc: ACHall
WCWaidler
KRichard
NWeiss
JDVincent
ABRomney

John

P-2.2.1

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 18, 1958

FILE MEMORANDUM

MISSION - LOT 10
Metallurgical Samples

Hornfels. White, soft diopside, mostly fine-grained granular, but partly as bladed or fibrous (probably hedenbergite molecule present), fine-grained aggregates. Chalcopyrite is the principal sulphide, and occurs as small to large heavily disseminated blebs and in short discontinuous stringers. Pyrite is present as disseminated blebs. The rock as mined is well fragmented and contains a high proportion of fines, in about the same quantity as previous lots of hornfels. The fines contain some sulphides.

JOHN E. KINNISON

JEK/ds
cc: ACHall
WCWaidler
KRichard
NWeiss
JDVincent
ABRomney

AMERICAN SMELTING AND REFINING COMPANY
Tucson   Arizona
August 18, 1958

<u>FILE MEMORANDUM</u>

Lot No. 9
<u>MISSION METALLURGICAL SAMPLES</u>

Lot No. 9 was a repeat of Lot No. 3 and therefore is not described.

JOHN E. KINNISON

cc: ACHall
WCWaidler
KRichard
HWeiss
JDVincent
ARRomney

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 22, 1958

FILE MEMORANDUM

MISSION - LOT 11
Metallurgical Samples

Hanging wall rock from Pima Mine pit.
Argillite and sandy argillite. Light to dark brown, dense, very hard, highly recrystallized argillite with local concentrations of small round quartz grains. The rock is quite hard to break with a geology pick, and breaks to a semi-conchoidal uneven fracture. Sulphides are disseminated moderately throughout the rock, but occur in equal abundance as thin vein fillings. Sulphides are mainly pyrite and chalcopyrite in about equal amounts, but either one may locally exceed the other. Individual disseminated sulphide grains are usually 1/2 to 2 mm. in size. The chalcopyrite shows prevalent tarnish, but some small amount of the tarnished sulphide may be bornite. Epidote and chlorite are frequently associated with the sulphide grains. Chlorite is also present as thin films on fracture surfaces. A trace of galena and sphalerite is present. The rock as brought from the Pima pit contains many large fragments, exceeding one foot, but no boulders. A small percentage of fines is present.

This sample contains rocks essentially identical to a substantial part of the argillite rocks at East Pima which will be milled. It compares to the hardest type which will be encountered. Possibly a large portion of the East Pima argillite is somewhat softer, at least from a crushing standpoint. The ratio of pyrite to chalcopyrite from this lot (about 1:1) is not representative, however, of most of the East Pima argillite. At East Pima the ratio of pyrite to chalcopyrite will normally exceed 1:1, and may at times be several times greater. The sulphides at East Pima will be principally disseminated, and contain fewer sulphide veinlets, in contrast to this sample.

JOHN E. KINNISON

JEK/ds
cc: ACHall
WCWaidler
KRichard
HWeiss
JDVincent
AHRomey

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
September 2, 1958

FILE MEMORANDUM

MISSION - LOT 12

Lot 12 is the same material as Lot 11 and therefore is not described.

JOHN E. KINNISON

ds
cc: ACHall
WCWaidler
KRichard
NWeiss
JDVincent
ABRomney

J E Kinnison

MIS-2.1

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
September 4, 1959

MEMORANDUM FOR T. A. SNEDDEN

MISSION ORE BODY
Analyses of Molybdenum
And Other Elements -
Composite Samples

This describes a collection of composite sample analyses for molybdenum and other metals through the entire Mission ore body. This basic information has, for the most part, already been used by you and others in your metallurgical considerations. The data is compiled here merely to get it all in one place for the record.

Sometime ago it was determined by Mr. Boss at Silver Bell that, due to the presence of tungsten, most of the molybdenum assays made during the course of the main drilling campaign were in error, or at least suspect. This was due to the obscure fact that in conventional analytical determinations of moly, any tungsten present tends to produce an erratic moly value, usually on the high side.

Early in the drilling program it was observed in the core that moly was in spotty occurrence and not in sufficient abundance to warrant systematic assaying of all individual core samples for moly. Occasionally, individual samples were assayed for moly in order to gain a general idea of the grade range. The fact that these random samples are now thought to be in error is of no particular consequence. The values for these random samples are recorded only on the "Drill Assay Logs" which are on file at the Mission Laboratory.

Eventually, a method for accurate analysis of moly was worked out by Silver Bell and checked. Composite samples then were made up to determine the average amount and distribution of moly in the ore body. These composites had the following specifications:

> All samples were inside or within a reasonable distance of the ultimate pit limit. All ore lenses of more than 30' in drillhole length were included. Each composite pulp was made up by combining weighed amounts from pulps of individual core samples, proportioned according to length of core run. Each composite consisted of ore lenses from several holes depending on area and ore type. The areas were selected as being structural units in a general sense. They are shown on the attached map (Att. A), whereon Areas A through D represent the eastern one-third of the ore body, and E through K the western two-thirds. The ore in each area was further subdivided according to the following ore types:

1. Tactite-Hornfels
2. Argillite (Papago formation, principally)
3. Mixed intercepts: tactite-hornfels with argillite and gypsum (intruded in part by thin metaporphyry sills)
4. Quartzite

The number of composite samples was limited due to the complexity and expense of the moly determinations.

Attachment B is a tabulation (1) of the individual core intervals constituting each of the 28 composite samples, (2) of the percent Cu of the composites as calculated (weighted) from original, individual core sample assays (Silver Bell), and (3) of the MoS2-Cu-WO3 assays of the composite samples by Silver Bell, using their revised and checked analytical procedure for moly and tungsten.

The drillhole intervals are plotted on a working set of the 100-scale Geological Sections in my office, and also on that set of 100-scale sections in Mr. Schubel's office which shows the ore blocks and yearly pit outlines.

The composite samples individually represent blocks of ore ranging in size from 0.5 to 7.8 million tons. Although the distribution of moly within each of these large blocks of ore is not known with any precision, by visual inspection of core it is erratic. The moly probably is somewhat concentrated in small zones sporadically distributed through the ore blocks. This condition is further evidenced by the fact that the above-average moly composite samples represent only one-third of the total ore body. Moly does not follow the copper; that is, higher grade copper ore does not necessarily contain better moly value, and some small occurrences of moly, up to .7 or .8% in grade, are in material which is below ore grade in copper. In some instances these small pockets of relatively high grade moly might be milled regardless of their sub-ore Cu content.

There appears to be no consistent favorability of moly for any one of the principal ore types, as shown on the following table:

Ore Type	Drillhole Length	Weighted % MoS2
Tactite-Hornfels	7467.9	.024
Argillite	3403.9	.023
Mixed	402.2	.075
Quartzite	1246.8	.021
Total and Average	12,520.8	.025

Although the lenses of "mixed" ore types on the above tabulation are erratically high in moly content, they constitute only a small portion of the ore body.

The following table groups the composites according to the areas shown on Attachment A:

Area	Drillhole Length	Weighted % MoS2
A	1176.5	.039
B	1023.5	.024
C	1624.3	.014
D	316.2	.018
E	1202.3	.035
F	444.2	.030
G	1937.7	.014
H	1232.2	.025
I	768.4	.028
J	883.5	.044
K	1912.0	.021
Total & Average	12,520.8	.025
Eastern Area (A thru D)	4,140.5	.024
Western Area (E thru K)	8,380.3	.026
Total & Average	12,520.8	.025

The above data suggest that the higher values in area A are related to the East vein, and those in areas I and J are associated with metaporphyry sills. Otherwise, there is no clear relation between the distribution of moly and those structures which are believed to influence copper distribution.

The composite sample blocks are re-calculated to correspond to the yearly ore production intervals of the ore reserve report of March 2, 1959, as follows:

Interval	Weighted % MoS2	Weighted % Cu
Pre-Mine	.030	.96
1st Year	.020	.95
2	.025	.95
3	.023	.97
4	.027	1.09
5	.026	1.30
6	.031	1.07
7	.027	.94
8	.027	.73
Ultimate	.023	.78
Average	.025	.90

When applied to the yearly open pit outlines, each composite sample becomes subdivided, and the assay value may appear in weighted proportion in several yearly intervals. As can be noted above, this has the effect of smoothing the moly values. This would seem to indicate that the mixing effect of mining will provide a uniform moly content in mill feed. However, this applies only when averaged over large production intervals. It is important to recognize that in short intervals of days or weeks the moly content of mill feed may fluctuate radically.

All of the composite samples have been analyzed spectrographically by our Central Research Laboratories. As a matter of record these results are included as Attachment C. Mr. Courtright and I discussed these data with Messrs. Weiss and Vincent. It was concluded that, with the exception as noted below of Pb and Zn, no elements other than moly are in sufficient abundance to be of present concern from the standpoint of extractive metallurgy.

Attachment D is a tabulation of the Zn-Pb-Au-Ag values in the composite samples, as reported by Jacobs of Tucson. He told me that accurate determinations of Zn and Pb in such small amounts are difficult, but that he took all possible care with these determinations. The Au-Ag assays were made merely to confirm the opinion that no significant concentrations of these metals occur within the ore body.

With the exception of one small composite, J1, which contains 0.46% Zn, the Zn and Pb assays range from trace to 0.06%. This demonstrates that, as an average through the ore body, these metals exist neither in recoverable nor in deleterious quantities. However, there are a number of irregular pods and lenses which contain from 1.0 to 10.0% of both Pb and Zn. Most of these bodies probably are small -- up to a few thousand tons -- and only rarely contain more than 1.0 or 2.0% Pb and Zn. But there is one occurrence in the eastern part of the ore body which might consist of as much as 100,000 tons. This is penetrated by drillhole 152 which shows 40.5' with an average of 8.3% Pb and 12% Zn. (See El Paso Flotation test 612F, 10/4/57.) Also, at the bottom of the ore body in the western part there is a fairly consistent layer containing sphalerite and lesser galena which ranges from 1 to 10 feet in thickness. This layer usually contains less than 4.0 or 5.0% Zn-Pb combined, but occasionally it will carry more.

Although these various Zn-Pb occurrences are of no consequence in terms of the whole ore body, they may possibly seem big for an occasional day's or week's mill run, say, unless this material is sorted out (stockpiled?) during mining in order to avoid short-term metallurgical difficulties.

In answer to a request from the Smelting Department for chemical analyses of the various ore types, six of the composite samples were selected as being representative, and were analyzed at the El Paso Umpire Laboratory. These results have already been reported in your letter of June 12, 1959 to Mr. Pope, but they are repeated here because they provide additional information on the distribution of elements in the ore body.

Composite No.	Cu	SiO2	Fe	CaO	Al2O3	MgO
A-1	1.61	40.68	10.15	24.26	5.53	5.35
C-1	1.01	41.06	8.66	25.82	3.93	7.70
C-4	1.35	49.27	8.04	13.85	8.23	3.51
G-2	0.84	61.34	5.14	5.45	10.09	2.88
H-1	1.10	45.35	10.13	20.0	3.43	6.65
I-3	0.48	44.18	3.17	15.08	4.83	3.45

Original Signed By
K. Richard

KENYON RICHARD

Attachments - A, B, C, D
KR/ds
cc, with attachments:
DJPope
CPPollock
NWeiss
JDVincent
ACHall
RBMeen
File Copy routed to:
WOSchubel
JHCourtright
SVFay
JEKinnison ☞

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 13, 1958

Mr. Norman Weiss
Milling Engineer
American Smelting and Refining Company
600 Crandall Building
Salt Lake City, Utah

EAST PIMA
Metallurgical Ore
Types and Distribution

Dear Sir:

Enclosed is a memorandum by Mr. Kinnison with attached diagrammetic section and tabulation giving relative percentages among ore types. The ore is subdivided into those physical types which seem to have fairly distinctive metallurgical characteristics, particularly as regards grinding and crushing. (As stated in the last sentence of Kinnison's memorandum, the ore body cannot yet be subdivided into types having clearly contrasting flotation characteristics.)

At one time I indicated to you that we possibly could determine the tonnages of the various metallurgical ore types within specified production periods. It now is apparent that this cannot be done accurately because the physical differences are too subtle and tend to vary too widely within each small, individual stratigraphic and structural unit of the ore body. However, when compared with his diagrammetic section showing ore in relation to the 2-year, 8-year and ultimate shape of the pit, Kinnison's tabulation provides a general idea of the proportions of the ore types and the periods during which the principal ones will predominate in the mill feed. Even though these data are no more than generalizations, they may be of help in the mill planning.

As we discussed during your last visit here, the physical character (in terms of grinding and crushing) of ore mined from this deposit will vary much more widely than at Silver Bell or any of the other large-scale disseminated deposits. This applies when considering hourly and daily production units as well as monthly and yearly intervals. Among the so-called porphyry plants, the Kennecott mill at McGill has probably handled the greatest variety of ore types during the past 20 years. This mill has treated large tonnages of material similar to some of the East Pima ore types, particularly tactite and hornfels. Of course, McGill's major tonnage has been ordinary porphyry ore, and I would not know the scheduling and mixing procedures. In any case, it would seem to me that the McGill mill feed may represent the closest physical comparison to some of the East Pima conditions, although it will not reflect the extremes during short time intervals which should be anticipated at East Pima.

A set of 18 specimens of typical ores has been selected and thin sections, petrographic descriptions and photomicrographs are now being prepared with emphasis on metallurgical problems, in accordance with our discussions with you. These will be sent to you soon.

By his copy Mr. Pope will be advised that a suite of typical ore specimens will be sent to him shortly.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

Attachments
cc - all with attachments:
DJPope
LHHart
NWeiss - 2 extra
JDVincent
RJMellen
bc: JHCourtright
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 10, 1958

MEMORANDUM TO K. E. RICHARD

EAST PIMA
Metallurgical Ore
Types and Distribution

The attached diagram and tabulation of rock distribution illustrates the occurrence and proportions of the different types of ore bearing rocks in the East Pima copper deposit.

The host rock types shown on the diagram and tabulation sheet constitute over 95 per cent of the material which will be milled, and with but slight modification are classified in the same manner as used on the geological sections prepared last summer (both Mr. Hart in the New York office and Mr. Lacy in the Salt Lake office have a set of these 100-scale sections).

The per cent distribution of the host rock types was estimated visually by studying the geological cross sections, and by utilizing general familiarity with East Pima geology. As such, this estimate is not a precise measurement but is the product of personal judgment guided by the data recorded on the geological cross sections. Furthermore, only ore bearing rocks within the ultimate pit (engineer's design of 1957) were considered, and any change in the shape of the pit will change somewhat the estimated per cent distribution.

The tests conducted at El Paso (Serial 612) have made apparent the fact that different rocks from East Pima react variously to grinding and require different flotation treatment.

From a metallurgical viewpoint, the following rock types are the most important:

1. Argillite. A generally very hard, siliceous rock, but commonly fractured. In part it contains stringers of chlorite and serpentine. It is essentially a silt-sized arkose with a variable quantity of small (less than 3/4 mm) sand grains. The grade of ore in this rock type is normally less than 0.8 per cent copper.

2. Quartzite. A pure, fine-grained quartzite, with silica cement. The grade of ore is normally less than 0.8 per cent copper.

3. Feldspar rock. In the eastern ore body coarse-to fine-grained feldspar, with some quartz, occurs as host to a small tonnage of better grade ore. It probably would compare metallurgically to the argillite.

4. Tactite. A garnet rich rock which varies from euhedral friable to structureless masses. It commonly contains admixed soft diopside, sometimes constituting a major portion of the rock. Some of the tactite is extremely hard and tough, but the diopside-rich type is a hybrid rock containing both hard and soft minerals which may produce a differential grinding problem.

5. Hornfels. The hornfels variety of host rock is more variable in character than are most of the other rocks. It is dominently a diopside rock, with minor garnet, but exhibits 3 physical types.

A. Hard, dense. This rock is massive and uniform, and microscopic work suggests that this type may contain more iron than types B. or C., and possibly it grades toward a fine-grained hedenbergite rock. This type may be hard to crush, but may grind more easily than tactite.

B. Fine-grained, granular. This type appears "sandy." It consists of granular massive diopside. The rock crushes fairly easily, and as indicated by El Paso mill test grinds easily also.

C. Fine-grained, pulverent. Similar to type B., but is finer grained and tends to disintegrate easily. This type may be expected to crush and grind easily.

Of these rock types, the tactite and siliceous rocks (argillite, quartzite, feldspar rock) are hard rocks, and the hornfels types are softer and require less grinding time. However, the hornfels types as a group show a wide range of physical properties.

There is as yet no clearly definable relation between the host rocks described above and the copper recovery or grade of concentrate.

JOHN E. KINNISON

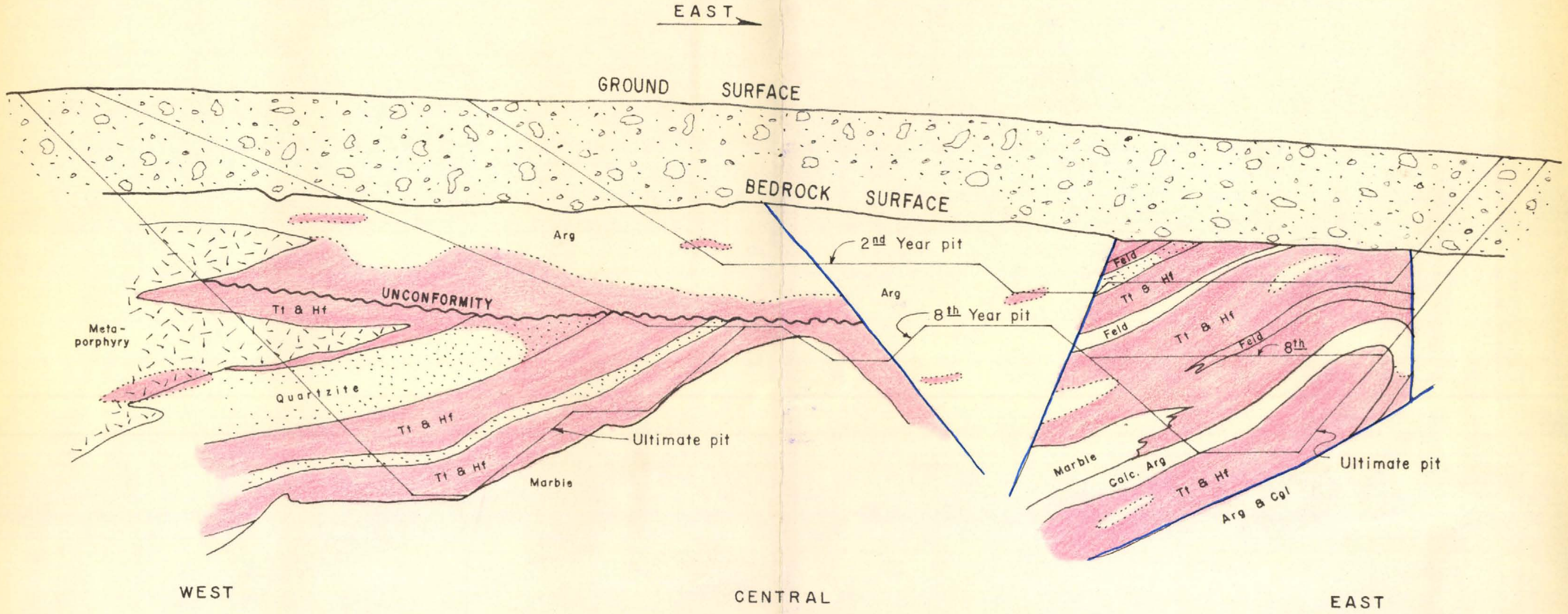
JEK/ds

DIAGRAMATIC CROSS SECTION – EAST PIMA

LOOKING NORTH

Showing Approximate Rock Distribution.

(NOT TO SCALE.)



Potential ore zones shown diagramatically in red.

TO ACCOMPANY Letter
DATED Mar. 10, 1958
BY John Kinnison

TABULATION – ORE HOST ROCKS.

(Within the ultimate pit.)

Host rock		West & Central Area				East Area			Total		
	Argillite	35%	35%	35%	35%	2%	2%	2%	25%	25%	25%
Lime silicate rocks	Tactite	30	30	30	60	75	75	90	43	43	68
	Hard, dense Hf (A)	9	10	30		—	—		4	25	
	Fn-gr, granular Hf (B)	12	20			9	15		12		
	Fn-gr, pulverent Hf (C)	9				6			9		
	Feldspar rock	—	—	—	—	6	6	6	3	3	3
	Quartzite	5	5	5	5	2	2	2	4	4	4

May 23, 1958

R. L. DuBois, Geologist
1309 East Elm Street
Tucson, Arizona

EAST PIMA PETROGRAPHIC
Descriptions for Metallurgy

Dear Sir:

We recently reviewed briefly with our metallurgists, Mr. Weiss and Mr. Vincent, your petrographic reports on the eighteen thin sections of specimens selected for metallurgic purposes. The metallurgists seemed quite pleased with this information and expect to make use of it during test work to be conducted with the University Pilot Plant here beginning in June or July. It seems to me that at that time they may have occasion to go into this matter further with you.

I believe that John Kinnison has already advised you that the metallurgists would like another set of the microphotographs, probably on dull finish prints, with some of the minerals identified in some manner by ink symbols.

Again let me say that the form and context of your reports are excellent.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
cc: NWeiss
JDVincent
JEKinnison

East Pima Metallurgy

Hand Specimens

Memo to K. E. Richard

The following descriptions pertain to a selected suit of samples collected for use

Papago formation

D.D.H 96 @ 262' Argillite. This sample shows some chloritic alteration, and is typical of much of the ore bearing argillite, although some varities are more dense and hard and lack the chloritic alteration. This rock type constitutes an important host in the central and western areas. Arkose (minor quantity) and conglomerate (locally dominant) have similar hard siliceous characters.

D.D.H. 48 @ 351' Argillite. This sample shows some chloritic and argillic (?) alteration.

D.D.H 88 @ 375' Argillite. Some chloritic alteration. Sulfides associated with quartz veins. This sample may be considerably recrystallized.

Pima formation.

D.D.H. 151 @ 344' Diopside hornfels. The fine-grained, granular, moderately soft variety, containing ~~are~~ diopside and calcite in varying amounts, which is the dominant type of hornfels. This rock type is an important host rock throughout the deposit. ~~Its minerals~~

D.D.H. 151 @ 370' Diopside hornfels. Like above sample, showing heavy sulfides

D.D.H. 138 @ 301' Diopside hornfels. Soft "clay-like" variety. This is a prominent type of ore host.

D.D.H. 151 @ 380' Diopside hornfels. Like 151 @ 344', showing heavy, disseminated sulfides.

D.D.H. 113 @ 383' Diopside hornfels. Abundant calcite. Hematite veins and dissemination, and disseminated sulfides.

D.D.H. 151 @ 313 Tactite with diopside. This sample shows a mixture of garnet and diopside in nearly equal amounts, and represents a transition phase between pure tactite and diopside hornfels.

D.D.H. 113 @ 374 Tactite. Massive garnet with possibly a small quantity of admixed diopside. Hematite and sulfides heavy. This type constitutes and important ore host in the central area, and locally is important elsewhere.

D.D.H. 49 @ 555'

Quartzite. This sample is typical of the quartzites of the Pima formation. They are not an important host rock.

D.D.H 32 @ 541'

Wollastonite hornfels with garnet. This sample shows typical coarse-grained fibrous wollastonite. Massive garnet occurs throughout the sample in large blebs. Sulfide disseminated in large blebs. Wollastonite is only locally important as a host rock.

Igneous

D.D.H. 101 @ 336'

Metaporphyry. Typical sample, but showing more Kaolinization (?) of the feldspar than normal. This rock only rarely consitutes an ore host.

Kinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 29, 1957

MEMORANDUM FOR MR. K. E. RICHARD

EAST PIMA
El Paso Tests - Serial 612-F

In reference to a letter by Mr. Norman Weiss, dated October 15, 1957, the following points seem pertinent:

Mr. Weiss classified the results of Serial report 612-F (El Paso Ore Testing Laboratory) into groups labeled good, fair, and poor. For the reasons listed below, in only one case is it fair to suscribe the poor results to an inherent rock characteristic.

Recovery possibly related to rock type or alteration

Test	Feed	Copper Conct.	Recovery	Rock Type	Comment
Test C, DDH 152-U	.46	13.48	67.0	Hornfels and Tactite	Both with clay alteration. Some Pb-Zn. Loss to rougher and cleaner tail.

Positive correlation to rock type impossible

Test	Feed	Copper Conct.	Recovery	Rock Type	Comment
Test H, DDH 160	.58	10.76	83.9	Siliceous	This sample contained values concentrated in a small part of the whole sample, therefore is a mixture of ore and waste. The grade of feed is such that in these tests somewhat lower grade concentrate would be expected. The feed contained 14%+65 mesh. The cleaner tail contained 1.62% Cu @ 6.6% recovery.
Test D, DDH 152-D	.62	2.43	74.8	Siliceous with carbonate	This sample contained abundant Pb-Zn and a Pb-Cu conct was produced. This unusual type needs special treatment.
Test M, DDH 164	.64	9.56	90.7	Tactite	This rock contained a high pyrite-chalcopyrite ratio. The grade of feed is such that in these tests a somewhat lower grade of conct would be expected. The combination of factors may have resulted in the very low conct grade.

	Feed	Copper Conct	Recovery	Rock Type	Comment
Test L, DDH 162	1.58	28.19	64.3	Hornfels	The rougher tailing contained 27%+65 mesh assaying 1.13% Cu.
Test E, DDH 154	1.64	22.75	77.4	Tactite	The rougher tailing contained 15.7% +65 mesh assaying .37%Cu, and the cleaner tailing loss was 10.5% to a product assaying 3.49% Cu.
Test O, DDH 167	2.70	28.30	77.0	Hornfels	The rougher tailing contained 6.5%+65 mesh assaying 2.55% Cu. In addition the sample contained a small amount of copper oxides and native copper, and a significant amount of chalcocite.

A definable relation between recovery and type of rock or alteration, with sufficient knowledge thereof to allow visual recognition with sufficient accuracy on which to estimate quantities, will probably require additional ore testing.

The following list of rocks which occur in the Pima formation (principal and most diverse of the host formations) suggests the magnitude of host rock complexity. It also should be remembered that these types may often occur in beds too small to be separated in an open pit mining operation.

Possible gangue combinations in Pima formation

Tactite

1. Massive garnet, varying from euhedral friable masses to structureless, soft to hard masses, with or without clay alteration.
2. Garnet in a matrix of other minerals such as diopside, serpentine, or others.

Hornfels

1. Hard, dense (massive) to soft and pulverent, and hard and granular. Mineral composition may vary and occur with or without veinlets of actinolite or serpentine, and clay alteration.
2. The above types with amounts of garnet, increasing transitional to tactite.

Tactite-hornfels

Mixture of the above mentioned types in patches large enough to be classified by themselves, but too small to be individually logged or separated on geological maps.

Others

Massive, fine to coarse-grained, actinolite or wollastonite.
Marble.
Feldspathic tactite, or garnetiferous feldspar rock.
Quartzite and argillite, with or without minor garnet.

JOHN E. KINNISON

JEK/ds

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 29, 1957

MEMORANDUM FOR MR. K. E. RICHARD

EAST PIMA
El Paso Tests - Serial 612-F

In reference to a letter by Mr. Norman Weiss, dated October 15, 1957, the following points seem pertinent:

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Recovery possibly related to rock type or alteration

Test C, DDH 152-U

Feed	Copper Conct.	Recovery	Rock Type	Comment
.46	13.48	67.0	Hornfels and Tactite	Both with clay alteration. Some Pb-Zn. Loss to rougher and cleaner tail.

Positive correlation to rock type impossible

Test H, DDH 160

Feed	Copper Conct.	Recovery	Rock Type	Comment
.58	10.76	83.9	Sili-ceous	This sample contained values concentrated in a small part of the whole sample, therefore is a mixture of ore and waste. The grade of feed is such that in these tests a somewhat lower grade concentrate would be expected. The feed contained 14%+65 mesh. The cleaner tail contained 1.62% Cu @ 6.6% recovery.

Test D, DDH 152-D	.62	2.43	74.8	Siliceous with car-bonate	This sample contained abundant Pb-Zn and a Pb-Cu conct was produced. This unusual type needs special treatment.
Test M, DDH 164	.64	9.56	90.7	Tactite	This rock contained a high pyrite-chalcopyrite ratio. The grade of feed is such that in these tests a somewhat lower grade of conct would be expected. The combination of factors may have resulted in the very low conct grade.

	Feed	Copper Conct	Recovery	Rock Type	Comment
Test L, DDH 162	1.58	26.19	64.3	Horn-fels	The rougher tailing contained 27%+65 mesh assaying 1.13% Cu.
Test N, DDH 154	1.64	22.75	77.4	Tac-tite	The rougher tailing contained 15.7% +65 mesh assaying .37%Cu, and the cleaner tailing loss was 10.5% to a product assaying 3.49% Cu.
Test O, DDH 167	2.70	28.30	77.0	Horn-fels	The rougher tailing contained 6.5%+65 mesh assaying 2.55% Cu. In addition the sample contained a small amount of copper oxides and native copper, and a significant amount of chalcocite.

A definable relation between recovery and type of rock or alteration, with sufficient knowledge thereof to allow visual recognition with sufficient accuracy on which to estimate quantities, will probably require additional ore testing.

The following list of rocks which occur in the Pima formation (principal and most diverse of the host formations) suggests the magnitude of host rock complexity. It also should be remembered that these types may often occur in beds too small to be separated in an open pit mining operation.

Possible gangue combinations in Pima formation

Tactite

1. Massive garnet, varying from euhedral friable masses to structureless, soft to hard masses, with or without clay alteration.
2. Garnet in a matrix of other minerals such as diopside, serpentine, or others.

Hornfels

Hard, dense (massive) to soft and pulverent, and hard and granular. Mineral composition may vary and occur with or without veinlets of actinolite or serpentine, and clay alteration.
The above types with amounts of garnet, increasing transitional to tactite.

Tactite-hornfels

Mixture of the above mentioned types in patches large enough to be classified by themselves, but too small to be individually logged or separated on geological maps.

Others

Massive, fine to coarse-grained, actinolite or wollastonite.
Marble.
Feldspathic tactite, or garnetiferous feldspar rock.
Quartzite and argillite, with or without minor garnet.

JOHN E. KINNISON

JEK/ds

190
7 1250

A-1 - 1092' - 154
A-4 - 140' - 20

B-1 - 1045' - 150

C-1 - 1305' - 186
C-2 - 165' - 22
C-4 - 205' - 29

D-1 - 315' - 45

E-1 - 942' 135
E-2 - 270' 38

F-1 - 325' 46
F-2 - 85' 12

G-1 - 770' 110
G-2 - 795 113
G-4 - 190 27

H-1 - 632 90
H-2 - 295 42
H-4 - 75 11

I-1 - 350' 50
I-2 - 210' 30
I-3 - 90' 13
I-4 - 85' 12

J-1 - 155 22
J-2 - 300 43
J-3 - 320 46
J-4 - 115 16

K-1 - 282 40
K-2 - 1090 154
K-4 - 275 39

Composites - see sections

Formations

1. Tac - Hufls.
2. Papago
3. ~~Mildapos.~~ Tt-Hf (Arg. & gypsiferous) w/ thin Mp sills
4. Qtz.

Areas

a, b, c, d } Eastern area

e, f, g, h, i, j, K. } Western 2/3

inside or
All comp. within
reasonable distance
of ult. pit

all ore lenses
over ± 30' in drill
hole length

~~File Memorandum~~

Memorandum for:

Mr Kenyon Richard

~~cc~~

East Pima

El Paso Tests – Serial 612F

~~Dear Sir:~~

In reference to a letter by Mr. Norman Weiss, dated October 15, 1957, the following points seem pertinent:

Mr Weiss classified the results of serial report 612-F (El Paso Ore testing laboratory) into groups labeled good, fair, and poor. For the reasons listed below it is not fair to suscribe the poor results to an inherent rock characteristic in only one case.

Recovery Possibly related to rock type or alteration

	Feed	Copper Conct.	Recovery	Rock Type	Comment
Test C, DDH. 152-U.	.46	13.48	67.0	Hornfels and Tactite,	both with clay alteration. Some Pb-Zn. Loss to rougher and cleaner tail.

Positive correlation to rock type impossible

		Feed	Copper conct.	Recovery	Rock Type	Comment
Test H,	DDH. 160	.58	10.76	83.9	Siliceous.	This sample contained values concentrated in a small part of the whole sample, therefore is a mixture of ore and waste. The grade of feed is such that in these tests a somewhat lower grade concentrate would be expected. The feed contained 14 % +65 mesh. The cleaner tail contained 1.62 % Cu @ 6.6% recovery.
D	152 D	.62	2.43	74.8	Siliceous with carbonate.	This sample contained abundant Pb-Zn, and a Pb-Cu conct was produced. This unusual type needs special treatment.

Possible gangue combinations ~ Pima formation

Tactite

1. Massive garnet, varying from euhedral friable masses to structureless, soft to hard masses, with or without clay alteration.

2. Garnet in ~~with~~ a matrix of other minerals such as diopside, serpentine, or others.

Hornfels.

Hard, dense (massive) to soft and pulverent, and hard and granular. Mineral composition may vary, and occur to with or without veinlets of actinolite or serpentine, and clay alteration.

The above types with ~~small~~ increasing amounts of garnet, ~~varying upward~~ transitional to tactite.

Tactite-hornfels

Mixture of the above mentioned types in patches large enough to be classified by themselves, but too small to be individually logged or separated on geological maps.

Others

Massive, fine to coarse-grained, actinolite ~~or~~ wollastonite.

Marble.

Feldspathic tactite, or garnetiferous feldspar rock.

Quartzite and argillite, with or without minor garnet.

~~Any of these rocks~~ types ~~may occur in lenses too small to separate placing~~ mining.

Yours very truly,

John E. Kinnison

Test	DDH	Feed	Copper Conct	Recovery	Rock type	Comment
~~M~~	164	.64	9.56	90.7	Tactite	This rock contained a high Pyrite-chalcopyrite ratio. The grade of feed is such that in these tests a somewhat lower grade of conct. would be expected. moreover the combination of factors may have resulted in the very low conct. grade.
L	162	1.58	28.19	64.3	Hornfels	The rougher tailing contained 27% +65 mesh assaying 1.13 % Cu.
E.	154	1.64	22.75	77.4	Tactite	The rougher tailing contained 15.7 % + 65 mesh assaying .37 % Cu, and the cleaner tailing loss was 10.5 % to a product assaying 3.49 % Cu.
O	167	2.70	28.30	77.0	Hornfels.	The rougher tailing contained 6.5% +65 mesh assaying 2.55 % Cu. In addition the sample contained a small amount of copper oxides and native copper, and a significant amount of chalcocite.

A definable relation between recovery and type of rock or alteration, with sufficient knowledge thereof to allow visual recognition with ~~types with a~~ sufficient ~~to~~ accuracy on which to estimate quantities, will probably require additional ore testing.

~~As an indication of the host rock complexity,~~ ¶ The following list of rocks which occur in the Pima formation (principal and most diverse of the host formations) suggests the magnitude of host rock complexity. It also should be remembered that these types ~~may~~ often occur in beds too small to be separated in an open pit mining operation.

Siliceous Rocks

Not useful for this analysis

DDH 150 .20% heads

152 High Pb-Zn, produce Pb-Cu Conc.

160 19% +65 mesh

Good tests

DDH	Possibilities	
78	Cl Tail	Pgf
134	Cl Tail (also contained some Cu)	(Pgf)

Low grade Conc

DDH	Possibilities		
158	?	Pgf	
162	?	Pgf	
171 218-263, 324-338	?	Pgf	Mixed Tt-feld-Arg
175 307-316, 326-350	?	Pgf	Mixed Tt, Hf, Arg.

different Cell and in Ball mill diff reagents. shorter Res time

6/2 !!

Flotation Test
East River Ore

A review of flotation tests made at El Paso, for the purpose of ~~in order to~~ arriving at some conclusions regarding the relation of rock types to flotation recovery, has brought to light the following points which must be cleared up before an evaluation of test results for purposes of this review can be completed.

1. The data sheets of serial reports 612 to 612c report, among other things, these critical data: per cent copper in "copper concentrate", "cleaner tails", and "rougher tails", together with the weight and per cent recovery of each. The total weight and total per cent recovery of the three products equals 100 per cent. The recovery of copper is apparently obtained by using the weight and assay of the heads in ratio with the weight and assay of the individual product. Due to inherent limit of accuracy these percentages do not total precisely 100 per cent, and are adjusted in ratio with the weights of the products. My attempts to duplicate this work shows small differences with that given by El Paso, which may result from methods of rounding off figures, or possibly these figures were computed by slide rule at El Paso. Two examples are tabulated below.

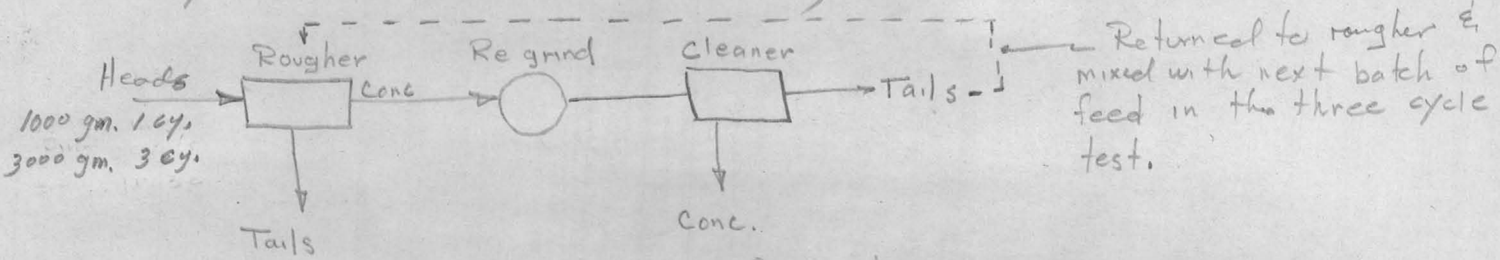
Serial 612-c test A. 3 cycle

	Weight	Assays	Recoveries	JEK calculation Measured Rec.	Adjusted Rec.
Feed	3000 grams	2.17 % Cu	—	—	—
Copper Conc.	198	30.84	94.1 %	93.8	94.1
Cleaner Tails	60	2.92	2.7	2.7	2.7
Rougher Tails	1742	.077	3.2	3.2	3.2
Totals	3000		100	99.7	100

Serial 612-C Test B Single Cycle

	Weights	Assays	Recoveries	JEK Calculation Measured Rec	Adjusted Rec
Feed	1000 grams	.58 %	—	—	—
Copper conc	14	24.33	57.1%	58.7%	57.1 %
Cleaner Tail	86	1.93	28.3	28.6	27.9
Rougher Tail	900	.098	14.6	15.2	14.8
	1000		100	102.5	100

From the data presented on the test sheets, summaries are compiled which quote the per cent copper in the copper concentrate, together with the corresponding recovery. The point I wish to make is that the cleaner tails, which are really a middling, and are returned to the second stage rougher in the three cycle test, represent a circulating load which would be a part of the total copper recovery in closed circuit mill operation. The flow sheet of the tests, as I understand it, is:



The concentrate weight and assay in three cycle tests are presumably obtained from the combined concentrates. The cleaner tailing weight and assay is probably (?) the third cycle product.

Only in the first report (612) are the recoveries for copper concentrate and cleaner tailing combined in the summary to indicate total copper recovery.

Taggert has the following comment on laboratory tests:

Taggart, p. 12 30

"The recovery [in a mill] will come close to the indicated extraction calculated by the formula (10), p. 1236, from the laboratory results, if, in the calculation, the figure for grade of concentrate is that obtained from the cleaner operation, the figure for the rougher tailing is that obtained from the rougher operation, and the middling or cleaner tailing obtained in the laboratory is disregarded, provided that the grade of this middling product is not more than twice the grade of the original heads, and that the mineralogical character of the middling is not markedly different from that of the original feed."

formula 10, p 1236.

$$\text{Recovery (\%)} = \frac{100 \times \text{assay of conc.} (\text{Assay of feed} - \text{Assay of tail})}{\text{Assay of feed} (\text{Assay of conc} - \text{Assay of tail})}$$

Using Test B, Serial 612-C (see table above), this formula gives:

$$100 \times \frac{24.33(.58 - .098)}{.58\ (24.33 - .098)} = 83.4\ \%\ \text{Recovery}$$

¶ This formula, in effect, assumes that only the copper in the rougher tails is lost, and that, under the limitation set forth, all the cleaner tailing will be recovered. Thus, adding the cleaner concentrate and cleaner tailing recoveries yields an equivalent result: 57.1 + 28.3 = 85.4 % recovery. The difference in results is explained by the fact that one method uses assays only, and the other uses assays (some from different products), and weights which are reported to the nearest gram.

The foregoing analysis leads me to believe that there exists a fundamental error in the method of reporting results; furthermore, concentration ratio, where reported, has been derived directly from the weights of the feed and "copper concentrate", thus ignoring the possible effect of the circulate load from the cleaner tailing, which may be appreciable is some instances.

2. In the tests of Serial report 612-D to 612-F, a three cycle flow sheet is used in which the third cycle cleaner produces a "second copper concentrate", which is combined with the "first copper concentrate" in the summary results. Since I do not understand the mechanics of producing the two concentrates, there is nothing on which to base an intelligent opinion concerning the relation of the cleaner tails to a final recovery.

Conclusions: Before attempting to analyze the effect of rock type on flotation results, the above points must be clarified.

612-E

Tested 148-149-150-151-152 individually

			Grinding time	% -200
148	296-306 / 312-363	Hf w/ some grnt.	3 1/2 / 5 1/2	64 1/2 / 57 1/2
148	432-452	Tt	3 1/2	68
149	236-281	Tt -14' & grntiferous Hf (Tt &) & G-Hf	4 1/2	64
149	281-359	Tt. some Dense Hf at beginning.	5	61
149	363-408	Tt	6	46.8
150	794-834	Arg w/ some ark.		
151	280-301 / 354-385	Tt - 21' / Hf 31' — Tt & Hf / fn-gr granular diof.	3 1/2 / 9	63 / 26 1/2
152	314-355	Tt		

65.2 gr.

612 May 1 1956

7 crushed samples gave poor recovery

1 uncrushed sample (DDH 62) gave good recov. (294.3 - 305.8) "Hornfels" type. Woll, some serp., Mb, and dense mineral

612 A - July 1956

Grinding was not tested accurately but the time to grind through the same mesh size is as follows

DDH 68	407-420 -	Hornfels	5	minutes	(75% -200)
76	408-418 -	Tactite	10	"	(76% -200) (sludge board)
78	276-332 -	Ark or Arg	16	"	(?)

68 - 28.65% conct w/ 84.9% recov (best of 3 test)
76 - 29.72 " 87.4% " (best of 2 test)
78 - 29.23 " 89.2% " (one test)

612 A - March 1957

DDH 125 282-330' - Tt. w/ hematite

29.74 % conct	91.2 % rec.	also tested molly
29.19	89.7	
28.12	92.0	

612 - C April 1957

DDH 134 243 - 287, 297 - 304 } 2.17 % Cu | 69% Massive feldspar, 31% quartzite

142 292 - 288 } .58 % Cu Tactite

Grinding time 134 - 20 minutes
142 - 12 minutes

243-278
47
35
16
51

87
78
9
1/6

134 readily gave 94% recovery in a 30.8% conct.

142 would yield no better than 83% recovery in a 25% conct. Mellen attributes this to high Py-cpy ratio (.58% Cu and 9.8% Fe).

612 - D - Composite of 8 samples

151 200

Hornfels

Not useful for analyses

DDH 162 - 27% +65 mesh

Good Test

DDH	Possibilities	
62	Cl Tail	Not typical Hf.
151 280-301	—	Tt & diop Hf.

Fair Test

DDH	Possibilities	
68	Cl & Ro Tail	5' 75% -200
151 443-486	Cl & Ro Tail	

Poor Test

DDH	Possibilities	
86 AD	Ro Tail	Mixed Hf-Tt-Qfm high Fe/Ca ratio
167	Ro Tail	Arg. Hf. 40% Ca ore.

Tactite

High conc

Good Ro Rec	Fair Ro Rec	Poor Ro Rec.
125 - cl	76 Mixed	
148 296-306 Cl - Ro? Mixed	142 Cl	
148 432-452 Ro?	149 236-281 Cl? Mixed	
168 Cl? (HA)	149 363-408 Cl	
171 388-417 Cl - 10% +65	178 413-450 Cl Mixed	
178 350-413 Cl?		
174 Cl, Ro. (H.A.)		

Low Conc

152 437-486 Ro-cl poor. Mixed, clay alt.

158 310-348 Ro fair

161 451-504 Ro fair Cl good Mixed., silic.

161 321-347 389-404 Ro good Cl fair

164 Ro fair Cl good High Fe/cu

166 Ro fair Cl good Tt & qtz

(HA) 173 Ro fair High Fe/cu

(HA) 178 250-299 Ro fair Cl fair

178 299-365 Ro-cl good

Polished sections of probable interest to metallurgical tests.

X-Section Geol. Log	Sirvas No.	Hole & depth		Thin section (DuBois classification)
	P 5	DDH A2 @	392.5	– TS. Diop. Tran.-Act. Hf
	P 7	47	422.0	– (TS - 427' - Tt)
	P 7a	47	418.0	–
(Tt)	Hf - P 13	22	456.5	– No TS – H
spng-chl Gnd.	Hf - P 15	56	766.0	– No TS
Hf	Hf - P 17	45	804.5	– (T.S - 795 qtz-diop Hf)
Tt	Tt - P 19	78	745.0	–
?	Hf - P 20	90	366.0	– TS 364 Diop Hf.

East Pima

The metallurgical sample results furnished by El Paso, analyzed by rock type, show the following trends.

The tests of siliceous rocks inconclusively suggest that good recoveries can be made. Of the 9 tests on siliceous types, 3 were not subject to analysis. Two gave good recoveries with good concentrates and a possibility of additional recovery from the cleaner tail. The remaining four, two of which were mixed tactite and argillite, gave low grade concentrates. These rocks need further testing, particularly checking the possibility that the low grade concentrates were caused by locked pyrite-chalcopyrite grains, and may require a finer grind.

The tests of hornfels show varied reaction. Of the 7 tests on hornfels, one was not subject to analyses, two gave good recoveries, two gave fair recoveries, and two gave poor recoveries, all producing a suitable grade concentrate. One of the good tests was made on a sample not typical of the hornfels as a general group; the fair tests show the possibility of further recovery from the cleaner tailing, but also a sizable loss to the rougher tailing; and the poor tests, one of which was made on a mixed rock not typical of hornfels and one on the soft variety of hornfels, both gave a high loss to the rougher tailing. The latter test on soft hornfels, however, was complicated by nearly half the sample containing some chalcocite. These rocks need further testing.

Siliceous

DDH No	Feed %Cu	Feed %Fe	Cleaner Conc % Cu	Cleaner Conc % Rec	Cleaner tail % Cu	Cleaner tail % Rec	Ro Tail % Cu	Ro Tail % Rec	Remarks
78	1.18	4.8	29.23	89.2	.72	5.4	.072	5.4	Pgf
134	2.17	4.7	30.84	94.1	2.92	2.7	.077	3.2	Massive feldspar, & qtzt w/minor Tt. some Cc
150	.20	4.0	14.15	69.6	.57	12.6	.036	17.8	
152 504-545	Pb-Cu Conc.								Pre-min Bx and cgl.
158 253-298	1.13	6.3	14.05	89.5	1.00	3.4	.116	9.1	Pgf
160	.58	3.5	10.76	83.9	1.62	6.6	.060	9.5	14% +65 Pgf
171 218-363 324-338	.57	6.0	17.87	87.6	.44	2.5	.060	9.9	Arg (feld) and Tt Pgf
[illegible] 307-316 326-350	2.39	8.5	21.50	94.6	.090	2.3	.089	3.1	Tt and Arg (feld)
162	.85	3.3	14.54 -	88.9	.41 -	1.8	.087	9.3	Pgf

Tactite

DDH No	Feed % Cu	Feed % Fe	Cleaner Conc % Cu	Cleaner Conc % Rec.	Cleaner Tail % Cu	Cleaner Tail % Rec	Ro Tail % Cu	Ro Tail % Rec	Remarks
76	.90	—	29.72	87.4	.86	2.3	.097	10.3	sludge board. Log Hf w/grnt
125	1.11	12.9	29.74	91.2	1.50	5.3	.039	3.2	w/hematite. (Mo conc)
142.	.58	9.8	25.50	83	1.09	4.7	.068	12.3	Massive Grnt.
148 296.1-306	1.69	6.5	31.08	88.5	6.00	5.7	.105	5.8	Sludge Board. Loc Grnt'ous Hf
148 432-452	3.14	8.2	27.31	96.6	1.11	.6	.100	5.7	
149 236-281	.58	6.3	22.85	87.4	.69	2.2	.063	10.4	Mixed Tt and Cs gr Axinite.
149 280-359	.33	3.1	28.89	79.3	1.43	3.0	.059	17.7	Tt & Hf. - Grnt, diop Axinite.
[illegible] 363-408	.41	7.9	28.75	84.6	.87	2.5	.053	12.9	
152 314-355	.29	8.1	16.13	89.9	.34	1.4	.026	8.7	Tt & Hf
152 437-486	.46	6.4	13.48	67.0	2.37	11.8	.079	16.4	Tt and Hf, both clay like.
154	1.64	8.9	22.75	77.4	3.49	10.5	.221	12.1	Tt & silic. Hf. 15% +65
158 310-348	.70	7.3	19.59	88.8	.34	1.1	.075	10.1	
161 451-504	2.23	10.4	23.91	90.9	.85	1.9	.18	7.2	Tt & Silic. Hf., some qtzt.
164	.64	13.5	9.56	90.7	.144	2.2	.05	7.1	Tt
166	.55	5.8	14.87	90.6	.28	1.8	.045	7.6	Tt & arg (Pgf)
168 50'	1.93	11.2	29.79	95.0	1.19	1.2	.078	3.8	Co lost 10' H. A.
171 388-417	5.31	19.4	26.75	96.4	2.00	1.6	.139	2.0	10% +65
173	.39	16.6	17.00	89.8	.33	1.3	.036	8.9	w/ Hem. H-A
174	2.78	18.0	28.39	93.1	2.09	1.9	.158	5.0	H-A
178 250-299	.66	11.6	23.35	90.9	1.17	2.4	.031	6.7	
178 299-365	1.20	11.0	23.46	97.3	.36	.7	.025	2.0	
178 356-413	1.49	9.1	30.30	96.0	1.32	1.4	.041	2.6	Possible Tr Cc.
178 413-450	2.29	12.1	29.89	84.6	5.36	8.8	.168	6.6	Tt & dense Hf
161 321-347 389-404	1.38	6.3	22.27	93.3	.82	2.0	.073	4.7	Tt, dense Hf, and qtzt

Hornfels

DH No	Feed % Cu	Feed % Fe	Cleaner Conc % Cu	Cleaner Conc % Rec	Cleaner tail % Cu	Cleaner tail % Rec	Ro Tail % Cu	Ro Tail % Rec	Remarks
62	1.15	—	33.60	92.6	4.34	2.64	.026	1.97	"Hornfels" type. Woll & Mb w/ Some serp and dense white silicate. LoG Ls. (2 tests)
68	1.02	—	28.65	84.9	.84	2.2	.14	12.9	LoG SH.
151 280-301 354-385	2.04	7.4	29.17	97.9	.69	.5	.037	1.6	Hf- fn-gr gran. diop. 31' Tt- 21'
86 AD	.61	16.0	28.28	83.2	.78	2.0	.094	14.8	q-fm & Hf, & Tt,
151 443-486	1.38	3.9	26.82	86.8	.95	2.7	.158	10.5	Hf (arg) & Mb
[162 444-464 483-493	1.58	3.3	28.19	64.3	1.05	3.2	.56	32.5	prtly crushed. sulfide vein: Act halo's. 27% +65
167 230-284	2.70	4.1	28.30	77.0	.165	.2	.686	22.8	Argill. (20' ?c)

Hole	Final Conc't Grade	Final Conc't Recovery	Cl. Tail Grade	Cl. Tail Recovery	
D.D.H 86A	28.28	83.2	0.78	2.0	X
151	26.82	86.8	0.95	2.7	X
152	13.48	67.0	2.37	16.6	—
152	Pb – Cu				
154	22.75	77.4	3.49	10.5	—
158	14.05	87.5	1.00	3.4	—
158	19.59	88.8	0.34	1.1	x
160	10.76	83.9	1.62	6.6	←
161	22.27	93.3	0.82	2.0	X
161	23.91	90.9	0.85	1.9	X
162	14.54	88.9	.41	1.8	—
162	28.19	64.3	1.05	3.2	X
164	9.56	90.7	0.44	2.2	—
166	14.87	90.6	0.28	1.8	—
167	28.30	77.0	0.165	0.2	X
168	29.79	95.0	1.19	1.2	X
171	17.87	87.6	0.44	2.5	—
171	26.75	96.4	2.00	1.6	X
173	17.00	89.8	0.33	1.3	—
174	28.39	93.1	2.09	1.9	X
175	21.50	94.6	0.09	2.3	—
178	23.35	90.9	1.17	2.4	—
178	23.46	97.3	0.36	0.7	X
178	30.30	96.0	1.32	1.4	X
178	29.89	84.6	5.36	8.8	—

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

November 20, 1957

NOTICE

THANKSGIVING DAY, NOVEMBER 28, WILL BE OBSERVED AS A HOLIDAY. DO NOT REPORT FOR WORK UNLESS SO INSTRUCTED BY YOUR FOREMAN.

D. R. Purvis
Superintendent