CONTACT INFORMATION
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3550 N. Central Ave, 2nd floor
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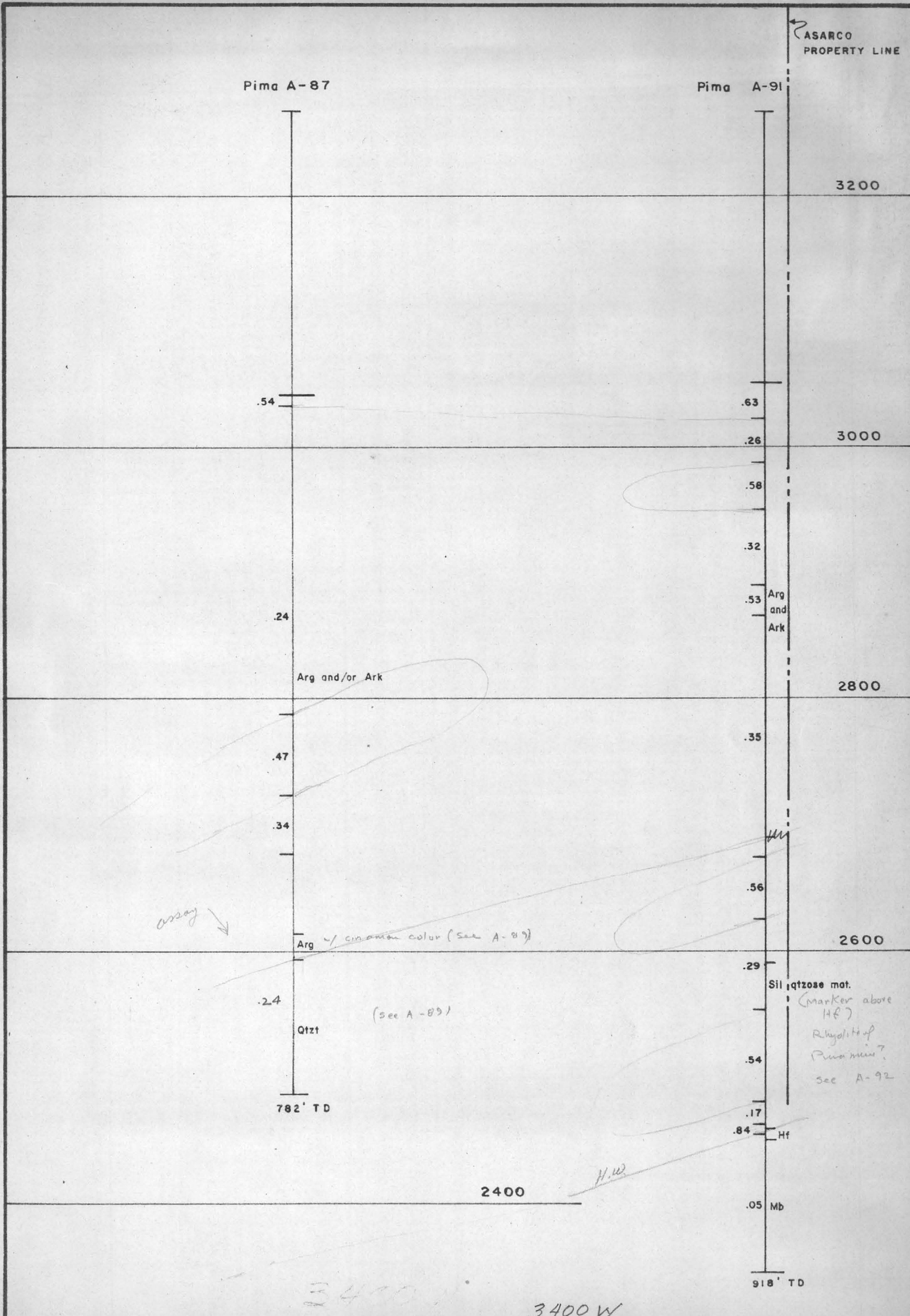
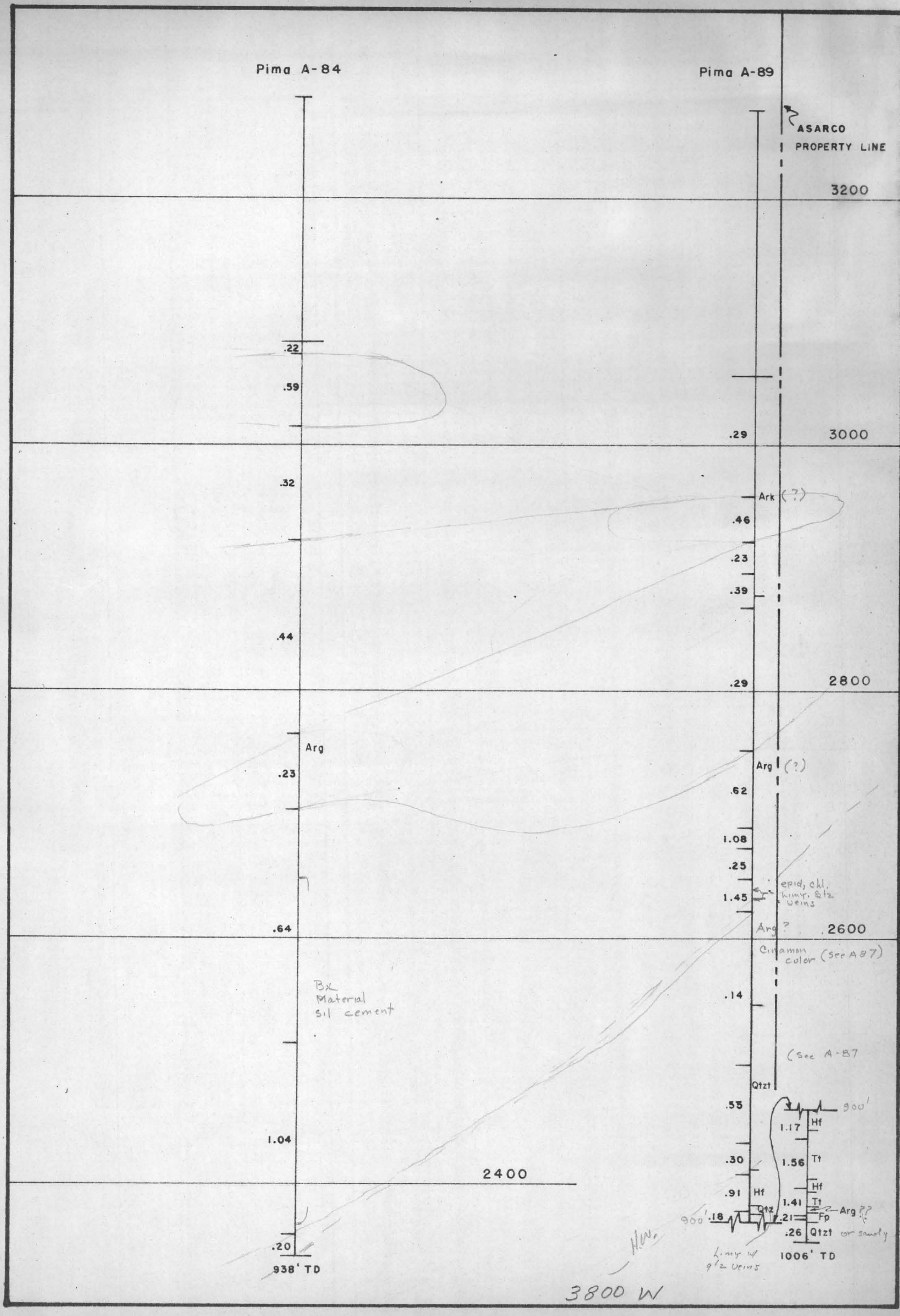
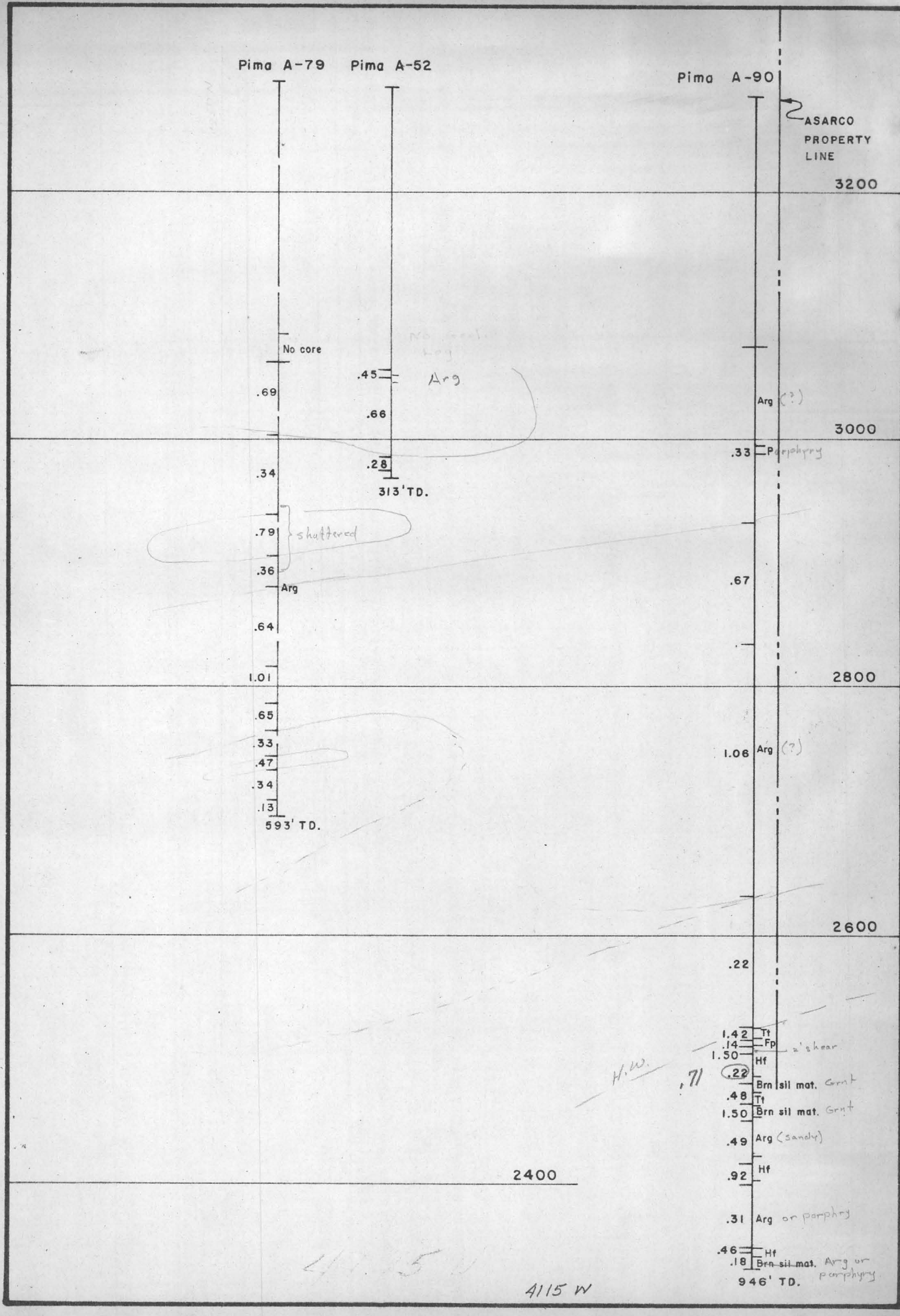
Drill Logs — Pima.



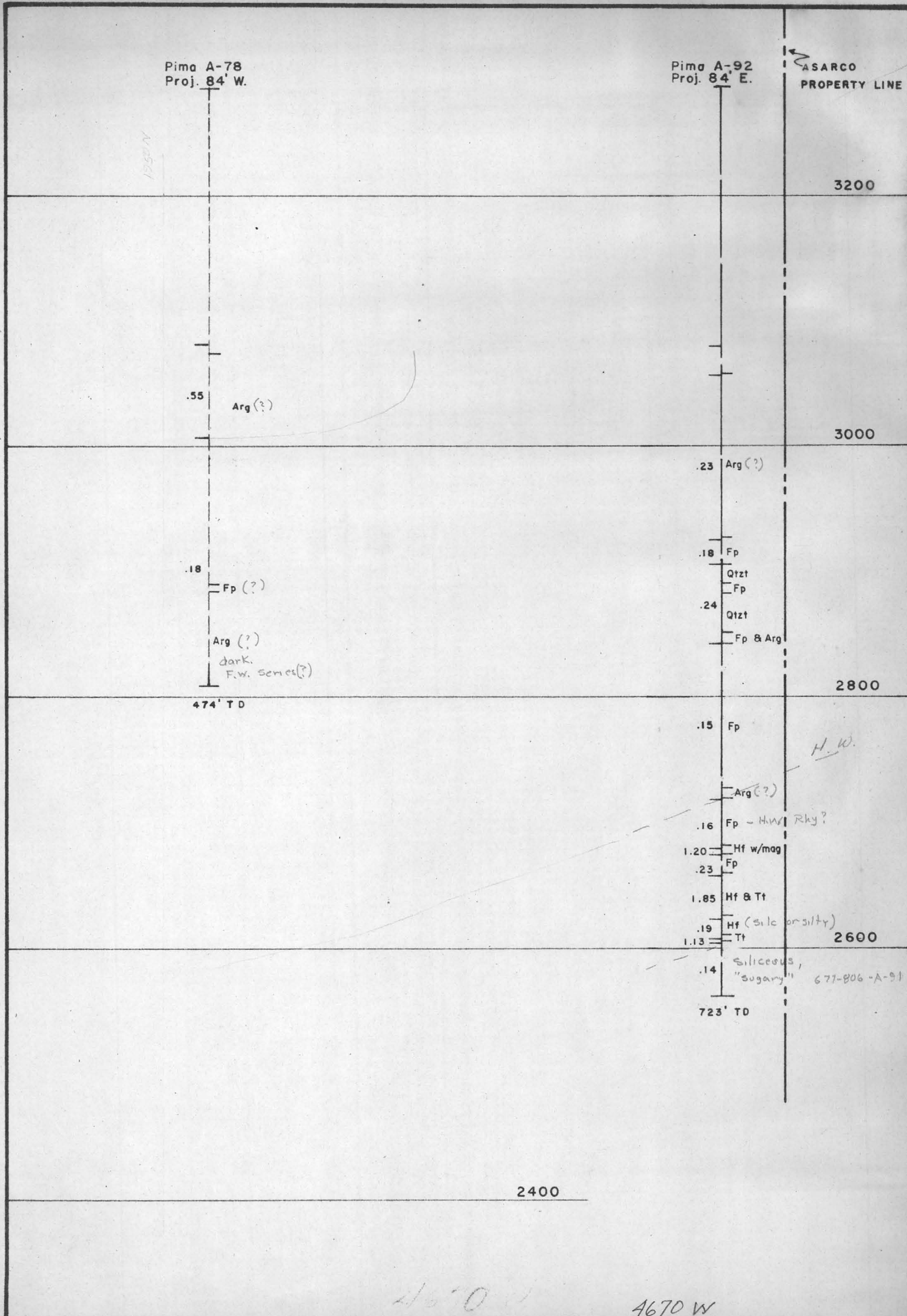
ASARCO PROPERTY LINE
Pima A-87
Pima A-91
3200
3000
2800
2600
2400
.54
.24
Arg and/or Ark
.47
.34
assay
Arg w/ cinnamon color (see A-89)
.24
(see A-89)
Qtzt
782' TD
.63
.26
.58
.32
.53
Arg and Ark
.35
.56
.29
Sil qtzose mat.
(marker above Hf)
.54
.17
.84
Hf
H.W.
.05 Mb
918' TD
3400 W



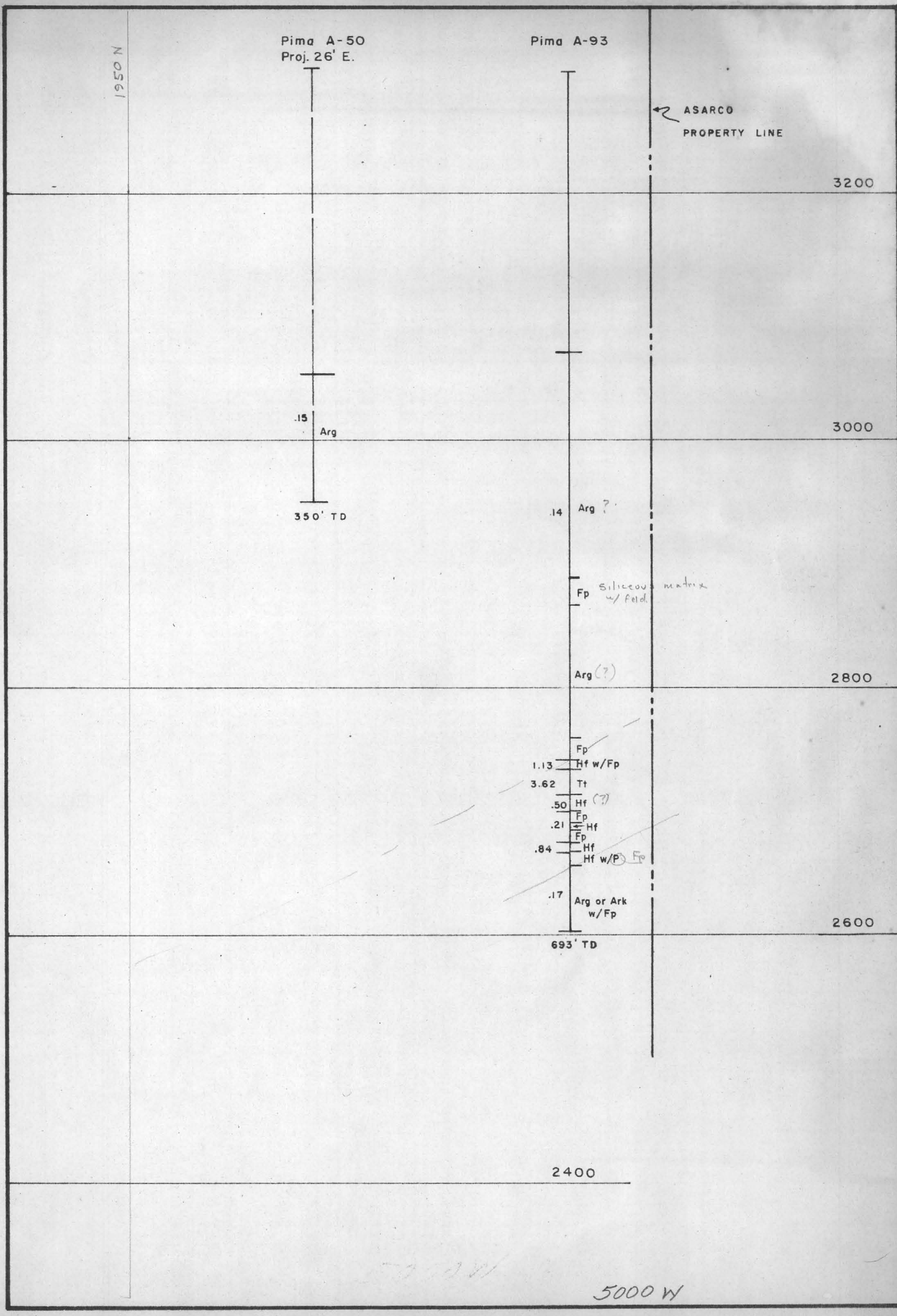
Pima A-84
Pima A-89
ASARCO PROPERTY LINE
3200
3000
2800
2600
2400
.22
.59
.32
.44
Arg
.23
.64
Bx Material sil cement
1.04
.20
938' TD
.29
Ark (?)
.46
.23
.39
.29
Arg (?)
.62
1.08
.25
1.45
epid, chl, limy, Qtz veins
Arg ?
Cinnamon color (see A 87)
.14
(See A-87
Qtzt
.55
.30
.91
Hf
Qtz
.18
900'
1.17
Hf
1.56
Tt
Hf
1.41
Tt
.21
Fp
Arg ??
.26
Qtzt
or sandy Arg
1006' TD
Limy w q'z veins
3800 W



Pima A-79
Pima A-52
Pima A-90
ASARCO PROPERTY LINE
3200
3000
2800
2600
2400
No core
.69
.34
.79
shattered
.36
Arg
.64
1.01
.65
.33
.47
.34
.13
593' TD.
.45
Arg
.66
.28
313' TD.
Arg (?)
.33
Porphyry
.67
1.06
Arg (?)
.22
1.42
Tt
.14
Fp
1.50
Hf
.22
Brn sil mat. Grnt
.48
Tt
1.50
Brn sil mat. Grnt
.49
Arg (sandy)
.92
Hf
.31
Arg or porphyry
.46
Hf
.18
Brn sil mat. Arg or porphyry
946' TD.
H.W.
.71
4115 W



Pima A-78
Proj. 84' W.
Pima A-92
Proj. 84' E.
ASARCO
PROPERTY LINE
3200
3000
2800
2600
2400
.55
Arg (?)
.18
Fp (?)
Arg (?)
dark.
F.W. Series(?)
474' TD
.23
Arg (?)
.18
Fp
Qtzt
Fp
.24
Qtzt
Fp & Arg
.15
Fp
H.W.
Arg (?)
.16
Fp - H.W. Rhy?
1.20
Hf w/mag
Fp
.23
1.85
Hf & Tt
.19
Hf (silic or silty)
1.13
Tt
siliceous,
"sugary"
.14
677-806-A-91
723' TD
4670 W


1950 N
Pima A-50
Proj. 26' E.
Pima A-93
ASARCO
PROPERTY LINE
3200
3000
2800
2600
2400
.15
Arg
350' TD
.14
Arg ?
Fp
siliceous matrix
w/ feld.
Arg (?)
Fp
1.13
Hf w/Fp
3.62
Tt
.50
Hf (?)
Fp
.21
Hf
Fp
.84
Hf
Hf w/P Fp
.17
Arg or Ark
w/Fp
693' TD
5000 W

ABSTRACT OF DRILL LOGS - PIMA

Hole	Coord.	Collar Elev.	Depths: Bedrock	Depths: Total	
A-50		3302	245	350	3057
A-93		3295	227	693	3068
A-92		3287	228	723	3059
A-78		3285	203 - 210	474	3079 (using BR 206)
A-79		3289	205±	593	
A-52		3245	?	313	
A-90		3278	202	946	3076
A-89		3271	215	1006	3056
A-84		3281	201	938	3080
A-91		3265	215	918	3050
A-87		3268	225 (?)	782	3043
A-58		3246	213 (?)	495	218' J.H.C & KR Log
A-67		3243	190 (?) 210	404	J.H.C & KR Log
A-68		3234	220 (?)	411 (?)	218' J.H.C & KR Log

ABSTRACT OF DRILL LOGS - PIMA

(Logged by J. Journey) - summarized for use on East Pima sections

A-89 Bedrock @ 215'
215-393 Ark(?) (log pyroclastic)
feld. developments. 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(?) - cinnamon 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, fine-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

ABSTRACT OF DRILL LOGS - PIMA

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 porphyry. (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

ABSTRACT OF DRILL LOGS - PIMA

A-90 Bedrock @ 202

202-282 Arg(?) (log pyroclastic) w/bleaching.

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

289-751 Arg(?) (log pyroclastic)

751-760 Tactite (log garnet Hf)

760-765 Felsite porphyry

765-789 Hornfels (log diopside Hf)
770-772 sheared quartzose material

789-802 Brown siliceous material, some garnet and other lime silicate.

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

ABSTRACT OF DRILL LOGS - PIMA

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

ABSTRACT OF DRILL LOGS - PIMA

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

ABSTRACT OF DRILL LOGS - PIMA

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(?).
441-557	Felsite porphyry
557-565	Arg(?)
565-604	Felsite porphyry (log rhyolite) prob. hangingwall 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 qtztic)
675-679	Tactite
679-723	Siliceous. Sugary texture. Like 677-806 in DDH A-90 (must be 91)

Bottom

ABSTRACT OF DRILL LOGS - BANNER

Geology by McKenzie
Abstract by J. F. Kinnison

DDH 104 Bedrock @ 210

3242'
54 + 18N
47 + 50W

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

ABSTRACT OF DRILL LOGS - BANNER

DDH 107 Bedrock @ 178

3273'
69 + 84W
44 + 44N

3273
178
3095

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

ABSTRACT OF DRILL LOGS - BANNER

DDH 82 Bedrock @ 217.5

30 + 99W
52 + 12N
3211'

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 Bedrock @ 206'

52 + 05N
44 + 31W
3238'

206-226 Ark? leached
226-231 45° pre min. 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 Bedrock @ 197

52+ 02N
57 + 45W
3251'

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

Bottom

ABSTRACT OF DRILL LOGS - BANNER

DDH 98 Bedrock @ 203

3243'
52 + 03N
48 + 73W

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	Hornfels
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

ABSTRACT OF DRILL LOGS - BANNER

DDH 91 Bedrock @213

3235'
56 + 44N
46 + 37W

213-286 Ark or Qtzt
286-288 Metaporphyry
288-745 Ark & Qtzt. No data 450 to 724'.

1 1/2' 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 Bedrock @ 204

3231'
54 + 20N
45 + 30W

3231
204
3027

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)
615-690 Qtzt, grey white

ABSTRACT OF DRILL LOGS - BANNER

DDH 93 Bedrock @ 169

3271'
46 + 47N
69 + 85W

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 Quzt, 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 Bedrock @ 204

3233'
54 + 23N
43 + 29W

3233
204
3029

204-687 Ark & qtzt
Gg 334-339
Flt zone 478-482
Mp? 643-646
Local Hf(?) below 610
Flt zone 599-603

599-603 Flt zone

Bottom

7-10-57
NPW

BANNER-ASARCO PIPE LINE

300 x 9 = 2700
\+ 148
2848' coupled length

45 x 30 = 1350' uncoupled length

28 x 30 = 840' stacked joints
Assuming average length of 30'/Section

2848
1350
4198' = Total length of line

+840
5038' = Total pipe footage

Two gate valves in coupled line.

Gate valve and "T" at east end of coupled line.

Kinnison copy

June 19, 1957
1309 E. Elm St.
Tucson, Arizona

Mr. Kenyon Richard
American Smelting and Refining Co.
813 Valley National Bldg.
Tucson, Arizona

Dear Sir:

The following is a list of thin-sections and their rock type as requested by Mr. J. Kinnison. This tabulation gives the hole number and footage preceding the rock name. The terminology used to separate the rocks into broad groups and the individual rock names follows that outlined in a File Memorandum No. P-10.10.2 signed by J. Kinnison and enclosed in your letter of May 24, 1957 to Mr. L. H. Hart. The question marks are used when the formational grouping of the thin-section is open to interpretations.

This list will form an appendix of a report discussing the petrographic and petrogenetic features of these rock units that is in process of preparation by myself. Also included in the report as an appendix will be detailed factual descriptions of each individual thin-section as collected by J. Courtright, J. Kinnison, J. Clark, E. Sirvas, myself, and others.

Yours very truly,

Robert L. Du Bois
Geologist

ROCKS BELONGING TO THE PAPAGO FORMATION

Argillite

29-286 Argillite
29-342 Argillite
31-271 Contact between quartz monzonite porphyry and sandy argillite
31-303 Fragmental sandy argillite
32-279 Argillite
37-554 Sandy argillite
41-311 Sandy argillite
41-341 Sandy argillite
45-450 Sandy argillite
48-455? Argillite
48-482? Argillite
49-279 Fragmental sandy argillite
56-303 Fragmental argillite
64-430? Argillite
65-249 Argillite
68-300? Calcareous sandy argillite
69-320 Sandy argillite
74-254 Sandy argillite
78-367 Argillite
88-251 Argillite
88-264 Argillite
88-298 Argillite
88-317 Argillite
88-370 Argillite
88-414 Sandy argillite
100-267 Argillite
100-367 Sandy argillite
114-262 Sandy argillite
114-283 Argillite
114-287 Banded arkosic argillite
119-265? Argillite
119-270? Spotted argillite
119-300? Spotted argillite

Conglomerate

32-331 Conglomerate
33-337 Conglomerate with volcanic fragments
36-275 Conglomerate
36-322 Conglomerate
88-244 Conglomerate with volcanic fragments
108-408? Conglomerate
111-420 conglomerate

Miscellaneous

17-249? Tremolite calcite hornfels
19-255? Diopside calcite hornfels
34-344? Diopside calcite hornfels
56-376 Gypsum hornfels
64-295 Fine-grained arkose
114-394 Arkose

Note: The ? mark refers to uncertainty as to which formation the specimen belongs.

ROCKS BELONGING TO THE PIMA FORMATION

Argillite

36-385? Argillite
41-581 Argillite ? Calc Arg.
41-644 Argillite prob. Kf. Cgl arkitic [illegible]
49-466? Argillite
62-418 Argillite Calc Arg
88-420? Calcareous argillite - Log Hf. Prob Pgf
88-451? Argillite - Log Ark. Pgf also sect @ 450 Arg w/ introduced Biotite Resembles Gwk
149-742 Argillite . Calc Arg
149-788 Calcareous argillite Calc Arg

Quartzite

22-424? Quartzite
22-425? Quartzite
22-687? Calcite bearing quartzite
23-355 Quartzite
53-500? Quartzite
63-420? Quartzite
73-423? Quartzite
81-464? Quartzite
81-481? Quartzite
88-453? Quartzite
88-478 Sericite bearing quartzite
88-482 Quartzite
88-490 Sericite bearing quartzite
88-504 Sericite bearing quartzite
88-560 Quartzite
88-611 Quartzite
88-627 Quartzite
88-653 Sericite bearing quartzite
97-347 Quartzite

Hornfels

20-363 Garnet diopside calcite hornfels Garnet rock
22-233? Quartz tremolite hornfels Gyp & Silt
22-498 Biotite quartz feldspar hornfels Log Biot Ark.
23-413 Diopside hornfels Greenish gray Hf.
24-567 Garnet tremolite gypsum hornfels silt & Hf
28-335 Tremolite feldspar hornfels Garnet Rock
37-680 Diopside hornfels light green dense
37-707 Quartz feldspar calcite hornfels light green dense
41-585 Tremolite quartz hornfels light colored silt
42-392? Diopside tremolite actinolite hornfels light green silt
42-562 Tremolite quartz hornfels - [illegible] and silt
42-610 Diopside hornfels Hf
43-612 Gypsum hornfels L.S.
45-795 Quartz diopside hornfels Hf - abund Garnet
45-849 Wollastonite calcite hornfels Marble

Note: The ? mark refers to uncertainty as to which formation the specimen belongs.

Hornfels continued

47-555	Tremolite diopside hornfels	not h.s. - Mainly Garnt.
64-734	Garnet diopside quartz hornfels	Garnet Rock w/ Hf
88-425?	Tremolite hornfels	dense light green Hf in Pgf?
88-462	Actino-tremolite hornfels	Green Hf in Pgf?
88-468	Quartz calcite feldspar hornfels	Green Hf in Pgf?
88-475	Tremolite hornfels	Green Hf in Pgf.?
88-562	Quartz feldspar actino-tremolite hornfels	light gree Hf
88-669	Tremolite diopside hornfels	light green Hf
88-685	Diopside tremolite hornfels	light green Hf
88-721	Wollastonite hornfels	± within Tactite zone
88-808	Calc-silicate hornfels	white fn-gr.
90-364	Diopside hornfels	- white soft
100-472?	Biotite quartz feldspar hornfels	+ 1' Mp @ 472-473. sharp cnt.
149-562	Quartz feldspar calcite hornfels	Possible feld intergrowth - probably a veinlet
149-770	Diopside tremolite quartz feldspar hornfels	Calc Arg
149-810	Tremolite hornfels	- alt MB zone at base of Calc Arg

Tactite

22-553	Quartz garnet tactite
28-281	Quartz garnet tactite
37-734	Wollastonite garnet tactite
42-480	Diopside gypsum garnet tactite
44-706	Garnet tactite
46-327?	Diopside garnet tactite
47-437	Garnet tactite
47-455	Diopside tremolite garnet tactite
50-458	Garnet tactite
51-376	Garnet tactite
53-643	Diopside tremolite garnet tactite
63-498	Garnet tactite
65-271	Diopside garnet tactite
65-304	Garnet tactite
76-408	Diopside garnet tactite
76-499	Diopside tremolite garnet tactite
88-429?	Epidote garnet tactite
88-437?	Diopside garnet tactite
88-700	Garnet tactite
88-712	Garnet tactite
88-727	Garnet tactite
88-740	Garnet tactite
88-748	Garnet tactite
90-251?	Quartz garnet tactite
90-389	Diopside garnet tactite

Marble

21-359	Marble
21-387	Wollastonite bearing marble
46-498	Marble
47-587	Marble
54-309	Marble
78-752	Irregular zones of cryptocrystalline quartz in marble

Note: The ? mark refers to uncertainty as to which formation the specimen belongs.

Marble continued

88-757	Marble
88-764	Marble
88-780	Marble
88-793	Marble
88-815	Marble
88-828	Tremolite wollastonite marble
88-836	Wollastonite marble
93-704	Calc-silicate quartzite zone in marble
94-716	Marble
149-723	Marble
149-812	Marble

Miscellaneous

109-398	Quartz feldspar banded rock
134-265	Feldspar replacement
134-275	Quartz feldspar replacement

ROCKS BELONGING TO THE KINO FORMATION

Argillite

41-780	Sandy argillite
41-800	Argillite
54-430	Argillite
54-475	Argillite
54-510	Conglomeratic argillite with volcanic fragments
62-616?	Banded argillite
62-716?	Argillite?
62-719?	Fragmental sandy argillite
105-675?	Fragmental argillite
148-582	Fragmental argillite
148-592	Spotted argillite

Conglomerate

116-554	Conglomerate
129-883	Conglomerate
129-927	Conglomerate
148-636	Conglomerate
148-638	Conglomerate

Note: The ? mark refers to uncertainty as to which formation the specimen belongs.

ROCKS FROM EAST END DRILL HOLES BELONGING TO EITHER THE PAPAGO OR KINO FORMATION

Argillite

52-535	Argillite
57-369	Sandy argillite
61-348	Sandy argillite
75-300	Sandy argillite
79-340	Fragmental sandy argillite
85-307?	Calcareous argillite
85-365?	Argillite
103-307	Arkosic argillite
110-284	Banded argillite
110-322	Arkosic argillite
110-324	Sandy argillite
110-404	Arkosic argillite
115-226	Argillite
128-884	Sandy argillite
132-320	Banded sandy argillite
139-575	Argillite in contact with calcareous argillite
140-337	Sandy argillite
140-342	Argillite
140-384	Fragmental argillite
140-653	Argillite
146-285	Sandy argillite

Arkose

71-230	Fragmental arkose
110-367	Arkose
110-453	Arkose

Conglomerate

52-255	Conglomerate with volcanic fragments
61-215	Conglomerate
128-875	Conglomerate

Quartzite

57-987	Garnet bearing quartzite

ROCKS OF THE BASEMENT COMPLEX

137-1395	Quartz monzonite

Note: The ? mark refers to uncertain hole location.

MISCELLANEOUS UNITS

Meta-porphyry

18-245	Quartz monzonite porphyry
22-351	Quartz monzonite porphyry
24-451	Quartz monzonite porphyry
31-271	Contact between quartz monzonite porphyry and sandy argillite
33-353	Quartz monzonite porphyry
39-342	Quartz monzonite porphyry
42-330	Quartz monzonite porphyry
73-352	Quartz monzonite porphyry
77-223	Quartz monzonite porphyry
78-244	Quartz monzonite porphyry
81-348	Quartz monzonite porphyry
81-430	Quartz monzonite porphyry
81-450	Quartz monzonite porphyry
88-212	Quartz monzonite porphyry
99-345	Quartz monzonite porphyry
99-348	Quartz monzonite porphyry
100-566	Quartz monzonite porphyry

Felsite porphyry

50-613	Latite porphyry
52-410	Quartz latite porphyry
52-431	Quartz latite porphyry
52-552	Latite
52-580	Porphyritic latite
52-598	Porphyritic quartz latite
63-429	Quartz latite porphyry
75-540	Porphyritic latite
108-234	Quartz latite porphyry
110-562	Latite porphyry
116-534	Quartz porphyry
128-828	Quartz latite porphyry
128-901	Quartz latite porphyry
129-919	Porphyritic rhyolite
140-322	Rhyolite porphyry
140-331	Rhyolite porphyry
140-898	Quartz latite porphyry

Andesite

33-283	Quartz latite porphyry (Probably logged as andesite because of megascopic appearance.)
43-671	Biotite andesite
52-392	Dacite (Probably logged as andesite because of megascopic appearance.)
52-616	Dacite (Probably logged as andesite because of megascopic appearance.)
59-328	Biotite andesite
108-338	Andesite

Hole No.	Depth	Rock Type
17	249'	Tremolite calcite hornfels
18	245'	Quartz Monzonite Porphyry
19	258'	Diopside Calcite hornfels
20	363'	Garnet diopside calcite hornfels.
21	359'	Marble
21	387'	Wollastonite bearing Marble
22	283'	Quartz tremolite hornfels
22	351'	Quartz Monzonite Porphyry
22	424	Quartzite
22	425	Quartzite
22	498	Biotite Quartz Feldspar hornfels.
22	553	Quartz garnet tactite
22	68?	Calcite bearing Quartzite
23	355	Quartzite
23	413	Diopside hornfels.
24	451	Quartz monzonite Porphyry
24	567	Garnet tremolite gypsum hornfels
28	281	Quartz garnet tactite
28	335	Tremolite feldspar hornfels
29	286	Argillite
29	342	Argillite
31	271	Contact between Qtz. Monzonite porphyry & Sandy Argillite
31	303	Fragmental Sandy Argillite
32	279	Argillite
32	331	Conglomerate
33	283	Quartz latite porphyry (Probably logged as andesite because of megascopic appearance,)
33	337	Conglomerate with [illegible] fragments

Hole	Depth	[illegible]
34	344	Diopside calcite hornfels.
36	275	Conglomerate
36	322	Conglomerate
36	385	Argillite
37	554	Sandy Argillite
37	680	Diopside hornfels
37	707	Quartz feldspar calcite hornfels
37	734	Wollastonite garnet tactite
39	342	Quartz Monzonite porphyry
41	311	Sandy Argillite
41	341	Sandy Argillite
41	381	Argillite
41	385	Tremolite Quartz hornfels
41	644	Argillite
41	760	Sandy Argillite
41	800	Argillite
42	330	Quartz Monzonite porphyry
42	392	Diopside tremolite actinolite hornfels
42	480	Diopside gypsum garnet tactite
42	562	Tremolite quartz hornfels
42	610	Diopside hornfels.
43	612	Gypsum hornfels
43	671	Biotite andesite.
44	706	Garnet dacite
45	450	Sandy Argillite
45	795	Quartz diopside hornfels
45	849	Wollastonite Calcite hornfels
46	327	Diopside garnet tactite
46	498	Marble

Hole	Depth	Rock type
47	427	Garnet tactite
47	455	Diopside tremolite garnet tactite
47	555	tremolite diopside hornfels
47	587	Marble
48	455	Argillite
48	482	Argillite
49	279	Fragmental sandy Argillite
49	466	Argillite
50	458	Garnet tactite
51	376	Garnet tactite
52	392	Dacite - Probably logged as andesite because of megascopic appe
52	410	Quartz latite Porphyry
52	431	" "
52	535	Argillite
52	552	Latite
52	580	porphyritic latite
52	598	porphyritic Quartz latite
52	616	Dacite - Probably logged as andesite because of megascopic appeara
52	255	Conglomerate with volcanic fragments
53	500	Quartzite
53	643	Diopside tremolite garnet tactite
54	309	marble
54	430	Argillite
54	475	Argillite
54	510	Conglomerate argillite with volcanic fragments
56	303	Fragmental argillite
56	376	Gypsum hornfels

Hole		
57	3.69	Sandy argillite
57	987	Garnet bearing quartzite
59	328	Biotite Andesite
61	215	Conglomerate
61	348	Sandy Argillite
62	418	Argillite
62	616	Banded Argillite
62	716	Argillite
62	719	Fragmental sandy argillite
63	420	Quartzite
63	429	Quartz latite porphyry
63	498	Garnet tactite
64	295 ✓	Fine-grained Arkose
64	430 ✓	Argillite
64	734 ✓	Garnet diopside quartz.
65	244 ✓	Argillite
65	271 ✓	Diopside garnet tactite
65	304 ✓	Garnet tactite
68	300	Calcareous sandy argillite
69	320 ✓	Sandy Argillite
71	230	Fragmental Arkose
73	352 ✓	Quartz Monzonite porphyry
73	423	Quartzite
74	354	Sandy Argillite
75	300	Sandy Argillite
75	540	Porphyritic Latite
76	408	Diopside garnet tactite
76	499	Diopside tremolite garnet tactite
77	223	Quartz monzonite porphyry
78	244	Qtz monzonite porphyry
78	367	Argillite
78	752	Irregular zones of [illegible] in middle

Hole No.	Depth	Rock Type
79	340	Fragmental Sandy Argillite
81	248	Quartz Monzonite Porphyry
81	430	[illegible]
81	450	[illegible]
81	464	Quartzite
81	481	"
85	307	Calcareous Argillite
85	365	Argillite
88	212	Quartz Monzonite Porphyry
"	244	Conglomerate with volcanic fragments.
"	251	Argillite
"	264	"
"	298	"
"	317	"
"	370	"
"	414	[illegible]
"	420	Calcareous Argillite
"	425	Tremolite hornfels
"	429	Epidote garnet tactite
"	437	Diopside garnet tactite
"	451	Argillite
"	453	Quartzite
"	462	Actinolite tremolite hornfels
"	468	Quartz calcite feldspar hornfels
"	475	tremolite hornfels
"	478	Sericite bearing Quartzite
"	482	Quartzite
"	490	Sericite bearing Quartzite

[illegible]		
88	560	Quartzite
	611	"
	637	"
	653	Sericite bearing quartzite
	662	Quartz feldspar actino-tremolite hornfels
	669	Tremolite diopside hornfels
	685	Diopside tremolite hornfels
	700	Garnet tactite
	712	" "
	721	Wollastonite hornfels
	727	Garnet tactite
	740	
	748	
	757	Marble
	764	"
	780	"
	793	"
	808	Calc-silicate hornfels.
	815	Marble
	828	Tremolite wollastonite Marble
	836	Wollastonite Marble
90	251	Quartz Garnet Tactite
90	364	Diopside hornfels
90	369	Diopside garnet tactite
93	704	Calc-silicate quartzite zone in Marble
94	716	Marble
97	347	Quartzite
99	245	Quartz Monzonite porphyry
99	348	" "
100	267	Argillite

[illegible]	Depth	Rock type
100	472	Biotite quartz feldspar hornfels.
[illegible]	366	Quartz monzonite porphyry
103	307	Arkosic argillite
[illegible]5	675	Fragmental argillite
[illegible]8	234	Quartz latite porphyry
	338	Andesite
8	408	Conglomerate
9	348	Quartz feldspar banded rock
[illegible]	284	Banded argillite
[illegible]	3[illegible]	Arkosic argillite
[illegible]	324	Sandy argillite
[illegible]	404	Arkosic argillite
[illegible]	562	Latite porphyry
[illegible]	420	Conglomerate
[illegible]	262	Sandy argillite
[illegible]	28[illegible]	Argillite
[illegible]	287	Banded arkosic argillite
[illegible]	394	Arkose
[illegible]	726	Argillite
4	334	Quartz porphyry
6	554	Conglomerate
[illegible]	265	Argillite
[illegible]	370	Spotted Argillite
[illegible]	200	"
8[illegible]	828	Quartz latite porphyry
[illegible]	8[illegible]	Conglomerate
8	88[illegible]	Sandy Argillite
8	[illegible]	Quartz latite porphyry
[illegible]4	883	Conglomerate

123	477	Porphyritic rhyolite
128	927	Conglomerate
132	320	Banded Sandy Argillite
134	265	Feldspar replacement
134	275	Quartz feldspar replacement.
137	1395	Quartz Monzonite
139	575	Argillite in contact with calcareous argillite
140	222	Rhyolite porphyry
140	221	"
140	387	Sandy Argillite
140	342	Argillite
140	384	Fragmental Argillite
142	423	Argillite
145	898	Quartz latite porphyry
146	285	sandy argillite
148	582	Fragmental argillite
148	532	Spotted argillite
148	636	Conglomerate
149	638	Conglomerate

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
May 24, 1957

Mr. L. H. Hart, Chief Geologist
New York Office

EAST PIMA STRUCTURE,
STRATIGRAPHY, PETROGRAPHY

Dear Sir:

Under the guidance of Mr. Courtright, for the past few weeks Mr. Kinnison has been carefully studying and reviewing cores and sludge boards and revising structural interpretations in the East Pima ore zone. In conjunction with this work, Dr. Dubois of the University has been doing petrographic work. As a result the principal elements of structure and stratigraphy now are fairly well understood. In the attached file memorandum with legend, Mr. Kinnison carefully describes the sedimentary and igneous units which he and Mr. Courtright have worked out and which we now are adopting as standard nomenclature for use in future core logging and on new 100-scale sections now being drafted.

Although most of the features of structure and stratigraphy which relate to the distribution of copper have been plotted on our work sections in pencil note form, new 100-scale tracings will have to be drafted in order to illustrate these features properly. A series of plan maps showing structure and mineralization on different levels also will be compiled. This drafting has been started, but it will be an extensive job. It will be several weeks, then, before a set of prints can be completed and sent to you. The ore outlines which will be shown on these sections and plan maps should, of course, be taken into account in any final ore reserve calculation system. Mr. Schubel is aware of this,and this information will be made available to him as soon as possible. He plans to use it in any final ore reserve estimates he may make.

Dr. Dubois has been using the thin sections of Ernesto Sirvas, as well as a large number of sections prepared from specimens selected by Courtright, Kinnison, Clark and himself. This work has been very helpful in eliminating many uncertainties as to sedimentary or igneous origin, in tracing sedimentary horizons, and in permitting rocks to be grouped in a manner which clarifies the whole picture of structure. You will note that qfm has been identified as an igneous rock. This applies principally to the large mass in the western part of the zone. However, throughout the ore body there are pods of quartz-feldspar-mica rock which represent true replacement material. The petrographic reports on individual thin sections by Sirvas have been well done and have been useful to us. However, I doubt that by restudy of cores, as suggested in your letter of May 20, he now would be able to improve our present correlations. He is welcome to look over the core again if he cares to do so in order to improve or clarify the thesis itself.

I believe the men working on this intricate problem are to be complimented for having gone a long way toward solving it.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
cc: RJLacy WOSchubel
JHCourtright JLClark
JKinnison RHDubois
(all w/attachments)

FILE MEMORANDUM

Proposed Rock Classification: East Pima

The rocks of East Pima as now known represent (1) originally chemical (limy or gypsiferous) sediments, (2) clastic sediments, and (3) igneous.

It is proposed that these rocks be grouped by generalized lithology and/or original composition, and further subdivided by rock types readily determined in the field.

These basic groups are as follows:

1. A clastic rock series consisting of siltstone, arkose, conglomerate, in part originally calcareous, which forms the presently known hanging wall unit. This might be termed the Papago formation.

2. A fairly thick originally limy series, in part gypsiferous, now consisting of lime-silicate minerals of varying composition and texture, with inter-bedded quartzites, which lies below group No. 1 above. It might be termed the Pima formation.

3. A clastic-volcanic(?) unit consisting of siltstone, conglomerate, arkose, and pyroclastics (?), which forms the presently known footwall. This might be termed the Kino formation.

4. An altered igneous rock presently termed Q.F.M. (quartz, feldspar, mica rock). This rock appears to be a porphyry of original dacitic composition with introduced quartz and orthoclase. It is proposed that this rock type be termed meta-porphyry.

5. Andesite - The term andesite as now used should be retained.

6. Other volcanic-textured acid porphyry rocks of sometimes undetermined (due to alteration) composition. These might be generally termed felsite porphyry.

The sedimentary rocks should be classified on the basis of readily identifiable field criteria, but at the same time related to petrographic classification.

Proposed terminology for clastic rocks:

1. Arkose - A granular-textured rock similar to quartzite but containing enough feldspar grains to be readily recognizable as such. The arkose can be further described as 1. fine-grained--1/4-1 mm; 2. medium-grained--1-2 mm; and 3. coarse-

grained--2-4 mm. 1/4 mm is approximately the minimum limit of identification with the hand lens.

2. Quartzite - a pure quartzite with grains large enough to be distinguished with a hand lens. The same grain size limits as for arkose would apply.

3. Argillite - a hard, dense, massive rock in which no grains can be identified with a hand lens. Petrographic work to date shows this type to be a siltstone or sandy siltstone, and in field use would include those rocks with some quartz grains in an argillite matrix.

4. Conglomerate - a rock containing 25% or more of fragments greater than 4 mm (Wentworth classification).

5. Graywacke - this term should be used in the manner of general acceptance, in preference to more recent classification by Pettyjohn; i.e. a rock consisting of numerous fragments of dark silt or volcanic rocks and/or ferro-magnesian minerals as grains or in the matrix. This definition emphasizes the ferro-magnesian content. [To date no rocks of this type have been verified petrographically at East Pima.] Only local thin band of graywacke, limited to the Rural formation, have been verified petrographically.

Proposed terminology for the metamorphosed (or metasomatized) limy sediments:

1. Tactite - a coarse-grained rock with garnet and/or other lime-silicates. Scarn implies magnetite and therefore is not suitable as a general term in this instance.

2. Hornfels - a generally hard but sometimes soft, generally slightly greenish, fine-grained rock consisting of lime silicates. This rock may have been originally an argillaceous limestone.

3. Marble - a limestone which shows some recrystallization.

4. A presently indeterminant "siliceous" rock unit which may be metamorphosed limestone. Petrographic studies will determine its type, and a name may then be applied.

JOHN KINNISON

Att: Legend

A "siliceous" rock unit variously termed siliceous hornfels, quartzite, calcareous quartzite, arkose and others. This type of rock has been determined petrographically to be traceable to two origins. One, a feldspathic alteration probably involving metasomatism, produces a fine to coarse grained pink feldspathic appearing rock within the tactite and/or hornfels zone of the Pima formation. In some varieties the feldspar is massive and coarse grained and easily recognizable but in others it is so fine grained that the rock has merely a dense pinkish appearance. Quartz is commonly present and gives the rock a resemblance to arkose. This unit commonly carries high grade ore. This type of alteration is probably related to highly aluminous zones in the pre-alteration limestone

EAST PIMA GEOLOGIC SYMBOLS

(See attached explanation)

ROCKS

META-SEDIMENTS (Note: The term META applies to nearly all sediments in mineralized area)

Clastic	Argillite	Arg.
	Arkose	Ark.
	Quartzite	Qtzt.
	Conglomerate	Cgl.
Limy	Tactite	Tt.
	Hornfels	Hf.
	Marble	Mb.

IGNEOUS

Pre-ore	Meta-porphyry	Mp.
	Felsite porphyry	Fp.
Post-ore ~	Andesite	And.

ABBREVIATIONS:

MINERALS -

Quartz — Qtz.
Feldspar - Fld.
Gypsum - Gyp.
Wollastonite - Woll.
Garnet - Grnt
Diopside - Diop.
Magnetite - Mag.
Pyrite - Py.
Chalcopyrite - Cpy.
Chalcocite - Cc.
Molybdenite - Mo.
Sphalerite - Sph.

OTHERS -

Gouge - Gg.
Breccia - Bx.
Massive - Mass.
Siliceous - Sil.
Silicified - Silf.
Silicated - Silct.
Gypsiferous - Gyp.
Altered = alt.

FORMATIONS

Pgf	Pif	Kf
Papago formation	Pima formation	Kino formation

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 9, 1957

Mr. L. H. Hart, Chief Geologist
New York Office

PETROGRAPHIC REPORT
East Pima

Dear Sir:

Enclosed is a petrographic report on the rock units in the East Pima area by Dr. Dubois of the University of Arizona. This report is based on about 300 hours of work which was begun in February. The work is continuing. The third part of the report -- detailed descriptions of individual thin sections -- is not yet complete. Also, I believe these studies should be extended to include outlying drill holes to the east and southeast, and I expect that we will have need for petrographic work on drill cores in the Reservation.

It is an excellent report; already the results have been of material aid in solving problems of structure, and it will continue to be a valuable reference for all of us.

I believe it is an unusually fine application of petrography to the practical solution of obscure but important structural problems. The report should be read in conjunction with Mr. Kinnison's memorandum transmitted to you with my letter of May 24. Copies of these data are enclosed for your convenience.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
Enclosures
cc: All with enclosures -
RJLacy
WESaegert
JHCourtright
JKinnison
JLClark
RCribbs

August 3, 1957
1309 E. Elm St.
Tucson, Arizona

Mr. Kenyon Richard
American Smelting and Refining Company
813 Valley National Bldg.
Tucson, Arizona

Dear Sir:

The enclosed report on the rocks of the East Pima area is respectfully submitted for your approval. This paper is the result of petrographic studies made on thin-sections that have been examined to date. It includes a general discussion of the rocks divided by units and individual types. Also included as Appendix I is a listing of the individual thin-sections and their corresponding rock types. The terminology used follows that of File Memorandum No. P-10.10.2.

Sincerely yours,

Robert L. DuBois
Geologist

RLD:j

Enc.

PETROGRAPHIC DISCUSSION OF THE ROCK UNITS PRESENT IN THE EAST PIMA AREA

INTRODUCTION

This report covers a petrographic discussion of the rock units present in the East Pima area and was prepared at the request of the American Smelting and Refining Company. The material of the report is presented in three parts. The first part, forming the body of the report, is a general discussion of the petrographic and petrogenetic aspects of the rock units. The second part, an appendix, covers a listing of the individual thin-sections by formation showing rock names, hole numbers, and footages. A detailed factual description of each thin-section is given in the third part, also forming an appendix. In these presentations, lacking knowledge of geological age, the three main units are discussed in order of increasing depth during drilling.

The various thin-sections used in the preparation of this paper were collected by J. Courtright, J. Kinnison, J. Clark, E. Sirvas, the author and others. The terminology follows that suggested in American Smelting and Refining Company Memorandum P-10.10.2 signed by J. Kinnison.

PAPAGO FORMATION

General:

The Papago Formation is a unit derived from a series of clastic sedimentary rocks that normally occur in the hanging wall. Originally this series of rocks were derived from types varying from siltstones and sandy siltstones to arkoses and conglomerates. Their original characteristics have been modified by alteration which in some cases has resulted in minor changes and in others has resulted in very extensive changes in features. A more complete discussion of the petrogenesis is included under that heading at the end of this section.

Argillite:

A rock type termed argillite is the predominate one of this formation. Megascopically this rock is generally too fine grained to be able to identify the constituent minerals under the 10 x hand lens. It generally appears massive and varies from dark grays and browns to tans and almost whites in color. Speckled varieties were also observed. Numerous small narrow light colored alteration veinlets crisscross the specimen in most places. Some of these veinlets have a core of sulfide minerals which is bordered on both sides by white and light gray colored zones which in turn give way to irregular brown colored zones along the contacts with the normal argillite. In some areas the entire specimen has been affected by the alteration.

Megascopic description of alteration veinlets

Microscopically the argillite type rocks have a very fine grained clastic texture which has in part been recrystallized.

In some specimens (sandy varieties) larger crystals occur being set in the normally fine grained equigranular groundmass. Fragmental textures are present, being characterized by small generally more or less round fragments of mudstone. Minor fragments of quartzite are also noted.

These rocks are composed of varying percentages of quartz, plagioclase, orthoclase, microcline, biotite, sericite, muscovite, clay, apatite, epidote, zircon, chlorite, calcite, gypsum, and opaque that form the matrix. These crystals are generally less than 0.06 mm in diameter and have irregular outlines. The larger crystals present in some specimens are mainly quartz but also included are minor ones of feldspar. Their sorting varies from good to poor and their shape varies from angular to well rounded.

Numerous veinlets of quartz, quartz feldspar, and calcite to quartz calcite transect the fabric of the rock. They have a narrow zone of introduced material in the center which gives way to a recrystallized area of quartz and feldspar and finally to a sericite and in some cases a biotite zone at their outer margins.

petrographic desc. of alt. veins,

Conglomerate:

While not as abundant as the argillite facies of this unit, a conglomeratic one is locally characteristic of it. Specimens of these rocks examined have a speckled greenish, blackish, tanish, and whiteish appearance. There, overall texture is clastic and quite varied. Relative abundance of fragments, phases from varieties composed mostly of these to those in which only one or two per square inch are present. It should also be mentioned that with a decrease in fragment size these conglomeratic rocks grade to ones here termed fragmental argillite.

The fragments are usually of siltstone or quartzite but these are also associated with arkosic types and with volcanic porphyry and granitoid types. Besides the fragments numerous large crystals of quartz and feldspar are present. The matrix of these specimens is composed of a fine grained aggregate of quartz, feldspar, sericite, chlorite, zircon, biotite, calcite, clay or silt, and opaques. For the most part these minerals take on an irregular shape as a function of their recrystallization and crystallization.

As in the normal argillite of this unit numerous transecting veinlets are present in these rocks. They are of a similar type and show the same degrees of recrystallization.

<u>Arkose</u>:

Arkosic phases are present in minor amounts in this formation. These rocks are mainly composed of grains of quartz and feldspar around 0.3 mm in diameter. An original clastic texture is strongly evidenced by the rounded to subrounded shape of the composing minerals and minor rock fragments. The original feldspar component has been partially altered to clay and sericite. These minerals along with fine quartz, apatite, and epidote make up the matrix of the specimen. At least in part the epidote is an alteration mineral, as is, of course, part of the clay and sericite. Recrystallization has locally strongly acted upon these rocks giving them an irregular texture. Minor transecting calcite veinlets are noticeable in many thin sections.

Petrogenesis:

That these rocks were originally sedimentary is suggested by the abundance of clay and quartz originally present. This conclusion is also borne out by the local sandy and conglomeratic components present. Further evidence of origin is suggested by the presence of clastic textures exemplified by the rounded shape and sorting characteristics of the constituent parts. The unit was in part calcareous as indicated by locally a high carbonate content. Fragmental features are exhibited by some specimens and may represent a local sedimentary reworking of original siltstone material.

A more or less general period of low to medium temperature recrystallization and crystallization has been superposed on these rocks and which has developed an irregular fabric from the original clastic one. During this time, the original matrix has been the most strongly affected. The larger clastic grains do though in some cases participate in the recrystallization. Local recrystallization and crystallization has taken place along transecting fractures. In these areas an introduced central zone of quartz or calcite gives way to a recrystallized zone of quartz and feldspar. The outermost

[illegible]

[illegible] relationships.

PIMA FORMATION

General:

The [illegible] Pima Formation [illegible] occupy the interval between the upper Papago Formation and the lower Kino Formation. This unit consists of a series of argillites, quartzites, lime-silicate and [illegible] rocks which are designated quartzite, hornfels, tactite, [illegible] under the proposed East Pima terminology. Originally these rocks were a series of sandstones, calcareous sandstones, calcareous siltstones and limestones. They have been locally extensively silicated and recrystallized with the [illegible] development in places of new lime-silicate minerals. [illegible] of the variances within this unit, the [illegible] lined at end of the discussion of each rock type.

Argillite:

A [illegible] termed argillite is [illegible] formation. These [illegible] too fine grained to identify the [illegible] minerals megascopically. They are brown, tan, [illegible], and greenish grays [illegible] with local [illegible] tings and [illegible]. Their texture is [illegible] [illegible] is generally lacking.

Microscopically the texture is clastic and is generally made up of grains less than 0.06 mm in diameter. Relatively larger grains are sometimes set in this fine grained matrix. The composition varies somewhat from specimen to specimen but generally includes quartz, feldspar, sericite, clay, calcite, and opaque. Locally these rocks contain tremolite, actinolie, epidote, diopside, and zircon. Quartz is the main distinguishable detrital grain with its characteristically rounded and subrounded outline. Most of the minerals show rather than a rounded shape one highly irregular in equigranular development. This fine grained granoblastic fabric is a result of recrystallication and crystallization which predominantly acted upon the original matrix materials and only slightly affected the large detrital grains. Minor quartz and calcite veins transect the specimen.

The original material from which these rocks were derived was a sediment rich in a silt component but which also included calcareous and sandy zones. This sedimentary source is amply evidenced by preserved clastic features in the included sand grains. The calcareous conditions are suggested by the presence of calcite and lime-silicate minerals.

Quartzite:

The quartzite that is present in the Pima Formation varies from shades of brown to gray to white in color. The texture is fine grained and generally lacks evidence of original bedding. Irregular features are commonly obvious in the brownish colored varieties as a result of recrystallization and metasomatic conditions along irregular fractures.

Microscopically these rocks have a granoblastic texture and are characterized by irregular equigranular quartz grains. Some varieties of the quartzite contain essentially nothing but quartz whereas other varieties contain abundant sericite and muscovite and still others have a percentage of the mineral calcite. Zircon, opaques, and feldspars are also present in minor amounts. In relating these compositional differences to megascopic characteristic, the sericite bearing varieties are generally brownish in color and the relatively pure varieties are gray to white in color.

As in other rocks of the East Pima area numerous alteration veinlets and zones occur. Compositionally they vary from calcite types to quartz types. Besides these, there occur minor granulated zones along which only minor recrystallization has taken place and which are characterized by cataclastic textures.

Originally the quartzites were a series of sandstones which contained locally a pure quartz sand and locally a silt or clay matrix. In addition some areas had a calcareous matrix. All of the specimens examined had undergone extensive recrystallization of the quartz and crystallization of mica type minerals.

Hornfels:

Hornfels type rocks are very common in certain portions of the Pima Formation. These rocks are generally fine grained and have a greenish color which ranges from light yellowish greens to dark deep greens. Most varieties have several variations in shades of greenish colors in a single specimen. Some have brownish areas and are mottled in appearance. Others, the specimens are white in color with only local tan or grayish zones.

Microscopically the texture is quite variable, ranging from generally fine grained aggregates to locally coarse grained ones. The fabric is granoblastic being characterized by an irregular mosaic arrangement of mineral grains. The composition of these rocks is also quite variable as to mineral type and relative amount but always includes a large percentage of lime-silicate minerals. A listing of minerals present in these type rocks includes tremolite, actinolite, calcite, quartz, feldspar, diopside, epidote, garnet, wollastonite, chlorite, gypsum, biotite, clay, zircon, apatite, and opaques (mainly sulfides).

Of these minerals some rock types are composed of almost entirely diopside, whereas others are composed of diopside plus tremolite, garnet or calcite. Other varieties are characterized by the mineral tremolite or gypsum and still others by wollastonite. Noteworthy are some types that contain abundant zircon in addition to other lime-silicate minerals. For a complete understanding of the variation in the mineral assembleges of these rocks the reader is referred to the appendix.

The paragenetic sequence of mineral formation of these rocks is usually simple with the lime-silicate minerals like tremolite, diopside, garnet, and wollastonite forming early.

Their formation was accompanied by the partial to complete recrystallization of quartz and calcite. Feldspar formed at these same general times in part as a product of recrystallication and part as a product of crystallization. Sulphide mineralization was post lime-silicate mineral formation as evidenced by replacement textures. These textures frequently show that the replacement by sulfide minerals of the silicates was locally guided by the cleavage plains in the silicates. In some specimens, there are irregular zones and bands of feldspar with which there are associated a relatively higher sulfide mineral concentration. A likely interpretation of the features present would be the formation of the feldspar rich zone as a result of a metasomatic process replacing earlier lime-silicate minerals. Subsequent to or contemporaneous with the feldspar development sulfide minerals were introduced and in part replaced the feldspar and/or earlier lime-silicates. This interpretation, of course, does not preclude that some sulfides were introduced prior to feldspar veinlet formation. A late stage of low temperature altered zones and veinlets also transect these rocks and in some sections alteration of earlier silicates to calcite is common.

These hornfelsic rocks were derived from sedimentary rocks containing admixtures of calcite, dolomite, quartz, and clay in varying proportions. Thus, the original rocks varied from calcareous sandstone through calcareous siltstones to silty and in some cases sandy limestones and to slightly impure limestones. These types of source rocks are evidenced by the chemical composition of lime-silicate minerals formed. As the main mineral assemblage characteristic of these rocks are calcium magnesium silicates, they bespeak of a source material rich in calcite-dolomite and quartz. As minor amounts of garnet (grossularite - andradite) are also present, the source materials contained minor quantities of aluminum. The aluminum content of the original material is further evidenced by the presence of feldspar.

The main lime-silicate mineral assemblage that is present would generally indicate a high temperature existing during its formation. This is especially true of such minerals as wollastonite and diopside. While diopside does form under temperatures whose range is below that at which wollastonite can form, its upper limit extends over the field of wollastonite formation. Tremolite, another associate mineral, is recognized to normally have a very wide range of thermal stability, and thus would be stable under these temperatures. The association of primary calcite plus quartz in some of these rocks would seem to stand out in contrast as it would indicate an existing temperature below that at which wollastonite forms. This association would seem to suggest the condition that while temperatures were generally high during lime-silicate formation there was considerable local variance in magnitude. This idea is further brought out by the local presence of actinolite and epidote which are generally low to medium grade minerals.

Tactite:

The rocks considered as tactites are another common type of the Pima Formation. They are usually fairly coarse grained and are characterized by abundant garnet. Megascopically these rocks have a highly irregular massive texture with some varieties tending to have a very rude banding. The color is locally quite variable in distribution, but is generally in shades of browns, whites, and greenish tans. Red brown variations are also noted. Sulfides are generally visible.

Microscopically, the texture is granoblastic being characterized by an irregular mosaic of mineral grains. The composition is variable from diopside garnet rocks through tremolite bearing ones to quartz varieties. The list of minerals present includes quartz, feldspar, garnet, wollastonite, diopside, tremolite, calcite, epidote, sericite, clay, gypsum, apatite, zircon, idocrase?, chlorite, forsterite?, and opaques. The garnets present in these rocks are of the series grossularite to andradite and are inpart anisotropic in optical character. They commonly have a well developed zoning and are sometimes twinned.

Of these minerals the predominate mineral is garnet and the associated ones vary from specimen to specimen. Quartz, diopside, and tremolite are the most common. The reader is referred to the appendix for a complete listing of the mineralogic varieties and particular associations.

The paragenetic relationships are the same for the tactite as for the hornfels. Garnet, diopside, tremolite and other lime-silicate minerals were the first to form. These are followed by the development of some sulphide minerals through replacement of the earlier silicates. Either post this period of sulfide formation or contemporaneous with it, a generation of alteration veinlets and zones were formed. These conditions altered the silicates to calcite and clay and allowed for the local formation of quartz and feldspar. As commonly part of the sulfide mineralization is associated with these zones, they can be considered as channels for introduction. It is of course realized that they could or could not be channels for the earlier period of sulfide mineralization if two separable periods are here represented. Post this early generation of alteration zones and post sulfides are ones of a late age. Predominantly they are composed of calcite but locally iron oxide minerals. In some specimens gypsum has formed, occurring as narrow veinlets and in some cases as a result of lime-silicate mineral alteration. In these conditions the gypsum seems to take the place of calcite as an alteration mineral.

The mineral assemblages represented by these rocks are in general the same relatively high temperature ones as that represented by the hornfels series. The same post lime-silicate low temperature alterations are noted.

That the original rocks contained calcium is amply evidenced in the calcium silicate minerals formed. Aluminum was relatively abundant as indicated by the presence of garnet. These rocks were therefore derived from a series of argillaceous limestones. The limestones were in part dolomitic as this component would be necessary to supply the magnesium for calcium magnesium silicate formation.

Marble:

Marble is the main rock type occurring in the lower footages of this formation as intersected by drill holes. These rocks are generally medium to coarse grained and massive. They are whites and grays with some times a mixing of the two in local footages. In some specimens gray colored streaks and bands were noted.

Microscopically these rocks have a granoblastic fabric and vary considerably in grain size, from fine to coarse within a single section. They are composed of essentially calcite but it should be noted that dolomite could be present as part of what is considered calcite. Other minerals of minor percentages include wollastonite, diopside, forsterite, tremolite, quartz, and clay. Their distribution varies from single occurrences to irregular and elongate concentrations.

The type of mineral assemblage present would indicate the same high temperature conditions as those already discussed. The occurrence of clay follows post lime-silicate fractures of low temperature formation. The original material from which these rocks were derived would have been a relatively pure limestone. Whether or not it was in part dolomitic is unproven but an extremely high dolomite content might be expected to manifest itself by the formation of more magnesium rich silicates than those present or some magnesium oxide type minerals.

KINO FORMATION

General:

Rocks of the Kino Formation form the presently known foot-wall. They were derived originally from a series of siltstones with local intercalations of sandy and conglomeritic phases. Some materials making up this series of rocks have certain pyro-clastic-like aspects. Petrogenetic interpretations of these rocks are included at end of this section.

Argillite:

Argillite type rocks are the most abundant ones making up the Kino Formation. These rocks are megascopically generally fine grained, massive in appearance, and grayish in color. In some specimens small crystals and rock fragments can be identi-fied.

Microscopically the texture is mainly clastic as evidenced by the presence of rounded to sub-rounded sand grains and a preponderance of silty material in the matrix. That some of the materials represent pyroclastic debris is considered because small tuffaceous-like fragments are visible in some specimens. Also in a few thin sections, very elongate (length to width ratio of about 4:1) crystal fragments of quartz and minor feld-spar are present. Such shaped crystals can be easily visual-ized to be of a pyroclastic origin. In these thin sections glass was not observed to be present but in some its former presence might be inferred from minute arcuate strings of of alteration products such as sericite and clay.

These rocks are predominately made up of materials with a grain size less than 0.06 mm in diameter but crystals and rock fragments with diameters exceeding 0.2 mm are also present. The distribution of constituents is generally uniform but banded varieties were noted.

Compositionally these rocks contain quartz, orthoclase, microcline, plagioclase, sericite, muscovite, clay, zircon, chlorite, epidote, apatite, opaques and calcite with quartz, feldspar, sericite and clay being the most abundant. Most of these minerals show some effects of recrystallization which has imparted partially an irregular granular fabric to the rock. This is especially true of those derived from the original silty component and not so true for larger rounded to subrounded quartz grains which still reflect their past sedimentary environment.

The included rock fragments were derived from siltstone, chert, quartzite, arkose and volcanic varieties in part of tuffaceous aspect. The latter ones are in part composed of abundant elongate quartz, plagioclase and orthoclase crystal fragments with minor muscovite set in a fine crystalline matrix of quartz, feldspar, clay, opaques, and sericite. Others contain abundant devitrified glass. The distribution of these constituents is highly variable.

As was discussed in other formations small veinlets transect these rocks. Some of these veinlets are composed of mainly untwined negative relief type feldspar which has been introduced. Calcite filled veinlets are also present and in some cases cross or follow the earlier feldspar ones.

Conglomerate:

These rocks vary from grays, tans, to browns in color and are sometimes mottled. They are generally coarse grained and rock fragments are especially noticeable. The fragments are quite variable in size, from microscopic ones to ones with a diameter measured in inches. The texture is typically clastic composed of rounded to subrounded and angular mineral grains and rock fragments with a matrix of fine sedimentary materials.

These rocks are composed of abundant rounded to subrounded quartz grains with a very fine grain aggregate of quartz, feldspar, clay, zircon, apatite, sericite, muscovite, calcite, and opaques forming the matrix. Large feldspar crystals are in the minority. The rock fragments are for the most part siltstone, sandy siltstone, chert and quartzite but some of volcanic origin were noted as were medium grained aggregates of quartz, feldspar and muscovite. The volcanic fragments were at least in part originally vitreous to crystalline tuffaceous materials.

As in other rocks of this area recrystallization and crystallization has been active. It has predominately affected the matrix, developing in it an irregular random fabric. An irregular shape for some of the larger quartz grains has also developed under these conditions. Narrow recrystallized alteration veinlets in part containing metasomatically added materials transect the fabric. Especially noted were ones containing calcite.

Petrogenesis:

The origin of these rocks is considered to be sedimentary with some components being derived from volcanic materials. The compositional complexity would seem to indicate water laid materials in part reworked. The volcanic debris was probably also water transported into the area of accumulation as this would explain its variable distribution, mixed relationship, and size variation. A general low to medium temperature period of alteration involving recrystallization of old minerals and crystallization of new ones has been emposed. This has been followed by local extensive metasomatic activity along fractures.

Rocks of the Basement Complex:

One sample was obtained from rocks which are considered to be of the basement complex. The rock type represented is a coarse grained porphyritic quartz monzonite. Quartz, one of the most abundant minerals present, occurs as large irregular crystals interstitially to the other minerals. The feldspars present include orthoclase, microcline, and plagioclase. The orthoclase is anhedral, partly perthitic, and essentially unaltered. Microcline, mostly twined, tends to form large phenocrysts with poor form. These crystals are weakly altered and generally fractured. Plagioclase occurs as subhedral to euhedral crystals, that are commonly twined and partially zoned. Locally they are altered to sericite and clay. Minor amounts of muscovite, chlorite and opaques are also present.

The sequence of mineral formation of the main minerals would place plagioclase early as it occurs as inclusions. It has been followed in turn by quartz and orthoclase. The microcline is the last mineral to develop as it engulfs earlier formed ones.

The textural aspects and the crystal features of the plagioclase suggests that this rock is igneous. The formation of the microcline phenocrysts is considered to have occurred in the solid state, either under deutaric conditions, or completely post magmatic. This conclusion is suggested by its relationship to other minerals. After microcline formation the rock was fractured, locally granulated, and altered to a minor degree.

MISCELLANEOUS ROCKS

<u>Meta-porphyry</u>:

The rocks included in this group are medium to coarse grained and have a light grayish colored matrix in which are set tannish colored phenocrysts. The fabric is porphyritic and is locally transected by narrow veinlets. The rock type is termed quartz monzonite porphyry.

Microscopically the rocks are composed of quartz, plagioclase, orthoclase, biotite, muscovite, zircon, apatite, sericite, clay, chlorite, epidote, calcite, and opaques. The quartz occurs in several forms; as phenocrysts, in the matrix, as inclusions, and as veinlets. Some of the crystals have wavy extinction and are dusty. Quartz phenocrysts are commonly round or elipsiodial in shape and have numerous embayments composed of matrix materials. Their edges are in part highly irregular with thin projections extending into the matrix and sometimes surrounding completely small areas of matrix. In the matrix the quartz is irregular in character and varies in size from specimen to specimen and from area to area within a specimen. The larger sized grains within a section are frequently associated with or near veinlets. As inclusions, the quartz occurs as small anhedral crystals commonly in the orthoclase. Veinlets of irregularly shaped quartz grains transect some of the specimens.

Plagioclase occurs mainly as phenocrysts which are anhedral to subhedral in outline and locally partially altered to clay and sericite. They range in composition from oligoclase to sodic-andesine and are generally twined and sometimes zoned. Plagioclase is not a common constituent of the matrix.

The orthoclase occurs both as phenocrysts, in the matrix, as inclusions in plagioclase crystals, and in veinlets. As phenocrysts the orthoclase is both of large and small size. They are generally rectangular in shape, although irregular shaped crystals do occur. Some crystals are perthitic. The large rectangular ones have very irregular borders with thin projections extending into the matrix. They also have inclusions of matrix materials near the margins. Within the main mass of the crystal are found inclusions of quartz and plagioclase. In the matrix of the specimens othroclase is the most abundant mineral. Here it is anhedral and generally of small size. Locally, however, larger crystals are present, especially near veinlets. Some orthoclase crystals occur as a replacement of the plagioclase and others are associated with veinlets. Alteration is incipient and then only locally present.

The other minerals present in these rocks make up less than 5% of the total. Most are minor accessory minerals; typical of these would be the euhedral zircons and apatite. Others are minor alteration products.

Petrogeneses:

The shape and occurrence of the phenocrysts, especially that of the quartz which is very similar to that found to be present in volcanic and hypabyssal rocks, points to the conclusion of an igneous deviation for these rocks. That its history is by no means simple is shown by the irregular borders of the quartz qhich are interpreted to indicate a period of recrystallization and crystal growth as a post magmatic igneous phenomenon. This period of recrystallization has also generally acted on the original matrix. The inclusions of quartz and plagioclase in the large orthoclase phenocrysts and replacement of plagioclase in the large orthoclase phenocrysts and replacement of plagioclase by orthoclase would indicate a late time of formation for these occurrences of this mineral. The association of orthoclase with quartz in veinlets may suggest that this late orthoclase is at least in part metasomatic in origin.

This, of course does not mean that all of the orthoclase is introduced into these rocks as that of the matrix is surely primary. With these veinlets there is associated rather extensive local recrystallization of quartz and orthoclase.

In some specimens examined there has been a late stage of granulation and with which is associated only minor recrystallization. Locally this granulation has been intense enough to almost destroy the original fabric.

<u>Felsite Porphyry</u>:

These rocks of this group are generally light gray but locally dark gray in color and are characterized by small irregular to rectangular whitish spots. The texture is aphanitic and generally massive. The rock types included are rhyolite, quartz latite, and latite with some having porphyritic and others porphyry type features.

Microscopically the texture is generally porphyritic with an aphanitic groundmass of quartz and feldspar. Phenocrysts are feldspar which sometimes can be identified as orthoclase or as orthoclase and plagioclase. Ones of quartz are also noted. A rather perfect rectangular shape of the feldspar phenocrysts and a round and embayed shape of the quartz phenocrysts suggests an igneous origin for these rocks. In most of the specimens examined the matrix shows evidence of recrystallization and some of the phenocrysts of secondary growth. Devitrification of original glass has occurred. Alterations are present in these rocks as in others of the area.

Andesite:

Megascopically these rocks are of a greenish gray to gray color, generally apanitic but locally very small unidentifiable light colored phenocryts can be observed. Microscopically the rocks contain phenocrysts of feldspar, biotite and in some specimens quartz. In addition large round to elongate to irregular bleds of calcite are present. The feldspar phenocrysts are generally plagioclase but in one specimen here included orthoclase was also noted. The character of the matrix is determinable in only a few specimens and in those it is composed of quartz, feldspar, biotite, clay, sericite, and opaques.

The texture and phenocrysts indicate that these rocks are igneous. There has been a post-magmatic alteration which has affected various specimens to various degrees. In some, recrystallization of the constituent minerals is especially obvious while in others only alteration of existing minerals took place.

Rocks from Drill Holes of East End Area:

The rocks from the east end were treated separately in the appendix as their assignment to either the Papago as Kino Formation involves the interpretation of the fault near this end of the property. If the fault is considered one in which the east side moves down then these rocks belong to the Papago Formation where as if the east side moved up they belong to the Kino Formation.

Considering the petrographic features of these rocks, they are like those described for the Papago Formation. The main exception to this is in thin section No. 146-285 from hole 146 which has some features similar to those considered to be of pyroclastic derivation from the Kino Formation. Primarily these are the presence of very elongate and angular quartz and feldspar grains. While these rocks are considered to be of the Papago Formation, this occurrence may point out some discrepancies and suggest the need for further work on these units.

CONCLUSIONS

Petrographic studies have been made on the rocks of the East Pima area. The sub-division of these rocks into three broad units, Papago, Pima, and Kino Formations seems valid. These units can be broadly correlated between drill holes when their recognizable variations are understood.

The Pima Formation is a strikingly different unit derived from a series of calcareous rocks. The Papago and Kino Formations have many similarities, both being derived from a series of siltstone with local intercalations of sand, arkose, and conglomerate. An existing difference between the two may lie in the presence of volcanic pyroclastic materials in the Kino Formation.

A meta-porphyry rock is present and which is recognized to have originated as an igneous type. It has been extensively altered by recrystallization, crystallization and metasomatic activity. Other igneous types include felsite porphyry and andesite.

The over-all alteration effects in these rocks are generally intense but with lower temperature ones in the Papago and Kino units and higher temperature ones in the Pima unit. This striking difference in thermal activity in the different units can be explained by a variance in intensity of activity of hot solutions, the most intense activity taking action in a more susceptible Pima unit. It also can be explained as a function of low angle faulting bringing unlike thermal affected rocks together. The final solution to this problem maybe could be a combination of these two ideas with faulting causing major differences and solutional activity minor ones.

APPENDIX I.

LISTING OF INDIVIDUAL THIN-SECTIONS
AND CORRESPONDING ROCK TYPE

ROCKS BELONGING TO THE PAPAGO FORMATION:

Argillite

29-289	Argillite
29-342	Argillite
31-271	Contact between quartz monzonite porphyry and sandy argillite
31-303	Fragmental sandy argillite
32-279	Argillite
37-554	Sandy argillite
41-311	Sandy argillite
41-341	Sandy argillite
45-450	Sandy argillite
48-455?	Argillite
48-482?	Argillite
49-279	Fragmental sandy argillite
56-303	Fragmental argillite
64-430?	Argillite
65-249	Argillite
68-300?	Calcareous sandy argillite
69-320	Sandy argillite
74-254	Sandy argillite
78-367	Argillite
88-251	Argillite
88-264	Argillite
88-298	Argillite
88-317	Argillite
88-370	Argillite
88-414	Sandy argillite
100-267	Argillite
100-367	Sandy argillite
114-262	Sandy argillite
114-283	Argillite
114-287	Banded arkosic argillite
119-265?	Argillite
119-270?	Spotted argillite
119-300?	Spotted argillite

Conglomerate

32-331	Conglomerate

(Note: The ? mark refers to uncertainty as to which formation the specimen belongs.)

[illegible] (Continued)

[illegible]	Conglomerate with volcanic fragments
[illegible]	Conglomerate
[illegible]	Conglomerate
[illegible]-264	Conglomerate with volcanic fragments
10[illegible]-408?	Conglomerate
111-[illegible]	Conglomerate

Miscellaneous

17-[illegible]?	Tremolite calcite hornfels	– dirty green chl. Hf w/ CO_3, chl vein
19-[illegible]?	Diopside calcite hornfels	– Green brown chl. Hf
34-344?	Diopside calcite hornfels	
[illegible]-37[illegible]	Gypsum hornfels	– cyp chl Hf
[illegible]	Fine-grained arkose	– well shaped feld. might think of qtz-feld replacement
[illegible]	Arkose	

ROCKS BELONGING TO THE PIMA FORMATION:

Argillite

[illegible]	Argillite
[illegible]-571	Argillite
[illegible]	Argillite
[illegible]	Argillite
[illegible]	Argillite
[illegible]	Calcareous argillite
[illegible]	Argillite
[illegible]	Argillite
[illegible]	[illegible] argillite

[illegible]

[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	Calcite quartz[illegible]
[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	Quartzite
[illegible]	[illegible] quartzite
[illegible]	[illegible]
[illegible]	[illegible] quartzite
[illegible]-504	Sericitic [illegible] quartzite
[illegible]	Quartzite
88-611	Quartzite
88-627	Quartzite

(Tu[illegible])

44-344 Soft green-yellow diops? with chl veins

Quartzite (Continued)

88-563 Sanidite bearing quartzite
97-[illegible] Quartzite

Hornfels

20-383 Garnet [illegible] hornfels — Tt, clay alt.
22-[illegible] Quartz [illegible] — No H.S.
22-493 Biotite quartz feldspar hornfels — feld rock. chl & Biot.
23-412 Diopside hornfels — No H.S.
24-[illegible] Garnet [illegible] hornfels — Trem - gyp - chl
28-335 Tremolite feldspar hornfels — This prob. not be identified. possibly would call it feld rock w/ chl.
37-[illegible] Diopside hornfels — hard dense dirty white — Fe-Trem veinlet in section. May have borders of b dirty brown green. dense. chl. Calc Arg?
37-737 Quartz feldspar calcite hornfels
41-[illegible] Tremolite [illegible] hornfels — Highly calc diops? Hf. or Mb. Fine gr.
42-39? 12 Diopside tremolite [illegible] hornfels — granular diops Hf w/ trem-act. veins
42-[illegible] Tremolite quartz hornfels — green dense Hf. hard.
42-510 Diopside hornfels — green [illegible] Hf. ✓ good grain size
42-512 Gypsum hornfels
46-795 Quartz diopside hornfels — green (light) massive.
46-841 Wollastonite calcite hornfels — Woll.
47-5[illegible] Tremolite diopside hornfels — Grnt woll (Sect did not cut grnt)
[illegible]-744 Garnet diopside quartz hornfels — Tt, clay alt foamy.
88-425? Tremolite hornfels — Green Hf, granular, some grnt. some feld? chl veins
88-463 Actino-tremolite hornfels — like above, more translucent, some feld?
88-468 Quartz calcite feldspar hornfels — like above, visible trem, serp? chl? & feld or qtz.
88-475 Tremolite hornfels — Green [illegible] trem w/ trem? vein (T.S. Not cut vein) Trem.
88-662 Quartz feldspar actino-tremolite hornfels — qtzt or qtz-feld w/ chl
88-669 Tremolite diopside hornfels — somewhat pulverent, dirty dark green Hf w/ some qtz - chl.
88-685 Diopside tremolite hornfels — Green chl w/ 50% Euh. yellow - buff grnt
88-721 Wollastonite hornfels — Woll, diop? & Mb
88-[illegible] Calc-silicate hornfels — woll & diops?
90-364 Diopside hornfels — fairly hard granular white diops.
100-472? Biotite quartz feldspar hornfels — Mp or cut w/ brown [illegible]
149-562 Quartz feldspar calcite hornfels — Mb w/ silicate? (colorless)
149-770 Diopside tremolite quartz feldspar hornfels — Calc Arg
149-810 Tremolite hornfels — woll. (white fibrous (chert) w/ Mb?

Tactite

22-553 Quartz garnet tactite
28-281 Quartz garnet tactite
37-734 Wollastonite garnet tactite
42-480 Diopside gypsum garnet tactite — Tt, el clay
44-706 Garnet tactite
46-327? Diopside garnet tactite — Massive light col grnt diops vein in grnt (T.S.)
47-427 Garnet tactite
47-455 Diopside tremolite garnet tactite —
50-458 Garnet tactite
51-376 Garnet tactite

(Note: The ? mark refers to uncertainty as to which formation the specimen belongs.)

Tactite (Continued)

53-643	Diopside tremolite garnet tactite Tt - clay alt
63-498	Garnet tactite
65-271	Diopside garnet tactite light col grnt, clay heavy
65-304	Garnet tactite
76-408	Diopside garnet tactite
76-499	Diopside tremolite garnet tactite - Massive - prob not identifiable
88-429?	Epidote garnet tactite - Prob log it as Green chl Alt w/ altered grnt.
88-437?	Diopside garnet tactite Reddish tt. some trans veins
88-700	Garnet tactite
88-712	Garnet tactite
88-727	Garnet tactite
88-740	Garnet tactite
88-748	Garnet tactite
90-251?	Quartz garnet tactite light col grnt, feld or siliceous.
90-389	Diopside garnet tactite Tt light tan-green

Marble

21-359	Marble
21-387	Wollastonite bearing marble
46-498	Marble
47-587	Marble
54-309	Marble
78-752	Irregular zones of cryptocrystalline quartz in marble
88-757	Marble
88-764	Marble
88-780	Marble
88-793	Marble
88-815	Marble
88-828	Tremolite wollastonite marble
88-836	Wollastonite marble
93-704	Calc-silicate quartzite zone in marble
94-716	Marble
149-723	Marble
149-812	Marble

Miscellaneous

109-398	Quartz feldspar banded rock
134-265	Feldspar replacement
134-275	Quartz feldspar replacement

ROCKS BELONGING TO THE KINO FORMATION:

Argillite

41-780	Fragmental sandy argillite

(Note: The ? mark refers to uncertainty as to which formation the specimen belongs.)

Argillite (Continued)

41-800	Argillite
54-430	Argillite
54-475	Argillite
54-510	Conglomeratic argillite with volcanic fragments
62-616?	Banded argillite
62-716?	Argillite?
62-719?	Fragmental sandy argillite
105-675?	Fragmental argillite
148-582	Fragmental argillite
148-592	Spotted argillite

Conglomerate

116-554	Conglomerate
129-883	Conglomerate
129-927	Conglomerate
148-636	Conglomerate
148-638	Conglomerate

(Note: The ? mark refers to uncertainty as to which formation the specimen belongs.)

ROCKS FROM EAST END DRILL HOLES BELONGING TO EITHER THE PAPAGO OR KINO FORMATION

Argillite

52-535	Argillite
57-369	Sandy argillite
61-348	Sandy argillite
75-300	Sandy argillite
79 340	Fragmental sandy argillite
85-307?	Calcareous argillite
85 365?	Argillite
103-307	Arkosic argillite
110-284	Banded argillite
110-322	Arkosic argillite
110-324	Sandy argillite
110-404	Arkosic argillite
115-226	Argillite
128-884	Sandy argillite
132-320	Banded sandy argillite
139-575	Argillite in contact with calcareous argillite
140 337	Sandy argillite
140-342	Argillite
140-384	Fragmental argillite
140-653	Argillite
146-285	Arkosic argillite

Arkose

71-230	Fragmental arkose
110-367	Arkose
110-453	Arkose

Conglomerate

52-255	Conglomerate with volcanic fragments
61-215	Conglomerate
128-875	Conglomerate

Quartzite

57-987	Garnet bearing quartzite

ROCKS OF THE BASEMENT COMPLEX

137-1395	Quartz monzonite

(Note: The ? mark refers to uncertain hole location.)

MISCELLANEOUS UNITS

Meta-porphyry

18-245	Quartz monzonite porphyry
22-351	Quartz monzonite porphyry
24-451	Quartz monzonite porphyry
31-271	Contact between quartz monzonite porphyry and sandy argillite
33-353	Quartz monzonite porphyry
39-342	Quartz monzonite porphyry
42-330	Quartz monzonite porphyry
73-352	Quartz monzonite porphyry
77-223	Quartz monzonite porphyry
78-244	Quartz monzonite porphyry
81-348	Quartz monzonite porphyry
81-430	Quartz monzonite porphyry
81-450	Quartz monzonite porphyry
88-212	Quartz monzonite porphyry
99-345	Quartz monzonite porphyry
99-348	Quartz monzonite porphyry
100-566	Quartz monzonite porphyry

Felsite porphyry

50-613	Latite porphyry - Int ig
52-410	Quartz latite porphyry - flow?
52-431	Quartz latite porphyry
52-552	Latite
52-580	Porphyritic latite
52-598	Porphyritic quartz latite
63-429	Quartz latite porphyry
75-540	Porphyritic latite
108-234	Quartz latite porphyry - ok
110-562	Quartz latite porphyry —
116-534	Quartz porphyry
128-828	Quartz latite porphyry
128-901	Quartz latite porphyry
129-919	Porphyritic rhyolite
140-322	Rhyolite porphyry
140-331	Rhyolite porphyry
140-898	Quartz latite porphyry

Andesite

33-283	Quartz latite porphyry (Probably logged as andesite because of megascopic appearance.) — not logged as andesite
43-671	Biotite andesite

Andesite (Continued)

52-392	Dacite (Probably logged as andesite because of megascopic appearance.)
52-616	Dacite (Probably logged as andesite because of megascopic appearance.)
59-328	Biotite andesite
108-338	Andesite