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The following file is part of the

James Doyle Sell Mining Collection

Petrography - Age Dates - Metallurgy Reports.

* — *

OF-1A & M-1 (Earlier Volcanics basalt) March 5, 1971.
Microprobe of Native Copper from hole M-1A, Tw. July 13, 1971.
DCA-1A (zeolite Heulandite from Tw). Nov. 30, 1971.
Microprobe of Native Copper - Augite from A-4 (2) Dec. 10, 1971.
DCA-1A. (fossils from Naco & Escabrosa). Jan 12, 1972.
Cactus bx & Whitetail Cgl, outcrop & DDH. Jan. 19, 1972
Core Holes M-1A (1) & A-4 (6). Jan. 20, 1972
Age-Date from Holes M-1A & A-4 Jan. 27, 1972
Photomicrograph of Chalcocite-Hematite, A-2. March 22, 197[illegible]
Submittal of Ten Core Samples from hole A-2. March 30, 1972
Petrographic Exam of Manitou Gr (4) & Lost Gulch Mn (1) May 5, 19[illegible]
Hydrothermal Alteration in Holes AI-1 (11) & A-2 (14) June 17, 1974
Petrography of Ray West, RW-54, q.latite porphyry. Oct-24, 197[illegible]
Hydrothermal Alteration in hole DCA-34 (8) Nov 8, 1974
Metallurgical Tests on Native Copper Ore. Dec. 13, 1974.
Sample Preparation & Metallurgical Testing of Cu° Ore - Jan. 31, 197[illegible]
Fluid Inclusions in LB-4 (5) Feb. 13, 1975
Notes on Sample Identification. April 25, 1975.
Further Metallurgical Testing of Native Cu Ore April 30, 1975
Age-Date Request for Tuff in Whitetail Cgl. March 3, 1977
Beneficiation of Native Cu Ore - Az & Michigan July 20, 1977
Identification of "bladed" chalcocite-bornite w/py, A-9. Feb. 23, 197[illegible]
Thin-Sections, hole B-6 (Newmont) (3). May 31, 197[illegible]
Sulfide Assemblages from A-8 (3) & A-9 (1). March 11, 1980.
* Sample List Series & Number-Types of Thin-sections, double polished Thin sections, and Polished Thin Sections, & Polished Sections June 30 19[illegible]

Sample List Series: 6/30/82

Hole:

A-1

A-2

A-2w

A-3

A-4

A-7

A-8

A-9

A-10

A-11

A-12

A-12-A

A-13

A-14

AOF-1

DCA-1A

DCA-2A

DCA-3A

M-1A

OF-1A (Kerr-McGee)

LB-4 (P.Kaysen)

Sacaton basal flt.

QDC-5

X & Z, Lost Gulch qm. & Manitou gr.

Hole B-6, A-B-C, Sect. 6 (Magma).

QC-Series (7 samples) (Queen Creek).

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Tuff Beds to Check:

Elev.

E of RHC.

E4720 A-1 Tw 1527-1566 ash flow tuff 1532-1535 E4720 +3185
BR 1566 (+3155).

E4800 DCA-2A Tw 1415-1442 Trt 1442-1452 altered "dacitic" material Tw @ 1410-1415 ?? E4800 +335
BR 1452 (+3350).

E4975 AOF-2 Tw 800-3058 T.D. Silicic material @ 2690 few shy frags @ 2890 E4975 (?+22 ? +2085
BR below 3058. (below +1915)

E4240 AOF-1 Tw 1106-2939 None reported; increase Cu @ 2800' E4240 ?+144
BR 2939 (+1300)

Between RHC & DC.

E4640 DCA-3A Tw 2430-4454. Tuff wacke; brst. tuff; No increase in Cu "tuw" 3204-3205 E4640 DCA 3320SV +143
BR 4454 (SB) (+185)

E4425 AI-1 Tw 2250-3073 None recorded E4625
BR 3073 (SB). (+1550)

E4685 A-8 Tw 2213-3224 chance of 3200'; increased Cu° E4685 ? +148
BR 3224 (SB). (+1460)

E4340 A-2 Tw 2020-3920 None reported. E4340 —
BR 3920 (SB). (+420)

A-9 A92916V [illegible] (to DCA 3320SV)

Tuff Beds to Check (Continued).

W of DC.

E 4785 DCA-1A. Tw 2210-4669 None noted in rotary cuttings nor core E4785 —

BR 4669 (+ 115)

E 4500 M-1A Tw 2428-4998 E4500

ck lithic ss & tuff @ 2430 ? + 2070

ck vitric tuff 2903-2904 ? + 1595

M1A3818V

ck gray tuff mudstone 3818-3819 & 3837-3838 ? + 680

Also ck lithic SS in Lupai at 4998-4922-4936

& below to base at 5108 (ck 5040-5006 Tm).

BR 4998 (-500)

E 4020 A-5 Tw 2600-3145 T.D. None reported in rotary cuttings E4020 —

BR below 3145 (below + 870)

E4210 A-7 Tw 2445-5610. ? tuff bed or lens @ 4690-4695. Cu below. A74691H A74694H E4210 -480

ck tuff ss in Lupai @ 5663-5748. A75710H

BR 5610 (-1400)

E4100 A-4 Tw 2133-6484 lithic ~~ss~~ tuff 3808-3810 ~~2920-2943~~ A43810V E4100 +290 ~~(? + 2070)~~

~~vitric~~ lithic tuff 3976-3984 ~~2903-2904~~ A43978V (+120) ~~(? + 1595)~~

~~gray~~ lithic tuff ~~mudstone~~ 4201½-4203 A44202V (-100)

A-45084 Horizontal Vertical

lithic tuff w/ Cu below. 5083-5102 & to 5112 A45098H A45108V -1000

BR 6484 (-2385)

E4125 A-3 Tw 1430-6008 T.D. lithic tuff 3671-3677 T.S. 3671 E4125 +450

" ", silic 4485-4490 w/ Cu T.S. 4488 -360

BR below 6008 (below -1885)

Thin-section, etc. collection

Drill Hole No. A-1

Sample No.	Thin-section	Polish. thin-section	Polished section	X-ray data	Remarks	
TBX-4-A-1-1397					breccia	TBX samples, see report Jan 19, 1972 by G.J.S.
TBX-6-A-1-1509					breccia	
TBX-5-A-1-1557					Tw	
A-12100					pEpi	

Micro-section, etc., collection

Drill Hole No. A-2

Sample No.	Thin Sec.	Polished Thin Sec.	Polished Section	X-ray Study	Remarks
A-2-4253		■	■		A-2 type
A-2-4262		■			" "
A-2-4263			■		" "
A-2-3 (4301)					*
A-2-4308			■		
A-2-4340		■	■		
A-2-4360		■	■		
A-2-4(4394)					*
A-2-4401			■		
A-2-5 (4403)					*
A-2-4412			■		
A-2-4419			■		
A-2-4445			■		
A-2-4459			■		
A-2-6 (4499)					*
2-4229		Double Polished			for heat stage work.

Also see V. Hudrugh report of March 22, 1972, on sample A-2 (4076-4078) X-ray diffraction & photomicrographs.

* See report June 17, 1974 by FTG

Thin-sections, etc., collection

Drill Hole No. A-2 W (wedge)

Sample No	Thin Section	Polished Thin Section	Polished Section	Rock Slab	Remarks	
A-2W 4242				—	pory.	
A-2W 4248				—	schist	
A-2W 4309					pory.?	
A-2W 4325					schist	
A-2W 4541				—	pory.	
A-2W 4545					schist	
A-2-7 (4457)						*
A-2W 4780					schist	
A-2W 4736					pory.	
A-2-8 (4864)						*
A-2-9 (4910)						*
A-2W 4928				—	blk pory	
2W-4300		Double Polished			for heat stage work.	

* See report of June 17, 1974 by FTG.

Thin-section, etc. collection

Drill Hole No. A-3

	Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
old sections	A-33674 Vert cut					[illegible]
	A-33674 Horiz cut				—	"
	A-34488					"

Thin-section, etc., collection

Drill Hole No. A-4

Sample No.	Thin Section	Polished Thin Section	Polished Section	K-Ar Date	Remarks
A-4 3810 Vert.					tuff
A-4 3978 Vert.					"
A-4 4202 Vert					"
A-4 5084 Horiz.				?	" Cu marks
A-4 5084 Vert.				?	" " "
A-4 5098 Horiz.					" " "
A-4 5708 Vert					"
A-4-4-6562					Escalnase bx ✓
A-4-2-6602					basalt - blk grey ✓
A-4-6-6612					blk por. ✓
A-4-1-6656					blk por. ✓
A-4- 6657					blk por.

(Brace next to samples A-4-4-6562 through A-4-1-6656:) See report of Jan 20, 1972 by G.S.S. Also containing reports on sample at 6573' & 6445.

(Next to A-4- 6657:) See report of June 17, 1974 by FTG.

Also see report by V. Kudryk (Dec. 10, 1971) on microscopic & microprobe result of
A-4 - 5090 (lithic tuff)
& A-4 - 5106 (conglomerate)

Also see report by Geochron Laboratories, Jan 20, 1972, on age date of sample A-4-C 12-1 (depth of 6620-6630').

Thin-section, etc. collection

Drill Hole No. A-7

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
A-7 4491 Horz					tuff-lim
A-7 4494 Horz					" "
A-7 5710 Horz					"Sespai ss"

Thin-section, etc. collection

Drill Hole No. A-8

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
A-8 3198					Tw
A-8 3252					A-2 type SB
A-8 3449					" " "
A-8 3543				x	" " " Lgranite [illegible] old [illegible]
A-8 3487					" " "
A-8 3814					leached BR
A-8 3883				x	self. Lbfp [illegible]
A-8 3891					" pepi " "
A-8 3958 A-8 3978		x	x		pepi py-cc " "
A-8 4023		x			Lbfp gb-sulf m " "
A-8 4088		x		x	pepi gb-sulf m " "
A-8 4111				x	Lbfp " "
A-8 4202 (see 4402) A-8 4249 A-8 4253 A-8 4614 A-8 4355 A-8 4402		x		x	Lbfp " "
A-8 4422				x	Lbfp " "
A-8 4726				x	Lbfp [illegible] " "
A-8 4835				x	pepi K-[illegible] " "
A-8 4905					
A-8 3978			x		py-cp, bn-cc
A-8 4249			x		bn-cc
A-8 4253			x 4		bn-cc
A-8 4355			x		py-cp, bn-cc
A-8 4402 (not/ marked 4202)			x		[illegible] bn, py-cc
8-4064		Doubly Polished			for heat-stage work
8-4157		"			" " "

Thin-section, etc. collection

Drill Hole No. A-9

Sample No.	Thin-Section	Polished Thin Section	Polished Section	K-stain Slab	Remarks	
A-9 2916 Vent					tuff bxs	old sect.
A-9 3252					Tuv	
A-9 3306					M1A SB	
A-9 3347					A-2 SB	
A-9 3429				x	" "	
A-9 3598					" "	
A-9 3634					" "	
A-9 4023				x	leached BR	
A-9 4026				x	" "	
A-9 4068			x		sulfide	
A-9 4070			x			
A-9 4136			x			
A-9 4159				x		
A-9 4202				x	foliated porp.	old sect.
A-9 4279			x			
A-9 4282		x	x			
A-9 4437				x	bfp	old sect.
A-9 4449			x			
A-9 4580				x	xl	" " *
A-9 4734				x		
A-9 4737						
A-9 4902				x		
9-4055		Double Polished			for heat-stage work	
9-4428		"			" " " "	
9-4856		"			" " " "	

* See V. Kovalenko's report of March 10, 19?? for sample A-9-4493.

Thin-section, etc. collection

Drill Hole No. A-10

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
A-10 3369					Tw
A-10 3388					M-1A SB
A-10 3436				—	A-2 SB
A-10 3442				—	" "
A-10 3597					" "
A-10 3691				—	" " blk porp.
A-10 3697				—	" "
A-10 3765			—		
A-10 3829					" "
A-10 3891				—	leached BR
A-10 3899					" "
A-10 3961			—		
A-10 4052				—	blk porp.
A-10 4163				—	old section
A-10 4180				—	" "
A-10 4235			—		
A-10 4264				—	" "
A-10 4278				—	" "
10-3990		Double Polished			for heat-stage work
10-4272		"			" " " "

/Mau-section, etc. collection

Drill Hole No. A-11

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	X-Stain Slab	Remarks
11-4283		Doubly Polished			for heat-stage work
11-4503		"			" " " "

Thin-section, etc. collection

Drill Hole No. A-12 and A-12-A (wedge)

Sample No.	Thin Section	Polished Thin Section	Polished Section on glass slide	K-Stain Slab on glass slides	Remarks
A-12-3530	X				schist bx
A-12-3764	X				schist w/hematite
A-12-4021	X			SCX	schist, qtz-sericite, hem after cc?
A-12-A-4100			X		schist capping w/ Cu
A-12-A-4110	X			X	schist capping
A-12-A-4129	X			X	porphyry bx, leached capping, qtz-seri. ~~schist w/ cc-py~~
A-12-A-4136	X			X	porphyry, 90% alt to qtz-seri.
A-12-A-4146			X		schist w/ Cu-specularite vn (oxidized
A-12-A-4167		X (marked "4647PT")	X		schist w/ cc oxidized vein
A-12-A-4172			X		schist, sulfide cc
A-12-A-4178			X		schist, py-cc vn + diss.
A-12-A-4195	X			X	porphyry & qtz + qtz seri.
A-12-A-4208			X		schist, py-cp-cc vn
A-12-4219		X			schist w/ cc-py vn
A-12-4220			X		schist w/ cc-py vn
A-12-A-4223		X			schist w/diss cc in schistosity, qtz-seri
A-12-A-4236			X		schist, py-cc vein + diss.
A-12-4256	X			should be	Lbfp alt band
A-12-4355		X			schist w/cc-py vn
A-12-4448			X		massive py-cp-cc-bn?
A-12-4527			X		massive py-cp-bn-cc in qtz vn
A-12-4587			X		vn of py-bn repl in schist
A-12-4589	X			X	Lbfp w/ alt band
A-12-4627	X			X	Lbfp w/alt band

continued

Thin-section, etc. collection

Drill Hole No. A-12 & A-12-A Continued (2)

Sample No.	Thin-Section	Polished Thin Section	Polished Section	K-Stain Slab	Remarks
A-12-4633		X			schist bx w/ py-bn
A-12-4666			X		qtz vn w/ bn
A-12-4669		X			alt schist w/ irregular bn
A-12-4822			X		py-cp-bn in qtz-porphyry
A-12-4826	X			3 1X6	Lbfp w/diss bn
A-12-4848		X			schist, alt, w/diss bn
A-12-4850			X		massive bn-py
A-12-4898			X		massive py-cp-bn (cc)
A-12-4970		X	X		py-cp-bn vn in Lbfp qtz-seri band
A-12-5113			X		py-cp w/ bn ?
A-12-5127			X		cp
A-12-5131			X		cp-bn
A-12-5155		X			cp - speculite
A-12-5174		X			cp-qtz vn w/cp-bn
A-12-5252	X			X	blk biotite schist w/ sugary qtz vn
A-12-5260	X			X	qtz infiltrated ~~?~~ schist w/ cp
A-12-5348	X			X	schist w/ qtz + K-spar vn
A-12-5356	X			X	schist w/ qtz + K-spar vn
A-12-5358	X			X	Lbfp, bx
A-12-5368	X			X	Lbfp w/ qtz-seri vn
A-12-5375	X			X	Lbfp w/qtz-seri vn & enhanced feldspar
A-12-5393	X			X	Lbfp w/qtz-seri vn & enhanced feldspar
A-12-5411	X			X	Lbfp as above (greenish) + py-hematite
A-12-5417	X			X	Lbfp as above ; no py-hem

Continued

[illegible] collection

Drill Hole No. A-12 & A-12-A Continued

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
A-12-5434		X w/K-stain "blank"		X	Lbfp bx w/qtz-seri + cp-hem.
A-12-5486	X			X	Lbfp, enhanced feldspars
A-12-5551	X			X	Lbfp, enhanced feldspars
A-12-5622	X			X	Lbfp, slightly stained
A-12-5623	X			X	Lbfp, more stained a/ hem fractures
A-12-5625	X			X	Lbfp, more stained w/ qtz-seri.
A-12-5627	X			X	Lbfp, sheared & gougy
A-12-5633	X			X	Lbfp, very sheared & gougy
A-12-5665	X			X	schist, cataclastic crushing
A-12-5692	X			X	schist, silica saupried, fine aluinits
A-12-5716	X			X	schist, with aluinits? on.

Drill Hole A-14

14-4147	Double Polished	for heat-stage work
14-4262	"	" " " "
14-5170	"	" " " "
14-5735	"	" " " "

Micro-section, etc.
collection

Drill Hole No. AI-1

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	Kyte Lab.	Remarks
AI-12822				—	M-1A SG
AI-12997					" "
AI-13054					A-2 SG.
AI-13199					" "
A-I-1 (3261)					*
A-I-14 (3304)					*
AI-13342				—	BR
AI-13498				—	
A-I-15 (3511)					*
AI-13547				—	
AI-13557					pepi, anhydrite
A-I-16 (3624)					*
A-I-17 (3711)					*
A-I-18 (3810)					*
AI-13921					pinol
A-I-19 (3949)					*
A-I-20 (3963)					*

* See report June 17, 1974 by FTG.

Thin-section, etc. collection

Drill Hole No. AOF-1 of Inspiration Con. Copper Co.

Sample No.	Thin-section	Polished Thin-section	Polished Section	K-stain slab	Remarks
3450				—	pepi

Thin-section, etc. collection

Drill Hole No. DCA-1A

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
					See report by Emanuel Nieves on samples DCA-1A-4716 & DCA-1A-5301 (fossil identification), dated Jan. 12, 1972.

Thin-section, etc. collection

Drill Hole No. DCA-2A

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
DCA-2 1538					schist
DCA-2 1547					schisty
DCA-2 1928					schist
DCA-2 2393					schist

Thin-section, etc., collection

Drill Hole No. DCA-3A

Sample No	Thin-Section	Polished Thin-section	Polished Section	K-stain Feld	Remarks	
DCA-33205 [illegible]					tuff-lime	
DCA-34100					M-1A SB	
DCA-34193					Tu	
DCA-34334				■	M1A SB	
DCA-3A-4387						*
DCA-3A-4460						*
DCA-34512				■	A-2 SB	
DCA-34637				■	" "	
DCA-3A-4662						*
DCA-3A-4693						*
DCA-3A-4717						*
DCA-34747				■	BK	
DCA-3A-4780						*
DCA-34858				■		
DCA-3A-4874						*
DCA-3A-4975						*
DCA-34991						
DCA-35137						
3A-4699		Double Polished			for heat-stage work	
3A-4805		"			" " " "	

* See report of Nov. 8, 1974 by FTG

Thin-section, etc. collection

Drill Hole No. M-1A

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
M-1-2241' (~~[illegible]~~)					} 2 [illegible] samples, one ⊥ other ∥ to core axis. ~~[illegible]~~ earlier volcanics. See report March 5, 1971 GRK.
M-2-2241' (~~[illegible]~~)					
M-1A-1-2981					M-1A SB — See report Jan. 20, 1972 by GJS.
TBX-7-M-1A-2457					Tw. — TBX samples: See report Jan. 19, 1972 by GJS.
TBX-8-M-1A-3125					Tw.
TBX-9-M-1A-4278					Tw.
M-1A 3318 Vent					tuff

Also see report by V Kaelnzh[?] to Collins July 13, 1971 on microscopic & microprobe work on sample M-1A - 4209.

Also see Agedate report by Geochron Laboratories, Jan. 20, 1972 on sample M-1A-A (2935-2945)

Thin-section, etc. collection

Drill Hole No. ~~OFA-1 & OFA-2~~ OF-1A hole of Kerr-McGee ~~of Kerr-McGee~~

Sample No.	Thin-section	Polished Thin-section	Polished Section	K-Stain Slab	Remarks
OFA-1-2140'					same sample, one cut 1, other cut 2 ... earlier volcanics — #2140 — See report March 5, 1971 JRK
OFA-2-2140'					" " — #2140
~~OFA-2~~					earlier ~~volcanics~~

Thin-section, etc. collection

Drill Hole No. LB-4

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slide	Remarks
LB-4-2600				slide	* See report Feb. 13, 1975 by FTG on fluid inclusions
LB-4-3092				~~slide~~ No	*
LB-4-3410				slide	*
LB-4-4200				slide	*
LB-4-4850				slide	*

Thin-section, etc. collection

Drill Hole No. Sacaton Basal fault

Sample No.	Thin-section	Polished Thin-section	Polished Section	K-stain slab	Remarks
SACBF-1	—				
SACBF-2	—				

Thin-section, etc. collection

Drill Hole No. QDC-5

Sample No.	Thin-section	Polished Thin-section	Polished Section	K-stain slab	Remarks
QDC-5538					
QDC-55575					
QDC-51800					
QDC-52729				?	
QDC-52802					
QDC-52811				?	
QDC-52858					
QDC-52887					
QDC-52900					
QDC-573202					
DC-53502					

Thin-section, etc., collection

Drill Hole No. Other Samples from District

Sample No	Thin-Section	Polished Thin-Section	Polished Section	K-Stain Slab	Remarks
X-14	|||	in basement file			Lost Gulch quartz monzonite
Z-1 Z-2 Z-3 Z-4	||||	in basement file			Manitou granite

See report May 5, 1972 by GSS.

Thin-section, etc., collection

Drill Hole No. Magma B-6 hole.

Sample No.	Thin-Section	Polish Thin-Section	Polished Section	K-Stain	Remarks
B-6-A		—			Trog w/ cc on py.
B-6-B					Martin regl texture
B-6-C		—			Trog, w/ mn

Thin-section, etc., collection

Drill Hole No. Queen Creek (Superior, Az) QC - Series

Sample No	Thin-section	Polished thin-section	Polished section	[illegible]	Remarks
QC-1A					middle Naco; Mn-rich
QC-2A					top Escabrosa: Mn-rich
QC-3A					middle Escabrosa; excell. repl. texture
QC-7A					lower Martin; excellent repl. texture
QC-8A					upper Bolsa qtzte. Fe-stained
QC-101					lower Naco; 45' above Karst above QC-102
QC-102					upper Escabrosa; mushroom Mn, below Karst.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

March 5, 1971

TO: J. D. Sell

From: J. R. King

Re: Petrographic Examination of Selected Samples from Kerr McGee (OF-1A) and Continental (M-1) Drill Holes - Superior East Project - Pinal County, Arizona

One sample from drill hole OF-1A (2140') and one sample from drill hole M-1 (2261') were petrographically examined. Each sample was thin-sectioned parallel and perpendicular to the core length and then examined at the Silver Bell laboratory. One polish section was made of OF-1A to determine metallics present.

Conclusions

Both samples are identical in texture and mineralogic composition. They are classified as aphanitic, hypocrystalline andesites with probable trachyte chemical affinities. Both show obvious flowage textures as evidenced by:

1. Strong fluidal alignment of microcrystalline plagioclase laths (trachytic texture);

2. Wrapping of minute plagioclase laths around larger phenocrysts; and

3. Alignment of phenocrysts parallel to the fluidal lineations of the microlites.

The flowage appears to be dipping 15° (OF-1A) to 40° (M-1) from the normal to the core length. Mineralogical composition of the two samples is identical. They are essentially composed of 60-70% plagioclase (An_{20}-An_{40}); 10-20% clinopyroxenes ($\pm$ orthopyroxenes); 5-8% magnetite (5% of which is being oxidized to hematite); 5-10% chlorite-antigorite; 3-7% glass. Other mineral constituents which occur in trace amounts are quartz, calcite, sericite, olivine, biotite and iddingsite.

The plagioclase laths are essentially fresh with only trace occurrences of sericite along cleavage planes. The pyroxenes are commonly altered to chlorite-antigorite masses which in turn may show limited regeneration of biotite. The glass is for the most part devitrified to unidentifiable cryptocystalites and, to a lesser extent, altered to plagonite.

This alteration seen in both samples is the result of either late deutric alteration and/or very weak metamorphic alteration which is commonly seen in basaltic and andesitic lavas that are fractured and permeated by warm meteoric water. Veins of quartz and calcite cut both rocks. In general, quartz is deposited first and line the veins. Calcite fills the inward portion of the veins and is considered younger. No alteration of the rock immediately surrounding these veins has taken place.

The only microscopic difference between the two samples is a very slight increase in grain size of the Margaret andesite. In hand sample, the Margaret andesite shows strong fracturing with the development of chloritic slicks and quartz-calcite veins whereas the OF-1A sample shows only moderate fracturing with the development of predominantly quartz veinlets. The Margaret sample is somewhat easier to scratch with a knife than the OF-1A sample which may be the result of a combination of factors, mainly the slight differences in grain size and the difference in fracture intensity.

John King mw

John R. King

JRK:mw
cc: W. E. Saegart

WES

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J., 07080

RECEIVED
JUL 19 1971
S. W. U. S. EXPL. DIV.

July 13, 1971
Ref. 3175

W.E.S.
JUL 19 1971

Mr. John J. Collins
Director of Exploration
NEW YORK OFFICE

Superior East, Arizona
Project No. MA #0010-03

The attached memorandum by Mr. R. B. Haagensen summarizes the microscopic and microprobe examination of the samples submitted from Superior East, Arizona. The results are quite positive that the copper did not originate from a sulfide origin, but apparently penetrated as native copper. As can be noted from the analysis, the copper is relatively pure and perhaps the contaminants are more of surface rather than part of the copper.

I hope that this information will be helpful; however, if there are anymore details you would like, please let me know.

V. Kudryk

VK/lk

cc: RBHaagensen
WLKurtz
EMartinez

Hole M-1A
Sample depth 4209 feet

See letter to JDS from V. Kudryk dated Dec. 10, 1971 for info on A-4 samples.

AMERICAN SMELTING AND REFINING COMPANY

CENTRAL RESEARCH LABORATORIES

SOUTH PLAINFIELD, N. J., 07080

July 8, 1971

Ref: 3175
MA #0010-03

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

Superior East, Arizona (MR-192)

The sample of drill core was examined in polished section by the optical microscope and the electron microprobe. In addition, four samples of native copper were handpicked from different sections of the sample and submitted for qualitative spectrographic analysis. Attached are two photomicrographs of selected areas of the sample together with the spectrographic results.

Photomicrographs No. 1 and No. 2 show the typical occurence of native copper in this drill core sample. The copper generally appears to follow tectonic cracks and grain boundaries and is found in veins measuring on the order of 10 to 20 microns across. No sulfides were found either associated with the native copper or elsewhere in the sample. The accompanying spectrographic analyses show that the handpicked copper samples are probably contaminated in varying degrees with gangue constituents.

The following is a brief report on the electron microprobe analysis by Mr. T. Kartelias:

> "The polished section of the drill core was carbon coated for examination in the scanning electron microprobe. Five separate veins of native copper were examined with two points of analysis per vein for sulfur.
>
> No sulfur was detected in the veins of native copper. The edges of these veins were also examined for sulfur, however, none was detected. The copper content of the veins ranged from 95% to 99% (±2 to 3% absolute). The average copper concentration of the ten points analysed was 97% copper."

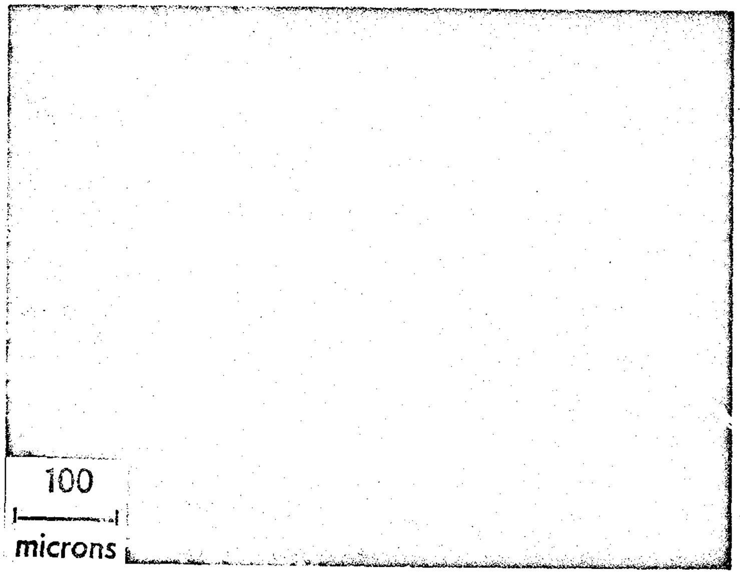
No evidence was found to establish that the native copper present in this drill core is a replacement of a copper sulfide mineral.

R. B. Haagensen

RBH/dm
Attachs.

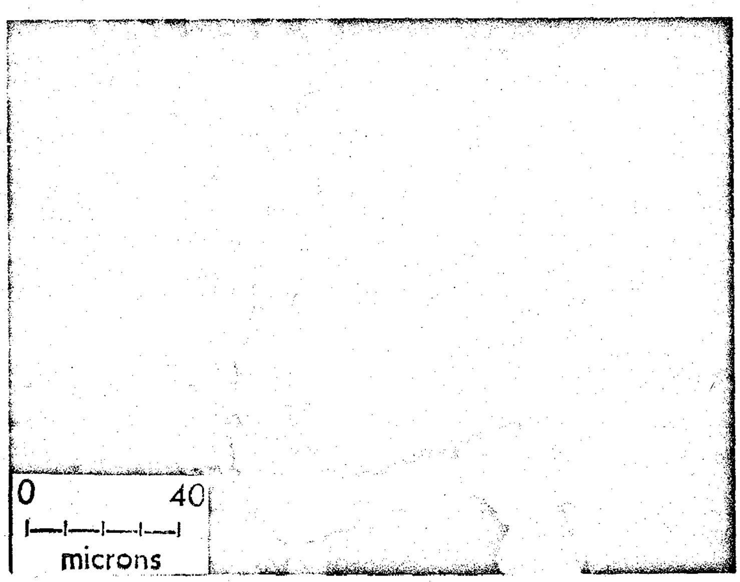
Superior East, Arizona
(MR-192)

Drill Hole M-1A, footage 4209'.



No. 1

125X, polished section. The section shows a portion of two typical native copper veins cutting across both silicates (black) and oxides (gray). The gray intergrowths are hematite-magnetite while the silicates are mainly quartz and pyroxene-amphibole. The copper appears to follow tectonic cracks and grain boundaries.



No. 2.

450X, polished section. Part of same section shown in Photomicrograph No. 1. No evidence of sulfides was found associated with the various native copper veins examined in this drill core.

SPECTROGRAPHIC ANALYSES

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J.

July 2, 1971

Drill Core - Superior East, Arizona

Handpicked Native Copper

SAMPLE No.	A	B	C	D
Cu	CMC	CMC	CMC	CMC
Si	LMC	LMC	LMC	LMC
Mg	S+	S+	S+	LMC
Fe	S	S	S	S-
Al	S	S-	S-	LMC-
Ca	S-	M+	M-	S
Mn	M-	M-	M-	M
Ti	M	TR	L	TR
Bi	FTR	FTR	FTR	TR
Ag	FTR	FTR	FTR	TR
Ba	FTR	FTR	FTR	TR
Sr	FTR	FTR	FTR	TR
Pb	TR	L-	TR	TR

Not Detected

As, Be, Cd, Te, B, Au, P, Hg, Sb, Pt, Tl, W, Mo, V,
In, Ge, Zn, Ni, Co, Sn, Cr

CODE:

CMC	-	Chief Major Constituent >50
MC	-	Major Constituent 10-50
LMC	-	Low Major Constituent 1-10
S	-	Strong .1-1
M	-	Moderate .01-.1
L	-	Low .001-.01
Tr	-	Trace .0005-.001
F Tr	-	Faint Trace .0001-.0005
V F Tr	-	Very Faint Trace <.0001=<1 ppm
N.D.	-	Not Detected

Cauvin - copy for Gen File

W.E.S.
JUN 21 1971

RECEIVED
JUN 25 1971
S. W. U. S. EXPL. DIV.

June 23, 1971

Mr. V. Kudryk
Asarco - Central Research Laboratories
South Plainfield, N.J.

Superior East
Arizona

Dear Sir:

Herewith is a piece of drill core from our deep hole project on the Dacite Plateau between Superior and Miami, labeled Hole M-1A, depth 4209 ft. This is a boulder in a Tertiary conglomerate.

The native copper is obvious but we wonder if it is a replacement of a copper sulphide mineral. Perhaps the scanning electron microprobe will reveal sulphur associated with the native copper? Would you try please and charge this to project MA #0010-03, sending a copy of the results to Mr. Kurtz, address below.

If you can concentrate some of the native copper, please run a semi-quantitative spectrographic analysis for minor elements.

Thank you.

Very truly yours,

Original Signed By
John J. Collins
John J. Collins

CC-WLKurtz ✓
American Smelting and Refining Co.
P.O. Box 5747
Tucson, Arizona 85703

JHCourtright

Note: AARL assay sample #7103, dated July 10, 1971 reported that this interval, 3856.2-3857.3 feet, ran 0.61% copper. (ie 1.1 ft @ 0.61% copper).

OF-1A & M-1 (Earlier Volcanics basalt) March 5, 1971.
Microprobe of native copper from hole M-1A, Tw. July 13, 1971
DCA-1A (zeolite Heulandite from Tw) Nov. 30, 1971
Microprobe of native copper-cuprite from A-4 (2) Dec. 10, 1971.
DCA-1A (Fossils from Naco & Escabrosa) Jan. 12, 1972

Cactus bx & Whitetail Cgl. Jan. 19, 1972. (Outcrop & drill hole core).

Core holes M-1A(1) & A-4.(6) & Jan. 20, 1972.

Age-Dates from holes M-1A & A-4. Jan. 27, 1972.
Photomicrographs of chalcocite-hematite from A-2. (11) & March 22, 1972.
Hydrothermal alteration in hole AI-1 & A-2 (14) & June 17, 1974.

Ray West, RW-54. qtz latite porphyry. Oct. 24, 1974.

~~DCA-3A. (8)~~
Hydrothermal alteration in hole DCA-3A (8) Nov. 8, 1974.
Metallurgical tests on Native Copper Ore Dec. 13, 1974
Sample preparation & metallurgical testing of Native Copper Ore. Jan. 31, 1975.
Fluid Inclusions in LB-4. (5) Feb. 13, 1975.
Note on Sample [illegible] April 25, 1975
Further Metallurgical Testing of Native Copper Ore. April 30, 1975.
Identification of "bladed" chalcocite-bornite w/pyrite from hole A-9. Feb. 23, 1978.
Submittal of 10 core samples from hole A-2 - March 30, 1972.
Petrographic Exam of Monitor gr (4) and Lost Gulch gm (1), & May 5, 1972.

Age Date request for Tuff in Whitetail March 3, 1977.
Beneficiation of Native Copper Ore - Arizona & Michigan July 20, 197[illegible]

Thin-sections, hole B-6 (Newmont) (3) May 31, 1978

Sulfide assemblages from DDH A-8(3) and A-9 (1). March 11, 198[illegible]

17

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 30, 1971

TO: R. B. Cummings

FROM: G. J. Stathis

I received your core specimen of Whitetail rock from drill hole DCA-1A this afternoon.

The colorless, monoclinic prisms in the open cavity were identified by oil immersion work and optic sign (+) as being Heulandite (Zeolite mineral). Formula for this mineral varies according to text books. Deer, Howie and Zussman (probably the best reference) give the formula for Heulandite as $(Ca, Na_2)(Al_2Si_7O_{18})\cdot 6H_2O$.

Cheers,

George

George J. Stathis

GJS:lad

cc: JDSell
WLKurtz

9108

ASARCO

AMERICAN SMELTING AND REFINING COMPANY

CENTRAL RESEARCH LABORATORIES

SOUTH PLAINFIELD, N. J. 07080

WILLIAM P. ROE
DIRECTOR OF RESEARCH
VAL KUDRYK
MANAGER, MINERALS RESEARCH
H. E. HOWE
MANAGER, METALS RESEARCH

December 10, 1971

A-4

Mr. James D. Sell
Southwestern Exploration Division
TUCSON OFFICE

Superior East Project
MA-0010-04 - Microprobe Samples

The attached report by Mr. R. B. Haagensen summarizes his microscope and microprobe findings. We trust that the equilibrium diagrams included with the report will be helpful.

If you should like any additional information, please let me know.

V. Kudryk

V. Kudryk

VK/lk
Attach.

cc: JJCollins
RBHaagensen
EMartinez
WLKurtz

See letter to JJC from V. Kudryk dated July 13, 1971 for info on M-1A samples.

ASARCO

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J. 07080

WILLIAM P. ROE
DIRECTOR OF RESEARCH
VAL KUDRYK
MANAGER, MINERALS RESEARCH
H. E. HOWE
MANAGER, METALS RESEARCH

December 8, 1971
Ref. 3175
MA #0010-04

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

Superior East, Arizona
MR-229 and 230

The two following drill core samples were received:

MR-229	Sample A-4, #5090	Lithic tuff
MR-230	Sample A-4, #5106	Conglomerate

The samples were microscopically examined in polished section to determine the relationships between the contained native copper and cuprite, Cu_2O. Microprobe analyses of selected areas aided in phase identifications. Spectrographic analyses of ground representative portions of the as received samples are attached together with the requested phase diagrams (Cu-O, Cu-FeO and Cu-Si-O).

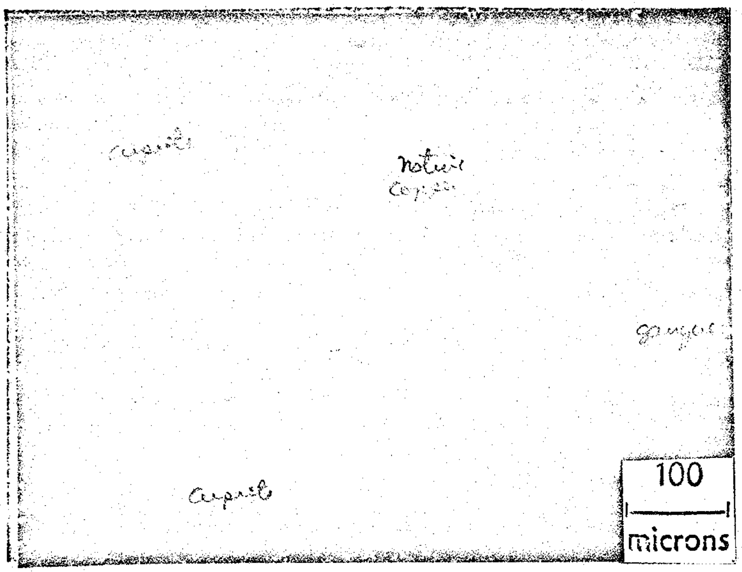
Microscopic examinations of both samples indicate a similar relationship between native copper and cuprite. It is apparent that the native copper primarily occurs in these samples unreplaced, or nearly so, by copper oxide. Instances of cuprite replacing native copper are confined to a few small local areas. The abundant cuprite in both samples has been emplaced as Cu_2O and has not formed primarily from the oxidation of native copper. Evidence of this can be seen in the attached color photomicrographs.

Photomicrograph No. 4 (Sample A-4, #5106, MR-230) shows part of a large magnetite-ilmenite grain. Occasional large grains of this material occur in this sample in fairly close association with the native copper or with the cuprite.

RBH/lk

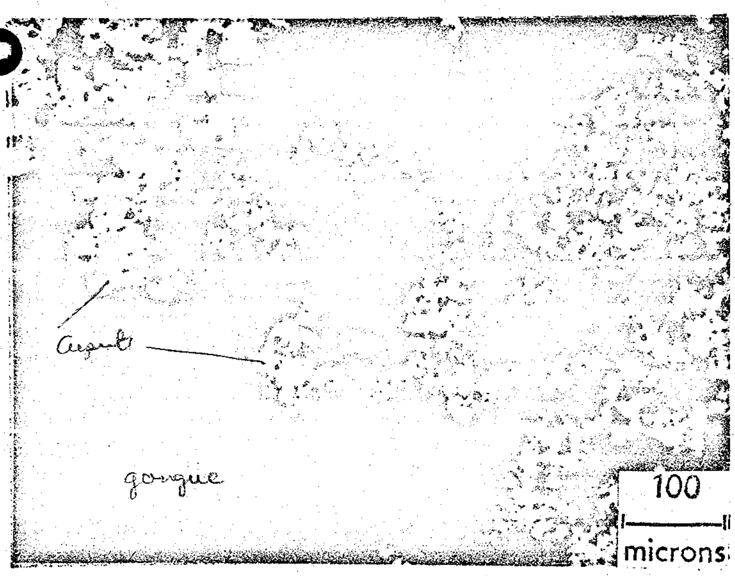
R. B. Haagensen

Superior East Arizona
Sample A-4, #5090(MR-229)



No. 1

125X, polished section, polarized incident light. Phases shown are native copper (dark with copper highlights), cuprite (red to red-gray) and gangue (remainder). Most of the native copper and cuprite are below the polished surface. Cuprite was not formed from oxidation of the native copper.

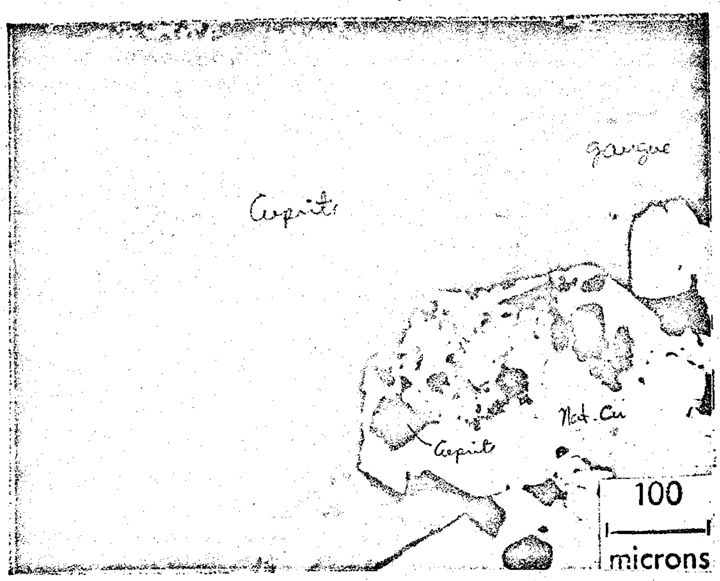


No. 2

125X, polished section, incident light. Another area of the sample showing well formed cubic crystals of cuprite (light) in gangue (dark). Cuprite is also below the surface of the gangue throughout most of this area.

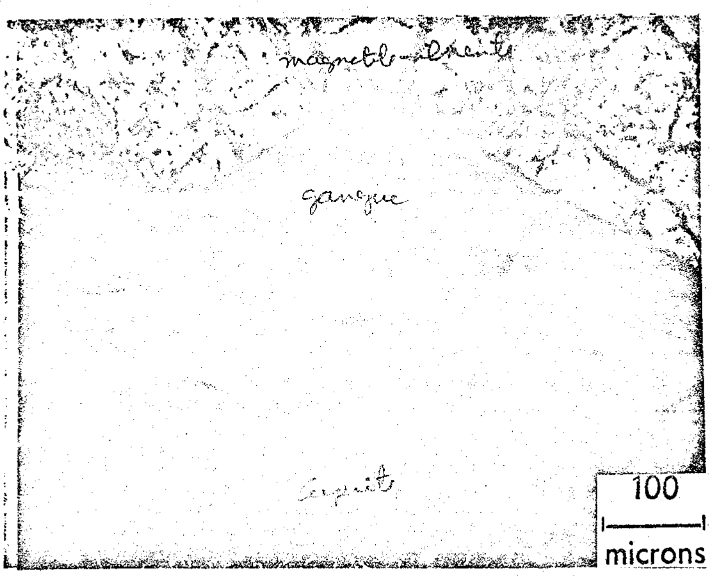
Superior East, Arizona

Sample A-4, #5106(MR-230)



No. 3

125X, polished section, polarized incident light. Phases shown are well developed native copper crystals (pale yellow at lower right), cuprite (red to red gray) and gangue (remainder). Purple-brown grains within the native copper are cuprite, indicating local replacement. This cuprite apparently is of a distinctly different origin from the emplaced cuprite shown.



No. 4

125X, polished section, polarized incident light. Phases shown are magnetite-ilmenite (gray-tan across top), cuprite (red) and gangue (remainder).

3175

SPECTROGRAPHIC ANALYSES

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J.

11-24-71

Superior East - Haagensen

2.

SAMPLE No.	MR 229	MR 230							
Si	MC	MC							
Al	MC	MC							
Fe	LMC	MC-							
K	LMC	LMC							
Ca	LMC	S+							
Mg	S	LMC-							
Cu	S+	LMC							
Ti	S+	LMC							
Na	S+	S+							
S	S+	M							
Ba	M+	M							
Ni	M-	M							
Zn	ND.	M							
Cr	L	L+							
Mn	L	L							
Pb	TR	L							
Bi	L+	M-							
V	FTR	L-							
Be	TR	TR							
Co	FTR	TR							
Ag	FTR	FTR							

NOT DETECTED
Te, B, P, Hg, Sb, Pt, Au, T[illegible]
In, Ge, As, Sn, Mo, C[illegible]
W

CODE:

CMC	-	Chief Major Constituent >50
MC	-	Major Constituent 10-50
LMC	-	Low Major Constituent 1-10
S	-	Strong .1-1
M	-	Moderate .01-.1
L	-	Low .001-.01
Tr	-	Trace .0005-.001
F Tr	-	Faint Trace .0001-.0005
V F Tr	-	Very Faint Trace <.0001 <1 ppm
N.D.	-	Not Detected

Cu–O

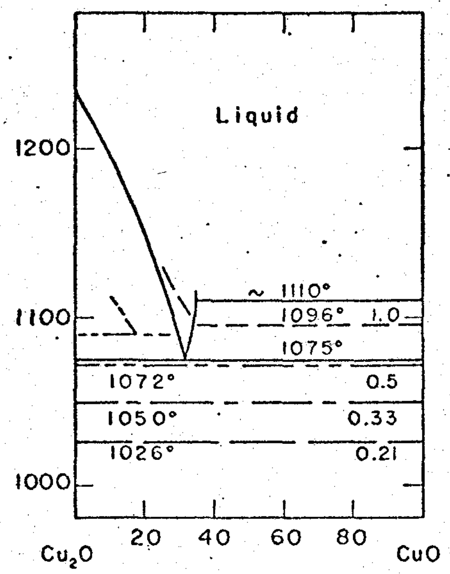


FIG. 2069.—System Cu_2O–CuO at various oxygen pressures. Solid lines are phase boundaries according to Vogel and Pôcher.

A. M. M. Gadalla, W. F. Ford, and J. White, *Trans. Brit. Ceram. Soc.*, 62 [1] 57 (1963).

Cu–O

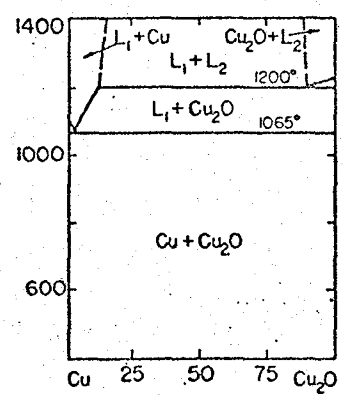


FIG. 7.—System Cu–Cu_2O.
Erich Gebhardt and Walter Obrowski, *Z. Metallk.*, 45, 333 (1954).

Cu–Fe–O

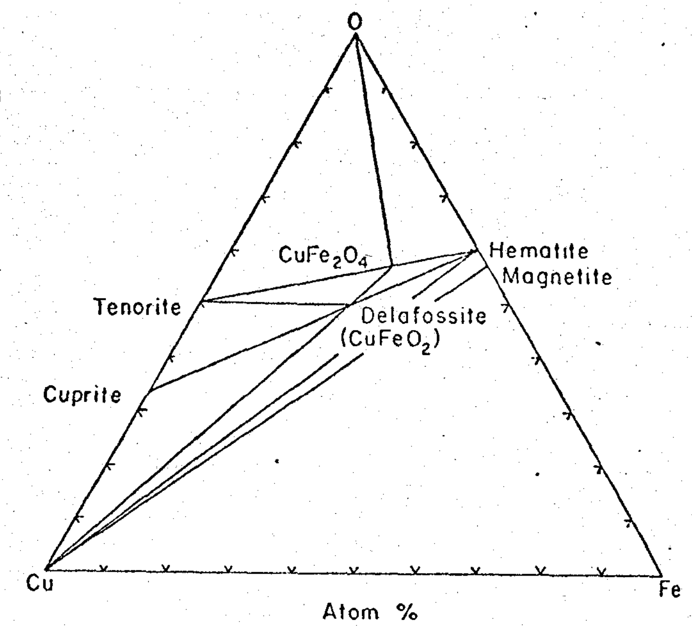


FIG. 2136.—System Cu–Fe–O; stable assemblages below 560°C, the lowest temperature at which wüstite is stable. Diagram probably holds at 25°C.

R. A. Yund and G. Kullerud, *Am. Mineralogist*, 49, 693 (1964).

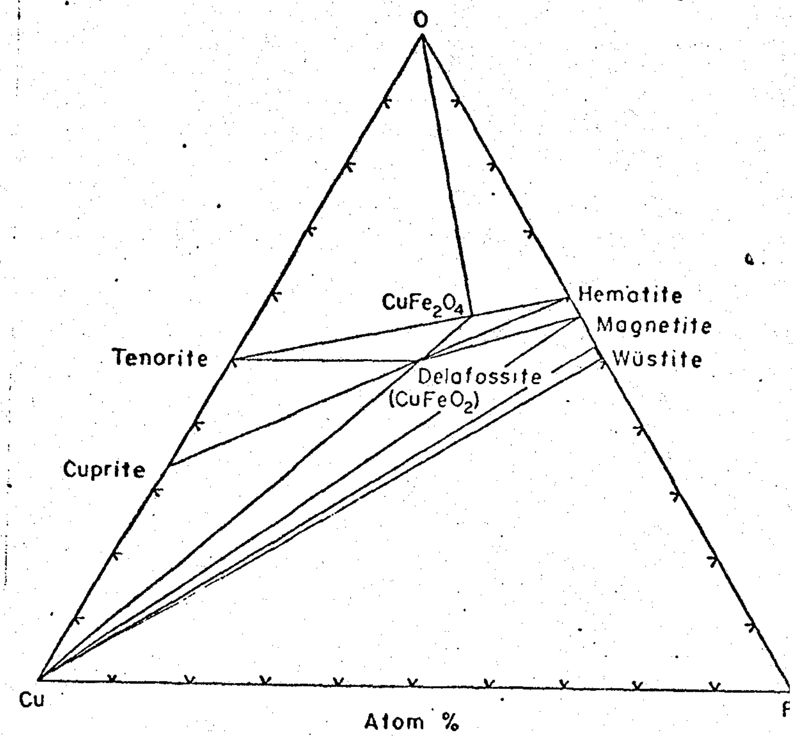


FIG. 2137.—System Cu–Fe–O; stable assemblages above 675°C, the lo[w] temperature at which delafossite and magnetite are stable together.

R. A. Yund and G. Kullerud, *Am. Mineralogist*, 49, 691 (1964).

Cu–Fe–O

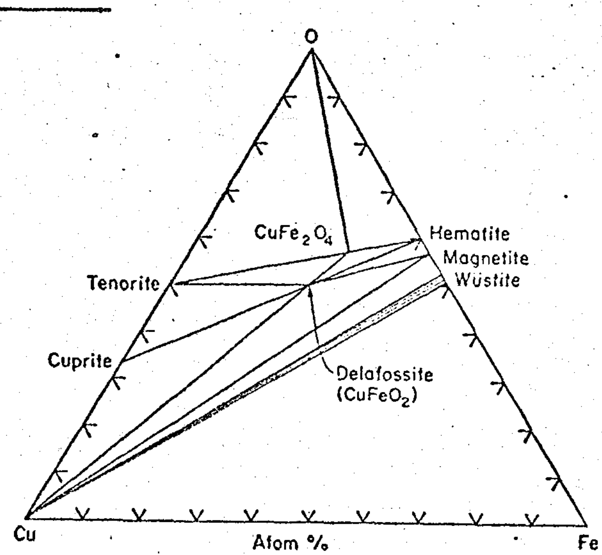


FIG. 59.—System Cu–Fe–O at 800°C.

R. A. Yund and G. Kullerud, Ann. Rept. Director Geophys. Lab. 1960–61; in *Carnegie Inst. Washington Year Book*, 60, 181 (1961).

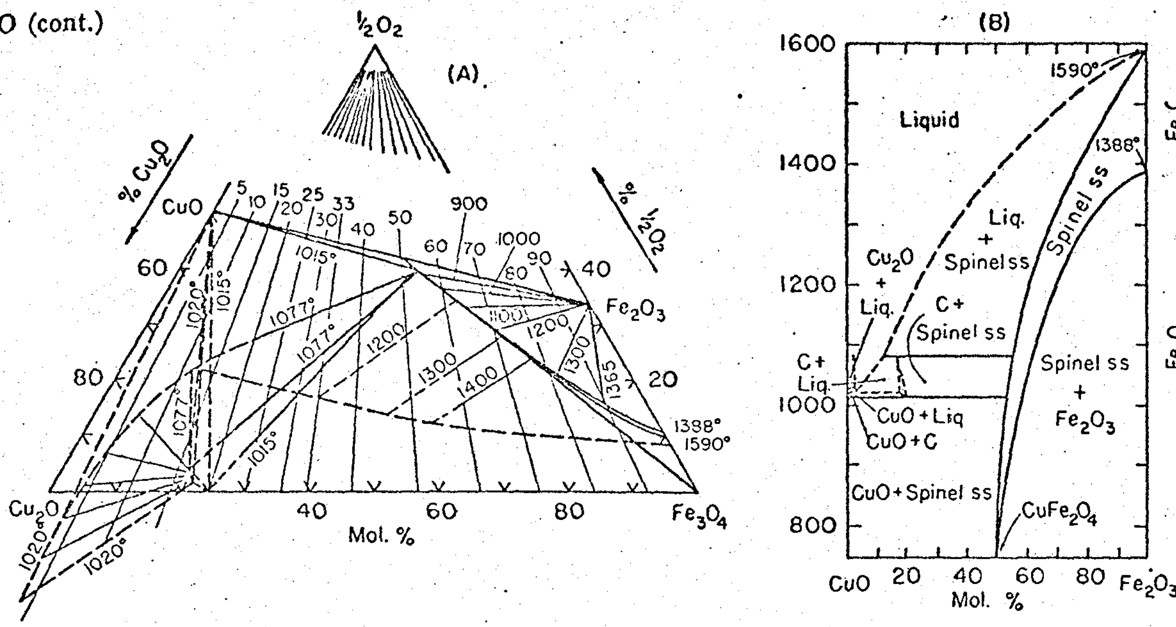


FIG. 2138.—System Cu–Fe–O, isobaric in air. (*A*) Represented on the composition triangle Cu_2O–Fe_3O_4–$^1/_2O_2$; (*B*) represented on temperature-composition plane. Thin lines converging toward oxygen corner are the dissociation paths, with indicated amounts of Fe_2O_3, in original mixtures. Isotherms are also tie lines in two-phase regions. Conjugation triangles are shown at 1015°, 1077°, and 1020°C.

A. M. M. Gadalla and J. White, *Trans. Brit. Ceram. Soc.*, 65 [1] 7 (1966); D. S. Buist, A. M. M. Gadalla, and J. White, *Mineral. Mag.*, 35 [273] 733 (1966).

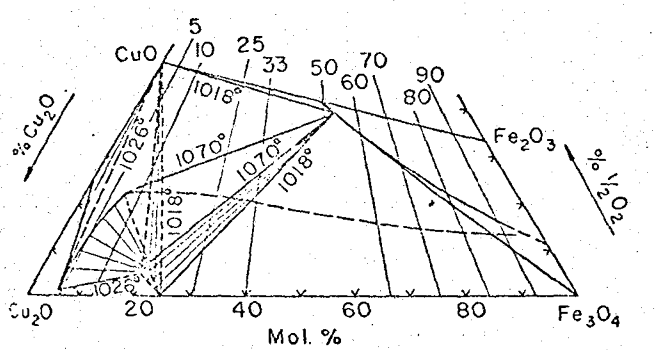
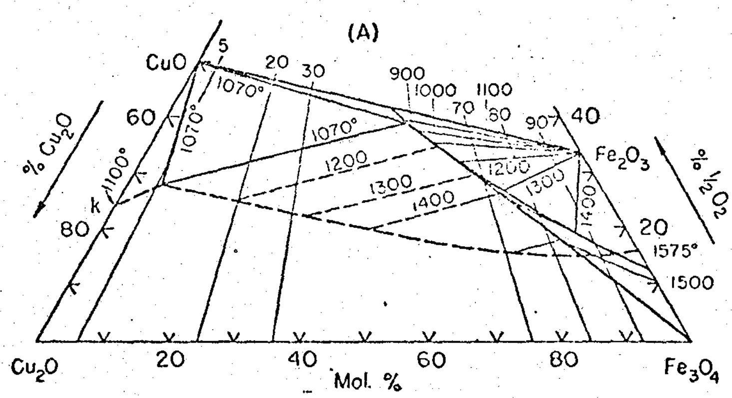


FIG. 2139.—System Cu–Fe–O at 0.6 atm oxygen as represented on the Cu_2O–Fe_3O_4–$^1/_2O_2$ composition triangle.

A. M. M. Gadalla and J. White, *Trans. Brit. Ceram. Soc.*, 65 [1] 12 (1966).



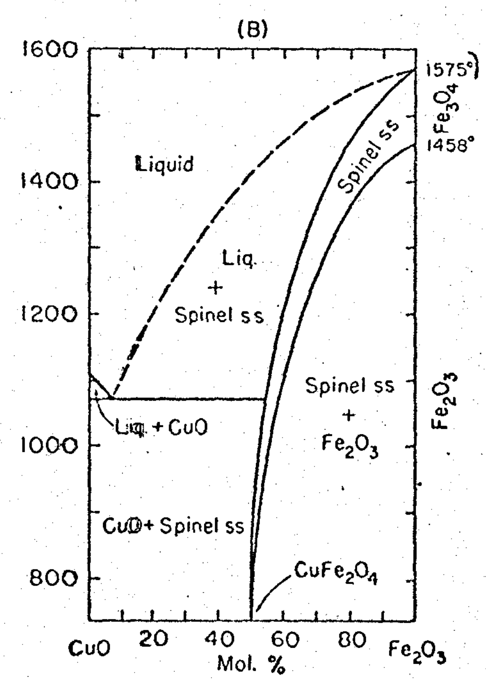


FIG. 2140.—System Cu–Fe–O at 1.0 atm oxygen. (*A*) Represented on the composition triangle Cu_2O–Fe_3O_4–$^1/_2O_2$; (*B*) represented on temperature-composition plane. Conjugation triangle occurs at 1070°C. K is the composition of the liquid formed when pure CuO melts at 1.0 atm oxygen at 1100°C.

A. M. M. Gadalla and J. White, *Trans. Brit. Ceram. Soc.*, 65 [1] 14 (1966).

Cu–Fe–O (concl.)

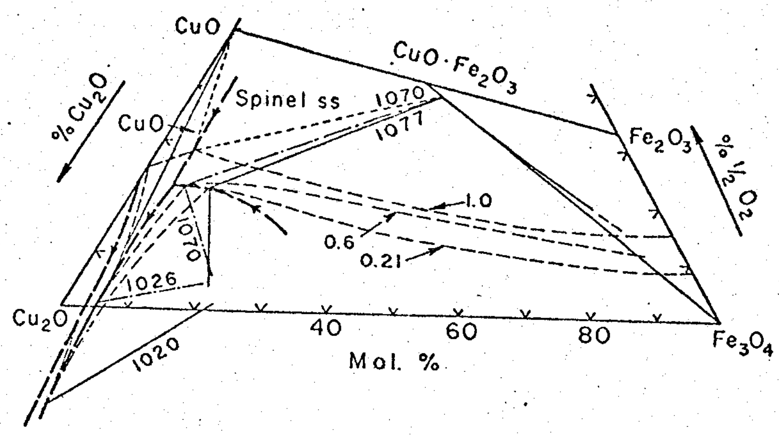


FIG. 2141.—System Cu_2O-CuO-Fe_3O_4-Fe_2O_3 showing liquidus isotherms at 0.21, 0.6, and 1.0 atm oxygen pressures and phase boundaries established by their intersections.

A. M. M. Gadalla and J. White, *Trans. Brit. Ceram. Soc.*, 65 [1] 15 (1966).

Cu–Si–O

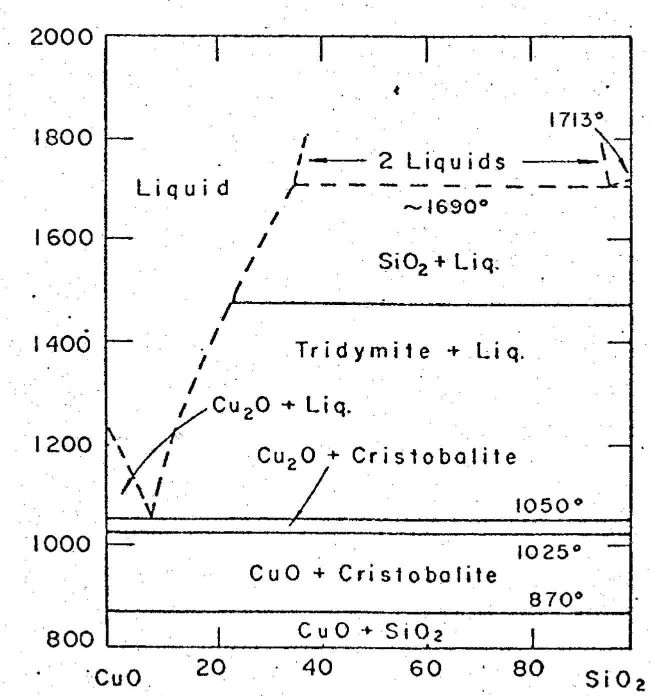


FIG. 2142.—System CuO-SiO_2. Cu^{2+} acts as a mineralizer in the crystallization of cristobalite at low temperatures. Compilers do not believe that this is an equilibrium diagram.

V. M. Ust'yantsev, L. P. Sudakova, and A. F. Bessonov, *Zh. Neorgan. Khim.*, 11 [5] 1177 (1966); *Russ. J. Inorg. Chem. (English Transl.)*, 631 (1966).

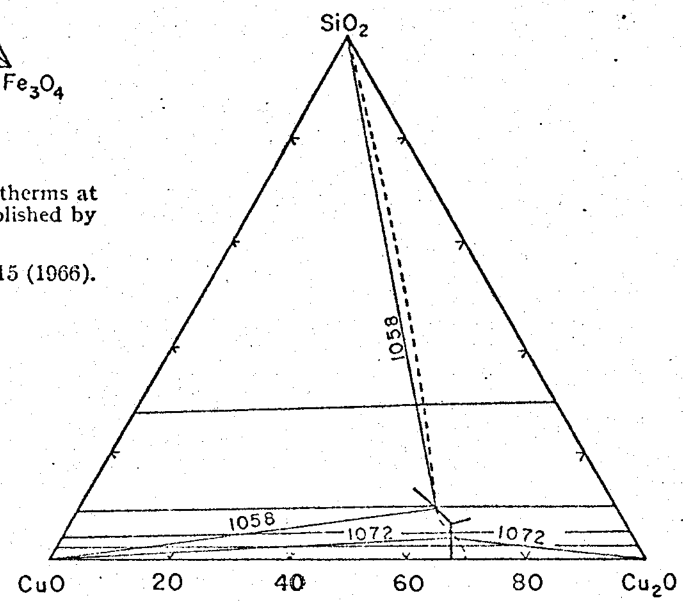


FIG. 2143.—System Cu_2O-CuO-SiO_2 at partial pressure 0.5 atm O_2. Dissociation paths are represented by thin lines; composition isotherms are designated by temperatures; liquidus isobar is shown by dashed line.

A. M. M. Gadalla, W. F. Ford, and J. White, *Trans. Brit. Ceram. Soc.*, 62 [1] 62 (1963).

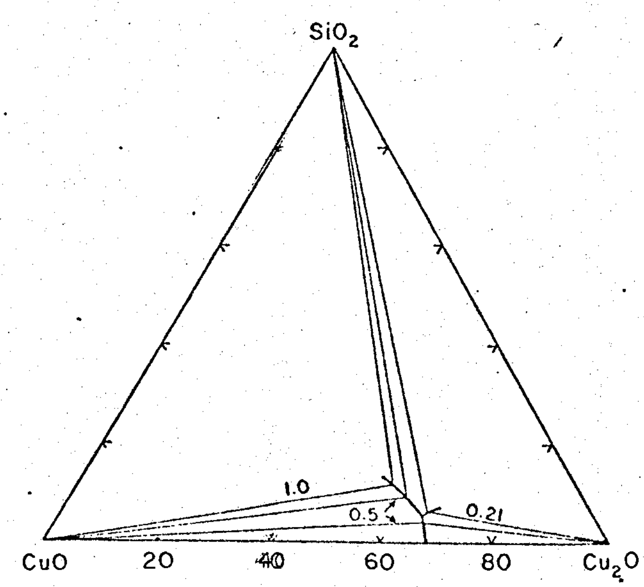


FIG. 2144.—System Cu_2O-CuO-SiO_2 showing isotherms at 0.21, 0.5, and 1.0 atm O_2 pressure.

A. M. M. Gadalla, W. F. Ford, and J. White, *Trans. Brit. Ceram. Soc.*, 62 [1] 63 (1963).

Microscopic Samples from Drill Hole A-4, Superior East Project, Pinal County, Arizona.

A-4 #5090. Lithic tuff with seams of deep ruby red (internal reflection) cuprite and minor native copper. Ruby color altering to flat red. Note color change to black where seams were cut by cored surface.

A-4 #5095. Lithic tuff with crystalline cuprite disseminated throughout. Note also the dull orange-brown spots - altered cuprite?

A-4 #5096. Lithic tuff with seams of cuprite. Very good example of color change to black where cut by cored surface.

A-4 #5106. Conglomerate with disseminated crystalline cuprite containing native copper in direct association. Note especially in circled area on roughly broken surface of core (perpendicular to core axis and nearly along axis line).

A-4 #5809. Conglomerate with native copper. Shows strong preference to large fragment boundaries, but also crosscuts the fragments. Also some disseminated in matrix in circled area to right of "9".

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 14, 1971

TO: W. L. Kurtz

FROM: J. D. Sell

Microprobe Samples
Drill Hole A-4
Superior East Project
Pinal County, Arizona

Dr. V. Kudryk has submitted the report of Mr. R. B. Haagensen (Reference 3175, dated December 8, 1971) on the cuprite-native copper samples from drill hole A-4. The samples were submitted with my letter of November 11, 1971.

As noted, they believe that both the native copper and cuprite were emplaced as the respective minerals. This was the original statement in my letter to them where it was asked as a question. No statement was made by Haagensen as to whether the two minerals might have been associated with prior sulfides, but it appears from their statement that sulfides in the Whitetail were not present or involved in the copper distribution.

The spectrographic analysis of these samples versus the M-1A samples shows essentially the same, with somewhat higher values in Si, Al, Ba, and Ti in the A-4 samples.

The phase diagrams attached to their report appear to be involved in something other than the carrying of copper ions or material and the subsequent deposition of the copper. Thus, the diagrams appear to have no relationship to the Whitetail problem.

James D. Sell
James D. Sell /lad

JDS:lad

AMERICAN SMELTING AND REFINING COMPANY
ASARCO
SOUTHWESTERN EXPLORATION DIVISION
P. O. BOX 5747, TUCSON, ARIZONA 85703

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

November 11, 1971

Drill Hole A-4
Depth # 5090' & 5106'

Dr. Val Kudryk
Central Research Laboratories
American Smelting and Refining Company
South Plainfield, New Jersey 07080

Microprobe Samples
Cuprite and Native Copper
Superior East Project, MA-0010-04
Pinal County, Arizona

Dear Dr. Kudryk:

Under separate cover are two samples containing cuprite and native copper. As with your previous study of a specimen from this project (Reference #3175, MA-0010-03, Superior East, Arizona (MR-192) report dated July 8, 1971 from R. B. Haagensen to you; with cover letter from you to J. J. Collins dated July 13, 1971), I request microscopic and microprobe examinations of the submitted samples.

Sample A-4 #5090. Lithic tuff with seams of deep ruby red (internal reflection) cuprite and minor native copper. Note the ruby red altering to flat red along edges of seams. Also, note color change from red to black where seams were cut by cored surface of specimen.

Sample A-4 #5106. Conglomerate with disseminated crystalline cuprite containing native copper in direct association. (Note especially in circled area on roughly broken surface of core, perpendicular to core axis and nearly along core axis line.)

A spectrographic analysis of the specimens would also be in order.

From the specimens, it would appear that the cuprite was not formed from the oxidation of native copper, but was emplaced as cuprite. Your examination of the polished section will be invaluable in determination of the mode of formation.

This particular drill hole cored into limestone below the conglomerate and native copper was also found in seams through the limestone. I would be interested in receiving any phase diagrams of the copper systems which might be applicable to the problem.

Sincerely,

James D. Sell

James D. Sell

JDS:lad

cc: WLKurtz
RBCummings
GJStathis

Mr. Emanuel J. Nieves
5019 E. Scarlett
Tucson, Arizona 85711
January 12, 1972

Mr. J. Sell
American Smelting & Refining Co.
1150 N. 7th Avenue
Tucson, Arizona 85705

Office 624-0429
or 884-3603

Dear Mr. Sell:

Attached please find a report on the core samples from DCA - 1A from 4716 and 5201 feet.

In the report I have included comments pertinent to the environment of deposition and other salient features which may be of use in the interpretation of the stratigraphic history of the area in which the cores were taken.

A total of 25 hours was spent in making and examining the thin sections. As usual, the major part of the examination was used in the search for index fossils in those portions of the cores in which they were either very rare or absent. At an hourly rate of $4.00 per hr., the total charge is $100.00.

I appreciate the opportunity to be of service and sincerely hope I may continue to be so in the future.

Sincerely yours,

Manny Nieves

Emanuel J. Nieves

OK for Payment
Fossil Identification
Sacaton East Project
MA-0010-04

James D. Sell

MICROPALEONTOLOGY REPORT

ASARCO CORE SAMPLES DCA-1A; 4716 feet, 5201 feet

Sample No. DCA-1A

Depth: 4716 feet

Age: Pennsylvanian

Rock type: Limestone (gray)

Environment: Shallow water, open marine

Fossils present: Fusulina(Ab), chrinoid stems(C), Foraminifera(R), Brachyopods(F), Bryozoa(F)

Fossil preservation index: Very good

Comments: The majority of the fusulinid specimens were very well preserved. No evidence was found to indicate folding or other deformation of the formation of sufficient intensity to crush or distort the fusulinid tests. The faunal assemblage was typical for that of shallow water, open marine conditions. Poorly developed laminae consisting of fusulinids may be indicative of bedding planes which in this sample dipped at a slight angle to the cut of the core. Veins of pure calcite were frequently observed. In some cases the veins passed through fusulinid tests thereby indicating a post diagenetic oregin. Fractures containing iron oxide were noted in major planes of weakness, e.g. where the core separated easily. In these areas, iron oxide had also invaded portions of some of the fusulinid tests.

Sample No. DCA-1A

Depth: 4716 feet

Age: Indeterminate

Rock type: Limestone (heavily stained by iron oxide)

Environment: Shallow water, open marine

Fossils present: Brachyopods(Ab), chrinoid stems(Ab), Bryozoa(C)

Fossil preservation index: Poor to good

Comments: This portion of the core lies above the fusulinid "zone". The sample appears to be conglomoratic however thin sections and slices indicate it is thinly bedded. The "conglomorate" texture is derived from iron oxide staining of the abundant fossils and or clasts which masks the bedded nature of the rock. The thin beds consist of angular calcite clasts and fossil fragments. These beds were deposited in an environment of limestone deposition with staining by iron oxide contemporaneous with deposition. Larger, unbroken brachyopod valves in the limestone layers between the thin clastic layers indicate the normal depositional environment of the limestone that was interrupted --

contd.

by successive deposition of the thin clastic layers. Sorting in these layers is very poor and suggests the source of the clasts was not far away. The environment of this sample although marine is shallower than that of the gray laemstone upon which it rests.

Sample DCA-1A

Depth: 5201 feet   Escabrosa

Age: Indeterminate

Rock type: Limestone (gray)

Environment: Shallow water, open marine

Fossils present: Chrinoids(Ab), Brachyopoda(F), Coral fragments(F)

Fossil preservation index: Good

Comments: This sample also represents a shallow water, open marine environment however the change in the faunal assemblage in comparison to the gray limestone at 4716 feet is interpreted as an increase in the depth of environment. The chrinoids were found to be both fragmented and whole transverse sections suggesting at least part of the assemblage is allochthonous.

Summary: Limestones from 5201 feet and 4716 feet were examined. The sample from 5201 feet is gray in color and represents a shallow water, open marine environment. Chrinoid stems dominate the assemblage. The sample from 4716 feet consists of two facies, the lowest is gray in color, contains abundant fusulinids of Pennsylvanian age and represents shallow water, open marine conditions. The upper portion consists consists of a bedded limestone heavily stained by iron oxide. Successive layers alternate between normal limestone deposition and layers of angular clasts. The sample sequence suggests regressive conditions were active in the area of deposition.

Quantitative key

Ab - abundant

C - common

F - few

R - rare

E.J. Nieves

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

February 15, 1972

FILE MEMORANDUM

Fossil Identification
Limestone in DCA-1A
Superior East Project
Pinal County, Arizona

Three pieces of core from the limestone section encountered in DCA-1A were submitted to Mr. E. J. Nieves for fossil identification and age designation.

The sample at 4716 footage contained two "different" features and fossils were found in both. However, only the lower portion contained determinate fossils of Pennsylvanian age.

A sample from 4889 was reported as Pennsylvanian in age in a verbal telephone conversation of December 20, 1971. The sample was the first of the series and no write-up was apparently made.

Sample 5201 contained good fossil preservation, but the forms recovered precluded an age determination.

Logging of contacts by R. B. Cummings and myself placed the units as:

4669-4998	Pennsylvanian
4998-5452	Mississippian
5452-5777	Devonian

Mr. Nieves' report is attached.

James D. Sell

James D. Sell

JDS:lad
Attach.

cc: RBCummings

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

January 19, 1972

FILE MEMORANDUM

Petrographic Examination of
Cactus Breccia and Whitetail
Conglomerate
Superior East Project Area
Pinal County, Arizona

Conclusions:

1. Thin section examination revealed no obvious difference in the texture and matrix between the Cactus breccia and Whitetail rocks.

2. The Whitetail sections examined showed that some of the clasts were composed of granitic (quartz monzonite?) material. Thin sections of the Cactus breccia showed no granitic clasts. However, granitic clasts are common to parts of the Cactus breccia in diamond drill core shown to the writer while visiting the project area.

3. The Whitetail fragments or clasts are quite angular like the Cactus breccia material. The impression gained is that there has been very little water transport of the Whitetail material and that the "conglomerate" material was quickly dumped in a basin.

4. Diabase and basic volcanic clast material was noted only in section TBX-5 (Whitetail).

Introduction

A company memo of September 7, 1971, by J. C. Balla to J. D. Sell, states that: "Nine samples were collected for thin section study in an attempt to ascertain if there was a difference in the matrix between Cactus breccia rocks and Whitetail rocks."

Information supplied to the writer is as follows:

Section #	Description
TBX-1	Cactus breccia, road cut
TBX-2	Cactus breccia, road cut
TBX-3	Cactus breccia, road cut
TBX-4	Cactus breccia, drill hole A-1, 1397'
TBX-5	Whitetail, drill hole A-1, 1557'
TBX-6	Cactus breccia, drill hole A-1, 1509'
TBX-7	Whitetail, drill hole M1-A, 2457'
TBX-8	Whitetail, drill hole M1-A, 3125'
TBX-9	Whitetail, drill hole M1-A, 4278'

Thin sections were examined in the fall of '71 and results were reported verbally to J. D. Sell. Notes on the thin section examination are appended to this report.

George J. Stathis

George J. Stathis

GJS:lad

cc: JHCourtright
WLKurtz
JDSell
JCBalla
RBCummings

APPENDIX

Notes on Thin Section Examination

1. Section TBX-1 *Cactus - Outcrop*
   - Texture: breccia
   - Moderate to strong pervasive oxidation.
   - Mostly goethite with traces of hematite and leucoxene.
   - 80 (volume) percent of the rock comprised of breccia clasts.
   - Two sizes ranges of clasts:
     1. 0.25 mm or less.
     2. 0.5 mm to 5 mm -- average 1.0 mm.
   - 75 (volume) percent of clasts consist of small size material which is comprised of nearly all quartz.
   - Large clasts -- 75 (volume) percent.
   - Composed of quartz and 25 (volume) percent sericitized (schist?) clasts with some biotite and trace augite.
   - Trace secondary biotite in groundmass.

2. Section TBX-2 *Cactus - Outcrop*
   - Texture: breccia
   - Weak oxidation as light geothite staining and trace hematite.
   - 90 (volume) percent of the rock comprised of moderately altered breccia clasts.
   - Two size ranges of clasts:
     1. 0.25 mm or less.
     2. 1.0 mm to 2.5 mm (plus? alteration masking).
   - Two size ranges of clasts occur 50:50?
   - Small clasts all quartz.
   - Large clasts composed nearly 50:50 quartz and sericite (schist?) with 0.5 (volume) percent biotite.
   - Sericite alteration extends into groundmass. Estimate 1/3rd of rock sericitized. 0.5 (volume) percent disseminated magnetite in groundmass.

3. Section TBX-3 *Cactus - Outcrop*
   - Texture: breccia
   - Strong pervasive oxidation (goethite-hematite).
   - 80 (volume) percent of rock comprised of breccia clasts.
   - Two size ranges of clasts:
     1. 0.25 mm or less.
     2. 0.5 mm to 6 mm -- average 1.5 mm.
   - 75 (volume) percent of clasts consist of small size material (all quartz).
   - Half of the large clasts are completely sericitized with minor biotite and trace augite. The remaining large clasts composed of quartz and 1/3rd banded (schistosity) sericite.

4. Section TBX-4 *Cactus - Drill hole A-1*

Texture: breccia

Moderate to strong oxidation (goethite-hematite).

80 (volume) percent of rock comprised of breccia clasts.

Two size ranges of clasts:

1. 0.25 mm or less.
2. 0.5 mm to 6 mm.

75 (volume) percent of clasts consist of small size material (all quartz).

Half of the large clast volume consists of quartzite. The remaining half consists of quartz-sericite-biotite schist fragments. 1 (volume) percent or so, fine biotite disseminated in groundmass.

5. Section TBX-5 *Whitetail - Drill hole A-1*

Texture: breccia

Light, selective oxidation locally.

90 to 95 (volume) percent of the rock comprised of breccia clasts.

Two size ranges of clasts:

1. 0.25 mm or less.
2. 0.5 mm to 3.5 mm -- average 1.2 mm.

70 (volume) percent plus of clasts consist of the larger size material.

Large clasts consist of diabase and basic volcanic material (felty texture).

Orthopyroxenes in diabase altering to chlorite and serpentine. Some large clasts containing plagioclase, perthite, and quartz (granitic) noted. Small clasts mostly quartz, some plagioclase locally.

Rock moderately to strongly altered (80 percent by volume).

Siderite? as fracture fillings.

Chalcedony as cavity fillings.

Minor sericite and gypsum noted locally.

2 to 3 (volume) percent disseminated, weakly oxidized magnetite.

6 to 7 (volume) percent geothite in mafic clasts.

6. Section TBX-6 *Cactus - Drill Hole A-1*

Texture: breccia

Very light oxidation

85 (volume) percent of the rock comprised of breccia clasts.

Two size ranges of clasts:

1. 0.25 mm or less.
2. 0.5 mm to greater than 7 mm -- average 1.5 mm.

85 (volume) percent of clasts consist of small size (quartz) material.

Half of the large size clasts are completely sericitized. Remainder consist of quartz and minor sericite (schist?), with traces of biotite. Trace, incipient biotite in groundmass. 3 (volume) percent disseminated, partly oxidized, magnetite in clasts and groundmass.

Section TBX-7 *Whitetail - Drill hole M-1A.*

Texture: breccia

Light oxidation (goethite-hematite).

80 (volume) percent of the rock comprised of breccia clasts.

Two sizes of clasts:

1. 0.25 mm or less.
2. 0.5 to 2.5 mm -- average 1.0 mm.

Two size ranges of clasts occur 50:50.

Small clasts quartz. Large clasts consist of quartzite?, qtz.-sericite schist and quartz-perthite-plagioclase fragments in about equal proportions.

0.5 (volume) percent, small, biotite laths in groundmass.

0.5 (volume) percent disseminated magnetite mostly in large clasts.

Section TBX-8 *Whitetail - Drill Hole M-1A*

Texture: breccia

Light oxidation (goethite-hematite).

90-95 (volume) percent of the rock comprised of breccia clasts.

Two sizes of clasts:

1. 0.25 mm or less.
2. 0.5 mm to 3.5 mm -- average 0.7 mm.

Two size ranges of clasts occur 50:50.

Large clasts consist of quartz-sericite (with biotite and minor chlorite) schist, quartzite, and quartz-microcline-perthite-plagioclase fragments in about equal proportions.

0.5 to 1.0 (volume) percent biotite laths in groundmass.

0.5 (volume) percent disseminated magnetite mostly in clasts.

Section TBX-9 *Whitetail - Drill Hole M-1A.*

Texture: breccia

Light oxidation (goethite-hematite).

90 (volume) percent of the rock comprised of breccia clasts.

Two sizes of clasts:

1. 0.25 mm or less.
2. 0.5 mm to 5.0 mm -- average 1.0 mm.

Two size ranges of clasts occur 50:50.

Large clasts mostly altered to sericite clay (kaolin) and chlorite.

15 to 20 (volume) percent chlorite in clasts and 5 (volume) percent overall in section. Groundmass chlorite Fe>Mg variety.

Estimate 80 (volume) percent plus of large clasts probably altered quartz monzonite, remainder quartzite.

Most of groundmass chlorite after biotite laths.

2 to 3 (volume) percent disseminated jarosite in groundmass.

5 (volume) percent disseminated, oxidized magnetite.

2 to 3 (volume) percent gypsum intimately associated with chlorite.

Trace epidote.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

September 7, 1971

TO: J. D. Sell

FROM: J. C. Balla

Thin sections,
Cactus Breccia

Nine samples were collected for thin section study in an attempt to ascertain if there was a difference in the matrix between Cactus breccia rocks and Whitetail rocks. The interpretation of the thin sections will be by George Stathis. The location of the samples is as follows:

TBX-1	Cactus Breccia, road cut	
TBX-2	Cactus Breccia, road cut	
TBX-3	Cactus Breccia, road cut	
TBX-4	Drill hole A-1, 1397'	Cactus Bx
TBX-5	Drill hole A-1, 1557'	Whitetail
TBX-6	Drill hole A-1, 1509'	Cactus Bx
TBX-7	Drill hole MI-A, 2457'	Whitetail
TBX-8	Drill hole MI-A, 3125'	"
TBX-9	Drill hole MI-A, 4278'	"

John

John C. Balla

JCB:lad

cc: GJStathis
RBCummings

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

January 20, 1972

FILE MEMORANDUM

Petrographic Examination of
Thin Sections from Core Holes
M-1A and A-4
Superior East Project
Pinal County, Arizona

Introduction

Seven rock samples, from Superior East Project, were submitted by J. D. Sell on November 11, 1971 for thin section examination. The samples were notated as follows by R. B. Cummings:

1. Sample #1 (2981' depth) drill hole M-1A.
   Porphyritic quartz monzonite from slide block within Miocene Whitetail conglomerate.

2. Sample #1 (6656' depth) drill hole A-4.
   Porphyritic biotite quartz monzonite (?) or granodiorite (?). 10-20% secondary K-spar (?), salmon-colored, as replacement band along fracture planes and in phenocrysts. Trace of pyrite and chalcopyrite.

3. Sample #2 (6602' depth) drill hole A-4.
   Quartz biotite schist, well banded. Trace of pyrite and chalcopyrite. Could it be a mafic-rich border phase to the intrusive (samples A-4-1 and A-4-6)?

4. Sample #3 (6573' depth) drill hole A-4.
   Cemented fault gouge. Could it be Whitetail conglomerate? Are catoclastic textures prominent? What is the gray sulfide -- is it detrital?

5. Sample #4 (6562' depth) drill hole A-4.
   Silicic limestone. Could it be a siltstone?

6. Sample #5 (6445' depth) drill hole A-4.
   Silicic limestone breccia or siltstone breccia.

7. Sample #6 (6612' depth) drill hole A-4.
   Biotite quartz monzonite. Highly sheared portion of equivalent (?) sample number A-4-1 above.

Thin sections of the seven rock samples were cut and examined last month. At that time, a brief summary of the examination was reported verbally to Messrs. Kurtz and Sell.

Thin Section Descriptions

1. Section M-1A-1 (2981')
   - Texture: Medium grained, hypidiomorphic-granular. Slight tendency to porphyritic texture.
   - 60 percent (volume) plagioclase.
   - 20 percent (volume) quartz. Some quartz "eyes".
   - 5 percent (volume) biotite. Shreddy, little alteration to magnetite.
   - Remainder -- mostly orthoclase.
   - Weak alteration of feldspars (oligoclase and orthoclase) consisting of incipient clay and traces of sericite.
   - Reflected light shows 5 percent geothite and some jarosite staining. Minor hematite along microfractures. Trace to 0.5 percent disseminated magnetite.
   - Conclusion: Weakly altered porphyritic quartz monzonite.

2. Section A-4-1 (6654')
   - Texture: Medium grained, porphyry.
   - Groundmass accounts for 20 percent of the rock volume and consists of 50:50 or more orthoclase over quartz.
   - Phenocrysts mostly plagioclase, 75 percent by volume.
   - Quartz phenocrysts 20 percent of phenocryst volume. Locally some large (greater than 1/4") quartz "eyes".
   - Less than 10 percent orthoclase phenocrysts.
   - 6 to 8 percent biotite in groundmass.
   - Biotite shreddy, 1/3rd altered to chlorite.
   - Feldspar phenocrysts moderately altered, 1/3rd to locally 1/2 of the feldspar phenocrysts surface altered to sericite and incipient clay.
   - Reflected light shows traces of magnetite, limonite and groundmass sericite.
   - Conclusion: Weak to moderately altered quartz monzonite porphyry. Traces of pyrite and chalcopyrite noted in hand sample along microfractures. Salmon coloration along fracture planes appears to be limonite "dusting" of quartz and plagioclase phenocrysts (cross-cutting relationships noted under binocular microscope).

3. Section A-4-2 (6602')
   Quartz-biotite-chlorite-sericite schist. Some quartz veinlets parallel to and nearly at right angle to the schistosity.
   0.5 to 1.0 (volume) percent, very finely disseminated pyrite and chalcopyrite.
   Conclusion: A good schist. Highly unlikely that it represents a mafic-rich border phase of an intrusive rock.

4. Section A-4-3 (6573')
   Texture: Cataclastic.
   Quartzite and quartz-sericite schist fragments.
   60 (volume) percent ferruginous (hematitic) groundmass.
   6 (volume) percent disseminated, bluish-gray, fine grained, opaque grains noted in groundmass believed to be chalcocite (copper assay return from 10-foot interval in the fault zone averaged over 1.5 percent, according to J. D. Sell).
   Conclusion: Original rock type ?
   Rock can be termed a cataclasite.

5. Section A-4-4 (6562')
   Texture: Highly contorted, banded rock. Mylonitized.
   Fine quartz crushed. Selective, goethite staining along bands.
   Opal along bands. Minor chalcedony veinlets, fine Kaolin ? clay.
   Conclusion: Mylonitized siltstone ?

6. Section A-4-5 (6445')
   Texture: Fine grained, banded (bedding).
   Fine magnetite (locally oxidized) distributed along bedding.
   Quartz augen structures developed occasionally along bedding often with native copper concentrated along the edge of the quartz augens and alongside recrystallized quartz bands (with magnetite).
   Traces sericite. Bulk of rock fine clay-quartz aggregate.
   Conclusion: Siltstone. Native copper concentrated along bedding and strong preference to deposit along edge of quartz-rich zones locally recrystallized (augens common). Magnetite shows similar detrital association with quartz.

7. Section A-4-6 (6612')
   Texture: Porphyry. Cataclastic.
   Groundmass is much finer than A-4-1 and accounts for 40 percent of the rock volume.
   70 percent of the phenocryst volume consists of plagioclase, 6 percent biotite and the rest quartz (quartz phenocrysts are smaller than those in A-4-1).

Plagioclase phenocrysts are incipiently altered to clay. Biotite phenocrysts shreddy, trace chloritization.
Groundmass composed mostly of quartz and orthoclase.
Traces of sericite in groundmass.
Rock is shattered and veined by carbonate (dolomite?) stringers which cut groundmass, quartz and biotite phenocrysts.
5 to 7 (volume) percent carbonate veining in rock.
No magnetite or limonite veining in reflected light.
Conclusion: Biotite quartz monzonite porphyry. Rock essentially fresh (assuming porphyry texture is a primary feature).

See also. Petrographic Analysis report by FTG, 11/29/74 on sample A-4:6657.

George J. Stathis

George J. Stathis

GJS:lad

cc: JHCourtright
WLKurtz
JDSell ☞
RBCummings

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 11, 1971

TO: G. J. Stathis

FROM: J. D. Sell

Thin-Section Examination
Core Holes M-1A and A-4
Superior East Project
Pinal County, Arizona

The following samples are submitted for thin-section examination for rock type, alteration, and reference. The following notes are submitted by R. B. Cummings.

M-1A-1. Depth 2981. Porphyritic quartz monzonite from slide block within Miocene Whitetail Conglomerate.

A-4-1. Depth 6656. Porphyritic biotite quartz monzonite (?) or granodiorite (?). 10-20% secondary K-Spar (?), salmon-colored, as replacement band along fracture planes and in phenocrysts. Trace of pyrite and chalcopyrite.

A-4-2. Depth 6602. Quartz biotite schist, well banded. Trace of pyrite and chalcopyrite. Could it be a mafic-rich border phase to the intrusive (Samples A-4-1 and A-4-6)?

A-4-3. Depth 6573. Cemented fault gauge. Could it be Whitetail Conglomerate? Are cataclastic textures prominent? What is the gray sulfide -- is it detrital?

A-4-4. Depth 6562. Silicic limestone. Could it be a siltstone?

A-4-5. Depth 6445. Silicic limestone breccia or siltstone breccia.

A-4-6. Depth 6612. Biotite quartz monzonite. Highly sheared portion of equivalent (?) sample number A-4-1 above.

James D. Sell

James D. Sell

cc: WLKurtz
RBCummings
JCBalla

ASARCO

AMERICAN SMELTING AND REFINING COMPANY
SOUTHWESTERN EXPLORATION DIVISION
P. O. BOX 5747, TUCSON, ARIZONA 85703

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

November 12, 1971

Mr. Rudolf von Huene
1757 Paloma Street
Pasadena, California 91104

Dear Mr. von Huene:

Ten rock and core drill samples are being sent to your laboratory on Monday, November 15th. Please prepare one standard thin section from each sample.

The core samples are labelled as follows: M-1A-1, A-4-1, A-4-2, A-4-3, A-4-4, A-4-5, and A-4-6. The rock samples are labelled R-328, 329, and 330. Please note samples A-4-3 and A-4-2 require an oriented cut.

Yours truly,

George J. Stathis

George J. Stathis
Geologist

GJS:lad

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

January 27, 1972

Memorandum

TO: W. L. Kurtz

FROM: J. D. Sell

Age Dates and Petrographic Examination
DDH M-1A and A-4
Superior East Project
Pinal County, Arizona

Results from separate studies on core from the Superior East Project are now available. The request for the age dates was in a memorandum to J. C. Balla dated November 11, 1971, while the petrographic request was submitted to G. J. Stathis on the same date.

Sample M-1A-A is a weakly altered porphyritic quartz monzonite with an age date of 59.9 ± 2.2 m.y. The mass was emplaced as a slide block within the Whitetail conglomerate sequence.

Sample A-4 is a weakly altered quartz monzonite porphyry with an age date of 62.6 ± 2.3 m.y. The mass was found under a fault and is interpreted to be in place.

The two ages are in the same range as the Schultze granite (62 m.y.) and granite porphyry phase of the Schultze granite (58 m.y.) as determined in the Miami mineral district.

Attached is the age date data from the Geochron Laboratories. The petrographic work was submitted by G. J. Stathis in a memorandum dated January 20, 1972.

James D. Sell

James D. Sell

JDS:lad
Attach.

Geochron Laboratories, Inc.

24 Blackstone Street, Cambridge, Mass. 02139
Telephone TRowbridge 6-3691

20 January 1972

J.C. Balla
American Smelting and Refining Co.
Southwestern Exploration Div.
P.O. Box 5747
Tucson, Arizona 85703

Dear Mr. Balla:

Enclosed are the analytical reports of the K-Ar age determinations on the two rock samples described in your letter of 24 November 1971.

We analyzed a biotite concentrate sample and obtained indistinguishable ages of about 60 million years. You did not indicate the magnitude of the expected ages for these samples, so I cannot comment too much about them, other than to say that the biotites appeared to be in quite good condition and I would expect the measured ages to be reliable.

I am sending the mineral concentrates to you under separate cover.

If you should have any questions about the analyses, please do not hesitate to contact me. In the meantime, I am enclosing our invoice for this work. I hope that we may be able to serve you again in the near future.

Sincerely,
GEOCHRON LABORATORIES DIV.

Richard H. Reesman

Richard H. Reesman
General Manager

RHR/dm

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

POTASSIUM-ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B 2178

Date Received: 1 December 1971

Your Reference: A-4-C-121

Date Reported: 19 January 1972

Submitted by: J.C. Balla
American Smelting & Refining Co.
Southwestern Exploration Div.
P.O. Box 5747
Tucson, Arizona 85703

Sample Description & Locality: Granodiorite

Material Analyzed: Biotite concentrate, -40/+100 mesh.
Purity greater than 95%.

Ar^{40*}/K^{40} = .003725

AGE = 62.6 ± 2.3 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.03099	.680	.03122
.03144	.638	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
6.900	6.868	8.379
6.837		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

POTASSIUM-ARGON AGE DETERMINATION — **REPORT OF ANALYTICAL WORK**

Our Sample No. B-2177

Date Received: 1 December 1971

Your Reference: M-1A-A

Date Reported: 19 January 1972

Submitted by: J.C. Balla
American Smelting & Refining Co.
Southwestern Exploration Div.
P.O. Box 5747
Tucson, Arizona 85703

Sample Description & Locality: Granite

Material Analyzed: Biotite concentrate, -40/+100 mesh.

Ar^{40*}/K^{40} = .003561

AGE = 59.9 ± 2.2 **M.Y.**

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.03291	.540	.03285
.03278	.547	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.514	7.559	9.222
7.605		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln \left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1 \right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

Geochron Laboratories, Inc.

24 Blackstone Street, Cambridge, Mass. 02139
Telephone TRowbridge 6-3691

1 December 1971

J.C. Balla
American Smelting and Refining Co
Southwestern Exploration Div.
P.O. Box 5747
Tucson, Arizona 85703

Dear Mr. Balla:

We have your letter of 24 November 1971 and have safely received the two samples described therein, which you have submitted for potassium-argon age determination.

The samples appear to be adequate for dating and we shall be in touch with you when the analyses are completed, in approximately 30 days.

In the meantime, thank you for this opportunity to be of service to you and if you have any questions, please do not hesitate to contact us.

Sincerely,
GEOCHRON LABORATORIES DIV.

Richard H. Reesman

Richard H. Reesman
General Manager

RHR/db

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 11, 1971

MEMORANDUM:

TO: J. C. Balla

FROM: J. D. Sell

Age-Dating
Superior East Project
Pinal County, Arizona

Two rock units have been sampled for age-dating from core secured in the Superior East Project.

Sample M-1A-A is from 2935-2945 feet in drill hole M-1A. It is presently interpreted as a quartz monzonite slide block, quite badly brecciated in some areas, which was emplaced within the Whitetail Conglomerate sequence. The age-dating sample was selected on its lack of obvious alteration effects and less breccia matrix material. A sample of the material has been submitted for thin-section analysis under sample number M-1A-1. A sample, run by Salt Lake City on the biotite fraction, ran 660 ppm.

Sample A-4-A is from 6620-6630 feet in drill hole A-4. It is presently interpreted to be a porphyritic biotite quartz monzonite of probable Laramide age. The sample was also collected to minimize the effects of the adjacent fault zone. Sample A-4-A is the coarse reject from assay sample A-4-C121. A sample, A-4-1, is also being submitted for thin-section examination.

James D. Sell

James D. Sell

JDS:sg

cc: WLKurtz
RBCummings
GJStathis

SDS / HLC / SHC

ASARCO

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J. 07080

RECEIVED
MAR 24 1972
S. W. U. S. EXPL. DIV.

WILLIAM P. ROE
DIRECTOR OF RESEARCH
VAL KUDRYK
MANAGER, MINERALS RESEARCH
H. E. HOWE
MANAGER, METALS RESEARCH

March 22, 1972

W. L. K.
MAR 24 1972

Mr. W. L. Kurtz
Southwestern Exploration Div.
TUCSON, ARIZONA

The core sample A-2 referred to in your letter of March 9 was analyzed, and the attached memorandum by Mr. R. B. Haagensen indicates that the soft gray mineral consisted of chalcocite with hematite and distributed as shown in the photomicrograph.

V. Kudryk

V. Kudryk

VK/lk
Attach.

cc: JJCollins
RBHaagensen
EMartinez

Howard: you have won the title "Asarco's best Mineralogist"

from ~~Long~~ Longyear core @ 4076-4078 ft depth.

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J., 07080

March 17, 1972
Ref: 3175

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

Core Sample A-2 (MR-264)
4076-4078 feet

The attached photomicrograph shows a portion of a vein of gray metallic material present in this core sample. X-ray diffraction identified the material as a mixture of chalcocite, Cu_2S and hematite, Fe_2O_3.

Polished section, 56X. Dark areas are siliceous gangue. Light areas are chalcocite. Banded gray areas are hematite. Widest part of gangue at left measures about 200 microns across.

From the photomicrograph it is apparent that the chalcocite is a replacement of a former mineral (perhaps pyrite) and has disrupted the earlier colloform hematite in many areas.

R. B. Haagensen

RBH/dm

Earlier ?

AMERICAN SMELTING AND REFINING COMPANY
SOUTHWESTERN EXPLORATION DIVISION
P. O. BOX 5747, TUCSON, ARIZONA 85703

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

March 9, 1972

Mr. V. Kudryk
Central Research Laboratories
South Plainfield, New Jersey 07080

Dear Val:

I am enclosing one core sample (A-2) containing a steely, gray, soft, metallic mineral. This mineral contains copper, but does not "look like" chalcocite. Would you kindly identify this mineral for us.

Very truly yours,

W. L. Kurtz

WLK:lad
Enc.

cc: JDSell

ASARCO

AMERICAN SMELTING AND REFINING COMPANY
SOUTHWESTERN EXPLORATION DIVISION
P. O. BOX 5747, TUCSON, ARIZONA 85703

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

March 30, 1972

Mr. Rudolf von Huene
1757 Paloma Street
Pasadena, California 91104

Dear Mr. von Huene:

Under separate cover I am sending you ten core drill samples. Please prepare one polished thin-section and one briquetted polished section (for opaque mineral determination) on each sample submitted. I have marked a red line on each sample to indicate the area of primary interest.

The core samples are all prefixed "A-2" followed by one of the following numbers:

4253	4401
4262	4412
4308	4419
4340	4445
4360	4459

Yours truly,

James D. Sell

James D. Sell
Geologist

JDS:lad

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 5, 1972

Memorandum

TO: J. D. Sell

FROM: G. J. Stathis

Petrographic Examination of
Specimens X-14, Z-1 through Z-4
Superior, Arizona Region

Location: Unknown. Samples Z-1 through Z-4 said to be Manitou granite. X-14 is Lost Gulch quartz monzonite.

Conclusions:

Samples Z-1 through Z-4 appear to be basically the same rock. These rocks show some evidence of cataclastic deformation and recrystallization. The porphyry textures developed, which is not evident in handsample, may be partly due to crystallization of the "milled-down" material.

The sample X-14 of Lost Gulch quartz monzonite differs from the "Z" series of samples. Presence of Topaz (greisen environment) and calcite-clay veining suggests possibility that this rock may be peripheral to mineralization (Mo?)

Thin Section Descriptions

Section Z-2
Texture: Medium-grained porphyritic
75% volume phenocrysts
Orthoclase and microcline 25-30% vol.
Quartz 50-65% vol.
Plagioclase 15-20% vol.

Much of the quartz as lens-like concentrations. Plagioclase preferrentially replaced by fine sericite aggregate and extremely fine kaolin clay. Average 80-90 plag. phenocrysts volume replaced.

Orthoclase phenocrysts less alt. Limonite dusting common. Some perthite and myrmekite (qtz-plag?) noted. Orthoclase grains larger than plag. Both orthoclase and plagioclase show evidence of resorption and ragged outline due in part to groundmass replacement and cataclastic deformation. Groundmass 50:50 orthoclase and quartz.

Secondary biotite common to groundmass and associated with quartz. 5% biotite by volume.

Large shreddy sericite grains noted replacing altered (fine sericite-clay aggregate) plagioclase and quartz grains. This late sericite 2-3% by volume.

1 to 2% disseminated, late magnetite replacing secondary biotite and large sericite grains.

Relationship between secondary biotite and sericite not clear. Appear to replace one another. Associated with late magnetite introduction. At one corner of slide are traces of garnet with minute chlorite inclusions.

Rock is moderate to strongly altered. Lack of euhedral to subhedral feldspar grains due to cataclastic deformation and groundmass recrystallization and resorption.

Section Z-3

Similar to Z-2 -- somewhat less altered (less alteration in plagioclase 50% surface volume).

75% phenocryst volume (qtz-feldspar). More quartz than Z-2. Somewhat more K-felds. than plag. (<10%) compared to Z-2. K-feld. as orthoclase and microcline-perthite.

Groundmass more recrystallized than Z-2, and groundmass felds. less alt. (incipient clay).

Shreddy, dissem. sericite as in Z-2, mostly in groundmass, 2% by volume sericite. 0.5% dissem., secondary biotite in groundmass. Biotite-sericite relationship ? as in Z-2.

1% dissem. magnetite derived from biotite, unlike Z-2. Thus, some biotite may be altering to sericite.

Rock similar to Z-2 in that fracturing and other cataclastic features common.

Section Z-4

Texture similar to Z-2 and Z-3

80 to 85% of rock phenocrysts.

65-60% phenocrysts are K-feldspar, mostly orthoclase.

15% plagioclase and rest quartz.

Rock more limonite stained due to dusting of feldspars (both K-feld and plagioclase). Degree of rock alteration same as Z-2. Fine sericite and kaolin in plagioclase as Z-2.

Groundmass composed of quartz and orthoclase, plus some plagioclase. Groundmass resorption of phenocrysts common. 2-3% dissem. sericite flakes in groundmass. Disseminated magnetite, up to 0.5, by volume, oxidized to hematite. No secondary biotite (completely ozidized). Trace Zircon.

Section Z-1

Rock is basically same as Z-2, 3, and 4. Rock is fresher (less alteration of feldspar) and finer groundmass than other three rocks.

85-90% phenocrysts.

Quartz and K-feldspar (orthoclase and perthite) in about equal amounts.

10% plagioclase.

1% disseminated sericite grains.

No biotite.

2-3% disseminated magnetite (mostly derived from biotite originally) oxidized to hematite. Light, limonite dusting of feldspar gives reddish cast to rock.

Section X-14

Medium-grained, hypidiomorphic granuler.

Rock differs from "X" series.

10 to 20% quartz.

40 to 50% euhedral to subhedral plagioclase. Remainder large, anhedral, orthoclase plates, locally including plagioclase.

Limonite dusting or inclusions moderate to strong in feldspars.

5% disseminated, sericite laths replacing limonite-coated feldspars.

1% disseminated biotite oxidized to hematite and leucoxene.

0.5% (1% plus in handspecimen) disseminated and partly oxidized magnetite.

Trace fresh biotite, yet handspecimen shows 2% or more.

0.5 to 1.0% disseminated magnetite.

Trace zircon and fine apatite.

0.5% disseminated grains believed to be topaz.

Locally rock is shattered and veined with calcite plus clay material (Kaolin-illite mixed layer?). Veinlets are late and cut feldspar and sericite grains. Also clay? filled, vugs noted. The quartz monzonite is moderate to strongly altered.

George J. Stathis

GJS:lad

cc: JHCourtright
WLKurtz

ASARCO

AMERICAN SMELTING AND REFINING COMPANY
SOUTHWESTERN EXPLORATION DIVISION
P. O. BOX 5747, TUCSON, ARIZONA 85703

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

January 13, 1972

Manitou Granite
Castle Dome, Gila Co.

Mr. Rudolf von Huene
1757 Paloma Street
Pasadena, California 91104

Dear Mr. von Huene:

Five rock samples were mailed to your laboratory today. The rocks are labelled as follows: X-14, Z-1, Z-2, Z-3, and Z-4.

Please prepare one standard thin section of each sample.

Sincerely yours,

George J. Stathis

George J. Stathis

GJS:lad

cc: JDSell

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

June 17, 1974

Memorandum to: J. D. Sell

From: F. T. Graybeal

Hydrothermal alteration in
AI-I and A-2 samples
Superior East Project

Fourteen thin sections were examined in detail from two drill holes in the Superior East area. All sections examined in this phase were from below "fault 2". Data sheets for both the alteration and fluid inclusion studies are appended.

Hole AI-I *

The six samples studied are schistose and all contain variable amounts of quartz, orthoclase, biotite, sericite-muscovite, and sulfide. The schistosity is accentuated by the formation of alternating layers of quartz-orthoclase and biotite-sericite. The schist is cut by quartz-orthoclase veins of uncertain origin, either metamorphic or hydrothermal, which generally parallel the foliation. The vein orthoclase usually contains some extremely fine-grained reddish inclusions which probably account for its pinkish color. Some of the matrix orthoclase has a similar appearance suggesting a similar origin.

The biotite is generally elongate parallel to the foliation rather than in random orientation, suggesting metamorphic origin. However, in several samples lenses of biotite are notably coarser grained and more abundant where they are coincident with lenses of red inclusion-rich orthoclase. This latter occurrence, perhaps 5-10% of the total biotite + orthoclase, may be hydrothermal. In several places, biotite is more abundant where sulfides are more abundant.

Sericite is often medium-grained (muscovite), is concentrated along the foliation planes, and often cuts across biotite flakes.

Anhydrite (2-10%) and calcite (tr-1%) occur in four of the samples. Anhydrite is both disseminated and in the quartz veins and, in the sections examined, appears to decrease in abundance with increasing depth. Traces of chlorite were noted in A-I-20. In addition kaolinite, possibly with mixed very fine-grained quartz, is present in A-I-20. The presence of moderate cataclastic deformation features makes it unclear whether the kaolinite is an alteration mineral or simply part of a mylonite.

* Note: all A-1- should be AI-1- prefix. JDS

Fluid inclusions were examined in detail in four of the samples. In all cases they were found to be very small, rare, and of the two-phase type with liquid and a small gas bubble. A brief reconnaissance of the other two samples revealed a similar population. No daughter minerals or gas-rich inclusions were seen.

In summary, hole A-1 appears to contain some potassic alteration. The strongest evidence for this is the presence of locally abundant anhydrite. The near absence of fluid inclusions of any type suggests that alteration was not pervasive. Veins which crosscut the foliation are rare.

Hole A-2

The seven samples studied are mixed schist and granite porphyry. The matrix and phenocryst textures of the granite porphyry, particularly the quartz eyes, were rather distinctive and indicate that the aplite and feldspar veins noted on the logs are probably all granite porphyry. The orthoclase in the granite porphyry often contains abundant reddish inclusions which I have found to be typically a hydrothermal alteration phenomenon. The amount which is hydrothermal is unclear, but it could be 50 percent of the total orthoclase in the rock.

The sericite in the granite porphyry is clearly an alteration product of plagioclase. The abundant kaolinite in A-2-6 may be a result of the moderate cataclastic deformation of this sample, similar to that seen in sample A-1-20. Minor calcite is present in most of the granite porphyry samples.

The two samples of schist in this hole both contain calcite and sample A-2-7 also contains minor anhydrite and apatite. Both these latter two accessory minerals are characteristic of potassic alteration assemblages in other porphyry copper deposits.

Fluid inclusions are mostly small to medium size and are rare to common. Two-phase inclusions (water with a gas bubble forming 10-40 percent of the inclusion) generally form about 99 percent of the total inclusions present. The remainder are three-phase inclusions containing small but recognizable daughter minerals particularly a small birefringent, blocky species. Several inclusions contain an opaque mineral and several other anisotropic species may be present. The overall abundance and type of fluid inclusions indicate the presence of a hydrothermal fluid of low to moderate salinity.

In summary, hole A-2 appears to contain an uncertain but possibly substantial amount of hydrothermal alteration minerals. This is probably a function of the abundance of granite porphyry encountered in the hole. Circulation of a hydrothermal fluid of low to moderate salinity is also indicated. No obvious vertical changes are present.

Comparison of holes A-l and A-2

The comparison of alteration in the two holes is admittedly difficult due to significant differences in rock type which tend to influence alteration mineralogy. Both holes contain probable potassic alteration minerals; however, in A-2 these minerals are more abundant and varied than in A-l. In addition fluid inclusions in A-2 are larger, more abundant, and contain a more saline hydrothermal solution than in A-l. Although the fluid inclusions are more abundant and varied in the granite porphyry as compared to the schist in A-2, a comparison of schist samples in holes A-l and A-2 strongly suggests that alteration was more pervasive in A-2.

The apparent stronger alteration in A-2 may be related to the abundance of granite porphyry, the probable source rock. Nothing can be said about the relative depth of the two holes in the hydrothermal system. The fluid inclusions in the granite porphyry in A-2 are similar to but not as abundant or saline as fluid inclusions examined from a single granite porphyry sample collected from the OxHide deposit. Thus it is possible that the center, or most intense zone of alteration-mineralization has not yet been intersected in the Superior East area, if indeed one was or is still present.

F. T. Graybeal

F. T. Graybeal

FTG:lb
Attachs.

cc: WLKurtz

PETROGRAPHIC ANALYSIS

Section No. A - I - 14 (3304)

Rock Name
quartz - biotite - anhydrite schist

Megascopic description
massive, grayish, quartz - biotite schist; med. grained; no obvious layering; cut by quartz - k-feldspar veins w. trace of cpy. in veins and disseminated.

Microscopic description

Minerals
quartz - 30% 15%, cgr in veins; 15% med - f.gr. in bio-anh - or lenses.
orthoclase - 45%, mostly f.gr, in massive lenses w. bio-anh; some is fairly clear, some rather abundant translucent inclusions
biotite - 10%; med-fgr, orientation generally sub-parallel to schistosity and veins
sericite - 3%
anhydrite - 10%
calcite - tr.
sulfide - 2%.

Textures
Weak schistosity is clearly present; quartz veins occur more or less parallel to the schistosity.

PETROGRAPHIC ANALYSIS

Section No. A-I-15 (3511')

Rock Name
quartzite - quartz biotite schist (gneiss)

Megascopic description

gray, fine-medium grained, weakly broken; probably a quartzite; traces of cpy along joints and disseminated. Rock looks weakly micaceous (biotite?)

Microscopic description

Minerals

quartz - 53%; 20% is med-cgr, rounded-anhedral; 3% in a vein; 30% is f.gr. in the matrix

orthoclase - 15%, f gr in the matrix; weakly cruddy

biotite - 15%, f gr. weak parallel elongation

sericite - 2%

anhydrite - 10%; fine-coarse grained dissem. and in qtz. vein; some twinning

sulfides - 5%

Textures

Very weak gneissic-schistose texture seen in biotite + coarse-grained quartz elongation.

Amount of introduced potassic alteration minerals unclear - except for the anhydrite.

Biotite and sulfides appear more abundant together in heavy disseminations parallel to schistosity.

PETROGRAPHIC ANALYSIS

Section No. A-I-16 (3424')

Rock Name
biotite quartzite or
quartz-biotite schist (gneiss)

Megascopic description

grayish, massive quartzite w. 5-10% biotite, cut by pink kspar vein; tr. disseminated sulfides

Microscopic description

Minerals

quartz - 50% 20% med. gr, anhedral, slightly elongate; 30% f.gr equant in matrix.

orthoclase - 30%; 10% in med. gr. 1/8" vein, 20% dissem f.gr. in matrix; vein material has abundant brownish inclusions (crud) - possibly FeC

biotite - 10% med-f.gr, dissem. in same direct. as qtz is elongated; more abund zones have some assoc. cruddy kspar.

chlorite - tr.
anhydrite - 5%
sericite - 3%
sulfides - 2%
calcite - tr.

Textures

Very weak schistosity; alteration is potassic; amount of hydrothermal sericite is unclear.

PETROGRAPHIC ANALYSIS

Section No. A-I-17 (3711')

Rock Name
quartz-sericite-biotite schist

Megascopic description

massive gray quartz-biotite-sericite(?) schist cut by quartz-Kfeldspar veins to +1" thick. Veins could be thin aplite-type dikes.; trace of cpy.

Microscopic description

Minerals -

quartz - 65%: 25% f.gr. in matrix; 40% in cgr. qtz vein

orthoclase - 5% f.gr., tr in qtz vein.

biotite - 10%; f-med.gr, somewhat elongate parallel to foliation

sericite - 15%; strongly concentrated along folia.

anhydrite - 3% mostly in the quartz vein.

calcite - 1%, mostly in qtz. vein, some may be iron carbonate

sulfides - 1%

Textures

Moderately well-developed schistose texture. Quartz vein with cal-anhyd-kspar has negligible effect on wall rock. Vein is estimated to contain 90-95% qtz.

Calcite rims anhydrite

PETROGRAPHIC ANALYSIS

Section No. A-I-18 (3810')

Rock Name
quartz-sericite-biotite schist.

Megascopic description

massive, gray quartz-sericite-biotite schist with well-developed schistosity, cut by somewhat irregular vein-like quartz-kspar mass; tr. cpy.

Microscopic description

Minerals

quartz - 50%; 30% coarse-f gr. layers in schist; 20% in quartz-kspar vein

orthoclase - 15%; 10% cgr. in vein; 5% dissem. in quartzose layers
Vein kspar has abundant very f.gr. brownish inclusions

sericite - 25%; in massive micaceous layers in schist

biotite - 7%; in massive " " " " with sericite

calcite - tr.

sulfides - 3%

Textures

Strong schistose texture cut by quartz-kfeldspar vein. Biotite is cut by sericite

PETROGRAPHIC ANALYSIS

Section No. A-I-19 (3949')

Rock Name
quartz-sericite schist

Megascopic description

massive, gray; med. grained quartz-sericite-biotite schist cut by 1/10-1/2" quartz veins; tr. diss cpx

Microscopic description

Minerals

quartz - 50% 20% med-cgr in vein; 30% coarse-f.gr. in matrix - similar to quartzite.

orthoclase - 33%; 10%; cgr. mostly in qtz. veins, contains elongate swarms of brownish v.f.gr inclusions, 23% f.gr. in matrix (cruddy)

biotite - 8%, med-f.gr. coarser and more abundant in elongate zones parallel to schistosity with matrix kspar and sulfides.

sericite - 4% in elongate med-f.gr aggregates, cuts biotite.

anhydrite - 2%

sulfides - 2%

Textures

Weak schistosity obvious from elongation of coarse-grained quartz and parallel orientation of sericite grains

Presence of coincident crud-rich kspar + coarser, more abundant biotite + sulfides indicates some or all of these minerals may be hydrothermal.

Quartz vein is offset by slip which is nearly parallel to foliation and along which quartz grains have healed leaving no evidence of slip

Secondary fluid inclus. copious present.

PETROGRAPHIC ANALYSIS

Section No. A-I-20 (3963')

Rock Name
quartz-biotite-kaolinite(?) schist

Megascopic description

massive - broken; light gray; medium grained; rock looks like a quartz-sericite schist with moderate clay or sericite pervasive alteration and along slip surfaces - may be in part anhydrite - cut by several quartz veins.

Microscopic description

Minerals

quartz - 45%; 5% med-c grained in a vein; 40% med-fgr, highly irregular material in matrix

orthoclase - 10%; fgr in matrix

kaolinite(?) - 25%; very fine-gr, poorly crystallized in matrix and in veins which offset quartz veins. Birefringence is low but could this be in part mylonitized quartz(?)

sericite - 5%; med-fgr

biotite - 10%; med-fgr, in elongate zones.

chlorite - tr

calcite - tr.

sulfides - 2%

Textures

Weakly schistose; variable cataclastic deformation seen in cross-cutting kaolinite-mylonite veins which offset quartz veins and presence of similar material throughout the matrix.

FLUID INCLUSION PETROGRAPHY

Section No. A-1-15 (3511')

Rock Type
qtz-bio schist

Host mineral
quartz - med-cgr, in matrix

Abundance, size of inclusions
Rare ; mostly small

Distribution of inclusions
Often in small aggregates - possibly a pseudosecondary zone nearly in plane of section. Appear to be mostly primary - pseudosecondary. However some swarms (not a single fracture) extend across several grains. Minor extremely small secondary

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p,ps.,s.		small	gas = 2-20%	

No type 3 inclusions seen

FLUID INCLUSION PETROGRAPHY

Section No. A-1-17 (3711')

Rock Type
qtz-ser-bio schist

Host mineral
quartz - vein and matrix; med-cgr.

Abundance, size of inclusions
Rare, small

Distribution of inclusions
In thin fractures

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 s (ps?)	100%	s	gas = 2-15%	

FLUID INCLUSION PETROGRAPHY

Section No. A-1-18 (3810')

Rock Type
qtz-ser-bio schist

Host mineral
quartz – med + c gr, in matrix and in massive vein-like masses.

Abundance, size of inclusions
Rare, small

Distribution of inclusions
Possibly more common in the larger grains, mostly (98% ?) secondary

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 s	99.99%	s	gas = 2-15%	
3(?)	trace	s	rare birefringent specks which may or may not be present in a fluid inclusion were seen in the quartz	

FLUID INCLUSION PETROGRAPHY

Section No. A-1-19 (3949')

Rock Type

qtz-ser schist

Host mineral

quartz - medium-coarse grained

Abundance, size of inclusions

Rare-common, small

Distribution of inclusions

Rather uniform along parallel fractures which are present throughout the section. Estimate 99% are secondary

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 s	100%	s	gas = 2-10%	

Zones of fracturing are well defined by secondary inclusions of type 1.

PETROGRAPHIC ANALYSIS

Section No. A-2-3 (4301')

Rock Name
granite porphyry

Megascopic description

variably soft, weakly sheared; whitish - light pink; med. grained slightly porphyritic granite. Rock is moderately sericitized (?) with 1/8" quartz vein. Possibly some 2nd kspar? Phenocrysts are quartz eyes

Microscopic description

Minerals

quartz - 45%; 25% partly rexl, c.grained eyes to 6mm dia; 15% f.gr in matrix; 5% med-f.gr. in vein.

orthoclase - 20%; f-c.gr, anhedral, highly irregular shapes; moderately abundant dark translucent crud; partly 2nd (?)

plagioclase - 2%; remnant phenocrysts

sericite - 30%; f.gr., massive tabular aggregates after plag. pheno, minor in orthoclase; coarser where it replaces mafics

perovskite + rutile - tr

opaque - tr.

Textures

Granite por. texture clearly visible. Origin of kspar uncertain - abundance of crud suggests (not proof) very late magmatic or hydrothermal.

Alteration may be both phyllic + potassic

Some fluid incl have m.p. daughter minerals

PETROGRAPHIC ANALYSIS

Section No. A-2-4 (4394')

Rock Name
granite porphyry.

Megascopic description
small piece of core looks like strongly kspar-altered porphyry (pink with 10% 1mm. altered tabular phenocrysts) cut by a quartz-sericite-pyrite vein with 1/4" gray sericite selvage. Section covers kspar portion

Microscopic description

Minerals
quartz - 35%; 34% is f.gr, somewhat blocky, equigran., forms matrix; 1% is vein-like zone.

orthoclase - 40%; med-f gr, anhedral, forms matrix; moderate crud

plagioclase - 5%; remnant parts of c.gr, subhedral phenocrysts (orig. 20%)

biotite - 1%; f.grained, dissem. and one larger subhedral grain.

sericite - 10%; dissem. med.gr adjacent to pyrite vein, and f.gr in feldspars.

kaolinite - 5%, in massive aggregates altering from plagioclase phenocrysts; appears most abundant on rims and may be cutting earlier f.gr sericite in cores of former plag.

calcite - 1% in a vein and dissem. in massive kaolinite

opaque - tr.

Textures
Granite porphyry texture still visible. The pervasive pink color in hand specimen + the abundant crud in thin section suggests most of the kspar is hydrothermal. The kaolinite-calcite assemblage is curious. Age of biotite unclear.

The medium gr. sericite cuts all earlier kspar and appears to be the latest alteration mineral; clearly different from the f.gr sericite in the feldspars

Parageneses:

plag → f.gr. sericite → kao + cal

kspar → med.gr. sericite

Alteration is dominantly potassic with a late phyllic vein.

PETROGRAPHIC ANALYSIS

Section No. A-2-5 (4403')

Rock Name
quartz- biotite schist.

Megascopic description

quartz - biotite schist with 60% quartz (?); rock is cut by numerous later quartz veins.

Microscopic description

Minerals

quartz - 40%; fine - coarse grained; coarse-grained aggregates contain no kspar.

orthoclase - 15%; f.gr.; assoc. with lenses of f.gr. quartz.

biotite - 30%; mostly fine gr, in massive lenses; grains show minor tendency to orient parallel to lens; well-crystallized.

sericite - 5%; f.gr. in bio lenses as small aggregates

kaolinite - 7%; f.gr, in bio lenses.

calcite - 1%; assoc. w. sericite

opaque - tr

Textures

Lenses of biotite - sericite - kaolinite - calcite alternate with lenses of quartz - orthoclase

Unclear whether sericite is originally part of schist or later.

Assemblage would be very stable in a potassic environment.

Coarser quartz may be post- metamorphic (?)

PETROGRAPHIC ANALYSIS

Section No. A-2-6 (4499')

Rock Name granite porphyry

Megascopic description

whitish with vague pinkish cast; looks compact, medium grained slightly porphyritic granite with 5% dissem biotite. Alteration is pervasive destruct of plagioclase only (?)

Microscopic description

Minerals

quartz - 25%; 10% med. gr., rounded eyes to 2 mm, usually with thin granophyre-like rim; 15% f. gr. in matrix.

orthoclase - 35%; mostly med-f gr, original matrix.

biotite - 5%; med. gr.

sericite - 5%, mostly f. gr, includes some hydromica

kaolinite - 25%; f gr. in massive tabular-square aggregates after plag (?) phenocrysts and in the matrix of the rock May cut kspar

opaque - tr (magnetite)
zircon - tr

Textures

Porphyritic texture apparent.

Kaolinite may cut kspar and may be cut by sericite. Thus - is kspar magmatic

Moderate cataclastic deformation with shattered + offset quartz crystals. Kaolinite appears to occur in shattered portions of the matrix.

PETROGRAPHIC ANALYSIS

Section No. A-2-7 (4457')

Rock Name
quartz- sericite - biotite schist

Megascopic description
quartz-biotite schist with alternating lenses of qtz-rich rock and biotite-rich rock. ; cut by occas. veins, trace of pyrite.

Microscopic description

Minerals
quartz - 40% ; fine to coarse grained, anhedral, highly variable grain size
orthoclase - 15% ; generally f.gr., in elongate aggregates within quartz-rich lenses
biotite - 15% ; in massive biotite-sericite aggregates and as f.gr. dissem within the elongate orthoclase aggregates
sericite - 15% ; fine - med. gr., cuts biotite in the bio-ser lenses
carbonate - 5%, predominantly a crud-rich variety (Fe carbonate ?)
apatite - 2% ; med. gr. anhedral; assoc. w. sulfide - anhydrite - cgr. qtz.
anhydrite - 2%
sulfides - 3%

Textures
Schistose but much of mica in the micaceous lenses is of diverse orientation.
Presence of the intimate mixing of kspar - bio within the quartz lenses, anhydrite, apatite all suggest potassic alteration
Amount of hydrothermal kspar uncertain.
Apatite is probably hydrothermal ; cruddy carbonate is puzzling

PETROGRAPHIC ANALYSIS

Section No. A-2-8 (4844')

Rock Name
Granite porphyry

Megascopic description

possibly a granitic rock (?); contains 1/8" qtz vein with 1/4" pink kspar selvage which cuts an earlier muscovite vein. Outside of vein alteration rock is coarse grained with mixed greenish-gray chlorite-biotite(?) and coarse-grained quartz; tr. cpy. Overall looks like strong alteration

Microscopic description

Minerals

quartz - 45%; 30% in med-cgr. eyes, original or completely recrystallized, includes several elongate aggregates; 5% in veins; 10% f.gr in matrix

orthoclase - 20%, fgr in matrix

sericite - 30%, f.gr. in blocky aggregates after feldspar phenocrysts; minor coarse gr., dissem.

chlorite - tr, pseudom @ biotite; cores Mg-rich, edges Fe-rich; cut by sericite.

kaolinite - 1% in small, fgr., mass aggreg.

calcite - 1%, f gr; dissem + assoc. w. kao.

anhydrite - tr.

sulfides - 3%

Textures

Originally granite porphyry, but severely recrystallized. Numerous inclusions of matrix quartz in kspar suggests kspar is hydrothermal - normally quartz and orthoclase in a porphyry matrix are cotectic. Sericite is possibly superposed on the orthoclase.

Fluid incl. are rare

PETROGRAPHIC ANALYSIS

Section No. A-2-9 (4910')

Rock Name
Granite porphyry

Megascopic description

greenish - pinkish somewhat mottled colors in a strongly altered granite porphyry, rock is massive w. pink kspar, sericite, and qtz phenocrysts; specular hematite on slip surface.

Microscopic description

Minerals

quartz - 40% 15% rounded, cgr. eyes; 10% in vein like zones (med.-cgr.), 15% fgr. in matrix

orthoclase - 25% 5% cgr phenocrysts (?); 20% fgr anhedral in matrix. Small former plagioclase inclusions in kspar phenocrysts completely altered to sericite, kspar mostly untouched.

sericite - 30% fgr replacing tabular plag; minor coarser in former mafic site

perovskite - tr.
calcite - tr.
opaque - tr.

Textures

Porphyritic texture clearly visible. Stability of kspar startling in view of total destruction of plagioclase. Minor med. grained sericite cuts kspar.

FLUID INCLUSION PETROGRAPHY

Section No. A-2-3 (4301)

Rock Type granite porphyry

Host mineral
quartz phenocryst

Abundance, size of inclusions
Overall rare - common;
Size generally medium, although many secondary incl. are very small. Larger inclusions are mostly primary, smaller ones mostly secondary

Distribution of inclusions
Somewhat erratic within individual grains and in different grains. Recrystallized portions have fewer inclusions.
Estimate 20% of inclusions primary, rest are pseudosec. + sec. Abundance of pseudosec vs. sec. hard to tell but perhaps equal - are mostly type 1.
Shapes irregular, negative crystals minor.

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p, ps, s	98%	s-l	gas = 10-40%	
3 p (ps?)	2%	m	gas = 20-40%	a.) elongate, tabular, birefringent (anhydrite b.) elongate, wispy, birefringent. c.) halite (??) - very rai

Notes:
1) Type 2 appear generally absent - although gas-rich inclusions are rarely present.
2) Presence of halite highly questionable. Inclusions suggest moderately saline fluids in some primary inclusions, mostly more dilute in the secondary types.
3.) vein quartz very clear

FLUID INCLUSION PETROGRAPHY

Section No. A-2-4 (4394')

Rock Type granite por.

Host mineral

matrix quartz — no phenocrysts present.

Abundance, size of inclusions

Rare and mostly small

Distribution of inclusions

Erratic, but low abundance makes it hard to typify.
Abundance ∂) primary = secondary (?)

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p/ps	99.5%	s-m	gas = 10-40%	
3 p	0.5%	m	gas = 10-40%	a) rare birefringent mineral.

Remarks:

Quartz phenocrysts absent; matrix quartz is rather clear as in A-2-3.

FLUID INCLUSION PETROGRAPHY

Section No. A-2-5 (4403')

Rock Type
quartz - biotite schist.

Host mineral
quartz - med-cgr. in layers of schist

Abundance, size of inclusions
Rare ; small - medium.

Distribution of inclusions
Distribution is irregular within grains and between different grains.
Probably 30% are primary - 70% pseudosec + sec.

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 (p, ps, s)	99.9%	s-m	gas = 10-30%	
3 (p?)	0.1%	s-m	gas = 25%	a) very small opaque

Remarks:
1) Daughter minerals are mostly absent, but scarcity of inclusions gives inadequate sample.

FLUID INCLUSION PETROGRAPHY

Section No. A-2-6 (4499')

Rock Type
granite porphyry

Host mineral
quartz phenocrysts

Abundance, size of inclusions
Rare - common, small - large

Distribution of inclusions
Somewhat variable but all phenocrysts have some.
Inclusions appear to be mostly primary and pseudosecondary and are commonly elongate.

Inclusion data

syl. ??
hem ?
bire (

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p,ps	99.5%	s-m	gas = 5-30%	
3 p,ps	0.5%	m	gas = 20-30%	several types present but all uncertain. a.) sylvite (??) - somewhat clear, poorly formed b.) hematite - only 1 grain c.) birefringent mineral (s very small but may be elongate.

Remarks:
1.) daughter minerals present only in one grain where inclusions are common - abundant; other grains have mostly rare quantities of inclusions

FLUID INCLUSION PETROGRAPHY

Section No. A-2-7 (4457')

Rock Type
qtz-ser-bio schist

Host mineral
quartz - med- coarse grained, in layers

Abundance, size of inclusions
Rare - common; mostly small - medium; possibly more abundant in the larger grains.

Distribution of inclusions
Somewhat erratic, mostly primary + pseudosecondary; possibly 60% are pseudosec

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p, ps	99.5%	s-m	gas = 5-20%	
3 p, ps?	0.5%	s-m	gas = 10-20%	a.) birefringent, blocky b.) opaque

Remarks:

1.) blocky daughter mineral could be mistaken in shape for halite-sylvite, but biref is often prominent (calcite ??)
Volume of daughter minerals in inclusions is always very small

FLUID INCLUSION PETROGRAPHY

Section No. A-2-8 (4864)

Rock Type granite porphyry

Host mineral
quartz phenocrysts - partly recrystallized

Abundance, size of inclusions
Rare - common; also abundant particulate matter which makes recognition of very small inclusions difficult.
Size mostly small - med.

Distribution of inclusions
Distrib. appears mostly random, but more abundant in the original unrecrystallized portions of the grains.
Difficult to determine relative amounts of pri - ps - sec. inclusions.

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p, ps?	99.8%	s-m	gas = 5-30%	
2 p. (?)	0.05%	s-m	gas = 60% (??) - very rare	
3 p, ps.	0.15%	s-m	gas = 10-30%	a.) blocky, birefringent.

FLUID INCLUSION PETROGRAPHY

Section No. A-2-9 (4910')

Rock Type
granite porphyry

Host mineral
quartz phenocrysts.

Abundance, size of inclusions
Common, mostly small-medium.

Distribution of inclusions
Highly irregular within grains with clusters of abundant inclusions possibly occurring at intersections of pseudosecondary zones. Somewhat more uniform in different grains.
Inclusions in the abundant zones have highly irregular shapes
Probably mostly pseudosecondary (60%?)

Inclusion data

Type	Abundance	Size	Fluids - vol. %	Minerals
1 p, ps.	99.9%	s-m	gas = 5-30%	
3 p, ps	0.1%	s-m	gas = 5-30%	a.) blocky, birefringent.

Remarks:

1.) possibly some very rare gas-rich inclusions (gas = 60%)

2.) although inclusions more abundant in this section than in rest of the hole, type 3 inclusions are still pretty rare

Thin Section Samples.

Rock No.	Type	Footage (Depth)	
A-2-1	Tgmp	4078	
A-2-2	pЄpi w/cc.	4212	fault ②
A-2-3	Tgmp	4301	
A-2-4	aplite	4394	
A-2-5	pЄpi veinlet	4403	
A-2-6	Tgmp w/ feldspar	4499	
A-W-7	pЄpi w/ veinlet	4657	
A-W-8	pЄpi w/ aplite feldspar	4864	
A-W-9	pЄpi w/ feldspar + veining	4910	
A-I-10	bx (M-1A Type) pi-gr.	2884	
A-I-11	bx (M-1A type) pi-gr.	2981	fault ①
A-I-12	Leach Cap bx pi.	3092	
A-I-13	Leach Cap bx pi-gr.	3200	fault ②
A-I-14	pЄpi w/ veinlet	3304	
A-I-15	pЄpi w/ lucip veinlet	3511	
A-I-16	pЄpi w/ qtz-feldspar veinlet	3624	
A-I-17	pЄpi w/ qtz-feldspar-py veinlet	3711	
A-I-18	pЄpi w/ qtz xcutting	3810	
A-I-19	pЄpi w/ qtz, feldspar, py	3949	
A-I-20	pЄpi w/ clay veinlet	3963.	

ck: Thin section reports
M-1A, A-2, A-4.

PETROGRAPHIC ANALYSIS

Section No. A-I-1:3261

Rock Name
granite porphyry

Megascopic description

medium-dark gray rock with 20% whitish feldspar phenocrysts in a dark gray matrix; one 1/8" qtz-kspar vein; tr. py; minor schist xenoliths.

Microscopic description

Minerals

quartz - 15%; fine grained, disseminated in the matrix
orthoclase - 40%; 30% is f.gr in matrix; 10% as phenocrysts
plagioclase - 30%; mostly med-c.gr phenocrysts
biotite - 7%; 3% med.gr. phenocrysts; 4% f.gr. dissem. in linear swarms in matrix; looks like flow structure or schist.
magnetite - tr.
apatite - tr
anhydrite - 5%
sericite - 2%
calcite - tr

Textures

Strongly porphyritic with pheno-matrix = 45-55%
Biotite in matrix may be hydrothermal but it is generally aligned in schist-like swarms - may indicate replaced schist or a flow structure
Dark color due to dissem. biotite
Matrix much finer grained than A-4:6657 and occasionally is granophyric

See similar rock description in Section A-4:6657

11/29/74 FTG.

PETROGRAPHIC ANALYSIS

Section No. A-4: 6657

Rock Name
quartz monzonite porphyry ⊛

Megascopic description

medium gray, moderately sheared, "granite por"; 40% whitish feldspar phenocrysts in a dark gray matrix, rock appears fresh

Microscopic description

Minerals

quartz – 18% 15% is fine gr, equant dissem. in matrix; 3% is med-coarse grained in somewhat recrystallized phenocrysts.

orthoclase – 35%; 25% is fine gr, in matrix; 10% as phenocrysts or as replacement of plagioclase

plagioclase – 39%, phenocrysts

biotite – 5%; 3% is phenocryst-like grains, somewhat shreddy; 2% is f gr. in matrix and as inclusions in some phenocrysts

chlorite – tr.
apatite – tr.
calcite – tr.
anhyd sericite – 1%, altering feldspar.
anhydrite – 1%
magnetite – tr.

Textures

Phenocryst – matrix = 55-45; porphyritic texture well-developed. No certain evidence of alteration strength. Anhydrite suggests some later fluids. Orthoclase could just as easily be magmatic, particularly that which replaces certain plag. phenocrysts. Matrix biotite (fine-grained variety) origin is uncertain. Minor cataclastic fracturing.

Dark color of matrix is due to disseminated biotite.

Fluid inclusions are rare, secondary, gas-poor (almost absent.)

⊛ rock is a qmp regardless of earlier conventions re rock terminology

See Similar rock in Description AI-1:3261.

11/29/74 FTG

F. T. Graybeal 10/24/74

PETROGRAPHIC ANALYSIS

Section No. RW-54 (Ray West)

Rock Name
quartz latite porphyry

Megascopic description

variable light buff - light reddish brown, massive, possible weak foliation; 10% quartz, 20% feldspar, 10% biotite phenocrysts in f. gr. matrix; biotite is tabular - elongate and show weak alignment parallel to foliation Variable coloration throughout matrix; quartz is euhedral to angular, is biotite rarely bent around other phenocrysts?

Microscopic description

Minerals

quartz - 10%; med - coarse gr, subhedral - euhedral; rarely resorbed and angular.

K-feldspar - 5% (?), med-cgr, euhedral, 40% altered to calcite - sericite

plagioclase - 20%; med-cgr, euhedral, 30-60% altered to calcite - sericite - clay (?)

biotite - chlorite - sericite - 10%; euhedral, tabular - elongate former biotite phenocrysts mostly altered to chlorite - sericite but with some residual biotite characteristics.

calcite - 5%; altering feldspar phenocrysts

sericite - 10%; mostly altering feldspar phenocrysts

opaque - tr.

MATRIX - 40% very fine-grained, brownish colored - possibly qtz - kspar - sericite - clay

Textures

Clearly porphyritic, flow structure in thin section is vague

Broken phenocrysts and occasionally bent biotites suggest an ash flow tuff; however rock could easily be intrusive. There are no foreign inclusions, which might argue for intrusive origin — field criteria must be used.

Alteration of feldspars is typical of low temp., indecisive, autoalteration I've seen in other rocks of this type.

Rock classification is approximate as feldspar ratio is a rough estimate. Can't tell whether K-feldspar is orthoclase or sanidine.

Rock is surprisingly similar to what I would predict unaltered, near-surface samples of the quartz feldspar porphyry in Sunnyside area would look like.

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

November 8, 1974

TO: J. D. Sell

FROM: F. T. Graybeal

Petrography of samples from hole
DCA-3A; Superior East Project

Eight thin sections from hole DCA-3A were examined for evidence of hydrothermal alteration and other significant features. Data sheets for the individual samples are appended.

All samples between 4387 and 4780 were granite porphyry, the local term for this rock, although mineralogically it is actually a quartz monzonite. The porphyritic texture is quite variable in the different samples; however, no uniform variations were noted. Large phenocrysts of quartz and orthoclase and seriate phenocrysts of plagioclase are typical of all the samples.

The extent of hydrothermal alteration in these rocks is unclear. Kaolinite forms 10-30 percent of the rock, mostly as an alteration of plagioclase. Sericite is generally rare. The amount of hydrothermal orthoclase is unclear. Although an abundance of pink feldspar is seen in hand specimen, the majority appears to be magmatic in thin section. Sample 4662 contained orthoclase with an increased abundance of very fine-grained, particulate iron oxide inclusions, which I generally assume to be an indicator of hydrothermal feldspar. This sample also contained zones of shreddy biotite and traces of associated apatite. In hand specimen these biotitic zones look like light gray inclusions.

Fluid inclusions are generally rare, secondary, and type 1, rather typical of the Schultze as a whole. The exception was sample 4717 where fluid inclusions were common and occasionally of intermediate size.

The abundance of kaolinite and the general small amount of iron oxide suggest that this alteration may be hypogene. The presence of kaolinite in thin sections in A-2 and AI-1 within the sulfide zone support this suggestion. The near absence of introduced quartz, obvious hydrothermal orthoclase, and abundant fluid inclusions indicate that these rocks did not come from within a zone of potassic alteration. Alteration in the Pinal schist appears weak, although it may be somewhat concealed by later cataclastic deformation.

The granite porphyry at 4780 has suffered from strong cataclastic deformation which has apparently polished many slip surfaces causing the rock to look more altered than it actually is. The Pinal schist samples at 4874 and 4975 are both cataclastically deformed and contrast strongly in this regard with the basement schist samples in A-2 and AI-1. Calcite is always more abundant in the cataclastically deformed rocks.

A comparison of DCA-3A with A-2 and AI-1 is difficult due to rock type variations and cataclastic effects. The granite porphyry in DCA-3A is clearly less altered than granite porphyry in A-2. Pinal schist in DCA-3A is weakly pyritized, although it appears to contain no anhydrite, contrasting with the locally abundant anhydrite in AI-1. Such a variation might indicate weaker alteration in DCA-3A.

F. T. Graybeal

F. T. Graybeal

FTG:lb
Attachs.

cc: WLKurtz - w/o attachs.

PETROGRAPHIC ANALYSIS

Section No. DCA-3A : 4387

Rock Name
"granite" porphyry

Megascopic description
reddish-brown, fairly hard; probably a porphyritic granite with medium-coarse grained biotite-quartz-feldspar. Plagioclase (?) feldspar is bleached white and soft; rock does not otherwise look altered however nature of reddish color is unclear.

Microscopic description

Minerals
quartz - 20% 5% is med-cgr rounded and weakly resorbed phenocrysts with highly irregular rims, vaguely granophyric which may reflect later eutectic growth or corrosion; 15% is med-fine gr, dissem, blocky-equidimensional grains
orthoclase - 35% 10% euhed cgr. pheno to 1/2" long; 25% med-f gr, anhedral material in the matrix - some of which has moderate amount of translucent Fe-rich material
plagioclase - 10%; remnant of med. gr. euhedral phenocrysts, now altered to clay
biotite - 4%, med-cgr, subhedral
magnetite - 1%, disseminated
sericite - 5%; mostly altering plagioclase, dissem. in plag
kaolinite - 20%; fine gr, massive aggregates in cores of plagioclase (is it really kao or another type of clay?)
FeOx - 2%

Textures
Texture is porphyritic with phenocrysts of orthoclase - quartz - plagioclase. biotite (large-small) forming at least 60% of rock, matrix is 40% or less
Nature of clay alteration (hypogene-supergene) unclear.
Nature of matrix kspar also uncertain. Occasional Fe oxide inclusions and occurrence as thin overgrowths on some feldspars suggests late magmatic or hydrothermal origin
Feldspar ratios indicate rock is a qtz monz por — like the entire Schultze mass.

Fluid inclusions are rare, sec, type I.

10/24/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A:4460

Rock Name
granite porphyry

Megascopic description

massive, hard, light reddish-brown colored granite por with orthoclase phenocrysts to 1/2" long. Pinking may be magmatic or hydrothermal - it is weak, pervasive and no veins of it. Possibly trace of leached pyrite; white plagioclase feldspars are soft probably clay-sericite. Biotite is 5% - fresh.

Microscopic description

Minerals

quartz - 20% 5% med - cgr. rounded phenocrysts w. somewhat irregular, corroded-looking rims; 15% med - f. gr, squarish, equidimensional grains uniform. dissem. in matrix.

orthoclase - 40%; mostly med. gr. anhedral irregular grains in matrix, rare larger anhedral phenocryst-like grains; possibly 4-7% (?) H.40% contains abundant brownish translucent cmd and this orthoclase ~~occurs as mottles around clear orthoclase grains.~~

plagioclase - 20%; euhedral, med. gr. phenocrysts (or clase), partly alt. to ser-clay

biotite - 4%

magnetite - 1%

sericite - 5%; mostly f. gr. alt. of feldspars, tr. muscovite

calcite - tr

kaolinite - 9% massive f. gr. aggregates replacing cores of plagioclase.

Textures

Weakly porphyritic; texture very similar to #4387' but no large kspar pheno in thin section.

Nature of clay alt unclear. - presence in core of plag suggests hypogene?

The cmd-rich kspar may well be hydrothermal. Its presence may be compatible with the corroded-looking borders around the quartz phenocrysts.

Fluid inclusions extremely rare.

10/24/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A : 4662

Rock Name
"granite" porphyry

Megascopic description

grayish, massive, variably fractured granite with irregular vein-like zones of pink feldspar. Former plagioclase phenocrysts (?) are white and soft (clay alteration ?). Possibly 30-40% grayish inclusions of a medium grained igneous rock; 3-5% fresh biotite flakes in granite. Minor muscovite on some joints; very minor limonite on some fractures.

Microscopic description

Minerals

quartz – 20% 8% med-cgr, rounded phenocrysts; 12% f.gr., anhedral, blocky-equidimen. dissem. in matrix.

orthoclase – 50%; 5% in med-c.gr, irregular anhedral grains w. FeOx particle streaking; 45% med-f.gr., anhedral in matrix; one small zone of Kspar has abundant FeOx particles.

plagioclase – 5%; euhedral phenocrysts mostly altered to clay

biotite – 6%; 2% is med gr. flakes, 4% is f.gr uniform. dissem shreddy bio

magnetite – tr.

sericite – 3%; in feldspars

kaolinite(?) – 15%; fine gr, bulk replacement of cores of plagioclase (montmorillonite)

apatite – tr., assoc. w. shreddy biotite

calcite – tr

Textures

Variability and coarseness of textures (phenocrysts + inclusions ?) is too great to define accurately in a single thin section.

Part of rock is typical "granite" porphyry. In thin section it is unclear just where the boundaries of the vein-like kspar and shreddy biotite zones are — that is they aren't obvious inclusions.

In general the zones w. shreddy biotite also contain dissem. apatite, rare plagioclase (fresh + altered equiv.), no phenocrysts, and the kspar has more FeOx particulate cnd than is normal for matrix kspar in the Schultze. These zones 25-30% of this section may represent strong potassic alteration (described in hand spec. as inclusions of med.gr. gy ign. rk)

Possibly 50% of total kspar in rock is hydrothermal

Fluid incl rare, sec.; type 1 (one type 3, mica(?))

10/26/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A: 4693

Rock Name
"granite" porphyry

Megascopic description
whitish, massive, porphyritic granite w. 15% quartz + kspar phenocrysts, white 30% plagioclase phenocrysts are soft, probably alt. to clay; 5% biotite is fresh. Vein-like zones of pink feldspar (?) cut across rock. No pink in matrix; no pyrite or limonite

Microscopic description

Minerals
quartz - 15%; 5% in c.gr. rounded phenocrysts; 10% med.gr. anhedral matrix
orthoclase - 20%; mostly med.gr in matrix, partly clay-altered.
plagioclase - 25%; mostly med-coar, euhedral, well altered phenocrysts.
biotite - 5%; med.gr, subhedral, dissem.
magnetite - 1% f-med gr, dissem
sericite - 2%
kaolinite (?) - 30%; massive f.gr alteration of cores of plagioclase; irregular alt. of orthoclase; associated wispy mineral in plagioclase may be montmorillonite (??)
calcite - tr
apatite - tr

Textures
Porphyritic, but not strongly so due to medium-grained matrix.
Estimate originally 50% plagioclase, 25% orthoclase. Size range of plag. from med-coarse gr makes a phenocryst-matrix ratio a bit of a guessing game.
Rock is very fresh, compositionally a quartz monzonite like the rest of the Schultze.

Fluid inclusions rare, pr-sec, mostly type I; same are internal size.

10/26/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A: 4717

Rock Name
"granite" porphyry

Megascopic description

grayish-white granite porphyry w. 15% qtz-kspar phenocrysts; 30% white plag grains are clay altered; 5% biotite is fresh. Rock cut by a quartz vein with highly irregular pink clots along it which extend into adjacent rock and appear to convert all preexisting minerals to pink (hydrothermal kspar).

Microscopic description

Minerals

quartz - 25%; 10% c.gr rounded phenocrysts, 5% med.gr. elongate masses which define a vein, 10% med-f.gr, equant in matrix.

orthoclase - 40% 15% in a single phenocryst; 20% med.gr. irregular in matrix; ~~possibly~~ 5% adj to vein which <u>may</u> have additional FeOx material and could therefore be hydrothermal.

~~plagioclase - 15%; med-c.gr., subhedral altered phenocrysts.~~

biotite - 3%, weakly alt to sericite-muscovite

magnetite - tr.

sericite - 1%, in plagioclase

muscovite - 1, in plag

kaolinite - 13% altering plagioclase

Textures

Well-developed porphyritic texture. Potassic alteration is not evident. However although both the kspar phenocryst and the pink clots along the qtz vein are pink in hand spec. only the clots show the ultrafine FeOx particles in thin section.

Fluid inclusions are common; pri-sec, small-intermed

10/26/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A: 4780

Rock Name
crushed granite porphyry.

Megascopic description

whitish, granite porphyry with pink kspar, whitish plag euhedral feldspar phenocrysts (?); 5% dissem biotite. Rock looks to be pervasively altered to weak sericite. Numerous thin, irregular joints and shear planes suggest some cataclastic deformation.

Microscopic description

Minerals

quartz - 15%; generally badly broken - crushed; several aggregates where presence of former phenocrysts is indicated

orthoclase - 45%; fine - coarse grained both in highly broken masses (former phenocrysts) and dissem. throughout. Somewhat perthiti

plagioclase - 15%; generally med. gr, crushed.

biotite - 5%, med-f gr, bent

magnetite - tr

sericite - 5%

kaolinite - 10%, mostly as an alteration of plagioclase

calcite - 5%, mostly in veins and as a joint filling.

Textures

Strong cataclastic deformation of granite porphyry. Although igneous texture is still present, the extent to which the porphyritic texture developed is uncertain.

Alteration strength is considerably less in thin section than estimated from hand specimen. Possibly shiny surfaces thought to be sericite were polished slip surfaces.

Fluid inclusions rare

10/28/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A: 4874

Rock Name cataclasite – possibly mixed schist and potassic-altered gran. por.

Megascopic description

gray, massive; cut by numerous irregular joint-shear surfaces but rock is compact. Rock type uncertain and may be a mixture of schist and granite clasts themselves too badly crushed to permit recognition of original textures.

Microscopic description

Minerals

quartz – 40%; mostly med-f gr, occas. broken; larger knots of qtz grains may be rexl single grains

orthoclase – 20%; unclear, med-f gr in equigran. qtz-or-plag-bio clasts (?) similar to grayish zones in #4662. Appear preserved between zones of strong deformation.

plagioclase – 5%; med-f gr,

biotite – 10%; med-f gr dissem in qtz-or-plag-bio clasts and in intervening crushed zones.

calcite – 10%; mostly f gr, dissem. in crushed zones

magnetite – tr

apatite – tr, in qtz-or-plag-bio clasts.

fine-grained matrix – finely crushed material, probably mostly quartz

Textures

Cataclastically deformed rock with rather unbroken clasts of what may be the possibly strong potassic-altered material in DCA-3A: 4662. (note presence of apatite).

Abundance of quartz suggests that much of the cataclastically deformed matrix in the rock may be Pinal schist – unclear.

Presence of calcite appears typical of cataclastically deformed zones (see # DCA-3A: 4780)

10/28/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A: 4975

Rock Name
Pinal schist.

Megascopic description

med gray; massive but cut by numerous paper-thin shears - joints; looks like a crushed Pinal schist (?); 0.5 % dissem. py. Schist is very siliceous.

Microscopic description

Minerals

quartz - 50 %; fine to coarse gr, mostly angular, broken; grains very irregular shape - suggests recrystallization

orthoclase - 10%; partly altered to clay

biotite - 5%; med-f gr; in discontinuous, thin layers

muscovite - sericite - 5 %; med gr in distorted thin layers

hydromica (?) - 15 %; in massive, very fine gr aggregates

calcite - 3%

sulfide - opaque - 5%

crushed matrix - 7%; very fine-grained

Textures

Schistosity moderately preserved by layering of coarser and finer quartz with interlayered biotite and muscovite bands.

Rock has suffered moderate - strong cataclastic deformation which has not severely disturbed the foliation of the schist.

Fluid inclusions extremely rare

11/8/74

CM 5115

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

December 13, 1974

File Memorandum: Misc. 2F - Native Copper Ore Project

Subject: Test Work by Hazen Research

The following results of assays and metallurgical test work to date on this sample of native copper ore were reported to me by Mr. Pete Thomas of Hazen Research.

Total copper content of the ore determined by separate assaying of +10 mesh metallics and -10 mesh ore was found to be 1.13% Cu. The coarse metallics assayed 86.55% Cu and the minus 10 mesh ore assayed 0.92-0.96% Cu. Other assays of the minus 10 mesh were as follows:

Percent				
CaO	Fe	Tot.S	Sulf S	SiO_2
1.29	5.16	.05	.01	59.34

One flotation test was run on minus 10 mesh ore following a 12-minute grind. No size analysis of the tailings was made, but the flotation feed was described as being rather coarse.

A rougher copper concentrate was floated. The rougher tails were screened through 35-mesh, which took out coarse metallic copper in the tails. Results were as follows:

Product	Wt. %	% Cu	Cu Content	Cu Recovery
R. Flot. Conc.	8.7	6.40	.557	61.0
+35 Metallics	0.6	42.60	.256	28.0
(Combined Conc. Calculated)	(9.3)	(8.74)	(.813)	(89.0)
Final Tailing	90.7	0.11	.100	11.0
Calc. Head			0.913	100.0

I requested further flotation testing at a finer grind, say 70% minus 200-mesh, with two cleanings of the rougher concentrate and screening of coarse metallics from the flotation tails.

Also, jigging tests at 10-mesh with finer grinding of the jig tails followed by flotation will be tried.

T. D. Henderson Jr.

T. D. Henderson, Jr.

TDH:vh
cc: WLKurtz
DFCrowell

JBS → wlk

~~Misc. LE~~

Extra Copy

HAZEN RESEARCH, INC.

7511 SO. HOUGHTON RD.
POST OFFICE BOX 17928
TUCSON, ARIZONA 85731
TELEPHONE (602) 886-5545

T.D.H.

January 31, 1975

FEB 5 1975

MINERAL
JAN 3 1975
BENEFICIATION DEPT

Mr. Tom Henderson
American Smelting & Refining Company
P. O. Box 5747
Tucson, Arizona 85703

Re: HRI Project 2036

Dear Tom:

On November 5, 1974, Hazen Research, Inc. received from American Smelting & Refining Company three samples, weighing approximately 10.6 pounds each, to be tested for native copper recovery. Sample preparation and metallurgical testing was performed in the following manner.

SAMPLE PREPARATION

The three minus 3/4-inch samples, with ASARCO designations A-4C-29, A-4C-31, and A-4C-33, were logged in and blended together to form Hazen Research Sample HRI T-48 Composite. Sample preparation was performed as shown in Figure 1. Great care was taken in all sample preparation steps to insure representative samples.

ASSAYS AND SCREEN ANALYSES

Local assayers were given specific instructions for each sample that was analyzed. This was necessary because the samples could not be pulverized and blended using normal sample preparation techniques.

Head assaying was accomplished by screening and hand picking the coarse native copper during the 10-meshing phase of sample preparation. This coarse fraction, which represented 0.22% of the total sample, assayed 86.55% total copper. Four head samples labeled A through D were split from the minus 10-mesh portion. Head D was held for possible use at a later date. Head B was returned to ASARCO for emission spectrographic analysis. Heads A and C were analyzed individually using different techniques.

D. E. C.
FEB 3 1975

Figure 1

Project 2036 Flowsheet

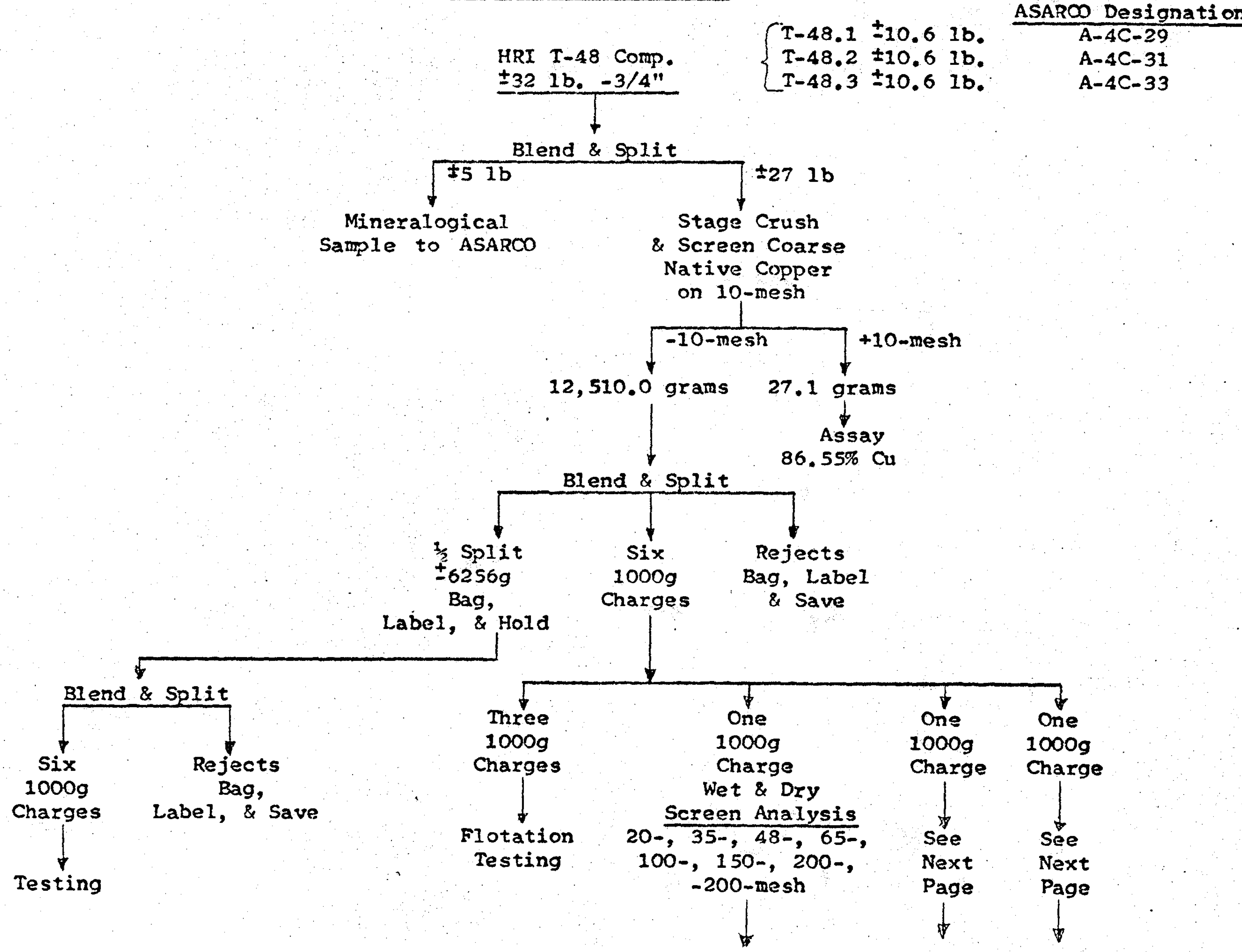
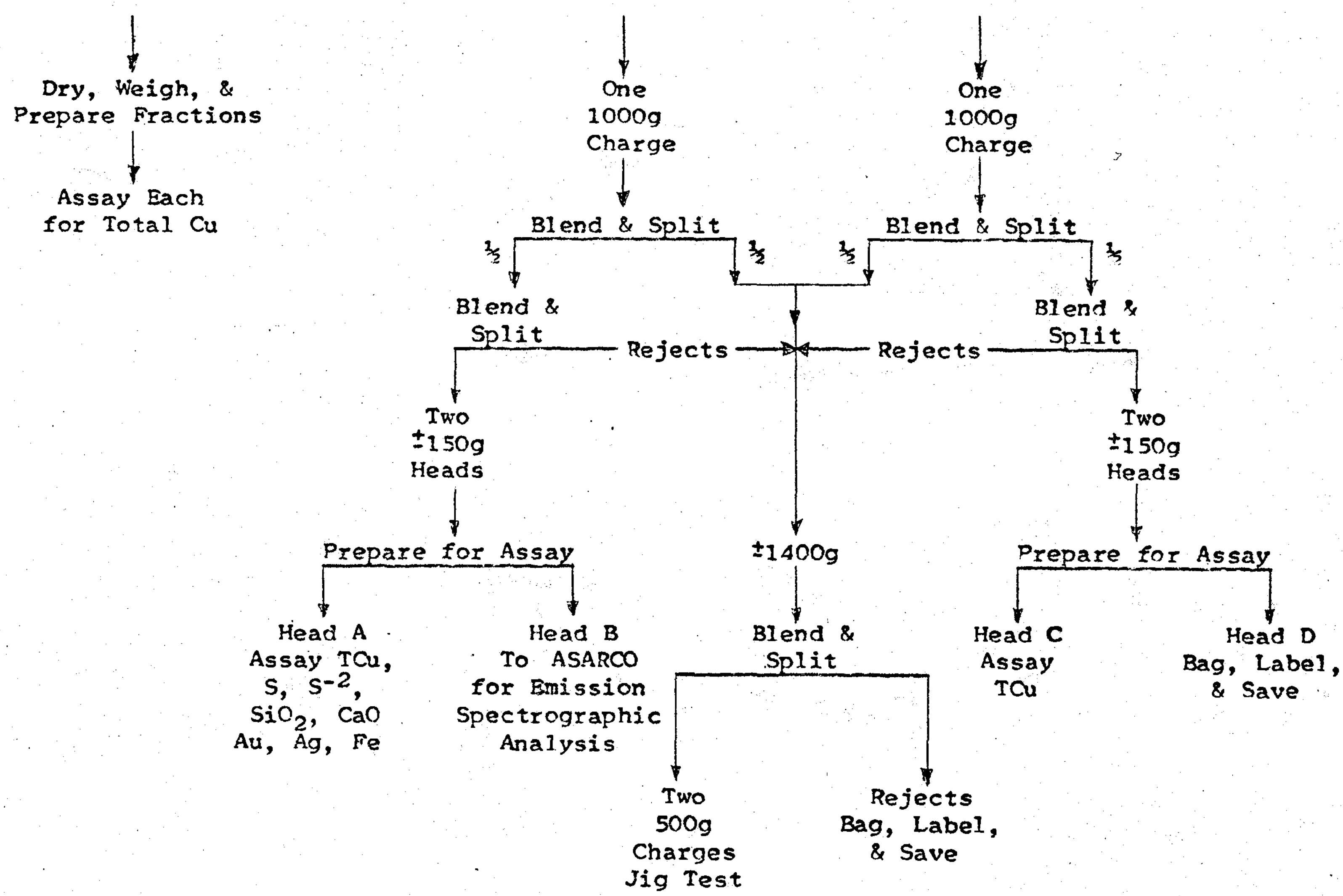


Figure 1
(continued)

Project 2036 Flowsheet



The minus 10-mesh Head A was ground by mortar and pestle and screened on 150-mesh. The entire plus 150-mesh fraction was digested and analyzed for total copper. Three 5.0-gram samples of the minus 150-mesh fraction were digested and analyzed individually for total copper. Analyses for other elements and compounds were performed on the minus 150-mesh fraction.

Head C was totally digested in eight separate digestions. Based on the weights and assays of the eight digestions, the percent total copper in Head C was calculated. The residues from the eight digestions were combined, filtered, and dried. The resulting residue was pulverized and then analyzed. No further copper was found.

Analyses indicated that the total ore assayed 1.13% total copper and that the minus 10-mesh fraction used for testing assayed 0.94% total copper.

An assay size analysis performed on the minus 10-mesh ore showed a fairly uniform copper analysis of approximately 0.8% copper in the coarse fractions. The calculated head from the assay size analysis of 0.74% copper deviates from the actual head assays by approximately 20%. This is most likely due to difficulties in assaying the coarse fractions of the size analysis.

Results of all head assays, including the assay size analysis, is included in Table 1.

MINERAL JIG TEST

from 0.94% Cu heads > Poor conc

A 500-gram charge of the minus 10-mesh ore was tested using a Denver Mineral Jig. Jigging produced a concentrate and bed assaying, respectively, 2.35 and 2.04% copper. Combined, these products represent a copper recovery of 77.6%. Low grades of the concentrate and bed were due to the presence of a heavy mineral of nearly the same size as that of the copper. Copper recoveries from this test ~~are tabulated in Table 2.~~

A portion of the gangue minerals associated with the bed and concentrate exhibited magnetic properties. These materials were given to ASARCO for further testing by magnetic means.

FLOTATION TESTING

A series of four flotation tests were conducted using 1000-gram charges of the minus 10-mesh ore. Three different grinds were tried and in Test 3 the ground pulp was deslimed by decantation prior to flotation. In all tests, the rougher tails were screened to accomplish coarse copper recovery.

Table 1

Head and Screen Analyses

Plus 10-mesh ore copper assays:

Split 1	86.50% Total Copper
Split 2	86.59% Total Copper
Average	86.55% Total Copper

Heads A and C
Minus 10-Mesh Ore

Fraction	Weight %	Assays Percent Total Cu	CaO	Total Fe	Total S	S^{-2}	SiO_2	Troy Oz/Ton Au	Ag
Head A									
+150m	0.43	84.16 .362 ↙ 38%							
-150m	99.57	0.60	1.29	5.16	.05	.01	59.34	.005	.020
	100.00	0.96							
Head C	100.00	0.92							

Total Head Assay (Calculated)

	Weight %	TCu		
+10-mesh	0.22	86.55	.190	16.8%
-10-mesh	99.78	0.94	.938	83.2%
Total Head	100.00	1.13	1.128	100.0

Assay Size Analysis

Mesh Size	Weight % Retained	% Total Cu
+ 20	35.8	0.80
+ 35	23.2	0.88
+ 48	7.6	0.92
+ 65	6.0	0.92
+100	4.4	0.80
+150	4.4	0.60
+200	2.4	0.58
-200	16.2	0.32
Calculated Head	100.0	0.74

% Cu Distribution

Table 2

Mineral Jig Test Results

	Weight %	Assay % Total Cu	% Distribution
Jig Concentrate	17.73	2.35	43.8
Jig Bed	15.76	2.04	33.8
Jig Tails	66.51	0.32	22.4

77.6

In Flotation Test 1, a 14-minute grind produced a slimey pulp containing a considerable amount of coarse material. Collectors, Minerec B, Aerofloat 208, and Cresylic Acid were used in conjunction with a frother containing 50 volume percent each of Dowfroth 250 and pine oil. An alkaline circuit of pH 10.4 was maintained with an addition of lime equivalent to one pound per ton of ore. Flotation Test 1 yielded the most promising results with an overall recovery of 89.1% of the total copper present. The rougher concentrate contained 60.4% of the copper at a grade of 6.40% copper. The plus 35-mesh fraction of the rougher tails contained 29.1% of the copper at a grade of 42.6% copper.

flot + screening of tails

Flotation Test 2 used the same basic reagent combination as Test 1. The grinding time in Test 2 was increased to 18 minutes. The 18 minute grind of Flotation Test 2 produced an extremely fine pulp. The rougher tails had the following size analysis.

Mesh Size	Weight %
+ 65	1.0
+100	2.6
+150	8.1
+200	16.3
-200	72.0

With this finer grind, flotation recovery dropped to 39.3% in the rougher. However, overall recovery at 88.5% remained about the same as Test 1 due to increased coarse copper recovery in the plus 65-mesh fraction of the rougher tails. If the plus 65-mesh fraction of the rougher tails was combined with the rougher concentrate, the resulting copper grade would be 4.77%.

Following an 18-minute grind, the pulp of Flotation Test 3 was deslimed by decantation prior to flotation. The 35.72 weight percent removed by desliming contained 12.6% of the copper. This loss coupled with poor flotation recovery gave only a 69.4% overall copper recovery in the rougher concentrate and the plus 65-mesh fraction of the rougher tails.

Flotation Test 4, which involved two cleaning stages, demonstrated that an acceptable final flotation product could be obtained. The second cleaner concentrate, which assayed 19.34% copper, contained 28.3% of the copper. The overall recovery of 86.6% in the rougher concentrate and the plus 65-mesh fraction of the rougher tails, is slightly lower than Tests 1 and 2. This can be attributed to the coarser 10 minute grind used in Test 4. Besides enhancing flotation recoveries, a finer grind would tend to upgrade the coarse copper in the plus 65-mesh fraction of the rougher tails as demonstrated in Flotation Test 1.

A size analysis of the rougher tailings indicates that the 10 minute grind of Test 4 produced a material that was approximately 16% plus 65-mesh.

Flotation recoveries from the 10-mesh ore are summarized in Table 3. Reagents and dosages can be found in the flotation data sheets which are included as attachments to this letter.

Copper recoveries from the original ore are shown in Table 4. For the four flotation tests these recoveries ranged from 74.3% to 91.2% of the copper. These recovery figures include the rougher concentrate, the plus screen fraction of the rougher tailings, and the coarse copper recovered on the 10-mesh screen from the original ore.

No.

Preliminary flotation testing of HRI T-48 Comp. indicates that reasonable recoveries and grades can be expected using flotation techniques coupled with a size separation of the rougher tailings. We feel that with further testing, acceptable grades in both the cleaner concentrate and the plus 65-mesh fraction of the rougher tailings can be achieved. A two-stage cleaning flotation test with a grinding time of 14 minutes could likely achieve the desired results.

We appreciate working with you on this project and hope we can continue to serve you in the future.

Sincerely yours,

Thomas A. Applegate

Thomas A. Applegate
Research Engineer

TA/js
Attachments

cc: D. Crowell
Golden

Table 3

Flotation Copper Recoveries
% Distribution of Copper

Test	First Cl Conc.	First Cl Tails	Ro Conc.	Oversize Screen[1/] Fraction of Ro Tails	Cumulative[2/] Recovery	Tails	Slimes
1	-	-	60.4	29.1 35 Mesh	89.5	10.8	-
2	28.1	11.2	39.3[3/]	49.2 65 "	88.5	11.5	-
3	-	-	16.7	52.7 65 "	69.4	18.0	12.6
4	29.2[3/]	1.5	30.7[3/]	55.9 65 "	86.6	13.4	-

1/ Test 1 - +35-mesh
   Test 2 - +65-mesh
   Test 3 - +65-mesh
   Test 4 - +65-mesh

2/ Ro Conc plus oversize screen fraction of ro tails

3/ Calculated

Table 4

Flotation Recoveries Based on Original Ore

Flotation Test	Copper[1/] Recovery, %	Copper[1/] Overall Conc. Grade % Copper
1	91.2	10.65
2	90.2	5.87
3	74.3	19.73
4	88.5	4.32

1/ Includes coarse copper from original ore, rougher concentrate, and the plus screen fraction from the rougher tails.

FLOTATION TEST NO. 1

ORE T-48 Comp (1000 g -10-mesh)

PROJ. NO. 2036

DATE 11/18/74

TEST CONDITIONS:

Operation	Test Conditions				Reagents-lbs/ton						
	Time Min	Solids %	pH	Temp °C	Minerec B	AF 208	Cresylic Acid	DF250/[1] Pine Oil	CaO		
Grinding	14	67	9.1	Amb.							
Rougher	8	±27	10.4	Amb.	.088	.136	.155	.117	1.0		
1/ 1:1 volume ratio											

OBJECT: Float native copper

COMMENTS: Reagents stage added at two minute intervals. Lime added at beginning of rougher. Poor froth until lime addition. Ro tails were wet screened on 35-mesh. Ro conc and ro tails (-35-mesh) filtered slowly due to slimes.

TEST RESULTS

Test Products	Weight Grams	Weight %	Assays-Percent Total Cu				Units	Distribution-Percent Cu				
Rougher conc	85.8	8.69	6.40				55.61	60.4	} 89.5			
Rougher tails (+35m)	6.2	.63	42.60				26.84	29.1				
Rougher tails (-35m)	895.2	90.68	0.11				9.97	10.8				
Calculated head	987.2	100.00	0.92				92.12	100.0				

FLOTATION TEST NO. 2 PROJ. NO. 2036
ORE T-48 Comp (1000 g -10-mesh) DATE 12/10/74

TEST CONDITIONS:

Operation	Test Conditions: Time Min	Solids %	pH	Temp °C	Reagents-lbs/ton: Minerec B	AF 208	Cresylic Acid	DF250/ Pine Oil	CaO		
Grinding	18	67	10.0	Amb	.030	.032	.031	.037	1.0		
Rougher	10	±27	8.4 1/	Amb	.030	.064	.047	.095			
First cleaner	5	±10	10.4		.015	.032	.039	.116	2.0		
1/ At end of rougher											

OBJECT: Float native copper

COMMENTS: Poor froth in cleaner. Ro tails wet screened on 65-mesh for coarse copper recovery. Wet and dry screen analysis of rougher tails.

TEST RESULTS

Test Products	Weight Grams	Weight %	Assays-Percent: Total Cu				Units	Distribution-Percent	Cu				
First cleaner conc	24.2	2.50	9.82				24.55		28.1				
First cleaner tail	124.3	12.83	0.76				9.75		11.2				
Ro tail (+65m)	8.3	.86	50.00				43.00		49.2				
Ro tail (-65m)	811.7	83.81	0.12				10.06		11.5				
Calculated head	968.5	100.00	.87				87.36		100.0				

FLOTATION TEST NO. 3

PROJ. NO. 2036

TEST CONDITIONS:

ORE T-48 Comp (1000 g -10-mesh)

DATE 12/11/74

Operation	Test Conditions				Reagents-lbs/ton						
	Time Min	Solids %	pH	Temp °C	Minerec B	AF 208	Cresylic Acid	DF250/ Pine Oil	CaO		
Grinding	18	67	8.2	Amb							
Rougher	8	±20	10.9	Amb	.030	.104	.031	.117	1.0		

OBJECT: Float native copper with desliming prior to rougher flotation.

COMMENTS: Four three-minute settling periods followed by slime decantation.
pH = 8.2 after desliming
pH = 10.9 after CaO addition
pH = 10.4 after four minutes of rougher

TEST RESULTS

Test Products	Weight Grams	Weight %	Assays-Percent					Units	Distribution-Percent					
			Total Cu							Cu				
Rougher conc	24.7	2.53	6.18					15.64		16.7				
Rougher tail (+65m)	14.7	1.51	32.70					49.38		52.7				
Rougher tail (-65m)	587.3	60.24	0.28					16.87		18.0				
Slimes	348.2	35.72	0.33					11.79		12.6				
Calculated head	974.9	100.0	0.94					93.68		100.0				

FLOTATION TEST NO. 4 | PROJ. NO. 2036

TEST CONDITIONS: | ORE T-48 Comp (1000g -10-mesh) | DATE 1/9/75

Operation	Test Conditions				Reagents-lbs/ton						
	Time Min	Solids %	pH	Temp °C	Minerec B	AF 208	Cresylic Acid	DF250/ Pine Oil	CaO		
Grinding	10	67	10.4	Amb	.030	.032	.031	.073	1.0		
Rougher	10	±27	10.4 1/	Amb	.075	.080	.045	.118			
First cleaner	6	±10	10.5	Amb	.030	.032	.023	.110 2/	0.1		
Second cleaner	5	± 5	10.2	Amb					0.1		

OBJECT: Float native copper.
Two cleaning stages.

COMMENTS: Screen ro tails at 20-, 28-, 35-, 48-, 65-, and 100-mesh and assay all fractions.

1/ pH 9.8 at end of rougher

2/ This large amount of frother most likely was not needed. Excellent froth formed when machine rpm's were increased to 1100.

TEST RESULTS

Test Products	Weight Grams	Weight %	Assays-Percent						Distribution-Percent					
			Total Cu					Units		Cu				
2nd Cleaner conc	15.2	1.55	19.34					29.977		28.3				
2nd Cleaner tail	22.2	2.26	.44					.994		0.9				
1st Cleaner tail	66.8	6.81	.23					1.566		1.5				
Rougher tail (+20m)	8.5	.87	21.52					18.722		17.8				
Rougher tail (+28m)	5.4	.55	23.42					12.881		12.2				
Rougher tail (+35m)	8.5	.87	10.25					8.918		8.5				
Rougher tail (+48m)	29.9	3.05	3.72					11.346		10.8				
Rougher tail (+65m)	89.2	9.09	.76					6.908		6.6				
Rougher tail (+100m)	114.3	11.65	.34					3.961		3.8				
Rougher tail (-100m)	621.1	63.30	.16					10.128		9.6				

hri 50-13

cm to JDS ✓

ASARCO

AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J. 07080

WILLIAM P. ROE
VICE PRESIDENT
VAL KUDRYK
MANAGER
H. E. HOWE
MANAGER, METALS RESEARCH

RECEIVED
MAR 31 1975
S. W. U. S. EXPL. DIV.

March 26, 1975
Re: 247

Mr. T. D. Henderson, Jr.
TUCSON

Native Copper Ore

Enclosed is a memorandum by Mr. R. B. Haagensen giving the results of his study of the native copper ore sample you sent to Central Research.

As you requested, a mineralogical examination has been conducted and a size-assay distribution (copper-copper oxide) of a sample crushed to minus 10 mesh has been obtained.

Edward Martinez

EM:rg
cc: DECrowell
RBHaagensen
VKudryk
WLKurtz ✓

AMERICAN SMELTING AND REFINING COMPANY

CENTRAL RESEARCH LABORATORIES

SOUTH PLAINFIELD, N. J. 07080

WILLIAM P. ROE
VICE PRESIDENT
VAL KUDRYK
MANAGER
H. E. HOWE
MANAGER, METALS RESEARCH

March 26, 1975
Re: 247

Mr. E. Martinez
B U I L D I N G

Native Copper Ore, MR-709
(#2036, HRIT-48 Composite, As Is)

A five pound sample of native copper ore sent from the Mineral Beneficiation Department at Tucson was received at Central Research (T. D. Henderson, Jr. letter to R. B. Haagensen, November 5, 1974). It was requested that the occurrence and size distribution of the copper mineralization be determined. An assay pulp sample of the same ore on which spectrographic analysis was requested was not received.

The sample was crushed to minus 10 mesh prior to screening and cyclosizing. Spectrographic, X-ray diffraction, infrared, thermal, Satmagan and specific gravity analyses were obtained on a representative portion of the sample. Analytical work was performed on the head sample as well as on the screened and cyclosized fractions. Microscopical examinations were conducted on selected size fractions to determine the occurrences of the copper mineralization.

The attached spectrographic results show major amounts of iron, silicon and aluminum. Following are the analytical results on the head sample:

Native Copper Ore Assays (MR-709)

	%		%
Total Cu	1.08	Zn	.087
Oxide Cu	.30	Pb	.010
Insol.	74.0	Mo	.005
Fe	7.0	Ag	<.0005 =<0.145 troy oz
S	0.12	Au	<.0001 =<0.029 troy oz.

Attached Table No. 1 gives the size assay data obtained on the sample. Approximately 92 percent of the total copper and 80 percent of the oxide copper are present in the plus 200 mesh sizes. The total copper assays generally decrease with particle size. Note that the copper in the minus 200 mesh fraction is mainly oxide copper.

Attached Table No. 2 gives the results of X-ray diffraction, infrared, thermal, Satmagan and specific gravity analyses. Phases identified include quartz, mica, hematite, probably kaolinite, probable goethite and possible chlorite.

Microscopical examination of selected sized fractions in polished section showed an abundance of essentially free metallic copper particles, particulary in the coarser screened fractions. These usually occurred in spherical to semi-spherical shapes and occasionally as elongated "flakes". The spherical copper particles occasionally exhibited layered separations which indicated that some of these particles may have been formed during crushing, as was probably the case with the copper "flakes". Both the spherical and flake shaped copper particles usually carried small amounts of cuprite on their surfaces.

Elemental copper, often in interfingered masses, was also found locked with gangue constituents in most of the fractions examined. Grain sizes of locked copper varied greatly (<5 to >300 microns). Small amounts of cuprite were sometimes associated with the locked copper particles. Counting the previously mentioned spherical and flake shaped copper particles as free, the following occurrences of elemental copper were noted:

Elemental Copper Occurrences

Size Fraction	% Free	% Locked with Gangue
-10+20 mesh	20	80
-20+28 "	90	10
-28+35 "	90	10
-35+48 "	95	5
-48+65 "	50	50
-65+100 "	50	50
-100+150 "	60	40
-150+200 "	85	15

Microscopical examinations of the ore showed cuprite to be the only identified oxide copper mineral. The bulk of the cuprite occurred locked with gangue. Small amounts of cuprite were associated with native copper and traces occurred free.

During the course of the microscopical studies, a considerable amount of hematite (sometimes associated with titanium mineralization) was noted in the ore.

R. B. Haagensen

RBH:rg

TABLE NO. 1

Native Copper Ore (MR-709)
Size-Assay Analysis

Total Sample Weight = 350.3 grams
Minus 200 mesh run on Cyclosizer

Size Fraction	% Wt.	Total Copper Assay	Total Copper % Distr.	Oxide Copper Assay	Oxide Copper % Distr.
-10+20 mesh	13.2	1.33	16.0	0.24	8.2
-20+28 "	14.0	2.01	25.6	0.43	15.4
-28+35 "	14.0	1.22	15.6	0.37	13.3
-35+48 "	11.6	1.24	13.1	0.41	12.3
-48+65 "	9.5	1.03	8.9	0.42	10.3
-65+100 "	6.6	0.96	5.7	0.51	8.7
-100+150 "	6.3	0.81	4.6	0.42	6.7
-150+200 "	4.3	0.64	2.4	0.43	4.6
Cone 1 ∿42 micron cut	3.3	1.00	3.0	0.86	7.2
Cone 2 ∿31 "	2.8	0.38	1.0	0.35	2.6
Cone 3 ∿22 "	3.1	0.40	1.1	0.37	2.8
Cone 4 ∿16 "	2.5	0.42	0.9	0.38	2.3
Cone 5 ∿11 "	1.7	0.43	0.6	0.33	1.5
Effluent ∿6 "	2.6	0.29	0.6	0.27	1.8
Decant <6 "	4.5	0.22	0.9	0.20	2.3
	100.0		100.0		100.0
Calculated Head		1.10		0.39	
Composite -200 mesh	20.5	0.45	8.1	0.40	20.5

TABLE NO. 2

Native Copper Ore (MR-709)
Instrumental Analyses

X-ray Diffraction:	Quartz, mica, hematite, weak chlorite and/or kaolinite.
Infrared:	Quartz, probable kaolinite.
Thermal:	Quartz, probable goethite, possible kaolinite.
Satmagan[1]:	0.25 percent Fe_3O_4.
Specific Gravity[2]:	2.77

(1) Saturation Magnetic Analyzer - a magnetic balance.

(2) Beckman Air Comparison Pycnometer, Model 930.

SPECTROGRAPHIC ANALYSES
AMERICAN SMELTING AND REFINING COMPANY
CENTRAL RESEARCH LABORATORIES
SOUTH PLAINFIELD, N. J.

NATIVE COPPER ORE

SAMPLE No.	MR-709
Fe	MC
Si	MC
Al	MC
Mg	LMC
Cu	LMC-
Ca	S
Na	S
Ba	S-
Sr	S-
Ti	S
As	L
Ni	M-
Zn	M-
Pb	M-
Sn	L+
Mn	L
Cr	L
Co	Tr
V	L
Ag	FTr
Be	Tr

CODE:

CMC - Chief Major Constituent
MC - Major Constituent
LMC - Low Major Constituent
S - Strong
M - Moderate
L - Low
Tr - Trace
F Tr - Faint Trace
V F Tr - Very Faint Trace
N.D. - Not Detected

Not Detected - B, P, Hg, Pt, W, Ge, In
Tl, Te, Sb, Au, Bi, Mo, Cd,

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

February 13, 1975

TO: J. D. Sell

FROM: F. T. Graybeal

Fluid inclusions in LB-4
Superior East Project

A brief study of 5 thin sections from 2600-4850 ft. revealed that:

1) Type 1 inclusions form less than 1 percent of all inclusions;

2) Type 2 and 3 inclusions are absent;

3) Secondary inclusions of a low temperature type (less than 70°C) are irregularly present.

These low temperature inclusions are locally very abundant and generally quite small.

Fluid inclusions are clearly more abundant in this hole than in any of ASARCO's holes farther to the west. These low temperature types might be expected along the outermost fringe of a porphyry copper deposit or as part of the regional background. The presence of similar inclusion populations within the exposed portions of the Schultze granite suggests the latter. I conclude that LB-4 is not within the alteration halo of a porphyry copper system.

F. T. Graybeal

F. T. Graybeal

FTG:lb

cc: WLKurtz

W. L. K.

FEB 1[illegible] 1975

cpy JDS

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

February 13, 1975

→ low temp inclusions often have a "spidery" shape,  ← (an ink-blot spider!) no gas bubble, and generally low relief (due to filling of entire inclusion with liquid), you didn't see any.

TO: J. D. Sell

FROM: F. T. Graybeal

Fluid inclusions in LB-4
Superior East Project

A brief study of 5 thin sections from 2600-4850 ft. revealed that:

1) Type 1 inclusions form less than 1 percent of all inclusions;

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F. T. Graybeal
F. T. Graybeal

FTG:lb

cc: WLKurtz ✓

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

April 25, 1975

MEMORANDUM FOR GEOLOGISTS

Please play the silence and secrecy game and do not put drill hole number and footage on samples you send for thin sectioning at Western Petrographic.

WLK/
W. L. Kurtz

WLK:lb

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

April 30, 1975

File Memorandum: Misc. 2F

Subject: Further Testing of Native Copper Ore (Proj. 2036)

Two flotation tests were run on this ore to check previous flotation tests by Hazen Research. Data sheets for these tests (Test Nos. NC-3 and NC-4) are attached.

The ore was ground to 55% passing 200-mesh and floated for 15 minutes. Test NC-3 used Aeropromoter 208 collector and a combination of pine oil, DF 250, and cresylic acid frothers. Test NC-4 used AP 208 and the same frothers with addition of sodium hydrosulfide and Z-6 to attempt to get a stronger float condition for the coarse metallic copper.

Both tests yielded about 50% recovery of the copper in rougher concentrates assaying 6.7-7.0% Cu.

As in previous flotation tests the low copper recovery was due to failure to float the coarse (+65 mesh) metallic copper even with long flotation times and large collector dosages. In both tests only about 25% of the copper in the +65 mesh size floated.

The rougher tailings and concentrates were screened and the fractions assayed separately. Table 1 in the attached supporting data gives total copper assays of the screen fractions and distributions of copper in the products.

The +48 and +65 mesh fractions of the rougher tailings were added into the rougher concentrates by calculation for Tests 3 and 4 respectively. These results are summarized in Table 2. Addition of the coarse metallic copper in these fractions to the rougher concentrate yields copper recoveries of 88-92% in combined concentrates assaying 7.0-9.5% Cu.

Further test work on this ore should investigate the feasibility of coarse grinding followed by separation of metallics either by screening through 48 mesh or tabling. The screen undersize or table tailings would then be ground finer and floated. Cleaner flotation concentrate combined with +48 mesh metallics would be the final copper concentrate.

Two leach tests were run on minus 10-mesh ore to determine the amenability of the native copper to leaching by ammoniacal ammonium carbonate and H_2SO_4 - ferric sulfate solutions.

Test NC-1 used a 20 gpl. ammonium carbonate - 50 gpl. NH_3 solution. Test NC-2 used 50 gpl. sulfuric acid and 15 gpl. ferric iron (added as ferric sulfate).

Both leaches were agitated on bottle rolls at 33% solids for approximately four days. The leach pulps were filtered and washed on the filter with 5%

ammonia or acid solution and fresh water.

Leach residues and combined leach and wash solutions were assayed for copper, and the heads calculated. Recoveries were figured on calculated heads.

The ammonia leach gave only 53% recovery. An assay size analysis of the leach tailings (see supporting data) showed 39% of the copper in the tails was present in the minus 200-mesh fraction (23 weight percent) indicating possible adsorption of some of the dissolved copper by slimes. However, the coarser sizes, 65 thru 200 mesh, also contained 0.35-0.38% Cu, which showed generally poor leach recoveries at all sizes.

The acid-ferric sulfate leach resulted in 92.3% copper recovery. Washing of the leach residue was minimal because the slimy nature of the residue made filtration very slow. Titration of the acid solution at the end of the leach showed an acid consumption of 37 lbs. H_2SO_4 per ton of ore.

Conclusions:

1. Flotation without removal of coarse metallics from the tails gave copper recovery of about 50%.

2. Removal of metallics from flotation tailing by screening increased recovery to 90% in combined rougher flotation concentrate and screen oversize.

3. Ammoniacal leaching (4 days at 10-mesh) yielded 53% recovery.

   Acid-ferric sulfate leaching under the same conditions gave 92% copper recovery.

Recommendations:

1. Further investigation should be done of flotation with separation of metallics between stages of grinding.

2. Leaching with lower concentrations of sulfuric acid with ferric sulfate might be feasible and should be tried.

T. D. Henderson, Jr.

T. D. Henderson, Jr.

vh
Attachment

cc: WLKurtz
DECrowell

TABLE 1

Assay Size Analyses of Rougher Flotation Concentrates and Tails

Test NC-3

Rougher Tails

Size	Wt. %	Assay % Cu	Distribution %
+ 35	1.2	29.5	65.9
+ 48	1.0	5.55	10.4
+ 65	4.0	.49	3.7
+100	10.7	.19	3.7
+150	14.4	.11	3.0
+200	14.1	.11	3.0
-200	54.6	.10	10.3
	100.0	.537	100.0

Rougher Concentrate

Size	Wt. %	Assay % Cu	Distribution %
+ 65	3.1	63.6	29.3
+100	1.8	36.4	9.7
-100	95.1	4.32	61.0
	100.0	6.74	100.0

Test NC-4

Rougher Tails

Size	Wt. %	Assay % Cu	Distribution %
+ 65	5.5	7.45	82.8
- 65	94.5	.09	17.2
	100.0	.495	100.0

Rougher Concentrate

Size	Wt. %	Assay % Cu	Distribution %
+ 65	3.2	55.2	25.1
- 65	96.8	5.44	74.9
	100.0	7.03	100.0

TABLE 2

Recoveries With and Without Adding Metallics from Tails

Test NC-3

Treatment	Product	Wt. %	Assay % Cu	Copper Recovery
Flotation Only	R. Conc.	6.96	6.74	48.4
	Tails	93.04	.54	51.6
		100.00	.969	100.0
Flotation + Screening Tails	R. Conc.	6.96	6.74	48.4
	+48 Tails	2.04	18.72	39.4
	Combined	9.00	9.46	87.8
	-48 Tails	91.00	.130	12.2
				100.0

Test NC-4

Treatment	Product	Wt. %	Assay % Cu	Copper Recovery
Flotation Only	R. Conc.	6.80	7.03	50.9
	Tails	93.20	.495	49.1
		100.00	.939	100.0
Flotation + Screening Tails	R. Conc.	6.80	7.03	50.9
	+65 Tails	5.13	7.45	40.7
	Combined	11.93	7.21	91.6
	-65 Tails	88.07	.09	8.4
		100.00	.939	100.0

TABLE 3

Assay Size Analyses of Leach Tailings

Test NC-1 (Ammoniacal Ammonium Carbonate Leach)

Size	Wt. %	Assay % Cu	Distribution %
+ 65	67.3	.35	52.3
+100	4.1	.38	3.5
+150	3.4	.37	2.9
+200	2.5	.36	2.0
-200	22.7	.78	39.3
		.45	100.0

Test NC-2 (H_2SO_4- Ferric Sulfate Leach)

Size	Wt. %	Assay % Cu	Distribution %
+ 65	51.9	.055	37.2
-65	48.1	.100	62.8
	100.0	.077	100.0

ASARCO

Southwestern Exploration Division

March 3, 1977

TO: F. T. Graybeal

FROM: J. D. Sell

Age Dates
Tuff in Whitetail
Superior East Project
Pinal County, Arizona

As a continued study and data gathering process I believe it would be of interest to have an age date on the biotite tuff which we have at the top of the mineral zone in A-4 and A-7.

I see that F. R. Koutz will have some age date material to submit and inquire whether several projects can be submitted for a lower cost per sample rate.

James D. Sell

James D. Sell

JDS:lb

OK'ed by FTG
March 3, 1977

ASARCO

Southwestern Exploration Division

July 20, 1977

TO: F. T. Graybeal

FROM: J. D. Sell

Beneficiation of Native Copper Ore
Arizona and Michigan
Superior East Project
Pinal County, Arizona

In 1975, Hazen Research, Inc. reported on their study of the Superior East native copper in conglomerate from hole A-4 (report to T. Henderson, HRI Project 2036, Jan. 31, 1975). The recent AIME Preprint No. 77-B-15 is a report on the concentration recovery scheme for the Michigan native copper in conglomerate problem.

Hazen's report did not go past the preliminary studies but they report the following recovery percentages and overall concentrate grade as follows (from Table 4 of Hazen):

TABLE 1 — Flotation Recoveries Based on Original Ore

Overall Conc. Grade % Cu	Percent Recovery	Test No.
19.7	74.3	3
10.7	91.2	1
5.87	90.2	2
4.32	88.5	4

As shown in the attached abstract of Preprint 77-B-15, the Michigan study produced an average grade of 55.5% copper with the recovery range of 86-93%. The feed average was 2.09% copper. The Asarco total feed head assay was 1.13% copper.

Using figures from the Centennial Ore of Michigan, the following comparison can be made.

TABLE 2 — Comparison of A-4 (ASARCO) & Centennial Ore (Michigan)

	Wt % Retained				% Copper			
	A-4		CO		A-4		CO	
+1/2"	--	0.2	1.0	30.6	--	0.19	0.02	0.60
+10 mesh	0.2		29.6		0.19		0.58	
+20 mesh	35.7	58.8		23.0	0.36	0.62		0.45
+35 mesh	23.1		23.0		0.26		0.45	
+48 mesh	7.6	18.0		0.0	0.09	0.20		0.00
+65 mesh	6.0				0.07			
+100 mesh	4.4		0.0		0.04		0.00	
+150 mesh	4.4	23.0	(-100 mesh)	46.4	0.03	0.12	(-100 mesh)	0.91
+200 mesh	2.4		46.4		0.02		0.91	
-200 mesh	16.2				0.07			
	100.0		100.0		1.13%		1.96%	

The Centennial Ore had a mill head slightly below that given in the abstract but must have given a similar grade and recovery figure.

The low concentrate grade was not fully explained by Hazen for the A-4 core. The good recovery and grade on the Michigan ore suggests that further tests are warranted.

Note that in Table 2, even though CO ore produced about the same percentage of the values in the coarse fraction as did the A-4 core, the CO core also had a high percentage (46.4%) and healthy grade (0.91%) in the -100 mesh fraction whereas A-4 was much lower.

The Michigan study points out the feasibility of an autogenous grinding-jigging-flotation circuit as a means of recovering a better grade and concentrate.

A copy of the Preprint is attached to the File Copy.

James D. Sell

James D. Sell

JDS:lb
Att.

SOCIETY OF MINING ENGINEERS of AIME

540 ARAPEEN DRIVE SALT LAKE CITY, UTAH 84108

PREPRINT NUMBER

77-B-15

AUTOGENOUS GRINDING AND CONCENTRATION OF A MICHIGAN NATIVE COPPER ORE

Constance F. Acton
Assistant Professor
Metallurgical Engineering
Michigan Technological University
Houghton, Michigan

For presentation at the 1977 AIME Annual Meeting
Atlanta, Georgia - March 6-10, 1977

AUTOGENOUS GRINDING AND CONCENTRATION OF A MICHIGAN NATIVE COPPER ORE

Dr. Constance F. Acton*
Assistant Professor
Metallurgical Engineering
Michigan Technological University
Houghton, Michigan 49931

Based on laboratory structure analyses, a pilot plant investigation was undertaken to evaluate a Michigan conglomerate native copper ore. Comminution of sized feed was accomplished using wet, closed circuit autogenous grinding with and without crushing of the recirculating load. Coarse metallics were concentrated in two stages of jigging with fine metallic copper being recovered in a three-stage xanthate flotation circuit. With a feed averaging 2.09 % Cu, copper recovery ranged from 86-93 % Cu with an average grade of 55.5 % Cu.

An evaluation of the processing flowsheet is made in terms of pertinent independent, dependent, and external variables and design factors. Rate equations are developed to describe the grinding and flotation circuits separately as well as the entire circuit as a whole. Performance equations for the overall operation and for the unit operation of autogenous grinding alone are developed in terms of suitable capacity, efficiency and energy consumption terms. Thus, the effects of feed rate, recirculating load and flowsheet design can be rationally evaluated. Energy consumption for various conditions in the pilot plant is compared to the laboratory value. Additionally, size and scale up factors are discussed.

Recommendations are made for further studies to be undertaken to further quantify the ore characteristics and the nature of the autogenous grinding operation. However, the feasibilty of beneficiation of this type of native copper ore by means of an autogenous grinding/jigging/flotation circuit is clearly established.

*Current Address: Olin Corp., Metals Research Laboratories, New Haven, Conn.

ASARCO

Exploration Department
Southwestern United States Division

February 23, 1978.

Dr. Val Kudryk, Manager
Central Research Department
ASARCO Incorporated
901 Oak Street Road
South Plainfield, New Jersey 07080

Dear Sir:

I attach one piece of core, Sample No.A-94493, from the Superior East project, Arizona.

I would appreciate a mineral identification of the submitted sample with special interest in the lighter grey component having an apparent cleavage.

Sincerely,

James D. Sell

James D. Sell.

JDS:jlh
attmt

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

ASARCO

Central Research Department
South Plainfield, N.J. 07080

March 10, 1978
Re: 3175

Mr. J. D. Sell
Southwestern United States Division
TUCSON OFFICE

Superior East Project, Arizona
Drill Core Fragment No. A-94493 (MR-1302)

A drill core fragment weighing approximately 16 grams was received at Central Research for mineral identification studies (J. D. Sell letter to Dr. V. Kudryk dated 2/26/78).

The main portion of the sample is composed of quartz with locally abundant muscovite mica. The gray mineral in question is chalcocite (Cu_2S).

A polished section showed some bornite (Cu_5FeS_4) to be intimately associated with the chalcocite. In addition, pyrite remnants were present within the chalcocite-bornite intergrowths.

R. B. Haagensen

R. B. Haagensen

RBH:rg
cc: EMartinez
VKudryk

Sample of "bladed" grey sulfide, thought possibly to be enargite.
Hole A-9, footage 4493

ASARCO Southwestern Exploration Division

JDS

May 31, 1978

TO: F. T. Graybeal

FROM: J. D. Sell

Thin-Sections
Hole B-6 (Newmont)
Superior East Project
Pinal County, Arizona

The thin-sections of Troy quartzite with possible chalcocite have finally been found at Western Petrographics. Three samples were submitted for sectioning with two (B-6-A and B-6-C) for polished thin sections. The packet had been placed to one side during the busy season last September and when they went out of the "polished" work late last year, the samples were relaywayed.

After much ado, they were found and completed as regular thin sections. The results suggest:

B-6-A	Minor pyrite.
B-6-B	Minor chalcocite among the quartz grains and along fractures.
B-6-C	Minor chalcocite as above with weak oxidation effects and minor cuprite formed around the boundary of the disseminated group of chalcocite particles.

See memo on Geochemical Results (October 4, 1977) and the original memo of September 22, 1977, for info on this hole.

James D. Sell

James D. Sell

JDS:jlh

ASARCO

Southwestern Exploration Division

March 11, 1980

TO: J. D. Sell

FROM: P. G. Vikre

Sulfide assemblages from
DDH A-8 and DDH A-9,
Superior East Project, Arizona

Opaque mineralogy in four polished sections from Superior East DDH A-8 and A-9 were optically examined. Other sections from these holes contained similar assemblages.

A-8-3978 consists of bornite-chalcopyrite intergrowths, pictured in Figure 1, with an unknown phase occurring in bornite. The unknown is light blue, moderately anisotropic, and harder than bn and cpy. It may be chalcocite or djurleite, but, if so, the hardness is anomalous.

A-8-4202 consists of pyrite-chalcocite intergrowths, with bornite occurring as inclusions in chalcocite (Figure 2).

A-8-4253 consists of bornite-chalcocite intergrowths (Figure 3). The unknown phase described under A-8-3978 above also occurs in both bornite and chalcocite. The darker blue phase along chalcocite-bornite grain boundaries is probably digenite.

A-9-4449 consists of pyrite-chalcocite intergrowths, with bornite inclusions in chalcocite (Figure 4). The assemblage is similar to that of A-8-4202.

Despite the tendency of phases in the Cu-Fe-S system to rapidly equilibrate with decreasing temperature, only one of the four assemblages, that in A-8-3978, is probably stable at 25°C (Craig and Scott, 1974). However, mineral compositions must be known in order to predict relative assemblage stabilities with accuracy. Complications in the Cu-Fe-S system below several hundred degrees centigrade suggest that at least parts of the assemblages pictured in Figures 1 through 4 were not initially precipitated. The original phases that formed at more than several hundred C° may have been pyrite, chalcopyrite or idaite, and bornite with variable Cu/Fe. Upon cooling, these copper phases recrystallized to the assemblage observed here.

P. Vikre

P. G. Vikre

PGV:jlh
attachments
c.c. F.T.Graybeal

Craig, J.R., and Scott, S.D., 1974, Sulfide phase equilibria, in Ribbe, P.H. (ed.), Sulfide Mineralogy, Mineralogical Society of America Short Course Notes, pp.CS-1 - CS-104.

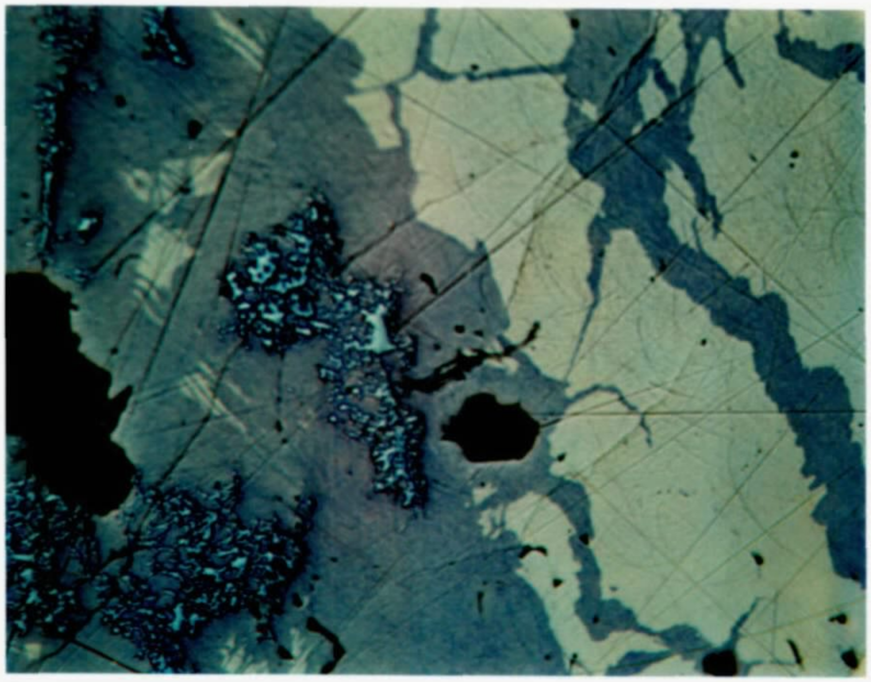

Figure 1 A-8-3978: bornite - lavender blue, chalcopyrite - light yellow, unknown - light blue. Width of image ≈ 665 μm

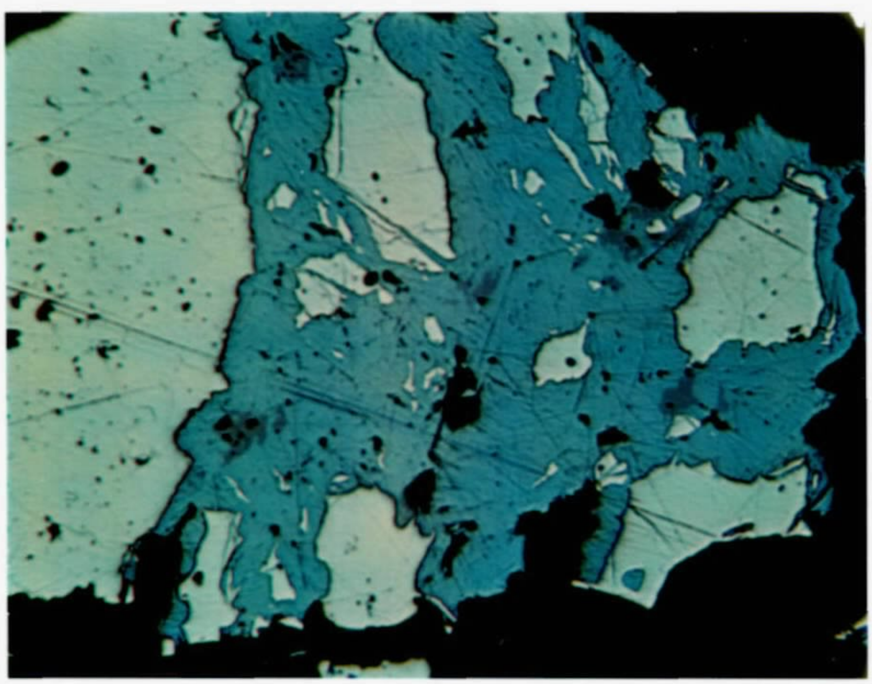

Figure 2 A-8-4202: pyrite - light yellow, chalcocite - blue, bornite - lavender. Width of image ≈ 665 μm

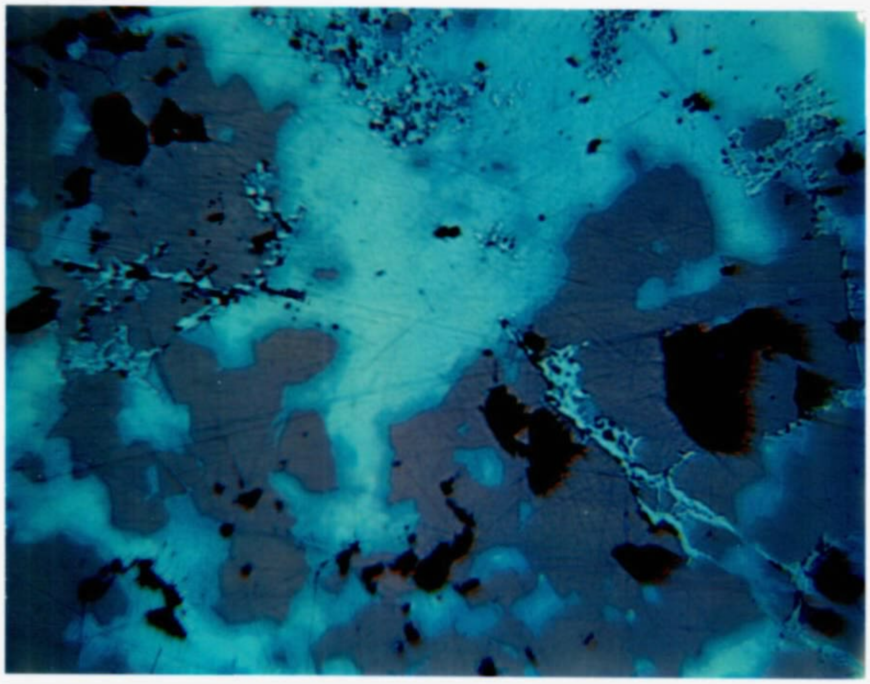

Figure 3 A-8-4253: bornite - lavender, chalcocite - blue, digenite - dark blue, unknown - light blue. Width of image ≈ 315 μm

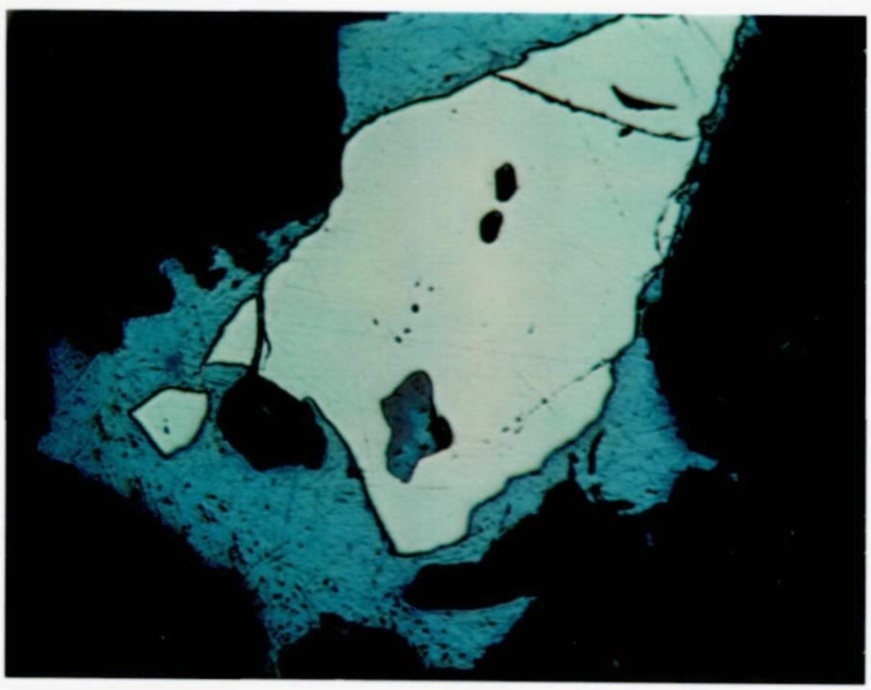

Figure 4 A-9-4449: pyrite - light yellow, chalcocite - blue, bornite - lavender. Width of image ≈ 665 μm