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ASARCO

Southwestern Exploration Division

JDS

December 29, 1986

F.T. Graybeal
Chief Geologist
New York Office

H.G. Kreis' Report
Alteration and Petrography
of Igneous Rocks
Superior East Project
Pinal County, AZ

The comprehensive report on the igneous petrography and alteration-mineralization features by Mr. Kreis is attached.

No additional target areas were noted in this study.

James D. Sell

James D. Sell

JDS:mek
Attachment

cc: W.L. Kurtz
H.G. Kreis

ASARCO

Southwestern Exploration Division

JDS

December 4, 1986

To: J.D. Sell

From: H.G. Kreis

Alteration and Petrography
of Igneous Rocks
Superior East Project
Pinal County, Arizona

Accompanying this memo is my report on the alteration and petrography of the Superior East igneous rock thin sections. As you know, this work was done as assessment work for the benefit of the Superior East unpatented mining claims.

H. G. Kreis

H. G. Kreis

HGK:mek
Att.

IGNEOUS ROCK
ALTERATION AND PETROGRAPHY

SUPERIOR EAST PROJECT
Pinal County, Arizona

ASARCO Incorporated
Henry G. Kreis
December 4, 1986

CONTENTS

	Page
Introduction	1
Summary and Conclusions	4
Rock Types	5
Granodiorite	5
Granodiorite Porphyry	7
Quartz Monzonite	8
Quartz Monzonite Porphyry	8
Fine-grained Granite	11
Quartz-Feldspar Porphyry	11
Rock Type Comparisons	14
Alteration	16
Kaolinite Alteration	16
Sericite Alteration	19
Biotite-Orthoclase Alteration	20
Drill Hole Remarks	21
A-2 and A-2W	21
A-4	22
A-8	22
A-9	22
A-10	23
A-12 and A-12A	24
AI-1	25
DCA-2A	25
DCA-3A	25
LB-4	26

FIGURES

Figure		Page
1	Drill Hole and Land Status Map	2
2.	Thin Section Status Map	3
3.	Granodiorite and Granodiorite Porphyry Distribution	6
4.	Quartz Monzonite and Quartz Monzonite Porphyry Distribution	9
5.	Fine-Grained Granite Distribution	12
6.	Quartz-Feldspar Porphyry Distribution	13
7.	Alteration Map	17

TABLES

Table		Page
1.	Granodiorite Mineral Composition	5
2.	Granodiorite Porphyry Mineral Composition	7
3.	Granodiorite Porphyry Texture and Mineral Distribution	7
4.	Quartz Monzonite Composition	8
5.	Quartz Monzonite Porphyry Composition	10
6.	Quartz Monzonite Porphyry Texture and Mineral Distribution	10
7.	Fine-Grained Granite Composition	11
8.	Quartz-Feldspar Porphyry Texture and Phenocryst Composition	14
9.	Textural - Compositional Continuum	14
10.	Textural Comparisons	15
11.	Comparison of Phenocryst Sized Grains	15
12.	Comparison of Groundmass Sized Grains	15
13.	Whole Rock Mineral Composition Comparison	15
14.	Compilation of Alteration in Igneous Rocks	18
15.	Alteration of Igneous Rocks in A-12	16
16.	Sericite Selvage Alteration	19

APPENDIX

Appendix

I. Thin section descriptions by H.G.K. (1986)

II. G.J.S. memo on petrography of M-1A and A-4 (1-20-1972)

F.T.G. memo on alteration in A-1 and A-2 (6-17-1974)

F.T.G. memo on petrography of DCA-3A (11-8-1974)

F.T.G. notes on A-8 and A-9

G.J.S. memo on petrography X-14 and Z-1 to -4 (5-5-1972)

F.T.G. memo on fluid inclusions in LB-4 (2-13-1975)

Western Petrographic descriptions of LB-4 (circa 1974-1975)

III. J.D.S. list of reports on petrography, age dates, and metallurgy

J.D.S. list of thin section collection

IV. J.D.S. memo to H.G.K. requesting thin section study (2-26-1986)

TAB

INTRODUCTION

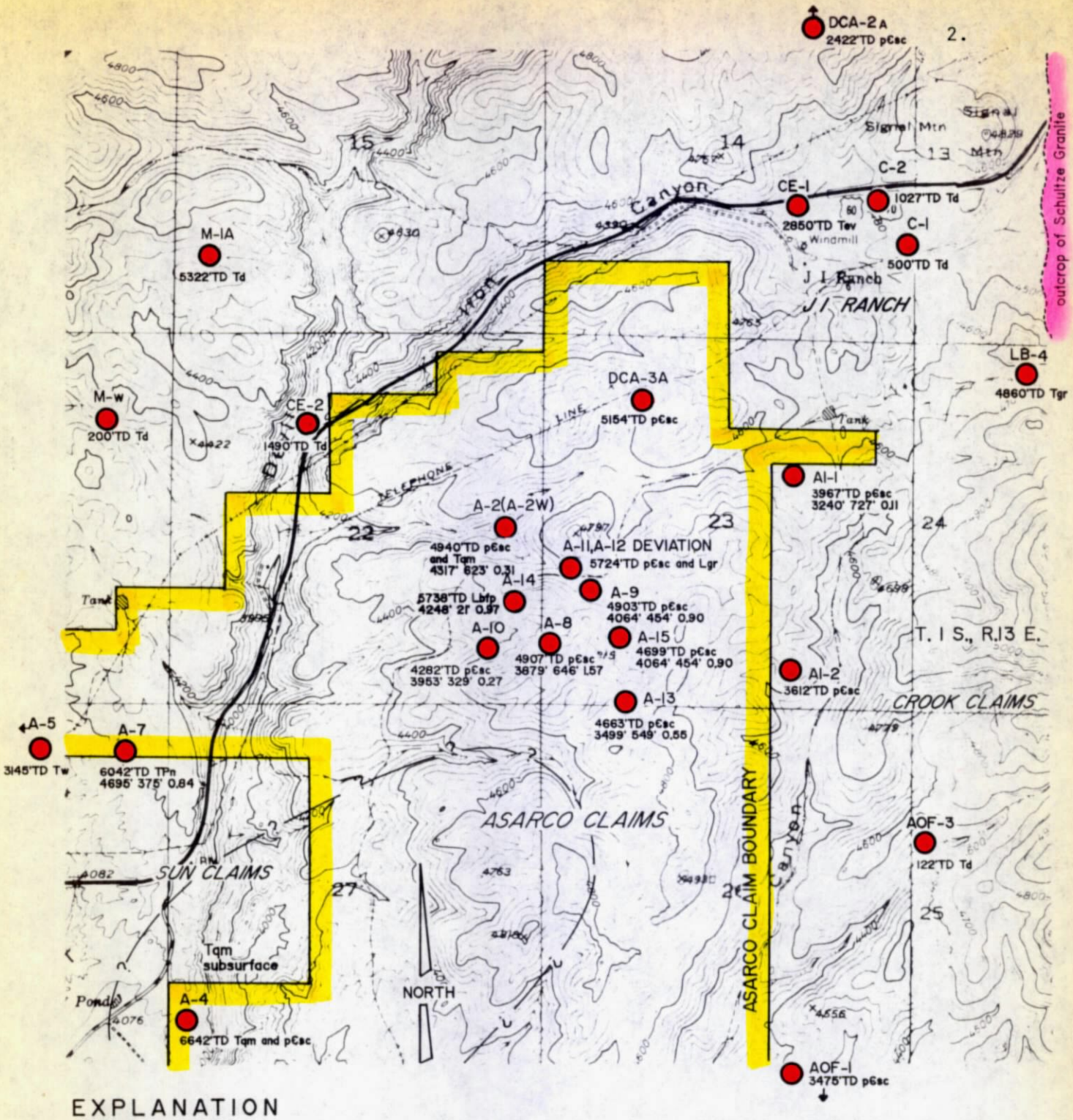
INTRODUCTION

This report examines the Superior East thin sections of igneous rocks. It was done at the request of J.D. Sell (memo in Appendix IV). The igneous rock thin sections are from the drill holes in and about the claim group shown in Figure 1. The locations of the thin sections evaluated in this report and the availability of Pinal Schist thin sections for future work are shown in Figure 2. Most of the thin sections were taken in the area of copper mineralization, a 2000' diameter area centered on A-14. Only a few of the thin sections are off the claim group, but the data gained from these sections is important to the evaluation of the geology within the claim group.

This report concentrates on the igneous rock petrography and alteration. The texture and modal composition of each thin section were determined, and this information became the basis for describing and categorizing the igneous rock types. The alteration of each rock forming mineral in each thin section was recorded; and, likewise, the alteration was described and categorized. The rock type and alteration categories are described in the following sections of this report, and remarks on the igneous rock types and alteration encountered in each drill hole are made in the last section of this report. The reports on the individual thin sections of this evaluation are in Appendix I, and reports by others are in Appendix II.

An evaluation of the sulfide mineralization and zoning patterns was not attempted using the petrographic microscope. Such a study can only be done by logging the core and taking selected samples at the time of logging. These samples would then be evaluated with a reflecting microscope and the results used to supplement the logging data. This is a study that should be done. Coupled with structural logging, the sulfide logging will give a far better understanding of the copper mineralization than any other type of evaluation.

Fluid inclusions of the igneous rocks were not examined at this time. Earlier work, present in Appendix II, found the fluid inclusions in A-2 (0.5% Cu) to be 99% two-phase inclusions (water with 10% to 40% gas). Thin sections from a couple of outlying drill holes showed rare, small fluid inclusions. A fluid inclusion evaluation would get the best results using the Precambrian schist thin sections and the heating-cooling stage at the Reno office.



EXPLANATION

- Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)
- Post mineral cover
- Premineral Schultze Granite

FIGURE 1

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DRILL HOLE AND LAND STATUS

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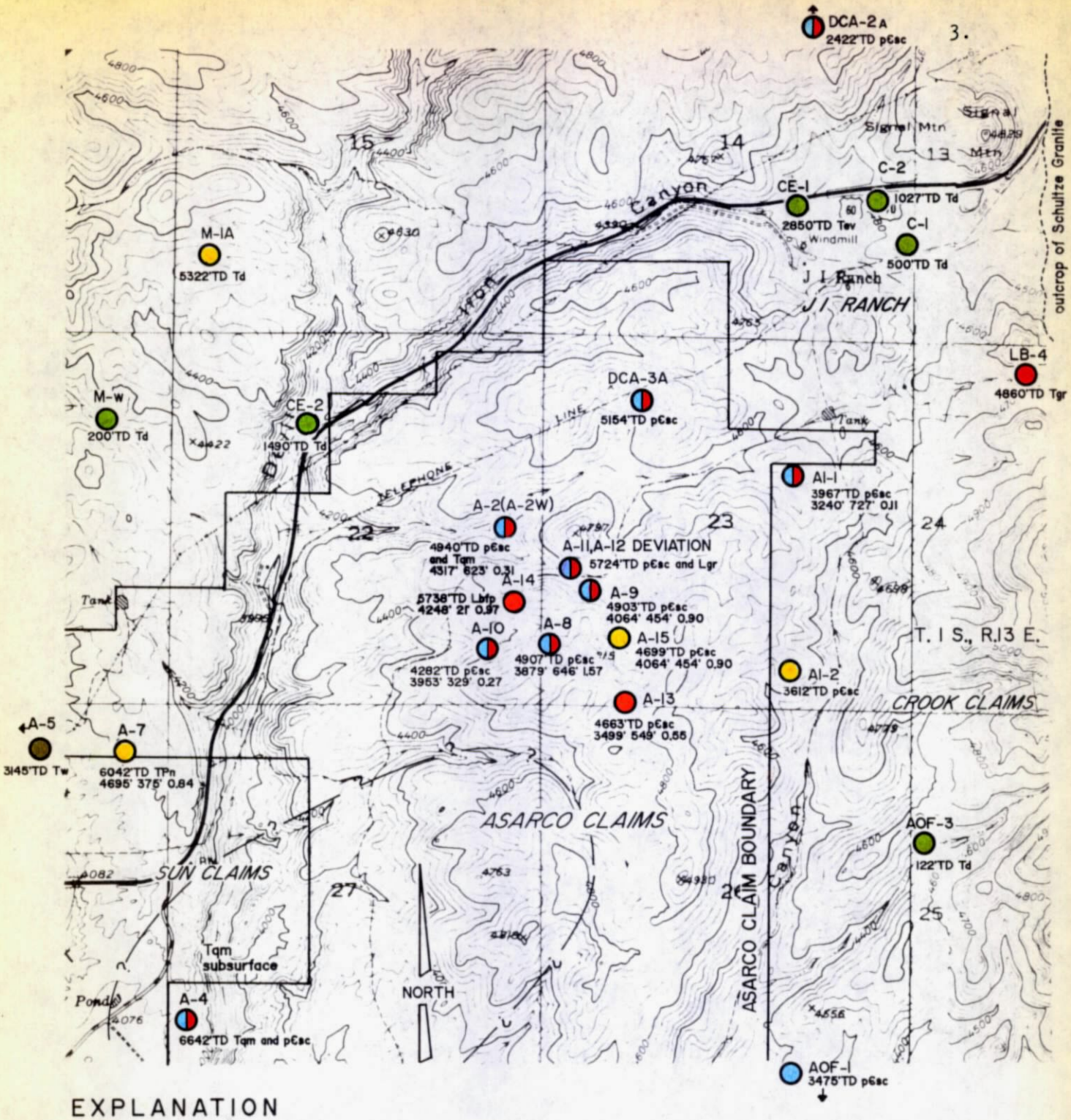

EXPLANATION

- Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)
- Premineral igneous rock thin sections evaluated in this report.
- Pinal Schist thin sections available
- No thin petrographic thin sections; only doubly polished sections for temperature studies.
- No thin sections of premineral igneous rocks or Pinal Schist.
- Hole bottomed in post mineral cover.

FIGURE 2

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THIN SECTION STATUS

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TAB

Summary + Conclusion

SUMMARY AND CONCLUSIONS

The mineral composition and texture of each igneous rock thin section was described, and the descriptions were used to classify the igneous rocks. The igneous rock types are: granodiorite, granodiorite porphyry, quartz monzonite, quartz monzonite porphyry, fine-grained granite, and quartz-feldspar porphyry. The thin section evidence suggests quartz-feldspar porphyry is the oldest igneous rock type, and there is a textural and compositional continuum from granodiorite (older) to granodiorite porphyry to quartz monzonite porphyry to fine-grained granite (younger).

The granodiorite in the Schultze Granite stock, and its texture and composition are very similar to the granodiorite Sacaton Peak and Mineral Mountain stocks (Casa Grande to Florence). The granodiorite porphyry is a porphyritic phase of the granodiorite, and it is not clear if the drill hole intercepts of granodiorite porphyry represent a contact phase of the stock or dikes from the stock. The quartz monzonite porphyry and fine-grained granite are common dike rocks, and they occur in the drill holes where there is strong copper mineralization. Quartz-feldspar porphyry dikes are not common, and they occur in only three drill holes.

Three types of alteration were observed in the igneous rock thin sections. In decreasing order of abundance in igneous rocks, they are kaolinite alteration, sericite alteration, and biotite-orthoclase alteration. Kaolinite alteration and sericite alteration were observed in all the igneous rock types. Biotite-orthoclase alteration occurs only in the quartz-feldspar porphyry. The kaolinite alteration is a pervasive form of alteration while the sericite alteration is confined to vein selvages. Stronger kaolinite alteration is associated with higher copper grades (Table 15). The same is probably true with sericite alteration, but it would take detailed core logging rather than a thin section examination to evaluate and utilize this relationship.

This evaluation of the igneous rock types and their alteration should be an integral part of any evaluation of the Superior East copper deposit. However, a detailed evaluation of the sulfide mineralization utilizing core logging and ore microscopy would be the most valuable tool for exploring the Superior East copper deposit. An evaluation of the alteration in the schist and an evaluation of the fluid inclusions would also be helpful. When most of these evaluations have been done, the results should be plotted on 1"=200' scale cross sections and interpreted. The resulting interpretation should improve the success of future drilling.

TAB

Rock Types

ROCK TYPES

As previously mentioned the following igneous rock type classification was derived on the basis of textural observation and modal analyses (eye estimates) from thin sections. The rock types are granodiorite (Schultze Granite), granodiorite porphyry, quartz monzonite, quartz monzonite porphyry, fine-grained granite, and quartz-feldspar porphyry. All of these igneous rocks are premineral in age and intrude the Precambrian Pinal Schist. None of the igneous rock thin sections appeared to be post mineral in age, and no thin sections of diabase were encountered. Not all of the igneous rock intercepts had thin sections made from them; so there could be a rock type classification or two that has yet to be identified.

Granodiorite

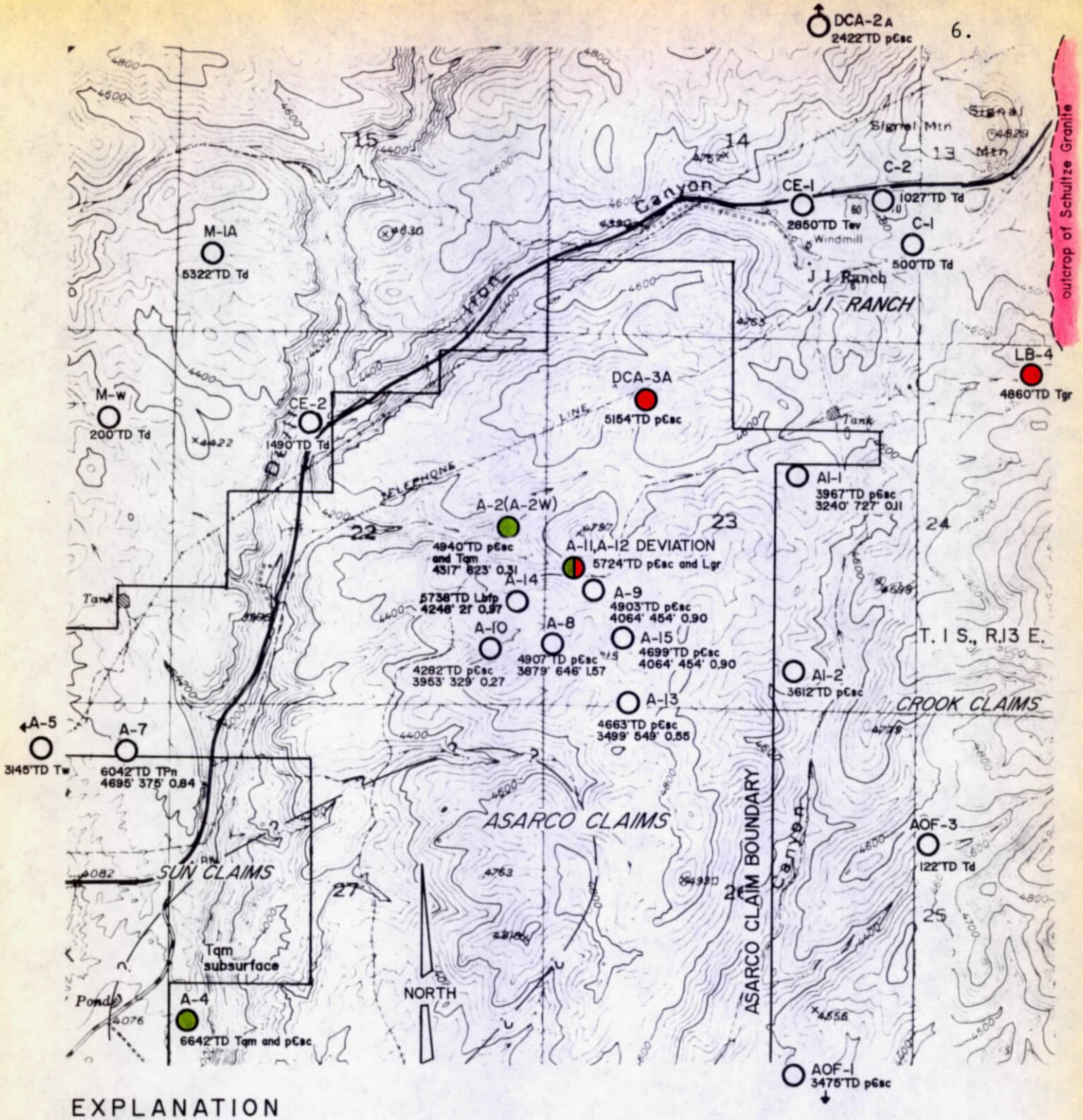
Granodiorite occurs in three drill holes: DCA-3A, LB-4, and A-12 (see map, Figure 3). The granodiorite in drill hole LB-4 is that of the Schultze Granite stock. The granodiorite in drill holes DCA-3A and A-12 are probably fault blocks off the outer edges of the stock.

The mineral composition (mode) of the granodiorite is: 4% biotite, 56% plagioclase, 19% orthoclase, and 21% quartz. The mineral composition of the individual thin sections is summarized in Table 1. As a double check, a 116-point count was done on LB-4, 3410'; and the results were: 3% biotite, 48% plagioclase, 16% orthoclase, and 33% quartz. The point count confirmed the granodiorite composition of the rock, and suggested eye estimates of the quartz content may be on the low side.

Table 1. Granodiorite Mineral Composition

Hole	Depth	Composition (% of rock)				Grain Size (mm)
		Biotite	Plag.	Ortho.	Qtz.	
DCA-3A	4747'	5	55	≤15	25	1-3
LB-4	2600'	3	55	20	20	1-3
	3410	3	56	15	26	1-3
	4850	3	57	20	18	1-3
A-12	5551	5	55	20	20	1-5
	5623	5	55	25	15	1-3
	Average	4	56	19	21	1-3

The texture of the granodiorite is hypidiomorphic granular. The grain size is fine to medium, 1 to 3mm, with little variation from section to section. The plagioclase grains are typically euhedral to subhedral. The orthoclase varies from being totally interstitial to part phenocrystal (poikiloblastic) and part interstitial. Quartz is interstitial with local



EXPLANATION

- Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)
- Granodiorite (Schultze Granite)
- Granodiorite porphyry

FIGURE 3

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GRANODIORITE and GRANODIORITE PORPHYRY DISTRIBUTION

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minor phenocryst-like grains. The texture of DCA-3A, 4747', is interesting because it varies from hypidiomorphic-granular to the initial stages of porphyritic development (up to 10% fine-grained quartz-orthoclase groundmass). Conceivably, this initial stage of porphyritic development suggests the possibility of a suite of granodiorite textures that would be gradational into granodiorite porphyry.

The texture and composition of the granodiorite (Schultze Granite) is very similar to that in the granodiorite of the Poston Butte and Florence Pediment drill holes (Sacaton Peak Granite and Mineral Mountain Stock). The granodiorite at Poston Butte and Florence Pediment is composed of 9% biotite, 0-2% hornblende, 52% plagioclase, 15% K-feldspar, and 23% quartz.

Granodiorite Porphyry

Granodiorite porphyry is present in DCA-~~2~~3A, A-2W, A-4, and A-12 (see map, Figure 3). The granodiorite porphyry has a mineral composition of 6% biotite, 59% plagioclase, 16% orthoclase, and 19% quartz. The mineral composition of the individual thin sections is summarized in Table 2.

Table 2. Granodiorite Porphyry Mineral Composition

Hole	Depth	Composition (% of rock) Biotite	Plag.	Ortho.	Qtz.
DCA-2A	1547'	6	64	12	18
A-2W	4910'	8	52	20	20
A-4	6612,6656, 6657'	8	58	15	18
A-12	5417'	4	60	16	20
	Average	6	59	16	19

The texture of the granodiorite porphyry is obviously porphyritic with 76% phenocrysts, typically 1 to 4 mm in size, and 24% fine-grained, aplitic groundmass, 0.2 mm in size. The texture of the granodiorite porphyry and the distribution of the minerals in the porphyry texture are shown in Table 3. A characteristic of the porphyry is a high percentage of plagioclase phenocrysts, 1 to 4 mm size, comprising 55 to 60% of the rock.

Table 3. Granodiorite Porphyry Texture and Mineral Distribution

	Grain Size (mm)		Phenocrysts					Groundmass				
Hole*	Pheno.	Gm.	% Rock	Plag. (% Pheno)	Quartz (% Pheno)	Ortho. (% Pheno)	Bio. (% Pheno)	% Rock	Plag. (% Gm)	Quartz (% Gm)	Ortho. (% Gm)	Bio. (% Gm)
DCA-2A	2-6	.1	80	80	10	5	5	20	0	50	40	10?
A-2W	1-4	.2	75	65	15	10	10	25	10	35	55	?
A-4	1-3	.3	70	83	10	0	7	30	0	35	55	10
A-12	1-4	.1	80	75	15	5	5	20	-	40	60	0
Average	1-4	.2	76	76	12	5	7	24	3	40	52	5

*See Table 2 for depths of thin sections.

The granodiorite porphyry has the same mineral composition as the granodiorite (compare Table 2 with Table 1). Likewise, the size of the phenocrysts in the granodiorite porphyry is the same as the grain size of the granodiorite. For these two reasons, it is apparent that the granodiorite porphyry is simply a textured variation of the granodiorite.

However, it is not clear if the granodiorite porphyry is a contact phase of the granodiorite Schultze Granite stock or dikes from the stock or both. The granodiorite porphyry intercept in DCA-2A, 1540' to 1620', is bounded by faults. The granodiorite porphyry in A-2W, 4910' to 4940' T.D., is open at depth. Likewise, the granodiorite porphyry in A-4, 6610' to 6664' T.D., is open at depth. In A-12 the granodiorite porphyry in the 5417' thin section apparently grades into the granodiorite of thin sections 5486', 5551', and 5623'; and the hole bottoms in granodiorite at 5724'.

Quartz Monzonite

Quartz monzonite is present in three drill holes: DCA-3A, A-2, and A-12 as shown in Figure 4. The quartz monzonite's mineral composition is listed in Table 4. I am not sure this quartz monzonite classification actually exists. This classification may exist simply because of errors inherent in making eye estimations (particularly so in sections not stained for K-feldspar such as DCA-3A and A-2), or it may exist because they are plagioclase rich members of the fine-grained granite classification (to be described).

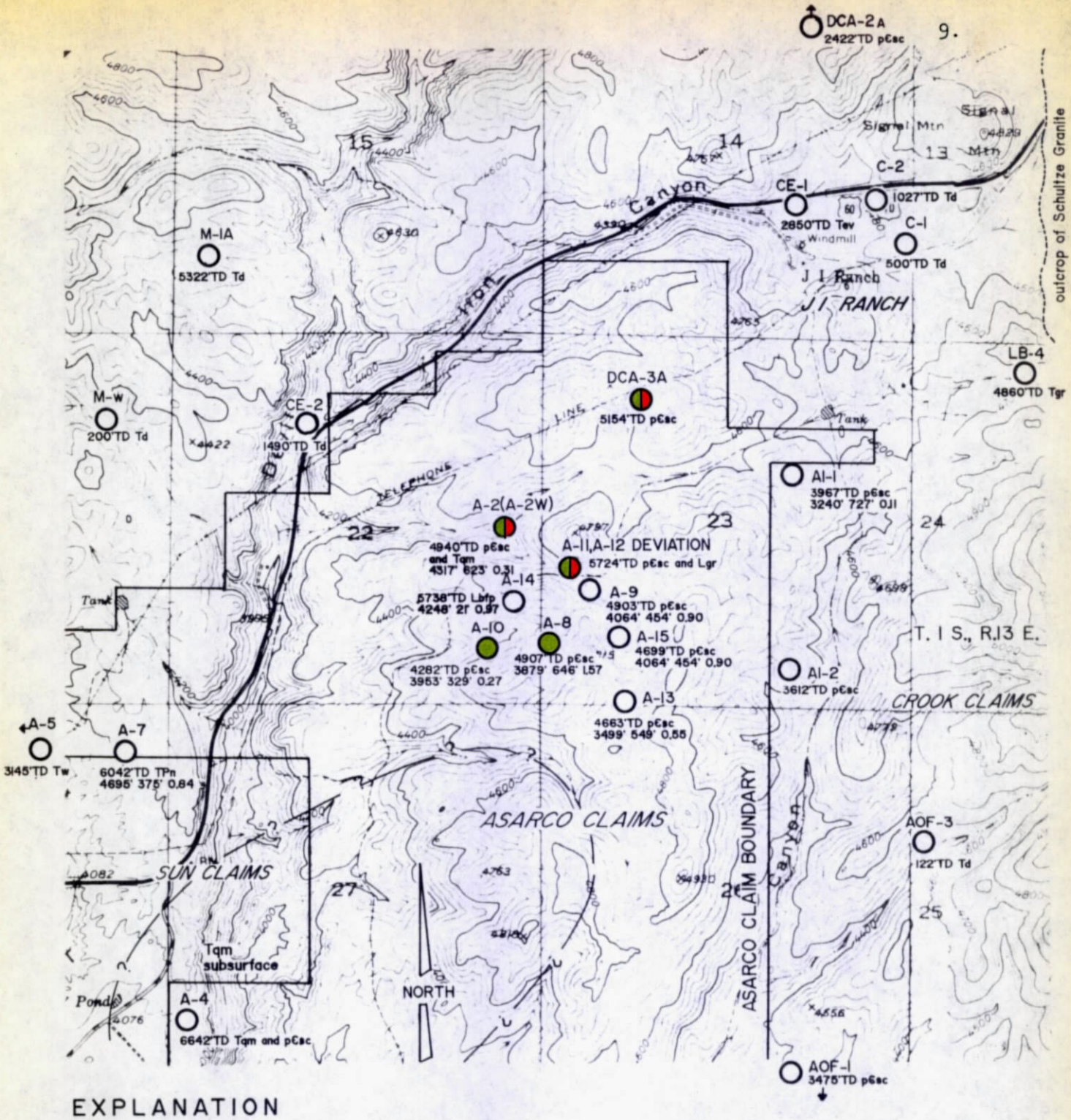
Table 4. Quartz Monzonite Composition

Hole	Depth	Composition (% of rock) Biotite	Plag.	Ortho.	Qtz.	Grain Size (mm)
DCA-3A	4512'	5	30	40	25	.2-1
A-2	4394'	3	32	35	30	.2-.4
A-12	5368'	3	28	34	35	.5-1
	Average	4	30	36	30	.2-1

The texture of the quartz monzonite is fine-grained hypidiomorphic granular. The typical grain size is 0.2 to 1 mm.

Quartz Monzonite Porphyry

Quartz monzonite porphyry is a common dike rock type. It's mineral composition is 5% biotite, 38% plagioclase, 32% orthoclase, and 25% quartz. The mineral composition of the individual thin sections is shown in Table 5.



EXPLANATION

- Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)
- Quartz monzonite porphyry
- Quartz monzonite

FIGURE 4

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QUARTZ MONZONITE and QUARTZ MONZONITE PORPHYRY DISTRIBUTION

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Table 5. Quartz Monzonite Porphyry Composition

Hole	Depth	Composition (% of rock) Biotite	Plag.	Ortho.	Qtz.
DCA-3A	4334'	6	44	28	22
A-2W	4242'	3	50	27	20
A-2	4308'	3	45	32	20
	4541'	6	38	33	23
A-8	4111'	6	39	32	23
	4622'	6	34	36	24
A-10	4052'	5	25	43	27
	4264'	6	41	25	28
A-12	4589'	2	30	40	28
	5393'	6	43	23	28
	Average	5	38	32	25

The texture of the quartz monzonite porphyry is comprised of 45% medium-grained phenocrysts, typically 1 to 3 mm in size, set in 55% aplitic-granitic groundmass, 0.05 to 0.2 mm in size. The quartz monzonite porphyry's texture and distribution of minerals in its texture are listed in Table 6.

Table 6. Quartz Monzonite Porphyry Texture and Mineral Distribution

	Grain Size (mm)		Phenocrysts					Groundmass				
Hole*	Pheno.	Gm.	%Rock	Plag. (% Pheno)	Quartz (% Pheno)	Ortho. (% Pheno)	Bio. (% Pheno)	% Rock	Plag. (% Gm)	Quartz (% Gm)	Ortho. (% Gm)	Bio. (% Gm)
DCA-3A	.5-1	.05-.1	60	67	15	10	8	40	10	50?	50?	2
A-2W	1-2	.2	60	75	10	10	5	40	20	25	55	-
A-2	1-3	.1	50	75	15	5	5	50	15	25	60	-
	1-2	.2	35	75	15	-	10	65	18	27	50	5
A-8	1-2	.06	50	70	10	10?	10	50	10	32	53	5
	1-3	.06	35	50	20	20	10	65	25	25	45	5
A-10	1-3	.02-.1	30	60	20	10	10	70	10	30	57	3
	1-3	.1	50	73	20	-	7	50	10	35	50	5
A-12	1-3	.2	25	75	15	-	10	75	13	32	55	-
	1-3	.5	60	65	20	5	10	40	15	35	50	-
Average	1-3	.05-.2	45	70	15	5	10	55	15	30	53	2

*See Table 5 for depths.

It is interesting to note that the composition of the phenocrysts (Table 6) is very similar to that of the granodiorite porphyry (Table 3). Consequently, the difference in mineral composition between the two rock types is due to the abundance of fine-grained aplitic-granitic groundmass.

Fine-Grained Granite

Fine-grained granite exists in drill holes A-8, A-9, A-10, and A-12A (see Figure 5). Fine-grained granite has a mineral composition of 3% biotite, 17% plagioclase, 51% orthoclase, and 29% quartz. The mineral composition of the individual thin sections is presented in Table 7.

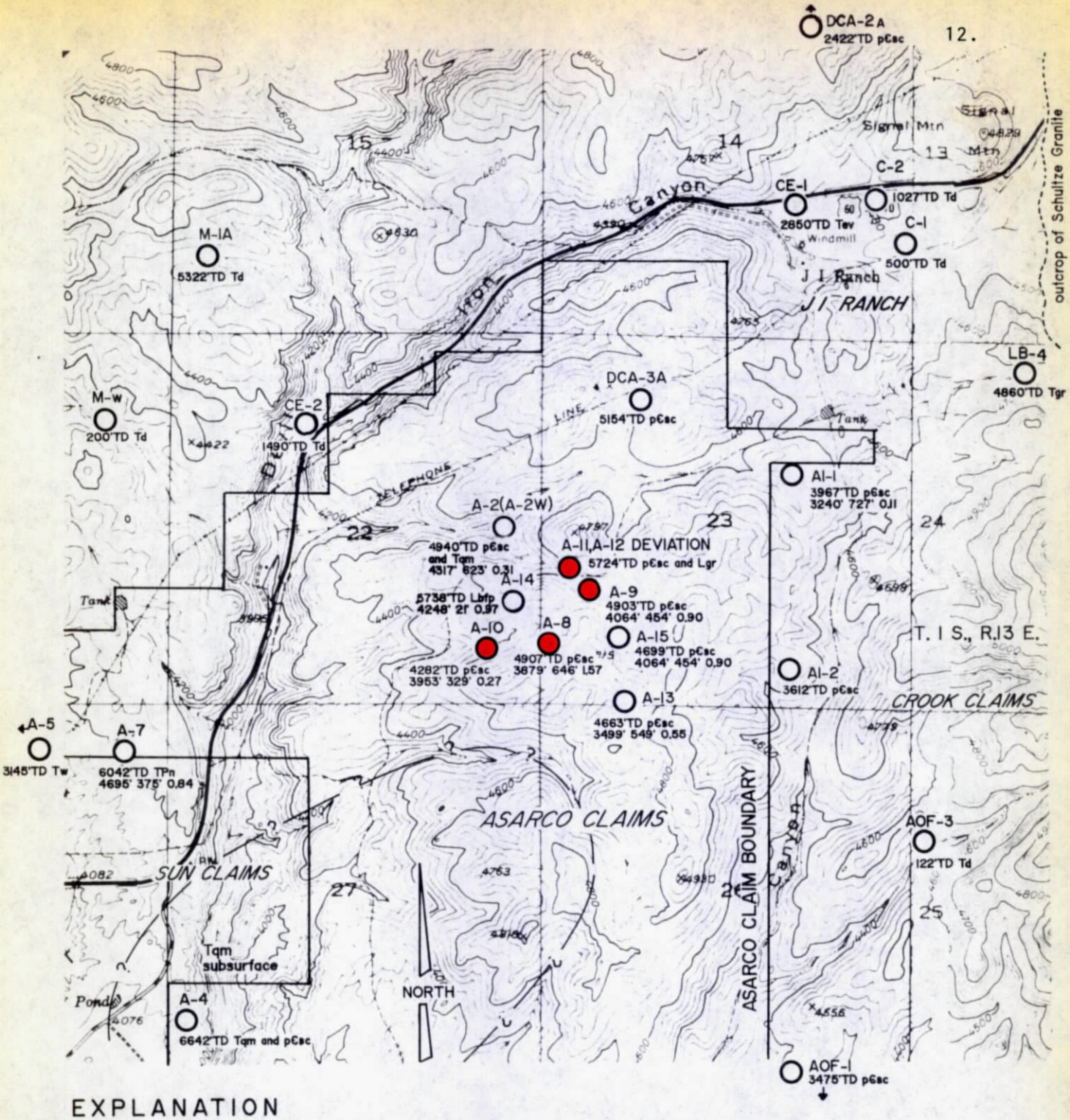
Table 7. Fine-Grained Granite Composition

Hole	Depth	Composition (% of Rock) Biotite	Plag.	Ortho.	Qtz.	Grain Size (mm)
A-8	4726'	3	15	50	32	.4-3
A-9	4026'	3	22	45	30	.2-2
	4159'	4	15	56	25	.1-.7
	4734'	4	15	51	30	.1-2
A-10	3436'	3	23	47	27	.1-.2
	3697'	3	22	45	30	.1-.3
	3891'	3	15	47	35	.1-.7
	4163'	3	15	50	32	.1-1
	4278'	3	25	42	30	.1-3
A-12A	4129'	2(?)	15	58	25	.3-.6
	4195'	2(?)	10	68	20	.1-.2
	4627'	2	15	48	35	.5-2
	Average	3	17	51	29	.1-2 Range .2-.7 Av

The texture of the fine-grained granite is somewhat variable. The texture is hypidiomorphic-granular but grades into allotriomorphic-granular in sections where the orthoclase is less euhedral. In addition the granular texture grades into varying degrees of porphyritic texture. A few of the fine-grained granite thin sections are sufficiently porphyritic to be called granite porphyry.

Quartz-Feldspar Porphyry

Quartz-feldspar porphyry is a category of rocks that are too fine-grained to determine mineral composition. The thin sections of rock in this category are listed in Table 8. Typically 85% or more of the rock is groundmass with a grain size of 0.03 mm and an apparent quartz-feldspar composition. The remainder of the rock is 1mm-sized phenocrysts of dominantly plagioclase. The location of the drill hole intercepts of quartz-feldspar porphyry are shown in Figure 6.



EXPLANATION

○ Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)

● Fine-grained granite

FIGURE 5

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FINE-GRAINED GRANITE DISTRIBUTION

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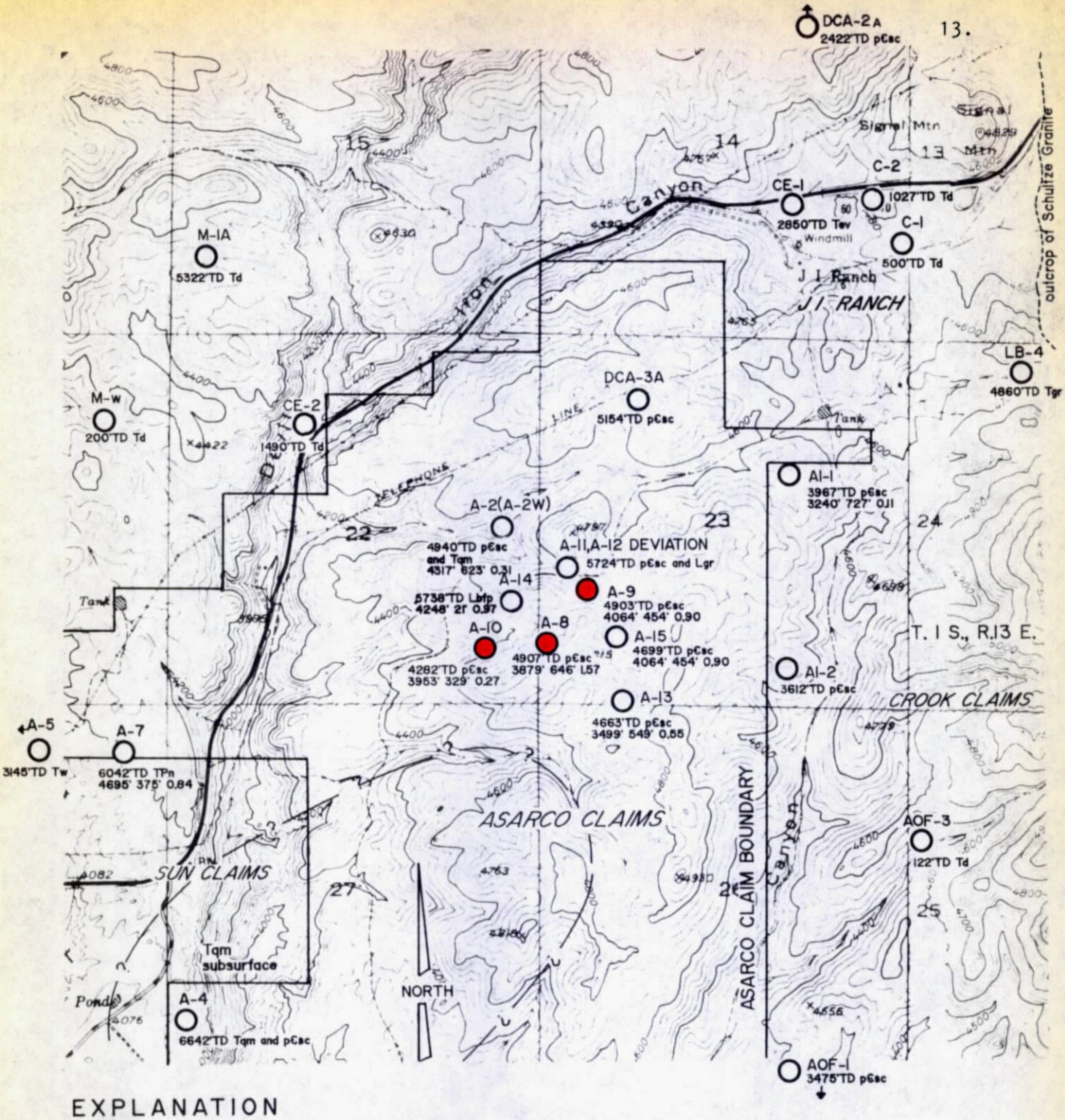

EXPLANATION

- ○ Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)
- ● Quartz-feldspar porphyry

FIGURE 6

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QUARTZ-FELDSPAR PORPHYRY DISTRIBUTION

H.G.Kreis **May, 1986**

0 2000'

mn 6395 HGK/dam tucson 6/86

Table 8. Quartz-Feldspar Porphyry Texture and Phenocryst Composition

Hole	Depth	Rock Name	Grain Size (mm) Pheno.	Grain Size (mm) Gm.	% of Rock	Phenocrysts Plag. (% Pheno)	Phenocrysts Qtz. (% Pheno)	Phenocrysts Biotite (% Pheno)
A-8	3883'	Quartz-feldspar porphyry	.5-1	.04	15	85	15	-
A-9	4202'	Quartz-feldspar porphyry	1	.02	6	95	5	-
A-9	4580'	Aphanite	-	.02	0	-	-	-
A-10	3691'	Feldspar porphyry	1	.02	15	90	-	15

One of the characteristics of this rock type is an abundance (5-15%) of fine-grained biotite, most of which appears to be secondary. About half of this fine-grained biotite occurs in pseudomorphs of an elongate mineral that was probably primary biotite or possibly hornblende.

Rock Type Comparisons

There is a resonable textural and compositional continuum from granodiorite to granodiorite porphyry to quartz monzonite porphyry to fine-grained granite. The features that give evidence of the continuum are summarized in Table 9 and shown in detail in Tables 10, 11, 12, and 13.

This continuum of texture and composition may reflect the actual sequence of intrusion. Although there is no convincing thin section evidence as to which rock type was first, the granodiorite (Schultze Granite) was probably the first to be intruded and fine-grained granite the last.

The quartz monzonite and quartz-feldspar rock types are not included in the continuum. The quartz monzonite rock type was not included because it is too poorly defined. The quartz-feldspar porphyry rock type was not included, because alteration evidence suggests it predates the other rock types. The quartz-feldspar porphyry may be pre-Mesozoic in age.

Table 9. Textural-Compositional Continuum

FEATURE	ROCK TYPE SIMILARITIES: Granodiorite	Granodiorite Porphyry	Quartz Monz. Porphyry	Fine-grained Granite	SEE TABLE FOR DETAILS
Texture:					
Abundance of pheno. sized grains	→ Continuous Decrease →				Table 10
Size of phenocryst sized grains	X Same	X Same	X		Table 11
Size of groundmass sized grains		X Same	X Similar	X	Table 12
Composition:					
Whole rock mineral composition	X Same	X			Table 13
Comp. of phenocryst sized grains	X Similar	X Same	X		Table 11
Comp. of groundmass sized grains		X Similar	X Same	X	Table 12

Table 10. Textural Comparisons

	Grano-diorite	Grano. Porphyry	Qtz.Monz. Porphyry	Fine-g. Granite
Abundance Phenocryst-Sized Grains	100%	76%	45%	<15%
Abundance Groundmass-Sized Grains	0%	24%	55%	>85%

Table 11. Comparison of Phenocryst-Sized Grains

Rock Type	Grain Size (mm)	Abundance (% of rock)	Plag. (% of pheno.)	Quartz (% of pheno.)	Ortho. (% of pheno.)	Biotite (% of pheno.)
Granodiorite	1-3	100	56	21	19	4
Granodio. Porp.	1-4	76	76	12	5	7
Qtz.Monz. Porp.	1-3	45	70	15	5	10

Table 12. Comparison of Groundmass-Sized Grains

Rock Type	Grain Size (mm)	Abundance (% of gm.)	Plag. (% of gm.)	Quartz (% of gm.)	Ortho. (% of gm.)	Biotite (% of gm.)
Granodio. Porp.	.2	24	0-10	40	52	5
Qtz.Monz. Porp.	.05-.2	55	15	30	53	2
F-g. Granite	.2-.7	>85	17	29	51	3

Table 13. Whole Rock Mineral Composition Comparison

Rock Type	Plag. (%)	Quartz (%)	Ortho. (%)	Biotite (%)
Granodiorite	56	21	19	4
Granodiorite Porphyry	59	19	16	6
Quartz Monz. Porphyry	38	25	32	5
Fine-grained Granite	17	29	51	3

TAB

Alteration

ALTERATION

An examination of the thin sections of Superior East premineral igneous rocks shows two dominent types of alteration in the immediate area of copper mineraliztion. They are kaolinite alteration and sericite alteration. An apparently minor type of alteration exists in the quartz-feldspar porphyry, and it is biotite-orthoclase-kaolinite alteration.

Judging from the collection of igneous rock thin sections, the kaolinite alteration is a pervasive dissemination type of alteration while most, if not all, of the stronger sericite alteration is vein selvage type alteration. The selvage nature of sericite alteration was obvious in a number of thin sections and strongly suspected in a number of others.

Kaolinite Alteration

Kaolinite alteration of the igneous rocks is best displayed in the area of copper mineralization, the area bounded by A-2, A-9, A-8, and A-10 (Figure 7). Typical kaolinite alteration consists of 50 to 100% replacement of plagioclase by kaolinite. Kaolinite does not replace orthoclase, and the orthoclase is virtually always fresh outside of sericite alteration selvates. Usually biotite is fresh or altered to muscovite, but this muscovite alteration of biotite is believed to be related to sericite alteration.

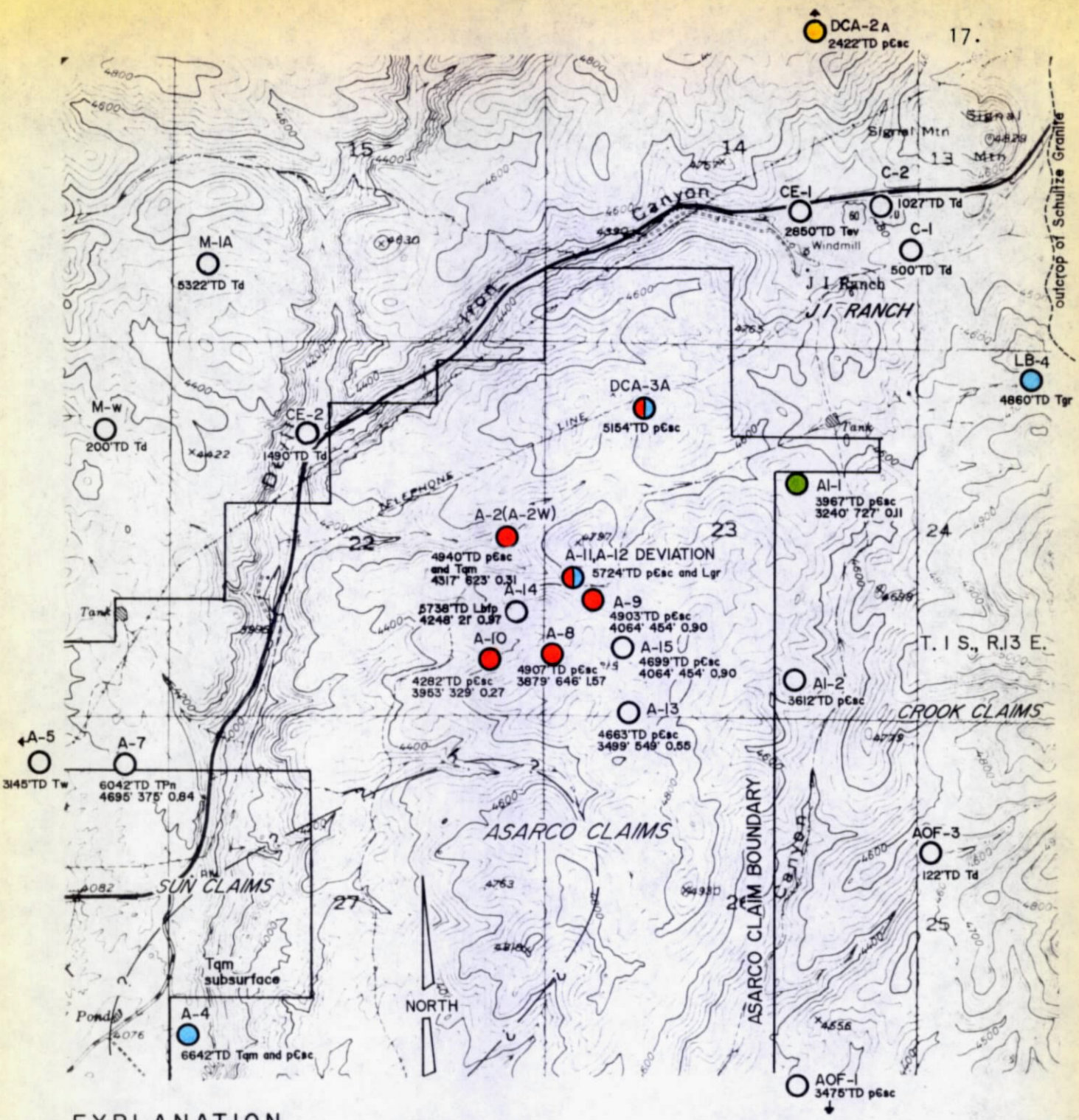
Virtually every rock type exhibits some degree of kaolinite alteration. Most of the thin sections are either quartz monzonite porphyry or fine-grained granite so most observations of argillic alteration were made in these rock types. A compilation of the degree of alteration in the various rock types is in Table 14 (page 18).

Holes A-2, A-8, A-9, A-10, and A-12 all have good examples of kaolinite alteration. The kaolinite alteration and associated copper grades in drill hole A-12 (and A-12A) are summarized in Table 15.

(Table 14. Follows on page 18)

Table 15. Alteration of Igneous Rocks in A-12

A-12 Depth (ft.)	Rock Type	Copper Grade	Plagio. Abund. (% rock)	Plagio. Alter. (% repl.)	Plagio. Alt.Prod. (% rock)	Biotite Alter. (% repl.)	Ortho. Alter. (% repl.)
4129'	f.g.gr	≥0.3% & some 1-4% assays (cc,bn,cpy)	15-30%	100%	15% kaol 5% ser.	30% to 100% altered to muscov.	Essentially Fresh
4136'	pqm.						
4195'	f.g.gr						
4589'	qmp						
4627'	f.g.gr						
4826'	f.g.gr			35% ↓ 15%	1-7% kaol. 0-3% ser.		
5368'	f.g.qm	Typically 0.01-0.09% (cpy)					
5393'	qmp						
5417'	gdp		55%	15% ↓ 5%	Tr-5% kaol. 0-2% ser. 2% calc. Tr anhy.	Fresh	
5486'	gd						
5551'	gd						
5623'	gd						



EXPLANATION

- Drill holes in area of study showing rock type at T.D. and copper intercept (depth, thhickness, %Cu)
- Kaolinite alteration with sericite selvage alteration
- Fresh and weakly altered granodiorite and granodiorite porphyry
- Fresh quartz monzonite porphyry
- Sericitized in the one and only thin section but drill log says fresh(DCA-2A)

FIGURE 7

ASARCO Incorporated

SUPERIOR EAST PROJECT
PINAL COUNTY, ARIZONA

ALTERATION MAP

H.G.Kreis **May, 1986**

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TABLE 14. THIN SECTION EXAMINATION

ROCK NAME *IGNEOUS ROCKS* SUPERIOR EAST HGK 1986

Hole	Depth	Rock Type	Degree of Alt.	Biot. Alteration Products: Bio.	K-t.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus.			Degree of Alt.	Plag. Alteration Products: Bio.	K-t.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Allophane	Mus.	Degree of Alt.	Ortho. Alteration Products: Bio.	K-t.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.				% Alteration Products: Bio.	K-t.	Qtz	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus.	Anh.	Allophane
AI-1	3261	Qmp	0													2				+					+			0														½								1			
DCA-2A	1547	Gdp	100							+			+++			90		Tr?		+++								Tr				Tr										Tr?		58			3			3		
DCA-3A	4334	Qmp	15							+			+			50				+	+++							0														3	17		2			1		
	4512	Qm	0													Tr				Tr	Tr				Tr			0														½	½		½		Tr	1		
	4747	Gd	0													5				+	+							0														1	2		½					
LB-4	2600	Gd	0						Tr							0												0																Tr							
	3410	Gd	0						Tr							Tr				Tr	Tr							0														Tr	Tr	Tr						
	4850	Gd	0						Tr							Tr				Tr					Tr			0																Tr				Tr		
A-2W	4242	Qmp	100					+++								100					+++							0															48		1			Tr		
A-2	4301	Qmp	100										+++			90				+++								40				+++										40			½			2		
	4308	Qmp	Tr						Tr							100				+	+++				Tr			0													Tr	3	40	Tr	Tr		Tr			
	4394	Qm	0													25				++	+							Tr														4	4		Tr		Tr	Tr		
	4499	Qmp	0													100				+	+++							0														4	31							
A-2W	4541	Qmp	10						+							50				+	+++				+			0														2	14	Tr			4	Tr		
	4910	Gdp	100				+						+++			100				+++								0														50						6		
A-4	6656	Gdp	10						+							5				+	Tr				Tr			0														3	Tr	1			Tr			
A-8	3883	Qfp	50	+++												100?					+++							0												4	1		1	12							
	4111	Qmp	0													100?					+++				Tr	+		0															30		½		Tr			9
	4614	Fgr	100				+++									100				+++	+							100			+	+++										12	47	7						
	4622	Qmp	60				++		+							70				+	+++				Tr			0														3	20	1	Tr		1	1		
	4726	Fgr	0													50				+	+++				Tr			0														1	6				Tr			
A-9	4026	Fgr	10					Tr	Tr							90			Tr		+++							0													Tr		20		Tr					
	4159	Fgr	Tr										Tr			50?					+++				+			3									+			?			1	5				3		
	4202	Qfp	100	+++												100 of phenos		+			+++							–												12	5			5				4		
	4580	Qfp	100	+++												?		+			+							–												15	3		2	4				2		
	4734	Fgr	80										+++			80		+		+	+++				+			0												?	1		1	10					3		
A-10	3436	Fgr	0													50				+	+++							0														2	10		Tr					
	3691	Qfp	90	+++												70?	+	+?		+	+++							?	++				+?							9	4?		2	12		2		½	Tr		
	3687	Fgr	0													10				+	+++							0														1	4		Tr					
	3891	Fgr	0													100				+	+++							0														2	12		½					
	4052	Qmp	0													80	+			+	+++				Tr			Tr	Tr			Tr								2			2	17		½		Tr			
	4163	Fgr	0													30					+++				+			0													?		1	5	Tr	½		1		½
	4180	Qmp	100				++						+++			100			+	+++								100			+	+++									10?	48	5					Tr	
	4264	Qmp	0													20				++	+++							0														1	4	Tr	½		2	Tr		
	4278	Fgr	0													10				+	++					+		Tr				+										2	1					Tr		
A-12A	4129	Fgr	100										+++			100				++	+++							<5				+										4	8		Tr			2		
	4136	Qm	100										+++			100				++	+++							≤10				+										10	17					2		
	4195	Fgr	100				+?	+?								100		?		Tr	++							0														1	9							
A-12	4589	Qmp	80										+++			100				++	+++							0														7	23		Tr		2	1		
	4627	Fgr	100										+++			100				Tr	+++							0														1	14					2		
	5368	Qm	30										+			15				+++	+				+			0												Tr		3	1				½	1		
	5393	Qmp	0													15				+	Tr			+	+		+	0														1	1		½		3		4	
	5417	Gdp	0													15					+++				+		Tr	0															7		½		2		Tr	
	5486	Gd	Tr									Tr				10		Tr		+	+++				++			2				+									Tr	2	5		½				½
	5551	Gd	0													6					+				+	Tr	Tr	0														½	2		Tr		2	Tr	½
	5623	Gd	0													5				Tr	Tr				++			0														Tr	Tr		1		2			

Explanation

Degree of Alteration: shows percentage of mineral replaced by alteration products.

+++ ++ + : relative abundance of the particular alteration mineral replacing the specified rock forming mineral. +++ is the most abundant.

% Alteration Productions: percentage of whole rock.

SUPERIOR EAST PROJECT

Compilation of Alteration in Igneous Rocks

H.G. Kreis May 1986

Compiled from Individual Thin Section Reports

In the kaolinite alteration the total kaolinite content of the rock varies from 5 to 30%. Typically 1 to 5% sericite, 0 to 2% calcite, and local traces of secondary biotite also occur with the kaolinite in the altered plagioclase sites. Kaolinite selectively replaces the plagioclase by starting in the cores of plagioclase phenocrysts and then, as its degree of replacement increases, in the rims of plagioclase phenocrysts and in the groundmass plagioclase.

Sericite Alteration

Strong sericite alteration was observed in a number of thin sections. In several of these sections it was obvious that the sericite alteration was occurring along quartz veins or fractures in selvage form. A few thin sections showed uniformly pervasive sericitization throughout the thin section, but these are thought to be thick alteration selvages rather than an area of pervasive sericitization

In every case this sericitization occurs in igneous rocks having varying degrees of kaolinite alteration. Apparently the sericitization is superimposed upon the kaolinite alteration. Commonly, the sericitization is accompanied by disseminated sulfides and minor amounts of quartz (vein flooding and/or alteration quartz). The effects of sericite alteration are summarized in Table 16.

Table 16. Sericite Selvage Alteration

Alteration Type	Kaolinite and minor sericite	Sericite with some quartz flooding	Quartz Vein with or without sulfides.
Rock Type	Igneous host rock, mostly Qmp and F-g.Gr.		
Alteration of Biotite	Fresh to strongly altered to muscovite. Local minor chlorite and clay replacement.	Moderately to strongly to muscovite and/ or sericite	
Alteration of Plagioclase	Moderately to strongly altered to kaolinite with minor sericite and traces of calcite.	Strongly altered to sericite	
Alteration of Orthoclase	Fresh	Weakly to strongly altered quartz sericite	
Sulfides	Sulfides with weak to moderate copper grades.	Stronger sulfides and higher copper grades.	

One of the common characteristics of sericite alteration is the variable grain size of the sericite. Some of the sericite becomes sufficiently coarse and plately that it could be called muscovite. Occasionally some of the coarser sericite formed with a rosette texture.

Some examples of sericite alteration are: A-10 4180', A-10 4614', A-2 4301', A-2 4412', A-2 4445', and A-2W 4910'. Thin section DCA-2A, 1547' has strong sericite replacement of plagioclase and strong muscovite replacement of biotite. The DCA-2A geologic log describes the interval from 1540' to 1620' as being fresh granite; so, presumably the DCA-2A, 1547' thin section represents sericite selvage type alteration.

No zone of pervasive sericite alteration, such as that observed at Santa Cruz, exists in the examined thin sections. In all probability such a zone exists in the Superior East project area, but it has yet to be located. An examination of the thin sections used in this report provides an inadequate data base to predict the location of such a sericite zone. Predicting the location of a sericite zone will require logging the core using appropriate logging criteria.

Biotite-Orthoclase Alteration

Biotite-orthoclase alteration affects the quartz-feldspar porphyry rocks (Table 8). This type of alteration is characterized by strong biotite replacement of biotite (and/or hornblende) phenocrysts and weak orthoclase replacement of plagioclase. The secondary biotite is fine grained and pseudomorphic. The secondary orthoclase partially replaces plagioclase phenocrysts in disseminated form and in vein selvages. Most, if not all, of the plagioclase not replaced by orthoclase is replaced by kaolinite.

The effects of biotite-orthoclase alteration are somewhat difficult to assess because of the texture of quartz-feldspar porphyry. The phenocrysts are fine-grained in size and sparse in abundance. The groundmass, ≥80% of the rock, is aphanitic so its composition and alteration cannot be evaluated with the microscope used in this report.

Biotite-orthoclase alteration is not exhibited in the other igneous rock type categories. This is probably a function of alteration-intrusive timing rather than a function of rock chemistry. The biotite-orthoclase alteration appears to be the first alteration event, postdating the quartz-feldspar porphyry dikes and predating the other igneous rock types and the other alteration types.

TAB

Drill Hole

DRILL HOLE REMARKS

This section is composed of remarks about the igneous rock petrography and alteration encountered in the individual drill holes. As previously mentioned the descriptions of each thin section are in Appendix I.

A-2 and A-2W Drill Holes

The thin sections of A-2 (and A-2W) presented something of a problem for petrographic descriptions. A number of the thin sections are in poor physical condition because of cracked balsam, and some slides had too small an area of rock to obtain a representative description. Many of the thin sections are predominated by thick quartz veins and strong sericite selvages along the quartz veins.

The igneous rocks of A-2 (and A-2W) consist of two types: quartz monzonite porphyry and porphyritic quartz monzonite. Although there are not many appropriate thin sections for texture and composition determinations, some reconnaissance grade comparisons can be made. The compositions of the two rock types are similar, but the quartz monzonite porphyry has a higher ratio of plagioclase to orthoclase.

The quartz monzonite porphyry contains equal amounts of phenocrysts and groundmass. The phenocrysts are typically 1 to 5 mm in size, and the groundmass is 0.1 to 0.2 mm in size.

The porphyritic quartz monzonite is composed of grains 0.2 to 0.4 mm in size which are coarser than the groundmass of the quartz monzonite porphyry. A small percentage of phenocrysts, 1 to 1.5 mm in size, give the rock a weakly developed porphyritic texture.

The quartz monzonite porphyry of A-2 exhibits total replacement of plagioclase by kaolinite at 4242', 4308', and 4499'. The degree of biotite alteration varies from fresh to totally clay altered. In all the sections the orthoclase is unaltered.

A thin section of quartz monzonite porphyry at 4301' has strong sericitization of plagioclase, weak sericitization of orthoclase, and strong replacement of biotite by muscovite. It appears that this alteration is selvage type alteration associated with quartz veining.

Three thin sections of porphyritic quartz monzonite (4394', 4412', and 4445') are sericite and quartz-sericite altered, and this is probably quartz vein selvage type alteration. Away from the stronger selvage alteration the plagioclase is moderately altered to a mixture of kaolinite and sericite.

A-4 Drill Hole

Three thin sections of granodiorite porphyry in A-4, 6610-6664' T.D., exhibit very weak chlorite-calcite-sericite-sulfide-anhydrite. The total abundance of these minerals is 10% at 6612', but less than 5% at 6656' and 6657'. All the sections contain 1 to 2% magnetite and traces of sulfide. There is no supergene oxidation and the interval averages 0.04% Cu and 0.0024% Mo. The composition of this porphyry is similar to that of the Schultze Granite. Although definitely porphyritic, the porphyry texture of A-4 6656' is gradational between the strongly porphyritic texture of A-4 6612' and the Schultze Granite (as in LB-4). The weak chlorite-calcite and fluid inclusions suggest fringe alteration-mineralization, while the texture of the porphyry and the presence of anhydrite suggest the possibility of an interior position.

A-8 Drill Hole

The thin sections of A-8 igneous rocks show three rock types: quartz-feldspar porphyry, quartz monzonite porphyry, and fine-grained granite. The quartz-feldspar porphyry, 3883', is composed of 15% plagioclase >> quartz phenocrysts and a groundmass that is too fine-grained to determine its composition.

Both thin sections of quartz monzonite porphyry, 4111' and 4622', are typical of quartz monzonite porphyry in other holes, but these two sections contain more K-feldspar phenocrysts. The K-feldspar phenocrysts make up 7 to 10% of the rock and 20% of the amount of phenocrysts. In one section the phenocrysts are 1 to 3 mm in size and in the other 10 mm in size.

Thin sections of fine-grained granite are from 4614' and 4726'. The fine-grained granite is of the same composition and texture of fine-grained granite in other holes.

The alteration in A-8 is typical, total to near total replacement of plagioclase by kaolinite with local strong sericitization in selvages along veins. There are a few minor variations of this kaolinite alteration. In the quartz-feldspar porphyry at 3883' an elongate mafic mineral was replaced by secondary biotite; so there is 4-8% secondary biotite associated with total (?) kaolinite replacement of the plagioclase. In the quartz monzonite porphyry at 4111' allophane, probably of supergene origin, occurs with kaolinite in totally altered plagioclase sites.

A-9 Drill Hole

There are two types of igneous rocks in A-9: porphyritic fine-grained granite and quartz-feldspar porphyry. The porphyritic fine-grained granite, as seen in thin sections at 4026', 4159', and 4734', is a porphyritic variety of fine-grained granite. Its porphyritic texture

- is composed of K-feldspar and/or plagioclase phenocrysts 1 mm to 2 mm in size set in a quartz-K-feldspar-plagioclase matrix 0.1 mm to 0.7 mm in size. Some of the K-feldspar phenocrysts exhibit Carlsbad twinning.

The quartz-feldspar porphyry occurs at 4202' in a 6' thick vertical intercept. It is composed of 8% plagioclase phenocrysts (0.6 mm in size) and 1% quartz phenocrysts set in an aphanitic groundmass 0.02 mm in size. The texture and the apparent composition of this groundmass appears to be the same as the rock called aphanite at 4580'. Although the aphanite at 4580' is not porphyritic it is thought to be the same igneous rock as the quartz-feldspar porphyry. Both the aphanite and the quartz-feldspar porphyry had a former mafic mineral, biotite or hornblende, that was totally replaced by secondary biotite.

Both the quartz-feldspar porphyry (4202') and the aphanite (4580') exhibit biotite-orthoclase alteration. As previously mentioned, secondary biotite completely replaces a former mafic mineral. In addition there is abundant (10%) fine-grained biotite disseminated throughout the rock, and it appears to be secondary biotite. Five to 8% of the rock consists of biotite-orthoclase replacement veins that are up to 3 mm in thickness. Some clay alteration was noted along one of these veins. Pervasive alteration is not readily discernible because of the aphanitic texture of the rock.

The alteration of the porphyritic fine-grained granite in A-9 is typical of that observed in nearby drill holes. Plagioclase is moderately to strongly replaced by kaolinite and very small amounts of calcite. Biotite is fresh except in one thin section where it was nearly totally altered to muscovite.

A-10 Drill Hole

There are three igneous rock types in A-10: fine-grained granite (3436', 3697', 3891', 4163', and 4278'), feldspar porphyry (3691'), and quartz monzonite porphyry (4052' and 4264'). The fine-grained granite has a hypidiomorphic granular texture with most grains 0.1 to 0.3 mm in size. The fine-grained granite is weakly porphyritic with 5 to 10%, 0.5 to 1.5 mm sized phenocrysts in the upper three thin sections. The porphyritic texture is more strongly developed in the lower two thin sections where 15%, 1 to 3 mm sized phenocrysts are present. Distinctive 1 to 3 mm sized quartz phenocrysts (eyes) are a characteristic of the lower two fine-grained granite thin sections. These quartz phenocrysts are similar to those in the quartz monzonite porphyry.

The quartz monzonite porphyry has 40% phenocrysts, 1 to 6 mm in size, and 60% groundmass, 0.02 to 0.1 mm in size. The phenocrysts are composed of 66% plagioclase (1 to 3 mm in size), 20% quartz (1 to 6 mm in size), 9% biotite (1 mm in size), and 0 to 10% orthoclase (4 mm in size). The groundmass is composed of 54% orthoclase, 32% quartz, 10% plagioclase, and 4% biotite.

Feldsapr porphyry at 3691' consists of 15% phenocrysts (1 mm in size) and 85% groundmass (0.02 mm in size). The phenocrysts are composed of 90% plagioclase and 10% biotite. The groundmass is too fine-grained to determine its composition. There is abundant fine-grained biotite in the feldspar porphyry. Some of this biotite is obviously secondary, occurring in clumps, along veins, and in altered plagioclase sites. In the feldspar porphyry most of the rock forming biotite is replaced by secondary biotite, and most of the plagioclase is replaced by kaolinite with minor sericite and biotite. A small amount of secondary orthoclase occurs in vein form.

The alteration of the gine-grained granite and quartz monzonite porphyry is typical kaolinite type alteration. The plagioclase in these rock types is 10% to 100% replaced by kaolinite with small amounts of sericite, calcite, and biotite. The plagioclase appears to be less altered with depth. The biotite and orthoclase in these rock types are unaltered except where sericite selvages are present. Every one of the thin sections of these rock types has 1% to 3% quartz veining present.

A-12 and A-12A Drill Hole

There are three igneous rock types in A-12 (and A-12A): fine-grained granite, quartz monzonite porphyry, and granodiorite (Schultze Granite). The fine-grained granite occurs as $\leq$10' thick dikes above a depth of 4900'. The granodiorite is part of an igneous rock intercept from 5450' to 5650', and it may have been part of the Schultze Granite stock as the lower contact at 5650' is a strong fault. The quartz monzonite porphyry is at 4589'.

The fine-grained granite has a composition of 3% biotite, 15% plagioclase, 57% orthoclase, and 25% quartz. The texture is fine-grained, allotriomorphic-granular with grains 0.2 to 1 mm in size. Many of the orthoclase grains exhibit Carlsbad twinning.

The geologic log of A-12 describes porphyry from 5357' to 5650'. Thin sections at 5368', 5393', and 5417' are respectively quartz monzonite (fine-grained texture), quartz monzonite porphyry, and granodiorite porphyry. Thin sections at 5486', 5551', and 5623' are granodiorite of uniform texture and composition, and they have the same texture and composition as the granodiorite (Schultze Granite) in drill hole LB-4. This granodiorite may have been faulted off the Schultze Granite stock as suggested by rock type similarities and a strong fault at the lower contact (5650' according to the geologic log). The granodiorite porphyry at 5417' is simply the granodiorite with 20% 0.1 mm sized, quartz-orthoclase groundmass. The quartz monzonite at 5368' and the quartz monzonite porphyry at 5393' are either a contact phenomena of the granodiorite or a separate intrusive phase.

The alteration ofthe igneous rocks in A-12 is summarized in Table 15. There are essentially two types of alteration in the igneous rocks of A-12. In the upper part of the hole, 4129' to 4627', there is 100% alteration of

plagioclase to kaolinite >> sericite, and 30% to 100% replacement of the biotite by muscovite. This alteration is associated with pervasive copper grades of ≥0.3% Cu. Below 5417', in the granodiorite, the plagioclase is very weakly altered to kaolinite-sericite-calcite-trace anhydrite. This alteration is associated with weak copper mineralization having a grade of 0.01 to 0.09% Cu. This weak alteration and mineralization are suggestive of the interior (core) of the sulfide system.

AI-1 Drill Hole

Drill hole AI-1 has one igneous rock thin section, quartz monzonite porphyry at 3261'. This quartz monzonite porphyry has 20% phenocrysts, 1 to 3 mm in size, and 80% groundmass, 0.05 mm in size. The rock forming minerals are unaltered except for some very minor calcite-sericite (2%) in the plagioclase. There is 8% fine-grained biotite in the groundmass of the porphyry, but it is primary in origin. It is often elongated, and it may be the mineral now represented by elongate, secondary biotite pseudomorphs in quartz-feldspar porphyry.

DCA-2A Drill Hole

There is only one igneous rock thin section in DCA-2A, and it is of granodiorite porphyry (1547'). It was taken from an interval, 1540' to 1676', described in the log as fresh Schultze Granite. The texture and composition of this granodiorite porphyry is the same as that in A-4, 6610' to 6664' (T.D.).

The DCA-2A 1547' thin section shows strong sericitization of plagioclase and strong muscovite-magnetite replacement of biotite. Since the geologic log describes the interval in which this thin section occurs as being fresh, this sericitization is probably selvage type alteration.

DCA-3A Drill Hole

Thin sections of DCA-3A igneous rocks from depths of 4334', 4512', and 4747' were examined. The rock at 4747' is quartz monzonite porphyry. It is composed of 60% phenocrysts, most being 0.5 to 1 mm in size. Forty percent of the quartz monzonite porphyry is groundmass, and it has a variable 0.05 to 1 mm grain size. The quartz monzonite porphyry has moderate kaolinite replacement of the plagioclase and weak muscovite replacement of the biotite.

Quartz monzonite at 4512' may be a compositional variation of fine-grained granite. It has a 0.2 to 1 mm sized, hypidiomorphic granular texture and is slightly porphyritic. The quartz monzonite is virtually fresh with only 2% sericite-muscovite-clay alteration.

At 4747' the rock is fine-to-medium-grained, porphyritic granodiorite. The texture varies from hypidiomorphic granular to the initial stages of porphyritic textural development with up to 10% fine-grained quartz-orthoclase. Several 5 mm sized quartz eyes give the rock an obvious porphyritic texture. The alteration in this porphyritic granodiorite is very weak clay-sericite replacement of plagioclase.

LB-4 Drill Hole

Drill hole LB-4 penetrated unmineralized, unaltered granodiorite from 334' to the bottom of the hole at 4860' T.D. This granodiorite is part of the Schultze Granite stock that outcrops from the east edge of the Superior East project to the west side of the town of Miami. Thin sections from 2600', 3410', and 4850' have an average composition of 3% biotite, 56% plagioclase, 19% orthoclase, and 22% quartz. The tecture is medium-grained, hypidiomorphic granular, and the grains of plagioclase are typically 1 to 3 mm in length. The plagioclase is commonly zoned with some weakly developed polysynthetic twinning. The orthoclase varies from interstitial to poikiloblastic (8 mm in size).

The texture and mineral composition of this granodiorite (Schultze Granite) are typical of a Laramide stock having associated porphyry copper mineralization. The mineral composition of the granodiorite is very similar to that of the Three Peaks-Sacaton Peak-Mineral Mountain stock (9% biotite, 53% plagioclase, 15% K-feldspar, 22% Quartz, and 0 to 1% hornblende).

The fluid inclusions of LB-4 are the subject of a memo by F.T. Graybeal, February 13, 1975. Graybeal found locally abundant, low temperature fluid inclusions. The abundance of Type I inclusions is <1% and Types II and III are absent.

- End -

TAB

Appendix 1

THIN SECTION EXAMINATION

ROCK NAME Quartz monzonite porphyry

SAMPLE NO. A-2W 4242

HGK 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		M/O
ROCK FORMING MIN.	Hornblende														
	Biotite	3?	0	100					++						
	Plagioclase	50	0	100					+++						
	Orthoclase	27*	27	Tr											0
	Quartz	20	20												
		* discounted because of large K-f phenos													
ALTER. & MIN. MINERALS	Biotite														
	K-feldspar														
	Quartz														
	Sericite														
	Clay		48												
	Chlorite														
	Magnetite		≤1												
	Epidote														
	Calcite														
	Sulfides														
	Limonite		2												
	Qtz Vn		2												
	Muscov.		Tr												

REMARKS: Thin section is of a small area.
K-feld. phenos 2×10mm (poikiloblastic)
Some K-feld. exhibits carlsbad twins.

1 to 2mm

Pheno 60% mm		GM 40% <2mm	
Plag.	75%	Plag	20%
Qtz	10	Qtz	25
K-feld	10*	K-f	55
Bio.	5?		

*Discounted because of 1 large pheno

MN 2890

THIN SECTION EXAMINATION

A-2

ROCK NAME Brecciated and qtz. flooded qtz. monz. or granite

SAMPLE NO. 4262

HGK 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		M/O	
ROCK FORMING MIN.	Hornblende															
	Biotite		Tr	90												
	Plagioclase		0?	100		?		++	++				Tr			
	Orthoclase		19	5				+							0	
	Quartz		10	—												
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz		60													
	Sericite - mus.		5													
	Clay		4													
	Chlorite		Tr													
	Magnetite		Tr													
	Epidote															
	Calcite		Tr													
	Sulfides															
	Limonite (Hem.)		2													

REMARKS: Insufficient amount of original rock to evaluate its texture and composition.
Appears to be (originally) fine to med. grained granite or quartz monzonite (granitic texture). Carlsbad twinning in some K-feld.
Brecciated and quartz veined-flooded.
SEE A-2W 4242 for texture & composition

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Quartz monzonite porphyry*

SAMPLE NO. *A-2 4301*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Musc.		
ROCK FORMING MIN.	Hornblende															
	Biotite		0	100										+++		
	Plagioclase		≤5	90				+++								
	Orthoclase		15	40				+++								
	Quartz		35	–												
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		40													
	Clay															
	Chlorite															
	Magnetite		≤½													
	Epidote															
	Calcite															
	Sulfides		Tr													
	Limonite															
	Otz. Vn		2													
	Muscov.		2													

REMARKS:

Thin section in v. poor condition.

Suspect this sericitization is a local feature related to qtz veining.

Thin sections above (A-2, 4262; A-2W, 4242) and below (A-2, 4308) have strong clay replacement of plag rather than sericite replacement.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Quartz monzonite porphyry*

SAMPLE NO. *A-2 4308*

H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3	Tr						Tr						
	Plagioclase	45	0	100				+	+++				Tr			
	Orthoclase	32	31	0												
	Quartz	20	20													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar		Tr													
	Quartz															
	Sericite		3													
	Clay		40													
	Chlorite		Tr													
	Magnetite		Tr													
	Epidote															
	Calcite		Tr													
	Sulfides		Tr													
	Limonite															
	Qtz Vn		2													

REMARKS:

0.7 to 3mm
1-5mm
Length: 1mm
Upto 5mm

Pheno 50% mm		GM 50% 0.1mm	
Plag	75%	K-feld	60%
Qtz	15	Qtz	25
Bio	5	Plag	15
K-feld	5		

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Porphyritic quartz monzonite* SAMPLE NO. *A-2 4394'*

HGK 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3	0												
	Plagioclase	±32	24	25				++	+				Tr			
	Orthoclase	±35	34	Tr												
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		4													
	Clay		4													
	Chlorite															
	Magnetite		Tr													
	Epidote															
	Calcite		Tr													
	Sulfides		Tr													
	Limonite															
	Qtz vn		½													
	Muscov.		Tr													

REMARKS:

Small phenocrysts (1 to 1½ mm) and somewhat coarser "groundmass" than in above section (0.2 to 0.4 mm) results in a weakly developed porphyry texture.

Sericitization in corner of slide is probably related to a vein not seen in the slide.

Texture and degree of alteration are such that it is difficult to get a good plag : K-feld ratio. Above estimate may be closer to a granite composition than indicated.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Porphyritic quartz monz. & qtz-ser. vein* SAMPLE NO. *A-2 4412*

HGK 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase	See below														
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		5													
	Limonite															
	Qtz-ser vn		Abundant													

REMARKS:

Porphyritic quartz monzonite with abundant quartz > sericite >> sulf. mineralization (vein and/or flooding).

The host rock and its alteration are the same as that described in A-2, 4394!

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-2

ROCK NAME Porph. qtz mons and qtz-sericite (vn.) SAMPLE NO. 4445

H.G.K. 3-1985

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase		See Below													
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															

REMARKS:

2/3's of slide is composed of 50% quartz (mostly primary) and 50% sericite. Probably related to vein mineralization

1/3rd of slide is porphyritic quartz monzonite (appears granitic) with mod. clay-ser. alt. of plagioclase. Primary biotite unaltered.

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Qtz vein and qtz-ser. selvage w/ sulfides

SAMPLE NO. A-2 4459

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase		See Below													
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides Mostly Pyr		>5													
	Limonite															

REMARKS:

Host rock is too altered (qtz-ser.) to identify but was taken from an interval of schist.

≥90% of the sulfides (ccp/py) are in the qtz-ser. selvage.

No feldspar or biotite remains.

Some of the sericite is coarse enough to be called muscovite.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Quartz monzonite porphyry*

SAMPLE NO. *A-2 4499'*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	5	5													
	Plagioclase	±35	0	100				+	+++							
	Orthoclase	±30	±30													
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		4													
	Clay (kaol.)		31													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite		—													
	Sulfides		Tr													
	Limonite															

REMARKS: *Thin section in poor condition.*

	Pheno % mm		GM % mm	
Upto 3mm —	Plag	%		%
" " "	Qtz			
1mm	Bio			
	K-f			

MN 2890

THIN SECTION EXAMINATION

A-2W

ROCK NAME Quartz monzonite porphyry

SAMPLE NO. 4541

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende	—														
	Biotite	6	5	10						+						
	Plagioclase	38	19	50				+	+++				+			
	Orthoclase	33	33	0												
	Quartz	23	23											-		
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		2													
	Clay		14													
	Chlorite		Tr													
	Magnetite															
	Epidote															
	Calcite		4													
	Sulfides		Tr													
	Limonite															
	Muscov		Tr													

REMARKS: Plag. phenocrysts tend to be totally altered to clay and calcite. Apparent vein related sericitization in corner of slide. Near the sericitization biot. is alt. to muscovite.

2mm thick vein of what looks like f.-g. granite.

Some of the K-f in groundmass has carlsbad twinning

	Pheno 35% mm		GM 65% 0.2mm	
Typically 1-2mm; 1x.4mm	Plag	75%	K-feld	50%
Couple @ 5mm	Qtz	15	Plag	18
Bio. ≤1mm	Bio	10	Qtz	27
			Bio	5

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz vein

SAMPLE NO. A-2W 4736
H.G.K 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase															
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															

REMARKS: Almost all of the thin section is a quartz vein. Too small an amount of wallrock is included to provide a meaningful description.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz veins with muscov. & sericite in what appears to be qtz mons. porph. or granod. porph.

SAMPLE NO. A-2W 4864 H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase															
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		✓													
	Limonite															

REMARKS: Thin section in poor shape.

Veins of quartz with minor muscovite have accompanying weak to strong sericitization of feldspar and chlorite-muscovite replacement of biotite.

2-3% py-cpy.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-2W

ROCK NAME *Granodiorite porphyry*

SAMPLE NO. *4910'*

H.G.K. 4-1986'

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus		
ROCK FORMING MIN.	Hornblende															
	Biotite	8	0	100				+						+++		
	Plagioclase	52	0	100				+++								
	Orthoclase	20	19	0												
	Quartz	20	19													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		50													
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		2													
	Limonite															
	Qtz Vn		4													
	Muscov.		6													

REMARKS:

LOG: p-Epi w/ Tgm dikes
0.4% Cu } 4910
0.25% Cu } Tgm w/ minor p-Epi
4940 T.D.

	Pheno 75% mm		GM 25% <2mm	
1 to 4mm	Plag	65%	K-feld	55%
1 to 3mm	Qtz	15	Qtz	35
couple @ 5mm	K-feld	10	Plag	10
	Bio	10	Bio	?

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz vein with a sliver of wallrock on edge of slide. Wallrock: qtz mons porph. w/ wk. sericite-kaol.-calcite altn.

SAMPLE NO. 4928 A-2W

HGK. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase															
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															

REMARKS:

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Granodiorite porphyry

SAMPLE NO. A-4 6612'
(A-4-6) H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase															
	Orthoclase															
	Quartz															
		See Below														
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															

REMARKS:

Same rock type as A-4 6656. The alt.-min. is similar; but this section has 6% calcite (mostly in veinlets), 2% chlorite in veinlets, 2% magnetite, trace sulfide, trace anhydrite. More contrast between phenocryst size and groundmass size (v.f.g.) than in A-4 6656

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Granodiorite porphyry*

SAMPLE NO. *A-4 6656'* (A-4-1)

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	8	7			None obvious				+						
	Plagioclase	58	55					+	Tr				Tr			
	Orthoclase ✓	15	15													
	Quartz	18	18													
	Magnetite	1	1													
	Sulfides		<<1													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		3													
	Clay		Tr													
	Chlorite		1													
	Magnetite															
	Epidote															
	Calcite		Tr													
	Sulfides															
	Limonite															

REMARKS: AGE DATED: 62.6 ± 2.3 m.year (RBC report of 5-30-72)

Geologic Log shows:
Schist & Qmp
6610' 45° FLT.
Qmp
6664 T.D.
6610-6664 is all qmp with <4% qtz veins. 1/2% tot. sulf py + qtz mo 0.04% Cu 20ppm Mo

This porphyry is mineralogically similar to the Schultze Granite (see LB-4). Most of the plag. phenocrysts are of a size similar to that in LB-4. This section of porphyry looks gradational between porphyry in A-4 6612' and the Schultze Granite (LB-4).

Pheno 70%	mm	GM 30%	<3mm
Plag	83%	Ortho	55%
Qtz	10	Qtz	35
Bio	7	Bio	10

commonly 1-3mm, locally to 12mm

some qtz eyes, 3-6mm 1-2mm long

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Granodiorite porphyry*

SAMPLE NO. *A-4 6657'*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite															
	Plagioclase		See Below													
	Orthoclase															
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															

REMARKS:

Same rock type and alteration-mineralization as A-4 6656. This section has 1% calcite veinlets and traces of anhydrite.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz-feldspar porphyry

SAMPLE NO. A-8 3883

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	4-8	4	≥50	+++											
	Plagioclase		?	100?					+++							
	Orthoclase		?	0												
	Quartz		?													
ALTER. & MIN. MINERALS	Biotite		≥4													
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay		≥12													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															
	Qtz veins		2													
	K-f veins		1													

REMARKS: The texture of the groundmass is too fine-grained to determine composition.

8% fine-grained biotite. About half of it appears to have replaced elongate crystals of hornblende or biotite. The other half may be secondary or primary.

All the plagioclase phenocrysts are totally altered to clay (kaolinite).

Local sericite in clay alt. plag. site and along a vein.

	Pheno 15% mm		GM 85% 0.04mm	
0.5-1	Plag	85%	Feld.	%
1-2mm	Qtz	15	Qtz	
			Bio	

MH 2890

THIN SECTION EXAMINATION

ROCK NAME Strongly sericitized and quartz veined (formerly ?)

SAMPLE NO. A-8 4023

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite		–	100				+++								
	Plagioclase		–	100				+++								
	Orthoclase		–	100				+++								
	Quartz		25													
ALTER. & MIN. MINERALS	Biotite		-													
	K-feldspar		-													
	Quartz		5?													
	Sericite		60													
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		2													
	Limonite															
	Qtz veins		8													

REMARKS:

Pheno	%	GM	%
	%		%

MN 2890

THIN SECTION EXAMINATION

A-8

ROCK NAME Quartz monzonite porphyry
(If composition were not discounted for large K-f phenos. the comp. would be close to granite porphyry)

SAMPLE NO. 4111
H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Allophane		M/O
ROCK FORMING MIN.	Hornblende															
	Biotite	6	6	0												
	Plagioclase	39	0	100?					HH				Tr	+		
	Orthoclase	32	32	0												0
	Quartz	23	23													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay kaol		30													
	Chlorite															
	Magnetite		½													
	Epidote															
	Calcite		Tr													
	Sulfides															
	Limonite															
	Allophane		9													

REMARKS: Couple of v. large (≥10mm) megaphenocrysts (poikiloblastic) of orthoclase.

Plagioclase phenocrysts totally replaced by clay and what may be amorphous silica or allophane. Difficult to eval. degree of alteration in plag. of the groundmass.

Pheno 50% mm		GM 50% 0.06mm	
Plag	70%	K-f	53%
Qtz	10	Qtz	32
Bio	10	Plag	10
K-feld	10?	Bio.	5

1-2mm
1-2mm
0.5mm
>10mm

Abundance of K-f phenos substantially discounted →

MN 2890

THIN SECTION EXAMINATION

A-8

ROCK NAME Sericitized fine-grained granite SAMPLE NO. 4614

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	?	0	100				+++								
	Plagioclase	?	0	100				+++	+							
	Orthoclase	?	0	100			+	+++								
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz		12													
	Sericite		47													
	Clay		7													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		4													
	Limonite															

REMARKS: Some argillized feldspar on edge of slide. Suspect some of plag. replaced by kaolinite prior to strong sericitization.

Judging from the texture of the quartz and the sericite masses, this rock was fine-grained granite (same as A-8, 4726).

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-8

ROCK NAME Quartz Monzonite Porphyry

SAMPLE NO. 4622

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	6	2	60					++	+						
	Plagioclase	34	10	70				+	+++				Tr			
	Orthoclase	36	36	0												
	Quartz	24	24	–												
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		3													
	Clay (Kaol.)		20													
	Chlorite		1													
	Magnetite		Tr													
	Epidote															
	Calcite		1													
	Sulfides		3													
	Limonite															
	Muscov.		1													

REMARKS:

Note abundance of K-feldspar phenocrysts as as percentage of all phenocrysts -- rather high. Some of them exhibit Carlsbad twins.

Variable degrees of replacement of plagioclase by alteration minerals.

Rock inclusion.

	Pheno 35 % mm		GM 65 % 0.02 mm	
1-3mm	Plag	50%	K-feld	45%
1-4mm	Qtz	20	Qtz	25
1-3mm	K-feld	20	Plag	25
0.5mm	Bio	10	Bio	5

MN 2890

THIN SECTION EXAMINATION

A-8

ROCK NAME Fine-grained* granite
*(actually medium grained)

SAMPLE NO. 4726
H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			M/O
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3	0												
	Plagioclase	15	8	50				+	+++				Tr			
	Orthoclase	50	50	0												0
	Quartz	32	32	–												
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay (Kad.)		6													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite		Tr													
	Sulfides		Tr													
	Limonite															

REMARKS: Fine to med. grained (a lot of K-f, 1-3mm; a lot of 1mm qtz; a lot of 1-3mm plag.), more or less hypidiomorphic granular. A lot of grains circa 0.4mm in size give the rock a weakly developed porphyritic texture.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Porphyritic fine-grained granite or granite porphyry*

SAMPLE NO. *A-9 4026*

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	3	≤	10					Tr	Tr						
	Plagioclase	22	2	90			Tr		~~HH~~							
	Orthoclase	45	45	0												
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz		Tr													
	Sericite															
	Clay (kaol.)		20													
	Chlorite															
	Magnetite		Tr													
	Epidote															
	Calcite															
	Sulfides															
	Limonite		Tr													

REMARKS: Much of the K-f. is 1-2mm in size; plag is <1mm.; Qtz, ≈ .2mm. Some K-f exhibits carlsbad twinning. K-feldspar tends to be phenocrystal giving the rock a porphyritic texture

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Fine-grained granite*

SAMPLE NO. *A-9* *4159*

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus		
ROCK FORMING MIN.	Hornblende															
	Biotite	4	4	Tr										Tr		
	Plagioclase	15	7?	50?					+++				+			
	Orthoclase	56	54	3									+			
	Quartz	25	25	—												
ALTER. & MIN. MINERALS	Biotite		?													
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay *kaol*		5													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite		3													
	Sulfides															
	Limonite															
	Qtz ms		1													

REMARKS: *Fine-grained with a couple of plag. and quartz phenocrysts (plag. 1-2mm; qtz up to 3mm.). Typical grain size about 0.1-0.7mm in diam.*

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz-feldspar porphyry SAMPLE NO. A-9 4202

HGK 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	8?	0	100	+++											
	Plagioclase		?	100 of phenos		+			++							
	Orthoclase		?													
	Quartz		?													
ALTER. & MIN. MINERALS	Biotite		12													
	K-feldspar		5		replacement veins											
	Quartz															
	Sericite															
	Clay		5													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite		4		disseminated											
	Sulfides															
	Limonite															

REMARKS: Groundmass 0.02mm in size, too small for composition determination with this microscope. The K-feldspar stain on the T.S. slab shows the K-feld. replacement veins. There is no K-feld. stain of the groundmass which suggest this rock has little or no K-feldspar.

Biotite replaces a former elongate mafic mineral (bio. or hornblende). See A-8, 3883' for same rock type and alt'n.

Plag. pheno. totally alt. to clay. (5% former plag pheno. 1mm in size)

Except for 2nd K-feld vn. the groundmass does not appear altered.

Pheno 6 mm		GM ? mm	
Plag	95%		%
Qtz	5		

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Aphanite*

SAMPLE NO. *A-9 4580*

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite		0	100	+++											
	Plagioclase			?		+			+							
	Orthoclase		72													
	Quartz															
ALTER. & MIN. MINERALS	Biotite		15		some in replacement vein											
	K-feldspar		3		replacement vein											
	Quartz															
	Sericite		2													
	Clay		4		Along veins											
	Chlorite															
	Magnetite															
	Epidote															
	Calcite		2													
	Sulfides		1													
	Limonite															
	Qtz Vn		1													

REMARKS:

5% replacement veins of 2nd bio., K-feld, & sericite

Biotite is finely disseminated through out the rock and this f.g. biot. totals about 10% of the rock. Some clumps of f.g. biotite after a mafic mineral.

Av. grain size is 0.02 mm. Rock appears to be composed of fine grained bio.-qtz-K-feld. and suspect it might be an igneous rock in the final schist.

Probably related to the quartz.

Pheno	%	mm	GM	%	mm
	%			%	

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Porphyritic fine-grained granite or granite porphyry*

SAMPLE NO. *A-9 4734*
H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus		
ROCK FORMING MIN.	Hornblende															
	Biotite	4	1	80										++		
	Plagioclase	15	3	80		+		+	+++				+			
	Orthoclase	51	50	0									+			
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite		?													
	K-feldspar		1													
	Quartz															
	Sericite		1													
	Clay		10													
	Chlorite															
	Magnetite		–													
	Epidote															
	Calcite															
	Sulfides															
	Limonite															
	Qtz Vn		1													
	Muscov		3													

REMARKS: *Plag & K-feld phens. typically 1 to 2 mm and a few upto 5 mm. The groundmass grain size is 0.1 to 0.7 mm.*

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Fine-grained granite*

SAMPLE NO. *A-10 3436*

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3	0												
	Plagioclase	23	11	50				+	++							
	Orthoclase	47	46	0												
	Quartz	27	26													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		2													
	Clay		10													
	Chlorite															
	Magnetite		Tr													
	Epidote															
	Calcite															
	Sulfides															
	Limonite		½													
	Qtz vein		2													

REMARKS: 2mm thick quartz vein

Phenocrystal plag. typically 0.5–1.5mm while remainder of rock typically is 0.1–0.2mm in size.

Plag. nearly totally altered while small sized plag. grains are only weakly to moderately altered (locally fresh).

Porphyritic

	Pheno 10% mm		GM % mm	
.5-1.5mm	Plag	90 %		%
2mm	Qtz	10		

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Feldspar porphyry*

SAMPLE NO. *A-10 3691'*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende }															
	Biotite }	5?	1?	90	+++											
	Plagioclase		17?	70?	+	+?		+	+++							
	Orthoclase		20?		++				+?							
	Quartz		30													
ALTER. & MIN. MINERALS	Biotite		9													
	K-feldspar & Vr		4?													
	Quartz															
	Sericite		2													
	Clay kaolinite		≥ 12													
	Chlorite															
	Magnetite		2													
	Epidote															
	Calcite		< ½													
	Sulfides															
	Limonite		<1													
	Quartz vns		2													
	Muscov		Tr													

REMARKS: Groundmass is too fine-grained to determine composition.
2mm vein of qtz >> calcite ; K-f veinlet.

Abundant fine grained biotite. Some of it is obvious secondary biotite (clumps of f.g. bio, bio. veins, bio in alt. plag. sites); most biotite appears secondary; but some may be f.g. primary biotite. Abundant 2nd biot. along qtz vein.

Plag. phenos. are totally altered and there is significant alteration in the groundmass.

Pheno 15% 1 mm		GM 85% .02mm	
Typically 1mm → Plag	90%	Qtz	30?%
Bio	10	K-f	?
		Plag	high?

(Best guess is a granodiorite composition)

MN 2890

THIN SECTION EXAMINATION

A-10

ROCK NAME *Fine-grained granite*

SAMPLE NO. 3697

H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		M/O	
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3													
	Plagioclase	22	17	10				+	++							
	Orthoclase	45	44												O	
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay Kaol		4													
	Chlorite															
	Magnetite		Tr													
	Epidote															
	Calcite															
	Sulfides		—													
	Limonite		Tr													
	Qtz vein		1													

REMARKS: Granitic textured (hypidiomorphic granular).
Fine grained texture (most grain 0.1-0.3mm).
Slightly porphyritic (5% phenocrysts, 0.5-1.5mm).
1mm Qtz vein.
Carlsbad twinning is common.
Plag. pheno. are strongly kaolinite replaced.

	Pheno 5% mm		GM % mm	
.5-1.5mm	Plag	70%		%
	Qtz	15		
	K-feld	15		

MN 2890

THIN SECTION EXAMINATION

A-10

ROCK NAME *Fine-grained granite* SAMPLE NO. *3891*

Total alt^n of plag. given good plag. & K-feld est. *H.G.K. 3-1986*

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		%/m	
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3													
	Plagioclase	15	0	100				+	+++						0	
	Orthoclase	47	46													
	Quartz	35	34													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		2													
	Clay *kaolinite*		12													
	Chlorite															
	Magnetite		≤½													
	Epidote															
	Calcite															
	Sulfides															
	Limonite															
	Qtz vns		3													

REMARKS:

Plag. pheno. or xenolith (plag. rich), 7mm in diam, composed of a f.g. mass of kaolinite → biotite (secondary like) & sericite.

Several quartz veins 1 to 4mm thick.

Plag. is replaced (totally) by kaolinite except near quartz veins where it is replaced by sericite.

Fine grained.

Slightly porphyritic w/ 1mm sized plag., qtz, and K-feld. pheno.

Typical grain size, .1-.7mm.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-10

ROCK NAME Quartz Monzonite Porphyry

SAMPLE NO. 4052

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	5	5	0												
	Plagioclase	25	4	80	+			+	+++				Tr			
	Orthoclase	43	42	Tr	+			+								
	Quartz	27	27													
ALTER. & MIN. MINERALS	Biotite		2													
	K-feldspar															
	Quartz															
	Sericite & Muse.		2													
	Clay		17													
	Chlorite															
	Magnetite		½													
	Epidote															
	Calcite		Tr													
	Sulfides															
	Limonite		Tr													
	Qtz Vn		≤1													

REMARKS:

	Pheno ≥ 30%	mm	GM ≤ 70% .02 ~ 1mm	
1-1.5mm	Plag.	60%	K-f	5%
2-3mm	Qtz	20	Qtz	30
4mm	K-feld	10	Plag	10
	Bio	10	Bio	<4

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Porphyritic Micro Granite*

SAMPLE NO. *A-10, 4163'*

H6K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3	Tr						Tr						
	Plagioclase	15	10	30		?			+++				+			
	Orthoclase	50	48													
	Quartz	32	31													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar		?													
	Quartz															
	Sericite - Musc.		≤1													
	Clay Kaol.		5													
	Chlorite		Tr													
	Magnetite		<½													
	Epidote															
	Calcite		1													
	Sulfides															
	Limonite		Tr													
	Qtz Vn		2													
	Anhydrite ?		≤½													
	Native Cu		Tr													

REMARKS: Some 1-3mm sized plag, K-f, qtz, bio. pheno.

	Pheno 15% mm		GM 85% .1-.2 mm	
1mm →	Plag	30%	K-f	55%
1-3mm →	Qtz	50	Qtz	30
upto 3mm →	K-f	5	Plag	15
	Biot.	15		

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz monzonite porphyry (?)

SAMPLE NO. A-10 4180'

H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Muscov		
ROCK FORMING MIN.	Hornblende															
	Biotite		0	100				+						++		
	Plagioclase		0	100			+	+++	+							
	Orthoclase		0	100			+	+++								
	Quartz		30	—												
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz v.f.g.		10?													
	Sericite		48													
	Clay Kaol		5													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		4													
	Limonite															
	Qtz Vns		3													
	Muscov		Tr.													

REMARKS:

Strongly sericitized. Judging from the texture this was quartz monzonite porphyry or fine-grained granite.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz Monzonite Porphyry

SAMPLE NO. A-10 4264

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus.		
ROCK FORMING MIN.	Hornblende															
	Biotite	6	6	0												
	Plagioclase	41	32	20				++	+++				++	Tr		
	Orthoclase	25	25	0												
	Quartz	28	28													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay		4													
	Chlorite		Tr													
	Magnetite		½													
	Epidote															
	Calcite		2													
	Sulfides		Tr													
	Limonite															
	Apatite		Tr													
	Qtz Vn		1													
	Muscov.		Tr													

REMARKS:

	Pheno 50% mm		GM 50% 0.1mm	
1-6mm	Qtz	20%	Qtz	35%
1-3mm	Plag.	73	K-feld	50
1mm	Bio.	7	Plag	10
			Bio	5

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Fine-grained Granite*

SAMPLE NO. *A-10 4278*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Muscov		
ROCK FORMING MIN.	Hornblende															
	Biotite	3	3													
	Plagioclase	25	23	10				+	++					+		
	Orthoclase	42	40	Tr				+								
	Quartz	30	30													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		2													
	Clay (kaol.)		1													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides		Tr													
	Limonite															
	Muscovite		Tr													
	Qtz Vein		1													

REMARKS:

1 to 3 mm distinctive quartz grains stand out on K-f stained slab but are not so distinctive in thin section.

Variable grain size 0.1 - 3 mm.

Granitic texture overal but locally exhibits a fine grained texture as if grading into porphyry.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-12A

ROCK NAME Micro granite

SAMPLE NO. 4129

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus		
ROCK FORMING MIN.	Hornblende															
	Biotite	2	0	100										+		
	Plagioclase	15	0	100				++	+++							
	Orthoclase	58	60	<5				+								
	Quartz	25	25													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite & Muse		6													
	Clay Kaol.		8													
	Chlorite															
	Magnetite		Tr													
	Epidote															
	Calcite															
	Sulfides															
	Limonite		1													
	Qtz veins		Abundant													

REMARKS: Thin section of a very small area of core.

Granite (qtz mons) cut by several quartz veins.

0.3-0.6 av. grain size

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-12A

ROCK NAME Porphyritic quartz monzonite

SAMPLE NO. 4136

HGK 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Musc.		
ROCK FORMING MIN.	Hornblende	*														
	Biotite		0	100										++		
	Plagioclase	SEE ABOVE	0	100				++	+++							
	Orthoclase		35*	≤10				+								
	Quartz		35*													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		10*													
	Clay Kaol.		17*													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															
	Muscov		2													
	Qtz Vn		1													

REMARKS: *Poor quality thin section of a small area of core.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Micro granite*

SAMPLE NO. *A-12A 4195*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		M/O	
ROCK FORMING MIN.	Hornblende															
	Biotite	?	0	100				+?	+?							
	Plagioclase	10	0	100		?		Tr	+++							
	Orthoclase	70	67	0											0	
	Quartz	20	19													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar		?													
	Quartz															
	Sericite		1													
	Clay *Kaol.*		9													
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite		Tr													
	Qtz Vn		4													

REMARKS:

Many K-f grains are Carlsbad twinned

Most grains 0.1-1.2mm in size

There are a lot of holes in the slide. Suspect at least some of the holes are in alt. plag. sites.

Pheno ? mm		GM ? mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz mons. porph.

SAMPLE NO. A-12 4589

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus		
ROCK FORMING MIN.	Hornblende															
	Biotite	≥2	≤1	80										+		
	Plagioclase	30	0	100				++	+++							
	Orthoclase	40	39	0												
	Quartz	28	27													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		7													
	Clay Kad.		23													
	Chlorite															
	Magnetite		Tr?													
	Epidote															
	Calcite Veins		2													
	Sulfides		1/2													
	Limonite		–													
	Muscov		1													

REMARKS:

Qtz-sericite vein on very edge of slide. Some coarsely crystalline sericite (almost rosette clds) -- disseminated and in a monomineralic vein -- indicative of a nearby quartz vein.

	Pheno 25% mm		GM 75% .2mm	
1 to 2mm	Plag	75%	K-f	55%
2 to 3mm	Qtz	15	Qtz	32
	Bio.	10	Plag	13

MH 2890

THIN SECTION EXAMINATION

ROCK NAME *Fine-to med-grained granite*

SAMPLE NO. *A-12 4627*

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus.	M/O
ROCK FORMING MIN.	Hornblende														
	Biotite	2	0	100										+	
	Plagioclase	15	0	100				Tr	+++						
	Orthoclase	48	47	0				Tr							0
	Quartz	35	35	–											
ALTER. & MIN. MINERALS	Biotite														
	K-feldspar														
	Quartz														
	Sericite		1												
	Clay *Kaol.*		14												
	Chlorite														
	Magnetite														
	Epidote														
	Calcite														
	Sulfides		Tr												
	Limonite														
	Qtz vn		1												
	Muscov.		1-2												

REMARKS:

Some course sericite along quartz vein

Fine to medium grained (.5-2 mm) allotrimorphic-granular texture, Some K-f upto 3mm long. Plag. is fine grained.

Pheno	%	mm	GM	%	mm
	%			%	

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Fine-grained granite*

SAMPLE NO. *A-12* *4826*

H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Musc		
ROCK FORMING MIN. (½ of slide)	Hornblende															
	Biotite	3	-	30										+		
	Plagioclase	15		35					+++							
	Orthoclase	60		0												
	Quartz	22														
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															
½ of slide	Qtz + Ser															

REMARKS:

One half of slide is 50% quartz and 50% sericite-muscovite that replaces and floods the rock.

Other half of slide is fine-grained granite with only weak to mod. alteration of biotite and plagioclase. Grain size is more variable and porphyritic than the same rock type at A-12, 4627.

Pheno mm	%	GM mm	%

MH 2890

THIN SECTION EXAMINATION

ROCK NAME *Fine-grained qtz monz.*

SAMPLE NO. *A-12, 5368*

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus.		
ROCK FORMING MIN.	Hornblende															
	Biotite	3	2	30										+		
	Plagioclase	28	24	15				+++	+			--	+			
	Orthoclase	34	33													
	Quartz	35	34													
ALTER. & MIN. MINERALS	Biotite		Tr													
	K-feldspar															
	Quartz															
	Sericite		3													
	Clay *Kaol.*		1													
	Chlorite															
	Magnetite															
	Epidote		1/2													
	Calcite		1/2													
	Sulfides		≤1/2													
	Limonite															
	Qtz Vn		2													
	Muscov.		1													

REMARKS:

Fine grained (0.5-1mm), hypidiomorphic granular. Few plag. grains upto 2mm in size.

Feldspar ratios rather variable from place to place in the thin section.

Sericite is disseminated throughout most of the plag. grains while clay is locally present in the largest plag. grains.

Pheno	%	GM	%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Quartz monzonite porphyry

SAMPLE NO. A-12 5393

HGK 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Anh	M/O	
ROCK FORMING MIN.	Hornblende															
	Biotite	6	6	0												
	Plagioclase	43	38	15				+	Tr			+	+	+		
	Orthoclase	23	22												0	
	Quartz	28	26													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay		≤1													
	Chlorite															
	Magnetite		½													
	Epidote															
	Calcite		3													
	Sulfides		1													
	Limonite															
	Anhydrite		4													

REMARKS:

Albitic rims on plag. Anhydrite occurs in veins and as replacement of plagioclase.

	Pheno 60% mm		GM 40% 0.5mm	
1-3mm	Plag	65%	K-f	50%
3-6mm	Qtz	20	Qtz	35
3mm	K-f	15	Plag	15
1mm	Bio	10		

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Granodiorite porphyry

SAMPLE NO. A-12 5417

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Anh.		
ROCK FORMING MIN.	Hornblende															
	Biotite	4	4													
	Plagioclase	60	49	15					HH				+	Tr		
	Orthoclase	16	16													
	Quartz	20	19													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay Kaol.		7													
	Chlorite															
	Magnetite		Vs													
	Epidote															
	Calcite		2													
	Sulfides															
	Limonite															
	Qtz-K-f Vs		2													
	Anhydrite Vs		1													

REMARKS:

This may be a porphyritic contact phase of the granodiorite in thin sections A-12 5486, 5551, 5623.

Pheno 80% mm		GM 20% 0.1mm	
Plag	75%	K-f	60%
Qtz	15	Qtz	40
K-fel	5		
Bio.	5		

2-4mm

Commonly 1mm; 4mm up to

One 8mm in size

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Granodiorite

SAMPLE NO. A-12, 5486

H.G.K 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende	SEE BELOW														
	Biotite			Tr									Tr			
	Plagioclase			10		Tr		+	+++				++			
	Orthoclase			2				+								
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar		Tr													
	Quartz															
	Sericite		2													
	Clay Kaol.		<5													
	Chlorite															
	Magnetite		1/2													
	Epidote															
	Calcite		2													
	Sulfides															
	Limonite															
	Apatite		Tr													
	~~Muscov.~~															
	Anhydrite		1/2													

REMARKS:

Composition not meaningful because of one large K-f pheno in a section of small area.

Medium grained, hypidiomorphic granular.

Also see descriptions at 5551' and 5623' in this drill hole.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

A-12

ROCK NAME Granodiorite

SAMPLE NO. 5551

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus	Anh.	N/O
ROCK FORMING MIN.	Hornblende															
	Biotite	5	5	–												
	Plagioclase	55	51	6					+				+	Tr	Tr	
	Orthoclase	20	20													O
	Quartz	20	20													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		½													
	Clay Kaol.		2													
	Chlorite															
	Magnetite		Tr													
	Epidote															
	Calcite		2													
	Sulfides		Tr													
	Limonite															
	Anhydrite		½													
	Muscovite		Tr													

REMARKS:

Some coarse muscovite in feld. and also adjoining primary biotite (near edge of slide).

Medium grained hypidiomorphic granular. (1mm–5mm).

K-feld is interstitial.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Granodiorite

SAMPLE NO. A-12 5623

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			M/O
ROCK FORMING MIN.	Hornblende															
	Biotite	5	5	0												
	Plagioclase	55	52	5				Tr	Tr				+			
	Orthoclase	25	25	0												0
	Quartz	15	15													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		Tr													
	Clay		Tr													
	Chlorite															
	Magnetite		1													
	Epidote															
	Calcite		2													
	Sulfides															
	Limonite															

REMARKS:

Medium-grained (1-3mm), hypidiomorphic granular

Most of the K-f tends to be phenocrystal.

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

AI-1

ROCK NAME Quartz monzonite porphyry

SAMPLE NO. 3261

H.G.K. 4-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite			0												
	Plagioclase			2				+					+			
	Orthoclase			0												
	Quartz															
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite-musc.		½													
	Clay															
	Chlorite															
	Magnetite															
	Epidote															
	Calcite		½-1													
	Sulfides															
	Limonite															
	Anh.		Tr													

REMARKS:

About 8% f.-g. bio. in the groundmass.
Fresh except for some local calcite (½%) in plagioclase and flecks of sericite-muscov. in plag.

Pheno 20% 1-3mm		GM 80% 0.05-0.1mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Granodiorite Porphyry*

SAMPLE NO. *DCA-2A 1547'*
H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Muscov.	M/O
ROCK FORMING MIN.	Hornblende														
	Biotite	6	0	100							+			+++	
	Plagioclase	64	6	90		Tr?		+++							
	Orthoclase	12	11	Tr				Tr							0
	Quartz	18	18												
ALTER. & MIN. MINERALS	Biotite														
	K-feldspar														
	Quartz														
	Sericite		58												
	Clay														
	Chlorite														
	Magnetite		3												
	Epidote														
	Calcite														
	Sulfides														
	Limonite		1												
	Former sulfides		(+1%)												
	Muscovite		3												

REMARKS:

This granodiorite porph. is the same as that in A-4, 6610-6664 T.D. Only this thin section has strongly sericitized plag. The geology of the interval in which this thin section occurs is described as "Fresh Schultze Granite" in the geologic log of DCA-2A.

	Pheno 80% mm		GM 20% 0.1mm	
Commonly 2-6mm →	Plag.	80%	Qtz	50%
" " " " →	Qtz.	10	Ortho.	40
3-6mm →	Ortho.	5	Bio	10?
	Bio	5		

MN 2890

THIN SECTION EXAMINATION

DCA-3A

ROCK NAME Quartz Monzonite porphyry (Possibly granodiorite porphyry)

SAMPLE NO. 4334

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Mus.		
ROCK FORMING MIN.	Hornblende															
	Biotite	6	5	15							+			+		
	Plagioclase	44	22	50				+	+++							
	Orthoclase	28	28					+								
	Quartz	22	22													
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		3													
	Clay (kaolinite)		17													
	Chlorite															
	Magnetite		2													
	Epidote															
	Calcite															
	Sulfides															
	Limonite															
	Musc.		1													

REMARKS:

Groundmass is more inequigranular than the typical f.-g., equigranular qtz-K-feld matrix.

Groundmass has ophitic like texture.

Appears in thin section and hand sample to be a porphyritic variety of DCA-3A 4512'.

Note: 4297'-4394' is logged as a slide block of qtz mons.

Few 2-6mm; Commonly .5-1mm

Minor brecciation

Selvage type sericite - muscov, near edge of slides

Largest up to 6mm

one pheno 6x10mm

.5-1mm

Pheno 60% mm		GM 40% 0.05-0.1 mm Variable	
Plag	67%	Qtz	50% ?
Qtz	15	K-feld	50 ?
K-feld	10	Bio	2
Bio	8	Plag.	10

MN 2890

THIN SECTION EXAMINATION

DCA-3A

ROCK NAME Quartz Monzonite* SAMPLE NO. 4512

*(Probably a comp. variation of f.-g. granite) H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.	Muscov	M/O
ROCK FORMING MIN.	Hornblende														
	Biotite	5	5												
	Plagioclase	30	28	Tr				Tr	Tr				Tr	Tr	
	Orthoclase	40	39												0
	Quartz	25	24												
ALTER. & MIN. MINERALS	Biotite														
	K-feldspar														
	Quartz														
	Sericite		Tr												
	Clay		Tr												
	Chlorite														
	Magnetite		Tr												
	Epidote														
	Calcite (Veinlets)		2												
	Sulfides														
	Limonite		Tr												
	Muscov		1												

REMARKS:

Fine to medium grained (0.2-1mm); slightly porphyritic. Local minor brecciation (along a fract.). Calcite in veinlets & breccia filling. A K-f stain would be helpful in refining the ratio of K-feldspar to plag along with a couple more thin sections from this interval.

Note: 4454' to 4666' (Flt.) is logged as an oxidized block of Schultze Gr. having 0.33% Cu

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

ROCK NAME *Porphyritic granodiorite*

SAMPLE NO. DCA-3A 4747

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS: Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.			
ROCK FORMING MIN.	Hornblende															
	Biotite	5	5	–												
	Plagioclase	55	52	5				+	+							
	Orthoclase	≤15	≤15	–												
	Quartz	25	25	–												
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		1													
	Clay		2													
	Chlorite															
	Magnetite		½													
	Epidote															
	Calcite															
	Sulfides															
	Limonite		Tr													

REMARKS:

Interesting texture -- variable. Varies from hypimorphic granular to the initial stage of porphyritic texture development (upto 10% (1-3mm) qtz & K-feld). Fine to medium grained with a few 6mm sized qtz phenocrysts (qtz eyes).

Note: 4670'(Flt.) – 4806'(Flt.) is logged as Schultze Granite with 0.12% Cu (sulfide zone)

Pheno	%	mm	GM	%	mm
	%			%	

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Granodiorite (Schultze Granite) SAMPLE NO. LB-4 2600

H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS											
					Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		M/O	
ROCK FORMING MIN.	Hornblende	—														
	Biotite	3								Tr						
	Plagioclase	55														
	Orthoclase	20													O	
	Quartz	20														
	Anhydrite	<1														
	Magnetite	≤1														
	Apatite	Tr														
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite															
	Clay															
	Chlorite		Tr													
	Magnetite															
	Epidote															
	Calcite															
	Sulfides															
	Limonite															

REMARKS:

K-feld. in interstitial

Plag. grain size commonly 1-3mm in diameter. Polysyn. twinned & zoned

Qtz grain size <1mm.

Rare myrmekite texture

Pheno % mm		GM % mm	
	%		%

MN 2890

THIN SECTION EXAMINATION

LB-4

ROCK NAME Granodiorite (Schultze Granite) SAMPLE NO. 3410

H.G.K. 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		M/o
ROCK FORMING MIN.	Hornblende	—													
	Biotite	3								Tr					
	Plagioclase	55						Tr	Tr?						
	Orthoclase	15													0
	Quartz	26													
	Misc	≤1													
ALTER. & MIN. MINERALS	Biotite														
	K-feldspar														
	Quartz														
	Sericite														
	Clay														
	Chlorite														
	Magnetite														
	Epidote														
	Calcite														
	Sulfides														
	Limonite														

REMARKS:

K-feld is interstitial.

Plag. size is typically 0.7-3mm long; zoned & polysyn twinned plag.

116-point	point count	EYE EST.
Plag	48%	62
Ortho	16	15
Qtz	33*	19
Bio	3	3
		1 Misc.

Pheno % mm		GM % mm	
	%		%

* Seems a little high for this section & too high for 2600 E 4850

MN 2890

THIN SECTION EXAMINATION

ROCK NAME Granodiorite (Schultze granite) SAMPLE NO. LB-4 4850

H.G.K 3-1986

	MINERALOGY	PRE ALT. (%)	POST ALT. (%)	DEGREE OF ALT.	ALTERATION PRODUCTS Bio.	K-f.	Qtz.	Ser.	Clay	Chl.	Mg.	Epid.	Cal.		m/o	
ROCK FORMING MIN.	Hornblende	—														
	Biotite	3								Tr						
	Plagioclase	57						Tr					Tr			
	Orthoclase	20													O>M	
	Quartz	18														
	Apatite	<1														
	Muscov.	Tr														
	Magnet.	<1														
ALTER. & MIN. MINERALS	Biotite															
	K-feldspar															
	Quartz															
	Sericite		Tr													
	Clay															
	Chlorite		Tr													
	Magnetite															
	Epidote															
	Calcite		Tr													
	Sulfides															
	Limonite															

REMARKS:

80% of K-feld occurs in large 8-10 mm sized poikiloblastic grains. The remainder is interstitial.

Plag. grains typically 1+3 mm in length; polysynth. twinned & zoned

Pheno % mm		GM % mm	
	%		%

MN 2890

TAB

Appendix II

Reports

W. L. K.

JAN 25 1972

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
   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
   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 hard 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
   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
   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
   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
   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
   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).

George J. Stathis

George J. Stathis

GJS:lad

cc: JHCourtright
WLKurtz
JDSell
RBCummings

4

16A.16.19C

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

June 17, 1974

Memorandum to: J. D. Sell

From: F. T. Graybeal

Hydrothermal alteration in
A-1 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 A-1

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-1-20. In addition kaolinite, possibly with mixed very fine-grained quartz, is present in A-1-20. The presence of moderate cataclastic deformation features makes it unclear whether the kaolinite is an alteration mineral or simply part of a mylonite.

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-1 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-1. In addition fluid inclusions in A-2 are larger, more abundant, and contain a more saline hydrothermal solution than in A-1. 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-1 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

Rock Name
quartz - biotite - anhydrite schist

Megascopic description
massive, grayish, quartz - biotite schist; med. grained; no obvious layering; cut by quartz - 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

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 crudy

biotite - 15%, f.gr. weak parallel elongation

sericite - 2%

anhydrite - 10%; fine-coarse grained disseminated 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.

Section No. A-I-16

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 Fe

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

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

Textures

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

PETROGRAPHIC ANALYSIS

Section No. A-I-17

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

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 ve
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

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 cpy.

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 (crudd)

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 dag which quartz grains have healed leaving no evidence of slip

Secondary fluid inclus. c prisms, recent.

PETROGRAPHIC ANALYSIS

Section No. A-I-20

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.

Section No. A-1 -15

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

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

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 = 2-5%	
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

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

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 recrl, 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 minor daughter minerals

PETROGRAPHIC ANALYSIS

Section No. A-2-4

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

Paragenesis:

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

Rock Name
quartz-biotite schist.

Megascopic description

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

Microscopic description

Minerals

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

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 <u>very</u> stable in a potassic environment.

Coarser quartz may be post-metamorphic (?)

PETROGRAPHIC ANALYSIS

Section No. A-2-6

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

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. discern within the elongate orthoclase aggregates
sericite - 15%; fine-med.gr., cuts biotite in the bio-ser lenses
carbonate - 5%, predominantly a cind-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

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; core Mg-rich, edges Fe-rich; cut by sericite.

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

calcite - 1%, fgr, 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

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

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-1	gas = 10-40%	
3 p (ps?)	2%	m	gas = 20-40%	a.) elongate, tabular, birefringent (anhydrite b.) elongate, wispy, birefringent. c.) halite (??) - very ra

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

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

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

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

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 cubic, poorly formed b.) hematite - only 1 grain. c.) birefringent mineral (s very small but may be elongate.

syl. ??
hem ?
bire C

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

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 bref is often prominent (calcite ??)
Volume of daughter minerals in inclusions is always very small

FLUID INCLUSION PETROGRAPHY

Section No. A-2-8

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

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.

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: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. - c.gr. 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% (?) H2O contains abundant brownish translucent cmd and this orthoclase occurs as mantles around clear orthoclase grains.

plagioclase - 20%; euhedral, med.gr. phenocrysts (or close), 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 phenos 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 : 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-equidim grains
orthoclase - 35% 10% euhed cgr. pheno to 1/2" long; 25% med-fgr, 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 core 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, typel.

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 shredding bio

magnetite – tr.

sericite - 3%; in feldspars

kaolinite(?) - 15%; fine gr, bulk replacement of coarse plagioclase (montmorillonite)

apatite - tr., assoc. w. shredding 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 shredding biotite zones are — that is they aren't obvious inclusions.

In general the zones w shredding biotite also contain dissem. apatite, rare plagioclase (fresh + altered equiv.), no phenocrysts, and the kspar has more FeOx particulate cond 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 igm. 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 + k-spar 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 mopy 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, pri-sec, mostly typel; some are intermed 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 may have additional FeOx material and could therefore be hydrothermal.

plagioclase - 15%; med-c.gr., extensively 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-internal

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% disseam 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 disseam throughout. Somewhat perthitic

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 estimate from hand specimen. Possibly shiny surfaces thought to be sericite were polished slip surfaces.

Fluid inclusions <u>rare</u>

10/28/74

PETROGRAPHIC ANALYSIS

Section No. DCA-3A : 4874

Rock Name
cataclasite — possibly mixed schist and potassic-altered granitic

Megascopic description

gray, massive ; cut by numerous irregular joint-clear 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.

Preserved 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 <u>extremely rare</u>

11/8/74

T.L.G.'s NOTES
ON A-8 & A-9

F.T.G.'s Notes

A-8

3198 - sericite alt on rims of some clasts? - post-Whitetail alt? Several clasts w. nice FI

3543 - minor cataclastic deform of Lgr aplite?

3687 - minor but nice Type 2, increase greenish-olive biotite

3814 - " " " FI

3883 - lots of 2nd bio, FI rare in Lgr.

below here FI generally rare, alt. in Lgr strongly variable - often lots of fresh biotite; plag. usually shot; Lose schistosity below slide block

A-9

to 4000 is boring Whitetail, well foliated schist

4023 - lots of olive-grn biotite, 2nd kspar, sericite vein cutting kspar; vein qtz has modest FI

4202 - similar to A-8: 3883; st. alt 2nd bio

4580 - more st. bio, no qtz for FI

4734 - wk alt in Lgr to EOH.

Superior Dist
Prop

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

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

Sample No.: LB-4-2600

Name: Quartz monzonite

Mineralogy:	Comp. (%) Est. X PC Orig.	Pres.	Individual Minerals Average size (mm)	% Alt'd.	Alteration products
quartz	30	30	1-2		
K-feldspar	25	25	1-3		
plagioclase	40	40	1-4	tr	clay-illite, carbonate
biotite	4	4	2	tr	chlorite, rutile
apatite	tr	tr	0.1		
chlorite		tr	0.2		
clay-illite		tr			
anhydrite		tr	0.3		isolated patches
carbonate		tr	0.1		
magnetite	1	1	0.2		
rutile		tr	0.02		

Petrography:

This sample is of a relatively equigranular quartz monzonite. The rock is essentially fresh appearing in thin section, with only traces of clay-illite alteration occurring in plagioclase, and minor chlorite replacement of biotite. Small quantities of anhydrite, unrelatable to any preexisting mineral, occur as isolated, sparsely scattered patches. No sulfides are visible in thin section; however, and primary disseminated magnetite is unsulfidized. No secondary biotite, sericite, or secondary K-feldspar is present. Myrmekite textures are locally present.

WESTERN PETROGRAPHIC

Sample No.: LB-4-3092

Name: Quartz monzonite

Mineralogy:	Comp. (%) Est. X PC__ Orig.	Pres.	Individual Minerals Average size (mm)	% Alt'd.	Alteration products
quartz	30	30	0.5-4		
K-feldspar	25	25	1-6		
plagioclase	40	39	0.5-3	5	clay-illite, carbonate
biotite	4	4	0.5-2	5	chlorite, rutile
apatite	tr	tr	0.05-0.2		
muscovite		tr	0.1		
zircon	tr	tr	0.1		
carbonate		tr	0.2		
clay-illite		1			
chlorite		tr	0.1		
rutile		tr	0.02		
magnetite	1	1	0.1-.7		

Petrography:

With respect to primary composition and texture, and with respect to the lack of appreciable alteration, this quartz monzonite is virtually identical to Sample LB-4-2600. Only traces of clay-illite and chlorite, respectively, replace plagioclase and biotite. Sericite, secondary biotite, secondary K-feldspar, and anhydrite are absent. Disseminated primary magnetite is unoxidized and has not been sulfidized.

Sample No.: LB-4-3410

Name: Quartz monzonite

Mineralogy:	Comp. (%) Est. x PC Orig.	Pres.	Individual Minerals Average size (mm)	% Alt'd.	Alteration products
quartz	30	30	0.5-5		
K-feldspar	25	25	0.2-3		
plagioclase	40	40	0.5-5	tr	clay-illite, carbonate
biotite	4	4	0.5-2	10	chlorite, rutile, carbonate
muscovite	tr	tr	0.2		
apatite	tr	tr	0.05-0.1		
chlorite		tr	0.2		
carbonate		tr	0.3		
rutile		tr	0.05		
magnetite	1	1	0.15		

Petrography:

This quartz monzonite is essentially fresh. Traces of apparently deuteric clay-illite appear in plagioclase, and the biotite is slightly chloritized. No sericite, secondary biotite, secondary K-feldspar, or other hydrothermal alteration products are in evidence. Primary magnetite is unoxidized. No sulfides are present in the thin section.

Sample No.: LB-4-4200

Name: Quartz monzonite porphyry

Mineralogy:	Comp. (%) Est. x PC		Individual Minerals		
	Orig.	Pres.	Average size (mm)	% Alt'd.	Alteration products
quartz	30	30	0.5-5		
K-feldspar	25	25	0.5-5		
plagioclase	40	39	1-4	5	clay-illite, sericite, K-feldspar
biotite	4	4	0.2-2	10	chlorite, rutile, muscovite, epidote
apatite	tr	tr	0.15		
muscovite	tr	tr	0.2		
zircon	tr	tr	0.5		
clay-illite-seric.		1			
chlorite		tr	0.5		
K-spar(deuteric)		tr	0.05		
epidote		tr	0.2		
magnetite	1	1	0.8		

Petrography:

This sample, like the previous examples of quartz monzonite from LB-4, is essentially fresh, with only minor, apparently essentially deuteric alteration. Plagioclase is slightly dusted with clay-illite in the cores of individual crystals, and biotite is lightly replaced by chlorite-epidote. No secondary biotite, secondary K-feldspar, or extensive argillization are in evidence. Disseminated primary magnetite is fresh. No sulfides were detected in thin section.

Sample No.: LB-4-4850

Name: Quartz monzonite

Mineralogy:	Comp. (%) Est. x PC__ Orig.	Pres.	Individual Minerals Average size (mm)	% Alt'd.	Alteration products
quartz	22	22	0.5		
K-spar(perthitic)	45	45	0.5-15		
plagioclase	30	28	1-4	5-10	clay-illite,muscovite/sericite
biotite	3	3	1-0	10	chlorite,sericite/muscovite,rutile
apatite	tr	tr	0.15		
sericite/muscov.		1	0.15		
clay-illite		1			
chlorite		tr	0.2		
epidote		tr	0.15		
rutile		tr	0.02		
magnetite	tr	tr	0.25		

Petrography:

Alteration is only lightly developed in this sample of quartz monzonite. Relatively coarse-grained white K-mica very lightly stipples the cores of some plagioclase crystals, and in hand sample, occurs along a fracture surface. Biotite is slightly altered to chlorite, sericite-muscovite, and rutile. Disseminated magnetite is unoxidized, and sulfides are absent in thin section.

TAB

APPENDIX III

LIST OF SUPERIOR EAST
REPORTS AND THIN SECTIONS

*Included in Appendix II of this report.

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 Hornblendite 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.
Coetus 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, 1972.
Submitted of Ten Core Samples from hole A-2. March 30, 1972
* Petrographic Exam of Maintop Gr (4) & Lost Gulch qm. (1) May 5, 1972
* Hydrothermal Alteration in Holes AI-1 (11) & A-2 (14) June 17, 1974
Petrography of Ray West, RW-54, g. latite porphyry. Oct. 24, 1974.
* 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, 1975.
* 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 "blocky" chalcocite-bornite w/py, A-9. Feb. 23, 1978
Thin-Section, hole B-6 (Newmont) (3). May 31, 1978
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 (Append. III) June 30, 1982.

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. Kayser)

Sacaton basal flt.

QDC-5

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

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

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

Thin-section, etc., collection

Drill Hole No. A-1

Sample No.	Thin Section	Polished Thin Section	Polished Section	Rock Sample	Remarks
TBX-4-A-1-1397					breccia
TBX-6-A-1-1509					breccia
TBX-5-A-1-1557					Tw
A-12100					pEpi

TBX samples, see report Jan 19, 1972 by GJS.

Thin-section, etc., collection

Drill Hole No. A-2

Sample No.	Thin-section	Polished Thin-section	Polished Specimen	Kodak slide	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-2-4457					
A-2-6 (4499)					*
2-4229		Double Polished			forhead stage work.

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

* See report June 17, 1974 by FTG

Thin-section, study, collection

Drill Hole No. A-2 W (wedge)

Sample No	Thin Section	Polished Thin Section	Polished Section	K-Ar Sample	Remarks
A-2W4242				■	porp.
A-2W 4248				■	schist
A-2W 4309					porp.?
A-2W 4325					schist
A-2W 4541				■	porp.
A-2W 4545					schist
A-2-7 (4457)					*
A-2W 4760					schist
A-2W 4736					porp
A-2-8 (4864)					*
A-2-9 (4910)					*
A-2W 4928				■	blk porp
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	Kodak Slide	Remarks
A-33674 Vertical					Stoff
A-33674 Horizontal					"
A-34488					"

Drill Hole No. A-4

Sample No.	Thickness See Key	Polished Thin Sections See Key	Polished See Key	Kystic Fluid	Remarks
A-43810 Vat					tuff
A-43978 Vat.					"
A-44202 Vat					"
A-45084 Hoag				?	" Cu marks
A-45084 Vat.				?	" " "
A-45098 Hoag					" " "
A-45108 Vat					"
A-4-4-6562					Eocobrecia bx ✓
A-4-2-6602					fmat - blk group ✓
A-4-6-6612					blk pay. ✓
A-4-1-6656					blk pay. ✓
A-4-6657					blk pay.

See report of Jan 20, 1972 by G.J.S. also contains reports on samples at 6573', & 6445.

See report of Jan 17, 1974 by FTG.

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

Also see report by Isotopic Laboratories, Jan. 20, 1972, on age dots of samples A-4-C 121 (depth of 6622-6630).

Thin-section, etc. collection

Drill Hole No. A-7

Sample No.	Thin-Sec Pan	Polished Thin-Sec Pan	Polished Sec Pan	Polished Slab	Remarks
A-7 4691 Hoy					tuff-lav
A-7 4694 Hoy					" "
A-7 5710 Hoy					"Sepai ss"

Thin-section, etc. collection

Drill Hole No. A-8

Sample No.	Thin-Sec Pan	Polished Thin-Sec Pan	Polished Sec Pan	K-Ar Fel.	Remarks
A-8 3198					Tw
A-8 3252					A-2 type SB
A-8 3449					" " "
A-8 3543					" " " Lgraphic. old acct.
A-8 3487					" " "
A-8 3814					leached BR
A-8 3883					self. L bfp (occ. fine-grained) old acct.
A-8 3891					" pEpi " "
A-8 3958					pEpi py-cc. " "
A-8 3978 *					
A-8 4023					L bfp gb-sulf vn " "
A-8 4088					pEpi gb-sulf vn " "
A-8 4111					L bfp " "
A-8 4202 (see 4402)					
A-8 4249 A-8 4253					
A-8 4614 A-8 4355 A-8 4402					L bfp " "
A-8 4422					L bfp " "
A-8 4726					L bfp. blue feldspar " "
A-8 4835					pEpi K-spar vn " "
A-8 4925					
* A-8 3978					py cp, bn-cc
A-8 4249					bn-cc
A-8 4253					bn-cc
A-8 4355					py-cp, bn-cc
A-8 4402 (note, marked 4202)					spend bx, py-cc
8-4064		Coarse Lithol			for heat-stress work
8-4157		"			" " " "

Thin-section, etc. collection

Drill Hole No. A-9

	Sample No.	Thin-Section	Polished Thin-Section	Polished Section	K-Ar Tech Slide	Remarks	
—	A-9 2916 Vert	—				tuff lens	old sect.
—	A-9 3252	—				Tur	
—	A-9 3306	—				MIA SB	
—	A-9 3347	—				A-2 SB	
	A-9 3429	—			—	" "	
—	A-9 3598	—				" "	
—	A-9 3634	—				" "	
	A-9 4023	—			—	leached BR	
	A-9 4026	—			—	" "	
	A-9 4068			—		coal fill	
	A-9 4070			—			
	A-9 4136			—			
	A-9 4159	—			—		
—	A-9 4202	—			—	foliated porp.	old sect.
	A-9 4279			—			
	A-9 4282		NO	—			
—	A-9 4437	—		—	—	b.f.p.	old sect.
	A-9 4449			—			
—	A-9 4580	—			—	sch	" " *
	A-9 4734				—		
—	A-9 4737						
	A-9 4902	—			—		
	9-4055		Lauble Polished			for heat-stress work	
	9-4428		"			* See V. Kuroda's report of March 19, 1970 for sample A-9-4449	
	9-4856		"			" " " "	

Thin-section, etc. collection

Drill Hole No. A-10

Sample No.	Thin-Sec Pics	Polished Thin-Sec Pics	Polished Sec Pics	K-Stain Slab	Remarks
A-10 3369					Tw
A-10 3388					M-1A-SB
A-10 3436					A-2SB
A-10 3442					" "
A-10 3597					" "
A-10 3691					" " blk pay
A-10 3697					" "
A-10 3765					
A-10 3829					" "
A-10 3891					leached BR
A-10 3899					" "
A-10 3961					
A-10 4052					blk pay
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		"			" " " "

Thin-section, etc. collection

Drill Hole No. A-11

Sample No.	Thin-section	Polished Thin-section	Polished section	Kryptoscopic slide	Remarks
11-4203		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 slides	Kistler slide on glass slides	Remarks
A-12-3530	X				schist bx
A-12-3764	X				schist w/hematite
A-12-4021	X			SLXD	schist, qtz-seri alt, hem after cc?
A-12-A-4100			X		schist copping w/ Cu°
A-12-A-4110	X			X	schist copping
A-12-A-4129	X			X	porphyry bx, leached copping, qtz-seri. ~~schist w/ cc py vein~~
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 #4167PT)	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			Stouffle	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

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

Sample No.	Thin-section	Polished Thin-section	Polished Section	K-stain Slide	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			X	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 - specularite
A-12-5174		X			aplite vn w/ cp-bn
A-12-5252	X			X	blk biotite schist w/ sugar 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 (specimen) + py-hematite
A-12-5417	X			X	Lbfp as above ; no py-hem.

Continued

Thin-section, etc. 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/py-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 w/ hem fractures.
A-12-5625	X			X	Lbfp, more stained w/ py-seri.
A-12-5627	X			X	Lbfp, sheared & gouge
A-12-5633	X			X	Lbfp, very sheared & gouge
A-12-5665	X			X	Z schist, cataclastic crushing
A-12-5692	X			X	schist, silica overprint, fine alunite?
A-12-5716	X			X	schist, with alunite? on.

Drill Hole No. A-13

13-3552	Double Polished	for heat-stage work
13-3950	"	" " " "

Drill Hole A-14

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

Thin-section, etc., collection

Drill Hole No. AI-1

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	Rock Chips	Remarks	
AI-12822				■	M-1A SB	
AI-12997					" "	
AI-13054					A-2 SB.	
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					pinal	
A-I-19 (3949)						*
A-I-20 (3963)						*

* Sorted 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	Kystein Slide	Remarks
3450					pepi

Thin-section, etc. collection

Drill Hole No. DCA-1A

Sample No.	Thin-Section	Polished Thin-Section	Polished Section	Kylex Slide	Remarks

See report by Emanuel Weiner 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	Kystein Slide	Remarks
DCA-2 1538					schist
DCA-2 1547					schultz
DCA-2 1928					schist
DCA-2 2393					schist

Thin-section, etc. collection

Drill Hole No. DCA-3A

Sample No.	Thin Sec.	Polished Thin Sec.	Polished Sec.	Rock Slab	Remarks	
DCA-33205 Vet	—				tuff-lav.	
DCA-34100	—				M-1A SB	
DCA-34193	—				Tw	
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	—			—	BR	
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	Kystein Slide	Remarks
M-1 - 2241' (~~1225'~~)					~~Other~~ earlier volcanics — See report March 5, 1971 GRK.
M-2 - 2241' (~~1225~~)					
M-1A-1-2981					M-1A SB — See report Jan 20, 1972 by GJS.
TBX-7-M-1A-2457					Tcu — TBX samples: See report Jan 19, 197. by GJS.
TBX-8-M-1A-3125					Tcu
TBX-9-M-1A-4275					Tcu
M-1A 3515 Vat					tuff

Also see report by V. Kadrigh to Collins July 13, 1971 on microscopic & microprobe work on sample M-1A - 4239.

Also see assay report by Geochem Laboratories Jan 20, 1972 on sample M-1A-A (2935-2945)

OF-1A hole of Ken-McGee — collection

Drill Hole No. ~~OFA-1 & OFA-2~~ ~~of Ken-McGee~~

Sample No.	Thin Section	Polished Thin Section	Polished Section	Key Fossil Slide	Remarks
OFA-1-2140'	—				spine sample, one cut ⊥, other ∥ to core axis. earlier volcanics
OFA-2-2140'	—				" "
~~OFA-2~~	—				earlier ~~volcanics~~

#2140 See page March 5, 19 JHK

#2140

Thin-section, etc. collection

Drill Hole No. LB-4

Sample No.	Thin-Sec Pan	Polished Thin-Sec Pan	Polished Sec Pan	K-Ar Sample	Remarks
LB-4-2600	—			slide	* See report Feb. 13, 1975 by F.T.G. on fluid inclusion
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	Kystone Slide	Remarks
SACBF-1					
SACBF-2					

Thin-section, etc. collection

Drill Hole No. QDC-5

Sample No.	Thin-Sec. Pan	Polished Thin-Sec. Pan	Polished Sec. Pan	Kystin Slide	Remarks
QDC-5538	—				
QDC-5575	—				
QDC-51800	—				
QDC-52729	—			? —	
QDC-52802	—				
QDC-52811	—			? —	
QDC-52858	—				
QDC-52887	—				
QDC-52900	—				
QDC-53202	—				
DC-53502	—				

Thin-section, etc. collection

Drill Hole No. Other Samples From District

Sample No.	Thin Section	Polished Thin Section	Polished Section	Rock Specimen	Remarks
X-14		in basement file			Last Gabel quartz, monzonite
Z-1		in basement file			monzonite granite
Z-2					
Z-3					
Z-4					

See report May 5, 1972 by G.S.S.

Thin-section, ore, collection

Drill Hole No. Magma B-6 hole.

Sample No	Thin Sec.	Polished Thin Sec.	Polished Sec.	Kyle Sec.	Remarks
B-6-A		■			Troy w/ cc on sp.
B-6-B	■				Martin repl texture
B-6-C		■			Troy, w/ mn

Thin-section, etc., collection

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

Sample No.	Thin Sec.	Polished Thin Sec.	Polished Sec.	K-Ar Sample	Remarks
QC-1A					middle Naco ; mn nicks
QC-2A					top Escabrosa ; mn. nicks
QC-3A					middle Escabrosa ; excell. repl. textures
QC-7A					lower Martin ; excellent repl. textures
QC-8A					upper Bolsa qtz. Fe-stained
QC-101					lower Naco ; 45' above Karst above QC-102
QC-102					upper Escabrosa ; mushroom Mn, below Karst.

Take on 15 OF-1 samples & send rest to USP — mark with stain of slab (also on loc sheet)

Things to be found:

One polished section of OF-1A (found) (piece of slab only).
One polished section of M1-1 (both E. vole.).

A-2-1 (4078') ~~E. vole~~
A-2-2 (4212') ~~E. vole~~
~~A-2-7 (4052)~~

A-4-3 (6573') filtrouse
A-4-5 (6445') Escabrosa Bx

Pyb formation

A-I-10 (2884')
A-I-11 (2981')
A-I-12 (3092')
A-I-13 (3200')

DCA-1A-4714 Moca (2 samples?) Mannies Sample
DCA-1A-5201 Escabrosa

Dr. Val Kudrysk, Manager
Central Research ~~Laboratories~~ Department
ASARCO Incorporated 901 Cole Street Road
South Plainfield, New Jersey 07080.

Sent 2/23/76

Call Jim Coley on polished section work.

TAB

Appendix IV

ASARCO

Southwestern Exploration Division

February 26, 1986

TO: H. G. Kreis

FROM: J. D. Sell

Thin-, Polished-, Heat Stage Sections
Superior East Project
Pinal and Gila Co's, AZ

I understand you have read the Superior East file of reports, drill hole data, assays, etc.

Attached is a list of the thin-sections, polished sections, and heat-stage sections of the collection from the Superior East Project and nearby areas. A list of reports on various parts of the collection is also attached and often noted on the individual drill hole or area list.

You are requested to study and write up each section available with particular attention to the igneous rock types, alteration phases, fluid inclusion types, and sulfide phases.

The thrust of the study is:

1. To better define the relationship of the igneous phases to each other and to the sulfide mineralization.
2. The zoning pattern in wall-rock and veins through changes in alteration and sulfide distribution.
3. The thermal zoning pattern.

A preliminary progress report should be completed on each hole. Conceptual notes written to suggest and guide future studies. Suggestions on additional material that may be needed for a final report should also be noted.

The present study is time limited.

James D. Sell
J. D. Sell

JDS/gb

Attachments

cc: FTGraybeal
WLKurtz