CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
http://www.azgs.az.gov
inquiries@azgs.az.gov

WLK

JDSell: What's the geology causing this thing? FTG

GEOPHYSICAL OFFICE - EXPLORATION DEPARTMENT
Salt Lake City, Utah

May 16, 1980

F.T.G.

RECEIVED
MAY 19 1980
S. W. U. S. EXPL. DIV.

Mr. F. T. Graybeal
Tucson Office

Dear Fred:

The anomaly outlined in red on the enclosed map is a 1200 gamma low. This is about 10 times what would be expected to occur from the magnetic high to the south. The only explanation I can think of is that a large amount of magnetite was emplaced here during a reversal in the magnetic poles. Possibly skarn or intrusive with lots of magnetite. It appears to fall completely in a pediment area.

Yours very truly,

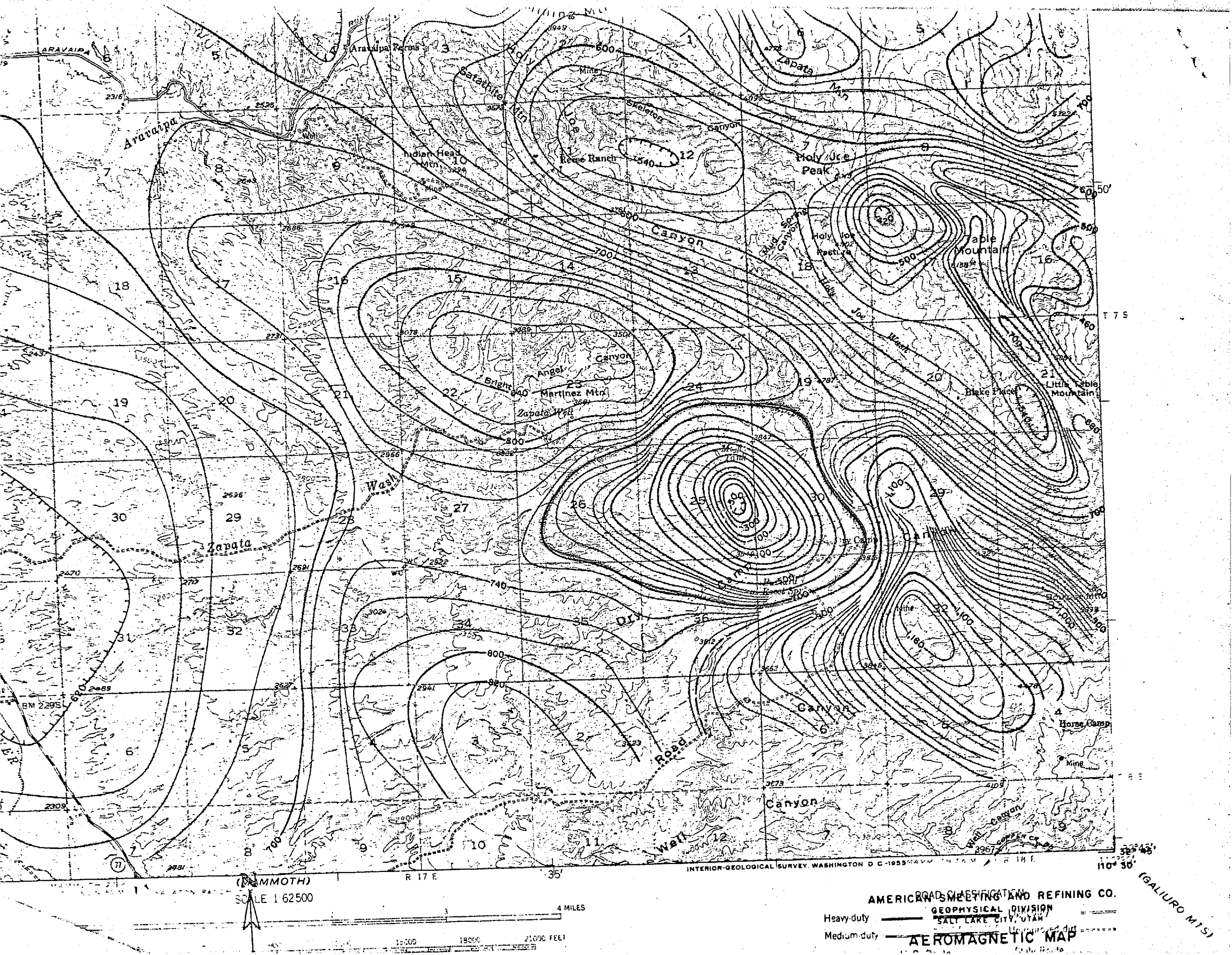
Jerry Montgomery

J.R MONTGOMERY

JRM:am
Enc.

The center of the low is in area of Pinal schist with some
Copper Creek granodiorite exposed at edge of cover which continues to east. Gravel to west.
west. Prominent outcrop in E 1/3 of Sec. 25.
SE of Holy Joe Peak is in
The 420 low in NW corner Sec. 17 (T 7S)
Martin & Escabrosa limestones; the 540 low in SW 1/4 of Sec. 21 (T 7S)
is in Escabrosa limestone.
on the basin side of the
Epidoted limestones were preserved
large (?) faults under the gravel cover of Sec. 25 & 26. They would
be very favorable for massive replacement by magnetite-specularite-
copper such as found at the Magma Superior Mine.

Holy Joe Quad GQ-669



AMERICAN SMELTING AND REFINING CO.
GEOPHYSICAL DIVISION
SALT LAKE CITY, UTAH
AEROMAGNETIC MAP

T-152

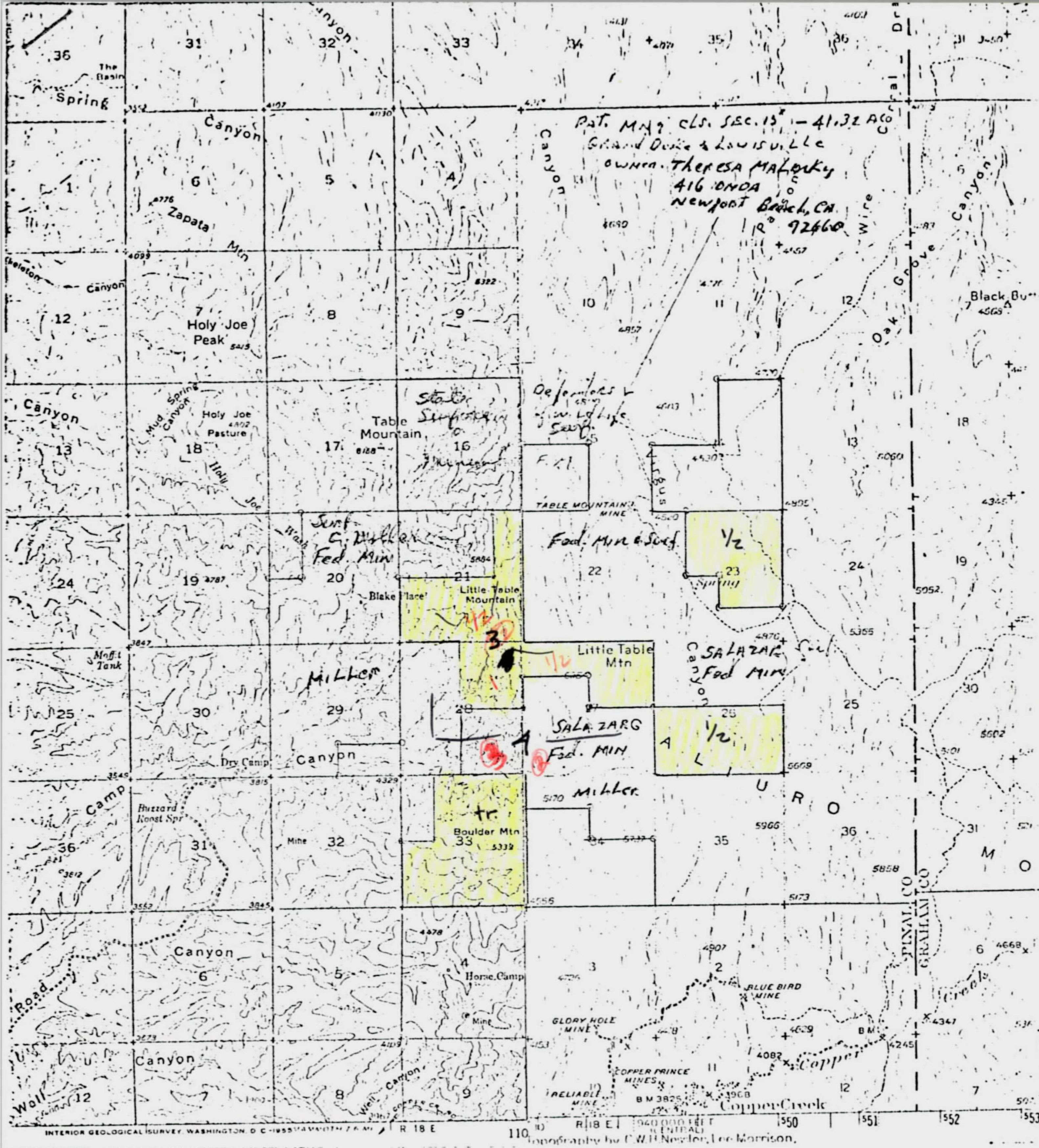
APRIL

1F 23 days

Total Cost 274.15

#11.92/day

± cost purchasing of
vehicle — depreciation,
gas etc [illegible] [illegible]
[illegible]



Filed Six P.P.
yellow Areas.
Orange is open
State Land
Uncolored is Fed. Mins

APPLICATION FOR PROSPECTING PERMIT

IN SECTION ____ TOWNSHIP 7 south RANGE 18 EAST

ASARCO INCORPORATED

scale 1" = 1 Mile base from USGS ________ topographic quadrangle (s)

3441 East Milber
Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE April 19, 1978

SAMPLE MARKED	GOLD OZ / TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-								
9			0.01	0.02		.0005		
10			0.01	0.02		.0008		
13			0.01	0.02		.0022		
15			0.01	0.02		.0009		
16			0.01	0.01		.0011		
18B			0.01	0.02		.0006		
LTM-20			0.01	0.02		.0004		

Invoice # 15741

CHARGES $ 237.50

Peter S Hor[illegible]
4/19/78
ASSAYER-CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

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LTM-							
22			0.02	0.03		.0012	
23			0.01	0.03		.0005	
24			0.01	0.03		.0010	
27			0.01	0.02		.0008	
28			0.01	0.01		.0009	
29			0.01	0.01		.0014	
30			0.01	0.01		.0003	
LTM-32			0.01	0.01		.0005	

Pete J. Flores
4/19/78

Invoice # 15741

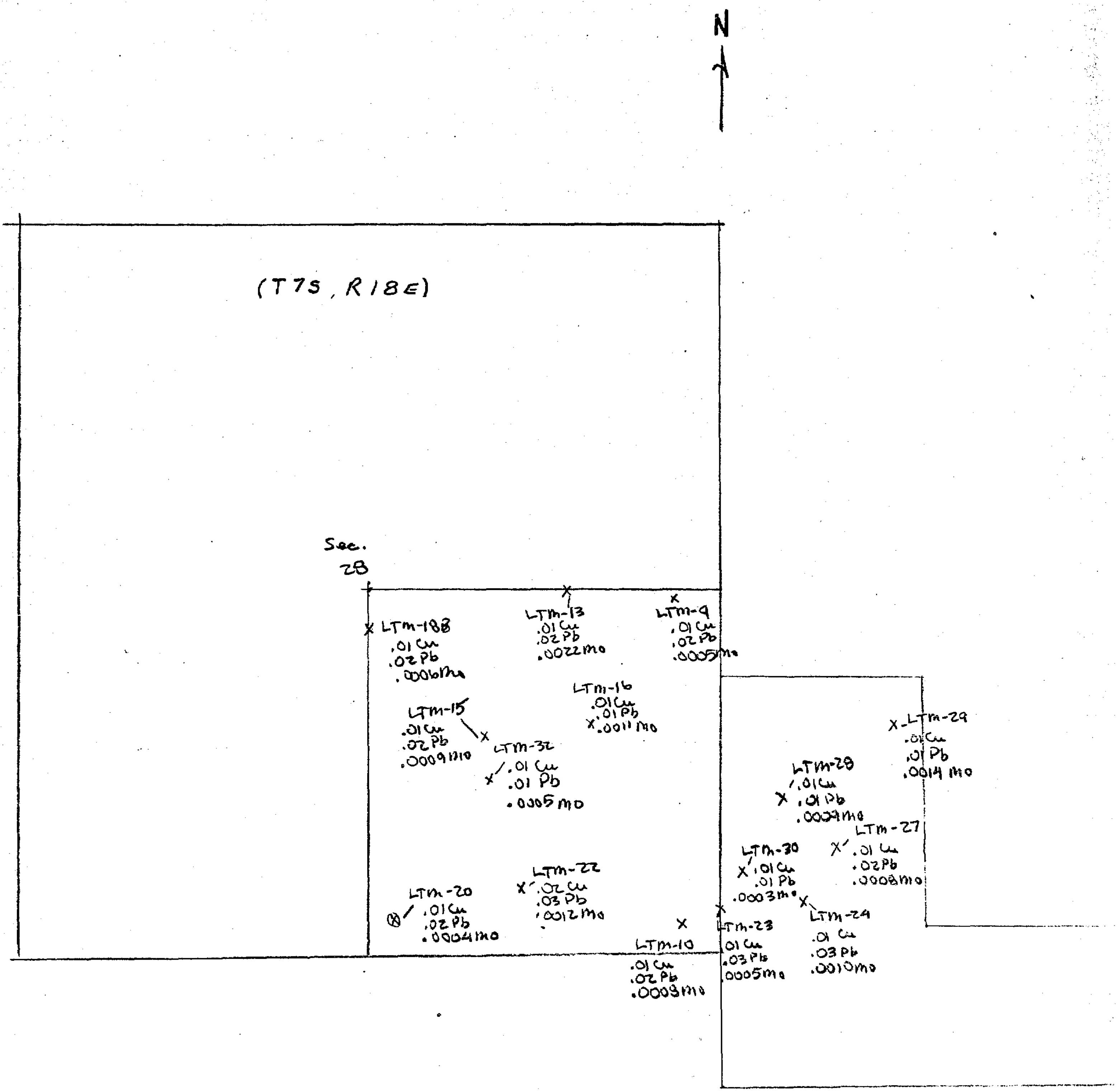
ITEM NO. SAMPLE NO.

2 = LTM-20

ITEM	2
ELEMENT	
Fe	3%
Ca	7%
Mg	3%
Ag	<1
As	<500
B	10
Ba	10
Be	<2
Bi	<10
Cd	<50
Co	10
Cr	20
Cu	10
Ga	<10
Ge	<20
La	20
Mn	1000
Mo	<2
Nb	<20
Ni	50
Pb	50
Sb	<100
Sc	<10
Sn	<10
Sr	200
Ti	500
V	30
W	<50
Y	<10
Zn	200
Zr	<20

Charles E. Thompson
Chief Chemist

SKYLINE LABS, INC.
SPECIALISTS IN EXPLORATION GEOCHEMISTRY



6/5/78

samples + assays on Parker - Johnson - Tapia permits + claims

LTM Project → PGV

1" = 1000'

SPECTROGRAPHIC ANALYSIS

LTM-20

element		
Fe	3%	
Ca	7%	
Mg	3%	
Ag	<1	ppm
As	<500	"
B	10	"
Ba	10	"
Be	<2	"
Bi	<10	"
Cd	<50	"
Co	10	"
Cr	20	"
Cu	10	"
Ga	<10	"
Ge	<20	"
La	20	"
Mn	1000	"
Mo	<2	"
Nb	<20	"
Ni	50	"
Pb	50	"
Sb	<100	"
Sc	<10	"
Sn	<10	"
Sr	200	"
Ti	500	"
V	30	"
W	<50	"
Y	<10	"
Zn	200	"
Zr	<20	"

3441 East Milber Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

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TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE April 19, 1978

SAMPLE MARKED	GOLD OZ/TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON
LTM-							
9			0.01	0.02		.0005	
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18B			0.01	0.02		.0006	
LTM-20			0.01	0.02		.0004	

4/19/78

Invoice # 15741

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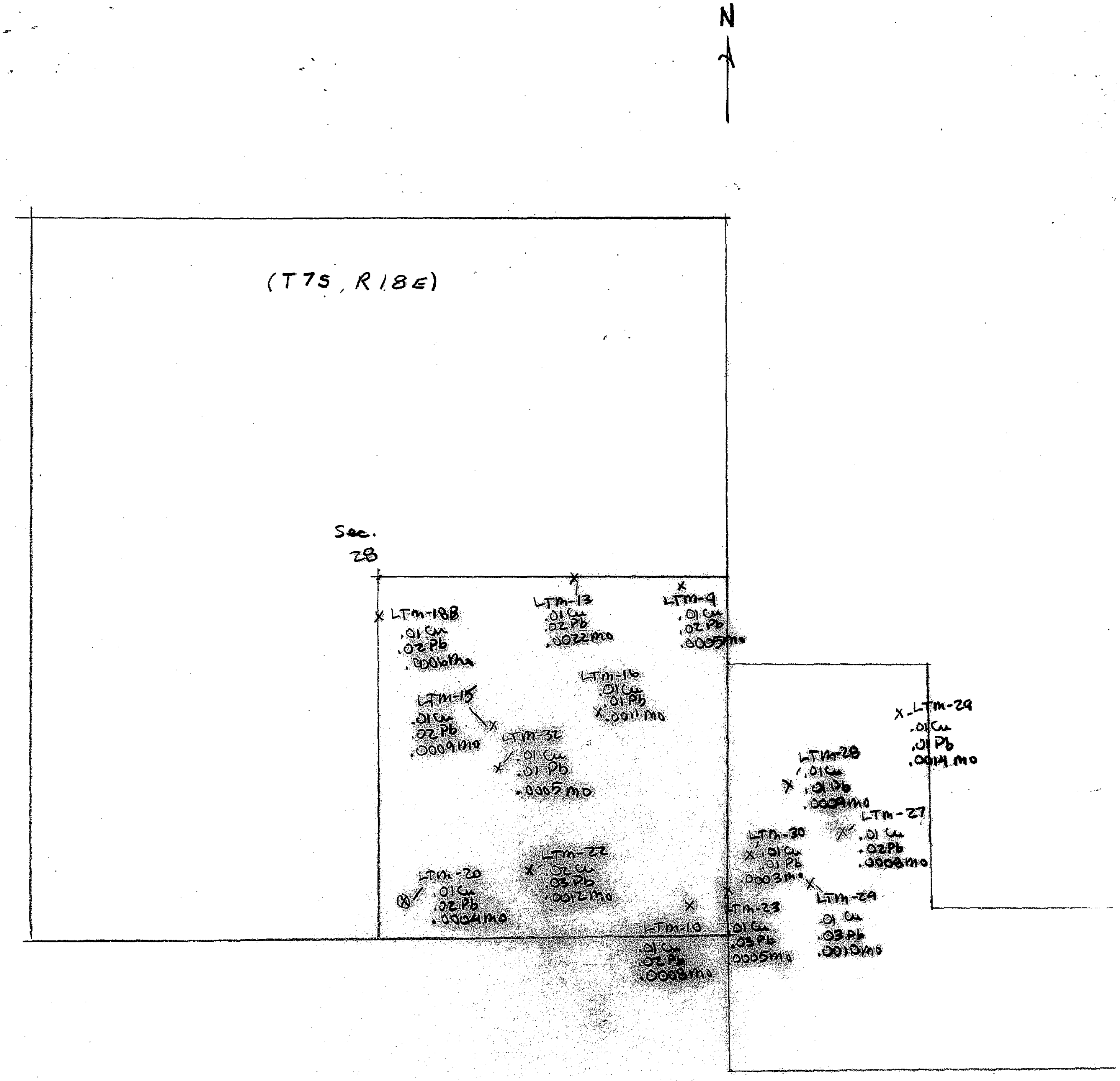
28			0.01	0.01		.0009	
29			0.01	0.01		.0014	
30			0.01	0.01		.0003	
LTM-32			0.01	0.01		.0005	

Pete A. Flores
4/19/78

Invoice # 15741
95.00



6/5/78

Samples + assays on Parker-Johnson-Tapia permits + claims

LTM Project → PGV

1" = 1000'

SPECTROGRAPHIC ANALYSIS

LTM-20

element		
Fe	3%	
Ca	7%	
Mg	3%	
Ag	<1	ppm
As	<500	"
B	10	"
Ba	10	"
Be	<2	"
Bi	<10	"
Cd	<50	"
Co	10	"
Cr	20	"
Cu	10	"
Ga	<10	"
Ge	<20	"
La	20	"
Mn	1000	"
Mo	<2	"
Nb	<20	"
Ni	50	"
Pb	50	"
Sb	<100	"
Sc	<10	"
Sn	<10	"
Sr	200	"
Ti	500	"
V	30	"
W	<50	"
Y	<10	"
Zn	200	"
Zr	<20	"

ITEM NO.		SAMPLE NO.
2	=	LTM-20

ITEM	2
ELEMENT	
Fe	3%
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Ba	10
Be	<2
Bi	<10
Cd	<50
Co	10
Cr	20
Cu	10
Ga	<10
Ge	<20
La	20
Mn	1000
Mo	<2
Nb	<20
Ni	50
Pb	50
Sb	<100
Sc	<10
Sn	<10
Sr	200
Ti	500
V	30
W	<50
Y	<10
Zn	200
Zr	<20

Charles E. Thompson
Chief Chemist

SKYLINE LABS, INC.
SPECIALISTS IN EXPLORATION GEOCHEMISTRY

Bob: This is ± the time spent on the Little Table Mtn area. Can a $ figure be given to Tapia?

Thanks,

Jim.

Prosp. Permit Sec. 21. ½ day PG Vikre.

Prosp. Permit Sec. 23 ½ day PG Vikre

Prosp. Permit Sec. 26 ½ day PG Vikre

Federal Mining Claims of Sec. 27. 2½ days PG Vikre
1 day JD Sell
½ day FT Grayhead
½ day drafting dept.
Amer. Analy Res. Lab ± ½ of assay = $22.00
½ day secretarial typing report.

Prosp. Permit NE¼ of Sec. 28. 1¼ days PG Vikre
½ day JD Sell
¼ day FT Grayhead
¼ day drafting dept.
¼ day secretarial typing.

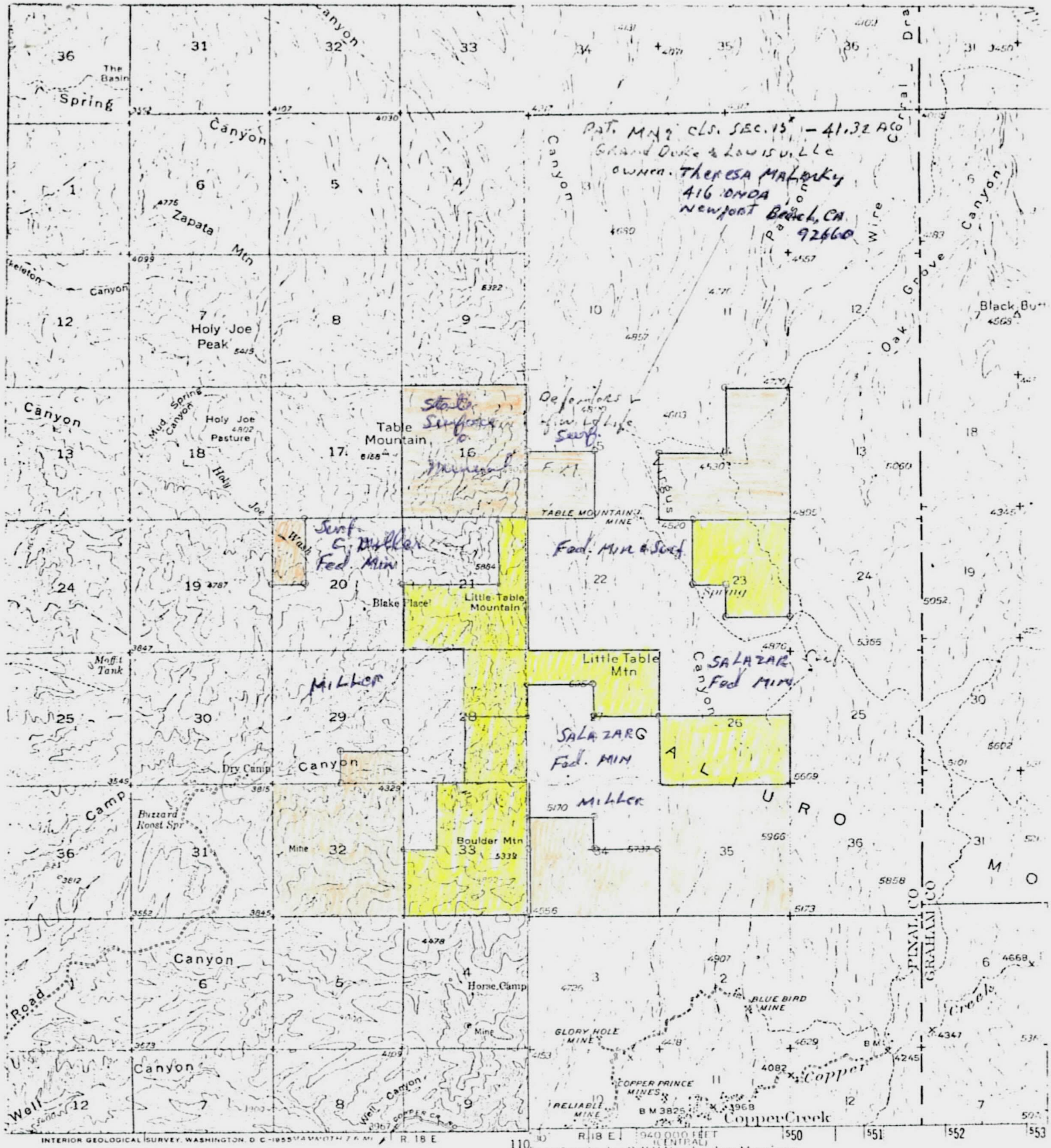
Prosp. Permit SE¼ of Sec. 28 (Tapia et al) 3¼ day PG Vikre
½ day JD Sell
¼ day FT Grayhead
¼ day drafting department
¼ day secretarial typing
Amer. Analy Res. Lab ± ½ of assay = $23.75
Skyline Labs ES report = $13.50.

Prosp. Permit Sec. 33 ¼ day PG Vikre

All Prospecting & Claim Area time of RB Cist.

Little Table Mtn Thin-Sections

LTM-1 Specularite cemented cornflake breccia.
LTM-2 Silica replaced limestone (jasperoid) from
LT mine, east side of range.



Filed Six P.P.
yellow areas.
Orange is open
State Land
Uncolored is Fed. Min.

APPLICATION FOR PROSPECTING PERMIT

IN SECTION ____, TOWNSHIP 7 SOUTH, RANGE 18 EAST

ASARCO INCORPORATED

scale 1" = 1 MILE base from USGS __________ topographic quadrangle (s)

1/20/78

JDS

this will give you a general idea of Surf. ownership
Should be more carefully checked.

Largest acreage: ① Catherine B. Miller
Mammouth
② Lupe Salazar (uncle) Bill & Tex Salazar
Aravaipa
③ Defenders of Wildlife
Tucson

Peter Vikre

4/10/78
COPPER CREEK

Still another change for a field review of Cu Creek mapping which should be mostly complete by then.

I suggest Monday, Apr. 17. Jim Sell will hook up with you or all meet at my house. You two pick the time and call me Sunday night April 16 to confirm.

You might have your back seat in by then as WLK may also want to go.

cc: JDS
WLK

FTG

[redacted]

(1) N70°E vert to 80°S. 1½' crushed SiO_2 & alunite? w/ MnOx + wolframite xls. in dense sheeted volc. rock, w/ minor limonite streaks & MnOx on fracture face.
6' cut along structure, then 20' S is 25' shaft (ca 1910 w/ buried small bucket!) on structure. Minor weak CuOx color adsorbed on clays.
Another subparallel structure 80-90' to N, also dips 80°S, qtz bx in weakly sheared wallrock.
Becomes increasing Fe stained & bleached as Dry Camp Canyon is approached along side gully. E-W fracture dipping 65-70°N, along ~~DC~~ Canyon offset N30°W fracture & bleached zone. N side West. Volc becomes fine porphyritic to very porphyritic (may be platy fragmental).
(2) bx pipe area. very broken w/ fluidized type dikes & zone outlines bleach. contains zones of very porous hematite filled rock type units, dull brick red few silic porphyry type w/ blk hematite stain. Main fractures 2-3' apart trend N60E & probably extend bx zones in same direction.
(3) Clean white to dusty grey qtz-ite unit (lots alteration again) trending N30°E dips steeply West, apparently 100' across & bounded both sides by relatively unaltered, grey volc. Apparently another shear to west.
(4) west of N10-20° creek between (3) & (1) is a subvolcanic fine porphyry with tight N10E fractures containing silica & weak Fe. Some diss. specularite esp. near fractures although some noted in wall rock see specimen
South of four are several 2-6" silic qtz filled fracture zone trending N15°E & N40E. Minor crushing, weak clay-alunite? carbonate? very weak Fe, minor CuOx (spots) "granite" wallrock weathering into 2-8" rounded boulders. Copper Creek granodiorite?
Further up ridge a small saddle is N45°E vertical 2-4' wide shear zone with minor MnOx, silica rich boxwork with dusky green coatings, some specularite
(5) & wolframite in crushed zones. Copper Creek gd tends to become more porphyritic & MnOx stained toward mineral-silica structures. Strange green coatings.
Also few vanadinite xls.
Subparallel structure to SE has green-yellow-blue green (Conichalcite? Arsenates?) in silica impregnated broken rock fracture zone.
from 5 ridge it appears that 2 zones can be delineated. The inner zone very colored variable brick red in bx pipes & shear bx zones elongated N60°E. The outer zone of silica carbonate? alunite? fracture fault zones trending various EW, N60E, N40E, N15E containing MnOx with spotty green chrysocolla, wolframite, vanadinite etc. weakly altered & bleached! Both zones grade outward into essentially

fresh copper[illegible] gel with the stronger fracture-shear fault zone w/ silica continuing [illegible]. Both zones appear to go under younger volcanics.
Recent sample high Pb, 1/2% Mo + 4 ppm Hg + Zinc Cu very low Ag Au
⑥ Very good spectacular cemented & xl coated bx zones trending N30-60°E.
In separate Mo block in contact with middle zone volcanic (mostly alt cut by few [illegible]) the contact w/ Mo is brecciated w/ plastic flow filling for 5-20 with minor wk alt (tactite) along sandy zone. Otherwise coarsening of lms w/ minor calcite xl zone & wk MnOx (?).
~~Some~~ silica added in contact zone, no chertification.
⑦ Lms ridge in creek. CC qd & fine green alt phase intruding lms alt to light yellow tactite interior w/ epidote-pyrite (oxidized limonite stained surface). The blk tactite looking zone ‖ to Madera's fault & saddle in ridge (NS) is 60-80' shale unit w/ lenses & bunts of blk oxidized zinc-Fe mineralization. Shale has much Fe on laminae & fractures (pyrite) Mineralized shale abuts on what a sill of greenish intrusive (diorite) about same thickness that has Fe on shears & fractures. Contact of shale-intrusive is fault controlled with fault continuing up, strike N15°E., near vertical. 10-15' wide alt zone in shale [illegible] converting them to [illegible] brown color w/ chert of Fe silica in [illegible] & nodules & irregular masses.
Just E of s in lms is a spectacular [illegible] qtz vn of lms bed. Outer contact may extend & include this area! (?). On eastward up ridge, the lms reflect increased alteration, green [illegible], pink marble etc. Undoubtably w/ zone.

Blood poison weed. good for infection, but weak tea, soak rags or around.

Frank Tapia
San Manuel Jct.
7:00 AM

Monday Jan. 9, 1978

GQ-469 Holy Joe
PP-441 Klondyke

RBC
JDS

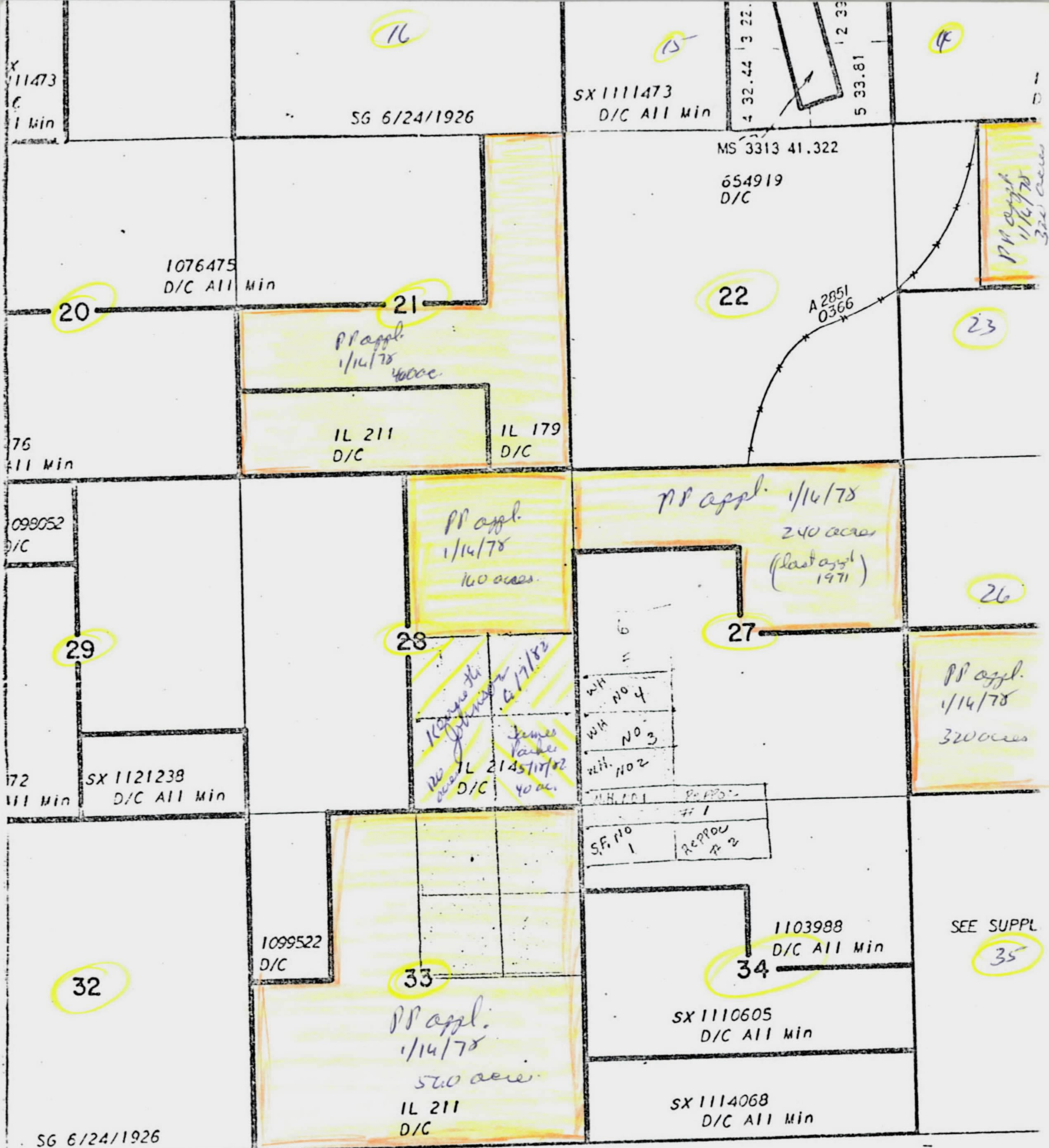
Tapio Group
Little Table Mtn
Pinal Co, Az

Need the Plats of T 7 S, R 18 E
~~T 6 S, R 19 E~~
~~T 8 S, R 18 E~~
~~T 8 S, R 19 E~~

Need ownership & State Lessees of

~~S~~ Sections 14, 15, 16 (including MS 3313)
20, 21, 22, 23
26, 27, 28, 29
32, 33, 34, 35

Dept. of Wildlife
Claude McNair



GREEN - STATE-LEASE

BROWN - Walls

SCALE

10 5 0 10 20 30 60

30 chains to the inch

Kenny Johnson

JIM PARKER

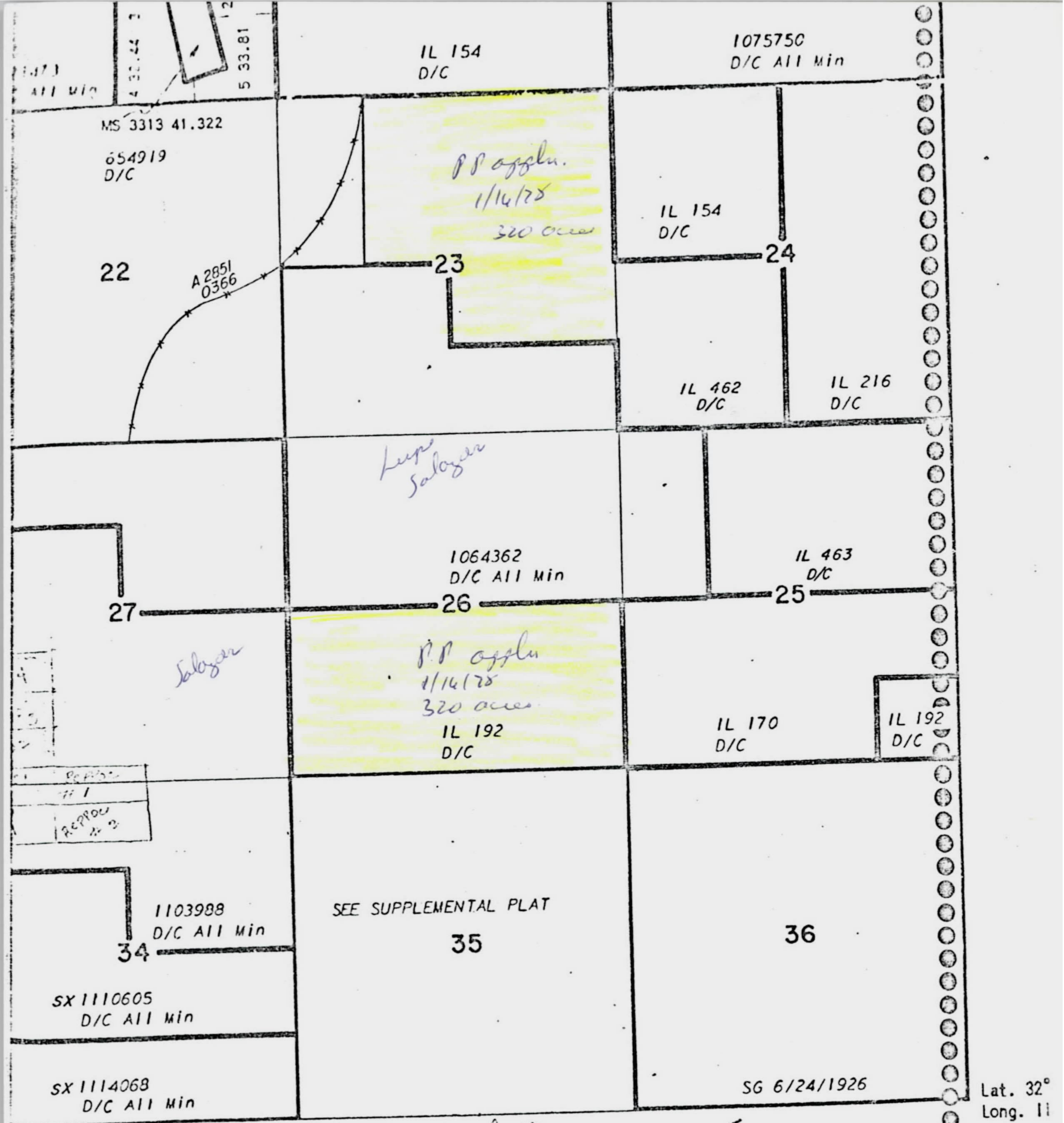
KENITH - JOHNSON

FRANK S TAPIA

T7S

R18E

ORANGE - Sam



BROWN - Walters 1-6 Claims
Kenny Johnson 1-4-6
San Francisco NO 1 - BOOK 815 Page - 648
Florence Az.
ORANGE
Frank A Lopez
Reppoc # 1 + 2
Leandro Montijo

Contact Tapia
ck State Lease area, number & date filed (Apr May 1977)
ck claims (9)
We will map & sample 2-3 months
? on holding off other while agreement is signed but final based on mapping sampling (OK)

Credit Card No. 150-2907-064-H
ph. 385-9268 San Manuel

JD Sell January 1

JD Sell

Property held by

Frank S. Tapia
112 4th Ave
San Manuel, Ariz. 85631
ph. 385-9268

Property 2 miles N of Cu Creek; has 2 State P.P. on 1/4 section and 9 unpatented claims. Geology as described in attached.

Access from Cu Creek road just W. of where road falls into Cu Creek at the mountain front.

Please review files to determine whether its worth a field exam + let me know at that time. Lms repl. potential?

If you don't want to do - give it back.

FTG
12/20/77

MINERAL PROPERTY EVALUATION

Property Investigated:

The "Tapia" claim located in NW/4 Section 34, Township 7S, Range 18E, Pinal County, Arizona, was visited briefly on March 24, 1977. The field party consisted of John Evans, Frank Tapia, Joe Robles, Frankie Tapia, Monty Montijo, and David Wahl.

Field Observations (see attached copy of field notes):

The main rock type at the prospect pit is a porphyritic andesite cut by a one foot (+) thick fault zone which trends N75E.* The vein is almost vertical, and contains some fairly well-developed wulfenite ($PbMoO_4$) crystals averaging 1/16 to 1/8 inch in cross section. Within 500 feet of the prospect pit, fine-grained light-colored granitic dikes 2 to 3 feet wide intrude the older volcanic rocks. These dikes trend NNE and contain much epidote as alteration features (Photos 32477-14 & 32477-15). A larger knob-like mass of granitic material crops out about 1000 feet SSE of the prospect pit.

Alteration of the entire area is striking (Photo 32477-17), and of particular interest is the exposure of Paleozoic limestones approximately 1 mile NW of the Tapia claim (Photo 32477-16). Numerous inactive and active (?) mines are scattered throughout the district.

Assay (see assay report):

One assay sample was collected by Evans, et. al., from the vein at the prospect pit (sample JE 4). The 2.10oz Ag/ton is somewhat encouraging, but rock of that grade is not usually mined, especially in thin veins.

Library Research:

Subsequent to the brief field inspection, two geologic maps were studied to evaluate observed field relationships (Krieger, 1968; Simons, 1964). These maps did indeed confirm that an intermediate volcanic pile (Glory Hole Volcanics) had been intruded and altered by a more silicic coarse-grained unit (Copper Creek Granodiorite). Fortuitously, the Copper Creek Granodiorite is Laramide

* SEVERAL N75E TO EW FAULTS WERE NOTED IN THE CLAIM AREA.

in age, the age of most well-developed copper mineralization in Arizona. Another salient feature in the local geology is the presence of large blocks of Paleozoic limestones. This limestone is the host for ore deposits at Table Mountain N of the Tapia claim, and elsewhere in the district. As the deposits at Table Mtn. are all oxides (surficial type deposits) there is a possibility that the ore bearing solutions originated from a buried unexposed source (Simons, 1964, p. 152).

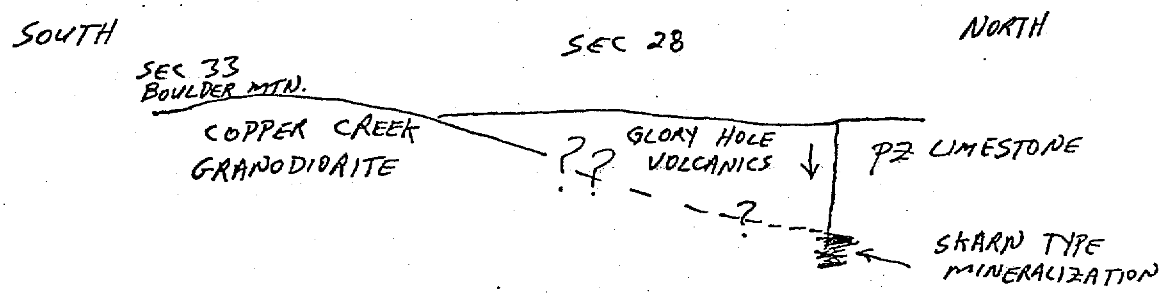
Approximately 1½ miles SE of the Tapia claim is the Bluebird lead-silver mine. This mine was developed on numerous subparallel fissures, and two mineralized bodies were encountered. One of these bodies was good silver-bearing galena, while the other was subcommercial wulfenite (Kuhn, 1951).

Conclusions:

In my opinion, the Tapia claim deserves consideration for further exploration. Normally the method of exploration would be a drilling and sampling program. In this case, however, actual adit and shaft driving may not be ill advised. Labor is apparently available at the right price, and saleable mineral specimens would more easily be recovered. If good mineral samples are not "quickly" found, I suggest that some sort of drill be brought in. Most of the wulfenite I observed at the prospect was not good enough to sell for much of a profit. Another word of caution; veins do not have to become richer at depth - - quite the contrary is often true (Butler, 1935). However, veins can change character with depth. Wulfenite, $PbMoO_4$, is quite commonly found in the oxidized zone above galena, PbS. Thus, it is within geologic reason to suggest that galena may be found at greater depth. Galena in this district apparently contains at least small amounts of silver (Simons, 1964).

In considering the general area of the Tapia claim (the Copper Creek District), I maintain that the entire area is a first rate low grade porphyry copper prospect (see the Tapia Claim Sketch Map). This is clearly shown by the fact that a major company is currently blocking out a sulfide ore body (Tapia, personal comm.). The geologic conditions are well aligned for this type of ore body: A Laramide ("copper age") intrusion is exposed over great surface area and the host rock (Glory Hole Volcanics) is at least partly receptive to mineralization. A plum in the pudding is nearby outcrops of limestone, a rock type that is usually very receptive to ore mineralization.

Much more literature research and field study would be required before more than a wild guess could be ventured, but the following sketch illustrates a very interesting possible situation which should be checked out if more work is done NW of the Tapia claim.



Note: This is an optimistic, but possible interpretation. The Copper Creek Granodiorite could be nowhere near a contact with the limestone, or even if there were a contact relationship no ore need have been produced (as north of the Bluebird mine). In any case, if I were working in the area, I would be sure to investigate section 28 NW of the Tapia claim.

David E. Wahl, Jr.
4/7/77

References Cited

Butler, G. M., 1935, Some facts about ore deposition: Arizona Bureau of Mines, Bull. 139, 99 p.

Krieger, M. H., 1968, Geologic Map of the Holy Joe Peak Quadrangle, Pinal County, Arizona: U. S. Geol. Survey Map GQ-669.

Kuhn, T. H., 1951, Bunker Hill District, in Arizona zinc and lead deposits, chap. 7, pt. 2: Arizona Bur. Mines Bull. 158, Geol. Ser. 19, p. 56-65.

Simons, F. S., 1964, Geology of the Klondyke Quadrangle Graham and Pinal Counties, Arizona: U. S. Prof. Paper 461, 173 p.

EXPLANATION

ROCKS OF INTEREST IN STUDY AREA

COPPER CREEK GRANODIORITE - 68 MILLION YEARS OLD - COPPER MINERALIZATION ECONOMIC AT SEVERAL LOCATIONS.

GLORY HOLE VOLCANICS - OLDER THAN COPPER CREEK GRANODIORITE, BUT PROBABLY LESS THAN 130 MILLION YEARS. HOST ROCK FOR SOME MINERALIZATION IN THE AREA.

PALEOZIC LIMESTONES - 300 TO 400 MILLION YEARS OLD, POTENTIALLY AN EXCELLENT HOST ROCK FOR LEAD OR COPPER MINERALIZATION.

AREA WHERE STAKING OF OTHER CLAIMS SHOULD BE CONSIDERED - ACTUALLY, ALMOST ANY COLORED AREA SHOWN ON THE MAP SHOULD HAVE SOME POTENTIAL FOR LOW GRADE COPPER MINERALIZATION. BEST CHANCE FOR A HIDDEN, UNEXPLORED TARGET WOULD PROBABLY BE IN SECTION 28 NW OF THE TAPIA CLAIM.

GEOLOGY TAKEN FROM KRIEGER (1968), AND SIMONS (1964)

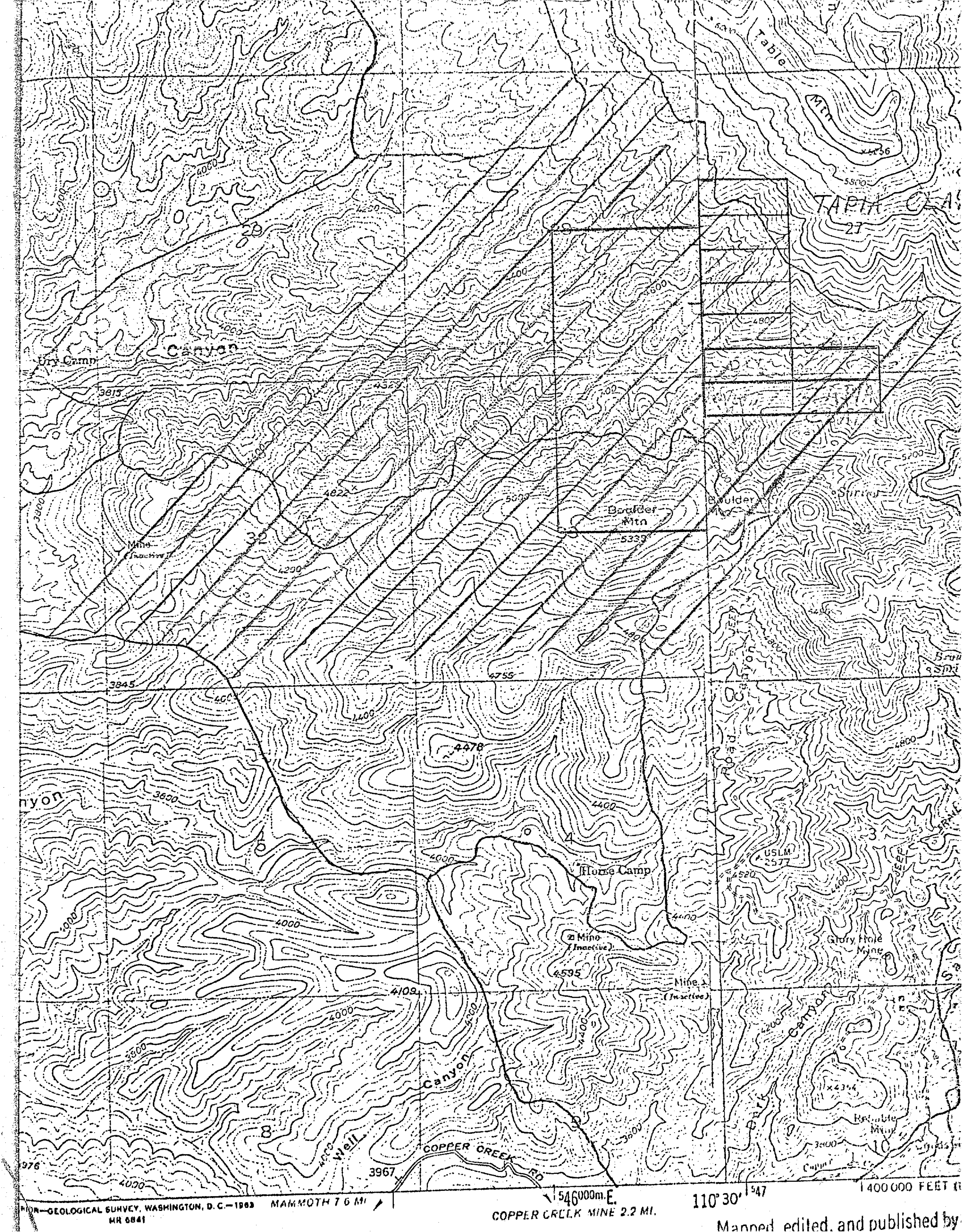


Table
Mtn
TAPIA
27
Canyon
Dry Camp
3815
4329
4822
5000
Boulder Mtn
Boulder
5333
32
Mine (Inactive)
4200
4755
3845
4478
4400
3600
4000
Horse Camp
USLM 2577
Mine (Inactive)
4595
4109
Glory Hole Mine
Mine (Inactive)
Canyon
Well
COPPER CREEK RD
3967
3976
Reliable Mine
3800
x4354
JEEP
4
5
8
9
3
10
34
MAMMOTH 7.6 MI
546000m. E.
COPPER CREEK MINE 2.2 MI.
110°30'
547
400 000 FEET
RIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1963
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GALIURO VOLCANICS, PINAL, GRAHAM, AND COCHISE COUNTIES, ARIZONA

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Abstract.— The Galiuro Volcanics occurs in the Galiuro, Winchester, and Little Dragoon Mountains, east and northeast of Tucson, Ariz. The sequence comprises lava flows and ash-flow tuffs ranging in composition from andesite to rhyolite. In general they can be subdivided into two parts separated by a major erosional unconformity. The lower part is predominantly lava flows ranging from andesite to rhyodacite but contains three ash-flow tuffs. The upper part is chiefly ash-flow tuff but also includes two areas of rhyolite-obsidian flows and domes and rhyolitic to andesitic flows. Conglomerate separates many if not all of the rock units in the upper part. The individual flows and tuffs are lenticular, and the stratigraphic relations are complex. Chemical variation diagrams suggest consanguinity among all the volcanic rocks, but the complex intercalation of rhyolite and andesite and of lava flows and ash-flow tuff indicates more than one magma chamber, different stages of differentiation in separate magma chambers, and several eruption centers. Chemical analyses indicate that the magmas were normal calc-alkaline. Eleven potassium-argon age determinations indicate that the Galiuro Volcanics accumulated from about 29 to 23 million years ago, which is in the middle of the mid-Tertiary volcanic and plutonic event in Arizona.

The Galiuro Volcanics occurs in the Galiuro, Winchester, and Little Dragoon Mountains, extending from a point about 64 kilometers east of Tucson northwestward for about 110 km (fig. 1). Most of the area underlain by the unit is shown on the geologic sketch map (fig. 2), but known or probable exposures of the formation crop out in and southeast of the gorge of the Gila River below San Carlos Lake (Creasey and others, 1961; Willden, 1964) and in the low pass between the Santa Teresa and Pinaleno (Graham) Mountains (fig. 1). Except in one small area (Krieger, 1968d), the Galiuro does not now extend southwest of the San Pedro valley, although it probably originally extended for some distance in that direction. Volcanic rocks of a similar age crop out in the Tucson (Damon and Bikerman, 1964), Santa Rita (Drewes, 1971a), and Patagonia Mountains (Simons, 1974; Drewes, 1971b), and slightly younger ash-flow tuffs and lavas occur west of Miami and between Miami and Ray (fig. 1) (Peterson, 1969; Creasey and others, 1975).

Plutonic rocks coeval with the Galiuro Volcanics crop out extensively in a northwest-trending zone defined by the Dragoon, Rincon, Santa Catalina, and Tortolita Mountains (fig. 1). No mid-Tertiary volcanic rocks occur within these ranges, only plutonic rocks. The contemporaneous volcanic rocks are confined to the flanking ranges to the southwest and northeast. Apparently this zone has been uplifted, and erosion since the mid-Tertiary has removed any preexisting mid-Teritary volcanic rocks and exposed the coeval plutonic rocks. These plutonic rocks do not extend southeast of Sulphur Spring Valley (fig. 1), and their extent to the northwest is not known to us.

The Galiuro Volcanics is gently deformed; dips uncommonly, if ever, exceed 20°. The rocks probably were tilted during the basin-and-range deformation of late Tertiary time. North of lat 32°45′, the Galiuro has been deformed into a broad, gentle downwarp, the axis of which trends east-west at the latitude of Aravaipa Creek. The elevation of the northern Galiuro Mountains probably is due to bounding normal faults on the northeast and southwest, although the faults are now largely covered by the basin fills of the San Pedro and Aravaipa valleys. South of lat 32°45′, the pile of Galiuro Volcanics forms a tilted fault block dipping gently to the east and southeast; only the western side of the mountains here is bounded by normal faults, which are well exposed around a butte near lat 32°42′, long 110°29′ (fig. 2). A parallel west-dipping normal fault extends for about 32 km through the center of the mountains (fig. 2). This fault has a vertical offset of 900–1200 meters and apparently was active during the accumulation of the Galiuro Volcanics.

PREVIOUS WORK

Early descriptions of the lithology and distribution of the Galiuro Vocanics are brief and generalized. As a part of the description of the wallrocks of a gold prospect in the central part of the Galiuro Mountains, Blake (1902) mentioned tuffs and lavas, and Darton

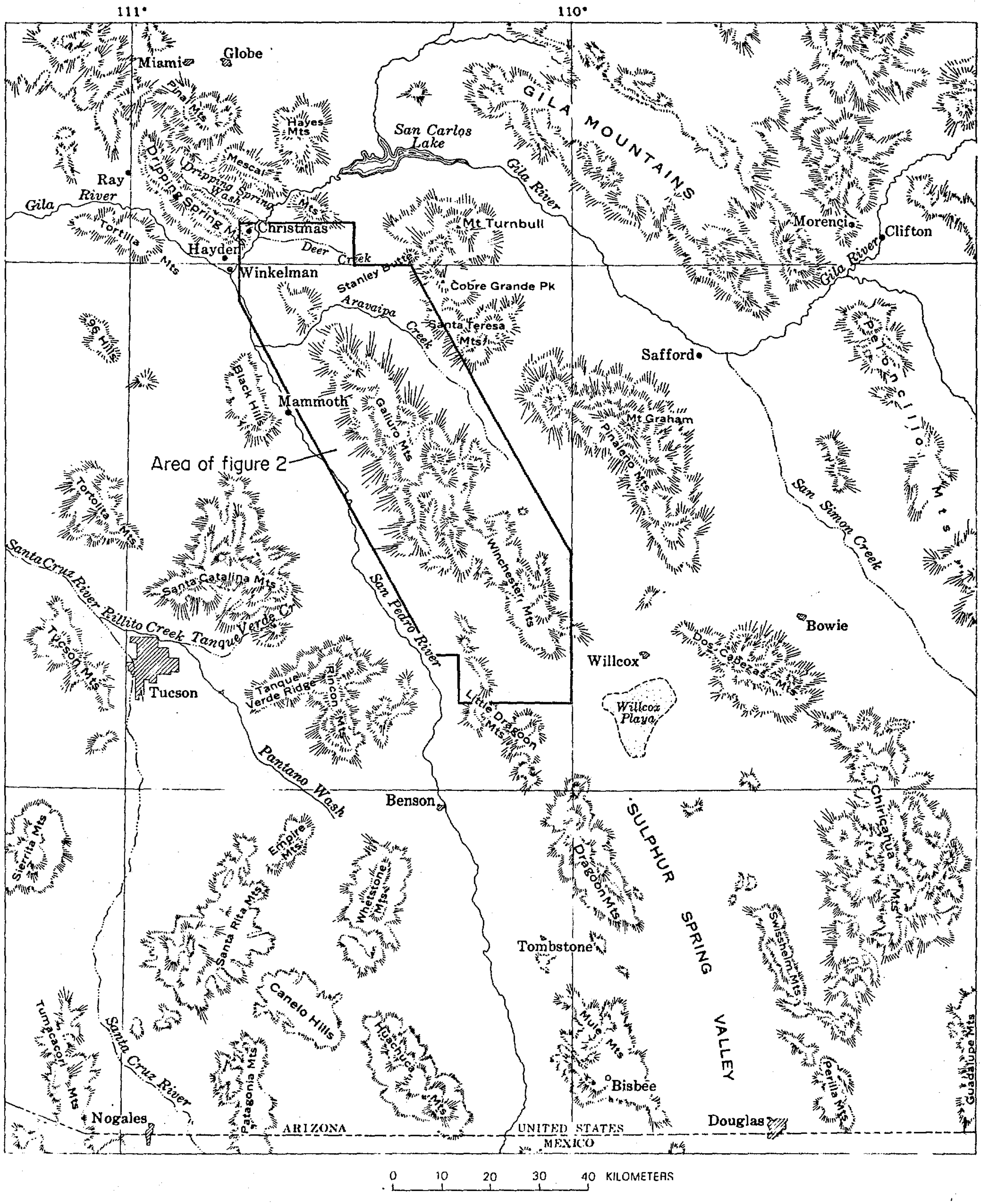


Figure 1.—Principal ranges and valleys in southeastern Arizona in relation to study area.

(1925), p. 273) described the Galiuro Mountains as "a great thickness of Tertiary volcanic rocks with some included beds of tuff, ash, and conglomerate." The first detailed descriptions of the Galiuro Volcanics were by Cooper and Silver (1964) and by Simons (1964). Although Blake referred to the rocks as the Galiuro Rhyolite, Cooper and Silver changed the name to Galiuro Volcanics because of the diverse lithology. Willden (1964) published a generalized geologic map of the northern end of the Galiuro Mountains, which contains a thin section of the volcanic rocks; however, he did not correlate those rocks with the Galiuro Volcanics. Kreiger (1968a,b,c,d) published detailed subdivisions of the volcanic rocks in the Holy Joe Peak quadrangle, and, while evaluating the mineral potential of the Galiuro Wilderness, S. C. Creasey (unpub. data) mapped in reconnaissance the central Galiuro Mountain, which contains the thickest section of the Galiuro Volcanics. With the completion of Creasey's mapping, the distribution and general character of the Galiuro Volcanics have been studied over an area from about lat 32°10′ to about 33°02′ (fig. 2). This paper summarizes what is now known of the general stratigraphy, lithology, chemical composition, and age of the formation.

Considering the complex stratigraphic relations of mappable units within the Galiuro Volcanics, agreement among those who have published maps of the rocks is remarkable. The only difference of major importance is between Simons (1964) and Krieger (1968a) on interpretation of the stratigraphic relation of andesite flows and rhyolite-obsidian near the boundary between the Klondyke and Brandenburg Mountain quadrangles. This difference is discussed below.

STRATIGRAPHY

A profound erosional unconformity separates the Galiuro Volcanics from the underlying rock. In the Little Dragoon Mountains, the volcanic rocks rest on a Tertiary conglomerate, Cretaceous sedimentary rocks, and Precambrian granite. In the middle of the Galiuro Mountains, the only exposure of the underlying rock is in a deep canyon at lat 32°32′, long 110°19′; it consists of the Precambrian Oracle Granite of Peterson (1938).

In the northern Galiuro Monutains, where the volcanic rocks thin, the underlying rocks are well exposed. They consist of Tertiary conglomerate; the Tertiary and (or) Cretaceous Copper Creek Granodiorite; the Cretaceous Glory Hole Volcanics; Paleozoic sedimentary rocks; and Precambrian diabase, Troy Quartzite, Apache Group, and Pinal Schist. Hence, the gently dipping Galiuro Volcanics are draped across rocks ranging in age from Precambrian to Tertiary.

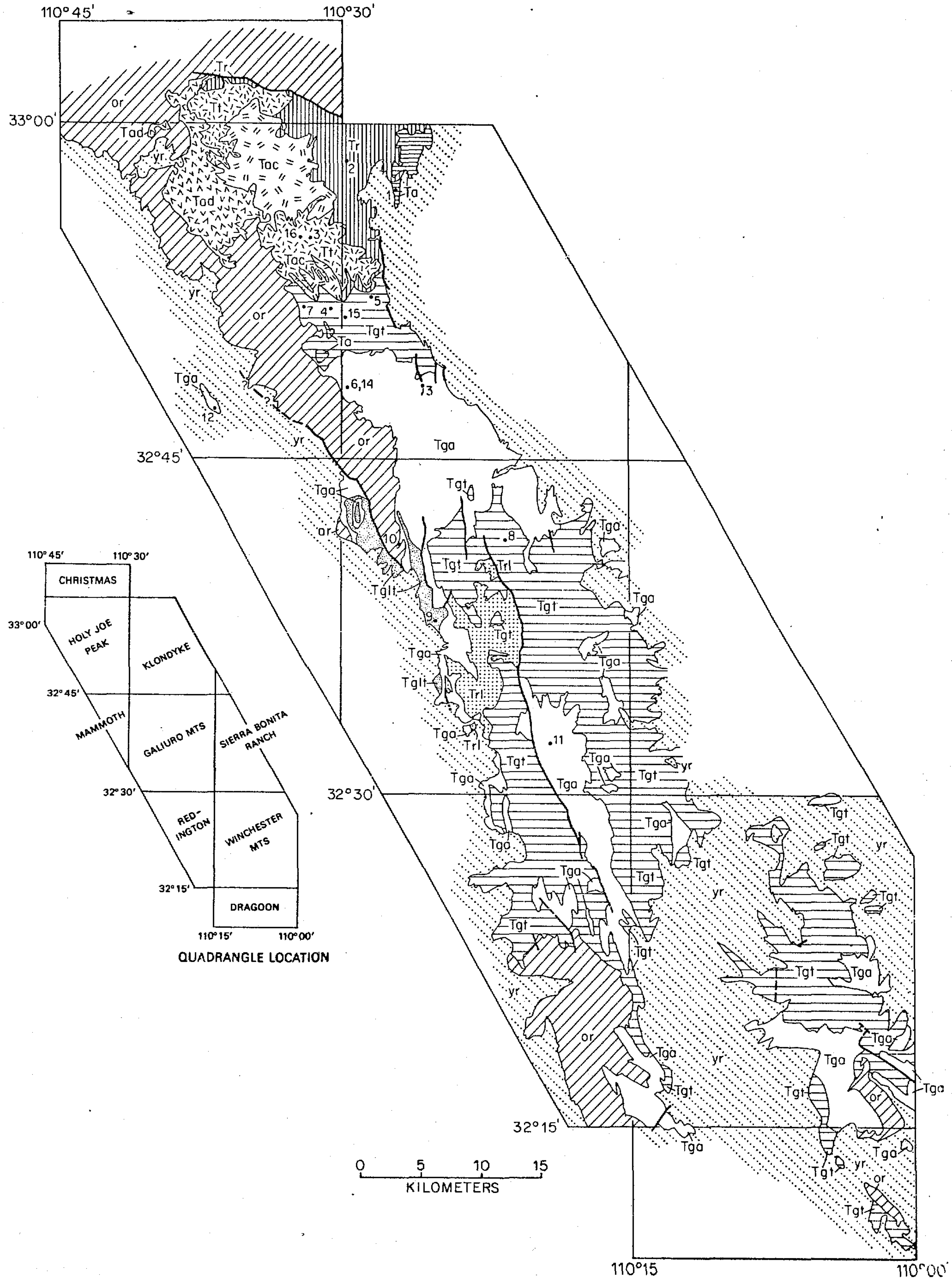
Tertiary and Quaternary gravels and basalt overlie the Galiuro Volcanics, mostly south of lat 32°45′. In some places, the angular discordance with the overlying rocks is pronounced, and in others it is slight.

The Galiuro Volcanics accumulated throughout a period of about 6 million years, during which time volcanism was intermittent and uplift, tilting, and erosion were active. Conglomerates, which are an important but subordinate part of the formation, separate most, if not all, of the lithologic units, and erosional discordances between units are common. The most pronounced erosional unconformity, on which the topographic relief south of lat 32°50′ is estimated to be about 300 m, divides the Galiuro Volcanics into two parts, a lower part dominated by lava flows and an upper part by ash-flow tuffs (fig. 3). Stratigraphy of the upper part of the Galiuro Volcanics is complex owing to differences of lithology, to lenticularity of the intercalated units, and to erosion of one unit before burial of the next. In figure 2, north of lat 32°45′, the upper part is divided into six map units. From oldest to youngest they are the lower rhyolite-obsidian unit; the ash-flow tuff and andesite unit; the upper rhyolite-obsidian unit; the crystal, vitric, and lithic tuff unit; the Apsey Conglomerate Member; and the upper andesite unit (fig. 3).

Andesite-rhyodacite and ash-flow tuff unit

The andesite-rhyodacite and ash-flow tuff unit (fig. 2) includes andesite and latite and ash-flow tuff of S. C. Creasey (unpub. data); lower andesite, latite, and silicic volcanic rocks of Simons (1964); andesite of Little Table Mountain, latite, and porphyritic andesite of Krieger (1968b, c); and basalt and andesite and latite of Cooper and Silver (1964). These rocks are all listed and correlated in figure 3.

The andesite-rhyodacite and ash-flow tuff unit extends from about lat 32°15′ in the Little Dragoon Mountains to about 32°50′ where it is overlapped by the upper part. Although the thickness of the lower part differs from place to place, Krieger (1968b) indicated as much as 200 m of flows in the northern Galiuro Mountains, and Simons (1964) more than 275 m at lat 32°45′. The thickest section is in the central part of the Galiuro Mountains; Creasey estimates the thickness here as 750–900 m. Southward from there the thickness diminishes, and in the Little


110°45'
110°30'
33°00'
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or
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yr
Tac
Ta
Tgt
Tga
Tglt
Trl
0 5 10 15
KILOMETERS
110°45' 110°30'
CHRISTMAS
HOLY JOE PEAK
KLONDYKE
MAMMOTH
GALIURO MTS
SIERRA BONITA RANCH
RED-INGTON
WINCHESTER MTS
DRAGOON
110°15' 110°00'
QUADRANGLE LOCATION

EXPLANATION

yr — YOUNGER ROCKS—Includes alluvium, conglomerate, gravels, lake beds, and basalt

GALIURO VOLCANICS (Tertiary)—Includes two parts:
UPPER PART—Includes:

Ta — Upper andesite unit—Includes andesite of Table Mountain of Krieger (1968b) and upper andesite unit of Simons (1964)

Tac — Apsey Conglomerate Member (Krieger, 1968a and b)

Tt — Crystal, vitric, and lithic tuff unit. Includes Hells Half Acre Tuff Member of Krieger (1968a and b); upper tuff unit and quartz latite unit of Hawk Canyon of Simons (1964); and tuff of Willden (1964)

Tr — Upper rhyolite-obsidian unit. Includes rhyolite-obsidian member and andesites and conglomerate of Virgus Canyon of Krieger (1968a); rhyolite-obsidian unit, tuff unit of Hawk Canyon, and intermediate andesite unit of Simons (1964); and rhyolite of Willden (1964)

Tad, Tgt — Ash-flow tuff (Tgt) and andesite (Tad) unit. Includes Aravaipa Member, tuff and conglomerate of Bear Springs Canyon, andesite and conglomerate of Depression Canyon, tuff of Oak Springs Canyon, and Holy Joe Member of Krieger (1968a and b); white tuff unit, upper welded tuff unit, rhyolite of Black Butte, olivine andesite, lower tuff unit, hornblende andesite of Parsons Canyon, biotite dacite unit, and lower welded tuff unit of Simons (1964); ash-flow tuff unit of Creasey (unpub. data); rhyolite member of Cooper and Silver (1964); and basalt and andesite of Willden (1964)

Trl — *Lower rhyolite-obsidian unit. Includes the rhyolite-obsidian unit and rhyolite breccia of Creasey (unpub. data)*

LOWER PART—Consists of:

Tglt, Tga — Andesite-rhyodacite (Tga) and ash-flow tuff unit (Tglt). Includes latitic lavas of Zapata Wash and andesite of Little Table Mountain of Krieger (1968b); latite subunit, lower andesite unit, and pyroclastic cones of Simons (1964); andesite unit of Creasey (unpub. data); and basaltic andesite member of Cooper and Silver (1964)

or — OLDER ROCKS—Includes Phanerozoic igneous and sedimentary rocks and Precambrian igneous, sedimentary, and metamorphic rocks

Contact

? — Fault—Dashed where approximately located; queried where uncertain

•15 — *Location of sample for chemical analysis and (or)* K-Ar age—Numbers refer to samples in tables

FIGURE 2.—Geologic sketch map showing general distribution and lithology of the Galiuro Volcanics.

Dragoon Mountains, it is only as much as 230 m (Cooper and Silver, 1964).

Within andesite-rhyodacite, Krieger (1968c) recognized both andesite and latite, but, because the two rocks are not in contact, she was not certain of their stratigraphic relation. Because both are overlain by a distinctive porphyritic andesite, locally called "turkey track" andesite, she suggested time equivalency. At the top of the unit, Simon (1964) also recognized locally the "turkey track" andesite, but he did not map it separately. He did, however, map separately a local latite and a local thin layer of heterogeneous silicic volcanic rocks at the top of the unit.

Creasey (unpub. data) recognized flows of different composition within the lower part, but he did not map them separately. In the field the flows were called latite, but chemical analyses have indicated that at least some are rhyodacite or rhyolite(table 1, No. 11)[1]. One thick (table 1, No. 9) and two thin ash-flow tuff units occur within the lower part between lat 32°25′ and 32°45′, but only the thick tuff (table 1, No. 9) is shown in figure 2. The tuff unit is lenticular. It starts at about lat 32°42½′ and thickens rapidly southward to as much as 580 m; its southern extent is unknown, owing to overlap by the younger gravel in the San Pedro valley.

Lower rhyolite-obsidian unit

The lower rhyolite-obsidian unit (fig. 2) includes a wedge of sedimentary rhyolite breccia lying along the eastern flank of the rhyolite-obsidian. The breccia accumulated against an active fault by erosion from topographically higher rhyolite-obsidian domes and flows.

The lower rhyolite-obsidian unit lies between lat 32°33′ and 32°41′ and occurs at the base of the upper part. It must have been a hill as high as 610 m resting on andesite and latitic flows at the time of eruption of the great sheets of ash-flow tuff, which eventually covered the lower rhyolite-obsidian unit. The lenticularity of the unit is indicated by a lateral-extent-to-thickness ratio of about 25:1.

Ash-flow tuff and andesite unit

Within the stratigraphic interval of the ash-flow tuff and andesite unit, Krieger (1968a,b) separated five map units in the Holy Joe Peak and Brandenburg Mountain quadrangles; Simons (1964), eight in the Klondyke quadrangle; Willden (1964) and Cooper and Silver (1964), two each in the Christmas and Dragoon quadrangles; and S. C. Creasey (unpub. data), one in the Galiuro Mountains quadrangle. These map units are listed in the explanation of figure 2 and are correlated in figure 3.

[1] Numbers refer to both chemical analyses and to the locations in figure 2.

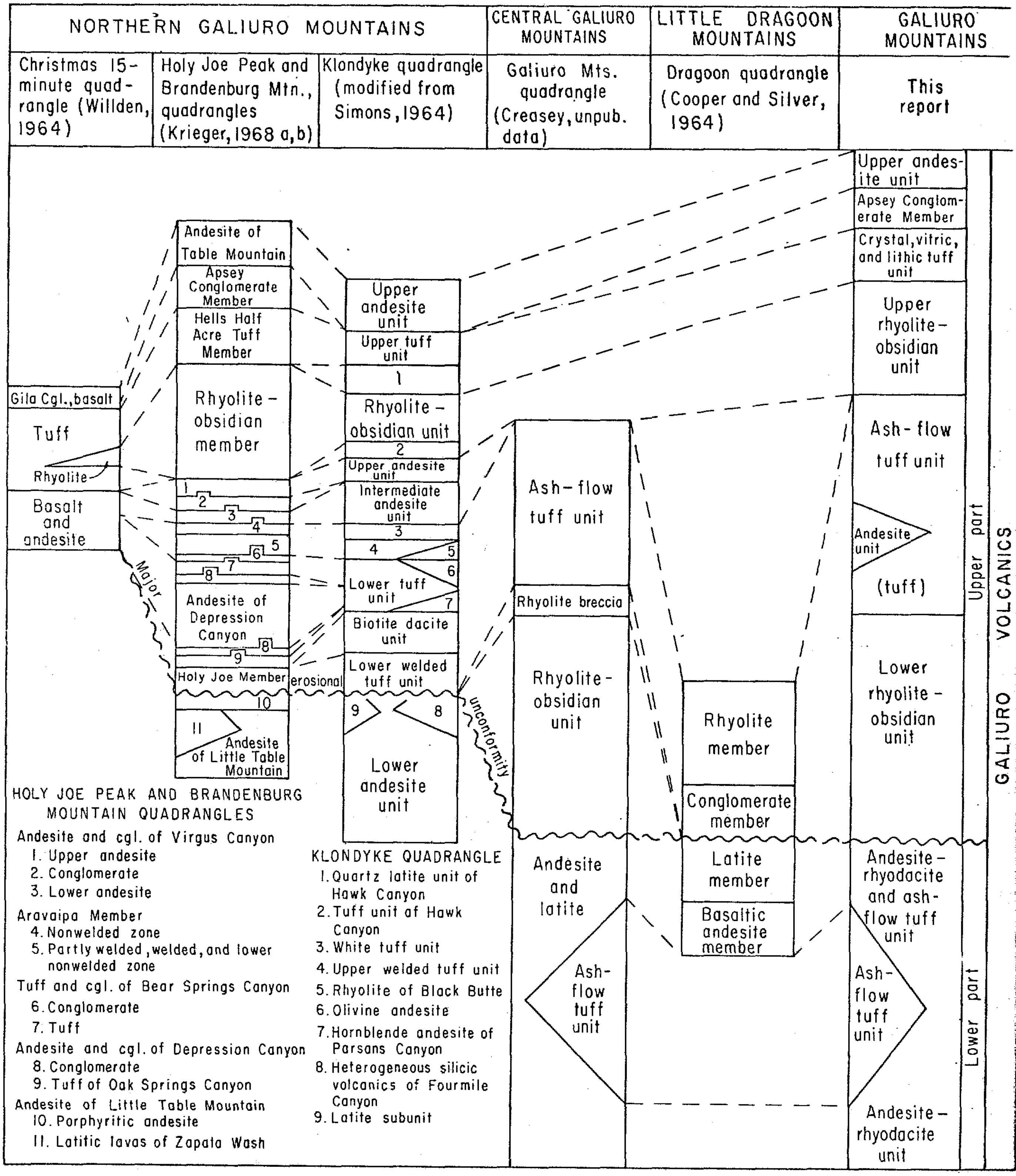

FIGURE 3.—Correlation chart showing relations of stratigraphic units in the Galiuro Volcanics within area of figure 2. Thicknesses of units are maximum in each quadrangle.

TABLE 1.—*Rock classification of analyzed samples of Galiuro Volcanics based on chemical and normative analyses*

Loc. on fig. 2	Laboratory no.	Rock unit of Krieger (1968) except nos. 9 and 10	Peterson (1961)	Rittmann (1952)	Irving and Barager (1971)	O'Connor (1965)
1	F2678	Andesite of Table Mountain	Andesite	Andesite	Andesite	N.A.[1]
2	F2779	Rhyolite-obsidian member	Rhyolite	Alkali rhyolite	Rhyolite	Rhyolite
3	M101317W	do	do	Rhyolite	do	Do.
4	159531	Aravaipa Member	do	do	do	Do.
5	F2680	do	do	do	do	Do.
6	G2965	Holy Joe Member	Quartz latite	Dark quartz latite	Dacite	Do.
7	159527	do	do	Rhyolite	Rhyolite	Do.
8	W182412	do	do	Quartz latite	do	Do.
9	W182414	Ash-flow tuff unit in andesite-rhyodacite unit	do	do	do	Do.
10	W182413	Dike	do	do	do	Do.
11	W182411	Andesite of Little Table Mountain	Rhyolite	Trachyte	do	Do.
12	M101316W	Latitic lavas of Zapata Wash	Rhyodacite	Rhyodacite	Dacite	Rhyodacite
13	F2681	Andesite of Little Table Mountain "turkey track"	do	Trachyandesite	Andesite	Rhyolite
14	F2682	Andesite of Little Table Mountain	Andesite	Olivine andesite	do	N.A.

[1] Contains less than 10 percent normative quartz; classification does not apply.

Ash-flow tuffs dominate this unit. They make up the Holy Joe and Aravaipa Members of Krieger (1968 a, b); the lower and upper welded tuffs and white tuff units of Simons (1964), the ash-flow tuff unit of Creasey (unpub. data), and the rhyolite (ash-flow tuff) and conglomerate members of Cooper and Silver (1964). North of lat 32°45′, the bulk of the ash-flow tuffs are in two sequences separated by andesite, dacite, rhyolite, conglomerate, tuff, and minor ash-flow tuff. In figure 2, all the rocks that separate the two sequences of ash-flow tuffs are shown as andesite, but the details of the stratigraphy are in figure 3 in the columnar sections for the Holy Joe Peak-Brandenburg Mountain and Klondyke quadrangles. Although not shown in either figure 2 or 3, at least five andesite flows occur in the Galiuro Mountains quadrangle within the ash-flow tuff unit.

Upper rhyolite-obsidian and andesite unit

The upper rhyolite-obsidian unit includes rhyolite-obsidian, the andesite and conglomerate of Virgus Canyon of Krieger (1968a, b), the intermediate andesite unit and tuff unit of Hawk Canyon of Simons (1964), and the tuff and rhyolite of Willden (1964) (fig. 2).

In that part of the southern end of the Christmas 15′ quadrangle covered by volcanic rocks, Willden mapped two small areas of rhyolite and the remainder as tuff and rhyolite undivided. The latter is interpreted to include rhyolite-obsidian, Hells Half Acre Tuff, and Apsey Conglomerate Members of Krieger (1968a, b, d); figure 2 shows Krieger's interpretation of the distribution of these members in the Christmas 15′ quadrangle.

The outcrop of the upper rhyolite-obsidian unit in figure 2 is restricted to the area between lat 32°55′ and 33°02′. Despite this lateral restriction, it is about 300 m thick. The exposed-lateral extent-to-thickness ratio is about 40:1, which differs somewhat from the 25:1 ratio for the lower rhyolite-obsidian unit.

Crystal, vitric, and lithic tuff; Apsey Conglomerate Member; and upper andesite unit

The three units overlying the upper rhyolite-obsidian unit of figure 2 are not composite except for the inclusion of a small area of latite flows with the upper tuff unit in the Klondyke quadrangle. The stratigraphic relations of the three units are shown in figure 3. Although agreement on the stratigraphy above the ash-flow tuff and andesite unit is generally good, Simons (1964) and Krieger (1968a) disagree on the position of the upper andesite unit. The differences between their interpretations of the stratigraphy are shown in figure 4. Krieger believes that the upper andesite unit north of Aravaipa Creek, which locally rests on the upper rhyolite-obsidian unit, is above Simons' upper tuff unit, whereas Simons believes it

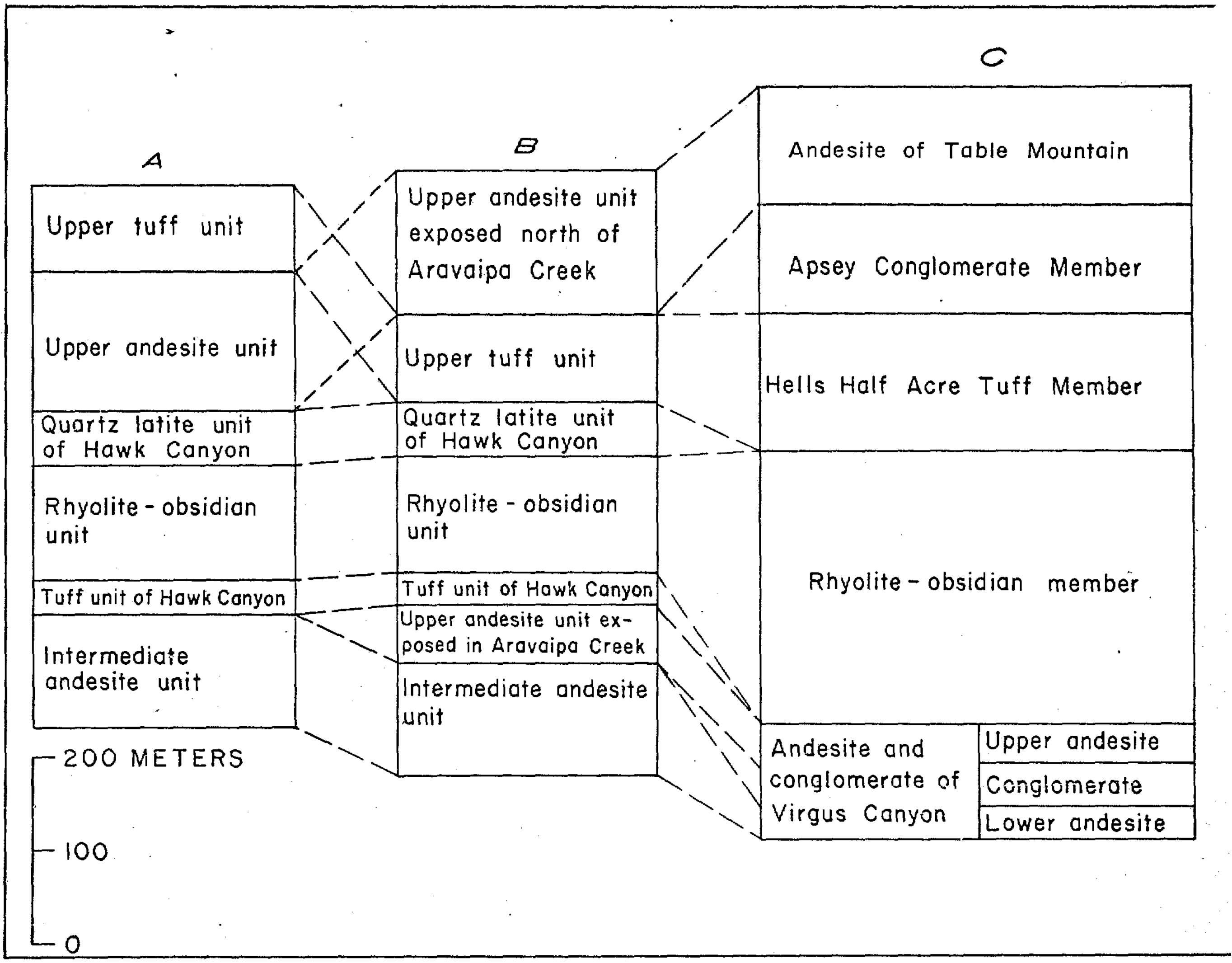

FIGURE 4.—Difference between Simons' and Krieger's interpretations of stratigraphic position of upper andesite unit. A, Simon's (1964) stratigraphy in Klondyke quadrangle. B, Krieger's reinterpretation of stratigraphy in Klondyke quadrangle. C, Krieger's (1968a, b) stratigraphy in Holy Joe Peak and Brandenburg Mountain quadrangles.

is below that unit. Krieger based her reinterpretation on correlation of Simons' upper andesite unit with her andesite of Table Mountain, which clearly overlies the Apsey Conglomerate Member in the Holy Joe Peak quadrangle. Also, the correlation of the upper tuff unit and the Hells Half Acre Tuff Member seems clear-cut. In addition, Krieger believes that what Simons called the upper andesite unit in Aravaipa Creek in the Klondyke quadrangle is the same as her upper andesite of Virgus Canyon in the Brandenburg Mountain quadrangle. She was able to walk the outcrop of the andesite from one locality to the other, a distance of about 2.5 km. Simons based his designation on the observation that the andesite in Aravaipa Creek in the Klondyke quadrangle overlies the upper rhyolite-obsidian unit. However, Krieger believes that the andesite actually underlies that unit. These relations and her correlations are shown in figure 4. More detailed information is presented in the geologic maps of Simons (1964) and Krieger (1968a).

LITHOLOGY

Andesite-rhyodacite and ash-flow tuff unit

The lava flow parts of the andesite-rhyodacite and ash-flow tuff unit are complex sequences of predominantly dark colored flows that contain minor tuff, agglomerate, rocks of vent areas, and intrusive rocks. Some flows have basal reddish flow breccia and scoriaceous tops, and about one-third of the flows are either vesicular or amygdaloidal or both. Most are porphyritic, but some are aphyric. Flow banding i rare, but it was observed by Krieger (1968b) in some latite flows. These rocks range in chemical composition from rhyodacite to andesite (table 1, Nos. 1, 11, 13, 14); by some chemical classifications, rhyolite flows may be represented, but if so, they are atypical in appearance.

The appearance of the flows is deceptive. They are typically dark colored, commonly red, purple, gray, or brown, owing to finely disseminated iron in the groundmass, yet some of these rocks are chemically rhyodacite or rhyolite. The phenocryst content ranges from virtually 0 to an estimated 25 percent, but typically it is low, particularly in the andesitic flows. This low phenocryst content means that the only megascopic minerals are those that crystallized early and that under normal conditions some of these would have later reacted and disappeared. For example, some of these rocks that contain olivine phenocrysts are oversaturated with silica; that is, they contain normative quartz and are rich in alkalic elements, which are all in the microcrystalline groundmass. The rocks are not especially rich in iron, but iron is finely divided in the groundmass, and the rocks appear much darker than if the bulk of the iron were concentrated in megascopic minerals. These factors make it difficult to determine rock types from either megascopic or microscopic examination, and therefore the relative abundance of andesite, latite, or rhyodacite is unknown; the best determination of rock types is through chemical classifications (table 1).

The porphyritic andesite, known locally in southeastern Arizona as "turkey track" andesites because of the glomeroporphyritic habit of large tabular plagioclase phenocrysts, are a distinctive type. They occur at or near the top of the unit near lat 32°45′ and elsewhere in the section. The coarsely porphyritic andesite consists of large platy plagioclase phenocrysts (2–15 millimeters) and of smaller grains of olivine and magnetite(?) set in an intergranular or pilotaxitic groundmass composed of plagioclase microlites, pyroxene, magnetite, and potassium feldspar. In contrast, the common andesite flow in the unit is porphyritic (small phenocrysts) with a microcrystalline pilotaxitic groundmass. About 1 out of 10 andesite flows, however, is aphyric microgranular. Phenocrysts consists of plagioclase and lesser amounts of clinopyroxene and (or) altered olivine; the groundmass comprises plagioclase microlites, pyroxene, and iron oxide minerals that commonly so obscure the groundmass that resolution of minerals is difficult.

The more silicic flows in this unit differ from the more basic ones both in texture and phenocryst composition, and they typically ring when struck with a hammer. These flows are all conspicuously porphyritic; plagioclase phenocrysts are dominant, biotite is almost always present, and clinopyroxene occurs in about one out of every four flows. Groundmass textures are microgranular in marked contrast to the pilotaxitic and intergranular texture of the andesites, and the groundmass minerals consist of plagioclase, potassium feldspar, and mafic constituents including much iron oxide. Silica in some form is probably present to judge by the normative quartz content, but quartz was not recognized as a groundmass mineral.

Table 2 lists four chemical analyses (Nos. 11–14) from the andesite-rhyodacite and ash-flow tuff unit, and figure 2 shows the locations of the samples. Two of these (Nos. 13 and 14) are from Simons (1964); they were collected to represent the common andesite and the "turkey track" andesite, respectively. Of the other two analyses, one is from a rock selected for potassium-argon age determination (table 1, No. 11); it was selected because of the high content of large unaltered biotite books and therefore probably represents the most differentiated (quartzose and alkalic) rock in the unit; the other, a rhyodacite (Tlz of Krieger, 1968b), also represents a differentiated type. Table 1 lists four different chemical classifications for the analyzed rocks of the Galiuro Volcanics. By the classification of O'Connor (1965), the rocks are dominantly rhyolitic, whereas by the more recent classification of Irving and Barager (1971), developed for the Geological Survey of Canada, they range from andesite to rhyolite. In her previous publications, Krieger has used the American Geological Institute classification (Peterson, 1961), and, when using rock names in this report, we will use that system insofar as it is possible. However, volcanic rock names derived from megascopic and microscopic examination commonly differ significantly from those derived from chemical analyses. Some inconsistency is inevitable because rock descriptions in this report are derived from both microscopic examinations and chemical analyses.

The ash-flow tuff interbedded in the andesite-rhyodacite is light-pinkish-gray to pale-red-purple, predominantly welded tuff; the vitrophyre is brown to black. The tuff consists of phenocrysts of plagioclase, sanidine, and dark-red-brown biotite in a groundmass of partly to completely devitrified glass in which only feldspar microlites can be recognized. Iron ores, sphene, apatite, and zircon are accessory minerals.

A chemical analysis of one of these ash-flow tuffs is represented by number 9 (table 2); the location of the sample is shown in figure 2. It is higher in silica and alkalic metals than the most differentiated of the

TABLE 2.—*Chemical and spectrographic analyses and catanorms of Galiuro Volcanics*

[Major oxide analyses by standard methods described in Peck (1964): 1, 2, 5, 13, 14 by D. F. Powers; 6 by J. W. Goldsmith; by methods described in Shapiro (1967): 8, 9, 10, 11 by P. Elmore; by methods described in Shapiro and Brannock (1962), supplemented by atomic absorption: 3, 12 by P. Elmore, L. Artis, G. Chloe, J. Glenn, S. Botts, H. Smith, and D. Taylor; 4, 7 by P. Elmore, S. Botts, H. Smith, and D. Taylor. Minor-element analyses by semiquantitative spectrographic methods in parts per million to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1; the numbers represent approximate midpoints of group data on a geometric scale. The assigned groups for semiquantitative results include the quantitative value about 30 percent of the time. N, not detected; d, barely detected, concentration uncertain; ---, not looked for. Looked for but not found: As, Au, Bi, Cd, Dy, Er, Eu, Ce, Hf, Ho, In, Li, Lu, Pd, Re, Sb, Sm, Ta, Tb, Te, Th, Tl, Tm, U, W. Dy, Er, Lu, Tb, Tm not looked for in 3, 8-12. Hf not looked for in 8-11]

	Andesite of Table Mountain	Upper rhyolite-obsidian unit		Aravaipa Member		Holy Joe Member			Ash-flow tuff unit[1]	Dike	Andesite-rhyodacite unit			
Lab. no.	F2678	F2679	M101317W	159531	F2680	G2965	159527	W182412	W182414	W182413	W182411	M101316W	F2681	[2]F2682
Loc. on fig. 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO_2	53.95	72.83	74.6	73.4	72.92	65.17	68.5	68.4	64.2	66.9	63.4	64.6	57.59	52.45
Al_2O_3	17.06	12.94	13.5	13.6	13.37	14.67	15.2	15.70	17.7	16.0	17.2	16.4	16.70	16.99
Fe_2O_3	4.24	1.13	1.3	1.2	1.36	2.04	2.5	2.60	3.1	3.0	4.2	4.4	6.55	6.11
FeO	4.25	.19	.12	.08	.02	.22	.30	.16	.16	.24	.20	.28	.99	2.88
MgO	3.91	.18	.11	.47	.51	1.40	.80	.54	.92	1.1	1.5	1.1	2.15	3.10
CaO	8.04	.41	.38	.44	.53	1.44	1.3	1.60	1.6	1.5	.90	3.3	5.27	7.02
Na_2O	3.66	4.10	4.2	3.6	3.42	2.97	3.8	4.10	3.6	4.1	4.3	4.2	4.05	3.79
K_2O	1.60	4.69	4.5	5.2	5.29	4.73	5.7	4.80	5.7	4.5	5.4	3.2	2.87	2.71
H_2O+	.40	2.98	.42	.93	.63	2.73	.53	.70	1.0	1.9	.30	.61	.72	.86
H_2O-	.69	.18	.10	.93	1.04	3.43	.32	.42	.84	.22	.80	.39	1.02	1.08
TiO_2	1.39	.19	.21	.24	.22	.49	.56	.61	.59	.74	---	.85	1.37	1.79
P_2O_5	.29	.02	.03	.06	.03	.10	.16	.12	.19	.19	.30	.34	.38	.67
MnO	.13	.10	.10	.08	.07	.07	.08	.09	.16	.14	.13	.12	.10	.13
CO_2	.03	.01	<.05	<.05	.04	.01	<.05	.08	.30	.03	.06	<.05	.01	.13
Cl	.01	.06	---	---	.01	.05	---	---	---	---	---	---	.01	.01
F	.05	.10	---	---	.06	.11	---	---	---	---	---	---	.06	.07
Subtotal	99.70	99.61			99.52	99.68							99.84	99.79
less oxygen	.02	.05			.03	.05							.03	.03
Total	99.68	99.56	100	100	99.49	99.63	100	100	99	99	99	100	99.81	99.76
Powder density	2.84	2.40			2.57								2.71	2.79
						SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSES								
Ag	---	---	<0.7	<0.7	N	N	<0.7	N	N	N	N	<0.7	N	N
B	---	---	10	30	N	15	N	15	N	N	N	N	N	N
Ba	700	300	50	500	300	700	2,000	1,000	2,000	1,000	1,500	1,000	1,500	700
Be	N	3	5	5	3	30	3	3	3	2	2	2	N	1.5
Ce	N	d	100	100	d	150	300	N	N	N	N	70	d	d
Co	30	N	N	N	N	1.5	5	2	3	2	7	7	30	30
Cr	30	N	N	3	3	1.5	20	3	N	30	3	N	1.5	30
Cu	70	3	3	3	3	70	20	10	7	100	30	3	70	300
Ga	15	15	20	20	15	15	20	15	15	15	15	1.5	15	15
Gd	N	N	---	N	N	---	30	---	---	---	---	N	N	N
La	30	70	70	50	70	70	150	100	70	70	70	50	70	70
Mo	N	d	2	3	N	3	3	3	N	N	N	5	N	N
Nb	15	30	30	20	30	15	20	15	10	15	10	15	15	15
Nd	N	150	N	N	d	70	150	N	N	N	N	N	d	150
Ni	30	N	N	10	N	N	30	N	N	N	15	N	15	70
Pb	N	15	50	30	30	30	30	30	20	20	20	30	15	d
Sc	30	7	5	3	7	7	10	7	7	7	7	7	15	15
Sn	N	N	N	N	N	7	N	N	N	N	N	N	N	N
Sr	1,500	15	7	70	70	300	500	500	500	500	700	500	1,500	1,500
V	700	N	N	10	15	15	50	20	20	30	30	30	300	300
Y	30	30	30	30	30	30	70	30	30	30	15	30	30	30
Yb	3	3	3	3	7	3	7	3	2	3	1.5	3	3	3
Zn	---	---	N	N	---	N	N	N	N	N	N	---	---	---
Zr	150	300	200	200	300	300	1,000	500	500	500	200	200	300	300
						MOLECULAR NORM CALCULATIONS (PERCENT)								
Si	50.99	70.04	70.18	69.59	69.63	65.09	64.39	64.33	60.56	63.10	59.89	61.00	54.83	50.13
Al	19.01	14.67	14.97	15.20	15.05	17.27	15.84	17.41	19.98	17.79	19.15	18.26	18.78	19.14
Fe^{3+}	3.02	.82	.93	.86	.98	1.54	1.77	1.85	2.21	2.13	2.99	3.13	4.71	4.40
Fe^{2+}	3.36	.16	.10	.07	.02	.19	.24	.13	.13	.19	.16	.23	.79	2.31
Mg	5.51	.26	.16	.67	.73	2.09	1.13	.76	1.30	1.55	2.12	1.55	3.06	4.42
Ca	8.15	.43	.39	.45	.55	1.55	1.31	1.62	1.62	1.52	.92	3.34	5.39	7.19
Na	6.71	7.65	7.66	6.62	6.34	5.76	6.93	7.48	6.59	7.50	7.88	7.69	7.49	7.03
K	1.93	5.76	5.40	6.29	6.45	6.03	6.84	5.76	6.86	5.42	6.51	3.86	3.50	3.31
Ti	.99	.14	.15	.18	.16	.37	.40	.44	.42	.53		.61	.99	1.29
P	.24	.02	.03	.05	.03	.09	.13	.10	.16	.16	.24	.28	.31	.55
Mn	.11	.09	.08	.07	.06	.06	.06	.08	.13	.12	.11	.10	.09	.11
C	.04	.02			.06	.02		.11	.39	.04	.08		.02	.17
H	(2.53)	(19.12)	(2.64)	(5.89)	(4.02)	(18.19)	(3.33)	(4.40)	(6.30)	(11.96)	(1.90)	(3.85)	(4.59)	(5.49)
Cl	(.02)	(.10)			(.02)	(.09)							(.02)	(.02)
F	(.15)	(.31)			(.19)	(.35)							(.19)	(.22)
Total Anions	160.48	181.22	173.09	174.35	173.71	178.64	169.06	170.21	168.96	173.37	165.15	168.85	165.12	161.98

[1]Ash-flow tuff in lower andesite-rhyodacite unit.

[2]"Turkey track" andesite.

TABLE 2.—*Chemical and spectrographic analyses and catanorms of Galiuro Volcanics*—Continued

	Andesite of Table Mountain	Upper rhyolite-obsidian unit		Aravaipa Member		Holy Joe Member			Ash-flow tuff unit	Dike	Andesite-rhyodacite unit			
Lab. no.	F2678	F2079	M101317W	159531	F2680	G2965	159527	W182412	W182414	W182413	W182411	M101316W	F2681	F2682
Loc. on fig. 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						CATANORM (PERCENT)								
Quartz	5.79	29.42	30.16	29.47	29.90	25.48	19.80	21.17	16.99	20.37	13.77	19.05	10.26	4.27
Corundum		.90	1.23	1.56	1.57	3.13	.89	1.47	4.28	2.43	3.90	.94		
Orthoclase	9.65	28.77	27.00	31.45	32.22	30.14	34.18	28.80	34.20	27.08	32.54	19.28	17.47	16.53
Albite	33.45	37.74	38.30	33.09	31.58	28.34	34.63	37.39	32.93	37.49	39.38	38.45	37.37	35.04
Anorthite	25.96	1.17	1.72	1.84	1.82	6.14	5.49	6.76	4.89	6.13	2.17	14.43	19.52	22.07
Halite	.04	.20			.04	.17							.04	.04
Wollastonite	4.98												1.62	3.38
Enstatite	11.02	.52	.31	1.33	1.46	4.17	2.25	1.52	2.59	3.10	4.23	3.10	6.12	8.84
Ferrosilite	1.94													
Magnetite	4.53	.30	.08								.79			3.37
Hematite		.63		.86	.98	1.54	1.77	1.85	2.21	2.13	2.47	3.13	4.71	2.16
Ilmenite	1.98	.28	.30	.26	1.15	.49	.59	.40	.51	.61		.64	1.75	2.58
Rutile				.05	.09	.13	.11	.24	.17	.23		.29	.34	
Apatite	.62	.05	.07	.13	.07	.23	.34	.26	.41	.41	.64	.73	.82	1.45
Fluorite	.11	.45			.26	.48							.12	.05
Calcite	.08	.03			.11	.03		.21	.78	.08	.16		.03	.34
Total	100.09	100.40	100.01	100.01	100.19	100.41	100.01	100.01	100.01	100.01	100.01	100.01	100.10	100.05
Diopside	9.96												3.23	6.75
Di-Wo	4.98												1.62	3.38
Di-En	4.24												1.62	3.38
Di-Fs	.75													
Hypersthene	7.98	.52	.31	1.33	1.46	4.17	2.25	1.52	2.59	3.10	4.23	3.10	4.51	5.46
Hy-En	6.79	.52	.31	1.33	1.46	4.17	2.25	1.52	2.59	3.10	4.23	3.10	4.51	5.46
Hy-Fs	1.20													
Percent An	43.70	3.0	4.29	5.26	5.44	17.80	13.68	15.30	12.94	14.04	5.22	27.29	34.32	38.65
D.I.	46.9	92.6	94.7	92.9	92.8	81.3	87.4	86.0	82.8	82.6	84.7	75.1	62.6	53.2
k-value	.224	.430	.414	.488	.505	.512	.497	.436	.511	.420	.453	.334	.318	.320
mg-value	.460	.197	.124	.404	.409	.540	.353	.271	.346	.389	.395	.311	.355	.394
c/a-value	.427	.232	.153	.139	.166	.202	.263	.245	.136	.201	.084	.301	.385	.410
Alk/fm value	.419	.911	.913	.887	.878	.754	.813	.826	.732	.765	.729	.399	.561	.480

flows in the unit, and, as will be discussed later, its source probably differed from that of the flows. By chemical classification, the tuff is either a quartz latite or a rhyolite (table 1).

Lower rhyolite-obsidian unit

The lower rhyolite-obsidian unit consists of domes, stubby flows, and subordinate tuffs and breccias. The color ranges widely: the stony (devitrified) and the originally microcrystalline rhyolites are off-white, pale red, pink, and orange, and the obsidians are dark hues of nearly black, brown, red-brown, green, and yellow. Contorted flow banding is common but not ubiquitous. Spherulites and lithophysae are common.

The rhyolite-obsidian is composed of phenocrysts and sanidine (most abundant) and quartz and sparse biotite and albite. The groundmass of the obsidian is either glass or devitrified glass, and that of the rhyolite is microcrystalline, containing feldspar microlites.

A sedimentary breccia (fig. 3) that is part of the lower rhyolite-obsidian unit crops out in the central part of the Galiuro Mountains. It represents rhyolite debris transported eastward from the topographically higher rhyolite-obsidian domes and flows and deposited against the fault scarp of the longitudinal fault in the central Galiuro Mountains. The breccia is crudely bedded, the beds typically dipping gently eastward except near the fault on the eastern margin of the breccia, where dips are as steep as 80° E.; these steep dips are attributed to movement along the fault during accumulation of the breccia. Individual beds are disordered accumulations of angular clasts ranging in size from microscopic to 1 or 2 m in diameter. Sorting within beds appears to be nonexistent and is only crude between beds. Rounding of fragments is minimal. Although the source of the fragments is primarily the underlying lower rhyolite-obsidian unit, fragments of ash-flow tuff are common, and here and there fragments of andesite occur.

Ash-flow tuff and andesite unit

Both Krieger (1968a,b) and Simons (1964) mapped the Galiuro Volcanics in detail, and both recognized two sequences of ash-flow tuffs, the Holy Joe and Aravaipa Members of Krieger and the lower and upper welded tuff and white tuff units of Simons. Both sequences probably extend into the central part of the Galiuro Mountains, but Creasey made no attempt to divide them.

The Holy Joe Member has a white- to cream-colored, nonwelded tuff base that grades upward into brown, partly welded tuff, black vitrophyre, and typical reddish, strongly welded devitrified tuff. It is composed of phenocrysts or fragments of phenocrysts (about 10 percent) of plagioclase, biotite (oxidized in devitrified rock), quartz, sanidine, and sparse clinopyroxene and magnetite; rock fragments and pumice lapilli are common. Except for the nonwelded base and the vitrophyre, the matrix has devitrified to a cryptocrystalline mass. As seen in thin sections, shard structure is not well preserved in some welded tuff south of lat 32°45′ but is generally well preserved in welded tuff north of that latitude. In the Holy Joe Peak quadrangle, the member was erupted as very hot ash flows that became densely welded and cooled as a unit.

Three samples of welded devitrified ash-flow tuff from the Holy Joe Member were analyzed (table 2, Nos. 6–8; geographic locations shown in fig. 2). The classification from the chemical analyses is either quartz latite or rhyolite (table 1). Quartz latite would be the more appropriate field term, as plagioclase and quartz phenocrysts are ubiquitous and sanidine sparse.

Between the Holy Joe Member and the next overlying major rock unit (Aravaipa Member) is a sequence of local tuffs, conglomerates, and andesitic to dacitic flows. North of lat 32°45′ and west of long 110°30′, Krieger (1968a,b) recognized a white to grayish-orange-pink rhyolitic tuff containing crystal fragments of quartz, feldspar, and biotite and pumice lapilli and accidental rock fragments (tuff of Oak Springs Canyon). Above this tuff, a sequence from top to bottom of conglomerate, vesicular and amygdaloidal andesite, and conglomerate (andesite and conglomerate of Depression Canyon) is exposed.

The andesite consists of phenocrysts of plagioclase, altered olivine, clinopyroxene, and magnetite in a pilotaxitic groundmass of plagioclase microlites, clinopyroxene, iron ores, some potassium feldspar, and alteration products. The conglomerates contain clasts from Paleozoic rocks, from older members of the Galiuro Volcanics, and locally from Late Cretaceous and (or) early Tertiary volcanic and intrusive rocks.

The next overlying unit (tuff and conglomerate of Bear Springs Canyon) consists of a thin, light-colored, rhyolitic ash-flow tuff that is both overlain and underlain by thin conglomerate beds. The tuff is composed of pumice lapilli, and crystal and accidental rock fragments. The clast in the conglomerate were derived from Paleozoic and older rocks and from older members of the Galiuro Volcanics. East of long 110°30′, in the same stratigraphic interval between the Holy Joe and Aravaipa Members, Simons (1964) recognized, from bottom to top, a biotite dacite, hornblende andesite, silicic tuff, silicic welded tuff, olivine andesite, and porphyritic rhyolite. Not all of these units occur in one place, and the tuffs, which are rhyolitic, differ from place to place in induration and color. The hornblende andesite consists of long phenocrysts of brown hornblende (oxidized) and plagioclase in a groundmass of plagioclase microlites, iron ore, and interstitial devitrified glass. The olivine andesite consists of small phenocrysts of clinopyroxene and red olivine in an intergranular groundmass of plagioclase laths and interstitial iron ores, olivine, and pyroxene. Figure 3 shows the correlation between Simons' and Krieger's map units in the stratigraphic interval between the two major ash-flow tuffs.

In the central part of the Galiuro Mountains within the ash-flow tuff unit between lat 32°30′ and 32°45′, Creasey mapped about five andesite flows separated by tuffs and welded tuffs. Some crystal-lithic andesitic tuffs associated with the andesite consist of lithic fragments of andesite and welded tuff and crystal fragments of plagioclase, quartz, and biotite in a tuff matrix. The andesite flows consist of phenocrysts of plagioclase and clinopyroxene in a pilotaxitic groundmass of plagioclase microlites and interstitial iron ores, pyroxene, and unidentified material.

The upper ash-flow tuff, the Aravaipa Member of Krieger (1968a,b) and the white tuff and upper welded tuff units of Simons (1964), is a simple cooling unit and probably a single ash flow. It is composed of pumice lapilli, crystal fragments (totaling about 6 percent of the rock) of feldspar (sanidine and plagioclase), quartz, and biotite, and sparse exotic fragments, chiefly dark volcanic rocks, in a matrix of shards. In the Holy Joe Peak quadrangle, the ash flow typically has a light-colored nonwelded base, a brown-to-black vitrophyre, a densely welded devitrified zone that in the lower part contains large vugs and silica-lined lithophysae, a somewhat lighter colored columnar-jointed zone, and a slope-forming very light gray to white slightly welded top. The two upper units show both devitrification and vapor-phase crystallization. The transition from the interior of the ash flow, which shows pronounced vertical zonation, to the distal end of the ash flow, is completely exposed in the east-central part of the Holy Joe Peak quadrangle. The distal end is nonwelded; it has been completely zeolitized. Table 2 lists two chemical analyses (Nos. 4 and 5) of the Aravaipa Member, which by chemical classification is a rhyolite (table 1).

Upper rhyolite-obsidian unit

Above the Aravaipa Member and below the rhyolite-obsidian member and north of lat 32°45′, Krieger (1968a,b) recognized an upper and lower andesite separated by a conglomerate (andesite and conglomerate of Virgus Canyon), whereas Simons (1964) also recognized two andesites (intermediate and upper andesite units) but not the conglomerate. In the northwest part of the Klondyke quadrangle, a tuff unit (tuff of Hawk Canyon) lies between his intermediate andesite and rhyolite-obsidian.

The lower andesite, a "turkey track" andesite, is medium gray on fresh fractures and light brown on weathered surfaces. It is composed of large plagioclase laths as long as 20 mm and small altered olivine and clinopyroxene in an intersertal or pilotaxitic groundmass of plagioclase microlites, clinopyroxene, iron ores, altered olivine, apatite needles, and glass.

The conglomerate between the two andesites consists of clasts derived from underlying "turkey track" andesite and from older rocks in a sand matrix. It thins and is largely absent in the Klondyke quadrangle. The upper andesite is dark colored, fine grained, and amygdaloidal. It consists of small phenocrysts of plagioclase, altered olivine, and clinopyroxene in an intergranular groundmass of andesine microlites and granules of clinopyroxene and sparse olivine and iron ore.

The tuff unit of Hawk Canyon of Simons is a cream-colored or pink massive coarse-grained rough-weathering rock composed of crystals of feldspar and quartz and fragments of volcanic rock in a glassy or pumiceous matrix.

The rhyolite-obsidian part of the unit is composed chiefly of domes and stubby flows and subordinate breccia, agglomerate, and cinder cones. Color of the obsidian ranges from gray to black; rhyolite is gray. Obsidian is perlitic to lithophysal. Both rhyolite and obsidian are characterized by finely laminated to contorted flow layering. Some breccia consists of angular fragments of vesicular rhyolite and obsidian. Rhyolite and obsidian contain sparse sanidine, quartz, plagioclase, pyroxene, hornblende, iron oxide, sphene, and scattered accidental fragments. Lithophysae, generally 10–30 mm in diameter, are strung out in places, giving large outcrops a steeply dipping bedded appearance. Table 2 lists two chemical analyses (Nos. 2 and 3) for the rhyolite-obsidian, which by chemical classification is a rhyolite (table 1).

Crystal, vitric, and lithic tuff unit

Overlying the upper rhyolite-obsidian and andesite unit is latite (quartz latite of Hawk Canyon of Simons, 1964) and tuff (Hells Half Acre Tuff Member of Krieger 1968 a, b, d ; upper tuff unit of Simons, 1964; and tuff of Willden, 1964). The quartz latite of Hawk Canyon occurs only east of long 110°30′. It is a massive reddish rock composed of abundant phenocrysts from 1 to 5 mm long of pink potassium feldspar, gray plagioclase, quartz, and biotite in a stony groundmass.

The lowest subunit of the Hells Half Acre Tuff Member is a cliff-forming rhyolite tuff. In the Klondyke quadrangle, it is predominately coarse grained but contains interbeds of fine-grained crystal-rich tuff; the lithic fragments are chiefly rhyolite derived from the rhyolite-obsidian. In the Holy Joe Peak 15′ quadrangle, the lowest subunit is a water-laid tuff, deposited in water impounded behind rhyolite flows; it is fine grained and contains fragments of pumice lapilli and crystals of quartz, feldspar, and biotite. Here it locally appears to be contemporaneous with the rhyolite-obsidian.

Resting on the lowest subunit is a massive, white, cliff-forming tuff composed of pumice lapilli, obsidian, and grains of quartz, feldspar, and biotite in a matrix of white ash. At least part of the subunit is probably a nonwelded to slightly welded ash-flow tuff. Pumice lapilli and some of the shard matrix have been altered to clinoptilolite.

The upper subunit is a variable vitric, lithic, and crystal tuff. It ranges in color from white to yellow-brown to brown. Some beds are cliff forming, and some are slope forming. It ranges from coarse to fine grained, and local beds are water laid. Lithic fragments comprise rhyolite, obsidian, pumice lapilli, and stony vitrophyre. Crystal fragments are quartz, feldspar, and biotite.

Apsey Conglomerate Member

The Apsey Conglomerate Member crops out prominently in the Brandenburg and Holy Joe Peak quadrangles, but it laps out eastward against the rhyolite-obsidian; it was not a mappable unit in the Klondyke quadrangle. It is a light-colored cliff-forming conglomerate and conglomeratic tuff containing pebbles, cobbles, and scattered boulders derived from the rhyolite-obsidian member. It also contains sparse to locally abundant clasts of older rocks including members of the Galiuro Volcanics older than the upper rhyolite-obsidian unit. The indurated and sandy matrix consists of quartz, feldspar, and many small lithic fragments. Pumice lapilli and shards are locally common, especially in the lower part.

Upper andesite unit

The andesite of Table Mountain of Krieger (1968b) and part of the upper andesite unit of Simons (1964), and possibly "basalt of Gila Conglomerate" of Willden (1964) that rests on the upper rhyolite-obsidian unit, are composed of dark-colored fine-grained amygdaloidal lavas, in which individual flows commonly have scoriaceous tops and flow breccia or agglomeratic bottoms. The andesite consists of small phenocrysts of plagioclase, red-altered olivine, and sparse clinopyroxene set in an intergranular groundmass of plagioclase microlites, and granules of clinopyroxene, olivine, and iron ores. Staining of the groundmass with sodium cobaltinitrite shows some potassium feldspar. Its chemical classification (table 2, No. 1) indicates it is either an andesite or olivine andesite (table 1).

CHEMISTRY

The chemical characteristics of the Galiuro Volcanics were obtained from 14 chemical and spectrographic analyses. Six of the analyses, from Simons (1964), were made to characterize the rocks in the Klondyke quadrangle. Four, from M. H. Krieger, were made to study the ash-flow tuffs. Four were made from samples used in this report, but only for dating purposes. The analyzed samples, therefore, are not a suite selected to represent the Galiuro Volcanics; rather, they are the available analyses most of which were made for other purposes. Nevertheless, they give considerable information about the chemical character of the rocks. Table 2 contains the 14 chemical and spectrographic analyses, as well as ionic percentages of the elements, catanorms, and differentiation indices (D.I.).

Numbers 11–14 (table 2) are from flows from the andesite-rhyodacite unit, and they probably represent the compositional range of the flows. Number 14 is a "turkey track" andesite and represents the most mafic of these lower flows. Number 13 is typical of the more common andesite flows and numbers 11 and 12 of the more silicic and alkalic flows. In consideration of the generation of the magmas responsible for the andesite-rhyodacite in the lower part of the Galiuro Volcanics, it is significant that the most mafic flow (No. 14) is at the top and the most salic (No. 11) is near the bottom. These relations imply more than one magma source, an implication supported by the intercalation of ash-flow tuffs in the lower flow unit. The only other analysis of a mafic flow is number 1 (discussed below), which is from andesite of Table Mountain. It is the most mafic rock analyzed, and it is at the very top of the volcanic pile. Number 9 is from an ash-flow tuff intercalated in the flows of the lower part of the Galiuro Volcanic and number 10 is from a dike that cuts flows near th ash-flow tuff. The chemical analyses of the ash-flo tuff and the dike are like those for the Holy Jc Member.

The chemical composition of rhyolite-obsidian i represented by two analyses (Nos. 2 and 3). Both sam ples came from the upper rhyolite-obsidian unit. Th Holy Joe and Aravaipa Members are ash-flow tuff characterized by three (Nos. 6–8) and two (Nos. 4 an 5) analyses, respectively. All five analyses represen devitrified parts of the ash-flow tuff, which hydrat less than the glassy parts and are therefore closer t the composition at the time of eruption.

The abundance of calcium, sodium, potassium, mag nesium, and ferrous iron relative to that of silicon ar shown in figure 5. Calcium shows a reasonably invers relation with silicon. A similar linear curve result when calcium is plotted against the D.I. Magnesium and, to some extent, ferrous iron also show an inverse relation to silicon, whereas potassium shows a direct relation, and sodium is nearly constant. These variation curves and the D.I. suggest a differentiating magma that produced early andesite and late rhyolite, but the elements do not vary systematically with stratigraphic position. The youngest rock in the volcanic pile has the lowest D.I. and the next to lowest silicon content. The rhyolite-obsidian, which is the most differentiated, occurs at two separate localities at different stratigraphic positions. Generally, however, the lower part of the Galiuro Volcanics is dominated by flows and contains the bulk of the andesite, and the upper part by ash-flow tuff and tuff. Probably there were two or more magma chambers in each of which differentiation occurred, and certainly there were several or many vent sites. From the similarities in geographic distribution, the Holy Joe and Aravaipa Members could have come from the same vent areas. The chemical analyses and the variation diagrams (table 2, fig. 5) show that the chemical compositions of the two ash-flows tuffs are distinctly different, those from the Aravaipa Member being significantly higher in silica and in D.I. If they came from the same magma chamber, differentiation was taking place.

The occurrence of the mafic andesite of Table Mountain at the top of the volcanic pile and of andesite intercalated in the predominantly ash-flow tuff parts of the volcanic pile suggests that within the limits of observation andesite was the parent magma and that periodically new andesitic magma was generated.

The tendency for the amounts of the individual elements to change systematically (smooth curves) on the silicon variation diagrams suggests that all of the

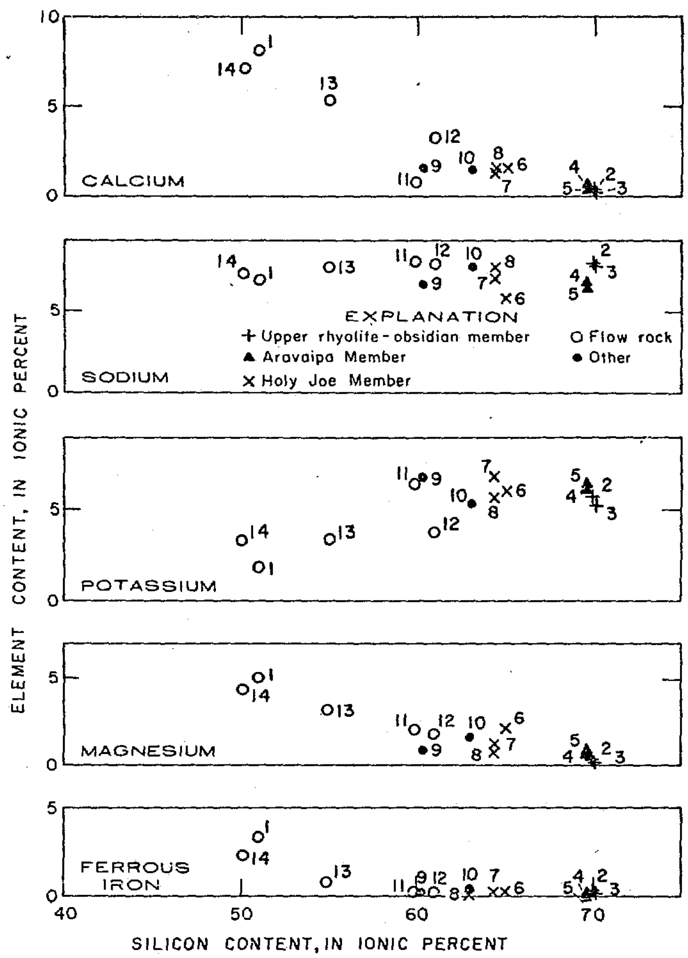

FIGURE 5.—Silicon variation curves for calcium, sodium, potassium, magnesium, and ferrous iron. Numbers refer to sample localities in figure 2.

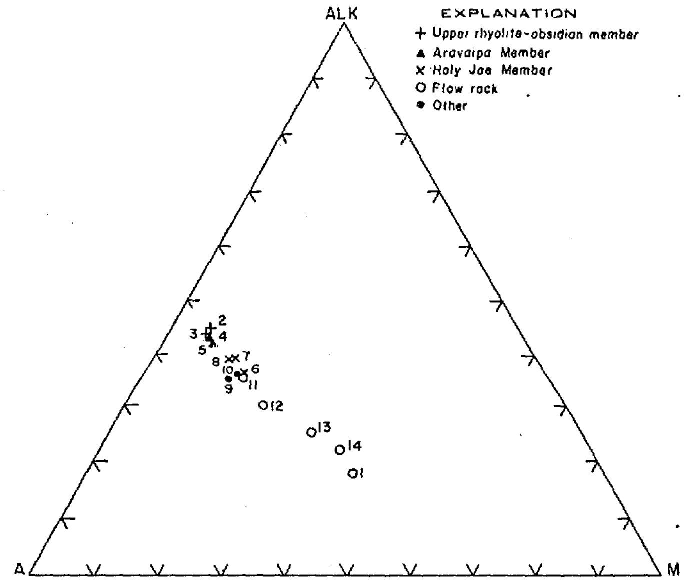

FIGURE 6.—Ternary Alk-A-M diagram for chemically analyzed samples of Galiuro Volcanics. Alk=Na+K, A=Al, M=Fe^{3+} +Fe^{2+}+Mg+Ca+Mn+Ni+Ba. Numbers refer to sample localities in figure 2.

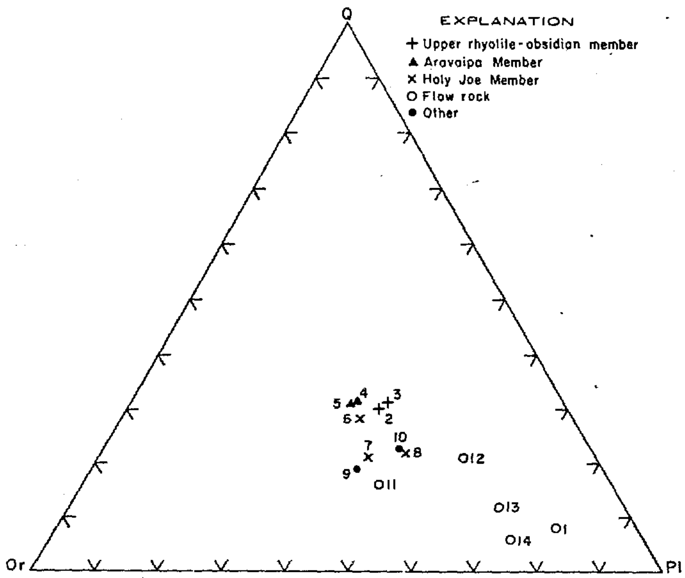

FIGURE 7.—Ternary Pl-Q-Or (plagioclase-quartz-orthoclase) diagram for chemically analyzed samples of Galiuro Volcanics. Numbers refer to sample localities in figure 2.

rocks in the Galiuro Volcanics are related and that the differences in composition probably represent different stages of differentiation for individual magma chambers. The suite of rocks is calc-alkaline, and all the rocks are somewhat high in alkalic elements.

The systematic relation of the elements in the volcanic rocks is indicated further by the Alk-A-M (sodium and potassium-aluminum-mafic elements) ternary diagram (fig. 6). Here the plots for the analyzed rocks aline remarkably well, showing a systematic variation in sodium and potassium (Alk), aluminum (A), and the "mafic" elements (M:Fe, Mg, Ca, Mn, Ni, and Ba). Plots of the molecular normative quartz (Q), orthoclase (Or), and plagioclase (Pl) (fig. 7) lie along a poorly defined differentiation trend line extending from the Pl corner to the center of the diagram, which is the approximate final composition of a granitic differentiate. Similar trend lines have been recorded for the Laramide stocks in Arizona, and it is believed to be characteristic of the granitic rocks in this region. Like the variation diagrams, figure 7 shows that the rhyolite-obsidian and the ash-flow tuff are the products of highly differentiated magmas.

AGE

The age of the Galiuro Volcanics generally ranges from about 23 to about 29 m.y. (Oligocene and Miocene) (fig. 8, table 3). In figure 8, they are arranged

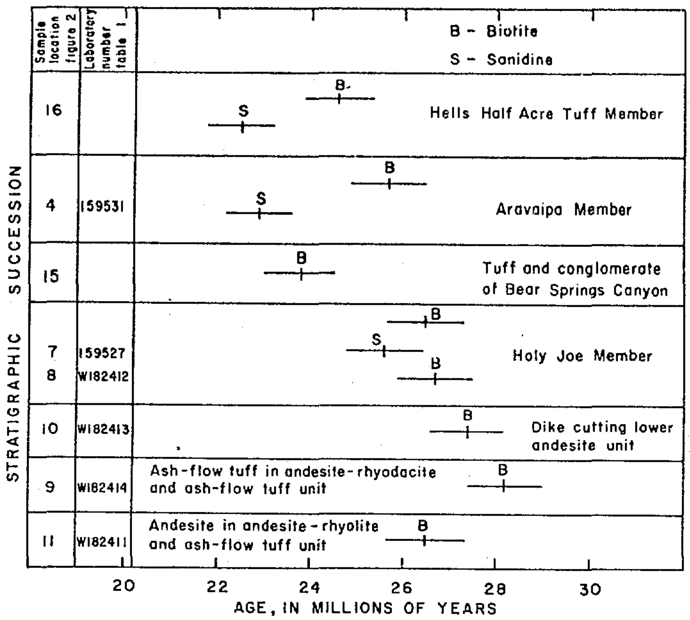

FIGURE 8.—Potassium-argon ages of the Galiuro Volcanics.

from top to bottom in the order of descending stratigraphic succession of the volcanics dated. The ages from about 24 to 28 m.y. are alined, and, if sanidine ages are accepted for the youngest ages, the linearity extends to 23 m.y. However, the two youngest biotite ages and the oldest age, which is also from biotite, each fall about 2 m.y. off the trend of the other ages. The discrepancies of these three ages are beyond the analytical uncertainty. To fix the age range more closely would require dating more samples, but because the approximate range from 23 to 29 m.y. is more than adequate to fit the Galiuro Volcanics into the mid-Tertiary volcanic and plutonic event in Arizona, there is no compelling geologic reason to do so.

Damon (1968) compiled a histogram of potassium-argon ages of volcanic and hypabyssal plutonic rock younger than 90 m.y. in the Basin and Range provinc south of lat 36° N. His histogram is bimodal, one pea extending from 10 to 40 m.y., with a maximum at 25 30 m.y., and the other peak extending from 50 to 8 m.y., with a maximum of about 65 m.y. The age of th Galiuro Volcanics falls about in the middle of th younger igneous event.

In the Santa Catalina Mountains, which lie south west of the Galiuro Mountains on the opposite side o the San Pedro valley (fig. 1), a mid-Tertiary quartz monzonite composite batholith ranges in cooling ag from 21 to 28 m.y. (Creasey and others, 1977). Th chemical and normative composition of the batholit lies in the same range as the tuffs of the Holy Joe an Aravaipa Members. The combination of proximity contemporaneity, and similar composition of the batholith and the Galiuro Volcanics indicates that both ar part of the same igneous event and explains the general absence through uplift and erosion of the Galiur Volcanics west of the San Pedro valley.

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TABLE 3.—*Analytical data for radiometric ages for the Galiuro Volcanics*

[$\lambda_{\varepsilon} = 0.585\times10^{-10}$/yr. $\lambda_{\beta} = 4.72\times10^{-10}$/yr. $K^{40}/K_{total} = 1.19\times10^{-4}$]

K-Ar lab no.	Sample loc. fig. 2	Mineral	K_2O (percent)	Ar^{40} (moles/g $\times10^{-10}$)	$Ar^{40}/\Sigma Ar^{40}$ (percent)	Age ($\times10^6$ years)
65I096	16	Biotite	8.82	3.233	63.3	24.6±0.7
65I094	16	Sanidine	6.66	2.230	89.4	22.5±0.7
KA418	4	Biotite	8.51	3.260	77.4	25.7±0.8
KA427	4	Sanidine	8.03	2.732	92.0	22.9±0.7
65I099	15	Biotite	8.47	3.000	62.0	23.8±0.7
KA154	7	do	8.14	3.212	74.5	26.5±0.8
65I095	7	Sanidine	8.68	3.305	97.1	25.6±0.8
75I316	8	Biotite	7.99, 8.00	3.178	87.2	26.7±0.8
75I310	10	do	8.42, 8.40	3.424	17.0	27.4±0.8
75I307	9	do	8.53, 8.58	3.590	81.3	28.2±0.8
75I314	11	do	8.45, 8.50	3.339	49.7	26.5±0.8

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———1968b, Geologic map of the Holy Joe Peak quadrangle, Pinal County, Arizona: U.S. Geol. Survey Geol. Quad. Map GQ–669, scale 1:24 000.

———1968c, Geologic map of the Lookout Mountain quadrangle, Pinal County, Arizona: U.S. Geol. Survey Geol. Quad. Map GQ–670, scale 1:24 000.

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ASARCO EXPLORATION RECORD

[X] FIELD EXAMINATION [ ] LITERATURE SEARCH [ ] ASARCO FILE [ ] ______

Section I General Indexing

① Name(s) of Property or Area	② Country	③ State or Province
LITTLE TABLE MOUNTAIN (Tapia Claims) COPPER CREEK MINING DISTRICT	USA	Arizona
	④ Co. or Map Sheet: Pinal	⑤ File or Gore No.: Aa.16A.3.3E

⑥ Latitude	⑦ Longitude	⑧ Mer.	Tws.	Rng.	Sec.	⑨ Examined by	⑩ Date	⑪ Office	⑫ Field Days
32°47½'N	110°29½'W	G&SRM	7S	18E	27	J.D.Sell	1/9/78	Tucson	1

Typed: 1/26/78

Section II Sources of Information

⑬ References

Author	Date	Title	Publications	Vol. No.
M.Krieger	1968	USGS Map GQ-669, Holy Joe Peak		
F.Simons	1964	USGS PP-461, Klondyke Quad.		

Section III Appraisal

⑭ Recommendations
- [X] Action Now
- [ ] Too Low Grade
- [ ] Too Small
- [ ] Ownership Problem
- [ ] Access Problem
- [X] mapping reconn.

⑮
- [ ] Past Producer
- [ ] Producer
- [ ] Mineral Deposit
- [X] Prospect
- [ ]
- [ ]
- [X] Geologic Concept
- [ ] Geochem Anomaly
- [ ] Geophy. Anomaly
- [ ]

⑯ Production

Commodity	Tons	Grade

⑰ Reserves [ ] Measured [ ] Estimated

Commodity	Tons	Grade

⑱ Num. Drill Holes: none
Approx. Total Footage: ______

⑲ Excavations: several small pits on veins

⑳ Spectro. Analysis Attached

㉑ Assays Attached

㉒ Geochem Results Attached

Section IV Geologic Data

㉓ Commodity or Contained Metals: Copper-moly prospect.

㉔ Ore Minerals - Major: ______ Minor: ______

㉕ Host Rocks - Major: Glory Hole volcanics & Bx pipes Minor: ______

㉖ Age of Host Rocks: Laramide

㉗ Nature of Exposures: Low hills partially rubble covered

㉘ Alteration: Qtz-sericite-specularite-argillic in bx pipes and veins.

㉙ Total Extent: 3/4 sq.mile going under volc.cover.

㉚ Structure: Predominantly N40-70°E trend to bx alignment and mineralized fracture

㉛ Ore Occurrence: In bx pipes and veins.

㉜ Age of Mineralization: Laramide

㉝ Conclusions and Recommendations: A dozen or more bx pipes and elongated masses with veins trending in same NE direction. Pipes contain specularite and FeOx in vugs and shears with qtz and sericite. Outside main zone the strongest veins contain minor wulfenite, vanadinite, and copper oxides. Main horseshoe shaped zone 3/4 mile on side goes under post-mineral volcanic cover. Detailed mapping and further general reconnaissance is recommended.

(For additional space use extra sheets)

JDS

ASARCO

Exploration Department
Southwestern United States Division

June 20, 1978

Mr. Frank Tapia
112 - 4th Avenue
San Manuel, Arizona 85631

Dear Frank:

I want to thank you on behalf of ASARCO Incorporated for your aid and interest on your property west of Little Table Mountain, Galiuro Mountains, Pinal County, Arizona.

After conducting our investigation, we have decided not to conduct further work on your property. Attached is an enlargement base of Section 28, and unsurveyed Section 27, showing the locations of our samples and their percent of copper, lead, molybdenum results on your property. Also attached is the spectrographic analysis results of sample LTM-20.

ASARCO Incorporated had also filed on six parcels for State Prospecting Permits in Sections 21, 23, 26, 27, 28, and 33, as shown on the attached plat. These have expiration dates of March 2, 1979, and will be relinquished at that time. They are available to you and your group by contacting Mr. Robert Crist of this office.

Also attached is an affidavit of expenditure covering $2,116.75 which is applicable to your ground and the State Prospecting Permit applications.

Again, we thank you for bringing this property to our attention and look forward to seeing you again.

Very sincerely,

R. B. Crist

for J. D. Sell

JDS:jlh
attmt - affidavit
c.c. F.T.Graybeal, w/attmt
R.B.Crist, w/attmt
P.G.Vikre, w/attmt

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

June 20, 1978

Mr. Frank Tapia
112 - 4th Avenue
San Manuel, Arizona 85631

Asarco holds the following State of Arizona Prospecting Permits and will assign any one or all of them to yourself or your group.

The five-year permits were all effective on March 3, 1978, and renewals or Affidavits of Performance of work must be filed by March 2, 1979 to keep them for the second year. The work as performed by Asarco would be allocated as outlined below.

P.P.	Section	Acres		Work Expenditures
59146	21	400	as outlined on the attached map	$93.00
59147	23	320		93.00
59148	26	320		93.00
59149	27	240		--
59150	28	160		389.50
59151	33	400		50.00

Prospecting Permit in SE¼ of Sec.28 - Tapia, et al... $699.75

Federal Mining Claims in Sec.27..... $698.50

$2,116.75

As you know, the cost of the permits cannot be used although the dollar per acre rental has been paid for the first two years of the permit.

ASARCO Incorporated,

R. B. Crist

R. B. Crist

My Commission Expires:

My Commission Expires Nov. 28, 1980

Mildred C. Cain

Notary Public

MILDRED C. CAIN NOTARY PUBLIC PIMA COUNTY, ARIZ.

Bob: This is ± the time spent on the Little Table Mtn area. Can a $ figure be given to Tapia? (See attached)

Thanks,

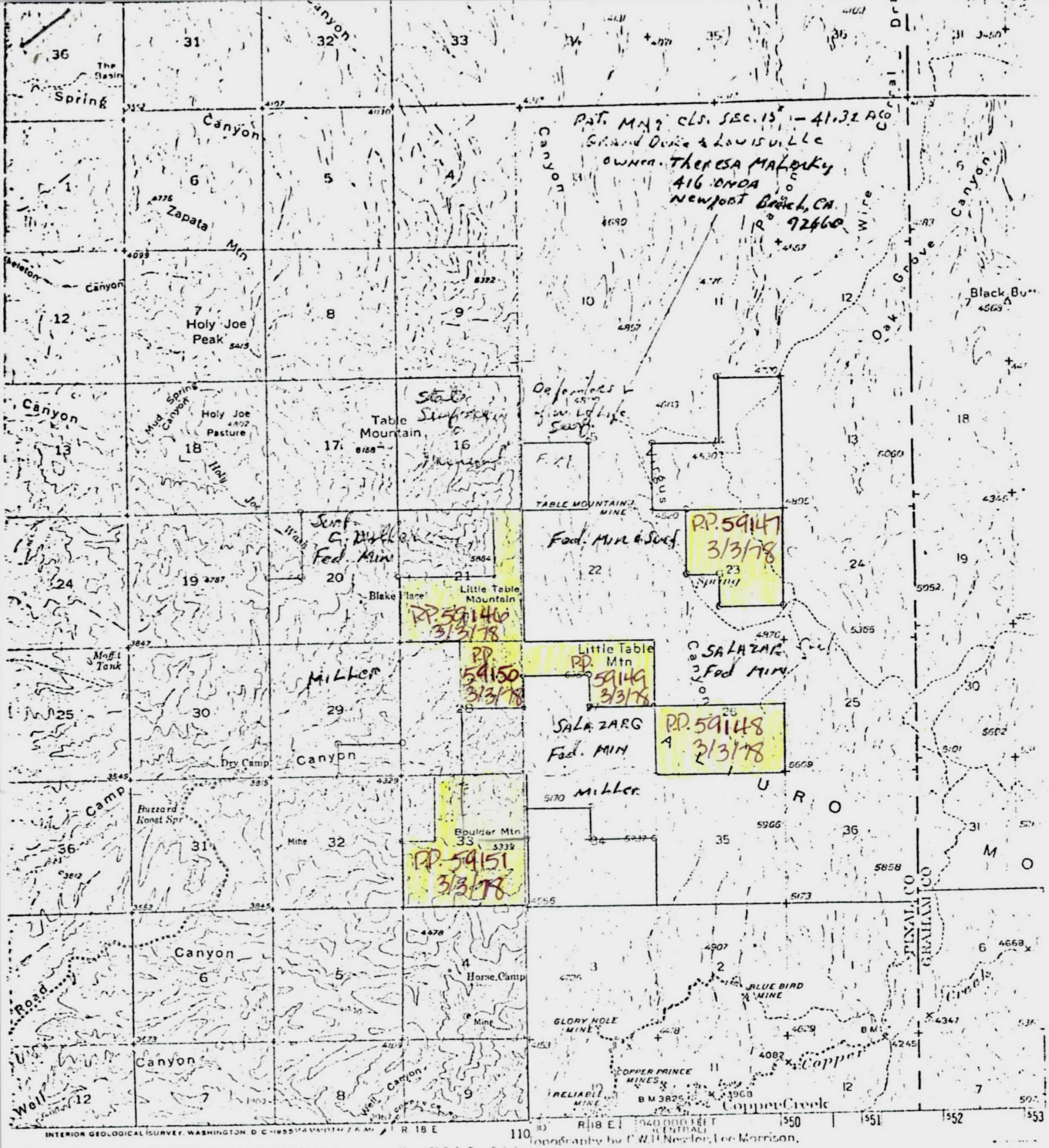
Jim.

+ mileage-vehicle

Prosp. Permit Sec. 21.	½ day PG Vikre	$75.00 + 18 = 93	
Prosp. Permit Sec. 23	½ day PG Vikre	75.00 " "	
Prosp. Permit Sec. 26	½ day PG Vikre	75.00 " "	
Federal Mining Claims of Sec. 27.	2½ days PG Vikre		375.00
	1 day JD Sell		150.00
	½ day FT Graybeal		75.00
	½ day drafting dept.		37.50
	Amer. Analy Res. Lab ± ½ of assay = $22.00		
	½ day secretarial typing report.		25.00
	Mileage		36.00
			698.50
Prosp. Permit NE¼ of Sec. 28.	1¼ days PG Vikre	187.50	
	½ day JD Sell	75.00	
	¼ day FT Graybeal	37.50	
	¼ day drafting dept.	37.50	
	¼ day secretarial typing	25.00	
	Mileage		27.00
			389.50
Prosp. Permit SE¼ of Sec. 28 (Tapia et al)	3¼ day PG Vikre		487.50
	½ day JD Sell		75.00
	¼ day FT Graybeal		37.50
	¼ day drafting department		37.50
	¼ day secretarial typing		25.00
	Amer. Analy Res. Lab ± ½ of assay = 23.75		
	Skyline Labs ES report = $13.50		
	Mileage		54.00
			753.75
Prosp. Permit Sec. 33	¼ day PG Vikre	37.50 + 12.50 = 50.00	

All Prospecting & Claim Area — time of RB Crist.

150/day Geol Time
.15/mile 120 Rd Trip $18.00/day



Filed Six P.P.
yellow Areas.
Orange is Open
State Land
Uncolored is Fed. Min

APPLICATION FOR PROSPECTING PERMIT

IN SECTION ______ TOWNSHIP 7 South RANGE 18 East

ASARCO INCORPORATED

scale 1" = 1 Mile base from USGS ____________ topographic quadrangle (s)

3441 East Milber Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE April 19, 1978

SAMPLE MARKED	GOLD OZ / TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-								
9			0.01	0.02		.0005		
10			0.01	0.02		.0008		
13			0.01	0.02		.0022		
15			0.01	0.02		.0009		
16			0.01	0.01		.0011		
18B			0.01	0.02		.0006		
LTM-20			0.01	0.02		.0004		

Invoice # 15741

CHARGES $ 237.50

Bill S. Ho[illegible]
4/19/78

ASSAYER · CHEMIST

3441 East Milber
Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE April 19, 1978

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON
LTM-							
22			0.02	0.03		.0012	
23			0.01	0.03		.0005	
24			0.01	0.03		.0010	
27			0.01	0.02		.0008	
28			0.01	0.01		.0009	
29			0.01	0.01		.0014	
30			0.01	0.01		.0003	
LTM-32			0.01	0.01		.0005	

Pete A. Flores
4/19/78

Invoice # 15741

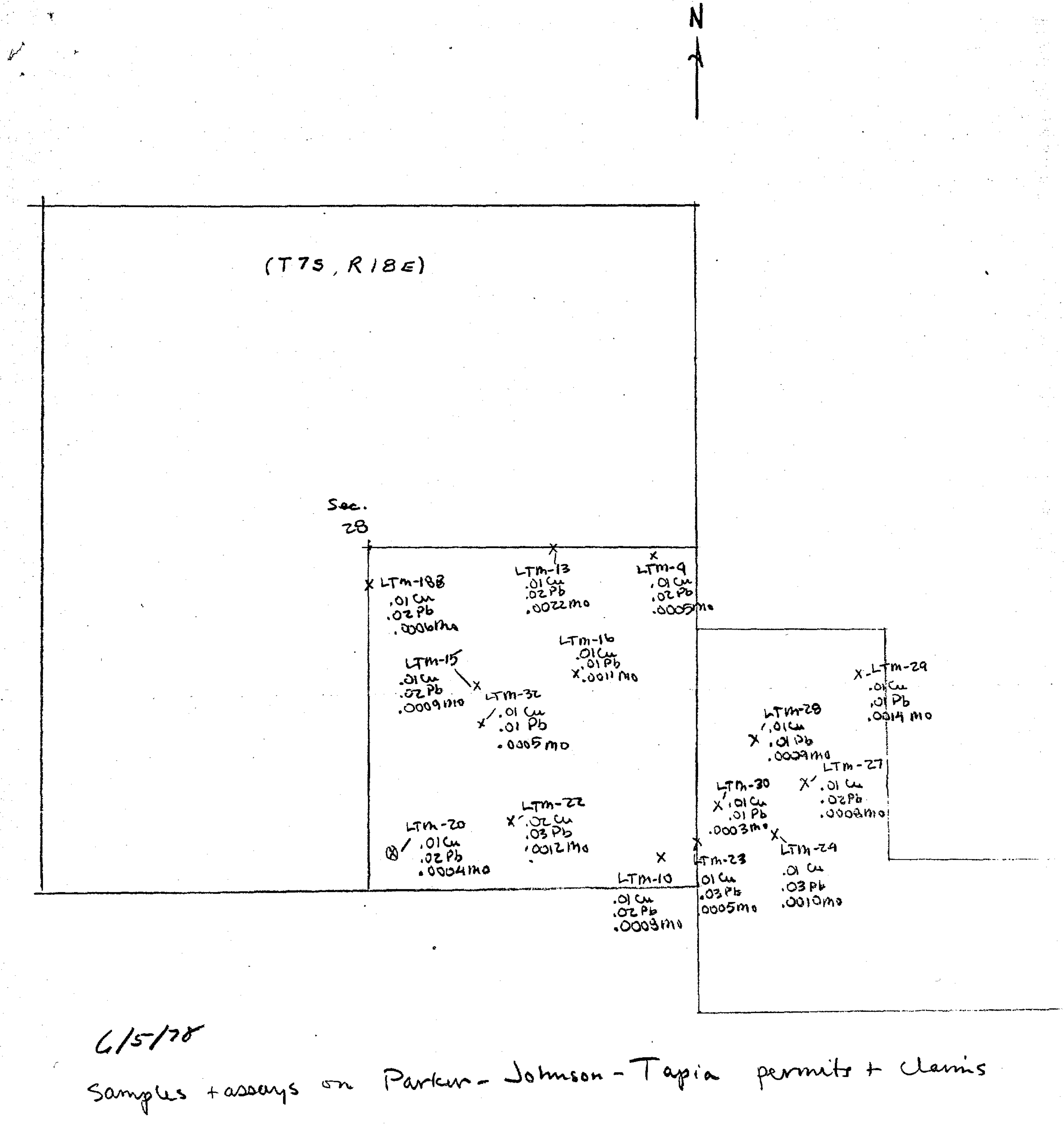
ITEM NO. SAMPLE NO.

2 = LTM-20

ITEM	2
ELEMENT	
Fe	3%
Ca	7%
Mg	3%
Ag	<1
As	<500
B	10
Ba	10
Be	<2
Bi	<10
Cd	<50
Co	10
Cr	20
Cu	10
Ga	<10
Ge	<20
La	20
Mn	1000
Mo	<2
Nb	<20
Ni	50
Pb	50
Sb	<100
Sc	<10
Sn	<10
Sr	200
Ti	500
V	30
W	<50
Y	<10
Zn	200
Zr	<20

Charles E. Thompson
Chief Chemist

SKYLINE LABS, INC.
SPECIALISTS IN EXPLORATION GEOCHEMISTRY



6/5/78

Samples + assays on Parker - Johnson - Tapia permits + claims

LTM Project → PGV

1" = 1000'

SPECTROGRAPHIC ANALYSIS

LTM-20

element		
Fe	3%	
Ca	7%	
Mg	3%	
Ag	<1	ppm
As	<500	"
B	10	"
Ba	10	"
Be	<2	"
Bi	<10	"
Cd	<50	"
Co	10	"
Cr	20	"
Cu	10	"
Ga	<10	"
Ge	<20	"
La	20	"
Mn	1000	"
Mo	<2	"
Nb	<20	"
Ni	50	"
Pb	50	"
Sb	<100	"
Sc	<10	"
Sn	<10	"
Sr	200	"
Ti	500	"
V	30	"
W	<50	"
Y	<10	"
Zn	200	"
Zr	<20	"

Ginny – Please make a
copy of the maps.

~~FVG~~

16A.3.3E

JOS. OK

I'd appreciate a copy of P&V's paper on the Little Table recon. "Breccias and massive silica deposits in the vicinity of Little Table Mtn" July 17, 1978 w/maps etc.

16A. 3. 3E folder 2

(Finally - M.V.K.)

Ao-... -2E

ASARCO

Southwestern Exploration Division

July 17, 1978

TO: F. T. Graybeal

FROM: P. G. Vikre

Breccias and massive silica deposits in the vicinity of Little Table Mountain Pinal County, Arizona

SUMMARY

More than 25 distinct intrusive breccias outcrop in the Galiuro Mountains southwest of Little Table Mountain, Pinal County, Arizona. The breccias occur in Glory Hole Volcanics which are similar to those that contained commercial copper-molybdenum deposits in the Copper Creek District three miles to the south. Massive silica replaces Escabrosa Limestone north of Little Table Mountain and hosts a small copper-gold deposit, the Table Mountain Mine. Alteration associated with breccias is quartz-hematite-clay-sericite. Limestone adjacent to massive silica is unaltered.

Anomalous metal values are present in the breccias and massive silica deposits. Forty-five samples assayed for gold (oz/ton), silver (oz/ton), copper (%), lead (%), molybdenum (%), and arsenic (%) yield the following averages (number of analyses in parentheses):

Breccias

Au(5)	Cu(35)	Pb(35)	Mo(35)	As(5)
0.0006	.01	.02	.0012	.0022

Massive Silica

Au(10)	Ag(10)	Cu(4)	Pb(4)	Mo(4)	As(3)
.0032	.20	.07	.73	.0067	.0057

Background values in "unaltered" Copper Creek granodiorite and Glory Hole volcanic rocks are: Au - trace, Ag - 0.01 oz/ton, Cu - 0.01%, Pb - trace to 0.01%, and Mo - 0.001%. Six spectrographic analyses reveal high barium, manganese, and titanium in breccias, and high barium, antimony, chromium, manganese, titanium, vanadium, and zinc in massive silica.

It is assumed that the structures and anomalous metals are time-space related to mineralization in the Copper Creek District. However, the potential for economic concentrations of metals at depth appears limited because of low values in surficial facies.

INTRODUCTION

Several square miles of pre-Miocene rocks in the vicinity of Little Table Mountain, Pinal County, Arizona, were mapped and sampled to determine if intrusive breccias, alteration, and siliceous deposits associated with these strata bore relation to economic porphyry copper-type or low-grade precious metal mineralization. The areas examined are exposed on the north and southwest flanks of Little Table Mountain where erosion has cut through post-mineralization Galiuro Volcanics which comprise Little Table Mountain, Table Mountain, and Holy Joe Peak, all in the Galiuro Mountains.

Interest in the area stems from several sources. Pre-mineralization rocks southwest of Little Table Mountain are partly covered by the claims and state prospecting permits of Frank Tapia, of San Manuel, Arizona, who submitted samples of breccia to Asarco. An examination of Tapia's holdings was made by J. D. Sell on January 9, 1978. Mr. Sell recommended detailed mapping and further geological reconnaissance of the area.

Pre-mineralization rocks near Little Table Mountain are the same as those in the Copper Creek District, 3 miles south of Little Table Mountain (Simons, 1964; Krieger, 1968). At Copper Creek, several millions of dollars in copper and molybdenum were recovered from breccia pipes in Glory Hole Volcanics and Copper Creek granodiorite (Simons, 1964). Deep drilling by EXXON and Newmont in recent years has discovered a low-grade porphyry-copper deposit at depth.

Ten field days in March and April 1978 were spent mapping and sampling near Little Table Mountain. J. M. Wood assisted in sampling. F. T. Graybeal and J. D. Sell made suggestions and constructive criticisms during two field visits. Six thin and polished thin sections helped document alteration and mineralization.

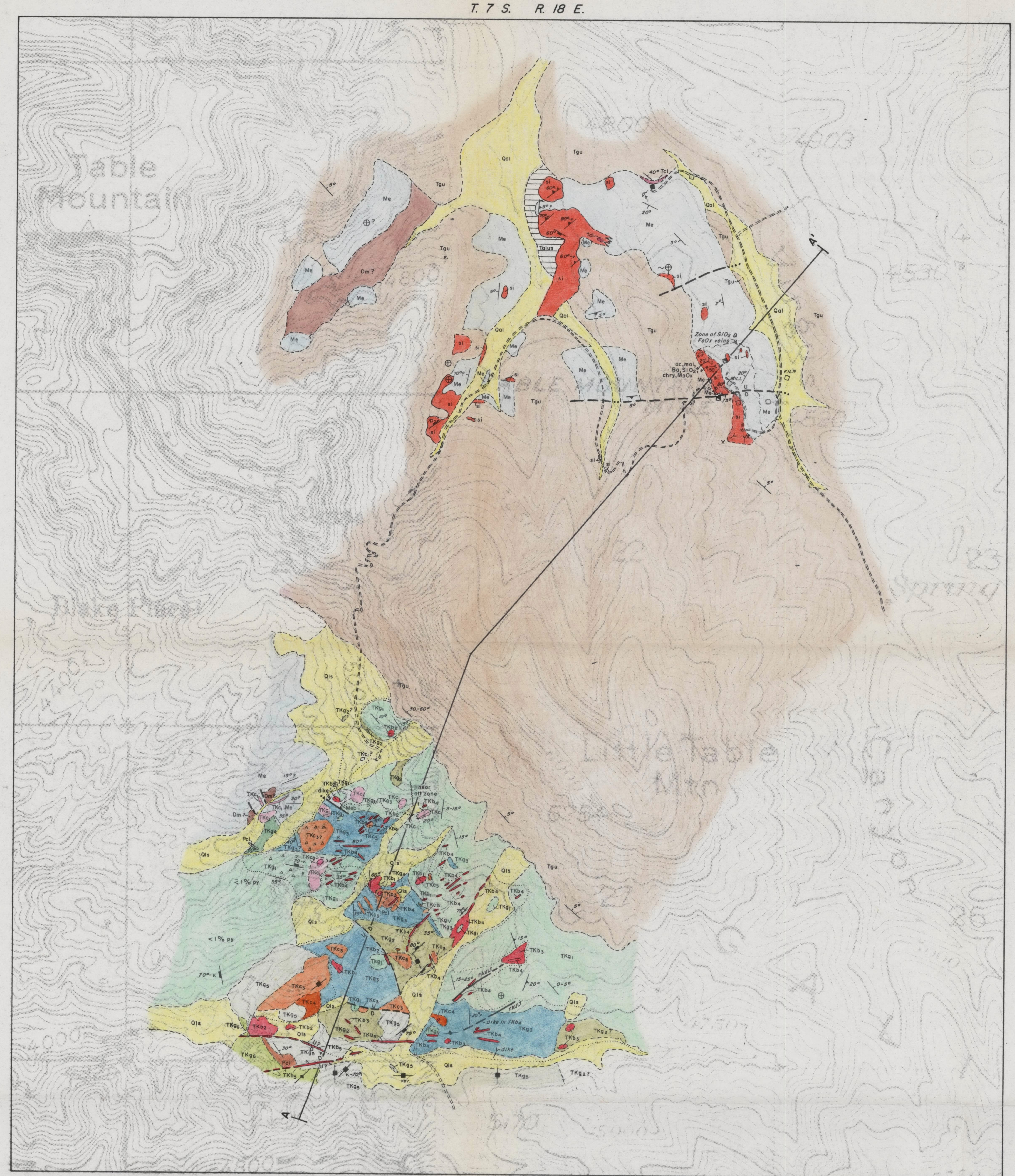
GEOLOGY

Figure 1, centered on Little Table Mountain, is a geologic map of the rocks and structures discussed below. Little Table Mountain consists of well-bedded andesites and coarse lithic tuff uniformly dipping about 5°NE. These rocks are members of the Galiuro Volcanics which are about 29 to 23 m.y. old (Creasey and Krieger, 1978). The Tertiary rocks primarily overlie, with slight angular unconformity, Mississippian Escabrosa Limestone north of Little Table Mountain and Glory Hole Volcanics southwest of Little Table Mountain. Small intrusive plugs of varying composition and texture intrude Glory Hole Volcanics. The intrusive rocks are probably apophyses of the Copper Creek granodiorite, the main mass of which is exposed to the south and southwest of Figure 1 (Simons, 1964; Krieger, 1968). Numerous breccias and fragmental dikes in Glory Hole Volcanics are conspicuous because of alteration and topographic relief. Prominent ledge and spine-like masses of chalcedonic quartz and siliceous breccia replace limestone northeast of Little Table Mountain. The Table Mountain Mine recovered copper, gold, and silver from about 100,000 tons of ore in one of these siliceous masses. Quaternary deposits include seasonal stream detritus and numerous landslides along the southwestern flank of Little Table Mountain.

No detailed petrography was attempted on any of the lithologies, but several breccias were examined under the microscope. Hand specimen and field descriptions of other units on Figure 1 are included in an APPENDIX.

Figure 1

T. 7 S. R. 18 E.



Base: U.S.G.S. 15' Topographic Quadrangles - Holy Joe Peak, Ariz. (1949) Klondike, Ariz. (1938)
Geology: P.G. Vikre, (1978)

EXPLANATION

CENOZOIC

QUATERNARY

- Qal / Qls — Surficial deposits; alluvium & landslides

— UNCONFORMITY —

TERTIARY

- Tgu — Galiuro volcanic rocks, undivided
- Tcl — Pre-Galiuro clastic rocks (Pinkard Formation?)

— UNCONFORMITY —

MESOZOIC

LOWER TERTIARY

BRECCIAS IN GLORY HOLE VOLCANICS

- TKb_1 — Imbricated/rotated clasts indicative of strong movement; FeOx, quartz, sericite matrix
- TKb_2 — Subordinate disrupted clasts indicative of partial movement; much fracturing in place; FeOx, quartz, sericite matrix
- TKb_3 — Country rock fractured in place, little or no evidence for clast movement; FeOx, quartz, sericite, clay matrix
- TKb_4 — Siliceous, occasionally flow-banded dikes; centers may consist of rotated fragments; includes linear zones of resistant country rock fractured, cemented in place; quartz ± sericite ± FeOx matrix
- TKb_5 — Siliceous, hematitic, brecciated, high-angle fault zones
- si — Siliceous deposits; massive chalcedonic quartz, partly brecciated and cemented by silica ± FeOx; locally contains barite, MnOx & copper minerals (Table Mtn. Mine); both conformable & unconformable masses restricted to Escabrosa Limestone

GLORY HOLE VOLCANICS

- TKg_1 — Porous, partly welded lithic tuff
- TKg_2 — Predominantly andesite breccia & tuff
- TKg_3 / TKg_3 / TKg_3 — Porphyritic andesite, subordinate tuff & breccias
- TKg_4 — Porphyritic, amygdaloidal andesite
- TKg_5 — Predomantly porphyritic andesite
- TKg_6 — Dense, siliceous lithic tuff & breccia

UPPER CRETACEOUS

COPPER CREEK GRANODIORITE FACIES

- TKc_1 — Quartz monzonite & granodiorite, slightly porphyritic & miarolitic
- TKc_2 — Granite
- TKc_3 — Hornblende granodiorite (?)
- TKc_4 — Composite cupolas of TKc_1, TKc_3, & various, intrusive porphyritic rocks
- TKc_5 — Diorite (?) & andesite

— UNCONFORMITY —

PALEOZOIC

MISSISSIPPIAN

- Me / Meb — Escabrosa limestone; limestone breccia

— DISCONFORMITY —

DEVONIAN

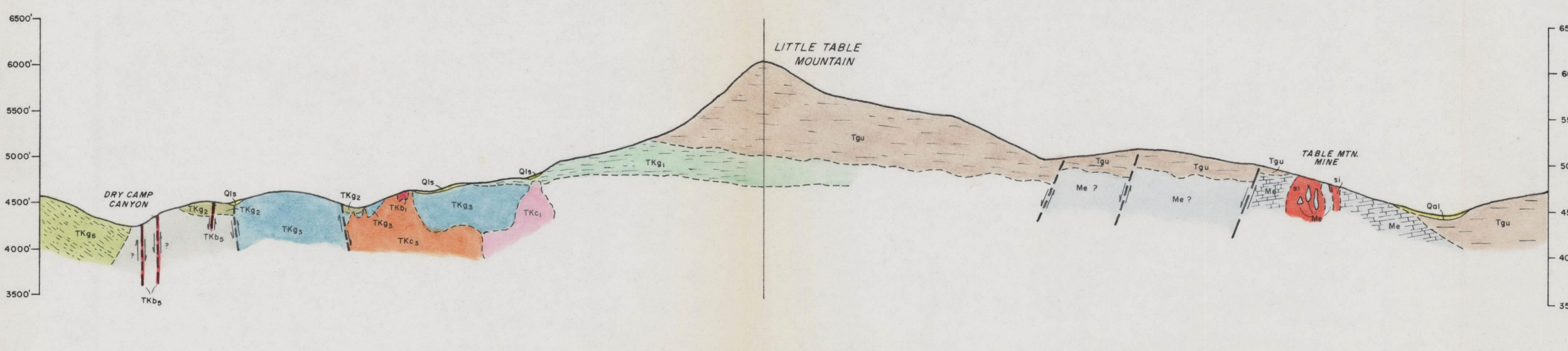
- Dm — Martin Formation shale

— UNCONFORMITY —

- Pcl — Chaotic blocks of Lower Paleozoic arkosic sandstone, quartzite & lithic tuff

Symbols:

- 75° — Quartz vein, showing dip
- D U — Fault, showing relative displacement
- 9° ⊕ — Strike & dip of bedding; vertical; horizontal
- 30° — Strike & dip of foliation; vertical
- 60° — Strike & dip of jointing; vertical
- Encloses rocks containing 1-3 % FeOx pseudomorphous after pyrite



NORTH

TO ACCOMPANY Report
DATED July 17, 1978
BY [signature]

Geologic Plan & Cross Section
OF THE
LITTLE TABLE MOUNTAIN AREA
PINAL COUNTY, ARIZONA
SCALE: 1" = 1000'

P.G. Vikre July, 1978

MVK-5006

BRECCIAS

Glory Hole Volcanics are cut by dozens of breccia plugs and dikes many of which weather as prominent land forms (Fig. 2). Equidimensional, cylindrical plugs are generally one hundred feet or less in diameter, but the largest breccia, although partly covered, is probably greater than 150 feet in diameter. Dikes have discontinuous exposures and rarely exceed 10 feet in width. Virtually all are vertical. The intrusive breccias have been placed in four categories on Figure 1: (1) breccias consisting of clasts and quartz+hematite±sericite matrix that distinctly show evidence of movement, or imbrication and are discordant to enclosing strata; (2) breccias consisting of disrupted clasts, indicative of partial movement, which are cemented by quartz, silicates, and iron oxides; (3) breccias that are essentially country rock fractured and cemented in place, with little or no evidence for clast movement; and (4) siliceous, occasionally flow-banded and zoned breccia dikes with foliated margins and centers consisting of rotated fragments. Distribution of breccia types is shown on Figure 3.

Breccia plugs are commonly enveloped by strong red-orange iron oxide staining in fractured and altered Glory Hole Volcanics (Fig. 2). Clasts measure from $<$1/4" to $>$4" and average about 2" in maximum dimension. They are usually unsorted and angular (Fig. 5A) but may be well-imbricated (Figs. 4A, 5B). TKb_1 and some TKb_2 clasts are primarily microcrystalline quartz+clay±sericite± iron oxide aggregates with rare quartz phenocrysts (see ALTERATION AND MINERALOGY OF BRECCIAS). Angular fragments of quartzite, "jasperoid," and porphyritic rocks are abundant in some quartz-rich breccias.

Breccia plugs that consist primarily of altered Glory Hole Volcanics are less erosionally resistant, and many barely outcrop. Any relief present may be attributed to quartz+iron oxide±sericite matrix. Clast alteration in these breccias is more strongly argillic than in breccias containing quartz-rich fragments. Both types of breccia may be cut by stringers of microcrystalline silica±iron oxides.

Breccia matrix in quartz-rich breccias is largely hematite (Fig. 5A) and/or quartz (Fig. 5B). Narrow, porphyritic mafic dikes cutting some breccias are probably sources for Galiuro Volcanics. Other well-sorted clastic dikes which transect foliation in breccias (Fig. 5C) apparently formed in late-stage fractures and were produced by autogenous milling in a fluid medium.

Breccia dikes range in structure from resistant linear zones of silicified country rock fractured and cemented in place to internally differentiated, composite dikes consisting of flow banded, foliated margins and brecciated interiors indicative of clast movement (Fig. 4B). Each structure is gradational with the other. In places, dikes appear to be circumferentially arranged about larger breccia plugs (Fig. 1). Nowhere do they cut plugs, and similar structure and envisioned mode of origin suggest that dikes and plugs are coeval.

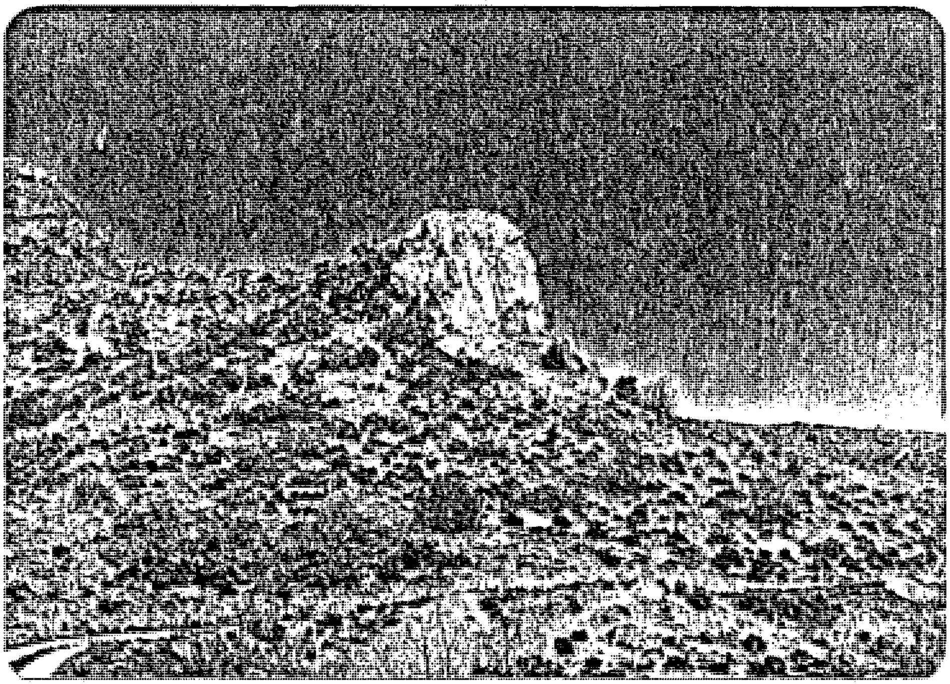
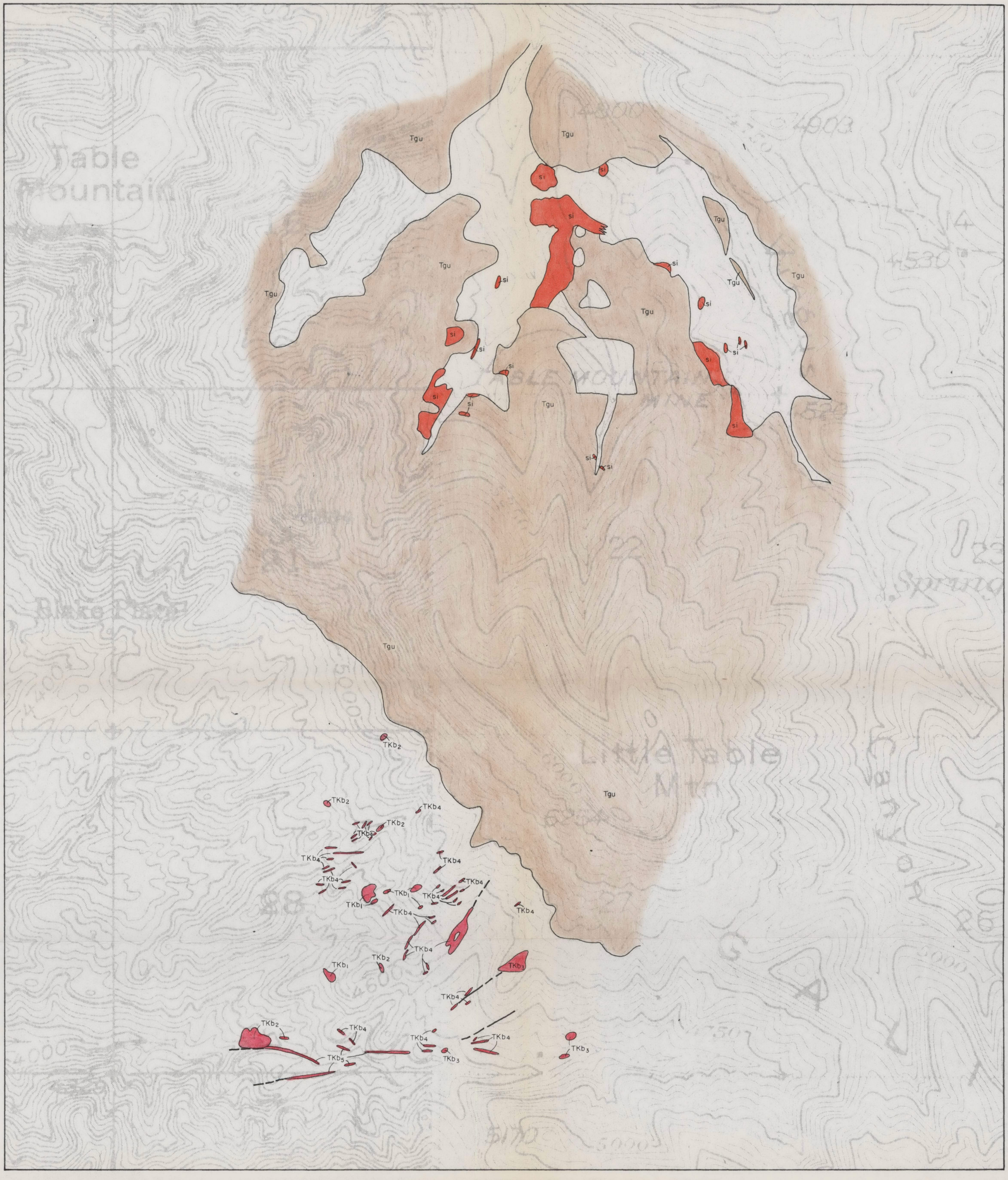


Figure 2. Breccia (TBO) plug (TKb_1) southwest of Little Table Mountain, Arizona surrounded by ferrugineous soil and float derived from altered Glory Hole Volcanics. Slight foliation (enhanced by jointing) strikes east and dips ~20°N (to the left) but locally varies.



EXPLANATION

Tgu Galiuro Volcanics

si Siliceous deposits

BRECCIAS

TKb1 Intrusive

TKb2 Intrusive/residual

TKb3 Residual

TKb4 Fragmental dikes

TKb5 Brecciated fault zones

Fault

NORTH

TO ACCOMPANY Report
DATED July 17, 1978
BY P.G. Vikre

Distribution of pre-Miocene siliceous deposits, breccias & related structures

OF THE

LITTLE TABLE MOUNTAIN AREA

PINAL COUNTY, ARIZONA

SCALE: 1" = 1000'

P.G. Vikre July, 1978

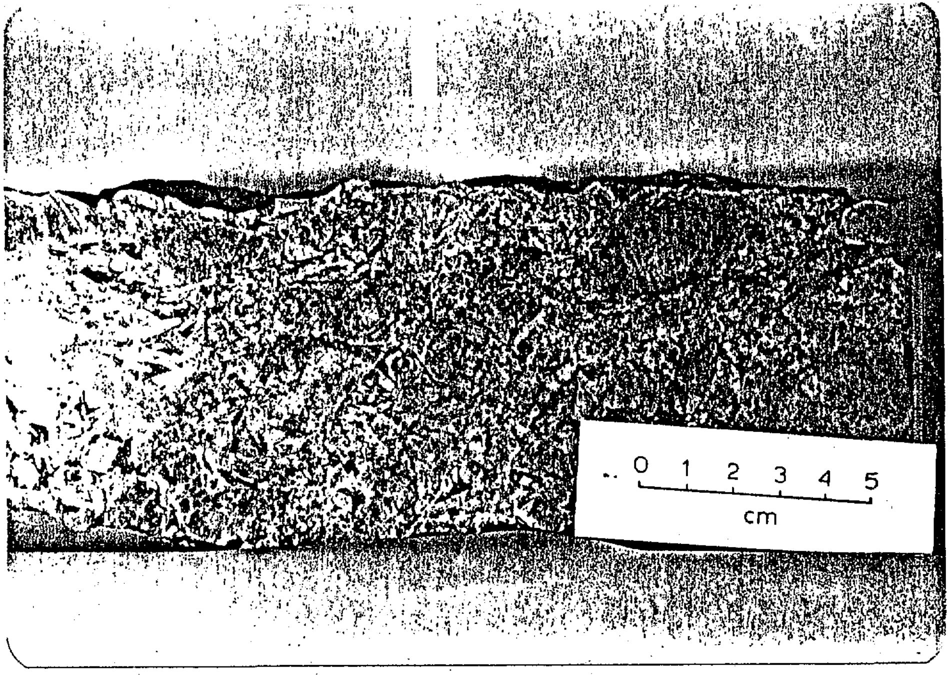
MVK-5007

Figure 4. Structure in breccia plugs and dikes, with hammer for scale, southwest of Little Table Mountain, Arizona.

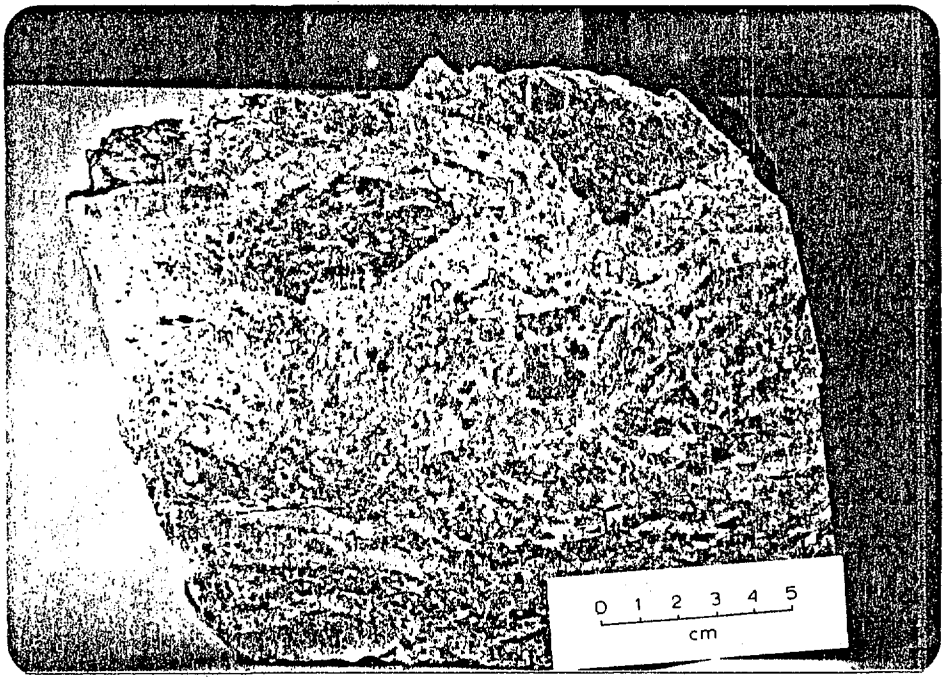
A. Breccia (TBL) plug (TKb_1) consisting of flattened, imbricated siliceous clasts in quartz+hematite± sericite matrix. Foliation strikes north, dips ~30°E (to the right), and locally varies.

B. Zoned breccia dike (TKb_4) displaying foliated margins and brecciated interior. Dikes trend east, or east-northeast, and are nearly always vertical.

A.



B.



C.

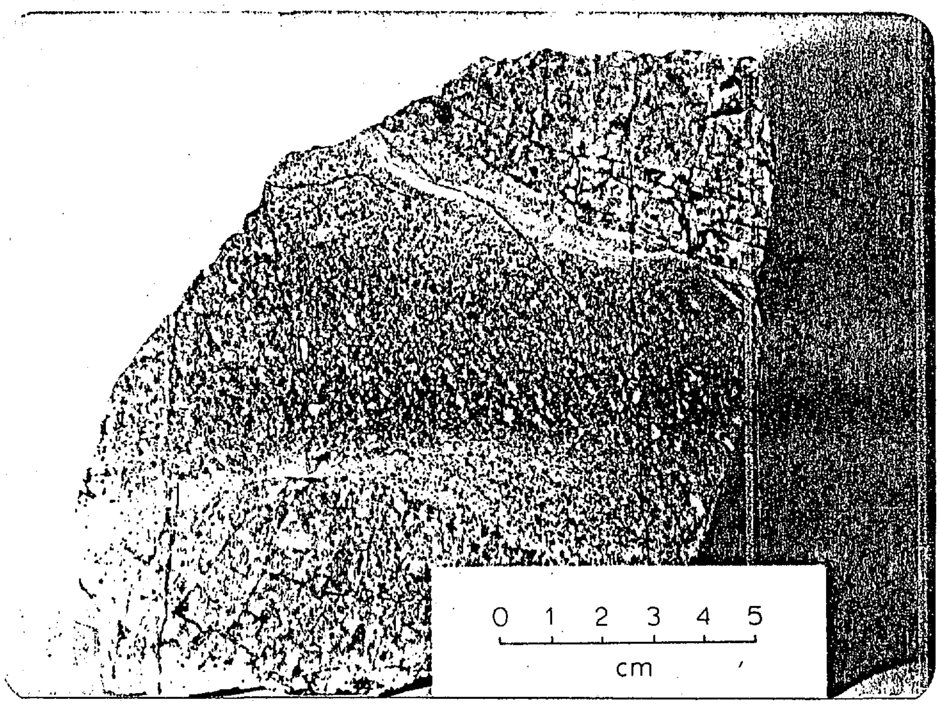


Figure 5. Cut slabs of breccia plugs (TKb_1), with scale, from Little Table Mountain, Arizona.

A. Unoriented, angular siliceous clasts in hematite-rich matrix. Hematite also occurs disseminated and along fractures in fragments.

B. Imbricated, flattened siliceous clasts in quartz+ sericite, iron oxide-deficient matrix, similar to the breccia pictured in Figure 4A.

C. Clastic dike intruded into foliated breccia, displaying lateral particle-size gradation and iron-oxide zonation.

STRUCTURE

Regional structure in the vicinity of Little Table Mountain is characterized by relatively flat-lying volcanic and sedimentary rocks partly deformed by intrusions, and by high-angle faulting of modest displacement. Bedding in Escabrosa Limestone rarely exceeds 15° and is commonly 5° or less. Limestone north of Little Table Mountain is remarkably undeformed. Southwest of Little Table Mountain limestone generally dips less than 15° north, but adjacent to dikes and plugs of Copper Creek granodiorite attitudes may approach 60°. Limestone there is weakly to intensely brecciated and cemented by carbonate± silica. Dikes of porphyritic mafic rocks, which are probably the sources for some of the Glory Hole eruptives, may have caused some of the deformation. The emplacement of massive siliceous breccias into limestone north of Little Table Mountain appears to have been entirely a process of dissolution and replacement and not forceful injection. Some ledge-like outcrops of chalcedonic quartz have selectively replaced carbonate beds and are conformable to enclosing limestone. In the vicinity of irregular cross-cutting silica masses, numerous chalcedonic stringers with random orientation pervade surrounding limestone, often hundreds of feet from the main silica body.

Attitudes of members of the Glory Hole Volcanics vary appreciably. The youngest eruptive rocks (TKg_1) dip less than 15° northeast except where arched by Copper Creek granodiorite and older Glory Hole intrusive andesites, or faulted. Other Glory Hole members have more erratic attitudes and little attempt was made to accurately reconstruct the stratigraphy.

Several exotic blocks of clastic sedimentary strata are engulfed by intrusive andesites and Copper Creek granodiorite plugs. The composition of the equigranular, sand-textured pendants is highly quartzose. Rarely do they contain more than a few percent rock fragments and feldspar. Iron oxides are a noticeable accessory in the northernmost block. These exotics have been assigned a lower Paleozoic age. Krieger (1968) reports similar landslide blocks of possible Troy quartzite which occur as inliers in Glory Hole Volcanics and in the Copper Creek granodiorite of Boulder Mountain.

Breccia dikes are strongly oriented east-northeast or east with few exceptions. Breccia plugs do not have a preferential orientation, nor are any noticeably aligned. High-angle joints, striking N50°E to N60°E, are conspicuously co-planar with many breccia dikes and occur throughout the mapped area in all pre-Galiuro rock units. Jointing is particularly prominent in the large silica masses north of Little Table Mountain.

Several normal faults displace Escabrosa Limestone and Glory Hole volcanic rocks. Not all faults were observed in outcrop and southwest of Little Table Mountain rapid facies changes, drainage patterns, and alteration were interpreted as evidence for faulting in some cases. Displacement along all faults is probably less than 100 feet, and attitudes of fault planes are nearly vertical. Most faults trend east or east-northeast, similar to the orientation of breccia dikes and regional jointing. Fault zones in Dry Camp Canyon consist of silicified, hematitic breccia that intermittantly weathers in relief (TKb_5).

Age of most faulting is post-Cretaceous and pre-Miocene, although displacement of some silica deposits north of Little Table Mountain probably occurred after deposition of Galiuro Volcanics. Galiuro units are generally uniformly bedded, but no large offsets in stratigraphy are noticeable in the extensive sections exposed on the east sides of Little Table and Table Mountains. Structural relations in the vicinity of the Table Mountain Mine may be explained by high pre-Galiuro relief, or by en echelon normal faulting in Escabrosa and Galiuro rocks of small individual, but large composite displacement.

ALTERATION AND MINERALOGY OF BRECCIAS

Quartz, clay minerals, iron oxides, iron sulfide, and minor amounts of sericite have been added to pre-Miocene rocks on the southwest side of Little Table Mountain. These minerals are most abundant in, or adjacent to, recognized breccias but are not confined to them. Glory Hole Volcanics contain sporadic occurrences of this assemblage which do not bear spatial relation to breccias. For this reason it is possible that more than one stage of alteration has affected Glory Hole rocks and some alteration may have occurred during or following the eruption of Glory Hole units. The most obvious alteration is associated with the intrusion of breccias.

There is no megascopic alteration associated with massive silica north of Little Table Mountain. The silica sharply borders enclosing limestone and secondary minerals in the carbonate were not observed. However, no optical examination of these rocks was made.

Under the microscope, breccia matrix consists of varying amounts of quartz, hematite, sericite, and clay minerals, mainly montmorillonite and kaolinite. Laths of fibrous, sagenitic hematite form up to 70% of breccia matrix along with lesser amounts of pyrite in sub-5 mm cubes, goethite pseudomorphous after pyrite, and rutile (or anatase). Breccia matrix may be as much as 50% void, often bordered by hematite plates. Most breccia clasts are mainly aggregates of fine-grained to microcrystalline quartz and hematite±clay minerals, sericite, and submicron pyrite, and rutile. Quartz generally forms 80+% of any breccia and hematite is always the second most abundant constituent. Spectrographic analyses suggest that minor amounts of barite and manganese oxides also occur in the breccias.

Many breccia clasts show no similarity to other rocks exposed in the vicinity of Little Table Mountain. They contain up to 5% partly resorbed quartz phenocrysts in irregular, jigsaw textured quartz-clay-FeOx mosaic. All fragments compositionally resemble breccia matrix and many are recognizable only because of variations in grain size and/or FeOx content. Random, coarse-grained quartz aggregates and veinlets cut breccia clasts and matrix. Simons (1964) considers breccia clasts in some of Copper Creek District breccias to be hornfelsed Glory Hole Volcanics.

FLUID INCLUSIONS

A brief examination of fluid inclusions in quartz phenocrysts and aggregates reveals two possible populations of primary inclusions: one, encompassing < 5% of all inclusions, contains 50-70% vapor; the other more prevalent variety contains 80-90+% vapor. No daughter minerals are present. Inclusions are extremely abundant in most phenocrysts -- $> 10^3$ inclusions/mm^2 of thin section surface area.

MINERALIZATION

Two types of known metal mineralization, one in the Copper Creek District and the other at the Table Mountain Mine, occur in rocks of the Little Table Mountain area. These deposits suggest, to an extent, the targets for exploration in pre-mineralization rocks of Little Table Mountain. The following deposit summaries are largely after Simons (1964).

The Copper Creek District is characterized by more than 200 breccia pipes, some of which contain copper, molybdenum, and other metals in Glory Hole Volcanics andCopper Creek granodiorite. Production to 1939 includes 8 million pounds of copper, 7 million pounds of MoS_2, 4 million pounds of lead and several hundred thousand ounces of silver. The productive breccias, which are 3 to 3-1/2 miles south-southeast of Little Table Mountain, are nearly vertical cylinders measuring a few feet to more than 600 feet in diameter. Their minimum vertical dimension is 850 feet. Many weather in relief as iron-stained elliptical knobs, often tens of feet high. The breccias consist of angular to rounded fragments of country rocks of varying size. Voids may be partly filled with quartz, sericite, and tourmaline. Pyrite, chalcopyrite, molybdenite, and bornite occur mainly in breccia interstices but also are disseminated in breccia fragments and wall rock, and rarely in crosscutting veinlets in breccia. Other sulfides, sulfosalts, and oxides are present in small amounts. Some breccias in volcanic rocks are crudely imbricated while others are unsorted and chaotic. Degree of fragmentation varies from intense crushing to incipient fracturing and alteration. Occurrences of unfractured latite porphyry in several pipes suggest contemporaneity with breccia intrusion. Most wall rock-breccia contacts are sharp and show few signs of movement. Quartz-sericite alteration of breccia fragments varies from marginal to complete recrystallization. Wall rock is little fractured and altered. Barren and mineralized breccias contain similar alteration assemblages. The emplacement of most pipes does not seem to have been structurally controlled, as there is little lineation or elongation of breccias. The origin of the breccias is conjectural.

The Table Mountain Mine, located 1-1/4 miles north-northeast of Little Table Mountain, produced copper and gold from about 100,000 tons of ore during the period ~ 1880-1928. Ore contained 7-14+% Cu and 0.2 oz. Au/ton. Remaining mineralization and smelter slag analyzed by Simons (1964) contain, respectively: 2-3% Cu, 0.5-0.6 oz. Ag/ton, and 0.14-0.15 oz. Au/ton; and 2.4% Cu and 0.02 oz. Au/ton. Minor amounts of lead and vanadium are reported.

Principal metal values occur as copper and lead silicates, carbonates, and arsenates in massive, irregular, chalcedonic silica and siliceous breccia. Barite is the only other common gangue mineral. The silica outcrops are mottled gray, red, brown, and white resistant knobs and ridges which locally exceed 100 feet in width and 1000 feet in length. The silica replaces coarse-grained Escabrosa Limestone, and both rocks are unconformably overlain by Galiuro Volcanics. Fault-bounded blocks of limestone are enclosed in the thicker silica masses, and irregular pods and veins of chalcedonic quartz laterally pervade adjacent limestone for several hundred feet. Wall rock alteration is unrecognizable.

Copper minerals are largely confined to pods, vugs, joint surfaces, and fractures in silica. They are particularly abundant in interstices of coarsely bladed barite aggregates. No sulfide minerals are reported by Simons nor were any observed.

Mineralization in the vicinity of Little Table Mountain. Forty-seven rock chip samples were analyzed to evaluate potentially mineralized areas on both sides of Little Table Mountain. Detection of disseminated copper-molybdenum and precious metal deposits were the object of the geochemical survey. Thirty-five samples were collected from breccias and altered country rock on the southwest side of Little Table Mountain. One sample each of Copper Creek granodiorite at Boulder Mountain and a lower andesite flow near Little Table Mountain were analyzed for background estimation. All of these samples were analyzed for copper, molybdenum, and lead. Ten samples were collected from siliceous replacement masses north of Little Table Mountain and in the vicinity of the Table Mountain Mine (Fig. 6). These were analyzed for gold and silver, and copper, molybdenum, and lead, in part. The results are attached and values plotted on Figure 7.

All of the above analyses were performed by American Analytical and Research Laboratories (Tucson, AZ). Five pulps of breccia and massive silica were sent to Skyline Labs, Inc. (Wheat Ridge, CO) for emission spectrographic analyses to check for unforeseen elemental abundances. Eight pulps of breccia and massive silica samples were analyzed for gold and arsenic by Skyline Labs, Inc. (Tucson, AZ). These results are also attached and plotted on Figure 7.

DISCUSSION

Metal values are tabulated according to lithology and structure on Table 1. It is evident that copper, lead, molybdenum, gold, silver, and possibly arsenic occur in anomalous concentrations in breccia plugs and dikes, in altered Glory Hole Volcanics, and in massive silica replacing Escabrosa Limestone. The abundances of the elements are 1 to more than 20 times greater in these lithologies than in "unaltered" country rocks. The most anomalous values appear to be gold, silver, molybdenum, copper, and lead in massive silica. Metals associated with intrusive breccias and related alteration are only slightly more enriched than in country rock, based on limited analyses.

Spectrographic analyses reveal high concentrations of barium, chronium, manganese, antimony, strontium, titanium, vanadium, zinc, zirconium, and nickel in breccias and massive silica. Of these, barium, manganese, titanium, and zinc appear to be anomalous in both lithologies while the other elemental abundances may be high, but are sporadic, given the limited analyses.

It was assumed that if copper-molybdenum mineralization is present in breccias at depth, surface sampling would indicate markedly higher values for these metals. Similarly, if the breccias were eruptive facies of an underlying

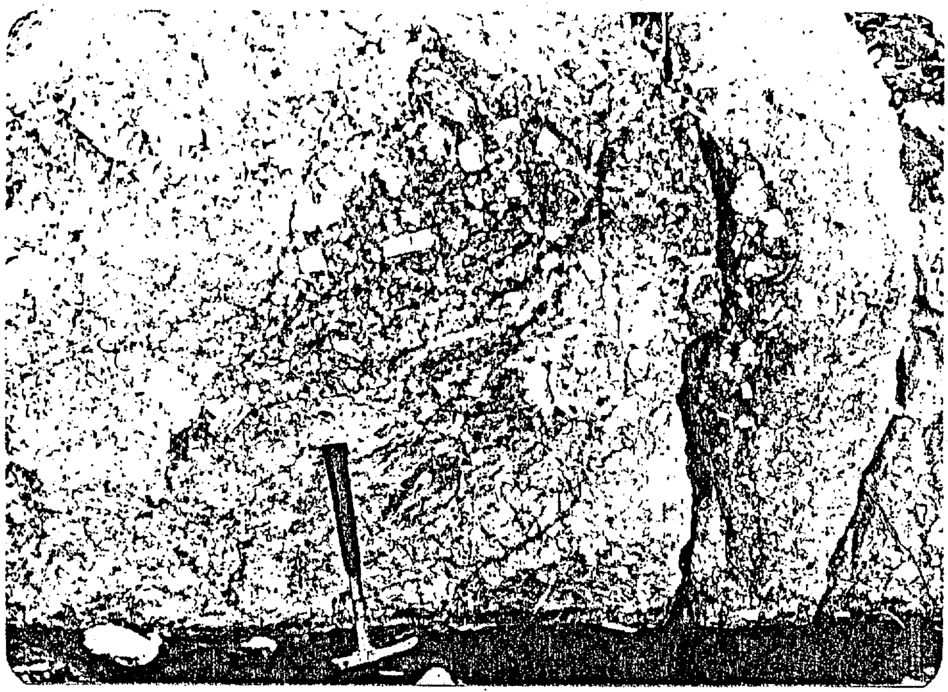


Figure 6. Siliceous breccia, north of Little Table Mountain, Arizona, with hammer for scale. Angular fragments consisting of textureless, microcrystalline silica, are contained in microcrystalline silica±FeOx matrix. Fragments of limestone and shale are extremely rare. Such outcrops grade into massive, microcrystalline silica which replaces Escabrosa limestone. Massive silica is typically unstructured and weathers in extreme relief.

TABLE I. Metal values in rocks of the Little Table Mountain area

A. Trace element analyses

ROCK TYPE	MAP UNIT FIGURE 1	NUMBER OF SAMPLES	Cu(%)	Pb(%)	Mo(%)	As(%)	Au oz/ton	Ag oz/ton
Breccia plugs	$TKb_{1,2,3}$	19	.011	.023	.0012			
		5				0.0022	< 0.0006	
Breccia dikes brecciated fault zone	$TKb_{4,5}$	6	.02	.018	.0010			
Altered Glory Hole volcanic rocks	$TKg_{1,2,3,4,5}$	10	.01	.021	.0006			
Massive silica	si	4	.07	.73*	.0067			
		10				0.0057	0.0032+	0.201
"unaltered" Copper Creek gd	TKc_1	1	.01	tr.	.0001		tr.	0.01
Galiuro andesite	Tgu	1	.01	.01	.0001		tr.	0.01

*includes one sample with 2.80% Pb
+"trace" analysis calculated as 0.001 oz/ton

B. Selected spectrographic analyses for other elements

Rock Type	Map Unit Figure 1	Number of Samples	High Elemental Abundance (Range) in PPM									
			Ba	Cr	Mn	Sb	Sr	Ti	V	Zn	Zr	Ni
Breccia plugs	$TKb_{1,2,3}$	2	10-500	20-50	20-1000	< 100	200	500-2000	30-70	< 200-200	< 20-70	< 5-50
Breccia dikes	$TKb_{4,5}$	1	150	30	100	< 100	300	2000	50	< 200	100	5
Massive silica	si	2	< 10- > 10000	150-200	200-5000	< 100-500	100-700	50-200	20-300	< 200- > 10000	< 20	15-20

Mill slag, Table Mountain Mine — 1 sample

Ag	As	B	Ba	Bi	Co	Cr	Cu	Mn	Mo	Nb
3	3000	150	> 10000	20	30	100	> 10000	> 10000	100	50

Ni	Pb	Sb	Sn	Si	Ti	V	Y	Zn	Zr
50	5000	1000	20	700	1500	1500	70	10000	100

Figure 7

EXPLANATION

TKc — Copper Creek granodiorite*

Tgu — Galiuro Volcanics*

Qal/Qls — Surficial deposits

partly after Simons (1964) & Krieger (1968)

LTM-24 ×(3) — Sample site (×) with sample number & rock type code (3)

(1) breccias undivided (TKb_1, TKb_2, Tkb_3)
(2) brecciated fault zones (TKb_5)
(3) fragmental dikes (TKb_4)
(4) Glory Hole volcanic rocks (TKb_{1-6})
(5) massive silica ± FeOx ± borite ± MnOx (si)
(6) Copper Creek granodiorite (TKc_{1-5})
(7) lower andesite, Galiuro Volcanics (Tgu)

gold (Au), silver (Ag) — Values in oz/ton

copper (Cu), molybdenum (Mo), lead (Pb), arsenic (As) — Values in weight percent

Sampling by J.M. Wood, P.G. Vikre, 1978

Assaying by AARL, Tucson, Arizona; Skyline Labs, Inc., Tucson, Arizona and Denver, Colorado.

— SPECTROGRAPHIC ANALYSES —

ELEMENT	SAMPLE NUMBERS				
	LTM-12	LTM-20	LTM-31	LTM-46	LTM-51
	Values in ppm unless otherwise noted				
Fe	2%	3%	1.5%	3%	10%
Ca	0.03%	7%	0.07%	0.02%	0.05%
Ms	0.07%	3%	0.1%	0.02%	0.03%
Ag	< 1	< 1	< 1	1.5	5
As	< 500	< 500	< 500	< 500	3000
B	10	10	< 10	< 10	20
Ba	500	10	150	< 10	> 10000
Be	< 2	< 2	< 2	< 2	< 2
Bi	< 10	< 10	< 10	< 10	10
Cd	< 50	< 50	< 50	< 50	< 50
Co	< 5	10	< 5	< 5	< 5
Cr	50	20	30	150	200
Cu	20	10	20	70	1500
Ga	10	< 10	10	< 10	< 10
Ge	< 20	< 20	< 20	< 20	< 20
La	50	20	50	< 20	< 20
Mn	20	1000	100	200	5000
Mo	< 2	< 2	< 2	7	200
Nb	< 20	< 20	< 20	< 20	< 20
Ni	< 5	50	5	15	20
Pb	10	50	20	< 10	10000
Sb	< 100	< 100	< 100	< 100	500
Sc	< 10	< 10	< 10	< 10	< 10
Sn	< 10	< 10	< 10	< 10	< 10
Sr	200	200	300	100	700
Ti	2000	500	2000	200	50
V	70	30	50	20	300
W	< 50	< 50	< 50	< 50	< 50
Y	< 10	< 10	< 10	< 10	10
Zn	< 200	200	< 200	< 200	> 10000
Zr	70	< 20	100	< 20	< 20

NORTH

TO ACCOMPANY Report
DATED July 17, 1978
BY P.G. Vikre

Sample Locations & Assays

OF THE

LITTLE TABLE MOUNTAIN AREA

PINAL COUNTY, ARIZONA

SCALE: 1" = 1000'

P.G. Vikre — July, 1978

MVK-5008

intrusive rock, mineralization in the intrusive would be reflected in the breccias. This reasoning is based, in a general way, on the occurrence of economic mineralization in the Copper Creek District, where similar-appearing breccias contain copper and molybdenum at the present surface. Mineralized porphyritic(?) rocks have been intersected by drilling at Copper Creek, although the mineralized breccias apparently do not directly overlie the intrusive (J.H.Courtright, F.T.Graybeal, pers. com.). Breccia distribution, structure, and associated alteration are impressive and generally comparable to those at Copper Creek, but the weak geochemical response of breccias in the Little Table Mountain area does not suggest worthy targets at depth.

Breccias in the Copper Creek District (Simons, 1964) differ from those southwest of Little Table Mountain in the following ways:

(a) breccias are more numerous, more concentrated and larger, on the whole
(b) they contain copper and molybdenum sulfides, pyrite, lead, zinc, and tungsten minerals
(c) pyrite may be abundant in wall rocks
(d) breccia matrices contain tourmaline, apatite, feldspar, calcite, gypsum, and biotite, in addition to quartz
(e) breccias occur in Copper Creek granodiorite as well as in hornfelsed Glory Hole Volcanics

It may be surmized that the breccias formed from rapid emplacement and devolatilisation of facies of Copper Creek granodiorite intruded into Glory Hole Volcanics, but economic metal abundances occurred only where underlying or nearby intrusives were Cu-Mo rich, as at Copper Creek. The numerous juxtaposed plugs and apophyses of intrusive rocks displaying a wide variety of textures and compositions near Little Table Mountain indicate that the so-called Copper Creek granodiorite is probably a related petrologic series of rapidly evolved and intruded fluid-rich phases. Source melt(s) in the Little Table Mountain area were evidently metal deficient. However, the potential remains for other mineralized intrusives and associated breccias within the Copper Creek granodiorite complex elsewhere. Much of the complex, particularly to the north and west of Copper Creek, is covered by post-mineralization volcanic rocks and gravels (Simons, 1964; Krieger, 1968), but units mapped as younger rocks may not be post-mineral, especially east of the Copper Creek District (J.H.Courtright, 1978, pers. com.).

The massive silica replacement deposits in limestone north of Little Table Mountain are somewhat enigmatic. Their size and metal content are fairly intriguing and their relation to mineralization and alteration in the Copper Creek District is, at best, circumstantial. The Table Mountain Mine contained moderately high-grade copper-gold ore, the former metal exclusively in non-sulfide forms. The forms of metal in massive silica analyzed for this report are unknown and it is not totally unreasonable to speculate that the copper silicates, carbonates, and arsenates at the Table Mountain Mine are primary. Vugs, euhedral crystals, and several generations of brecciation and cementation in massive silica suggest that replacement occurred at modest depths and perhaps had surface expression. Undoubtedly, other metalliferous siliceous masses are buried by (post-mineralization) Galiuro Volcanics, but no economic mineralization is indicated by sampling to date. Recognition of genetic relations to Copper Creek intrusive-breccia mineralization might permit exploration possibilities, such as massive sulfide replacement deposits in limestone, to assume other than hypothetical stature. The potential for low-grade precious metal deposits, in light of occurrences elsewhere in Nevada, California, and Arizona appears limited, although the prospective thesis by F. R. Koutz may cause some reevaluation of this assessment.

CONCLUSIONS

Potential for economic copper-molybdenum, low-grade precious metal, and perhaps other mineralization exists in the vicinity of Little Table Mountain, Arizona. Mapping and sampling, however, suggest no obvious areas for further exploration when interpreted in context with published and reported descriptions of mineralization in the Copper Creek District, to which at least some alteration and structure at Little Table Mountain is time-space related. Further work at Little Table Mountain should await (1) a bright idea, (2) "frivolous" money.

Peter G. Vikre
P. G. Vikre

PGV:lb
Atts.

REFERENCES

Creasey, S.C., and Krieger, M.H., 1978, Galiuro volcanics, Pinal, Graham and Cochise Counties, Arizona, U.S.G.S. Journal of Research, vol. 6, no. 1, pp. 115-131.

Krieger, M.H., 1968, Geologic map of the Holy Joe Peak Quadrangle, Pinal County, Arizona, U.S.G.S. Map GQ-669.

Simons, F.S., 1964, Geology of the Klondyke Quadrangle, Graham and Pinal Counties, Arizona, U.S.G.S. PP 461.

APPENDIX -- Description of some rock units in the vicinity of Little Table Mountain, Arizona

INTRUSIVE ROCKS

Copper Creek granodiorite facies
map symbol (Fig. 1)

TKc_1 fine-grained, miarolitic, equigranular to porphyritic feldspar±biotite± chlorite±hornblende±quartz; trace FeS_2, up to 5% epidote in cavities, also with calcite and sericite partly replaces feldspars and hornblende; quartz-feldspar proportions vary; rounded, knobby, spheroidally weathered outcrops.

TKc_2 medium to coarse-grained granite, approximately 60% K-feldspar, 40% quartz; occasional albite(?) megacrysts up to 2 cm long; poorly outcropping, occurs as blocks within other intrusive phases.

TKc_3 hornblende-rich variety of TKc_1; hornblende prisms up to 1 cm long form up to 15% of the rock.

TKc_4 varieties of TKc_1 and TKc_3 and quartz+feldspar porphyritic intrusive rocks of varying texture and composition often occurring intimately juxtaposed; incorporated into single unit because of mapping scale; variable quartz+ sericite±epidote±calcite alteration.

TKc_5 medium to fine-grained porphyritic andesite-diorite; porphyritic varieties mixed with equigranular facies; more than 15% of the rock consists of up to 3 mm laths of plagioclase and megacrysts of biotite and rare epidote in a gray-black microcrystalline matrix; rarely outcropping.

EXTRUSIVE ROCKS

Glory Hole Volcanics facies
map symbol (Fig. 1)

TKg_1 siliceous, porous, partly welded, lithic tuff; contains up to 60% angular fragments of older rocks in a light gray-white to iron-stained matrix; occasional feldspar and clear quartz phenocrysts; clasts and matrix largely altered to quartz+clay+pyrite±sericite; prominently outcropping.

TKg_2 coarse-grained massive lithic tuff and breccia, undivided; contains a variety of well-rounded to angular porphyritic and equigranular rocks in a purple-gray, microcrystalline, porphyritic matrix; 70% or more of breccia may be clasts; poorly outcropping.

TKg_3 porphyritic andesite, similar to TKg_5, but including subordinate tuffs and breccias; $<5\%$ to 15% sericitized feldspar euhedrons in gray to black, microcrystalline matrix.

TKg_4 porphyritic, amygdaloidal, hornblende andesite(?); contains up to 10% 2 mm hornblende prisms, and <5% epidote+zeolite?-filled amygdules in fine-grained to microcrystalline, green matrix; rare plagioclase phenocrysts partly altered to epidote; poorly outcropping.

TKg_5 porphyritic andesite, but <2 mm phenocrysts of plagioclase, biotite, and hornblende may be absent; gray-black microcrystalline to equigranular matrix; may in part be intrusive.

TKg_6 siliceous, porphyritic breccia and lithic tuff, undivided; poorly sorted and bedded; rock fragments indistinct on fresh surface; gray-green matrix partly replaces most clasts; may in part be intrusive.

SEDIMENTARY ROCKS

Pcl quartzite; clean to ferruginous exotic blocks of lower Paleozoic quartzite, usually well-sorted but structureless; also includes fine to medium-grained, well-sorted and bedded lithic arkoses, wackes, and tuffs, probably also exotic.

Me Escabrosa limestone; medium to coarse-grained, well-bedded calcite; bioclastic, ±varying amounts of irregular, microcrystalline silica veins; light gray, prominently outcropping.

Meb limestone breccia; variety of Escabrosa limestone strongly fractured and pervaded by irregular silica±iron oxide veins; some calcite veins also; locally replaced by silica; occurs only on the southwest side of Little Table Mountain.

Tcl pre-Galiuro clastic rocks; light-brown, soft, porous, sorted, equigranular lithic tuffs; poorly outcropping.

DIKE ROCKS NOT SHOWN ON FIGURE 1

(1) Dike occurring in breccias TBO, TBL, and TBC southwest side of Little Table Mountain; <1 foot to 2 feet wide consisting of 15-30% sericitized/kaolinized euhedral plagioclase in lavender to red iron-stained microcrystalline matrix; rare xenoliths of microcrystalline, white, siliceous rock; slight to pronounced trachytic texture.

(2) Silica-carbonate dike? in Escabrosa limestone (Me), northeast of Little Table Mountain; light gray-brown, coarse to fine-grained calcite (30%) and quartz (70%); contains <2 mm wide stringers of chalcedonic silica; probably replaces limestone.

(3) Dike occurring in limestone breccia (Meb), on the southwest side of Little Table Mountain in road cut; 5-10% phenocrysts of <2 mm hornblende prisms (weakly lineated) and rare sericitized plagioclase in light green-gray microcrystalline matrix; minor relict xenoliths; 1 to 2-inch selvedges of wollastonite(?) flank dike; attitude - N20°E, vertical.

3441 East Milber Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE April 19, 1978

SAMPLE MARKED	GOLD OZ / TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-1			0.02	0.05		.0017		
2			0.01	0.04		.0005		
3			0.01	0.03		.0009		
4			0.01	0.04		.0013		
4A			0.01	0.03		.0009		
4B			0.01	0.02		.0005		
5			0.01	0.03		.0014		
5A			0.01	0.03		.0005		
6			0.01	0.01		.0004		
7			0.01	0.02		.0022		
8			0.01	0.01		.0019		
9			0.01	0.02		.0005		
10			0.01	0.02		.0008		
11			0.01	0.01		.0021		
12			0.01	0.02		.0013		
13			0.01	0.02		.0022		
14			0.01	0.02		.0013		
15			0.01	0.02		.0009		
16			0.01	0.01		.0011		
17			0.01	0.02		.0008		
17A			0.01	0.01		.0005		
18A			0.06	0.01		.0008		
18B			0.01	0.02		.0006		
19			0.01	0.02		.0009		
LTM-20			0.01	0.02		.0004		

Peter S Harr[illegible]
4/19/78

Invoice # 15741

CHARGES $ 237.50

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE April 19, 1978

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-21			0.01	0.02		.0005		
22			0.02	0.03		.0012		
23			0.01	0.03		.0005		
24			0.01	0.03		.0010		
27			0.01	0.02		.0008		
28			0.01	0.01		.0009		
29			0.01	0.01		.0014		
30			0.01	0.01		.0003		
31			0.01	0.01		.0009		
LTM-32			0.01	0.01		.0005		

Pete J. Flores
4/19/78

Invoice # 15741
95.00

3441 East Milber Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE May 4, 1978

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PERCENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-40	Trace	0.01	0.01	Trace		.0001		
LTM-41	Trace	0.01	0.01	0.01		.0001		
LTM-42	.003	0.18						
LTM-43	Trace	0.03						
LTM-44	.004	0.19						
LTM-45	.002	0.16						
LTM-46	.003	0.22						
LTM-47	.001	0.11						
LTM-48	.006	0.38	0.02	0.01		.0014		
LTM-49	.005	0.23	0.03	0.02		.0010		
LTM-50	.003	0.18	0.01	0.09		.0091		
LTM-51	.004	0.33	0.20	2.80		.0154		

CHARGES $ 117.00

INVOICE NO. 15759

5/4/78

ASSAYER-CHEMIST

SKYLINE LABS, INC.
P.O. Box 50106 • 1700 West Grant Road
Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	Au ppm	As ppm							
1	LTM-43		20							
2	46		40							
3	50		110							
4	1	<0.02	30							
5	19	<0.02	40							
6	11	<0.02	10							
7	9	<0.02	20							
8	LTM-29	<0.02	10							

TO:
ASARCO, INCORPORATED
Southwestern Exploration Division
P. O. Box 5747
Tucson, Arizona 85703
Attn.: P. G. Vikre

REMARKS:
Trace analysis

CERTIFIED BY:

DATE REC'D: 5/17/78

DATE COMPL.: 6/5/78

JOB NUMBER: TAJ 014

SKYLINE LABS, INC.
SPECIALISTS IN EXPLORATION GEOCHEMISTRY
12090 WEST 50TH PLACE • WHEAT RIDGE, COLORADO 80033 • TEL.: (303) 424-7718

REPORT OF SPECTROGRAPHIC ANALYSIS

Job No. DCS006
May 19, 1978

ASARCO, Inc.
Attention: P. G. Vikre
1150 North 7th Avenue
P.O. Box 5747
Tucson, Arizona 85703

The attached pages comprise this report of analysis. Values are reported in parts per million (ppm), except where otherwise noted, to the nearest number in the series 1, 1.5, 2, 3, 5, 7, 10, etc. within each order of magnitude. These numbers represent the approximate boundaries and midpoints of arbitrary ranges of concentration differing by the cube root of ten. The "accepted" value for each element is considered to be within ± 1 step of the range reported at the 68 percent confidence level and within ± 2 steps at the 95 percent confidence level.

ITEM NO.		SAMPLE NO.
1	=	LTM-12
2	=	LTM-20
3	=	LTM-31
4	=	LTM-46
5	=	LTM-51

ITEM	1	2	3	4	5
ELEMENT					
Fe	2%	3%	1.5%	3%	10%
Ca	0.03%	7%	0.07%	0.02%	0.05%
Mg	0.07%	3%	0.1%	0.02%	0.03%
Ag	<1	<1	<1	1.5	5
As	<500	<500	<500	<500	3000
B	10	10	<10	<10	20
Ba	500	10	150	<10	>10000
Be	<2	<2	<2	<2	<2
Bi	<10	<10	<10	<10	10
Cd	<50	<50	<50	<50	<50
Co	<5	10	<5	<5	<5
Cr	50	20	30	150	200
Cu	20	10	20	70	1500
Ga	10	<10	10	<10	<10
Ge	<20	<20	<20	<20	<20
La	50	20	50	<20	<20
Mn	20	1000	100	200	5000
Mo	<2	<2	<2	7	200
Nb	<20	<20	<20	<20	<20
Ni	<5	50	5	15	20
Pb	10	50	20	<10	10000
Sb	<100	<100	<100	<100	500
Sc	<10	<10	<10	<10	<10
Sn	<10	<10	<10	<10	<10
Sr	200	200	300	100	700
Ti	2000	500	2000	200	50
V	70	30	50	20	300
W	<50	<50	<50	<50	<50
Y	<10	<10	<10	<10	10
Zn	<200	200	<200	<200	>10000
Zr	70	<20	100	<20	<20

for Edwin V. Post
Charles E. Thompson
Chief Chemist

SKYLINE LABS, INC.
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Of particular interest is a small incomplete example of the Permian index fossil Callipteris. Another is a fossil that resembles the base of Phasmatocycas the supposed early cycad leaf. A complete fern plant consisting of a rhizome with attached leaves and roots which has been found at the locality is probably the most unique fossil in the flora. The beds which contain the plants also contain numerous eurypterids, insects, ostracods and branchiopods and are thought to have been deposited in a deltaic environment. Adjacent beds contain a diverse marine fauna including fusulinids, brachiopods, molluscs, crinoids, and fish.

STRUCTURAL GEOLOGY OF A PORTION OF THE WASHAKIE RANGE, FREMONT COUNTY, WYOMING

TIMBEL, Ned R., Amoco Production Company, Denver Region, Security Life Building, Denver, Colorado 80202

Recent quadrangle mapping near Dubois, Wyoming documents previously constructed analytical shear fracture patterns for the Washakie and Owl Creek Ranges. Loading conditions which apply best to the Washakie Range include the combined effects of horizontal and vertical stress.

Laramide deformation of the study area began prior to deposition of the Paleocene Fort Union Formation and consisted of folding, faulting and subsequent erosion. The lower Eocene Indian Meadows Formation is not deformed by Laramide structures. Faults are divided into 3 genetic groups: (1)thrust faults; (2)primary high angle faults; (3)secondary high angle faults. Thrusting is commonly imbricate and preceded high angle faulting. The EA and North EA thrusts dip 34-38° NE, strike N60°W and have a combined displacement of about 9km. The previously mapped Black Mountain thrust strikes N30°W in the study area and changes strike to N60°W to the SE; structural transport was in a SW direction and is assumed to be perpendicular to strike. High angle faults are the result of extensional stress and occurred before the end of Laramide deformation. Primary high angle faults strike N30°W and have displacements of 100-370m while secondary high angle faults strike N60°W and have displacements of 25-225m. High angle faults were controlled by the trend of pre-existing thrusts.

The structural style of the Washakie Range is quite different than some other portions of the Wyoming Province which are characterized by basement-controlled vertical uplift and associated drape folding.

STRUCTURAL GEOLOGY OF THE LAKETOWN, UTAH 7½ MINUTE QUADRANGLE

VALENTI, Gerard L., Department of Geology, University of Wyoming, Laramie, Wyoming 82071

The Laketown, Utah quadrangle is located in northeast Utah at the south end of Bear Lake. Rocks exposed range in age from Precambrian-Cambrian (Brigham) to Tertiary (Wasatch); all systems except the Cretaceous are represented. The sedimentary section is deformed into a series of NNW trending folds, the easternmost of which is an anticline locally overturned to the east. Stratigraphic studies indicate the presence of several Cambrian units not recognized previously. Paleozoic rocks in this area appear to have stratigraphic affinities with units of the Paris thrust plate to the west and the Meade thrust plate to the north.

Several regional faults appear to converge at the south end of Bear Lake, but critical relationships are concealed by the Wasatch Formation, which unconformably overlies these features. However, local mapping and regional relationships permit some tentative conclusions. Faulting with minor stratigraphic throw in the western half of the quadrangle may represent imbrication of the Paris thrust. A major thrust fault underlies the area, and its trace probably lies buried by Wasatch cover near the eastern margin of the quadrangle. Rocks exposed in the canyons south and east of Laketown are considered to be a salient of a thrust sheet located between the front of the Paris plate to the west and the Crawford plate to the east. Current exploration for hydrocarbons in the area should soon provide information allowing more definite conclusions.

ARE MINE WASTE EMBANKMENTS STABLE LANDFORMS?

VANDRE, C. Bruce, U.S.D.A.-Forest Service, Intermountain Regional Office, Ogden, Utah 84401

Surface mining activities result in vast quantities of overburden rock and soil waste being excavated and being redeposited by construction equipment as valley fills or terraces. In opposition to mass wasting, attempts are being made to design waste embankments as stable landforms. The time period to be considered for the design of these embankments is a difficult decision. In a geologic context, stability is only temporary. The balancing of comparative rates of mass wasting of natural and man-made landforms could provide the key to resolving the time-stability issue.

For analysis purposes landslides are generally classified according to the type of movement occurring. Common types of landslides observed in overburden waste embankments are shallow flow slides, foundation slides, including spreading and translation, and rotational slides. All of these types of slides have counterparts occurring on natural landforms.

This presentation examines the time-stability relationship from both a geologic and design perspective, examines the factors which control slope stability, and compares landslides which occur on waste embankments with those that occur in excavations or on natural landforms.

STRATIGRAPHY, SEDIMENTARY PETROLOGY AND BASIN EVOLUTION OF THE ABIQUIU FORMATION (OLIGO-MIOCENE), NORTH-CENTRAL NEW MEXICO

VAZZANA, Michael E. and INGERSOLL, Raymond V., Department of Geology, University of New Mexico, Albuquerque, New Mexico 87131

The Abiquiu Formation (Oligo-Miocene) was described first by Smith (1938) for exposures of volcaniclastic sandstone in the vicinity of Abiquiu, New Mexico. Its three members (Lower, Pedernal and Upper) total approximately 300m in thickness. Exposures of the Lower Member primarily are restricted to areas south and west of the Rio Chama, and are composed of from 20 to 90m of Precambrian crystalline, cobble conglomerate. This poorly sorted detritus shows sedimentary features characteristic of piedmont deposition. Petrologic and paleocurrent analyses of this member indicate southwestern transport of sediments eroded from the Brazos-Sangre de Cristo geanticline to the northeast. The base of the overlying Pedernal Member (0-60m) is marked by the lowest laterally continuous, massive chert layers. From one to four chert layers, separated by gravelly sandstone, represent periods of soil formation. Pedernal Member sediments grade vertically into andesitic and rhyolitic volcaniclastic sandstone of the Upper Member (up to 170m), which exists primarily in the vicinity of the town of Abiquiu. Petrologic and paleocurrent analyses indicate San Juan volcanic field provenance and southeasterly transport, thus indicating a shift in regional dispersal patterns. Two possible causes for these changes in dispersal patterns are retrogradation of the Brazos-Sangre de Cristo geanticline piedmont surface, and incipient formation of the Española basin in the early Miocene.

RECOGNITION AND MONITORING OF ROCKFALL HAZARDS AT SELECTED NATIONAL PARK SERVICE SITES IN ARIZONA, NEW MEXICO AND COLORADO.

WACHTER, Bruce G., Department of Geosciences, University of Arizona, Tucson, Arizona 85721; RUTENBECK, Todd, National Park Service, Western Archeological Center, P. O. Box 41058, Tucson, Arizona 85717

Rockfall, not generally of high hazard potential among types of mass movement, assumes a high priority at certain National Park Service jurisdictions. Visitor traffic, particularly at archeological sites, is concentrated near cliff faces and beneath the overhanging ledges that shelter ruins.

Geologic recognition of fall prone areas, of progressing detachments and of frequency of fall events is aided by presence of disrupted archeological features. Recent rock motion may be recognized and classified as to type with implication for the "geologic imminence" of fall. A means of translating geologic observations into a decision-making format for non-geologists is provided. Actual time-prediction for fall events is difficult, depending on many natural and introduced parameters. Long-term monitoring of pre-fall motion of the several rock motion types observed should improve the sense of engineering timing for geologically imminent fall events.

Monitoring of crack length, crack width, subsidence or tilt should provide sufficient motion data in most cases. Methods include precise leveling, electronic gauges, and various mechanical displacement gauges. The use of these simple but effective methods holds costs and installation damage to the archeological sites to a minimum. Resulting data may be applied to decisions concerning rock stabilization, removal or traffic routing for increased visitor safety and protection of the archeological resources.

BRECCIA PIPES AT COPPER CREEK ARIZONA; EVIDENCE FOR MULTIPLE STAGES OF HYDROTHERMAL ACTIVITY

WALKER, V. A., Phelps Dodge Corp., 3007 So. W. Temple, SLC, UT 84115

The Copper Creek mining district, Arizona, is noted for its abundance of breccia pipes. Cu-Mo mineralization occurs in several of these pipes, and a Pb-Ag vein lies along the eastern edge of the district. The results of a fluid inclusion study on three variably mineralized breccia pipes and the Pb-Ag vein suggest that some of the breccia pipes and the vein were subjected to several pulses of hydrothermal activity, with sulphide deposition resulting from low salinity, moderate temperature fluids. Up to three chemically and temporally distinct fluids were recognized: an early, hypersaline fluid showing evidence for boiling at temperatures in excess of 800°C; a hypersaline, sulphide-bearing fluid with homogenization temperatures in the range 300-500°C from which sulphides were not deposited; and a late, low salinity, moderate temperature fluid (300-500°C) with which copper sulphide mineralization is apparently associated. While one of the pipes containing high temperature, hypersaline fluid inclusions is cemented primarily by potassium feldspar and biotite, the other pipes and the vein are filled by quartz and sericite. The single pipe showing potassium feldspar cement is one of a group of pipes of similar mineralogy which may be controlled by an early NNW tectonic fabric. An ENE-trending set of fractures superimposed upon the earlier fabric appears to be important in the localization of the pipes cemented by quartz and sericite. Consideration of the fluid inclusion results in conjunction with other geological relationships suggest that breccia pipes at Copper Creek are of two distinct generations. K-Ar age dating of sericite from several pipes in the district substantiates this, suggesting a time differential on the order of 12 million years.

ASARCO

Southwestern Exploration Division

March 15, 1982

To: W. D. Payne

From: H. G. Kreis

Holy Joe Aeromagnetic Anomaly
Pinal County, Arizona

A prominent aeromagnetic low is centered on the east half of Section 25, T 7 S, R 17 E. Mr. J. Montgomery of the Geophysical Division recognized the anomaly and recommended it for additional evaluation. From the geophysical data, Mr. Montgomery interpreted the anomaly as a strongly magnetic source (magnetite or pyrrhotite) having reverse polarity.

Mr. J. D. Sell and I examined the outcrops in the area of the anomaly and found them to consist of a suite of metamorphosed volcanic rocks. The aeromagnetic low is centered on and believed to be caused by a thick (600' to 800') basalt unit. The basalt is black colored and very hard, and it contains 5% (weight) magnetite and 0.5% pyrite (pyrrhotite?). Both are finely disseminated throughout the rock.

Sixteen geochem samples were collected (see attached map) and analyzed for copper, lead, zinc, gold, and silver (see attached Rocky Mountain analyses). The outcrop area of the aeromagnetic anomaly does not contain anomalous lead, zinc, or silver values. Copper is locally anomalous (as expected near a Laramide stock); but the area, as a whole, is not significantly anomalous in copper. The Rocky Mountain gold values are anomalous but may not be reliable. A few samples will be run for gold at Skyline Labs, Inc.

The geochem samples and the other rocks in the area showed no evidence of substantial hydrothermal alteration and mineralization. The weak sulfide mineralization in the basalt may not be related to the Copper Creek granodiorite stock, and the magnetite appears to be an accessory mineral in the basalt.

Mr. Montgomery's interpretation of the aeromagnetic low is well substantiated by the field evidence. Since there is insufficient geologic evidence to develop further interest in the area, no further work is recommended.

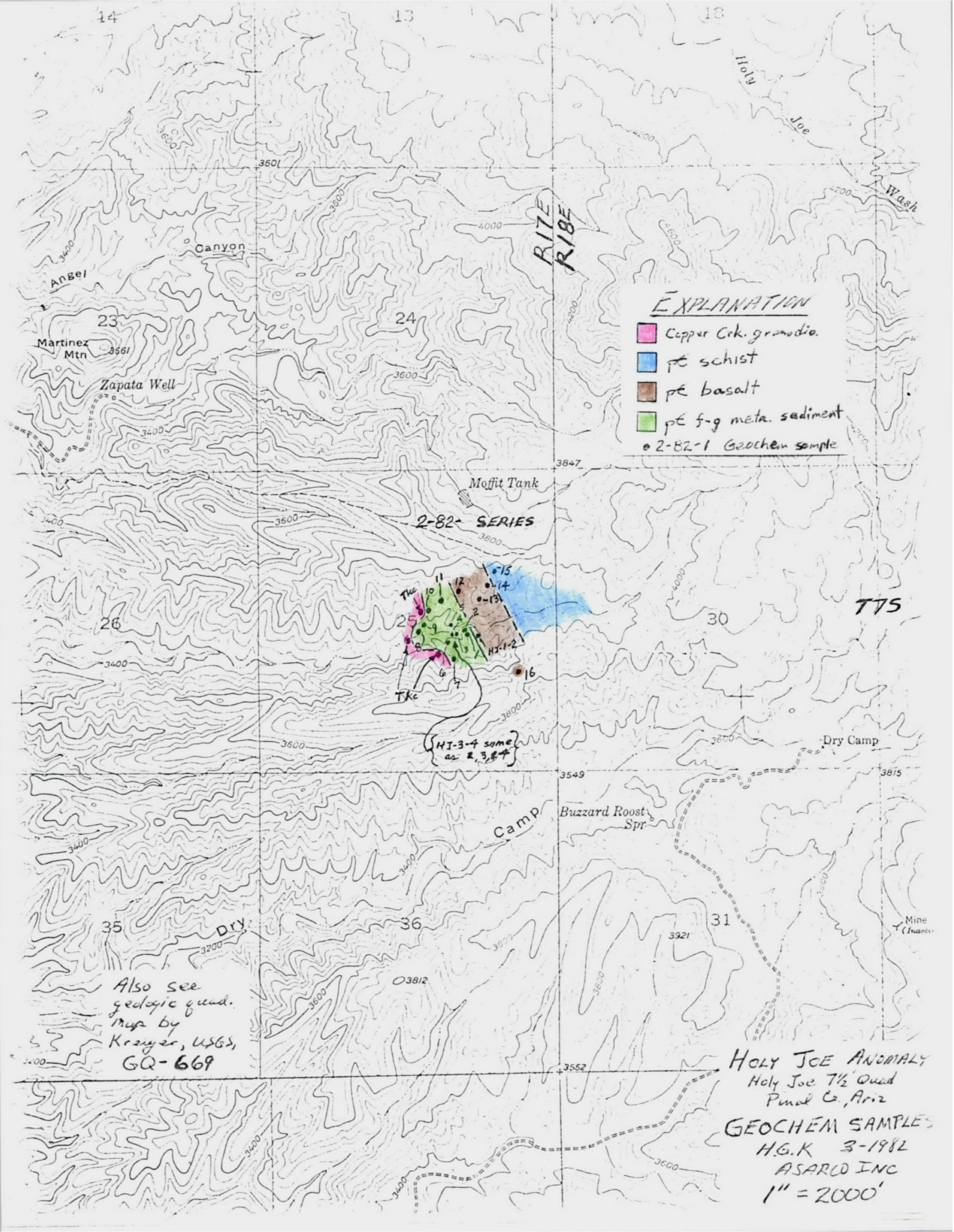
H. G. Kreis

H. G. Kreis

HGK/cg

Attachments

cc: J. Montgomery/B. Nichols
J. D. Sell



14
13
18
Holy
Joe
Wash
Angel
Canyon
R17E
R18E
EXPLANATION
Copper Crk. granodio.
p€ schist
p€ basalt
p€ f-g meta. sediment
2-82-1 Geochem sample
23
24
Martinez Mtn
3561
Zapata Well
3847
Moffit Tank
2-82- SERIES
T7S
26
25
30
TKc
HJ-1-2
16
HJ-3-4 same as 2, 3, & 4
Dry Camp
3549
3815
Buzzard Roost Spr
Camp
Dry
35
36
31
3921
3812
Mine
Also see geologic quad. map by Krieger, USGS, GQ-669
3552
HOLY JOE ANOMALY
Holy Joe 7½' Quad
Pinal Co., Ariz
GEOCHEM SAMPLES
H.G.K 3-1982
ASARCO INC
1" = 2000'

ROCKY MOUNTAIN GEOCHEMICAL CORP.

2561 EAST FORT LOWELL ROAD · TUCSON, ARIZONA 85716 · PHONE: (602) 795-9780

TUCSON OFFICE

Certificate of Analysis

RMGC Numbers:

Local Job No.: 82-18-25T

Foreign Job No.:

Invoice No.: T10939

Date: March 4, 1982

Client: Asarco, Inc.
P.O. Box 5747
Tucson, Arizona 85705

Client Order No.:

Report On: 16 samples

Submitted by: H. Kreis

Date Received: February 26, 1982

Analysis: Cu, Pb, Zn, Au & Ag

Analytical Methods: Determined by Atomic Absorption.

Remarks:

cc: Enc: 1
RMGC/SLC
file

SJA/lr

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

Client Asarco Date March 8, 1982 RMGC Job No. 82-18-25T

Sample Number	Cu ppm	Pb ppm	Zn ppm	Au ppm	Ag ppm
2-82-1	65	10	50	-0.1	-1
2	75	10	65	0.2	-1
3	90	10	75	0.1	-1
4	40	5	65	0.2	-1
5	40	15	85	0.1	-1
6	55	5	60	0.1	-1
7	20	5	80	0.4	-1
8	190	5	40	0.2	1
9	40	10	55	0.3	-1
10	20	10	65	0.3	-1
11	70	10	75	0.3	-1
12	75	20	95	0.2	-1
13	100	15	75	0.2	-1
14	110	15	45	0.2	-1
15	70	10	65	0.2	-1
16	65	20	60	-0.1	-1

By Shirley J. Aiken

Shirley J. Aiken

Duncan.

Mr. Doug Hansen ph. 359-2835

gold mine Table Mtn

Copper Creek

Massive Silica

gold in silica w/ some copper

200 wide — mile or so.

have been trying to open old tunnels 700' tunnel

+ winze (75').

20-40 claims

July 17, 1978

See Bx report by PGV - Little Table Mtn

see file note etc when you get land description.

Low gold values in PGV sampling.

Sec 15 / Sec 22 T 7S R 18E

I called Doug on 8/15 and got his father. Told him thanks for the report, confirmed it was the Little Table Mtn mine area and told him we had sampled there some 10 years ago — & if he did reopen the tunnels — we'd be glad to go see them.

Little Table Mtn
Sec15,
T7S,
R18E
Pinal Co
AZ

THE TABLE MOUNTAIN GROUP OF MINES

The above group comprises nine claims in all, Table Mountain Nos. 1 to 9 inclusive, and may be described as follows:

Location notices of numbers one and two are recorded in Book 39 in Record of Mines, at pages 519 and 520 respectively, in the County Recorder's offices, county of Pinal, Arizona.

Numbers three to nine inclusive adjoin numbers one and two and comprise with them a consolidated block of about 180 acres.

The Table Mountain Mine is located at a considerable elevation on the East shoulder of Table Mountain, a prominent land mark distant 15 miles East from Mammoth on the San Pedro River, and some twenty miles in a direct line from the copper smelter of Hayden at Winkleman on the S.P. R.R.

No adequate means exists of transport at the present. A feasable route has been reconnoited to Winkleman, of which the four miles nearest the mine present considerable constructional difficulty. An early road was constructed from Willcox some 90 miles to the South-west and is greatly out of repair. Railway connection can be made with the S.P. Ry. near Safford, entailing a haul of 30 miles, of which the ten to twelve miles nearest the mine would be over the early road. To rebuild this portion of the road would entail an expenditure of around 13,000.00.

The mine in common with many other mines of Arizona has a somewhat long and romantic history; its practical and more recent record began some fifty years ago, when it was operated as a gold mine, some very rich ore being extracted. Inexperienced mining and poor timbering closed the rich stopes and little, if any, attempt was made to reopen. Some records were made of gold obtained, and such are still available. Some 20 years later the mine was worked on a laeger scale, the ore being open cut over a large area; the road being built at this stage from Willcox; heavy machinery including two 100 horsepower boilers, engines, copper blast furnace, crushers, blowers, etc., being installed; also adequate water supplies, tanks, office and assay office, and living quarters. Some one hundred and fifty thousand tons of ore and waste were mined and some 20000 feet of development was done, almost entirely in the form of tunnels into the ore body. A considerable amount of copper ore was smelted for black copper, (Metallic) using the local ironstone as flux. As the ore contained no sulphur no concentration of the gold, silver and copper could be made in a mattee, and no attempt was made to secure pyritic ore as a flux. The attempt to smelt the oxidized ore to metallic copper was inevitably a failure owing to the continual freezing of the furnace. No method was known as the time of treating oxidized ore in limestone and operations were suspended. From the time to time small parcels of ore amounting to a few hundred tons were hand picked and shipped out by packing. The road having been allowed to get into disrepair. The ore still in the bins is of good quality, assaying 8% copper $4.00 in gold(*) and 3 ounces of silver per ton. The amount of ore smelted did not exceed a few thousand tons of 7 to 9 per-cent copper ore.

The surrounding country is high and deeply scored with deep gorges and canyons. The high peaks, flat topped, form

(*) 1936 Value - approximately

spectacular land marks visible upwards of one-hundred miles. These cappings are the remnants from the denudation of acid lava flows of a comparatively recently age. These lavas associated with tuffs and limestone are the prominent local geological features. The ore deposits occur in almost horizontally bedded limestone of probably Ordivician age, capped immediately by the andesite, and to the South in fault contact with a more basic intrusive.

The closely bedded limestone shows the usual silicification consequent upon metasomatic deposition of ore, and to a minor extent the development of a jasperoid gold-bearing quartz, no marmorization is in evidence even in the contact with the overlying lavas. The mineral bearing solutions were probably due to a dyke, or dykes, cutting the limestone in a general north and south direction, parallel to the strike. No evidence is known of mineralization west of this intrusion and little alteration is observable at the immediate contact, any crushed or brecciated limestone having been dissolved and removed or redeposited as calcite. The line of mineralization is very sharp, the tunnel less than 100 feet below the ore deposit shows little alteration beyong silicification. The ore body is probably only a remnant of what it was before, being denuded, but still gives evidence of enormous reserves of ore. The vertical thickness is apparently more than 200 feet, and may be much more, giving a cross section of this height by a breadth of from 400 to 600 feet, and for a length on the strike of about 4,000 feet, enclusive of its northly extension over two claims.

The ore body is immediately overlaying by the characteristic hornstone (silicified limestone) much of the ore body consists of residual and more insoluble ore together with a brecciated cherty material, with the usual residual material consequent upon the weathering a leaching of the ore body and accompanying limestone. The foregoing is more characterisitic of the northern part of the ore body which is strongly slumped; further south the ore, better protected by the over-burdened, shows less evidence of leaching, but is very cavernous. One cave at least, reached by a tunnel, driven 300 feet into the ore body is as far as explored, some 50 to 60 feet wide and 300 feet in length, this will be referred to later.

The ore as originally deposited was of Metasomatic origin, and due to ascending solutions which selected the soft and nearly parallel bedded limestone as a means of egress and replacement. The more massive limestone below being but slightly acted upon. Weathering and the free access of surface waters at a later stage brought about complete oxidation, concentrating the small amount of lead derived from the limestone in the resulting residual sandy clays. This lead collected and retained vanadium derived from the volcanics. Associated with this residual mass is much unaltered silicified limestone ore, impregnated with copper silicate and carbonate. In the immediate vicinity of the contact with the intrusive is a certain amount of barytes, and closely adjacent to the contact is a vertical vein of gold-bearing jasperoid quartz of considerable width, in places this is associated with a clear quartz which is extremely rich, in the immediate vicinity of the contact associated with the calcite introduced apparently by surface waters is a most unusual deposit of partially crystalline masses of vanadinite intergrown with a clear glassy quartz. This vanadinite of varying shades of orange, lemon and red is a very beautiful mineral, at times approaching eosite in composition, at other times corresponding to pure vanadinite, its general tenor is from 5% to 8% vanadic acid, the balance mainly quartz and lead.

Reference has been made to the caves, it is recorded that the walls of these caves exhibited remarkable color effects of yellow and red, it is probably due to a deposit of this vanadinite.

The massive and to some extent residual limestone of the ore body carrying a certain amount of silicate and carbonate of copper, and lends itself to selective mining, a portion being of shipping grade, a larger portion being of lower tenor. The ore body for a small and varying depth requires stripping of the more leached material, which contains some high grade copper carbonate. The jasperoid quarts associated with gold is an ore of entirely different character, being red, hard and brittle, carrying, when not associated with high values, from $5.00 to $18.00 in gold, 2 to 3 ounces in silver, three to four per-cent lead, one to two per-cent vanadic acid. This ore, and ore in its vicinity will require special treatment of the gold ore, coarse gold can be shown by dish washing along the strike, and even on the roadway into the mine.

The brecciated and residual ores are of a different class, and exist on a very large scale. Little if any values exist in the cherty material. Copper occurring in masses and boulders from time to time in silicified limestone. The essential values are in the residual somewhat sandy clay material, this includes the fines and even the surface soil, whilst values very, an average value is one half of one per-cent vanadic acid, three per-cent lead and a little silver and gold. The cherty material 60 to 70 per-cent by weight can be removed by screening after some attrition at a fine mesh, the balance carrying practically all the values other than those recoverable by hand picking on belts or other appliances. This lead vanadinite lends itself through finely crystalline to ordinary concentration. The ore is therefore of several distinct classes, high and low grade copper carbonates, low grade vanadium bearing residual ores associated with copper bearing ore in boulders and isolated masses gold, lead-vanadium quartz ore and finally the massive vanadinite locally called "candy ore" on account of its attractive appearance. A further feature is the presence of vanadium associated with the copper throughout the whole ore body to the extent of from one half per-cent to three per-cent vanadic acid, the recovery of this is a metallurgical problem to be solved.

The probable ore amounts to millions of tons, the ore actually in sight may be regarded as approximately one million tons of ore which in some form or another lends itself to payable treatment. The ore actually mined and on ore and spoil banks amounts to one hundred and fifty to one hundred and sixty thousand tons, of which one third may be regarded as waste, the balance being an ore, of milling grade, and yielding around one fifth of ore of shipping grade, if hand picked after washing on belts, the **balance treatable** as a copper and concentrating ore. The latter with reference to the gold-lead-vanadium content.

As may be already gathered the ore does not lend itself to copper concentration, nor to smelting on the spot. The copper ore can be efficiently and cheaply treated by the ammonia process, associated minerals being recoverable in part by subsequent concentration. As stated the residual sandy clay ores present no difficult finally the massive vanadinite can be recovered by selective mining and hand picking in the main, the balance by simply concentration. This hand-picked ore can be easily separated from its associated quartz by crushing and tabling, yielding a very high grade lead vanadium concentrate.

The blast furnace including boilers, engines, blowers, crushers, running gear tanks, cars, as well as many unroofed buildings and sundries constitute a valuable asset, and would be of great use in case of establishing a crushing, ammonia leaching, and concentration plant.

Development has been incidentally described in the foregoing, consisting mainly in open cutting and some 2000 feet of tunneling, a shaft was originally sunk 125 feet on the gold ore, and 40 feet winze some 40 feet from the shaft was sunk from a 700 foot tunnel driven some 35 feet below the upper Nos. 1, 2 and 3 tunnels, and 100 feet above the level of the lowest tunnel, No. 5, this has been driven in limestone at right angles to the strike of the ore body, some 500 feet, and should cut the dyke within 200 feet. Tunnels Nos. 1, 2 and 3 are driven at divergent angles at the same level from different points. No. 1, 135' above No. 5 being driven Southwest 300 feet to the large cave. No. 2 at a more obtuse angle 530 feet to contact; No. 3 driven to, and extends past the shaft. No. 4 tunnel at an intermediate level and at a slight angle to the strike has been driven some 700 feet through copper ore and brecciated vanadium bearing material associated with some high grade copper bearing boulders of unleached ore. In each case these tunnels have cut the high grade band of vanadinite at varying distances from the portals. These portals are at present closed with one exception owing to slides of ore and waste, otherwise the tunnels are believed to be in good state of preservation.

As stated, the ore is of several classes, all of which are payable in varying degrees, including even the weathered surface soil. The bulk consisting as already described of a loosely coherent material carrying low values of vanadium, lead and precious metals is amenable to washing, discarding all but the fine material below 20 mesh, after belt picking of the coarser copper-bearing ore. This fine material can be efficiently and cheaply tabled to a high grade concentrate. The highest grade copper ore is suitable for shipping, the intermediate and low grades lend themselves ideally to amonia leaching. One of the most important features of the ore is undoubtably the high grade massive "candy ore", considerable deposits of this material are indicated in a band up to 10 feet in width parallel to the strike and fault contact, this has been cut in every case by the tunnels at the expected point. The cave deposits of this ore may be of the utmost importance.

It is advised to make a survey of, and effect the repairs of the road required to make to Klondyke, an intermediate point between the mine and the S.P. Ry., a further reconnaisance might be made of an alternate route towards Winkleman.

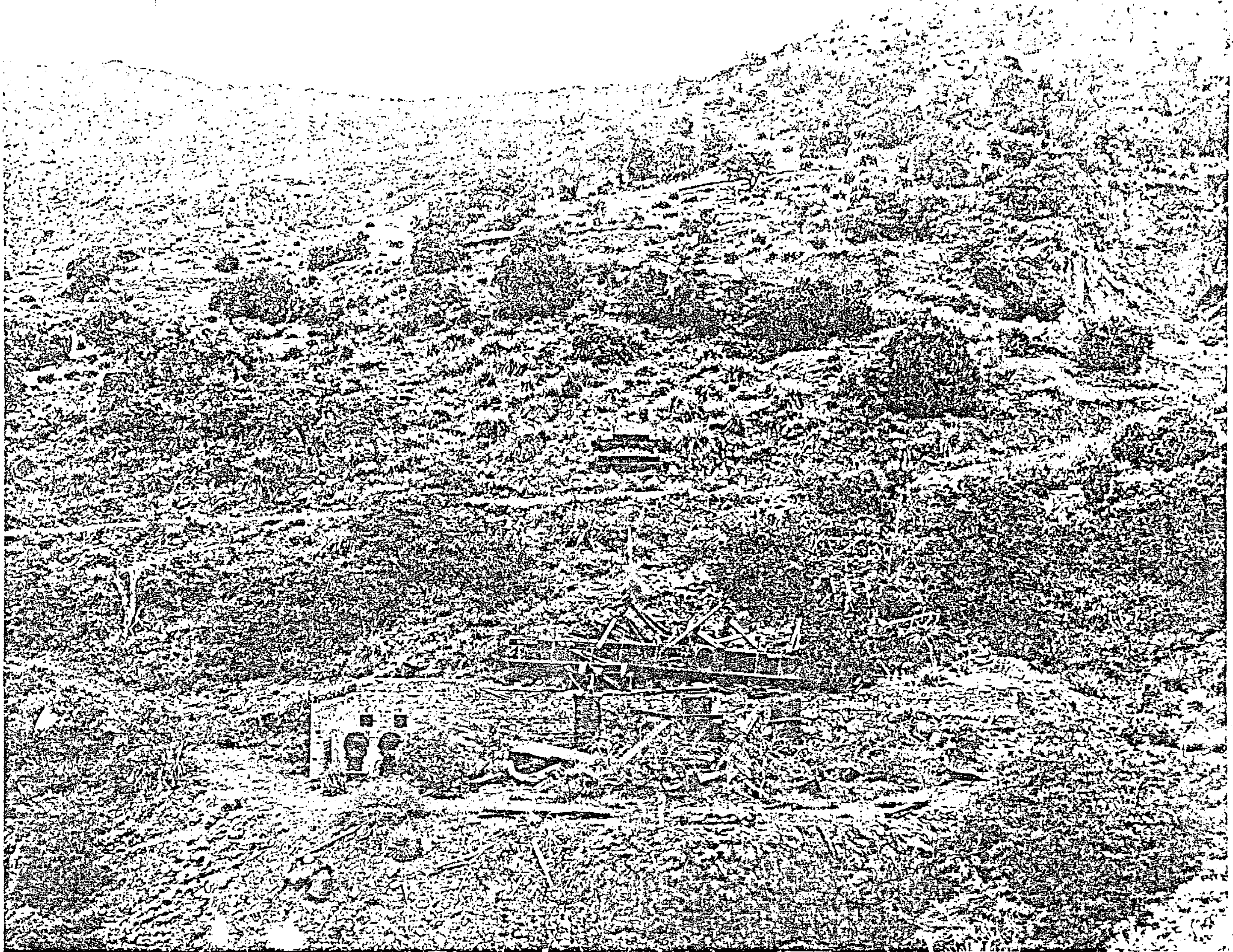
Certain mine equipment is required including compressor and machine drills, before commencing operations, whilst reparis are required to the various unroofed buildings, repairs are also required to the various unroofed buildings, repairs are also required to the engines, the boilers are apparently in good condition. It would be advisable whilst carrying out a policy of general development largely exploratory to extend the lower tunnel and put up raises at, and before reaching the contact. It is a point to be decided whether the ore be won from below by gloryholing from a series of raises to the horizontal ore body, or by simply open cutting. In any case it will probably be advisable to selective mine the gold and grade vanadium ore.

The large amount of ore of varying grades already mined warrant the installation of a mill on a moderate scale. Such a milling plant might take the form of belt picking of the ore and spoil banks, the high grade ore shipped, the lower grade crushed and leached, the waste discarded, the fine material concentrated on tables. This procedure while profitable would afford information as to treatment on a large scale. Development would be carried on simultaneously and the mine opened for large production.

The grade of copper ore ranges up to 18 per-cent and carries gold and silver from $3.00 to $8.00, this in part may be recovered by concentration, but preferably by smelting, where grade of copper permits. The large ore and spoil banks from a number of average samples evidence contents of more or less recoverable values of around $12.00 per ton, some 400 to 600 tons of selected ore from this source have been shipped from time to time of a grade exceeding 14% copper.

The average value of the ore and waste in ore and spoil banks, coupled with the value of the ore already shipped and smelted may be taken, as it were, as a cross section of the assay value of the ore body, a value difficult to arrive at by sampling in site whilst mining will be in the cheapest possible class-open cutting or gloryholing. Consideration must be taken of the cost of stripping and the disposal of the overburden. Mining costs alone should be under $1.00 per ton. One sixth of the whole will probably be overburdened waste to be stripped.

Cost of treatment, including ammonia leaching, and especial treatment of the gold and vanadium ore should not exceed $2.50 per ton and maybe much less. Recovery percentage cannot be closely estimated in advance. One copper recovery would almost certainly exceed 80% a high recovery would be made of "candy ore" vanadium contents.



FIRST CLASS

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ASARCO
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TUCSON, ARIZONA

85703

ASARCO

Southwestern Exploration Division

July 17, 1978

TO: F. T. Graybeal

FROM: P. G. Vikre

Breccias and massive silica deposits in the vicinity of Little Table Mountain Pinal County, Arizona

SUMMARY

More than 25 distinct intrusive breccias outcrop in the Galiuro Mountains southwest of Little Table Mountain, Pinal County, Arizona. The breccias occur in Glory Hole Volcanics which are similar to those that contained commercial copper-molybdenum deposits in the Copper Creek District three miles to the south. Massive silica replaces Escabrosa Limestone north of Little Table Mountain and hosts a small copper-gold deposit, the Table Mountain Mine. Alteration associated with breccias is quartz-hematite-clay-sericite. Limestone adjacent to massive silica is unaltered.

Anomalous metal values are present in the breccias and massive silica deposits. Forty-five samples assayed for gold (oz/ton), silver (oz/ton), copper (%), lead (%), molybdenum (%), and arsenic (%) yield the following averages (number of analyses in parentheses):

Breccias

Au(5)	Cu(35)	Pb(35)	Mo(35)	As(5)
0.0006	.01	.02	.0012	.0022

Massive Silica

Au(10)	Ag(10)	Cu(4)	Pb(4)	Mo(4)	As(3)
.0032	.20	.07	.73	.0067	.0057

Background values in "unaltered" Copper Creek granodiorite and Glory Hole volcanic rocks are: Au - trace, Ag - 0.01 oz/ton, Cu - 0.01%, Pb - trace to 0.01%, and Mo - 0.001%. Six spectrographic analyses reveal high barium, manganese, and titanium in breccias, and high barium, antimony, chromium, manganese, titanium, vanadium, and zinc in massive silica.

It is assumed that the structures and anomalous metals are time-space related to mineralization in the Copper Creek District. However, the potential for economic concentrations of metals at depth appears limited because of low values in surficial facies.

INTRODUCTION

Several square miles of pre-Miocene rocks in the vicinity of Little Table Mountain, Pinal County, Arizona, were mapped and sampled to determine if intrusive breccias, alteration, and siliceous deposits associated with these strata bore relation to economic porphyry copper-type or low-grade precious metal mineralization. The areas examined are exposed on the north and southwest flanks of Little Table Mountain where erosion has cut through post-mineralization Galiuro Volcanics which comprise Little Table Mountain, Table Mountain, and Holy Joe Peak, all in the Galiuro Mountains.

Interest in the area stems from several sources. Pre-mineralization rocks southwest of Little Table Mountain are partly covered by the claims and state prospecting permits of Frank Tapia, of San Manuel, Arizona, who submitted samples of breccia to Asarco. An examination of Tapia's holdings was made by J. D. Sell on January 9, 1978. Mr. Sell recommended detailed mapping and further geological reconnaissance of the area.

Pre-mineralization rocks near Little Table Mountain are the same as those in the Copper Creek District, 3 miles south of Little Table Mountain (Simons, 1964; Krieger, 1968). At Copper Creek, several millions of dollars in copper and molybdenum were recovered from breccia pipes in Glory Hole Volcanics and Copper Creek granodiorite (Simons, 1964). Deep drilling by EXXON and Newmont in recent years has discovered a low-grade porphyry-copper deposit at depth.

Ten field days in March and April 1978 were spent mapping and sampling near Little Table Mountain. J. M. Wood assisted in sampling. F. T. Graybeal and J. D. Sell made suggestions and constructive criticisms during two field visits. Six thin and polished thin sections helped document alteration and mineralization.

GEOLOGY

Figure 1, centered on Little Table Mountain, is a geologic map of the rocks and structures discussed below. Little Table Mountain consists of well-bedded andesites and coarse lithic tuff uniformly dipping about 5°NE. These rocks are members of the Galiuro Volcanics which are about 29 to 23 m.y. old (Creasey and Krieger, 1978). The Tertiary rocks primarily overlie, with slight angular unconformity, Mississippian Escabrosa Limestone north of Little Table Mountain and Glory Hole Volcanics southwest of Little Table Mountain. Small intrusive plugs of varying composition and texture intrude Glory Hole Volcanics. The intrusive rocks are probably apophyses of the Copper Creek granodiorite, the main mass of which is exposed to the south and southwest of Figure 1 (Simons, 1964; Krieger, 1968). Numerous breccias and fragmental dikes in Glory Hole Volcanics are conspicuous because of alteration and topographic relief. Prominent ledge and spine-like masses of chalcedonic quartz and siliceous breccia replace limestone northeast of Little Table Mountain. The Table Mountain Mine recovered copper, gold, and silver from about 100,000 tons of ore in one of these siliceous masses. Quaternary deposits include seasonal stream detritus and numerous landslides along the southwestern flank of Little Table Mountain.

No detailed petrography was attempted on any of the lithologies, but several breccias were examined under the microscope. Hand specimen and field descriptions of other units on Figure 1 are included in an APPENDIX.

BRECCIAS

Glory Hole Volcanics are cut by dozens of breccia plugs and dikes many of which weather as prominent land forms (Fig. 2). Equidimensional, cylindrical plugs are generally one hundred feet or less in diameter, but the largest breccia, although partly covered, is probably greater than 150 feet in diameter. Dikes have discontinuous exposures and rarely exceed 10 feet in width. Virtually all are vertical. The intrusive breccias have been placed in four categories on Figure 1: (1) breccias consisting of clasts and quartz+hematite±sericite matrix that distinctly show evidence of movement, or imbrication and are discordant to enclosing strata; (2) breccias consisting of disrupted clasts, indicative of partial movement, which are cemented by quartz, silicates, and iron oxides; (3) breccias that are essentially country rock fractured and cemented in place, with little or no evidence for clast movement; and (4) siliceous, occasionally flow-banded and zoned breccia dikes with foliated margins and centers consisting of rotated fragments. Distribution of breccia types is shown on Figure 3.

Breccia plugs are commonly enveloped by strong red-orange iron oxide staining in fractured and altered Glory Hole Volcanics (Fig. 2). Clasts measure from $<$ 1/4" to $>$ 4" and average about 2" in maximum dimension. They are usually unsorted and angular (Fig. 5A) but may be well-imbricated (Figs. 4A, 5B). TKb_1 and some TKb_2 clasts are primarily microcrystalline quartz+clay±sericite± iron oxide aggregates with rare quartz phenocrysts (see ALTERATION AND MINERALOGY OF BRECCIAS). Angular fragments of quartzite, "jasperoid," and porphyritic rocks are abundant in some quartz-rich breccias.

Breccia plugs that consist primarily of altered Glory Hole Volcanics are less erosionally resistant, and many barely outcrop. Any relief present may be attributed to quartz+iron oxide±sericite matrix. Clast alteration in these breccias is more strongly argillic than in breccias containing quartz-rich fragments. Both types of breccia may be cut by stringers of microcrystalline silica±iron oxides.

Breccia matrix in quartz-rich breccias is largely hematite (Fig. 5A) and/or quartz (Fig. 5B). Narrow, porphyritic mafic dikes cutting some breccias are probably sources for Galiuro Volcanics. Other well-sorted clastic dikes which transect foliation in breccias (Fig. 5C) apparently formed in late-stage fractures and were produced by autogenous milling in a fluid medium.

Breccia dikes range in structure from resistant linear zones of silicified country rock fractured and cemented in place to internally differentiated, composite dikes consisting of flow banded, foliated margins and brecciated interiors indicative of clast movement (Fig. 4B). Each structure is gradational with the other. In places, dikes appear to be circumferentially arranged about larger breccia plugs (Fig. 1). Nowhere do they cut plugs, and similar structure and envisioned mode of origin suggest that dikes and plugs are coeval.

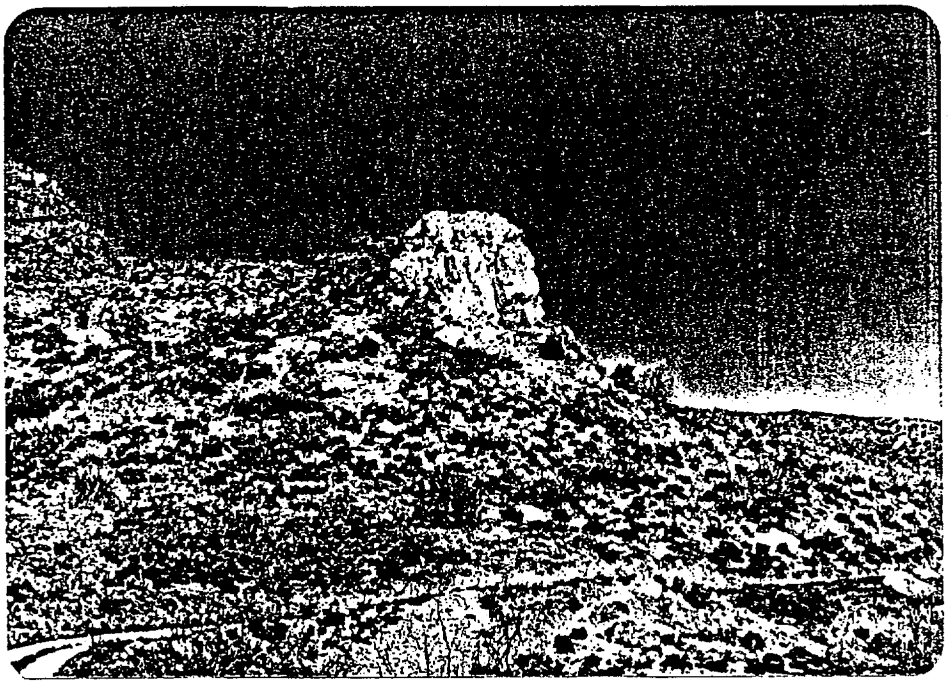

Figure 2. Breccia (TBO) plug (TKb_1) southwest of Little Table Mountain, Arizona surrounded by ferruginous soil and float derived from altered Glory Hole Volcanics. Slight foliation (enhanced by jointing) strikes east and dips $\sim$20°N (to the left) but locally varies.

Figure 4. Structure in breccia plugs and dikes, with hammer for scale, southwest of Little Table Mountain, Arizona.

A. Breccia (TBL) plug (TKb_1) consisting of flattened, imbricated siliceous clasts in quartz+hematite± sericite matrix. Foliation strikes north, dips ~30°E (to the right), and locally varies.

B. Zoned breccia dike (TKb_4) displaying foliated margins and brecciated interior. Dikes trend east, or east-northeast, and are nearly always vertical.

Figure 5. Cut slabs of breccia plugs (TKb_1), with scale, from Little Table Mountain, Arizona.

A. Unoriented, angular siliceous clasts in hematite-rich matrix. Hematite also occurs disseminated and along fractures in fragments.

B. Imbricated, flattened siliceous clasts in quartz+ sericite, iron oxide-deficient matrix, similar to the breccia pictured in Figure 4A.

C. Clastic dike intruded into foliated breccia, displaying lateral particle-size gradation and iron-oxide zonation.

STRUCTURE

Regional structure in the vicinity of Little Table Mountain is characterized by relatively flat-lying volcanic and sedimentary rocks partly deformed by intrusions, and by high-angle faulting of modest displacement. Bedding in Escabrosa Limestone rarely exceeds 15° and is commonly 5° or less. Limestone north of Little Table Mountain is remarkably undeformed. Southwest of Little Table Mountain limestone generally dips less than 15° north, but adjacent to dikes and plugs of Copper Creek granodiorite attitudes may approach 60°. Limestone there is weakly to intensely brecciated and cemented by carbonate± silica. Dikes of porphyritic mafic rocks, which are probably the sources for some of the Glory Hole eruptives, may have caused some of the deformation. The emplacement of massive siliceous breccias into limestone north of Little Table Mountain appears to have been entirely a process of dissolution and replacement and not forceful injection. Some ledge-like outcrops of chalcedonic quartz have selectively replaced carbonate beds and are conformable to enclosing limestone. In the vicinity of irregular cross-cutting silica masses, numerous chalcedonic stringers with random orientation pervade surrounding limestone, often hundreds of feet from the main silica body.

Attitudes of members of the Glory Hole Volcanics vary appreciably. The youngest eruptive rocks (TKg_1) dip less than 15° northeast except where arched by Copper Creek granodiorite and older Glory Hole intrusive andesites, or faulted. Other Glory Hole members have more erratic attitudes and little attempt was made to accurately reconstruct the stratigraphy.

Several exotic blocks of clastic sedimentary strata are engulfed by intrusive andesites and Copper Creek granodiorite plugs. The composition of the equigranular, sand-textured pendants is highly quartzose. Rarely do they contain more than a few percent rock fragments and feldspar. Iron oxides are a noticeable accessory in the northernmost block. These exotics have been assigned a lower Paleozoic age. Krieger (1968) reports similar landslide blocks of possible Troy quartzite which occur as inliers in Glory Hole Volcanics and in the Copper Creek granodiorite of Boulder Mountain.

Breccia dikes are strongly oriented east-northeast or east with few exceptions. Breccia plugs do not have a preferential orientation, nor are any noticeably aligned. High-angle joints, striking N50°E to N60°E, are conspicuously co-planar with many breccia dikes and occur throughout the mapped area in all pre-Galiuro rock units. Jointing is particularly prominent in the large silica masses north of Little Table Mountain.

Several normal faults displace Escabrosa Limestone and Glory Hole volcanic rocks. Not all faults were observed in outcrop and southwest of Little Table Mountain rapid facies changes, drainage patterns, and alteration were interpreted as evidence for faulting in some cases. Displacement along all faults is probably less than 100 feet, and attitudes of fault planes are nearly vertical. Most faults trend east or east-northeast, similar to the orientation of breccia dikes and regional jointing. Fault zones in Dry Camp Canyon consist of silicified, hematitic breccia that intermittantly weathers in relief (TKb_5).

Age of most faulting is post-Cretaceous and pre-Miocene, although displacement of some silica deposits north of Little Table Mountain probably occurred after deposition of Galiuro Volcanics. Galiuro units are generally uniformly bedded, but no large offsets in stratigraphy are noticeable in the extensive sections exposed on the east sides of Little Table and Table Mountains. Structural relations in the vicinity of the Table Mountain Mine may be explained by high pre-Galiuro relief, or by en echelon normal faulting in Escabrosa and Galiuro rocks of small individual, but large composite displacement.

ALTERATION AND MINERALOGY OF BRECCIAS

Quartz, clay minerals, iron oxides, iron sulfide, and minor amounts of sericite have been added to pre-Miocene rocks on the southwest side of Little Table Mountain. These minerals are most abundant in, or adjacent to, recognized breccias but are not confined to them. Glory Hole Volcanics contain sporadic occurrences of this assemblage which do not bear spatial relation to breccias. For this reason it is possible that more than one stage of alteration has affected Glory Hole rocks and some alteration may have occurred during or following the eruption of Glory Hole units. The most obvious alteration is associated with the intrusion of breccias.

There is no megascopic alteration associated with massive silica north of Little Table Mountain. The silica sharply borders enclosing limestone and secondary minerals in the carbonate were not observed. However, no optical examination of these rocks was made.

Under the microscope, breccia matrix consists of varying amounts of quartz, hematite, sericite, and clay minerals, mainly montmorillonite and kaolinite. Laths of fibrous, sagenitic hematite form up to 70% of breccia matrix along with lesser amounts of pyrite in sub-5 mm cubes, goethite pseudomorphous after pyrite, and rutile (or anatase). Breccia matrix may be as much as 50% void, often bordered by hematite plates. Most breccia clasts are mainly aggregates of fine-grained to microcrystalline quartz and hematite±clay minerals, sericite, and submicron pyrite, and rutile. Quartz generally forms 80+% of any breccia and hematite is always the second most abundant constituent. Spectrographic analyses suggest that minor amounts of barite and manganese oxides also occur in the breccias.

Many breccia clasts show no similarity to other rocks exposed in the vicinity of Little Table Mountain. They contain up to 5% partly resorbed quartz phenocrysts in irregular, jigsaw textured quartz-clay-FeOx mosaic. All fragments compositionally resemble breccia matrix and many are recognizable only because of variations in grain size and/or FeOx content. Random, coarse-grained quartz aggregates and veinlets cut breccia clasts and matrix. Simons (1964) considers breccia clasts in some of Copper Creek District breccias to be hornfelsed Glory Hole Volcanics.

FLUID INCLUSIONS

A brief examination of fluid inclusions in quartz phenocrysts and aggregates reveals two possible populations of primary inclusions: one, encompassing $<$ 5% of all inclusions, contains 50-70% vapor; the other more prevalent variety contains 80-90+% vapor. No daughter minerals are present. Inclusions are extremely abundant in most phenocrysts -- > 10^3 inclusions/mm^2 of thin section surface area.

MINERALIZATION

Two types of known metal mineralization, one in the Copper Creek District and the other at the Table Mountain Mine, occur in rocks of the Little Table Mountain area. These deposits suggest, to an extent, the targets for exploration in pre-mineralization rocks of Little Table Mountain. The following deposit summaries are largely after Simons (1964).

The Copper Creek District is characterized by more than 200 breccia pipes, some of which contain copper, molybdenum, and other metals in Glory Hole Volcanics andCopper Creek granodiorite. Production to 1939 includes 8 million pounds of copper, 7 million pounds of MoS_2, 4 million pounds of lead and several hundred thousand ounces of silver. The productive breccias, which are 3 to 3-1/2 miles south-southeast of Little Table Mountain, are nearly vertical cylinders measuring a few feet to more than 600 feet in diameter. Their minimum vertical dimension is 850 feet. Many weather in relief as iron-stained elliptical knobs, often tens of feet high. The breccias consist of angular to rounded fragments of country rocks of varying size. Voids may be partly filled with quartz, sericite, and tourmaline. Pyrite, chalcopyrite, molybdenite, and bornite occur mainly in breccia interstices but also are disseminated in breccia fragments and wall rock, and rarely in crosscutting veinlets in breccia. Other sulfides, sulfosalts, and oxides are present in small amounts. Some breccias in volcanic rocks are crudely imbricated while others are unsorted and chaotic. Degree of fragmentation varies from intense crushing to incipient fracturing and alteration. Occurrences of unfractured latite porphyry in several pipes suggest contemporaneity with breccia intrusion. Most wall rock-breccia contacts are sharp and show few signs of movement. Quartz-sericite alteration of breccia fragments varies from marginal to complete recrystallization. Wall rock is little fractured and altered. Barren and mineralized breccias contain similar alteration assemblages. The emplacement of most pipes does not seem to have been structurally controlled, as there is little lineation or elongation of breccias. The origin of the breccias is conjectural.

The Table Mountain Mine, located 1-1/4 miles north-northeast of Little Table Mountain, produced copper and gold from about 100,000 tons of ore during the period ~ 1880-1928. Ore contained 7-14+% Cu and 0.2 oz. Au/ton. Remaining mineralization and smelter slag analyzed by Simons (1964) contain, respectively: 2-3% Cu, 0.5-0.6 oz. Ag/ton, and 0.14-0.15 oz. Au/ton; and 2.4% Cu and 0.02 oz. Au/ton. Minor amounts of lead and vanadium are reported.

Principal metal values occur as copper and lead silicates, carbonates, and arsenates in massive, irregular, chalcedonic silica and siliceous breccia. Barite is the only other common gangue mineral. The silica outcrops are mottled gray, red, brown, and white resistant knobs and ridges which locally exceed 100 feet in width and 1000 feet in length. The silica replaces coarse-grained Escabrosa Limestone, and both rocks are unconformably overlain by Galiuro Volcanics. Fault-bounded blocks of limestone are enclosed in the thicker silica masses, and irregular pods and veins of chalcedonic quartz laterally pervade adjacent limestone for several hundred feet. Wall rock alteration is unrecognizable.

Copper minerals are largely confined to pods, vugs, joint surfaces, and fractures in silica. They are particularly abundant in interstices of coarsely bladed barite aggregates. No sulfide minerals are reported by Simons nor were any observed.

Mineralization in the vicinity of Little Table Mountain. Forty-seven rock chip samples were analyzed to evaluate potentially mineralized areas on both sides of Little Table Mountain. Detection of disseminated copper-molybdenum and precious metal deposits were the object of the geochemical survey. Thirty-five samples were collected from breccias and altered country rock on the southwest side of Little Table Mountain. One sample each of Copper Creek granodiorite at Boulder Mountain and a lower andesite flow near Little Table Mountain were analyzed for background estimation. All of these samples were analyzed for copper, molybdenum, and lead. Ten samples were collected from siliceous replacement masses north of Little Table Mountain and in the vicinity of the Table Mountain Mine (Fig. 6). These were analyzed for gold and silver, and copper, molybdenum, and lead, in part. The results are attached and values plotted on Figure 7.

All of the above analyses were performed by American Analytical and Research Laboratories (Tucson, AZ). Five pulps of breccia and massive silica were sent to Skyline Labs, Inc. (Wheat Ridge, CO) for emission spectrographic analyses to check for unforeseen elemental abundances. Eight pulps of breccia and massive silica samples were analyzed for gold and arsenic by Skyline Labs, Inc. (Tucson, AZ). These results are also attached and plotted on Figure 7.

DISCUSSION

Metal values are tabulated according to lithology and structure on Table 1. It is evident that copper, lead, molybdenum, gold, silver, and possibly arsenic occur in anomalous concentrations in breccia plugs and dikes, in altered Glory Hole Volcanics, and in massive silica replacing Escabrosa Limestone. The abundances of the elements are 1 to more than 20 times greater in these lithologies than in "unaltered" country rocks. The most anomalous values appear to be gold, silver, molybdenum, copper, and lead in massive silica. Metals associated with intrusive breccias and related alteration are only slightly more enriched than in country rock, based on limited analyses.

Spectrographic analyses reveal high concentrations of barium, chronium, manganese, antimony, strontium, titanium, vanadium, zinc, zirconium, and nickel in breccias and massive silica. Of these, barium, manganese, titanium, and zinc appear to be anomalous in both lithologies while the other elemental abundances may be high, but are sporadic, given the limited analyses.

It was assumed that if copper-molybdenum mineralization is present in breccias at depth, surface sampling would indicate markedly higher values for these metals. Similarly, if the breccias were eruptive facies of an underlying

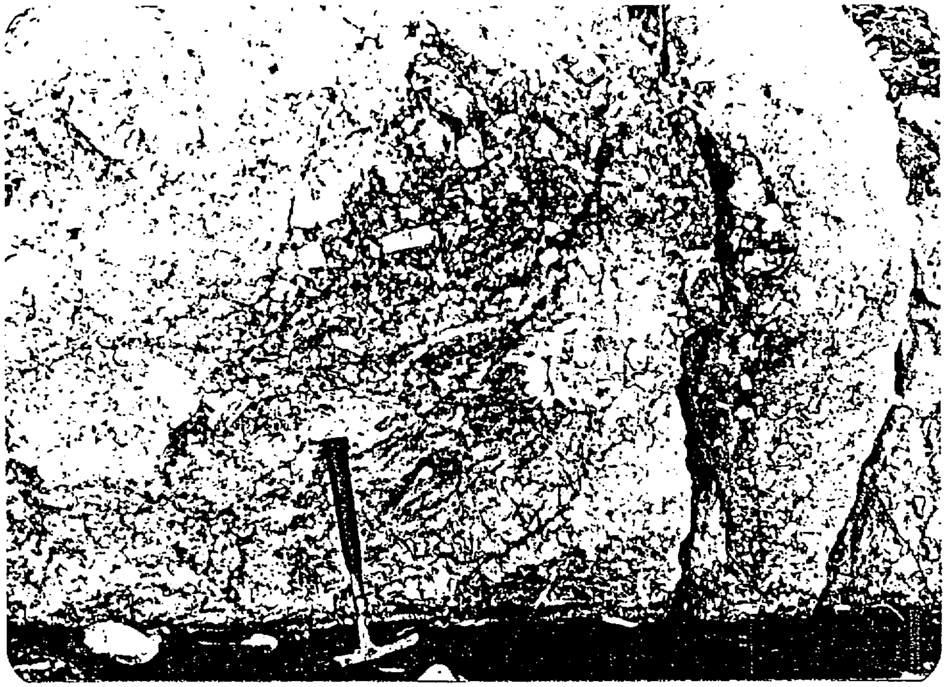

Figure 6. Siliceous breccia, north of Little Table Mountain, Arizona, with hammer for scale. Angular fragments consisting of textureless, microcrystalline silica, are contained in microcrystalline silica$\pm$FeOx matrix. Fragments of limestone and shale are extremely rare. Such outcrops grade into massive, microcrystalline silica which replaces Escabrosa limestone. Massive silica is typically unstructured and weathers in extreme relief.

TABLE I. Metal values in rocks of the Little Table Mountain area

A. Trace element analyses

ROCK TYPE	MAP UNIT FIGURE 1	NUMBER OF SAMPLES	Cu(%)	Pb(%)	Mo(%)	As(%)	Au oz/ton	Ag oz/ton
Breccia plugs	$TKb_{1,2,3}$	19	.011	.023	.0012			
		5				0.0022	< 0.0006	
Breccia dikes brecciated fault zone	$TKb_{4,5}$	6	.02	.018	.0010			
Altered Glory Hole volcanic rocks	$TKg_{1,2,3,4,5}$	10	.01	.021	.0006			
Massive silica	si	4	.07	.73*	.0067			
		10				0.0057	0.0032+	0.201
"unaltered" Copper Creek gd	TKc_1	1	.01	tr.	.0001		tr.	0.01
Galiuro andesite	Tgu	1	.01	.01	.0001		tr.	0.01

*includes one sample with 2.80% Pb
+"trace" analysis calculated as 0.001 oz/ton

B. Selected spectrographic analyses for other elements

Rock Type	Map Unit Figure 1	Number of Samples	High Elemental Abundance (Range) in PPM									
			Ba	Cr	Mn	Sb	Sr	Ti	V	Zn	Zr	Ni
Breccia plugs	$TKb_{1,2,3}$	2	10-500	20-50	20-1000	< 100	200	500-2000	30-70	< 200-200	< 20-70	< 5-50
Breccia dikes	$TKb_{4,5}$	1	150	30	100	< 100	300	2000	50	< 200	100	5
Massive silica	si	2	< 10- > 10000	150-200	200-5000	< 100-500	100-700	50-200	20-300	< 200- > 10000	< 20	15-20

Rock Type	Number of Samples	Ag	As	B	Ba	Bi	Co	Cr	Cu	Mn	Mo	Nb
Mill slag, Table Mountain Mine	1	3	3000	150	> 10000	20	30	100	> 10000	> 10000	100	50

	Ni	Pb	Sb	Sn	Si	Ti	V	Y	Zn	Zr
Mill slag, Table Mountain Mine	50	5000	1000	20	700	1500	1500	70	10000	100

intrusive rock, mineralization in the intrusive would be reflected in the breccias. This reasoning is based, in a general way, on the occurrence of economic mineralization in the Copper Creek District, where similar-appearing breccias contain copper and molybdenum at the present surface. Mineralized porphyritic(?) rocks have been intersected by drilling at Copper Creek, although the mineralized breccias apparently do not directly overlie the intrusive (J.H.Courtright, F.T.Graybeal, pers. com.). Breccia distribution, structure, and associated alteration are impressive and generally comparable to those at Copper Creek, but the weak geochemical response of breccias in the Little Table Mountain area does not suggest worthy targets at depth.

Breccias in the Copper Creek District (Simons, 1964) differ from those southwest of Little Table Mountain in the following ways:

(a) breccias are more numerous, more concentrated and larger, on the whole
(b) they contain copper and molybdenum sulfides, pyrite, lead, zinc, and tungsten minerals
(c) pyrite may be abundant in wall rocks
(d) breccia matrices contain tourmaline, apatite, feldspar, calcite, gypsum, and biotite, in addition to quartz
(e) breccias occur in Copper Creek granodiorite as well as in hornfelsed Glory Hole Volcanics

It may be surmized that the breccias formed from rapid emplacement and devolatilisation of facies of Copper Creek granodiorite intruded into Glory Hole Volcanics, but economic metal abundances occurred only where underlying or nearby intrusives were Cu-Mo rich, as at Copper Creek. The numerous juxtaposed plugs and apophyses of intrusive rocks displaying a wide variety of textures and compositions near Little Table Mountain indicate that the so-called Copper Creek granodiorite is probably a related petrologic series of rapidly evolved and intruded fluid-rich phases. Source melt(s) in the Little Table Mountain area were evidently metal deficient. However, the potential remains for other mineralized intrusives and associated breccias within the Copper Creek granodiorite complex elsewhere. Much of the complex, particularly to the north and west of Copper Creek, is covered by post-mineralization volcanic rocks and gravels (Simons, 1964; Krieger, 1968), but units mapped as younger rocks may not be post-mineral, especially east of the Copper Creek District (J.H.Courtright, 1978, pers. com.).

The massive silica replacement deposits in limestone north of Little Table Mountain are somewhat enigmatic. Their size and metal content are fairly intriguing and their relation to mineralization and alteration in the Copper Creek District is, at best, circumstantial. The Table Mountain Mine contained moderately high-grade copper-gold ore, the former metal exclusively in non-sulfide forms. The forms of metal in massive silica analyzed for this report are unknown and it is not totally unreasonable to speculate that the copper silicates, carbonates, and arsenates at the Table Mountain Mine are primary. Vugs, euhedral crystals, and several generations of brecciation and cementation in massive silica suggest that replacement occurred at modest depths and perhaps had surface expression. Undoubtedly, other metalliferous siliceous masses are buried by (post-mineralization) Galiuro Volcanics, but no economic mineralization is indicated by sampling to date. Recognition of genetic relations to Copper Creek intrusive-breccia mineralization might permit exploration possibilities, such as massive sulfide replacement deposits in limestone, to assume other than hypothetical stature. The potential for low-grade precious metal deposits, in light of occurrences elsewhere in Nevada, California, and Arizona appears limited, although the prospective thesis by F. R. Koutz may cause some reevaluation of this assessment.

CONCLUSIONS

Potential for economic copper-molybdenum, low-grade precious metal, and perhaps other mineralization exists in the vicinity of Little Table Mountain, Arizona. Mapping and sampling, however, suggest no obvious areas for further exploration when interpreted in context with published and reported descriptions of mineralization in the Copper Creek District, to which at least some alteration and structure at Little Table Mountain is time-space related. Further work at Little Table Mountain should await (1) a bright idea, (2) "frivolous" money.

Peter G. Vikre
P. G. Vikre

PGV:lb
Atts.

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Creasey, S.C., and Krieger, M.H., 1978, Galiuro volcanics, Pinal, Graham and Cochise Counties, Arizona, U.S.G.S. Journal of Research, vol. 6, no. 1, pp. 115-131.

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APPENDIX -- Description of some rock units in the vicinity of Little Table Mountain, Arizona

INTRUSIVE ROCKS

Copper Creek granodiorite facies
map symbol (Fig. 1)

TKc_1 fine-grained, miarolitic, equigranular to porphyritic feldspar±biotite±chlorite±hornblende±quartz; trace FeS_2, up to 5% epidote in cavities, also with calcite and sericite partly replaces feldspars and hornblende; quartz-feldspar proportions vary; rounded, knobby, spheroidally weathered outcrops.

TKc_2 medium to coarse-grained granite, approximately 60% K-feldspar, 40% quartz; occasional albite(?) megacrysts up to 2 cm long; poorly outcropping, occurs as blocks within other intrusive phases.

TKc_3 hornblende-rich variety of TKc_1; hornblende prisms up to 1 cm long form up to 15% of the rock.

TKc_4 varieties of TKc_1 and TKc_3 and quartz+feldspar porphyritic intrusive rocks of varying texture and composition often occurring intimately juxtaposed; incorporated into single unit because of mapping scale; variable quartz+sericite±epidote±calcite alteration.

TKc_5 medium to fine-grained porphyritic andesite-diorite; porphyritic varieties mixed with equigranular facies; more than 15% of the rock consists of up to 3 mm laths of plagioclase and megacrysts of biotite and rare epidote in a gray-black microcrystalline matrix; rarely outcropping.

EXTRUSIVE ROCKS

Glory Hole Volcanics facies
map symbol (Fig. 1)

TKg_1 siliceous, porous, partly welded, lithic tuff; contains up to 60% angular fragments of older rocks in a light gray-white to iron-stained matrix; occasional feldspar and clear quartz phenocrysts; clasts and matrix largely altered to quartz+clay+pyrite±sericite; prominently outcropping.

TKg_2 coarse-grained massive lithic tuff and breccia, undivided; contains a variety of well-rounded to angular porphyritic and equigranular rocks in a purple-gray, microcrystalline, porphyritic matrix; 70% or more of breccia may be clasts; poorly outcropping.

TKg_3 porphyritic andesite, similar to TKg_5, but including subordinate tuffs and breccias; <5% to 15% sericitized feldspar euhedrons in gray to black, microcrystalline matrix.

TKg_4 porphyritic, amygdaloidal, hornblende andesite(?); contains up to 10% 2 mm hornblende prisms, and <5% epidote+zeolite?-filled amygdules in fine-grained to microcrystalline, green matrix; rare plagioclase phenocrysts partly altered to epidote; poorly outcropping.

TKg_5 porphyritic andesite, but <2 mm phenocrysts of plagioclase, biotite, and hornblende may be absent; gray-black microcrystalline to equigranular matrix; may in part be intrusive.

TKg_6 siliceous, porphyritic breccia and lithic tuff, undivided; poorly sorted and bedded; rock fragments indistinct on fresh surface; gray-green matrix partly replaces most clasts; may in part be intrusive.

SEDIMENTARY ROCKS

Pcl quartzite; clean to ferruginous exotic blocks of lower Paleozoic quartzite, usually well-sorted but structureless; also includes fine to medium-grained, well-sorted and bedded lithic arkoses, wackes, and tuffs, probably also exotic.

Me Escabrosa limestone; medium to coarse-grained, well-bedded calcite; bioclastic, ±varying amounts of irregular, microcrystalline silica veins; light gray, prominently outcropping.

Meb limestone breccia; variety of Escabrosa limestone strongly fractured and pervaded by irregular silica±iron oxide veins; some calcite veins also; locally replaced by silica; occurs only on the southwest side of Little Table Mountain.

Tcl pre-Galiuro clastic rocks; light-brown, soft, porous, sorted, equigranular lithic tuffs; poorly outcropping.

DIKE ROCKS NOT SHOWN ON FIGURE 1

(1) Dike occurring in breccias TBO, TBL, and TBC southwest side of Little Table Mountain; <1 foot to 2 feet wide consisting of 15-30% sericitized/kaolinized euhedral plagioclase in lavender to red iron-stained microcrystalline matrix; rare xenoliths of microcrystalline, white, siliceous rock; slight to pronounced trachytic texture.

(2) Silica-carbonate dike? in Escabrosa limestone (Me), northeast of Little Table Mountain; light gray-brown, coarse to fine-grained calcite (30%) and quartz (70%); contains <2 mm wide stringers of chalcedonic silica; probably replaces limestone.

(3) Dike occurring in limestone breccia (Meb), on the southwest side of Little Table Mountain in road cut; 5-10% phenocrysts of <2 mm hornblende prisms (weakly lineated)and rare sericitized plagioclase in light green-gray microcrystalline matrix; minor relict xenoliths; 1 to 2-inch selvedges of wollastonite(?) flank dike; attitude - N20°E, vertical.

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SAMPLE SUBMITTED BY ASARCO, INC.

DATE April 19, 1978

SAMPLE MARKED	GOLD OZ / TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-1			0.02	0.05		.0017		
2			0.01	0.04		.0005		
3			0.01	0.03		.0009		
4			0.01	0.04		.0013		
4A			0.01	0.03		.0009		
4B			0.01	0.02		.0005		
5			0.01	0.03		.0014		
5A			0.01	0.03		.0005		
6			0.01	0.01		.0004		
7			0.01	0.02		.0022		
8			0.01	0.01		.0019		
9			0.01	0.02		.0005		
10			0.01	0.02		.0008		
11			0.01	0.01		.0021		
12			0.01	0.02		.0013		
13			0.01	0.02		.0022		
14			0.01	0.02		.0013		
15			0.01	0.02		.0009		
16			0.01	0.01		.0011		
17			0.01	0.02		.0008		
17A			0.01	0.01		.0005		
18A			0.06	0.01		.0008		
18B			0.01	0.02		.0006		
19			0.01	0.02		.0009		
LTM-20			0.01	0.02		.0004		

Bill [illegible]
4/19/78

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SAMPLE MARKED	GOLD OZ/TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON
LTM-21			0.01	0.02		.0005	
22			0.02	0.03		.0012	
23			0.01	0.03		.0005	
24			0.01	0.03		.0010	
27			0.01	0.02		.0008	
28			0.01	0.01		.0009	
29			0.01	0.01		.0014	
30			0.01	0.01		.0003	
31			0.01	0.01		.0009	
LTM-32			0.01	0.01		.0005	

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SAMPLE SUBMITTED BY ASARCO, INC. DATE May 4, 1978

SAMPLE MARKED	GOLD OZ/TON	SILVER OZ/TON	PERCENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT IRON	
LTM-40	Trace	0.01	0.01	Trace		.0001		
LTM-41	Trace	0.01	0.01	0.01		.0001		
LTM-42	.003	0.18						
LTM-43	Trace	0.03						
LTM-44	.004	0.19						
LTM-45	.002	0.16						
LTM-46	.003	0.22						
LTM-47	.001	0.11						
LTM-48	.006	0.38	0.02	0.01		.0014		
LTM-49	.005	0.23	0.03	0.02		.0010		
LTM-50	.003	0.18	0.01	0.09		.0091		
LTM-51	.004	0.33	0.20	2.80		.0154		

5/4/78

CHARGES $ 117.00

ASSAYER CHEMIST

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Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	Au ppm	As ppm							
1	LTM-43		20							
2	46		40							
3	50		110							
4	1	<0.02	30							
5	19	<0.02	40							
6	11	<0.02	10							
7	9	<0.02	20							
8	LTM-29	<0.02	10							

To:
ASARCO, INCORPORATED
Southwestern Exploration Division
P. O. Box 5747
Tucson, Arizona 85703
Attn.: P. G. Vikre

REMARKS:
Trace analysis

CERTIFIED BY:

DATE REC'D: 5/17/78

DATE COMPL.: 6/5/78

JOB NUMBER: TAJ 014

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REPORT OF SPECTROGRAPHIC ANALYSIS

Job No. DCS006
May 19, 1978

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P.O. Box 5747
Tucson, Arizona 85703

The attached pages comprise this report of analysis. Values are reported in parts per million (ppm), except where otherwise noted, to the nearest number in the series 1, 1.5, 2, 3, 5, 7, 10, etc. within each order of magnitude. These numbers represent the approximate boundaries and midpoints of arbitrary ranges of concentration differing by the cube root of ten. The "accepted" value for each element is considered to be within ± 1 step of the range reported at the 68 percent confidence level and within ± 2 steps at the 95 percent confidence level.

ITEM NO.	SAMPLE NO.
1 =	LTM-12
2 =	LTM-20
3 =	LTM-31
4 =	LTM-46
5 =	LTM-51

ITEM	1	2	3	4	5
ELEMENT					
Fe	2%	3%	1.5%	3%	10%
Ca	0.03%	7%	0.07%	0.02%	0.05%
Mg	0.07%	3%	0.1%	0.02%	0.03%
Ag	<1	<1	<1	1.5	5
As	<500	<500	<500	<500	3000
B	10	10	<10	<10	20
Ba	500	10	150	<10	>10000
Be	<2	<2	<2	<2	<2
Bi	<10	<10	<10	<10	10
Cd	<50	<50	<50	<50	<50
Co	<5	10	<5	<5	<5
Cr	50	20	30	150	200
Cu	20	10	20	70	1500
Ga	10	<10	10	<10	<10
Ge	<20	<20	<20	<20	<20
La	50	20	50	<20	<20
Mn	20	1000	100	200	5000
Mo	<2	<2	<2	7	200
Nb	<20	<20	<20	<20	<20
Ni	<5	50	5	15	20
Pb	10	50	20	<10	10000
Sb	<100	<100	<100	<100	500
Sc	<10	<10	<10	<10	<10
Sn	<10	<10	<10	<10	<10
Sr	200	200	300	100	700
Ti	2000	500	2000	200	50
V	70	30	50	20	300
W	<50	<50	<50	<50	<50
Y	<10	<10	<10	<10	10
Zn	<200	200	<200	<200	>10000
Zr	70	<20	100	<20	<20

Edwin V. Post
for Charles E. Thompson
Chief Chemist

SKYLINE LABS, INC.
SPECIALISTS IN EXPLORATION GEOCHEMISTRY

WXK

JDScott: What's the geology causing this thing? FTG

JDS Copy

GEOPHYSICAL OFFICE - EXPLORATION DEPARTMENT
Salt Lake City, Utah

May 16, 1980

F.T.G.

RECEIVED
MAY 19 1980
S. W. U. S. EXPL. DIV.

WDP - on area to keep in mind
JDS
also see rpt by PGV - Little Rebel mtn.
WK

Mr. F. T. Graybeal
Tucson Office

Dear Fred:

The anomaly outlined in red on the enclosed map is a 1200 gamma low. This is about 10 times what would be expected to occur from the magnetic high to the south. The only explanation I can think of is that a large amount of magnetite was emplaced here during a reversal in the magnetic poles. Possibly skarn or intrusive with lots of magnetite. It appears to fall completely in a pediment area.

Yours very truly,

Jerry Montgomery

J.R MONTGOMERY

JRM:am
Enc.

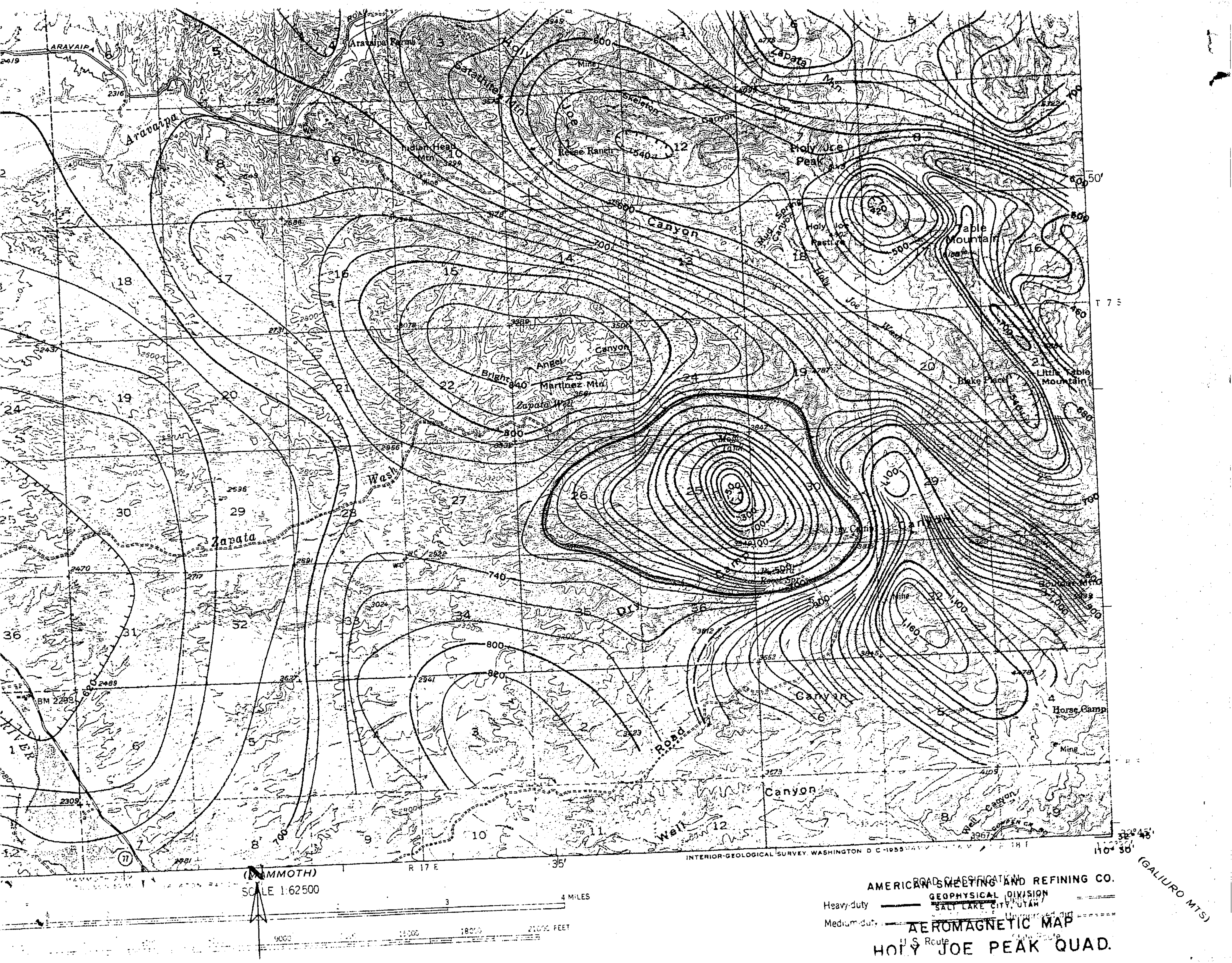
The center of the low is in area of Pinal schist with some Copper Creek granodiorite exposed at edge of cover which continues west. Prominent outcrops in E 1/3 of Sec. 25. & to east. Gravel to west.

The 420 low in NW corner Sec. 17 (T7S) SE of Holy Joe Peak is in Martin & Escabrosa limestones; the 540 low in SW 1/4 of Sec. 21 (T7S) is in Escabrosa limestone.

If indeed limestone was preserved on the basin side of the large (?) fault under the gravel cover of Sec. 25 & 26 they would be very favorable for massive replacement by magnetite-specularite-copper such as found at the Magma-Superior Mine.

Holy Joe Quad GQ-669

See report by HGK after visit w/ JDS in field.



AMERICAN SMELTING AND REFINING CO.
GEOPHYSICAL DIVISION
SALT LAKE CITY, UTAH

AEROMAGNETIC MAP
HOLY JOE PEAK QUAD.