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

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James Doyle Sell Mining Collection

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JDS

ASARCO

Southwestern Exploration Division

December 17, 1990

FILE NOTE

Gold Basin Compilation
Mohave County, AZ

I have retained registered geologist Russell M. Corn to compile a metallogenetic-tectonic-geologic report on the Gold Basin area of gold exploration interest.

Figure 1 exhibits the study area in relationship to western America. Figure 2, two parts, is the published sketch map of the district. The area covers the eastern half of the Senator Mountain (15') quadrangle and the western two-thirds of the Garnet Mountain (15') quadrangle. Figure 3 is the topographic coverage available, with orthophoto quads of 7½ minute, also available.

Mr. Corn's schedule of fees is Attachment A.

Work will start early in January 1991 and should be getting on paper within several weeks when a review will be made, then several more to tie the report into its final focus.

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: R.L. Brown
W.L. Kurtz
R.M. Corn

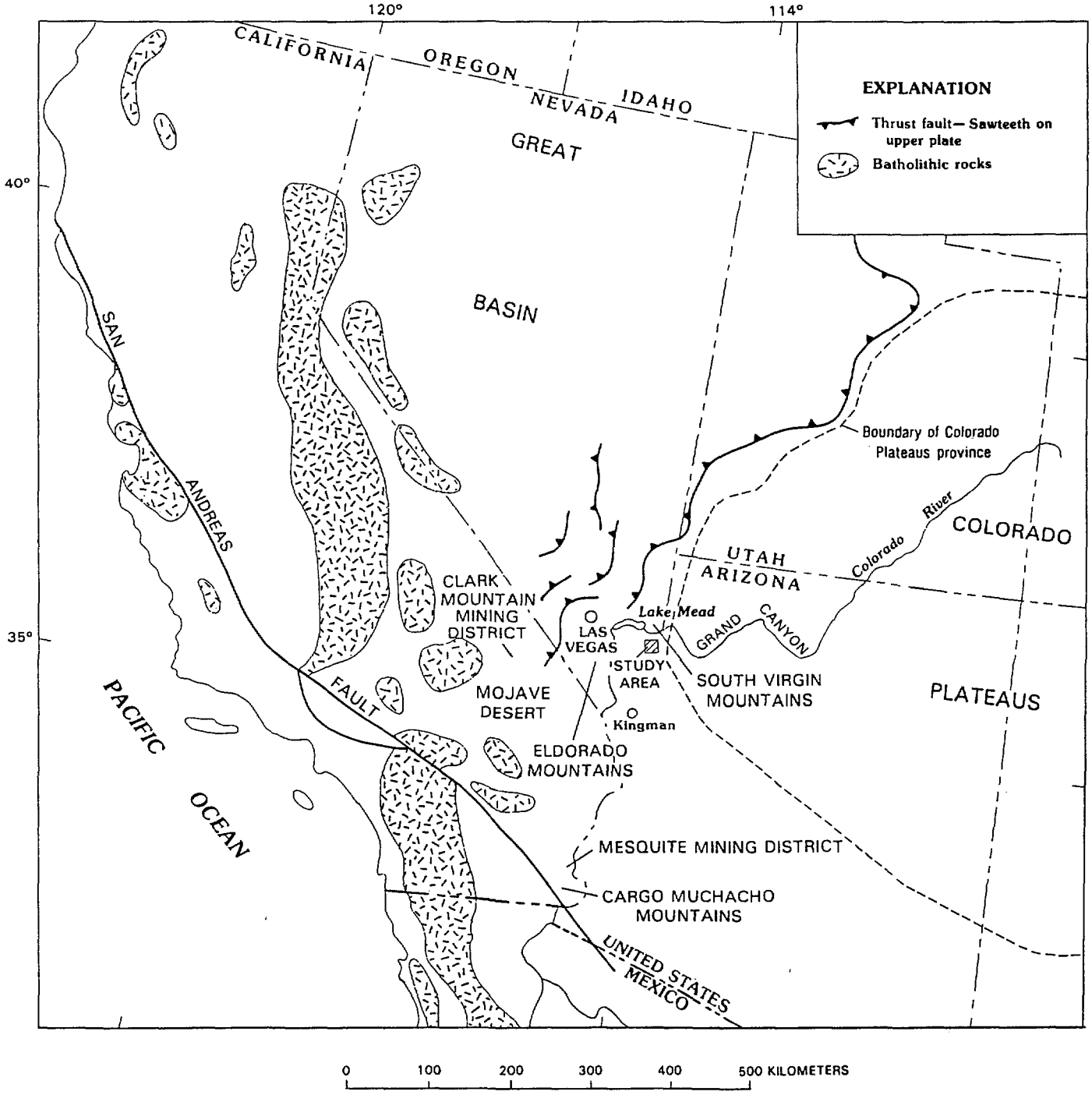


FIGURE 1.—Index map showing location of study area containing Gold Basin-Lost Basin mining districts. Modified from Haxel and others (1984).

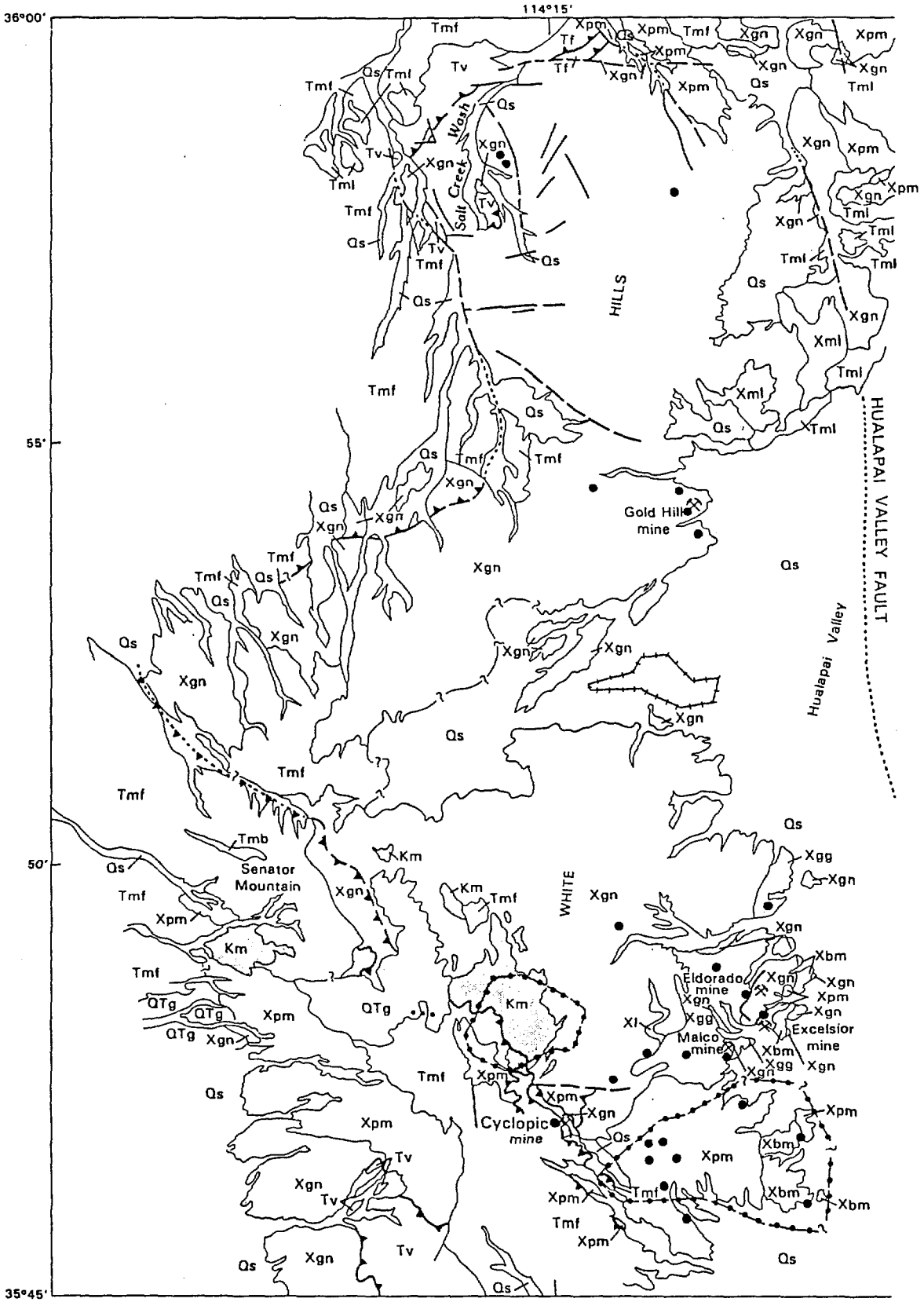


FIGURE 2.—Sketch map of area of Gold Basin-Lost Basin mining districts showing geology, major mines credited with production of metal(s), known occurrences of gold, and major placer workings. Geology modified from Blacet (1975), P.M. Blacet (unpub. data, 1967–72), Deaderick (1980), and K.A. Johnson (unpub. data, 1983). Field checked by T.G. Theodore and W.N. Blair, 1977–79.

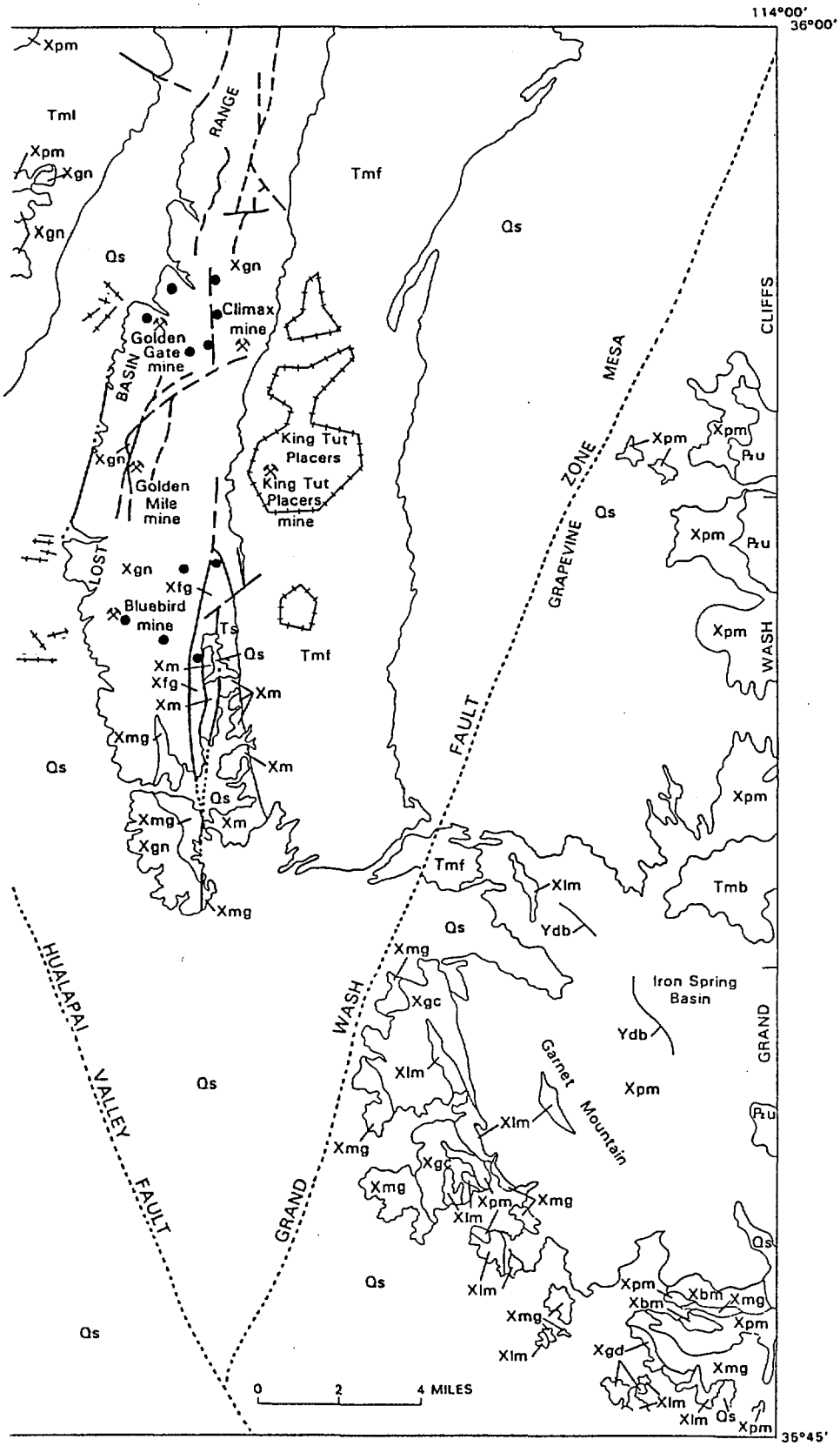
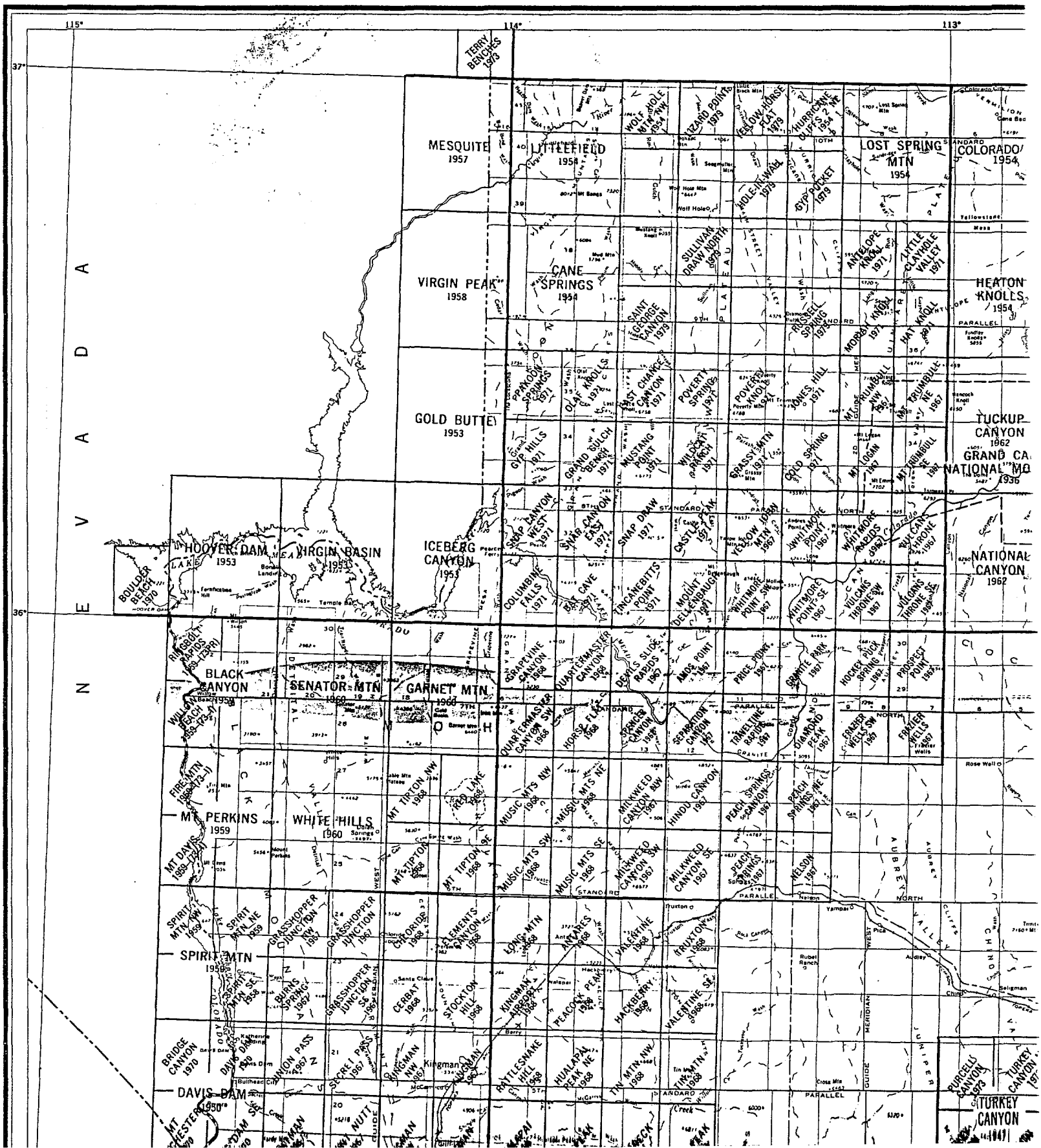


FIGURE 2.—Continued.

FIGURE 5


115°
114°
113°
37°
36°
NEVADA
TERRY BENCHES 1973
MESQUITE 1957
LITTLEFIELD 1958
LOST SPRING MTN 1954
COLORADO 1954
VIRGIN PEAK 1958
CANE SPRINGS 1958
HEATON KNOLLS 1954
GOLD BUTTE 1953
TUCKUP CANYON 1962
GRAND CA NATIONAL MO 1936
HOOVER DAM 1953
VIRGIN BASIN 1953
ICEBERG CANYON 1953
BOULDER BEACH 1970
NATIONAL CANYON 1962
BLACK CANYON
SENATOR MTN 1960
GARNET MTN 1960
MT PERKINS 1959
WHITE HILLS 1960
SPIRIT MTN 1959
BRIDGE CANYON 1970
DAVIS DAM
TURKEY CANYON

Attachment A

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

GENERAL SCHEDULE OF FEES AND EXPENSES

Fees - $350/day

Mileage - 45¢/mile for 4WD vehicle

Motels & Meals - cost

Supplies & Incidental Expenses - cost

Rough Estimate of weekly expenses - Kingman Area - $750

JDS

ASARCO

Southwestern Exploration Division

December 17, 1990

W.D. Gay

E½ Senator Mtn; W 2/3 Garnet Mtn.
Mohave County, Arizona

Use the attached 15' Senator Mtn.- Garnet Mtn. Quads, and using the BLM microfiche, record the number of claims in the sections. Some may be placer claims.

Much of the area is checkerboard Santa Fe sections and needs to be marked as such.

This is a get with it, close your door, take several days to do it, project.

Do E½ Senator Quad, W 2/3 Garnet Mtn.; but Lake Mead Rec. area not important at this time.

James D. Sell

J.D. Sell

JDS:mek
Atts.

cc: W.L. Kurtz (w/o atts.)

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

January 15, 1991

James D. Sell
Manager, Southwest Exploration
ASARCO, Inc.
P O Box 5747
Tucson, AZ 85703

STATEMENT

Gold Basin - Lost Basin Project, Mohave County, Arizona

Charges for December 19, 1990 through January 15, 1991

13 days of Geologic Research and Map Compilation @ $350/day	$4,550.00
Expenses	208.65
TOTAL	$4,758.65

Russell M. Corn

OK for payment
James D Sell
General Exploration 499-01
Gold Basin Study Area

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770
January 15, 1991

James D. Sell
Manager, Southwestern Exploration
ASARCO, Inc.

Re: Monthly Progress Report
Gold Basin Compilation

A tour of the Gold Basin Area was conducted early in January to acquaint ASARCO personnel with both the geology of the area and the different types and styles of gold mineralization. The tour emphasized (1) gold-bearing episyenite occurrences and (2) Tertiary epithermal gold mineralization in the vicinity of the Cyclopic Mine and along the Gold Basin Detachment Fault.

Work carried out on the compilation study included: (1) Obtaining Santa Fe Minerals land map, (2) Researching and reviewing geologic map and data sources and (3) Preliminary compilation and plotting of geologic data at a 1:24,000 scale for the Garnet Mountain Quadrangle and adjacent portions of the Senator Mountain Quadrangle. The search of published and unpublished sources of geologic data indicated that there has been very little recent geologic work in the area. The best source for map data on the Garnet Mountain Quadrangle is the USGS Open File Map, 75-93, complemented by a detailed thesis map of Lost Basin by A.J. Deaderick. Geologic data on the Senator Mountain Quadrangle is extremely limited. The generalized map presented in the Gold Basin Professional Paper was based on preliminary mapping by Blacet, and that work was later discarded by the USGS.

The initial compilation of geologic data indicates that the placer gold occurrences at Lost Basin were probably derived from mineralization in an adjacent detachment fault zone. Structurally-rotated, steeply-dipping, Tertiary sedimentary rocks are in fault contact with intensely sheared, altered and hematized, Precambrian rocks several thousand feet south of the placer gold occurrences. The altered detachment fault zone can be projected into the near vicinity of the placer gold concentrations.

Respectfully submitted,

Russell M. Corn

TIME DISTRIBUTION SHEET

Please Return by the 25th.

CLL

TUCSON OFFICE

Russell M Corn
~~Employee~~ Consultant

December, 1990
Month

Gold Basin Project

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1								
2								
3								
4								
5								
6								
7								
8								
9								
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14								
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19	8							8
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21								
22								
23								
24								
25								
26								
27	8							8
28								
29								
30								
31								
Total	16							16
Amount								

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: Russell M Corn

Approved: James D Self

TIME DISTRIBUTION SHEET

Please Return by the 25th.

CLL

TUCSON OFFICE

Gold Basin Project

Russell M Corn
~~Employee~~
Consultant

January, 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1								
2	8							8
3	8							8
4	8							8
5	8							8
6								
7	8							8
8	8							8
9	8							8
10	8							8
11	8							8
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14	8							8
15	8							8
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17								
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20								
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22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
Total	88							88
Amount								

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: Russell M Corn

Approved: James D Sell

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A

EXPENSES OF Russell M. Cox (NAME) FOR Dec (MONTH) 19 90.

DAY	TRANSPORTATION Auto Rail. Air, etc Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
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13										
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26										
27										
28										
29										
30								Rent Paid	77 40	
31										
TOTALS								77 40		

DISTRIBUTION OF EXPENSES

A/c ..... $ .....
A/c .....
A/c .....
A/c .....
TOTAL ..... $

DETAIL OF ADVANCES

Cash (.....Office) $ .....
Cash (.....Office) .....
Transportation .....
Personal Mileage .....@..... .....
(CO. OWNED CAR)
TOTAL ..... $

GRAND TOTAL EXPENSES $ 77 40
LESS ADVANCES .....
DIFFERENCE ..... $ 77 40
DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐
(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

1/15/91 DATE COMPLETED — CORRECT — EMPLOYEE'S SIGNATURE — APPROVED — DEPT. HEAD — ACCOUNTING DEI

DISPOSITION OF BALANCE OF EXPENSES AND ADVANCES:	Amount
Send check to Russell M Cline at 6425 Desert Sagebrush Tucson Ariz	77 40
Deposit check in _____ Bank of for credit to	
Herewith is my check to cover excess of advances over expenses	
Pay me in cash	
Credit my account at Plant or Office	

CASH RECEIVED

EXPENSE ACCOUNT INSTRUCTIONS

1. This form shall be used by all persons traveling or incurring expense on Company business. It must be promptly submitted for approval and settlement at the end of each month. A COPY SHOULD BE RETAINED BY THE INDIVIDUAL FOR PERSONAL INCOME TAX PURPOSES.

2. Expense accounts must be approved by Plant Manager, Superintendent, Department Head, or other properly designated authority.

3. Receipts must be attached to this statement for all principal items of expense, such as hotel bill, transportation ticket stubs, gasoline charge slips, auto rentals, regardless of amount; and for business meals, meetings, entertainment, etc., in excess of $25.00 exclusive of gratuities.

4. Expense incurred in operation of a Company-owned car shall be reported in total in the Transportation column supported by detailed automobile expense report Form FMD-1' Mileage charge for personal use of a Company-owned car shall be shown under "Advances".

5. Transportation and other items of expense paid directly by the Company shall be reported as expense and as advances.

6. The column for "Meals" should be used for expense of the employee while traveli: on Company business. Meals at business meetings, entertainment, etc., shall be reporte in the Entertainment, Business Meetings and Meals column. Tips shall normally be included with the related expense.

7. Dues to business or professional organizations shall be reported in the miscell aneous column.

DATE	DETAIL OF BUSINESS MEALS, MEETINGS, ENTERTAINMENT, ETC.	AMOUNT

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TUCSON, AZ. 85726

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DELIVER TRACING TO

WAITING	COD	CHARGE	WILL CALL	DELIVER	UPS	MAIL

DIAZO	PHOTO	MOUNTING	OFFSET	BINDING	XEROX

NO. OF ORIG.	QUANT. EA.	TOTAL PRINTS	NEG.	PCS.	KIND OF PRINTS	SIZE	NO. OF SQ. FT.	PRICE	
1	1	1			7450 Bond	8½x11			06
76	4	304			1090 Bond	8½x11		18	24
1	4	4			1090 Bond	8½x14			36
1	4	4			7450 Bond	11x17			60
2	4	8			5080 Bond	24x24	32	40	00
2	4	8			90# Gold covers	8½x11			40
		4			pockets			4	00
		4		1	fold 11x17				12
		[illegible]			fold 24x24		32	1	60
		12			Insert into pkts			[illegible]	48
					Spiral Bind			6	48
								72.34	
							TAX	5.06	
								77.40	

MCP

TERMS: NET 30. 1½% SERVICE CHARGE OR 18% PER YEAR, MINIMUM SERVICE CHARGE OF ONE DOLLAR APPLIES ON ALL PAST DUE ACCOUNTS.

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TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A.

EXPENSES OF Russell M. Carr (NAME) FOR Jan (MONTH) 19 91

DAY	TRANSPORTATION Auto Rail, Air, etc Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1										
2				Tucson –						
3				Kingman	26 28	7 25				
4				" Gen'l Exploration	26 28	7 00				
5				"		6 50				
6										
7							Map	5.00		
8							Postage	33.54		
9							Postage	18.06		
10										
11										
12										
13										
14							Postage	1.34		
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28										
29										
30										
31										
TOTALS					52 56	20 75		57 94		

DISTRIBUTION OF EXPENSES		DETAIL OF ADVANCES		
A/c	$	Cash (Office)	$	GRAND TOTAL EXPENSES $ 131 25 ~~208 65~~
A/c		Cash (Office)		LESS ADVANCES 131 25
A/c		Transportation		DIFFERENCE $ ~~208 65~~
A/c		Personal Mileage @ (CO. OWNED CAR)		DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐
TOTAL	$	TOTAL	$	(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

1-15-91 DATE COMPLETED — CORRECT — EMPLOYEE'S SIGNATURE — APPROVED — DEPT. HEAD — ACCOUNTING DE

DISPOSITION OF BALANCE OF EXPENSES AND ADVANCES:	Amount
Send check to Russell M Cox at 8425 Desert Springs Dr Tucson, AZ 85710	~~208.65~~ 131.25
Deposit check in _____ Bank of for credit to	
Herewith is my check to cover excess of advances over expenses	
Pay me in cash	
Credit my account at Plant or Office	

CASH RECEIVED

EXPENSE ACCOUNT INSTRUCTIONS

1. This form shall be used by all persons traveling or incurring expense on Company business. It must be promptly submitted for approval and settlement at the end of each month. A COPY SHOULD BE RETAINED BY THE INDIVIDUAL FOR PERSONAL INCOME TAX PURPOSES.

2. Expense accounts must be approved by Plant Manager, Superintendent, Department Head, or other properly designated authority.

3. Receipts must be attached to this statement for all principal items of expense, such as hotel bill, transportation ticket stubs, gasoline charge slips, auto rentals, regardless of amount; and for business meals, meetings, entertainment, etc., in excess of $25.00 exclusive of gratuities.

4. Expense incurred in operation of a Company-owned car shall be reported in total in the Transportation column supported by detailed automobile expense report Form FMD-19 Mileage charge for personal use of a Company-owned car shall be shown under "Advances".

5. Transportation and other items of expense paid directly by the Company shall be reported as expense and as advances.

6. The column for "Meals" should be used for expense of the employee while travelir on Company business. Meals at business meetings, entertainment, etc., shall be reportec in the Entertainment, Business Meetings and Meals column. Tips shall normally be included with the related expense.

7. Dues to business or professional organizations shall be reported in the miscellaneous column.

DATE	DETAIL OF BUSINESS MEALS, MEETINGS, ENTERTAINMENT, ETC.	AMOUNT

1989 05/92

RUSSELL H COLE

LAYERS INN KING
5020508917 MAN
5420090361 00489

010391

The Issuer of the Discover Card is authorized to pay the amount shown as **Total** upon proper presentation. I promise to pay such **Total** (together with any other charges due on it) subject to and in accordance with the Cardmember Agreement governing the use of the Discover Card. Cashback Bonus is paid annually by Discover Card, up to 1% based on annual level of purchases.

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FINANCIAL SERVICES CARD

Date 1-5-91	Clerk VB
Authorization No. # 226	

5707807

Cardmember Copy

Amount	
Tax	
Sub Total	
Sales Tax	
Tips/Misc.	
Total 52 156	

Any delayed charges are listed below
Type of Delayed Chg
Amount of Delayed Chg
Revised Total

Discover Card **Use Only**
Equivalent Amount

CASHBACK BONUS
This Purchase Qualifies

ROOM	NAME	RATE	No. 66554
226	Cozzi R	26 28	
CLERK	ADDRESS	IN DATE	
RA		1/3/91	FROM
CITY	STATE / ZIP CODE	OUT DATE	TO

REMARKS	AMOUNT			
			PBAL	0.00
			226 #	
			CONSINGL	24.00
			SUBTTL	24.00
6011009 165 1809			TXAMT1	2.28
			BALFWD	26.28
5/93		LNH08	NEWBAL	26.28
	01/03/91	THANKS	0013A	13:40
			PBAL	26.28
			226 #	
			CONSINGL	24.00
			SUBTTL	24.00
			TXAMT1	2.28
			BALFWD	26.28
		LNH16	NEWBAL	52.56
	01/04/91	THANKS	0027B	15:40

Best Western

THE Wayfarer's INN

PHONE
602-753-6271

PLEASE PAY
LAST AMOUNT

State of Arizona
ARIZONA
GEOLOGICAL
SURVEY

MM 88A $5.00
CASH $5.00

0636
CTHANKS 3
01-07-91 16:24

Photocopy Rec'd

BLUEPRINT

ORDERED BY _____

PHONE _____

DATE & TIME DUE _____

E: Corn's Aborn

WILL CALL _____ DELIVER _____ MAIL _____ UPS _____

JOB NO. _____ DATE _____ (ORDER PLACED)

IT TO _____

CING TO _____

CASH _____ C.O.D. _____ DEPOSIT _____

OPY: VELLUM BOND MYLAR

PERCENT OF ORIGINAL SIZE: _____

REDUCTION/ENLARGEMENT SIZE: _____

EDITING COORDINATES:

1. X____Y____; 2. X____Y____; 3. X____Y____; 4. X____Y____;

1. X____Y____; 2. X____Y____; 3. X____Y____; 4. X____Y____;

5. X____Y____; 6. X____Y____; 7. X____Y____; 8. X____Y____

5. X____Y____; 6. X____Y____; 7. X____Y____; 8. X____Y____

NO. OF ORIG.	QUANT. EACH	TOTAL NO. OF	REPRO. SIZE	SQ. FT. EACH	TOTAL SQ. FT.	PRICE PER SQ. FT.	TOTAL PRICE	
1	1	1	36x54	13.5	13.5	1 25	16	88
							Tx 1	18
							18	06

PAID
Cash
TUCSON BLUEPRINT CO.
1-9-91
TS

SPECIAL INSTRUCTIONS

TUCSON BLUEPRINT

-8881

537 N. 6TH AVE.

ORDERED BY Russell Corn

PHONE 298-1770

DATE & TIME DUE 1-8-91 NOON

: TO: NAME Corn and Chase

S:

ING ☐ WILL CALL ✓ DELIVER ____ MAIL ____

ORDER NO. ____ JOB NO. OR REG. NO. ____ DATE ____ (ORDER PLACED)

DELIVER PRINT TO ____

DELIVER TRACING TO ____

CHARGE ____ CASH ✓ C.O.D. ____ DEPOSIT ____

	NO OF PRINTS EACH	TOTAL NO PRINTS	SIZE	NO OF SQ FT	KIND OF PRINTS	PRICE
55	1	55	8½ x 11		1090 Bond .06	3.30
		2	8½ x 11		Index covers .05	.00
		1	1/16		Spiral Binding 1.41	1.41
		1	30x36	7.5		
		1	36x42	10.5 / 18.	5080 Bond 1.25	22.50
		1	8½ x 11		Pocket	1.00
		1	2'		Rebind	3.04
					PHOTOSTAT - PHOTOGRAPHIC	31.35

NO OF ORIG	SIZE	NEG.	POS.	SPECIAL INSTRUCTIONS	PRICE
					2.19
					33.54

PAID
Ck # 6182
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1-8-91 BB

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 708
January 21, 1991
GB-1
PAGE 1 OF 1

ASARCO Incorporated
JAN 22 1991
SW Exploration

ASARCO INCORPORATED
Attn: Mr. James D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 1 Rotary Cutting

ITEM	SAMPLE NO.	FIRE ASSAY Au (oz/t)	FIRE ASSAY Ag (oz/t)
1	GB-1	<.002	<.01

cc: Mr. John Malusa
Mr. Mark Miller
Mr. Russ Corn

Gold Basin
Mohave Co, AZ
Hole T-29 (Toltec-29)
360-400 (from cuttings pile)

To JDS

Date 2/12 Time 11:35 ☐ AM ☐ PM

WHILE YOU WERE OUT

M Warren Mallory

of

Phone (619) 966-2689

Area Code Number Extension

TELEPHONED	✓		PLEASE CALL	✓
CALLED TO SEE YOU			WILL CALL AGAIN	
WANTS TO SEE YOU			URGENT	
RETURNED YOUR CALL				

Message

Operator

AMPAD EFFICIENCY®

REORDER #23-000

King Tut Placer
Lost Basin Area

#100,000 down
(one stake).

then 200,000 in
7 payments ($7,500.00)
+ 5% NSR roy.

will send new
data package &
tour guide

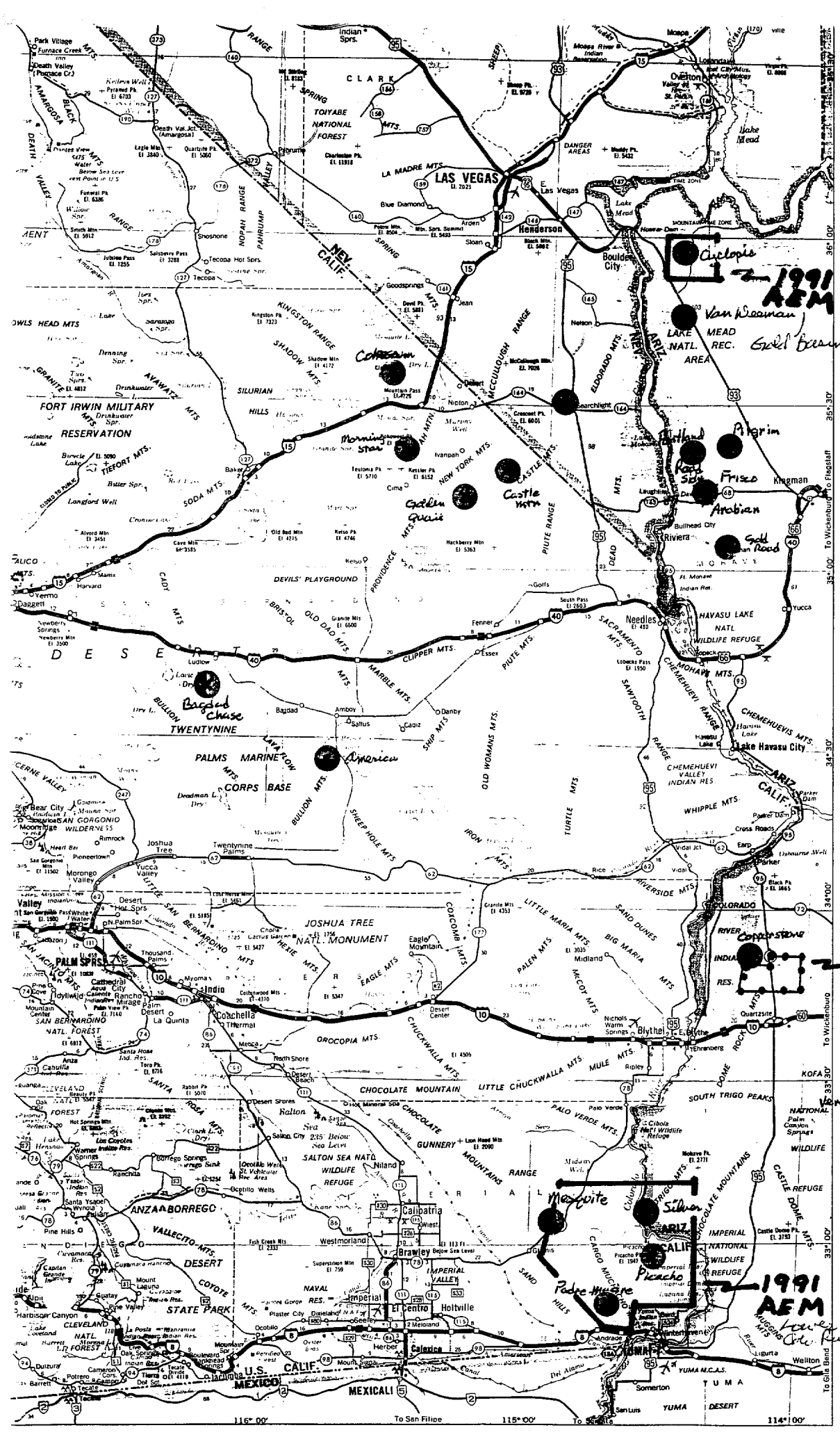
Canadians are offshore

1/4 mile HEM 8-40 sq miles
Cost $500/mi^2

1/16 mile HEM 4-8 ~~sq~~ mile
Cost $2000/m^2

Gold Basin 10 x 10 = 100 sq mile = $200,000 ! at 1/16
= 50000 ! at 1/4
Budget 50K

Mohave 20 x 20 = 400 x 2000 = 800,000 !
= x 500 = 200,000



Sierra, 3073 ... E-5
Siskiyou, 39732 ... A-3
Solano, 235203 ... H-3
Sonoma, 299827 ... H-3
Stanislaus, 265902 ... I-4
Sutter, 52246 ... F-4
Tehama, 38888 ... D-3
Trinity, 11858 ... C-3
Tulare, 245751 ... L-3
Tuolumne, 33920 ... H-5
Ventura, 529899 ... P-3
Yolo, 113374 ... G-4
Yuba, 49733 ... F-4

Cities & Towns

Acton, 650 ... P-4
Adelanto, 2164 ... O-5
Adin, 500 ... B-5
Agoura, 380 ... P-4
Ahwahnee, 600 ... J-6
Alameda, 63852 ... I-3
Alhambra, 64615 ... P-4
Alpaugh, 800 ... M-3
Alpine, 1900 ... S-6
Alta Hill, 1185 ... F-4
Alturas, 3025 ... B-5
Alum Rock, 18355 ... J-4
Anaheim, 221847 ... Q-5
Anderson, 7381 ... D-3
Angels Camp, 2302 ... H-5
Angwin, 2690 ... G-3
Antelope Acres, 900 ... O-4
Antioch, 43559 ... H-4
Applegate, 800 ... G-5
Apple Valley, 7500 ... O-5
Aptos, 8704 ... J-1
Arbuckle, 1037 ... F-3
Arcade, 41200 ... •
Arcata, 12338 ... C-1
Arden, 54000 ... •
Argus, 1130 ... M-5
Armona, 1392 ... L-3
Aromas, 750 ... K-1
Arroyo Grande, 11290 ... N-2
Arvin, 6863 ... N-4
Atascadero, 15930 ... M-2
Atwater, 17530 ... J-5
Auburn, 7540 ... G-5
Avalon, 2010 ... R-4
Avenal, 4137 ... L-2
Avila Beach, 400 ... N-2
Azusa, 29380 ... P-5
Baker, 500 ... N-6
Bakersfield, 105611 ... N-3
Banning, 14020 ... Q-6
Barstow, 17690 ... O-5
Bayview, 1300 ... C-1
Baywood Park, 1100 ... N-2
Beaumont, 6818 ... Q-6
Ben Lomond, 2793 ... J-3
Berkeley, 103328 ... I-3
Bertsch Terrace, 900 ... A-1
Bethel Island, 1398 ... H-4
Beverly Hills, 32367 ... P-4
Big Bear City, 950 ... P-6
Big Bear Lake, 3274 ... P-6
Big Creek, 450 ... J-6
Biggs, 1413 ... F-4
Big Pine, 950 ... J-7
Big Sur, 150 ... L-1
Biola, 600 ... B-2
Bishop, 3333 ... J-7
Blue Lake, 1201 ... C-1
Blythe, 6805 ... Q-8
Bolinas, 600 ... I-3
Bonita, 2300 ... †
Bonnyview, 4892 ... C-3
Boonville, 750 ... F-2
Boron, 2500 ... N-6
Borrego Springs, 900 ... R-6
Boulder Creek, 4000 ... J-3
Bowman, 290 ... G-4
Boyes Hot Springs, 3558 ... H-3
Brawley, 14946 ... S-7
Brentwood, 4434 ... I-4
Bridgeport, 500 ... H-6
Broderick, 9900 ... G-4
Bryte, 2900 ... G-4
Buena Park, 64165 ... Q-5
Burbank, 84625 ... P-4
Burkett Acres, 1600 ... I-4
Burkett Gardens, 4400 ... I-4
Burlingame, 26173 ... I-3
Burney, 2190 ... C-4
Butte Meadows, 60 ... D-4
Buttonwillow, 1193 ... N-3
Byron, 685 ... I-4
Calavo Gardens, 6100 ... †
Calexico, 14412 ... S-7
California City, 2743 ... N-5
Calimesa, 2400 ... P-5
Calipatria, 2636 ... R-7
Calistoga, 3879 ... G-3
Calpella, 700 ... F-2
Calwa, 5191 ... K-3
Camarillo, 37732 ... P-3
Camarillo Heights, 4100 ... P-4
Cambria, 1716 ... M-1
Camino, 900 ... G-5
Campbell, 27067 ... J-4
Camptonville, 200 ... F-4
Canby, 450 ... B-5
Capistrano Beach, 4149 ... R-5
Capitola, 9095 ... K-1
Cardiff By The Sea, 6800 ... R-5
Carlsbad, 35490 ... R-5
Carmel, 4707 ... K-1
Carmel Highlands, 900 ... K-1
Carmel Point, 800 ... K-1
Carmel Valley, 3026 ... K-1
Carmel Woods, 1400 ... K-1
Carmichael, 43800 ... G-4
Carpinteria, 10835 ... B-3
Caruthers, 940 ... K-3
Casitas Springs, 1113 ... P-3
Castaic, 900 ... O-4
Castle Park, 5000 ... †
Castroville, 3235 ... K-1
Cathedral City, 3640 ... Q-6
Cayucos, 1772 ... N-2
Cedarville, 800 ... A-5
Central Valley, 2361 ... C-3
Ceres, 13281 ... I-5
Chapmantown, 1795 ... E-4
Cherry Valley, 3165 ... Q-6
Chester, 1531 ... D-4
Chico, 26601 ... E-4
Chowchilla, 5122 ... J-5
Chualar, 600 ... K-1
[illegible] 83927 ... S-5
[illegible] ... G-4
Clearlake Highlands, [illegible] ... G-3
[illegible], 950 ... F-3
[illegible], 900 ... F-3
Cloverdale, [illegible] ... G-2
Clovis, 33021 ... K-3
Coachella, 9129 ... Q-6
Coalinga, 6593 ... L-2
Colfax, 981 ... F-5
Colton, 21310 ... P-5
Columbia, 600 ... H-5
Colusa, 4075 ... F-3
Corcoran, 6454 ... L-3
Corning, 4745 ... E-3
Corona, 37791 ... Q-5
Coronado, 16859 ... S-5
Costa Mesa, 82291 ... Q-4
Cotati, 3475 ... H-3
Cottonwood, 1288 ... D-3
Cou[illegible], 400 ... H-4
Co[illegible] 950 ... E-2
[illegible] City ... A-1
[illegible] ... P-5
Cro[illegible] 500 ... J-4
Cut[illegible] 2503 ... K-3
Cutten, [illegible] ... C-1
Daggett, 650 ... O-6
Dana Point, 4745 ... Q-5
Davis, 36640 ... G-4
Death Valley, 25 ... L-6
Delano, 16491 ... M-3
Del Dios, 450 ... R-5
Delhi, 2063 ... J-5
Del Mar, 5017 ... S-5
Del Monte Park, 1500 ... K-1
Del Rey, 900 ... K-3
Del Rey Oaks, 1557 ... K-1
Denair, 1128 ... I-5
Derby Acres, 300 ... N-3
Descanso, 500 ... S-6
Desert Hot Springs, 5941 ... Q-6
Desert View Highlands, 2172 ... D-4
Diamond Springs, 900 ... G-5
Dinuba, 9907 ... K-3
Dixon, 7541 ... H-4
Dorris, 836 ... A-4
Dos Palos, 3123 ... J-2
Downieville, 500 ... E-5
Dunlap Acres, 3300 ... P-5
Dunsmuir, 2253 ... B-3
Durham, 950 ... E-4
Eagle Mountain, 2453 ... Q-7
Earlimart, 3080 ... M-3
East Blythe, 1252 ... Q-8
Easton, 1065 ... K-3
East Porterville, 4042 ... K-4
East Quincy, 1500 ... E-5
Edgemont, 4400 ... Q-5
El Cajon, 73892 ... S-6
El Centro, 23996 ... S-7
El Dorado, 550 ... G-5
El Encanto Heights, 6225 ... P-3
Elk Creek, 300 ... E-3
Elk Grove, 3721 ... H-4
El Portal, 600 ... I-6
El Rio, 6173 ... P-3
El Verano, 1753 ... H-3
Elverta, 825 ... G-4
Empire, 2016 ... I-5
Grossmont, 2000 ... †
Grove Highlands, 350 ... K-1
Grover City, 8827 ... N-2
Guadalupe, 3629 ... N-2
Gualala, 600 ... G-2
Guerneville, 900 ... G-2
Gustine, 3142 ... J-5
Hamilton City, 800 ... E-3
Hanford, 20958 ... L-3
Happy Camp, 800 ... A-2
Harbison Canyon, 2300 ... S-6
Harbor Side, 2900 ... †
Hatton Fields, 1900 ... K-1
Havasu Lake, 200 ... O-8
Hayfork, 950 ... C-2
Hayward, 94167 ... I-3
Healdsburg, 7217 ... G-3
Heber, 950 ... S-7
Hemet, 23211 ... Q-6
Herndon, 400 ... K-3
Hesperia, 5700 ... P-5
Hickman, 400 ... I-5
Hidden Hills, 1760 ... P-4
Highland, 12300 ... P-5
Highway City, 1100 ... K-3
Hilmar, 900 ... J-5
Hollister, 11488 ... K-1
Holtville, 4399 ... S-7
Home Gardens, 5116 ... Q-5
Hoopa, 600 ... B-2
Hope Ranch, 3400 ... P-3
Hopland, 900 ... G-2
Hughson, 2943 ... I-5
Huntington Beach, 170505 ... Q-4
Huron, 2768 ... L-2
Hydesville, 700 ... C-1
Idyllwild, 900 ... Q-6
Imperial Beach, 22689 ... S-5
Independence, 950 ... K-4
Indio, 21611 ... Q-6
Inglewood, 94245 ... Q-4
Inyokern, 800 ... M-5
Ione, 2207 ... H-5
Isla Vista, 13441 ... P-3
Isleton, 918 ... H-4
Ivanhoe, 1595 ... L-3
Jackson, 2331 ... H-5
Jacumba, 600 ... S-6
Jamestown, 950 ... I-5
Johnsondale, 600 ... M-4
Johnstown, 650 ... †
Julian, 500 ... R-6
Kelseyville, 900 ... G-3
Kerman, 4002 ... K-2
Kernville, 950 ... M-4
Kettleman City, 500 ... L-3
Keyes, 1875 ... I-5
King City, 5495 ... L-1
Kings Beach, 2000 ... F-5
Kingsburg, 5115 ... K-3
Klamath Glen, 600 ... A-1
Knights Landing, 900 ... G-4
Laguna Beach, 17860 ... Q-5
La Honda, 400 ... J-3
Lake Arrowhead, 400 ... P-5
Lake Elsinore, 5982 ... Q-5
Lake Hughes, 600 ... Q-4
Lake Isabella, 900 ... M-4
Lakeport, 3675 ... F-3
Lake San Marcos, 2000 ... R-5
Lakeside, 15300 ... S-6
Lakeview, 50[illegible] ... Q-5
La Mesa, 503[illegible] ... S-5
Lamont, 700[illegible] ... N-4
Lancaster, 48027 ... Q-4
La Quinta, 800 ... Q-6
Larkfield, 1000 ... G-3
La Selva Beach, 1171 ... K-1
Lathrop, 2137 ... I-4
Laton, 1071 ... L-3
Laytonville, 900 ... E-2
Lebec, 600 ... O-4
Le Grand, 900 ... J-5
Lemon Grove, 20780 ... S-5
Lemoore, 8832 ... L-3
Lenwood, 3834 ... O-5
Leucadia, 6500 ... R-5
Lewiston, 750 ... C-3
Lincoln, 4132 ... G-4
Lincoln Acres, 1600 ... †
Lincoln Village, 6112 ... I-4
Linda, 7731 ... F-4
Lind Cove, 325 ... L-3
Linden, 900 ... H-4
Lindsay, 6924 ... L-3
Little Lake, 3500 ... Q-6
Littlerock, 1500 ... O-5
Live Oak, 3103 ... F-4
Livermore, 48349 ... I-4
Livingston, 5326 ... J-5
Locke, 300 ... H-4
Lockeford, 1500 ... H-4
Lodi, 35221 ... H-4
Loleta, 800 ... †
Lompoc, 2626[illegible]
London, 600
Lone Pine, 18[illegible]
Long Beach, [illegible]
Loomis, 1108
Los Alamos, 60[illegible]
Los Angeles, 2968763 ... Q-4
Los Banos, 10341 ... J-5
Los Gatos, 26593 ... J-4
Los Molinos, 900 ... D-3
Los Osos, 2400 ... N-2
Los Serranos, 3900 ... Q-5
Lower Lake, 850 ... G-3
Loyalton, 1030 ... E-5
Lucerne, 1300 ... F-3
Lucerne Valley, 1000 ... P-6
McArthur, 400 ... B-4
McCloud, 1643 ... B-3
McFarland, 5151 ... M-3
McKinleyville, 2000 ... C-1
Madera, 21732 ... K-2
Malaga, 800 ... K-3
Malibu, 7000 ... P-4
Malibu Canyon Homes, 1700 ... P-4
Mammoth Lakes, 900 ... I-7
Manhattan Beach, 31542 ... Q-4
Manteca, 24925 ... I-4
Maricopa, 946[illegible] ... N-3
Marina, 20647 ... K-1
Mariposa, 950 ... J-6
Martinez, 22582 ... H-3
Marysville, 9898 ... F-4
Maxwell, 700 ... F-3
Meadow Vista, 900 ... F-4
Meiners Oaks, 5600 ... P-3
[illegible]
Mendota, [illegible] ... K-2
Menlo Park, [illegible] ... J-3
Mentone, [illegible] ... P-5
Merced, 36[illegible] ... J-5
Meridian, 330 ... F-4
Middletown, 900 ... G-3
Mill Valley, 12967 ... I-3
Milpitas, 37820 ... J-4
Mint Canyon, 1600 ... P-4
Mira Monte, 700 ... P-3
Miranda, 350 ... D-2
Mission Viejo, 45000 ... Q-5
Modesto, 106105 ... I-4
Mojave, 2573 ... N-4
Mokelumne Hill, 560 ... H-5
Monrovia, 30531 ... P-5
Montague, 1285 ... A-3
Montecito, 7500 ... P-3
Monterey, 27558 ... K-1
Mon[illegible] ... H-2
Mo[illegible]
Mo[illegible]park, [illegible] ... P-[illegible]
M[illegible]ada, [illegible]
Morgan Hill, [illegible]060 ... J-4
Moro[illegible] Vall[illegible], 20[illegible]
Mo[illegible]
M[illegible]nt[illegible], 58655 ... J-[illegible]
Mountain View Acres, 1200 ... O-5
Mount Helix, 850 ... †
Mount Shasta, 2837 ... B-3
Napa, 50879 ... H-3
National City, 48772 ... S-5
Needles, 4120 ... O-8
Nevada City, 2431 ... F-4
New Almaden, 250 ... J-4
Newberry Springs, 650 ... O-6
Newcastle, 900 ... G-4
New Cuyama, 585 ... O-3
Newhall, 9651 ... P-4
Newman, 2785 ... J-5
Newport Beach, 63475 ... Q-4
Nice, 700 ... F-3
Niland, 950 ... R-7
Nipomo, 3642 ... N-2
Norco, 21126 ... Q-5
Northcrest, 900 ... A-1
North Edwards, 700 ... N-5
North Highlands 36800 ... G-4
North Oaks, 5800 ... P-4
North Palm Springs 500 ... Q-6
Norwalk, 85232 ... Q-4
Novato, 43916 ... H-3
Nuevo, 500 ... Q-5
Nyland Acres, 1300 ... P-3
Oakdale, 8474 ... I-5
Oakhurst, 500 ... J-6
Oak Knolls, 2700 ... O-2
Oakland, 339288 ... I-3
Oakley, 1306 ... H-4
Oak View, 4872 ... P-3
Oceano, 2564 ... N-2
Oceanside, 76698 ... R-5
Oildale, 20500 ... N-3
Ojai, 6816 ... P-3
Olivehurst, 8100 ... F-4
Olympic Valley, 600 ... F-5
Opal Cliffs, 5425 ... J-3
Orange, 91788 ... Q-5
Orange Cove, 4026 ... K-3
Prunedale, 800
Quail Valley, 600
Quartz Hill, 4935
Quincy, 2500
Ramona, 4200
Rancho California, 2500
Rancho Cordova, 39000
Rancho Mirage, 6281
Rancho Palos Verdes, 35227
Rancho Santa Fe, 2500
Red Bluff, 9490
Redding, 41995
Redlands, 43619
Redondo Beach, 57102
Redway, 950
Redwood City, 54965
Redwood Estates, 1000
Redwood Valley, 500
Richgrove, 1023
Richmond, 74676
Ridgecrest, 15929
Rio Dell, 2687
Rio Linda, 7524
Rio Vista, 3142
Ripley, 500
Ripon, 3509
Riverbank, 5695
Riverdale, 1722
Riverside, 170876
Rocklin, 7344
Rohnert Park, 22965
Romoland, 700
Rosamond, 2281
Roseland, 5105
Roseville, 24347
Rosewood, 900
Rovana, 400
Ryans Slough, 3922
Sacramento, 275741
St. Helena, 4898
Salida, 1456
Salinas, 80479
Salton City, 900
Samoa, 600
San Andreas, 1564
San Anselmo, 11927
San Bernardino, 118057
San Bruno, 35417
San Clemente, 27325
San Diego, 875504
San Fernando, 17731
San Francisco, 678974
Sanger, 12558
San Jacinto, 7098
San Joaquin, 1930
San Jose, 629442
San Juan Bautista, 1276
San Leandro, 63952
San Luis Obispo, 34252
San Marcos, 17479
San Martin, 1392
San Mateo, 77561
San Miguel, 800
San Pablo, 19750
San Rafael, 44700
Santa Ana, 203713
Santa Barbara, 74542
Santa Cruz, 41483
Santa Margarita, 730
Santa Maria, 39685
Santa Monica, 88314
Santa Paula, 20552
Santa Rosa, 83205
Santee, 20764
Saratoga, 29261
Saugus, 7700
Scotia, 950
Scotts Valley, 6891
Seal Beach, 25975
Seaside, 36567
Sebastopol, 5500
Seeley, 950
Serad Valley, 275
Selma, 10942
Sespe, 350
Shafter, 7010
Shasta, 650
Sheridan, 400
Short Acres, 1476
Shoshone, 200
Silverado, 900
Simi Valley, 77500
Smith River, 900
Solana Beach, 6000
Soledad, 5928
Solvang, 2004
Somis, 600
Sonoma, 6054
Sonora, 3239
Soquel, 5795
South Dos Palos, 700
South Laguna, 2566
South Lake Tahoe, 20681
South Modesto, 7889
South Oroville, 3100
South Taft, 2214
South Turlock, 1762
Spreckels, 650
Spring Valley, 36400
Springville, 950
Squaw Valley, 30
Stirling City, 375
Stockton, 149779
Stratford, 800
Strathmore, 1221
Sultana, 500
Summerland, 800
Sunny Brae, 950
Sunnyvale, 106618
Sunol, 450
Sun Village, 1000
Susanville, 6520
Sutter, 1488
Sutter Creek, 1705
Taft, 5316
Tahoe City, 1394
Talmage, 900
Tecopa Hot Springs, 300
Tehachapi, 4126
Temecula, 220
Templeton, 750
[illegible]ella, 1037
Thermal, 600
Thermalito, 4217
Thornton, 800
Thousand Oaks, 77797
Tipton, 950
Tracy, 18428
Tranquillity, 600
Trona, 1500
Truckee, 1392
Tulare, 22475
Tulelake, 783
Tuolumne, 1365
Turlock, 26291
Twain Harte, 1484
Twentynine Palms, 6000
Twin Lakes, 2300
Ukiah, 12035
Upper Lake, 700
Vacaville, 43367
Valencia, 4243
Vallejo, 80188
Valle Vista, 1500
Valley Springs, 800
Val Verde Park, 500
Ventura, 74474
Victorville, 14220
Villa Verona, 1000
Visalia, 49729
Vista, 35834
Vista Park, 950
Walnut Creek, 53643
Walnut Grove, 900
Wasco, 9613
Waterford, 2683
Watsonville, 23543
Weaverville, 1489
Weed, 2879
Weimar, 900
Weott, 450
Westlake Village, 4500
Westley, 700
West Modesto, 6135
Westmorland, 1590
West Point, 900
West Sacramento, 12002
Westwood, 1862
Wheatland, 1474
Whittier, 68872
Williams, 1655
Willits, 4008
Willow Creek, 900
Willows, 4777
Wilseyville, 500
Windsor, 2359
Winterhaven, 800
Winters, 2652
Winton, 3393
Wofford Heights, 900
Woodbridge, 1397
Woodlake, 5375
Woodland, 30235
Woodville, 1031
Yermo, 1304
Yolo, 600
Yosemite National Park, 900
Yountville, 2893
Yreka, 5916
Yuba City, 18736
Yucaipa, 17400
Yucca Valley, 4300

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770
February 16, 1991

James D. Sell
Manager, Southwestern Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AS 85703

Re: Monthly Progress Report
Gold Basin Project

The geologic map compilation studies and review of data on mineralization in the Gold Basin - Lost Basin districts has been completed and geologic maps and a report are being prepared. Most of the time and effort during the past month were spent on field review of the geology in the area with particular emphasis on defining the projected Gold Basin detachment fault in the Senator Mountain quadrangle. The results are a major improvement over published maps which are extremely generalized and do not reflect the widespread detachment-type faulting. The geologic studies and field work indicate that:

(1) Precambrian rocks exposed south and west of the Gold Basin detachment fault are fault bounded slices in the upper plate of the detachment fault.

(2) Placer gold deposits in the Gold Basin district, like those at Lost Basin, are located downslope from the eroded projection of the detachment fault zone, particularly where recent erosion has exhumed the Mid-Tertiary erosion surface.

(3) Extensive chlorite-siderite-hematite alteration occurs through a several hundred foot thick interval associated with the middle and lower plates of the Gold Basin detachment fault zone.

(4) Gold prospects in the western part of the district north of White Hills exhibit the same type of epithermal gold mineralization as the Cyclopic mine, but are hosted by fault breccias in upper plate rocks above the detachment fault.

Respectfully submitted,

Russell M. Corn

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

February 16, 1991

James D. Sell
Manager, Southwestern Exploration
ASARCO, Inc.
P.O. Box 5747
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(4) Gold prospects in the western part of the district north of White Hills exhibit the same type of epithermal gold mineralization as the Cyclopic mine, but are hosted by fault breccias in upper plate rocks above the detachment fault.

Can you, Corn, & I go up ± March 6-8 to review area, esp. the King Tut Placer etc.?! JDS.

Respectfully submitted,

Russell M. Corn

Accounting

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

February 16, 1991

James D. Sell
Manager, Southwest Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

STATEMENT

Gold Basin - Lost Basin Project, Mohave County, Arizona

Charges for January 16, 1991 through February 15, 1991

21 days of Geologic Research & Investigations @ $350/day		$7,350.00
Mileage 3,150 miles @ .45¢/mile for 4WD vehicle		1,417.50
Expenses		592.84
	TOTAL	$9,360.34

Russell M. Corn

OK for Payment
Gen. Exploration
(GB-LB Project)

TIME DISTRIBUTION SHEET

Please Return By The 25th.

Gold Basin Project

CLS

TUCSON OFFICE

Russell M Corn
~~Employee~~
Consultant

February, 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1	8							8
2								
3								
4	8							8
5	8							8
6	8							8
7	8							8
8	8							8
9								
10								
11	8							8
12	8							8
13	8							8
14	8							8
15	8							8
16								
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18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
Total	88							88
Amount								

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: [signature]

Approved: James D. Self

TIME DISTRIBUTION SHEET

Please Return by the 25th.

Gold Basin Project

CLS

TUCSON OFFICE

Russell M Corn
~~Employee~~ Consultant

January, 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
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17	8							8
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21	8							8
22	8							8
23	8							8
24	8							8
25	8							8
26								
27								
28	8							8
29								
30	8							8
31	8							8
Total								
Amount	80							80

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: [signature]

Approved: James D Sell

DATE	USER	STARTING AND ENDING LOCATIONS PURPOSE OF TRIP	ODOMETER READING BEGIN	END	Total Miles	Days Comm.		Department/ Project
								Exploration
1/20	RM Corn	Flagstaff - Kingman	69,380	69,534	154			Gold Basin
		Geol Eqd. - Gold Basin						
1/21	"	" "	69,534	69,700	166			
1/22	"	" "	69,700	69,872	172			
1/23	"	Kingman - Tucson	69,872	70,330	458			
1/30	"	Tucson - Kingman	71,152	71,478	326			
		Geol Eqd - Gold Basin						
1/31	"	" "	71,478	71,635	157			
2/1	"	Kingman - Tucson	71,635	72,130	495			
2/4	"	Tucson - Kingman	72,168	72,489	321			
		Geol Eqd - Gold Basin						
2/5	"	"	72,489	72,625	136			
2/6	"	"	72,625	72,784	159			
2/7	"	"	72,784	72,930	146			
2/8	"	"	72,930	73,390	460			
				TOTAL MILES	3,150			

Total Days Commuting _____

Signature [signature]

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A.

EXPENSES OF Russell M. Corn (NAME) FOR February (MONTH) 19 91

DAY	TRANSPORTATION Auto Rail Air, etc Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1				Kingman – Tucson		19 90				
2										
3				Tucson – Kingman	26 28	10 07				
4				Gen'l Exp.	26 28	24 08				
5					26 28	21 35				
6					26 28	23 00				
7						21 00				
8										
9										
10										
11										
12										
13										
14							Photocopy	77		
15							Photocopy	20 06		
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
TOTALS					105 12	119 40		20 83		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj.	$ 245	35
A/c		
A/c		
A/c		
TOTAL	$ 245	35

DETAIL OF ADVANCES

Cash (Office)	$
Cash (Office)	
Transportation	
Personal Mileage @ (CO. OWNED CAR)	
TOTAL	$

GRAND TOTAL EXPENSES	$ 245 35
LESS ADVANCES	
DIFFERENCE	$ 245 35

DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

2/16/91 — DATE COMPLETED

CORRECT — EMPLOYEE'S SIGNATURE

APPROVED — DEPT. HEAD

ACCOUNTING DEPT.

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A

EXPENSES OF Russell M. Cox (NAME) FOR January (MONTH) 19 91

DAY	TRANSPORTATION Auto Rail, Air, etc Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1										
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13										
14										
15										
16										
17								Phoenix Maps	46 95	
18								"	21 40	
19										
20				Flagstaff - Kingman	26 28	16 50				
21				Gen'l Expl.	26 28	21 50				
				"	26 28	22 75				
				"		19 00				
23										
24										
25								Map	4 54	
26										
27										
28							Photocopy	22 93		
29										
30				Tucson - Kingman	26 28	19 60				
31				Gen'l Expl.	26 28	21 00				
TOTALS					131 40	120 37		95 72		

DISTRIBUTION OF EXPENSES

A/c	Gold Basin Proj.	$ 347 49
A/c		
A/c		
A/c		
TOTAL		$ 347 49

DETAIL OF ADVANCES

Cash (.....Office)	$
Cash (.....Office)	
Transportation	
Personal Mileage @ (CO. OWNED CAR)	
TOTAL	$

GRAND TOTAL EXPENSES	$ 347 49
LESS ADVANCES	
DIFFERENCE	$ 347 49

DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

2/16/91 DATE COMPLETED — CORRECT — EMPLOYEE'S SIGNATURE — APPROVED — DEPT. HEAD — ACCOUNTING DE

JDS

ASARCO

Exploration Department
Southwestern United States Division
James D. Sell
Manager

March 11, 1991

Tracey E. Cascadden
% Dr. Eugene I. Smith
Department of Geosciences
University of Nevada
Las Vegas, Nevada 89154

Dear Tracey:

I note your abstract on page 12 of the Cordilleran Meeting Abstracts with Programs, and unfortunately I will not be in Frisco to hear/see your presentation.

Will a copy of your paper be available after the meeting? If so, I would be pleased to be placed on your list of people to receive a copy.

Thank you and best of all things for your presentation.

Sincerely,

James D. Sell

JDS:mek

cc: W.L. Kurtz

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue FAX (602) 792-3934 Phone (602) 792-3010

JDS FILE
Gold Basin
Mohave Co, AZ

DEPARTMENT OF GEOSCIENCE

UNIVERSITY OF NEVADA, LAS VEGAS
4505 MARYLAND PARKWAY • LAS VEGAS, NEVADA 89154-4010 • (702) 739-3262 • FAX (702) 597-4064

April 2, 1991

James D. Sell
Exploration Department
Southwestern United States Division
ASARCO Incorporated
P.O. Box 5747
Tucson, AZ 85703-0747

Dear Mr. Sell,

Thank you for you inquiry regarding the abstract I cowrote with Gene Smith. The material covered in the GSA talk is a portion of my master's thesis research. The thesis is being written in three portions, each of publishable size, and hopefully of publishable interest. At least two of the portions will be submitted for publication this summer, and I will keep you name and address on file to notify you when the writing is completed. Thank you for your interest.

Sincerely,

Tracey E. Cascadden

Bring to Cecty 3/18/91 JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

March 16, 1991

James D. Sell
Manager, Southwest Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

STATEMENT

Gold Basin - Lost Basin Project, Mohave County, Arizona

Charges for February 16th through March 15th, 1991

14 days of Geologic Research & Investigations @ $350/day	$4,900.00
Expenses	903.26
TOTAL	$5,803.26

Russell M. Corn

Russell M. Corn

OK for Payment
James D. Sell
General Expl (Gold Basin Study Area)

TIME DISTRIBUTION SHEET

Please Return by the 25th.

Gold Basin Project

CLf

TUCSON OFFICE

Russell M Corn
~~Employee~~
Consultant
February, 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1								
2								
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31								
Total	32							32
Amount								

REPORT ACTUAL TIME WORKED
Use following symbols for time not worked.
N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: [signature]

Approved: [signature]

TIME DISTRIBUTION SHEET

Please Return By The 25th

Gold Basin Project

CLS

TUCSON OFFICE

Russell M Cox
~~Employee~~
Consultant
March, 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1								
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30								
31								
Total	80							80
Amount								

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: [signature]

Approved: [signature]

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A.

EXPENSES OF Russell M. Corn (NAME) FOR February (MONTH) 19 91.

DAY	TRANSPORTATION Auto Rail Air, etc. Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1										
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30										
31										
							Photog Repair	90 40		
							Photog Maps	55 50		
							Photog	10 26		
TOTALS								154 22		

DISTRIBUTION OF EXPENSES

A/c	Gold Bond Pay	$ 154 22
A/c		
A/c		
A/c		
TOTAL		$ 154 22

DETAIL OF ADVANCES

Cash (Office)	$
Cash (Office)	
Transportation	
Personal Mileage @ (CO. OWNED CAR)	
TOTAL	$

GRAND TOTAL EXPENSES	$ 154 22
LESS ADVANCES	
DIFFERENCE	$ 154 22

DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

3/6/91 DATE COMPLETED — CORRECT — Russell M. Corn EMPLOYEE'S SIGNATURE — APPROVED — James D. Scott DEPT. HEAD — ACCOUNTING DE

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-83)
PRINTED IN U.S.A.

EXPENSES OF Russell M. Cora (NAME) FOR March (MONTH) 19 91

DAY	TRANSPORTATION: Auto, Rail, Air, etc. (Code)	Amount	Taxi, Bus, etc.	ITINERARY: Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC.: Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC: Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1										
2										
3							Photocopy			
4							Maps	59.52		
							Photocopy			
5							Kept	40.23		
				Tucson -			Photocopy			
6				Kingman	26.28		Maps	40.13		
7				Gen'l Expl.	26.28	9.80				
				Kingman -						
8				Tucson		7.40				
9										
10										
11							Photocopy			
12							Maps/Kit.	94.21		
13										
14	A	269.00		Tucson -						
	H	46.74		Oceanside, Cal.	60.99	15.25	Photocopy.	14.85		
	P	6.00		Gen'l Expl		23.50		9.16		
15										
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20										
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25										
26										
27										
28										
29										
30										
31										
TOTALS		321.74			113.55	55.65		228.10		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj. $ 749.04
A/c
A/c
A/c
TOTAL $ 749.04

DETAIL OF ADVANCES

Cash (Office) $
Cash (Office)
Transportation
Personal Mileage @
(CO. OWNED CAR)
TOTAL $

GRAND TOTAL EXPENSES $ 749.04
LESS ADVANCES
DIFFERENCE $ 749.04
DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐
(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

3/16/91
DATE COMPLETED

CORRECT [signature]
EMPLOYEE'S SIGNATURE

APPROVED James D. Seal
DEPT. HEAD

ACCOUNTING DE

FILE

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

March 17, 1991

James D. Sell
Manager, Southwestern Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

Monthly Progress Report
Gold Basin Project
March, 1991

A brief report summarizing the results of the regional geologic study of the Gold Basin - Lost Basin districts was submitted early in March. The study indicated that the detachment fault-hosted epithermal gold mineralization has a greater exploration potential than other types of gold mineralization in the area. Previous exploration has been limited to areas of known mineralization and there is a favorable exploration potential for gold mineralization concealed beneath structurally-displaced rock units or post-mineral fanglomerate. Geologic relationships and the detachment fault-hosted mineralization were examined during an extensive tour of the area early in March. Areas examined included the gold mineralization and placer occurrences at Lost Basin, the Gold Basin Detachment Fault and mineralization along it in the Cyclopic - Red Cloud area, the Senator Mine and Senator Mountain area, and the Owens Mine - White Elephant Wash - Salt Spring Wash area. The intensely sheared, middle plate zone of the detachment fault exhibits widespread chlorite-siderite alteration but mineralization of interest is limited in extent and may be controlled by northwest-trending subsurface tear faults.

A review of old geochemical data from the Gold Basin district indicated that the mineralized area near the Cyclopic - Red Cloud - Fry prospects is reflected by a broad halo of weakly anomalous mercury, tungsten and gold values. However, prominently anomalous gold and associated trace elements were not found in upper-plate rock units or in areas where mineralization was concealed by alluvium. The 600 foot by 1,500 foot sample spacing was too large to define individual zones and lenses of mineralization. The sample data suggests however, that there are additional mineralized zones that have not been drilled near the Cyclopic and Red Cloud prospects and that there is potential concealed detachment-hosted mineralization in an area 2½ miles south of the Cyclopic Mine.

The American Heavy Minerals property at Lost Basin was briefly examined and their drill hole data was reviewed. Billiton Minerals held the property in 1989 and drilled 30 to 40 shallow holes testing its placer potential. An elongate area, one to several thousand feet wide along the contact of sheared and altered Precambrian rocks and overlying post-mineral fanglomerate could have potential for bulk tonnage gold mineralization. The few old drill holes in this area are reported to contain gold values of .01 to .02 oz Au/T but the assays may not be reliable. Surface sampling near the old drill holes and along the contact with post-mineral fanglomerate is the easiest and least expensive way to test the validity of the old assays and determine if the property may be of interest.

Respectfully submitted,

Russell M. Corn

JDS

SKYLINE LABS, INC.

1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

INVOICE
NET 30 DAYS

Job No. TAJ 722
April 11, 1991
LB-1-A TO LB-44-B

ASARCO Incorporated

APR 1 5 1991

SW Exploration

ASARCO INCORPORATED
Attn: Mr. Russell Corn
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 100 Rock Chip Samples

100 GREAT BASIN #3 @ $17.25*	$1725.00
100 samples crushed, split and pulverized @ $3.52	$352.00
50 samples dried @ $0.65	$32.50
Totals	$2109.50

* Multi Element Discount

APPROVED FOR PAYMENT

By:_____
(Signature)

Sent 4-15

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 722
April 11, 1991
LB-1-A TO LB-44-B

ASARCO Incorporate.
APR 1 5 1991
SW Exploration

ASARCO INCORPORATED
Attn: Mr. Russell Corn
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 100 Rock Chip Samples

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	
1	LB-1-A	.016	.05	2.0	<.1	.03	
2	LB-1-B	.002	.15	5.5	.2	<.01	
3	LB-1-C	.004	.25	14.0	<.1	<.01	
4	LB-1-D	.002	.30	3.0	<.1	.01	
5	LB-1-E	<.002	<.05	4.8	<.1	.02	
~~6~~	~~LB-1-Z~~	~~.250~~	~~6.10~~	~~55.0~~	~~8.5~~	~~.56~~	control
7	LB-2-A	<.002	<.05	4.6	.6	.01	
8	LB-2-B	<.002	.05	1.4	<.1	.03	
9	LB-2-C	<.002	.05	.8	<.1	.02	
10	LB-2-D	<.002	<.05	.6	<.1	.01	
11	LB-3-A	<.002	<.05	.6	<.1	.03	
12	LB-3-B	<.002	.05	5.0	.6	.02	
13	LB-4-A	<.002	<.05	1.2	<.1	.01	
14	LB-4-B	.008	.05	.6	<.1	.01	
15	LB-5	.002	.35	13.0	<.1	<.01	
16	LB-5-A	.020	.05	.6	<.1	<.01	
17	LB-6	<.002	.10	4.8	<.1	<.01	
18	LB-6-A	<.002	<.05	.6	<.1	.02	
19	LB-7	<.002	<.05	6.5	.2	.01	
20	LB-7-A	<.002	<.05	5.5	.8	.02	
21	LB-8	4.300	13.00	4.2	.2	1.00	
22	LB-9	.004	.10	18.0	1.6	.02	
23	LB-10	.002	.10	4.0	<.1	.01	
~~24~~	~~LB-10-Z~~	~~.240~~	~~5.70~~	~~55.0~~	~~8.0~~	~~.56~~	control
25	LB-11	.002	.15	3.8	<.1	.02	

"A" on map

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)
✓26	LB-12	.004	.10	8.5	<.1	.02
✓27	LB-13	<.002	.10	8.0	.4	.02
✓28	LB-14	.002	.10	.4	<.1	.03
✓29	LB-15-A	.020	.10	.6	<.1	.02
✓30	LB-15-B	.002	.10	1.2	.1	.02
✓31	LB-15-C	.014	.05	<.2	<.1	.04
✓32	LB-15-D	.110	.10	1.4	<.1	.03
✓33	LB-16-A	.002	.10	2.2	<.1	.02
✓34	LB-16-B	.006	.05	.2	<.1	.01
✓35	LB-17-A	<.002	.15	2.8	.1	.02
✓36	LB-17-B	<.002	.05	1.8	<.1	.01
✓37	LB-17-C	<.002	.05	1.8	<.1	.02
✓38	LB-17-D	.002	<.05	1.8	<.1	.03
✓39	LB-17-E	.085	.10	1.2	.1	.04
✓40	LB-18-A	.050	.05	1.2	<.1	.02
✓41	LB-18-B	<.002	.10	1.4	.1	.03
✓42	LB-19-A	.580	1.40	.8	.2	.04
✓43	LB-19-B	.065	.25	.8	.3	.03
✓44	LB-20-A	.180	.90	2.6	<.1	.02
✓45	LB-20-B	.042	.45	11.0	<.1	.04
✓46	LB-20-C	.006	.25	2.6	.1	.02
✓47	LB-20-D	.110	.55	8.5	.2	.02
~~48~~	~~LB-20-Z~~	~~.240~~	~~5.70~~	~~50.0~~	~~9.0~~	~~.44~~
✓49	LB-20-E	.006	1.30	50.0	.7	.30
✓50	LB-21-A	.010	.20	2.8	.3	.02

Sterling on wo 263

which one? where

control

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 722
April 11, 1991

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)
✓51	LB-21-B	.002	.05	.8	<.1	.01
✓52	LB-21-C	<.002	.15	6.0	<.1	.03
✓53	LB-21-D	.002	.15	.8	<.1	.01
✓54	LB-22	1.000	.85	10.0	.7	.02
✓55	LB-23-A	.004	.10	3.0	.1	<.01
✓56	LB-23-B	.010	.10	1.8	.1	.02
✓57	LB-23-C	.002	.05	.4	<.1	<.01
✓58	LB-23-D	.004	.25	1.4	.2	.02
✓59	LB-24	.004	.10	.6	.2	.02
✓60	LB-25-A	.002	.10	1.0	.3	<.01
✓61	LB-25-B	<.002	.10	3.2	.4	<.01
✓62	LB-26	<.002	<.05	.2	.3	<.01
✓63	LB-27	.002	<.05	1.6	.1	.01
✓64	LB-28	.014	.95	30.0	.2	.02
✓65	LB-29-A	<.002	.15	.8	.2	.03
✓66	LB-29-B	<.002	.05	1.0	.2	<.01
✓67	LB-30-A	.040	.65	9.5	<.1	.02
✓68	LB-30-B	.170	.40	19.0	.3	.01
✓69	LB-30-C	.006	.35	28.0	.4	.01
~~70~~	~~LB-30-Z~~	~~.250~~	~~5.60~~	~~55.0~~	~~10.0~~	~~.46~~ voided
✓71	LB-31	<.002	.05	1.2	.3	.01
✓72	LB-32-A	.006	.15	2.2	.2	.02
✓73	LB-32-B	.002	.05	1.4	.2	.02
✓74	LB-33-A	<.002	.10	2.8	<.1	.02
✓75	LB-33-B	.008	.50	.8	.1	.03

where is 32c lost

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 722
April 11, 1991

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)
✓76	LB-34-A	.010	.10	1.6	.1	.02
✓77	LB-34-B	.050	.80	75.0	4.1	.04
✓78	LB-34-C	<.002	<.05	1.2	.3	.03
✓79	LB-35-A	.014	.20	6.5	.1	.02
✓80	LB-36-A	.002	.10	6.5	.2	.01
✓81	LB-36-B	.002	.10	2.8	<.1	.02
✓82	LB-37-A	.022	.10	1.2	<.1	.01
✓83	LB-37-B	<.002	.05	.4	<.1	<.01
✓84	LB-38-A	.050	.10	1.2	<.1	<.01
✓85	LB-39-A	.040	.10	2.0	<.1	.03
✓86	LB-39-B	.002	.10	.8	<.1	.02
✓87	LB-39-C	<.002	.20	4.6	.5	.04
✓88	LB-40-A	.008	.05	6.0	.1	.02
✓89	LB-40-B	.020	.10	1.4	.4	.14
~~90~~	~~LB-40-Z~~	~~.260~~	~~5.50~~	~~50.0~~	~~8.0~~	~~.44~~ contd
✓91	LB-41-A	1.100	.40	1.8	.1	.04
✓92	LB-41-B	.060	.10	4.4	.3	.03
✓93	LB-41-C	<.002	<.05	2.0	<.1	.02
✓94	LB-41-D	.034	.15	1.2	<.1	.02
✓95	LB-42	<.002	<.05	<.2	<.1	.01
✓96	LB-43-A	<.002	<.05	1.4	<.1	.02
✓97	LB-43-B	.004	<.05	.4	<.1	.01
✓98	LB-43-C	<.002	<.05	.2	<.1	.01
✓99	LB-44-A	<.002	.10	2.0	.2	.02
✓100	LB-44-B	<.002	.25	1.8	<.1	.01

*NOTE: Method of analysis by combination fire assay and atomic absorption based on a two assay-ton sample.

cc: Mr. J. J. Malusa

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK ARIZONA U.S.A.

William L. Lehmbeck
Manager

4/11/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

JDS

ASARCO

Southwestern Exploration Division

April 12, 1991

Russ Corn

Gold Basin Project

Items:

1. I've found a few things on the maps that you might have cleaned up. Some of the minor contacts on overlapping maps are not as important as misplaced contacts or missing units, or misnamed units.

2. Can you get all the MAPCO drill holes, etc. of the Owens Mine area and prepare a separate report with cross sections and proposed drill holes, depth of cover, etc., for the covered area to the north of all the present drilling.

3. See what you can do with drawing a cross section on Senator Mtn. Southeast Quad, say from top of NE of Owens Mine southwesterly to bottom of Quad at Sec. 3-4 corner. Same scale as map.

4. Need cross section from White Hills westerly to Gulf drill hole and into mountains west of US 93. Any thoughts on depth to detachment structure? Does gravity in valley help out? Other drill hole info?

5. Need to wrap-up project in final report with maps et al.

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz

~~FILE~~

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

James D. Sell
Manager, Southwestern Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

April 15, 1991

Monthly Progress Report
Gold Basin Project
April, 1991

The American Heavy Mineral's Lost Basin property was sampled and evaluated to determine if the property had potential for concealed bulk-tonnage gold mineralization. Sampling was directed toward crushed and sheared rocks in and near the Lost Basin Detachment Fault; metamorphic rocks exposed at the edge of cover along the projected detachment fault, and in areas where reported assays from old drill holes suggested the presence of gold mineralization of interest. Results showed that the old assays are incorrect and none of the samples from the detachment fault or along the edge of post-ore cover reflected adjacent concealed mineralization. The Lost Basin property does not have a favorable exploration potential for concealed bulk-tonnage gold mineralization and rejection of the submittal is recommended.

Geologic investigations at Gold Basin included reviewing the distribution of mineralization and the extent of previous drilling at the Owens, Cyclopic, and Red Cloud properties. With the exception of the U.S. Borax drill hole fences south of the Cyclopic and two or three Toltec drill holes, including their high-grade intercept, all drilling has been limited to the near vicinity of exposed mineralization.

Investigations of the limonitic and hematitic colored sheared Precambrian granite south of the Cyclopic - Senator Mountain zone of mineralization, indicate that the granite is an intermediate, fault-bounded slice within the detachment packet. The granite is sheared and "disaggregated" and contains rotated blocks of Tertiary volcanic and volcaniclastic rocks. South of Senator Mountain the hematitic granite occurs as an upper unit above detachment fault breccia and underlying intensely sheared Cretaceous granite that is believed to be in the lower plate of the Detachment Fault zone.

The Consolidated Rhodes - Toltec venture initiated additional drilling at Gold Basin on April 12th. Their plans call for approximately 3,500 feet of reverse circulation drilling in closely-spaced (50 feet or less) drill holes adjacent to their previous close-spaced drill holes. The planned drilling includes angle holes that will test the width and extent of the higher-grade mineralization encountered last year by Toltec in hole T-11 (55 ft @ .477 oz Au/T). The planned drilling will not test additional mineralized zones or substantially expand the known mineralization.

Respectively submitted,

Russell M. Corn

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

April 15, 1991

James D. Sell
Manager, Southwest Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

STATEMENT

Gold Basin - Lost Basin Project, Mohave County, Arizona

Charges for March 16, 1991 through April 15, 1991

20 days of Geologic Research & Investigations @ $350/day	$7,000.00
Mileage - 1,498 miles @ 45¢/mile for 4WD vehicle	674.10
Expenses	592.59
TOTAL	$8,266.69

Russell M. Corn

OK for Payment
James D Sell
Gen-Expl 499-01
(Gold Basin)

TIME DISTRIBUTION SHEET

Please Return by the 25th

Gold Basin Project

CLS

TUCSON OFFICE

Russell M Corn
~~Employee~~ Consultant

March 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1								
2								
3								
4								
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22	8							8
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24								
25	8							8
26	8							8
27	8							8
28	8							8
29	8							8
30								
31								
Total								
Amount	80							80

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: [signature]

Approved: JD Sell

TIME DISTRIBUTION SHEET

Please Return by the 25th.

Gold Basin Project

CLS

TUCSON OFFICE

Russell M Corn
~~Employee~~ Consultant

April
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
1	8							8
2	8							8
3	8							8
4	8							8
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27								
28								
29								
30								
31								
Total								
Amount	80							80

REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: Russell M Corn

Approved: James D Self

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U S A

EXPENSES OF Russell M. Corn (NAME) FOR March (MONTH) 19 91

DAY	TRANSPORTATION Auto Rail, Air, etc Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amo
1										
2										
3										
4										
5										
6										
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9										
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12										
13										
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16										
17										
18							Photocopy	3 21		
19							"	12 29		
20										
21										
							Photocopy	35 88		
23										
24										
25				Tucson – Kingman	26 28	22 50	Photocopy	7 53		
26				General Expl.	26 28	24 40				
27				"	26 28	23 00				
28				"	26 28	24 50				
29				"		22 00				
30										
31										
TOTALS					105 12	116 90		58 91		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj	$ 280	43
A/c		
A/c		
A/c		
TOTAL	$ 280	43

DETAIL OF ADVANCES

Cash (Office)	$
Cash (Office)	
Transportation	
Personal Mileage @ (CO. OWNED CAR)	
TOTAL	$

GRAND TOTAL EXPENSES	$ 280 43
LESS ADVANCES	
DIFFERENCE	$ 280 43

DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

4/15/91 — DATE COMPLETED

CORRECT — EMPLOYEE'S SIGNATURE

APPROVED — DEPT. HEAD

ACCOUNTING DE

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A.

EXPENSES OF Russell M. Cann (NAME) FOR April (MONTH) 19 91

DAY	TRANSPORTATION: Auto, Rail, Air, etc. Code	Amount	Taxi, Bus, etc.	ITINERARY: Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC.: Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC: Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
1							Photocopy	96		
2							"	42 33		
3							"	14 77		
4										
5										
6										
7				Tucson - Kingman General Exp.	26 28	10 60				
8				Gold Basin	26 28	22 60				
9				"	26 28	24 00				
10				"	26 28	21 50				
11				"	26 28	23 00				
12				Kingman - Tucson		21 00				
13										
14										
15										
16										
17										
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19										
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21										
22										
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24										
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26										
27										
28										
29										
30										
31										
TOTALS					131 40	122 70		58 04		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj $ 312 16
A/c
A/c
A/c
TOTAL $ 312 16

DETAIL OF ADVANCES

Cash (Office) $
Cash (Office)
Transportation
Personal Mileage @
(CO. OWNED CAR)
TOTAL $

GRAND TOTAL EXPENSES $ 312 16
LESS ADVANCES
DIFFERENCE $ 312 16
DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐
(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

4/15/91 DATE COMPLETED — CORRECT — EMPLOYEE'S SIGNATURE — APPROVED — James W. Sell DEPT. HEAD — ACCOUNTING DE

VEHICLE NO. _____ MONTH/YR Mar-April '91 ODOMETER START 76,007 END 77,828

DATE	USER	STARTING AND ENDING LOCATIONS PURPOSE OF TRIP	ODOMETER READING BEGIN	ODOMETER READING END	Total Miles	Days Comm.		Department/ Project
3/20	R.M. Cora	Tucson – Cochise – Tucson General Exploration	76,007	76,186	179			Exploration ~~Gold Basin~~ Gen'l Expl.
4/7	"	Tucson – Kingman Gen'l Expl – Gold Basin	76,509	76,831	322			Exploration Gold Basin Project
4/8	"	" "	76,831	76,966	135			
4/9	"	" "	76,966	77,111	145			
4/10	"	" "	77,111	77,246	135			
4/11	"	" "	77,246	77,381	135			
4/12	"	Kingman – Tucson	77,381	77,828	447			
				TOTAL MILES	1498			

Total Days Commuting _____

Signature _____

9/08

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 722
April 8, 1991
LB-1-A TO LB-44-B
PAGE 1 OF 4

ASARCO INCORPORATED
Attn: Mr. Russell Corn
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Lost Basin
King Tut Arizona

Preliminary Analysis of 100 Rock Chip Samples

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	
1	LB-1-A	.016	
2	LB-1-B	.002	
3	LB-1-C	.004	
4	LB-1-D	.002	
5	LB-1-E	<.002	
6	LB-1-Z	.250	control
7	LB-2-A	<.002	
8	LB-2-B	<.002	
9	LB-2-C	<.002	
10	LB-2-D	<.002	
11	LB-3-A	<.002	
12	LB-3-B	<.002	
13	LB-4	<.002	
14	LB-4-B	.008	
15	LB-5	.002	
16	LB-5-A	.020	
17	LB-6	<.002	
18	LB-6-A	<.002	
19	LB-7	<.002	
20	LB-7-A	<.002	
21	LB-8	4.300	
22	LB-9	.004	
23	LB-10	.002	
24	LB-10-Z	.240	control
25	LB-11	.002	

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 722
April 8, 1991
PAGE 2 OF 4

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	
26	LB-12	.004	
27	LB-13	<.002	
28	LB-14	.002	
29	LB-15-A	.020	
30	LB-15-B	.002	
31	LB-15-C	.014	
32	LB-15-D	.110	
33	LB-16-A	.002	
34	LB-16-B	.006	
35	LB-17-A	<.002	
36	LB-17-B	<.002	
37	LB-17-C	<.002	
38	LB-17-D	.002	
39	LB-17-E	.085	
40	LB-18-A	.050	
41	LB-18-B	<.002	
42	LB-19-A	.580	
43	LB-19-B	.065	
44	LB-20-A	.180	
45	LB-20-B	.042	
46	LB-20-C	.006	
47	LB-20-D	.110	
48	LB-20-Z	.240	control
49	LB-20-E	.006	
50	LB-21-A	.010	

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 722
April 8, 1991
PAGE 3 OF 4

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	
51	LB-21-B	.002	
52	LB-21-C	<.002	
53	LB-21-D	.002	
54	LB-22	1.000	
55	LB-23-A	.004	
56	LB-23-B	.010	
57	LB-23-C	.002	
58	LB-23-D	.004	
59	LB-24	.004	
60	LB-25-A	.002	
61	LB-25-B	<.002	
62	LB-26	<.002	
63	LB-27	.002	
64	LB-28	.014	
65	LB-29-A	<.002	
66	LB-29-B	<.002	
67	LB-30-A	.040	
68	LB-30-B	.170	
69	LB-30-C	.006	
70	LB-30-Z	.250	control
71	LB-31	<.002	
72	LB-32-A	.006	
73	LB-32-B	.002	
74	LB-33-A	<.002	
75	LB-33-B	.008	

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 722
April 8, 1991
PAGE 4 OF 4

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	
76	LB-34-A	.010	
77	LB-34-B	.050	
78	LB-34-C	<.002	
79	LB-35-A	.014	
80	LB-36-A	.002	
81	LB-36-B	.002	
82	LB-37-A	.022	
83	LB-37-B	<.002	
84	LB-38-A	.050	
85	LB-39-A	.040	
86	LB-39-B	.002	
87	LB-39-C	<.002	
88	LB-40-A	.008	
89	LB-40-B	.020	
90	LB-40-Z	.260	control
91	LB-41-A	1.100	
92	LB-41-B	.060	
93	LB-41-C	<.002	
94	LB-41-D	.034	
95	LB-42	<.002	
96	LB-43-A	<.002	
97	LB-43-B	.004	
98	LB-43-C	<.002	
99	LB-44-A	<.002	
100	LB-44-B	<.002	

*NOTE: Analysis based on a two assay-ton sample.

William L. Lehmbeck
Manager

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

DATE: 4/12/91

TO: J J Malusa
Asarco Inc.

FROM: William L Lehmbeck

OUR FAX NUMBER: (602) 622-6065

RE: TAJ722

TOTAL NUMBER OF PAGES 5, INCLUDING COVER SHEET

Please call Barbara (at (602) 622-4836)
if there are any problems with this transmission

COMMENTS:

ASARCO Incorp...

APR 1 2 1991

SW Exploration

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 722
April 11, 1991
LB-1-A TO LB-44-B
PAGE 1 OF 4

ASARCO INCORPORATED
Attn: Mr. Russell Corn
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Inc.
APR 12 1991
SW Exploration

Analysis of 100 Rock Chip Samples

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	
1	LB-1-A	.016	.05	2.0	<.1	.03	
2	LB-1-B	.002	.15	5.5	.2	<.01	
3	LB-1-C	.004	.25	14.0	<.1	<.01	
4	LB-1-D	.002	.30	3.0	<.1	.01	
5	LB-1-E	<.002	<.05	4.8	<.1	.02	
~~6~~	~~LB-1-Z~~	~~.250~~	~~6.10~~	~~55.0~~	~~8.5~~	~~.56~~	control
7	LB-2-A	<.002	<.05	4.6	.6	.01	
8	LB-2-B	<.002	.05	1.4	<.1	.03	
9	LB-2-C	<.002	.05	.8	<.1	.02	
10	LB-2-D	<.002	<.05	.6	<.1	.01	
11	LB-3-A	<.002	<.05	.6	<.1	.03	
12	LB-3-B	<.002	.05	5.0	.6	.02	
13	LB-4	<.002	<.05	1.2	<.1	.01	
14	LB-4-B	.008	.05	.6	<.1	.01	
15	LB-5	.002	.35	13.0	<.1	<.01	
16	LB-5-A	.020	.05	.6	<.1	<.01	
17	LB-6	<.002	.10	4.8	<.1	<.01	
18	LB-6-A	<.002	<.05	.6	<.1	.02	
19	LB-7	<.002	<.05	6.5	.2	.01	
20	LB-7-A	<.002	<.05	5.5	.8	.02	
21	LB-8	4.300	13.00	4.2	.2	1.00	
22	LB-9	.004	.10	18.0	1.6	.02	
23	LB-10	.002	.10	4.0	<.1	.01	
~~24~~	~~LB-10-Z~~	~~.240~~	~~5.70~~	~~55.0~~	~~8.0~~	~~.56~~	control
25	LB-11	.002	.15	3.8	<.1	.02	

Charles E. Thompson

William L. Lehmbeck
Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASASCO

APR 1 2 1991

SW Exploration

JOB NO. TAJ 722
April 11, 1991
PAGE 2 OF 4

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)
26	LB-12	.004	.10	8.5	<.1	.02
27	LB-13	<.002	.10	8.0	.4	.02
28	LB-14	.002	.10	.4	<.1	.03
29	LB-15-A	.020	.10	.6	<.1	.02
30	LB-15-B	.002	.10	1.2	.1	.02
31	LB-15-C	.014	.05	<.2	<.1	.04
32	LB-15-D	.110	.10	1.4	<.1	.03
33	LB-16-A	.002	.10	2.2	<.1	.02
34	LB-16-B	.006	.05	.2	<.1	.01
35	LB-17-A	<.002	.15	2.8	.1	.02
36	LB-17-B	<.002	.05	1.8	<.1	.01
37	LB-17-C	<.002	.05	1.8	<.1	.02
38	LB-17-D	.002	<.05	1.8	<.1	.03
39	LB-17-E	.085	.10	1.2	.1	.04
40	LB-18-A	.050	.05	1.2	<.1	.02
41	LB-18-B	<.002	.10	1.4	.1	.03
42	LB-19-A	.580	1.40	.8	.2	.04
43	LB-19-B	.065	.25	.8	.3	.03
44	LB-20-A	.180	.90	2.6	<.1	.02
45	LB-20-B	.042	.45	11.0	<.1	.04
46	LB-20-C	.006	.25	2.6	.1	.02
47	LB-20-D	.110	.55	8.5	.2	.02
~~48~~	~~LB-20-Z~~	~~.240~~	~~5.70~~	~~50.0~~	~~9.0~~	~~.44~~ control
49	LB-20-E	.006	1.30	50.0	.7	.30
50	LB-21-A	.010	.20	2.8	.3	.02

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASARCO Incorporated

APR 1 2 1991

SW Exploration

JOB NO. TAJ 722
April 11, 1991
PAGE 3 OF 4

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)
51	LB-21-B	.002	.05	.8	<.1	.01
52	LB-21-C	<.002	.15	6.0	<.1	.03
53	LB-21-D	.002	.15	.8	<.1	.01
54	LB-22	1.000	.85	10.0	.7	.02
55	LB-23-A	.004	.10	3.0	.1	<.01
56	LB-23-B	.010	.10	1.8	.1	.02
57	LB-23-C	.002	.05	.4	<.1	<.01
58	LB-23-D	.004	.25	1.4	.2	.02
59	LB-24	.004	.10	.6	.2	.02
60	LB-25-A	.002	.10	1.0	.3	<.01
61	LB-25-B	<.002	.10	3.2	.4	<.01
62	LB-26	<.002	<.05	.2	.3	<.01
63	LB-27	.002	<.05	1.6	.1	.01
64	LB-28	.014	.95	30.0	.2	.02
65	LB-29-A	<.002	.15	.8	.2	.03
66	LB-29-B	<.002	.05	1.0	.2	<.01
67	LB-30-A	.040	.65	9.5	<.1	.02
68	LB-30-B	.170	.40	19.0	.3	.01
69	LB-30-C	.006	.35	28.0	.4	.01
~~70~~	~~LB-30-Z~~	~~.250~~	~~5.60~~	~~55.0~~	~~10.0~~	~~.46~~ contd
71	LB-31	<.002	.05	1.2	.3	.01
72	LB-32-A	.006	.15	2.2	.2	.02
73	LB-32-B	.002	.05	1.4	.2	.02
74	LB-33-A	<.002	.10	2.8	<.1	.02
75	LB-33-B	.008	.50	.8	.1	.03

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASARCO Inc.
APR 1 2 1991

JOB NO. TAJ 722
April 11, 1991
PAGE 4 OF 4

ITEM	SAMPLE NUMBER	FIRE ASSAY Au* (ppm)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)
76	LB-34-A	.010	.10	1.6	.1	.02
77	LB-34-B	.050	.80	75.0	4.1	.04
78	LB-34-C	<.002	<.05	1.2	.3	.03
79	LB-35-A	.014	.20	6.5	.1	.02
80	LB-36-A	.002	.10	6.5	.2	.01
81	LB-36-B	.002	.10	2.8	<.1	.02
82	LB-37-A	.022	.10	1.2	<.1	.01
83	LB-37-B	<.002	.05	.4	<.1	<.01
84	LB-38-A	.050	.10	1.2	<.1	<.01
85	LB-39-A	.040	.10	2.0	<.1	.03
86	LB-39-B	.002	.10	.8	<.1	.02
87	LB-39-C	<.002	.20	4.6	.5	.04
88	LB-40-A	.008	.05	6.0	.1	.02
89	LB-40-B	.020	.10	1.4	.4	.14
~~90~~	~~LB-40-Z~~	~~.260~~	~~5.50~~	~~50.0~~	~~8.0~~	~~.44~~ control
91	LB-41-A	1.100	.40	1.8	.1	.04
92	LB-41-B	.060	.10	4.4	.3	.03
93	LB-41-C	<.002	<.05	2.0	<.1	.02
94	LB-41-D	.034	.15	1.2	<.1	.02
95	LB-42	<.002	<.05	<.2	<.1	.01
96	LB-43-A	<.002	<.05	1.4	<.1	.02
97	LB-43-B	.004	<.05	.4	<.1	.01
98	LB-43-C	<.002	<.05	.2	<.1	.01
99	LB-44-A	<.002	.10	2.0	.2	.02
100	LB-44-B	<.002	.25	1.8	<.1	.01

*NOTE: Method of analysis by combination fire assay and atomic absorption based on a two assay-ton sample.

cc: Mr. J. J. Malusa

Ring Test Control Samples

all PPM

Sample	Au	Ag	As	Sb	Hg
LB-1-Z	.250	6.10	55.0	8.5	.56
LB-10-Z	.240	5.70	50.0	8.0	.56
LB-20-Z	.240	5.70	50.0	9.0	.44
LB-30-Z	.250	5.60	55.0	10.0	.46
LB-40-Z	.260	5.50	50.0	8.0	.44
	1.24/5	28.6/5	265/5	43.5/5	2.46/5
	= .248	= 5.72	= 53.0	= 8.7	= .492

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

James D. Sell
Manager, Southwestern Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

May 15, 1991

Monthly Progress Report
Gold Basin Project
May, 1991

Geologic investigations included a review of geologic and drill hole data and detachment faulting relationships between the Gold Basin District and the Black Mountains, preparation of cross sections, and a thorough review of Mapco's geologic and drill hole data on the Owens Mine.

The Gold Basin Detachment Fault Zone dips gently to the south and west with upper-plate, structurally-rotated, fault-bounded slices of juxtaposed Precambrian and Tertiary rocks increasing in number and thickness to the south and west. The detachment fault and upper-plate units are down-dropped beneath a thick evaporite sequence in Detrital Valley and continue into the Black Mountains with drill hole data on the west side of Detrital Valley indicating the presence of more than 800 feet of upper-plate Precambrian rocks cut by repetitive major low-angle faults.

Mapco drilled 53 shallow holes in the vicinity of the Owens Mine with most of their drilling concentrated on and in the immediate vicinity of exposed mineralization. Their drill hole data indicates that the detachment fault zone and gold mineralization are cut by and displaced along post-detachment, low-angle and high-angle faults. The known gold mineralization at the Owens Mine is preserved in the foot wall of a post-mineral, low-angle fault that juxtaposes unmineralized fanglomerate against intensely sheared, mineralized gneiss. The data indicates that the concealed detachment fault is faulted up beneath cover north of the mine and should occur at reasonable drilling depths over a substantial area. Post-mineral, high-angle faults offset the mineralization along strike, and indicate that there should be additional mineralization in the offset detachment fault zone where it is preserved beneath post-mineral cover north and east of the Owens Mine.

Respectively submitted,

Russell M. Corn

ASARCO Incorporated
MAY 17 1991
SW Exploration

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

May 16, 1991

James D. Sell
Manager, Southwest Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
MAY 17 1991
SW Exploration

STATEMENT

Gold Basin - Lost Basin Project, Mohave County, Arizona

Charges for April 16, 1991 through May 15, 1991.

22 days of Geologic Research & Investigations @ $350/day	$7,700.00
Expenses	96.30
TOTAL	$7,796.30

Russell M. Corn

APPROVED FOR PAYMENT
By: W. H. Ray
(Signature)

TIME DISTRIBUTION SHEET

Please Return by the 25th.

CLL

TUCSON OFFICE

Gold Basin Project

Russell M Corn
~~Employee~~
Consultant

May, 1991
Month

Account Number								Total
Day	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
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Total	88							88
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REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: Russell M Corn

Approved: W. U. Gay

TIME DISTRIBUTION SHEET

Please Return By ~~the 25th~~

Gold Basin Project

CLS

TUCSON OFFICE

Russell M Corn
~~Employee~~
Consultant

April 1991
Month

Account Number								Total
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Total	88							88
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REPORT ACTUAL TIME WORKED
Use following symbols for time not worked.
N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: Russell M Corn

Approved: W. H. Gay

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U.S.A.

EXPENSES OF Russell M. Corn (NAME) FOR April (MONTH) 19 91

DAY	TRANSPORTATION Code	TRANSPORTATION Amount	TRANSPORTATION Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	MISC. Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amc
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TOTALS								67 74		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj $ 67 74
A/c
A/c
A/c
TOTAL $ 67 74

DETAIL OF ADVANCES

Cash (Office) $
Cash (Office)
Transportation
Personal Mileage @
(CO. OWNED CAR)
TOTAL $

GRAND TOTAL EXPENSES $ 67 74
LESS ADVANCES
DIFFERENCE $ 67 74

DUE TO EMPLOYEE ☒ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

5/6/91 DATE COMPLETED — CORRECT — EMPLOYEE'S SIGNATURE — APPROVED — W. H. Gay DEPT. HEAD — ACCOUNTING DE

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV. 1-63)
PRINTED IN U.S.A

EXPENSES OF Russell M. Corn (NAME) FOR May (MONTH) 19 91

DAY	TRANSPORTATION Auto, Rail, Air, etc Code	Amount	Taxi, Bus, etc.	ITINERARY Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC. Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
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TOTALS								28 56		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj. $ 28.56
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A/c
A/c
TOTAL $ 28.56

DETAIL OF ADVANCES

Cash (Office) $
Cash (Office)
Transportation
Personal Mileage @
(CO. OWNED CAR)
TOTAL $

GRAND TOTAL EXPENSES $ 28.56
LESS ADVANCES
DIFFERENCE $ 28.56

DUE TO EMPLOYEE ☐ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

5/16/91 DATE COMPLETED — CORRECT — EMPLOYEE'S SIGNATURE — APPROVED W. H. May DEPT. HEAD — ACCOUNTING DE

JDS

RUSSELL M. CORN
Registered Geologist
8425 DESERT STEPPES DR.
TUCSON, ARIZONA 85710
PHONE 602 - 298-1770

June 5, 1991

James D. Sell
Manager, Southwest Exploration
ASARCO, Inc.
P.O. Box 5747
Tucson, AZ 85703

STATEMENT

Gold Basin - Lost Basin Project, Mohave County, Arizona

Charges for May 16, 1991 through May 31, 1991.

3 days of Report preparation @ $350/day		$1,050.00
Expenses		65.12
	TOTAL	$1,115.12

Russell M. Corn

APPROVED FOR PAYMENT

By: _____
(Signature)

Signed 6/7/91

ASARCO Inc.

JUN 7 1991

SW Exploration

TIME DISTRIBUTION SHEET

Please Return By the 25th

Gold Basin Project

CLL

TUCSON OFFICE

Russell M Corn
Employee
Consultant

May, 1991
Month

Account Number								Total
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REPORT ACTUAL TIME WORKED

Use following symbols for time not worked.

N - Not Scheduled.
P - Off with Permission.
S - Off due to Personal Sickness.
V - Vacation.
L - Leave of Absence.
H - Holiday.

Signed: Russell M Corn

Approved: _____

TRAVEL AND OTHER REIMBURSABLE EXPENSE

FORM AD 126-ASARCO
(REV 1-63)
PRINTED IN U S A

EXPENSES OF Russell M. Cox (NAME) FOR May (MONTH) 19 91

DAY	TRANSPORTATION: Auto, Rail, Air, etc. Code	Amount	Taxi, Bus, etc.	ITINERARY: Starting point, destination, hotel name, business purpose. (Show mileage if personal car used)	HOTEL	MEALS	MISC.: Telephone, Telegrams, Postage, etc. Detail	Amount	ENTERTAINMENT, BUSINESS MEETINGS AND MEALS, ETC: Firm and individuals, place and business purpose (Additional space on reverse side)	Amt
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TOTALS								65 12		

DISTRIBUTION OF EXPENSES

A/c Gold Basin Proj $ 65 12
A/c
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TOTAL $ 65 12

DETAIL OF ADVANCES

Cash (Office) $
Cash (Office)
Transportation
Personal Mileage @
(CO. OWNED CAR)
TOTAL $

GRAND TOTAL EXPENSES $ 65 12
LESS ADVANCES
DIFFERENCE $ 65 12

DUE TO EMPLOYEE ☐ DUE TO COMPANY ☐

(Indicate disposition of balance on reverse side)

*CODE: A - Air; B - Excess Baggage; R - Rail; C - Personal car; H - Rented car; K - Company car; P - Parking; T - Tolls

June 5, 1991 CORRECT — DATE COMPLETED

EMPLOYEE'S SIGNATURE

APPROVED — DEPT. HEAD

ACCOUNTING DE

JDS

ASARCO

Southwestern Exploration Division

July 18, 1991

M.A. Miller

GIS Data Gathering
Gold Basin Area
Mohave County, AZ

As we have the 7½' quads showing geology, structure, mineral zones, etc., get the various drill holes, assay data, surface geochem, etc. on overlays of the quads listed, for GIS inclusion.

Senator	Mountain	NE
"	"	SE
"	"	SW
"	"	NW
Garnet	Mountain	NE
"	"	SE
"	"	SW
"	"	NW
White	Hills	NE
"	"	NW
Mt. Tipton		NW

James D. Sell

JDS:mek

James D. Sell

cc: W.L. Kurtz

ASARCO

Southwestern Exploration Division

JDS

July 18, 1991

FILE NOTE

Radiometrics
Gold Basin Flight Block
Mohave County, Arizona

I submit to the files, the four colored maps covering Uranium, Thorium, Potassium, and Total Count for the Dighem printout.

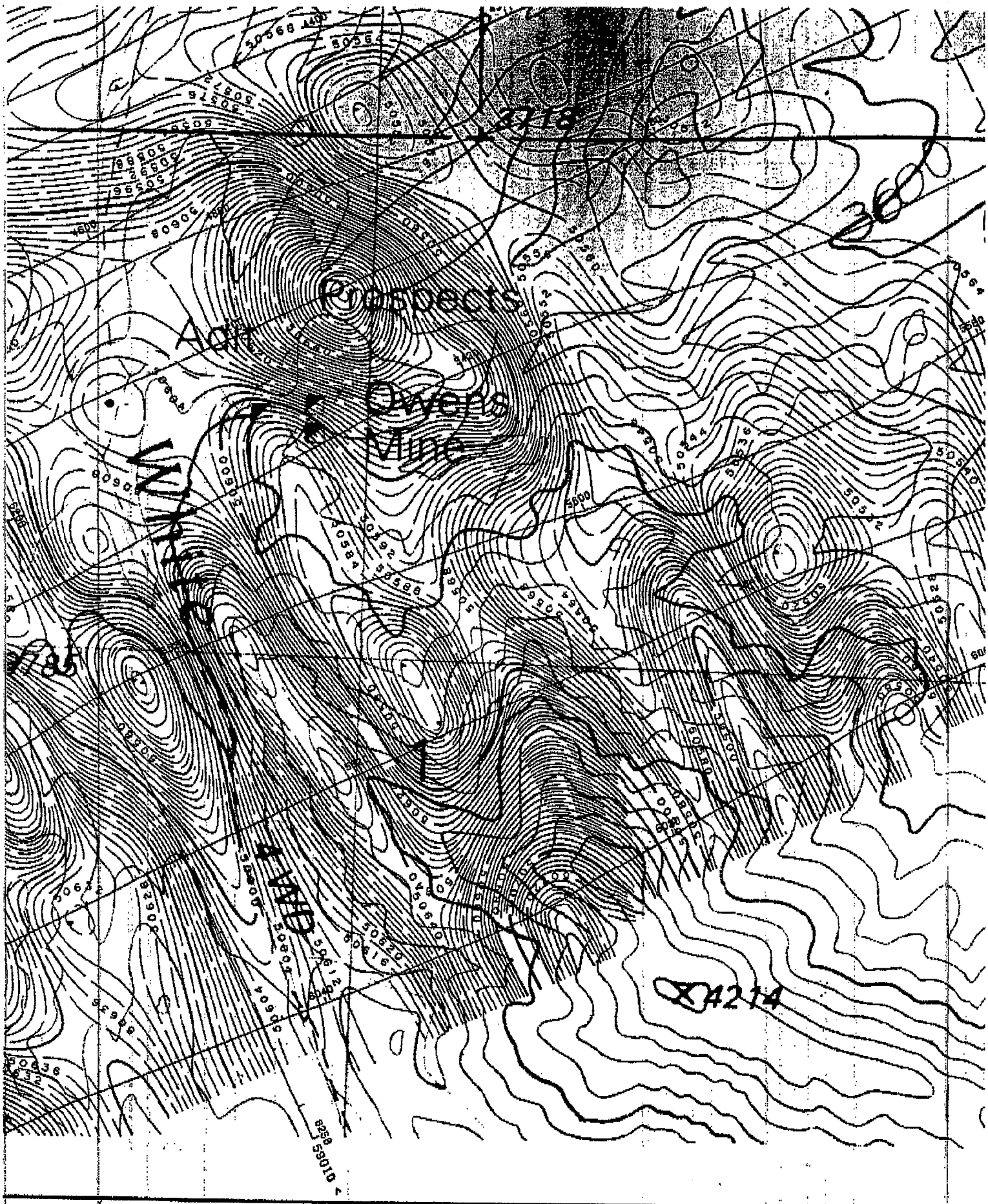
The final copies will be out shortly with the correct coordinates.

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: W.L. Kurtz (w/o atts.)



TION MAP

Jim - ok
FYI

JDS FILE
Gold Basin, AZ

Dighem

Job 577-4

Invoice #910708
July 23, 1991

ASARCO Incorporated
JUL 31 1991
SW Exploration

Asarco Incorporated
274 Union Boulevard
Suite 450
Lakewood, Colorado 80228
U.S.A.

Attention: Carl Windels, Manager, Geophysics and Technology

IN ACCOUNT WITH
DIGHEM SURVEYS & PROCESSING INC.

Re:

Dighem Airborne Geophysical Survey in the Western U.S.A., as per Agreement dated April 12, 1991.

Final invoice, pursuant to paragraphs A3.3 of the Agreement and A2.3 of Addendum A and A2.2 of Addendum B, upon delivery of the final products.

Combined EM/Magnetics/Radiometrics Surveys

Tonopah-Goldfield, Clifford and North Sleeper Areas

Survey charges: 1650 line-miles at US $95.00/line-mile	US $156,750.00
South Eureka Area	
Survey charges: 450 line-miles at US $89.00/line-mile	US $ 40,050.00
Gold Basin Area	
Mobilization/demobilization	US $ 7,304.00
Survey charges: 64 line-miles at US $89.00/line-mile	US $ 5,696.00
Total	US $209,800.00
ARCHIVE Tape Backup System	US $ 461.00
	US $210,261.00
Less, Dighem net charges previously invoiced pursuant to paragraphs A3.1 and A3.2	(US $122,190.00)
Dighem net	US $ 88,071.00

See their report of mos in file.

24 650
7 500
20 000
$122,190

Dighem Surveys & Processing Inc.
TEL. (416) 890-0313
228 MATHESON BLVD. EAST
FAX (416) 890-0347
MISSISSAUGA, ONTARIO, CANADA L4Z 1X1
TELEX 06-961334

GST at 0% (Registration No. R101391001) $ 0.00

Please pay this amount US $ 88,071.00

DIGHEM SURVEYS & PROCESSING INC.

OK Carl Q Winters

Doug McConnell

Douglas L. McConnell
Geophysicist

DLM/sdp

TERMS: Payment is due upon receipt. Accounts not paid within 30 days of date of invoice are subject to an interest charge of 1.2% per month from the date of invoice.

JC29107.08

Distribution:

Great Basin Division

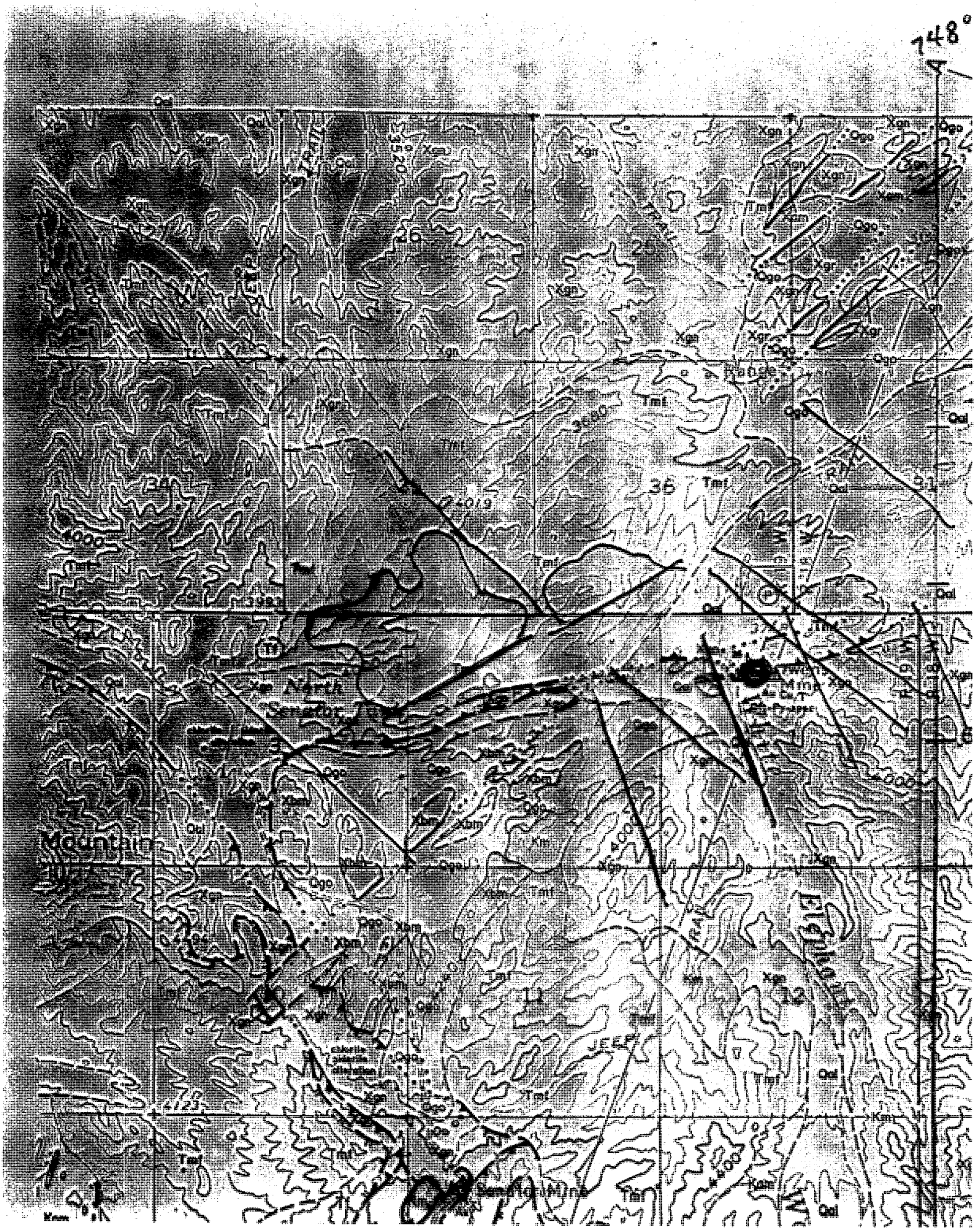
TONOPAH & GOLDFIELD	$35,300
Clifford	$16,420
North Sleeper	$10,670
So. Eureka	$19,720

Southwester U.S. Division

GOLD Basin	$5500.
GEOTECH	$461.

Total: 88,071

148°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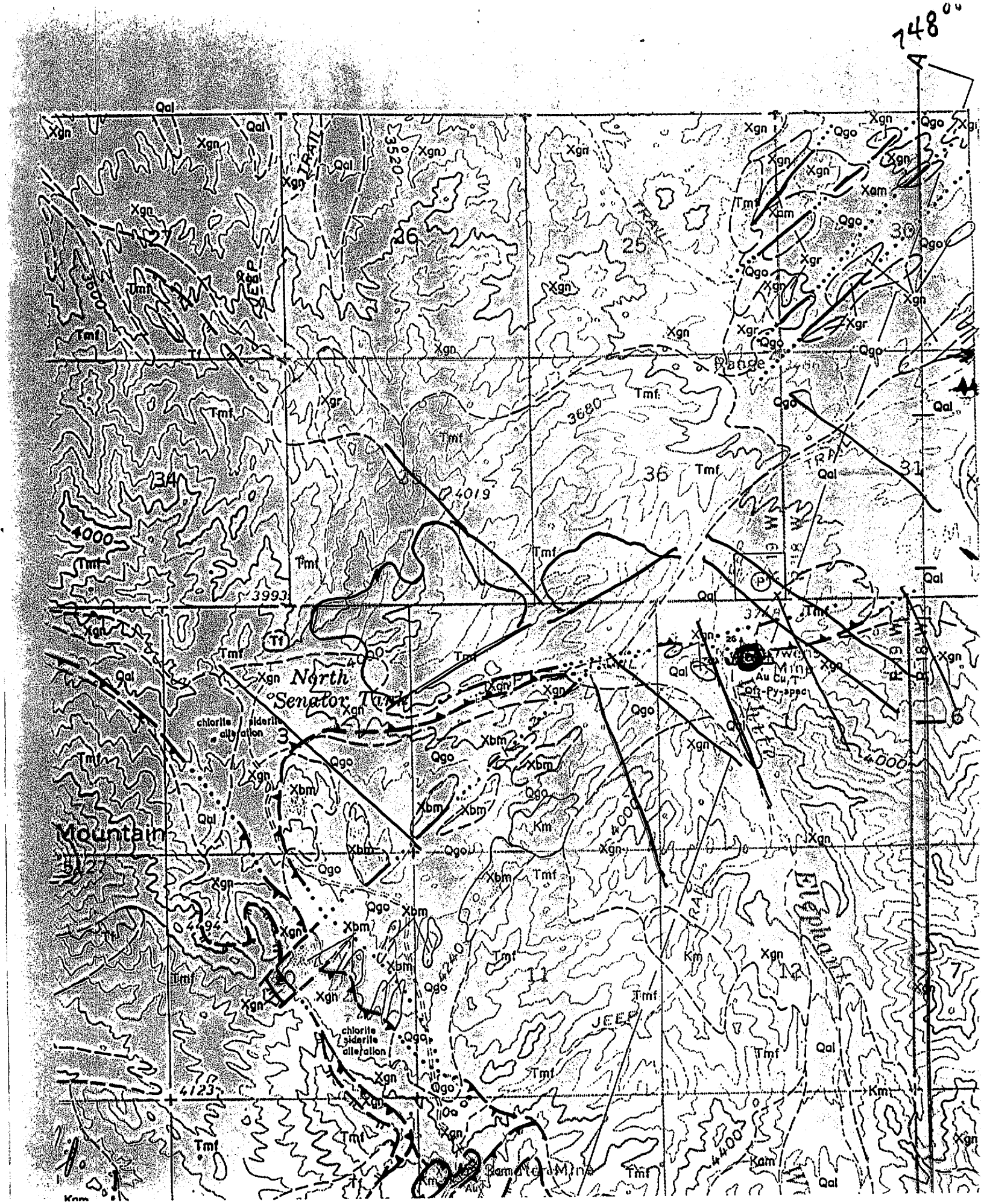
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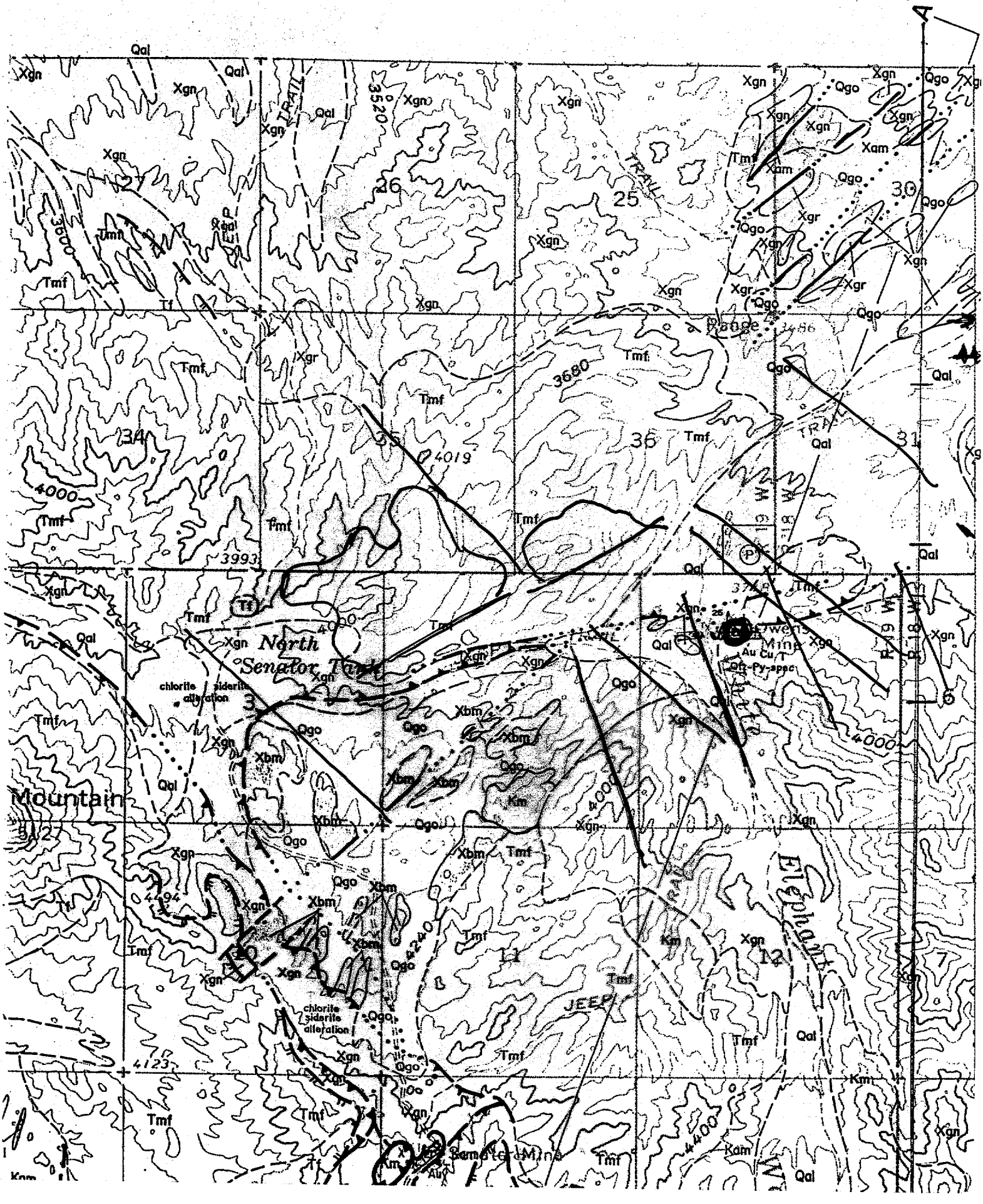
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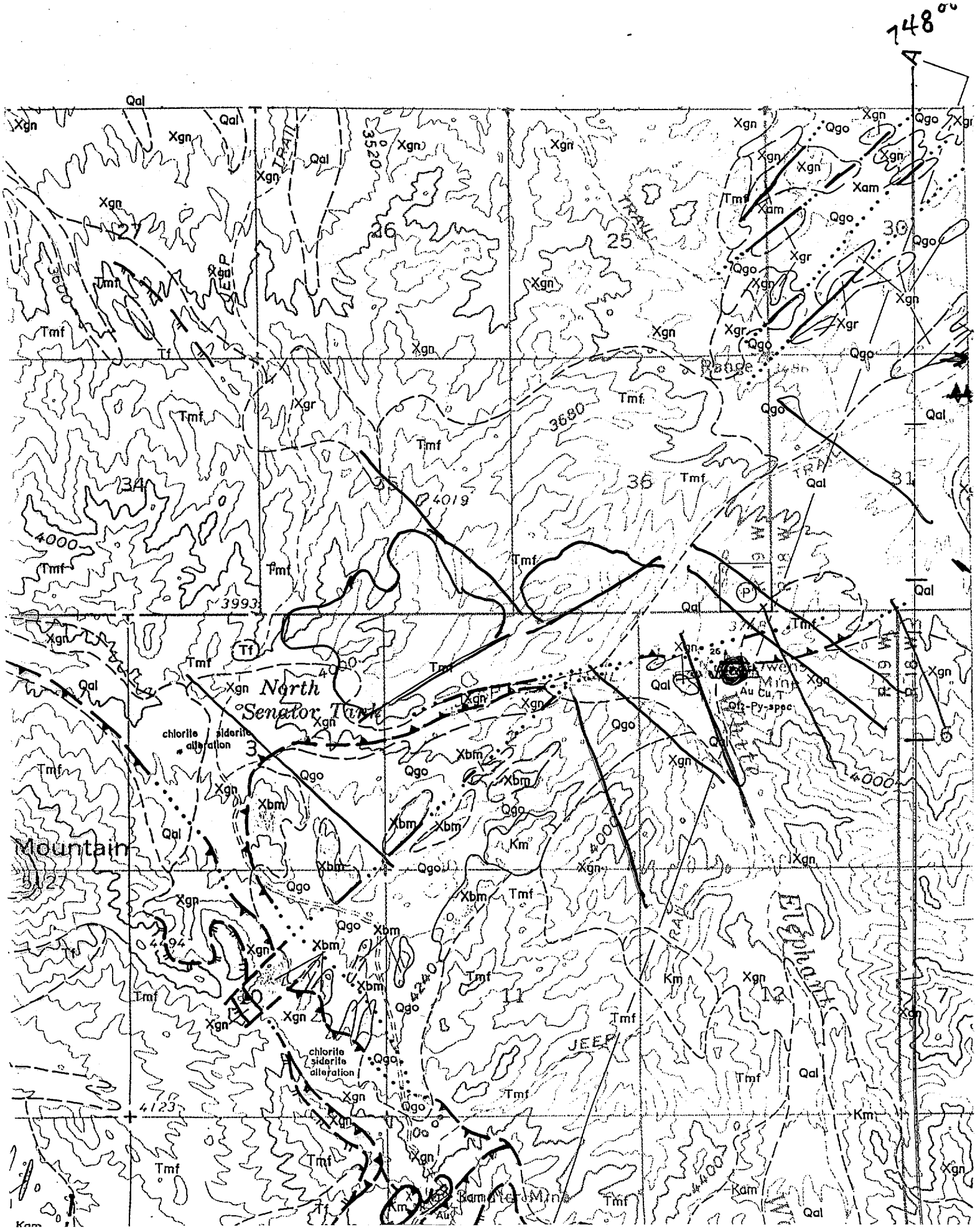
148°
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Senator Tank
Mountain
Elephant
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Au Cu, T
Qtz-Py-spec
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JDS

ASARCO

Southwestern Exploration Division

August 14, 1991

C.O. Windels

LLOYD Geophysics
Mag-VLF-Resistivity DOS Disc
Gold Basin District
(Cyclopic Mine Area)
Mohave County, Arizona

Attached is a Sony 1.44 disc which has magnetics, VLF, resistivity ground data from the Cyclopic Mine area, Gold Basin District, Mohave County, AZ.

The DOS format disc came from the present claim owners who optioned the property to Toltec Resources who did the work.

The owners have displayed the data which is in notebook form showing location and the data read. Should you plot this data on to a plan map as raw data, please send two hard copies to SWED so I can give them a copy.

If the data is useful for your interpretive work, through programs such as "Brief" and "Geosoft" (they say), then proceed with your evaluation.

Drill data and geochemical data as hard copy is available in the Tucson SWED office.

James D. Sell

JDS:mek
Att.

cc: W.L. Kurtz (w/o att.)

JDS

ASARCO

Southwestern Exploration Division

August 16, 1991

FILE NOTE

Santa Fe Minerals Royalty
(Cerrillos Land Co.)
Gold Basin District
Mohave County, Arizona

I note in the George Cross News Letter No. 155 (1991), page 4, August 11, 1991, that Silver Talon has assigned mineral subleases to Tropicana in the Road Runner property area.

Article 3 addresses the transfer and royalty.

> **3. A 29May91 assignment agt. whereby Silver Talon assigned certain mineral subleases in Mohave county, Arizona, for $10. Pursuant to the underlying subleases, Tropicana has to pay the Cerrillos Land Co. an annual advance royalty of $20 U.S. per acre or a minimum of $3,800 U.S. The property is also subject to a production royalty equal to 5% of the net returns of minerals mined and removed and to the case of placer minerals, 10% of revenue rec'd. less costs of milling and concentrating.**

I do not know if this royalty is standard for the Santa Fe Minerals land, or whether the royalties are negociated.

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz
W.D. Gay

JDS

ASARCO

Exploration Department
Southwestern United States Division
James D. Sell
Manager

August 20, 1991

Mr. Warren M. Mallory
General Manager
American Heavy Minerals
P.O. Box 730
Laramie, Wyoming 82070

American Heavy Minerals
Property
Lost Basin Area
Mohave County, Arizona

Dear Warren:

ASARCO SWED thanks you for the opportunity of inspecting your files and investigating your property adjacent to the King Tut placers in Mohave County, Arizona.

Mr. R.M. Corn and assistant collected 100 samples along the trend and had multi-element geochemical results reported.

The attached sheets list the sample sites and the geochemical results for Au, Ag, As, Sb, and Hg in ppm values. The attached maps plot the sample sites listed. Note that samples ending in "Z" are control standards sent in with the samples and will not be found on the maps.

Mr. Corn and assistant's expenses are as follows:

1.	Trip, Tucson-Oceanside, CA-Tucson	$1,145.49
2.	Field Geologic Research and Investigations	5,542.87
3.	Office Geologic Research and Investigations	747.19
	Total	$7,435.55

Again, SWED appreciates your aid in this investigation.

Sincerely,

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: W.L. Kurtz
W.D. Gay

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue FAX (602) 792-3934 Phone (602) 792-3010

35¢/day

~~5~~RMC 35¢/day, 454 miles, + costs.

American Heavy Metals Property Lost Basin

March 17 Proj Report (March

briefly examined.

Sam1 day

Sam1 day

March 24 Reviewed AHM Proj. 2p. + 3 maps (from files)

April 8 TAJ 722 100 rock chip samples

$2109.50 Shipping.

5 day sampling
5 also Malusa

April 15 Monthly Report (April) } 4 x 2 x 26.28 = room
Sampled (w/ Malusa). } 4 x 2 x ~~[illegible]~~ 114.40

2 day report, maps

April 19 Geol Eval + Sample Panels 3p. + maps, logs, letter.

? Plane ticket to ~~San Diego~~ Ocotillo, CA? to see Mallary & set further dates?
March 14

249.00	ticket
46.74	car
6.00	parking
60.99	Hotel
38.75	food
24.01	photocopies

× 350
350
700
445.49

Statement Dec-14 → Jan 15

Jan 16

NEED

→ April 15

Statement April 16 → May 15

Statement May 16 → May 31

113.63 + 22% = 25.00
22) 2500
Malusa = 138.70/day

2-4 → 2-8
miles 321
136
159
144
460
× 454

Also need JJ Malusa's
5 days - Lost Basin sampling (Jan.)

To JDS

Date 8/15 Time 3:38 ☐ AM ☐ PM

WHILE YOU WERE OUT

M Warren Mallory

of

Phone (307) 742-6668

Area Code Number Extension

TELEPHONED	✓	PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	
RETURNED YOUR CALL			

Message Wanted to find out how much ASARCO spent on investigation of his property by Russ Corw. He wants to apply the cost to his assessment work.

Mary

Operator

AMPAD EFFICIENCY®

REORDER #23-000

Expenses of RM. Corn and assistant
~~Apache Ore~~ American Heavy ~~Metal~~ Mineral Property
Lost Basin, Mohave County, AZ.

March 14. Tucson - Oceanside, CA - Tucson #1145.49

March 25-29 ~~April 7-12~~ Field Stay 5 day x 350 = 1750.00
5 day x 140 = 700.00
room 4 x 2 x 26.28 = 210.24
food 2 x 116.40 = 232.80
Mileage 1184 x 0.45 = 532.80
(4/7-4/12 mileage 41 April 8) photocopy = 7.53
assays = 2109.50
Report April 18-19 2 days x 350 = 700.00
photocopy = 47.19

6290.06

307-742-6648

Mr. Warren M. Mallary
General Manager
American Heavy Minerals
PO Box 730

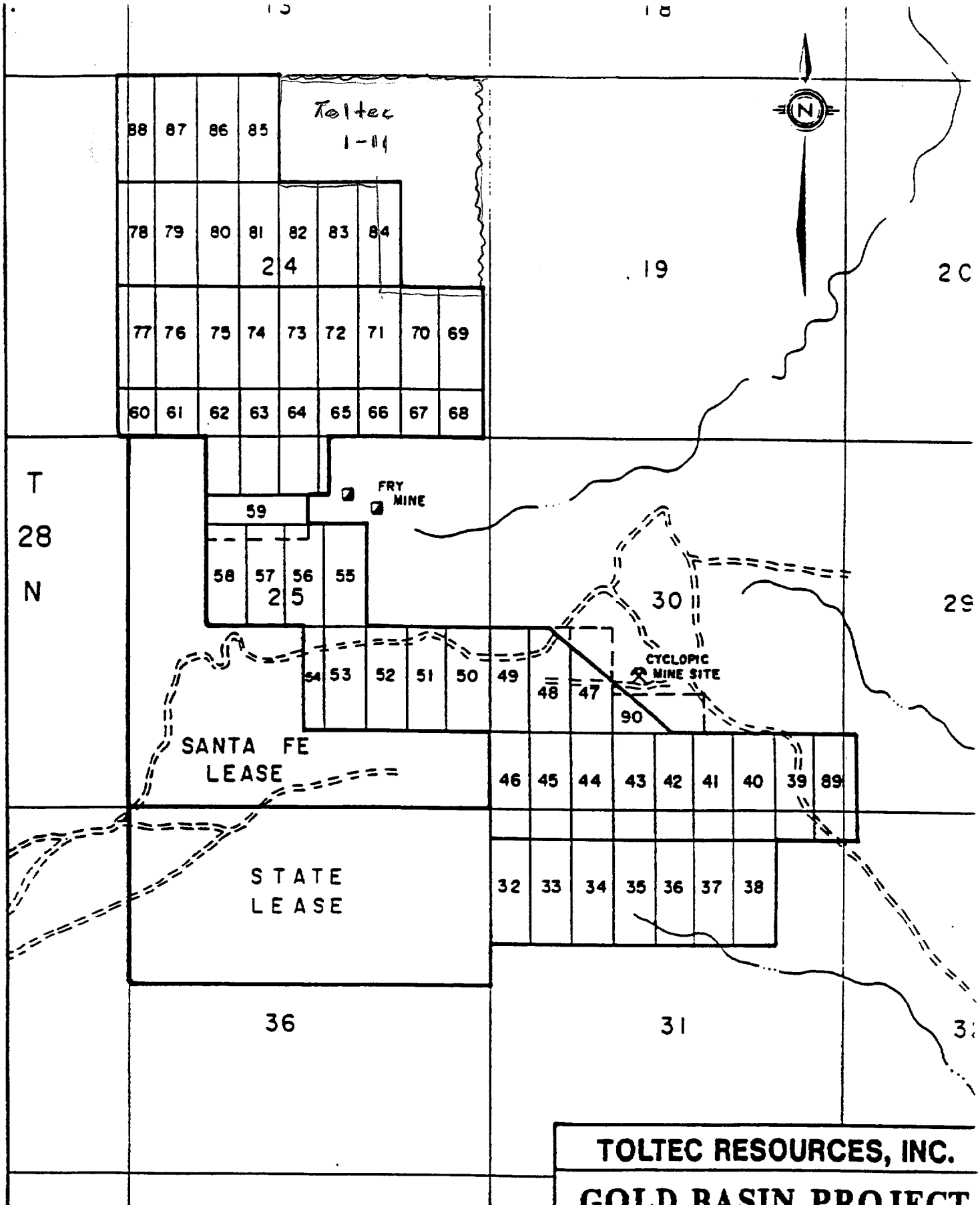
Laramie, Wyoming 82070

Expenses
American Heavy Minerals Property
Lost Basin Area
Mohave County, AZ

Expenses of RM Corn and JJ Malusa, assistant.

March 14-15, Tucson - Oceanside, CA - Tucson	$1145.49
March 25-29, Field Geologic Research & Investigations	5542.87
April 18-19, Office Geologic Research & Investigations	747.19
	$7,435.55

dots assay



FEET
0 2000 4000

BW Hestler report Sept. 20, 1989.

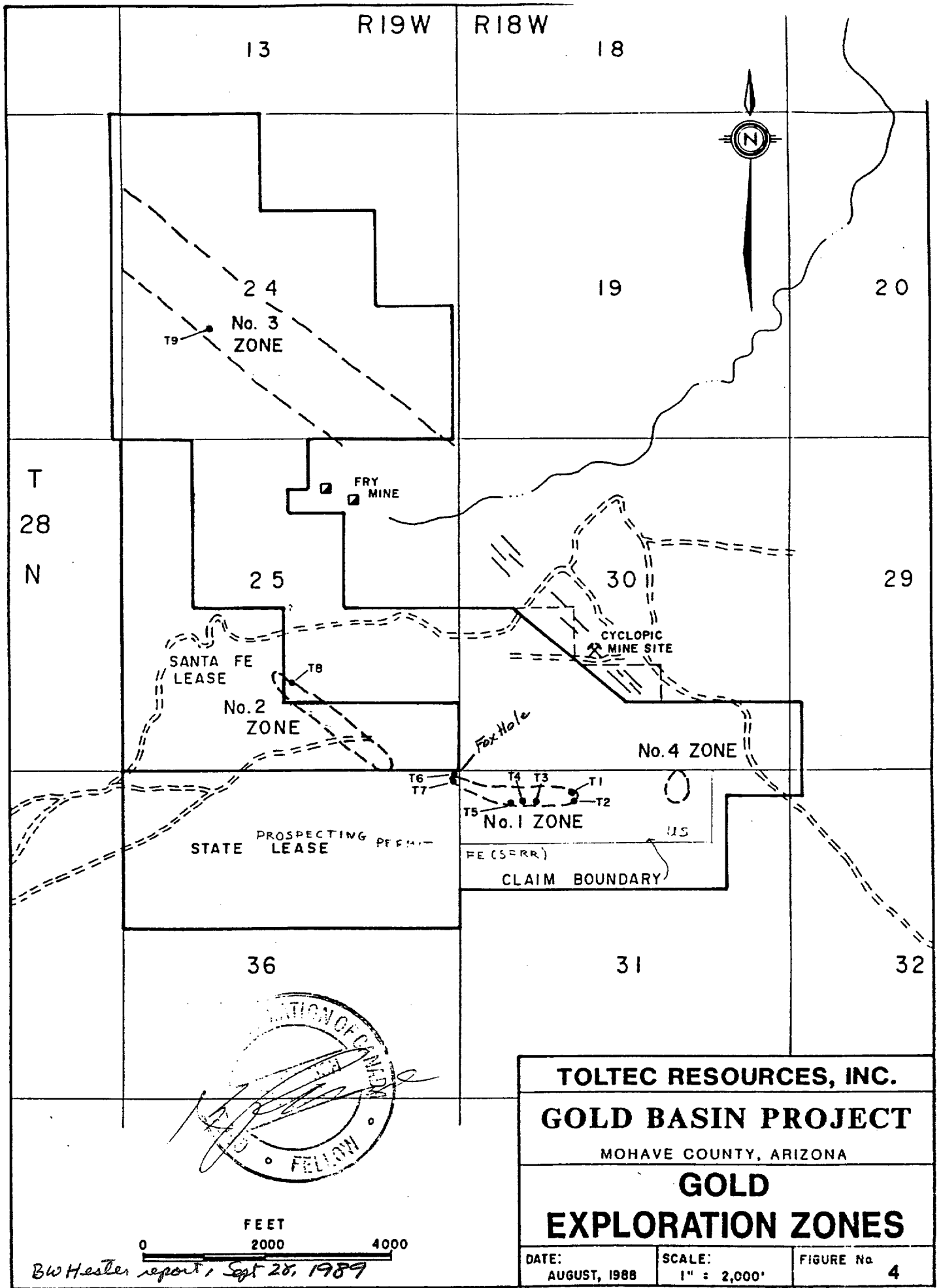
TOLTEC RESOURCES, INC.

GOLD BASIN PROJECT

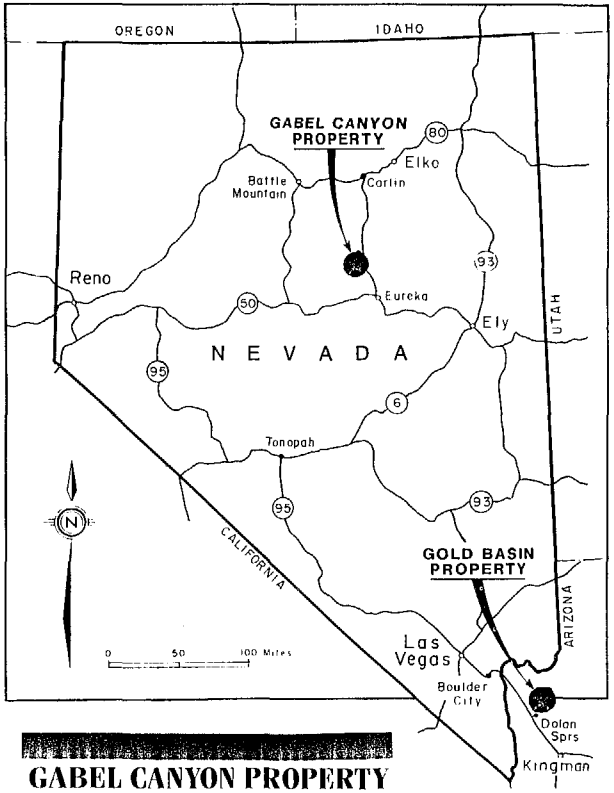
MOHAVE COUNTY, ARIZONA

CLAIM MAP

DATE:	SCALE:	FIGURE No.
AUGUST, 1988	1" = 2,000'	2



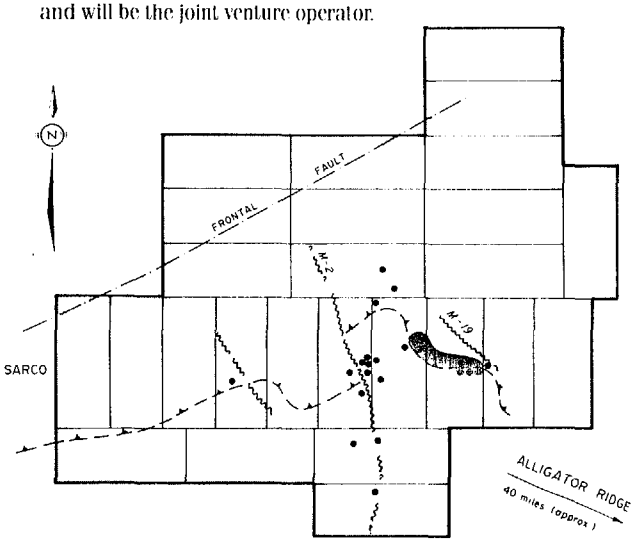
BW Hester report, Sept 28, 1989



GABEL CANYON PROPERTY
Eureka County, Nevada

This property is located on the productive Cortez Belt, Nevada, in the vicinity of other major mines.

Toltec owns an 85% interest in this property and has an agreement in place for another company to spend $150,000 to drill 10 or more holes. Toltec retains a carried interest of 50% and will be the joint venture operator.



GOLD BASIN – CYCLOPIC PROPERTIES
Mohave County, Arizona

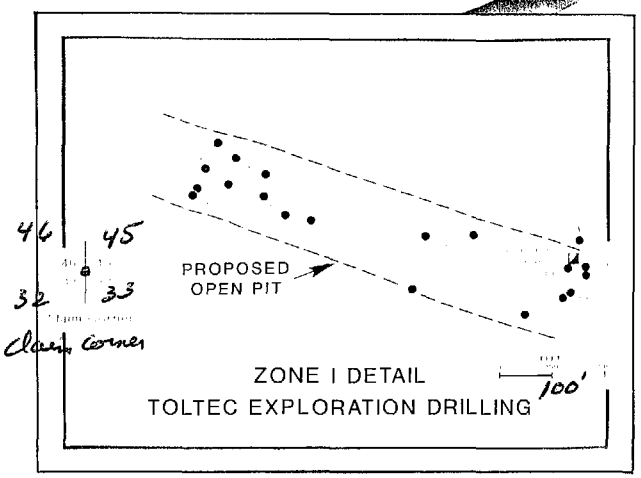
The G.B. – Cyclopic properties cover two major Northwest – trending structural zones (a detachment fault environment with extensive crush zones and feeder faults) known to contain gold deposits of economic grade. Disseminated ores and high grade shoots are both prevalent.

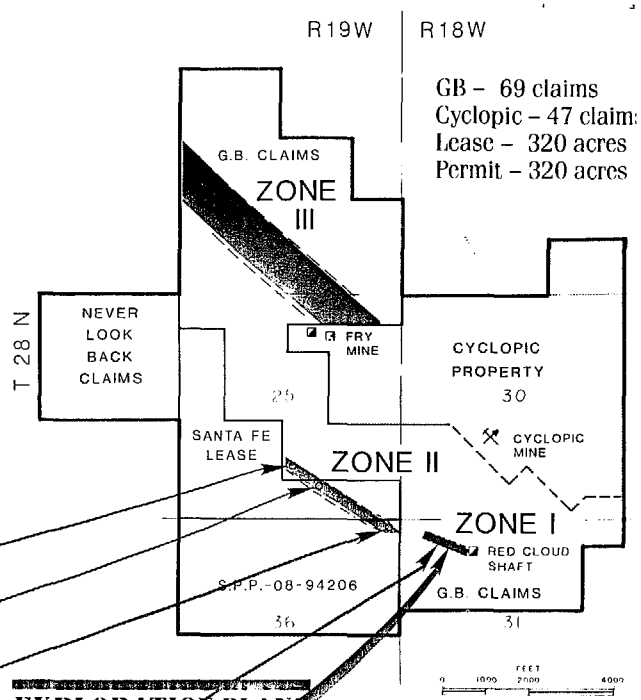
A. The Gold Basin zone I, has had sufficient drilling to indicate a prospective open pit with leachable ore to depths of several hundreds of feet and with an excellent strip ratio. Length has been proven to exceed 800'. Zone II extends this trend to over 5,000' length.

B. The Cyclopic – Fry Mine – G.B. zone III covers a length of 12,000', half of which has been partially explored.

SIGNIFICANT EXPLORATION HOLES

T-10	
T-11	30' of .85 O.P.T.
T-29	20' of .138 O.P.T.
T-13	
T-15	125' of .046 O.P.T.
T-23	175' of .032 O.P.T.
T-26	35' of .030 O.P.T.
T-27	35' of .034 O.P.T. 20' of .047 O.P.T.
T-28	5' of .080 O.P.T. 10' of .050 O.P.T.





GB – 69 claims
Cyclopic – 47 claims
Lease – 320 acres
Permit – 320 acres

EXPLORATION PLANS

Gabel Canyon – Phase I program		$150,000 U.S. in drilling
Gold Basin G.B. claims	1990	$300,000 U.S. – surveys Geology, Geophysics and drilling
	1991	$300,000 – Drilling
	1992	$400,000 – Drilling & Development
	Total	$1,000,000 – to be spent by another company
Cyclopic Phase I (a)	1990-91	$100,00 U.S. – Geology, Surveys, Geophysics
(b)		$200,000 U.S. – Drilling
Stage II		$750,000 – Drilling
Stage III		$1,000,000 – Contingent for production

Note expenditures on Cyclopic: *50% Toltec, 50% another Company*

PROFILES

A Geologist with over 40 years experience in mineral exploration and development. Played key roles in the discovery of two major developments:

- WABUSH LAKE, LABRADOR
- THOMPSON, MANITOBA

R.J. MacNeill
B.A., M.S., P.ENG.

International Nickel Co. of Canada Ass't. Chief Exploration Geologist
Newfoundland & Labrador Corp., V.P., Chief Geologist
Canadian Longyear Ltd. – Manager
Western Heritage Properties Ltd. – V.P.
Diamond Clay Products Ltd. – Pres.
Kaiser Aluminum Co. Technical Services – V.P.
Derry Michener & Booth – Consultants
Bathurst Norsemines Ltd. – Pres.
Etruscan Enterprises Ltd. – Pres.

Derek Huston

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1990 promotions – Barkhor Resources Ltd.
1990 promotions – Toltec Resources Ltd.

TOLTEC
RESOURCES

TOLTEC RESOURCES LTD. – Named after the historically important Toltecs who predated the Aztecs in Central America. The Toltecs had a highly developed culture, were able warriors and miners.

TOLTEC RESOURCES LTD.

Subsidiary Toltec Resources Inc. – a Nevada Corporation

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Fax: (604) 929-2337

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480 – 650 West Georgia Street,
Vancouver, B.C., V6B 4N9

TRANSFER AGENT: PACIFIC CORPORATE TRUST CO.
Suite 830 – 625 Howe St.,
Vancouver, B.C. V6C 3B8

OFFICERS: R.J. MACNEILL, President
K.S. EWALD, Secretary

DIRECTORS: R.J. MACNEILL
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D. HUSTON
C. IDZISZEK
M. PEZIM

PROMOTER: D. HUSTON
Phone: (604) 929-2337
Fax (604) 929-2337
Cellular (604) 657-5539

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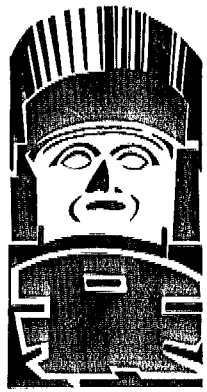
TOL-V
S.E.C. 12g – 2 (b)
EXEMPTION No. 82-2983
Listed in Standard and Poor's Corp. Records.

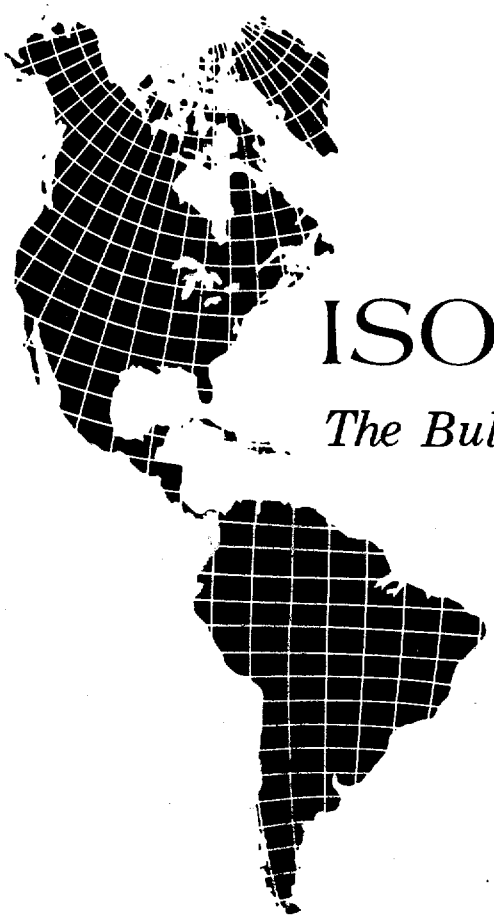
BROKER REFERENCE:

TOLTEC

R E S O U R C E S



No. 57, July 1991



ISOCHRON/WEST

The Bulletin of Isotopic Geochronology

NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES

and

NEVADA BUREAU OF MINES AND GEOLOGY

Major geochronologic and chronostratigraphic units

Subdivisions in use by the U.S. Geological Survey (map symbols)					Age estimates of boundaries in million years[1, 5]	
Eon or Eonothem	Era or Erathem	Period or System		Epoch or Series		
Phanerozoic	Cenozoic (Cz)	Quaternary (Q)		Holocene	0.010	
				Pleistocene	1.65	(1.65–2.2)
		Tertiary (T)	Neogene Subperiod or Subsystem (N)	Pliocene	5	(4.9–5.3)
				Miocene	23.7	(23–26)
			Paleogene Subperiod or Subsystem (P€)	Oligocene	36.6	(34–38)
				Eocene	57.8	(54–57.8)
				Paleocene	66	(63–66)
	Mesozoic (Mz)	Cretaceous (K)		Late / Early — Upper / Lower	96	(95–97)
		Jurassic (J)		Late / Middle / Early — Upper / Middle / Lower	138	(135–141)
		Triassic (TR)		Late / Middle / Early — Upper / Middle / Lower	205	(200–215)
	Paleozoic (Pz)	Permian (P)		Late / Early — Upper / Lower	250	
		Carboniferous Periods or Systems (C)	Pennsylvanian (IP)	Late / Middle / Early — Upper / Middle / Lower	290	(290–305)
			Mississippian (M)	Late / Early — Upper / Lower	~330	
		Devonian (D)		Late / Middle / Early — Upper / Middle / Lower	355	(360–365)
		Silurian (S)		Late / Middle / Early — Upper / Middle / Lower	405	(405–415)
		Ordovician (O)		Late / Middle / Early — Upper / Middle / Lower	435	(435–440)
		Cambrian (€)		Late / Middle / Early — Upper / Middle / Lower	510	(495–510)
Proterozoic (P)	Late Proterozoic[3] (Z)				~570[2]	
	Middle Proterozoic[3] (Y)				900	
	Early Proterozoic[3] (X)				1600	
Archean (A)	Late Archean[3] (W)				2500	
	Middle Archean[3] (V)				3000	
	Early Archean[3] (U)				3400	
pre-Archean[4] (pA)		(3800?)			4550	

[1]Ranges reflect uncertainties of isotopic and biostratigraphic age assignments. Age of boundaries not closely bracketed by existing data shown by ~. Decay constants and isotopic ratios employed are cited in Steiger and Jäger (1977).

[2]Rocks older than 570 Ma also called Precambrian (p€), a time term without specific rank.

[3]Geochronometric units.

[4]Informal time term without specific rank.

[5]Age estimates for the Phanerozoic are by G. A. Izett, M. A. Lanphere, M. E. MacLachlan, C. W. Naeser, J. D. Obradovich, Z. E. Peterman, M. Rubin, T. W. Stern, and R. E. Zartman at the request of the Geologic Names Committee. Age estimates for the Precambrian are by International Union of Geological Sciences Working Group on the Precambrian for the United States and Mexico, J. E. Harrison, Chairman. The chart is intended for use by members of the U.S. Geological Survey and does not constitute a formal proposal for a geologic time scale. Estimates of ages of boundaries were made after reviewing published time scales and other data. Future modification of this chart will undoubtedly be required. The general references apply where references are not given for specific boundaries.

Geologic Names Committee, 1983
with additions from Snelling, 1985

See inside back cover for references.

No. 57, July 1991

ISOCHRON/WEST

The Bulletin of Isotopic Geochronology

JDS
We received
2 copies - I
put one in the
Library.
Mary

Published at irregular intervals as articles are available. Issues contain at least 24 pages, and are numbered consecutively. Covers isotopic age-dating (except carbon-14) on rocks and minerals from the Western Hemisphere.

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Contributions (manuscripts and other editorial matters) should be sent to John Schilling, 1301 Royal Dr., Reno, Nevada 89503.

CONTENTS

K-Ar AGE OF SILICIC VOLCANIC ROCKS WITHIN THE LOWER COLUMBIA RIVER BASALT GROUP AT TIMBER BUTTE, BOISE AND GEM COUNTIES, WEST-CENTRAL IDAHO

DREW M. CLEMENS
SPENCER H. WOOD

Department of Geology and Geophysics, Boise State University, Boise, ID 83725

The Timber Butte study area is located approximately 65 km north of Boise, Idaho (fig. 1). The rhyolites discussed in this preliminary study are here named for Timber Butte, where the type section for the Timber Butte Rhyolite (TBR) is exposed (Clemens, 1990). This locality also represents the eastern margin of the Miocene Columbia River Basalt Group (CRBG) in the Weiser Embayment (Hooper, 1988, Fitzgerald, 1982). Poor exposures allow for several possible TBR-CRBG stratigraphic interpretations. One sample of sanidine-phenocryst separates was dated using the K-Ar method to ascertain whether these silicic volcanics were correlative with the Eocene Challis Volcanics (Moye and others, 1988) of east-central Idaho, or the lower CRBG basalts of the Weiser Embayment (Fitzgerald, 1982).

GEOLOGIC SETTING

The boundary or contact separating the Cretaceous Idaho batholith and the Miocene CRBG (fig. 2) bisects the Timber Butte study area, and is about 50 km east of the Cornucopia dike swarm. This dike swarm represents the feeder system for the earliest flows of the CRBG, the Imnaha Basalt (Hooper, 1988). Previous work (Kirkham, 1931) correlated the TBR with the extensive Miocene rhyolite flows of the Idavada Group (Armstrong and others, 1975) in the Owyhee Mountains of southwestern Idaho and southeastern Oregon. These silicic rocks were later subdivided into a group of 15-16.4 Ma precious-metal mineralized, hydrous-mineral bearing rhyolites (2-3% biotite, ± hornblende, ± pyroxene) which include the Silver City, Wall Creek, Jarbidge rhyolites, and the 9-14 Ma nonmineralized, relatively anhydrous Idavada rhyolites (Armstrong and others, 1975, Ekren and others, 1984). However, the hydrous mineral assemblage (20% biotite ± hornblende, ± pyroxene) of the upper flow at Timber Butte indicates that this rhyolite was formed under different pressure and temperature constraints than those which produced the contemporaneous, relatively anhydrous Idavada rhyolites.

A dissected surface on granodiorite of the Cretaceous Idaho batholith forms the basement in the study area. Unconformably overlying the granodiorite are weathered R_0 flows of the Imnaha Basalt (Fitzgerald, 1982), using the CRBG magnetic stratigraphy defined by Hooper and Swanson (fig. 3). Imnaha R_0 flows either lap onto or underlie aphyric glassy and perlitic rhyolite flows. The lower TBR has a reversed polarity. A poorly sorted accretionary lapilli tuff separates the glassy flows from overlying, reversed polarity, aphyric, stony flows which comprise the middle TBR. The upper TBR consists of a phyric unit with an N polarity, which was sampled for dating by the K-Ar method. The glassy nature of the lower TBR, the presence of the overlying accretionary lapilli tuff unit suggest the presence of a nearby vent, according to criteria published by Bonnichsen and Kauffman (1987), and Cas and Wright (1987). The low temperature of the upper TBR flows, as inferred from their hydrous mineral assemblage, would have imparted a high viscosity to these flows, causing them to have a small areal extent, and placing the vent's location at or near Timber Butte.

R_0 and N_0 Imnaha Basalt flows lap onto and surround the TBR. These in turn are overlain by early, phyric R_1 Grande Ronde Basalt flows (Hooper and Swanson, 1990, Hooper, 1988, Hooper and others, 1984). The lower CRBG Imnaha and Grande Ronde basalts and the TBR are capped by the hackly jointed, aphyric dacite of Soldier Creek, informally named here for the nearby Soldier Creek drainage (fig. 1). Stratigraphic relationships cannot be fully resolved by field mapping without an accompanying detailed geochemical survey to distinguish the lower CRBG from the local Weiser Basalt Group (Swanson and Hooper, in press). Possible interpretations are shown in figure 4.

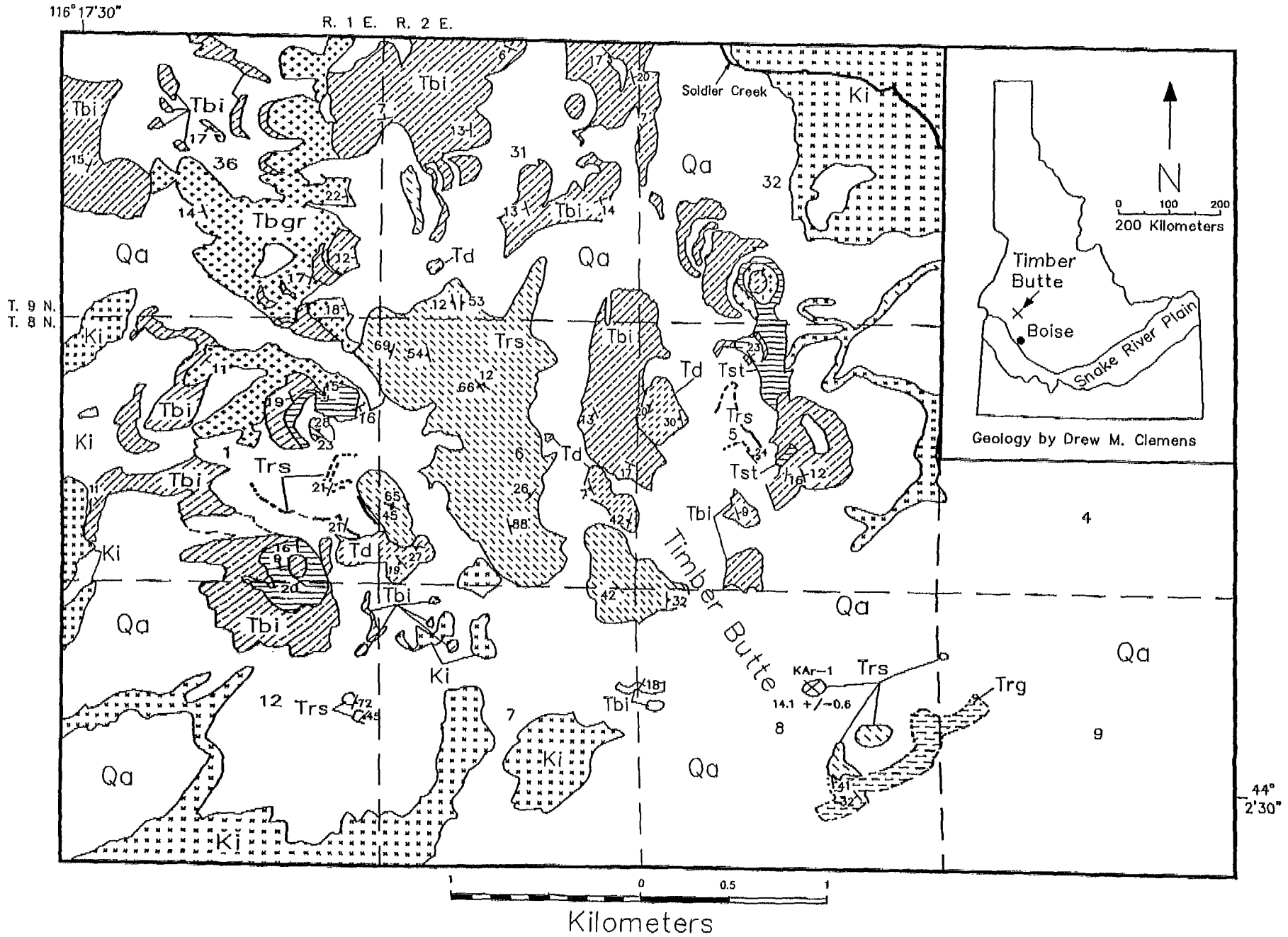
ANALYTICAL PROCEDURES

Large rhyolite slabs containing sanidine were reduced using a hydraulic rock splitter to remove all weathered material. The resulting fresh rhyolite was crushed in a porcelain jaw crusher and sieved at Boise State University, retaining the 80-200 mesh material. The sanidines were removed from the sieved fraction by using heavy liquid separation techniques, and treated with dilute HF and HNO_3 at the Geochron Laboratories Division of Krueger Enterprises, Inc. The constants and formulas used for the age determination were those of Steiger and Jaeger (1977).

DISCUSSION AND CONCLUSIONS

Field relationships, magnetic stratigraphy, and poor exposures allow an interpretation that the TBR was emplaced during or after the extrusion of the Imnaha and early Grande Ronde Basalts (fig. 4). On the basis of field relations and magnetic stratigraphy alone, figure 4a)-c) are possible, with the extrusion of the TBR occurring before or during the Imnaha Basalt episode being favored. Published K-Ar ages and magnetic character of the CRBG (Hooper and Swanson, 1990, Hooper, 1988, 1984, Fitzgerald, 1982) in conjunction with the upper TBR sanidine date (14.1 Ma) favor figure 4c) or d). If we accept the best fit interpretation of TBR-CRBG field relations depicted in figure 4b) and presented in this paper, then the published ages for the extrusion of the Imnaha Basalt (17.5-16.5 Ma), the Grande Ronde Basalt (16.5-14.5 Ma), and their changes in magnetic polarity are 1-3 m.y. too old. Further detailed geochemical studies to differentiate local volcanic units belonging to the post CRBG Weiser Basalt (Fitzgerald, 1982) from the CRBG and dating of the TBR are necessary to resolve this conflict with the CRB chronology.

The hydrous mafic mineral assemblage of the TBR indicate that these rhyolites formed under lower pressure and temperature regimes than those which produced the high temperature, high pressure Idavada rhyolites (Ekren and others, 1984). This difference is also reflected in their respective geochemistries (fig. 5), which suggest that the parental magma of the TBR formed at shallower depth in the upper crust relative to the parental magma which produced the Idavada rhyolites (Norman and Leeman, 1989). The geographic nearness of the Cornucopia Dike Swarm to Timber Butte, the upper crust affinity and age of the TBR


116° 17'30"
R. 1 E.
R. 2 E.
T. 9 N.
T. 8 N.
44° 2'30"
Soldier Creek
Timber Butte
Tbi
Tbgr
Qa
Ki
Td
Trs
Tst
Trg
KAr-1
14.1 +/-0.6
N
0 100 200
200 Kilometers
Timber Butte
Boise
Snake River Plain
Geology by Drew M. Clemens
1 0 0.5 1
Kilometers

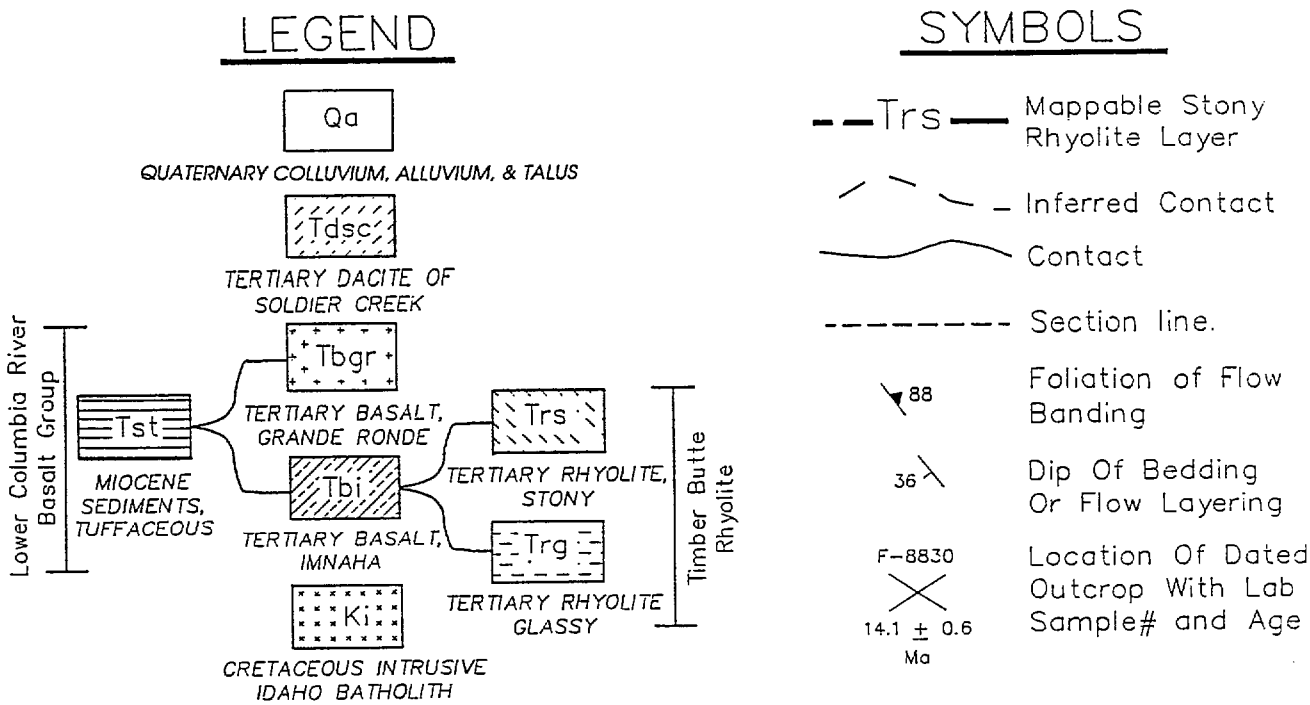


FIGURE 1. a) Outcrop geologic map of the Timber Butte Area, and b) Correlation of units.

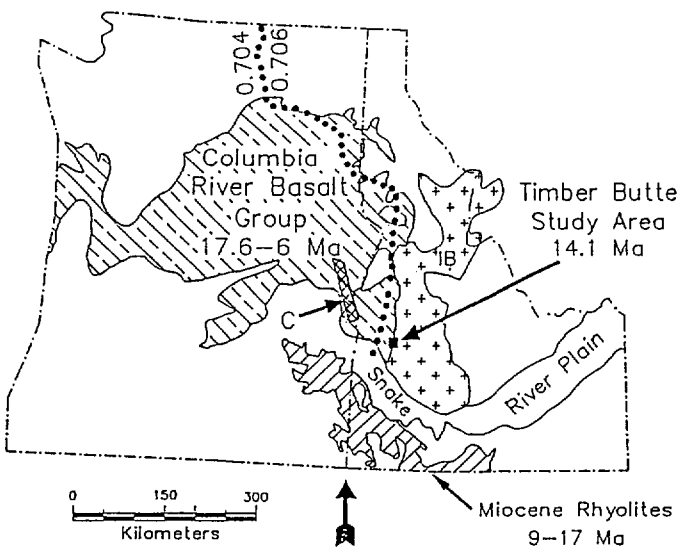


FIGURE 2. Regional geologic map showing the Columbia river Basalt Group, the Idaho batholith (IB), Cornucopia Dike Swarm (after Hooper, 1988), Miocene rhyolites in southwestern Idaho and southeastern Oregon (Stewart and Carlson, 1978), the $^{86}Sr/^{87}Sr$ isopleth (Moye and others, 1988), and the Timber Butte Study Area.

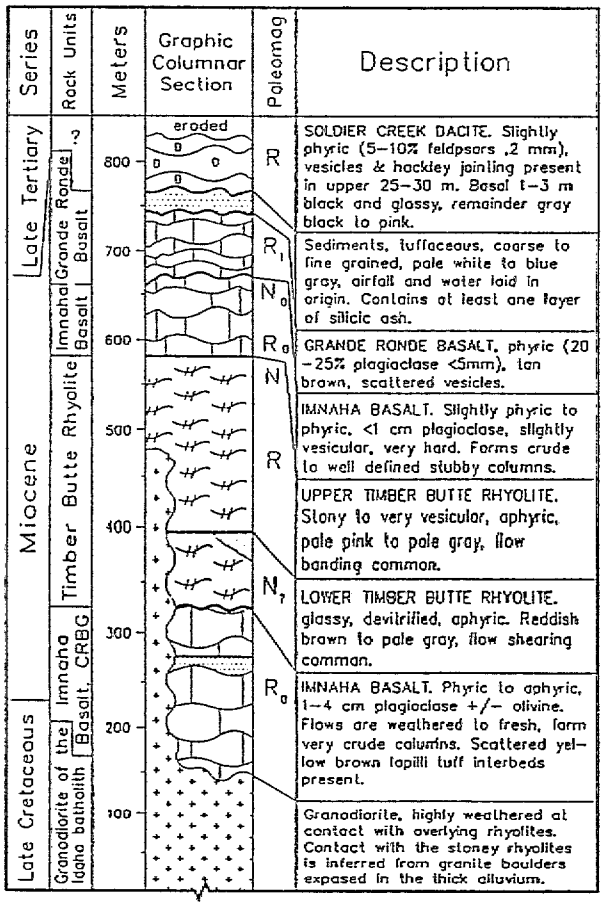


FIGURE 3. Preferred interpretation expressed as a composite stratigraphic column showing the rock units present in the study area and their magnetic polarity. Actual stratigraphic relationship of rhyolite and basalt is uncertain as shown in figure 4.

suggest that the parental magma of the lower CRBG may have partially melted the shallow upper crust. The resulting hydrous, relatively cool and viscous silicic magma was then erupted at or near Timber Butte.

ACKNOWLEDGEMENTS

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SAMPLE DESCRIPTION

1. *F-8830* K-Ar
Rhyolite flow (44°02'30" N, 116°14'00" W; SW/4, NE/4, S8,T8N,R2E; Dry Buck Valley 7.5' quad.; porphyritic rhyolite flow outcrops in a saddle at 4,680 ft near Hill 4851). *Analytical data:* K_2O = 8.25 wt.%; $^{40*}Ar$/total ^{40}Ar = 0.728%. *Collected by:* Drew Clemens.

(sanidine) 14.1 ± 0.6 m.y.

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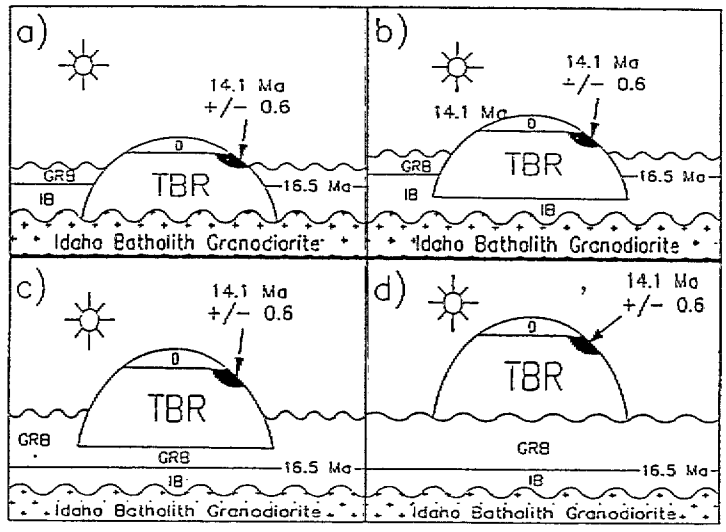

FIGURE 4. Relationships of the Imnaha Basalt may be such that it does not underly the TBR (b), but laps onto the TBR (a), or the Imnaha Basalt and/or the Grande Ronde Basalt may underly the TBR entirely (c and d)! D = Dacite of Soldier Creek, TBR = Timber Butte Rhyolite, GRB = Grande Ronde Basalt, IB = Imnaha Basalt. Dates on Imnaha and Grande Ronde Basalts are from Hooper (1988).

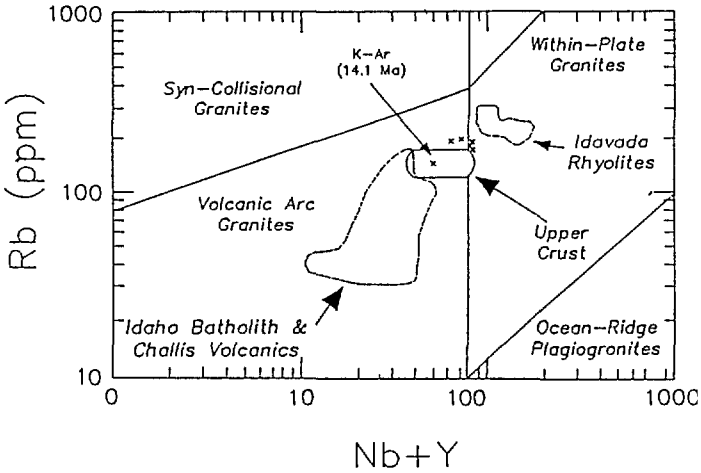

FIGURE 5. Tectonic discrimination diagram for silicic rocks in the study area (X) and the Owyhee rhyolites based on Y + Nb vs. Rb (ppm). WPG = within-plate granites, SYG = syncollisional granites, VAG = volcanic arc field, UC = upper crust, ORG = ocean-ridge plagiogranites (after Norman and Leeman, 1989).

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NEW K-Ar AGES OF MAFIC LAVAS FROM THE BASIN AND RANGE–CASCADE TRANSITION ZONE IN NORTHEASTERN CALIFORNIA AND SOUTHERN OREGON

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The distribution of major volcanic rock types in the Pacific Northwest is in part attributed to tectonic interactions between the subducting Juan de Fuca plate and the overriding western portion of the North American plate (Atwater, 1970). During the past five million years, subduction directly or indirectly accounts for the origin of the predominantly calc-alkaline extrusive rocks of the Cascade arc (Thorpe, 1982). Likewise, during at least the past five million years, the tensile stresses involved with the development of the Basin and Range gave rise to faulting and basaltic volcanism (Lawrence, 1976; Hart and others, 1984). One of the objectives of this study was to evaluate the age and distribution of volcanic materials within the northwestern Basin and Range—Cascade arc transitional area.

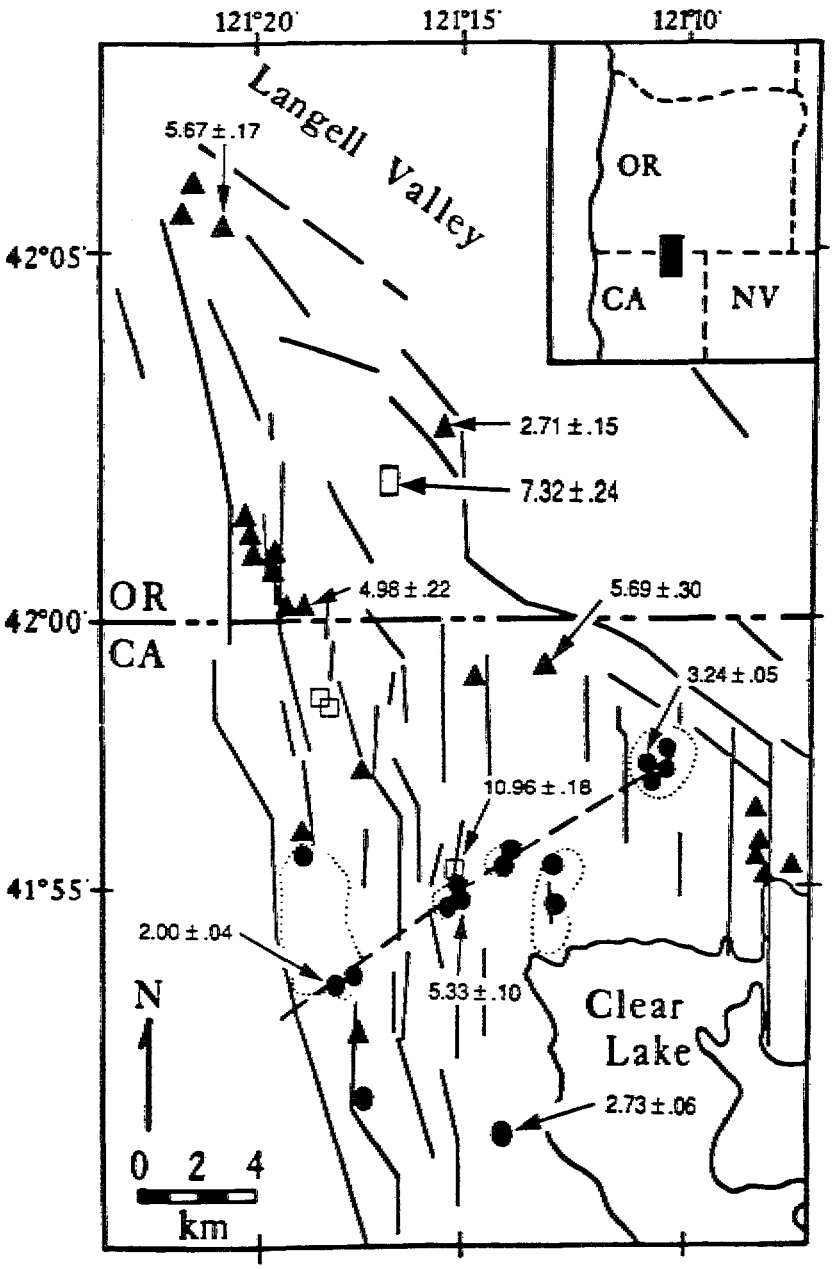

FIGURE 1. Map of study area showing distribution of major rock types, faults, and locations of dated samples. Samples are labelled according to their age (Ma) and correspond to the samples shown in table 1 and the sample descriptions. Filled circles are CABA lavas, filled triangles are HAOT lavas, and open squares are older lavas of the chemically heterogeneous group. Faults are marked as bold black lines. Areas enclosed by dots represent concentrations of CABA vents and/or associated flows. CA = California; NV = Nevada; OR = Oregon. *Note:* Sample KM86-34 is not located on this map.

The volcanic rocks found northeast of the Medicine Lake Highland and in the western portion of the Devil's Garden Lava field (McKee and others, 1983) help to define a portion of the northwestern Basin and Range–Cascade arc transitional area. The study area (fig. 1) is located within the little characterized west-central portion of the Devil's Garden lava field. This area is also impinged by the northeastern extent of a proposed segment boundary of the Cascade volcanic arc (Hughes and others, 1980).

Petrographic and geochemical data indicate that two main rock types characterize the study area; [1] calc-alkaline basalts/basaltic andesites (CABA), and [2] low-K, high alumina olivine tholeiites (HAOT). A third, less abundant suite of basalts and basaltic andesites is also observed. In some cases these lavas display chemical characteristics intermediate between those of CABA and HAOT (e.g. KM87-53), and in other cases they are very similar to the CABA except for markedly higher Sr contents (e.g. compare KM86-96 to a typical CABA, KM86-78). Chemical analyses for these three types are given in table 1 and their sampled distributions are shown on figure 1.

The CABA from this area erupted from small cinder cones aligned parallel to the direction of plate convergence (N50°E; Atwater, 1970). These cinder cones are similar in size and orientation to those documented by Hughes and Mertzman (1976) and Hart and others (1979) in areas adjacent to the Medicine Lake Highland. Rocks of the second major type (HAOT) are indistinguishable from those described by Hart and others (1984) and Bullen (1986). All HAOT lavas are found cut by or filling the valleys formed by north-south and northwest trending faulting. This faulting is typical of the northern termination of east-west extension in the northwestern Basin and Range (Lawrence, 1976). Lavas of the third group have field affinities more similar to HAOT, but are also observed in close spatial association to some CABA lavas.

TABLE 1. Major and trace element data and normative mineralogy.

Sample Type	86-34 Other	85-51 HAOT	86-56 HAOT	86-72 HAOT	86-78 CABA	86-80 CABA	86-96 Other	87-11 CABA	87-50 CABA	87-53 Other	87-128 HAOT
SiO_2	50.84	47.66	47.49	46.73	55.51	55.12	54.14	57.03	50.99	50.92	47.94
TiO_2	0.99	1.47	0.86	0.77	0.88	1.21	1.00	1.68	1.24	1.26	0.93
Al_2O_3	17.49	17.13	17.50	16.79	17.28	17.16	17.36	16.37	17.98	18.33	16.80
Fe_2O_3	3.71	3.53	4.25	1.81	3.98	3.47	2.90	9.92	10.01	10.61	10.34
FeO	5.14	8.16	5.86	8.29	3.75	4.93	5.20	—	—	—	—
MnO	0.15	0.19	0.18	0.18	0.13	0.14	0.14	0.18	0.16	0.16	0.17
MgO	6.72	7.21	8.90	9.67	4.80	3.68	4.23	2.68	6.46	6.34	9.04
CaO	9.17	9.99	11.34	11.82	6.99	7.30	6.97	6.45	9.47	9.27	11.80
Na_2O	3.54	3.33	2.64	2.44	4.07	4.27	4.10	4.30	3.54	3.61	2.46
K_2O	0.73	0.38	0.20	0.23	1.30	1.38	2.22	1.39	0.55	0.58	0.19
P_2O_5	0.26	0.30	0.11	0.09	0.22	0.33	0.48	0.73	0.43	0.39	0.20
L.O.I.	0.83	0.58	0.86	0.59	0.59	0.68	0.96	0.25	−0.05	−0.02	−0.39
TOTAL	99.57	99.93	100.19	99.41	99.50	99.67	99.70	100.97	100.78	101.45	99.48
qtz	0.00	0.00	0.00	0.00	4.22	4.18	0.78	9.46	0.00	0.00	0.00
or	4.31	2.25	1.18	1.36	7.68	8.16	13.12	8.21	3.25	3.43	1.12
ab	29.95	28.18	22.34	18.55	34.44	36.13	34.69	36.39	29.95	30.55	20.82
an	29.68	30.67	35.31	34.18	25.04	23.58	22.41	21.26	31.55	32.10	34.24
ne	0.00	0.00	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
di	11.42	13.79	16.37	19.36	6.65	8.57	7.37	4.92	10.22	9.22	18.55
hy	11.67	0.75	1.66	0.00	15.08	11.31	13.69	10.32	14.30	12.46	6.07
ol	5.49	15.70	16.97	19.94	0.00	0.00	0.00	0.00	3.50	5.64	12.52
mt	3.61	4.31	3.42	2.62	3.45	3.93	3.62	4.61	3.97	4.00	3.52
il	1.88	2.79	1.63	1.46	1.67	2.30	1.90	3.19	2.36	2.39	1.77
ap	0.60	0.70	0.25	0.21	0.51	0.76	1.11	1.69	1.00	0.90	0.46
Rb	6	<5	5	5	21	34	21	18	10	<5	5
Sr	711	446	321	336	503	578	709	453	579	595	336
Ba	339	283	129	155	405	464	768	567	307	379	204
Y	13	41	30	23	20	24	16	64	22	23	27
Zr	99	113	86	47	161	177	172	160	94	96	44
V	196	235	237	241	164	225	161	175	246	269	278
Ni	107	142	191	175	75	37	49	<10	53	97	129
Cr	181	137	210	224	113	71	65	<10	48	68	241

Notes: All samples have KM-prefix; major elements in wt.%; trace elements in ppm; L.O.I. = loss on ignition.

RESULTS

We report 11 new whole rock K-Ar ages on representative samples from the previously defined rock types (fig. 1, table 1, sample description summary). The analyzed lavas range in age from 2.0 to 11.0 Ma, in agreement with the range reported on chemically similar lavas from this general region (McKee and others, 1983; Hart and others, 1984; Pickthorn and Sherrod, 1990). These results indicate that within the study area the CABA are between 2.0 and 5.3 Ma in age and the HAOT are between 2.7 and 5.7 Ma in age. Older ages ranging from 6.2 to 11.0 Ma characterize the third, chemically heterogeneous group of lavas.

The data clearly show (fig. 1) that the two major rock types, CABA and HAOT, were erupting contemporaneously. In addition, the age range defined by lavas from vents along the N50°E CABA trend (fig. 1) is consistent with estimates of the timing of correspondingly oriented convergence between the Juan de Fuca and North American plates (Atwater, 1970). The close spatial and temporal association of distinct rock types (CABA and HAOT) and their associated distinct structural styles indicate that magma generation and evolution within the transition zone between the Basin and Range and Cascade provinces has been a complex process that is strongly linked to the interfingering structural and tectonic styles. Petrologic details of these relationships, and the significance of the older ages observed for the third, more chemically diverse suite will be discussed elsewhere.

Argon measurement procedures follow those described by Hart and Carlson (1985) and Hart and others (1984).

TABLE 2. Potassium values for K-Ar geochronology.

Sample	(A)	(B)	(C)	(D)	(E)
KM86-34	0.730	0.742	–	–	0.742
KM86-51	0.380	0.386	–	–	0.386
KM86-56	0.200	0.192	0.214	0.201	0.208
KM86-72	0.230	0.200	–	–	0.200
KM86-78	1.300	–	1.279	1.256	1.267
KM86-80	1.380	1.379	1.368	1.375	1.374
KM86-96	2.220	2.282	–	–	2.282
KM87-11	1.390	–	1.463	1.361	1.412
KM87-50	0.550	–	0.634	0.621	0.627
KM87-53	0.580	–	0.635	0.621	0.628
KM87-128	0.190	–	0.243	0.231	0.237

A – Major element analysis (KM86-X, XRF; KM87-X, DCP): whole rock powders
B – Flame photometry: powdered from 12–35 mesh Ar split
C – DCP (dissolution 1): powdered from 12–35 mesh Ar split
D – DCP (dissolution 2): powdered from 12–35 mesh Ar split
E – K_2O concentrations used in age calculations; using either (B), average of (B)(C)(D), or average of (C)(D)

Note: All values in wt.% K_2O

Potassium concentrations were determined by XRF, Flame Photometer, and/or Direct Current Argon Plasma Spectrometer (DCP). Comparisons of the results of these different methods are given in table 2. All samples were analyzed petrographically to assure minimal secondary alteration. Reproducibility of the Ar measurement techniques was tested by analyzing one sample in duplicate (KM86-56). Therefore, the age used on figure 1 is the calculated average age of 2.71 ± 0.15 Ma. The decay constants used in the age calculations are: $\lambda_\varepsilon = 5.81 \times 10^{-11}$ yr^{-1}; $\lambda = 5.543 \times 10^{-11}$ yr^{-1}; and $^{40}K/K = 1.167 \times 10^{-4}$ atom/atom.

ACKNOWLEDGEMENTS

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SAMPLE DESCRIPTIONS

1. *KM86-34* K-Ar
Basalt (42°15'15", 121°01'00"; NE/4,S22, T38S,R14E; top flow at summit of Horsefly Mtn., Klamath Co., OR). Fine grained, holocrystalline, slightly trachytic; olivine phenocrysts; plagioclase is predominantly labradorite (An_{56-58}). MODE: 46.1% plagioclase, 26.4% olivine, 16.7% augite, 5.7% oxide, 5.1% matrix. *Analytical data:* Sample weight = 7.0433 gm; K_2O = 0.742 (wt)%; $^{40}Ar^*$ = 6.5992 × 10^{-12} mol/gm; $^{40}Ar^*$ = 32.90%. *Note:* This sample is not found on figure 1.
(whole rock) 6.17 ± 0.13 Ma

2. *KM86-51* K-Ar
Basalt (42°05'45", 121°20'45"; SW/4,S18, T40S,R12E; top flow at S end of Harpold Reservoir, Klamath Co., OR). Fine to medium grained, diktytaxitic, holocrystalline, intergranular to subophitic; some iddingsitized olivine; plagioclase is predominantly labradorite (An_{58-60}). MODE: 48.2% plagioclase, 25.4% olivine, 21.0% augite, 3.9% oxide, 1.5% matrix. *Analytical data:* Sample weight = 8.0790 gm; K_2O = 0.386 (wt)%; $^{40}Ar^*$ = 3.1534 × 10^{-12} mol/gm; $^{40}Ar^*$ = 38.66%.
(whole rock) 5.67 ± 0.17 Ma

3. *KM86-56* K-Ar
Basalt (42°02'15", 121°15'15"; SE/4,S2, T41S,R12E; first exposed flow up from West Langell Valley Road, Klamath Co., OR). Medium grained, diktytaxitic, holocrystalline, intergranular to subophitic; some iddingsitized olivine; plagioclase is predominantly labradorite (An_{57-59}). MODE: 51.3% plagioclase, 21.8% olivine, 23.1% augite, 2.5% oxide, 1.3% matrix. *Analytical data:* Sample weights = 8.1033 gm, 7.9360 gm; K_2O = 0.208 (wt)%, 0.208 (wt)%; $^{40}Ar^*$ = 7.6665 × 10^{-13} mol/gm, 7.9422 × 10^{-13} mol/gm; $^{40}Ar^*$ = 19.21%, 18.58%. *Note:* Figure 1 shows average age: 2.71 ± 0.15 Ma.
(whole rock) 2.77 ± 0.16 Ma
(whole rock) 2.65 ± 0.13 Ma

4. *KM86-72* K-Ar
Basalt (41°59'00", 121°13'15"; SW/4,S19, T48N,R7E; Hopeless Pass, Modoc Co., CA). Medium grained, diktytaxitic, holocrystalline, intergranular to subophitic; plagioclase is predominantly labradorite (An_{61-64}). MODE: 46.5% plagioclase, 23.4% olivine, 22.8% augite, 5.6% oxide, 1.7% matrix. *Analytical data:* Sample weight = 6.0184 gm; K_2O = 0.200 (wt)%; $^{40}Ar^*$ = 1.6406 × 10^{-12} mol/gm; $^{40}Ar^*$ = 24.73%.
(whole rock) 5.69 ± 0.30 Ma

5. *KM86-78* K-Ar
Basaltic andesite (41°53'30", 121°17'50"; NW/4,S28,T47N,R6E; cliff forming flow on top of Horse Mtn., Modoc Co., CA). Fine to medium grained, holocrystalline; plagioclase laths show distinct sieve

texture or resorption; plagioclase is predominantly andesine (An_{49-50}). MODE: 20.9% plagioclase, 0.6% olivine, 1.0% cpx, 5.5% oxide, 72.0% matrix. *Analytical data:* Sample weight = 4.4513 gm; K_2O = 1.267 (wt)%; $^{40}Ar^*$ = 3.6593 × 10^{-12} mol/gm; $^{40}Ar^*$ = 24.47%.

(whole rock) 2.00 ± 0.04 Ma

6. *KM86-80* K-Ar
Basaltic andesite (41°51′00″, 121°13′50″; SE/4,S1,T46N,R6E; top flow at N end of Clear Lake Hills, Modoc Co., CA). Fine grained, holocrystalline, seriate textured; plagioclase shows some resorption texture; minor subhedral olivine phenocrysts; plagioclase is predominantly labradorite (An_{55-57}). MODE: 21.2% plagioclase, 5.4% olivine, 2.0% cpx, 4.0% oxide, 67.4% matrix. *Analytical data:* Sample weight = 6.0886 gm; K_2O = 1.374 (wt)%; $^{40}Ar^*$ = 5.4300 × 10^{-12} mol/gm; $^{40}Ar^*$ = 22.38%.

(whole rock) 2.73 ± 0.06 Ma

7. *KM86-96* K-Ar
Basaltic andesite (42°02′00″, 121°16′30″; NE/4,S10,T415,R12E; top flow at summit of Bryant Mtn., Klamath Co., OR). Medium grained, holocrystalline, vesicular, trachytic; iddingsitized olivine phenocrysts; plagioclase is predominantly andesine (An_{40}). MODE: 59.4% plagioclase, 22.9% olivine, 6.3% cpx, 8.2% oxide, 3.2% matrix. *Analytical data:* Sample weight = 6.0288 gm; K_2O = 2.282 (wt)%; $^{40}Ar^*$ = 2.4097 × 10^{-11} mol/gm; $^{40}Ar^*$ = 41.39%.

(whole rock) 7.32 ± 0.24 Ma

8. *KM87-11* K-Ar
Basaltic andesite (41°57′15″, 121°10′15″; SE/4,S33,T48N,R7E; from Carr Butte, Modoc Co., CA). Fine grained, holocrystalline, seriate textured; sieve or resorption textured plagioclase laths; plagioclase is predominantly andesine (An_{45}). MODE: 9.3% plagioclase, 1.0% olivine, 2.0% cpx, 0.2% opx, 2.5% oxide, 85.0% matrix. *Analytical data:* Sample weight = 4.6760 gm; K_2O = 1.412 (wt)%; $^{40}Ar^*$ = 6.5772 × 10^{-12} mol/gm; $^{40}Ar^*$ = 21.32%.

(whole rock) 3.24 ± 0.05 Ma

9. *KM87-50* K-Ar
Basaltic andesite (41°54′45″121°14′50″′; SE/4,S14,T47N,R6E; from vent, Modoc Co., CA). Fine to medium grained, holocrystalline; subhedral to euhedral phenocrysts of olivine; plagioclase shows some resorption; plagioclase is predominantly andesine (An_{48}). MODE: 49.4% plagioclase, 22.0% olivine, 10.5% cpx, 11.4% oxide, 6.7% matrix. *Analytical data:* Sample weight = 5.0577 gm; K_2O = 0.627 (wt)%; $^{40}Ar^*$ = 4.8151 × 10^{-12} mol/gm; $^{40}Ar^*$ = 37.80%.

(whole rock) 5.33 ± 0.10 Ma

10. *KM87-53* K-Ar
Basalt (41°55′15″, 121°14′55″; NE/4,S14, T47N,R6E; flow directly below KM87-50, Modoc Co., CA). Fine to medium grained, diktytaxitic, holocrystalline, intergranular to subophitic; some iddingsitized olivine; plagioclase is predominantly labradorite (An_{58-60}). MODE: 46.8% plagioclase, 23.5% olivine, 21.1% augite, 6.5% oxide, 2.1% matrix. *Analytical data:* Sample weight = 5.0254 gm; K_2O = 0.628 (wt)%; $^{40}Ar^*$ = 9.9261 × 10^{-12} mol/gm; $^{40}Ar^*$ = 57.76%.

(whole rock) 10.96 ± 0.18 Ma

11. *KM87-128* K-Ar
Basalt (42°00′00″, 121°18′35″; NE/4,S20, T41S,R12E; top flow on E side of valley, Klamath Co., OR). Fine grained, diktytaxitic, holocrystalline, intergranular to subophitic, glomerporphyritic; some iddingsitized olivine; plagioclase is predominantly labradorite (An_{64-66}). MODE: 50.2% plagioclase, 22.7% olivine, 24.8% augite, 1.6% oxide, 0.7% matrix. *Analytical data:* Sample weight = 6.7287 gm; K_2O = 0.237 (wt)%; $^{40}Ar^*$ = 1.6977 × 10^{-12} mol/gm; $^{40}Ar^*$ = 26.68%.

(whole rock) 4.98 ± 0.22 Ma

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NEW K-Ar AGES FOR PLIOCENE MAFIC TO INTERMEDIATE VOLCANIC ROCKS IN THE REVEILLE RANGE, NEVADA

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In this paper we report 16 new K-Ar ages for Pliocene mafic to intermediate volcanic rocks in the Reveille Range, Nevada and one K-Ar date of a Miocene-aged tristanite from the vicinity of the Reveille Range.

The Pliocene volcanic rocks of the Reveille Range represent the southern half of a 20 km wide by 100 km long north to N30°E trending belt that combined with the Lunar Crater Volcanic Field extends from 37°45′ to 38°45′ in the south-central Great Basin (fig. 1a). According to the classification of Irvine and Baragar (1971) volcanic rocks range in composition from picrite to trachyte and occur as shallow intrusions, domes, flows and dissected cinder cones. Based on field relations, petrology and K-Ar ages volcanic rocks of the Reveille Range are divided into three episodes (Naumann and Smith, 1988) (fig. 1b and 2). These are:

Episode 1 (5.9 to 5.0 Ma): Basalts of Episode 1 are porphyritic olivine basalts that contain plagioclase megacrysts (up to 40 modal %). They range in composition from alkali basalt to hawaiite (44 to 48% SiO_2). Fifty-two vents occur on both the east and west flanks and near the crest of the range (fig. 1b).

Episode 2 (4.6 to 3.0 Ma): Basalts of Episode 2 are porphyritic olivine basalts containing megacrysts of augite (up to 40 %), amphibole (up to 35 %) and plagioclase (< 5%) and coarse grained xenoliths of gabbro and dunite (up to 20 cm in length). They range in composition from picrite to trachybasalt (41 to 56% SiO_2). Fourteen Episode 2 vents occur on the northeast piedmont and flank of the range (fig. 1b).

Evolved volcanism (4.4 & 4.2 Ma): Eruptions of trachyte (60% SiO_2) and tristanite (58% SiO_2) containing ferrosillite, hedenburgite, anorthoclase, sanidine, and andesine produced two domes (volumes are < 0.01 km^3 and 0.26 km^3, respectively) on the northeast flank of the range (Naumann and others, 1990) (fig. 1b). The northernmost dome is associated with an apron of pyroclastic flow and surge deposits and volcaniclastic debris (fig. 1b).

The new K-Ar dates establish that two episodes of basaltic volcanism occurred in the Reveille Range between 5.9 and 3.00 Ma. Episodes of basaltic volcanism were separated by the eruption of trachytic lavas and pyroclastic units at 4.4 and 4.2 Ma (fig, 2).

Previously published K-Ar ages for the Reveille Range include a date of 5.7 ± 0.2 Ma on an Episode 1 basalt flow on the northwestern flank of the range (Marvin and others, 1973). Dates of 5.8 ± 0.3 and 5.6 ± 0.3 Ma were obtained for Episode 1 basalt flows in the western part of the range, and 3.9 ± 0.2 and 3.8 ± 0.3 Ma for Episode 2 basalt flows on the east flank of the range (Dohrenwend and others, 1985). The K-Ar dates reported in this paper indicate that the most recent activity in the Reveille Range occurred at 3.0 Ma rather than 3.8 Ma.

MIGRATION OF VOLCANISM

Foland and others (1987) reported that volcanism migrated to the north in the Reveille-Lunar Crater field. According to their model, volcanism initiated at about 9 Ma and migrated north to the Lunar Crater field at a rate of about 1 cm/year. Detailed dating of volcanic centers in the northeast Reveille range indicates that migration patterns are locally more complicated. For example, in the northeastern Reveille Range, Episode 1 activity migrated mainly to the south while Episode 2 volcanism migrated both north and south. The youngest Episode 2 volcano (3.0 Ma) formed in the south (fig. 3).

MISCELLANEOUS NYE COUNTY VOLCANIC ROCKS

A previously unmapped trachyte dome and flow complex located 20 km southeast of the Reveille Range in the White Blotch Springs quadrangle yielded a K/Ar date of 14.1 Ma. The dome is 1 km in diameter and 150 m high and was mapped on the Geologic Map of Southern Nye County as undifferentiated Pliocene welded Tuff (Cornwall, 1972).

ANALYTICAL TECHNIQUES

All dates were obtained from groundmass plagioclase separates. Feldspar phenocrysts and megacrysts were removed from samples prior to analysis. Analytical procedures discussed by Damon and others (1983) were used in this study (constants: $\lambda_\beta = 4.963 \times 10^{-10}\ yr^{-1}$, $\lambda_\epsilon = 0.581 \times 10^{-10}\ yr^{-1}$, $\lambda = 6.544 \times 10^{-10}\ yr^{-1}$, $^{40}K/K = 1.167 \times 10^{-4}$ atom/atom).

ACKNOWLEDGEMENTS

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SAMPLE DESCRIPTIONS

Episode 1

1. *R8-1-17-LN* K-Ar
Porphyritic olivine basalt flow; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°4′15″, 116°7′24″; Reveille Range, Nye County, NV). *Analytical data:* K = 0.846, 0.849, 0.823%; $^*Ar^{40}$ = 7.335, 7.462, 7.651, 7.461 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 54.5, 55.2, 56.4, 55.3%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah. *Comment:* This sample was collected from the youngest Episode 1 flow.

(plagioclase) 5.13 ± 0.15 Ma

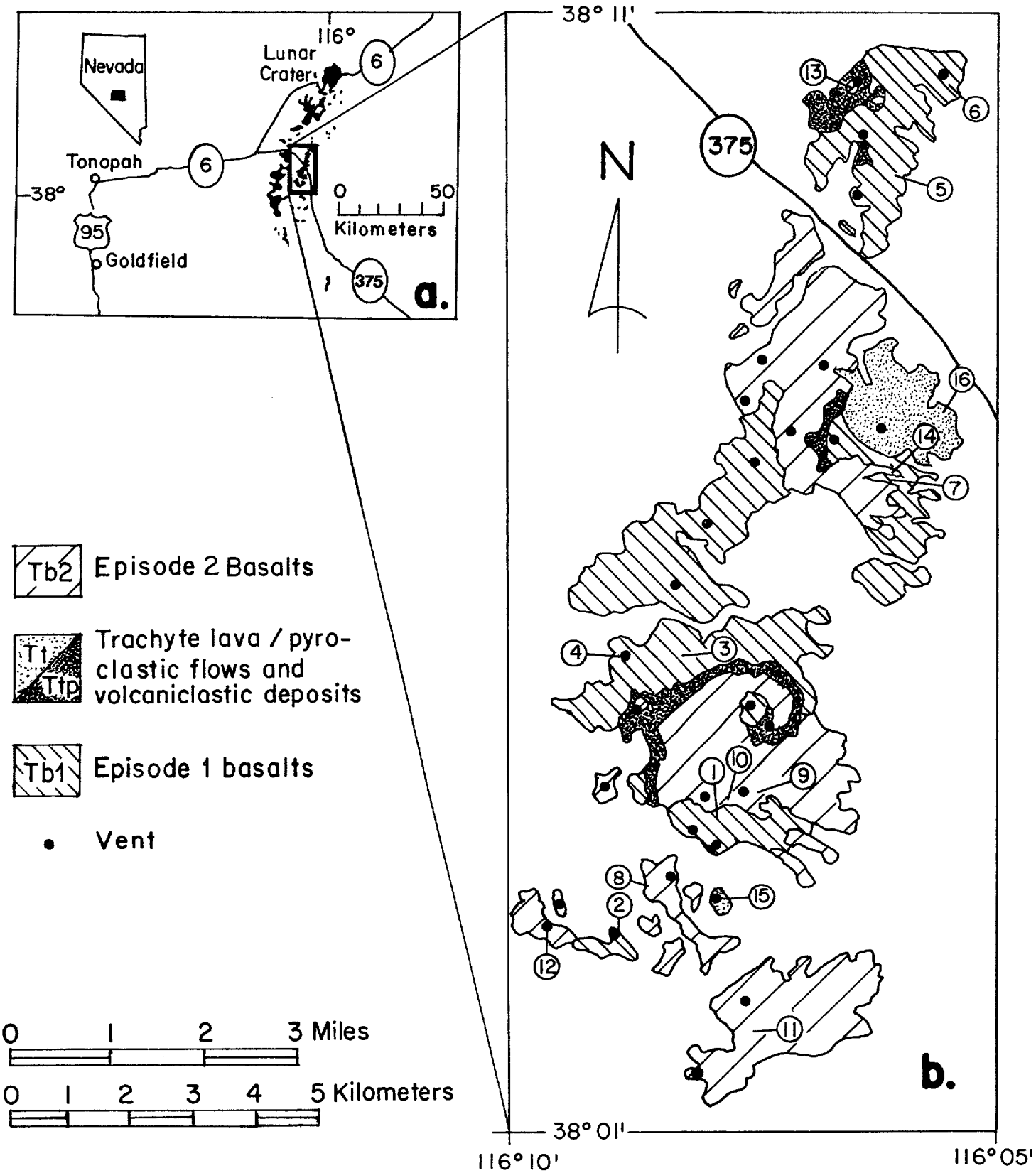

FIGURE 1. *a*—Location of Pliocene and younger volcanic rocks of the Reveille Range—Lunar Crater volcanic field. *b*—Generalized geologic map of the Pliocene volcanic rocks in the northeastern Reveille Range. Circled numbers are sample locations for K-Ar dates.

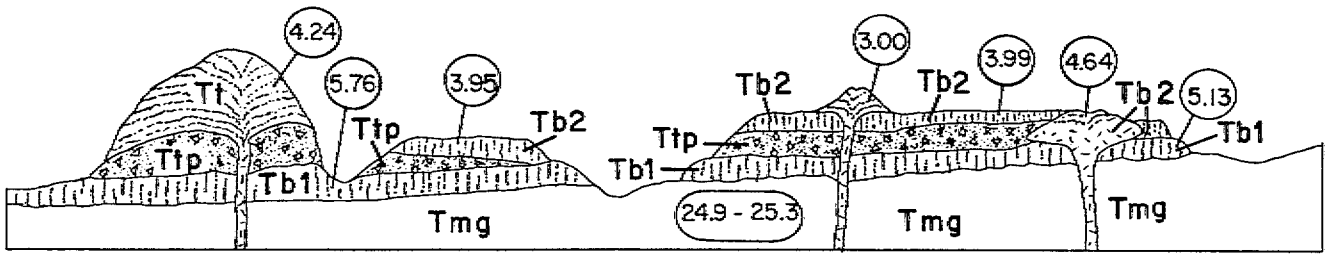

FIGURE 2. Cartoon cross-section showing the stratigraphic relationships among the dated volcanic units in the Reveille Range. Symbols are the same as in figure 1b. Tmg = Tuff of Goblin Knobs (Monotony Tuff) a densely welded, coarsely devitrified quartz latitic to rhyolitic welded tuff. Dates for Tmg were reported in Ekren and others (1973).

2. *R8-1-24-LN* K-Ar
Porphyritic olivine basalt dike; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°3′18″, 116°8′52″; Reveille Range, Nye County, NV). *Analytical data:* K = 0.871, 0.871, 0.891, 0.887%; $^*Ar^{40}$ = 8.233, 8.390, 8.374, 8.254 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 78.4, 78.5, 76.4, 64.5%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 5.44 ± 0.14 Ma

3. *R8-1-28-LN* K-Ar
Porphyritic olivine basalt flow; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°5′40″, 116°8′5″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.693, 1.683, 1.652, 1.679, 1.683, 1.679%; $^*Ar^{40}$ = 16.57, 16.78, 16.80 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 66.4, 68.1, 68.2%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah. *Comment:* This sample and R8-1-29-LN were collected from the same cinder cone-flow complex.
(plagioclase) 5.74 ± 0.10 Ma

4. *R8-1-29-LN* K-Ar
Porphyritic olivine basalt plug; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°5′39″, 116°8′40″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.116, 1.079, 1.067, 1.118, 1.095%; $^*Ar^{40}$ = 10.92, 10.73, 10.55, 10.48 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 50.7, 49.7, 49.0, 48.6%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 5.61 ± 0.15 Ma

5. *R9-1-48-LN* K-Ar
Porphyritic olivine basalt flow; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°9′48″, 116°6′02″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.194, 1.176, 1.229, 1.185, 1.170%; $^*Ar^{40}$ = 12.08, 12.04, 12.03, 11.80 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 75.7, 75.5, 75.7, 75.2%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 5.80 ± 0.13 Ma

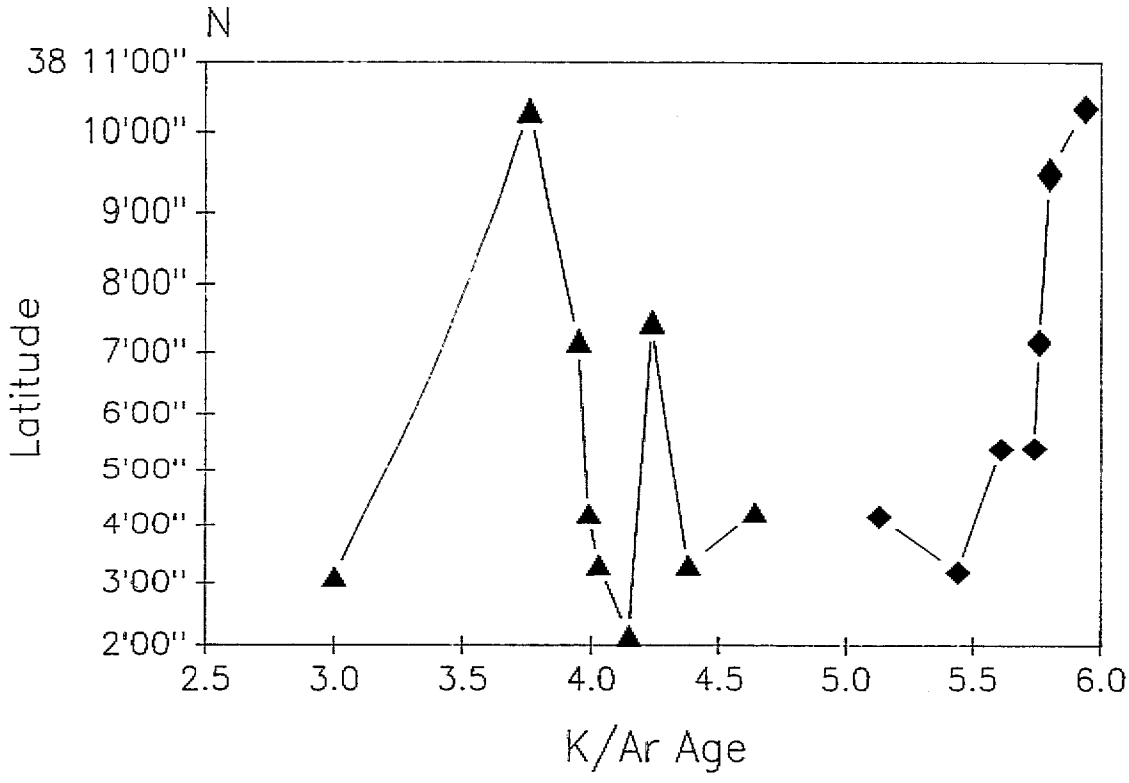

FIGURE 3. Plot of K-Ar age against latitude for dated volcanic centers in the northeast Reveille Range. Diamonds = Episode 1 basalts; Triangles = Episode 2 basalts and trachyte lavas.

6. *R9-1-56-LN* K-Ar
Porphyritic olivine basalt plug; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°10′33″, 116°5′30″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.257, 1.260, 1.225, 1.209%; $*Ar^{40}$ = 12.92, 12.67, 12.66, 12.82 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 67.2, 65.7, 65.8, 66.8%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah. *Comment:* This sample was collected from the stratigraphically lowest Episode 1 flow.
(plagioclase) 5.94 ± 0.14 Ma

7. *R9-1-57-LN* K-Ar
Porphyritic olivine basalt; contains large plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°7′15″, 116°5′45″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.365, 1.367, 1.384, 1.393, 1.360%; $*Ar^{40}$ = 13.73, 13.73, 13.77 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 68.0, 66.9, 66.9%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah. *Comment:* R9-1-57-LN is overlain by pyroclastic deposits from the adjacent trachyte dome.
(plagioclase) 5.76 ± 0.14 Ma

Episode 2

8. *R8-1-2-LN* K-Ar
Porphyritic olivine basalt flow; contains plagioclase and augite megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°3′30″, 116°8′20″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.469, 1.468, 1.444, 1.469, 1.497%; $*Ar^{40}$ = 10.12, 10.24, 10.50, 10.33, 10.25, 10.29, 10.29, 10.20 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 71.2, 72.9, 74.0, 68.9, 68.6, 69.0, 68.5, 72.6%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 4.03 ± 0.12 Ma

9. *R8-1-13-LN* K-Ar
Porphyritic olivine basalt plug; contains large plagioclase and augite megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°4′23″, 116°7′18″; Reveille Range, Nye County, NV). *Analytical data:* K = 0.805, 0.825, 0.839%; $*Ar^{40}$ = 6.730, 6.676, 6.607, 6.482 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 68.3, 67.8, 67.3, 67.5%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah. *Comment:* This sample was collected from the oldest Episode 2 basalt.
(plagioclase) 4.64 ± 0.14 Ma

10. *R8-1-18-LN* K-Ar
Porphyritic olivine basalt flow; contains large plagioclase and augite megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°4′20″, 116°7′24″; Reveille Range, Nye County, NV). *Analytical data:* K = 0.999, 0.994, 0.987, 0.969, 0.972%; $*Ar^{40}$ = 6.757, 6.801, 6.867 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 73.7, 74.9, 75.4%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 3.99 ± 0.10 Ma

11. *R8-1-19-LN* K-Ar
Porphyritic olivine basalt flow; contains large plagioclase and augite megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°2′15″, 116°7′10″; Reveille Range, Nye County, NV). *Analytical data:* K = 0.911, 0.875, 0.840, 0.905, 0.874, 0.872, 0.854%; $*Ar^{40}$ = 6.387, 6.627, 6.240, 6.327 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 68.1, 66.2, 66.1, 66.9%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 4.15 ± 0.13 Ma

12. *R8-1-27-LN* K-Ar
Porphyritic olivine basalt plug; contains large plagioclase and augite megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°3′10″, 116°9′23″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.886, 1.809, 1.863, 1.833%; $*Ar^{40}$ = 9.939, 9.643, 9.594, 9.355 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 51.9, 50.5, 50.0, 48.6%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 3.00 ± 0.08 Ma

13. *R9-1-46-LN* K-Ar
Porphyritic olivine basalt flow; contains large augite and plagioclase megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide. (38°10′30″, 116°6′30″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.621, 1.580, 1.584, 1.582, 1.630%; $*Ar^{40}$ = 10.47, 10.66, 10.36, 10.30 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 38.3, 39.0, 38.1, 38.0%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 3.76 ± 0.11 Ma

14. *R9-1-58-LN* K-Ar
Porphyritic olivine basalt flow; contains large plagioclase and augite megacrysts in a holocrystalline matrix of coarse plagioclase, augite and Fe-oxide (38°7′17″, 116°5′45″; Reveille Range, Nye County, NV). *Analytical data:* K = 1.386, 1.343, 1.361, 1.371, 1.366%; $*Ar^{40}$ = 9.24, 9.51, 9.44, 9.22 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 57.2, 58.6, 58.3, 57.6%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah. *Comment:* This sample was collected from a flow that directly overlies pyroclastic deposits from the adjacent trachyte dome.
(plagioclase) 3.95 ± 0.12 Ma

Evolved Volcanic Rocks

15. *R8-1-16-LN* K-Ar
Tristanite dome containing plagioclase and sanidine (38°3′18″, 116°8′52″; Reveille Range, Nye County, NV). *Analytical data:* K = 3.617, 3.517, 3.687, 3.757, 3.556, 3.567%; $*Ar^{40}$ = 27.79, 27.41, 27.55, 27.37 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 86.4, 86.0, 86.5, 86.0%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 4.39 ± 0.18 Ma

16. *R8-1-43-LN* K-Ar
Trachyte flow containing sanidine and plagioclase phenocrysts in a matrix of green glass (38°7′45″, 116°5′20″; Reveille Range, Nye County, NV). *Analytical data:* K = 4.838, 4.841, 4.931%; $*Ar^{40}$ = 36.04, 35.79, 35.69, 35.96 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 65.2, 65.7, 65.4, 58.4%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.
(plagioclase) 4.24 ± 0.06 Ma

Miscellaneous Nye County Volcanic Rocks

17. *N9-SD-LN* K-Ar
Tristanite dome containing sanidine and plagioclase (37°41′30″, 115°56′30″; Nellis Bombing and Gunnery Range, Nye County, NV). *Analytical data:* K = 1.724, 1.720, 1.738, 1.727, 1.719, 1.715, 1.701%; $^{*}Ar^{40}$ = 41.96, 41.89, 42.47, 42.14 × 10^{-12} mol/gm; $^{*}Ar^{40}/\Sigma Ar^{40}$ = 83.4, 82.9, 83.7, 83.2%. *Collected by:* T. R. Naumann; *dated by:* M. Shafiqullah.

(plagioclase) 14.1 ± 0.14 Ma

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NEW K-Ar DATES FOR LATE MIOCENE TO EARLY PLIOCENE MAFIC VOLCANIC ROCKS IN THE LAKE MEAD AREA, NEVADA AND ARIZONA

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We report the results of 13 new K-Ar radiometric ages for basaltic andesites from the Callville Mesa volcanic field on the north shore of Lake Mead, Nevada, and basalts from the Fortification Hill volcanic field, Arizona and Nevada (fig. 1). These volcanic fields are located in the northernmost part of the Colorado River extensional corridor, an area of extensive Miocene igneous activity and upper crustal extension (e.g., Longwell and others, 1965; Anderson, 1971; Anderson and others, 1972; Bohannon, 1984; Smith and others, 1990).

CALLVILLE MESA VOLCANIC FIELD

The Callville Mesa (CM) volcanic field is exposed primarily on Black and Callville Mesas north of Lake Mead. Basaltic andesite erupted from compound cinder cones on Callville Mesa and in West End Wash between 10.46 to 8.49 Ma. These dates are slightly younger than the whole rock K-Ar dates of 11.3 ± 0.3 Ma and 11.1 ± 0.5 reported by Anderson and others (1972) for basaltic andesite of Callville Mesa.

Basaltic andesite of Callville Mesa locally overlies and is interbedded with the Red Sandstone unit (Bohannon, 1984), sandstone and conglomerate that was deposited in a structurally controlled basin in the upper plate of the Saddle Island detachment (Duebendorfer and others, 1990; Duebendorfer and Wallin, 1991). The basin and extensional allochthon are bounded to the north by the Las Vegas Valley Shear Zone (Duebendorfer and Wallin, 1991) (fig. 1). Callville Mesa basaltic andesite was erupted during the late stages of development of the Red Sandstone basin and represents the only volcanism during active upper

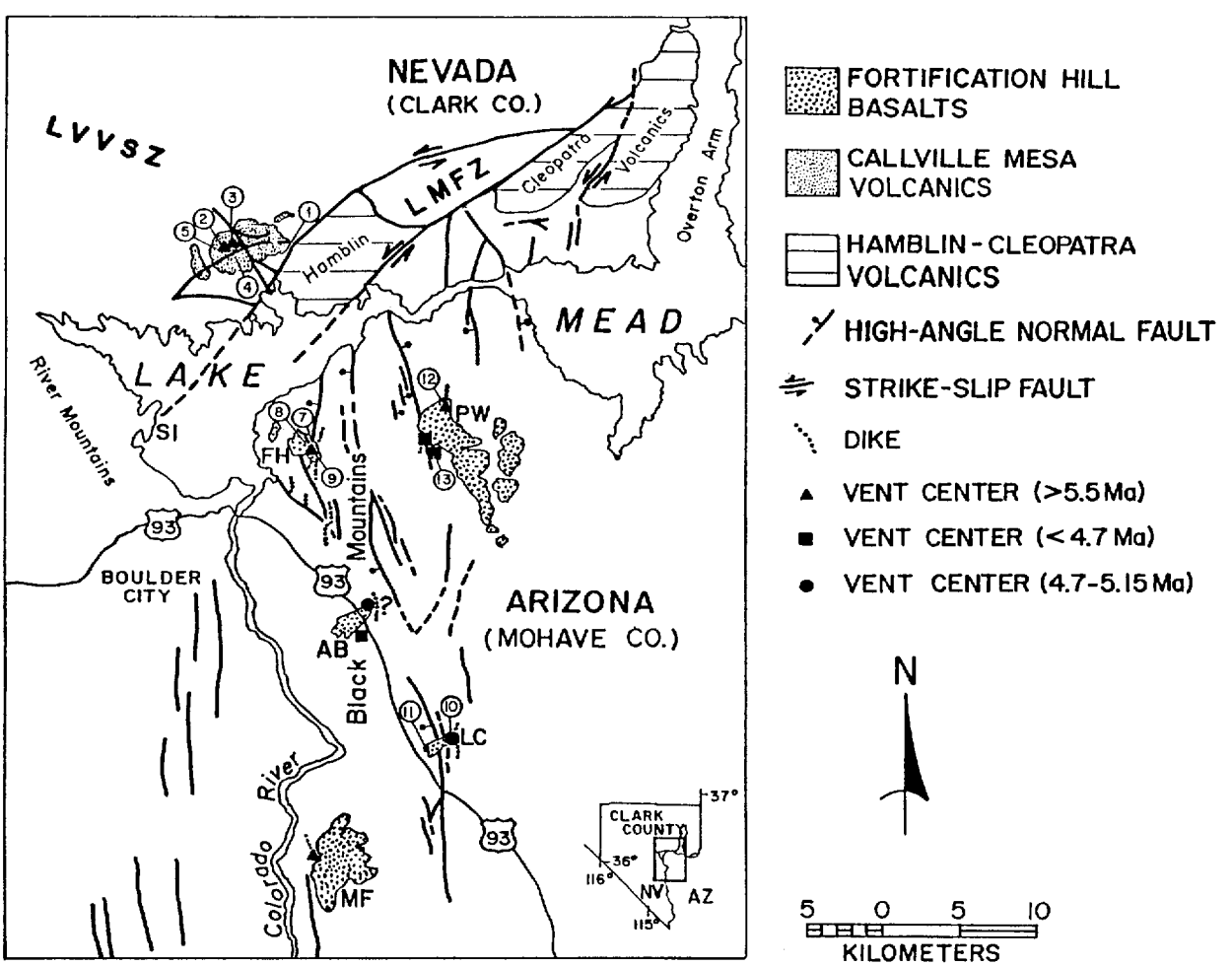

FIGURE 1. Generalized geologic map of the Lake Mead area, showing locations of samples for K-Ar dating. SI = Saddle Island; PW = Petroglyph Wash; FH = Fortification Hill; AB = alkalic basalt along U.S. 93; LC = Lava Cascade; MF = Malpais Flattop; LMFZ = the Lake Mead Fault Zone; LVVSZ = Las Vegas Valley Shear Zone.

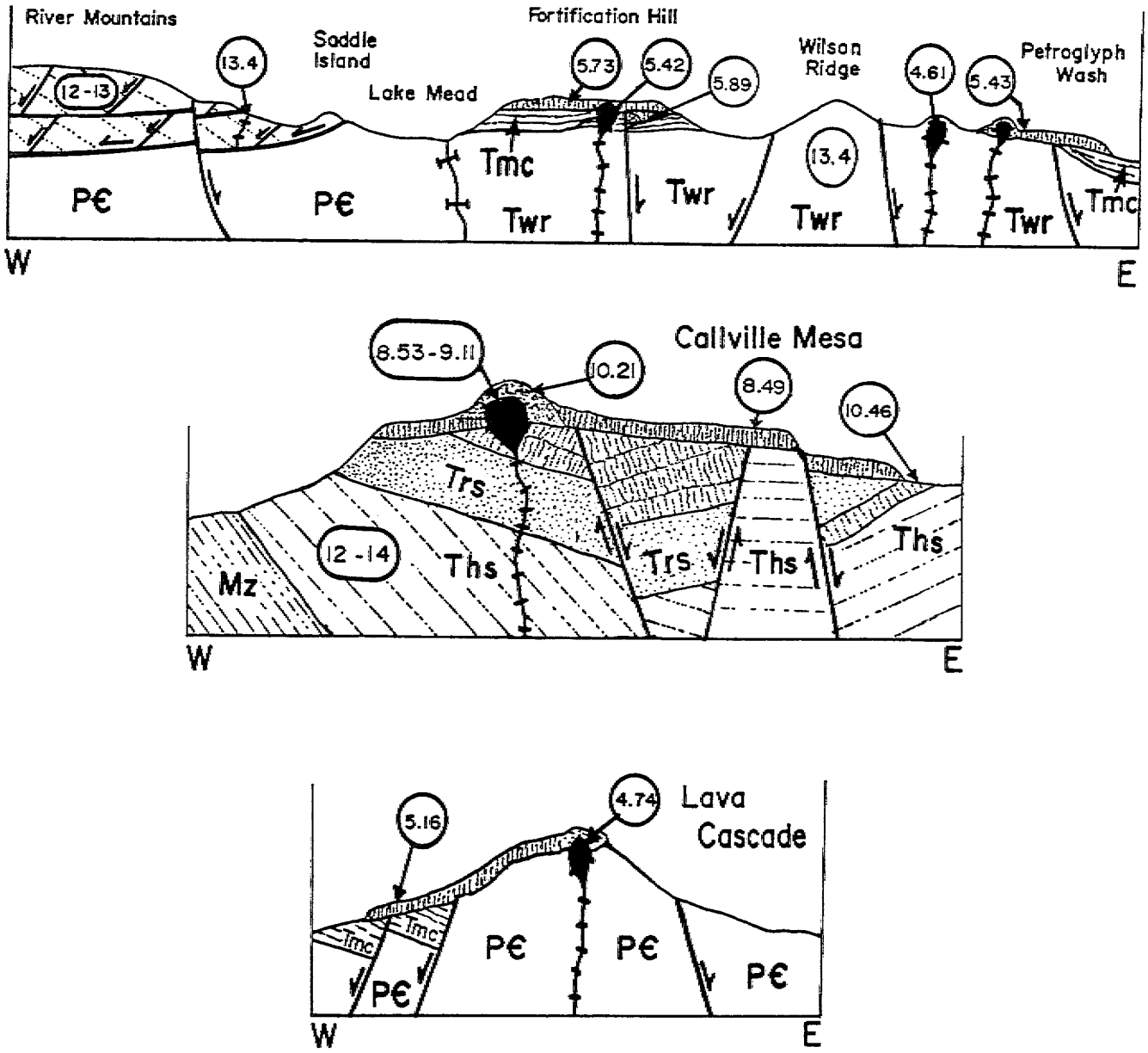

FIGURE 2. Cartoon cross sections showing stratigraphic relationships and major structures. The River Mountains are primarily intermediate volcanic flows and intrusive rock (Smith, 1982). Dates for the River Mountains from Anderson and others (1972) and Weber and Smith (1987). Tmc = Muddy Creek Formation (Late Tertiary clastic sediments). Trs = the Red Sandstone Unit (Tertiary clastic sediments); Ths = Tertiary Horse Spring Formation. Dates for the Horse Spring Formation from Bohannon (1984); Twr = Tertiary Wilson Ridge intrusive rocks. Date from Larson and Smith (1990); Mz = Mesozoic sediments; P€ = undifferentiated Precambrian rock.

crustal extension and stratal tilting in the Lake Mead area. Since basaltic andesite dated at 10.46 Ma is tilted and younger units (10.21 to 8.7 Ma) are not, the major phase of tilting related to motion on the Saddle Island detachment occurred after 10.46 Ma (fig. 2). In other parts of the Lake Mead area, stratal tilting may have occurred as early as 13 Ma (Bohannon, 1984).

FORTIFICATION HILL BASALT

The Fortification Hill basalt field comprises at least eight volcanoes that occur in a 75 km long north-northeast trending zone that extends from Malpais Flattop, Arizona to Black Point, Nevada. Tholeiite, calc-alkalic and alkalic basalt periodically erupted from 6.02 (this study) to 4.3 Ma (Anderson and others, 1972). The Fortification Hill basalts form the uppermost part of the Muddy Creek Formation (Longwell and others, 1965; Bohannon, 1984).

Subalkalic and alkalic basalts occur in the Fortification Hill field (FH). We divide FH basalt into three groups (table 1; refer to fig. 1 for locations): (1) Tholeiitic two-pyroxene basalt (6.02–5.71 Ma) (SAB) at Black Point and Malpais Flattop and subalkalic basalt at Fortification Hill (lower part of the section). (2) Alkali basalt (5.42 to 4.74 Ma) (OAB) at Fortification Hill (upper section), Petroglyph Wash and Lava Cascade. (3) Alkali basalt (4.61, this study; to 4.3 Ma, Anderson and others, 1972) (YAB) along U.S. 93 near Hoover Dam, Saddle Island and in Petroglyph Wash.

TABLE 1. The subalkalic and alkalic suites of mafic lavas in the Lake Mead area. Abbreviations are defined in the text.

Alkalic	*Sub-alkalic*	*Age (Ma)*
	Callville Mesa (CM)	10.46-8.49
	Black Point (SAB)	6.02
	Malpais Flattop (SAB)	5.8
Fortification Hill (OAB)	Fortification Hill (SAB)	5.89-5.42
Petroglyph Wash (OAB)		5.43
Lava Cascade (OAB)		5.16-4.74
Young Alkalic Basalt (YAB)		4.61-4.3

The transition from subalkalic to alkalic volcanism occurred during eruptions at Fortification Hill and occurred just prior to 5.42 Ma.

ANALYTICAL TECHNIQUES

All dates were obtained from groundmass plagioclase separates. Analytical procedures discussed by Damon and others (1983) were used in this study (constants: $\lambda_\beta = 4.963 \times 10^{-10}\ yr^{-1}$, $\lambda_\epsilon = 0.581 \times 10^{-10}\ yr^{-1}$, $\lambda = 6.544 \times 10^{-10}\ yr^{-1}$, $^{40}K/K = 1.167 \times 10^{-4}$ atom/atom).

ACKNOWLEDGEMENTS

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SAMPLE DESCRIPTIONS

Callville Mesa (CM)

1. *F8-24-100-LN* K-Ar
Olivine-pyrosene basalt flow (36°10′19″N, 114°42′30″W; just W of Callville Wash, Clark County, NV). *Analytical data:* K = 0.969, 0.951, 0.942, 0.963%; $^*Ar^{40}$ = 17.61, 17.33, 17.44, 17.15 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 62.2, 61.5, 61.3, 60.3%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This flow is interbedded with tilted Red Sandstone and represents the oldest activity associated with volcanism at Callville Mesa.
(plagioclase) 10.46 ± 0.23 Ma

2. *F8-24-88-LN* K-Ar
Basaltic andesite plug (36°10′33″N, 114°44′16″W; within volcanic center on Callville Mesa, Clark County, NV). *Analytical data:* K = 1.952, 1.978, 1.981, 1.952%; $^*Ar^{40}$ = 31.73, 31.50, 30.83, 30.37 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 41.5, 41.0, 40.4, 39.6%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This plug contains plagioclase megacrysts and xenocrysts of quartz.
(plagioclase) 9.11 ± 0.30 Ma

3. *F8-24-90-LN* K-Ar
Basaltic andesite plug (36°10′29″N, 114°43′52″W; within volcanic center on the W side of West End Wash, Clark County, NV). *Analytical data:* K = 1.794, 1.805, 1.819, 1.805%; $^*Ar^{40}$ = 26.52, 26.64, 27.10, 26.83 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 77.3, 77.4, 78.4, 78.0%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah.
(plagioclase) 8.53 ± 0.22 Ma

4. *F8-24-85-LN* K-Ar
Basaltic andesite flow (36°09′51″N, 114°43′57″W; upper flow on Callville Mesa, S of volcanic center, Clark County, NV). *Analytical data:* K = 2.070, 2.075, 2.081, 2.067, 2.071%; $^*Ar^{40}$ = 30.214, 30.474, 30.684, 30.870 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 79.0, 79.9, 80.4, 80.3. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This sample contains xenocrysts of quartz and alkali-feldspar and is the youngest rock dated in the Callville Mesa volcanic field.
(plagioclase) 8.49 ± 0.20 Ma

5. *88-24-146-LN* K-Ar
Basaltic andesite flow (36°10′37″N, 114°44′39″; flow on flank complex cinder cone on Callville Mesa, S of volcanic center, Clark Cunty, NV). *Analytical data:* K = 2.230, 2.227, 2.234, 2.242%; $^*Ar^{40}$ = 39.65, 39.34, 40.48, 39.04 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 88.4, 88.2, 92.4, 87.8%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah.
(plagioclase) 10.21 ± 0.23 Ma

Fortification Hill (SAB)

6. *87-10-129-LN* K-Ar
Olivine-pyroxene basalt flow (36°24′43″N, 114°23′02″W; flow directly E of feeder dike at Black Point, Clark County, NV). *Analytical data:* K = 0.655, 0.634, 0.639, 0.643%; $^*Ar^{40}$ = 6.93, 6.70, 6.84, 6.67 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 10.5, 10.1, 10.3, 10.1%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* Rocks from this exposure contain hypersthene and pigeonite as well as augite and olivine phenocrysts.
(plagioclase) 6.02 ± 0.39 Ma

7. *F7-38-13-LN* K-Ar
Olivine basalt flow (36°03′45″N, 114°40′56″W; lowest flow at Fortification Hill, Mohave County, AZ). *Analytical data:* K = 0.935, 0.922, 0.943, 0.927, 0.931%; $^*Ar^{40}$ = 9.446, 9.512, 9.616, 9.562 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 52.3, 52.6, 53.3, 52.9%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* Located at the north end of Fortification Hill.
(plagioclase) 5.89 ± 0.18 Ma

8. *87-38-142-LN* K-Ar
Olivine-plagioclase-pyroxene basalt flow (36°03′18″N, 114°40′54″W; flow erupted from cinder cones on Fortification Hill, Mohave County, AZ). *Analytical data:* K = 0.932, 0.925, 0.953%; $^*Ar^{40}$ = 9.45, 9.31, 9.22, 9.32 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 49.5, 48.5, 48.2, 48.7%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This flow lies stratigraphically above F7-38-13-LN.
(plagioclase) 5.73 ± 0.13 Ma

Fortification Hill (OAB)

9. *87-38-143-LN* K-Ar
Olivine-plagioclase-pyroxene basalt plug (36°03′02″N, 114°40′37″W; one of many plugs that intrude cinder cones on Fortification Hill, Mohave County, AZ). *Analytical data:* K = 1.275, 1.268, 1.280, 1.256%; $^*Ar^{40}$ = 11.85, 11.98, 12.02, 11.96 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 44.4, 44.5, 44.7, 44.3%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah.

Comment: A sample of a basalt plug that represents the youngest volcanism at Fortification Hill.

(plagioclase) 5.42 ± 0.13 Ma

10. *87-57-131-LN* K-Ar
Olivine basalt plug (35°52′38″N, 114°35′15″W; plug intruding vent center at Lava Cascase, Mohave County, AZ). *Analytical data:* K = 0.810, 0.793, 0.836%; $^*Ar^{40}$ = 6.69, 6.63, 6.75, 6.69 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 46.3, 46.0, 46.8, 46.1%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* Collected from a plug within the vent of the Lava Cascade at the summit of the Black Mountains.

(plagioclase) 4.74 ± 0.12 Ma

11. *87-57-132-LN* K-Ar
Olivine basalt flow (35°52′26″N, 114°36′06″W; distal end of flow at Lava Cascade, Mohave County, AZ). *Analytical data:* K = 0.857, 0.874, 0.892, 0.878%; $^*Ar^{40}$ = 8.00, 7.82, 7.74, 7.78 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 37.2, 35.9, 35.7, 35.8%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This sample was collected just east of U.S. 93.

(plagioclase) 5.16 ± 0.14 Ma

12. *F8-42-82-LN* K-Ar
Olivine basalt flow (36°04′37″N, 114°35′44″W; flow at from cinder cone at Petroglyph Wash, Mohave County, AZ). *Analytical data:* K = 1.298, 1.268, 1.240, 1.267%; $^*Ar^{40}$ = 11.68, 12.01, 12.03, 12.14 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 52.3, 53.4, 53.5, 53.8%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* The cinder cone is located just south of Gilbert Wash near the junction with James Bay Wash.

(plagioclase) 5.43 ± 0.16 Ma

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K-Ar AND FISSION-TRACK AGES (DATES) OF VOLCANIC INTRUSIVE, ALTERED, AND METAMORPHIC ROCKS IN THE MOHAVE MOUNTAINS AREA, WEST-CENTRAL ARIZONA

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The Mohave Mountains and adjacent ranges of west-central Arizona (fig. 1) occupy a key area for unraveling the evolution of Tertiary tectonics in the Colorado River extensional corridor. The area lies in the east part of the north-trending, 100-km-wide corridor, and flanks a belt of metamorphic core complexes that define the center of the corridor (Davis and others, 1980; Howard and John, 1987). Field studies in the Mohave Mountains area indicate a record of extension-related Tertiary intrusion, volcanism, sedimentation, detachment faulting, tectonic fragmentation, and tilting (Howard and others, 1982a, in press; Pike and Hansen, 1982; Nakata, 1982; Light and others, 1983; Nielson, 1986; Nielson and Glazner, 1986; Howard and John, 1987; Nielson and Beratan, in press). The dating was carried out partly to support an appraisal of mineral-resource potential (Light and others, 1983). Preliminary K-Ar dates reported earlier (Light and others, 1983; Nielson, 1986; Glazner and others, 1986) are here fully documented, and in some cases have been corrected. Corrections follows discovery by Nakata of a spike calibration error.

In this paper we report 57 conventional K-Ar and 7 fission-track ages (dates) on 52 rock samples located in figure 2. We term those with mixed cooling histories dates, following Armstrong (1966), to emphasize that they do not necessarily correspond to emplacement ages. Dated rocks include 13 volcanic, 14 dike, 6 granitoid, and 9 gneissic rocks and 6 rocks that experienced alteration related to mineralizing processes. Materials dated by K-Ar were: biotite, sanidine, plagioclase, muscovite, sericite, hornblende, and whole rocks. Zircon was dated by fission tracks. Figure 3 divides the dated rocks into four sample groups and presents histograms of the ages, identified by the material dated.

These ages help to calibrate the time of Tertiary deposition and deformation, constrain the timing of different styles of Tertiary magmatism, and provide age information helpful for interpreting Tertiary uplift, Mesozoic alteration and intrusion, and cooling of Proterozoic rocks. We interpret ages of events from these dates within the framework of our working model established by field studies from 1979 to 1987.

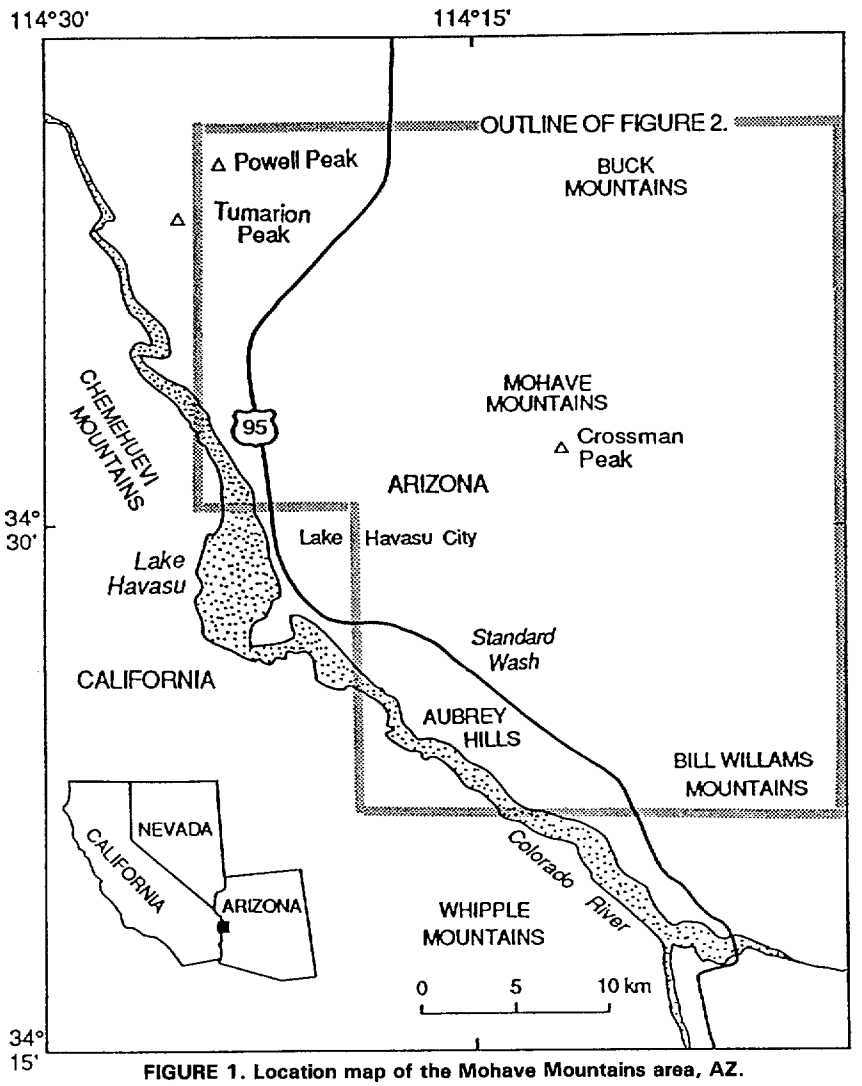

FIGURE 1. Location map of the Mohave Mountains area, AZ.

The ages on volcanic rocks (figs. 3a, 4) in most cases are consistent with or close to the crystallization age inferred from regional geologic relations, although dates on some hornblende and sanidine separates seem too young. Tertiary and Mesozoic dikes and stocks (fig. 3b) yielded biotite ages that in many cases are geologically consistent as emplacement ages but, whole-rock, plagioclase, and hornblende dates are nearly all variant. Secondary muscovite from altered gneiss yielded dates that can be interpreted as near the age of alteration, but finer grained low-K_2O sericite and zircon yielded younger dates. Dates determined from biotite and zircon (fission-track) on

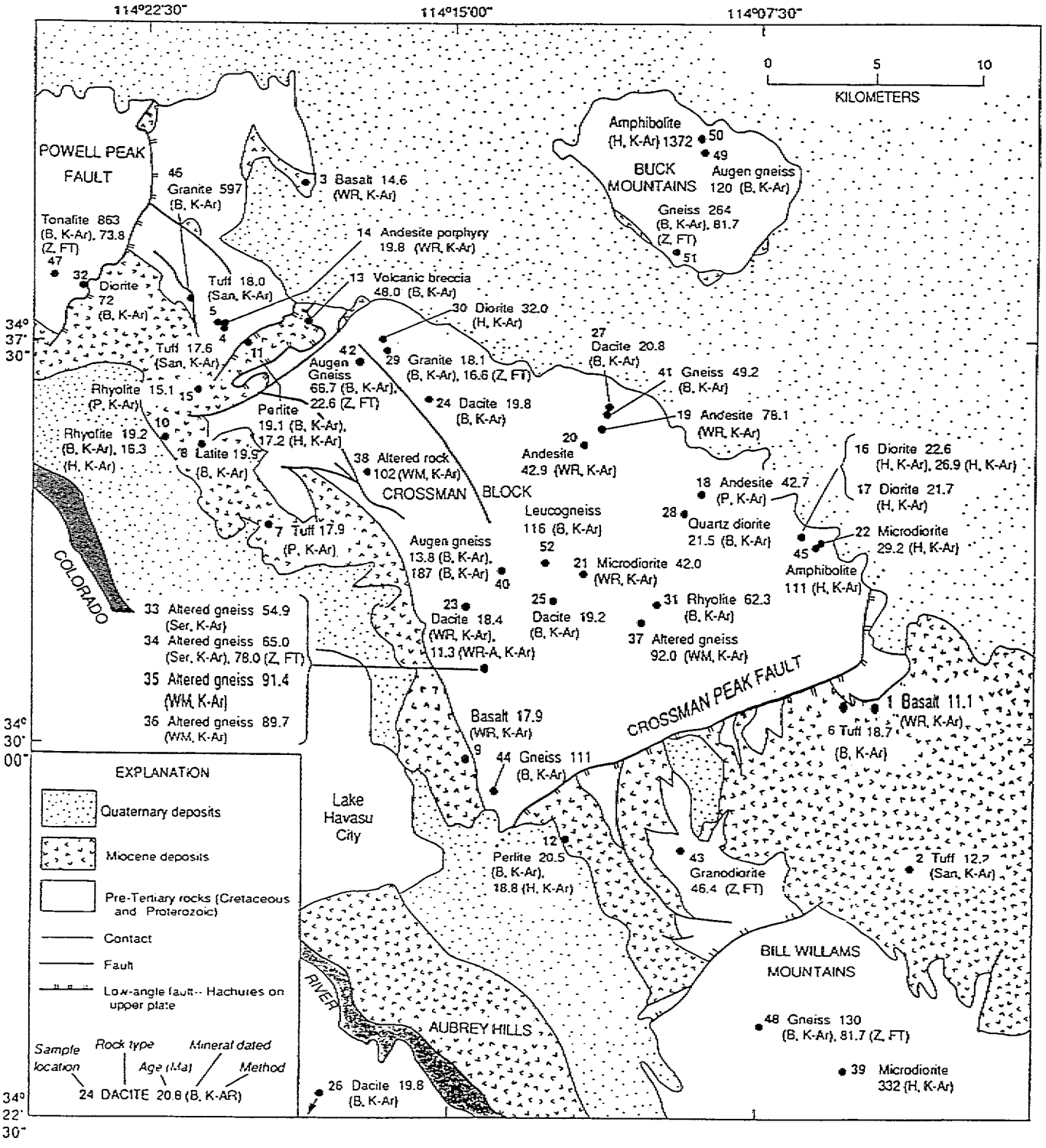

FIGURE 2. Simplified geologic index map of the Mohave Mountains area showing sample localities and dates except for sample number 26, which was collected from the Whipple Mountains west of the map area. The northwest-southeast trending Mohave Mountains dike swarm is not portrayed for graphic simplicity. The mineral and rock abbreviations are as follows: B = biotite, H = hornblende, P = plagioclase, San = sanidine, Ser = sericite, WR = whole rock, WM = white mica, Z = zircon.

Proterozoic rocks are all younger than the original crystallization age.

If cooling is relatively slow and excess radiogenic products are not incorporated by the minerals, those species with lower blocking temperatures will give younger ages than those with higher blocking temperatures. A common order of progressively decreasing closure or annealing temperatures is: hornblende (K-Ar), muscovite (K-Ar), biotite (K-Ar) and zircon (fission-track) (Armstrong 1966; Turner and Forbes 1976; Harrison and others 1979; and Hurford 1986). This order varies depending upon the extraction technique used to determine the blocking temperature (Harrison and Fitzgerald 1986; Gaber and others 1988). Other factors that complicate interpretation of the numerical age include rate of cooling, mineral structure, and availability of excess radiogenic argon from external sources.

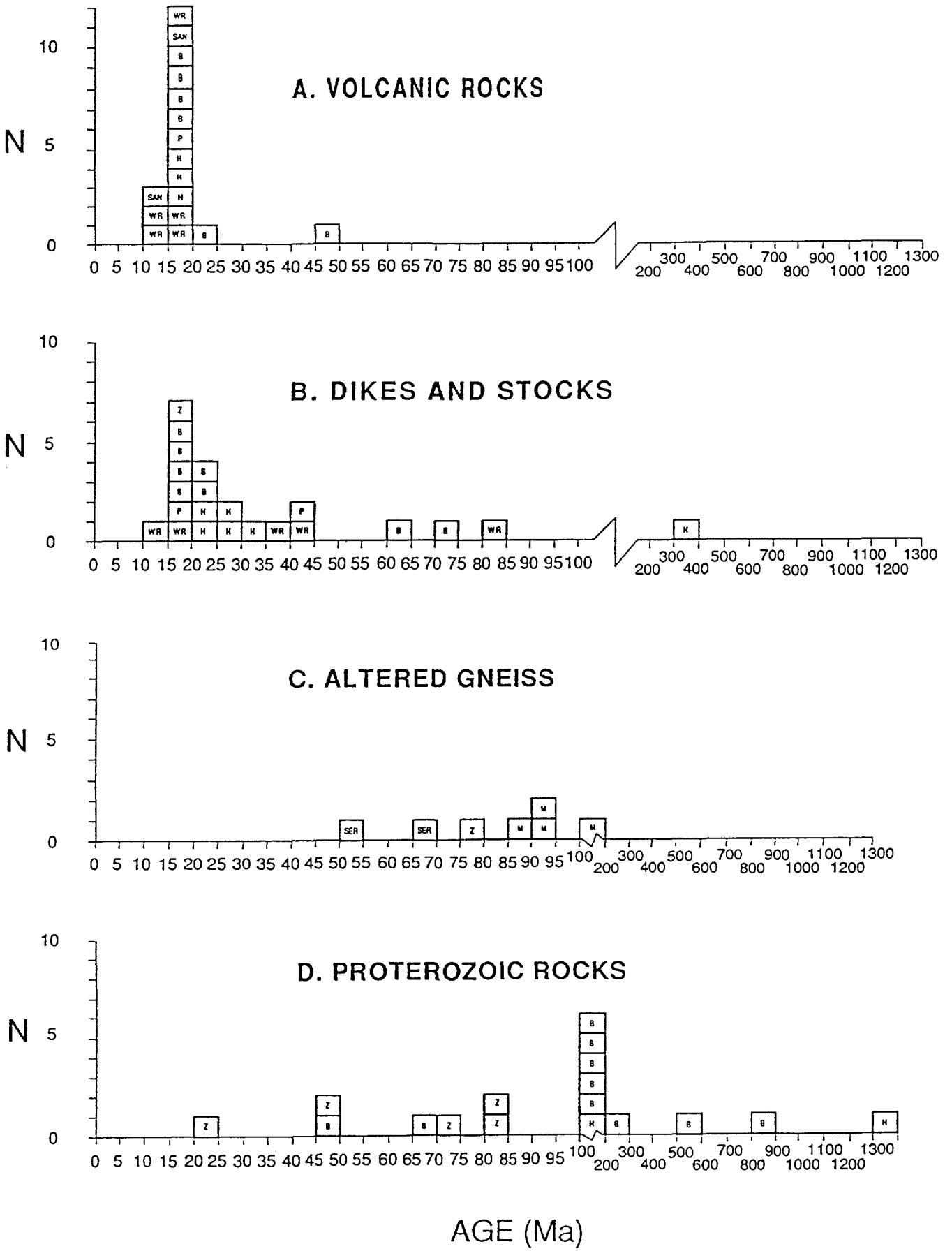

FIGURE 3. Histograms of dates, divided into four groups of samples. Abbreviations: (K-Ar) WR = whole rock, H = hornblende, P = plagioclase, San = sanidine, B = biotite, M = muscovite, Ser = sericite; (fission-track) Z = zircon.

GEOLOGIC FRAMEWORK

The Mohave, Buck, and Bill Williams Mountains expose Proterozoic gneisses and intrusive rocks, Mesozoic intrusive rocks, Tertiary dikes, and Neogene volcanic and sedimentary rocks (fig. 2). Paleozoic and Mesozoic strata that are present elsewhere in the region were stripped prior to the middle Tertiary, so that the pre-Tertiary rocks are overlain nonconformably by volcanic and clastic rocks of Miocene and Oligocene(?) age. In the Mohave Mountains a swarm of northwest-trending dikes intrudes the pre-Tertiary rocks and lower parts of the Tertiary section. The dikes occupy about 16 percent of the central Mohave Mountains east of Lake Havasu City, where their total thickness is about 2 km (Nakata, 1982).

Angular unconformities in the lower Miocene section document progressive westward tilting due to extensional growth faults. The younger strata are little tilted or faulted, in contrast to the older units, which commonly dip at steep angles and are locally overturned. Tilting of fault blocks was unidirectional to the southwest. The Crossman Peak fault and the probably equivalent Powell Peak fault are both normal faults with moderate dips. They juxtapose numerous fault-bounded blocks 1 to 2 km thick in their hanging walls against large rotated crustal blocks as much as 15 km across. These large blocks form the central Mohave Mountains (Crossman block), Bill Williams Mountains, and Powell Peak/Tumarion Peak area. The structurally equivalent Whipple Mountains and Chemehuevi faults, in exposures near the Colorado River, project beneath these large rotated blocks (Howard and others, 1982a, 1987, in press; Howard and John, 1987).

VOLCANIC ROCKS

Conventional K-Ar ages of volcanic rocks (figs. 3a and 4) help to constrain the time of tilting and faulting as well as to calibrate the magmatism. Nielson (1986) divided the pre-Pliocene Tertiary section into four sequences numbered: I, II, III and IV, from oldest to youngest.

The Peach Springs Tuff of Young and Brennan (1974) is the only unit of regional extent found in the Mohave Mountains area. It is a single cooling unit of welded tuff that outcrops in an area of at least 280 by 170 km (Glazner and others, 1986; Wells and Hillhouse, 1989). The Peach Springs has yielded a spread of K-Ar ages (Young and Brennan, 1974, Glazner and others, 1986), but studies using the $^{40}Ar/^{39}Ar$ technique indicate its emplacement age is 18.5 ± 0.2 Ma (Nielson and others, 1990).

The youngest rocks dated are olivine basalt (sample no. 1) at 11.1 ± 0.3 Ma (whole rock), and an underlying silicic tuff (no. 2) dated at 12.7 ± 0.6 Ma (sanidine); both are included in sequence IV. These rocks have southwest dips of 5° to 15° and contain normal faults with down-to-the northeast displacements in contrast with much steeper to overturned beds in the underlying Miocene strata. The change in dip marks the waning stages of deformation following extreme extensional faulting and tilting that affected the older rocks. Suneson and Lucchitta (1979, 1983) reported similar ages for basalt and rhyolite that occur a few kilometers to the southeast of samples no. 1 and 2, in the Castaneda Hills; they reported a age of 8.6 Ma for an undeformed basalt flow 8 km southwest of sample no. 1 (fig. 2).

A 14.6 ± 0.4 Ma whole-rock age was determined on a steeply dipping olivine basalt lava flow in a fault block in the

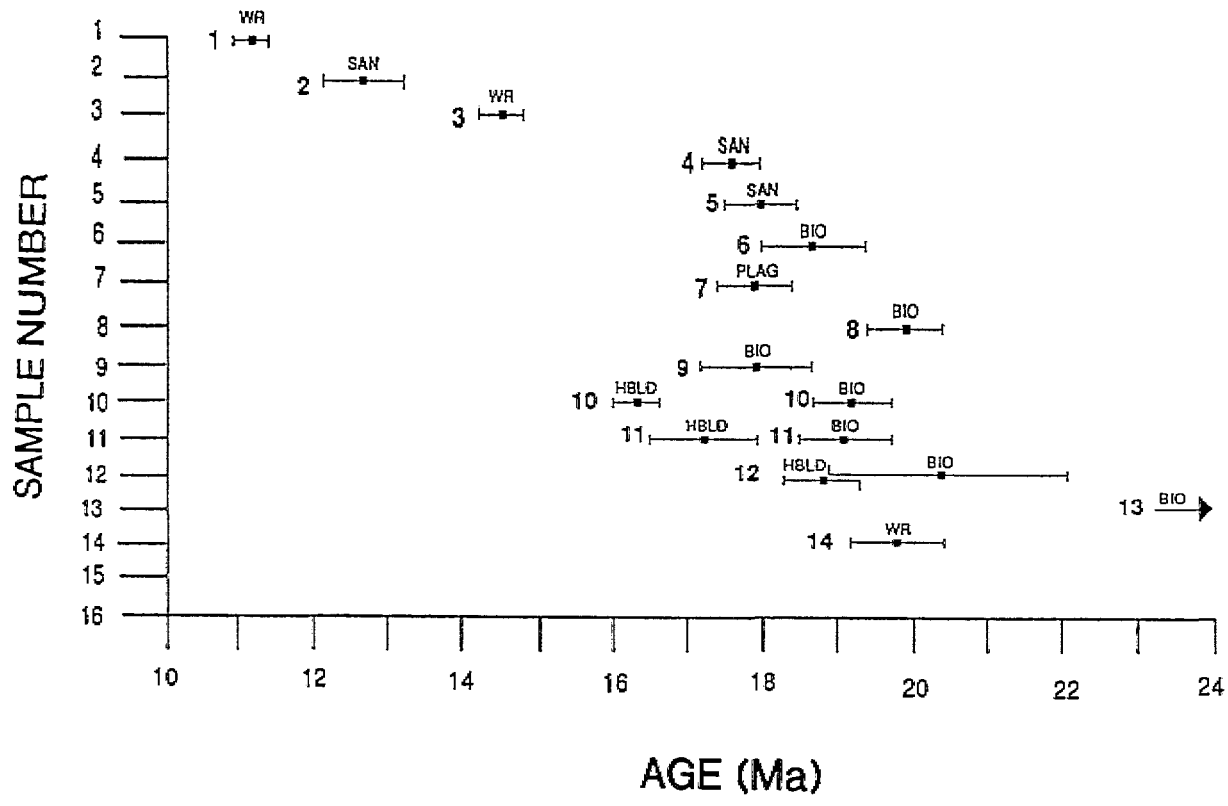

FIGURE 4. K-Ar ages (error bars) for volcanic rocks, arranged by sample number along the ordinate in approximate order of increasing stratigraphic age. A geologically anomalous date of 48.0 ± 1.2 Ma (no. 13) is not shown.

northern Mohave Mountains (no. 3). The basalt overlies and dips the same direction as volcanic rocks of sequence I and is overlain by moderately dipping arkosic sandstone of sequence III. Similar olivine basalt flows both underlie and overlie the Peach Springs Tuff nearby in the same fault block. This association suggests that the dated basalt may be close in age to the Peach Springs age of 18.5 Ma reported by Nielson and others (1990). If the 14.6-Ma K-Ar age correctly dates the basalt, alternatively then its steep dip implies that this fault block tilted since 14.6 Ma. This age of tilting is not inconsistent with the time of tilting of laterally equivalent units in adjacent areas; for example, 55 km to the northnorthwest in the Sacramento Mountains 14.6 Ma, and the Dead Mountains later than 12.2 Ma (Spencer, 1985). Major tilting ceased by 13 Ma 20 km to the south in the Whipple Mountains region (Davis and others, 1980; Dickey and others, 1980).

Major tilting of some large fault blocks, including the Crossman block of the central Mohave Mountains (fig. 2), occurred earlier. Gently dipping (100) rocks dated at 17.9 ± 0.7 Ma (plagioclase, no. 7) and 19.9 ± 0.5 Ma (biotite, no. 8) unconformably overlie vertical to moderately tilted older Miocene strata (sequence I) that are part of that upended block. Within the estimated precision (± 0.5 Ma) the age on no. 8 overlaps a biotite age on the underlying sequence (19.2 ± 0.5 Ma, no. 10), which suggests that the unconformity age is within the overlap, about 19.5 Ma. The section containing samples 7 and 8 lacks the Peach Springs Tuff, which elsewhere is an important regional marker (Glazner and others, 1986).

The Peach Springs Tuff in other fault blocks of the study area commonly dips at moderate angles, and overlies sequence I with slight angular discordance. Within the map area the Peach Springs Tuff yielded K-Ar sanidine dates of 17.6 ± 0.4 and 18.0 ± 0.5 Ma (nos. 4 and 5), and a rock tentatively identified as belonging to the Peach Springs Tuff yielded a biotite age of 18.7 ± 0.7 Ma (no. 6). The young K-Ar dates on the sanidine may reflect incomplete recovery of argon during extraction because of high sample viscosities, as suggested by McDowell (1983) and G. B. Dalrymple (written communication, 1986).

Volcanic rocks that are or thought to be stratigraphically below the Peach Springs Tuff yielded K-Ar dates ranging from 16.3 ± 0.4 to 48 ± 1.2 Ma (nos. 9-14), but the most reliable lie between 18 and 21 Ma. A basalt (no. 9) dated at 17.9 ± 0.7 Ma occurs in sequence I where the Peach Springs Tuff is absent. It may be a sill that post-dates eruption of the Peach Springs. A "turkey-track"-textured porphyry with altered composition (no. 14) yielded a geologically reasonable whole-rock age of 19.8 ± 0.6 Ma. Three rhyolitic rocks (nos. 10, 11, 12) yielded biotite ages of 19.2 ± 0.5, 19.1 ± 0.6 and 20.5 ± 1.6 Ma, but consistently younger hornblende dates of 16.3 ± 0.4, 17.2 ± 0.7 and 18.8 ± 0.5 Ma; repeated extractions showed similar results. Miller and Morton (1980) found that 35 percent of their 45 biotite-hornblende pairs from the southern Mojave Desert, California, yielded younger hornblende dates because at standard extraction temperature (1,200° to 1,400° C) the refractory hornblende was not completely fused. Like theirs, our samples were run before the availability of water-cooled extraction bottles which allow higher fusing temperatures. All our samples appeared fused, but dates are systematically younger than biotite by as much as 15 percent, suggesting incomplete recovery of argon. A whole-rock K-Ar age of 21.5 Ma was reported by W. Rehrig for a mafic lava flow low in sequence I (Pike and Hansen, 1982; Nielson, 1986; Nielson and Beratan, 1990). One silicic breccia (no. 13) yielded an anomalously old date on biotite of 48 ± 1.2 Ma, from which contamination by xenocrystic biotite is suspected. Based on ages that we consider the most reliable, the age of the part of the volcanic section lower than the Peach Springs Tuff (sequence I of Nielson, 1986) is concluded to be about 19 to 22 Ma. This age span matches that for fresh rocks of similar stratigraphic position dated from the Turtle and Stepladder Mountains, 50 km west of the study area (Howard and others 1982b; Nielson and Glazner, 1986).

We conclude, based on these data and on biotite ages from dies and stocks (see below), that a suite of basaltic, andesitic, dacitic, latitic, and rhyolitic rocks were intruded and erupted in the early part of the extensional event between about 19 and 22 Ma. After the rhyolitic Peach Springs Tuff was deposited across the area at 18.5 Ma, magmatism in the area produced mainly olivine basalt and rhyolite through the late stages of deformation from 15 to 12 Ma and the cessation of deformation between 8 and 12 Ma.

DIKES AND STOCKS

Dike rocks yielded a wide variety of dates, only a few of which seem consistent with geological evidence for the age of emplacement. Most of the dates appear to be too old, and may reflect excess argon derived from the Proterozoic host rocks and incorporated in the younger intrusive rocks. For nonvolcanic rocks we regard the K-Ar ages on potash-rich mica as minimum ages and relatively insensitive to excess argon.

A 15.1-Ma plagioclase age is taken as the emplacement age of a distinctive thick rhyolitic dike (no. 15) that cuts Miocene volcanic and sedimentary rocks. Its trend, outcrop style, and subvolcanic character are different from dikes in the Mohave Mountain dike swarm.

The Mohave Mountains dike swarm is interpreted as having intruded at about 20 Ma on the basis of (a) similar biotite ages (19.8 ± 0.5, 19.8 ± 0.2, 20.8 ± 0.5 Ma, nos. 24, 25, 27) on dacitic dikes, (b) a biotite age of (19.8 ± 0.5 Ma, no. 26) on a similar dike from the possibly correlative Chambers Well dike swarm in the Whipple Mountains, California, and (c) intrusion of the swarm into the lower part of the volcanic section of sequence I. A diorite dike in Proterozoic rocks, which cuts other dikes of the Mohave Mountains swarm, yielded hornblende dates of 22.6 ± 0.7 (no. 16), 26.9 ± 0.7 (flux added to no. 16), and 21.7 ± 0.7 (no. 17). These dates (no. 16 and no. 16 w/flux) are older than seem likely for the emplacement age because the dike swarm is intrusive into part of sequence I. Other intermediate-composition dikes from the Mohave Mountains dike swarm yielded discordant hornblende, plagioclase, and whole-rock dates ranging from 11.3 ± 0.3 to 78.1 ± 2.0 Ma (nos. 18-23). We do not interpret these as emplacement ages. A small body of quartz diorite (no. 28) that grades into a mafic dike of the dike swarm yielded a biotite age of 21.5 ± 0.5 Ma, in agreement with most other biotite ages from dikes and with the geologically interpreted emplacement age.

Evidence of Laramide-age (Cretaceous to earliest Tertiary) magmatism is provided by ages on a rhyolite dike and a granitoid porphyry apophysis. Except for its northeast-trend, the rhyolite dike (no. 31), resembles rocks of the middle Tertiary dike swarm. It yielded an age of 62.3 ± 1.6 Ma on biotite. The porphyry (no. 32), which yielded a biotite age of 72.0 ± 1.8 Ma, is satellitic to a granodiorite pluton at Powell Peak, which is tentatively correlated to biotite granodiorite of Late Cretaceous age in the Chemehuevi Mountains (Howard and others, 1982a; John, 1988; John and Mukasa, 1990). Further independent support for an age of about 72.0 Ma (no. 32) for the Powell Peak pluton is a

73.8 ± 7.7-Ma zircon fission-track date on a nearby Proterozoic rock which yielded a biotite date of 863 ± 21.6-Ma (no. 47). We infer that the ambient temperature in the local Proterozoic rocks was colder than the blocking temperature for biotite, but was thermally perturbed by emplacement of the pluton and its satellites at about 72-74 Ma.

Ages on a small diorite stock and associated younger granite, which resembles Late Cretaceous granites in the region, are harder to interpret (nos. 30 and 29). The diorite yielded a hornblende date of 32.0 ± 1.0 Ma and the granite yielded a biotite (K-Ar) date of 18.1 ± 0.5 Ma and zircon fission-track date of 16.6 ± 1.7 Ma. The dates are younger than mica and zircon cooling ages in most of the rest of the Crossman Peak fault block, and suggest the possibility of Tertiary emplacement.

A microdiorite dike which cuts an augen gneiss in the Bill Williams Mountains yielded a hornblende date of 332 ± 16 Ma (no. 39), which is not a crystallization age because Paleozoic sections in nearby regions exhibit no evidence of magmatism (Stone and others, 1983). The dike could be Tertiary, Mesozoic, or most likely Precambrian in age.

ALTERED ROCKS

Ages were measured on white mica from six intensely altered and sericitized Proterozoic rocks associated with metalliferous mineralization, (Light and others, 1983) in order to investigate the age of mineralization (fig. 3c). The white mica replaced feldspars during the alteration event. Four of the white mica samples were muscovite coarser than 0.1 mm. These micas have normal K_2O contents of 10.5 to 11.2 percent (nos. 35, 36, 37, and 38) and yielded dates of 91.4 ± 2.3, 89.7 ± 2.2, 92.0 ± 2.3, and 102 ± 2.6 Ma. The other two samples were sericitic mica finer than 0.1 mm, which yielded younger K-Ar dates of 65 and 55 Ma (nos. 34 and 33). The two younger dates correlate approximately linearly with lower K_2O contents when compared with the muscovite dates. The sericite that yielded the youngest date (55 Ma) has a K_2O content of only 6.7 percent, whereas the next older (65 Ma) one has an intermediate K_2O content of 8.9 percent. McDougall and Harrison 1988 suggest that low-K_2O sericites may in fact be illite or hydromuscovite. The sericite may record cooling through lower blocking temperatures than does the muscovite. If so, a measure of the sericite blocking temperature for argon retention may be a zircon fission-track date for the sericite sample (no. 34) of intermediate-K_2O content. Zircons in the sample seem to represent 2 populations. The fission-track age of 78 ± 9 Ma although crude nevertheless slightly exceeds the sericite K-Ar age and suggests that this sericite retained argon only at or below the annealing temperature for fission tracks in zircon, on the order of 2000 (Harrison and others, 1979; Hurford, 1986). The lower-K_2O sericite (no. 33) from the same locality, with the youngest apparent age, may record a lower cooling temperature yet.

The muscovite dates between 90 and 102 Ma are crudely concordant. Because they occur at different pre-tilting structural depths, we suspect that they may approximate the age of the alteration event rather than younger cooling, which would be expected to vary systematically with structural depth. An age of alteration of about 100 Ma would be consistent with dates obtained from plutons in the Turtle Mountains and from an upper plate adamellite in the Whipple Mountains (Davis and others, 1980; Howard and others, 1982b): both localities are near restored pre-extension positions of the Mohave Mountains fault blocks (Howard and others 1982a).

PROTEROZOIC ROCKS

Dates determined on altered Proterozoic rocks (fig. 3d) can be interpreted as mixed cooling ages. The regional Proterozoic rock suite is known to comprise Early Proterozoic gneisses and granitoids and Middle Proterozoic granitoids and diabase (Lanphere 1964; Howard and others, 1982b; Anderson, 1983; in press; Wooden and others, 1988). Granodiorite, tentatively correlated with the Middle Proterozoic granodiorite of Bowmans Wash of Anderson (1983), yielded a fission track date on zircon of 46.4 ± 5.4 Ma (no. 43). Rocks assigned to the Early Proterozoic by Howard and others (1982a; in prep.) (samples 40 to 42 and 44 to 52) yielded hornblende K-Ar dates ranging from 104 ± 2.6 to 1372 ± 34 Ma, biotite K-Ar dates ranging from 49.2 ± 10.5 to 863 ± 21.6 Ma, and zircon fission-track dates ranging from 22.6 ± 1.9 to 81.7 ± 8.7 Ma. These dates are taken to imply cooling of some rocks as recently as the Miocene. An analysis of cooling and uplift patterns is in progress.

ANALYTICAL METHODS

K-Ar

The K-Ar age determinations were made in the isotope laboratories of the U.S. Geological Survey at Menlo Park, California, using the methods described by Dalrymple and Lanphere (1969). Argon was extracted on an ultrahigh vacuum system by fusion; the reactive gases were then scrubbed by an artificial molecular sieve, Cu-CuO and Ti metals.

The spectrometry was performed on a Nier-type, 15-cm radius, 60° sector and a multichannel, 23-cm radius, 90° sector mass spectrometers, both operated in the static mode. Argon was analyzed by comparing the liberated gas to a "pure" ^{38}Ar spike of known volume and composition added during fusion. The decay constants used are those published by Steiger and Jager (1977):

$^{40}K/K$	1.67×10^{-4} mol/mol
λ ($^{40}K_b$-)	4.962×10^{-10} yr^{-1}
λ (^{40}Ke) + λ' (^{40}Ke)	0.581×10^{-10} yr^{-1}

Flame photometry with a lithium internal standard was used to analyze potassium using the procedure described by Cremer and others (1984). All samples were run in duplicate to check precision.

Radiogenic argon ($^{40}Ar^*$) as a percent of total argon ($\Sigma^{40}Ar$) may differ by as much as 17 percent from replicate analysis of the same sample on different extraction lines, with different bakeout times, spike sets and the total amount of sample used. These factors contribute varying atmospheric components and thereby lead to an apparent discrepancy in the radiogenic argon percentages from one extraction to the next. However, the total atmospheric components are subtracted and the final age calculations are based on radiogenic Ar concentration measured in moles/gram, which differ by no more than 3 percent.

The 2.5-3.0 percent (±)error represents a conservative estimate of the overall analytical precision for samples with greater than 10 percent radiogenic argon. This is based on empirical tests over a period of 14 years at the U.S. Geological Survey Isotope laboratory in Menlo Park, California, (Tabor and others 1985). All samples run prior to 1980 have an error of 3.0 percent; at this time a change to digital readouts decreased the error to 2.5 percent. For results averaged from determinations on two splits of the same sample, the error reflects the same conservative 2.5–3.0 percent estimates at ± 1 standard deviation and 68-percent confidence level. However, agreement

between replicate analysis were usually less then 2 percent. For those samples with greater than 3 percent error between replicate analysis the dates were averaged and a standard deviation was calculated and reported to ± 1 standard deviation.

Fission Track

The external detector method was used to date the zircons (Naeser, 1976, 1979), which were mounted in Teflon and etched in a eutectic melt of KOH-NaOH (Gleadow and others, 1976) at 215°C for 30–50 hours. The Teflon mounts were covered with a muscovite detector and irradiated along with neutron dose monitors (U-doped glasses SRM 962 also covered with muscovite detectors) in the U.S. Geological Survey TRIGA reactor at Denver, Colorado. The neutron dose was determined using track densities in the muscovite detectors and the Cu calibration for SRM 962 (Carpenter and Reimer, 1974). The errors shown for the fission-track dates are ± 2 standard deviations.

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SAMPLE DESCRIPTIONS

1. *P81MH-8a* K-Ar
Olivine basalt (34°30′44″N, 114°04′27″W; S31,T14N,R17W; Buck Mountains SE 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 1.326%, 1.317%, 1.337%; $^{40}Ar^*$ = 2.16 × 10^{-11} mol/gm, 2.09 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 45%, 34%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Gently dipping basalt flow, sequence IV; caps Black Mountain. Holocrystalline subophitic basalt containing phenocrysts of olivine, clinopyroxene, and plagioclase. Age is revised from 10.6 Ma age reported by Nielson (1986).
(whole rock) 11.1 ± 0.3 Ma

2. *JP82MH-23* K-Ar
Silicic tuff (34°27′36″N, 114°33′36″W; S17,T13N,R17W; Parker Dam 15′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 9.03%, 9.06%; $^{40}Ar^*$ = 1.66 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 63%. *Argon analysis:* J. K. Nakata. *Collected by:* J. E. Nielson. *Comments:* Flow-banded tuff, sequence IV, not welded, with sanidine as sole crystals; no lithic clasts present.
(sanidine) 12.7 ± .6 Ma

3. *H81MH-18* K-Ar
Olivine basalt (34°40′55″N, 114°18′42″W; S36,T14N,R20W; Franconia 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 1.846%, 1.861%, 1.854%; $^{40}Ar^*$ = 3.87 × 10^{-11} mol/gm, 3.95; × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 62%, 64%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Steeply dipping basalt, sequence II. Overlies intermediate-composition volcanic rocks (sequence I of Nielson, 1986) and underlies steeply dipping arkosic sandstone and conglomerate (sequence III of Nielson, 1986) that contains clasts of the olivine basalt. Intergranular to diktytaxictic texture. Glass content less than 5%. Rock generally fresh. Olivine rimmed by iddingsite. Age is revised from 14.1 Ma age reported by Nielson (1986).
(whole rock) 14.6 ± 0.4 Ma

4. *JP80MH-192* K-Ar
Peach Springs Tuff (34°37′49″N, 114°21′10″W; S22,T15N,R20W; Franconia 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 9.09%, 9.06%, 9.08%; $^{40}Ar^*$ = 2.34 × 10^{-10} mol/gm, 2.30 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 72%, 64%. *Argon analysis:* J. K. Nakata. *Collected by:* J. E. Nielson. *Comments:* Salmon-pink crystal-lithic tuff breccia, unwelded, sequence IV; occurs above bedded tuff (altered pumice fragments). Sanidine is dominant crystal. Age is revised from 16.7 Ma and 17.8 Ma ages reported by Nielson (1986).
(sanidine) 17.6 ± 0.4 Ma

5. *P81MH-2* K-Ar
Peach Springs Tuff (34°37′54″N, 114°21′21″W; S22,T15N,R20W; Franconia 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 9.36%, 9.35%, 9.32%, 9.46%; $^{40}Ar^*$ = 2.40 × 10^{-10} mol/gm, 2.48 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 67%, 87%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* Strongly welded crystal-lithic rhyolite tuff, sequence II. Phenocrysts are sanidine and lesser biotite, opaques, hornblende, and sphene. Sanidine is euhedral and fresh. Date is revised from 17.4 Ma date reported by Nielson (1986).
(sanidine) 18.0 ± 0.5 Ma

6. *JP81MH-159* K-Ar
Silicic tuff (34°30′41″N, 114°05′11″W; S31,T14N,R17W; Standard Wash 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.04%, 8.05%; $^{40}Ar^*$ = 2.22 × 10^{-10} mol/gm, 2.14 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 37%, 54%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* In fault block that exposes bedded rocks of sequence I of Nielson (1986). Flattened pumice fragments show no preferred orientation. Probably the Peach Springs Tuff, sequence II.
(biotite) 18.7 ± 0.7 Ma

7. *JP81MH-388B* K-Ar
Silicic tuff (34°33′50″N, 114°19′27″W; S11,T14N,R20W; Lake Havasu City N 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 1.19%, 1.17%, 1.18%; $^{40}Ar^*$ = 3.06 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 31%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* Overlies the flow sampled as JP81MH-378. Gently dipping. Ashy matrix contains relatively fresh plagioclase and fused-appearing biotite. Silicified. Flow-banded.
(plagioclase) 17.9 ± 0.5 Ma

8. *JP81MH-378* K-Ar
Andesitic flow (34°35′25″N, 114°21′08″W; S33,T15N,R20W; Havasu City N 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.34%, 8.33%, 8.32%; $^{40}Ar^*$ = 2.34 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 69%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* Fine-grained groundmass with large (6-mm) phenocrysts and clusters of phenocrysts. Contains relatively unaltered biotite in addition to altered plagioclase and clinopyroxene and emphibole.
(biotite) 19.9 ± 0.5 Ma

9. *JP81MH-14a* K-Ar
Basalt (34°39'42"N, 114°14'34"; S3, T13N,R19W; Standard Wash 7.5' quad., Mohave Co., AZ. *Analytical data:* K_2O = .93%, .92%; $^{40}Ar^*$ = 2.33 × 10^{-11} mol/gm, 2.44 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 37%, 41%. *Argon analysis:* J. K. Nakata. *Collected by:* J. E. Nielson. *Comments:* Flow or dike in sequence I of Nielson (1986). Porphyritic olivine basalt; holocrystalline groundmass. Plagioclase laths, clinopyroxene and olivine in granular opaques and alterations indicate chlorite. Olivine is fine-grained. Age is revised from 17.8 Ma age reported by Nielson (1986).
(whole rock) 17.9 ± 0.7 Ma

10. *P81MH-296* K-Ar
Rhyolite flow (34°35'31"N, 114°22'01"W; S33N,T15N,R20W; Lake Havasu City N 7.5' quad., Mohave Co., AZ). *Analytical data:* (biotite) K_2O = 8.54%, 8.55%; $^{40}Ar^*$ = 2.37 × 10^{-10} mol/gm, 2.03 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 48.9%, 13.8%; (hornblende) K_2O = 0.866%, 0.858%; $^{40}Ar^*$ = 2.03 × 10^{-11} mol/gm, 2.02 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 14%, 10%. *Argon analysis:* J. K. Nakata. *Collected by:* J. E. Nielson. *Comments:* In sequence I of Nielson (1986). Medium-grained matrix with large plagioclase phenocrysts and glomerophenocrysts; mafic phenocrysts are relatively fresh; hornblende is green.
(biotite) 19.2 ± 0.5 Ma
(hornblende) 16.3 ± 0.4 Ma

11. *P80MH-223* K-Ar
Rhyolitic perlite (34°37'31"N, 114°20'02"W; S20,T15N,R20W; Franconia 7.5' quad., Mohave Co., AZ). *Analytical data:* (biotite) K_2O = 8.34%, 8.32%; $^{40}Ar^*$ = 2.31 × 10^{-10} mol/gm, × 10^{-10} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 53.5%, 63.6%; (hornblende) K_2O = .82%, .80%; $^{40}Ar^*$ = 2.08 × 10^{-11} mol/gm, 1.93 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 19%, 22%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* Base of rhyolite flow in sequence I of Nielson (1986). Dark, perlitic glass, containing 2-mm-sized biotite. Previously reported as sample JP81-123 (Nielson, 1986).
(biotite) 19.1 ± 0.6 Ma
(hornblende) 17.2 ± 0.7 Ma

12. *JP80MH-139* K-Ar
Rhyolitic perlite (34°28'14"N, 114°12'02"W; S13,T13N,R19W; Standard Wash 7.5' quad., Mohave Co., AZ). *Analytical data:* (biotite) K_2O = 8.46%, 8.43%; $^{40}Ar^*$ = 2.44 × 10^{-10} mol/gm, 2.35 × 10^{-10} mol/gm, 2.71 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 75%, 66%, 60%; (hornblende) K_2O = 0.710%, 0.694%; $^{40}Ar^*$ = 1.93 × 10^{-11} mol/gm, 1.88 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 10%, 11%. *Argon analysis:* J. K. Nakata. *Collected by:* J. E. Nielson. *Comments:* Base of rhyolite flow in sequence I of Nielson (1986). Glassy, perlitic groundmass with abundant plagioclase and biotite phenocrysts and accessory hornblende.
(biotite) 20.5 ± 1.6 Ma
(hornblende) 18.8 ± 0.5 Ma

13. *JP81MH-361* K-Ar
Silicic volcanic breccia (34°37'57"N, 114°18'34"W; S24,T15N,R20W; Franconia 7.5' quad., Mohave Co., AZ). *Analytical data:* K_2O = 7.33%, 7.31%; $^{40}Ar^*$ = 5.12 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 80%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* Breccia contains plagioclase and biotite crystals, recrystallized quartz, clasts of vitrophyre containing plagioclase, biotite, and magnetite phenocrysts, clasts of porphyry containing biotite and altered plagioclase, and clasts of tuff, sequence I. *Date is considered much older than geologically reasonable* and may indicate the presence of xenocrystic biotite.
(biotite) 48.0 ± 1.2 Ma

14. *P80MH-187* K-Ar
Latite (34°37'53"N, 114°21'08"W; S22, T15N,R20W; Franconia 7.5' quad., Mohave Co., AZ). *Analytical data:* K_2O = 3.04%, 3.06%, 3.08%, 3.03%; $^{40}Ar^*$ = 8.72 × 10^{-11} mol/gm, 8.75 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 86%, 88%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. E. Nielson. *Comments:* Platioclase-pyroxene-phyric "turkey-track" or "jackstraw" porphyry; holocrystalline. Apatite very abundant. Plots in latite field using normative minerals, may have had andesitic affinities before alteration. High K_2O may indicate potassium enrichment from metasomatism.
(whole rock) = 19.8 ± 0.6 Ma

15. *P81MH-1* K-Ar
Rhyolitic dike (34°36'01"N, 114°21'12"W; S28, T15N,R20W; Lake Havasu City N 7.5' quad., Mohave Co., AZ). *Analytical data:* K_2O = 0.679%, 0.679%, 0.676%; $^{40}Ar^*$ = 0.158 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 53%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Southwestern pinnacle of a line of pinnacles formed by 100-m-thick dike, on west side of Arizona highway 95. Flow-banded rhyolite containing phenocrysts of plagioclase, K-feldspar, quartz, biotite, hornblende, sphene, and apatite. Plagioclase is euhedral and fresh; grain size 1–2 mm. Age is revised from 16.2 Ma age reported by Nielson (1986).
(plagioclase) = 15.1 ± 0.4 Ma

16. *JN-81MH-90-2* K-Ar
Diorite dike (34°33'39"N, 114°06'20"W; S12, T14N,R18W; Buck Mountains SE 7.5' quad., Mohave Co., AZ). *Analytical data:* (hornblende) K_2O = 0.782%, 0.789%; $^{40}Ar^*$ = 2.57 × 10^{-10} mol/gm, (with flux) 3.06 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 14%; (with flux) 25%. *Argon analysis:* J. K. Nakata. *Collected by:* J. K. Nakata. *Comments:* Northeast trending dike that cuts other nearby dacitic and andesitic dikes. Fine- to medium-grained hypidiomorphic granular texture. Hornblende is fresh with some alteration to chlorite. Second analysis used flux and H_2O-cooled bottle for fusion, and therefore would be expected to be more accurate. *Both dates are suspected to be older than the geologic age of emplacement.*
(hornblende) 22.6 ± 0.7 Ma
(with flux) 26.9 ± 0.7 Ma

17. *JN-81MH-90-2A* K-Ar
Diorite dike (34°33'39"N, 114°06'20"W; S12, T14N,R18W; Buck Mountains SE quad., Mohave Co., AZ). *Analytical data:* K_2O = 0.78%, 0.78%; $^{40}Ar^*$ = 2.46 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 12%. *Argon analysis:* J. K. Nakata. *Collected by:* J. K. Nakata. *Comments:* Same dike as JN-81MH-90-2. Fine-grained hypidiomorphic granular texture.
(hornblende) 21.7 ± 0.7 Ma

18. *BLM-139-8* K-Ar
Andesitic dike (34°34'30"N, 114°08'47"W; S3, T14N,R18W; Crossman Peak 7.5' quad., Mohave Co., AZ). *Analytical data:* K_2O = 1.426%, 1.434%; $^{40}Ar^*$ = 8.9 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 57%. *Argon analysis:* J. K. Nakata. *Collected by:* J. K. Nakata. *Comments:* Trachytic-textured (turkey-track); mafic minerals are altered to chlorite. *Date is considered to be older than the likely geological age of emplacement.*
(plagioclase) 42.7 ± 1.1 Ma

19. *BLM-163-35* K-Ar
Andesitic dike (34°35'45"N, 114°11'15"W; S31, T15N,R18W; Crossman Peak 7.5' quad., Mohave

Co., AZ). *Analytical data:* K_2O = 2.382%, 2.464%; $^{40}Ar^*$ = 2.83 × 10^{-10} mol/gm, 2.74 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 78%, 78%. *Argon analysis:* J. K. Nakata. *Collected by:* J. K. Nakata. *Comments: Date is considered to be older than the likely geological age of emplacement.*

(whole rock) 78.1 ± 2.0 Ma

20. *BLM-163A* K-Ar
Andesitic dike (34°35′18″N, 114°11′37″W; S26, T15N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 2.20%, 2.15%; $^{40}Ar^*$ = 1.36 × 10^{-10} mol/gm, 1.36 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 70%, 70%. *Argon analysis:* J. K. Nakata. *Collected by:* J. K. Nakata. *Comments: Date is considered to be older than the likely geological age of emplacement.*

(whole rock) 42.9 ± 1.1 Ma

21. *P81MH-15B* K-Ar
Microdiorite dike (34°32′58″N, 114°11′38″W; S13,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 2.83%, 2.80%, 2.87%, 2.85%; 1.77 × 10^{-10} mol/gm, 1.61 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 47%, 45%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Dike 3-m thick, trends NE and dips N. Cuts ore and quartz veins in the Sunset mine. Fine grained, intergranular microdiorite, consisting of plagioclase (altered), brown hornblende, magnetite, interstitial quartz, and secondary epidote, chlorite, and calcite. Color index 25. *Date is considered to be older than the likely geological age of emplacement.*

(whole rock) 39.9 ± 1.0 Ma

22. *H83MH-66* K-Ar
Microdiorite dike (34°33′34″N, 114°05′49″W; S13,T14N,R18W; Buck Mountains SE 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 0.978%, 0.984%; $^{40}Ar^*$ = 4.15829 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 39%. *Argon analysis:* J. K. Nakata. *Collected by:* K. A. Howard. *Comments:* NW-trending dike, east of jeep trail. Cuts gneiss and amphibolite (sampled as H83MH-67). Fine-grained microdiorite consisting of plagioclase, brown hornblende, interstitial epidote and quartz, and secondary calcite. Color index 40. Hornblende is brown, subhedral, acicular; grain size 0.5–2 mm. *Date is suspected to be older than the likely geological age of emplacement.*

(hornblende) 29.2 ± 0.7 Ma

23. *BLM-190-8* K-Ar
Felsic dike (34°32′N, 114°15′W; S22,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* (whole rock, fine fraction) K_2O = 5.23%, 5.22%; $^{40}Ar^*$ = 1.39 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 35%; (whole rock, coarse fraction, acid-treated) K_2O = 5.08%, 5.01%; $^{40}Ar^*$ = 8.23 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 52%. *Argon analysis:* J. K. Nakata. *Collected by:* J. K. Nakata. *Comments:* Acid-treated coarse fraction (−35 +60 mesh) gives younger date than nonacid-treated fine fraction (−60 +140 mesh). Argon may have been lost preferentially over potassium during acid treatment thereby giving a younger date.

(whole rock) 18.4 ± 0.5 Ma
(acid-treated) 11.3 ± 0.3 Ma

24. *H81MH-5* K-Ar
Dacite dike (34°36′19″N, 114°15′32″W; S28, T15N,R19W; Lake Havasu City 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 7.97%, 7.95%, 7.97%; $^{40}Ar^*$ = 2.28 × 10^{-10} mol/gm, 2.30 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 70%, 64%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Microcrystalline groundmass and 25% phenocrysts of altered plagioclase, biotite, and K-feldspar. Biotite is interleaved with chlorite and opaques, and less commonly included with hematite and sphene.

(biotite) 19.8 ± 0.5 Ma

25. *H81MH-39* K-Ar
Dacite dike (34°32′29″N, 114°12′21″W; S24, T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.02%, 8.01%, 7.85%, 8.00%; $^{40}Ar^*$ = 2.24 × 10^{-10} mol/gm, 2.20 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 70%, 66%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Dike 0.5 m thick; cuts augen gneiss. Biotite phenocrysts in microcrystalline matrix; biotite is fresh, subhedral, and has a grain size of 1 mm.

(biotite) 19.8 ± 0.2 Ma

26. *H81WH-62* K-Ar
Dacite dike (34°16′10″N, 114°29′03″W; S8, T2N,R24E; Whipple Mountains SW 7.5′ quad., San Bernardino Co., CA). *Analytical data:* K_2O = 9.07%, 9.09%, 9.07%, 9.08%; $^{40}Ar^*$ = 2.63 × 10^{-10} mol/gm, 2.58 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 79%, 68%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* In Chambers Well dike swarm (Davis and others, 1980; 1982). Beside Chambers Well road in southern exposures of lower plate of the Whipple Mountains detachment fault (Carr and others, 1980). Microcrystalline groundmass contains 25% phenocrysts of plagioclase, biotite, sphene, and altered hornblende. Biotite is fresh, subhedral, and has a grain size 0.5–1 mm.

(biotite) 19.8 ± 0.5 Ma

27. *H82MH-15* K-Ar
Dacite dike (34°36′13″N, 114°11′02″W; S31, T15N,R18W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 7.95%, 7.99%; $^{40}Ar^*$ = 2.43 × 10^{-10} mol/gm, 2.35 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 76%, 71%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Dike 5–8 m thick, beside jeep trail. Intrudes granulitic gneiss (sample H82MH-16). Microcrystalline groundmass and 25% phenocrysts of sericitized plagioclase, biotite, K-feldspar, and opaques. Biotite is interleaved with chlorite and opaques. Age is revised from 19.7-Ma age reported by Nielson (1986).

(biotite) 20.8 ± 0.5 Ma

28. *H81MH-57B* K-Ar
Quartz diorite (34°34′14″N, 114°09′04″W; S9, T14N,R18W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 6.82%, 6.90%, 6.73%, 6.75%; $^{40}Ar^*$ = 2.16 × 10^{-10} mol/gm, 2.08 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 76%, 80%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Dike, associated with leucocratic hornblende quartz diorite. Cuts gneiss. In Burro Canyon. Medium-grained melanocratic biotite-hornblende quartz diorite. Potassium content is slightly low for biotite.

(biotite) 21.5 ± 0.5 Ma

29. *H80MH-310* K-Ar and fission-track
Granite (34°37′21″N, 114°16′36″W; S20, T15N,R19W; Lake Havasu City N 7.5′ quad., Mohave Co., AZ). *Analytical data:* (biotite) K_2O = 8.62%, 8.54%; $^{40}Ar^*$ = 2.24 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 57%. *Argon analysis:* M. A. Pernokas. Fission-track (zircon, 6 grains) Ps = 2.69 × 10^6 tracks/cm² (641); Pi = 9.58 × 10^6 tracks/cm² (1144); d = 9.91 × 10^{14} n/cm²; U = 300 ppm. *Counted by:* J. S. Shannon. *Collected by:* K. A. Howard. *Comments:* Small stock of medium-grained sphene-hornblende-biotite monzogranite. Color index 6. Associated with and cuts diorite sampled at station (no. 30) H80MH-311.

K-Ar (biotite) 18.1 ± 0.5 Ma
fission-track (zircon) 16.6 ± 1.7 Ma

30. *H80MH-311* K-Ar
Diorite (34°37′33″N, 114°16′42″W; S20, T15N,R19W; Franconia 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 0.47%, 0.46%, 0.49%, 0.49%; $^{40}Ar^*$ = 0.22 × 10^{-10} mol/gm, 0.22 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 19%, 17%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Medium-grained hornblende diorite in small stock. Intruded by and associated with granite sampled at station (no. 29) H80MH310. Color index 52. Hornblende is euhedral to subhedral, and has brown cores and green rims.
(hornblende) 32.0 ± 1.0 Ma

31. *P81MH-20* K-Ar
Rhyolite dike (34°32′26″N, 114°09′49″W; S20, T14N,R18W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.91%, 8.90%, 8.87%, 8.90%; $^{40}Ar^*$ = 8.10 × 10^{-10} mol/gm, 8.14 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 86%, 84%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* ENE-trending dike 3.5 m thick. Cuts gneiss in the Jupiter mine area. Microcrystalline matrix and 30% phenocrysts of quartz, plagioclase, biotite, microcline, and sphene. Biotite is medium-grained (1–2 mm), subhedral, and intergrown with muscovite and abundant includions of apatite, zircon, and calcite.
(biotite) 62.3 ± 1.6 Ma

32. *H81MH-154* K-Ar
Quartz monzodiorite porphyry (34°40′29″N, 114°24′15″W; S1,T15N,R20½W; Topoc 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 7.87%, 7.81%; $^{40}Ar^*$ = 8.24 × 10^{-10} mol/gm, 8.35 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 86%, 83%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Satellitic to Cretaceous granodiorite pluton that underlies Powell Peak. Light gray. Occurs in with similar appearing granite that is cut by Proterozoic(?) pegmatites containing retrograded garnets. Medium grained. Plagioclase mostly euhedral. Color index 6. Biotite is fresh.
(biotite) 72.0 ± 1.8 Ma

33. *P81MH-21B* K-Ar
Sericite-quartz rock (34°31′14″N, 114°14′05″W; S27,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 6.70%, 6.73%, 6.66%; $^{40}Ar^*$ = 5.39 × 10^{-10} mol/gm, 5.35 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 89%, 92%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Highly altered gneiss from shear zone at stope entrance. Pittsburg mine area. Quartz is foliated. Hematite disseminated and fills fractures. Sericite is very fine-grained (0.01–0.1 mm). Sericitic patches may represent altered feldspar.
(sericite) 54.9 ± 1.4 Ma

34. *P81MH-21C* K-Ar and fission-track
Quartz-sericite rock (34°31′14″N, 114°14′05″W; S27,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* (sericite) K_2O = 8.90%, 8.86%, 8.82%; $^{40}Ar^*$ = 8.48 × 10^{-10} mol/gm, 8.40 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 85%, 84%. *Argon analysis:* M. A. Pernokas. Fission-track (zircon, 7 grains) Ps = 12.2 × 10^5 tracks/cm² (1209); Pi = 9.85 × 10^5 tracks/cm² (454); d = 9.55 × 10^{14} n/cm²; U = 289 ppm. *Counted by:* J. R. Shannon. *Collected by:* M. A. Pernokas. *Comments:* Veined rock inside stope, Pittsburg mine area. Contains some opaques, K-feldspar, and zircon. Sericite is mostly very fine-grained less than 0.05 mm. Zircons examined for fission tracks strongly zoned; appear to be two populations; date is based on grains having poor intersection and geometry.
K-Ar (sericite) 65.0 ± 1.6 Ma
fission-track (zircon) 78.0 ± 9.0 Ma

35. *P81MH-21A* K-Ar
Sericitized granitic augen gneiss (34°31′14″N, 114°14′05″W; S27,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 10.58%, 10.56%, 10.53%, 10.55%; $^{40}Ar^*$ = 1.44 × 10^{-9} mol/gm, 1.41 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 96%, 94%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Borders a quartz vein near the Pittsburg mine. Highly altered medium- to coarse-grained gneiss. Contains much sericite, clays, and less chlorite and hematite. White mica occurs as fine-grained aggregated crystals (0.1–1 mm grain size).
(white mica) 91.4 ± 2.3 Ma

36. *P82MH-21D* K-Ar
Muscovite-quartz vein (34°31′14″N, 114°14′05″W; S27,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 11.12%, 10.91%, 10.93%, 10.92%; $^{40}Ar^*$ = 1.46 × 10^{-9} = × 10^{-9} mol/gm, 1.44 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 92%, 95%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* White mica concentration along margins of a small quartz vein in augen-gneiss host rock; bottom back side of stope, Pittsburg mine area. White mica averages 0.2 mm in grain size, includes very fine opaques, and occurs as subhedral to anhedral grains.
(white mica) 89.7 ± 2.2 Ma

37. *K81MH-36* K-Ar
Sericitized gneiss (34°32′06″N, 114°10′14″W; S20,T14N,R18W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 10.48%, 10.49%, 10.42%; $^{40}Ar^*$ = 1.42203 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 94%. *Argon analysis:* M. A. Pernokas. *Collected by:* R. D. Knox. *Comments:* Sericitized coatings on joints in sericitized granite gneiss, from hanging wall within 1 m of vein, at prospect near Jupiter mine. Sericite is fine- to medium-grained in gneiss, and joint coatings are coarse-grained muscovite books.
(white mica) 92.0 ± 2.3 Ma

38. *K81MH-62A* K-Ar
Quartz-sericite rock (34°34′33″N, 114°17′04″W; S6,T14N,R19W; Lake Havasu City N 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 11.1%, 11.1%, 11.3%, 11.1%; $^{40}Ar^*$ = 1.66 × 10^{-9} mol/gm, 1.70 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 92%, 96%. *Argon analysis:* M. A. Pernokas. *Collected by:* R. D. Knox. *Comments:* Altered rock near quartz vein, 100 m N of Wing mine. Rock contains opaques. White mica is as coarse as 0.5 mm.
(white mica) 102 ± 2.6 Ma

39. *G81BW-167* K-Ar
Microdiorite dike (34°23′33″N, 114°05′09″W; S12,T12N,R15W; Parker Dam 15′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 0.821%, 0.823%; $^{40}Ar^*$ = 4.16 × 10^{-9} mol/gm, 4.48 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 80%, 86%. *Argon analysis:* M. A. Pernokas. *Collected by:* J. W. Goodge. *Comments:* Cuts augen gneiss. Fine grained hornblende diorite, containing biotite, clinopyroxene, and sphene. Color index 45. Amphibole is concentrated in the dike center, suggesting igneous sorting. Amphibole is green, subhedral, fine grained (0.5 mm), and may be metamorphic.
(hornblende) 332 ± 16.3 Ma

40. *H87MH-29* K-Ar
Augen gneiss (34°33′02″N, 114°13′38″W; S14,T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.4%, 8.39%; $^{40}Ar^*$ = 1.67 × 10^{-10} mol/gm, 2.41 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 95%, 92%. *Argon analysis:* J. K. Nakata. *Collected by:* K. A. Howard. *Comments:* More than 6 m from the nearest dike in a densely diked zone. Hornblende-biotite granodiorite augen gneiss. Color index 8. Biotite is lepidoblastic and fresh.
(biotite) 188 ± 4.7 Ma

41. *H82MH-16* K-Ar
Granulitic gneiss (34°36′11″N, 114°11′05″W; S31, T15N,R18W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.71%, 8.74%; $^{40}Ar^*$ = 7.62 × 10^{-10} mol/gm, 4.91 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 84%, 82%. *Argon analysis:* M. A. Pernokas. *Collected by:* K. A. Howard. *Comments:* Along jeep trail, several dike widths from dike sampled as H82MH-15 (no. 27).
(biotite) 49.2 ± 10.5 Ma

42. *P81MH-6* K-Ar and fission-track
Granodiorite augen gneiss (34°37′12″N, 114°17′17″W; S19,T15N,R19W; Lake Havasu City N 7.5′ quad., Mohave Co., AZ). *Analytical data:* K-Ar (biotite) K_2O = 8.26%, 8.19%, 8.26%, 8.22%; $^{40}Ar^*$ = 7.98 × 10^{-10} mol/gm, 8.13 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 74%, 89%. *Argon analysis:* M. A. Pernokas. Fission-track (zircon, 7 grains) Ps = 3.72 × 10^6 tracks/cm² (1190); Pi = 10.10 × 10^6 tracks/cm² (1619); d = 1.03 × 10^{15} n/cm²; U = 304 ppm. *Counted by:* J. R. Shannon. *Collected by:* M. A. Pernokas. *Comments:* Medium grained, seriate gneiss. Color index 10. Biotite occurs as subhedral books, and is fresh except for a few percent interleaved with chlorite.
K-Ar (biotite) 66.7 ± 1.7 Ma
fission-track (zircon) 22.6 ± 1.9 Ma

43. *P81MH-9* fission-track
Granodiorite (34°25′01″N, 114°09′08″W; S16,T13N,R18W; Lake Standard Wash 7.5′ quad., Mohave Co., AZ). *Analytical data:* (zircon, 7 grains) Ps = 3.43 × 10^6 tracks/cm² (839); Pi = 4.40 × 10^6 tracks/cm² (539); d = 1.00 × 10^{15} n/cm²; U = 137 ppm. *Counted by:* J. R. Shannon. *Collected by:* M. A. Pernokas. *Comments:* Dark, medium- to fine-grained biotite-hornblende granodiorite, probably Proterozoic in age. Color index 15. Abundant opaques.
(zircon) 46.4 ± 5.4 Ma

44. *P81MH-22* K-Ar
Porphyritic granite gneiss (34°29′10″N, 114°13′46″W; S10,T13N,R19W; Standard Wash 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 7.97%, 7.96%; $^{40}Ar^*$ = 1.30 × 10^{-9} mol/gm, 1.33 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 87, 93%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Medium- to coarse-grained biotite syenogranite gneiss. Biotite is olive-colored, anhedral, fine-grained (0.1–1 mm), and includes opaques along cleavage.
(biotite) 111 ± 2.8 Ma

45. *H83MH-67* K-Ar
Amphibolite (34°33′22″N, 114°05′55″W; S13, T14N,R18W; Buck Mountains SE 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 0.412%, 0.415%; $^{40}Ar^*$ = 6.3896 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 32%. *Argon analysis:* J. K. Nakata. *Collected by:* K. A. Howard. *Comments:* More than 3 dike widths from the nearest dike. Medium grained. Color index 50. Bears opaques, quartz, epidote. Amphibole is green-brown and is in aggregates consisting of fine (0.1 mm) subhedral grains.
(hornblende) 104 ± 2.6 Ma

46. *P81MH-10* K-Ar
Granite (34°38′24″N, 114°21′27″W; S16, T15N,R20W; Franconia 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 9.06%, 9.03%; $^{40}Ar^*$ = 9.41 × 10^{-9} mol/gm, 9.16 × 10^{-9} mol/gm, 9.09 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 97%, 97%, 97%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Medium-grained monzogranite containing microcline. Color index 5. Biotite occurs as fresh books, locally associated with minor muscovite; some biotite shows pleochroic halos.
(biotite) 597 ± 11 Ma

47. *81MH-155* K-Ar and fission-track
Tonalite (34°40′48″N, 114°24′43″W; S36, T16N,R20½W; Topoc 7.5′ quad., Mohave Co., AZ). *Analytical data:* K-Ar (biotite) K_2O = 8.48%, 8.49%, 8.46%, 8.42%; $^{40}Ar^*$ = 1.32 × 10^{-8} mol/gm, 1.38 × 10^{-8} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 89%, 98%. *Argon analysis:* M. A. Pernokas. Fission-track (zircon, 7 grains) Ps = 4.28 × 10^6 tracks/cm² (1507); Pi = 3.48 × 10^6 tracks/cm² (614); d = 1.01 × 10^{15} n/cm²; U = 107 ppm. *Counted by:* J. R. Shannon. *Collected by:* K. A. Howard. *Comment:* Medium-grained biotite tonalite.
K-Ar (biotite) 863 ± 21.6 Ma
fission-track (zircon) 73.8 ± 7.5 Ma

48. *H81BW-25* K-Ar and fission-track
Gneiss (34°24′20″N, 114°07′14″W; S3, T12N,R18W; Parker Dam 15′ quad., Mohave Co., AZ). *Analytical data:* K-Ar (biotite) K_2O = 8.97%, 8.91%; $^{40}Ar^*$ = 1.72 × 10^{-9} mol/gm, 1.18 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 89%, 84%. *Argon analysis:* M. A. Pernokas. Fission-track (zircon, 7 grains) Ps = 8.358 × 10^6 tracks/cm² (1465); Pi = 6.20 × 10^6 tracks/cm² (544); d = 1.02 × 10^{15} n/cm²; U = 189 ppm. *Counted by:* J. R. Shannon. *Collected by:* K. A. Howard. *Comment:* Medium-grained biotite granite gneiss.
K-Ar (biotite) 130 ± 3.3 Ma
fission-track (zircon) 81.7 ± 8.7 Ma

49. *P81BK-12* K-Ar
Augen gneiss (34°41′32″N, 114°08′19″W; S28, T16N,R18W; Buck Mountains NE 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 8.70%, 8.75%, 8.86%, 8.75%; $^{40}Ar^*$ = 1.5638 × 10^{-9} mol/gm, 1.56103 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 89%, 87%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Inequigranular biotite granodiorite augen gneiss containing medium- to coarse-grained feldspar augen. Biotite and minor epidote are in fine-grained aggregates. Biotite is interleaved with small amount of chlorite.
(biotite) 120 ± 3.0 Ma

50. *P81BK-13* K-Ar
Amphibolite (34°41′50″N, 114°08′22″W; S28, T16N,R18W; Buck Mountains NE 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 1.029%, 1.024%, 1.029%, 1.026%; $^{40}Ar^*$ = 3.15 × 10^{-9} mol/gm, 2.93 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 94%, 94%. *Argon analysis:* M. A. Pernokas. *Collected by:* M. A. Pernokas. *Comments:* Medium grained. Contains quartz and minor opaques, biotite, apatite, and sphene. Hornblende is pale to light greenish brown, and occurs as fresh, subhedral to anhedral grains (0.5–1 mm grain size).
(hornblende) 1372 ± 34 Ma

51. *81BK-7A* K-Ar and fission-track
Granodiorite gneiss (34°39′34″N, 114°09′27″W; S9, T15N,R18W; Buck Mountains 7.5′ quad., Mohave Co., AZ). *Analytical data:* K-Ar (biotite) K_2O = 7.66%, 7.72%, 7.70%; $^{40}Ar^*$ = 3.15 × 10^{-9} mol/gm, 3.14 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 90%, 91%. *Argon analysis:* M. A. Pernokas. Fission-track (zircon, 7 grains) Ps = 7.77 × 10^6 tracks/cm² (1497); Pi = 5.84 × 10^6 tracks/cm² (562); d = 1.03 × 10^{15} n/cm²; U = 176 ppm. *Counted by:* J. R. Shannon. *Collected by:* K. A. Howard. *Comments:* Medium-grained hornblende-biotite granodiorite gneiss. Biotite is unstrained and fresh.
K-Ar (biotite) 264 ± 6.6 Ma
fission-track (zircon) 81.6 ± 8.6 Ma

52. *H87MH-30* K-Ar
Granite gneiss (34°33′13″N, 114°12′33″W; S13, T14N,R19W; Crossman Peak 7.5′ quad., Mohave Co., AZ). *Analytical data:* K_2O = 7.15%, 7.14%; $^{40}Ar^*$ = 1.24 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 71%. *Argon analysis:* J. K. Nakata. *Collected by:* K. A. Howard. *Comments:* Leucocratic biotite granite gneiss. Weathered. Red-brown biotite (1-mm grain size) is partly intergrown with chlorite.
(biotite) 116 ± 3 Ma

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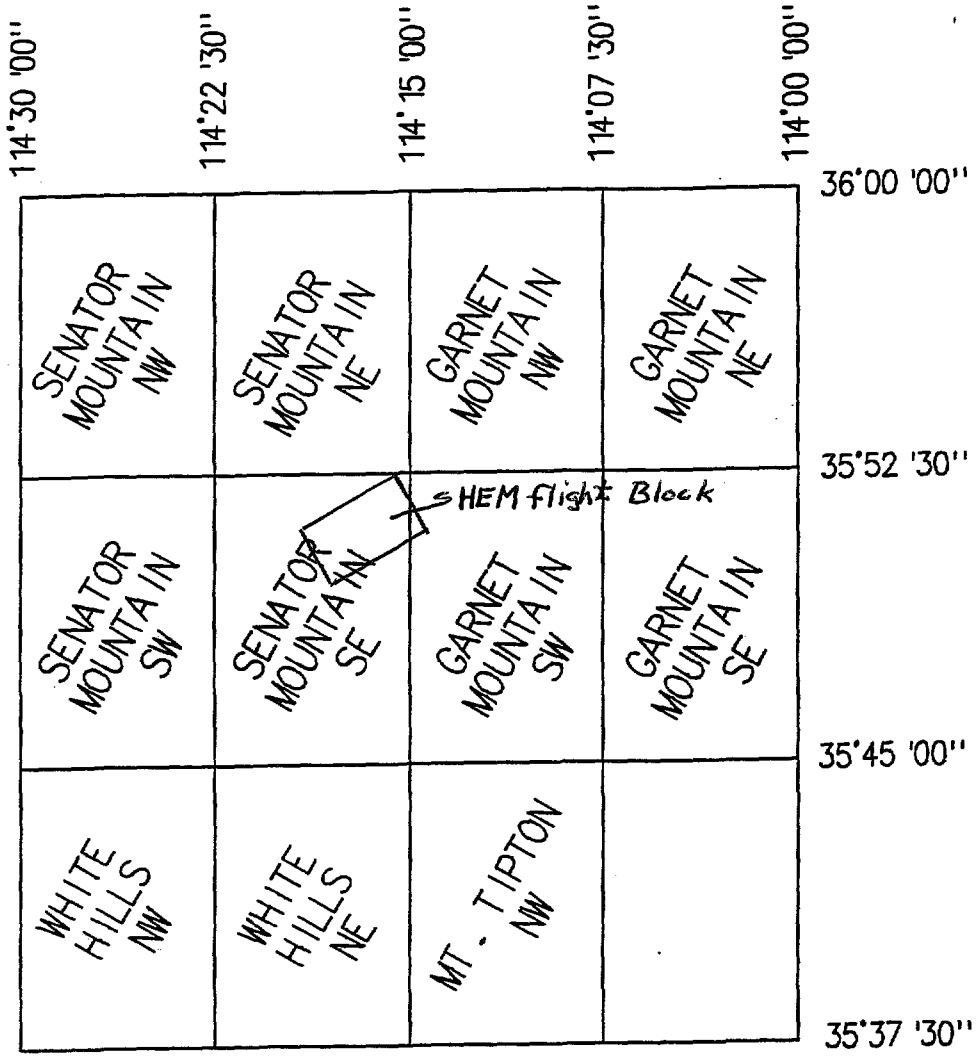
FIGURE 1



NOT TO SCALE

INDEX MAP
7 1/2' QUADRANGLES
GOLD BASIN PROJECT
MOHAVE CO., ARIZONA

J.D.SELL 8/91

mn GB910805 JDS/DAM TUC 08/12/91
PLOT CHG: SP7-/.25

JDS

ASARCO

Southwestern Exploration Division

September 5, 1991

File Note

Dighem Final Maps
Gold Basin HEM
Owens Mine Area
Mohave County, AZ

The following color maps have been placed in the Drafting Section files. Map scale at 1" = 500'. Coordinate crosses are the 1000-meter Universal Transverse Mercator grid ticks (shown in blue on the 15' quadrangles).

Figure 1 (attached) indicates the approximate position of the flight block in relation to the 7½ minute topographic quadrangles, covering the Owens Mine Area.

Maps:

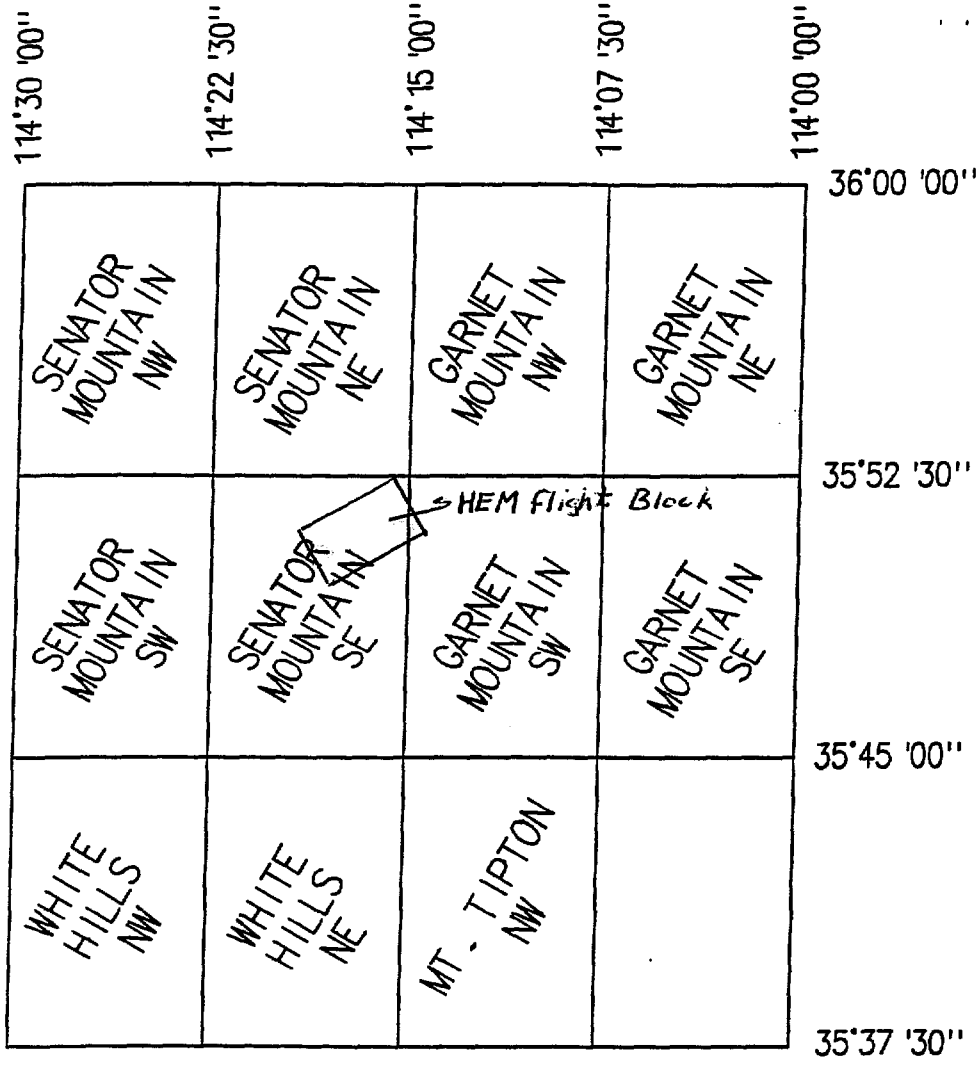
1. Resistivity (519 Hg)
2. Resistivity (1280 Hg)
3. Resistivity (7200 Hg)
4. Resistivity (56,000 Hg)
5. Total Field Magnetics
6. Residual Magnetics
7. Radiometrics Total Count
8. Radiometrics Ternary
9. Radiometrics Th/K Ratio.

James D Sell
James D. Sell

JDS:mek
Att.

cc: W.L. Kurtz

FIGURE 1



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INDEX MAP
7 1/2' QUADRANGLES
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J.D.SELL **8/91**

mn GB910805 JDS/DAM TUC 08/12/91
PLOT CHG: SP7-/.25

Table 2. Gold Basin Mineralized Long Drill Hole Intercepts

Toltec

Hole	Interval	Feet	PPB Au	OPT Au	
GB-2	0-50	50	123		
	110-240	130	103	.005 best	
	110-140	30	183		
GB-5	80-180	100	279		
	110-130	20	845	.025 best	
GB-7	0-185	185	576	.017	0-5 = 5' = 0.047 60-75 = 15' = 0.104 130-150 = 20' = 0.035
GB-9	0-50	50	35		
	85-240	155	47		
GB-10	10-90	80	35		
GB-11	145-150	5	2310	.068 (GB-11)	
GB-12	50-230	180	104		
	185-195	10	390	.011 best	
GB-13	85-120	35	186		
	110-115	5	990	.029 best	
GB-16	5-90	85	181		
	45-70	5	900	.026 best	
T-1	90-160	70	441	.013 ✓	
	90-110	20	935	.028	
T-2	90-190	100	304		
	150-190	40	625	.018 ✓	w/150-160 = 10' 0.051
T-3	0-240	240	183		
	100-220	120	287	.008	
T-4	0-260	260	113		
	120-170	50	333	0.010	
T-5	0-240	240	~~643~~ 632	.019 ✓	
T-6	10-170	160	441	.013	50-120 = 70' =
	10-250	240	376	.011	6 Mob = 0.018
	10-310	300	326	.010	
	10-330	320	304	.009	
T-7	0-80	80	291		
	50-80	30	580	0.017	50-60 = 0.020
T-8*	90-290	200	147		
	90-130	40	360	.011	
	250-290	40	318	.009	
T-9 None above 20ppb					
T-10*	10-50	40	415	.012	
T-11*	90-105	15	1020	.030	
	340-440	100		.270	← bottom 45' = 0.013
	360-390	30		.849	
	360-395	35		.738	
	340-395	~~45~~ 55		.477 ✓ best	
T-12*	5-30	25	348	.010	
T-13	180-460	280	182		260-275 = 15' =
	180-295	115	321	.009	1.467/38 = 0.034
	335-460	125	106		

Table 2. (Continued)

Hole	Interval	Feet	PPB Au	OPT Au	
T-14	0-135	135	151		
	0-60	60	208	.006	
T-15	0-160	160	1317	.038	3 ore + 3 w zones
	0-125	125	1560	.046	3 ore 2 w separated with 2 barren zones.
T-16	0-25	25	758	.022	
T-17	0-20	20	535	.016	
T-18	0-220	220	88	best	0-20 = 20' = .439/34 = 0.013 opt.
T-19	0-125	125	898	.026	centr. gm 0.015
	5-45	40	1264	.037	
T-20	0-210	210	410	.012	
	0-40	40	724	.021	
	185-210	25	1022	.030	
T-21	0-255	255	294	.009	
	105-130	25	690	.020	
T-22	0-75	75	524	.015	
	35-75	40	856	.025	or .027 use opt sheet
T-23	0-170	170	1044	.033	
T-24	0-325	325	90		0-20 = .009 best !
	0-150	150	129		125-150 = .010 best !
T-25	150-315	165	142		285-290 = 5' of .045 best only
T-26	65-455	390	195		
	65-325	260	282		
	65-205	140	380	.011	70-105 = 35' = .029; 195-205 = 10' = 0.030
T-27	65-105	40	960	.028	
	65-205	140	537	.016	70-105 = 35' = 0.031; 185-205 = 20' = .047
T-28	0-255	255	214		
	55-255	200	262		
	120-240	120	364	.011	120-130 = 10' = .044; 230-240 = 10' = .051
T-29*	75-95	20	4400	.129	= .139 opt sheet
	75-110	35	2553	.075	best 15' = .003 !

* No. 2 Zone

TOLTEC RESOURCES LTD.

GOLD BASIN PROJECT
MOHAVE COUNTY, ARIZONA

1990 DRILLING PROGRAM

NOVEMBER 1, 1990

REVISED JANUARY 15, 1991

BY

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CONSULTING GEOLOGIST

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See list of Attachments, maps, in Drafting.

Table 1. Gold Basin Ore Grade Drill Hole Intercepts
Toltec

Hole	Interval	Feet	PPB Au	OPT Au
GB-5	110-120	10	1140	.033
GB-7	0-5	5	1610	.047
	60-75	15	3537	.103
	130-140	10	1735	.051
GB-11	145-150	5	2310	.067
T-1	90-110	20	935	.027
T-2	150-160	10	1740	.051
T-5	0-30	30	1150	.034
	70-110	40	738	.022
	150-170	20	738	.022
	200-240	40	1388	.041
T-6	50-60	10	1080	.032
	110-120	10	1930	.056
	160-170	10	1040	.030
T-11*	90-105	15	1020	.030
	360-390	30	--	.849
	410-415	5	1000	.029
	470-475	5	1800	.053
T-13	260-275	15	1166	.034
T-15	0-20	20	1452	.042
	65-90	25	2186	.064
	115-125	10	8050	.235
T-16	0-20	20	888	.026
T-17	0-10	10	835	.024
T-19	0-45	45	1185	.035
	45-60	15	720	.021
	90-105	15	1400	.041
	115-125	10	1090	.032
T-20	0-10	10	1145	.033
	30-45	15	937	.027
	55-65	10	760	.022
	185-210	25	1022	.030
T-21	25-30	5	1300	.038
	245-250	5	3200	.093

Table 1. (Continued)

Hole	Interval	Feet	PPB Au	OPT Au
T-22	35-45	10	1125	.033
	65-75	10	1350	.035
T-23	30-40	10	2500	.073
	50-55	5	1100	.032
	60-80	20	1513	.044
	95-100	5	1000	.029
	110-115	5	1300	.038
	130-145	15	1243	.036
	150-170	20	2475	.072
T-25	285-290	5	1200	.035
T-26	70-80	10	1800	.053
	100-105	5	1900	.055
	195-205	10	975	.028
T-27	70-105	35	1054	.031
	185-205	20	1575	.046
T-28	120-125	5	3100	.091
	230-235	5	3000	.088
T-29*	75-95	20	4400	.129

* No. 2 Zone

APPENDIX 14.2: GOLD BASIN
TOLTEC RESOURCES SIGNIFICANT INTERSE

HOLE #	FROM (FT)	TO (FT)	INT (FT)	GOLD (OPT)
NUMBER ONE ZONE				
2	150	160	10	0.051 ✓
5	0	30	30	0.034 ✓
5	70	110	40	0.022 ✓
5	150	170	20	0.022 ✓
5	200	240	40	0.041 ✓
*6	50	60	10	0.032 ✓
*6	110	120	10	0.056 ✓
*6	160	170	10	0.030 ✓
*13	260	265	5	0.032 } 0.039
*13	265	270	5	0.047
		AVERAGE	10	0.039
15	10	15	5	0.044
15	15	20	5	0.055
		AVERAGE	10	0.049 ✓
15	65	70	5	0.060
15	70	75	5	0.085
15	75	80	5	0.090
15	80	85	5	0.021
15	85	90	5	0.042
		AVERAGE	25	0.060 ✓
15	115	120	5	0.240
15	120	125	5	0.150
		AVERAGE	10	0.195 ✓
16	0	5	5	0.042 ✓
17	0	5	5	0.038 ✓ --

NOTE: HOLES MARKED * (6 AND 13) DRILLED

SECTIONS

HOLE #	FROM (FT)	TO (FT)	INT (FT)	GOLD (OPT)	
NUMBER ONE ZONE					
				from ppm sheet	fire-assay sheet opt
19	5	10	5	0.070	0.060
19	10	15	5	0.038	0.022
19	15	20	5	0.032	0.036
19	20	25	5	0.029	0.034
19	25	30	5	0.044	0.055
		AVERAGE	25	0.043	0.041
19	40	45	5	0.035	0.022
19	90	95	5	0.035	0.040
19	95	100	5	0.058	0.070
19	100	105	5	0.029	0.034
		AVERAGE	15	0.041	0.048
19	120	125	5	0.035	0.040
20	0	5	5	0.047	0.050
20	30	35	5	0.047	0.048
20	190	195	5	0.058	0.060
20	195	200	5	0.029	0.038
		AVERAGE	10	0.044	0.049
21	25	30	5	0.038	0.040
21	245	250	5	0.093	0.100
22	35	40	5	0.038	0.048
22	65	70	5	0.038	0.050
22	70	75	5	0.041	0.038
		AVERAGE	10	0.040	0.044

DRILLED IN FOX HOLE ZONE

APPENDIX 14.2: GOLD BASIN
TOLTEC RESOURCES SIGNIFICANT INTERSECT

HOLE #	FROM (FT)	TO (FT)	INT (FT)	GOLD (OPT)	F
NUMBER ONE ZONE CONTINUED (2)					opt sheet
23	30	35	5	0.067	.070
23	35	40	5	0.079	.095
		AVERAGE	10	0.073	0.083
23	50	55	5	0.032	.038
23	65	70	5	0.029	.034
23	70	75	5	0.038	.046
23	75	80	5	0.082	.105
		AVERAGE	15	0.050	0.062
23	95	100	5	0.029	0.028
23	110	115	5	0.038	0.040
23	130	135	5	0.035	.040
23	135	140	5	0.047	.044
		AVERAGE	10	0.041	0.042
23	150	155	5	0.058	.060
23	155	160	5	0.061	.070
23	160	165	5	0.090	.105
23	165	170	5	0.079	.080
		AVERAGE	20	0.072	0.079
25	285	290	5	0.045	0.045
26	70	75	5	0.070	.070
26	75	80	5	0.035	.048
		AVERAGE	10	0.051	0.059
26	100	105	5	0.055	.055
26	195	200	5	0.029	.032

SECTIONS

HOLE #	FROM (FT)	TO (FT)	INT (FT)	GOLD (OPT)	orig sheet
No 1 Zone Continued					
27	85	90	5	0.050	.060
27	95	100	5	0.055	.065
27	185	190	5	0.079	.075
27	195	200	5	0.061	.070
27	200	205	5	0.038	.038
		AVERAGE	10	0.049	0.054
28	120	125	5	0.090	.080
28	230	235	5	0.088	.080

APPENDIX 14.2: GOLD BASIN
TOLTEC RESOURCES SIGNIFICANT INTERSECTIONS

HOLE #	FROM (FT)	TO (FT)	INT (FT)	GOLD (OPT)
NUMBER TWO ZONE				
11	90	95	5	0.061
11	340	345	5	0.032
	345	350	5	0.008
	350	355	5	0.024
11	355	360	5	0.255
11	360	365	5	2.120
11	365	370	5	0.460
11	370	375	5	0.595
11	375	380	5	0.044
11	380	385	5	0.050
11	385	390	5	1.620
11	390	395	5	0.075
		AVERAGE	40	0.652
	395	400	5	0.003
	400	405	5	0.003
	405	410	5	0.003
11	410	415	5	0.029
	415	420	5	0.003
	420	425	5	0.009
	425	430	5	0.019
11	430	435	5	0.044
	435	440	5	0.008
11	470	475	5	0.053
29	75	80	5	0.046
29	80	85	5	0.286
29	85	90	5	0.110
29	90	95	5	0.070
		AVERAGE	20	0.128

55' = 5.283/11 = 0.480 opt.

340-440 = 100' = 5.482/20 = 0.273 opt.

45' = 0.115/9 = 0.0128 opt

opt sheet
.060
.300
.115
.080
0.139

APPENDIX 14.1: GOLD BASIN PROPERTY

GB-91 - Semi

CONSOLIDATED RHODES 1990 - 1991
REVERSE-CIRCULATION DRILL RESULTS
> 0.029 OPT GOLD

HOLE	FROM	TO	Au (OPT)	
	HEMA 55-105			
1	55	60	0.062	
1	60	65	0.049	65-70: 0.008
1	70	75	0.172	75-80: 0.005
1	80	85	0.047	85-90: 0.021
1	110	115	0.072	
	HEMA 40-65			
2	35	40	0.042	
2	40	45	0.067	
2	45	50	0.050	
2	50	55	0.032	
2	55	60	0.030	
2	60	65	0.030	65-70: 0.020
2	165	170	0.034	isolated
	HEMA 25-45; 115-130			
3	115	120	0.039	110-115: 0.022; 120-125: 0.021
3	125	130	0.153	130-135: 0.023
4	HEMA 75	80	0.074	
4	non mentionable 80	85	0.052	
4	85	90	0.070	
4	90	95	0.052	
4	95	100	0.077	
4	100	105	0.088	
4	105	110	0.032	
4	110	115	0.194	115-120: 0.029
4	120	125	0.041	
4	135	140	0.056	
10	HEMA 20	25	0.037	15-20: 0.017
10	0-20 155	160	0.081	isolated
10	200-240 195	200	0.033	
11	HEMA 50	55	0.030	
11	170-225 115	120	0.031	
11	240-295 135	140	0.034	
11	275	280	0.035	isolated
12	HEMA 165	170	0.061	
12	165-170 180	185	0.043	
12	200-220 215	220	0.049	
12	225	230	0.030	

55-90 = 35' = .364/7 = 0.052
35' @ 0.052

55-115 = 60 = .469/12 = 0.039
60' @ 0.039

35-70 = 35' = .271/7 = 0.039
35' @ 0.039

105-135 = 30' = .081/6 = 0.014
30' @ 0.014

20-45 = 25' = .051/5 = 0.010

110-135 = 25' = .258/5 = 0.052

45-155 = 110' = .928/22 = 0.042

or 75-125 = 50' = .700/10 = 0.070

See Separate Sheets for 5, etc.

15-25 = 10' = .054 = 0.027

or 195-230 = 35' = .083/7 = 0.012

40-155 = 115' = .329/23 = 0.014
with 50-80 = 30' = .108/6 = 0.018
with 115-145 = 30' = .118 = 0.020

155-185 = 30' = .139/6 = 0.023

205-230 = 25' = .110/5 = 0.022

or 145-185 = 20' = .115/4 = 0.029

or 215-230 = 15' = .082/3 = 0.027

Consolidated Rhodes 1990-1991 GB-91- Series.

5. 85-100 = 15' = .049/3 = 0.016 HEMA 0-70

plus 110-125 = 15' = .043/3 = 0.014

or 85-125 = 40' = .096/8 = 0.012

6. 10-25 = 15' = .050/3 = 0.017 HEMA 20-25

best 125-130 = 5' of 0.020 isolated

7. None HEMA, none mentioned

(130-145 = 15' = .017/3 = 0.006)

(210-225 = 15' = .018/3 = 0.006)

8. 35-130 = 95' = .225/19 = 0.012 HEMA 40-50 85-160

includes 40-60 = 20' = .064/4 = 0.016

includes 90-120 = 30' = .085/6 = 0.014

9. 25-135 = 110' = .439/22 = 0.020 HEMA 35-50 90-150

include 35-50 = 20' = .125/4 = 0.031

includes 100-110 = 10' = .130/2 = 0.065

13. best 205-215 = 10' = .033/2 = 0.017 HEMA 75-120 200-210

14. (20-25 = 5' of 0.012 HEMA none mentioned

150-155 = 5' of 0.013

175-180 = 5' of 0.017)

continued

Consolidated Rhodes 1990-1991 GB-91-Series

15. best 105-110 = 5' of 0.023 HEMA none mentioned

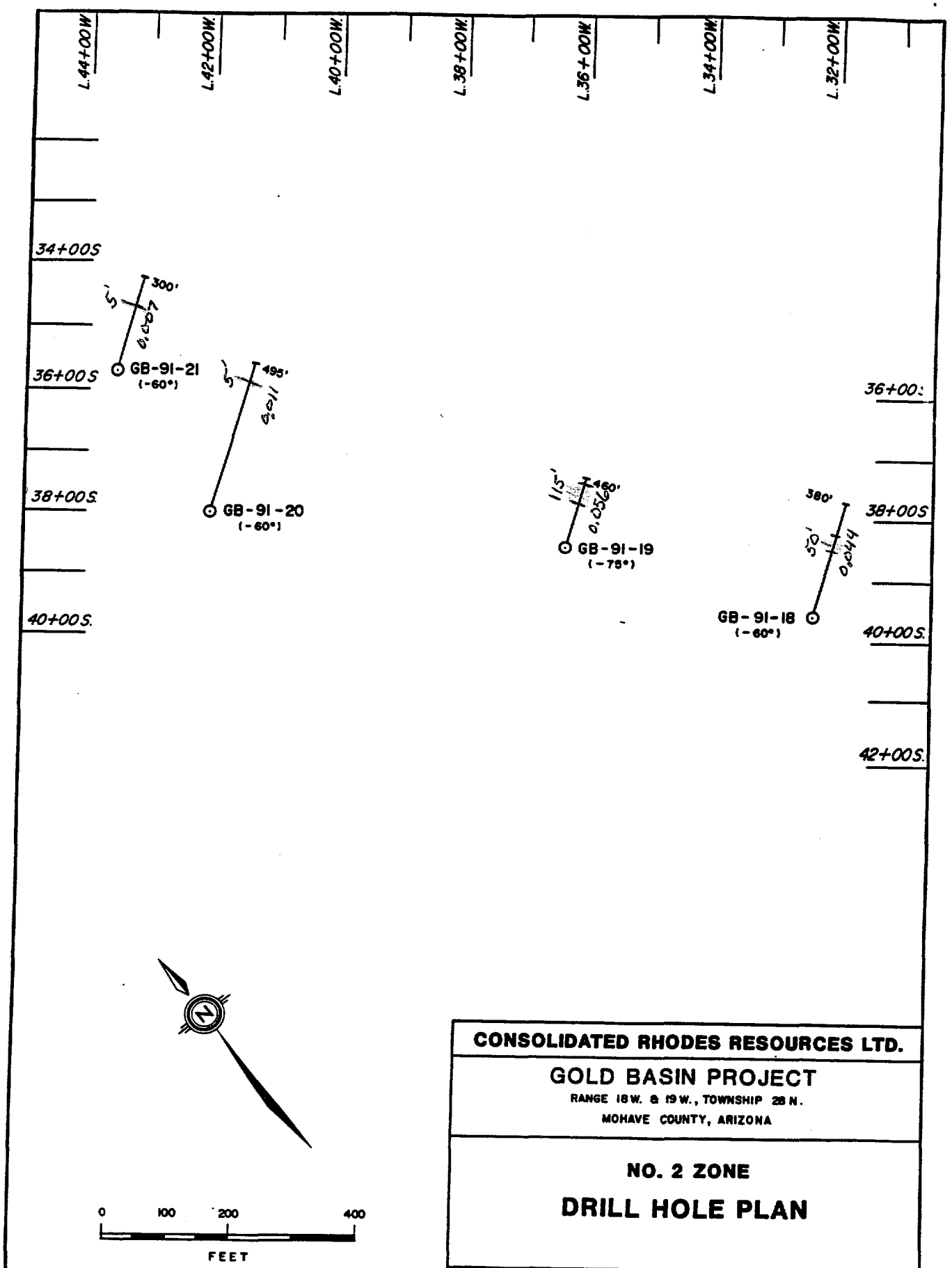
16. best 15-30 = 15' = .060/3 = 0.020 HEMA none mentioned

17. best 85-105 = 20' = .044/4 = 0.011 HEMA none mentioned

GB-20	None.	Best & only, 450-455 = 5' of 0.011		HEMA 165-180
-21	None.	Best and only, 210-215 = 5' of 0.007		HEMA 145-240
-22.	None.	Best & only, 200-205 = 5' of 0.006		HEMA 175-185 225-230 240-245
-23	~~No log~~ - assays, ~~must be on another property.~~ Nope, on West Zone Plan Fig 4.5			
-24	None	Best & all, <0.001	Water @ 175, T.D.	No HEMATITE
-24A	None	Best & all, <0.001	Water @ 140', T.D.	NO HEMA

Analytical results are presented as APPENDIX 10.3. All values in excess of 0.029 ounces per ton (one gram) are summarized below:

	HOLE	FROM (FEET)	TO (FEET)	WIDTH (FEET)	GRADE (OPT)	
HEMA-220-285	GB-91-18	240	245	5	0.064	235-285 = 50' (-43' Vertical)
	GB-91-18	245	250	5	0.117	= 4.36/10 = 0.044
	@ -60° incl.	250	255	5	~~0.077~~	
				~~AVERAGE 10~~	~~0.091~~	with 240-260 = 20'
	GB-91-18	255	260	5	0.069	= 1.327/4 = 0.082
HEMA-135-340	GB-91-19	300	305	5	0.031	300-415 = 115' = (-105' Vertical)
	GB-91-19	305	310	5	0.040	
	GB-91-19	310	315	5	0.138	
	@ -75° incl.					
				AVERAGE 15	0.070	1.287/23 = 0.056
	GB-91-19	345	350	5	0.123	
	GB-91-19	350	355	5	0.155	
	GB-91-19	355	360	5	0.014	
	GB-91-19	360	365	5	0.044	
	GB-91-19	365	370	5	0.113	
	GB-91-19	370	375	5	0.290	
	GB-91-19	375	380	5	0.163	
				AVERAGE 35	0.129	
	GB-91-19	405	410	5	0.076	
		400	415	15	0.037	



CONSOLIDATED RHODES RESOURCES LTD.

GOLD BASIN PROJECT

RANGE 18W. & 19W., TOWNSHIP 28N.

MOHAVE COUNTY, ARIZONA

NO. 2 ZONE

DRILL HOLE PLAN

DATE: APRIL, 1991	SCALE: 1" = 200'	FIGURE No. 4.0

Phase II

11

CONSOLIDATED RHODES RESOURCES LTD.

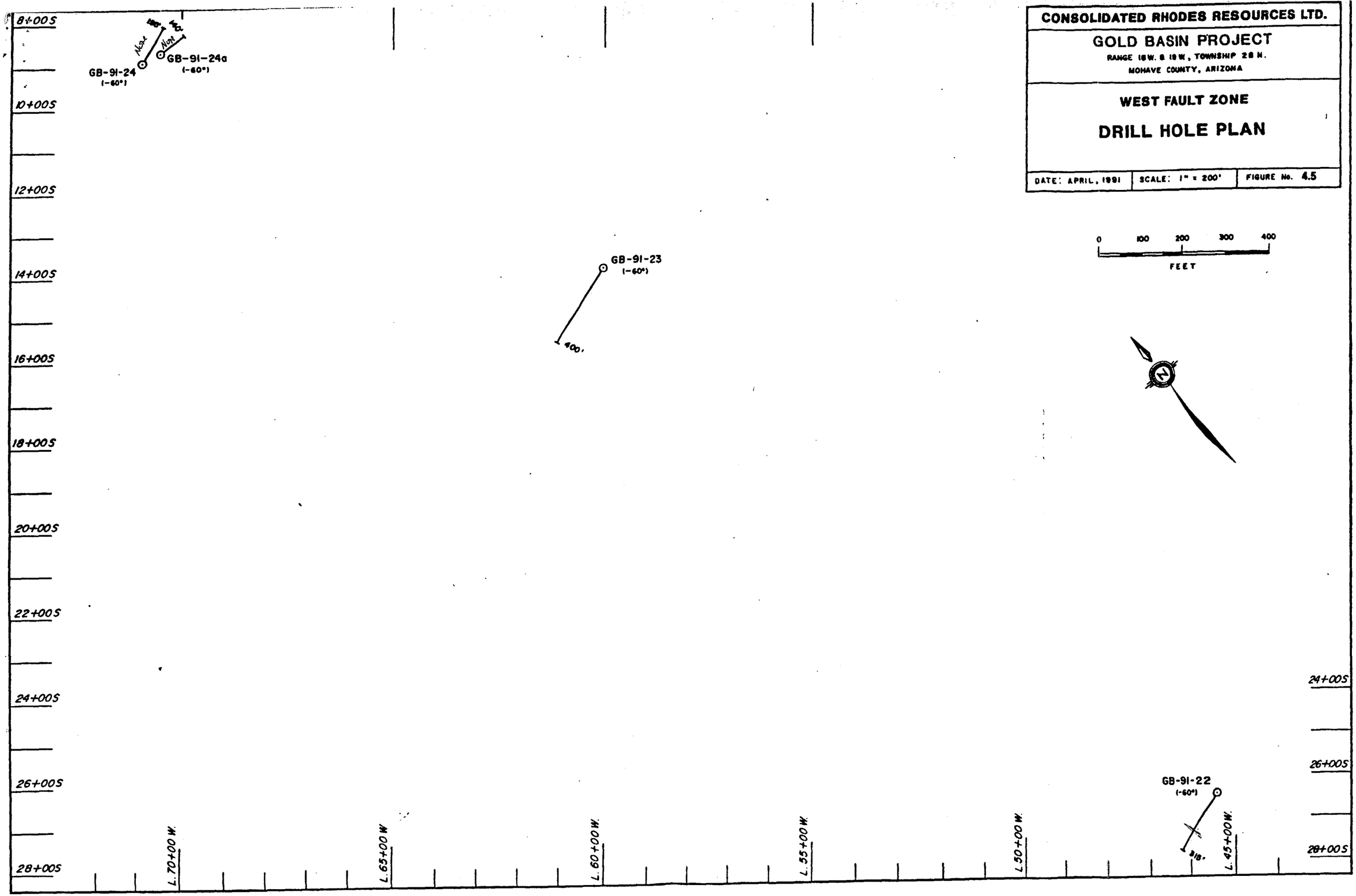
GOLD BASIN PROJECT

RANGE 18W. & 19W., TOWNSHIP 28 N.
MOHAVE COUNTY, ARIZONA

WEST FAULT ZONE

DRILL HOLE PLAN

DATE: APRIL, 1991	SCALE: 1" = 200'	FIGURE No. 4.5



Phase II

14.0 APPENDICES

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TO

JDS

ASARCO

Southwestern Exploration Division

September 10, 1991

J.D. Sell

Asarco Prospect Compilation
for GIS Study
Kingman AMS Sheet

The attached printout is the compilation result from digitizing the Asarco prospect locations on the Kingman AMS sheet. This has been saved on flopy disk and is called GISCOM.COM. A copy of the file of disk and hard copy has been sent to D. Turner on September 10, 1991 for inclusion into the GIS.

MAM:mek

Mark A. Miller

LOCATION NUMBER	PROSPECT NAME	COMMODITY	UTM #s NORTHING	EASTING
1.00	PIUTE	Ag,Pb,Zn	3963396.70	595751.50
2.00	KAME HILL	Ag,Pb	3963021.80	596881.20
3.00	BECK	Cu,Fe	3959730.80	597031.80
4.00	CRYSTAL SPRING MINE	Ag,Pb,Zn	3961495.10	594492.40
5.00	EASTERN STAR	Au,Ag,Pb	3935728.60	594494.50
6.00	GOLD HILL	Au,Ag,Pb,Zn	3936962.10	609504.00
7.00	SHADOW MTN MINES	Cu	3934490.30	608502.30
8.00	TURKOIZ	Cu,Mo	3920372.40	597001.10
9.00	ARROWHEAD GOLD	Au	3915710.80	594734.30
10.00	TRIANGLE YTTRIUM	Y	3915854.40	597173.60
11.00	KENNECOTT COPPER	Cu	3920123.10	599236.60
12.00	HUFF TURQUIOSE MTN	Cu	3920076.90	600227.20
13.00	HALLORAN SPRINGS DISTRICT	Au	3914320.40	600747.50
14.00	TELEGRAPH	Au	3915726.60	606352.10
16.00	SHADOW MTN RECON	Au	3920651.70	603990.70
17.00	PAYMASTER MINE	Au	3895045.30	600325.20
18.00	ORO FINO	Au	3894672.80	601561.30
19.00	BRANNIGAN	Cu	3893560.30	601661.90
20.00	GRAY GHOST	Au,Ag	3892579.30	605861.90
21.00	LUCKY	Au,Ag	3888722.70	601284.40
22.00	BIG LIME	Pb	3887352.10	603238.60
23.00	RAM HORN	Cu	3880312.00	617429.40
24.00	GREEN MONSTER	Ag,Pb,Zn	3972344.30	622139.70
25.00	POTISI MINE	Pb,Zn	3980647.80	631907.70
26.00	DOUBLE UP	Zn	3978124.40	635216.10
27.00	PILGRIM	Zn	3971075.60	635640.80
28.00	PRAIRIE FLOWER	Zn	3968910.10	635709.30
29.00	YELLOW PINE	Ag,Pb,Zn	3967647.60	635825.90
30.00	CHAQUITA	Au,Ag,Cu	3967139.30	631140.20
31.00	ISLAND	Zn	3966546.40	630414.80
32.00	BOSS(DIST) FILE	Au,Cu,Pt	3965111.40	629288.90
33.00	CLEMENTINE DIST FILE	Au,Cu	3964518.10	633185.70
34.00	BILL NYE DIST FILE	Zn	3963795.80	633916.30
35.00	WHALE DIST FILE	Ag,Zn,Ag,V	3962501.30	633457.40
36.00	HOOSIER DIST FILE	Pb,Zn	3962487.80	635324.20
37.00	COLUMBIA	Au,Ag,Cu,Zn,Co	3964717.10	637765.80
38.00	ARGENTENA	V	3963793.30	638175.30
39.00	MOUNTAIN TOP DIST FILE	Pb,Zn	3962936.90	639341.10
40.00	SINGER DIST FILE	Pb,Zn	3959126.00	633478.40
41.00	SULTAN	Ag,Pb,Zn	3957147.20	635953.90
42.00	INGOMAR DIST FILE	Pb,Zn	3952943.40	636444.90
43.00	BULLION DIST FILE	Zn	3954262.80	638813.40
44.00	VALENTINE DIST FILE	Zn	3954365.30	639731.80
45.00	ANCHOR DIST FILE	Zn	3955287.30	639240.90
46.00	MONTE CRISTO DIST FILE	Zn	3959470.40	641124.10
47.00	IRELAND DIST FILE	Zn,Cu	3959203.70	642602.10
48.00	JEAN STOCKPILE	Zn	3960326.20	651676.70
49.00	STATELINE-SILVER RAM	Ag,Pb,Zn	3943768.00	642461.30
50.00	POCO MOWO	REE	3937951.50	626705.00
51.00	COLOSSEUM	Au	3936881.80	629767.20
52.00	COPPER WORLD	Ag,Cu,Pb,Zn	3929499.20	627105.50
53.00	MOHAWK MINE	Au,Ag,Cu,Pb,Zn	3926758.90	626141.20
54.00	YUCCA QUEEN	Au,Ag,Cu,Pb,Zn	3926376.40	627490.30
55.00	MOUNTAIN PASS MINE	REE	3927113.30	633673.90

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
56.00	MINERAL HILL GROUP	REE	3924920.60	634745.10
57.00	IVANPAH DIST		3922988.80	638171.50
58.00	CARBONITE KING	Ag,Pb,Zn	3919600.70	636545.60
59.00	SILVER STAR	W	3918096.30	633486.10
60.00	CIMA DIST	Au,Ag,Cu	3917671.10	635976.10
61.00	IVANPAH AERIAL RECONN		3914648.10	633339.70
62.00	STANDARD NO. 2	Au,Ag,Pb,Zn	3912833.30	633675.70
63.00	ALM HILLS MINES CO.		3912863.10	635798.20
64.00	MORNING STAR	Au,Ag	3912230.10	637416.10
65.00	ALLURED AND NEW TRAIL	Au,Ag	3915757.10	638544.00
66.00	DEATH VALLEY MINE	Au,Ag,Pb	3897960.10	640580.50
67.00	COLUMBIA	Au,Ag,Cu,Pb,Zn	3881138.80	639281.40
68.00	FRANCES	Ag,Cu,Pb,Zn	3879838.60	637482.40
69.00	HUFF PROSPECT	Cu	3879577.10	638095.90
70.00	KELSO AERIAL RECONN	Cu	3878806.20	637800.40
71.00	BIG HUNCH	Mo	3902807.60	650953.90
72.00	GOLDEN QUAIL	Au	3897818.30	654882.50
73.00	GIANT LEDGE	Cu,Pb,Zn,W	3902333.40	654854.10
74.00	WESTERN SOLDIER	Ag,Cu,Zn,W,CaF2	3904000.30	654897.30
75.00	DOOR TUNGSTEN	W	3901650.40	657299.90
76.00	SAGAMORE	Cu,Pb,Zn,W	3902386.10	656882.20
77.00	BRONZE	Ag,Cu,Zn	3903195.60	657220.60
78.00	VANDERBELT MINE AND RECONN	Au,Ag,Pb	3910605.30	659424.40
79.00	LAST CHANCE	V	3916737.30	658895.50
80.00	LUCY GREY	Au,Ag,Cu	3936045.80	657494.50
81.00	PLUMBERS	Au,Ag,Cu,Zn	3933112.60	662046.20
82.00	SILVER BOWL	Au,Ag,Pb	3931698.60	668122.60
83.00	CRESCENT PEAK	Au,Ag,Cu,Pb	3927030.30	670208.80
84.00	BLUE CRYSTAL	Au,Ag,CaF2,Pb,	3924647.50	664351.00
85.00	LILY GROUP	Au,Ag	3922103.60	667033.60
86.00	ORO BELLE		3912893.70	666900.30
87.00	VALLEY VIEW	Au,Ag	3905558.10	674214.80
88.00	DENVERS CLAIMS	Au	3878361.30	663740.10
89.00	LOUISIANA CALIFORNIA	Au,Ag,V	3879602.10	670049.90
90.00	VON TRIGGER	Au,Cu	3879351.90	670882.40
91.00	LEISERRAY AERIAL RECON	Cu,V	3877814.90	679517.00
92.00	QUARTETTE	Au,Ag,Cu,Pb,V	3925314.40	688793.30
93.00	CAMP DUPONT GRP	Au,Ag,Cu,Co	3937844.90	701808.90
94.00	SILVER LEGION	Au,Ag,Cu,Pb	3949809.40	694519.80
95.00	CAPITAL HILLS GOLD	Au,Ag	3949109.90	703617.40
96.00	NEVADA EAGLE	Au,Ag	3951145.30	703339.00
97.00	HERLAND	Au,Ag,Cu,Pb,Zn	3953812.60	697841.40
98.00	COPPER MTN GRP	Au,Ag	3954184.10	697106.40
99.00	DOLPH, JOHN D	Ag,Pb	3955134.40	700310.10
100.00	SEGGERSON PRESENTATION	Cu,Co	3962411.80	686639.90
101.00	BLUE QUARTZ	Au, Ag	3977044.90	685101.80
102.00	POPE MINE	Au, Ag	3957452.30	721639.40
103.00	GOLD BUG AND MOHAVE	Au, Ag	3950596.30	723919.80
104.00	PULOSKY	Au, Ag	3940646.60	730035.30
105.00	KLONDIKE	Au, Ag	3933855.80	723683.60
106.00	PORTLAND	Au, Ag	3918020.90	727165.80
107.00	PILGRIM	Au, Ag	3919066.50	739711.90
108.00	GOLD CHAIN	Au, Ag	3904886.20	727398.10
109.00	KATHERINE	Au, Ag	3901855.20	723590.70

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
110.00	BLACK DYKE	Au, Ag	3901955.60	728241.90
111.00	ROADSIDE	Au, Ag	3899817.90	730069.60
112.00	SHEEPTRAILS BLVD	Au, Ag	3900547.30	732376.60
113.00	TRYO MINE	Au, Ag	3902437.60	734512.80
114.00	FRISCO	Au, Ag	3899655.90	735566.10
115.00	ARABIA AND PHILDELPHIA	Au, Ag	3897298.40	733547.10
116.00	SECRET PASS	Au, Ag	3892754.80	741066.90
117.00	MOSS	Au, Ag	3887083.00	732716.60
118.00	MIDNIGHT	Au, Ag	3880569.70	735189.60
119.00	VIVIAN	Au, Ag	3877772.40	734201.60
120.00	UNITED EASTERN	Au, Ag	3879442.80	739035.90
121.00	TOM REED	Au, Ag	3878670.50	739498.40
122.00	HARTMAN	Au, Ag	3878219.60	740316.60
123.00	GOLD ROAD ANNEX	Au, Ag	3880598.60	740274.60
124.00	SENATOR	Au, Ag	3966618.00	745792.90
125.00	CYCLOPTIC	Au, Ag	3963345.00	748911.80
126.00	OK EXCELSIOR, ELDORADO	Au, Ag	3965229.90	753271.60
127.00	JOHNSTON	Au, Ag	3979083.90	760093.90
128.00	WHITE HILLS DIST	Ag	3956599.80	737723.90
129.00	ARIZONA MAGMA	Au	3922731.90	752066.50
130.00	TINTIC	Au	3921235.30	752082.10
131.00	SILVER HILL	Au,Ag,Pb,Zn	3922058.30	754098.70
132.00	ELKHART	Ag,Pb	3923486.60	755481.40
133.00	TENNESSEE	Cu	3922666.50	755769.60
134.00	HERCULES	Au,Ag,Pb,Zn	3923710.90	757067.10
135.00	PAYROLL	Au,Ag,Pb,Zn	3922555.90	756955.80
136.00	RAINBOW	Au,Ag,Pb,Zn	3922232.10	758403.80
137.00	SAMOA	Au,Ag,Pb	3921968.80	759211.50
138.00	MARY BELL	Au,Ag,Cu,Pb,Zn	3921976.20	757075.60
139.00	MINN. CONNOR	Au,Ag,Cu,Pb,Zn	3921259.50	756960.50
140.00	HIDDEN TREASURE	Au,Ag	3920622.10	757294.50
141.00	EL ORO	Au,Ag,Pb,Zn	3919757.60	757013.70
142.00	MERIDITH	Ag	3919652.50	756527.60
143.00	MIDNITE	Au,Ag,Zn	3919559.40	756016.10
144.00	MORGAN	Cu	3919156.10	757822.90
145.00	KEYSTONE	Au,Ag	3918620.80	758787.20
146.00	WHITE HORSE	Au,Ag,Cu,Pb,Zn	3917961.80	758182.30
147.00	MINERAL PARK-ITHACA PK	Cu	3917156.80	756672.50
148.00	EMERALD ISLE	Cu	3916862.80	755320.10
149.00	ARK	Au,Ag	3914872.40	758109.10
150.00	GRANDVIEW	Cu,Pb,Zn,Mo	3915268.50	760905.90
151.00	WHITE EAGLE	Au,Ag,Cu,Pb	3916198.70	762412.80
152.00	SEMISON	Au	3913916.50	760398.30
153.00	SUMMIT	Au,Ag,Cu,Pb,Zn	3914013.50	761623.60
154.00	COD	Au,Ag,Cu,Pb,Zn	3914842.90	763377.10
155.00	I.X.L.	Au,Ag,Cu,Pb,Zn	3913997.80	763941.30
156.00	WRIGLEY	Au,Ag,Cu,Pb,Zn	3914088.60	763256.60
157.00	MID. GOLCANDA	Ag,Zn	3912952.20	760407.80
158.00	GOLCANDA	Au,Ag,Zn	3912387.00	760614.90
159.00	WALLAPAI	Au,Ag,Pb,Zn	3912077.10	761574.10
160.00	FOUNTAINHEAD	Au,Ag,Cu,Pb,Zn	3912614.20	762601.40
161.00	ALTA	Au,Ag,Cu,Pb,Zn	3912198.30	763312.40
162.00	DE LA FONTIANE	Au,Ag,Cu,Pb,Zn	3912061.80	762275.90
163.00	GOLDCONDA ANNEX	Pb	3911457.80	761882.60

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
164.00	FLORES	Au	3911209.80	760078.30
165.00	CERBAT	Au,Ag,Cu,Pb,Zn	3911184.90	760905.60
166.00	GOLDEN GEM	Au,Ag	3910490.90	760414.10
167.00	CHAMPION	Au,Ag,Cu,Pb,Zn	3909318.00	759244.80
168.00	BI-METAL		3894183.10	766212.00

JDS

INVOICE

To: ASARCO, S.W.E.D.
P. O. Box 5747
Tucson, Arizona 85703

ASARCO Inc.
SEP 2 6 1991
SW Exploration

From: Arden L. Larson
2340 Viewcrest Road
Henderson, Nevada 89014 ph. 702/451-4600

Item: Photocopying and mailing data package on Cyclopic mine per the request of Mr. James Sell

Amount: $65.00

Date: September 20, 1991

OK for payment
James D Sell
Gold Basin Area
General Expl.
499-01

JDS

ASARCO

Southwestern Exploration Division

September 17, 1991

FILE NOTE

Larson Cyclopic Data
Sec. 30, T28N, R18W
Gold Basin District
Mohave County, Arizona

A packet of material has been secured from Arden L. Larson, 2340 Viewcrest Road, Henderson, NV 89014, phone: 702/451-4600, who is owner of claims covering the Cyclopic Mine, the Lee Mine and the Fry areas of the Gold Basin District.

Included is his cover letter, attached, and the following material sent to the files, and which will be integrated in the overall study in progress.

1. A false color satellite view of Gold Basin.
2. An oblique airplane view to the northwest along the Cyclopic zone.
3. IP-Resistivity pseudosections and interpretation of three lines (from Consolidated Rhodes grid) of the Cyclopic Mine by Reynolds Metals Expl. Inc. (1991).
4. AMOCO drill logs summary and assay results, CY-1 thru CY-17 (1985).
5. Inspiration drill hole log summary and assay results, C-1 thru C-16, with C-10 missing (1978) (have assay sheet of C-10 values).
6. 11" x 17" Map showing locations of Inspiration holes C-1 thru C-16, (14 & 16 not found); AMOCO holes C-1 thru C-17; Moly Corp holes 1 thru 32 and AMCA Worldwide Mineral drill line #14.
7. Contour map of Cyclopic footwall sampling with ppb Au values (by J.L. Lessman).
8. Geologic Summary Report by J.L. Lessman, 10 p., May 1988.
9. Report: Interpretation of 1988 Surface Rock Chip-Sample (110 samples), J.L. Lessman, Paragon/OP&P JV, 5 p. plus assay sheets CY-88-9 thru CY-88-111, and sample description sheets CY-88-01 thru CY-88-135 (no assays for samples CY-88-112 thru CY-88-135).
10. Folio of 11" x 17" plates with topography (5' contours), with sample sites for CY-88 samples.
11. 8½" x 11" claim map, centered on Cyclopic.
12. 11" x 17" Folio of Moly Corp soil geochemistry of Cyclopic zone, showing pits and drill holes, with Au, Pb, Hg contoured values (1989).

13. 11" x 17" copy of geology map of Cyclopic zone with some CY-88 sample sites; 1" = ~500'.
14. 11" x 17" copy of Gold Basin (1" = 1 mile) topo sheets showing interpreted linears.
15. Results of J. Robinson, Otago Press and Produce Co., trench sections and assays BTH-1 thru BTH-6 (1987), and Cyclopic Sample Descriptions.
16. Plate III, showing McIntire Trench sampling (block line only), 1981 Track drill holes on 8' centers, 30 feet deep by Miller-Kappes for AMCA Worldwide Minerals, and selected Inspiration drill holes, in Cyclopic Mine area; with Sections of trenches and drill hole numbers with 0.01+ opt gold values noted, and listing of air-track drilling result tonnages and grade blocks.
17. Moly Corp, Cyclopic Mine Project packet (1989)
    a. Map of drill holes along lines B,C,D,E,F,G, & H.
    b. Soil geochemistry ppm Au contours at 0.05 ppm intervals.
    c. Soil geochemistry ppm Au contours at 0.02 ppm intervals.
    d. Soil geochemistry Pb contours in ppm.
    e. Soil geochemistry Mo contours in ppm.
    f. Cross-sections with drill hole assays of A-A', B-B', C-C', D-D', E-E', F-F', G-G', & H-H'.
    g. Drill hole location surveys; from, to, angle, depth. CyC-891 thru CYC-8932.
    h. Drill hole logs. Holes CYC-891 thru CYC-8932 with assays.

James D. Sell

James D. Sell

JDS:mek
Attachment (cover letter)

cc: W.L. Kurtz (cover letter)

ARDEN L. LARSON
2340 Viewcrest Road
Henderson, Nevada 89014
(702) 451-4600

September 20, 1991

Mr. James Sell
ASARCO, S.W.E.D.
P. O. Box 5747
Tucson, Arizona 85703

Dear Mr. Sell:

I certainly enjoyed talking with you the other day and am pleased that Asarco has such an interest in Gold Basin. As you have requested, I have copied and am enclosing some of my data on my Cyclopic property. I will attempt to interpret some of this data for you prejudiced of course by my own ideas!

My own feeling is that the major structural feature in this portion of the Gold Basin district is a northwest trending shear zone with right lateral displacement of mid Tertiary age. This shear zone is likely the extension of the Walker Lane zone of Nevada although it is not quite that simple. The zone is clearly evident on satellite photos but because of later movement and other faulting as well as cover it is not obvious on the ground. Displacement is indicated by examining the offset of the Cretaceous two-mica granite north of the Cyclopic. It appears to be offset to the northwest at least two miles by at least two strands of this "Gold Basin Shear Zone". The evidence for this offset is from the satellite photos and field examination.

The detachment faulting has been much ballyhoed as the panacea for the structure and location of the mineralization in this area. I have a lot of misgiving with this concept. First of all, the regional setting of this district is on the projection of the Sevier belt of thrusting which has been mapped on the other side of Lake Mead. To

my knowledge this thrust zone has not been identified south of the lake but I doubt if the water stopped it! The second concern that I have is lack of identification of the detachment zone to the northeast of the Cyclopic even though the topography should allow it to be there. I do not deny that there are low angle structures in the district, I do have some doubts as to their origins and interpretations. With the amount of intense shearing exhibited in the Cyclopic area, it is easy to get caught up in the detachment model to the exclusion of any other interpretations. The low angle structure at the Cyclopic pit is partly post mineral as it terminates high angle structures and premineral as it contains significant gold and mercury mineralization but no silica. The concept of a thick "crushed zone" is appealing and may be present in some locations but it is not the target zone in my thinking.

Later faulting in several directions has obscured structural relationships. I believe that there are a series of north south high angle structures that systematically drop the west side down. Such a structure probably exists immediately east of the main pit at the Cyclopic, at the west end of the 'red hill' (west of the water tank) and perhaps going through the east Fry shaft and extending to the northeast. Finally there is evidence of high angle post mineral movement subparallel to the Gold Basin shear zone in the Fry mine area.

These are my structural observations but undoubtedly they are not all that exist and most probably are not correctly interpreted. The Miocene fanglomerate contains tuff beds that are tilted at nominally forty-five degrees in various directions. Clearly their attitude is structural but to what? Also, examination of air photos of various scales shows drainage patterns that have a rectilinear appearance.

My emphasis in this rambling is that there is a major structure through this property that has been basically overlooked and virtually untested. This structure is broad, composed of anastomising shears that have produced the necessary ground preparation to host a major gold deposit.

I am sure that you are aware of the strong concentric magnetic anomaly centered in section 32 southeast of the Cyclopic. It is my

belief that this anomaly is the result of an intrusive at depth which could have served as the source of the gold, lead and mercury mineralization or perhaps it was only the heat source to drive the hydrothermal system(s?) that were responsible for the mineralization. This indicated intrusive is most likely not a Cretaceous two mica granite as there are no apparent magnetic anomalies related to any of the exposed two mica plutons. Most likely, this intrusive is the origin of the numerous lamprophyre dikes that seem to occur very near any alteration and gold mineralization on both the northwest and southeast sides of the intrusive. These dikes have been mapped as Tertiary in age by the USGS. They are altered and veined by iron carbonate in numerous places. These altered dikes are anomalous in gold (50 to 200 ppb) and mercury (several ppm). They occur in both the footwall and hanging wall of the 'detachment' as well as within the Gold Basin shear zone. This latter reference is to the west pit on the Cyclopic property where a highly altered slice of a dike is enclosed within an intense shear which contains widespread gold mineralization and alteration.

The mineralization in the Cyclopic area has attracted well over one hundred geologists that I can identify and probably confused at least two hundred more. Most of them have been attracted to either the sexy looking quartz breccias or the red stained hill north of the pit area. Both are misleading. The quartz breccias are probably the earliest gold mineralization and occur in northwest trending veins or vein zones that commonly contain one-half of an ounce per ton of gold with some mercury and lead and very little pyrite. Although this is the most attractive material to the eye, it was only a small portion of the ore mined in the past. The ore mined in the main pit occurs in a northwest trending shear as exposed in the west face of the pit containing gray quartz, gold, minor galena and pyrite and visible cinnabar and wulfenite. The north side of this shear is a very sharp contact with intensely sheared (ductile) precambrian granite.

The red stained hill to the north of the pit has caught the eye of a number of geologists with good reason. The staining itself is probably transported hematite which is quite common and totally

unrelated to the gold mineralization in this area. The origin of the iron has been interpreted as oxidized chlorite or pyrite. The hill itself is quite anomalous in gold as you have seen in the geochem data you have. There is one area (reference Toltec grid 10W 350N) that contains ore grade gold in quartz stockwork mineralization that has been untested to date and unexplained by the detachment model.

The west pit area contains a wide shear that I believe is the only good exposure of a portion of the Gold Basin shear zone. This shear strikes northwest and dips to the northeast at seventy degrees. It is parallel to both the sexy quartz breccias and to the shear mined in the main pit. The zone itself contains quartz breccia zones, exotic looking clay zones with purple, red and yellow colors and two very interesting rock segments. The first was the altered and sheared lamprophyre described before, the second interesting rock is a slice of 'footwall' (to the detachment) schist which is mineralized (.07 oz. Au/tn) and at least two hundred feet vertically out of place. This pit was drilled by holes 7, 8, 9 of Molycorp. All of the holes intersected wide but low grade mineralization. Holes 10, 11, 12 of Molycorp tested the zone 500 feet to the west with similar results. The holes were angle holes and only 250 feet in length.

The alteration pattern in this shear is most interesting. The core zone as best seen in a shallow backhoe trench that I dug between Molycorp's two drill lines contains a yellow clay zone forty feet wide with one ppm gold. Peripheral to this as seen in the drill pads of holes 10, 11, 12 is a zone of iron carbonate veining. Now this alteration color and iron carbonate zoning looks very much like the high grade zone Toltec drilled on the Santa Fe lease held by Ahern, et al. The high grade intercept is yellow and contains free gold, cinnabar, wulfenite and minor pyrite and galena. Prior to intercepting the zone the cuttings were hematitic and contained iron carbonate veinlets. After passing through the ore zone, the hole intersected a distinct gray green unmineralized metamorphic rock. These observations were made while the hole was being drilled and from examining the panned concentrates of the ore zone under my binocular microscope.

Most of the drilling on my property has been rather haphazard. Amoco drilled seventeen holes in 1985. They actually were trying to drill this property on one thousand foot centers with the idea that if they couldn't find it with that drill pattern it wasn't big enough for them! I guess they are still looking. Pay attention to drill holes 1, 4, 9, and 10 which all show significant gold in the 'footwall' of the detachment. The assay data is rather lacking as there are no geochem results. Also for some odd reason they drilled holes and didn't assay the cuttings (holes 6, 12, and 14). The latter two holes were collared in sheared material and interpreted in the field as overburden.

I am enclosing the results from Molycorp's work in 1989. They were in a hurry to get the program over with and drilled the first phase before they had the results of their geochem survey. Their concept was rather simplistic as they drew a line between the main pit and the west pit and drilled four fences at five hundred foot intervals. They also offset Amoco hole 9 with their holes 13, 14, and 15. Their last phase of drilling was centered around a high grade intercept near the main pit. All of their holes need to be interpreted as to their significance by their geological setting. For example holes 1, 2, and particularly 3 were drilled mostly in the 'footwall' of the detachment, yet these holes show significant gold mineralization in stockwork veining with pyrite and quartz. Holes 4, 5, and 6 were drilled across the main pit.

Earlier drilling, first by Inspiration and later an airtrack program by "AMCA Worldwide Minerals" (yup another Vancouver company) were too shallow to be of much significance. Inspiration's holes were only 50 feet deep and the air track holes were 30 feet deep and were assayed by cyanide bottle roll tests. These results do indicate ore grade gold in "footwall" intercepts as this drilling was conducted without any apparent knowledge that the low angle structure existed.

Geophysical and geochemical work has been conducted on the property. The Toltec group ran a detailed geochem survey and a VLF and magnetic survey. Molycorp ran a geochem survey but not as many samples as Toltec. Unfortunately the Toltec samples were never analyzed for mercury. The last geophysical work was performed for Reynolds

Metals who have my Lee mines property leased (on the southeast side of the buried intrusive). I am enclosing a copy of the resistivity profiles. This work was conducted by them for comparison purposes to the property they have leased. They ran three lines along the Toltec grid. Each line is 400 feet apart. I was very surprised at their results. First the rocks south of approximately the road are very low in resistance compared to those north of the road. Now this contact is at the trace of the "detachment" outcrop. With rocks as markedly different in resistivity as these appear to be, I would expect that a low-angle structure would have really stood out, but it appears that this low resistance rock is a graben type structure which correlates with my Gold Basin shear zone concept. Indeed, the southwest end of these lines lap on to my neighbor's property where Toltec found a good gold geochem zone with evidence of quartz breccias. The apparent dip of these resistance zones also parallels that of the west pit and other high angle shear zones.

I have found rocks that contain stockworks of quartz carbonate veinlets at numerous locations on my property but have never personally had an assay run. In showing these specimens to another geologist I was told that this material indeed is very anomalous in gold.

I have been involved with this property for almost ten years. I can identify over one hundred geologists who have examined it in some form or another. This reminds me of the three blind men trying to describe an elephant. Well I've given you my description, it is up to you to find it!

If I can be of further assistance, please let me know.

Sincerely,

Arden L. Larson

Arden L. Larson

Cyclopic Drilling Key

Moly Corp.

A

B - B' 10, 11, 12

C - C' 7, 8, 9

D - D' 2, 3, 31, 32 — 13, 14, 15 around CY-9

E - E' 1, 28, 29, 30

F - F' 4, 5, 6, 24, 25, 26, 27

G - G' 21, 22, 23

H - H' 16, 17, 18, 19, 20

AMC Woodlawn Mine drill hole & centuries old log.

14

$\boxed{\text{lies 1 thru 14}}$

Amoco		Duquesne	
CY-1,	H 5589 ?	C- 1	
- 2		C- 2	
- 3		- 3 ~~or~~	~~D~~
- 4		- 4	
- 5		- 5	
- 6 (Fry Mine)	bulk C1870-1874	- 6	
- 7	" C 1862 - 1865	- 7	D
- 8		- 8	D
- 9		- 9	D
- 10		- 10	
- 11		- 11	
- 12		- 12	
- 13		- 13	
- 14		-	
- 15		- 15	
- 16		-	
- 17			

Flight Block GOLD BASIN LINE MILES: 71 FLIGHT LINE DIRECTION: NE-SW

Scale 1:6000

Location Lat. _____ Long. _____ NE Corner UTM EAST 749,000 UTM NORTH 3,973,000

Lat. _____ Long. _____ SW Corner UTM EAST 744,000 UTM NORTH 3,969,000

COUNTY: MOHAVE COUNTY STATE ARIZONA_____ MINING DISTRICT _____

WORKSHEET DATE : 17-Jun-91	Date Completed	Scale	CHECKED/ APPROVED	NOTES
Geologic Base				
Land Status				
Flying Completed	MAY 3,1991			
RAW DATA RECEIVED BY DIGHEM TORONTO	MAY 12,1991			
RAW DATA RECEIVED BY ASARCO	MAY 14,1991	1:12000	C.WINDELS	DIGITAL GRIDS WHERE NOT ALIGNED WITH NORTH UP (5/14/91)
	MAY 22,1991	1:6000	C.WINDELS	NEW DIGITAL GRIDS RECEIVED WITH CORRECT ORIENTATION. (notified by DIGHEM 6/3/91 that the UTM tie points are in error) <<<<<**********
Preliminary GRID DATA RECEIVED BY ASARCO (RADIOMETRICS)	MAY 14,1991	1:12000	C.WINDELS	DIGITAL GRIDS WHERE NOT ALIGNED WITH NORTH UP (5/14/91)
	MAY 22,1991	1:6000	C.WINDELS	NEW DIGITAL GRIDS RECEIVED WITH CORRECT ORIENTATION.
	JUNE 5,1991	1:6000	C.WINDELS	CORRECTED UTM GRID RECEIVED FED EX NOTIFIED TUSCON TO DISTROY PRELIMINARY DIGHEM DATA AND ASARCO COLOR 8x11'S (6/7/91)
	JUNE 10,1991	1:6000	C.WINDELS	MAILED TO J.SELL AT THE TUCSON OFFICE-- NO TARGETS PICKED YET--I'm not sure of the geology-target (6/7/91) RADIOMETRICS MAILED TO TUCSON 6/18/91
Asarco Processing LAYERED DOMAIN	MAY 24,1991	1:14,300 +/-	C.WINDELS	MAILED TO J.SELL AT THE TUCSON OFFICE-- NO TARGETS PICKED YET--I'm not sure of the geology-target (5/24/91)
LAYERED RAD 8x11 COLOR	JUNE 7,1991	8X11 color	m.asplund	MAILED TO J.SELL AT THE TUCSON OFFICE-- NO TARGETS PICKED YET--I'm not sure of the geology-target (6/7/91)
	JUNE 13,1991	8X11 color	M.ASPLUND	MAILED TO J.SELL AT THE TUCSON OFFICE-- (6/18/91)
DIGHEM FINALS				
ASARCO FINALS LAYERED DOMAIN				

Geology and Gold Mineralization of the Gold Basin-Lost Basin Mining Districts, Mohave County, Arizona

By TED G. THEODORE, WILL N. BLAIR, *and* J. THOMAS NASH

With a section on K-AR CHRONOLOGY OF MINERALIZATION AND IGNEOUS ACTIVITY

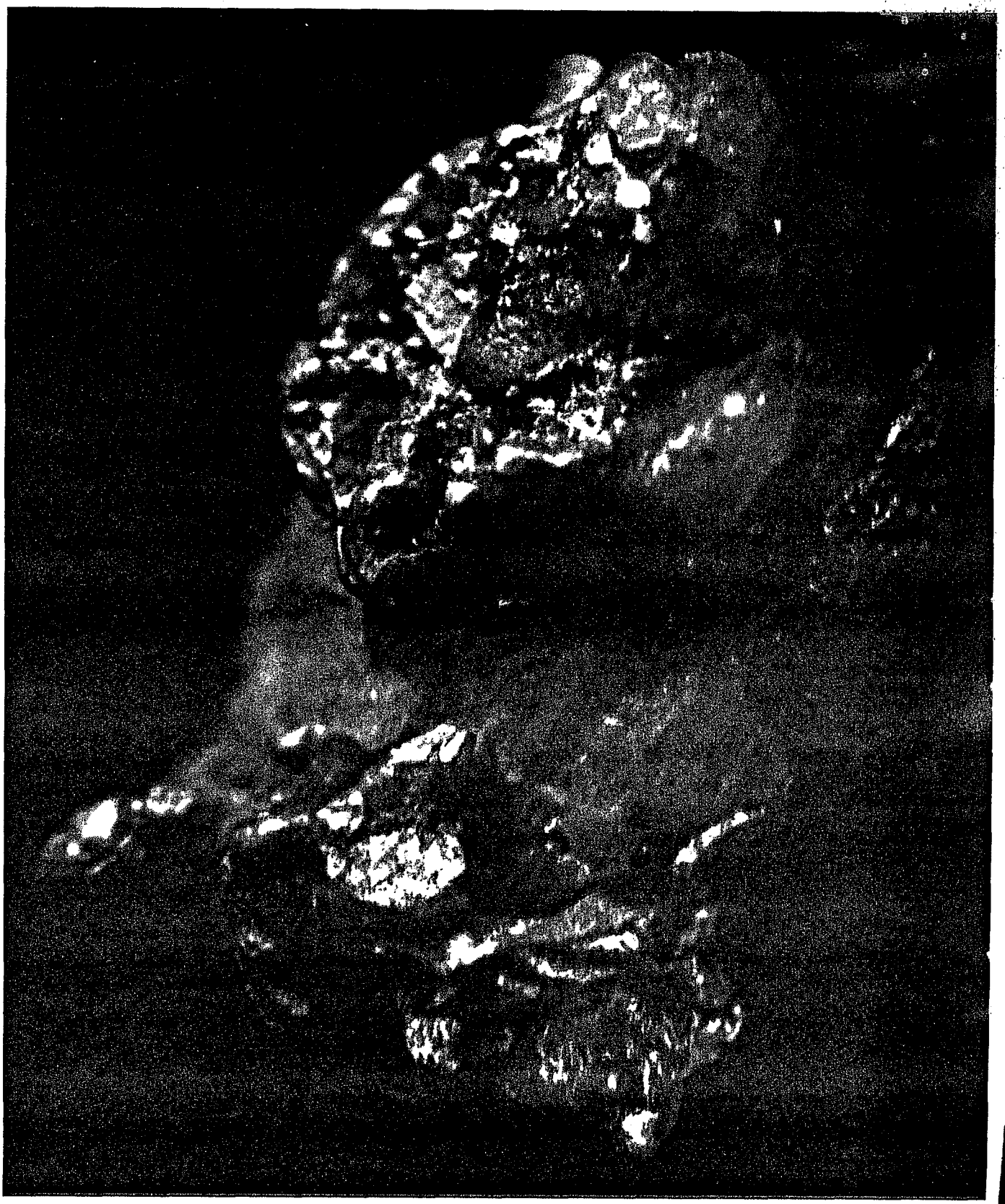
By EDWIN H. McKEE

and a section on IMPLICATIONS OF THE COMPOSITIONS OF LODE AND PLACER GOLD

By J.C. ANTWEILER *and* W.L. CAMPBELL

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1361

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1987



Placer gold nugget about 1 cm wide showing gold molded partly against rounded fragment of clear vein quartz. Collected from King Tut placer workings, Lost Basin mining district.

GEOLOGY AND GOLD MINERALIZATION OF THE GOLD BASIN-LOST BASIN MINING DISTRICTS, MOHAVE COUNTY, ARIZONA

By Ted G. Theodore, Will N. Blair, and J. Thomas Nash

[illegible] to be [illegible] in the sulphide zone in the lower part of the mine than in the oxide zone near the surface. Its run of mine, roughly computed from a record of the output from October 10, 1885, to March 6, 1901, is about as follows: Silver 160 ounces and gold 2 ounces to the ton; lead, 12 to 20 per cent.

Production.—The production is reported to be $1,300,000, that of silver alone amounting to about $1,000,000; and several thousand dollars' worth of medium-grade ore are said to now lie on the dump. The output was mostly made between the autumns of 1885 and 1892. During this period 3,687 tons of ore are reported, according to smelter return sheets, to have contained about 402,000 ounces of silver, 1,180 ounces of gold, and 515,760 pounds of lead. Later, about 1900 to 1902, about 17,550 ounces of silver, 180 ounces of gold, and 114,360 pounds of lead are said to have been obtained from 330 tons of concentrates.

MINES OF CANYON STATION WASH.

In Canyon Station Wash, about a mile north of C. O. D. Wash, there are reported to be several small mines, of which the most important seem to be the Baden-Baden, King, and Queen mines, said to be owned by Lewis Davidson, of Kingman.

MINES IN "TOP OF STOCKTON HILL" AREA.

The "top of Stockton Hill" is situated in the northwestern part of the district, at the crest of the range, between the northern part of the Cerbat district on the west and the heads of I. X. L. and C. O. D. washes on the east. The mines include the Cincinnati, Miner's Hope, Blue Bell, Fountain Head, Brown, and others, the most important of which seems to be the Cincinnati. It is situated near the crest of the range about midway between Lane Springs and I. X. L. basins. It has not been worked for many years, but is regarded as a good property.

GOLD BASIN DISTRICT.

GENERAL FEATURES.

The Gold Basin mining district, of which Basin is the post-office, is situated in the eastern part of the White Hills (fig. 18). It extends over a hilly area about 6 miles in diameter, sloping to Hualpai Wash on the east, and ranges from 2,900 to 5,000 feet in elevation. The northeastern portion, where most of the mines are situated, is rugged, being marked by longitudinal fault scarps and scored by several deep transverse washes, of which the principal ones are Banker, O. K., and Cyclopic, situated about 2 miles apart. The nearest railway station is Hackberry, 40 miles to the south, with which connection is made by stage line. Colorado River lies 16 miles to the north. Mineral was first discovered here early in the seventies, but remoteness from the base of supplies, together with scarcity of fuel and water, renders operations expensive and has materially retarded developments. Nevertheless, considerable progress has been made and much ore has been produced and worked in arrastres and mills.

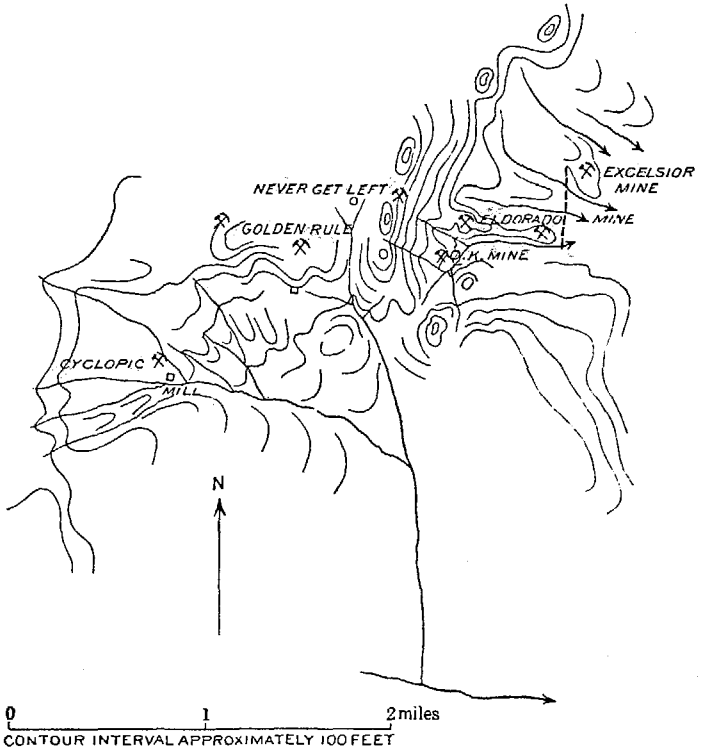


FIGURE 18.—Sketch map of Gold Basin district.

The deposits occur mainly in fissure veins in the pre-Cambrian crystalline rocks. The veins dip southeastward or northwestward, mainly at angles of 40° or 70°. The gangue is quartz, in places with siderite, and the metal is gold, mostly free milling, but it is associated with lead or copper ores, copper stain being a good indication of the gold values. Pyrite, chalcopyrite, galena, molybdenite, and wolframite are found, but the ore is largely oxidized, the water level not having been reached. Among the oxidized products are limonite, malachite, cerusite, and vanadinite.

The mine is said to contain no copper above the 200-foot level, but in an opening [illegible] half a mile west of the mine and about 500 feet above it, on what is thought to be [illegible] C. O. D. vein, the ore, which here occurs in a milk-white quartz gangue, consists chiefly bornite and chalcopyrite, with some zinc blende, and about $20 in gold to the ton.

USGS Bull 397 F.C. Schrader 1909

The district contains about half a dozen small mines and about an equal number of good-looking prospects. The relative location of the most important is shown in the small sketch map (fig. 18). The principal mines are the Eldorado, Excelsior, Golden Rule, Jim Blaine, Never-get-left, O. K., and Cyclopic. The production of the district is given as more than $100,000, most of which came from the Eldorado mine.

ELDORADO MINE.

Location and history.—The Eldorado mine is located in the high foothills in the eastern part of the district, at about 4,000 feet elevation and 1,000 feet above Hualpai Wash, which is about 2 miles distant. The mine is reached by wagon road, over which most of the ore was hauled to the Basin or O. K. mill, 4 miles distant in Hualpai Valley. This mill, which was burnt while in operation in August, 1906, contained 10 stamps and a cyanide plant.

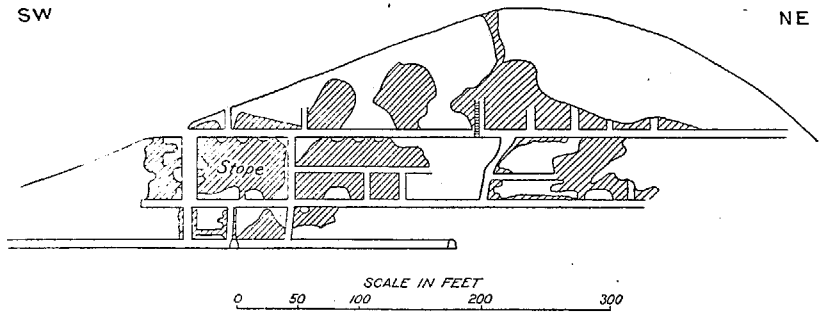


FIGURE 19.—Longitudinal section of Eldorado mine, showing stopes.

The mine was discovered late in the seventies and produced the first bullion taken from the district, much of its ore being at first worked in arrastres. It is owned by the Arizona-Minnesota Gold Mining Company, of Minneapolis. The production is reported to be $65,000, of which $5,000 was produced prior to 1902.

Developments.—The mine is developed principally by about 2,000 feet of tunnels and drifts and 40,000 cubic feet of stopes on three levels, aggregating probably about 90,000 cubic feet of underground work and distributed approximately as shown in the accompanying diagram (fig. 19). The lower tunnel trends about N. 33° E. and strikes the vein at about 200 feet in from the mouth. From this point the drift extends about 200 feet to the northeast.

Geology.—The country rock is a reddish schistose medium-grained granite. On the northeast, however, as shown at the surface and in the bottom of the mine, this rock gives way to a dark friable biotite granite. The contact between the two rocks dips about 30° W. It is usually sharp and is probably a fault plane, which seems to cut off the vein on the northeast.

Veins and ores.—The deposit is a fissure vein, which strikes about N. 50° E. and dips 65° SE. It is continuous from the apex at the crest of the ridge to the contact in the lower tunnel of the mine and is stoped out through most of this extent. The walls are fair, but not regular. The vein averages several feet and the ore shoot about 20 inches in width. It contains iron-stained, free-milling gold-quartz ore, and is reported to average from $12 to $15 a ton in gold. The other associated minerals are malachite, lead carbonate, and vanadinite, the last occurring locally as incrustations of crystals one-fourth inch in maximum length. The principal mill treatment given to the ore was crushing, plate amalgamation, and cyanidation.

Just northwest of the apex of the vein above described and about 80 feet above it is the blanket vein, which is exposed for a length of 600 feet and a width of about 100 feet and which has contributed largely to the output of the mine. It dips about 25° E.

O. K. AND EXCELSIOR MINES.

The O. K. and Excelsior mines were discovered and located by three prospectors, Patterson, Rowe, and Fox, early in the eighties. They worked the ores in arrastres and hauled some to the 4-stamp mill at Grass Springs. In 1886 the O. K. was sold to a Kansas City company, which at once put up the O. K. mill in Hualpai Valley and ran it intermittently from 1887 to 1890. The mill burned down in 1893, but was rebuilt in 1896 and operated by lessees for a time, and then again shut down. It started once more early in 1902 and ran intermittently until 1906, when it burned down while in operation. The water used at the mills was piped from the springs or water tunnels in the upper part of Grand Wash Cliffs, 7 miles to the northeast. The mines are now owned by the Arizona-Minnesota Gold Mining Company.

O. K. mine.—The O. K. mine is about half a mile south of the Eldorado mine and about 100 feet below it, on the opposite side of O. K. Wash. The mine is developed mainly by adit drifts, winzes, and stopes on four levels. There is about 1,600 feet of underground work, distributed approximately as shown in the section (fig. 20). The production is reported to be about $25,000.

The country rock is a dark biotite granite, about the same as that which occurs in the bottom of the Eldorado mine. The strike is N. 30° E., with dip vertical. Slickensides pitch northeast-east toward the mouth of the drifts at angles of about 35°.

The vein trends N. 65° E., but curves to the north in its course and dips about 75° NW. It averages about 18 inches in width and is

composed mainly of seamed, gold-bearing limonite-stained quartz, said to average about $10 in gold to the ton. The hanging wall of the fissure is regular, but rough. Small faults 2 to 6 feet in throw occur, locally accompanied by overlap and enlargement of the vein. The ore favors the hanging wall, but where the vein overturns on the third level and the hanging wall becomes the foot wall the ore, nearly 1 foot thick, occurs in the foot-wall side.

The ore is free milling, but not so much so as the Eldorado ore, the gold being associated with cerusite. The principal other associated minerals are limonite, hematite, siderite, galena, molybdenite, and wolframite.

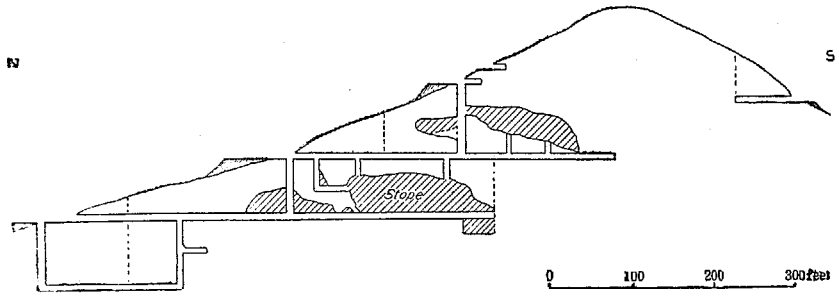


FIGURE 20.—Longitudinal section of O. K. mine, showing stopes.

Excelsior mine.—The Excelsior mine is about a mile northeast of the Eldorado and O. K. mines, in the low foothills near the edge of Hualpai Valley and about 500 feet above it, on the north side of O. K. Wash. The mine is developed to a depth of about 100 feet, principally by inclined shafts, drifts, and stopes, aggregating 500 feet of underground work. The production is reported to be $5,000.

The country rock is a coarse reddish granite associated with black amphibolite schist. The vein dips about 45° NW. It is from 1 to 4 feet in width and is locally occupied by gouge only. The ore shoot contains deeply iron-stained gold-bearing quartz or ore. It varies from three-fourths to 1 foot in width and occurs mainly on the hanging wall. The ore is said to be cyaniding ore, only a small percentage of the values yielding to amalgamation.

MASCOT MINE.

The Mascot, formerly the Old Homestake mine, is situated north of the Excelsior mine in the foothills at the edge of Hualpai Wash, and is said to contain a vein only 3 inches in width, which, however, is reported to be very rich. It is owned by the Arizona-Minnesota Mining Company.

NEVER-GET-LEFT MINE.

The Never-get-left mine is located in the upper part of a cliff or fault scarp that overlooks the Eldorado mine on the east, from which it is but a few hundred yards distant. It is situated at about 4,500 feet elevation, or 1,600 feet above Hualpai Valley. It is owned by Henry Paully, of Basin, and is developed principally by an adit drift, shallow shafts, and open cuts, aggregating several hundred feet of work.

The country rock is dark gneissoid schist. The structure dips about 50° W., but the principal deposit dips about 80° N. It has a width of 6 or 8 feet and contains mainly iron-stained or copper-stained crushed gold-bearing quartz. The country rock is greatly disturbed by jointing, fracturing, and faulting, and its true character is somewhat doubtful. The mine has been a small producer for some years and was shipping ore in April, 1906.

GOLDEN RULE MINE.

Location and history.—The Golden Rule mine is about 1 mile west of the Never-get-left mine, at the extreme head of O. K. Wash, at about 4,550 feet elevation. It was discovered in the early eighties by Robert Patterson and Saul Rowe, who hauled some of the ore to the Grass Springs mill. Subsequently they leased the mine to Mr. Quackenback, and in 1900 sold it to the present owner, the Arizona-Minnesota Gold Mining Company. This company did but little development work on it till 1906. From May 15 to November 1 it was operated with a force of ten men, but was closed on the latter date. The production of the mine is estimated to be about $5,000, most of which came from the blanket vein.

Development.—The mine is developed by a 75-foot shaft, about 300 feet of drift, stopes, and a 25° incline about 100 feet long and 20 to 40 feet in width, the incline being on the south, where the deposits occur in the form of a blanket vein. The workings are contained within a horizontal distance of about 700 feet and a vertical distance of about 100 feet. The mine is handicapped by lack of water, which has to be hauled from the Cyclopic mine or from Basin, in Hualpai Valley.

Geology and ore deposits.—The country rock is the pre-Cambrian gneiss and schist. The fissure vein containing the principal part of the deposits strikes N. 20° E. and dips about 70° ESE. The croppings, which in part are prominent, form a reef of iron-stained, firmly cemented quartz breccia. The vein is best exposed in the north drift. It is about 2½ feet in average width and contains gold-bearing normal vein quartz, locally crushed, recemented, and iron-stained. Associated with it on either side is a sheet of pale grayish or whitish

gouge. The vein is said to yield good values throughout, the average being about $10 in gold to the ton, but the honeycombed quartz is the richest part of it.

At 120 feet in from the mouth of the drift the vein is abruptly cut off by a fault, immediately beyond which occurs a dark schistose rock that may be an intrusive. Near the fault the vein enlarges to about 12 feet in width, the enlargement being mainly on the foot-wall side and containing much honeycombed quartz, and the ore, greatly increased in quantity, is said to contain higher values. Some of it averaged about $100 a ton in a large chamber, from which much ore has been removed.

The fault hades north at an angle of about 10°. It is a normal one and the lost portion of the vein has risen toward the southeast. The amount of throw was not determined, but it is probably not very great. Beyond the fault the drift extends about 100 feet on the projected course of the vein which, however, has not been found.

On the south the deposits occur in a blanket vein, which is 3 to 5 feet thick, dips about 25° SE., and is probably a portion of the vein in the north drift, for it straightens up in that direction toward the top of the hill. The blanket portion has been mined over an area of about 100 feet along the strike and a breadth of 35 feet down the dip, and it probably produced good values.

CYCLOPIC MINE.

Location and history.—The Cyclopic mine is located in the southeastern part of the district, about 5 miles southwest of the Eldorado mine, near the head of Cyclopic Wash, at about 4,500 feet elevation, on open ground. It was discovered in the early eighties by Patterson, Rowe, and Glen, and about 1896 it was leased to a Seattle company. In 1901, with the Golden Rule mine, it was sold to Robbins & Walker, of Minneapolis, who milled some ore. The coarse tailings still on the ground are said to contain about $7 in gold to the ton. Since 1904 the mine has been owned by the Cyclopic Gold Mining Company, of Denver. A considerable amount of bullion is said to have been produced, but the exact amount was not ascertained.

Developments.—The mine is developed mainly by shallow, mostly inclined shafts, drifts, and crosscuts to a maximum depth of about 70 feet, but most of the workings do not extend below 30 feet. The developments probably aggregate about 1,000 feet of work.

As the mine is located in a broad wash, some of the workings have become filled with wash débris at times of flood. The principal equipments are an Ellspass mill, operated by a 26-horsepower engine, and a cyanide plant. The water supply is pumped by a small gasoline plant from the west side of the range, several miles distant.

Geology.—The country rock is a medium-grained coarsely porphyritic granite. It outcrops in association with the deposits and forms the foothills immediately on the southwest. Paralleling this rock, the wash, and the deposits on the northeast, and constituting the ridge on which the office and other buildings stand, is a fine-grained reddish granitic rock, with which is associated some of the same biotite granite that underlies the Eldorado mine. In contact with the deposits, particularly to the northwest, there is also a coarse red pegmatite.

Deposits.—The deposits are ill defined and not well understood. They consist of gold-bearing iron-stained breccias and sands of vein quartz, in a few places somewhat resembling conglomerate. This material is cemented by silica and iron oxide, but is in part loosely coherent. It trends from a point near the mill N. 57° W. up the wash and is contained in, and for the most part seems to occupy, an area three-fourths of a mile in length by about 200 feet or more in width. Prominent reefs of silicified iron-stained breccia several or more feet in width outcrop several feet above the surface. They are in practically all respects identical with the croppings of the Golden Rule and other veins that have been described. They do not, however, as a rule, continue in depth in the manner of a fissure vein, nor seem to have any definite fissure wall, but usually at a short distance below the surface give way to less firm material having an imperfect synclinal structure. In the northern part, the pseudovein croppings dip toward each other and their attitude suggests that they may be synclinal limbs of the same vein deposit.

From the principal openings near the mill in the southeastern part of the deposit the croppings representing the main or Cyclopic vein extend N. 57° W. They are continuous for the first 400 feet and are accompanied by some underlying vein quartz or ore and show ore in sight at both ends of the 400-foot excavation. Between this vicinity, however, and the northwest limits of the deposits, the croppings of the vein are interrupted, and some pits and cuts have failed to find ore there.

The croppings of the other vein extend without interruption from a point about one-fourth of a mile northwest of the principal opening for a distance of 350 feet to the northwest. They are nearly parallel with the main vein, from which they are about 350 feet distant.

The ore thus far has been derived mostly from these veins, but crosscuts 80 feet or more in length have been run in a considerable portion of the deposits between them and report fair values, which, however, seem to occur in lines or zones paralleling the deposit. Practically no mining has been done below a depth of about 30 feet. Near this level there is reported to occur a bed of red clay or gouge which was formerly supposed to mark the lower limit of the ore, but

ore is said to have been found below it. The altered granite for a width of 100 feet or more bordering the deposit is also said to contain $2 to $4 a ton in gold.

The ore is of low grade, and is said to mill on the average from $7 to $8 a ton in gold, and to cyanide well. It contains also a little silver and a trace of copper, the latter occurring chiefly as malachite and not in sufficient amount to interfere with the cyanidation. The company is reported to have recently computed about 1,000,000 tons of ore in sight.

GOLD BELT MINE.

The Gold Belt mine is located on the southeast side of Banker Wash, at about 5,000 feet elevation. It is owned by Henry Paully. The country rock is an amphibolite schist, dipping about 30° W. At the western of the two principal openings the deposits are contained in a blanket vein of quartz 15 feet thick, inclining gently eastward, but thinning out in a distance of about 30 feet. The eastern opening shows two quartz blanket veins, each 2 to 6 feet in thickness, dipping gently westward and separated by a 4-foot dike of some volcanic rock that seems to be basalt, but is altered beyond identification.

The ore is said to be of two grades, the lower grade yielding from $4 to $7 in gold to the ton and the better grade from $16 to $20 to the ton and some as high as several hundred dollars a ton, that occurring in the porous or honeycombed quartz being the best. The deposit is reported to have produced a few hundred dollars' worth of ore.

SENATOR MINE.

The Senator mine is located some distance beyond the border of the Gold Basin district, about 7 miles northwest of the Eldorado and Golden Rule mines and about 7 miles south of Colorado River, on a low round hill at the southeast base of a prominent landmark known as "Senator Mountain." The mine was discovered late in the eighties by John Burnett, who in 1892 sold it for $14,000 to Senator Page, of Los Angeles, who in turn sold it to a Colorado company. The company at once installed a 10-stamp mill on Colorado River, 2 miles below Salt Springs, operated the mine and mill for about six months, and then suspended. Later the property was acquired by or leased to the Salt Springs Mining Company, which operated it about a month in 1903 and shut down, the ore being of too low grade to pay for its haulage to the mill, 7 miles distant, and for bringing supplies from Hackberry and Kingman, 50 and 60 miles distant, respectively. The mine is reported to have been abandoned since then.

The mine is developed principally by open work, cuts, and adit [illegible] The deposits are said to be nearly flat lying and similar in [illegible] those of the Cyclopic mine (p. 125), but they form a

larger body. The ore is said to be similarly low in grade, averaging about $3 in gold to the ton. According to Comstock,[a] the deposits exhibit structural features resembling those of "brecciated fusion" and "cooling lamination" and in origin seem to be associated with igneous intrusion.

DEPOSITS AT SALT SPRINGS.

The Salt Springs mine is about 7 miles northeast of the Senator mine and several miles south of Colorado River, in the first canyon west of Hualpai Wash. It is owned by the Salt Springs Mining Company, which is said to include members of the Arizona-Minnesota Gold Mining Company. The country rock is granite. The gold ore is said to occur sporadically in quartz bodies, and its downward limit is usually indicated by copper-stained quartz.

Other properties in this district are the Smuggler-Union group, the Eureka mine, and the Lutley group.

WHITE HILLS DISTRICT.

GENERAL DESCRIPTION.

LOCATION AND HISTORY.

The White Hills district is located about 28 miles north of Chloride, in the western border of the White Hills, at about 3,000 feet elevation. It comprises an area about 2 miles in diameter and is a part of the Indian Secret mining district, so named because the knowledge of the presence of its mineral was for a long time withheld from the whites by the Indians.

The first discovery of mineral in the district by white men was made by Henry Shaffer in May, 1892, through the aid of an Indian known as Hualpai Jeff, who exhibited a piece of rich silver ore at Gold Basin and showed Shaffer its source, where the Indians procured the supply of red iron oxide with which they adorned their faces. The locality is at the site of the Hidden Treasure mine.

After making several locations, Shaffer reported the discovery at Gold Basin and was soon joined by John Burnett and John Sullivan, who also located what later proved to be some of the best mines. The trio began work and were soon shipping very rich ore, some averaging $1,000 a ton. The camp soon became the largest in the region and reached its zenith in 1894, with a population of 1,200. Within a short time the camp was owned by one company, the White Hills Mining Company, of which the chief men were R. T. Root and D. H. Moffatt, of Denver. A 10-stamp mill was built early in 1904; in

[a] Comstock, Theodore B., Geology and vein phenomena of Arizona: Trans. Am. Inst. Min. Eng., vol. 30, 1900, pp. 1048–1049.

The gangue is usually iron-stained quartz and the ore contains gold, some silver, oxide of manganese, and considerable hematite.

LOST BASIN DISTRICT.

The Lost Basin district is situated in the most northern part of the region examined. It comprises the belt lying between Hualpai Wash on the west and Pierce Mill Canyon on the east, and extending from Colorado River at the mouth of the Grand Canyon southward through the Grand Wash Cliffs to a point 12 miles beyond Scanlon Ferry, near the latitude of Gold Basin. It has a length of 20 miles and a width of about 9 miles. It is reached by wagon road descending Hualpai Wash from Gold Basin to Colorado River at Scanlon Ferry.

The principal veins occur south of the middle of the belt, about 7 miles northeast of Gold Basin, where, between elevations of about 2,000 feet on the west and 5,000 feet on the east, they trend about east and west across the district for a distance of 6 miles.

They were discovered about 1886, and considerable ore has been taken out from time to time and treated in arrastres or milled, but the ground on the whole is but little more than prospected. This is probably due to the lack of water. The nearest water supply is Colorado River at Scanlon Ferry, 8 miles to the north, whence water is now hauled at a cost of $2 a barrel. The two points, however, could be readily connected by pipe line.

The ore could without difficulty be hauled to the river, with which the area is said to be connected by a good wagon road, but its transportation by water down the river, advocated by some, does not seem feasible, owing to the dangerous rapids that would be encountered and the impracticability of bringing barges or bottoms of any kind up the river and the great cost of bringing them overland.

The deposits are mostly owned by about half a dozen men. They occur mainly in the pre-Cambrian granitic rocks in well-defined, strong quartz fissure veins, of which there are two sets. Those on the west strike northward with dips vertical or steep to the east and are chiefly gold bearing; those on the east strike west-northwest and are chiefly copper bearing. The relative age of the two sets of veins has not been determined, but it is possible that the copper deposits may be in part pre-Cambrian.

The principal gold properties are known as the Scanlon-Childers mines and are owned chiefly by Mike Scanlon, of Basin, and Cy Childers, of Kingman. The veins average from 4 to 6 feet in width. Several of them are reported to be from 10 to 14 feet in width and from 1 to 2 miles in length. The croppings are principally brown and green iron and copper-stained quartz and are in part prominent.

Some of the veins are said to be exposed in the canyons to a depth of 200 feet or more and yield good shipping ore from the surface down to this depth. The ore contains principally gold and silver and a little copper, but no copper of commercial value and not enough to interfere with cyaniding.

The ore on the whole is fine in texture. It has been sampled and tested by Denver men and was found to be excellent cyaniding ore, and is reported to contain on the average $8 or upward in gold to the ton.

The copper deposits are said to extend from a point near the middle of the belt nearly to the summit of the Grand Wash Cliffs and Colorado Plateau on the east. They are owned chiefly by James Burrows and J. W. Mouat, of White Hills. Other owners are Messrs. Grant, Fielding, and Roseborough, of Hackberry. The pre-Cambrian complex is here more schistose than on the gold-bearing side of the belt, and some of the deposits on the extreme east are said to be associated with limestone. The copper-bearing veins, as indicated, strike west-northwest at nearly right angles to the gold-bearing veins. The croppings are large, and, as seen by the writer, consist principally of oxidized masses of brown and black quartz, with some malachite and azurite. The ore contains principally copper and carries also some gold and silver. Some of it is reported to have assayed from 17 to 20 per cent of copper.

The production of the district is reported to be many thousand dollars, chiefly in gold.

BLACK MOUNTAINS.

INTRODUCTION.

The deposits of the Black Mountains differ in most respects very markedly from those of the Cerbat Range. They occur chiefly in the Tertiary volcanic rocks. Their trend is west-northwest to northwest, the dip steep. Their gangue is mainly calcite and dolomitic carbonates, but these minerals have largely been replaced by quartz and adularia, a variety of orthoclase free from sodium and with characteristic crystal form. They are deeply oxidized and, as a rule, contain no sulphides, and their values are almost exclusively in gold there being usually no base metals present. There is a general absence of fluccan or gouge, the veins being usually frozen fast to the country rock.

The districts in the Black Mountains, named in order from north to south, are the Eldorado Pass, Gold Bug, Mocking Bird, Virginia, Pilgrim, Union Pass, Gold Road, Vivian, and Boundary Cone. Of these the most important is the Gold Road district. The two first