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GEOLOGY, ALTERATION AND MINERALIZATION IN THE OATMAN MINING DISTRICT, MOHAVE COUNTY, ARIZONA

Text of Talk Presented by Perry Durning

to the Arizona Geological Society Meeting

August 5, 1980

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I. INTRODUCTION AND ACKNOWLEDGEMENTS

I'd like to thank you for the opportunity to present some of the results of our work at Oatman and share with you some of our successes and disappointments.

I'd also like to thank Fischer-Watt Mining and Canadian Natural Resources for their continuing support of our exploration efforts, and acknowledge the contributions of Larry Buchanan, Gary Clifton, Fred Haynes, Don Muchow and Masters thesis students Bob Smith and Al Morris, all of whom have contributed to our geological understanding of Oatman.

III. LOCATION

The Oatman district is located about 30 miles southwest of Kingman and approximately 100 miles SSE of Las Vegas on old Highway 66. (Figure 1)

III. HISTORY OF FISCHER-WATT MINING INVOLVEMENT

Carl Fischer and Tim Watt as individuals became interested in the Oatman district in 1977. Initial work involved deepening the Ida Shaft on the Tom Reed Jr. Vein. In 1979, Fischer-Watt Mining was organized to evaluate the exploration potential for the entire Oatman district as well as identify other exploration and mine development opportunities throughout the western United States.

During April, 1979, critical land positions were negotiated and geological, geochemical and fluid inclusion studies were initiated.

Drilling was begun in September, 1979, and to date 35 drill holes varying 200 to 1,900 feet have been completed.

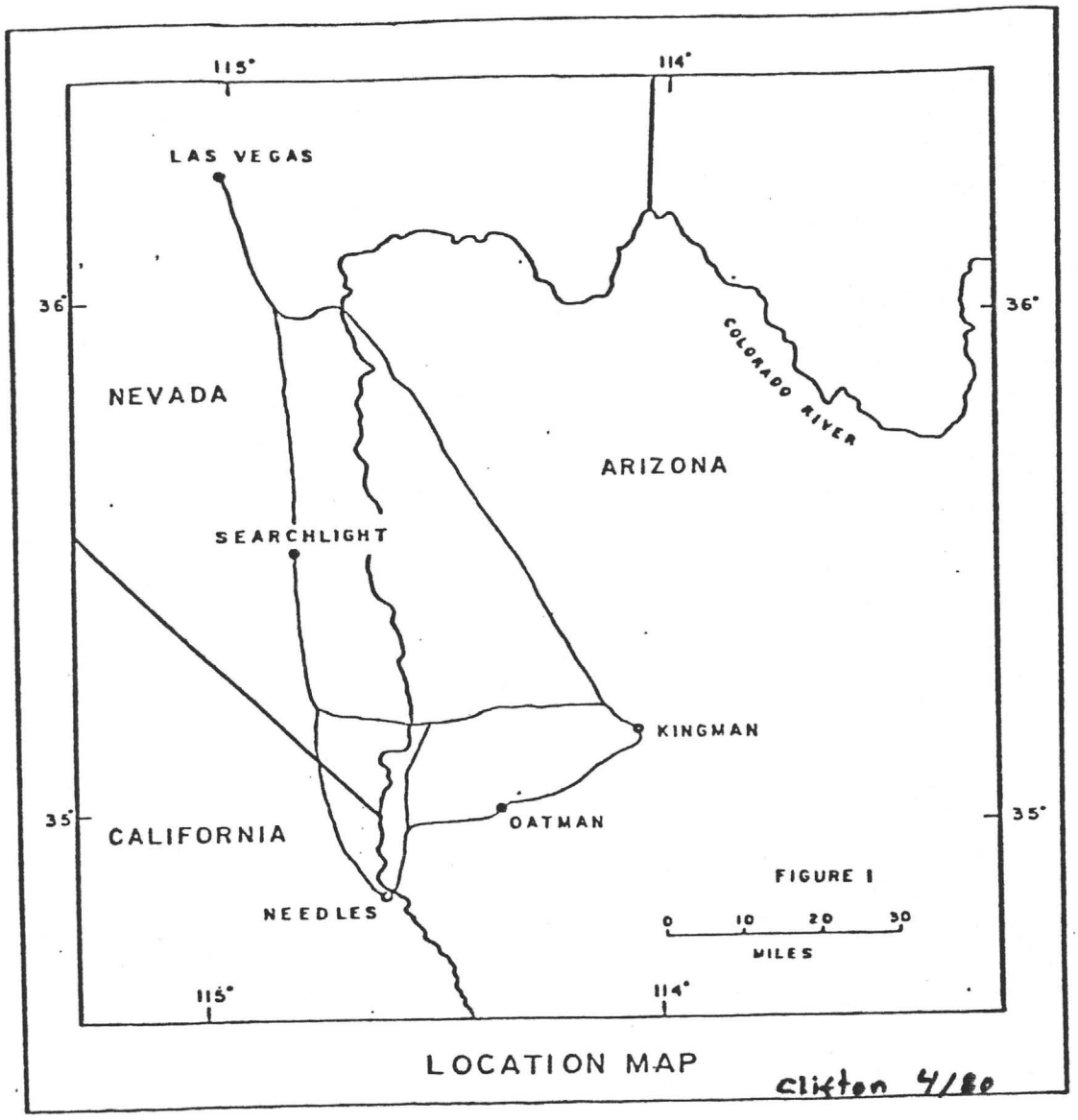
115°
114°
LAS VEGAS
36°
36°
NEVADA
COLORADO RIVER
ARIZONA
SEARCHLIGHT
KINGMAN
35°
35°
CALIFORNIA
OATMAN
FIGURE I
NEEDLES
0 10 20 30
MILES
115°
114°
LOCATION MAP
clifton 4/80

figure I

IV. HISTORY AND PRODUCTION

The original discovery at Oatman was made on the Moss vein in the western part of the district in 1863. However, mine development was discouraged by unfriendly Indians. Mining activities resumed in the 1880's but it was not until the discovery of the Gold Road Vein in 1900 that prospecting activities centered in the central part of the district. In 1901 gold was found on the Tom Reed vein but it was not until 1906 that rich ore in the Tip Top and Ben Harrison ore shoots was discovered. In 1915 and 1916 the Big Jim, Aztec and United Eastern ore bodies were discovered on the Tom Reed vein and the resultant boom swelled the population of Oatman and Gold Road to over 10,000 people. By the mid 1920's Oatman's population had dwindled and most of the mines had turned to leasor operations. Elevation of the gold price from $20. to $35./oz. in 1933 resulted in a revival of the Tom Reed and Gold Road Mining Company properties until they were closed by war board order L-208 in 1942.

The town of Oatman was named after Olive Oatman who was held captive by Indians for several years then found wandering in the desert by a rancher near the present town site.

Total production for the Oatman district between 1897 and 1942 was about 2.2×10^6 ounces Au and $.8 \times 10^6$ ounces Ag. The metal was derived from 3.8×10^6 T of ore with an average grade of 0.59 o/T Au, 0.20 o/T Ag. (Table 1) The majority of this production came from 8 major ore shoots on the Tom Reed and Gold Road vein. (Table 2) All other mines contributed about 10% of total district production.

V. REGIONAL GEOLOGY AND STRUCTURE

Geologic maps covering the Oatman District compiled by Ransome 1923, Lausen 1931, and Thorson 1971, provide excellent regional geologic coverage. Since the meat of my discussion will involve detailed description of the local vein geology I will deal only briefly with the regional geological environment.

The Oatman district lies within a thick sequence of 30 to 10 million year old Trachyatic, latitic and rhyolitic volacanic rocks on the southwestern flank of the Black Mountains. (Figure 2) The Oatman district may lie within a large circular caldron-like structure characterized by exceptionally thick sequences of Trachytes and latites and intruded along its margins by late stage epizonal quartz monzonite to rhyolitic stocks and plugs. (Figures 3a, 3b) The circular feature is also the margin for a

Table 1

INDIVIDUAL MINE PRODUCTION

OATMAN MINING DISTRICT, MOHAVE COUNTY, ARIZONA

Mine	Gold $20.67/oz 1897-1933 Tons of Ore	Mined Grade oz/T	Gold $35/oz 1934-1942 Tons of Ore	Mined Grade oz/T	Total Tons of Ore	Average Mined Grade oz/T
Tom Reed	981,090	0.70	205,125	0.32	1,186,215	0.64
United Eastern	687,038	1.12	0	0	687,038	1.12
Gold Road	737,926	0.47	775,895	0.22	1,513,823	0.32
Total Prod.	2,406,054	0.74	981,020	0.24	3,387,076	0.59
Other Mines				(est.)	400,000	0.60

Clifton 4/80

Table 2

SUMMARY OF OREBODY CHARACTERISTICS MINED FROM THE
TOM REED-UNITED EASTERN AND GOLD ROAD VEINS, OATMAN, ARIZONA

Orebody	Symbol Fig. 3 & 14	Tonnage	Grade O/T Au	Maximum Dimensions Length	Width	Height
United Eastern	(UE)	550,000	1.10	450	45	700
Tip Top	(TT)	250,000	±0.70	500	20	1300
Ben Harrison	(BH)	250,000	±0.70	650	20	750
Big Jim Aztec	(BJ) (A)	±500,000	±0.75	1950	35	800
Black Eagle	(B)	±200,000	±0.50	350	10	1000
United American	(UA)	±140,000	±0.50	300	10	1000
United Western	(UW)	40,000	0.30	990	6	300
Gold Road	(GR)	1,500,000	0.32	6,200	22	1300
Telluride	(T) *	20,000	1.0	200	2-3	200
Argo	(AR)	none				
Olla Oatman	(OO)	none				
Red Cloud	(RC)	none				
United Eastern #3	(UE3)	none				
Pasadena	(P)	none				

* Figures are estimates

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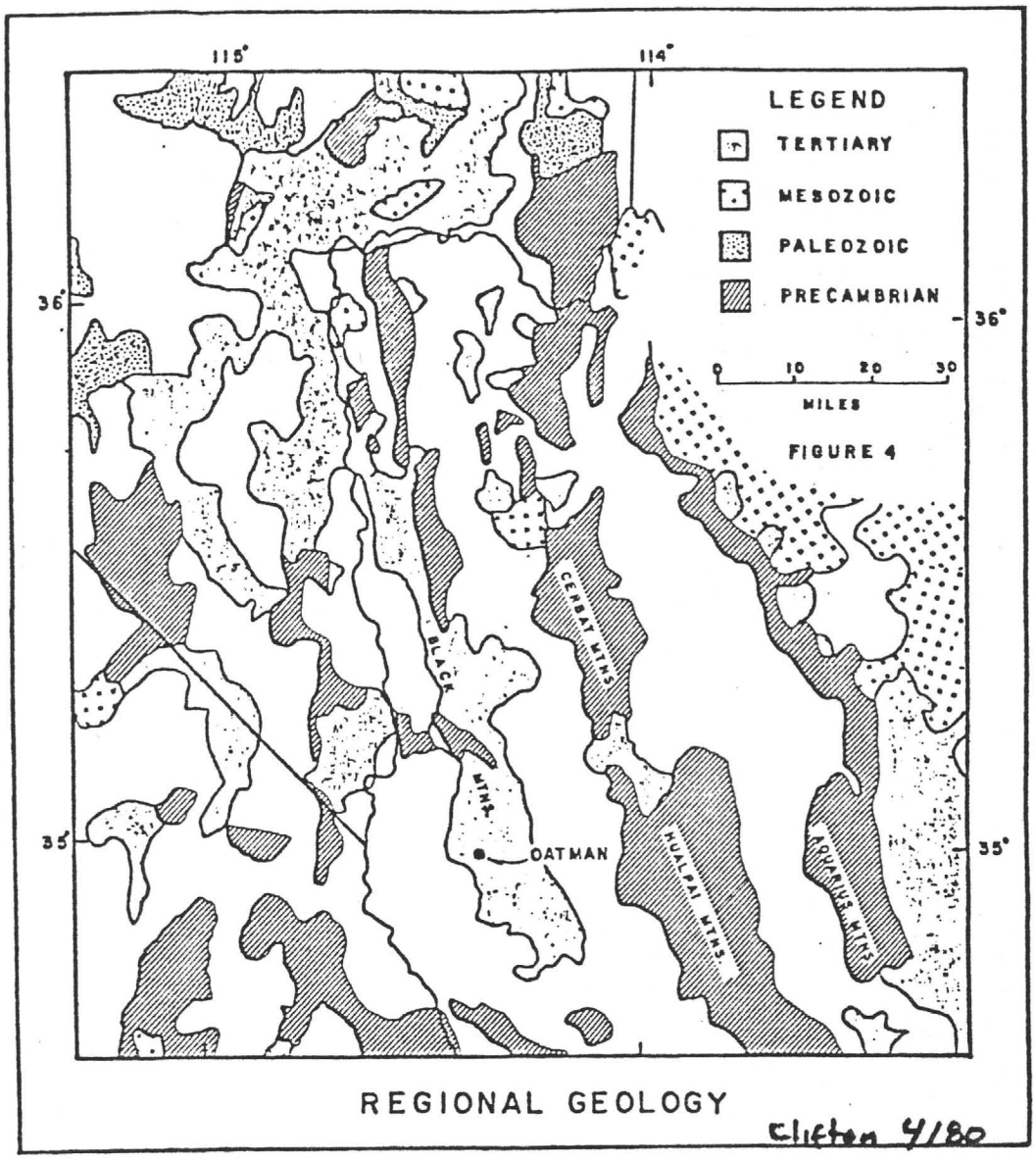
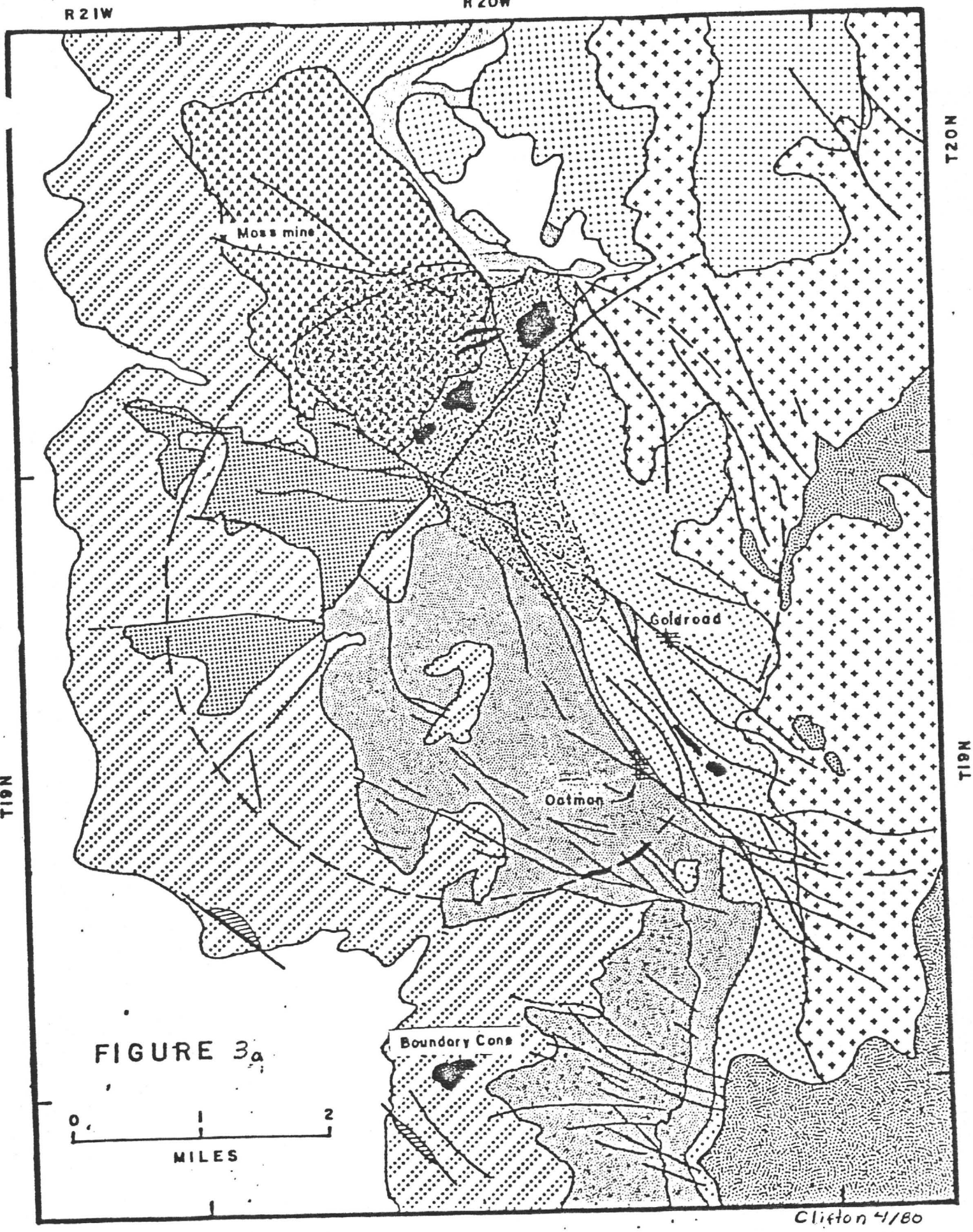

115°
114°
36°
35°
LEGEND
TERTIARY
MESOZOIC
PALEOZOIC
PRECAMBRIAN
0 10 20 30
MILES
FIGURE 4
BLACK MTNS
CERBAT MTNS
HUALPAI MTNS
AQUARIUS MTNS
OATMAN
REGIONAL GEOLOGY
Clifton 4/80

Figure 2



GEOLOGY AND STRUCTURE OF THE OATMAN DISTRICT

FIGURE 3b

LEGEND

QUAT.		ALLUVIUM	
MIDDLE AND UPPER MIOCENE		OLIVINE BASALT	
		RHYOLITE DIKES, PLUGS, FLOWS	
		MOSS PORPHYRY 10.4 ±.5 my	
		LATITE, RHYOLITE (undifferentiated) 19.7 ±.9 my	UPPER VOLCANICS
		GOLD ROAD LATITE 18.2 ±.9 my	MIDDLE VOLCANICS
		OATMAN LATITE	
		ESPERANZA TRACHYTE	
LOWER MIOCENE		TIMES PORPHYRY 22.6 my	LOWER VOLCANICS
EOCENE		ALCYONE FM.	
PRECAM.		GRANITE, GNEISS, SCHIST	

VEIN

JOINTS OR LINEARS

PHYLLIC/ARGILLIC ALTERATION

COMPILED FROM:

RANSOME (1923)

LAUSEN (1931)

THORSON (1971)

THIS REPORT

Clifton 4/80

thick sequence of tuffacous volcanic rocks which thin away from the Oatman district.

The structural pattern is dominated by a set of concentric fractures which define a near perfect 5 mile diameter circular feature identified from landstat imagery and high altitude aerial photography. Cutting the concentric feature is a separate set of fractures which radiate from a common point near the center of the circular feature. The major ore deposits of the central district are located within a wedge of radial fractures which cut the concentric fracture set 3 miles southeast of the center-point.

VI. LOCAL - GEOLOGY

The predominant features of this geology in the vecinity of the Tom Reed and Gold Road veins is a thick sequence of biotite free latite (Oatman latite), biotite rich latite (Gold Road latite) and intrusive biotite rhyolite plugs and dikes (Elephant tooth rhyolite). (Figure 4) Underlying the volcanics near the town of Oatman at a depth of about 2,000 feet is preCambrian Granite as identified in drill holes from the bottom of the United Eastern Mine.

The volcanic units are cut by a series of NW trending fault veins which dip primarily to the north and are the host for the majority of the gold mineralization at Oatman. Oblique slip movement on each of the major faults was probably a few hundred feet and is both pre and post-mineral. The emplacement of the rhyolite dikes was also controlled by pre-mineral NW fault trends and the rhyolites are probably closely related in age to the mineralization. Post-ore faults such as the Mallery and Oatman faults have had a significant impact, in that locally they displace major ore shoots.

Rock types exert a profound influence on the nature of mineralization in the veins. In the Gold Road latite, the mineralization is frequently in long, narrow fissure veins. (Figure 5) In the Oatman latite however, stockwork vein development occurs with quartz and calcite replacing the host Oatman latite over widths of up to 45'. Ore bodies in the Gold Road therefore, have a long strike length and limited vertical range while those in the Oatman exhibit a short strike length and a vertical range 1 to 4 times the strike.

VII. MINERALIZATION AND ALTERATION

The epithermal precious metal veins at Oatman are typical of those found throughout the world in the tertiary volcanic

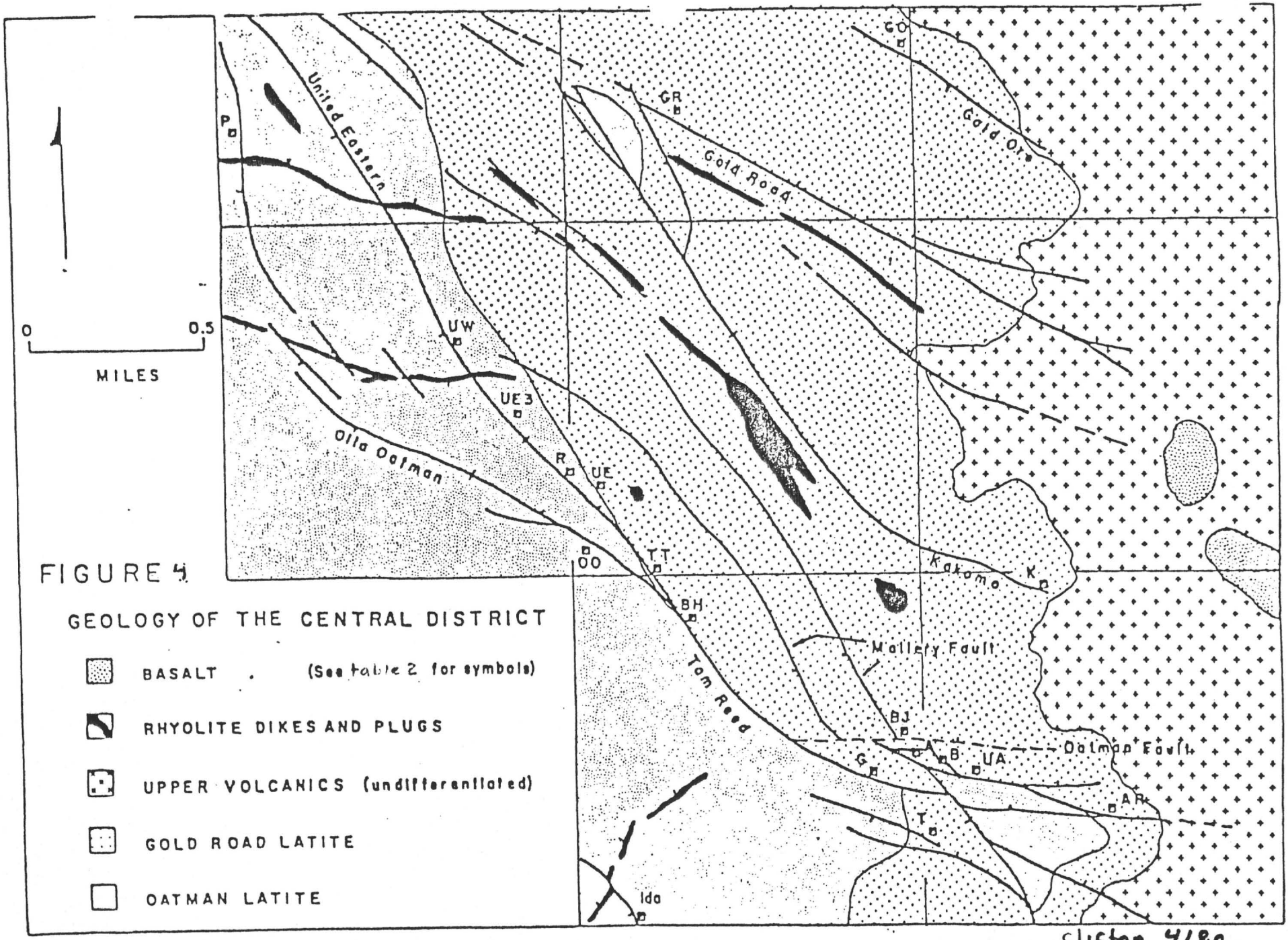


FIGURE 4

GEOLOGY OF THE CENTRAL DISTRICT

BASALT (See table 2 for symbols)

RHYOLITE DIKES AND PLUGS

UPPER VOLCANICS (undifferentiated)

GOLD ROAD LATITE

OATMAN LATITE

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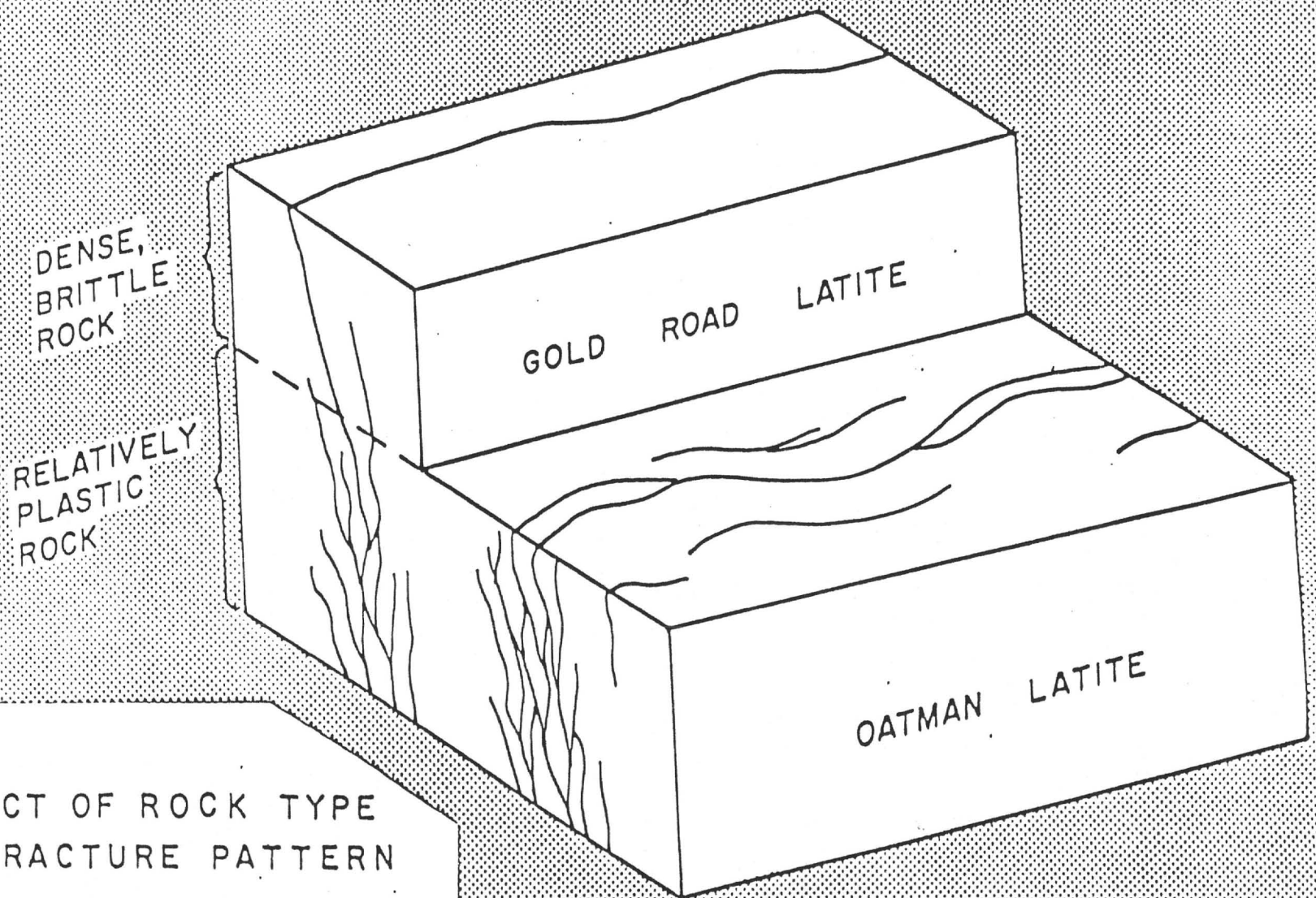


ECT OF ROCK TYPE
FRACTURE PATTERN

FIGURE 5

Buchanan 4/80

environment. They are quartz-calcite adularia fissure fillings and/or replacement lodes which for the majority of their strike length are barren but which locally form shoots of ore grade mineralization. Mineralization at Oatman consists of free gold and electrum with <¼% sulfides. As with most epithermal districts neither vein material nor mineralization extended to the surface at the time of formation and it was only through the kindness of Nature that erosion exposed the tops of the Gold Road and Tip Top ore shoots. (Figure 6) The ore shoots at Oatman pinch vertically and laterally and decrease in grade and depth. Lausen identified 5 stages of quartz-calcite adularia vein formation and it is only in areas of multiple stage mineralization that significant high grade mineralized ore shoots were formed.

The Gold Road vein to the north is a fissure filling in Gold Road latite more or less continuously mineralized over its explored length of 6,200 feet. Ore shoots are centered at local irregularities along the strike of the vein. Ore grade mineralization cropped out at the surface and led to its early discovery. Enveloping the vein are local zones of phyllic alteration with minor silicification. High in the volcanic pile in exposures believed to be near the paleosurface at the time of formation the vein is expressed as a 2-5' wide zone of phyllic alteration with a 1" thick seam of calcedonic quartz. The Gold Road vein had a total production of about 1.5 x 10^6 T of ore grading 0.32 o/T Au.

The Tom Reed vein which lies about 1 mile south of the Gold Road vein has a much more subtle expression. Only above the Tip Top and Ben Harrison ore shoots was there significant quartz or silicification. Ore on the Tom Reed vein is entirely in Oatman latite and rather than forming a discrete fissure filling produced stockwork quartz-calcite adularia loads which locally exceeded 45' in width. Ore shoots were localized at flexures along the vein. Unlike the Gold Road vein most of the Tom Reed vein ore shoots had an extremely subtle surface expression and it was only through sinking shafts that buried ore shoots were discovered.

I'll use the surface expression over the great United Eastern ore shoot to illustrate how subtle the surface expression of these ore shoots can be.

The surface expression of the United Eastern ore shoot is a 200' wide zone of phyllic alteration of the Oatman latite which shows moderate chemical destruction of the andesite but no discoloration and no significant quartz or calcite veining. (Figure 7)

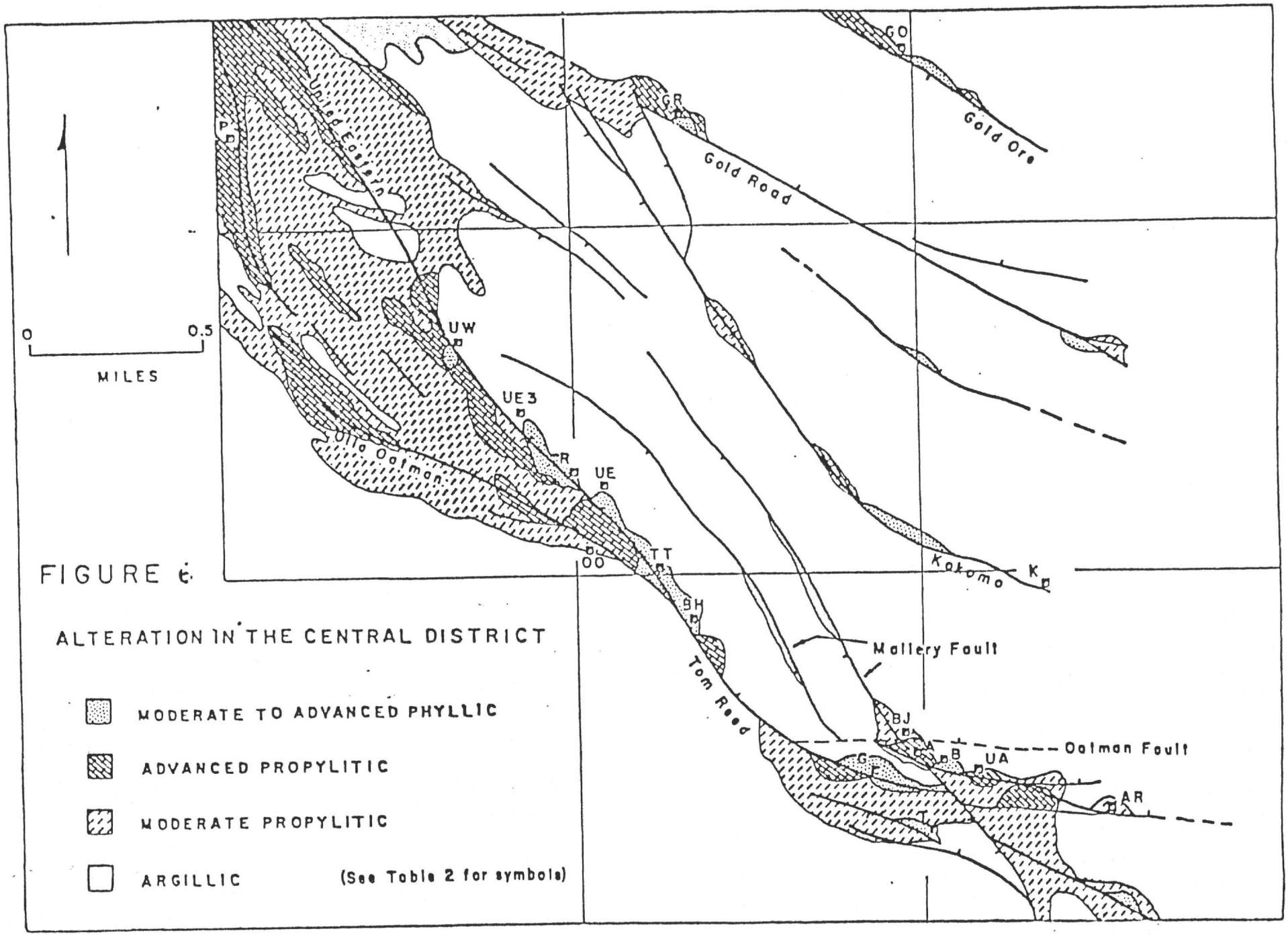


FIGURE 6

ALTERATION IN THE CENTRAL DISTRICT

MODERATE TO ADVANCED PHYLLIC

ADVANCED PROPYLITIC

MODERATE PROPYLITIC

ARGILLIC (See Table 2 for symbols)

Clifton 4/80

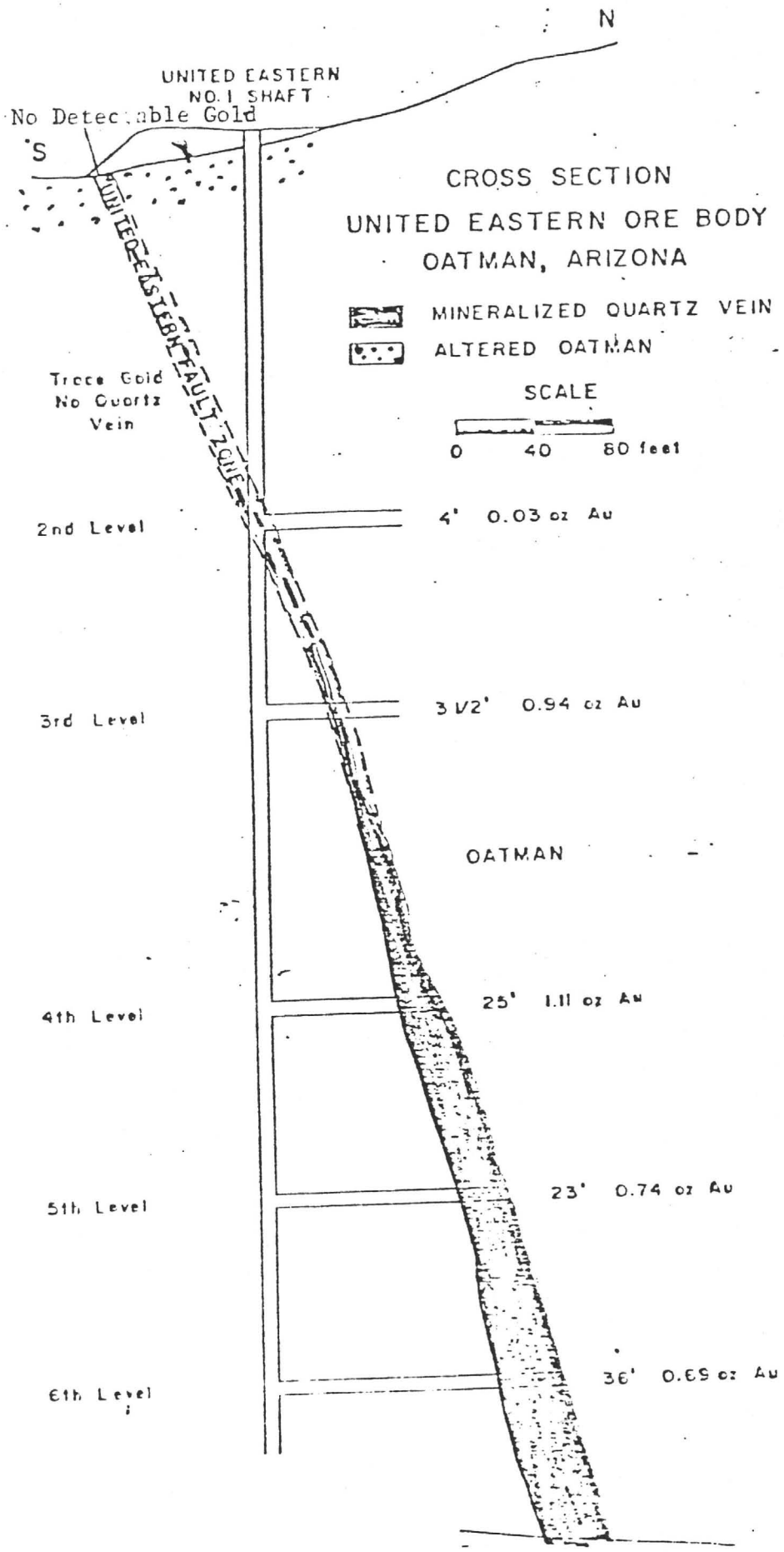

N
UNITED EASTERN
NO. 1 SHAFT
No Detectable Gold
S
CROSS SECTION
UNITED EASTERN ORE BODY
OATMAN, ARIZONA
MINERALIZED QUARTZ VEIN
ALTERED OATMAN
SCALE
0 40 80 feet
Trace Gold
No Quartz
Vein
2nd Level
4' 0.03 oz Au
3rd Level
3 1/2' 0.94 oz Au
OATMAN
4th Level
25' 1.11 oz Au
5th Level
23' 0.74 oz Au
6th Level
36' 0.69 oz Au

Figure 7

The Oatman latite has lost its original textural characteristics and appears to the casual observer to be nothing more than strongly weathered volcanics. A cross section through the United Eastern #1 or discovery shaft shows there is no vein material and no detectable gold at the surface. At 200 feet the shaft cut a 4' wide fault gouge zone containing 4' of 0.03 o/T Au; at 300 feet, 3½' of quartz and calcite returned 0.94 o/T Au and at 450' the vein showed 25' of vein material which graded 1.11 o/T Au. Total production from the United Eastern ore shoot was 550,000 T of 1.11 o/T Au!

It should be noted that in the work by Ransome and Lausen no specific structural control or alteration features were associated with the localization of the ore shoots at Oatman.

VIII. EXPLORATION TECHNIQUES

Fischer-Watt Mining entered the Oatman district believing that with detailed geology specific structural controls and the high level expression of buried ore shoots could be identified. This information would then be utilized to evaluate the inadequately prospected areas along the major vein structures and areas covered by pre-ore cover, that is, areas where the only expression of a buried ore shoot might be a small area of alteration.

Four principal techniques were utilized at Oatman: detailed alteration mapping; vein contouring; rock chip vein geochemistry; and fluid inclusion analysis. The vein contouring and alteration mapping have largely been completed, however, the geochem and fluid inclusion studies are continuing.

A) Alteration Mapping and Vein Contouring

As mentioned earlier, alteration features at Oatman probably extended to the paleosurface at the time of ore formation and even though no gold mineralization overlies most of the ore shoots characteristic and identifiable alteration halos were found.

Mapping was initiated in the central part of the district to identify specific alteration features over the past productive ore shoots and then extend the mapping into lesser prospected areas. (Figure 5)

At Oatman, mapping of phyllic and/or argillic alteration proved most significant. However, on a broad scale propylitic alteration also enveloped the veins although often not directly ore associated. Mapping was done at 1"=100' which was necessary in order to map subtle alteration changes.

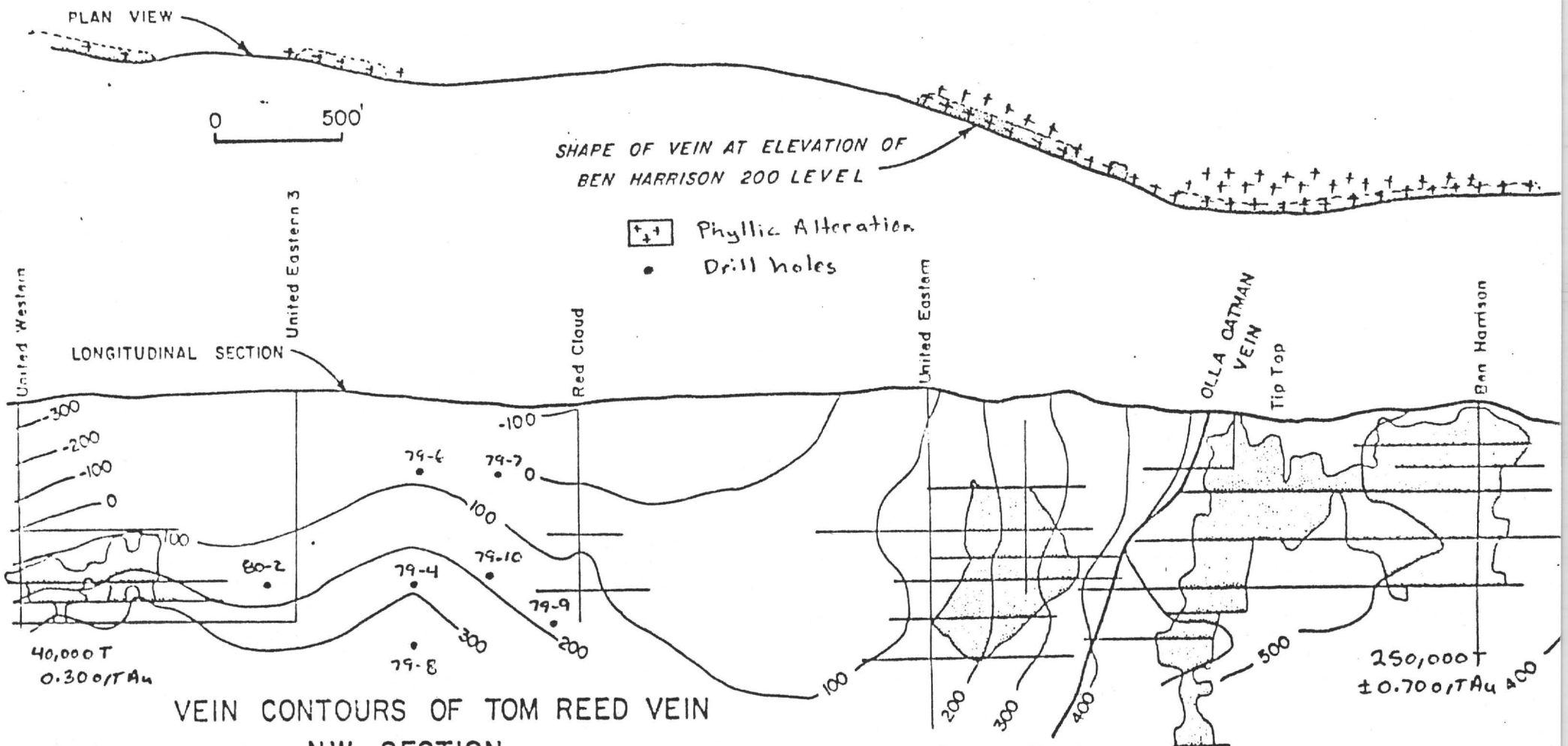
With field mapping it was nearly impossible to distinguish between phyllic and argillic alteration except for their differing distribution patterns. The phyllic alteration (illite and sericite as identified by X-Ray) tends to blossom beyond the specific cracks over the tops of ore shoots and may pervasively alter the wall rocks for up to 100' away from the vein. The argillic alteration is most frequently associated with post-mineral faulting and barren portions of pre-mineral faults, and has a definite footwall and hanging wall. Silicification or quartz or calcite veining is most frequently found within a few tens of feet from the top of ore.

Phyllic alteration is frequently expressed as small valleys less resistant to erosion than the surrounding rock. The rock is often light gray to locally white. Original textures may be totally to locally destroyed and in extreme cases some yellowing from oxidation of pyrite may be present.

For the most part the phyllic alteration over the tops of the oreshoots was so subtle that detailed mapping was absolutely necessary. As will be discussed later the distribution of phyllic alteration frequently corresponds with bends representing dialatant zones along the veins.

This detailed alteration mapping showed that every past productive ore shoot had a distinctive phyllic alteration envelope over it. (Figure 8a, 8b)

In addition to the alteration mapping, very careful attention was given to mapping slight changes in altitude of the vein. This involved not only plotting the information on the field sheets but also marking the position of each exposure on the ground then actually surveying its precise position and orientation so bends due to topographic effects could be removed. This survey data was then plotted on a map and the position of the surface and underground expression of the vein related to the distance from a hypothetical perfect plane. These distances were then contoured and showed irregularities in the vein in both a vertical and horizontal plan which might be related to ore. (Figure 8a, 8b) A horizontal slice through the long section of the Tom Reed vein showed pronounced to subtle concave north bends associated with every known ore shoot. Convex north bends related to pinch zones along the vein. The contouring also identified one inadequately explored area between the United Western and United Eastern ore shoots with a subtle concave north bend and weak phyllic alteration at the surface. This then became one of our principal targets. These subtle bends along an otherwise straight vein structure permitted development, during oblique slip fault

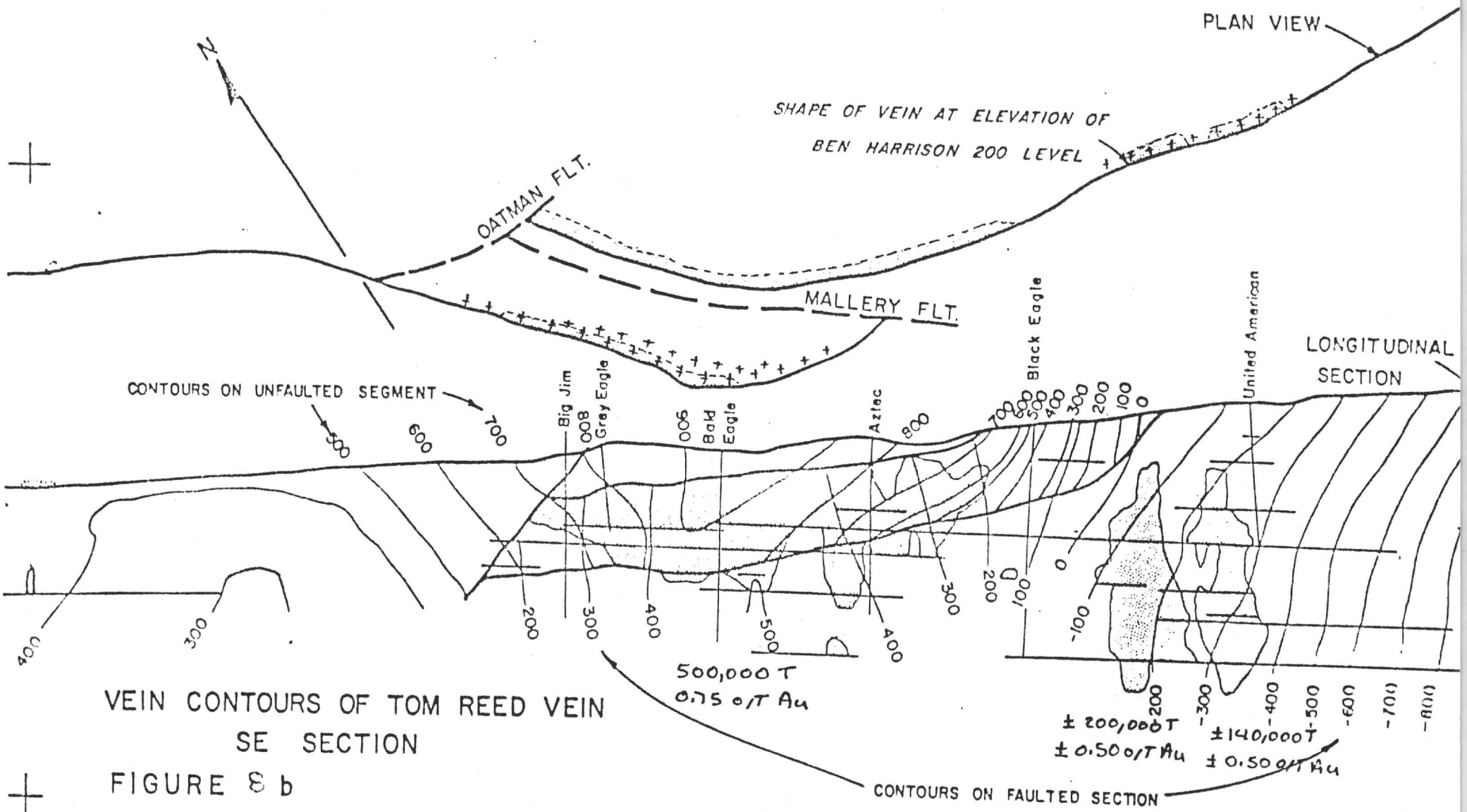


VEIN CONTOURS OF TOM REED VEIN
NW SECTION

FIGURE 2a

DH	Thickness	o/T Au
79-4	30 & 8	0.20 & 0.22
79-6	2	0.05
79-7	3	0.04
79-8	20	0.02
79-9	10	0.04
79-10	3.4	0.16
80-2	3 & 5	0.16 & 0.17

Modified after Clifton 4/80



VEIN CONTOURS OF TOM REED VEIN
SE SECTION

FIGURE 8 b

Modified after Clifton 4/80

movement, of dialatent zones or open areas which permitted ingress of ore forming fluids. Recurrent movement along these faults permitted up to 5 episodes of ore forming solutions.

Vein contouring on the Tom Reed vein was essential in establishing structural control for ore at Oatman and provided us with critical data needed to evaluate the structural favorability of less prospected veins.

The Kokomo vein which lies between the Tom Reed and Gold Road vein is a prime example. (Figure 9) Alteration mapping identified several alteration blossoms along the strike and vein contouring identified a major concave north bend in the area of best alteration which was comparable in magnitude to the beds associated with the Ben Harrison - Tip Top - United Eastern or Big Jim-Aztec ore shoots. The vein contouring was done strictly from surface measurements and then projected to a specified data plane. The magnitude of the bend and the intensity of the alteration identified the Kokomo as a major exploration opportunity not unlike the situation which resulted in the discovery of the Bulldog Mountain vein at Creede, Colorado.

I would like to now digress a bit and show some photos of the surface expression of the past-productive ore shoots as related to our observations regarding alteration and structure.

1) The unexplored area between the United Western and United Eastern shaft was drill tested by FWM and showed in our best intercept 30' T.T., 0.20 o/T Au, 500' below the surface. The surface outcrop showed a small area of very weak phyllic alteration, and gave no geochem anomaly.

2) The United Eastern ore shoot, 550,000 T, 1.11 o/T Au as discussed before shows gray phyllically altered Oatman latite 300' above ore.

3) The Tip Top ore shoot, 250,000 T, 0.70 o/T Au shows a massive quartz-calcite ridge with minor gold values at the surface ore is 70' below the outcrop.

4) Ben Harrison ore shoot, 300,000 T, 0.70 o/T Au shows a 10' wide silicified ledge with very minor gold values, 70' above ore.

5) The Gray Eagle-Bald Eagle area is the upper portion of the Big Jim-Aztec ore shoot which yielded 500,000 T, 0.75 o/T Au and shows a 50-100' wide zone of phyllic alteration with very minor quartz-calcite vein material and very minor gold values.

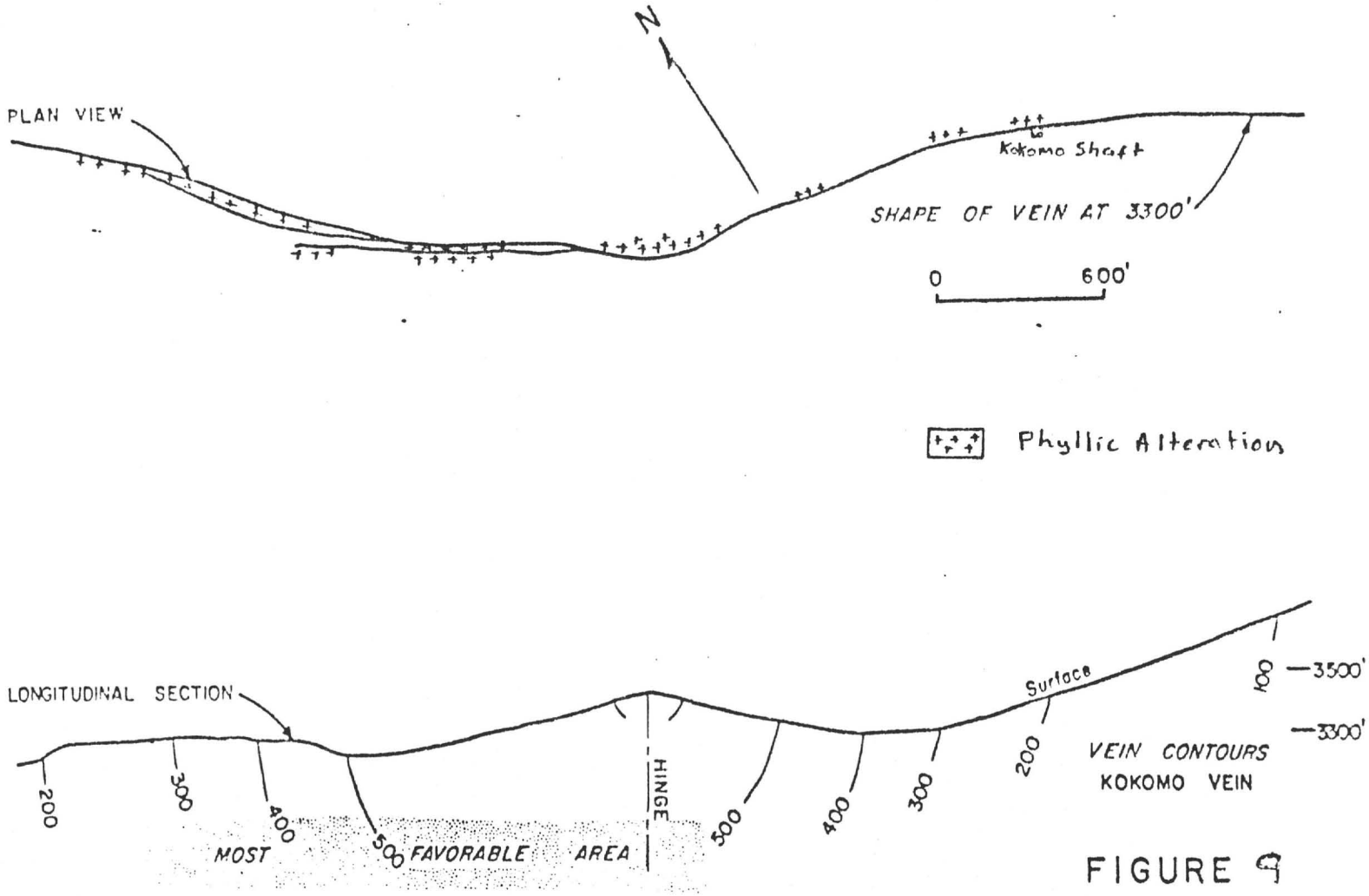


FIGURE 9

Modified after Clifton 4/80

6) The Black Eagle ore shoot. 200,000 T, 0.50 o/T Au shows a 10' wide zone of moderate to strong phyllic alteration and no quartz 300 feet above ore.

7) The United American ore shoot, 140,000 T, 0.50 o/T Au shows a 20' wide zone of phyllic alteration with minor quartz stringers 300' above ore.

8) The Kokomo vein one of our primary exploration targets, shows up to 100' of moderate to strong phyllic alteration.

The purpose of this suite of photos is to illustrate the subtle high level expression of buried epithermal ore shoots and to emphasize that without careful geological mapping and structural interpretation major buried ore shoots could easily be missed.

B) Fluid Inclusion Studies

A fluid inclusion study was initiated at Oatman in hopes of identifying specific hot spots where quartz or calcite vein material is exposed high above the ore shoots. We had also hoped to develop this tool as a reconnaissance techniqe to be used on virgin prospects by systematically sampling along the vein strike length in hopes of pinpointing local areas of boiling and with the temperature determinations and salinities, then predict the depth to the tops of potential buried ore shoots.

We have at Oatman a petrographic microscope and heating stage purchased from the University of Arizona. Our fluid inclusion results to date have shown that ore deposition occurred in the general temperature range of 220 to 240° and were of low salinities which is typical of epithermal vein systems. Boiling is locally present as identified by explosion textures from the top of the Tip Top ore shoot. To date the concept of utilizing fluid inclusions as a reconnaissance tool has not proven as useful as once anticipated. At Oatman, as in other less prospected areas, definitive fluid inclusion work is hindered for the following reasons:

1) High above the tops of ore shoots vein material is generally lacking.

2) If vein material is present it is often too fine grained for easy temperature and morphology determination and probably does not represent ore stage quartz.

3) Fluid inclusion determinations maybe extremely tedious and time consuming. From the fine grained quartz characteristic of the Oatman ores 3-5 fluid inclusion determinations are a good days production.

4) The thermal gradient which we had hoped to establish for quartz overlying ore shoots at Oatman has not materialized. So using fluid inclusion temperatures and salinities to predict the depth to tops of ore shoots at Oatman has not yet been perfected.

We still feel fluid inclusion determination will prove useful in reconnaissance and in target exploration, and we are continuing our research along these lines in hopes of a significant breakthrough.

C) Geochemistry

At Oatman we have found that gold and silver geochemistry have limited application for the following reasons:

1) Vein material is frequently absent over the tops of ore shoots and altered wall rocks give no anomalous gold or silver values.

2) Gold and silver anomalies are most frequently found at Oatman associated with quartz and calcite not accompanied by phyllic alteration. Drill tests of these anomalies have indicated we are probably looking at the low grade roots of eroded vein systems.

3) Trace element determinations for Cu, Mo, Pb, Zn, As, and Hg have given local anomalies which generally show no relationship to buried ore shoots. However, other elements may be useful.

4) If vein material associated with phyllic alteration is present gold and silver determinations are the best guide to ore. If no vein material is present assessment of ore potential is best based on structure and alteration.

IX. CONCLUSIONS

From our work at Oatman which to date has consisted of detailed mapping, structural interpretation, vein geochemistry, fluid inclusion studies, more than 25,000 feet of drilling and expenditures well in excess of $1. x 10^6, the following conclusions can be drawn.

A) With detailed geological and structural studies specific ore controls were established for gold mineralization at Oatman. It was necessary to utilize all available geological tools at our disposal in order to do this.

B) The surface expression of the buried ore shoots at Oatman is frequently no more than a zone of phyllic alteration with very poorly defined structure.

C) Fluid inclusion studies show much promise for aiding the explorationist in identifying the lateral and vertical position of buried ore shoots but much refining needs to be done with this tool.

D) Geochemistry may have limited application in the exploration of epithermal systems. Unless vein material comes through to the surface the veins are best evaluated by detailed geological mapping supported by geochemistry. The lack of geochemical anomalies should not in itself be discouraging.

E) Drilling vein targets is costly and in the case of gold, drilling results even after large expenditures may be inconclusive. At Oatman, we have drilled numerous holes which grade 0.10 o/T Au or better; a few of our holes have shown better than 0.5 o/T Au. We have not even with the extensive drilling completed to date been able to establish grade continuity between closely spaced holes.

F) Before one enters into an exploration program such as Oatman, they must realize that the ultimate proof of grade and tonnage will probably have to come through underground exploration. The decision to go underground will probably be based on little or no proven ore reserves. At Toyotita, Durango, Mexico, for example, drilling is done primarily to prove structure and not to establish grade. At Bulldog Mountain, Creede, Colorado, Bill Cox drilled 2 core holes but because of very bad drilling conditions and poor core recovery could confirm nothing more than the presence of a mineralized structure. Based on this data, a decision was made to explore the vein underground and resulted in the discovery of the Bulldog Mountain mine. At Oatman, our fate may be the same and if so, I hope our luck will be as good.

G) Luck accompanied by geological insight and utilizing of every tool at one's disposal plays a vital role in the exploration of high grade veins. It is much easier to drill a pinch, above or below an ore shoot than it is to hit the ore shoot. For example, Coastal Mining, at Seven Troughs, Nevada cut a couple of feet pf 4. o/T Au in their first hole; their next 49 holes were disappointing and the project has been abandoned.

On the other hand, Lacana in their first drill hole at Guanajuato, Mexico, hit 35 feet of 17 oz. Ag and 0.20 o/T Au. Subsequent drilling outlined 3.6×10^6 T $\pm$ 9. o/T Ag and now provides the feed for the Las Torres mine and mill complex.

H) There are no sure bets in vein exploration. If the potential for significant targets exists, management must be willing to persist until all reasonable targets are tested.

I) If one is hoping for quick, definitive exploration results you will likely be disappointed.

J) And last but not least, we all dream of finding our pot of gold at the end of the rainbow. (Photo with end of rainbow on Tom Reed vein)

SOCIETY OF MINING ENGINEERS OF AIME

CALLER NO. D, LITTLETON, COLORADO 80123

PREPRINT NUMBER

80-143

EXPLORATION PROCEDURE AND CONTROLS OF MINERALIZATION IN THE OATMAN MINING DISTRICT, OATMAN, ARIZONA

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For presentation at the AIME Annual Meeting
Las Vegas, Nevada - February 24-28, 1980

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Abstract. The Oatman District produced approximately 2.2 x 10^6 ounces of gold and 0.8 x 10^6 ounces of silver between 1897 and 1942. A total of 3.8 x 10^6 tons of ore averaging 0.58 O/T gold and 0.17 O/T silver was extracted from eight major orebodies and a number of lesser deposits.

Oatman lies at the center of a trachyte-latite-rhyolite volcanic complex which contains at least one resurgent caldera. The orebodies are typical epithermal quartz-calcite ± adularia lode deposits which are very deficient in sulfur. Ore deposition has occurred within dilatant zones on faults which radiate from a common point within the complex.

Fischer-Watt Mining approached the Oatman District with an integrated exploration program utilizing four basic procedures to define the characteristics of past productive areas, the results of which were applied to unexplored portions of the vein system. These procedures listed in their order of usefulness in defining known and prospective mineralized zones are: vein contouring, detailed alteration mapping, fluid inclusion temperature determinations, and geochemical sampling.

All known deposits were found to be located at particular points of curvature on the veins and all, irrespective of the level exposed in the hydrothermal system, exhibited a distinctive and predictable alteration signature. Fluid inclusion studies indicated boiling or nonboiling conditions during deposition, temperature of deposition at the sample point, level of exposure relative to the boiling interface and, by establishing a paloegeothermal gradient to the ore horizon, a depth control for drilling. Geochemical sampling has produced inconsistent and, at times, misleading indications of mineralization at depth. The method has to date been of limited use in the determination of location of known oreshoots or new targets. Approximately one man year was expended in establishing these relationships before drilling was recommended.

Introduction

Precious metal vein deposits occurring in Tertiary volcanic terrains - the so-called epithermal vein deposits - have received little attention by American exploration groups in the last 40-50 years. Numerous factors have contributed to this, including the low price of silver and fixed price of gold, escalating labor and materials costs, and an interest in longer term, larger tonnage operations such as porphyry copper and molydenum deposits. In addition, with few exceptions, no significant precious metal vein deposit has been discovered in the United States since the 1920's and many deposits which have been mined for years, such as the Idarado and Camp Bird mines in Colorado, have recently become uneconomic. The relative difficulty in evaluating vein systems for ore reserves, their limited size, erratic grades, and the requirement of underground mining methods have also discouraged exploration.

With the recent rise in precious metal prices, increased capital costs of bulk tonnage operations, and the high cost of borrowed money, low capital cost, rapid return high grade vein mining operations are once again becoming attractive. Cash flow analyses indicate intermediate size deposits (0.5 to 1.0 million tons) of intermediate

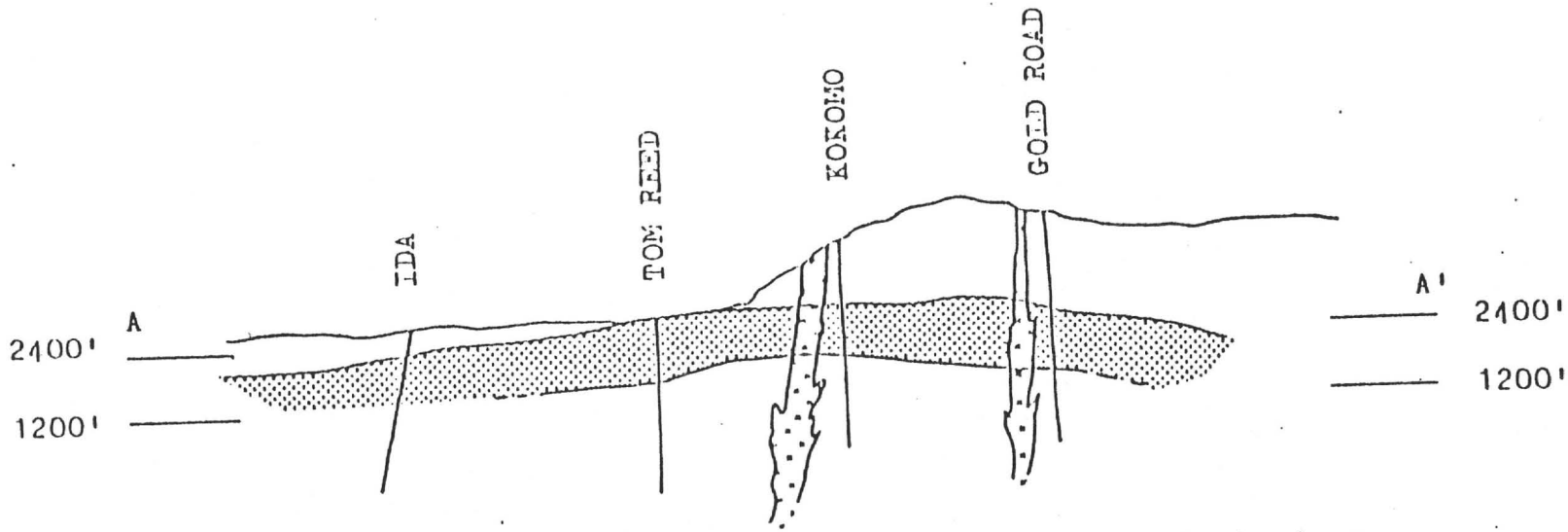

FIGURE 20 Section A-A'; view N50W. Top and bottom of the horizon of ore deposition at the time of ore formation. Section is corrected for post-ore faulting and is relative to present-day topography and position of rhyolite dikes. Elevations in feet above sea level.

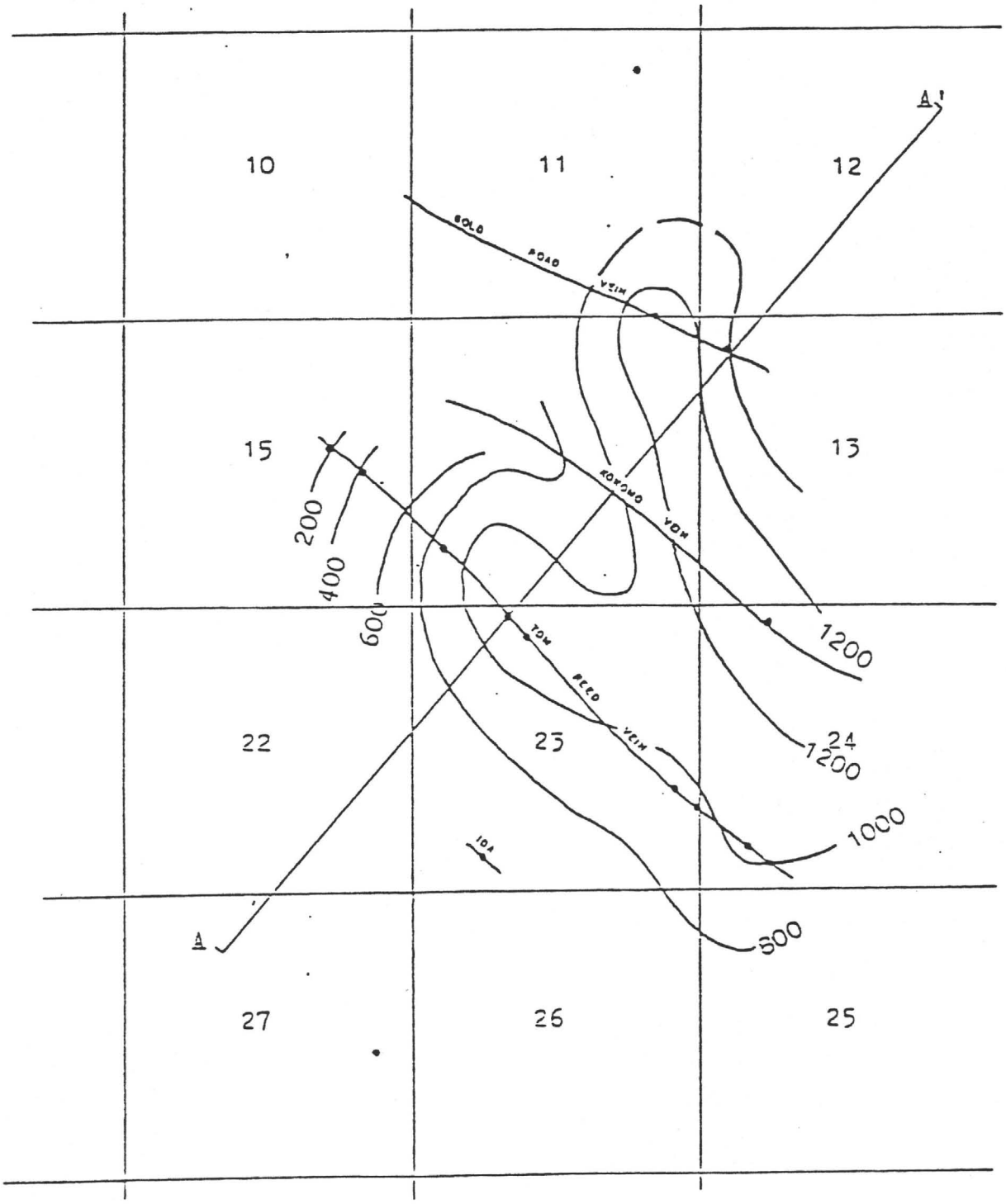

FIGURE 19 Vertical interval of ore, in feet, in the horizon of ore deposition.
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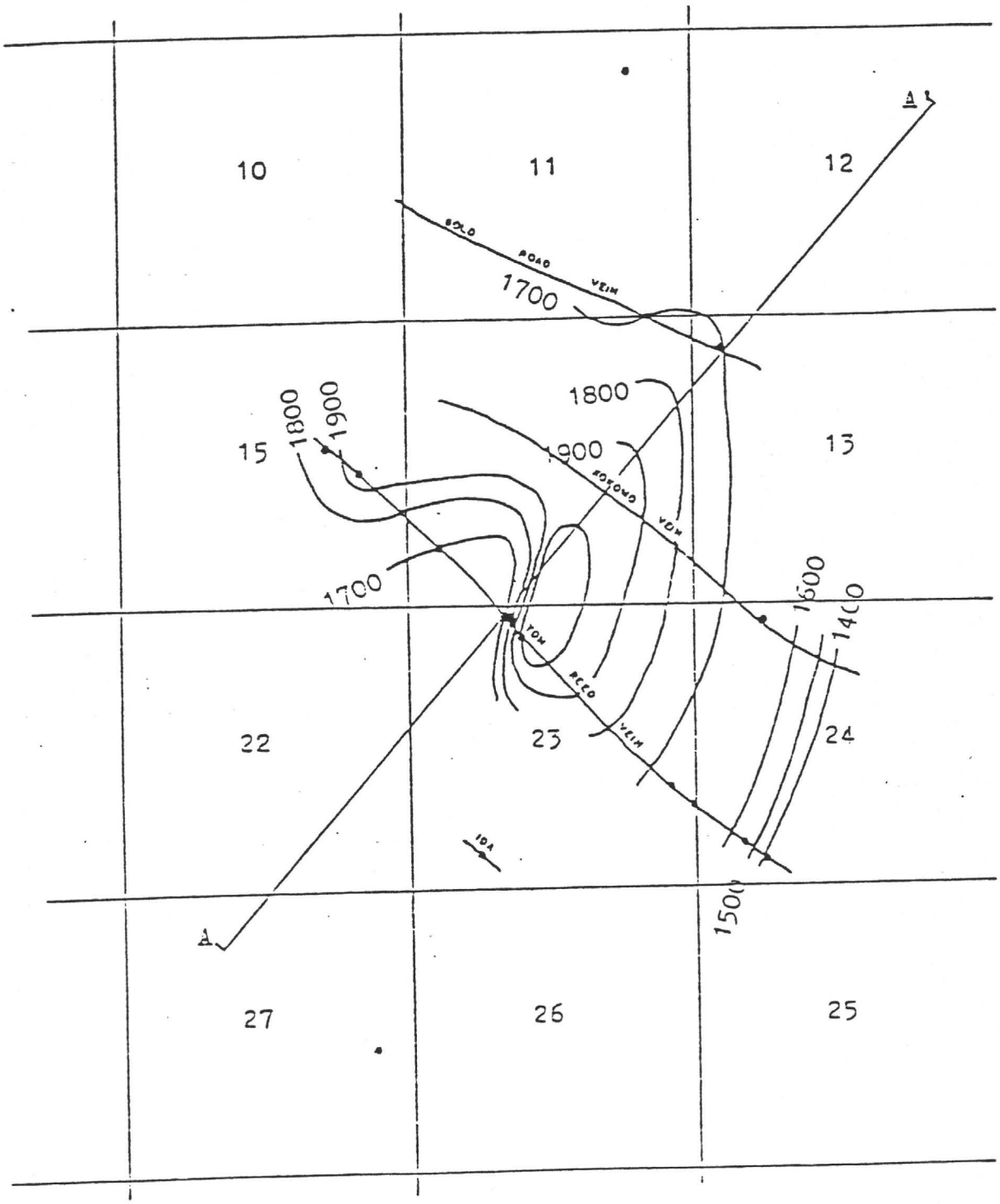

FIGURE 18 Elevations, in feet above sea level, of the bottoms of ore shoots.
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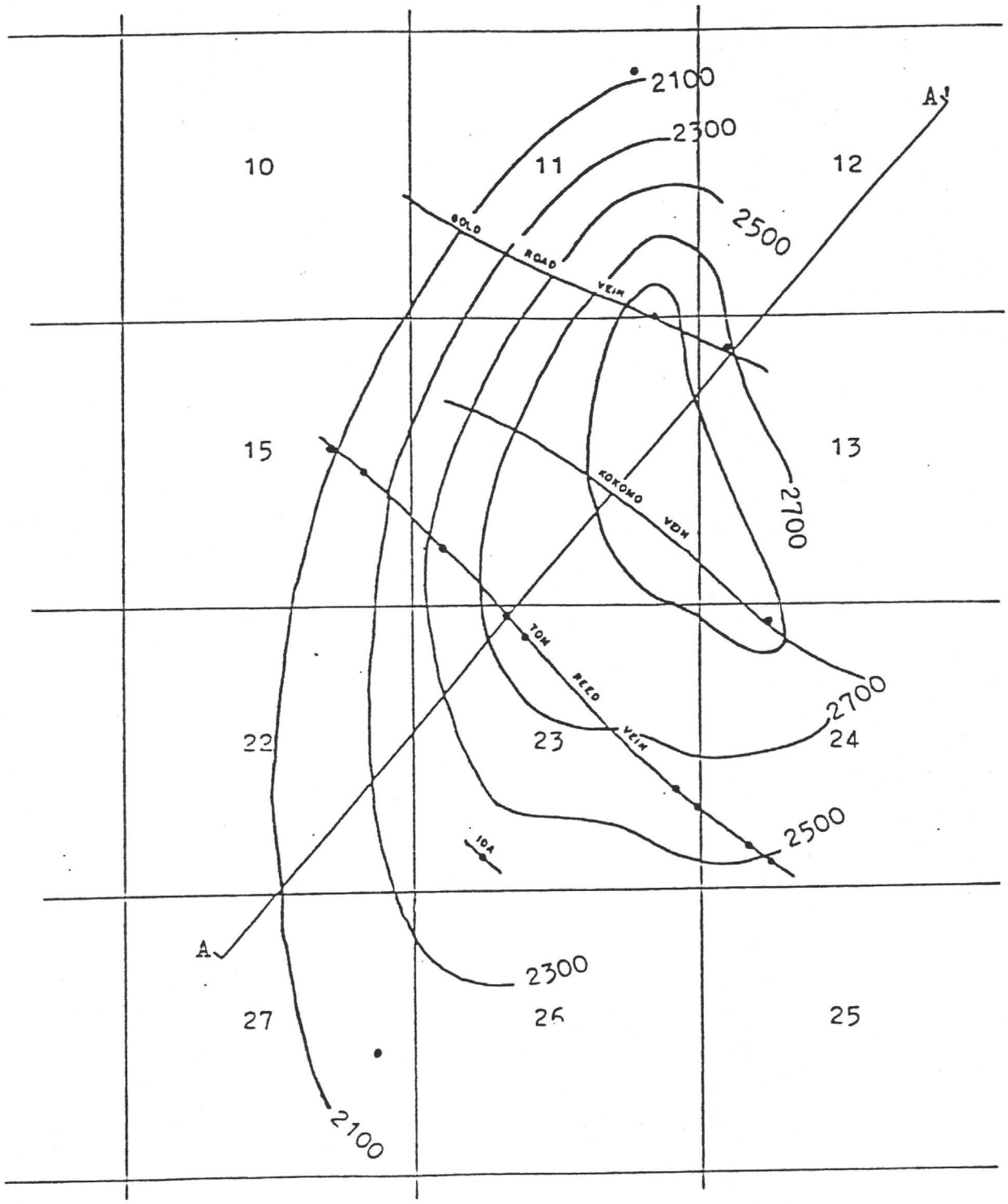

FIGURE 17 Elevations, in feet above sea level, of the tops of ore shoots.
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