CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
1520 West Adams St.
Phoenix, AZ 85007
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

THE ARIZONA GEOLOGICAL SOCIETY SPRING FIELD TRIP

THE ANDERSON MINE AREA

MAY 27, 1978

THE ARIZONA GEOLOGICAL SOCIETY SPRING FIELD TRIP

Welcome to the Arizona Geological Society Spring Field Trip.

Minerals Exploration Company and its parent firm, Union Oil Company, have graciously arranged for the AGS and its guests to visit the Anderson Mine area. This prospect has a potential of developing into a major uranium producer and we are pleased to be able to visit this prospect at such an early stage in its development.

The visit today is intended to permit viewing of some of the features discussed by Bill Buckovic in his address to the Society on May 2nd. Much of the substance of this address was taken from a paper on the area by J. E. Sherborne, Jr., W. A. Buckovic, D. B. DeWitt and S. J. Pavlak of Minerals Exploration Company, Casper, Wyoming; and T. S. Hellinger, Minerals Exploration Company, Tucson, Arizona. The paper will soon be published in the American Association of Petroleum Geologists (AAPG) Journal. Some of the text and figures in that article have been excerpted for the purpose of your field guide. We are indebted to the editors of the AAPG Journal for permission to use this material.

Travel directions from Wickenburg to the Anderson Mine are shown in Table 1. Since most of you joined the trip at the intersection of Highway 93 and Alamo Road, you may follow the road log from that point.

Minerals Exploration has laid out a parking site in the general mine area near Flat Top Hill. We have been asked to keep vehicle usage within the mine to a minimum, therefore, all points of interest will be visited on foot. Please stay with the Minerals Exploration Company Guides.

On arrival at the mine site, the guides will point out your location on Figure 1D. This figure can be used as a general guide to the geology of the area. Some of the features are explained in the summary. Notes on the geology of each stop and the proposed mining and milling plan are also included, and have been provided by Minerals Exploration Company.

SUMMARY

The Anderson Mine has been a known Uranium resource area for some time. Limited production occurred prior to the major exploration in the area. This production is summarized in Table 2. With the kind permission of Minerals Exploration Company and the AAPG editors, the following material has been excerpted from J. E. Sherborne, Jr., W. A. Buckovic, D. B. DeWitt, T. S. Hellinger, and S. J. Pavlak's (of Minerals Exploration Company) paper on the geology of the Anderson Mine soon to be published in the AAPG Journal. As a regional guide, we present a generalized geologic map of the northeastern Date Creek Basin as Figure 2. A more detailed geologic map of the Anderson Mine area is shown in Figures 1D and 3.

From the assembly point near Flat Top Hill, some of the general geology can be viewed and it is also possible to see a section containing the lake sediments at Anderson Mine. Particular emphasis is placed on these sediments since they are the principal uranium bearing hosts in the northeastern Date Creek Basin. The view, and an explanation thereof, are shown in Figure 3 and the section is shown in considerably more detail in Figure 4. Comments on the stratigraphy have been taken directly from Sherborne, et. al's paper.

Several stops have been scheduled in the mine area to permit study of the detailed geology, the uranium mineralization and some of the factors relevant to mining. At the end of these scheduled stops, there will be an opportunity to walk the entire Tertiary section.

The Tertiary section is divisible into two stratigraphic sequences characterized by complex assemblage of arkosic sediments overlain by silicic volcaniclastics. Within these two sequences, five stratigraphic units are recognized. The lower sequence includes the basal Tertiary and Arrastra Volcanics; the upper sequence contains the Miocene "Anderson Mine" Formation, the Flat Top and Upper Miocene Basalt Conglomerate. The Tertiary section is overlain by Plio-Pleistocene older alluvium.

The various units of interest are identified on the geological maps and your field guides will point out certain relevant features. Particular attention is directed to the Anderson Mine Formation.

GENERAL

Uranium mineralization occurs near the northern margin of the present Date Creek Basin in a gently-dipping sequence of Miocene lacustrine volcaniclastic sediments. The uranium is associated with lignites, carbonaceous and silicified tuffaceous mudstones, calcareous mudstones, and impure limestones and marlstones. The mineralized units are interbedded with green tuffaceous mudstones, light-colored calcareous, fossiliferous and tuffaceous mudstones and tuffs, and a few thin sandstone and sandy siltstone beds.

The uranium deposit has a tabular blanket-type configuration with minimum dimensions of approximately 1,000 m by 1,500 m. The mineralization extends at least an additional 1,000 m down-dip. The zone is comprised of several mineralized beds which are generally from 1 to 3 m thick but occasionally ranges up to 11 m. The mineralization is stacked in most areas and aggregate thicknesses in excess of 15 m are not uncommon. Most of the mineralization has grades ranging from 0.03 to 0.10% U_3O_8 with an average grade of approximately 0.06%. Elements which appear to be concentrated with the uranium mineralization include arsenic, molybdenum, organic carbon, total sulfur, and vanadium. Other elements which are anomalous in the Anderson Mine sediments include manganese, lithium, and flourine. In portions of the ore body, there are considerable variations in the disequilibrium factor; however, the overall factor is close to one.

During compaction and dewatering of uranium-rich volcanic lake sediments, the derived fluids probably came into contact with a strongly reducing paludal environment causing precipitation and fixation of the uranium. This would indicate an early diagenetic origin for the primary mineralization. Some remobilization into fractures has occurred in more recent geologic time.

The Anderson Mine area is located in the Basin and Range physiographic province approximately 72 kilometers northwest of Wickenburg, Arizona (Fig. 1). The uranium deposit occurs in Tertiary rocks in the northern portion of an area designated by Otton (1977b) as the Date Creek Basin. This basin, which encompasses an area in excess of 900 km^2, has recently gained national interest as the result of considerable land acquisition and exploration drilling by a number of companies. The main stimulus to this exploration activity was the discovery that uranium mineralization at the old Anderson Mine was considerably more extensive than had previously been thought. This is illustrated in a recent publication by the United States Energy Research and Development Administration (1976) which states that the $30 per pound uranium reserves for the entire Basin and Range Province is 2,800,000 pounds U_3O_8 (Table 1). Exploration drilling at the Anderson Mine indicates that the reserves in this area alone are considerably in excess of this figure. This is significant in that it lends credence to the high uranium resource estimates for this province made by U.S.E.R.D.A in the same publication.

Anomalous radioactivity was first discovered in the Anderson Mine area by T. R. Anderson of Sacramento, California while conducting an airborne scintillometer survey in early 1955. Several hundred claims were located after a ground check of the anomaly revealed surface uranium mineralization. A limited drilling program indicated sufficient mineralization to justify a small mining operation. This resulted in the production of 33,230 pounds of U_3O_8 between 1955 and 1959 from ore that averaged 0.15% U_3O_8 (W. L. Chenoweth, personal communication, 1977). The production figures are summarized in Table 2. After this period, however, the property remained essentially idle until 1967 when the claims were optioned to a major oil company. This option was terminated in 1968 even though exploration drilling outlined several areas of uranium mineralization. This decision was probably influenced by the low price of uranium at that time and the remote location of the deposit. Prompted by the increasing price of uranium in 1974, Minerals Exploration Company, a wholly-owned subsidiary of Union Oil Company of California, obtained an option on the Anderson Mine property. The claims were purchased in 1975 following a drilling program on a 244 m (800 foot) grid which showed the uranium mineralization to be considerably more widespread than had previously been suspected. Subsequent drilling on a 122 m (400 foot) grid has indicated that the uranium mineralization is laterally continuous. The data generated from this program has served as the basis for this study. More recently, drilling on a 61 m (200 foot) grid has further substantiated the lateral continuity of the uranium mineralization. At present, the company is completing the first phase of development drilling and is undertaking mine and mill design and feasibility studies. In addition, consultants have been retained to conduct extensive studies of the potential physical impacts the project will have on native wildlife, plantlife, water quality and availability, air quality, and socio-economic impacts on neighboring communities.

If all the studies now underway indicate the project is feasible, mine preparation and mill construction could begin in 1979 and continue for approximately 18 months. Mining would begin concurrently, with mill start-up to follow late in 1980. The mill would operate continuously over an expected minimum life of 15 years at a designed throughput rate of between 2,000 and 2,500 tons of ore per day. The ore would be mined initially by open-pit methods with an underground mining operation to follow.

"Anderson Mine" Formation (Tma)

The "Anderson Mine" Formation ranges from 80 to 150 m thick and includes a lower arkosic member and an upper uranium-bearing tuffaceous lutite member. In the vicinity of the Anderson Mine workings, the sediments thicken gradually to the south and west and thin to the north and east where they onlap the "Arrastra" paleohigh (Fig.6). The section at Anderson Mine has been tentatively correlated with fanglomerates of the Chapin Wash Formation by Reyner, et. al. (1956), Peirce (1977), and Otton (1977b). The Chapin Wash Formation, which may grade into and intertongue with the Anderson Mine sediments, is formed of arkosic sandstones and conglomerates interbedded with silicic and basic volcanic rocks in the western Date Creek Basin (Laskey and Webber, 1949; Shackelford, 1976; Gassaway, 1977).

Lower Member (Tma_l)

The lower arkosic member consists of up to 120 m of coarse, poorly-sorted reddish to yellowish gray arkosic sediments and locally developed volcanic sandstones and conglomerates. This succession appears to represent the distal portion of a subaerial fan complex that coarsens and thickens to the west and south of the Anderson Mine. Due to the paleotopography developed on the Arrastra Volcanics, the lower member thins rapidly and pinches out in the northern portion of the Anderson Mine area. In the southern portion of this area the lower member consists predominantly of volcanic and arkosic sandstones and conglomerates which grade vertically into the finer-grained sediments of the upper member. Elsewhere, the lower member is formed principally of conglomerates and sandstones derived from a Precambrian (?) crystalline terrain.

Upper Member (Tmau)

The upper or tuffaceous lutite member is the principal uranium-bearing host rock in the northeastern Date Creek Basin. This member represents a paludal-lacustrine succession consisting of tuffaceous mudstones and siltstones interbedded with vitric tuffs, micritic limestones, marlstones, carbonaceous lutites, and a smaller proportion of tuffaceous and arkosic sandstones. In the southern portion of the area, the upper member is 140 m thick and thins to 80 m where the member onlaps the volcanics to the north (Fig.6). Four general stratigraphic units are recognized in this member: a lower carbonaceous unit, an intermediate clastic unit, an upper carbonaceous unit, and an upper tuff and limestone unit.

Lower Carbonaceous Unit ($Tmau_1$)

The lower unit infills local depressions and channels and averages 25 m in thickness. Massive green-gray micaceous tuffaceous lutite beds averaging 1 m thick constitute a major portion of the unit. The remainder consists of approximately equal proportions of micritic limestone, marlstone, carbonaceous lutite, and arkosic sandstone. The limestones and marlstones, which are found mainly in the western and southeastern parts of the area, are massive, light greenish-gray to off-white, and occur mainly in the upper 15 m of this unit. The thickest and most abundant limestones are found in the southeastern portion of the area where they have an aggregate thickness of up to 8 m. These limestones commonly contain comminuted carbonaceous material and grade laterally into carbonaceous lutites to the west.

Upper Carbonaceous Unit ($Tmau_3$)

The upper carbonaceous unit is the most laterally continuous unit in the upper member with individual beds extending for over 500 m. This unit is approximately 20 m thick and consists mainly of tuffaceous mudstones interbedded with subordinate amounts of carbonaceous lutites, tuffaceous siltstones, and micritic limestones. The remainder of this unit is formed of tuffaceous siltstones, marlstones, vitric tuffs, and a minor fraction of sandstones. The middle portion of the unit contains the wide distribution of carbonaceous lutites and limestones and an abundance of tuffaceous clastic sediments are in the northern part of the area.

The tuffaceous mudstone beds are massive, light greenish-gray in color, and contain carbonaceous rootlets and remnant pumice fragments. These beds, which average less than 1 m thick, form up to one-third of the unit in the southwestern part of the area. The abundance of organic structures and the massive character of the mudstones is indicative of the gradual influx of mainly air-fall tuffs washed in from surrounding uplands. Carbonaceous and lignitic lutites form about one-third of the carbonaceous interval in the central mine area.

Commonly interstratified with the carbonaceous beds are tan, gastropod-rich, tuffaceous marlstones that locally form up to one-third of the carbonaceous interval. The tan marlstones in the carbonaceous units are characterized by a strong fetid odor when broken. Analyses of the gas derived from these marlstones in the upper carbonaceous unit show an abundance of hydrogen sulfide and carbon dioxide. To the east these marlstones and carbonaceous beds grade and intertongue into micritic limestones (Fig.6). The limestone beds are up to 1.5 m thick and are very light greenish-gray to off-white in color. Varying amounts of tuffaceous and pumiceous material are interspersed in these limestones. Fossils commonly found in these beds include fresh-water pelecypods, gastropods, small fish, and rush-like plant material. Locally, these massive limestones are difficult to distinguish from massive calcareous vitric tuffs.

Upper Tuff and Carbonate Unit ($Tmau_4$)

Up to 80 m of this upper unit are preserved in the Anderson Mine area. It is formed largely of tuffaceous lutites, reworked vitric tuffs, marlstones, and micritic limestones. The tuffaceous lutites are greenish-gray and massive, comprising the largest part of this unit. The tuffs are similar to those in the underlying carbonaceous unit, except that some are yellowish to pinkishgray in color. A few thin lapilli-bearing pumice tuffs are recognized in the north-eastern mine area. The marlstones and limestones are massive and off-white in color, and occur mainly in the eastern and southern mine area. Reyner, et al. (1956) recognized a relatively persistent, thin-bedded marlstone that occurs near the top of the section. In much of the subsurface this marlstone is not preserved due to post "Anderson Mine" erosion. A few thin carbonaceous beds which are rare and laterally discontinuous occur in this unit (Fig. 6). The remainder of the unit consists of minor poorly-sorted tuffaceous sandstones.

Replacing limestones and lutites in this unit are beds of chalcedony up to 1 m thick. These beds and the associated carnotite fracture-fillings are prevalent features in the old pits exposed at Anderson Mine. The carnotite, though the most conspicuous type of surface mineralization, forms only a small proportion of the total uranium mineralization at Anderson Mine.

A Lower to Middle Miocene age is suggested for the Anderson Mine sediments by the presence of Hemingfordian-aged (17-21 m.y.) vertebrates and the relative stratigraphic position of the unit. An abundance of palm remains is indicative of tropical or subtropical conditions during the deposition of the Anderson Mine Formation.

"Flat Top" Formation (Tfc)

Unconformably overlying the Anderson Mine sediments is a thick upward coarsening succession of arkosic sediments up to 170 m thick in the Anderson Mine area (Fig. 6). This unit is composed largely of grayish-orange to yellowish-brown locally calcite-cemented arkosic siltstones, sandstones, and conglomerates, interbedded with minor reworked greenish-gray siltstones that are well exposed near Flat Top (Figs. 1, 1D). The finer-grained clastics fill an east-west trending channel that was scoured as much as 100 m into the Anderson Mine section. Elsewhere in the vicinity of the Anderson Mine area, this phase of sub-"Flat Top" erosion appears to have eliminated much of the Miocene lacustrine section.

The "Flat Top" section includes brown to buff siltstones interbedded locally with fine to coarse-grained arkosic sandstones that grade upward into pebble sandstones and conglomerates. Most of the coarser clastics that fill local channels in the section were derived from the Precambrian (?) crystalline complex. A minor amount of material was also derived from the older volcanic highlands as recognized by Reyner, et al. (1956).

The "Flat Top" Formation may be correlative to part of the Chapin Wash Formation of Lasky and Webber (1949). Based on the relative stratigraphic position, and associated structural events, the age of the "Flat Top" section is likely Middle to Late (?) Miocene.

URANIUM MINERALIZATION

The uranium deposit at the Anderson Mine is a stratiform, blanket-type deposit occurring within and in proximity to carbonaceous lacustrine sediments. The deposit, as presently drilled out, has minimum dimensions of approximately 1,000 by 1,500 m and extends at least another 1,000 m down-dip into the subsurface to the south. Most of the mineralization occurs in 1 to 3 m thick zones which, in highly mineralized areas, have composite thicknesses in excess of 15 m. The average grade and thickness of the uranium resources at the Anderson Mine are summarized in Table 3. It should be emphasized that these figures do not constitute average ore grades and thicknesses for the deposit since detailed mining feasibility studies have not yet been completed.

The majority of the uranium mineralization is associated with carbonaceous lutite beds in the two carbonaceous units of the Upper Anderson Mine member. It also occurs in the marlstones, limestones, and tuffaceous lutite strata interbedded with or laterally adjacent to the carbonaceous lutites. Many of these interstratified beds contain finely comminuted carbonaceous plant material and abundant silicified rush-like plant remains and gastropods.

The areal distribution of the mineralization is illustrated in Figure 8 which is a grade-thickness product contour map. The tabular configuration of the deposit is evident. A simplified cross-section (Fig. 8B) shows the lateral continuity of the uranium mineralization. It was not possible to show details of the lithology on these sections, but the mineralization is continuous across facies boundaries and locally crosscuts bedding. A comparison of the grade-thickness map and an isopach map of the carbonaceous sediments suggests a close spatial relationship between the carbonaceous sediments and the uranium mineralization. In addition, the most significant areas of uranium mineralization appear to coincide with the greatest thickness of carbonaceous material. These features indicate the importance of the paludal environment in the localization of the uranium mineralization at Anderson Mine.

Both oxidized and unoxidized uranium mineralization are recognized at the Anderson Mine. The unoxidized mineralization chiefly occurs in the upper and lower carbonaceous units and is rarely exposed in the study area. It ranges in grade from 0.03% to 0.10% U_3O_8 and probably averages 0.06% U_3O_8. The oxidized uranium mineralization, which is the mineralization previously identified by Reyner et al. (1958), Otton (1977a) and Peirce (1977), is found mainly in the northern part of the mine area. It occurs principally in silicified limestones, marlstones, and tuffaceous lutites overlying and laterally adjacent to the unoxidized mineralization. The oxidized uranium, which usually occurs in small irregular masses or as minor late-stage fracture fillings, probably has an average grade of greater than 0.10% U_3O_8. Select samples of this carnotite mineralization have assayed greater than 30% U_3O_8.

MINERALOGY

Several analytical methods were used to identify the unoxidized and oxidized uranium minerals at the Anderson Mine. Initially, the distribution of the radioactive minerals in all the unoxidized samples was determined by autoradiography. The autoradiographs showed finely disseminated radioactive mineralization which was judged to be too fine-grained to obtain suitable samples for X-ray diffraction analysis, therefore electron microprobe analyses and microscopic studies were initiated. These studies indicated that the unoxidized uranium mineralization consists of uranium silicate with a highly variable uranium to silicon ratio occurring in intimate association with carbonaceous material. The uranium content of this uranium silicate mineral was found to range from 4% to 20%. The chemical composition of this material suggests the mineral coffinite and an attempt was made to reconfirm this by X-ray analysis. One sample of black, sooty material with a high uranium content (determined from microprobe analyses) was isolated from a carbonaceous tuffaceous mudstone unit. The X-ray analysis of this uraniferous material showed no evidence of any uranium mineral. This indicates that the uranium minerals are very poorly crystallized to amorphous or too finely dispersed for conventional X-ray techniques (Breger, 1974).

ALTERATION

Anderson Mine member sediments have undergone extensive diagenetic silicification, calcification, zeolitization, and argillic alteration. The alteration which has affected the entire lacustrine unit varies in both intensity and type across the study area.

Silicification is the most common form of alteration and is found in all units except the lower Anderson Mine member. It appears to have begun early and continued throughout the diagenetic history of the sediments. The initial stage of silicification resulted in the dissemination of fine-grained multicolored chalcedony in the sediments, the replacement and preservation of delicate fossil forms (chiefly gastropods and ostracods), and the association of silica with disseminated uranium in carbonaceous plant material. Most of the carbonaceous beds have been partially to completely silicified. In general, the strong silicification has penetrated a few tens of centimeters into the carbonaceous beds at the upper and lower contacts of these beds with the enclosing sediments. Occasionally, entire beds of carbonaceous mudstone and siltstone have been completely silicified, but there seems to be no direct correlation between degree of silicification and intensity of uranium mineralization.

Diagenetic calcification has affected both members of the Anderson Mine sediments and has resulted in both the cementation and replacement of the sediments by calcite. Specifically, calcite replaces feldspars and cements the arkosic sandstones in the southern portion of the area and replaces and indurates tuffaceous and carbonaceous lutites and reworked tuffs. In addition, sparry calcite has replaced micrite in some of the marlstones and limestones of the upper Anderson Mine member. In thin-section studies, both calcite and silica can be found in cross-cutting relationships in veinlets indicating that the later phases of both may have occurred concurrently. However, in outcrop studies on the upper unit of the Anderson Mine member, calcification generally appears to be slightly younger than the silicification, particularly in the filling of voids and fractures.

The formation of clays and zeolites early in the diagenesis of the sediments may have been of some importance during the initial phase of uranium mineralization. Clinoptilolite-heulandite group zeolites, and to a lesser extent, montmorillonite-group clays can act as effective adsorbents of uranium from solution (Katayama, et al. 1974). Although this type of mineralization has not yet been recognized at Anderson Mine, it is possible that uranium could have been adsorbed in the early stages of mineralization and subsequently remobilized and reduced in proximity to the carbonaceous sediments. Katayama et al. (1974) report that uranium preferentially forms coffinite (or uranium silicates) when excess silica and strongly reducing conditions prevail as was likely the case in the paludal portion of the lake sediments at Anderson Mine.

Pyrite occurs in the carbonaceous sediments as finely-disseminated crystals and more commonly as fracture fillings. The disseminated pyrite is likely of syngenetic origin while the mineralization in veinlets was possibly formed during the diagenesis of the sediments. Pyrite is also found in portions of the arkosic sandstones in the southern part of the study area. Much of this pyrite occurs as a cementing agent around sand grains and resembles the "matrix" pyrite commonly found in unaltered sandstones in many Wyoming uranium districts. Interestingly, portions of these sandstones are limonite-stained and the pyrite, where present, is highly pitted and tarnished. It is conceivable that these limonite-stained sandstones are "altered" which suggests the possibility of "rollfront" type mineralization in these units. Minor quantities of medium-grade uranium mineralization have been found in these sands in general proximity to "altered-unaltered" contacts, but this mineralization has not been evaluated in any detail.

GEOCHEMISTRY

Quantitative analyses for U_3O_8, V_2O_5, CO_2, and total S were performed on samples representing 0.3 m (1 ft.) intervals throughout the mineralized sections of 14 widely-spaced core holes. In addition, the entire cored intervals from two holes were analyzed for U_3O_8, V_2O_5, As, Mo, Li, Mn, F, organic C, and total S. This latter study was primarily concerned with the geochemistry of the unoxidized mineralization and the respective underlying and overlying unmineralized sediments. Two commercial analytical laboratories were employed to cross-check analyses.

Disequilibrium studies were undertaken to ascertain the relationship between chemical and radiometric uranium. Chemical and radiometric values from all of the core holes were plotted as in Figure 9, and disequilibrium values were calculated. These values ranged from 0.48 to 1.18, with a weighted average disequilibrium factor approaching 1.00 for the deposit. Values ranging from 0.90 to 1.10 were obtained for mineralized intervals from the unoxidized zone suggesting only minor uranium migration in these portions of the deposit. In contrast, the oxidized uranium mineralization shows erratic disequilibrium factors, generally less than 0.90 or greater than 1.10. These erratic values indicate probable remobilization of uranium in the oxidized sediments, at least until fairly recent times.

Uranium mineralization appears to be closely related to the organic carbon content of the Anderson Mine sediments. The possibility that tuffaceous rocks are the source of uranium in many ore deposits has been considered for some time by Waters and Granger (1953) in the Colorado Plateau, Denson and

Gill (1956) in the northern Great Plains, and Weeks and Eargle (1963) in the Texas coastal plain. It is a good possibility that the tuffaceous sediments in the Anderson Mine sequence were the source of much of the uranium in the deposit.

DIRECTIONS TO THE ANDERSON MINE

0	Wickenburg
6.2	Highway 93
16.6	Highway 93 and 71
21.0	Alamo Road
26.9	Road fork - stay right
27.5	Cattle guard
30.6	Road to left - stay right
	Yellow cattle guard
31.5	Ranch
38.2	Stay left
	Cattle guard - Anderson Mine sign at left
38.4	Turn right
41.7	Stay right

Minerals Exploration Office
784 Whipple Street #3 - #5
Box 2246
Wickenburg, Arizona 85258
(602) 684 5155

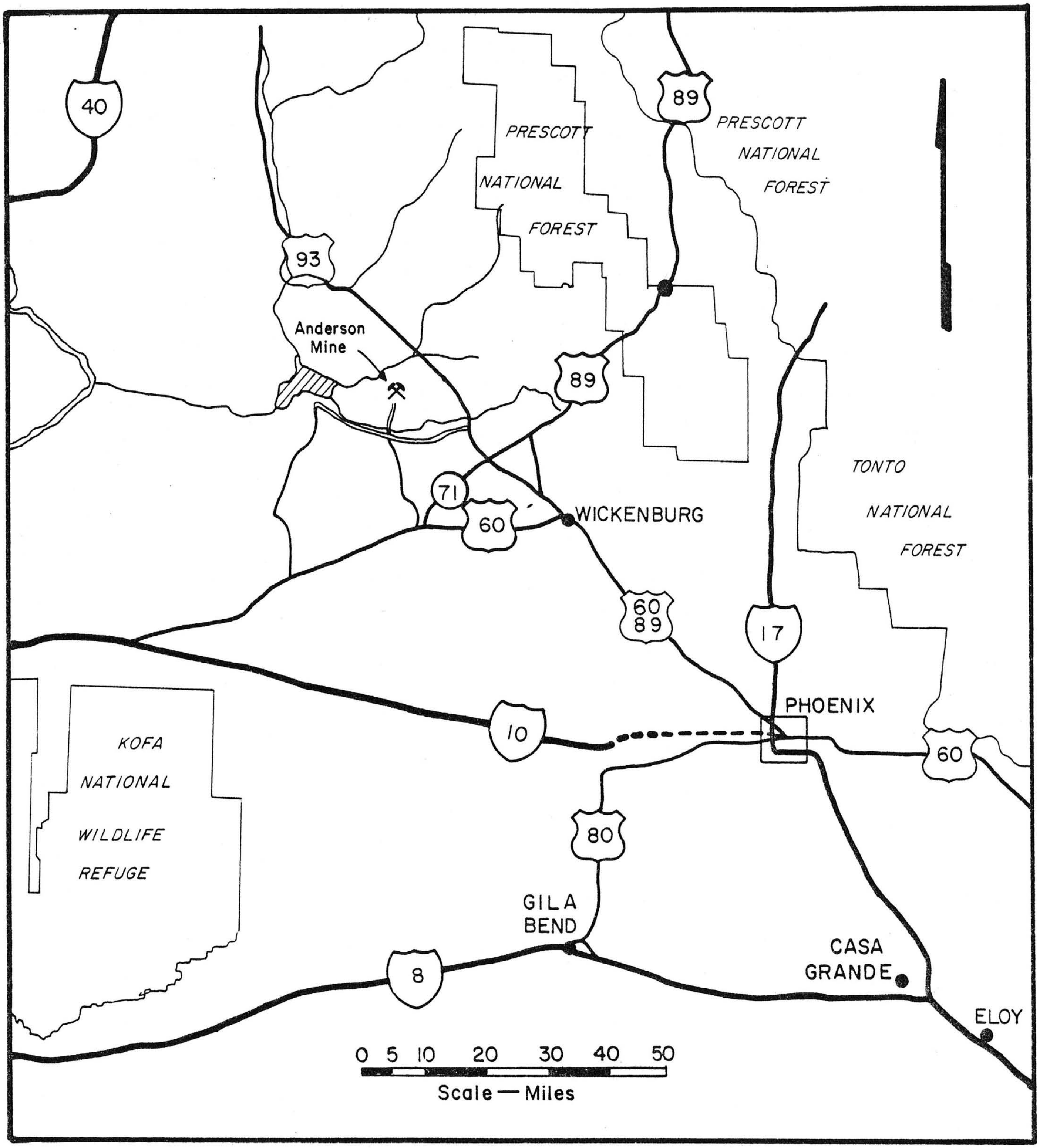
TABLE 1

TABLE 2: Production Figures from Anderson Mine

Year	Tons of Ore	Grade (%) U_3O_8	Lbs. of Ore
1955	9	0.56	101
1956	31	0.21	130
1957	3,614	0.19	14,043
1958	725	0.27	3,928
1959	6,379	0.12	15,028
TOTAL	10,758	Ave. 0.15% U_3O_8	33,230

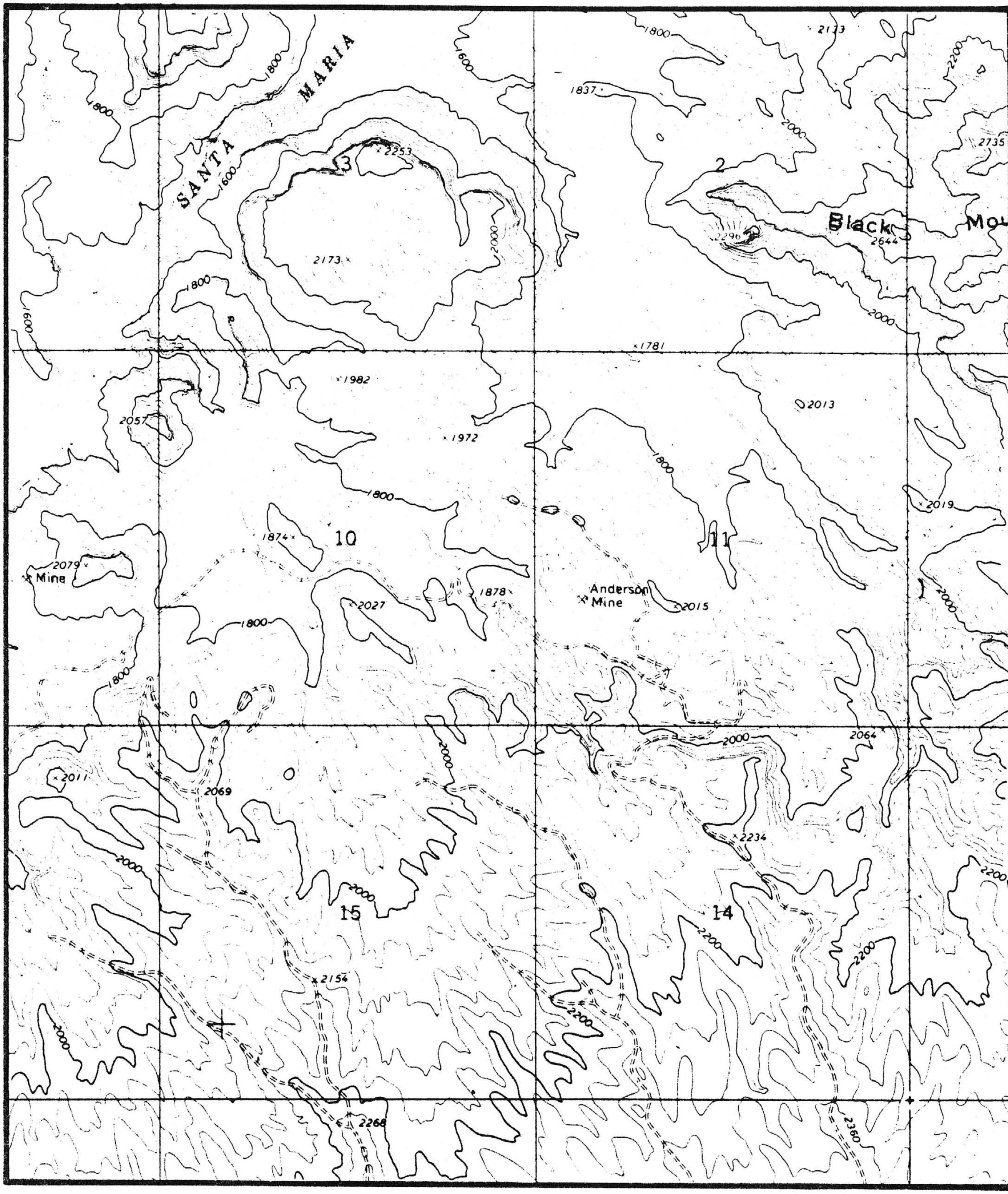
TABLE 3: Uranium Resources from Anderson Mine

Cutoff (% U_3O_8)	Average Grade (% U_3O_8)	Average Thickness (m)	Uranium Mineralization (%)
.02	.05	6.3	100%
.03	.06	4.2	83.1%
.05	.09	2.6	60.6%
.07	.12	2.0	47.9%

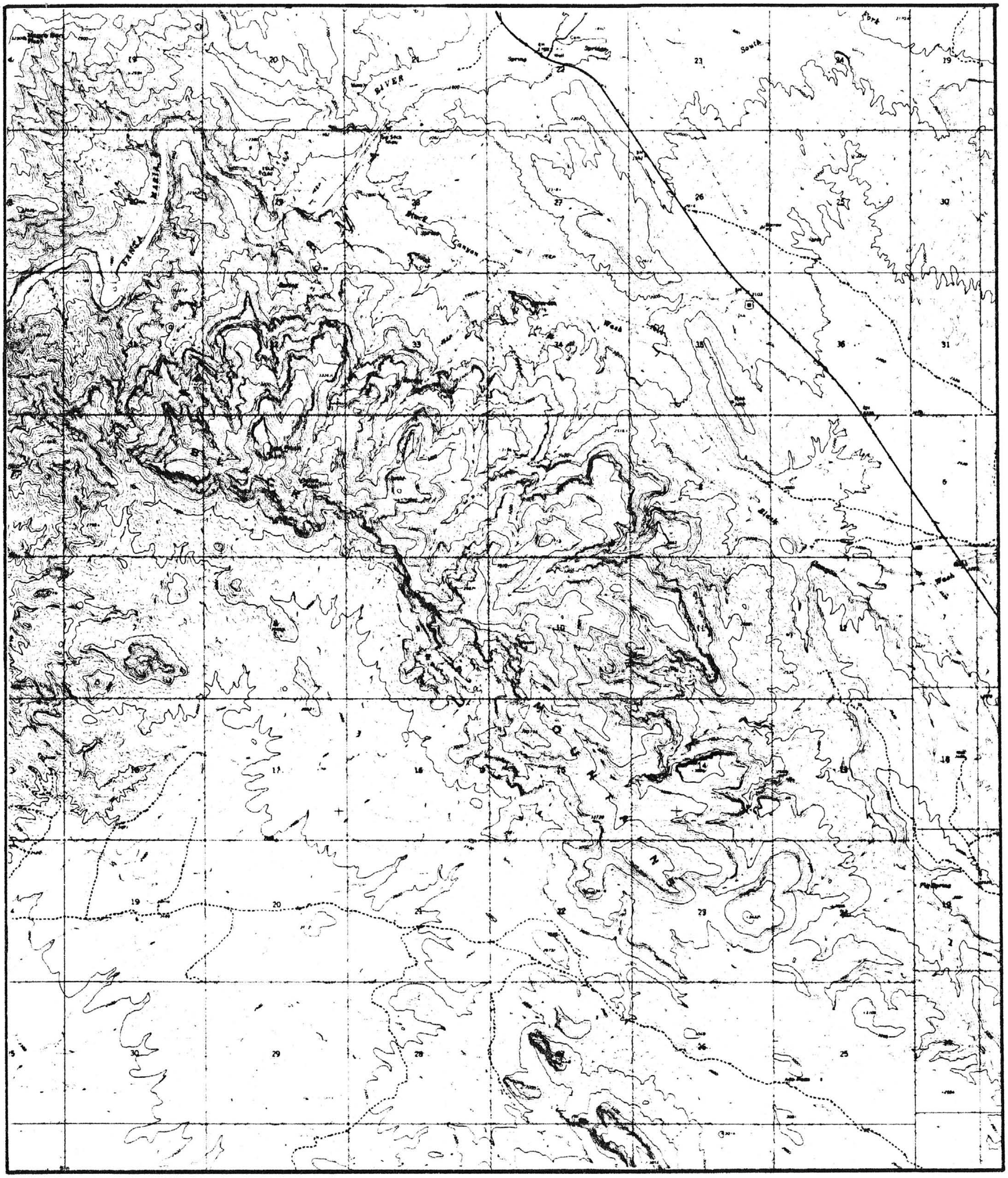


LOCATION MAP
ANDERSON MINE-
DATE CREEK BASIN AREA
Yavapai County, Arizona

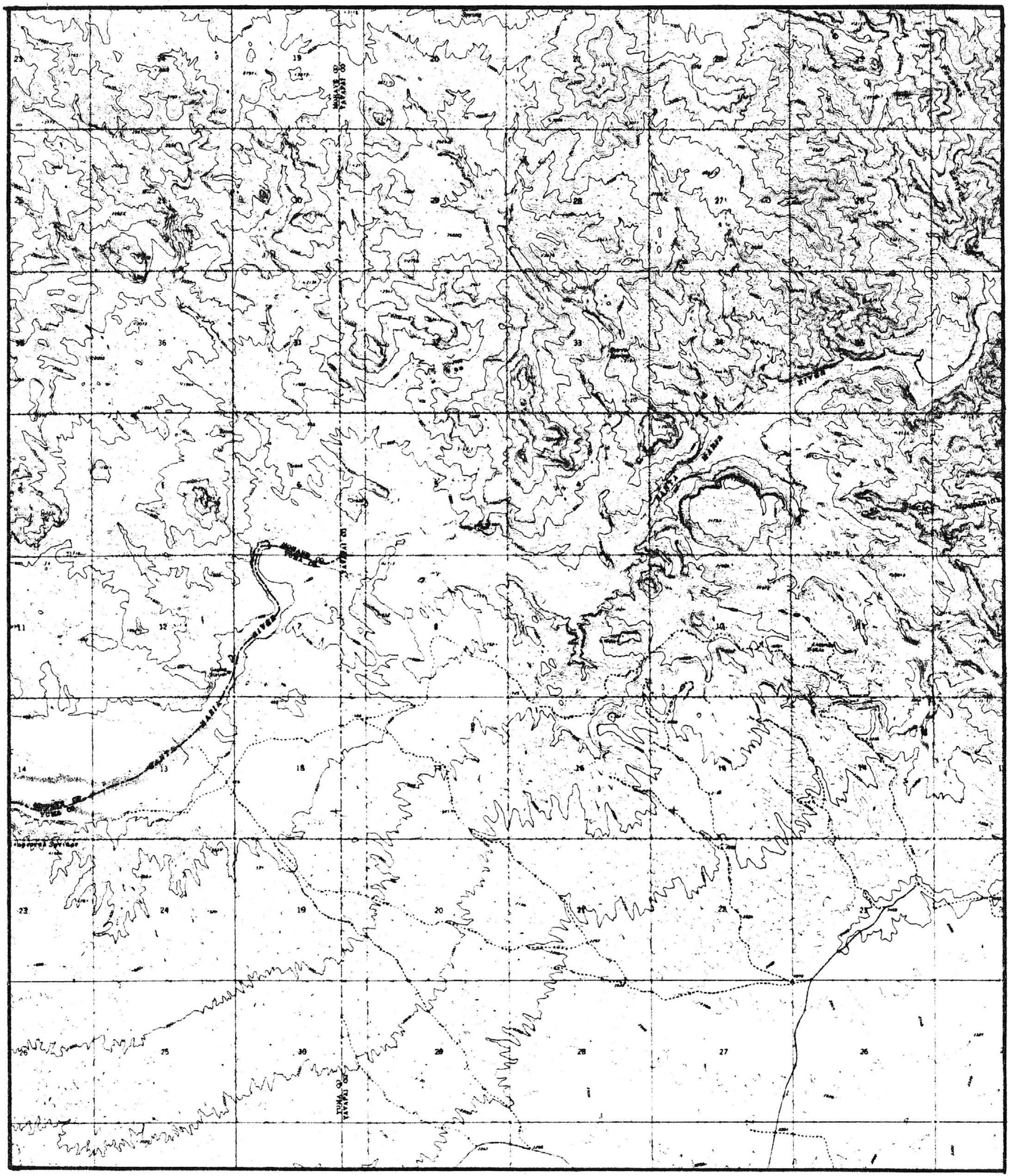
Fig. I-A



LOCATION MAP
ANDERSON MINE–
DATE CREEK BASIN AREA
Yavapai County, Arizona
Scale 1:24,000
Fig. 1-B



LOCATION MAP
ANDERSON MINE–
DATE CREEK BASIN AREA
Scale 1:62,500
Fig. 1-C



LOCATION MAP
ANDERSON MINE–
DATE CREEK BASIN AREA
Scale 1:62,500
Fig. 1-D

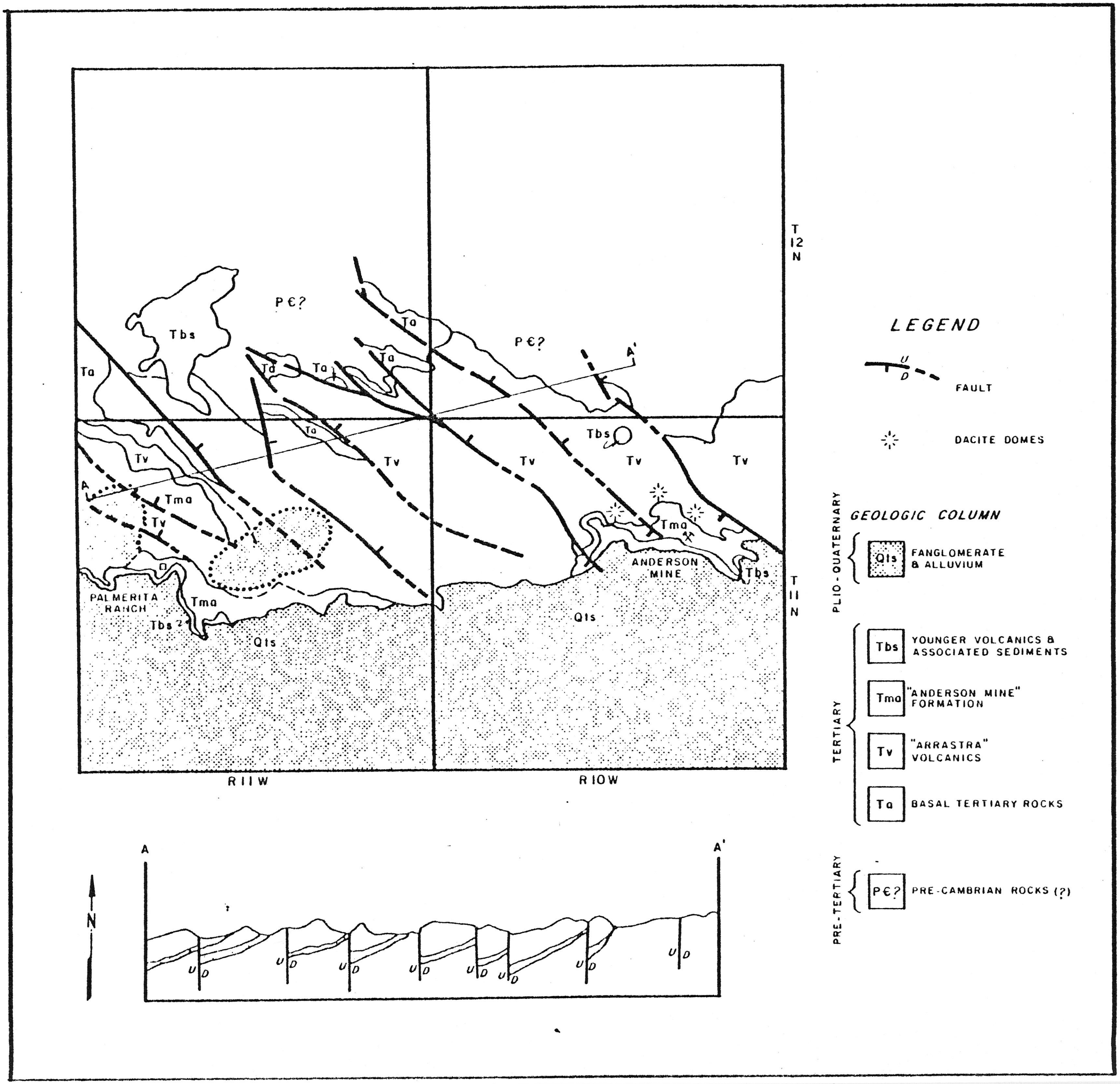

PЄ?
Tbs
Ta
Tv
Tma
Qts
PALMERITA RANCH
ANDERSON MINE
T 12 N
T 11 N
R11W
R10W
A
A'
N
LEGEND
FAULT
DACITE DOMES
GEOLOGIC COLUMN
PLIO-QUATERNARY
Qts FANGLOMERATE & ALLUVIUM
TERTIARY
Tbs YOUNGER VOLCANICS & ASSOCIATED SEDIMENTS
Tma "ANDERSON MINE" FORMATION
Tv "ARRASTRA" VOLCANICS
Ta BASAL TERTIARY ROCKS
PRE-TERTIARY
PЄ? PRE-CAMBRIAN ROCKS (?)

FIGURE 2

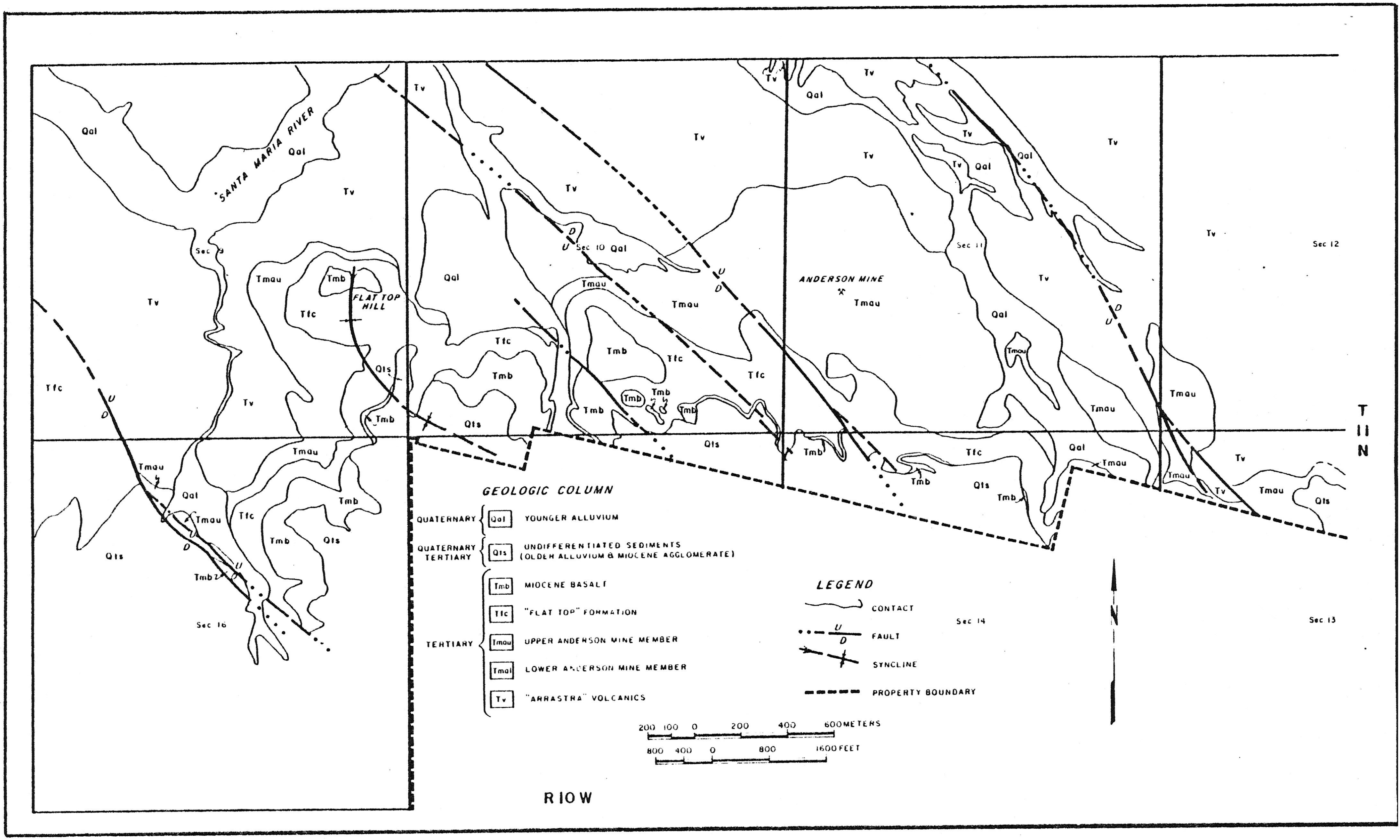
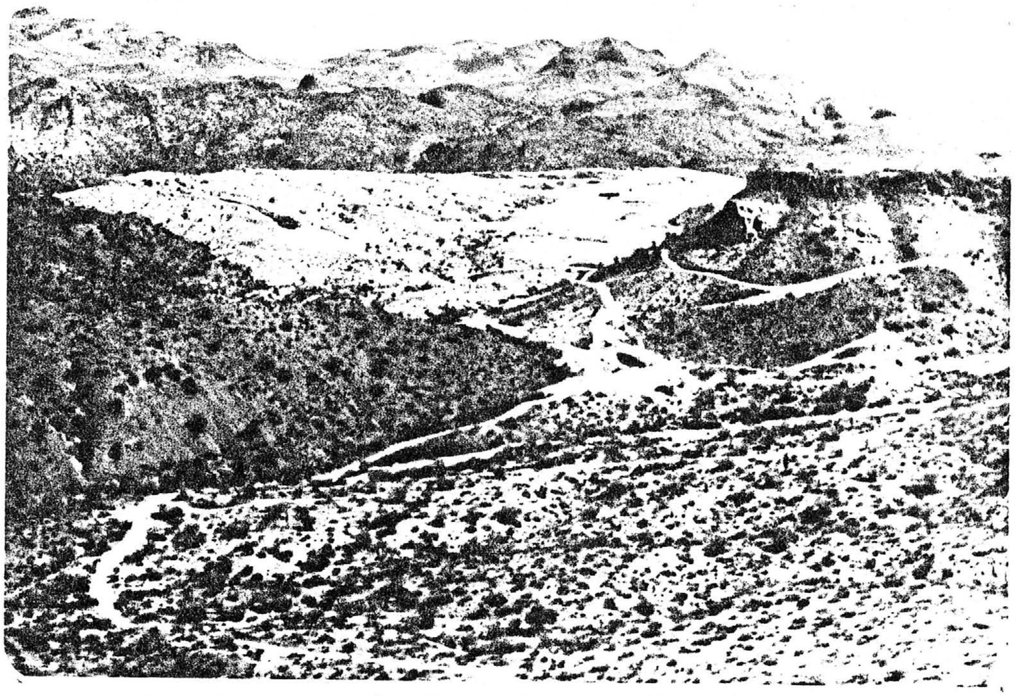

SANTA MARIA RIVER
FLAT TOP HILL
ANDERSON MINE
Sec 9
Sec 10
Sec 11
Sec 12
Sec 13
Sec 14
Sec 16
T 11 N
R10W
GEOLOGIC COLUMN
QUATERNARY
Qal YOUNGER ALLUVIUM
QUATERNARY TERTIARY
Qts UNDIFFERENTIATED SEDIMENTS (OLDER ALLUVIUM & MIOCENE AGGLOMERATE)
TERTIARY
Tmb MIOCENE BASALT
Tfc "FLAT TOP" FORMATION
Tmau UPPER ANDERSON MINE MEMBER
Tmal LOWER ANDERSON MINE MEMBER
Tv "ARRASTRA" VOLCANICS
LEGEND
CONTACT
FAULT
SYNCLINE
PROPERTY BOUNDARY
200 100 0 200 400 600 METERS
800 400 0 800 1600 FEET
N

FIGURE 3



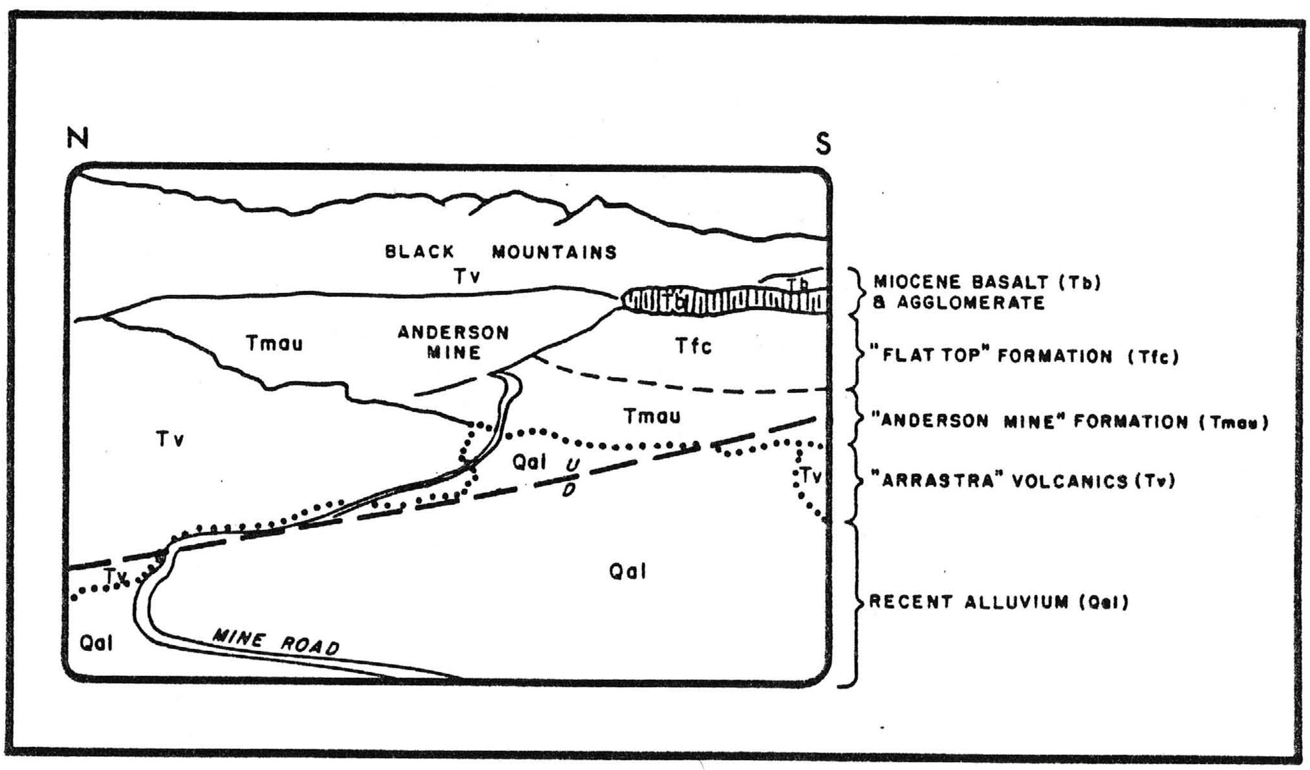

N
S
BLACK MOUNTAINS
Tv
Tb
Tfc
Tmau
ANDERSON MINE
Tfc
Tmau
Tv
Qal
U
D
Tv
Tv
Qal
Qal
MINE ROAD
MIOCENE BASALT (Tb) & AGGLOMERATE
"FLAT TOP" FORMATION (Tfc)
"ANDERSON MINE" FORMATION (Tmau)
"ARRASTRA" VOLCANICS (Tv)
RECENT ALLUVIUM (Qal)

FIGURE 4

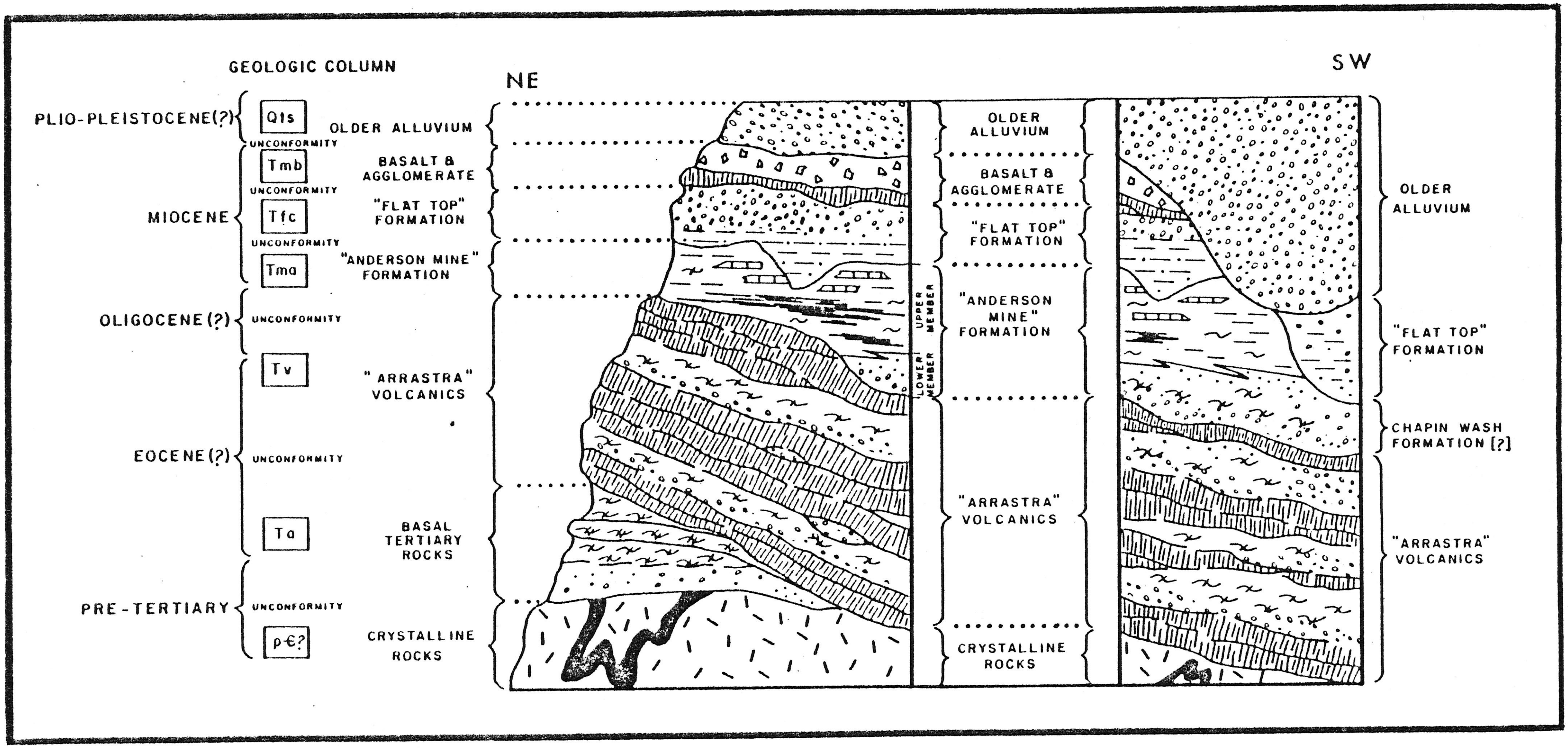
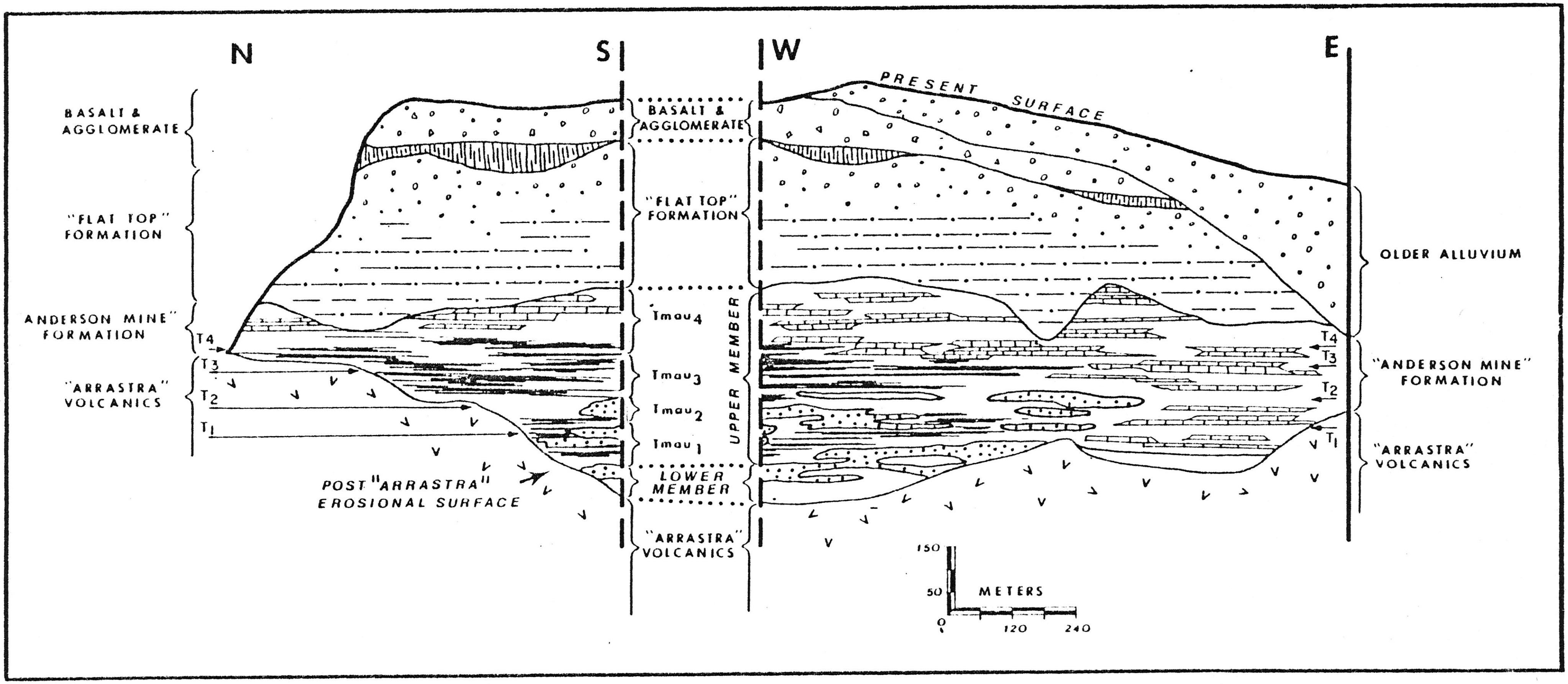

GEOLOGIC COLUMN
NE
SW
PLIO-PLEISTOCENE(?)
Qls
OLDER ALLUVIUM
UNCONFORMITY
Tmb
BASALT & AGGLOMERATE
UNCONFORMITY
MIOCENE
Tfc
"FLAT TOP" FORMATION
UNCONFORMITY
Tma
"ANDERSON MINE" FORMATION
OLIGOCENE (?)
UNCONFORMITY
Tv
"ARRASTRA" VOLCANICS
EOCENE (?)
UNCONFORMITY
Ta
BASAL TERTIARY ROCKS
PRE-TERTIARY
UNCONFORMITY
p€?
CRYSTALLINE ROCKS
OLDER ALLUVIUM
BASALT & AGGLOMERATE
"FLAT TOP" FORMATION
UPPER MEMBER
LOWER MEMBER
"ANDERSON MINE" FORMATION
"ARRASTRA" VOLCANICS
CRYSTALLINE ROCKS
OLDER ALLUVIUM
"FLAT TOP" FORMATION
CHAPIN WASH FORMATION [?]
"ARRASTRA" VOLCANICS

FIGURE 5



N
S
W
E
PRESENT SURFACE
BASALT & AGGLOMERATE
"FLAT TOP" FORMATION
"ANDERSON MINE" FORMATION
"ARRASTRA" VOLCANICS
T4
T3
T2
T1
BASALT & AGGLOMERATE
"FLAT TOP" FORMATION
Tmau4
Tmau3
Tmau2
Tmau1
UPPER MEMBER
LOWER MEMBER
"ARRASTRA" VOLCANICS
POST "ARRASTRA" EROSIONAL SURFACE
OLDER ALLUVIUM
"ANDERSON MINE" FORMATION
"ARRASTRA" VOLCANICS
150
50
0
METERS
120
240

FIGURE 6

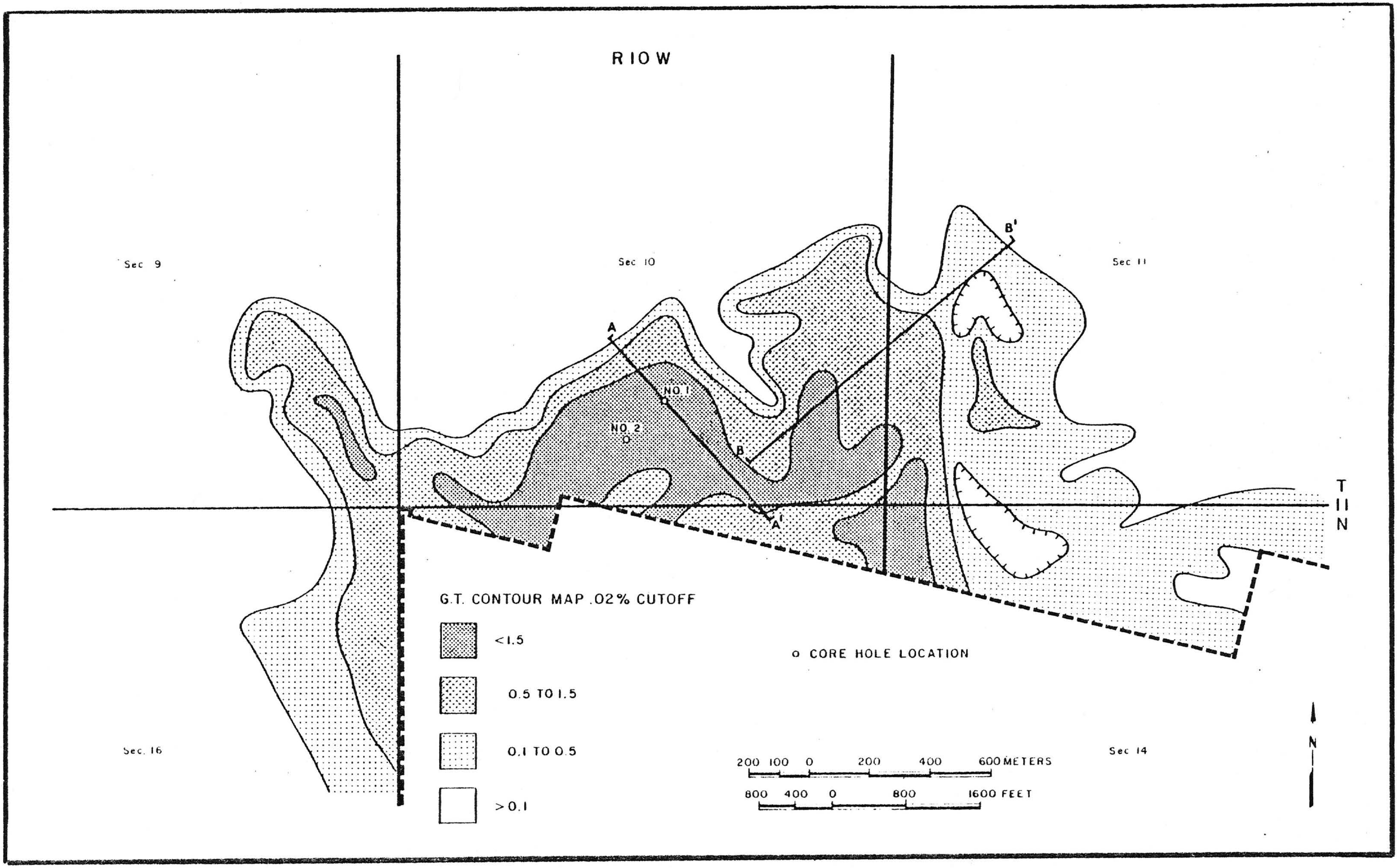
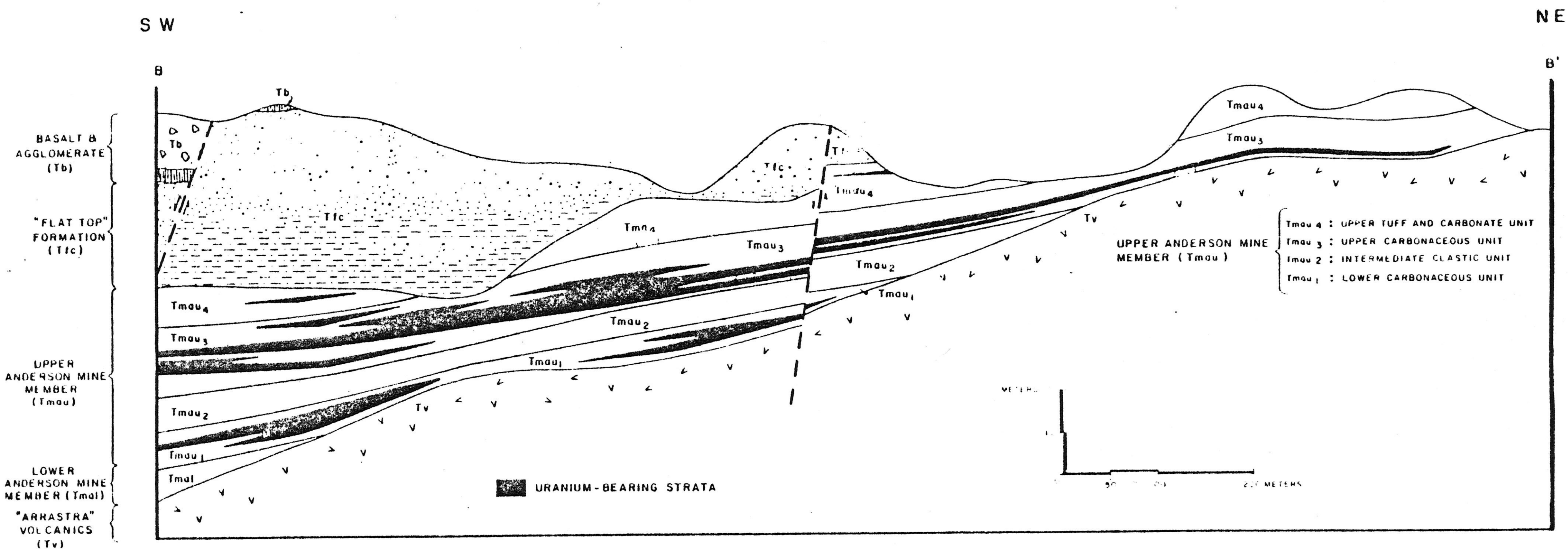

R10W
Sec 9
Sec 10
Sec 11
Sec 16
Sec 14
T11N
A
A'
B
B'
NO. 1
NO. 2
G.T. CONTOUR MAP .02% CUTOFF
<1.5
0.5 TO 1.5
0.1 TO 0.5
>0.1
o CORE HOLE LOCATION
200 100 0 200 400 600 METERS
800 400 0 800 1600 FEET
N

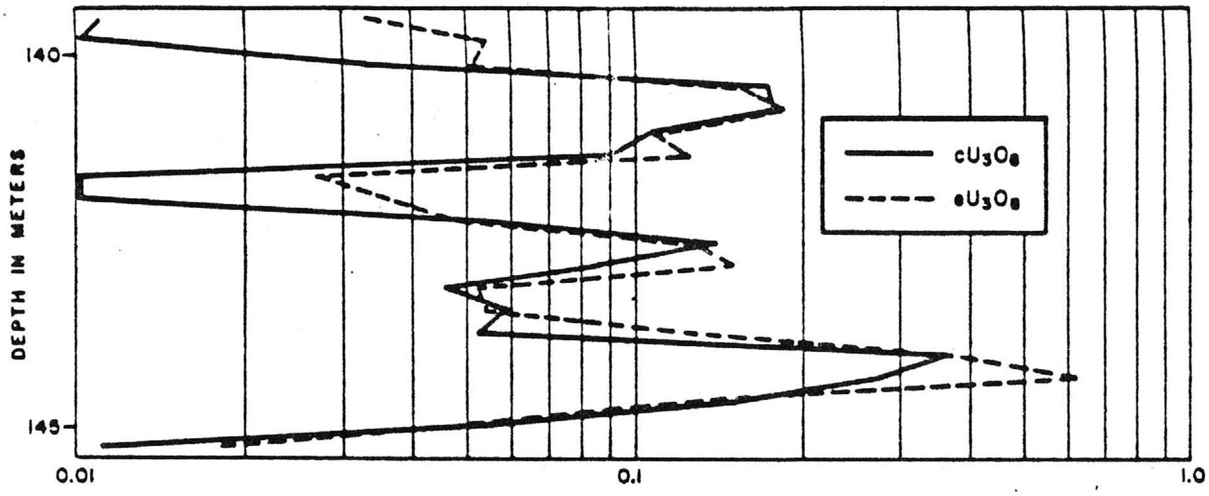
FIGURE 8



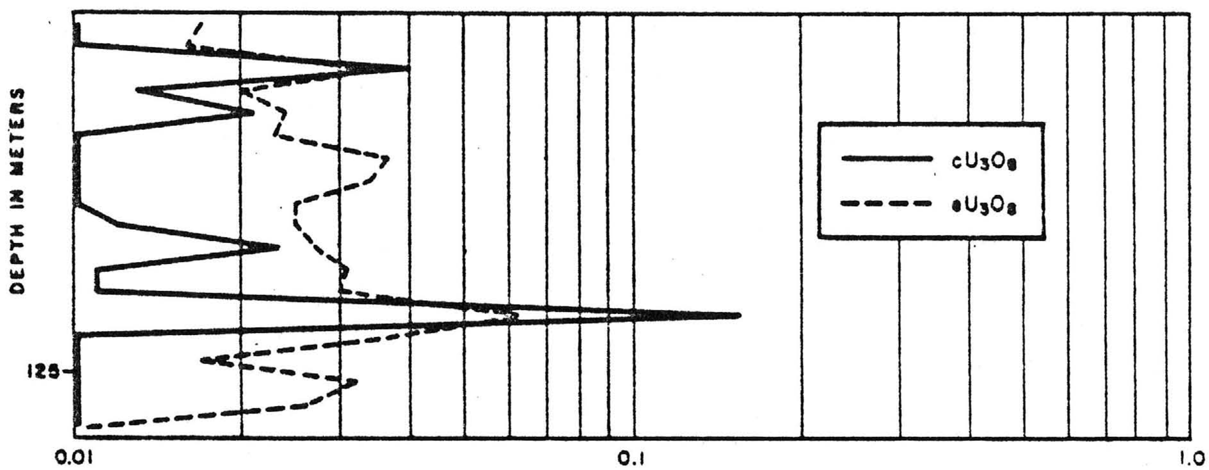
SW
NE
B
B'
BASALT & AGGLOMERATE (Tb)
"FLAT TOP" FORMATION (Tfc)
UPPER ANDERSON MINE MEMBER (Tmau)
LOWER ANDERSON MINE MEMBER (Tmal)
"ARRASTRA" VOLCANICS (Tv)
Tb
Tfc
Tmau4
Tmau3
Tmau2
Tmau1
Tmal
Tv
UPPER ANDERSON MINE MEMBER (Tmau)
Tmau 4 : UPPER TUFF AND CARBONATE UNIT
Tmau 3 : UPPER CARBONACEOUS UNIT
Tmau 2 : INTERMEDIATE CLASTIC UNIT
Tmau 1 : LOWER CARBONACEOUS UNIT
URANIUM-BEARING STRATA
METERS

FIGURE 8b

CORE HOLE NO. 1



CORE HOLE NO. 2



CORE HOLE NO. 2

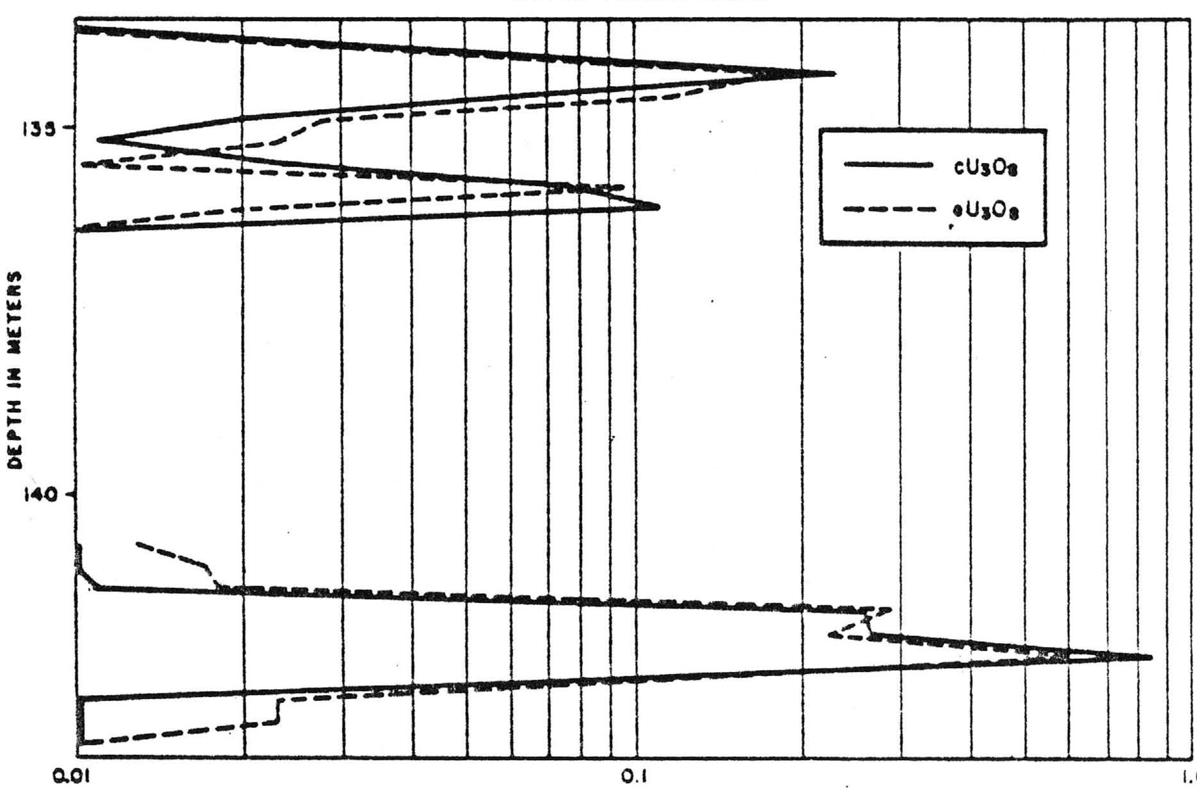


FIGURE 9

MEETING AREA - Route 93 and Alamo Road Junction.

The meeting area is slightly east of the eastern edge of the Date Creek Basin. To the northeast, across the highway are the granite gneiss' and schists of the Date Creek Mountains. To the northwest the Black Mountains composed of tertiary volcanics are apparent. To the west-southwest the Harcuvar Mountains composed of granite gneiss may be visable.

As we continue we will enter the date creek basin at approximately the first cattle guard we cross. As we continue into the basin, note the curvature of the Black Mountains (northeast) northwestward into the Poachie range. The Harcuvar Mountains are to the southwest.

The large drainage cutting the Date Creek Basin surface is Date Creek. As we come up out of Date Creek and continue west, the Artillery, Rawhide and Buckskin mountain ranges are seen on the western horizon.

STOP NO 1. ASSEMBLY.

This stop is made to let everyone catch up. We are on the approximate drainage divide between Date Creek to the south, and the Santa Maria River to the north. The lowest point on the skyline to the north-northeast is the Santa Maria River Canyon which delineates the boundry of the Black Mountains and the Poachie Range. To the north, note the onlap of the Tertiary volcanics onto and against the granitic portions of the Poachie Range. To the west note the dip of the Miocene Basalt into the Date Creek Basin as noted in the mesas along the flank of the Poachie Range. The general structural fabric of the area is northwest-southeast hinge faulting. Several major faults may be noted in the Poachie Range.

STOP No. 2

As we drive to this stop the Santa Maria River Channel will be seen to the west. We are drilling on the upper conglomeritic unit of Plio-Pleistocene age. As we approach our second stop we will drive onto a Miocene basalt. Vehicles will be parked at this point and the tour will continue on foot.

From this high vantage point on the basalt note the onlap of the lacustrian sediments on the underlying andesitic volcanics to the northeast.

Immediately beneath the basalt is the lower conglomerate which overlies the lacustrian sediments. To the northwest across the river note the pyramid-like peak. The lower conglomerate may be seen overlying the Arrastva Volcanics and in turn capped by the basalt. No lacustrian sediments are present there between the lower conglomèrate and the Arrastra Volcanics. Note the fault zone beneath us to the northwest in the Arrastra Volcanics. From here we will proceed downslope to the stop no. 3.

STOP No. 3.

At this location is one of the only out-crops of the carbonaceous material on the property. Note that the unit here is exposed only due to the bulldozer cut made for bulk sampling purposes. This is the middle carbonaceous zone which is the thickest and most continuous mineralized unit across the area. The unit thickens rapidly to the south (down dip) beneath the hill. The carnotite mineralization noted above the carbonaceous unit was not observable when the cut was made but "bloomed" two weeks later after a rain. Note the small tare zones and the close proximity of the fault zone to the north and the differences in elevation of the Arrastra volcanics.

STOP No. 4

This is the area of the old Anderson Mine. During the late 1950's, 33,230 pounds of U_3O_8 were produced from this area. In this cut a resistant tuffaceous siltstone with large silicified pods overlies a green tuffaceous siltstone. Near the base of the cut is a thin slightly carbonaceous zone which carries most of the uranium. Beneath these beds are varicolored siltstones exhibiting various degrees of silicification. This will be our lunch break.

STOP No. 5.

This stop will provide a look at the volcanics, volcaniclastics and intrusives older than the lacustrian sediments and thus unmineralized. Therefore those who wish to poke around in the lake beds longer or who wish to return to the vehicles may. At Stop No. 5, we are standing on the andesitic volcanic flows which forms the drilling basement as no mineralization has been noted in or below this unit. To the east the onlap and different thickenss of the lacustrian sediments overlying the andesite can be seen. In various outcrops in the valley to the northeast the volcaniclastic unit can be observed beneath the andesite. In general the basal portions of this unit are very tuffaceous and waterlain while the unit coarsens upwards becoming less tuffaceous and more sandy and conglomeritic. To the north and to the west are two light gray intrusive bodies. Flow structures may be noted and on close inspection can be clearly seen. Note the thick section of Tertiary volcanics northeastward in the Black Mountains and the granites to the north in the Poachie Range. This concludes the tour and we will proceed back to the vehicles. Union Oil thanks you for your participation and hopes that the tour has been enjoyable and informative for you.

MINERALS EXPLORATION COMPANY

A.G.S. ANDERSON MINE PROPERTY TOUR

Stop #2

The Anderson Mine Project is envisioned as a uranium mine-mill complex with a milling capacity of 2,000 TPD throughput. The mill will utilize a conventional acid leach, solvent extraction circuit.

Mine waste stripping will be accomplished using 17 YD^3 electric shovels and 120 Ton trucks. Mining of ore intervals will use more selective backhoe-front shovels and 35 Ton trucks. Waste material not backfilled into mined out increments will be placed into surface waste dumps to the north and northeast of the mine area. Maximum depth of the envisioned pit is about 700'.

Access to the mine will be via a paved road using a route north of that used today. Total employment at the mine site is expected to be in the neighborhood of 300 persons.

The mill site is situated on the nearest rhyolite outcrop to the north. Tailings from the mill will flow into a tailings pond which will be located below us and to the northeast. The tailings pond utilizes the first mined out pit increments as its site. Mining will extend from this point approximately 1,555' to the south, east and west, and approximately 500' to the north.

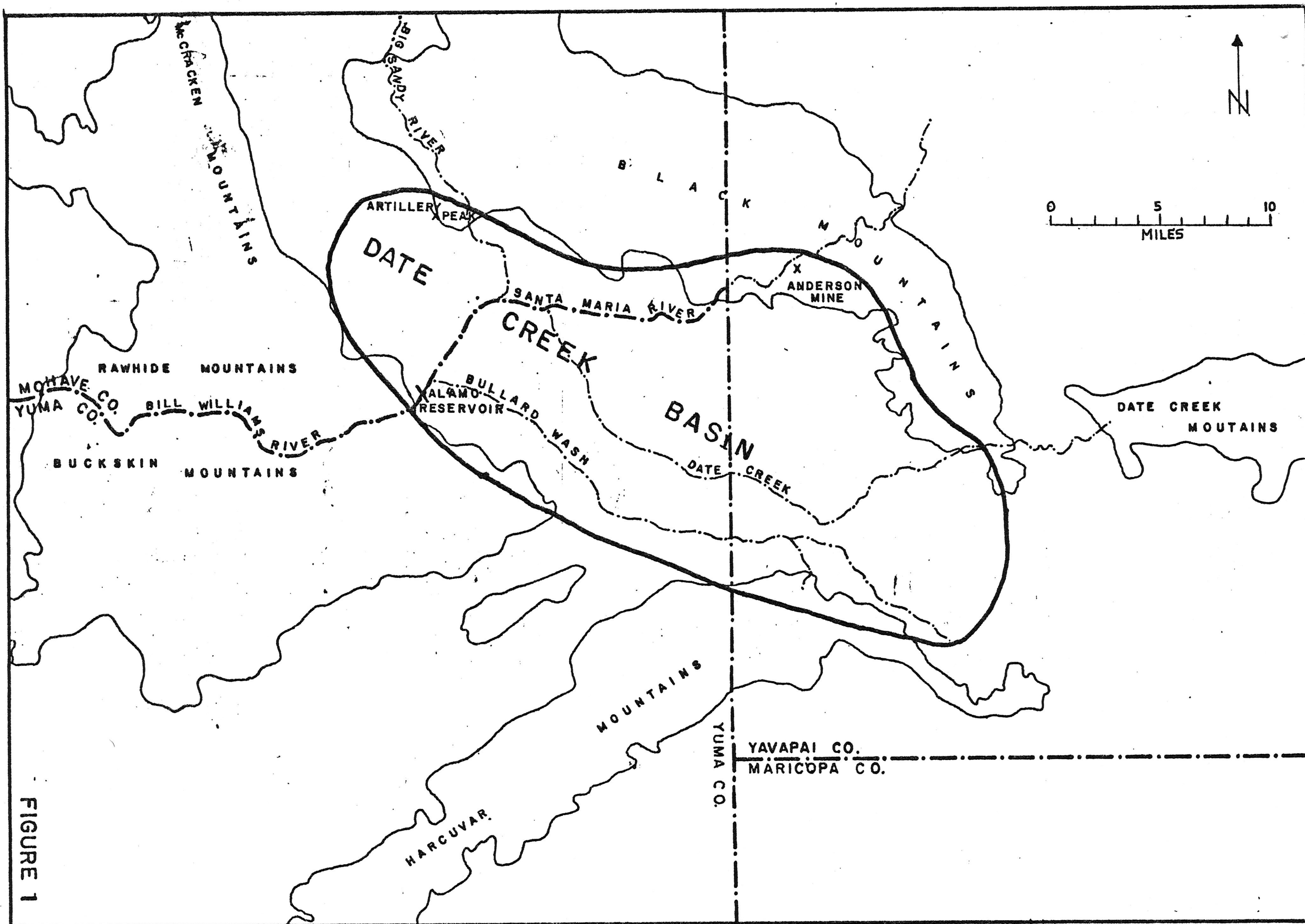
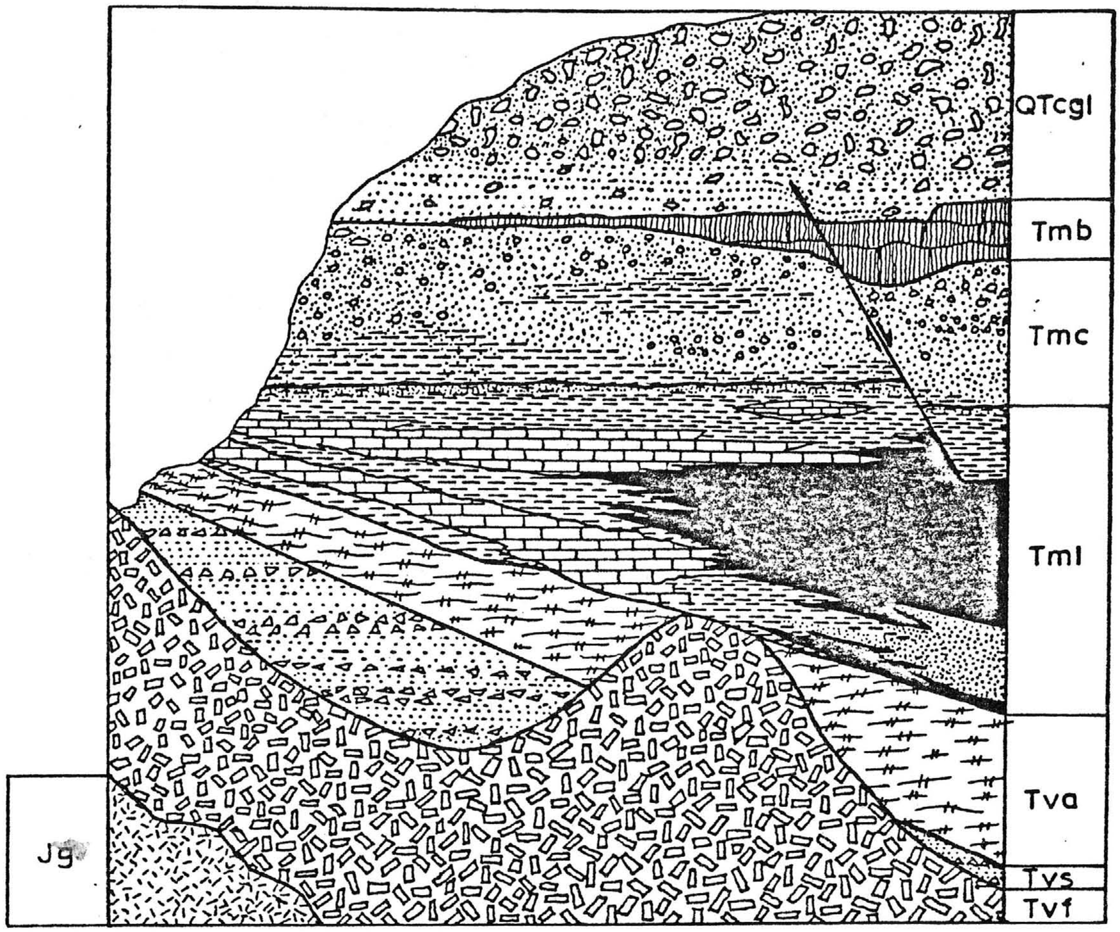
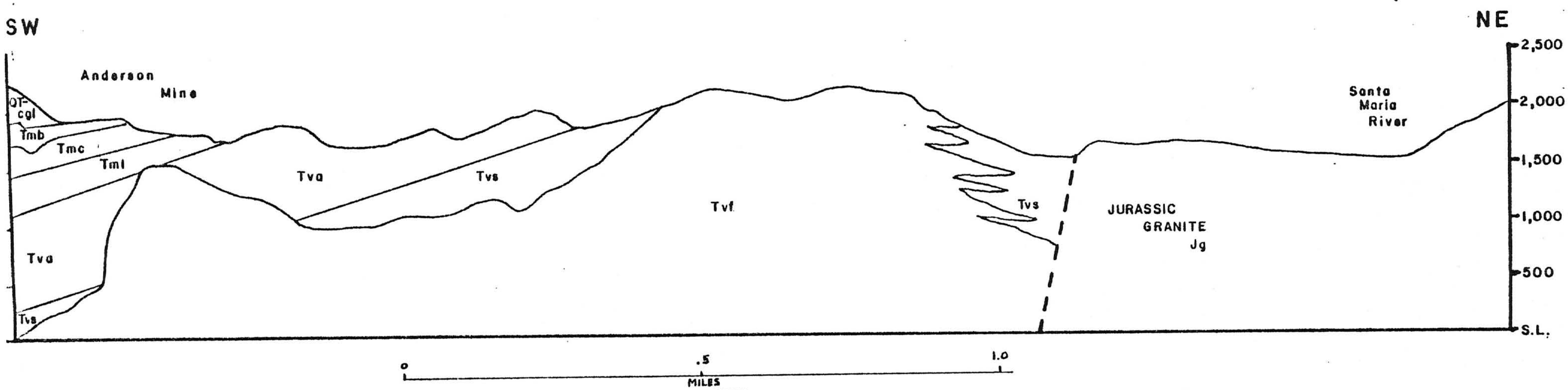

McCRACKEN MOUNTAINS
BIG SANDY RIVER
BLACK MOUNTAINS
ARTILLERY PEAK
DATE CREEK BASIN
SANTA MARIA RIVER
ANDERSON MINE
RAWHIDE MOUNTAINS
MOHAVE CO.
YUMA CO.
BILL WILLIAMS RIVER
ALAMO RESERVOIR
BULLARD WASH
BUCKSKIN MOUNTAINS
DATE CREEK
DATE CREEK MOUTAINS
HARCUVAR MOUNTAINS
YUMA CO.
YAVAPAI CO.
MARICOPA CO.
N
0 5 10
MILES

FIGURE 1


QTcgl
Tmb
Tmc
Tml
Tva
Tvs
Tvf
Jg



QTcgl	Quaternary–Tertiary conglomerate, 0-400', tan to white, sandy to very coarse, locally calcite cemented, granitic metamorphic felsic & basaltic clasts
Tmb	Tertiary Miocene basalt, black fine-grained to aphanitic, calcite–filled amygdules, commonly jointed parallel to flow surface, 0'–120'
Tmc	Tertiary Miocene conglomerate, tan to brown siltstone grades upward into arkosic sandstone & then into conglomerate with granitic & felsic clasts, 200'-450'
Tml	Tertiary Miocene lacustrine sediments, basal arkosic sandstone, carbonaceous siltstone & lignite, silty limestone, limy siltstone, green siltstones & mudstones, tuffaceous material throughout, 0'–400'
Tva	Tertiary volcanic andesite, gray, gray brown, brown, red brown, fine–grained, vesicular augite andesite, locally containing calcite-filled amygdules
Tvs	Tertiary volcaniclastic sediments, gray to white, felsic to intermediate tuffs, ash flows, lahar breccias, upper section yellow tan to tan, sandy
Tvf	Tertiary felsic to intermediate volcanics, white to gray, pink-gray, nechy flows & tuffs
Jg	Jurassic granite, brown, purple-gray, biotite granite

GENERALIZED CROSS SECTION ANDERSON MINE

FIGURE 2