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GEOLOGY OF NORTHERN FRENCHMAN FLAT, NEVADA TEST SITE

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GEOLOGY OF NORTHERN FRENCHMAN FLAT, NEVADA TEST SITE

By

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and R. M. Hazelwood

ABSTRACT

A special geologic and geophysical study of the northern part of Frenchman Flat yielded considerable detailed information on the stratigraphy and structure of that area. In general, the rocks are similar to those of Yucca Flat, except that the rocks of Frenchman Flat include relatively high-density and high-velocity alluvium at depths of 500-1,000 feet, and a greater proportion of dense tuff units, mainly welded tuff. Basalt lava flows are intercalated in the high-velocity alluvium. The Thirsty Canyon Tuff, an important stratigraphic marker, has been identified for the first time in this part of the Test Site.

The area is structurally complex, and appears to lie near the junction of two fault zones, the Cane Spring left-lateral fault system and a northwest-trending system with a component of right-lateral movement. Stresses induced by both systems may have resulted in movement or fracturing along certain trends in Holocene time. Faults in the tuff and older alluvium may be locally propagated to the surface by testing.

Seismic surveys located numerous small faults that displace the high-velocity older alluvium. Magnetic surveys, still in the experimental stage, effectively located faults in the tuffs and outlined the buried basalt lava flows. Updated gravity information shows the configuration of Frenchman basin, and can be closely related in most instances to the major faults of the area.

INTRODUCTION

The U.S. Geological Survey has conducted a special study of the geology of northern Frenchman Flat in order to establish with greater certainty the stratigraphy and structure of this new test area. The area of investigation is shown in figure 1. The work included detailed mapping and structural study of the bedrock around the northwest perimeter of the basin, ground magnetic traverses coupled with available aeromagnetic data, reevaluation of gravity data, and reflection and refraction seismic surveys. Data obtained from exploratory drill holes Ue11a, Ue11b, Ue11c, Ue5c, Ue5k, and Ue5i were also extremely valuable in constructing a geologic picture of northern Frenchman Flat. Trenches were dug near several sites to aid in the search for faults in the surface alluvium.

GEOLOGY

Before these geologic and geophysical studies of the northern part of Frenchman Flat, little was known about subsurface conditions in this part of the Nevada Test Site, although geologic quadrangle maps of the area have been published (Poole, 1965; Poole and others, 1965, Hinrichs and McKay, 1965). Drilling by the Defense Atomic Support Agency and Sandia Corporation, geophysical surveys and detailed mapping of the bedrock around the north edge of the basin (fig. 2) have resulted in a much better understanding of the geology of the area. The alluvial and volcanic deposits of Frenchman Flat are basically similar to those of Yucca Flat, although there is a widespread zone of well-indurated alluvium in Frenchman Flat that is higher in density and velocity than the alluvium so far studied in Yucca Flat. The tuffs of Frenchman Flat in general, have more and thicker welded zones than the tuffs of Yucca Flat. The complexity of structure of the two basins appears to be comparable, although the Frenchman basin may have a somewhat greater

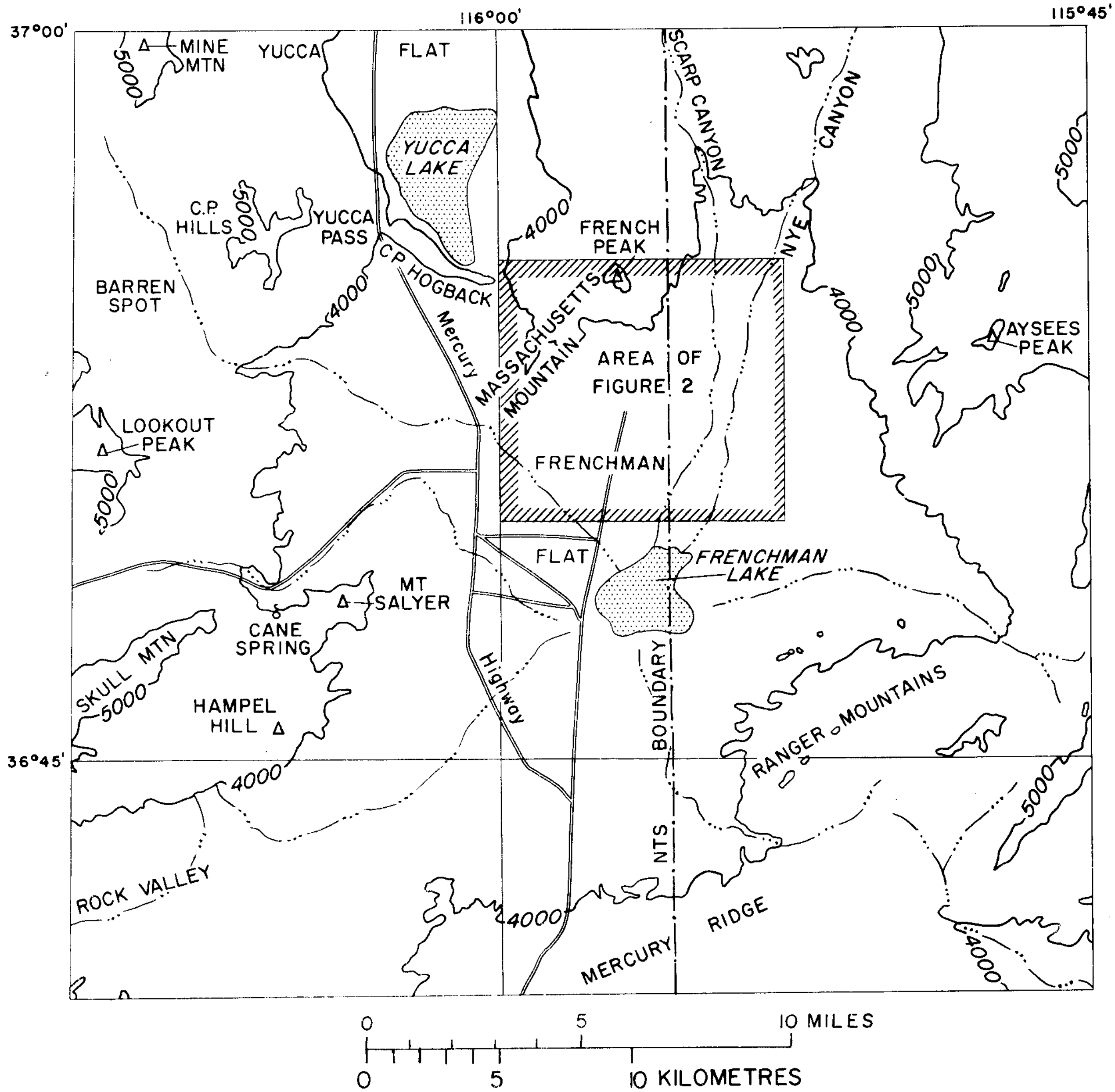

Figure 1.--Index map showing location of northern Frenchman Flat

number of faults cutting the tuff. Age of the faults is probably about the same in both areas.

Stratigraphy

The general stratigraphic sequence in northern Frenchman Flat is given in table 1. Some of the units in table 1 are found only locally and are therefore not shown on figure 2.

The Crater Flat Tuff is the oldest unit penetrated by drilling in northern Frenchman Flat. In exposures 7 miles to the west, in the Cane Spring area the Crater Flat Tuff is a gray to tan zeolitized biotite-bearing nonwelded tuff, but in drill hole Ue5c density logs suggest that it is welded.

Stratigraphically the lowest units that crop out in the area of northern Frenchman Flat are the tuffs and sedimentary rocks of the Salyer and Wahmonie Formations. These two formations are mapped together (fig. 2). Lava flows of the Wahmonie Formation are present in the southwestern corner of the area of figure 2, but elsewhere the Wahmonie lavas are absent and the Topopah Spring Member of the Paintbrush Tuff or the Rainier Mesa Member of the Timber Mountain Tuff overlies the Salyer and Wahmonie tuffs and sedimentary rocks. The Salyer and Wahmonie thicken southwestward toward their source in the Cane Spring area. In the northern Frenchman Flat area the two formations are grossly similar in lithology; both consist mainly of soft rhyodacitic to dacitic tuff and tuff breccia with local interbedded pink to red sandstone and tuffaceous sandstone. The tuffs

Table 1.--General stratigraphic sequence of northern Frenchman Flat

Unit	Lithology	Thickness (feet)[1/]
Alluvium and colluvium	Poorly indurated; sand and gravel with boulders common locally	0- 700
Alluvium and colluvium	Well-indurated; bouldery sand and gravel, tuffaceous sandstone	0-1,300
Basalt	Dense to scoriaceous and rubbly lava flows	0- 100
Thirsty Canyon Tuff	Nonwelded ash-flow tuff	0- 50
Conglomerate and colluvium	Moderately indurated clayey conglomerate	0- 500
Timber Mountain Tuff		
Ammonia Tanks Member	Welded and nonwelded ash-flow tuff	150- 350
Rainier Mesa Member	Welded and nonwelded ash-flow tuff	300- 600
Tuff and sandstone of Hampel Hill	Zeolitized bedded tuff and tuffaceous sandstone	25- 350
Paintbrush Tuff		
Topopah Spring Member	Welded ash-flow tuff	50- 225
Wahmonie Formation	Lava flows and bedded tuff	50- 500
Salyer Formation	Bedded tuff, sandstone and volcanic breccia	100- 300
Paintbrush Tuff		
Stockade Wash Member	Nonwelded ash-flow tuff	100- 300
Bedded tuff	Zeolitized tuff	100- 300
Crater Flat Tuff	Nonwelded to moderately welded ash-flow tuff	50- 300
Rocks of Pavits Spring	Bedded tuff, claystone, sandstone, and marl	200- 800
Paleozoic rocks	Limestone, dolomite, and quartzite	200- 800

1/ To convert feet to metres, multiply feet by 0.3048.

commonly contain abundant biotite and hornblende. In drill hole Ue5c a dense breccia flow at a depth of about 2,350 to 2,460 feet is probably part of the Salyer. The Wahmonie lava flows apparently are not present in drill hole Ue5c, although tuff breccias of the Wahmonie are.

In most of the northern Frenchman Flat area the Wahmonie is overlain by the Topopah Spring Member of the Paintbrush Tuff. The Topopah Spring pinches out southwestward on the constructional high of Wahmonie and Salyer volcanic rocks and appears to be absent in drill hole Ue5c. The Topopah Spring Member consists entirely of ash-flow tuff, for the most part densely welded. It has been divided into three parts on figure 2: A lower brown vitric partly welded zone about 50 feet thick, a middle densely welded purplish-gray devitrified zone about 150 feet thick, and an upper black to dark-brown vitrophyre densely welded zone about 25 feet thick. The Topopah Spring is locally highly fractured and the central part commonly has many flattened lithophysal cavities as much as 8 inches long.

The Topopah Spring is overlain by the tuff and sandstone of Hampel Hill (fig. 2), which consists almost entirely of light-yellow zeolitic crossbedded tuff, tuffaceous sandstone, and a few thin nonwelded ash flows. Near the top are a few feet of white vitric bedded tuff. The thickness of this unit is quite variable, partly because of erosion of the upper part, and partly because of depositional inequalities; maximum known thickness is about 350 feet at Ue11b. The unit thins abruptly northward and westward, and a mile north of Ue11b it is only about 100 feet thick. The lowermost part of the unit was the test medium at

U11b, the shotpoint being only a few feet above the top of the densely welded Topopah Spring Member.

For mapping purposes the next younger unit, the Rainier Mesa Member of the Timber Mountain Tuff, was divided into five zones (fig. 2). The Rainier Mesa is entirely ash-flow tuff. Unit a is nonwelded pink vitric tuff at the base, about 125 feet thick; unit b, light-gray moderately welded devitrified zone, about 100 feet thick; unit c, purplish-gray, densely welded, devitrified zone, about 75 feet thick; unit d, light-gray densely welded devitrified zone, about 75 feet thick; unit e, light-brown vapor-phase zone, moderately welded to nonwelded at top, about 150 feet thick. In areas where the Rainier Mesa Member thins (fig. 2), such as northeast of Ue11b, unit c thins or pinches out, and is not mappable. The welded zones of the Rainier Mesa tend to be highly fractured. The Rainier Mesa is reversely magnetized and therefore can give a negative magnetic anomaly, changes in the intensity of which can be used to locate faults. No other reversely magnetized units of significant thickness are known in the Frenchman Flat area.

The upper part of the Timber Mountain Tuff, the Ammonia Tanks Member (fig. 2), is separated from the Rainier Mesa Member by only about 10 feet of soft vitric bedded tuff. The Ammonia Tanks ash-flow tuff is generally similar in appearance and welding to the Rainier Mesa, and is also divided into five units: unit a, the above mentioned bedded tuff, too thin to show on the map (fig. 2) in most places; unit b, white, pink, and light-brown mostly vitric nonwelded zone, about 75 feet thick; unit c, light-gray moderately welded devitrified zone, about 50 feet thick; unit d, purplish-brown, crystal-rich, densely welded, partly vitric zone, about 200 feet thick; unit e, gray to red-brown, nonwelded vapor-phase zone, about 25 feet thick. The Ammonia Tanks is less variable in thickness than the Rainier Mesa probably because the Rainier Mesa filled most irregularities in the topography; but the Ammonia Tanks has been more widely removed or thinned by erosion.

Conglomerate and minor colluvium (fig. 2) of Tertiary age overlie the Ammonia Tanks in the Frenchman basin. This material consists of angular to well-rounded fairly well-indurated sand, pebbles, and boulders, mostly of tuff, eroded from fault blocks formed after deposition of the Ammonia Tanks Member. No surface exposures of this material exist in the mapped area, but similar material underlies the basalt of Skull Mountain 1 to 3 miles southwest of Cane Spring. About 10 feet of conglomerate is present in Ue5i drill hole where it was cored at a depth of 1,090 feet. The conglomerate probably thickens toward the center of the Frenchman basin, and has a structural attitude similar to that of the underlying tuffs, but dips are not as steep.

Locally overlying the Tertiary conglomerate and probably more or less conformable with it is a thin yellow zeolitic nonwelded ash-flow tuff, the Spearhead(?) Member of the Thirsty Canyon Tuff (fig. 2). The source of the Spearhead(?) was at Black Mountain about 50 miles northwest of Frenchman Flat. The Thirsty Canyon is about 7 million years old, and is an important stratigraphic marker that is probably present in parts of Yucca Flat as well, but is as yet unrecognized there.

A thick rather dense alluvium of Tertiary or Quaternary age (fig. 2) underlies most of northern Frenchman Flat. This alluvium, exposed in the tunnel at U5i, consists mainly of tuff sand, pebbles, and boulders, poorly bedded to locally well bedded, uniformly cemented by clayey calcium carbonate. Farther east, in the area of Ue11c and Ue5k, the alluvium contains mostly Paleozoic chert, dolomite, limestone, and quartzite fragments, probably derived from the Nye Canyon area to the northeast. Velocity logs indicate velocities of nearly 7,000 feet per second for this alluvium, which is more than 1,000 feet thick in the central part of the area of figure 2. The top of the alluvium was the principal refractor in the seismic survey of Frenchman Flat.

Within the high velocity alluvium are local basalt flows, also of Tertiary or Quaternary age (fig. 2), very similar to and probably the same age as the basalt that crops out in the Nye Canyon area. The amount of structural displacement and lack of quartz xenocrysts in this basalt suggests it may also correlate with the basalt of Kiwi Mesa in the eastern Jackass Flats area (Ekren and Sargent, 1965). The basalt at Ue5k appears to be coarser grained than that at Ue5i, and may be a different flow. The upper part of these basalts is locally scoriaceous.

The youngest alluvium (fig. 2) in the northern Frenchman area is in general poorly indurated, contains boulders, and consists almost entirely of tuff debris. A few layers are well cemented. Washouts of this unit cause caving and drilling problems.

Structure

Frenchman Flat is a structural basin formed chiefly in late Pliocene time but modified by repeated faulting throughout the Tertiary and Quaternary Periods. The northeast-trending Holocene faults shown by hachures in figure 3 are generally high-angle faults with the northwest side downthrown. Faults of this type may account for the fact, as pointed out by D. L. Healey (written commun., 1966), that the lowest part of the present topographic basin, Frenchman Lake, is about 2 miles south of the deepest part of the buried bedrock basin outlined by gravity data (figs. 2 and 3). The major structural elements of the northern Frenchman Flat area are: (1) northwest-trending, mostly pre-tuff faults in the northeastern part of the basin (inferred mainly from gravity data), (2) northeast-trending Cane Spring fault system, (3) northwest-trending zone of minor faults in northwest corner of basin, and (4) northeast-trending Holocene faults in alluvium. These fault systems are undoubtedly interrelated and overlap in time.

Prior to formation of the present basin a wide valley probably was present, its boundaries generally outlined by the steep gravity gradients around the north side of the present Frenchman Flat. This gradient is particularly notable on the northeast side of the basin where Paleozoic rocks are at the surface at the mouth of Nye Canyon and are downfaulted into the basin along probable large northwest-trending faults. Whereas the gravity data strongly suggest the presence of this fault system and possible extensions northward in the Scarp Canyon area and northwestward past French Peak, no comparable faulting exists in exposures of the tuffs.

The valley or basin outlined by these older faults was the site of accumulation of lower and middle Tertiary sedimentary rocks (rocks of Pavits Spring and older), and later volcanic rocks of the Salyer and Wahmonie Formations. These rocks thin abruptly at the margins of this early structural depression.

The Frenchman Flat-Rock Valley basin was further defined in mid-Tertiary time by continuing movement on the major Cane Spring fault system, a 5-10 mile-wide zone of northeast-trending faults (fig. 3) that extends from the Rock Valley-Skull Mountain area northeastward through the Massachusetts Mountain-French Peak area into Plutonium Valley. Many of these faults have a considerable lateral component of movement, especially farther south in the Cane Spring area. The Cane Spring fault zone (Poole and others, 1965), a major fault zone near the north edge of this fault system, has had a complex history of movement, but the major displacement has been left-lateral movement. Slickensides on fault surfaces of this zone mapped around the northwest perimeter of Frenchman Flat (fig. 2) commonly have a low angle of plunge. In the shaft at U11b north-trending high-angle faults were observed with horizontal slickensides. Positive proof of major left-lateral movement will require further study, but some lateral offset of lithologic units in the tuff appears to be present in the area west of French Peak and elsewhere. At some places the amount of displacement appears to be less in the Timber Mountain Tuff than it is in underlying units. In the Massachusetts Mountain-French Peak area, however, movement on most of these faults is largely dip slip; most of the faults dip northwestward 60° to 80° and the tuffs dip to the southeast from 10^{o} to 35^{o}. This results in a repetition (fig. 2) of the section many times, and such repetition appears to continue southeastward under the alluvium of the Frenchman basin. Probably more faults of this type exist than are shown on the cross section (fig. 2). Thus, the Cane Spring fault system is believed to be a major structural element under the Frenchman basin, but is gradually decreasing in displacement to the north. Movement in Holocene time on the Cane Spring and other faults shows that the system is still active, and the alinement of upper Tertiary or lower Pleistocene basalt flows and dikes along this trend indicates movement was occurring at that time.

A smaller, but significant zone of faults trends nearly at right angles to the Cane Spring system, through the northern Frenchman Flat area northwestward to Yucca Flat where it probably connects with a buried fault zone at the foot of the CP Hogback just south of Yucca Lake (fig. 3). This zone is not well defined on published maps and exposed displacements on it appear small, but several features suggest the zone has greater importance than exposures indicate. First, gravity contours (fig. 2) show a sharp bend in the area between French Peak and Puddle Peak, reflecting a major change in structural trends. The bend parallels northwest-trending faults of this zone that have been mapped. Second, the faults of the Cane Spring system show pronounced drag as they approach this zone (figs. 2, 3, and 4). This drag is consistent with a component of right-lateral movement on the northwest-trending zone. The attitude of the tuffs also conforms to this pattern, the strike swinging to east-west as the fault zone is approached (fig. 4). Curved cracks that have

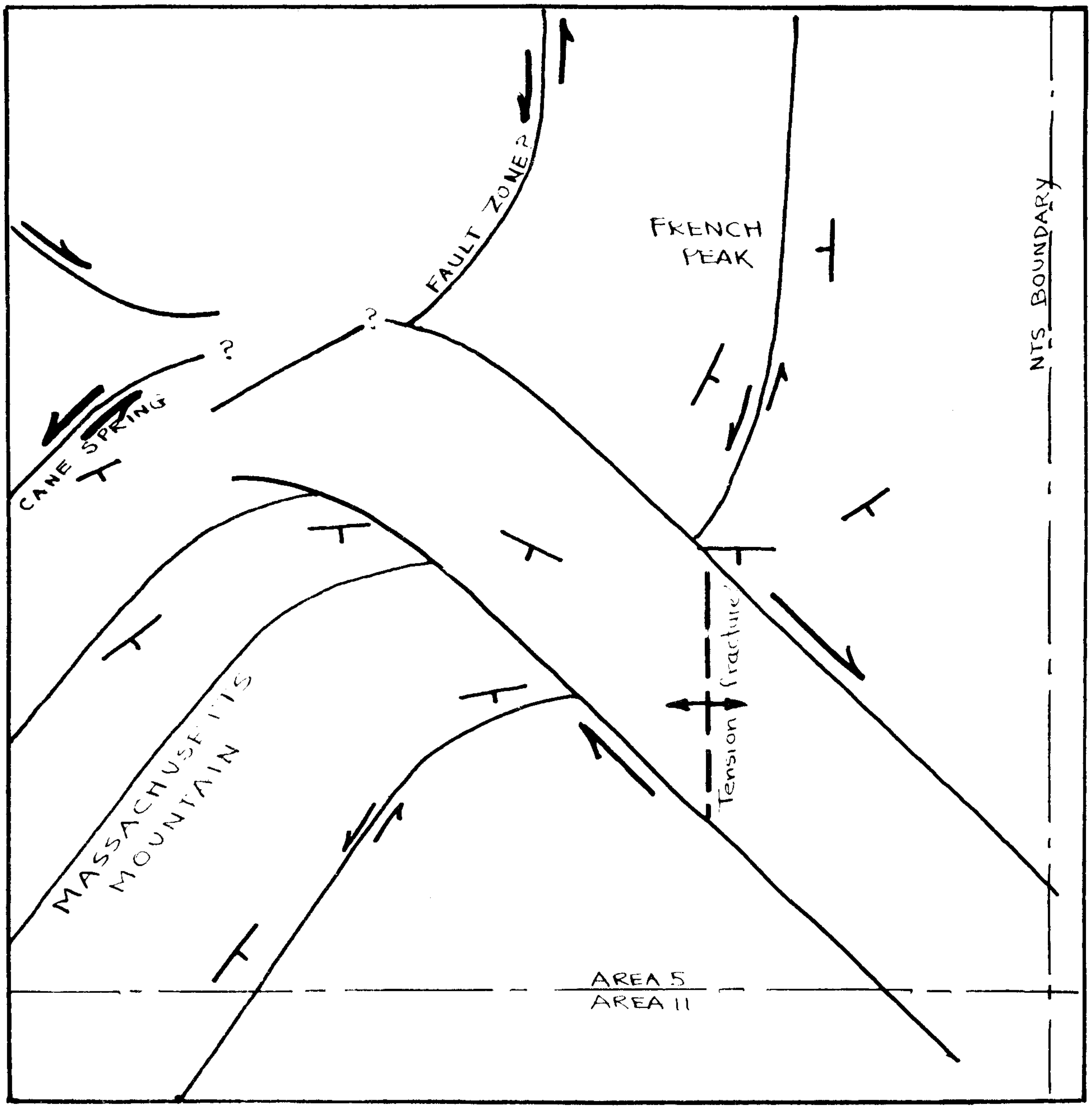

Figure 4.--Tectonic diagram of northwest perimeter of Frenchman Flat showing pattern of tuff attitudes and intersecting zones of strike-slip faults as described in text. Area shown is about 5 miles (8 km) across.

developed in Yucca Lake (fig. 3), including one that opened in 1963, have a trend that matches the drag of faults north of the northwest-trending zone. Explosion-induced fractures that were mapped at the surface at U11b and U5i have a north-northeast trend that coincides with the expectable trend for tension or extension fractures resulting from right-lateral movement on this zone. The fault found by drilling that cuts the basalt below the working point at U5i appears to have been propagated to the surface as a fracture, as a result of the test. A pretest trench at the side disclosed no fault in the alluvium. The dip of the fault is about 75° southeast. It is possible that enough stress exists in the alluvium, as a result of the tendency to right-lateral movement in the bedrock, to propagate fractures with a northerly trend from the tuff and older alluvium upward to the surface. Farther south, away from the northwest-trending zone, no fractures of this trend have been observed, but tests have not been conducted in this area. The trend of a subsurface fracture or fault in the alluvium in Uellc, which was seen by TV, has not been determined. The fracture does not appear to extend to the surface at present. Relative age of the Cane Spring fault zone and the postulated northwest-trending zone of right-lateral movement has not been determined, although mapping to date suggests that faults of each set are offset by the other. Eventually, it may be possible to show that the right-lateral zone joins the Yucca fault zone west of Yucca Lake. If so, the southeastward bending of the Yucca fault zone may be a form of drag on the left-lateral Cane Spring fault system.

A few reverse faults are present in these fault zones; one is shown on figure 2, half a mile northwest of Uella. A reverse fault is required by the repetition of part of the Ammonia Tanks in drill hole Ue5i.

The discontinuities detected by seismic surveys appear to be vertical displacements in the top of the higher velocity Tertiary or Quaternary alluvium and colluvium (fig. 2), mainly along faults with north to northeast trends. Most of these faults have 50 feet or less displacement, but a few may have as much as several hundred feet.

All known faults in the area that showed Holocene movement before testing trend about N. 50° E. These include the Cane Spring fault zone, a number of faults represented by scarps in the alluvium at the foot of the Ranger Mountains, several faults marked by scarps at the east end of Rock Valley, and a fault in the surface alluvium at the original drill site of U5i (figs. 2 and 3). These faults, almost without exception, are downdropped on the northwest. Many, if not all, of these Holocene faults represent renewed movement on previously established faults. Curved fractures in Yucca Lake, mentioned earlier, do not show any vertical movement, nor do the fractures in Frenchman Lake, which are probably desiccation cracks.

Other fractures cutting the younger alluvium will undoubtedly be found as work in Frenchman progresses. If such fractures are avoided in emplacement holes, and if sufficient thickness of alluvium is present, the fractures should not cause serious venting problems. In this connection, TV inspection of drill holes is extremely helpful in determining whether enlargement of holes is due to fractures or to changes in lithology.

As may be seen from figure 2, faults in the tuff probably contributed to the venting problem at U11b. Contaminants moving up through the fracture zones were not effectively sealed off by the thin alluvial cover. The presence of the top of the densely welded Topopah Spring Member not far below the shotpoint at U11b may have directed more than the usual amount of energy upward, contributing to fracture separation.

GEOPHYSICAL STUDIES

Gravity survey

Within the area of interest (fig. 1), gravity observations were made at bench marks or spot elevations shown on topographic maps, and at points where elevations were determined by plane table methods. Figure 2 shows Bouguer gravity anomaly contours at 1-milligal intervals.

The gravity method gives depths from the ground surface to the dense Paleozoic rocks that are buried by less dense alluvium and volcanic rock. With a sufficient number of interpreted depths it is often possible to map the configuration of the Paleozoic surface and delineate major faults and other structural features that may be present.

The reliability of interpreted depths in Frenchman Flat depends on our understanding of the contrast in density between the Paleozoic rocks and the overlying Tertiary and Quaternary alluvium and volcanic rock. Although the densities of Paleozoic rock range from 2.48 to 2.84 g/cc, the density of a very large mass of Paleozoic rock is considered to be relatively uniform and to average approximately 2.67 g/cc. The gross bulk densities of the overlying rocks are highly variable, depending on rock type. In the Massachusetts Mountain and Mt. Salyer area west of Frenchman Flat, 77 samples of volcanic rocks have bulk densities that range from 1.55 to 2.71 g/cc and average 2.22 g/cc. In drill hole Uellc of northern Frenchman Flat density log data show an average of 2.05 g/cc for 1,500 feet of alluvium. Available data thus indicate a density contrast of about 0.6 g/cc for the Frenchman Flat area, and figure 5 shows interpreted depths to Paleozoic rock based on this value.

A relatively small change in density contrast results in a significant change in depth. For example, an increase in contrast of 0.2 g/cc will decrease the maximum value of calculated depth at least 1,500 feet, or 38 percent. Figure 6 shows interpreted depths to Paleozoic rock based on a 0.8 g/cc density contrast. In Yucca Flat, where the density contrast is better known, the depth calculations that have been checked by drilling have an average error of about 17 percent.

The strong gravity gradients, shown in figures 2 and 3 along the southeast and northeast sides of Frenchman Flat, define the positions of major normal fault zones.

Magnetic surveys

Both aeromagnetic and ground magnetic surveys were made in the northern part of Frenchman Flat. Figure 7 shows the contoured aeromagnetic data from 12 aeromagnetic traverses flown across the area in an east-west direction, about 2,500 feet apart, at a barometric elevation of 8,000 feet. The ground magnetic data, also shown in figure 7, were measured at about 5-foot intervals with a rubidium

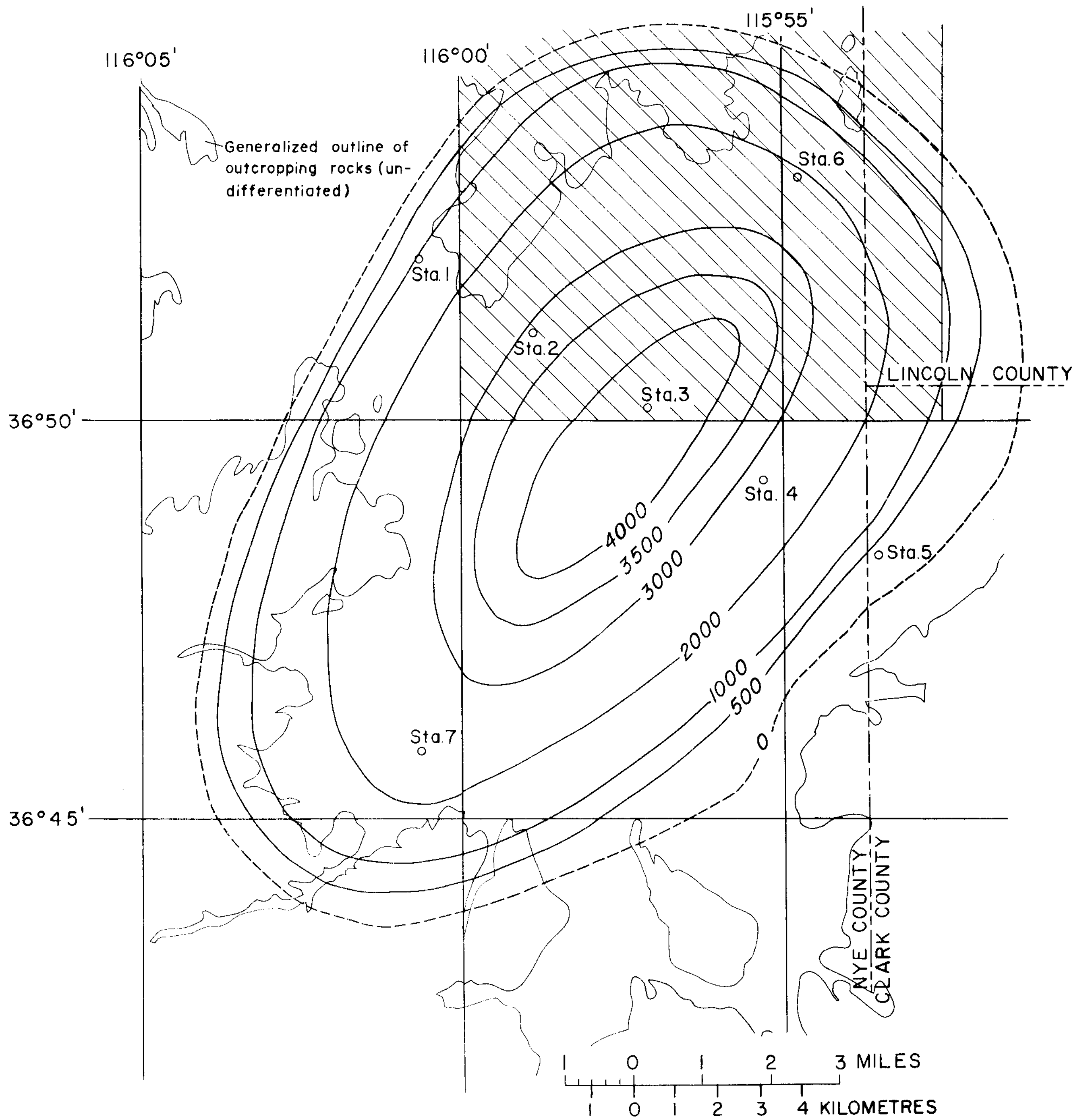

Figure 5.--Map showing approximate thickness of alluvium and volcanic rocks overlying Paleozoic rocks in Frenchman Flat if density contrast is assumed to be 0.6 g/cc. Area of figure 2 is shaded.

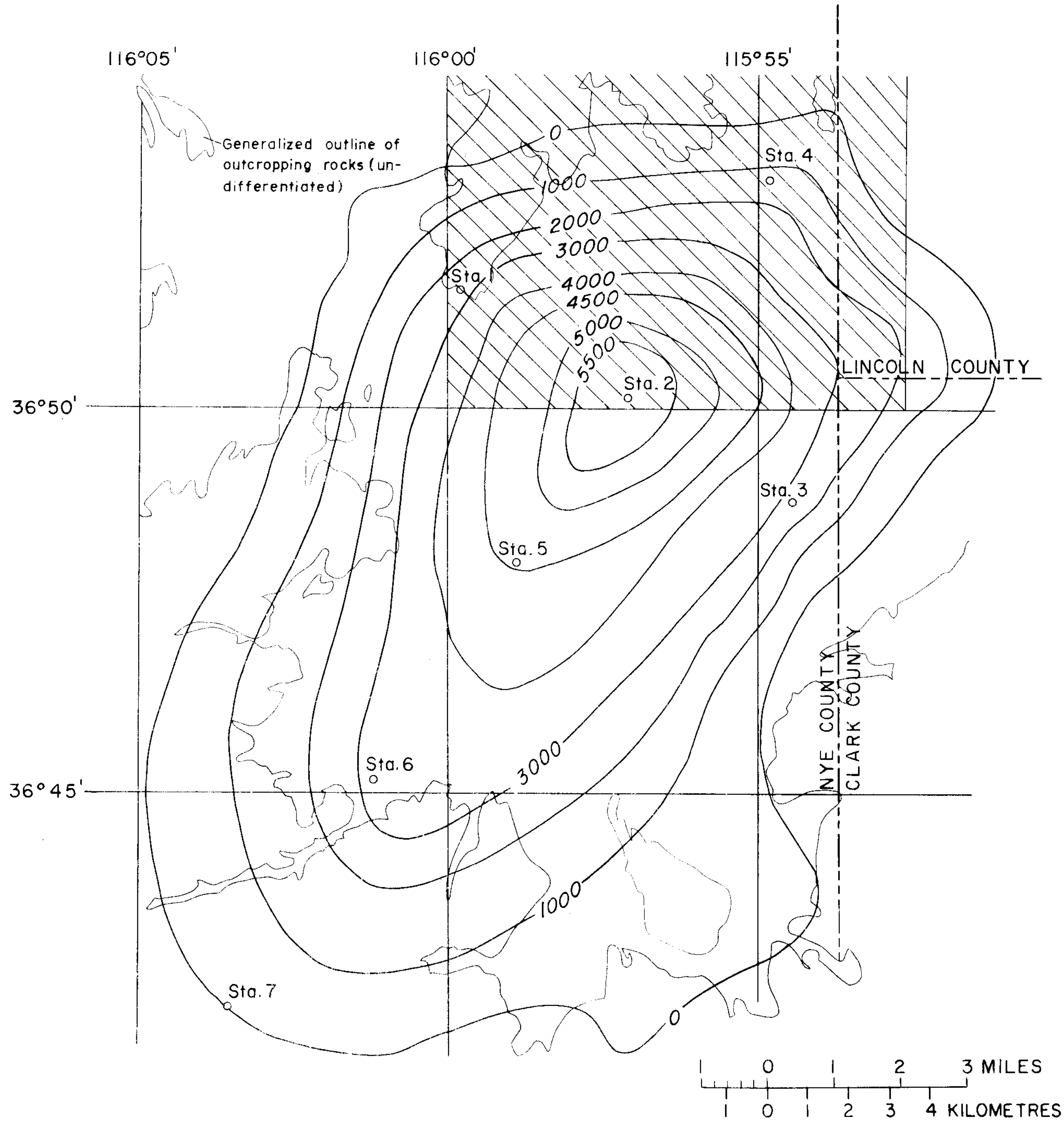

Figure 6.--Map showing approximate thickness of alluvium and volcanic rocks overlying Paleozoic rocks in Frenchman Flat if density contrast is assumed to be 0.8 g/cc. Area of figure 2 is shaded.

magnetometer carried 5 feet above the ground surface along 11 traverses. The ground survey was undertaken after the start of the drilling program, and the irregular pattern of traverse lines resulted from the necessity of avoiding areas where steel and iron installations produced large magnetic disturbances.

In the Frenchman Flat area the magnetic method outlines the more magnetic volcanic flows that are buried beneath alluvium or nonmagnetic volcanic rock, and the method provides approximate depths from the ground surface to the edges of these flows. Magnetic surveys also help to identify the anomaly-producing rocks. For example, positive anomalies are expected from the normally magnetized basalt flows found in drill holes Ue5i and Ue5k, and negative anomalies are expected from the reversely magnetized ash-flow tuff of the Rainier Mesa Member of the Timber Mountain Tuff.

Depths to the edges of buried anomaly-producing units are calculated from anomaly wave lengths. Depth error is assumed to be within 20 percent where the general strike of the edge of the unit is known. Where data are sparse and come from irregularly spaced traverses, as in the Frenchman Flat survey, some of the reported depths undoubtedly are in error more than 20 percent. The following table (Table 2) gives the computed depths to edges of several features within the area of the ground survey. The lettered-edge locations are shown in figure 7.

The rather subtle aeromagnetic anomalies of figure 7 show the general positions of the prominent positive anomalies found in the ground survey over basalt, and the prominent negative anomaly found over the

Table 2.--Estimated depths to buried anomaly-producing units in northern Frenchman Flat as computed from ground magnetic surveys

Location of edge as shown in figure 7 (compare fig. 2)	Feature	Depth, in feet	
		Computed from ground magnetic surveys	Actual and projected from drill hole data
	Basalt found in Ue5i		
A	West edge	950	850
B	North edge	1/ >700	900
C	East edge	800	900
	Basalt found in Ue5k		
D	Northwest edge	800	950
E	Northwest edge	1,000	
F	West edge	1/ >900	
	Outlier of basalt?		
G	West edge	650	
	Edge of magnetization contrasts 2/ within Rainier Mesa Member		
H	South edge	700	>850
I	Northwest edge	850	
J	South edge	640	
K	North edge	400	
L	Northeast edge	240	250
	Magnetized rocks that are near the surface		
M	Ammonia Tanks Member ash flow	15	
N	Ammonia Tanks Member ash flow	100	
O	Ammonia Tanks Member ash flow	3/ 250	
P	Rainier Mesa Member ash flow	3/ 300	

1/ Insufficient data to determine full wave length of anomaly.
2/ Magnetization contrast within Rainier Mesa Member may be caused by abrupt thickening of flow, vertical displacement due to faulting, or abrupt change from welded to nonwelded facies.
3/ Possible overestimate; strike data for edge lacking.

Rainier Mesa Member ash flow on the western part of ground traverse, line 8. The aeromagnetic datum is about 4,500 feet above the ground surface, and therefore the anomaly amplitudes are greatly attenuated and anomaly positions are somewhat displaced.

Seismic surveys

The U.S. Geological Survey has directed the National Geophysical Company in a seismic survey of seven refraction traverses and four reflection traverses in northern Frenchman Flat. Figure 2 shows the location of the seismic traverses made by the National Geophysical Company, Inc. (now Teledyne Exploration, written commun., 1966), and summarizes the U.S. Geological Survey's interpretation of the results in terms of displacement of a velocity-change interface within the alluvium.

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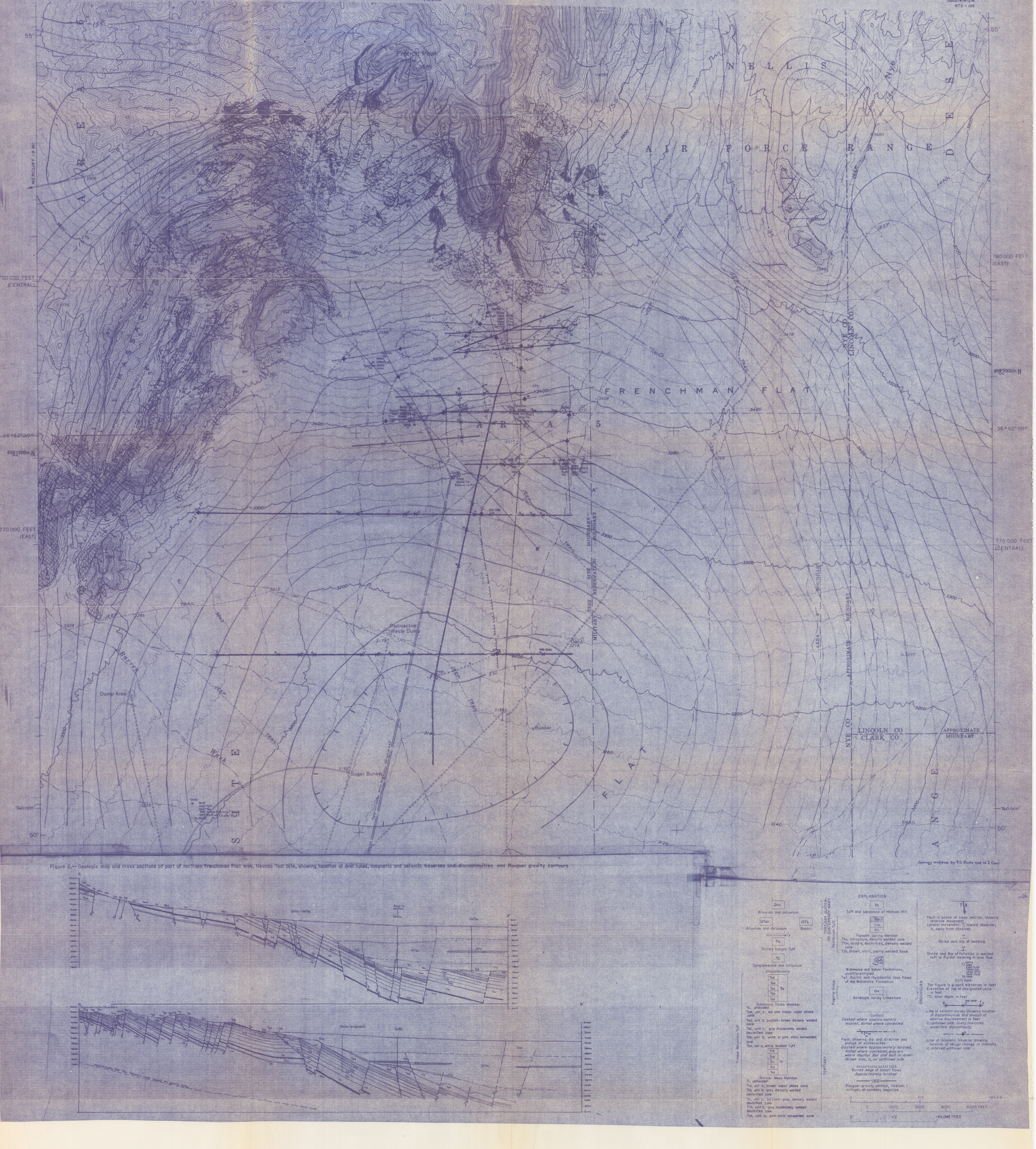

Figure 2.--Geologic map and cross sections of part of northern Frenchman Flat area, Nevada Test Site, showing location of drill holes, magnetic and seismic traverses and discontinuities, and Bouguer gravity contours

Figure 3.- Tectonic map of the southeastern part of Nevada Test Site

Complete Bouguer gravity contours by D.L. Healey

830-219 Pocket 100%

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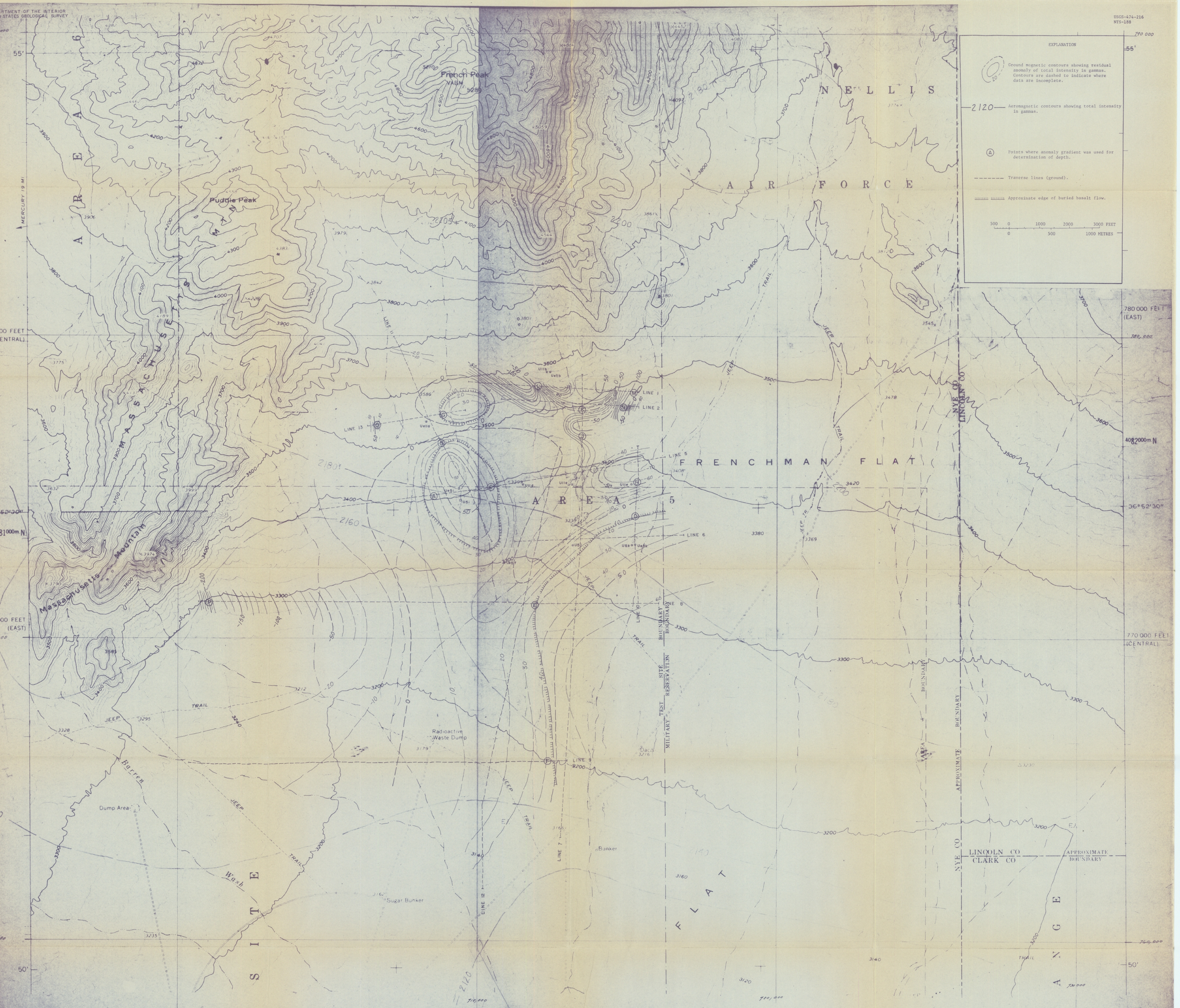

FIGURE 7.–TOTAL INTENSITY AEROMAGNETIC AND RESIDUAL GROUND ANOMALY MAP OF THE NORTHERN PART OF FRENCHMAN FLAT. AEROMAGNETIC DATA TAKEN ALONG TWELVE FLIGHT TRAVERSES, AND GROUND DATA TAKEN AT 5-FOOT INTERVALS WITH RUBIDIUM MAGNETOMETER CARRIED 5 FEET ABOVE THE GROUND SURFACE ALONG ELEVEN TRAVERSES