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Geology of Souse Springs Quadrangle, New Mexico

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Preface

The geologic investigation of the Souse Springs quadrangle was undertaken as part of a broader project calling for the detailed, systematic, geologic mapping of the Rio Grande trough and adjacent uplifts between the Caballo Mountains to the north and Las Cruces to the south, initiated in 1966 by W. R. Seager and J. W. Hawley. Prior to that time the only existing maps of this area, other than the state geologic map, were the Reconnaissance Geologic map of the Las Cruces 1:62,500 quadrangle (Kottlowski, 1960), and page-size maps in a New Mexico Geological Society guidebook (Kottlowski, 1953). The first two maps in this program, the San Diego Mountain area and Rincon quadrangle, are now completed (Seager, Hawley, and Clemons, 1971; Seager and Hawley, 1973, in press).

We started field work in the Souse Springs quadrangle in the winter of 1969. Work was continued during 1970 and 1971, and completed during the fall of 1971. The geologic map was made, in the field, on the U.S. Geological Survey topographic map of the Souse Springs quadrangle, and areal photos at a scale of about 1:31,000. Stratigraphic sections were measured by using a Brunton compass and Jacob's staff. Classification of ash-flow tuffs is after Cook (1965).

In presenting the geology of the Souse Springs quadrangle, we have established and extended correlations of rock units of the southern Caballo Mountains, Rincon Hills, and San Diego Mountain areas with the rock units in the Sierra de las Uvas. Thicknesses of Bell Top Formation and Uvas Basaltic Andesite rock units were measured, and probable source areas for some of these units have been determined.

Evidence for the origin of the principal structural features in the Souse Springs quadrangle is inconclusive, and we intend to interpret the rock structure beneath the volcanic and bolson cover when additional work is completed in adjacent areas.

This bulletin provides information essential in mineral exploration, ground-water studies, land-use studies, and general economic development. Evidence was not found in the Souse Springs quadrangle for barite-fluorite-manganese mineralization similar to that known to the east and northeast.

We are grateful to New Mexico Bureau of Mines and Mineral Resources, under the directorship of Don H. Baker, Jr., for sponsoring this work. The Bureau also provided about 100 thin sections, making possible the petrographic study of all the rock units; and two new K-Ar age determinations from rocks in the Souse Springs quadrangle. We want to especially thank Frank E. Kottlowski, assistant director of the Bureau, for his interest, encouragement, and suggestions concerning the overall project. His contributions have added significantly to the value of this report. Our thanks to the Research Center of New Mexico State University for partial financial support during 1969-70. Special thanks are also due to John W. Hawley for his freely offered knowledge and suggestions concerning the Cenozoic geology of the region. Finally, we thank W. Cothern and other ranchers of the area in kindly allowing access to the lands under their supervision to make field mapping possible.

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REAR POCKET

Abstract

The Souse Springs 71/2 minute quadrangle in northwestern Dona Ana County, New Mexico, includes the major part of the Sierra de las Uvas. Broadly domed and faulted volcanic rocks and interbedded clastic sedimentary rocks of middle Tertiary age are unconformably overlain by late Tertiary and Quaternary clastic sedimentary rocks. Only along the eastern side of the quadrangle are older rocks exposed by uplift, westward tilting and erosion.

Oldest rocks exposed in the quadrangle are the upper part of the Palm Park Formation (probably Eocene) unconformably overlain by the Bell Top Formation (Oligocene) which is subdivided into 6 ash-flow tuff units, a basalt flow, and 2 sedimentary units. Flows of Uvas Basaltic Andesite (Miocene) interfinger with the upper sedimentary member. Thickness and number of flows in the Uvas decrease radially away from the crest of the Sierra de las Uvas. The upper part of the Bell Top and the Uvas correlate with the lower half of the Thurman Formation to the northeast. Graben-fill fanglomerates and interbedded, reddish, basin-floor clastics, derived mainly from the Sierra de las Uvas, comprise the Rincon Valley Formation (Miocene? and Pliocene) which unconformably overlies the Uvas flows. The Rincon Valley Formation is, in turn, unconformably overlain by the Camp Rice Formation (Pleistocene). The Camp Rice is composed of fanglomerates, piedmont gravels, and finer basin facies, that overlap or grade in adjacent areas to fluvial sandstones deposited by the ancestral Rio Grande.

Several source areas for the Uvas Basaltic Andesite occurring in the quadrangle are located in complex, faulted grabens axial to the Sierra de las Uvas Dome. Source areas for several members of the Bell Top were probably in the Cedar Hills, southeast of the quadrangle. Late Tertiary faulting uplifted the Sierra de las Uvas range and resulted in tilting of the Uvas Dome to the northwest.

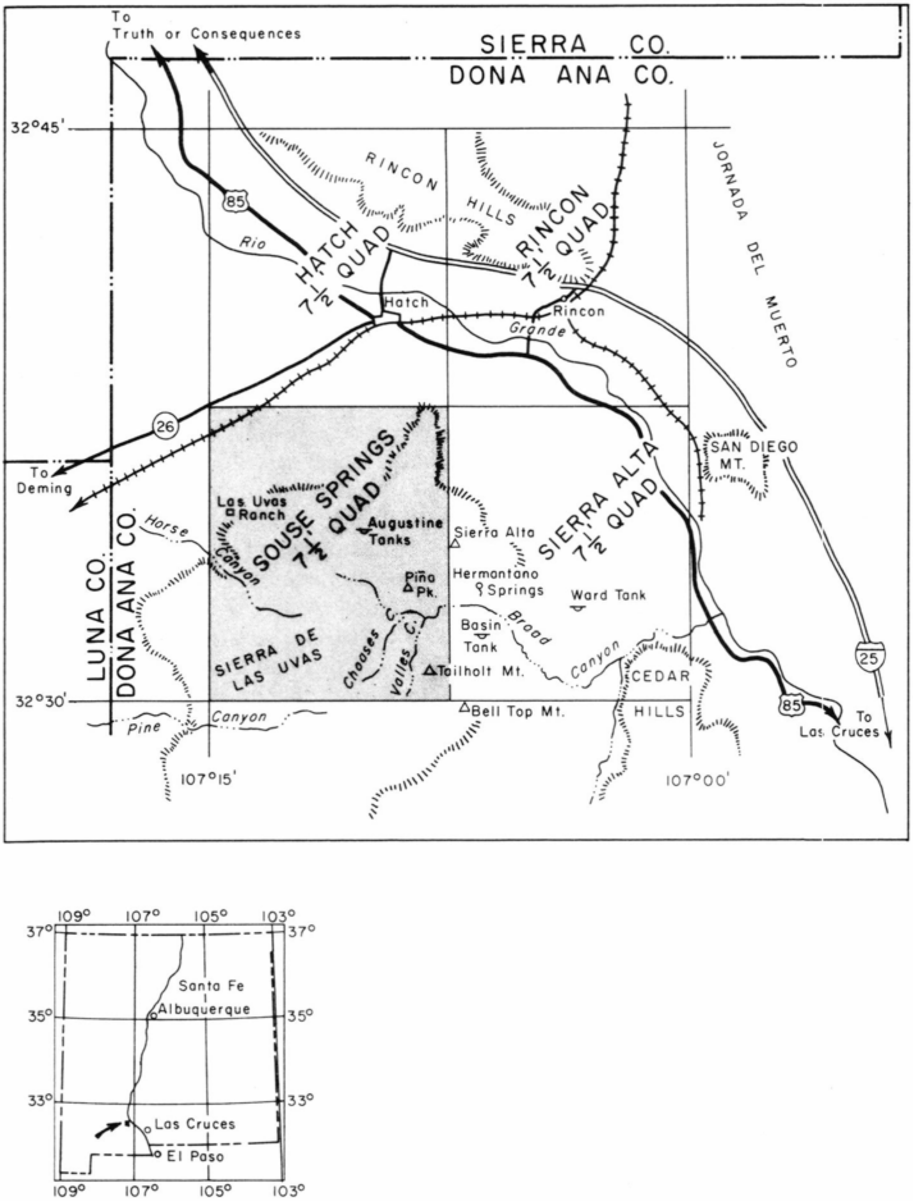

FIGURE 1 – *Index map showing location of study area in region.*

Introduction

The Souse Springs quadrangle is located in northwestern Dona Ana County two miles south of Hatch (fig. 1). The Atcheson, Topeka and Santa Fe Railroad from Hatch to Deming crosses the extreme northwest corner of the quadrangle. Water supplies are very limited and the rocky terrain supports a sparse cover of grass, cacti, and creosote bush. Few juniper trees exist at higher elevations. Principal use of the land is for grazing. The only place presently inhabited is the Las Uvas Ranch in the northwestern corner of the quadrangle. Light duty and unimproved dirt roads and jeep trails to scattered tanks and windmills provide access to most areas. The major part of the Sierra de las Uvas occurs in the quadrangle, and also extends into the Sierra Alta, Corralitos Ranch, and Nutt quadrangles to the east, south, and west, respectively. Elevations within the quadrangle range from about 4,320 ft along the northwestern edge to 6,500 ft on Mesa Azur on the south central edge. Local relief of 700 to 1,000 ft is common in the canyons through the southern and eastern parts of the quadrangle.

Stratigraphy

Rock units exposed in the Souse Springs quadrangle range in age from late Eocene (?) to Recent (fig. 2). Mapped in the quadrangle are five formations having a composite stratigraphic thickness of about 2,800 ft, not including the lowermost formation of which only the upper part is exposed. The Bell Top Formation is divided for the first time into 9 members described informally in this report. Four of these members, plus the overlying Uvas Basaltic Andesite, comprise the lower half of the Thurman Formation to the northeast (fig. 2).

PALM PARK FORMATION

The Palm Park Formation was originally defined by Kelley and Silver (1952) in the southern Caballo Mountains. Dunham (1935) and Darton (1928) briefly mentioned these rocks in the southern Caballos and Sierra de las Uvas, respectively. Seager and others (1971) described in detail the Palm Park Formation exposed in the San Diego Mountain area.

Limited exposures of the upper part of the Palm Park Formation occur near the southeast and northeast corners of the study area along the eastern side of the Sierra de las Uvas. Due to the nonresistant nature of the rocks, they are only exposed where gullies have cut into the soft slopes, or in arroyo bottoms. Much more extensive outcrops are contiguous to the southeast into the Sierra Alta and Corralitos Ranch quadrangles. The Palm Park is overlain by Bell Top Formation in the southeast corner of the quadrangle; the lower Palm Park is downfaulted and not exposed. In the northeast corner Palm Park is in fault or intrusive contact with all younger rocks except where unconformably overlain by the Camp Rice Formation and younger alluvium. Consequently, the thickness of the Palm Park Formation in the Souse Springs quadrangle is unknown. An estimated 200 to 300 ft are exposed.

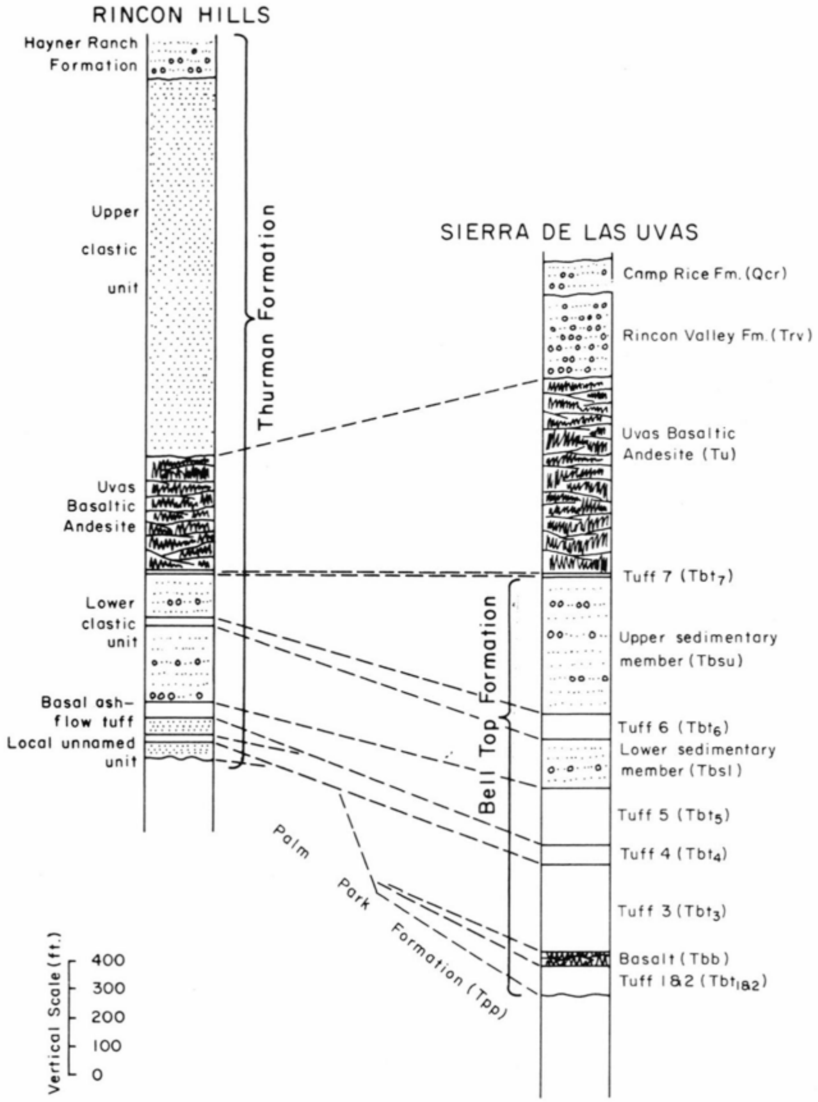

FIGURE 2—*Correlation of Thurman Formation of Rincon Hills with Bell Top Formation and Uvas Basaltic Andesite of Sierra de las Uvas.*

The Palm Park consists primarily of light-colored, friable, tuffaceous mudstone, sandstone, and conglomeratic sandstone. The rocks are characteristically poorly sorted and contain very angular to well-rounded grains of quartz, plagioclase, and volcanic rock fragments, as well as vitric ash. Bedding is poor and discontinuous with beds ranging in thickness from a few inches to several feet. Light shades of gray, pink, purple, and red predominate with some of the more tuffaceous, very fine grained sandstone beds being white. Slope debris associated with the Palm Park exposures in the Souse Springs quadrangle contains some subrounded to well-rounded pebbles and cobbles of andesite and latite weathering out of conglomerate lenses in the Palm Park. On the south slope of Bell Top Mountain, about 0.5 mile southeast of the southeast corner of the Souse Springs quadrangle, cobble and boulder conglomerate lenses occur in the upper Palm Park. Rounded to well-rounded porphyritic hornblende andesite and latite debris make up the bulk of this typical channel-fill conglomerate.

BELL TOP FORMATION

The Bell Top Formation was defined by Kottlowski (1953b) as more than 800 feet of "pumice, soft pink rhyolite tuffs, vitrophyre flows and dikes, banded rhyolite flows and domes interbedded with light-colored pumiceous and tuffaceous sandstones and a few lenses of stream gravels." The type locality is designated as Bell Top Mountain at the north-central edge of the Corralitos Ranch quadrangle. Some of the lithologies in the original description are not present at this locality, but are exposed to the east in the Sierra Alta quadrangle. Actually, only the lower part of the Bell Top Formation is present at Bell Top Mountain, but continuous outcrops to Choases Canyon provide excellent correlation and make possible a complete composite section of the Bell Top (fig. 3), which we consider to be the "composite type section" and "composite type locality." These rocks were also briefly mentioned by Darton (1928) and Dunham (1935).

In the Souse Springs quadrangle, the Bell Top Formation consists of ash-flow tuffs, tuffaceous clastic rocks, and a basalt flow. We have subdivided the formation into nine informal members. From oldest to youngest, they are: 1) tuff 1 & 2, 2) basalt, 3) tuff 3, 4) tuff 4, 5) tuff 5, 6) lower sedimentary member, 7) tuff 6, 8) upper sedimentary member, and 9) tuff 7. Thus the base of the Bell Top is the bottom of the lowest ash-flow tuff, and the top of the Bell Top is the top of the uppermost ash-flow tuff, or where tuff 7 is missing, the top of the upper sedimentary member.

The age of the Bell Top Formation is considered to be Oligocene on the basis of two K-Ar dates of 34 m.y. and 35 m.y. on tuff 5 member, and a K-Ar date of 26 m.y. on a basal Uvas flow.

TUFF 1 & 2 MEMBER

The only exposures of the basal member of the Bell Top Formation in the Souse Springs quadrangle are northwest and east of Tailholt Mountain in the southeast corner of the quadrangle. It is chiefly a slope-forming unit and typically poorly exposed except in gullies and steeper walls of recently cut arroyos. In Valles Canyon, along the western side of sec. 34, T. 20 S., R. 3 W., tuff 1 & 2 rests on Palm Park tuffaceous sandstone and is overlain by the basalt member. Tuff 1 & 2 is exposed with Palm Park in landslide blocks east of Tailholt Mountain. At this locality tuff 3 rests on tuff 1 & 2 where the basalt pinches out just east of the

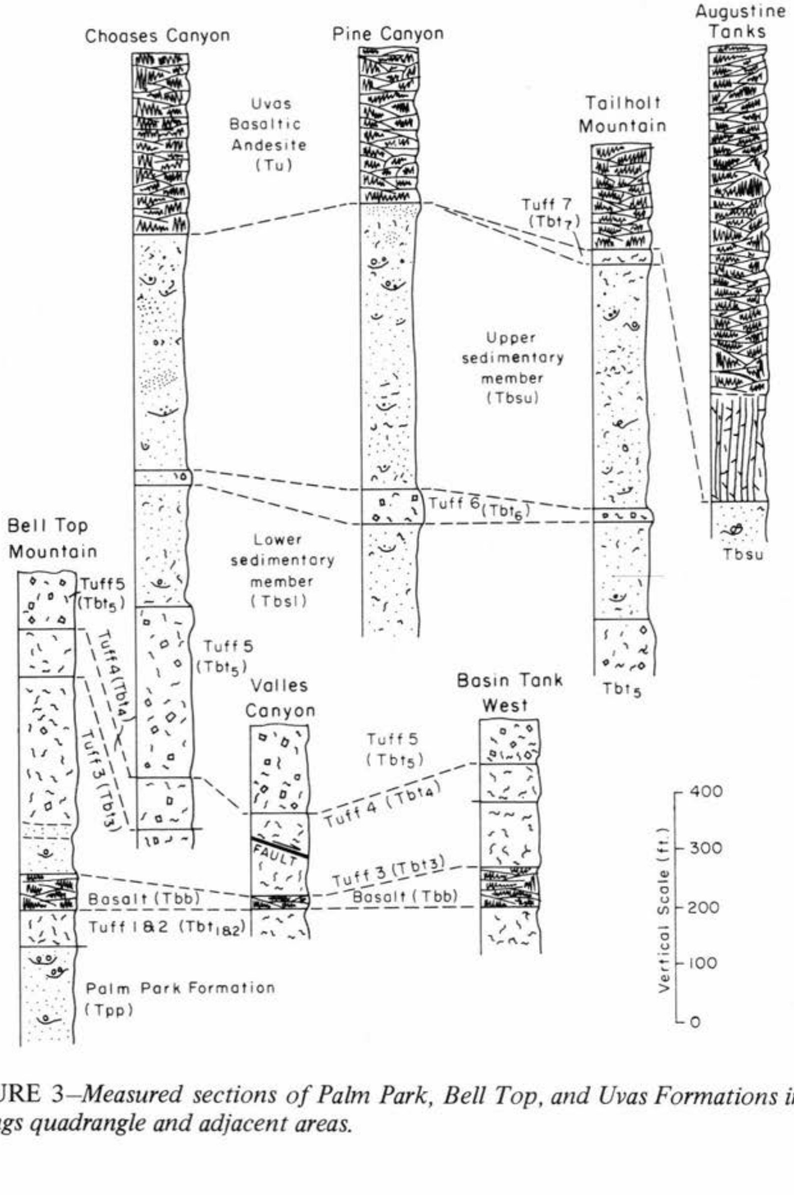

FIGURE 3–*Measured sections of Palm Park, Bell Top, and Uvas Formations in Souse Springs quadrangle and adjacent areas.*

quadrangle. In the SE 1/4 sec. 33, T. 19 S., R. 3 W., in the northeast corner of the quadrangle, tuff 4 rests directly on Palm Park, and the three lower members of the Bell Top are missing.

Southwest of Bell Top Mountain, and at one place in Valles Canyon, the basal member of the Bell Top Formation appears to possibly contain two separate ash-flow tuffs. They may be a multiple cooling unit because both are lithologically very similar, yet distinct from any of the other ash-flow tuffs in the area; hence naming them tuff member 1 & 2. This member varies in thickness but is generally about 70 to 90 ft. It is a pale red-purple, highly welded vitric ash-flow tuff with well-developed eutaxitic texture. Crystal fragments of shiny golden biotite and plagioclase can be seen in most specimens, but are generally less than 1 mm in diameter and make up less than 5 percent of the rock. Small (1 to 3 mm) white pumice fragments give the rock a mottled appearance. The rock is slightly porous and soft even though well indurated. A few spherulitic zones near the top of the unit at Bell Top Mountain contain spherulites averaging about 0.25 inch in diameter.

BASALT MEMBER

The basalt member of the Bell Top Formation is exposed in just two places in the Souse Springs quadrangle, in secs. 34 and 35, T. 20 S., R. 3 W., north and northeast of Tailholt Mountain. It is also exposed along Broad Canyon in the southwest part of the Sierra Alta quadrangle, and to the south in the north-central part of the Corralitos Ranch quadrangle. Thickness varies from 0 to 62 ft. It is partly covered by talus on the slopes but may be easily recognized from a distance as a dark band in the otherwise light-colored ash-flow tuffs and sandstones (fig. 4). The presence of similar thicker basalt flows and intrusives in the same stratigraphic position in the Cedar Hills suggests that the vent from which the basalt erupted is located in the Cedar Hills.

The basalt is olivine-bearing, grayish black, and very fine crystalline. The lower half to two-thirds of the flow is dense and breaks with a sharp, hackly fracture. Horizontal, platy joints resembling bedding are common. The upper part is vesicular, and scoriaceous on the upper surface. Locally, the upper part also contains a brownish-black flow breccia composed of 1- to 2-inch fragments. Olivine phenocrysts 0.5 to 2 mm in diameter make up less than 4 percent of the rock. They are embedded in an intersertal matrix of labradorite (An_{65-70}) laths, up to 0.15 mm in length, smaller pyroxene grains, iron oxide, and brownish glass.

TUFF 3 MEMBER

Ash-flow tuff 3 crops out only in the southeastern corner of the Souse Springs quadrangle and contiguous areas to the east and south. It rests disconformably on the basalt member, or where that unit is missing, directly on tuff 1 & 2. The tripartite nature of this unit is quite evident in most exposures—a cliff-former between two slope-formers—mostly the result of better, more dense, welding in the central part; but the lower part at Bell Top Mountain also includes up to 65 ft of poorly consolidated clastic sedimentary rocks which form slopes. Preliminary studies in the Cedar Hills area to the east indicate that the vent(s) from which ash-flow tuff 3 was erupted are probably located there. Dikes and intrusive masses of apparently identical rock having the same stratigraphic position can be traced laterally into the ash-flow tuff unit.

This member is a grayish orange-pink, poorly to moderately highly welded, vitric ash-flow containing up to 20 percent pale-red, flattened pumice fragments

FIGURE 4—*View over southeast corner of Souse Springs quadrangle. Lower slope just north of where road swings westward is Palm Park; Bell Top Formation rocks form hills in foreground and middle of photo; broadly domed Uvas Basaltic Andesite caps ridges in background.* (photo by James Cuffey)

as much as 4 inches in length and 1 inch thick. The upper and lower parts are very porous and even the central part, which has poorly developed, large, columnar joints on the cliff faces, is slightly porous. It also contains up to 8 percent, but usually less, small (less than 1.5 mm) crystal fragments of quartz, sanidine and biotite. The shards are devitrified and show axiolitic structure. A 25-ft thick, light pinkish-gray, sandy, vitric-crystal tuff underlies the cliff-forming zone at Bell Top Mountain.

TUFF 4 MEMBER

Ash-flow tuff 4 crops out in the southern, northeastern, and north-central parts of the quadrangle. It rests disconformably on tuff 3 wherever the base is exposed. It appears to fill a broad shallow depression in tuff 3 on the south slope of the cuesta north of Tailholt Mountain, indicating either an irregular surface on top of tuff 3, or, more likely, erosion preceding the deposition of tuff 4. In the northeast corner of the quadrangle, tuff 4 was deposited on Palm Park, and the lower tuffs were eroded or not deposited there. All lower tuff members, including tuff 4, thin to the north so nondeposition is a strong possibility. Tuff 4 ranges in thickness from 60 to 90 ft within the Souse Springs quadrangle, and pinches out in the basal Thurman Formation northeast of Hatch (Seager and Hawley, 1973, in press). A tentative correlation with a similar-appearing, much thicker, ash-flow tuff 6 miles down Broad Canyon to the east, suggests the source vent for this unit is in the Cedar Hills area.

Tuff 4 is a grayish red-purple, highly welded, dense, vitric-crystal ash-flow tuff containing abundant pale red, devitrified, flattened, pumice fragments. Some of the pumice fragments are up to 1 ft in length, but average about 1 inch. Small (less than 1.5 mm) crystal fragments of biotite, plagioclase, and sanidine comprise up to 15 percent of the rock. Glass shards show a well-developed eutaxitic texture and are especially compressed around crystal fragments. The upper two-thirds of the unit is very dense and a cliff-former. It grades downward into highly welded, crumbly, porous zone that is predominantly a slope-former. Locally, a similar but poorly welded thin layer occurs at the top of the member.

TUFF 5 MEMBER

Excellent exposures of tuff 5 are present in the eastern quarter and near Souse Springs in the north-central part of the quadrangle. Most extensive exposures are in the southeastern corner and excellent sections are exposed in Valles and Choases Canyons where streams have cut through the member forming near-vertical walls 100 to 150 ft high. It caps many of the hills, and forms dip slopes on predominantly northwest-trending cuestas. Within the Souse Springs quadrangle tuff 5 is generally about 150 to 300 ft thick.

Ash-flow tuff 5 is a pale red-purple to grayish-pink, moderately to highly welded, crystal-vitric ash-flow tuff with abundant soft, white, pumice fragments. Pumice fragments are generally less than an inch in diameter but a few are up to 3 inches in length where flattened in the middle and lower parts of the member. Biotite, euhedral quartz, sanidine, and plagioclase crystal fragments up to 5 mm across make up about 30 percent of the rock and are conspicuous in hand specimens. In thin section, these crystal fragments are seen embedded in a devitrified groundmass with few shards visible. The lack of abundant visible shards distinguishes this member from the other ash-flow tuffs in the quadrangle. The upper part of the member is porous, crumbly, and poorly welded, gradational downward into denser, highly welded tuff which has large, poorly developed, columnar joints.

A pale-red, dense, highly welded, vitric-crystal ash-flow tuff forms the uppermost part of the member near the confluence of Choases and Valles Canyons. The uppermost unit differs from typical ash-flow tuff 5 in being denser and more resistant, having smaller and darkened pumice fragments, containing fewer plagioclase crystals, and containing abundant devitrified shards with axiolitic structure. Actually, it resembles ash-flow tuff 6 much more than ash-flow tuff 5, but rests on the latter and definitely underlies the lower sedimentary member. Tuff 6 is above the lower sedimentary member. This particular vitric-crystal ash-flow was not seen elsewhere.

Ash-flow tuff 5 is extensively exposed to the southwest in the Corralitos Ranch quadrangle, and to the east in the Cedar Hills. In the Southern Caballo Mountains, in the Rincon Hills, and at Point of Rocks, ash-flow tuff 5 is the conspicuous ash-flow tuff at the Base of the Thurman Formation. This member covered at least 475 square miles in the Sierra de las Uvas-southern Caballo area, and possibly much more. It thins from about 300 ft in the Sierra de las Uvas to about 8 ft in Apache Canyon near Caballo Reservoir. Tuff 5 is not present in the Rough and Ready Hills to the southeast where tuff 6 rests directly on tuff 3. Tuff 5 may have covered this area originally, but was eroded possibly during the time the lower sedimentary member was being deposited. The whole Bell Top Formation is thin or missing in the Goodsight Mountains, west of the Sierra de las Uvas; to date ash-flow tuff 5 has not been recognized in the Goodsight Mountains. If it once covered this area, it was eroded prior to deposition of the Uvas Basaltic Andesite.

Potassium-argon dates of 34 m.y. for the basal Thurman ash-flow tuff (Kottlowski and others, 1969) and 35 (± 1.3) m.y. for ash-flow tuff 5 (Kottlowski, written communication, 1970) indicate that tuff is Oligocene. A K-Ar date of 39.4 (± 1.5) m.y. recently obtained for ash-flow tuff 1-2 (Kottlowski, written communication, 1973) indicates that the bulk of the Bell Top Formation was deposited during Oligocene time.

LOWER SEDIMENTARY MEMBER

Tuff 5 is overlain by about 200 ft of light-colored tuffaceous siltstone and sandstone containing some conglomerate lenses comprising the lower sedimentary member. It is best exposed along the upper part of Pine Canyon (fig. 5) in the northwest corner of the Corralitos Ranch quadrangle; its base is not exposed here. Good exposures are also present in Road Canyon, south of Piña Peak (Appendix, Choases Canyon section). Other partial sections are exposed at Tailholt Mountain, northeast of Sugarloaf ***Peak,*** in Horse Canyon, and along the northwestern edge of the Sierra de las Uvas. Exact relations with underlying tuff 5, and overlying tuff 6, are uncertain due to very limited and poor exposures of the contacts.

The tuffaceous sandstone and siltstone, for the most part, are poorly bedded and are pale yellow brown to pale grayish orange. Massive units up to 30 to 40 ft thick may not show any indication of bedding. Locally, siltstone and fine sandstone is thin to medium bedded. The rocks are chiefly poorly sorted vitric volcanic arenites composed of fresh angular plagioclase, quartz, sanidine, and ash-flow tuff fragments in a matrix of devitrified shards and clay. Some specimens examined had a calcitic cement and were more indurated than the typical porous, friable rocks which erode easily to form low-angle slopes. The rocks are intensely fractured and 2- to 6- inch fragments form a thin talus veneer on slopes as they break from the outcrop. The conglomerate lenses appear to be channel fills composed predominantly of rounded ash-flow tuff pebbles and cobbles with poorly sorted fine to coarse sand matrix. Some of the massive fine-grained beds also contain few randomly scattered ash-flow tuff pebbles. White to light-gray pumice fragments give some of the units a mottled appearance and are responsible for the coarse-pitted surface when weathered from outcrops. Pumice fragments do not, however, appear to be as abundant as in the upper sedimentary member.

TUFF 6 MEMBER

Ash-flow tuff 6 is a resistant ledge- and bench-forming unit (fig. 5) exposed throughout much of the quadrangle, generally in lower to middle slopes of hills capped by Uvas flows. Thickness varies from about 25 ft at Tailholt Mountain to 65 ft in Horse Canyon and west of Sugarloaf Peak (Appendix, Pine Canyon section). Southeast of the Las Uvas Ranch, thickness is about 100 ft. Extensive exposures of tuff 6 are contiguous into the northwestern part of the Corralitos Ranch quadrangle where the member caps prominent northwest-dipping cuestas (fig. 5). Apparently tuff 6 conformably overlies the lower sedimentary member because of a lack of relief on the contact over miles of lateral exposure.

Tuff 6 member is a pale-red to grayish-red-purple, highly welded, vitric-crystal ash-flow tuff containing abundant light-gray, flattened pumice fragments up to 4 inches in length. The upper 5 to 10 ft are darker colored and possess ubiquitous subconchoidal fractures in dense, resistant rock. This zone grades downward into a less dense, slightly porous, crudely columnar-jointed, cliff-forming zone. The basal 4 to 6 ft are poorly welded to nonwelded, porous, crumbly ash which is seldom exposed but can be seen in a gully southeast of Blanco Tank in the northeastern part of the quadrangle. Here crystal fragments can be picked out of unconsolidated vitric ash. Crystal fragments of sanidine, quartz, biotite, and plagioclase, comprising 15 to 20 percent of the tuff are readily visible in hand specimens.

UPPER SEDIMENTARY MEMBER

Ash-flow tuff 6 is conformably overlain by 200 to 500 ft of light-gray to reddish-brown tuffaceous sandstone and conglomerate. These clastic sedimentary rocks comprise the upper sedimentary member, which is the most widely exposed member of the Bell Top Formation in the Souse Springs quadrangle. This member underlies most of the high slopes and ridges capped by more resistant Uvas Basaltic Andesite (figs. 4 and 5). In the few places where the Uvas has been completely eroded, a rounded, hummocky topography is formed on the upper sedimentary member. Although the thickness of the sediments is quite variable locally, overall, thickness increases south and southeast. This thickening coincides with an increase in the number of coarse conglomerate beds and the amount of flow-banded rhyolite debris in the conglomerate. All these factors seem to indicate that the main source for the upper sedimentary member was the area of flow-banded rhyolite domes now exposed in the Cedar Hills area to the southeast.

The upper sedimentary member resembles the lower sedimentary member in many ways, but is distinguished from it in notable differences. In addition to position relative to tuffs 5, 6, 7, and Uvas Basaltic Andesite, the upper sedimentary member contains more low-angle cross-bedding, more ash and pumice fragments, and more and thicker conglomerate beds. The conglomerate is

FIGURE 5—*View east over head of Pine Canyon and Mesa Azur; Organ Mountains and San Andres Mountains in far background. Cliffs and light-colored benches in foreground are tuff 6 member of the Bell Top Formation; slopes below tuff 6 are on the lower sedimentary member. Dark-colored cliffs of Mesa Azur are Uvas Basaltic Andesite overlying slopes formed on the upper sedimentary member of the Bell Top.* (photo by James Cuffey)

also more variable in composition, containing rounded clasts of vesicular basalt, ash-flow tuffs, and felsite porphyry as well as flow-banded rhyolite. Two 2-ft vitric ash beds are separated by 15 ft of medium-grained sandstone and pebble conglomerate about midway in the member on the east slope of Tailholt Mountain. These beds probably represent air falls from eruptive activity outside the area, contemporaneous with deposition of the upper sedimentary member. The fine-grained sandstone, siltstone, and few shale beds contain abundant ash and abraded biotite flakes probably eroded from the older ash-flow tuffs. The uppermost 5 to 20 ft of the upper sedimentary member are thin- to medium-bedded, moderate reddish-brown, tuffaceous sandstone containing opalized zones where directly underlying Uvas flows.

TUFF 7 MEMBER

Ash-flow tuff 7 is present only on Tailholt Mountain and in the northeast corner of the quadrangle. It is the thinnest of the ash-flow tuffs, varying in thickness up to 19 ft. At Tailholt Mountain the upper 14 ft consist of a light-gray, dense, highly welded, vitric ash-flow tuff that breaks with a subconchoidal fracture, and grades downward into about 5 ft of pinkish-gray, friable, poorly welded vitric ash-flow tuff. It is comprised almost completely of glass shards with less than 1 percent crystal fragments. In the northeastern corner of the quadrangle, the whole member is similar to the upper part at Tailholt Mountain.

At one time tuff 7 must have covered much of the intervening and adjacent areas. Considering the resistant nature of the unit, that so much of it could have been eroded is surprising. Possibly it was deposited around high areas; or, the central part of the Sierra de las Uvas was already being uplifted prior to deposition of tuff 7. If so, the source area would appear to have been to the southeast. Significant erosion did occur locally after tuff 7 was deposited and before the basaltic andesite erupted. Evidence of this erosion includes intermittent outcrops of tuff 7 in local areas, coarse sandstone beds between tuff 7 and Uvas flows at some places, and apparent channel-form lenses of andesite resting on the upper sedimentary member at other places northeastward from the vicinity of Augustine Tanks. The Uvas flows and the upper sedimentary member also interfinger in many places in the central and western Sierra de las Uvas, indicating more or less continuous deposition.

UVAS BASALTIC ANDESITE

The Uvas Basaltic Andesite was defined by Kottlowski (1953b) as "flows of Uvas basalt/basaltic andesite with interbedded scoria and basaltic tuffs, as much as 145 ft thick." Darton (1928) and Dunham (1935) had earlier briefly mentioned these rocks in their reconnaissance surveys, but did not name them. The basaltic andesite flows are thickest (up to 800 ft) and most numerous (at least 14) along the crest of the Sierra de las Uvas dome. The type locality is designated at the high ridge 0.5 mile southwest of Augustine Tanks near the central part of the Souse Springs quadrangle. The type section is described in the Appendix (Augustine Tanks section).

Flows comprising the Uvas are chiefly basaltic andesite. Basaltic hornblende phenocrysts up to 1.5 mm long are enclosed in an intergranular felted matrix of andesine laths (averaging 0.3 mm long), pyroxene, and iron oxide grains. The rock is mostly microvesicular to vesicular, with some of the basal flows containing abundant calcite amygdules. Olivine phenocrysts, rarely up to 4 mm across, occur in a few of the darker-gray flows, but plagioclase composition (An_{45-50}) differs little from flows without olivine. Intrusive Uvas rocks appear locally and seem to have the same composition but are denser; many are more finely crystalline than the typical flow which approaches diabase in texture. A notable exception is a light- to medium-gray, hypersthene andesite that crops out in the vicinity of Augustine Tanks. Reddish-bronze bastite phenocrysts 1 to 2 mm in diameter speckle the rock. In thin section, they are seen to be in a matrix of similar size blocky andesine laths, hypersthene, augite, and smaller iron oxide grains.

The number of flows, and consequently the total thickness of the formation, decrease radially away from the domal axis of the Sierra de las Uvas. Southeastward the Uvas pinches out in fan debris of the upper sedimentary member adjacent to the Cedar Hills rhyolite domes. Westward, a few thin flows that overlap all underlying tuff units persist at least to the Goodsight Mountains, and possibly as far as the Cooks Range near Ft. Cummings. To the north, flows pinch out within the Thurman Formation in the southern Caballo Mountains (fig. 2).

Most of the flows came from vents in the Sierra de las Uvas area, but one vent, in the form of a dissected cinder cone about one mile in diameter, has been found in Broad Canyon about 6 miles east of the Souse Springs quadrangle. An intrusive mass (plug?) of basaltic andesite a few hundred yards across is mapped (map in pocket) near Escondido Ranch in the northeastern part of the quadrangle. It is associated with dikes that merge into basal Uvas flows. A larger vent is exposed just north of White Gap Tank in the south-central part of the quadrangle. Dikes and plugs in this area are associated with great amounts of basaltic lapilli tuff and exotic blocks of ash-flow tuff. The pyroclastics and basaltic andesite plugs are enclosed by a ring fracture and appear to have subsided from higher levels into the upper part of the Bell Top Formation as a vertical cylinder. A third possible vent area within the quadrangle, also along the Sierra de las Uvas domal axis, is marked by a coarse-crystalline intrusive dome-like mass of hypersthene andesite and associated thick stubby flows in the vicinity of Augustine Tanks.

The age of Uvas Basaltic Andesite is late Oligocene to early Miocene. K-Ar date of 31 m.y. (± 1.5) was obtained for a basaltic andesite exposed near the mouth of Broad Canyon to the east (Hawley and Kottlowski, 1965, p. 20). The altered and brecciated nature of the sample leaves this age date in doubt (J. W. Hawley, oral communication, December 1971). The next to the lowest Uvas flow on Mesa Azur (fig. 6) on the south-central edge of the quadrangle, has a K-Ar date of 25.9 (± 1.5) m.y. (Kottlowski, written communication, 1970). If both these ages are correct, andesitic volcanism apparently started in the Cedar Hills area and proceeded northwestward to the Sierra de las Uvas. We believe, however, that the difference actually is less than the 5 m.y. indicated by the K-Ar ages.

RINCON VALLEY FORMATION

The Rincon Valley Formation of the Santa Fe Group crops out in only a few places in the northeastern part of the quadrangle. In adjacent quadrangles it is widely exposed in badlands near the Rio Grande where it has been described in some detail by Hawley and others (1969), Seager, Hawley and Clemons (1971), and Seager and Hawley (1973 in press). The formation accumulated during latest stages of closed basin (bolson) filling in Pliocene and Miocene times and, in adjacent quadrangles, consists predominantly of fine-grained alluvial to playa basin-center clastics that grade downward into thick coarser-grained earlier bolson fill deposits (Hayner Ranch Formation). In the Souse Springs quadrangle, however, the formation consists of reddish-brown to tan fanglomerate, derived from the Sierra de las Uvas, and interbedded fine-grained basin-center clastics that overlap the faulted edges of the Sierra de las Uvas. The Rincon Valley Formation unconformably overlies the Uvas Basaltic Andesite in the Souse Springs quadrangle and in most places is gently deformed. About 200 to 300 ft of the formation is exposed.

CAMP RICE FORMATION

The Camp Rice Formation (Strain, 1966, 1969), youngest formation in the Santa Fe Group, crops out continuously along most of the northern margin of the Souse Springs quandrangle. In the Hatch and Rincon quadrangles to the north, and in the Sierra Alta quadrangle to the east, the formation crops out over wide areas in strips roughly adjacent and parallel to the present Rio Grande valley. In these areas the work of Hawley and others (1969), Seager, Hawley and Clemons (1971), and Seager and Hawley (1973, in press) have shown that the Camp Rice is early to middle Pleistocene and represents the culmination of basin filling in southern New Mexico prior to incision of the present valley system. Three major facies were mapped: 1) a basal piedmont-slope fanglomerate facies derived from local uplifts, 2) a medial fluvial facies consisting of sandstone, mudstone, and claystone deposited by an ancestral Rio Grande, and 3) an upper piedmont-slope facies consisting of fan gravel and fanglomerate, present near mountain fronts, grading basinward to finer grained clastics with multiple paleosols. Both piedmont facies intertongue with the fluvial facies; the upper fanglomerates overlap the fluvial facies.

In the Souse Springs quadrangle both upper and lower piedmont-slope deposits of the Camp Rice are well developed owing to their position adjacent to the Sierra de las Uvas front, but the fluvial facies between them is represented by only a few feet of soft, tan to light-gray, poorly indurated loam (Qcr). Northward beyond the map area, this loamy unit thickens and changes facies to about 300 ft of interbedded fluvial sandstone and interbedded flood-plain clays and siltstones. The lower piedmont-slope deposits (Qcrc) underlie wide-stripped structural surfaces along the northern edge of the map but are exposed only in the bottoms of a few gulches. They consist of boulder to cobble conglomerates derived from the Bell Top and Uvas Formations and are well indurated and usually lime-impregnated. The base is not exposed, but the unit probably is no thicker than 50 ft. The upper piedmont slope gravels (Qcrp) are primarily fanglomerates, but also include thin alluvial and colluvial veneers on erosion surfaces. They likewise were derived from the Bell Top and Uvas in the Sierra de las Uvas, are lime-impregnated and well lithified, but covered with slope debris. About 20 to 40 ft of upper piedmont slope gravels is present. The upper surface of the Qcrp unit forms the Jornada I surface of Gile and Hawley (1968).

POST-SANTA FE VALLEY FILL

Post-Santa Fe valley fill units include arroyo terrace and fan deposits, veneers on erosion surfaces, and slope colluvium along the sides of the major canyons in the Sierra de las Uvas. These deposits (Qvo) occupy topographic positions ranging from several feet to more than 120 feet above the floors of the present arroyo channels. In general the deposits are very gravelly and have extensive accumulations of carbonate below the overlying soils. They differ from younger valley fill deposits in this respect as well as by their topographic position.

Deposits associated with the latest stage of valley cutting and backfilling are

FIGURE 6—*View southeast over Mesa Azur; Sleeping Lady Hills and Rough and Ready Hills in middle background; and Franklin Mountains in far background. Road on Mesa Azur goes to New Mexico State University Mesa Azur Observatory visible near right side of photo.* (photo by James Cuffey)

included in the map unit (Qvy). These deposits include sand and gravel of the present arroyo beds, and the finer grained loamy alluvium of the arroyo banks and valley floors together with scattered isolated patches of wind-blown sand.

Structure

The Sierra de las Uvas is a partly dissected, faulted, domal uplift. The original dome may have been nearly circular or slightly elongate. Its size is indefinite, depending where the limits are drawn, but is about 12 miles in length and 8 to 10 miles in width, with the long axis trending northeast. Its dome-like form is readily apparent when viewed from the Rio Grande valley north of Hatch. A prong of the Sierra de las Uvas extends southwest from the main domal uplift for about another 12 miles, and then curves west to connect with the north-north-west-trending Goodsight Mountains. Uvas Basaltic Andesite caps both ranges, dipping west off the Sierra de las Uvas and east off Goodsight Mountains, thus forming the north-plunging Uvas valley syncline between them.

Doming of volcanic rocks in the Sierra de las Uvas apparently preceded late Tertiary block faulting. The dome has been uplifted and its original configuration modified by movement on the Sierra de las Uvas fault zone (map in pocket) and on the Ward Tank fault. The Sierra de las Uvas fault zone borders the range on the northwest. The Ward Tank fault forms the eastern margin of the Sierra de las Uvas and trends slightly east of north across the Sierra Alta quadrangle, passing about 0.2 mile east of Ward Tank (fig. 1) in the south-central part of the quadrangle. Uplift and northwest tilting appears to have been greater on the Ward Tank fault, so that the Sierra de las Uvas dome now plunges at low angles to the northwest; wide stripped surfaces on the Palm Park Formation are exposed to the southeast. The original curvature of the dome is still present south of Hatch and in the northeastern part of the Souse Springs quadrangle.

The fault pattern in the Souse Springs quadrangle is quite complex; faults probably related to the doming are difficult to differentiate from those that probably existed prior to the doming, as well as those associated with late Tertiary uplift of the range. Northwest-trending faults predominate in the extreme southeast and southwest parts of the quadrangle. North- and northwest-trending faults prevail in the north with the notable exception of the northeast-trending Sierra de las Uvas fault zone. Other exceptions are numerous; north- and northeast-trending faults are present to the south, and northwest- and east-trending faults are present to the north. Much of the diversity in trends is because the dominant high-angle normal faults curve as they cross the Sierra de las Uvas, and divide into several faults of various trends, forming a "horsetail" pattern. One example is the Hermantano Springs fault, a northwest-trending, down-to-the-southwest, high-angle, normal fault in the west-central part of the Sierra Alta quadrangle. Just before entering the Souse Springs quadrangle, this fault splits into several faults, some of which divide into more strands. The result is 6 to 8 faults diverging from the Hermantano Springs fault.

In the southeast corner of the Souse Springs quadrangle, a northwest-trending graben lies between the Mesa Azur fault on the southwest, and a major fault northeast of Tailholt Mountain on the northeast (map in pocket). This graben bifurcates near White Gap Tank into northwest- and north-trending grabens. The northwest-trending graben is bounded by the Big White Gap fault on the southwest and several en echelon faults on the northeast. The north-trending graben is bounded by the Little White Gap and Road Canyon faults on the west and east, respectively. Road Canyon fault may die out north of Valles Tank, or it may curve to the southeast and be continuous with the major fault northeast of Tailholt Mountain. All three grabens are intensely broken by transverse faults as well as faults parallel to the bounding faults, and appear to be part of an axial graben system on the crest of the dome. Structure sections, especially B-B' (map in pocket), clearly show the collapse of the dome's crest in the vicinity of White Gap Tank. The graben bifurcation is similar to structures reported elsewhere on the flanks of domes, and in experiments (Cloos, 1930, 1931, 1932; Hubbert, 1951; Woodring and others, 1941).

Another striking relation is the occurrence of basaltic andesite vents in the grabens. The best exposed vent area is located where the axial graben described above bifurcates at Little White Gap (map in pocket, B-B', D-D'). The vent area, approximately 0.5 mile in diameter, is enclosed by a circular fault zone to form a depressed cylindrical zone resembling a volcanic crater. Dikes and plugs of basaltic andesite are associated with basaltic lapilli tuff and exotic blocks of older ash-flow tuffs. The lapilli tuff and some beds of the upper sedimentary member (Bell Top) have centroclinal dips toward the center of the vent area. The vent associated with the hypersthene andesite is in the north-trending graben near Augustine Tanks. The pluglike mass at Escondido Ranch is in a small horst within a wide graben in which Spring Canyon is situated (map in pocket, C-C'). The intrusive lies just southeast of the line of section so is not shown on C-C'. The fact that all these vent zones are in the axial grabens seems more than fortuitous, and may be the result of eruptions or intrusions along tensional fractures formed during the doming.

LANDSLIDES

Several landslide areas are mapped. With the exception of the landslide of the Palm Park and tuff 1 & 2 in the southeast corner of the quadrangle, all are the result of blocks of Uvas and a few subjacent rocks sliding down slopes cut in the less resistant upper sedimentary member (Bell Top). On the south side of Horse Canyon, Uvas flows hold up a ridge, where they have been lowered 500 ft to seemingly rest on tuff 6. Southeast of Las Uvas Ranch, Uvas flows and some of the upper sedimentary member form a repeated slide sheet covering all of tuff 6 and part of the lower sedimentary member. Parts of the Uvas and tuff 7 that capped Tailholt Mountain have slid northwest and southeast forming complex stratigraphic relations on the slopes; and about one mile to the northeast Uvas flows have slid down, and now rest on tuff 6 and the lower sedimentary member.

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Appendix—measured sections

(Note: color code in accordance with the Munsell Color Co., Inc. soil color chart)

BELL TOP MOUNTAIN SECTION

South slope of Bell Top Mountain, sec. 11, T. 21 S., R. 3 W.; in north-central part of the Corralitos Ranch quadrangle Measured by R. E. Clemons, November 20, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Bell Top Formation		620
	Tuff 5 member (top eroded)		85
16	Crystal-vitric ash-flow tuff; pale-red-purple (5 RP 7/2); highly welded; abundant, slightly flattened, white pumice fragments; sanidine, quartz, plagioclase, and biotite crystals; cliff-former at top of mountain	30	
15	Crystal-vitric ash-flow tuff; moderate-grayish-pink (5 R 7/2); abundant white pumice fragments, sanidine, quartz, plagioclase, and biotite crystals; slope-former	55	
	Tuff 4 member		80
14	Vitric-crystal ash-flow tuff; grayish-red-purple (5 RP 4/2); highly welded; dense; abundant darkened pumice fragments; sanidine, quartz, plagioclase, and biotite crystals; cliff-former	50	
13	Vitric-crystal ash-flow tuff; moderate-grayish-red (5 R 5/2); highly welded; porous; same composition as unit 14; slope-former	30	
	Tuff 3 member		325
12	Vitric ash-flow tuff; moderate-orange-pink (10 R 7/4); highly welded; porous; abundant darkened pumice fragments up to 4 inches long and 1 inch thick; minor sanidine, quartz, and plagioclase crystals; slope-former	115	
11	Vitric ash-flow tuff; moderate-orange-pink (10 R 7/4); highly welded; slightly porous; same composition as unit 12; thin, black, fracture-filling veins common near base; large, poorly developed columnar joints; cliff-former; contact with underlying unit not exposed	120	
10	Vitric-crystal tuff; medium-grained; sandy; white (N9) to pinkish-gray (5 YR 8/1); mostly covered except in few gullies; slope-former	25	
9	Pebble-cobble conglomerate; gradational upward to coarse-grained tuffaceous sandstone; smaller clasts mostly crystal fragments, larger clasts are rounded quartz and volcanic rock fragments; poorly cemented;		

Unit No.	Lithology	Thickness (ft) Unit	Total
	poorly sorted; poorly bedded; apparently channel-fill deposits; poorly exposed in slope	65	
	Basalt member		60
8	Basalt breccia; brownish-black (5 YR 2/1); 1- to 2-inch fragments; vesicular to scoriaceous; poorly exposed in slope	15	
7	Basalt; grayish-black (N2); olivine-bearing; dense; horizontal joints resemble bedding	45	
	Tuff 1 & 2 member		70
6	Vitric ash-flow tuff; pale-red-purple (5 RP 6/2); highly welded; slightly porous; some spherulitic zones near top with spherulites averaging about ¼ inch in diameter; poorly exposed in slope; contacts with overlying and underlying units not exposed	70	
	Palm Park Formation		195
5	Cobble conglomerate; gradational upward to pebble conglomerate and coarse sandstone; composed of andesitic and latitic debris; poorly cemented; poorly bedded; channel fill deposits	50	
4	Sandstone, very fine grained, intensely fractured; pale-red-purple (5 RP 6/2); porous	5	
3	Cobble conglomerate; well-rounded andesite-latite cobbles; coarse sandy matrix of quartz and volcanic rock debris; channel fillings	10	
2	Sandstone, fine- to coarse-grained, poorly sorted, moderately well-cemented; thin-bedded; pale-grayish-olive (10 Y 5/2) to pale-yellowish-brown (10 YR 6/2); volcanic arenite	60	
1	Covered interval; base not exposed but other Palm Park units crop out in arroyo below	70	

CHOASES CANYON SECTION

Along Choases Canyon approximately 0.5 mile northeast of Alamo Windmills to confluence of arroyo from the northwest; offset approximately 0.5 mile parallel to strike, and up southwest slope of Piña Peak.
Measured by R. E. Clemons, October 7, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Uvas Basaltic Andesite (top eroded)		315
25	Basaltic andesite flows; dark-gray (N3) to brownish-black (5 YR 2/1); at least six flows present; most flow units have flow breccia at base, dense central part with few large vesicles, and vesicular to scoriaceous top; mostly cliffs with few steep slopes; caps Piña Peak	315	

Unit No.	Lithology	Thickness (ft) Unit	Total
	Bell Top Formation		1062
	Upper sedimentary member		408
24	Sandstone; fine- to medium-grained, tuffaceous, poorly sorted; moderate red (5 R 5/4) peppered with black glassy grains and white pumice fragments of 1 mm- to 2 mm-diameter; medium- to massive-bedded; baked contact under overlying basalt flow; ledge-former	46	
23	Sandstone; fine-grained, tuffaceous; pale-reddish-brown (10 R 5/4); medium-bedded	17	
22	Sandstone; medium- to coarse-grained, poorly sorted; pale-grayish-red (5 R 5/2); larger grains are rounded volcanic rock fragments, smaller are angular to subrounded quartz and volcanic rock fragments; a few abraded biotite flakes	15	
21	Sandstone; coarse-grained, poorly sorted; pale-reddish-brown (10 R 5/6); thin-bedded	3	
20	Vitric-crystal air-fall tuff; grayish-orange-pink (10 R 8/2); friable; porous; poorly bedded; wormy, nodular weathered surfaces produced where white pumice fragments (up to 1 cm) weather out; few interbeds of coarser pale-red (10 R 5/6) material	80	
19	Sandstone; fine- to medium-grained, poorly sorted; grayish-orange-pink (5 YR 8/2) to pale-red (5 R 6/2); friable; porous; some biotite flakes and small white pumice fragments; poorly bedded	105	
18	Sandstone; medium- to coarse-grained, poorly sorted; pale-red-purple (5 RP 7/2); friable; medium-bedded; angular to well-rounded grains	57	
17	Pebble conglomerate; pale-yellowish-brown (10 YR 7/2) matrix; hornblende andesite porphyry, basaltic andesite and ash-flow tuff boulders up to 18 inches in diameter; medium-grained volcanic arenite matrix of very angular to well-rounded grains; poorly bedded	11	
16	Sandstone; very fine grained to silty, tuffaceous; very pale orange (10 YR 8/2); abundant golden and fresh black biotite flakes; well-indurated; poorly bedded; wormy weathered surface; poorly exposed	51	
15	Covered interval; contact with underlying unit not exposed	23	
	Tuff 6 member		25
14	Vitric-crystal ash-flow tuff; grayish-pink (5 R 8/2); highly welded; dense; abundant flattened, medium-gray (N5) pumice fragments; biotite, sanidine and quartz crystals	9	
13	Vitric-crystal ash-flow tuff; pale-red (10 R 6/2); same composition as unit 14; cavities formed on surface where 2- to 3-inch pumice fragments weather out	16	

Unit No.	Lithology	Thickness (ft) Unit	Total
	Lower sedimentary member		207
12	Sandstone; fine- to medium-grained, poorly sorted, volcanic arenite; pale-yellow-brown (10 YR 7/2); well-indurated; porous; massive-bedded	60	
11	Sandstone; fine-grained, moderately well-sorted, volcanic arenite; pale-gray-orange (10 YR 8/4); well-indurated; medium- to massive-bedded	66	
10	Sandstone; bimodal, granule and medium-grained, poorly sorted, calcareous volcanic arenite; pale-gray-orange (10 YR 8/4); friable; medium-bedded; fine sandstone with abundant pumice fragments at top	65	
9	Sandstone; very fine grained at base to medium-grained at top; poorly sorted; calcareous volcanic arenite; grayish-orange-pink (10 R 8/2); friable; few ash-flow tuff pebbles up to 1 inch diameter throughout; medium- to thick-bedded	11	
8	Covered interval; contact with underlying unit not exposed	5	
	Tuff 5 member		301
7	Vitric-crystal ash-flow tuff; pale-red (10 R 6/2); highly welded; dense; few gray (N7) pumice fragments; sanidine, quartz, and biotite crystals; this unit lithologically resembles Tuff 6 more than Tuff 5; it is not present other than in this area near the confluence of Choases and Valles canyons	35	
6	Crystal-vitric ash-flow tuff; pale-red-purple (5 RP 7/2); highly welded; slightly friable; abundant white pumice fragments and black biotite flakes, sanidine and quartz crystals; gradational into unit 5	40	
5	Crystal-vitric ash-flow tuff; pale-red-purple (5 RP 6/2); more dense, and more flattened pumice fragments than in unit 6; large, poorly developed columnar joints	146	
4	Crystal-vitric ash-flow tuff; pale-red-purple (5 RP 7/2); same as unit 5, without jointing	70	
3	Covered interval; contact with underlying unit not exposed	10	
	Tuff 4 member		93
2	Vitric-crystal ash-flow tuff; pale-grayish-red (5 R 7/2) to grayish-red-purple (5 RP 4/2); highly welded; dense; abundant darkened pumice fragments up to 10 inches in length; ash-flow tuff lithic fragments and golden biotite flakes	93	
	Tuff 3 member		28
1	Vitric ash-flow tuff; orange-pink (10 R 7/4); highly welded; porous; abundant darkened pumice fragments up to 5 inches in length; base not exposed in fault scarp	28	

VALLES CANYON SECTION

Along Valles Canyon sec. 27 and 34, T. 20 S., R. 3 W.
Measured by R. E. Clemons, October 14, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Bell Top Formation		373
	Tuff 5 member		158
7	Vitric-crystal ash-flow tuff; pale-red (10 R 6/2); highly welded; dense; few light-gray (N7) pumice fragments; sanidine, quartz, and biotite crystals	48	
6	Crystal-vitric ash-flow tuff; pale-red-purple (5 RP 7/2); highly welded, slightly friable at top, dense central and lower parts; white pumice fragments and black biotite flakes throughout; sanidine and quartz crystals; large columnar joints in central part	110	
	Tuff 4 member		62
5	Vitric-crystal ash-flow tuff; grayish-red-purple (5 RP 4/2); highly welded; dense; abundant darkened pumice fragments; sanidine, quartz, plagioclase, and biotite crystals; base not exposed at fault	62	
	Tuff 3 member		75
4	Vitric ash-flow tuff; moderate-orange-pink (10 R 7/4); highly welded; porous; abundant darkened pumice fragments up to 3 inches in length; minor sanidine, quartz, and plagioclase crystals; top not exposed at fault	65	
3	Covered interval; contact with underlying unit not exposed	10	
	Basalt member		21
2	Basalt; olivine-bearing; brownish-black (5 YR 2/1); dense; vesicular to scoriaceous at top; irregular upper surface	21	
	Tuff 1 & 2 member		57
1	Vitric ash-flow tuff; pale-red-purple (5 RP 6/2); highly welded; slightly porous; base not exposed	57	

PINE CANYON SECTION

Section 6 and 7, T. 20 S., R. 3 W., west of Sugarloaf Peak on south-central border of Souse Springs quadrangle.
Measured by R. E. Clemons, October 19, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Uvas Basaltic Andesite		280
22	Andesite; dark-gray (N3); coarse-crystalline; moderate-red-brown (10 R 4/6) hypersthene phenocrysts;		

Unit No.	Lithology	Thickness (ft) Unit	Total
	gradational upward to finer-crystalline, microvesicular andesite; abundant vesicular zones showing gas stream pattern	85	
21	Sandstone; fine-grained, silty; moderate-red-brown (10 R 4/6); thin-bedded; gradational upward into massive, muddy, fine sandstone; very poorly sorted; volcanic arenite	38	
20	Basalt; brownish-black (5 YR 2/1); vesicular; large 3- to 4-inch horizontal flattened vesicles; pahoehoe upper surface	42	
19	Basaltic andesite; dark-gray (N3); dense; slightly vesicular; some calcite amygdules; large 3- to 4-inch horizontal elongated vesicles in central part; smaller vesicles at top	55	
18	Basaltic andesite; medium-gray (N5); horizontal joints at base; upper 35 feet columnar jointed; few white calcite amygdules; scoriaceous top	50	
17	Basaltic andesite breccia; medium-gray (N5); 2-inch to 3-foot blocks vesicular basalt; some tuffaceous sandstone matrix; gradational upward into basalt flow	10	
	Bell Top Formation		753
	Upper sedimentary member		488
16	Siltstone; moderate-red (5 R 5/4); black, glassy fragments and vesicular basalt; coarse sand fragments	5	
15	Sandstone; tuffaceous; moderate-red-brown (10 R 5/6); fine-grained; tuffaceous; few opal zones	20	
14	Sandstone; very fine grained; tuffaceous; grayish-orange-pink (10 R 8/2); friable; poorly bedded; abundant pumice fragments in upper part, some up to 2 inches in diameter	120	
13	Pebble conglomerate; pale-yellow-brown (10 YR 6/2); some cobbles of ash-flow tuff and rhyolite; coarse sandy matrix	8	
12	Sandstone; medium- to coarse-grained, friable, poorly cemented; pale-yellow-brown (10 YR 6/2); few 2- to 5-foot boulder beds with rounded ash-flow tuff and vesicular basalt boulders up to 3 feet diameter; cross-bedded; medium- to massive-bedded with a few clay lenses; sand consists of very angular to well-rounded quartz, sanidine, plagioclase, and volcanic rock fragments	215	
11	Boulder conglomerate; rounded ash-flow tuff and basalt up to 2 feet in diameter, averaging 6- to 8-inches; coarse sandy, granule matrix	20	
10	Sandstone; medium-grained with few coarse-grained zones; pale-yellow-brown (10 YR 6/2); friable; abundant abraded golden biotite flakes	2	

Unit No.	Lithology	Thickness (ft) Unit	Total
9	Sandstone; fine- to medium-grained, tuffaceous; yellowish-gray (5 Y 7/2) to light-brown (5 YR 6/4); porous; friable	53	
8	Sandstone; very fine grained, tuffaceous; pink-gray (5 YR 8/1) at base to yellowish-gray (5 Y 7/2) at top; very porous; friable; abundant fresh, black biotite at base with more golden biotite at top; abundant white pumice fragments at top; massive; poorly-bedded	45	
	Tuff 6 member		65
7	Vitric-crystal ash-flow tuff; pale-red (10 R 6/2); highly welded; slightly porous; upper 5 feet grayish-red-purple (5 RP 5/2); dense; intensely fractured; subconchoidal fracture; darkened pumice fragments ½ to 4 inches in length; sanidine, quartz, plagioclase and biotite crystals	65	
	Lower sedimentary member		200
6	Sandstone; fine- to medium-grained, tuffaceous; grayish-orange-pink (5 YR 8/2); thin- to medium-bedded; contact with overlying unit 7 covered with talus	85	
5	Sandstone; fine-grained, tuffaceous; grayish-orange-pink (5 YR 7/2); thick-bedded	15	
4	Sandstone; very fine grained, silty, tuffaceous; grayish-orange-pink (5 YR 7/2); thin- to medium-bedded	30	
3	Sandstone; medium-grained, tuffaceous; pale-yellow-brown (10 YR 6/2); bimodal, medium sand and vitric tuffaceous very fine sand; larger grains subangular to well-rounded and frosted	15	
2	Sandstone; fine-grained, tuffaceous; grayish-orange-pink (5 YR 7/2); white pumice fragments up to 1 inch diameter; poorly bedded; wormy, nodular weathered surfaces	30	
1	Sandstone; very fine grained, silty, tuffaceous; grayish-orange-pink (10 R 8/2); fresh biotite flakes common; rounded quartz and sanidine crystals; few volcanic rock fragments; base not exposed	25	

BASIN TANK WEST SECTION

One mile northeast of Tailholt Mountain in SW ¼ sec. 35, T. 20 S., R. 3 W.
Measured by R. E. Clemons, October 28, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Bell Top Formation		398
	Tuff 5 member (top eroded)		70

Unit No.	Lithology	Thickness (ft) Unit	Total
8	Crystal-vitric ash-flow tuff; pale-red-purple (5 RP 7/2); highly welded; abundant, slightly flattened, white pumice fragments; sanidine, quartz, plagioclase, and biotite crystals; cliff-former	40	
7	Crystal-vitric ash-flow tuff; moderate-grayish-pink (5 R 7/2); abundant white pumice fragments; sanidine, quartz, plagioclase, and biotite crystals; slope-former	30	
	Tuff 4 member		61
6	Vitric-crystal ash-flow tuff; grayish-red-purple (5 RP 5/2); highly welded; dense; abundant darkened pumice fragments; sanidine, quartz, plagioclase, and biotite crystals; cliff-former; 3- to 6-inch layers at top	46	
5	Vitric-crystal ash-flow tuff; moderate-grayish-red (5 R 5/2); highly welded; porous; same composition as unit 6; slope-former	15	
	Tuff 3 member		115
4	Vitric ash-flow tuff; moderate-orange-pink (10 R 7/4); highly welded; porous; abundant darkened pumice fragments up to 4 inches long and 1 inch thick; minor sanidine, quartz, and plagioclase crystals; slope-former	60	
3	Vitric ash-flow tuff; moderate-orange-pink (10 R 7/4); highly welded, slightly porous; same composition as unit 4	55	
	Basalt member		62
2	Basalt; olivine-bearing; brownish-black (5 YR 2/1); dense; weathers to brownish-gray (5 YR 4/1); vesicular to scoriaceous at top	62	
	Tuff 1 & 2 member		90
1	Vitric ash-flow tuff; pale-pink (5 RP 8/2); porous; abundant pale-red, flattened, pumice fragments; slope-former; base not exposed	90	

TAILHOLT MOUNTAIN SECTION

East slope of Tailholt Mountain.
Measured by R. E. Clemons, October 28, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Uvas Basaltic Andesite		180
21	Basaltic andesite; grayish-black (N2); dense; microvesicular; medium-crystalline basalt; vertical tubular vesicular zones and vesicular top	60	
20	Basaltic andesite; dark-gray (N3); dense; flattened vesicles; scoriaceous top	74	

Unit No.	Lithology	Thickness (ft) Unit	Total
19	Basaltic andesite; medium-gray (N5); dense; calcite amygdules at base; scoriaceous top	46	
	Bell Top Formation		730
	Tuff 7 member		19
18	Vitric ash-flow tuff; light-gray (N7); highly welded; dense; subconchoidal fracture; cliff-former	14	
17	Vitric ash-flow tuff; pinkish-gray (5 YR 8/1); poorly welded; friable; porous; slope-former	5	
	Upper sedimentary member		430
16	Sandstone; very fine to fine-grained; pale-yellowish-brown (10 YR 6/2); abundant white pumice fragments up to 4 inches diameter near top; few irregular medium-grained sandstone lenses	220	
15	Sandstone; fine-grained; moderate yellowish-brown (10 YR 5/4); massive-bedded at top; medium-gray (N6) and pale-red-purple (5 RP 6/2) zones below; 2-inch to 2-foot cross-bedded beds at base	28	
14	Vitric ash; white; friable; porous; minor amount of golden biotite and angular crystal fragments	2	
13	Sandstone; medium- to coarse-grained; yellowish-gray (5 Y 7/2) to pale-yellowish-brown (10 YR 6/2); friable; few pebble conglomerate layers with vesicular basalt and ash-flow tuff fragments	15	
12	Vitric ash; white; porous; minor biotite and crystal fragments	2	
11	Sandstone; medium- to coarse-grained; yellowish-gray (5 Y 7/2) to pale-yellowish-brown (10 YR 6/2); massive, 1- to 10-foot beds poorly developed; friable; coarser and thicker beds at top; some low-angle cross-beds; wormy weathered surface	93	
10	Sandstone; medium- to coarse-grained, tuffaceous; grayish-orange-pink (5 YR 7/2); friable; 1- to 6-inch beds poorly developed; few massive beds with low-angle cross-beds and dark granule zones comprise half of unit; light-gray (N7) shaly beds at base	45	
9	Covered interval; contact with underlying unit not exposed	25	
	Tuff 6 member		28
8	Vitric-crystal ash-flow tuff; pale-red-purple (5 RP 6/2) at top, pale-grayish-red (5 R 7/2) below; upper part is denser and possesses subconchoidal fractures whereas lower part contains abundant pumice fragments up to 2 inches in length and irregular fractures	28	
	Lower sedimentary member		153
7	Covered interval; contact with overlying unit not exposed	5	
6	Sandstone; fine- to medium-grained, tuffaceous; very pale orange (10 YR 8/2); mostly very angular crystal		

Unit No.	Lithology	Thickness (ft) Unit	Total
	fragments with few rounded volcanic rock fragments; medium- to thick-bedded; few granule conglomerate zones with dark-colored, rounded volcanic rock granules	55	
5	Sandstone; very fine to fine-grained, tuffaceous; pale-yellowish-brown (10 YR 6/2); abundant small (¼ to ½ inch) white pumice fragments; wormy weathered surface	8	
4	Sandstone; fine-grained, tuffaceous; very pale yellowish-brown (10 YR 7/2); massive; no evident bedding	60	
3	Sandstone; fine- to medium-grained, tuffaceous; light-colored; mostly covered	25	
	Tuff 5 member (base not exposed)		100
2	Vitric-crystal ash-flow tuff; pale-pink (5 RP 8/2); porous; abundant large, white pumice fragments; slope-former	30	
1	Vitric-crystal ash-flow tuff; pale-pink (5 RP 8/2); slightly porous; denser than unit 2; cliff-former; base not exposed at fault contact	70	

AUGUSTINE TANKS SECTION

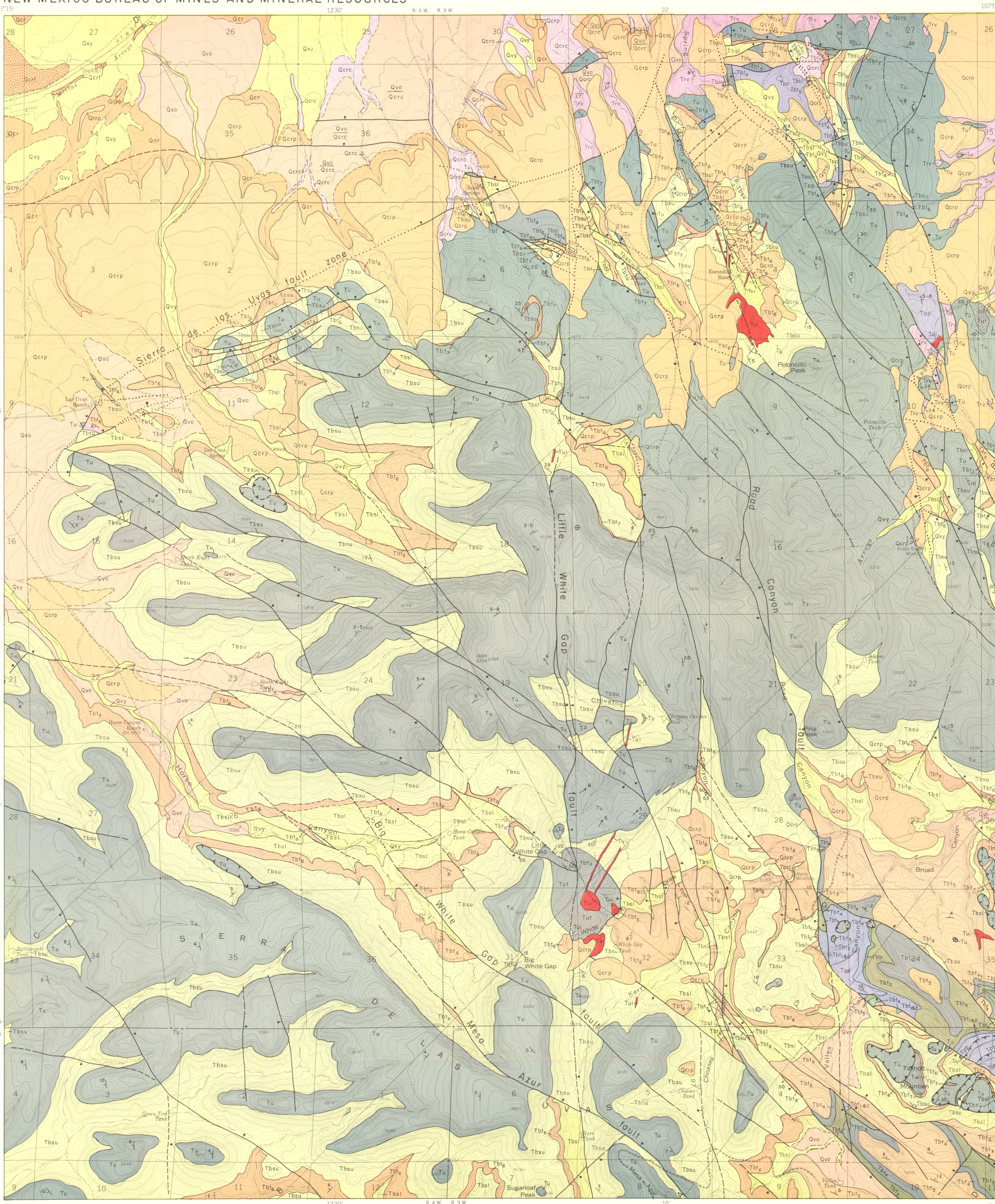
Half a mile southwest of Augustine Tanks in northeast part of Souse Springs quadrangle.
Measured by R. E. Clemons, November 4, 1971.

Unit No.	Lithology	Thickness (ft) Unit	Total
	Uvas Basaltic Andesite		785
17	Basaltic andesite; medium dark gray (N4); dense; platy joints; vesicular tops	70	
16	Covered interval; slope with abundant red scoria	5	
15	Basaltic andesite; medium dark gray (N4); dense; microvesicular with larger vesicles at top	39	
14	Basaltic andesite; medium dark gray (N4); dense; microvesicular with larger vesicles at top	43	
13	Covered slope	12	
12	Basaltic andesite; grayish-black (N2); dense; vesicular, scoriaceous top	32	
11	Basaltic andesite; grayish-black (N2); dense; vesicular, scoriaceous top	30	
10	Mostly covered slope; abundant red scoria and white chalcedony in float	70	
9	Basaltic andesite; grayish-black (N2); dense; vesicular, scoriaceous at top	20	

Unit No.	Lithology	Thickness (ft) Unit	Total
8	Lower 7 feet is vesicular basalt breccia gradational upward into dense, grayish-black (N2) vesicular basalt; 3- to 5-inch horizontal elongate vesicles; red-weathering scoriaceous top; unit may contain two flows	70	
7	Basaltic andesite; grayish-black (N2); dense, fine-crystalline; vesicular top	37	
6	Covered slope	6	
5	Basaltic andesite; dark-gray (N3); dense; horizontal to curved, platy jointing; vesicular top	25	
4	Basaltic andesite; medium dark gray (N4); dense; amygdaloidal at base, vesicular top	21	
3	Andesitic basalt; medium dark gray (N4); vesicular at base grading upward into dense; 5 to 10 feet flow-breccia at base; calcite amygdules; red, scoriaceous top	120	
2	Hypersthene andesite; light-gray (N7) to medium-gray (N5); red-bronze bastite phenocrysts 1 to 2 mm in size speckle the rock. (This unit appears to fill a large "channel" as it is missing a few hundred yards toward the southeast where unit 3 rests on an equivalent thickness of Tuff 7 and upper sedimentary member)	185	
	Bell Top Formation		
	Upper sedimentary member		60
1	Sandstone; medium- to coarse-grained, few granules; few vesicular basalt boulders up to 2 feet diameter; some cross bedding; mostly covered slope; (lower part not measured)	60	

Index

Numbers in **boldface** indicate main sections.



Base from U. S. Geological Survey

Geology by Russell E. Clemons and William R. Seager, 1969 through 1971

APPROXIMATE MEAN DECLINATION 1971

EXPLANATION

QUATERNARY

Holocene

Qvy — Sand, silt, and gravel on and along modern arroyo floors and terraces, and windblown sand; to 10 ft thick

Late Pleistocene to Holocene

Qvo — Caliche-cemented terrace deposits and fan and slope gravel; to 10 ft thick

UNCONFORMITY

Pleistocene — Camp Rice Formation

Qcrp — Caliche-cemented piedmont slope gravels derived from Sierra de las Uvas; 20 to 50 ft thick

Qcr / Qcrf — Fine-grained siltstone, sandstone and pebbly strata interpreted as piedmont toeslope deposits (Qcr); grade basinward into basin center facies including fluvial sandstones deposited by the ancestral Rio Grande (Qcrf); 20 to 100 ft thick

Qcrc — Caliche-cemented fanglomerate derived from the Sierra de las Uvas; thickness not determined

UNCONFORMITY

TERTIARY

Pliocene & Miocene(?) — Rincon Valley Formation

Trv — Interbedded fanglomerate and basin-floor sandstone, siltstone and claystone, all various shades of red, and derived mainly from the Sierra de las Uvas; gently deformed in most exposures; to 200 ft thick

UNCONFORMITY

Miocene — Uvas Basaltic Andesite

Tu, Tut, Tui — Dark gray to black scoriaceous, dense basaltic andesite and basalt flows containing minor interbedded red and tan sandstone; 100 to 800 ft thick. Unit includes some small plugs and dikes (Tui), and basaltic lapilli tuffs, agglomerate and cinder beds (Tut)

Oligocene — Bell Top Formation

Tbt7 — Dense, light brownish-gray to grayish-purple welded vitric ash-flow tuff; to 20 ft thick

Tbsu — Upper sedimentary member. Light-gray to brown and red siltstone, sandstone and conglomerate locally containing abundant clasts of flow-banded rhyolite, vesicular Uvas Basalt and ash-flow tuff. Bedding generally thick to medium and very regular; 200 to 500 ft thick

Tbt6 — Porous to dense, pale grayish-red, welded vitric-crystal ash-flow tuff. Forms persistent cliff and bench or cuesta topography; 100± ft thick

Tbsl — Lower sedimentary member. White to light-tan and gray tuffaceous siltstone and sandstone containing some lenticular channel-form conglomerate units; generally poorly sorted and poorly bedded; 100 to 200 ft thick

Tbt5 — Porous, grayish-pink, welded crystal-vitric ash-flow tuff. Abundant, slightly flattened, white pumice fragments and crystal of sanidine, quartz, plagioclase and biotite; resistant unit forming cuestas, cliffs or steep canyon walls; 100 to 300 ft thick

Tbt4 — Slightly porous to dense, pale grayish-red purple welded vitric crystal ash-flow tuff. Contains abundant flattened dark devitrified pumice fragments to 1 ft in diameter; forms persistent cliff and steep canyon walls; 90 ft thick

Tbt3 — Porous, grayish-orange pink to pale-red, poorly welded vitric ash-flow tuff containing 5 to 20 percent pumice fragments; present in southeastern part of Souse Springs quadrangle and farther east; to 325 ft thick

Tbb — Dense, black, olivine-bearing basalt flow, locally scoriaceous at the top. Only present in southeastern Souse Springs quadrangle and farther east; to 60 ft thick

Tbt1&2 — Variably welded, light-gray to pale grayish-red-purple ash-flow tuff exhibiting well developed eutaxitic structure. Only present in southeastern Souse Springs quadrangle and adjacent areas; to 90 ft thick

UNCONFORMITY

Eocene — Palm Park Formation

Tpp — Gray, red and purple tuffaceous sandstone, shale, conglomerate and breccia, consisting primarily of andesitic detritus

Geologic contact, dashed where inferred, dotted where concealed

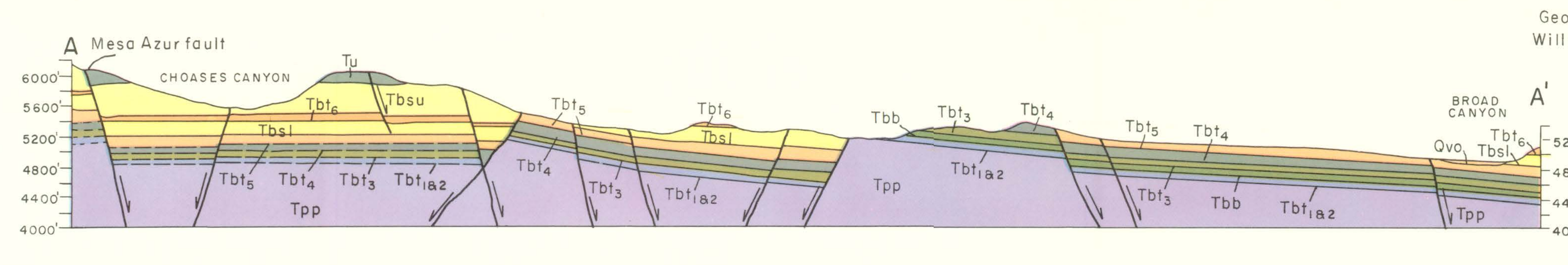
Normal fault, ball on downthrown side, dashed where inferred, dotted where concealed

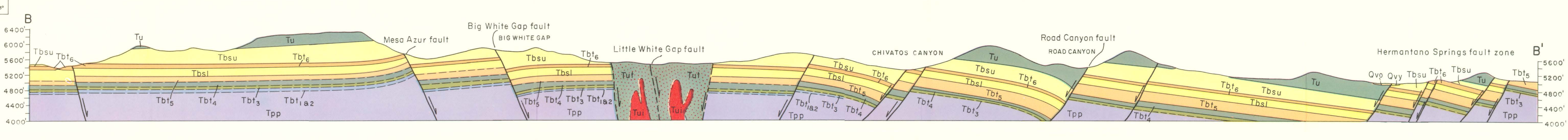
Landslide slip surfaces, sawteeth point to actively moving blocks

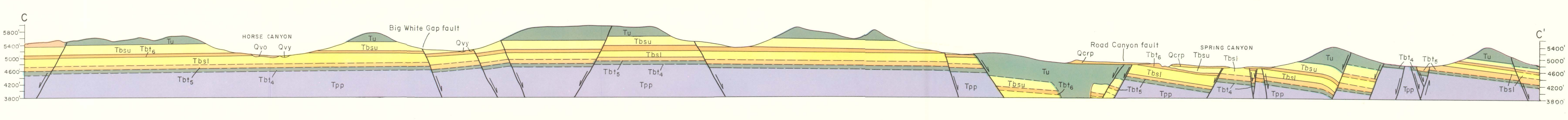
Strike and dip of beds

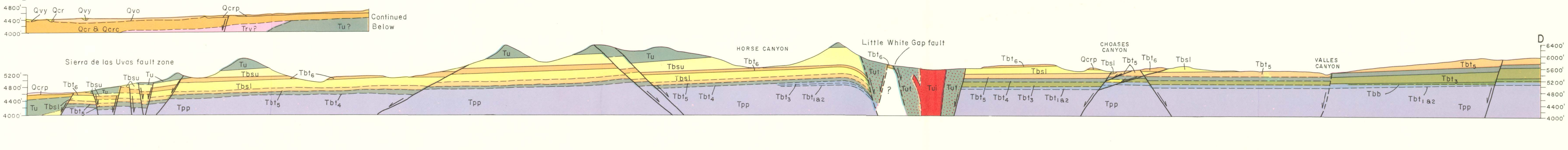
Apparent dip

Horizontal beds









GEOLOGIC MAP AND SECTIONS OF SOUSE SPRINGS QUADRANGLE, NEW MEXICO

by R. E. Clemons and W. R. Seager

SCALE 1:24000

1 MILE