# Geology and coal resources of Tejana Mesa quadrangle

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FIGURES

## Introduction

The Tejana Mesa 7.5 min quadrangle is northwest of Quemado on the southeastern edge of the Salt Lake coal field. This quadrangle contains the southeasternmost exposures of the Cretaceous coal-bearing rocks in the Salt Lake field. The area covered by this study includes portions of T. 3 N., R. 16 and 17 W., and T. 2 N., R. 16 and 17 W. (Fig. 1).

Access to Tejana Mesa quadrangle is limited to two well-maintained gravel roads out of Quemado; one going north and NM-32 going northwest to Salt Lake. The rest of the roads in the study area are normal ranch roads.

## Surface and mineral ownership

Six ranchers have patented surface rights on Tejana Mesa quadrangle, making up 38.6% of the total land ownership. Federal lands make up a large percentage, 42.8%, of the ownership, and the state holds 18.5% of the surface rights on this quadrangle. Mineral ownership on Tejana Mesa quadrangle is dominated by federal ownership, 77.2%, with the state having 20.2% of the mineral rights and 2.6% private minerals of the total ownership. Fig. 2a indicates surface ownership distribution and Fig. 2b is mineral ownership.

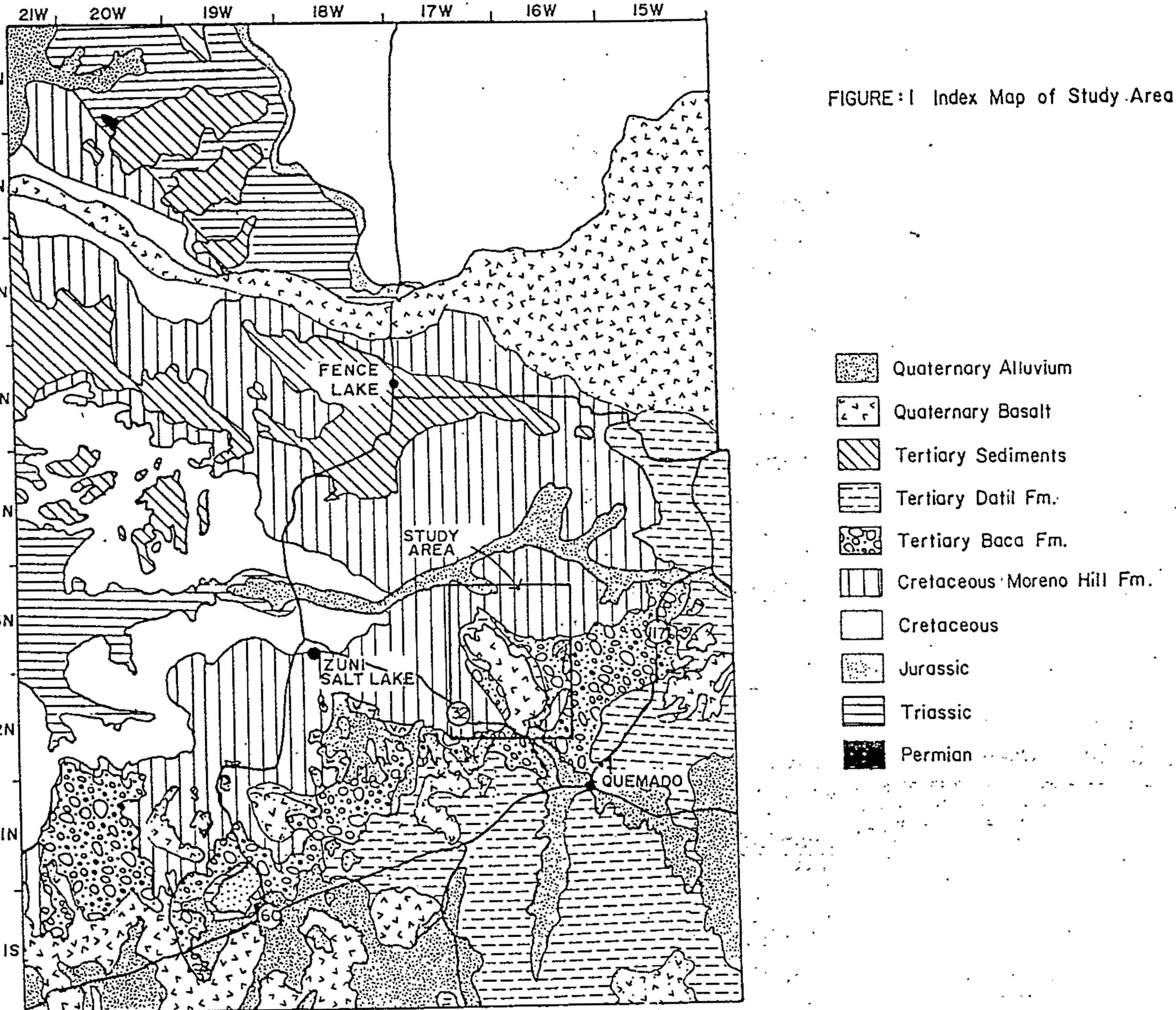



FIGURE: I Index Map of Study Area

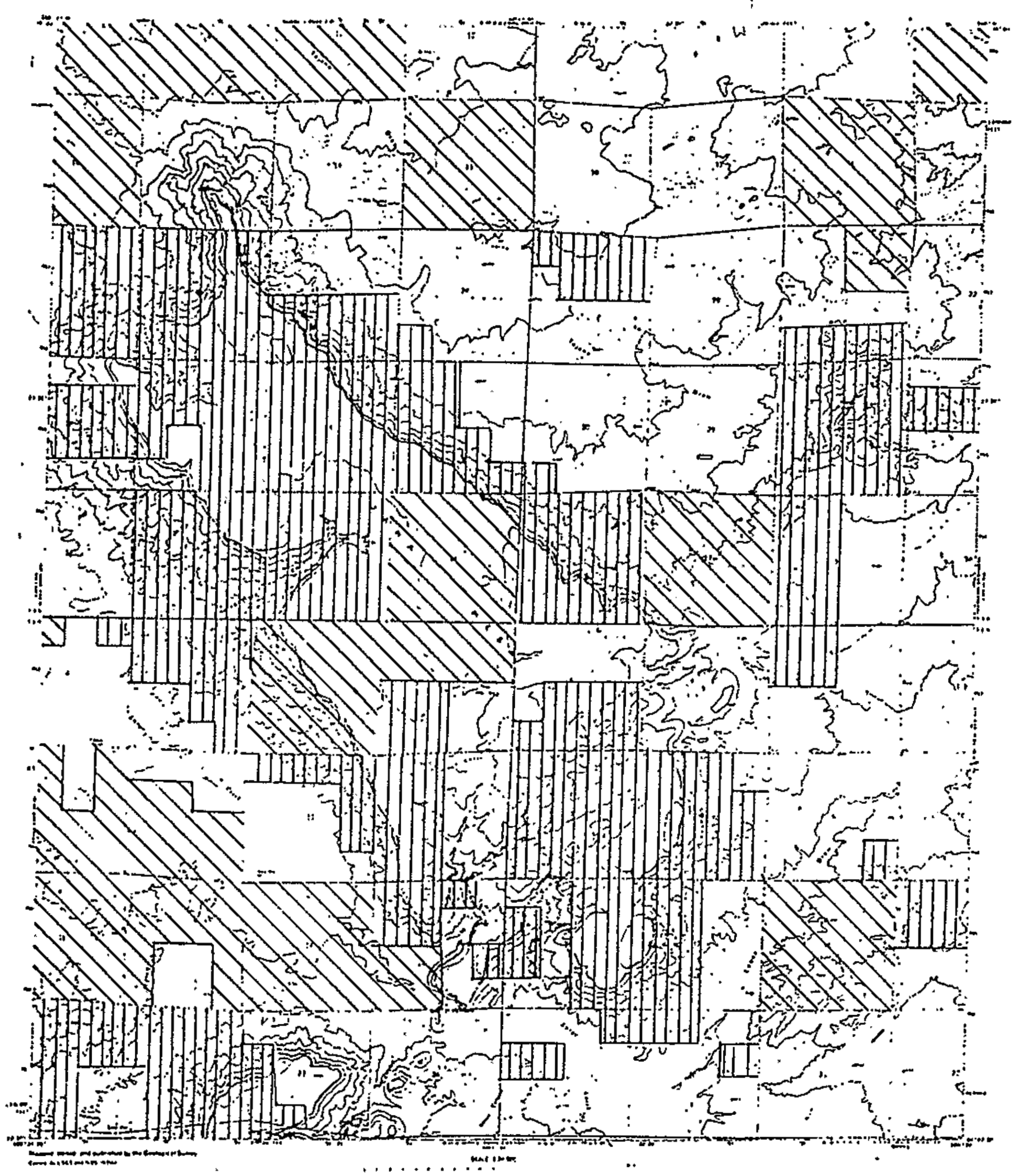


FIGURE 2a Surface Ownership
Tejona Mesa Quadrangle

| | |
|---|---|
| Private | [blank box] |
| State | [diagonal hatching] |
| Federal | [vertical hatching] |

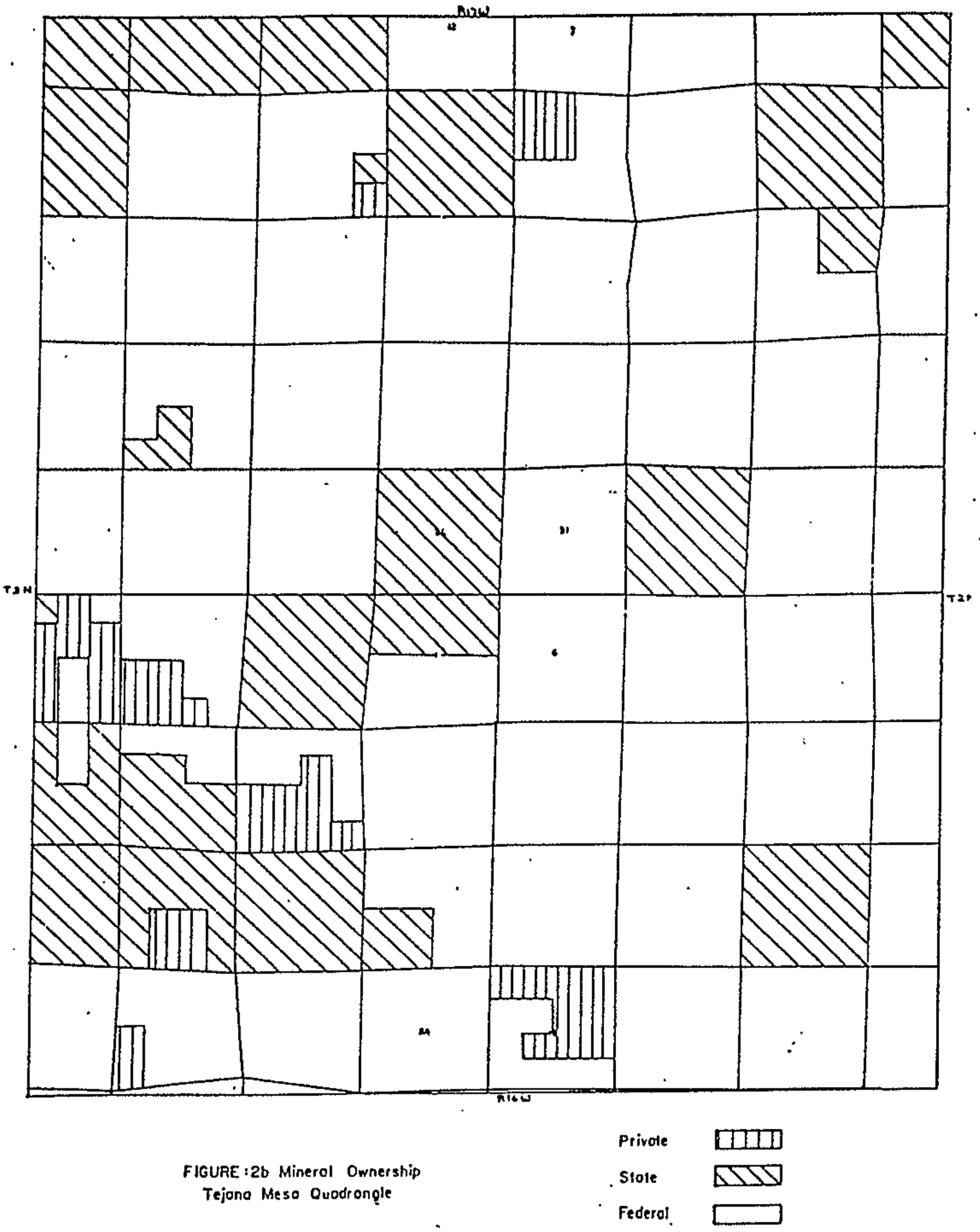



FIGURE:2b Mineral Ownership
Tejana Mesa Quadrangle

## Topography

Surface elevations on Tejana Mesa quadrangle range from 7,700 ft on the top of Mesa Tinaja to 6,560 ft in the Largo Creek area. Tejana Mesa is a major topographical feature oriented in a northwest-southeast direction covering approximately 25% of the quadrangle. Mesa Tinaja is another topographic high in the study area with a relief of 600 ft.

Three major drainage systems are on the quadrangle: Tejana Draw in the northeast portion of the study area, Lopez Draw in the southeast part , and Largo Creek on the southwest side of Tejana Mesa. All of these are ephemeral streams and are dry a great percentage of the year.

El Porticito at the southeast end of Tejana Mesa is a volcanic neck. Mesa Tinaja and two high points to the northeast and south of this point are also volcanic necks .

## Previous work

Little previous work has been done in the study area on the Cretaceous coal-bearing rocks. M.K. Shaler (1906) delineated the Salt Lake coal field in a reconnaissance study of the Durango-Gallup coal field. A reconnaissance map in this area for the state geologic map was done by Dane and Bachman (1965) in which the Cretaceous rocks were mapped as Mesaverde Group. Foster (1964) mentioned the Cretaceous rocks in Catron County in his discussion of this county's stratigraphy and petroleum potential and noted the occurence of coal in this strata. Recently the U.S. Geological Survey has proposed the name "Moreno Hill Formation" (McLellan, and others, 1983) for the coal-bearing units which outcrop north and west of the Tejana Mesa quadrangle. This proposed name is a result of a cooperative mapping project of eight quadrangles north and west of the study area by the U.S. Geological Survey Coal Branch and the New Mexico Bureau of Mines and Mineral Resources . The Cretaceous units outcropping in the study area are equivalent to the Moreno Hill Formation.

More work has been done on the Tertiary units in this area. Willard (1959) described the Baca and Datil Formations and the basalt flows in northern Catron County. Snyder (1971) and Johnson (1978) both did detailed studies on the Baca Formation in west-central New Mexico. The most recent work concerning the Baca Formation and the Cretaceous contact and its uranium potential has been done by Guilinger(1982) which included the northeast portion of the Tejana Mesa quadrangle.

## Scope of study

This report is to provide a geologic map of the Tejana Mesa quadrangle with emphasis on the Cretaceous coal-bearing sequence in the area. This work further delineates the southeastern portion of the Salt Lake coal field and extends the known coal-resource potential of the area south of the Fence Lake 1:100,000 map done by the U.S. Gelogical Survey and the New Mexico Bureau of Mines and Mineral Resources.

The report is based on field mapping of the Tejana Mesa 7.5 min quadrangle and subsequent drilling for subsurface stratigraphic data. Coals penetrated in drilling were collected and tested for quality.

## Structure

Structurally, the area shows minor flexures and northeast faulting in the area of Mesa Tinaja extending towards Tejana Mesa and into the Largo Creek area. The general dip of the rock units in the study area is to the southeast and averages 3-5 degrees. An anticlinal feature in the northern half of Tejana Mesa extends onto the southern portion of Cerro Prieto quadrangle. The flexure has an east-west to northeast-southwest trend and is plunging to the east. The general dip on the south limb of the anticline is 4 degrees to the southwest.

Along the edge of Tejana Mesa are several slump blocks and areas of minor faulting. A small northeast-trending dike occurs on the northeast side of Mesa Tinaja, but no major faulting occurred adjacent to this intrusion. A large system of faults and volcanic intrusions exists along a northeast-trending line including El Porticito and Mesa Tinaja extending north to Veteado Mountain. The southeast portion of Tejana Mesa is faulted along this northeast trend.

## Cross sections

Two cross sections were drawn to show the structure in areas where coal was seen in outcrop or evident from drilling in the study area. The locations of the cross sections are shown on the accompanying geologic map.

Section A-A′- (Fig. 3) is located in the Largo Creek area of the quadrangle oriented in a northwest-southeast direction, parallel to the general structural dip of the area. At the northwest end of the cross section the middle member of the Moreno Hill Formation is projected from an outcrop on the adjacent Lake Armijo 7.5 min quadrangle. The 1.5-ft coal is projected into the cross section from the outcrop indicated on the geologic map. The angle of dip is less than one degree on the northwest end of the cross section, but changes to three degrees on the other side of the fault, indicating that some tilting is associated with

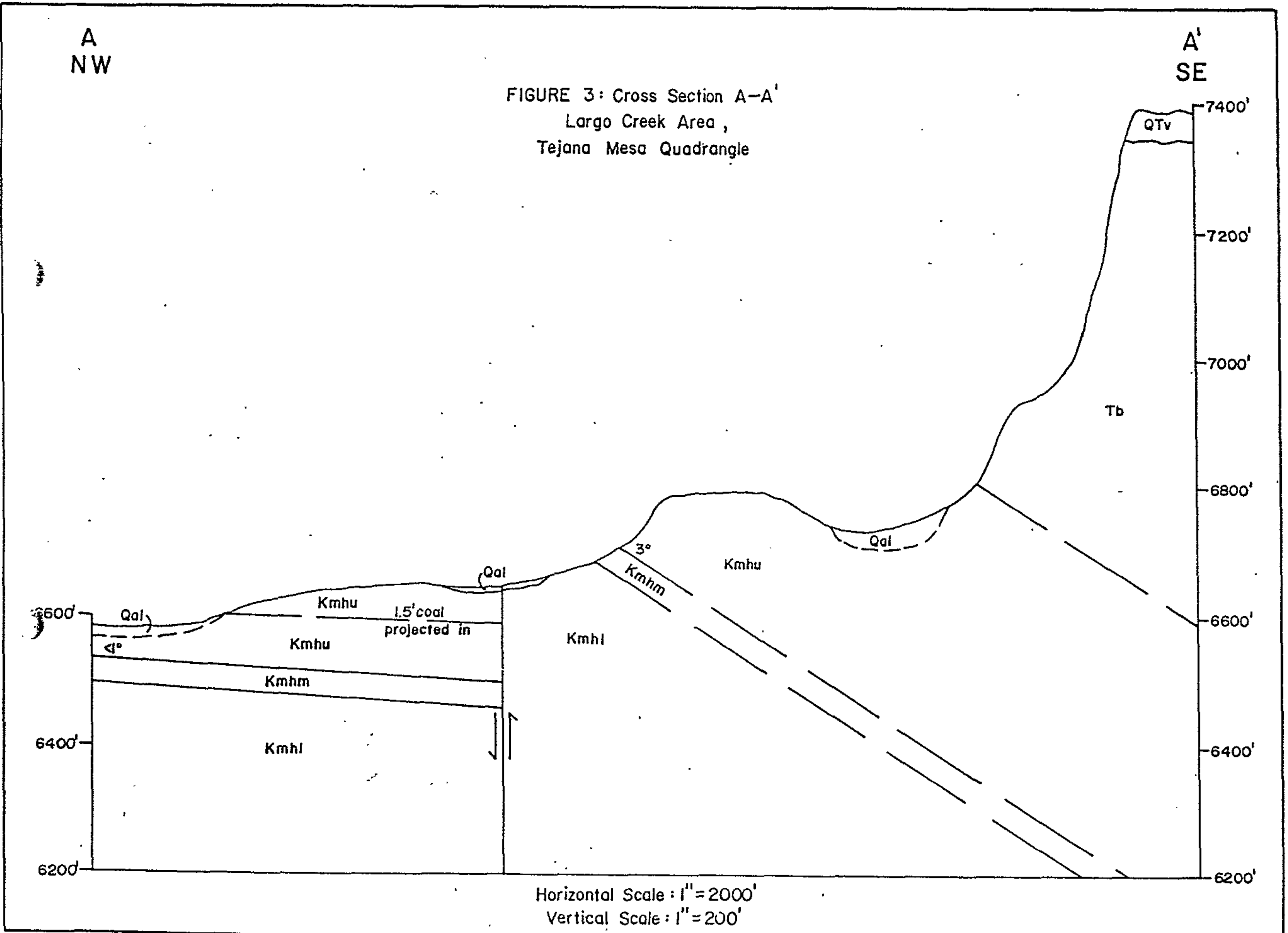



FIGURE 3: Cross Section A–A'
Largo Creek Area,
Tejana Mesa Quadrangle

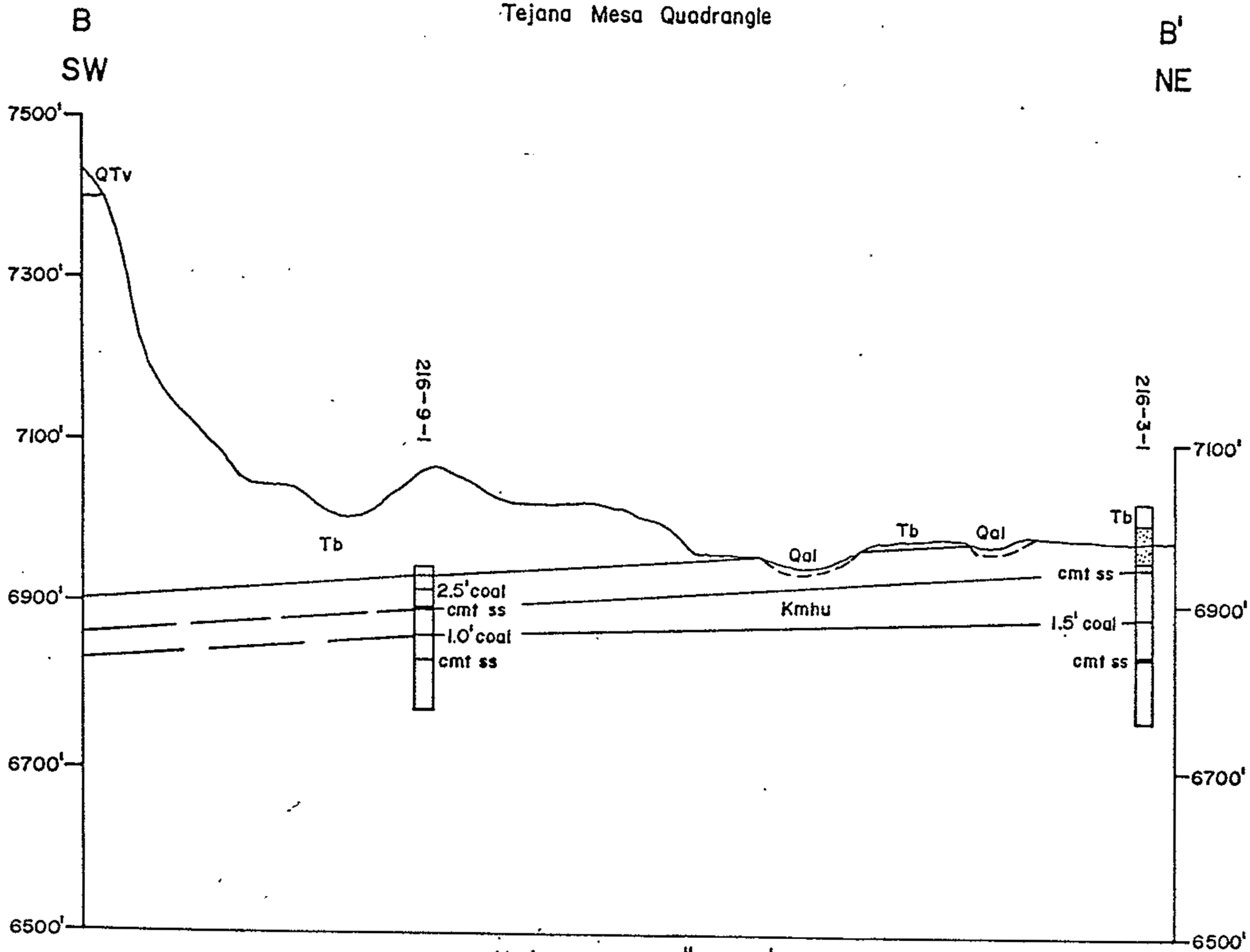
the faulting. The fault is not seen on the surface because of the valley fill but is indicated by the re-occurence of the middle Moreno Hill Formation in outcrop. From outcrop the northwest side of the fault is apparently downthrown with respect to the southeast side with a displacement of 330 ft.

Section B-B′- (Fig. 4) is located on the eastern edge of the Tejana Mesa with two drill holes projected into the line. The cross section is parallel to the general strike of the area. No faulting is evident in the area of the cross section. In the two drill holes, the Baca-upper Moreno Hill Formation contact is intersected. Two thin coals of the upper Moreno Hill Formation were found in drill hole 216-9-1 and one coal in drill hole 216-3-1. Although the middle Moreno Hill Formation was not reached in these drill holes, the upper member is known to be thick in this area; therefore, these coals are assumed to be not part of the twilight zone (Roybal, Campbell 1981) and probably represent a stratigraphically higher coal zone. Descriptions of the cuttings and geophysical logs are included in appendix A for these two holes.

## Igneous rocks

Tejana Mesa is covered by an olivine basalt flow that averages 40 ft in thickness. The southeastern part of this

FIGURE 4: Cross Section B-B'
East Central Portion,
Tejana Mesa Quadrangle




Horizontal Scale: 1" = 2000'
Vertical Scale: 1" = 200'

mesa is covered by a more scoriaceous part of the flow, indicating a volcanic neck, and stands out dramatically on areal photographs because of its red-brown color.

Extending from Tejana Mesa in sec. 5, T. 2 N., R. 16 W. is a breccia consisting of angular basaltic fragments and rounded calcareous sandstones of the underlying Datil Group. The angularity of the volcanic material indicates a closeness to the source. This breccia is cemented by botryoidal calcareous material that has been percolated through this detrital deposit, probably by ground water.

Another breccia occurs in sec. 5, T. 2 N., R. 16 W. coming off of Tejana Mesa from the area of the scoriaceous basalt flow. This breccia consists of fragments of scoria and other lithic fragments and is cemented together by tuffaceous material. These two breccias are concentrated at this point of the mesa and flow in a northeast direction. The basaltic breccia flowed further from the source and possibly was part of a mud flow caused by the volcanic activity.

Mesa Tinaja is capped by a basalt flow which is probably of the same age as the flow on Tejana Mesa. An older flow occurs below the cap rock on Mesa Tinaja and caps the small knoll south of Mesa Tinaja. Several necks in the vicinity of Mesa Tinaja as well as a small northeast-trending dike appear to be older than the cap rock of Tejana Mesa.

Small patches of in-place volcanic basalt southwest of Mesa Tinaja overly a gray to pinkish-gray calcareous lithic sandstone of the transitional zone between the Datil volcanic sediments and the Baca Formation. A thin sliver of basalt caps a slump block located on the north side of the ridge between the two mesas and uncomformably overlies a thin section of the same sandstone.

Flows on Tejana Mesa quadrangle are reported to be of late Tertiary or Quaternary age (Foster, 1964). No specific age has been assigned to these volcanics and no radiometric work is known to have been done on these rocks.

## General stratigraphy

Eight mappable stratigraphic units are exposed in the study area ranging in age from Quaternary to Cretaceous. The Quaternary units are alluvial valley fill and volcanics covering the prominent mesas: Tejana Mesa, El Porticito, and Mesa Tinaja, which are classified as Quaternary/Tertiary in age. The Datil Group volcanic sedimentary facies and the Baca Formation sedimentary units are of Tertiary age. The Cretaceous units are the three members of the Moreno Hill Formation. Fig. 5 is a generalized stratigraphic column for the study area.

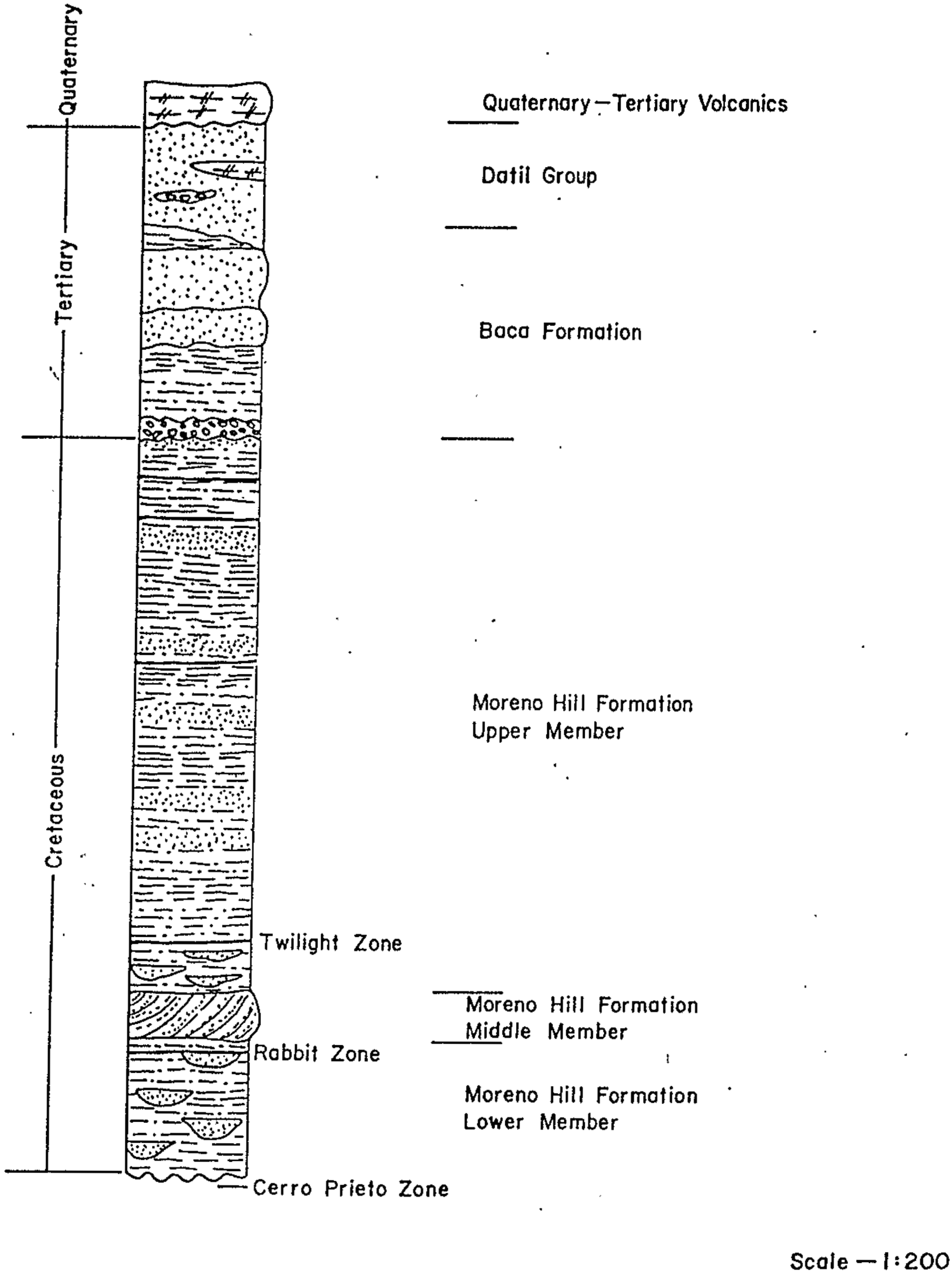



FIGURE 5: Generalized Stratigraphic Column for Tejana Mesa Quadrangle

Tertiary stratigraphy

The Datil volcanic sediments unconformably underlie Quaternary/Tertiary basalt flows in the northern portion of the quadrangle. The unit is thin (20-60 ft) in this region and has a gradational contact with the underlying Baca. Directly underneath the basalt flow, the Datil sediments are tuffaceous with pebbles of andesite and quartzite in the matrix. The majority of the Datil Group in the study area is made up of gray to pinkish-gray, fine-grained, lithic arenites. Predominant lithic fragments are andesites, quartzites, and limestones. Grains are subangular to subrounded in the sandstone which can be highly cemented by calcareous cement or friable. Within the Datil unit, vertical and horizontal variation ranges from fine-grained sandstone to lenses of pebble and cobble-size material in a finer grained, sand-sized matrix. This unit has been interpreted as Fence Lake Gravel (Guilinger,1982), but I disagree because of the minor percentage, mostly in thin conglomeratic lenses, of cobble material within the entire unit. Cobble material is a dominant feature of the Fence Lake Gravels. In the Fence Lake Gravels, basaltic material is predominant which is not the case here.

Datil sediments grade into the sedimentary sequence of the Baca Formation. The Baca consists of a sequence of red-brown to maroon mudstones and siltstones, gray to pink-gray, arkosic sandstones, and pebble conglomerate. The base of the Baca is generally determined in the study area by an erosional contact at the base of a loosely cemented conglomerate of highly rounded, red, purple, and gray quartzite pebbles , rounded lithic fragments of the underlying Cretaceous sandstones, and pieces of petrified wood from the Cretaceous . The conglomerate is poorly cemented and thin (6 inches-2 ft) and is often recognized by the lag gravel of quartzite cobbles covering Cretaceous outcrops. In many areas, because the conglomerate is non-existent, the contact between the Cretaceous sediments and the Baca is determined by the occurence of red-brown to maroon mudstones, claystones, and siltstones. In the northeast portion of the study area, this contact can be difficult to determine because of oxidation of the upper part of the Moreno Hill Formation due to a paleosol; however, the contact can be determined by looking closly at the sandstones.

The sequence of fine-grained sediments in the lower part of the Baca Formation ranges in thickness from 60 to 100 ft and is well exposed in the northeast portion of the quadrangle. The mudstones, siltstones, and claystones show some parallel bedding and burrowing, but are generally without structure. Within this fine-grained sequence are thin friable sandstones and conglomerates, indicating a rapid and relatively short-lived change in environment. The change from a low-energy fluvial environment to one of high energy indicates a time of flooding in a generally dry climate.

Above this fine-grained material are several sandstones in a sequence 60-120 ft thick exposed along Tejana Mesa and the ridge east of Mesa Tinaja. The lowermost sand is a yellow-gray subangular to subrounded, medium to coarse-grained, arkosic sandstone. The unit lacks internal structure in the upper part of this 20-40 ft sand, but contains rip up clasts of the underlying mudstone at the base.

Another sand in this sequence of the Baca Formation is a gray subangular to subrounded, medium to coarse-grained, arkosic sandstone. This sandstone shows bimodal characteristics: quartz, feldspar, and biotite grains are predominantly medium grained, the jasper and quartzite are coarser grained. Calcareous cementing within the unit varies, from friable to well cemented. The gray sandstone, which is laterally extensive with a thickness up to 60 ft on the Tejana Mesa quadrangle, shows a fining upward sequence in a generally massive sand unit. The presence of sandstones is indicative of a higher energy environment with larger material being transported. The unweathered state of the constitiuents and the lack of internal bedding indicate a period of rapid deposition .

Conformably overlying the gray, arkosic sandstone in the northern portion of the quadrangle in Tejana Mesa and the ridge between Mesa Tinaja is a much finer grained, pink-gray, lithic sandstone. This sandstone appears to be the transition zone between the Baca Formation and Datil Group because of the shift to predominantly lithic components and the highly cemented tuffaceous (?) nature of the unit. This sandstone is directly below the volcanic breccia and below the basalt block along the ridge from Tejana Mesa to Mesa Tinaja. Outcrops of this transition zone are indicated on the map as Td/Tb.

In the southern third of Tejana Mesa, the gray, arkosic sand is overlain by another sequence of fine-grained, red-brown to maroon mudstones and siltstones. This part of the Baca is at the most 20 ft thick and represents a return to a low-energy, dry environment similar to that represented by sediments at the base of the Baca Formation in this area.

Snyder (1971) and Johnson (1978) indicated that source areas for the Baca sediments from the northeast to the southwest are the Defiance and Zuni Uplifts, and the Mogollon Highland. This interpretation is based on the presence of quartzite and granite cobbles in the Baca conglomerates. Johnson (1978) postulates this area to be part of the distal-fan facies of the Baca Formation.

## Cretaceous stratigraphy

The Cretaceous coal-bearing sequence in the study area is tentatively named the Moreno Hill Formation by the U.S. Geological Survey (McLellan and others, 1983). The formation is divided into three members: the upper Moreno Hill, a siltstone/ claystone unit with a few friable sandstones and channel sandstones; the middle Moreno Hill, a persistent fluvial sandstone; and the lower Moreno Hill, a sandstone/mudstone sequence. Maximum thickness of the entire Moreno Hill Formation is 920 ft. The members are designated Kmhu, Kmhm, and Kmhl on the accompanying geologic map.

The lower Moreno Hill Formation in the study area is a maximum of 140-160 ft thick. Outcrops of the lower unit are predominantly channel sands and crevasse splays that grade laterally into siltstones and mudstones. Sands are well-sorted, well-rounded, fine to medium-grained sandstones of predominantly quartz (90-95%) in a siliceous cement. Secondary minerals in the lower sandstones are weathered feldspars that make up the remaining portion of rock constituients. Slight amounts of biotite and other mafics occur but are are rare (> 0.5%). Channel deposits that are 10-25 ft thick show trough crossbedding. The top 6 inches to 1 ft of these sands often have iron staining, giving a characteristic iron cap on a yellow-gray sandstone. The maturity of the constituients of the channel sands indicates a stream environment with a low gradient and the at some distance from the source of material.

Above and below the channel sandstones and laterally adjacent to crevasse splays of the lower Moreno Hill member are siltstones and mudstones. Several organic-rich gray, brown, and black mudstones occur within this sequence. Brown mudstones have a large amount of coalified plant fragments and often are found associated with a coal seam. These deposits are indicative of an anaerobic environment needed to produce coals. Lateral transition from crevasse splay to siltstones and mudstones indicates a floodplain environment.

Coal beds occur in this sequence. The rabbit coal zone is within 60 ft of the base of the middle sandstone unit of the Moreno Hill and outcrops in the study area in sec. 21, T. 3 N., R. 17 W.. The rabbit zone is recognized further north on the Cerro Prieto and The Dyke quadrangles (Roybal and Campbell,1981). There the coal outcrop is approximately 20 ft below the middle member and has one tonstein. This seam can be traced for 1/4 mi before it dips into the subsurface. The coal is 0.9 ft thick above the 4 inch tonstein. Below the parting, 0.75 ft of shaley coal occurs overlying another 0.75 ft seam of coal. A lower coal zone, the cerro prieto zone, in the lower member of the Moreno Hill Formation and 150 ft below the middle member is not exposed in this area, but is probably near the surface in the northern portion of the quadrangle,because of the gentle southeast dip of the beds.

The middle member of the Moreno Hill Formation is a medium to coarse-grained, subanglar to subrounded, fluvial sandstone. The middle unit consists of fluvial, coalescing-channel sands, predominantly of quartz (85%) with relatively unweathered plagioclaise feldspars (15%). This grain-supported rock is poorly sorted with little or no clay to silt fraction . The middle sandstone unit is predominantly massive to planar, trough-crossbedded pinkish-orange to gray sandstone that varies in thickness from 40 to 60 ft. Characteristically this nonfriable sandstone contains iron concretions that vary in size from 0.5 inches to 3 inches diameter and are more abundant in the upper portion of the unit. The lower contact is erosional with the lower Moreno Hill formation.

The overlying upper Moreno Hill consists of a thick sequence of silty sandstones, siltstones, claystones and thin coals. This sequence has greater exposure (700 ft) in the study area than to the north due to the general southeast dip of the beds. The contact between the middle sand and the upper unit is erosional and often a channel sand similar to the lower unit overlies the middle unit. Predominant, ledge-forming sandstones within the upper member are concentrated within the first hundred feet above the middle member. These trough-crossbedded sandstones of fine to medium-grained material are predominantly quartz (95%) with a siliceous cement. Sandstones show iron staining in the top 0.5 ft-1 ft of the outcrop. Above these channel sands, sandstones are yellow, gray to olive-gray, silty, and very friable. Silty sandstones are subangular to subrounded, medium to fine-grained, quartz-dominated with highly weathered feldspars going to clay. Yellow, gray, and olive claystones and siltstones make up a majority of this upper member, indicating a drier environment than when the underlying Moreno Hill was deposited. Occasionally, coals occur in this upper unit. Two coals were penetrated in drill holes done by New Mexico Bureau of Mines and Mineral Resources and one coal crops out. Because both drill holes penetrated the Baca/Moreno Hill contact but not the middle Moreno Hill member, they are discussed with respect to the Baca contact. Drill holes are numbered by township range, section, and number of holes in that section; i.e. 216-3-1 is in T. 2 N. R. 16 W., sec. 3, first drill hole in that section.

In sec. 9, T. 2 N., R. 16 W., a 2.5 ft coal in the upper Moreno Hill was penetrated 17.5 ft below the Baca contact. In the same drill hole, a 1.0 ft coal was found 52.5 ft below the base of the first coal. In sec. 3, T. 2 N., R. 16 W., a 1.5 ft coal is 112 ft below the Baca contact. These two drill holes are represented in cross section B-B' and have been projected into a line parallel to strike. The lower coal in 216-9-1 and the coal in 216-3-1 appear to be the same coal zone. The larger coal in 216-9-1 appears to be channeled out by a sandstone present in 216-3-1.

The coal outcrop in the upper member occurs in a knoll in sec. 10, T. 3 N., R. 17 W. The coal is 1.5 ft thick here, but because of the faulting cannot be projected to the south. This coal is projected into cross section A-A' which is a line parallel to dip. This coal seam would be equivalent to a seam in the twilight zone which is approximately 50-100 ft above the middle member of the Moreno Hill and consists of 1-3 coal seams(Roybal, Campbell, 1981) recognized to the north of this study area.

Coal quality

Coal-quality analyses for Btu, ash, and moisture were run on two coals in drill holes 216-9-1 and 216-3-1. The analyses are in the same range as analyses for coals in other areas of the Salt Lake coal field , but differences do exist. Btu values for the two coals (11,306 Btu/lb and 8,294 Btu/lb) are at the upper and lower limits of the standard-deviation range (+/-) for other analyses in the area (9,660 Btu/lb +/-1,516). Moisture content of these coals are 7.3% and 10.3% compared to the average moisture content of 4.9% +/-3.1 of other coals in the Salt Lake coal field. Ash content is lower (11.6% and 17.4%) than the average (21.8% +/- 11.0%) for other analyses and is at the low end of the standard deviation range for ash. Using the average sulfur content of Salt Lake coals, the rank, based on mineral matter free Btu/lb, is high volatile C bituminous and subbituminous C respectively for the coals analyzed from Tejana Mesa. The overall environment of deposition for the upper Moreno Hill is drier than the lower member, therefore the organic sulfur content should be lower in the upper member, raising the MMF Btu. Sulfur of a detrital or bacterial nature may increase the sulfur content of the coals, but analyses are needed to determine if these factors are significant. Fig. 6 shows data for the drill hole samples on Tejana Mesa and the average for coals in the Salt Lake field. A comparison of coals from above the middle member of the Moreno Hill is not available because of a lack of data from this zone north of Tejana Mesa quadrangle.

## Coal resources

Coal resources are based on information acquired during the course of this project on both subsurface and outcrop data. Average thickness of upper Moreno Hill Formation coals is 1.8 ft, with a standard deviation of +/-0.5 ft. These coals are thinner seams than those found just north of the Tejana Mesa quadrangle. The thicker coals are in the lower member of the Moreno Hill Formation and have greater economic potential. Measured and indicated coal-resource figures are based on 1800 tons/acre ft for bituminous coals and were figured according to U.S. Bureau of Mines-U.S. Geological Survey Prof. Paper 1450-B. Total strippable-coal resources for Tejana Mesa quadrangle are 34.7 million tons, 22.5 million tons of which are within a 20:1 stripping ratio. Fig. 7 shows a breakdown of the coal resources by township and range. Areas of coal potential indicated by outcrop and drilling data are concentrated in the three major drainage areas of the quadrangle. The outcrop of coal under the middle Moreno Hill sandstone in

Fig. 6. Analyses for coals in the Salt Lake field in comparison to coals on Tejana Mesa quadrangle

Analysis for Salt Lake field

| | | avg. | s.d. | max. | min. |
|---|---|---|---|---|---|
| Prox. Moisture | (18) | 4.9% | 3.09 | 10.86 | 1.56 |
| Prox. Ash | (31) | 21.8% | 11.0 | 49.6 | 5.1 |
| Btu/lb | (33) | 9960 | 1516 | 11786 | 6026 |

Analysis for Tejana Mesa quadrangle

| 216-3-1 140-145 ft | | 216-9-1 30-35 ft | |
|---|---|---|---|
| Prox. moisture | 7.3 | Prox. moisture | 10.3 |
| Prox. ash | 11.6 | Prox. ash | 17.4 |
| Btu/lb | 11306 | Btu/lb | 8294 |
| MMF Btu/lb | 12945 | MMF Btu/lb | 10109 |

Fig. 7. Coal resources for Tejana Mesa quadrangle by township and range (in millions of tons)

| Depth category | Township-Range | Measured | Indicated | Total |
|---|---|---|---|---|
| 0-150 ft | T2N R16W | 0.77 | 6.17 | 6.94 |
| 0-150 ft | T2N R17W | 0.68 | 5.42 | 6.11 |
| 150-250 ft | T2N R17W | 0.34 | 2.71 | 3.05 |
| 0-150 ft | T3N R17W | 2.27 | 16.29 | 18.56 |

Total 0-150 ft: 31.61 million tons

Total 150-250 ft: 3.05 million tons

| Total stripping at 20:1 ratio: | Measured | Indicated | Total |
|---|---|---|---|
| | 2.70 | 19.75 | 22.45 |

sec. 21, T. 3 N. R. 17 W. and the general geology on the northwest corner of the quadrangle indicate the possibility that thicker coals of the lower member are close to the surface in this area and on Lake Armijo, the quadrangle west of Tejana Mesa.

## Conclusions

Tejana Mesa quadrangle has a large amount of exposed Moreno Hill Formation Cretaceous overlain by Tertiary sediments and volcanic sediments that are capped by volcanics of Quaternary/Tertiary age. The extent of the Moreno Hill outcrops is further to the southeast than previously thought. Most of the exposed Cretaceous rocks are part of the upper member of the Moreno Hill Formation, a sequence of siltstones, silty sandstones, and a few thin (1.5 ft) coals. These coals because of their thinness, probably do not have economic significance at this time. The fact that the upper member is quite thick also becomes an obstacle in considering the lower member coals. Possibly that the upper Moreno Hill is not as thick on the south side of the northeast-trending fault zone;if this is so, the lower Moreno Hill coals would be within the 250 ft of the surface. More drilling is needed to determine the validity of this assumption.

The presence of several volcanic necks apparently of different ages and faulting in this quadrangle may complicate the structure more than what is seen in outcrop. More drilling on both sides of the fault area would indicate the extent of the faulting and its effect on the coal-bearing Moreno Hill Formation.

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# Appendix A: Drill Hole Descriptions from Cuttings and Geophysical Logs

Hole no. 216-3-1
Location 2600 E. of W. line
4750 N. of S. line
County: Catron
Quadrangle: Tejana Mesa
Water: Water well

Township 2N. Range 16W. Sec.3
Elevation 7030 ft
Mineral Ownership: Federal
Total Depth 263 ft

Data geophysical logs- gamma(api, cps), density (gm/cc), resistivity (ohm/m), caliper, porosity, s.p.(mv), neutron, resistance (ohms)

| Formation | Depth | Description |
|---|---|---|
| Baca Formation | 0.0-7.5 ft | Sandy siltstone, gray brown, coarse-medium grained,calcareous cement. |
| | 7.5-30.0 ft | Silty sandstone, brown,very fine-very coarse, subrounded very poorly sorted. |
| Moreno Hill Fm upper member | 30.0-35.0 ft | Sandy siltstone,yellow brown, very coarse-coarse grained, calcareous cement. |
| | 35.0-41.5 ft | Sandstone, yellow gray,fine sand-silt, angular, calcareous cement,minor coal. |
| | 41.5-45.5 ft | Silty sandstone,yellow gray, fine sand-silt,moderate sorting,angular,calcareous cement. |
| | 45.5-50.5 ft | Sandy siltstone,yellow gray, fine grained, iron staining. |
| | 50.5-54.0 ft | Siltstone, light gray, micaceous. |
| | 54.0-60.0 ft | Sandy siltstone, light gray, light gray, coarse-medium grained, minor coal fragments. |
| | 60.0-66.5 ft | Silty sandstone, yellow brown, coarse sand-silt,very poorly sorted, subangular. |

| | |
|---|---|
| 66.5-69.5 ft | Claystone, light gray, interbedded mudstone, iron staining. |
| 69.5-79.0 ft | Silty sandstone, gray, very coarse-coarse sand, very poorly sorted. |
| 79.0-87.5 ft | Claystone, olive gray, minute coal fragments. |
| 87.5-94.0 ft | Mudstone, light olive gray coal fragments. |
| 94.0 115.5 ft | Siltstone, olive gray, coal fragments. |
| 115.5-121. ft | Siltstone, medium light gray. |
| 121.0-136. ft | Mudstone, light olive gray, sandy from 122.5-123.5 ft coal fragments. |
| 136.0-140. ft | Silty sandstone, light gray, fine sand-silt, subangular. |
| 140.0-142. ft | Mudstone, olive gray, coal fragments. |
| 142.-143.5 ft | Coal |
| 143.5-152. ft | Mudstone, olive gray, coal fragments. |
| 152.0-169. ft | Mudstone, light gray, coal fragments. |
| 169.0-176. ft | Siltstone, olive gray, coal fragments. |
| 176.0-187. ft | Silty sandstone, light olive gray, fine sand-silt, subangular, poorly sorted, mica. |
| 187.-189.5 ft | Sandstone, light olive gray, fine sand-silt, angular, poorly sorted. |
| 189.5-196. ft | Sandstone, light gray, medium sand-silt, subangular, very poorly sorted. |

| | |
|---|---|
| 196.-202.5 ft | Silty sandstone, light gray, medium sand-silt, subangular very poorly sorted. |
| 202.5-212. ft | Sandstone, olive gray, medium sand-silt, subanglar, very poorly sorted, mica. |
| 212.-222.0 ft | Siltstone, olive gray, angular, coal fragments. |
| 222.-231.5 ft | Mudstone, olive gray, angular coal fragments. |
| 231.5-245. ft | Sandstone, light gray, fine sand-silt, subangular-sub-rounded, poorly sorted. |
| 245.0-249. ft | Silty sandstone, light gray coarse sand-silt, subangular very poorly sorted. |
| 249.-254.5 ft | Mudstone, olive gray, minor coal fragments. |
| 254.5-259.5 ft | Claystone, light olive gray. |
| 259.5-264.5 ft | Mudstone,light olive gray, coal fragments. TD |

Hole no. 216-9-1
Location 1190 E. of W. line
2000 N. of S. line
County: Catron
Quadrangle: Tejana Mesa
Water: Water well

Township 2N. Range 16W. Sec.9
Elevation 6940 ft
Mineral Ownership: Federal
Total Depth 175 ft

Data geophysical logs- gamma(api, cps), density (gm/cc), resistivity (ohm/m), caliper, porosity, s.p.(mv), neutron, resistance (ohms)

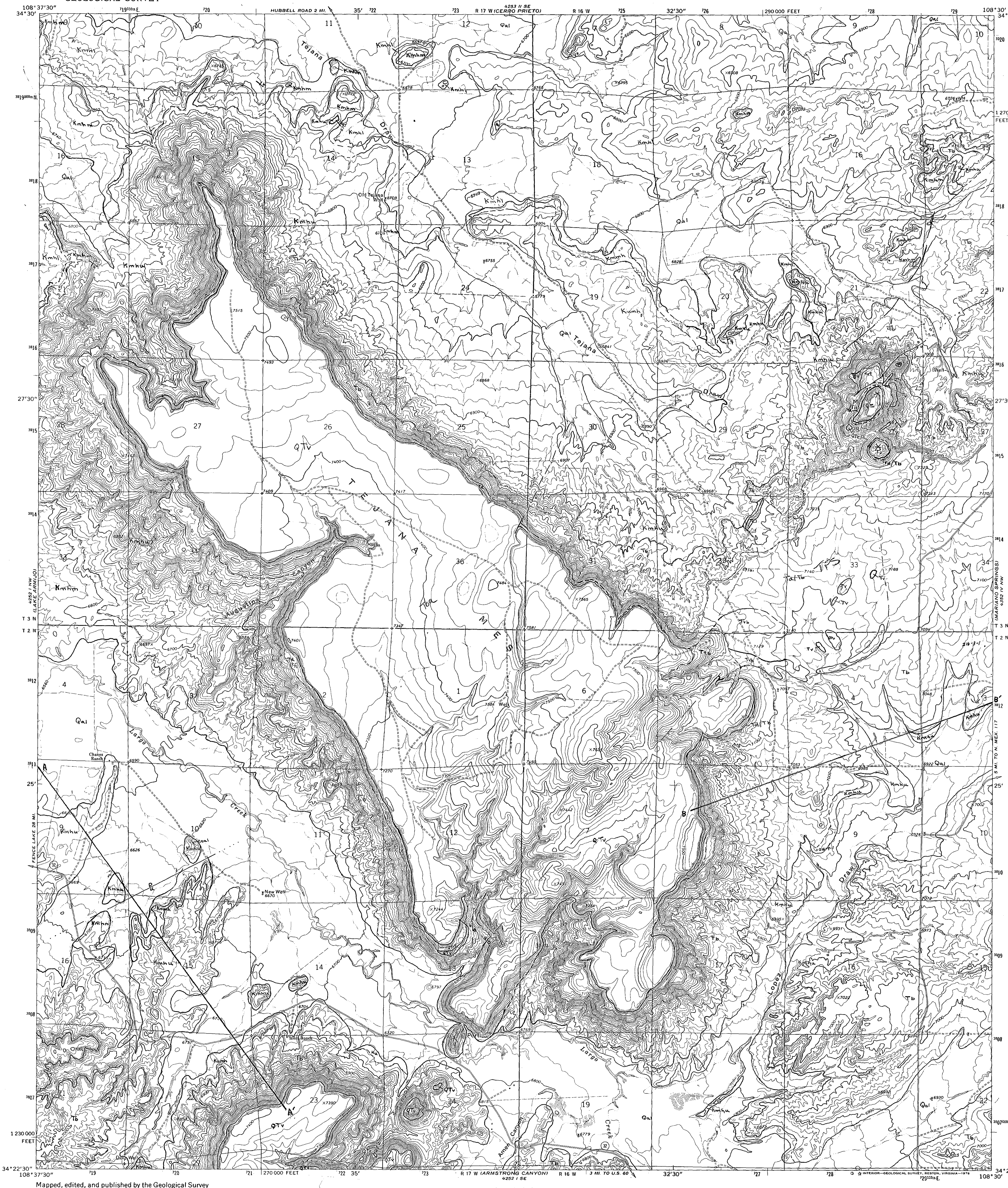
| Formation | Depth | Description |
|---|---|---|
| Baca Formation | 0.0-5.0 ft | Silty sandstone, medium brown very coarse-coarse sand, calcareous cement. |
| | 5.0-10.0 ft | Silty sandstone, medium brown coarse sand-coarse silt, subangular, coal fragments. |
| | 10.0-14.0 ft | Sandstone, medium brown, very coarse-fine sand, subangular, very poorly sorted. |
| Moreno Hill Fm upper member | 14.0-17.5 ft | Sandy siltstone, light olive gray, coal fragments. |
| | 17.5-24.5 ft | Silty mudstone, olive gray, coal fragments. |
| | 24.5-29.5 ft | Sandy mudstone, olive gray, coal fragments. |
| | 29.5-31.5 ft | Claystone, olive gray, coal fragments. |
| | 31.5-34.0 ft | Coal. |
| | 34.0-34.5 ft | Claystone, olive gray, coal fragments. |
| | 34.5-41.0 ft | Mudstone, brown gray, coal fragments, iron staining. |
| | 41.0-44.5 ft | Siltstone, medium gray. |
| | 44.5-49.0 ft | Silty sandstone, light gray, medium sand-medium silt, sub- |
| | 49.0-52.0 ft | Silty sandstone, medium-light gray, medium sand-medium silt, subangular, cemented. |

| | |
|---|---|
| 52.0-61.5 ft | Silty sandstone, light gray, medium sand-medium silt, angular. |
| 61.5-69.5 ft | Siltstone, light gray, coal fragments. |
| 69.5-78.5 ft | Siltstone, light gray, micaceous, coal fragments. |
| 78.5-81.0 ft | Clayey siltstone, medium light gray, coal fragments. |
| 81.0-84.5 ft | Siltstone, light gray. |
| 84.5-86.5 ft | Claystone, olive gray. |
| 86.5-87.5 ft | Coal. |
| 87.5-93.5 ft | Sandy mudstone, light olive gray, minor coal. |
| 93.5-104.5 ft | Sandy siltstone, light olive gray, coal fragments. |
| 104.5-114.5 ft | Mudstone, gray. |
| 114.5-122.0 ft | Sandy siltstone. |
| 122.0-125.5 ft | Claystone, olive gray, coal fragments. |
| 125.5-128.0 ft | Silty sandstone, light gray, fine sand-coarse silt, subangular, moderate-poorly srtd |
| 128.0-131.5 ft | Claystone, olive gray. |
| 131.5-134.5 ft | Sandstone with mudstone, light gray, subangular, very poorly |
| 134.5-139.0 | Claystone, olive gray. |
| 139.0-148.0 ft | Sandy siltstone, light olive gray, coarse sand-coarse silt subangular, very poorly srtd. |
| 148.0-153.0 ft | Sandy mudstone, light olive gray, fine-very fine sand. |

| | |
|---|---|
| 153.0 155.0 ft | Silty sandstone, yellow brown coarse sand-coarse silt, sub |
| 155.0-157.5 ft | Mudstone, olive gray, coal fragments. |
| 157.5-165.0 ft | Silty sandstone, light gray, very fine sand-coarse silt, subangular, moderately srtd. |
| | TD |

Plate 1

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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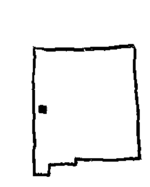
SCALE 1:24 000

CONTOUR INTERVAL 20 FEET



TEJANA MESA, N. MEX.

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## Explanation

- Qal - Quaternary alluvium
- Tba QTv - Quaternary/Tertiary volcanics
- QTvt-Tvt - volcanic talus
- Tba ~~Tv~~ - Tertiary volcanics
- Td - Tertiary Datil Group volcanic sediments
- Td/Tb - Tertiary Datil Group - Baca Formation transitional zone
- Tb - Tertiary Baca Formation
- Kmhu - Cretaceous upper Moreno Hill Formation
- Kmhm - Cretaceous middle Moreno Hill Formation
- Kmhl - Cretaceous lower Moreno Hill Formation