GEOLOGY AND COAL RESOURCES OF THE MARIANO SPRINGS QUADRANGLE, CATRON COUNTY, NEW MEXICO

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9/29/87

ABSTRACT

The Mariano Springs quadrangle is located in west-central New Mexico, approximately 3 mi north of Quemado. The structure in this area is simple. Strata are relatively flat lying, and faulting is minor. The Mariano Springs quadrangle contains seven mappable units: Quaternary alluvium; Tertiary Fence Lake, Spears, and Baca Formations; and the lower, middle, and upper members of the Moreno Hill Formation.

The Moreno Hill Formation consist of a coal-bearing sequence of sandstones, shales, and siltstones. The Baca Formation unconformably overlies the Moreno Hill Formation and contains red and white arkosic sandstones and red mudstones. The Spears Formation conformably overlies the Baca Formation and unconformably underlies the Fence Lake Formation. It contains light-gray sandstones that are composed of volcanic lithic fragments, quartz, and plagioclase. The Fence Lake Formation contains a sequence of basaltic boulder conglomerates and lithic sandstones.

Coal-resource potential in the Mariano Springs quadrangle is low to very low in both the lower and upper members of the Moreno Hill Formation. Coal in the lower member is too deep and cannot be economically recovered using conventional mining methods. Coal in the upper member occurs in thin stringers and, at present, is not an economical deposit.

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INTRODUCTION

This project was initiated by Brian Arkell in the summer of 1985 and completed by Kevin Cook in 1987. This work was part of a mapping project by the New Mexico Bureau of Mines and Mineral Resources and U.S. Geological Survey. The purpose of this part of the project was to map the Mariano Springs quadrangle in detail, in order to obtain an understanding of the stratigraphy, structure, and coal-resource potential in the area.

LOCATION AND ACCESS

The Mariano Springs quadrangle is located in west-central New Mexico, approximately 3 mi north-northeast of Quemado (Fig. 1). NM-117 provides major access to the area and intersects I-40 near Grants, New Mexico, to the north and US-60 to the south. Several well-maintained ranch roads, which run east to west through the area, provide additional access in the Mariano Springs quadrangle. Railroads and commercial airlines are not present in the area.

SURFACE AND MINERAL OWNERSHIP

Information concerning surface ownership was obtained from records at the Catron County Assessor's office in Reserve, New Mexico, and from the BLM District 2 office in Socorro, New Mexico. Fig. 2 shows the distribution of surface ownership in the Mariano Springs quadrangle. Most of the surface ownership is private (59%); the remainder is Federal (26.5%) and State (14.5%).

Mineral ownership for this area was determined from the US BLM Surface-Minerals, Management Quadrangles NW-26, NW-27, SW-1,

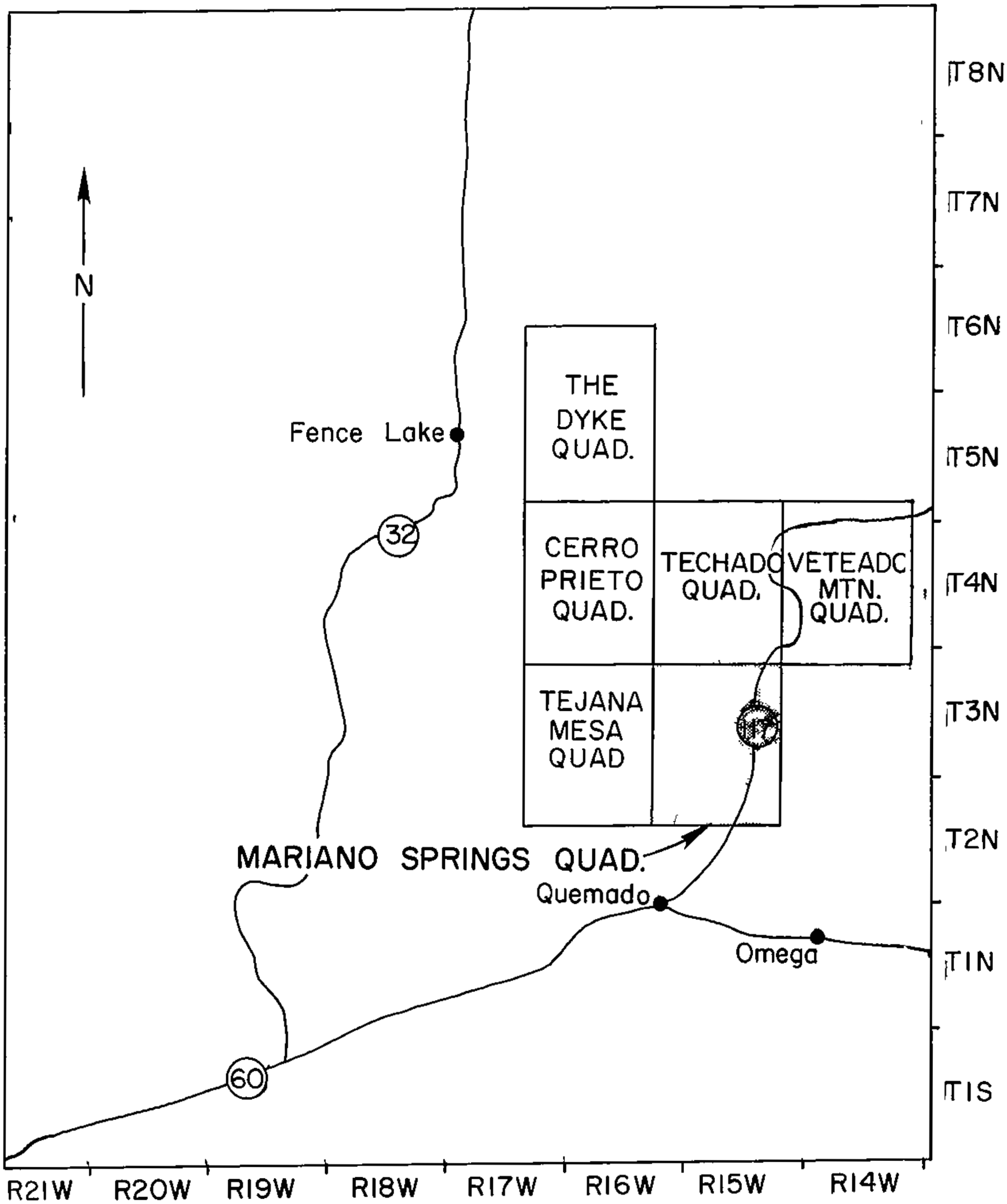


FIGURE 1- General location map of the Mariano Springs quadrangle, west-central New Mexico. Other quadrangles referred to throughout paper.

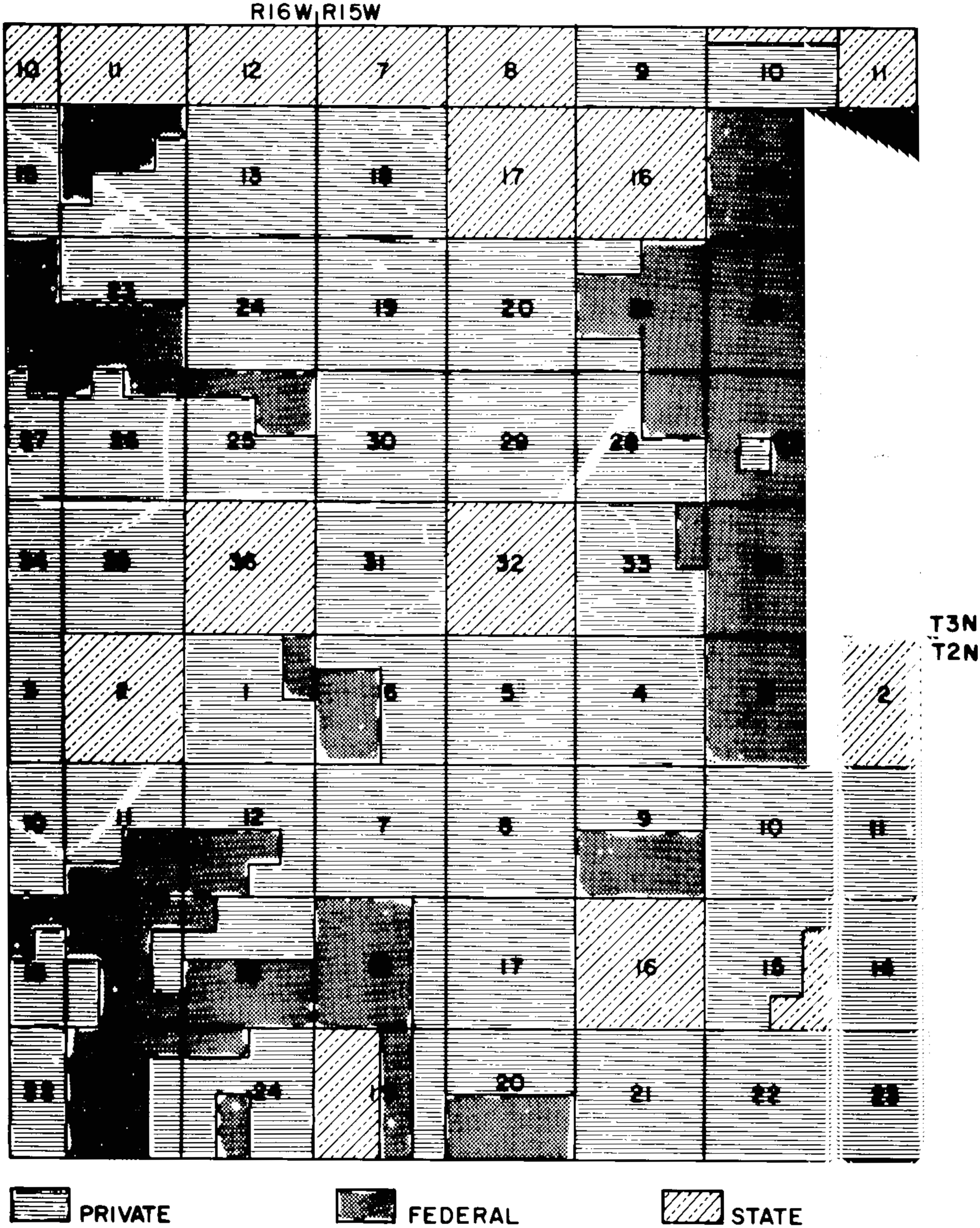


FIGURE 2-Surface ownership in the Mariano Springs quadrangle.

and SW-2. Coal ownership for the Mariano Springs quadrangle (Fig. 3) is predominantly Federal (76.5%); State and private ownership are 16.5% and 7%, respectively.

STRUCTURE

The Mariano Springs quadrangle is located along the southern end of the Colorado Plateau in a structural subdivision called the Mogollon Slope. The Mogollon-Datil volcanic field is located directly south of the study area.

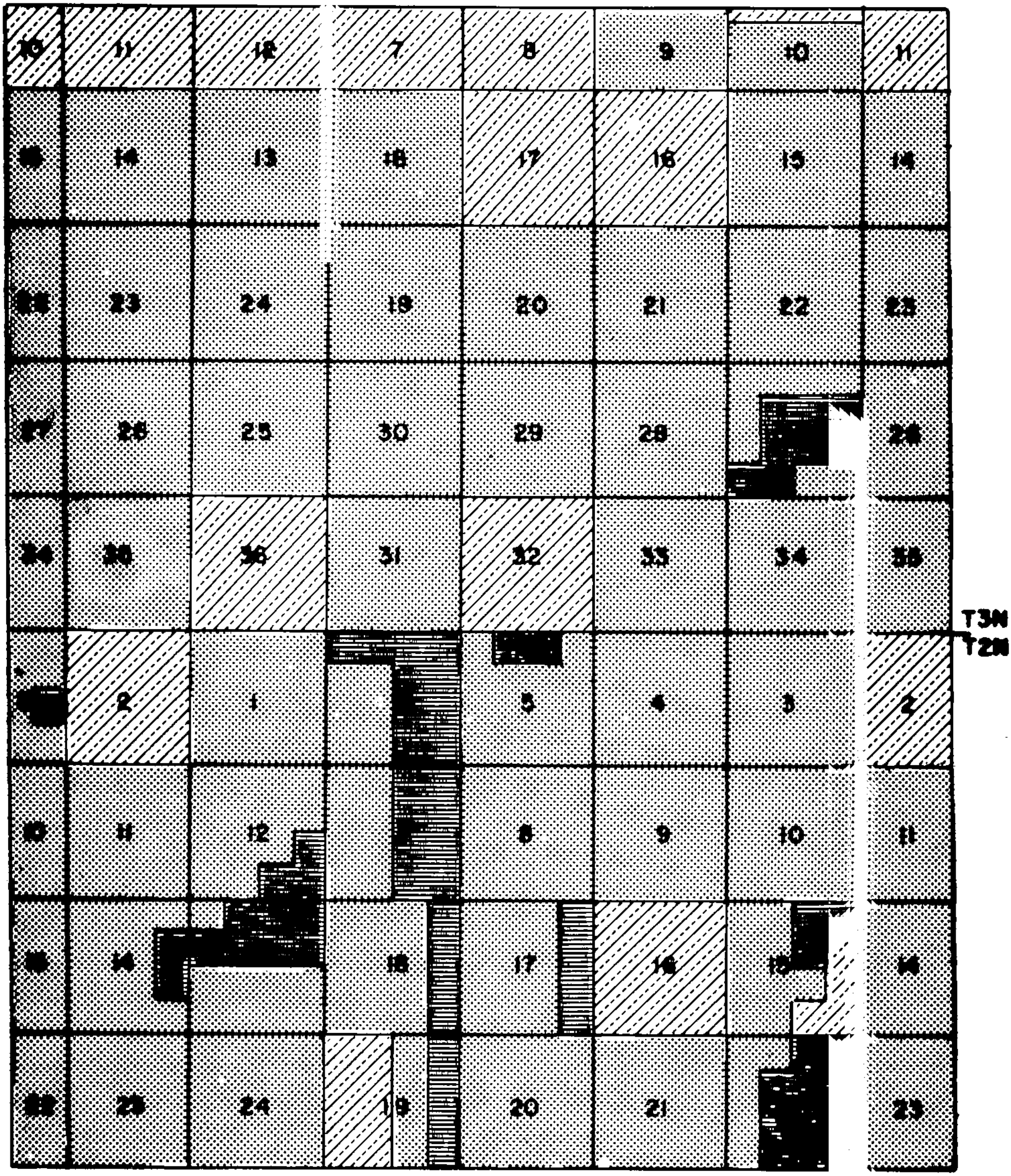
Structure in the Mariano Springs quadrangle is relatively simple (Pl. 2). Strata are relatively flat lying with a regional dip from 1° to 3° to the south and east.

Faulting is minor. Graben-style normal faults are present in secs. 14, 22, and 23, T3N, R16W. These faults are high angle with dips up to 60°. The northern-most fault shows the greatest displacement with a maximum throw of 250 ft (Guilinger, 1982). The southern fault shows a maximum displacement of less than 100 ft. Northeastward, these faults are covered by alluvium in the Mariano Springs quadrangle (Pl. 1) but reappear in the Techado quadrangle (Guilinger, 1982).

Several north-northeast-trending normal faults are present on Mariano Mesa in secs. 12, 13, and 14, T2N, R16W. The downthrown side of these faults is usually to the east, and the throw is only a few tens of feet.

GENERAL STRATIGRAPHY

Seven mappable units are exposed in the Mariano Springs quadrangle (Fig. 4). The Quaternary units consist of alluvial valley fill. Three Tertiary units that crop out in the


T3N
T2N

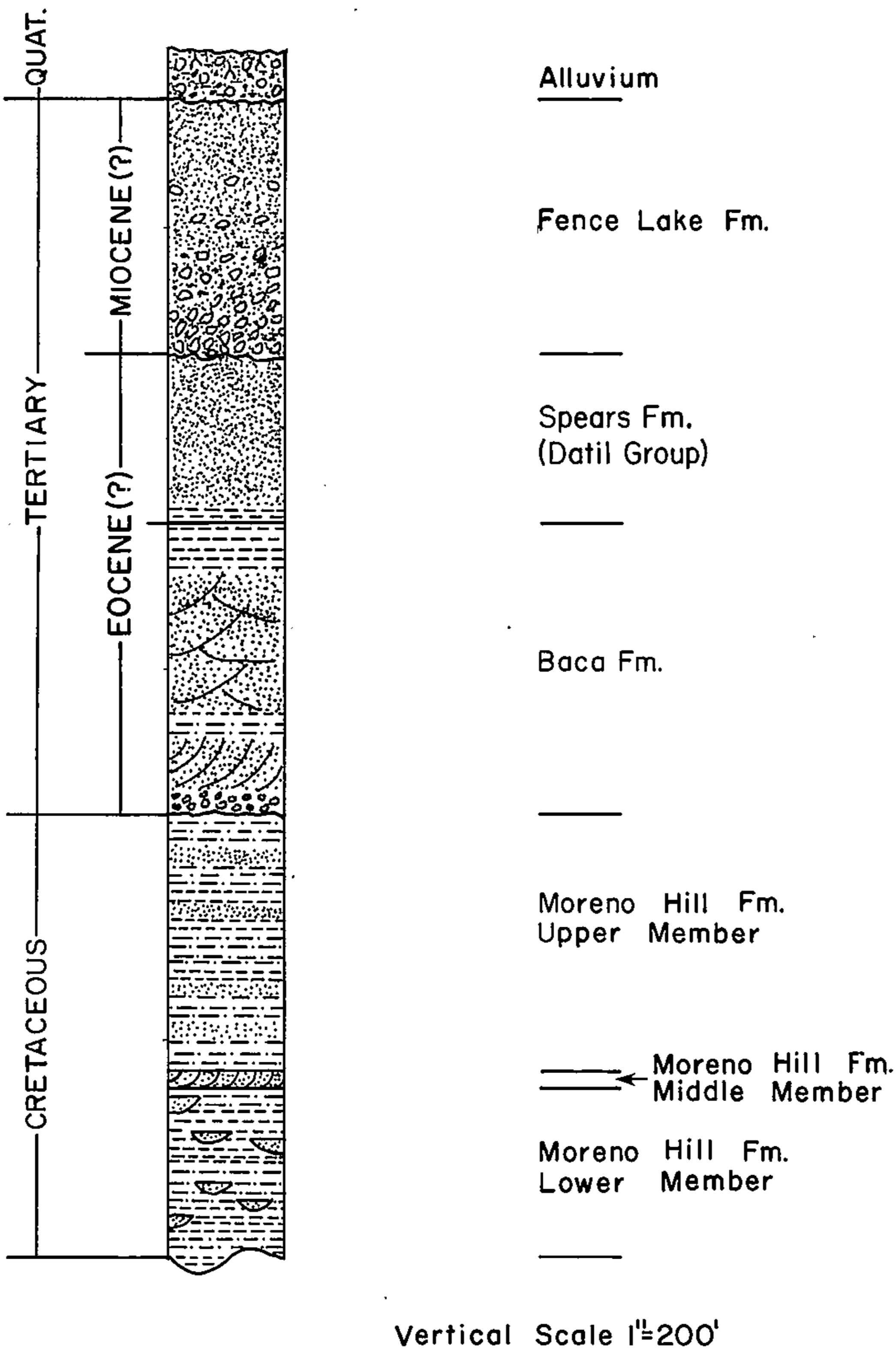


FIGURE 4 - Generalized stratigraphic column for the Mariano Springs quadrangle.

study area are the Fence Lake, Spears, and Baca Formations. The lower, middle, and upper members of the Moreno Hill Formation comprise the Cretaceous units in the study area.

MORENO HILL FORMATION

The Cretaceous Moreno Hill Formation is the oldest unit exposed in the Mariano Springs quadrangle. It is middle to late Turonian in age (McLellan et al., 1983). This unit consists of a coal-bearing sequence of sandstones, shales, siltstones, and carbonaceous shales. Exposures of the Moreno Hill Formation are restricted to the northern portion of the mapped area (Pl. 1). This formation is divided into three members: lower, middle, and upper.

Lower member

The lower member is exposed in the extreme northwestern portion of the Mariano Springs quadrangle (Pl. 1). Outcrops of the lower member consist of brown to yellowish-brown, fine- to medium-grained, well-rounded, moderately sorted, quartzose sandstones, which were deposited as fluvial-channel sands and crevasse splays. These sandstones are composed of quartz (95%), with minor feldspars (4%) and trace amounts of mafic minerals (1%). Sandstones grade laterally into light- to medium-gray siltstones and shales, which contain abundant small plant fragments and organic material. The minimum thickness of the lower member is 190 ft.

Campbell (1981) and Roybal (1982) indicate that beds of coal crop out in the lower member in Cerro Prieto, The Dyke, and Tejana Mesa quadrangles. Neither coal nor carbonaceous shales were observed in the Mariano Springs quadrangle. The reader is referred to Campbell (1981), Roybal (1982), and McLellan et al. (1983) for a detailed description of the lower member in adjoining areas.

Middle member

The middle member of the Moreno Hill Formation is limited to two small outcrops in the SE1/4 sec. 10, T3N, R16W of the Mariano Springs quadrangle (Pl. 1). The reader is referred to Campbell (1981), Roybal (1982), and McLellan et al. (1983) for a detailed description of this unit in surrounding areas.

In the Mariano Springs quadrangle the middle member is a massive, medium- to coarse-grained, angular to subangular, well-indurated, light-gray, quartzose sandstone. The unit is extremely resistant to weathering. Cement is noncalcareous, and the matrix consists of miniscule amounts of clay and silt. According to Campbell (1981) and Roybal (1982) this unit represents stacked channel sands. The lack of outcrops of the highly resistant middle member in the Mariano Springs quadrangle and adjacent Techado quadrangle (Arkell, 1984a), suggests that it pinches out in the northern portion of the Mariano Springs quadrangle.

Upper member

The upper member of the Moreno Hill Formation is present throughout the extreme northern portion of the Mariano Springs quadrangle (Pl. 1). This unit consists of yellowish-gray to tan sandstones, siltstones, and mudstones. Faulting, lack of good exposures, and the lack of a well-defined contact with the overlying Baca Formation preclude an accurate estimate of thickness for this unit in the Mariano Springs quadrangle. Based on exposures in the Techado (Arkell, 1984a), Tejana Mesa (Roybal, 1982), The Dyke, and Cerro Prieto quadrangles (Campbell, 1981), the upper member is roughly estimated to be from 250 to 300 ft thick.

Sandstones are lenticular, channel-shaped deposits, which exhibit trough and low-angle planar crossbedding. The cement for these sandstones is siliceous, and the matrix is very silty. Compositionally, these sandstones are subarkosic, containing predominantly quartz (85-90%) and feldspar (10-14%), with trace amounts of mafic minerals (1%). Sandstones are subangular to subrounded, very fine to medium grained, and poorly sorted. The channel-shaped sandstones are persistent for an average of 100 ft and grade laterally and vertically into siltstones and mudstones.

Most of the upper member is composed of siltstones and mudstones. Siltstones and mudstones are sandy and slighty carbonaceous and contain plant fragments and thin stringers of coal or carbonaceous shale.

The difference in color between the upper and lower members of the Moreno Hill Formation indicates that sediments in the upper member were probably deposited in a drier, oxygen-rich environment, whereas the sediments of the lower member were deposited in a backswamp environment under anoxic conditions (Campbell, 1981; Arkell, 1984a). Furthermore, the general upward-fining sequence of the entire Moreno Hill Formation suggests that the environment of deposition changed through time from a relatively high-energy fluvial environment to a low-energy, possibly low-sinuosity (Arkell, 1984a) meandering-stream environment.

BACA FORMATION

The Eocene Baca Formation unconformably overlies the Cretaceous Moreno Hill Formation. The Baca Formation crops out throughout most of central and northeastern Mariano Springs quadrangle (Pl. 1). The average thickness of the Baca Formation in the study area is 350 ft. However, Guilinger (1982) reported approximately 600 ft of Baca at Mariano Mesa.

The Baca Formation consists of red and white sandstones with some interbedded conglomerates and red to maroon mudstones. In the Tejana Mesa (Roybal, 1982), Veteado Mountain (Arkell, 1984b), and Techado (Arkell, 1984a) quadrangles, basal conglomerates define the contact between the Baca and Moreno Hill Formations. In general, these beds are not exposed in the Mariano Springs quadrangle. When present, these basal conglomerates consist of rounded pebbles that are composed of chert, petrified wood, sandstones, and mudstones from the underlying Moreno Hill Formation and minor igneous rocks.

Sandstones of the Baca Formation are subarkosic. They are composed of quartz (80%), feldspar (15%), and lithic fragments (5%). These sandstones are lenticular and are laterally persistent for several hundred feet. They exhibit high- to low-angle, trough-shaped tangential crossbedding with a curved, erosional lower contact. Sandstones are fairly well indurated to slightly friable and contain silica and calcite cements. The Baca sandstones are medium to coarse grained, angular to subangular, and moderately sorted.

Based on lithologic characteristics, sedimentary structures, geometry, and stratigraphic relationships the Baca is interpreted as a fluvial, probably braided-stream environment.

SPEARS FORMATION

The Eocene Spears Formation of the lower Datil Group (Osburn and Chapin, 1983) is present only in the northeastern section of the Mariano Springs quadrangle (Pl. 1). Elsewhere it has been stripped away by erosion. The Spears Formation is 100-250 ft thick and shows a rapid thickening trend to the north and northeast. This unit conformably overlies the Baca Formation and is covered by alluvium throughout most of the mapped area. Where exposed, the contact between the Baca and Spears is gradational.

The Spears Formation consists of light-gray sandstones and red mudstones. The sandstones are poorly sorted, fine to medium grained, and subangular to subrounded. These sandstones are composed of volcanic fragments, plagioclase, and minor quartz, with subordinant amounts of mafic minerals and volcanic glass. Sandstones are cemented with noncalcareous to calcareous cement.

FENCE LAKE FORMATION

The Miocene(?) Fence Lake Formation crops out in the southeastern and eastern portions of the Mariano Springs quadrangle (Pl. 1). It is present at higher elevations, where it forms a resistant cap on Mariano Mesa and the unnamed buttes to the north and west. This unit unconformably overlies the Tertiary Spears and Baca Formations throughout the study area. The contact with these formations is sharp, highly undulating, and exhibits pronounced erosional relief of the Baca and Spears. The minimum thickness of the Fence Lake Formation in the Mariano Springs quadrangle is 300 ft.

The Fence Lake Formation consists of white, gray, and pink sandstones, conglomeratic sandstones, and conglomerates. This unit shows a general fining-upward sequence (Fig. 4). Sandstones are fine to medium grained, subrounded to subangular, and moderately sorted. These sandstones are matrix supported, very friable, and very calcareous. They contain quartz (65-70%), abundant lithic fragments (20-25%), and minor mafic minerals and feldspar (5% combined).

Conglomerates consist of rounded, vesicular basaltic cobbles and boulders, which are commonly 2-2.5 ft in diameter. The cobbles and boulders are supported by a white to pinkish-gray, poorly sorted, very friable, quartzose sandstone. At the top of Mariano Mesa and the surrounding buttes, the Fence Lake Formation has undergone extensive subaerial erosion. The presence of boulder lag deposits, good outcrop exposures in the arroyos near Tarpley and Adobe wells (secs. 10 and 11, T2N, R15W), and regional stratigraphic and structural relationships all suggest that the Fence Lake is present in these questionable areas.

ECONOMIC GEOLOGY

In the Salt Lake coal field minable coal deposits occur in the Moreno Hill Formation, especially in the lower member (Campbell, 1981). Three coal zones (Rabbit, Cerro Prieto, and Antelope) are present in the lower member in the Cerro Prieto quadrangle (Campbell, 1981). The Rabbit zone occurs approximately

20 ft below the middle member, and it contains beds up to 12 ft thick. However, this zone has not been observed in outcrop or drill hole in the Cerro Prieto or Techado quadrangles (Arkell, 1984a). The Cerro Prieto zone is 150 ft below the botton of the middle member and contains coal beds up to 9.5 ft thick (Campbell, 1981). This zone has been penetrated by drill holes in the eastern portion of the Cerro Prieto quadrangle (Campbell, 1981). Arkell (1984a) predicted that the Cerro Prieto zone might be located between 200 and 500 ft below the surface in the Techado quadrangle. According to Arkell (1984a), the Antelope zone is 250 ft below the top of the middle member and is probably over 500 ft deep in the Techado quadrangle.

In the Mariano Springs quadrangle coal beds were not observed in outcrop. Based on the available information discussed above and taking into account the regional structural and stratigraphic relationships, the coal-resource potential of the lower member in the Mariano Springs quadrangle is low to very low. The most promising zone for economic recovery is the Rabbit zone. The Cerro Prieto and Antelope zones are too deep to economically exploit using current extractive techniques.

The coal-resource potential for the upper member is very low. Coals in this lithologic unit are too thin to be economically recovered. Arkell (1984a) suggests that the thinness of these beds can be attributed to the fluvial- and coastal-plain environments in the study area, which were too dynamic for stable swamp formation.

CONCLUSIONS

The Mariano Springs quadrangle contains Cretaceous and Tertiary clastic sedimentary rocks that belong to the Moreno Hill, Baca, Spears, and Fence Lake Formations. The Moreno Hill Formation contains a coal-bearing sequence of sandstones, siltstones, shales, and mudstones that was deposited in meandering-stream and coastal-plain environments. The Baca Formation consists of conglomerates, sandstones, and maroon to red mudstones. The Spears Formation contains sandstones and mudstones that are composed of volcanic fragments, quartz, plagioclase, and minor mafic minerals. The Fence Lake Formation contains conglomerates and quartzose sandstones. Both the Baca and Fence Lake Formations were probably deposited by braided streams.

Surface exposures of coal are not present in the lower member of the Moreno Hill Formation. Based on work by Campbell (1981) and Arkell (1984a) and accounting for regional structural and stratigraphic relationships, the coal beds in the Mariano Springs quadrangle are probably too deep to economically extract. Therefore, the coal-resource potential for the lower member is low to very low.

The coal-resource potential for the upper member is very low because coals are too thin to be economically exploited.

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PLATE I

GEOLOGIC MAP OF THE MARIANO SPRINGS QUADRANGLE, WEST-CENTRAL NEW MEXICO

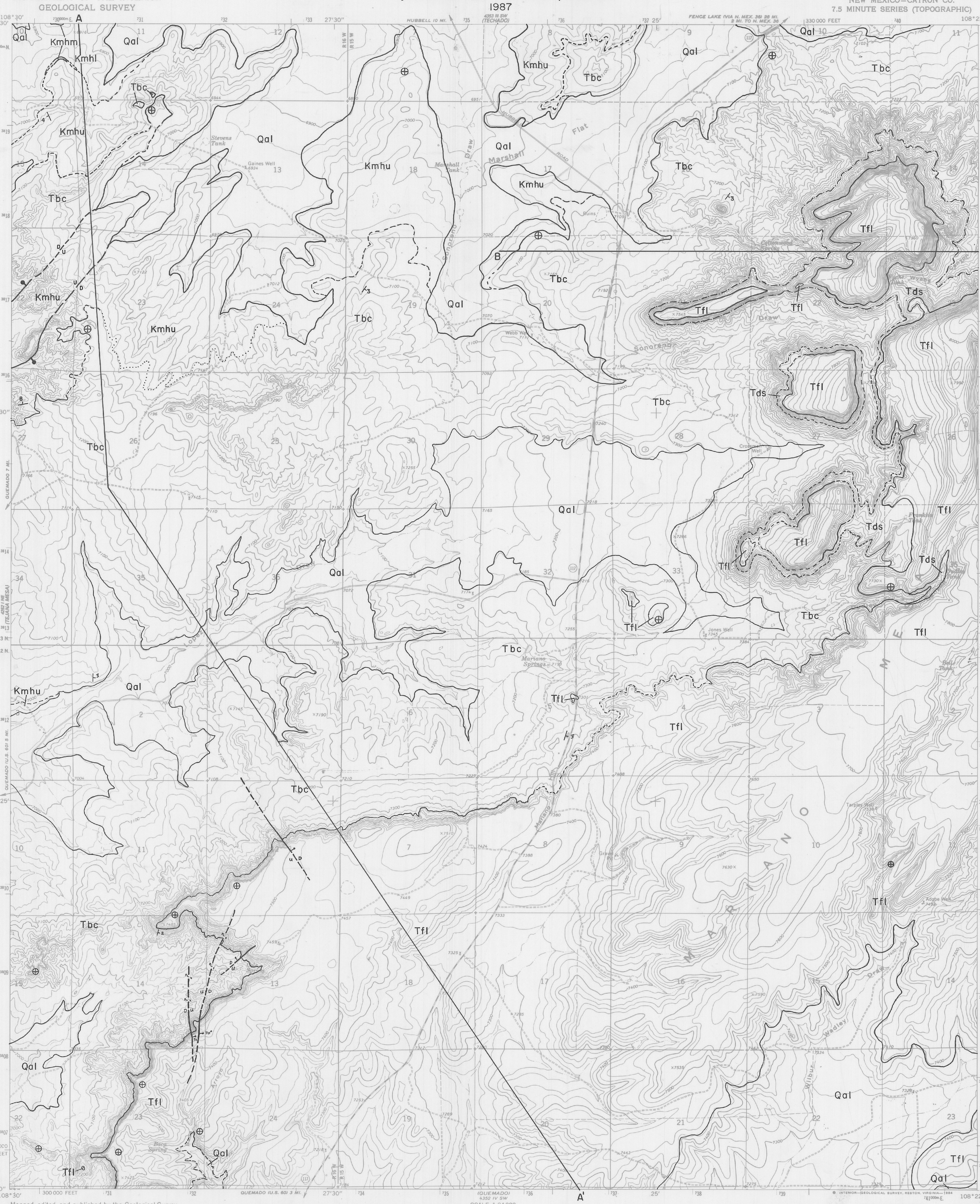
by Kevin Cook and Brian Arkell, NMBMMR

1987

OF 326

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MARIANO SPRINGS QUADRANGLE
NEW MEXICO—CATRON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1966. Field checked 1967

Polyconic projection. 1927 North American Datum
10,000-foot grid based on New Mexico coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Fine red dashed lines indicate selected fence lines

To place on the predicted North American Datum 1983 move the projection lines 2 meters south and 56 meters east as shown by dashed corner ticks

UTM GRID AND 1967 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

NEW MEXICO
QUADRANGLE LOCATION

ROAD CLASSIFICATION

Secondary highway, all weather, hard surface
Light-duty road, all weather improved surface
Unimproved road, fair or dry weather
State Route

MARIANO SPRINGS, N. MEX.
N3422.5—W10822.5/7.5
1967

DMA 4352 IV NW-SERIES V881

LEGEND

Qal=Quaternary alluvium

Tfl=Tertiary Fence Lake Fm.

Tds=Tertiary Spears Fm.

Tbc=Tertiary Baca Fm.

Kmhu=Cretaceous Upper Member, Moreno Hill Fm.

Kmhm=Cretaceous Middle Member, Moreno Hill Fm.

Kmhl=Cretaceous Lower Member, Moreno Hill Fm.

=Contact, dashed where inferred, dotted where implied

D/U =Fault, dashed where inferred

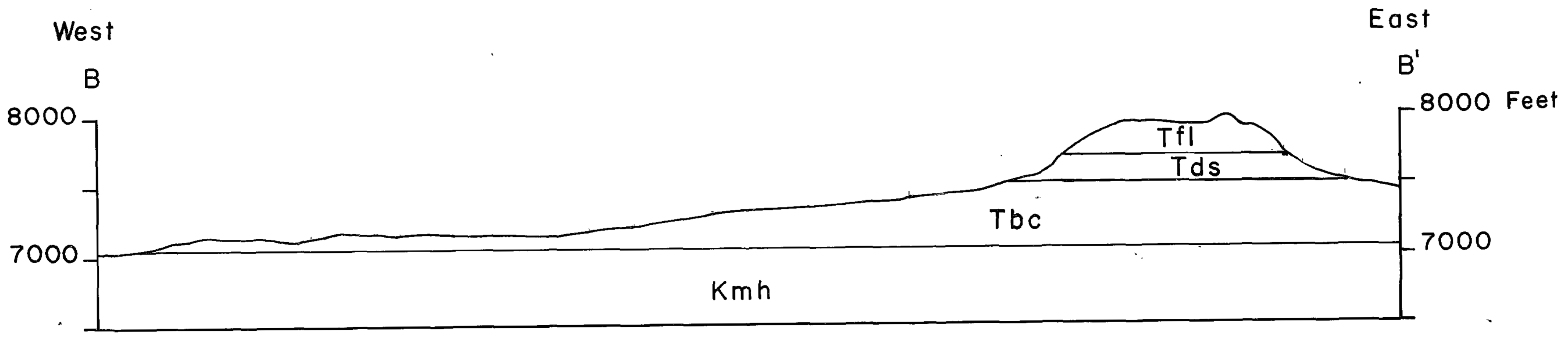
A A'=Cross-section lines (see PLATE 2)

= Strike and dip

= Horizontal strata

PLATE 2

GEOLOGIC CROSS-SECTIONS OF THE MARIANO SPRINGS QUADRANGLE, WEST-CENTRAL NEW MEXICO



Horizontal Scale 1"=2000' (1:24000)
Vertical Scale 1"=1000' (1:12000)
Vertical Exaggeration=2X