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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

# EXAMINATION AND REEVALUATION OF EVIDENCE FOR THE BARRERA FAULT, GUADALUPE MOUNTAINS, NEW MEXICO

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# EXAMINATION AND REEVALUATION OF EVIDENCE FOR THE BARRERA FAULT, GUADALUPE MOUNTAINS, NEW MEXICO

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## ABSTRACT

In southeastern New Mexico a prominent escarpment marks the southeastern boundary of the Guadalupe Mountains and the massive Capitan Limestone of Permian age is well exposed along the mountain front. Vincent Kelley (1971, 1972) described faults that he named the Barrera and Carlsbad Faults along the escarpment. As part of the earth-science investigations for the Waste Isolation Pilot Plant (WIPP) site, we examined the evidence for those faults in the field and conclude that the faults are nonexistent and that Kelley's conclusions were based on misinterpretation of exposures of fan gravel, jointing, and shrub alinement.

## INTRODUCTION

The Guadalupe Mountains are a northeasterly trending plateau in Trans-Pecos Texas and southeastern New Mexico. A prominent escarpment, reminiscent of block-faulted mountain fronts in the Basin and Range Province, marks the southeastern boundary of the Guadalupe Mountains in New Mexico. This escarpment is the eroded mass of a limestone-reef complex of Permian age which encircles the Delaware Basin. The reef complex is well exposed along the front of the Guadalupe Mountains but plunges eastward from the mountains into the subsurface. Recently, the mountain escarpment has been interpreted in part as being bordered by a frontal fault (Kelley 1971, 1972). This report is the result of a field investigation that examined the evidence for faulting presented by Kelley.

### Definitions

Definition of some deposits and features discussed in this report is as follows:

Breccia--a cemented rock composed of poorly sorted angular fragments.

Collapse breccia--a breccia formed by collapse of rock overlying a cavity produced by dissolution.

Gravel--unconsolidated, coarse-grained, rounded rock fragments produced by erosion.

Fan gravel--coarse, unconsolidated gravel deposited on an alluvial fan.

Fan--a fan-shaped mass of detritus or alluvium that accumulates at a place where the gradient of a slope decreases.

Pediment--a broad, flat or gently sloping, rock-floored erosion surface or plain of low relief.

## STRATIGRAPHY

The rocks discussed in this report are summarized in table 1. Detailed descriptions of these rock units have been published elsewhere (Hayes, 1957, 1964).

The Capitan Limestone is an organic-barrier reef, or bar, which was deposited in shallow seas around the edge of the Delaware Basin during the Guadalupian Provincial Series of Permian time (fig. 1). The Capitan includes a massive member and a talus member. The massive member is composed of yellowish-gray, fine-grained limestone virtually without bedding planes. The talus member is mostly fine-grained angular fragments, but also includes angular cobbles and boulders derived from the massive member. It was deposited on the basinward front of the massive member during reef growth. The average thickness of the Capitan is about 385 m (1,250 ft).

Equivalent formations on the northwest shelf that grade laterally into the massive member of the Capitan Limestone have been included in the Artesia Group. These are the Seven Rivers, Yates, and Tansill Formations which are composed of interbeds of limestone, dolomite, siltstone, and sandstone. Both the Seven Rivers and Tansill Formations are predominantly dolomite; whereas, the Yates Formation includes a large proportion of sandstone and siltstone. The combined thickness of the Seven Rivers,Yates, and Tansill is about 300 m (975 ft).

Within the Delaware Basin, the Bell Canyon Formation was deposited contemporaneously with the Capitan Limestone and grades laterally into the talus member of the Capitan along the basin margin. The Bell Canyon is as much as 215 m (700 ft) thick and includes five limestone members which are separated by thicker intervals of sandstone.

At the end of Guadalupian time, the Delaware Basin was cut off from free access to normal marine waters of the open sea and salts in the basin became highly concentrated. The Castile, Salado, and Rustler Formations were deposited in the basin during the Ochoan largely by precipitation from this concentrated solution. The Castile Formation, which is confined to the Delaware Basin, consists primarily of gypsum and anhydrite with interbeds of salt, and is about 560 m (1,825 ft) thick.

The Salado Formation is composed mainly of highly soluble rock salt. Consequently, this formation is not exposed as complete stratigraphic sections. Where the Salado interval is present at the surface, it is represented by chaotic collapse breccia composed of insoluble residuum of gray and pink gypsum embedded in red or gray clay. In complete stratigraphic sections in the subsurface, the Salado Formation is about 615 m (2,000 ft) thick, and includes potassium-bearing evaporites and minor beds of anhydrite as well as halite. The Salado is not confined to the Delaware Basin but extends northward across the Capitan Limestone and Artesia Group in areas east of the Pecos River (fig. 1).

The Rustler Formation is as much as 155 m (500 ft) thick and includes anhydrite, gypsum, sandstone, shale, and dolomite. The dolomite occurs as two distinctive members, the Culebra near the base and the Magenta near the top of the formation.

Gravel and alluvium cover parts of the region. The gravel occurs mainly as colluvium, fan gravels, and talus along the Reef Escarpment. Alluvium occurs as sand and gravel in arroyo beds. There are no true pediments along the base of the Reef Escarpment.

Table 1.--*Summary of stratigraphic relations of the Capitan Reef*

| Age | Series/Provincial Series | Stratigraphic unit | | | |
|---|---|---|---|---|---|
| Quaternary | Pleistocene-Holocene | Gravel and alluvium | | | |
| | | | | Unconformity | |
| | | | Northwest Shelf | Reef Margin | Delaware Basin |
| Permian | Ochoan | | Rustler Formation<br>Salado Formation | Rustler Formation<br>Salado Formation | Rustler Formation<br>Salado Formation<br>Castile Formation |
| | | | Unconformity | Unconformity | |
| Permian | Guadalupian | Artesia Group | Tansill Formation<br>Yates Formation<br>Seven Rivers Formation | Capitan Limestone | Bell Canyon Formation |

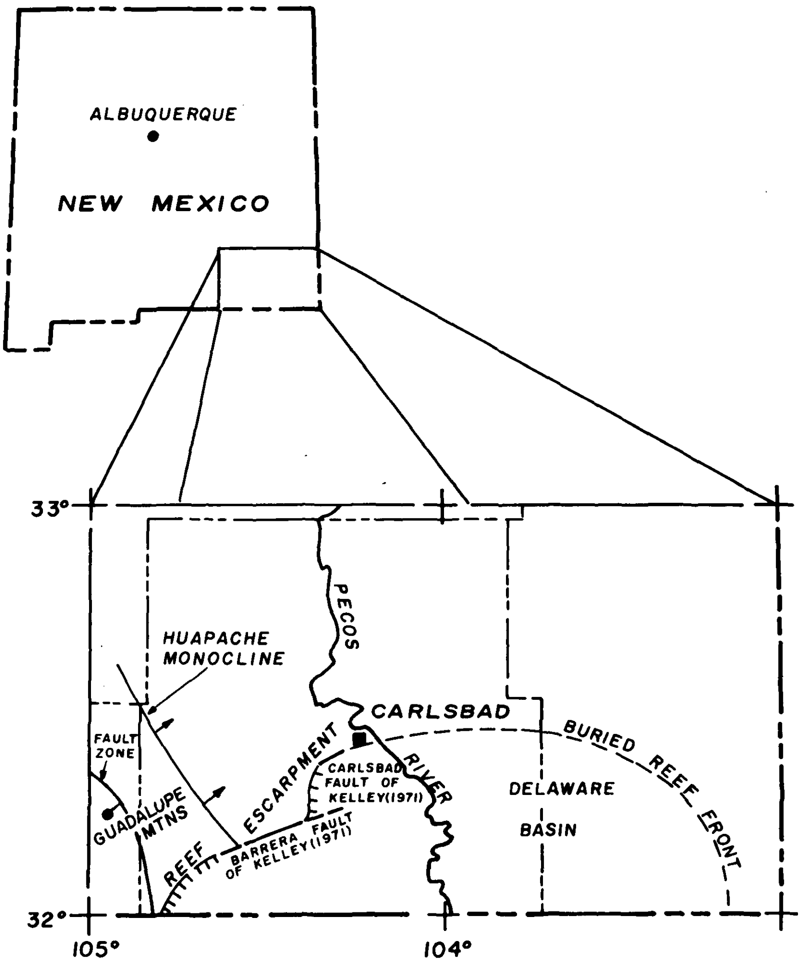


Figure 1.--Index map showing major features of the Carlsbad area.

## GEOLOGIC STRUCTURE

The Guadalupe Mountains uplift is a major structural feature in southeastern New Mexico. This uplift is a northeastward tilted block bounded on the west by a zone of en echelon normal faults and on the east by the Huapache monocline. The southeast margin of the Guadalupe Mountains coincides with the Capitan Reef Escarpment.

The tectonic component of dip on the Reef Escarpment forms the southeast flank of a long, sinuous northeast-trending anticline. A depositional dip of 20°-30° in the reef talus beds has apparently been increased as much as 10° by Cenozoic tectonism which formed this anticline. Numerous joints and a few normal faults of a few meters displacement in the Capitan Limestone parallel the Reef Escarpment (fig. 2). Associated with these joints and small faults are other less conspicuous joints that trend at right angles to the Reef Escarpment.

The joints are everywhere either parallel or at right angles to the Reef Escarpment, regardless of the trend of the escarpment, which suggests a relation between the Capitan Limestone and the joints. The joints could have formed soon after deposition of the Permian rocks by differential compaction, but it seems more probable that they formed during Cenozoic regional uplift by tensional stresses resulting from differential movement between the shelf and the basin.

## DISCUSSION

### "Barrera Fault"

Kelley (1971, p. 48-49) named the Barrera Fault along the base of the Capitan Reef Escarpment. He stated that:

> "The fault is expressed at the surface by small scarps and a line of bushes. It is shown strikingly on air photos by a smooth well-defined line. The fault surface has been found in two places, at the mouth of Rattlesnake Canyon in the west bank of the arroyo, where the dip is 65° S. on a carbonate footwall. The other exposure is near U.S. Highway 62, 2.4 miles east (sic) of White City where the dip is about 80° S. Highway 62 crosses the fault diagonally on the east bank of Jurnigan Draw just west of State Road. . . The next gully west of this point is where the above steep fault surface is exposed and here at least 20 feet of pediment gravel is downthrown opposite the Tansill near the fault.
>
> * * * * * * *
>
> In summary, the evidence for the fault includes exposure of its surface, scarps, a well-marked trace, offset of bedrock, and displacement of pediment gravel."

During the course of this investigation we examined the exposures mentioned by Kelley and traced the foot of the escarpment and parts of the line of vegetation on the ground from near White City northeastward to Jurnigan Draw (fig. 3). The line of bushes mentioned by Kelley corresponds to a zone of open joints in the Capitan Limestone. It is presumed that these joints hold more moisture than the surrounding terrain which accounts for the more dense vegetation along their trace. No vertical displacement was observed on any of these joints although they do form low eroded scarps at many places.

Kelley apparently did not follow this line of vegetation in demarkation of the Barrera Fault, because northeastward from Jurnigan Draw the line of vegetation curves toward the north; whereas Kelley projected the fault to the northeast.

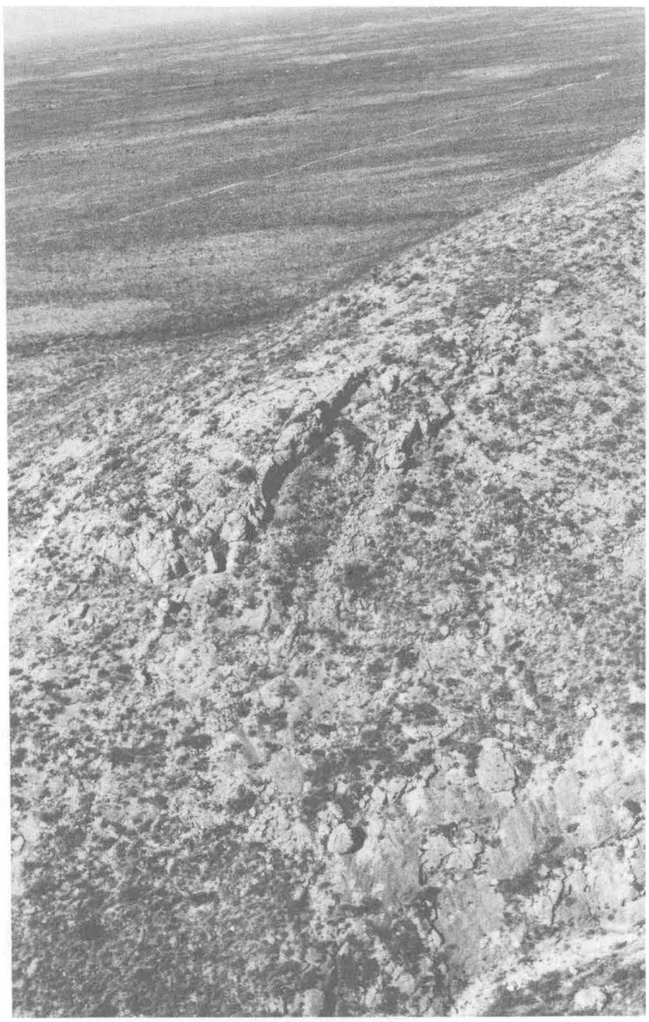

Figure 2.--View of open jointing in Capitan Limestone, about 2 km northeastward from White's City.

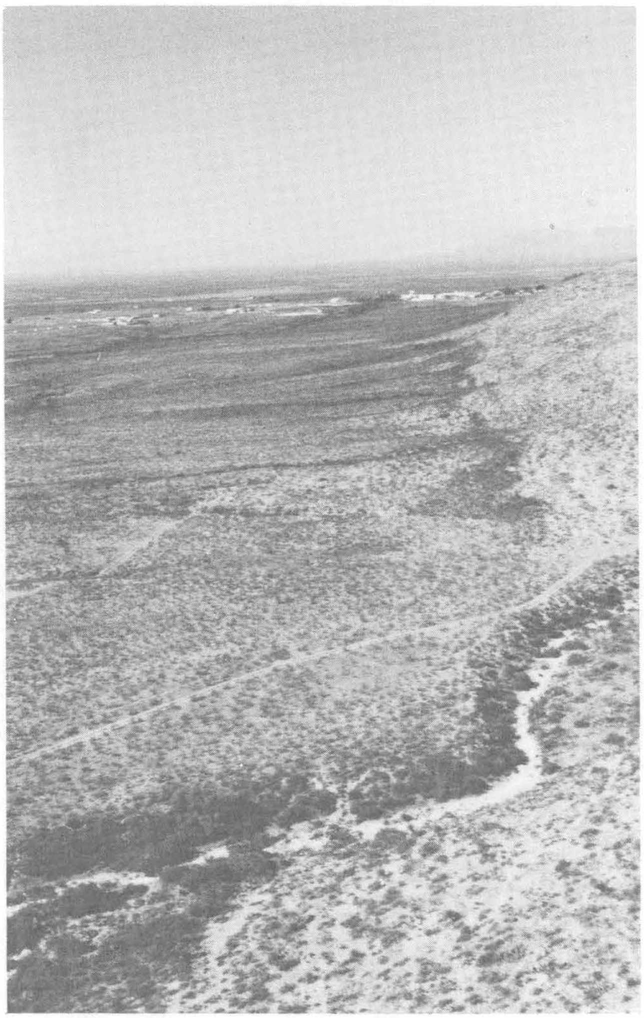

Figure 3.--View southwesterly along Capitan escarpment showing vegetation band. White's City in background.

At no place did we observe displacement of the gravel. In the gully described by Kelley, gravel has filled depressions in the joint system but we could find no clear indication that this gravel is displaced. Our field examination concurs with the original interpretation by Hayes (1964) that these exposures are fan gravels derived from the Capitan Limestone and related rocks exposed upgradient.

Additionally, Kelly appears to have misinterpreted some exposures along the south bank of Chinaberry Draw as Salado Formation. We did, however, observe exposures of laminated gypsum of the Castile Formation overlain by gravel in this area. We could not find any exposures of the Salado residuum as mapped by Kelley.

Search for displacement of bedrock lead to comparison of geologic maps by Hayes (1957, 1964, pl. I) and Kelley (1971, pl. 4). These indicated considerable differences of interpretation of surface exposures in the Delaware Basin along the front of the Guadalupe Mountains. In discussing the Barrera Fault, Kelley states (1971, p. 49):

> "At the surface between Jurnigan and Chinaberry Draws (pl. 4) the Salado contact is displaced to the right about two miles and on the basis of meager exposures it is estimated that the stratigraphic throw may be 200 to 400 feet."

We examined this area carefully on the ground and concluded that Kelley misinterpreted a fan gravel for surface expression of the Salado Formation. Delineation of exposures as Salado Formation between Jurnigan and Chinaberry Draws (secs. 17, 19, 20, 21, T. 24 S., R. 26 E.) by Kelley follows closely those exposures mapped by Hayes as "Gravel" (Qg).

## "Carlsbad Fault"

A second fault, the Carlsbad fault (fig. 1), was indicated and described by Kelley (1971, p. 50, pl. 4) along the northern part of the Guadalupe Mountains (sec. 6. T. 23 S., R. 26 E.). The main evidence for this fault presented by Kelley is that dips on the downthrown side of the fault would have to be about 35°. Apparently such dips seem abnormal to him and he conjectured that a fault must be present. However, south of White City where the Reef Escarpment is better exposed, dips in excess of 35° are not uncommon along the reef front. An initial dip of about 30° is not unreasonable for the Capitan talus member. This attitude has been increased by at least 10° by Cenozoic tectonism.

A major fault system borders the Guadalupe Mountains along their western margin and a gentle monocline trends northwest across the mountains (fig. 1). These are the only major tectonic features recognized in this region.

## CONCLUSION

After consideration and examination of the evidence in the field we do not believe there is a sound basis for interpreting a fault along the foot of the Reef Escarpment of the Guadalupe Mountains. This conclusion is based on the following observations related to Kelley's (1971, p. 49)evidence for the Barrera Fault:

1. Exposure of the fault plane or fault scarps was not definitely observed in the field.
2. The vegetation line near the base of the escarpment cited as evidence for a fault by Kelley coincides with a jointed zone in the Capitan Limestone and follows a stream course (fig. 3) rather than a fault trace.
3. Displacement cannot be demonstrated in either the bedrock or the surface gravels.

A careful field examination of the area of the Carlsbad Fault as described by Kelley failed to reveal any fault planes or fault scarps.

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