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STRUCTURE OF THE GUADALUPE BOX AREA, SANDOVAL COUNTY NEW MEXICO

by
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INTRODUCTION

The Guadalupe Box area is located on the southeast flank of the Nacimiento uplift about 8 miles north of Jemez Pueblo, New Mexico (Fig. 1). The area is characterized by a complex group of normal faults that cut strata ranging in age from Precambrian to Quaternary (Fig. 2).

The north-trending Nacimiento uplift is composed of a series of eastward-tilted fault blocks bounded on the west by the San Juan Basin part of the Colorado Plateau, and on the east by the Rio Grande depression. Much of the east flank of the uplift is covered by volcanic rocks derived from the Jemez volcanic center. In the vicinity of Guadalupe Box, however, the combination of erosion and (or) non-deposition of the volcanic rocks has left the margin of the uplift exposed. The rocks in this area have been deformed by at least one episode of Pennsylvanian uplift and at least three times by folding and faulting in the Cenozoic.

STRUCTURE

The map-area straddles the Sierrita fault, the boundary between the southeast Nacimiento uplift and the Rio Grande depression (Fig. 3). It is difficult to arrive at a precise figure for structural relief in the area because the sedimentary rocks have been stripped from the crest of the uplift. In the vicinity of Guadalupe Box the structural relief is estimated to be at least 5,100 feet (DuChene, 1973).

Two structures are primary contributors to the total structural relief. They are the northeast-trending Sierrita fault and the north-northwest-trending Jemez fault. Other significant structures in the area include the Osha Canyon fault and the Guadalupita fault.

Sierrita Fault

The Sierrita fault is a northeast-trending normal fault, downthrown to the east, which forms the southeastern boundary of the Nacimiento uplift. In the map-area, the fault ranges from a single break or narrow zone near Guadalupe Box to a zone 300 feet wide 2 miles to the southwest (Fig. 3). The attitude of the fault cannot be directly observed, but certain inferences can be made from the fault trace. Throughout most of its length the trace is relatively straight indicating that the fault is nearly vertical at the ground surface. The fault trace is sinuous where it crosses Guadalupe Canyon. This suggests an inclined fault surface dipping to the southeast at the structural level of the Precambrian rocks at Guadalupe Box. The fault is nearly vertical where it cuts the Bandelier Tuff about one mile northeast of Guadalupe Box. The Sierrita fault thus appears to be a curved surface at the structural level of the Precambrian rocks at Guadalupe Box, and it becomes more nearly vertical at higher structural and stratigraphic levels.

The stratigraphic separation on the Sierrita fault is difficult to determine because the fault is mostly covered and because the exact thicknesses of the stratigraphic units cut by the fault are not known. The vertical separation is estimated to be 2,250 feet at Guadalupe Box and 1,750 feet southwest of the Jemez fault. Movement along the fault appears to be dip-slip, and therefore the stratigraphic separation is probably close to the vertical component of slip.

The Sierrita fault cuts rocks tentatively identified by DuChene (1973) as part of the Abiquiu(?) Formation, a Tertiary unit believed to correlate with the Abiquiu Tuff of Miocene age (Smith, 1938). Northeast of Guadalupe Box the fault displaces rocks of the Bandelier Tuff. Most of the movement along the fault occurred prior to the deposition of the Bandelier Tuff, however.

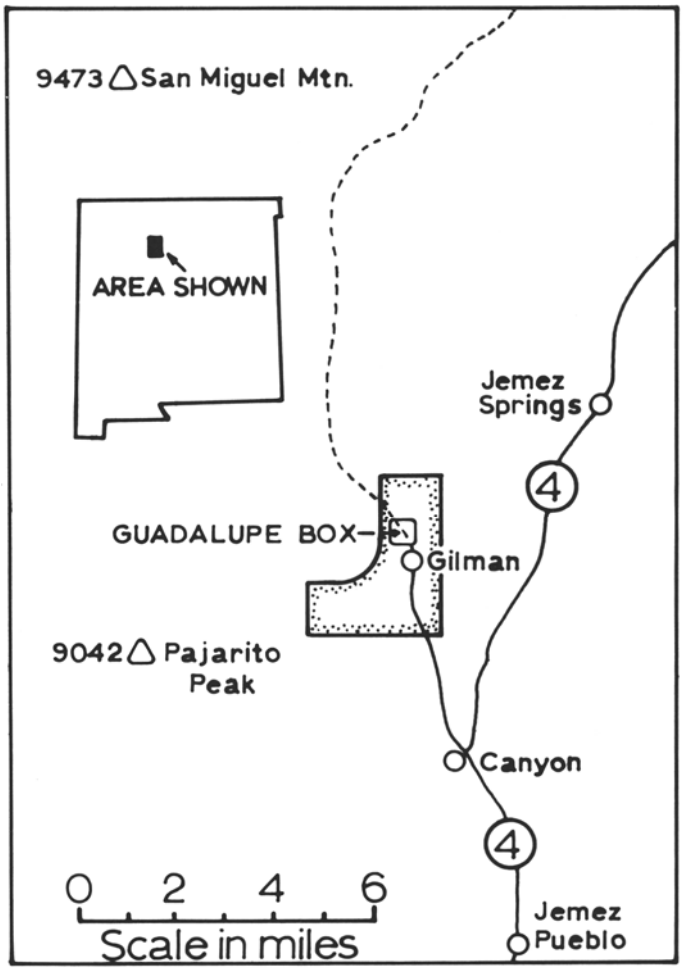

Figure 1. Index map showing location of geologic map-area (stippled).

Jemez Fault

The Jemez fault is a north-northwest-trending normal fault, downthrown to the east, and truncated by the Sierrita fault about one mile southwest of Guadalupe Box (Fig. 3). The relatively straight fault trace indicates that the fault is high-angle. Stratigraphic separation is estimated to be 800 feet along the fault near the south edge of the map-area. To the north the separation is difficult to determine because much of the trace is covered by terrace gravels or Bandelier Tuff. An estimate of the separation can be obtained by examining the Sierrita fault near the north end of the Jemez fault.

The Jemez fault and a sub-parallel fault about ¼ mile to the west are truncated by the Sierrita fault. Both of these faults are downthrown to the northeast. The stratigraphic separation along the Sierrita fault increases from about 1,750 feet southwest of the truncated faults to about 2,250 feet northeast of them. Part of the increase in separation, about 100 to 150 feet, is acquired as the Sierrita fault crosses the small western fault. The remainder of the increase in separation, about 350 to 400 feet, is acquired from the separation on the Jemez fault. Thus, it is inferred that the stratigraphic separation on the Jemez fault decreases from 800 feet at the south edge of the map-area to 350-400 feet at its northern end.

The Jemez fault cuts the Abiquiu(?) Formation indicating that the deformation occurred in post-Abiquiu(?) time. There is no evidence that the Jemez fault continues north of the Sierrita fault.

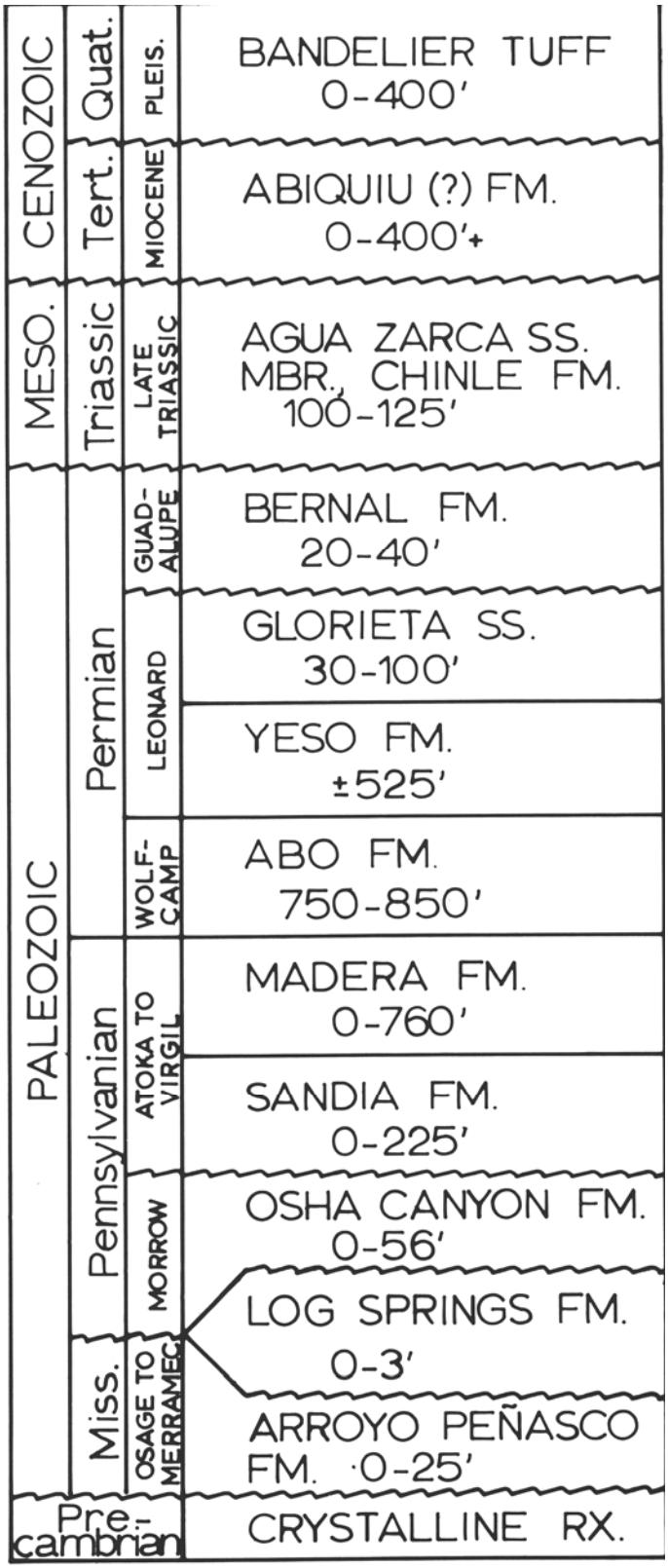

Figure 2. Stratigraphic column for Guadalupe Box and vicinity.

Osha Canyon Fault

The Osha Canyon fault is a north-northeasterly-trending normal fault, downthrown to the northwest. The fault has about 800 feet of stratigraphic separation and brings Precambrian rocks into contact with Pennsylvanian rocks (Fig. 3). The relatively straight fault trace suggests that the fault is high-angle for its entire length.

The Osha Canyon fault is truncated by the Jemez fault near the south edge of the map-area. It is possible that the Osha Canyon fault was once continuous with the east-trending fault located east of the Jemez fault in this area. If this is the case, then the Jemez fault separated the Osha Canyon fault into two discrete parts which developed opposite relative movement. Most of the movement along the Osha Canyon fault is post-Abiquiu(?) Formation and was caused by the same stresses responsible for the Jemez and Sierrita faults.

Guadal u pita Fault

The Guadalupita fault is a northeast-trending normal fault that is exposed in the east wall of Guadalupe Canyon south of Guadalupe Box. This fault is downthrown to the northwest with about 175 feet of stratigraphic separation. It was formerly thought that the Guadalupita fault was the eastern extension of the Sierrita fault (Wood and Northrop, 1946). DuChene (1973) shows that the Sierrita fault continues to the north along the east side of Guadalupe Box, and that the Guadalupita fault is a separate structure.

The Guadalupita fault is covered by 400 feet of unfaulted Bandelier Tuff on the east side of Guadalupe Canyon. It is probable that this fault developed during the same episode of deformation as the Jemez, Sierrita, and Osha Canyon faults.

Other Structures in the Map-Area

Between the Guadalupita and Sierrita faults is a graben which is cut by several northeast-trending normal faults (Fig. 3). The faults that cut this graben can be divided into two groups: The first group is a series of splinter faults located

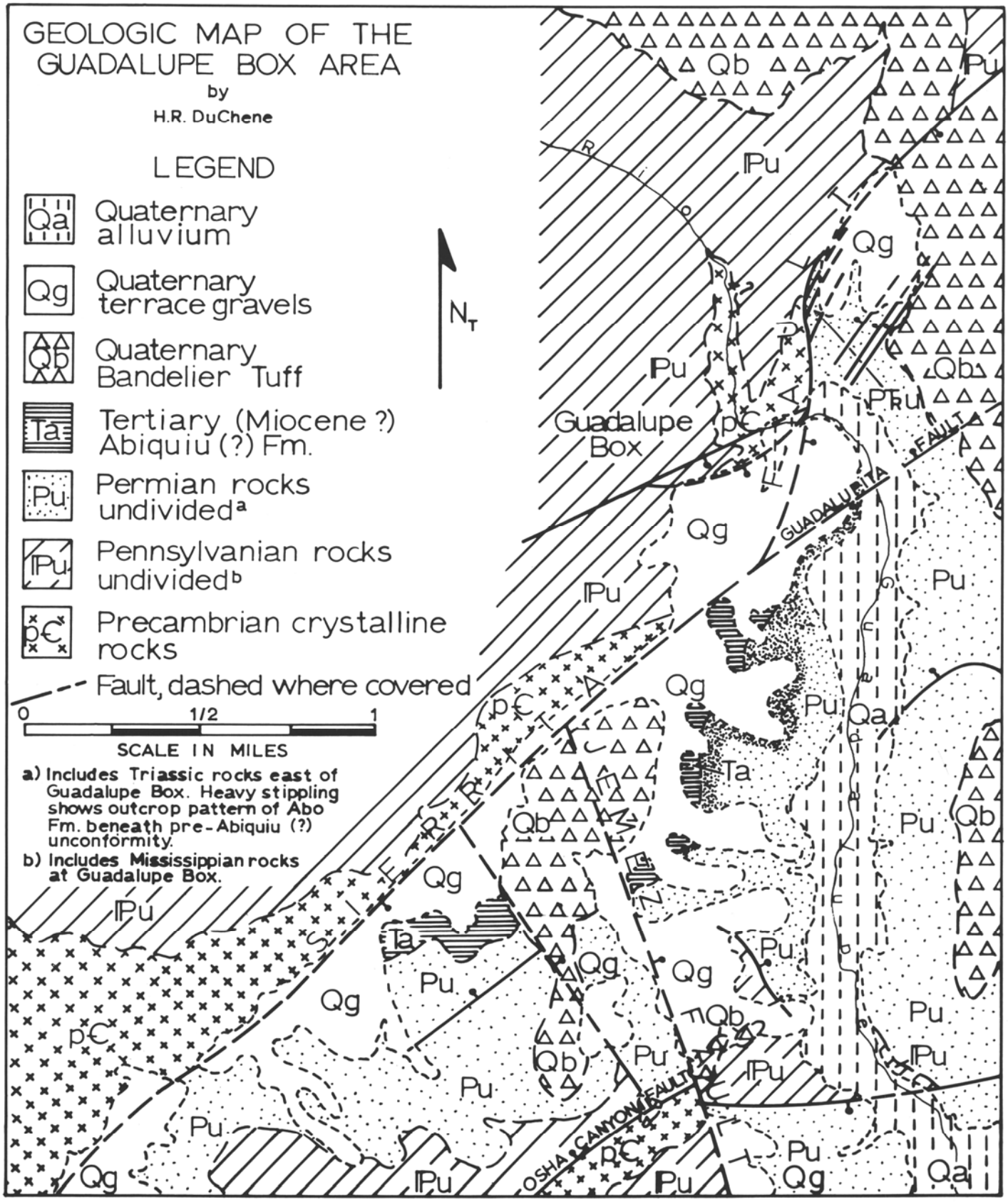

Figure 3. Geologic map of the Guadalupe Box area.

adjacent to the Sierrita fault; The second group is located in the center of the graben and consists of three parallel, northeast-trending normal faults, downthrown to the northwest.

The first group includes several sub-parallel faults between severely deformed Permian and Triassic rocks. These rocks have been sheared and contorted by local compression so that the sense of relative movement between faulted slivers is difficult to ascertain. These slivers behaved as a unit and are downthrown to the northwest with respect to the rest of the graben.

The second group consists of three normal faults located in the center of the graben. These faults have stratigraphic separations ranging from 10 to 150 feet and an aggregate separation of about 200 feet. The faults break the graben into a series of small blocks which stairstep down to the northwest toward the Sierrita fault.

At the south end of Guadalupe Box are two normal faults closely related to the Sierrita fault (Fig. 3). The northern fault is high-angle, trends east-northeast, and is downthrown to the south with about 40 feet of stratigraphic separation. The southern fault is downthrown to the south and has an east-northeast trending curved trace, concave to the north. The curved trace suggests a southeast-dipping fault surface similar to that described for the Sierrita fault. Stratigraphic separation is estimated to be 300 feet near the center of this fault, decreasing to the west. Both the northern and southern faults merge with the Sierrita fault on the east side of Guadalupe Box.

Near the apex of the wedge between the Sierrita and Jemez faults are two normal faults, one trending north-northwest and the other trending northeast. The first of these is downthrown to the northeast and has 100 to 150 feet of stratigraphic separation. This fault cuts the Abiquiu(?) Formation and is overlain by unfaulted Bandelier Tuff. The fault is truncated at its northern end by the Sierrita fault.

The second fault is downthrown to the northwest and has about 100 feet of stratigraphic separation. This fault cuts Permian rocks but does not appear to cut the Abiquiu(?) Formation. It is possible that this northeast-trending fault is older than the nearby Sierrita, Jemez, and Osha Canyon faults, and may be of Laramide age.

STRUCTURAL ANALYSIS

The present-day Nacimiento uplift is superimposed on an ancient highland that developed early in Pennsylvanian time. Wood and Northrop (1946, Fig. 6) show this highland as an elongate, north-trending feature that occupies approximately the same position as the modern Nacimiento uplift. Read and Wood (1947) called this Pennsylvanian highland the Periasco Axis. The development of the Pefiasco Axis apparently established a regional structural grain which influenced tectonic activity in Laramide and late Tertiary time.

Pre-Abiquiu(?) folding is evident southwest of Guadalupe Box where the Abiquiu(?) Formation rests with angular unconformity on rocks of Permian age (Fig. 3). The Permian rocks are preserved in what appears to be the northeast-dipping limb of a gently folded anticline which was eroded exposing progressively older rocks to the south. Along the eastern margin of the San Juan Basin are several en echelon, northwest-trending folds of probable Laramide age (Baltz, 1967). Baltz (1967) and Kelley (1955) attribute these folds to right shift of the Colorado Plateau. The fold that is partially exposed near Guadalupe Box is probably related to the folds of the eastern San Juan basin.

Pre-Abiquiu(?) Formation faults are not as obvious, but may be present in the map-area. One such fault is located near the apex of the wedge between the Sierrita and Jemez faults (Fig. 3). Here, a northeast-trending fault cuts Permian rocks but does not appear to cut the Abiquiu(?) Formation. To the south of the San Ysidro Quadrangle, northwest-trending folds and the northeast-trending faults that cut them are considered to be of Laramide age by Ruetschilling (1973) and Martinez (1974).

The Nacimiento uplift is asymmetric in cross-section, with the west side uplifted more than the east. The west side is clearly defined by the Nacimiento and Pajarito faults (Woodward and others, 1972, Fig. 2), whereas the east side is in contact with the Rio Grande depression.

The east flank of the uplift south of Guadalupe Box is defined by the Sierrita fault which forms a sharp boundary between the uplift and the depression. This fault has a curved surface, concave eastward (at Guadalupe Box), and generally appears to flatten with depth.

The faults east of the Sierrita fault are included in the Rio Grande depression. The area east of the uplift is characterized by normal uplifts, horsts, and grabens suggestive of adjustment to crustal elongation. The age of these faults and the Sierrita fault is post-Abiquiu(?), indicating that the greatest amount of uplift in the area occurred in late Tertiary (Miocene?) time.

Several of the faults east of the uplift truncate against the Sierrita fault. The Sierrita fault thus appears to have acted as a buffer zone which protected the core of the uplift from most of the faulting that took place to the east. The faults of the depression, such as the Jemez fault, were unable to propagate across the Sierrita fault. This suggests that the Sierrita fault may have been present, possibly as a zone of weakness adjacent to the incipient Nacimiento uplift, prior to the development of the faults of the Rio Grande depression.

Most of the faulting east of the Sierrita fault resulted from tension, but there are some local compressional faults. Adjacent to the Sierrita fault, east of the Guadalupe Box, are several sub-parallel faults bounding severely distorted Permian and Triassic rocks (Fig. 3). These are local compressional features that resulted from the movement of the hanging wall of the Sierrita fault over its curved footwall. At structural and stratigraphic levels higher than the Precambrian at Guadalupe Box, the surface of the Sierrita fault is relatively planar and nearly vertical. When this planar surface of the hanging wall moved downward relative to the curved footwall, compression occurred. The rocks squeezed against the footwall were distorted and sheared to fit the available space resulting in the small fault slices exposed adjacent to the Sierrita fault.

The most recent faulting in the map-area occurred in late Quaternary time. About one mile northeast of Guadalupe Box the Bandelier Tuff is offset 40 feet vertically along the Sierrita fault (Fig. 3). This slight rejuvenation of the fault may be related to the subsidence of the Valles Caldera to the north.

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