Annual Project Summary

PALEOSEISMICITY OF QUATERNARY FAULTS NEAR ALBUQUERQUE, NEW MEXICO

Contract 99HQGR0056

Principal Investigator:
James P. McCalpin
GEO-HAZ Consulting, Inc.
P.O. Box 1377, 1221 Graves Ave.
Estes Park, CO 80517
OFFICE: (970) 586-3217
FAX: (970) 577-0041
www.geohaz.com/geohaz

Co-PI
J.B.J. Harrison
Dept. of Earth & Environmental Sciences
New Mexico Tech
Socorro, NM 87801
bruce@prism.nmt.edu

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Investigations Undertaken

This study continues USGS-funded efforts to assess the activity and earthquake hazard potential of Quaternary faults in the Albuquerque metropolitan region. Our target in 1999 was the Calabacillas fault, a 40 km-long normal fault that trends N-S on the western edge of the Llano de Albuquerque (locally called West Mesa). The Calabacillas fault is one of several east-dipping normal faults that define the western margin of the Rio Grande rift at the latitude of Albuquerque Fig. 1). In the past 500,000 to 1 million years, since the abandonment of the Llano surface by the Rio Puerco and Rio Grande, vertical displacement on the Calabacillas fault has created at 27 m-high east-facing fault scarp on the western edge of the Llano. Our trenches were located about 1 km from the south end of the fault, where a 1 km-wide graben has formed east of the main fault scarp. The graben axis is a closed depression and is currently being used as the City of Albuquerque Soil Amendment Facility.

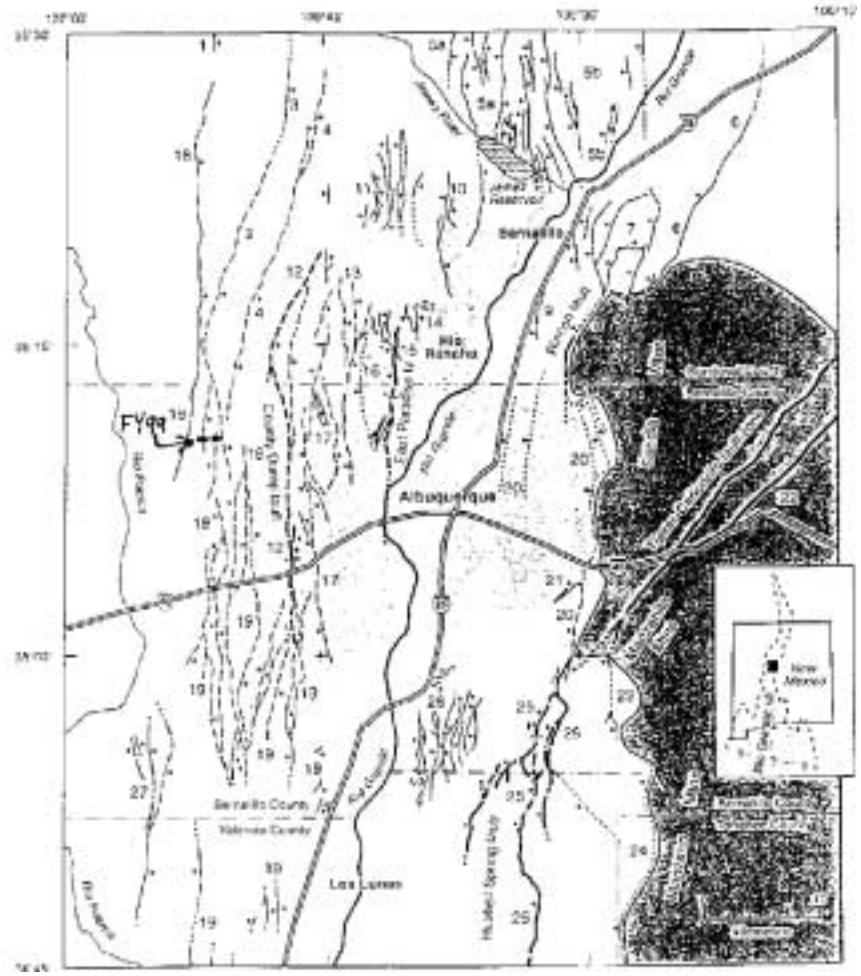

Fig. 1. Map showing faults with known and suspected displacements in Quaternary deposits near Albuquerque, New Mexico. Fault numbers correspond to those in Table 1 of Personius et al. (1999). Faults with known displacements in the late Pleistocene (10-130 ka) or Holocene (<10 ka) are shown with heavier line weight. Hollow bars on the East Paradise, County Dump, and Hubbell Spring faults mark locations of previous detailed trench studies. “FY99” marks the site of the 2 trenches across the Calabacillas fault described in this report. From Personius et al., 1999.

Results

Our trenching of the graben across the southern Calabacillas fault was 50% successful. The East Trench is located in the north-central part of the Llano de Albuquerque in the west-central part of The Volcanoes 7.5’ quadrangle. This area is the southern end of the Calabacillas fault, which terminates against the Loma Colorado transfer zone of Hawley et al. (1996). The trench site is at the northern margin of the City of Albuquerque Soil Amendment Facility (SAF). At the SAF sewage sludge from the City’s sewage treatment plants is tilled into the topsoil in the graben of the Calabacillas fault. Presumably, this site was chosen for the SAF because the graben is a closed depression here and runoff can be controlled. The 7.5’ topographic map of the

Volcano Ranch quadrangle (renamed in 1995 to The Volcanoes quad) shows three ephemeral lakes in the axis of the graben.

The paleoearthquake event history on the 5.3 m-high eastern boundary scarp could not be reconstructed in detail, because a strong caliche soil profile had overprinted the entire 3 m-thick colluvial wedge deposit (Fig. 2). Our interpretation is that numerous decimeter-size displacements had created this scarp, but the displacement was partitioned across several faults so no single free face was higher than 10-20 cm. Free faces this small did not create colluvial wedges, and thus faulting did not trigger the pattern of footwall erosion/ hanging wall deposition that is required to identify individual faulting events.

Fig.2. Photograph of the 1999 East Trench across the eastern (antithetic) fault scarp of the Calabacillas fault.

On the 27 m-high western main fault scarp we had better luck. Our 60 m-long trench (Fig. 3) straddled a slope break that turned out to overlie a major normal fault; we believe this is the main strand of the Calabacillas fault, although conceivably other strands could exist farther west.

The upper four soils exposed in the trench could be correlated across the main fault and indicated per-event displacements of 10 cm, 30 cm, 55 cm, and 20 cm in the latest four events. Six OSL dates on eolian sands came out in correct stratigraphic order and range from 14 ka at a depth of 0.5 m to 219 ka at a depth of 5 m. Secondary calcium carbonate has accumulated in soils here at a rate of 0.17-0.35 g/ka. The latest four faulting events are dated at approximately 14 ka,

Fig. 3. Photograph of the West Trench, looking east. The logged walls are at right. The spoil pile of the East Trench is visible in the distance at upper left. At upper center three of the Albuquerque Volcanoes appear on the horizon. The City of Albuquerque Soil Amendment Facility's main shed is visible just below the right-hand volcano. This shed lies just east of the antithetic fault on the eastern margin of the graben, so a line between the east Trench and the shed approximates the eastern margin of the graben. In the far distance at top are the Sandia Mountains. Photograph taken by J.P. McCalpin on June 1, 1999.

32 ka, 77 ka, and 151 ka. Thus, the displacement and recurrence times increase with increasing age, yielding relatively consistent slip rates of 0.0053-0.0072 m/ka (Fig. 4). This pattern would also result, however, if we missed evidence for some earlier events and our earlier seismic cycles were in fact composed of two events. However, that would not change the slip rate estimates.

There is evidence at this trench for a late Pleistocene (14 ka) small faulting/cracking event. This small young event is similar in displacement and timing to the youngest warping event interpreted for the County Dump fault (McCalpin et al., 2000). The displacements measured in the West Trench are even smaller than those inferred on the County Dump fault, despite the length of the Calabacillas fault (40 km) being similar to that of the County Dump fault (35 km). If our trenches had been located farther north toward the center of the Calabacillas fault the displacements may have been larger.

The ages and recurrence intervals of the four events post 151 ka are similar to those seen at the County Dump site. The youngest event on the Calabacillas fault had only 5-10 cm of throw, considerably smaller than the 20-55 cm throws of the three previous events. This situation parallels the County Dump chronology, where the youngest warping event was abnormally small compared to earlier events.

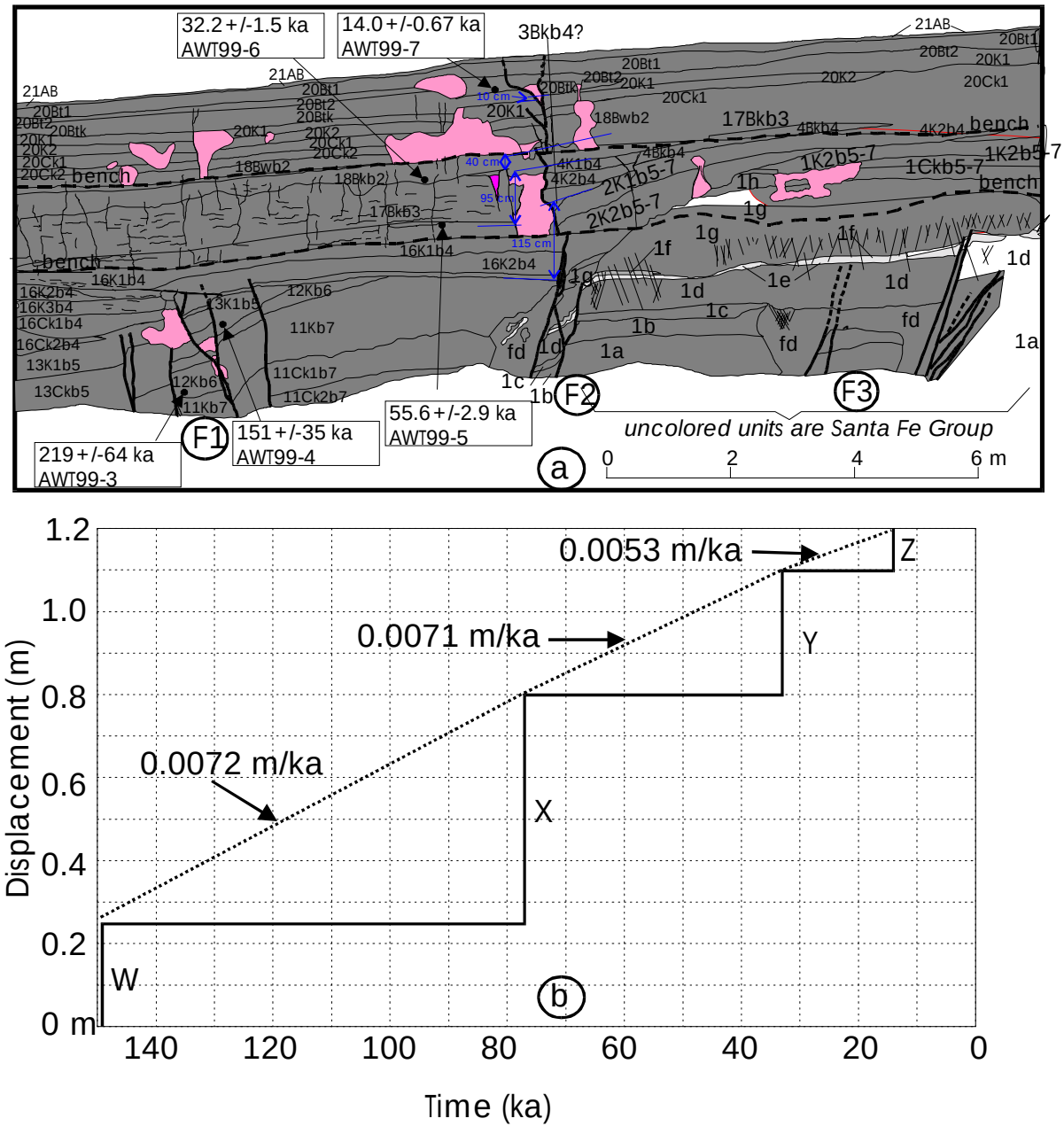

Fig. 4. The main fault zone in the West Trench and the inferred slip history. (a) Log of the center of the West Trench showing the main fault zone; (b) Slip history diagram based on the four differential offsets shown in part (a) and the IRSL age estimates.