Jump to Navigation

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Guaje Mountain fault (Class A) No. 2027

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Compiled in cooperation with the New Mexico Bureau of Geology & Mineral Resources

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Synopsis	The Guaje Mountain fault is mapped in middle Quaternary volcanic deposits and younger alluvium on the Pajarito Plateau. The fault is part of the Pajarito fault system, which is at least 4 km wide at this latitude and includes the Pajarito [2008] and Rendija Canyon [2026] faults. This group of north-striking faults defines the active western boundary of the eastern Española basin half graben (sensu Koning and others, 2013 #7265) of the Rio Grande rift.. The Guaje Mountain fault is associated with a prominent west-facing topographic scarp nearly 30 m high developed on middle Quaternary volcanic deposits. Paleoseismic data suggest that the Guaje Mountain fault possibly has multiple late Pleistocene movements and a probable mid-Holocene surface

	rupture. . Moreover, paleoseismic studies completed since the last version of this compilation suggest that the Rendija and Guaje Mountain faults co-rupture with the Pajarito fault (Lewis and others, 2009, #7228).
Name comments	The Guaje Mountain fault was mapped by Griggs (1964 #1434), Smith and others (1970 #1125), Budding and Purtymun (1976 #1088), Kelley (1978 #1107), Dransfield and Gardner (1985 #1093), and Carter and Gardner (1995 #1154). The fault was named the Guaje Mountain fault zone by Gardner and House (1987 #1097). The fault extends from the northern margin of the northern branch of Sawyer Canyon on the north, about 10 km north of the town of Los Alamos, through Los Alamos to Threemile Canyon.
County(s) and State(s)	LOS ALAMOS COUNTY, NEW MEXICO
Physiographic province(s)	SOUTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:125,000 scale. *Comments:* Location of the Guaje Mountain fault is based on field mapping compiled at scale of 1:125,000 (Smith and others, 1970 #1125) and 1:62,500 (Gardner and House, 1987 #1097), modified by field mapping and analysis of 1:6,000 to 1:58,000- scale aerial photography compiled at a scale of 1:100,000 (Wong and others, 1995 #1155).
Geologic setting	The Guaje Mountain fault is one of several faults within the Pajarito fault system, which is the primary structural boundary along the western margin of the eastern Española basin half graben (sensu Koning and others, 2013) of the Rio Grande rift.. This fault system probably accommodates most of east-west extension in the basin (Kelson and Olig, 1995 #1147), which is asymmetric and tilted to the west (Smith and others, 1970 #1125; Golombek, 1983 #1100; Gardner and House, 1987 #1097; Biehler and others, 1991 #1086; Koning and others, 2013 #7234). The Guaje Mountain fault is located 2 km east of the subparallel Rendija Canyon fault [2026] and 5 km east of the Pajarito fault [2008] (Gardner and House, 1987 #1097; Gardner and others, 1999 #7227). The Guaje Mountain fault is shorter than the Rendija Canyon fault but has comparable down to the west throw

	(35 m) of the 1.2-Ma Bandelier Tuff (Carter and Gardner, 1995 #1154; Olig and others, 1996 #1152). The southern extent and amount of displacement of the Guaje Mountain fault are not well characterized. The lack of a gravity gradient across the Guaje Mountain and Rendija Canyon faults suggests only minor long-term offset compared to the northern and southern sections of the east-down Pajarito fault (Koning and others, 2013 #7265).
Length (km)	11 km.
Average strike	N3°E
Sense of movement	Normal *Comments:* Down-to-the-west separation on the Guaje Mountain fault is expressed by offset of bedded volcanic deposits, alluvial rift-fill deposits, and fluvial deposits laid down by east-flowing, incised drainages developed into the Pajarito plateau. Gardner and others (1990 #1095) interpret dip slip and oblique slip on small faults within the fault zone, as exposed in a trench across the central part of the fault.
Dip	75° W. to 90° *Comments:* Subsurface geometric data are lacking for the Guaje Mountain fault. Fault plane measurement made during detailed bedrock mapping shows dips ranging from 75° W. to vertical (Carter and Gardner, 1995 #1154). Shallow dips are consistent with interpretations of the Guaje Mountain fault as a rift-bounding structure, and steeper dips are consistent with the linear fault trace and the possibility of lateral slip. Some structural models used by Wong and others (1995 #1155) suggest that the Guaje Mountain fault may intersect the rift-bordering Pajarito fault at shallow crustal depths, and therefore does not extend in the subsurface to seismogenic depths.
Paleoseismology studies	Exploratory trenches were excavated across the Guaje Mountain fault or its projection to the south as part of a seismic-hazard evaluation for Los Alamos National Laboratory (Wong and others, 1995 #1155; 1996 #1156) and a fault-rupture hazard evaluation for a laboratory facility (Kolbe and others, 1994 #1148). Gardner and others (1990 #1095) describe the Cabra Canyon trench site along the central part of the fault and Gardner and others (2003 #7186) document faulting at Chupadero

Canyon; the results of both studies indicate Holocene surface rupture. Wong and others (1995 #1155) describe detailed geomorphic mapping and a shallow trench across the central part of the fault in Rendija Canyon. Kolbe and others (1994 #1148) provide logs of several trenches spanning the southern projection of the fault south of Los Alamos.

Site 2027-1. Gardner and others (1990 #1095) document the results of excavating a trench across the fault in Cabra Canyon that exposed faulted valley-fill alluvium and colluvial derived from a west-facing escarpment. Ten radiocarbon samples constrain the age of faulted Holocene sequence (Gardner and others, 2003 #7186). Gardner and others (1990 #1095, 2003 #7186) interpret displacement along small faults offsetting middle Holocene deposits that are 4,000 to 6,000 years old. Stratigraphic relations do not permit identifying earlier surface rupture of the main fault (Gardner and others, 2003 #7186).

Site 2027-2. Wong and others (1995 #1155) document the results of excavating four trenches within Rendija Canyon in the vicinity of the Guaje Mountain fault. These trenches exposed late Holocene deposits that likely post-date the event interpreted by Gardner and others (1990 #1095) along the fault. No evidence of faulting was observed in these trenches, and Wong and others (1995 #1155) interpret that the fault is located directly west of the westernmost trench.

Site 2027-3. Kolbe and others (1994 #1148) excavated several trenches across the southern projection of the Guaje Mountain fault both north and south of Pajarito canyon. This series of trenches showed no evidence for displacement of the 1.2 Ma upper Bandelier Tuff, or late Pleistocene colluvium that predates the 50- to 60-ka (Reneau and others, 1996 #1264) El Cajete Pumice (Kolbe and others, 1994 #1148). On this basis, Wong and others (1995 #1155) interpret that the Guaje Mountain fault terminates to the north of the trench site, at about Mortandad Canyon.

Site 2027-4. Chupadero Canyon site consists of three trenches (CHU-1–CHU-3, numbered from south to north in Gardner and others, 2003 #7186). CHU-1 crosses the main fault trace and was up to 5 m deep. The exposure is 32–40 ka as determined by stratigraphic relations, three radiocarbon samples and nine optically stimulated luminescence (OSL) samples indicate the

	(Gardner and others, 2003 #7186). Holocene deposits at the site are eroded from the fault scarp. Trench CHU-1 contains evidence of two or three surface ruptures in the late Pleistocene. The other two trenches did not cross the trace of the main fault. M. Gonzalez and J. Gardner conducted field mapping of fluvial terraces and the Guaje Mountain fault in Rendija Canyon, along the central part of the fault (M. Gonzalez and J. Gardner, unpubl. mapping, 1990). Wong and others (1995 #1155) conducted additional detailed mapping of the Rendija Canyon area, which in turn has been investigated more thoroughly by McDonald and others (1996 #1162). Wong and others (1995 #1155) identified eight fluvial terraces along the Rendija Canyon drainage, and produced profiles of these surfaces across the Guaje Mountain fault. Age estimates of the terraces were based on relative soil development. Considering wide age ranges for the terraces and the measured vertical displacements, Wong and others (1995 #1155) calculate a range in slip rate along the Guaje Mountain fault of 0.01 to 0.03 mm/yr. They identify as many as three surface-rupture earthquakes along the fault, the oldest of which occurred prior to about 100 to 200 ka, and the two most recent occurring after about 100 to 200 ka. Wong and others (1995 #1155) postulate that the most-recent of these likely was the mid-Holocene event identified by Gardner and others (1990 #1095).
Geomorphic expression	The Guaje Mountain fault is associated with prominent west-facing topographic scarps extending 6 km across mesas underlain by the 1.2-Ma upper Bandelier Tuff. Scarps are up to about 30–40 m high, and the average net vertical tectonic displacement of 1.2-Ma tuff is 15 m (Wong and others, 1995 #1155; Olig and others, 1996 #1152, Carter and Gardner, 1995 #1154, Gardner and others, 2003 #7186). The southern extent and amount of displacement of the Guaje Mountain fault are not well characterized (Lewis and others 2009 #7228); the fault loses topographic expression between Rendija and Pueblo Canyons (Gardner and others, 2003 #7186). Although there is trench evidence of Holocene displacement along the fault, there is little or no geomorphic expression of the fault across alluvial valley floors -- even though single-event displacements both on the Rendija Canyon and Guaje Mountain faults are unexpectedly large (>1 m) considering their short 10-km lengths. Gardner and others (2003 #7186) confirm that single-event displacements are 1.5–2 m. These observations lead to the conclusion that both the Rendija Canyon and Guaje Mountain rupture coseismically with the Pajarito fault

	(Lewis and others, 2009 #1154).
Age of faulted surficial deposits	Pleistocene and middle Holocene colluvial and alluvial deposits are displaced by the Guaje Mountain fault, where it was exposed in a paleoseismologic trench in Cabra Canyon (Gardner and others, 1990 #1095). Ages of displaced alluvial and colluvial deposits are estimated from radiocarbon analyses.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Trenches excavated across the Guaje Mountain fault provide evidence for repeated late Quaternary surface ruptures, including a Holocene event (Gardner and others, 1990 #1095, 2003 #7186). Consistent results between trenches suggest the most recent surface rupture on the fault occurred in mid-Holocene time, 6.5–4.2 cal ka. The timing of this earthquake is tightly constrained in one trench; evidence from other trenches is consistent with this timing (Gardner and others, 2003). The age of an unfaulted deposit in the trenches is 3.8–0.3 cal ka.
Recurrence interval	 *Comments:* Long recurrence intervals are suggested from trenching data. Gardner and others (2003 #) considered all of the available data trench-site data to propose a chronology of two (or possibly 3) surface ruptures since about 40 k.y. The most recent occurred 4 to 6.5 ka and resulted in 1.5 to more than 2 m of vertical displacement. The chronology supported by Gardner and others (2003 #7186) is consistent with that for the Rendija Canyon fault (Wong and others, 1995 #1155 summarized in Olig and others, 1996 #1152).
Slip-rate category	Less than 0.2 mm/yr *Comments:* The low slip-rate category is assigned based on the reported cumulative vertical displacement in trench CHU-1 of 2 m (possibly 3 m) since about 40 ka (Gardner and others, 2003 #7186) and an average net vertical displacement of 15 m of the 1.2 Ma upper Bandelier Tuff (Wong and others, 1995 #1155; 1996 #1156).
Date and Compiler(s)	2015 Keith I. Kelson, William Lettis & Associates, Inc.

	Kathleen M. Haller, U.S. Geological Survey
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