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Quaternary Fault and Fold Database of the United States

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Rendija Canyon fault (Class A) No. 2026

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

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Synopsis	The Rendija Canyon fault is a dominantly down-to-the-west normal fault mapped in middle Quaternary volcanic deposits and younger alluvium in the Los Alamos area. This short fault is located about 3 km east of the Pajarito fault [2008] and is a component of the Pajarito fault system, which is at least 4–10 km wide at this latitude and includes the Guaje Mountain [2027] fault. 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 Rendija Canyon fault is associated with a prominent west-facing 40-m-high topographic scarp on middle Quaternary volcanic deposits, mainly ash-flow tuff. Paleoseismologic data suggest that the

	Rendija Canyon fault has had multiple late Pleistocene movements, with a possible surface rupture in the early Holocene. 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 Rendija Canyon 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 for Rendija Canyon by Gardner and House (1987 #1097). The fault extends from the northern margin of Guaje Canyon, about 8 km north of Los Alamos, New Mexico, south to Pajarito Canyon.
County(s) and State(s)	SANDOVAL COUNTY, NEW MEXICO LOS ALAMOS COUNTY, NEW MEXICO
Physiographic province(s)	SOUTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:125,000 scale. *Comments:* The location of the Rendija Canyon fault is based on field mapping compiled at a 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 Rendija Canyon 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 the roughly east-west extension in the eastern Española 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 Rendija Canyon fault exhibits west-down displacement, which is opposite in sense to the east-down displacement along the Pajarito fault [2008] located about 3 km to the west (Gardner and others, 1999 #7227). 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	N1°E
Sense of movement	Normal *Comments:* The Rendija Canyon fault exhibits down-to-the-west separation of bedded volcanic deposits, alluvial rift-fill deposits, and fluvial deposits laid down by east-flowing, drainages incised into the Pajarito plateau. Carter and Gardner (1995 #1154) stated that slickensides are steeply plunging to nearly vertical along the fault and, from kinematic analysis of these data, interpret that the axis of least principal horizontal stress (extension) trends approximately east.
Dip	60° W. to 90° *Comments:* Subsurface geometric data are lacking for the Rendija Canyon fault. Fault-plane measurements made during detailed bedrock mapping show dips ranging from 60° to 90° and averaging about 79° (Carter and Gardner, 1995 #1154). Shallow dips are consistent with interpretations of the Rendija Canyon fault as a rift-bounding antithetic 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 Rendija Canyon fault may intersect the rift-bordering Pajarito fault at shallow crustal depths and thus does not extend to seismogenic depths.
Paleoseismology studies	Exploratory trenches were excavated across the Rendija Canyon fault (Wong and others, 1995 #1155; Kelson and others, 1996 #1151) and its projection to the south (Kolbe and others, 1994 #1148) as part of a seismic hazard evaluation for Los Alamos National Laboratory and a fault-rupture hazard evaluation for a laboratory facility. Wong and others (1995 #1155) and Kelson and others (1996 #1151) describe the Guaje Pines trench site in the central part of the fault and the County Landfill exposure at the southern end of the fault, and Kolbe and others (1994 #1148) provide logs of several trenches spanning the southern projection

of the fault south of Los Alamos.

Site 2026-1. Wong and others (1995 #1155) excavated four trenches and three soil test pits at the Guaje Pines site along the central part of the fault during the summer of 1992. Two trenches excavated across the fault exposed faulted alluvium overlain by two packages of scarp-derived colluvial deposits that resulted from scarp degradation after west-down surface-rupturing earthquakes (Kelson and others, 1996 #1151). Ages of the alluvial and colluvial deposits are estimated from radiocarbon and luminescence analyses, and relative soil development. The trench exposures provided evidence of at least three and possibly as many as five surface-faulting events, with the oldest of these occurring prior to about 140 ka. Three or four events occurred since deposition of colluvium that is more than 140±26 ka. The most-recent rupture occurred at about 9 or 23 ka. The thickness of the upper colluvial package suggests 2.0±0.5 m of vertical displacement during the most-recent earthquake. Kelson and others (1996 #1151) estimated an average recurrence interval for surface-rupturing earthquakes of between 33 ka and 66 ka from age estimates of scarp-derived colluvium, and an interval of about 38–83 ka from the long-term slip rate and displacement-per-event data.

Site 2026-2. Wong and others (1995 #1155) documented an exposure of a main strand of the Rendija Canyon fault in the Los Alamos County Landfill, located directly south of the town of Los Alamos. The 13-m-deep excavation shows a net vertical tectonic displacement of 4 m of the 1.2-Ma upper Bandelier Tuff, and evidence of multiple ruptures of post-1.2-Ma fluvial deposits overlying the tuff. The plunge of slickensides along fault planes suggests 10–60 m of oblique slip, and an estimated post-1.2-Ma slip rate of 0.01–0.05 mm/yr. There is evidence of at least three surface-rupturing earthquakes in the past several hundred thousand years, although numerical age estimates are not available.

Site 2026-3. Kolbe and others (1994 #1148) excavated several trenches on Pajarito Mesa across the southern projection of the Rendija Canyon fault. These trenches show evidence for several minor, near-vertical faults within a 30-m-wide zone roughly coincident with an air-photo lineament along the strike of the easternmost trace of the southern Rendija Canyon fault. These faults show predominantly west-down vertical separations of less

	than 60 cm of alluvium overlying the 1.2-Ma upper Bandelier Tuff. The faults do not offset air-fall and associated deposits of the 50–60 ka (Reneau and others, 1996 #1264) El Cajete Pumice (Kolbe and others, 1994 #1148). These faults thus likely did not rupture during the most-recent and penultimate events interpreted from the Guaje Pines site (2026-1).
Geomorphic expression	The Rendija Canyon fault is expressed as prominent west-facing topographic scarps on mesas underlain by the 1.2-Ma upper Bandelier Tuff. Scarps are as much as 40 m high, and the average net vertical tectonic displacement of the tuff is 36±10 m (Carter, and Gardner, 1995 #1154; Olig and others, 1996 #1152). Fault scarps are also formed on late Quaternary alluvial deposits in major drainages that cross the fault (Wong and others, 1995 #1155; Kelson and others, 1996 #1151). Single-event displacement on the Rendija Canyon and Guaje Mountain faults are unexpectedly large (>1 m) considering their short 10-km lengths (URS); 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). The fault splays to the south into a broad zone of deformation nearly 1.5 km wide, where amount of vertical displacement and style of faulting differs (Gardner and others, 1999 #7227; Lavine and others, 2003 #7263; Lewis and others, 2009 #7228).
Age of faulted surficial deposits	Late Pleistocene and possibly early Holocene colluvial and alluvial deposits are displaced by the Rendija Canyon fault where it is exposed in a trench site [2026-1] at the Guaje Pines Cemetery (Kelson and others, 1993 #1149; Wong and others, 1995 #1155; 1996 #1151). Ages of displaced alluvial and colluvial deposits are estimated from radiocarbon and thermoluminescence analyses, and relative soil development. The youngest scarp-derived colluvial deposit is either 9 ka (based on radiocarbon analyses of charcoal fragments), or 23 ka (based on thermoluminescence analyses of silty colluvium). Deposits that have been faulted three or four times are estimated to be more than 140 ka on the basis of thermoluminescence analysis and relative soil development (Wong and others, 1995 #1155; Kelson and others, 1996 #1151).
Historic earthquake	
Most recent	late Quaternary (<130 ka)

prehistoric deformation	*Comments:* The youngest scarp-derived colluvial deposit exposed in trenches at the Guaje Pines trench site [2026-1] is either 9 ka, based on radiocarbon analyses, or 23 ka, based on thermoluminescence analyses (Wong and others, 1995 #1155; Kelson and others, 1996 #1151). Without further dating, we place the most recent movement in the late Quaternary (<130 ka) rather than the latest Quaternary (<15 ka).
Recurrence interval	33–83 k.y. *Comments:* Stratigraphic evidence at the Guaje Pines site [2026-1] suggests large earthquakes on the Rendija Canyon fault have recurrence intervals of a few thousand to several tens of thousands of years. Kelson and others (1996 #1151) estimate that the time between the two most-recent earthquakes is 33–66 k.y. On the basis of a long-term slip rate of 0.03±0.01 mm/yr and a displacement per event of 2.0±0.5 m, Kelson and others (1996 #1151) estimated a range in average recurrence of 38–83 k.y. These two studies indicate a possible range of 33–83 k.y. for the average recurrence interval.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Low slip-rate category assigned based on an average net vertical tectonic displacement of 21 m of the 1.2-Ma upper Bandelier Tuff. Kelson and Olig (1995 #1147) cite a preferred slip rate of 0.02 mm/yr for the Rendija Canyon fault.
Date and Compiler(s)	2015 Keith I. Kelson, William Lettis & Associates, Inc. Kathleen M. Haller, U.S. Geological Survey
References	#1086 Biehler, S., Ferguson, J., Baldridge, W.S., Jiracek, G.R., Aldren, J.L., Martinez, M., Fernandez, R., Romo, J., Gilpin, B., Braile, L.W., Hersey, D.R., Luyendyk, B.P., and Aiken, C.L., 1991, A geophysical model of the Española basin, Rio Grande rift, New Mexico: Geophysics, v. 56, p. 340–353. #1088 Budding, A.J., and Purtymun, W.D., 1976, Seismicity of the Los Alamos area based on geologic data: Los Alamos Scientific Laboratory Report LA-6278-MS, 7 p. #1154 Carter, K.E., and Gardner, J.N., 1995, Quaternary fault kinematics in the northwestern Española basin, Rio Grande rift, New Mexico, *in* Bauer, P.W., Kues, B.S., Dunbar, N.W.,

Karlstrom, K.E., and Harrison, B., eds., Geology of the Santa Fe region, New Mexico: New Mexico Geological Society, 46th Field Conference, September 27-30, 1995, Guidebook, p. 97-103.

#1093 Dransfield, B.J., and Gardner, J.N., 1985, Subsurface geology of the Pajarito Plateau, Española basin, New Mexico: Los Alamos National Laboratory Report LA-10455-MS, 15 p.

#1097 Gardner, J.N., and House, L., 1987, Seismic hazards investigations at Los Alamos National Laboratory, 1984-1985: Los Alamos National Laboratory Report LA-11072-MS, 76 p.

#7227 Gardner, J.N., Lavine, A., WoldeGabriel, G., Krier, D.J., Vaniman, D., Caporuscio, F., Lewis, C., Reneau, P., Kluk, E., and Snow, M.J., 1999, Structural geology of the northwestern portion of Los Alamos National Laboratory, Rio Grande rift, New Mexico —Implications for seismic surface rupture potential from TA-3 to TA-55: Los Alamos National Laboratory Report LA-13589-MS, 112 p.

#7186 Gardner, J.N., Reneau, S.L., Lavine, A., Lewis, C.J., Katzman, D., McDonald, E.V., Lepper, K., Kelson, K.I., and Wilson, C., 2003, Paleoseismic trenching in the Guaje Mountain fault zone, Pajarito fault system, Rio Grande rift, New Mexico: Los Alamos National Laboratory Report LA-14087-MS, 68 p., 5 plates.

#1100 Golombek, M.P., 1983, Geology, structure, and tectonics of the Pajarito fault zone in the Española basin of the Rio Grande rift, New Mexico: Geological Society of America Bulletin, v. 94, p. 192–205.

#1434 Griggs, R.L., 1964, Geology and ground-water resources of the Los Alamos area New Mexico: U.S. Geological Survey Water-Supply Paper 1753, 107 p., 1 pl., scale 1:31,680.

#1107 Kelley, V.C., 1978, Geology of Española basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map 48, 1 sheet, scale 1:125,000.

#1147 Kelson, K.I., and Olig, S.S., 1995, Estimated rates of Quaternary crustal extension in the Rio Grande rift, northern new Mexico, *in* Bauer, P.W., Kues, B.S., Dunbar, N.W., Karlstrom, K.E., and Harrison, B., eds., Geology of the Santa Fe region, New

Mexico: New Mexico Geological Society, 46th Field Conference, September 27–30, 1995, Guidebook, p. 9–12.

#1151 Kelson, K.I., Hemphill-Haley, M.A., Olig, S.S., Simpson, G.D., Gardner, J.N., Reneau, S.L., Kolbe, T.R., Forman, S.L., and Wong, I.G., 1996, Late Pleistocene and possibly Holocene displacement along the Rendija Canyon fault, Los Alamos County, New Mexico, *in* Goff, F., Kues, B.S., Rogers, M.A., McFadden, L.D., and Gardner, J.N., eds., The Jemez Mountains region: New Mexico Geological Society, 47th Field Conference, September 25-28, 1996, Guidebook, p. 153-160.

#1149 Kelson, K.I., Hemphill-Haley, M.A., Wong, I.G., Gardner, J.N., and Reneau, S.L., 1993, Paleoseismologic studies of the Pajarito fault system, western margin of the Rio Grande rift near Los Alamos, NM: Geological Society of America Abstracts with Programs, v. 25, no. 5, p. 61-62.

#1148 Kolbe, T., Sawyer, J., Gorton, A., Olig, S., Simpson, D., Fenton, C., Reneau, S., Carney, J., Bott, J., and Wong, I., 1994, Evaluation of the potential for surface faulting at the proposed mixed waste disposal facility, TA-67: Report for the Los Alamos National Laboratory.

#7265 Koning, D.J., Grauch, V.J.S., Connell, S.D., Ferguson, J., McIntosh, W., Slate, J.L., Wan, E., and Baldridge, W.S., 2013, Structure and tectonic evolution of the eastern Española Basin, Rio Grande rift, north-central New Mexico, *in* Hudson, M.R., and Grauch, V.J.S., New perspectives on Rio Grande rift basins—From tectonics to groundwater: Geological Society of America Special Paper 494, p. 185–219.

#7263 Lavine, A., Gardner, J.N., and Reneau, S.L., 2003, Total station geologic mapping—An innovative approach to analyzing surface-faulting hazards: Engineering Geology, v. 70, p. 71–91.

#7228 Lewis, C.J., Gardner, J.N., Schultz-Fellenz, E.S., Lavine, A., Reneau, S.L., and Olig, S, 2009, Fault interaction and along-strike variation in throw in the Pajarito fault system, Rio Grande rift, New Mexico: Geosphere, v. 5, p. 252–269; doi: 10.1130/GES00198.1.

#1152 Olig, S.S., Kelson, K.I., Gardner, J.N., Reneau, S.L., and Hemphill-Haley, M., 1996, The earthquake potential of the

Pajarito fault system, New Mexico, *in* Goff, F., Kues, B.S., Rogers, M.A., McFadden, L.D., and Gardner, J.N., eds., The Jemez Mountains region: New Mexico Geological Society, 47th Field Conference, September 25-28, 1996, Guidebook, p. 143-152.

#1264 Reneau, S.L., Gardner, J.N., and Forman, S.L., 1996, New evidence for the age of the youngest eruptions in the Valles caldera, New Mexico: Geology, v. 24, p. 7-10.

#1125 Smith, R.L., Bailey, R.A., and Ross, C.S., 1970, Geologic map of the Jemez Mountains, New Mexico: U.S. Geological Survey Miscellaneous Investigations Map I-571, 1 sheet, scale 1:125,000.

#1156 Wong, I., Kelson, K., Olig, S., Bott, J., Green, R., Kolbe, T., Hemphill-Haley, M., Gardner, J., Reneau, S., and Silva, W., 1996, Earthquake potential and ground shaking hazard at the Los Alamos National Laboratory, New Mexico, *in* Goff, F., Kues, B.S., Rogers, M.A., McFadden, L.D., and Gardner, J.N., eds., The Jemez Mountains region: New Mexico Geological Society, 47th Field Conference, September 25-28, 1996, Guidebook, p. 135–142.

#1155 Wong, I., Kelson, K., Olig, S., Kolbe, T., Hemphill-Haley, M., Bott, J., Green, R., Kanakari, H., Sawyer, J., Silva, W., Stark, C., Haraden, C., Fenton, C., Unruh, J., Gardner, J., Reneau, S., and House, L., 1995, Seismic hazards evaluation of the Los Alamos National Laboratory: Technical report to Los Alamos National Laboratory, Los Alamos, New Mexico, February 24, 1995, 3 volumes, 12 pls., 16 appen.