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Alamogordo fault, Three Rivers section (Class A) No. 2054a

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

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Synopsis	**General:** The Alamogordo fault is a long range-bounding fault that forms the structural boundary between the Sacramento Mountains (to the east) and the Tularosa Basin (to the west) in the southern Rio Grande rift. Conspicuous, nearly continuous fault scarps extend from near the north end of the Phillips Hills southward to about 22 km northeast of Orogrande, New Mexico. Detailed geologic and geomorphic mapping has been completed along most of the fault north of the McGregor Range. Near Alamogordo, numerous scarp profiles and dating of exposures

	constrain the timing of 3–5 late Quaternary surface-rupturing earthquakes that resulted in 5–10 m of cumulative slip. In addition, mountain-front morphology and geophysical data are used to identify the Deadman section [2054c], extending south of Alamogordo, as the most active part of the fault. **Sections:** This fault has 4 sections. The northern and southern sections are defined herein on the basis of fault location relative to the main escarpment of the Sacramento Mountains as well as continuity and apparent age of scarps. The central two sections are defined based on the frequency of late Quaternary surface ruptures and systematic differences of short- and long-term throw. These differences in throw are measured using fault-scarp height, elevation of stratigraphic markers on the mountain front, the elevation of the crest of the Sacramento Mountains with respect to the base of the mountain front, and estimation of basin-fill depth using geophysical data (Koning, 1999; #5535).
Name comments	**General:** First mapped by Otte (1959 #983) and later by Pray (1961 #984), this fault was initially named the Sacramento fault (Kelly and Thompson, 1964 #7254) but subsequently renamed the Alamogordo fault (Machette, 1987 #847) for its proximity to the town of Alamogordo, New Mexico. The fault is characterized by conspicuous fault scarps that extend from near the north end of the Phillips Hills (about 60 km north of Alamogordo, New Mexico), south through Tularosa and Alamogordo, and into the McGregor Bombing Range. The southernmost scarps end near Otero County Road 506, about 45 km south of Alamogordo. **Section:** Grant (1984 #2003) used the term "Three Rivers-Sacramento fault" for the northern extension of the Alamogordo fault. However, the simple section name "Three Rivers" is accepted herein for its proximity to the small town of Three Rivers, which is about 27 km north of Tularosa, New Mexico. The Quaternary trace of this section of the fault is conspicuous from 5 km north of the Phillip Hills (about 22 km north of Three Rivers) south to the north end of a 3 to 4-km-wide embayment centered at Temporal Creek (about 10 km south-southeast of Three Rivers). This embayment coincides with a 9-km-long boundary zone between the north end of the Coyote Hills (10 km north of Tularosa) and a northeast-striking transverse fault called the Salinas Draw fault (Koning and Kelley, 2009 #7333). Here, there are two fault zones: one along the mountain front to the east and another 3.5 km basinward (to the west-southwest). The eastern scarp is more degraded than the western, and so the

	western is interpreted to have ruptured more recently (Koning and Kelley, 2009 #7333). For the purposes of this compilation, we don't separate this boundary zone but subsume it into the Sabinata section. Thus, the south end of the Three Rivers section is placed at the intersection of the Alamogordo fault with the Salinas Draw fault of Koning and Kelley (2009 #7333). The north end of the Three Rivers section is placed near the northern extent of Quaternary fault scarps, which are 5 km north of the north end of the Phillips Hills (6 km northwest of Oscura). **Fault ID:** Previously referred to as fault 7 on figure 1 and table 2 of Machette (1987 #847), the southernmost part of 2054a and the northern part of 2054b (Machette and others, 1998 #2848).
County(s) and State(s)	LINCOLN COUNTY, NEW MEXICO OTERO COUNTY, NEW MEXICO
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location of the fault is based on mapping by Koning (2009 #7332), Koning and Kelley (2009 #7333), and Koning and others (2010 #7334, 2014 #7379). Fault location at the foot of the northern Phillips Hills was mapped from aerial photographs (scale of approximately 1:24,000) using stereogrammetry software (Stereo Analyst for ARCGIS 10.1, an ERDAS extension, version 11.0.6).
Geologic setting	The Alamogordo fault is a west-down, range-front normal fault forming the structural boundary between the west side of the Sacramento Mountains and the Tularosa Basin. The eastern Tularosa Basin corresponds to a half-graben tilted eastward towards the Alamogordo fault (Healy and others, 1978 #7329; Orr and Myers, 1986 #7338; Seager and others, 1987 #627; Johnson and others, 1989 #7331; Lozinsky and Bauer, 1991 #7336). The Alamogordo fault juxtaposes Quaternary basin fill against Paleozoic bedrock at the foot of the Sacramento Mountains. Due to variable northward and southward components of dip in the mountain block, the particular Paleozoic lithologic unit exposed at the ranges from Ordovician through Permian (Pray, 1961 #984). Sufficient throw occurred 25 km south of Alamogordo to expose local Proterozoic rock at the base of the mountains (Pray,

	1961 #984). North of La Luz, a broad pediment surface has formed largely in erodible strata of the Abo Formation (Otte, 1959 #983). In the Three Rivers area, relatively low hills, including the Phillips Hills, are found on the immediate footwall of the fault. Aside from the Godfrey Hills, relatively low relief and shallow Quaternary deposits characterizes the 18- to 23-km-wide area between the northern Alamogordo fault (i.e., the Three Rivers section) east to the imposing western face of Sierra Blanca. South of Bug Scuffle Canyon, the fault forms small scarps across the piedmont slope and along low-relief bedrock hills. Depth to basement in the eastern Tularosa Basin is 200–1,200 m based on geophysical and well data (Hood, 1959 #7330; McLean, 1970 #7337; Healy and others, 1978 #7329 Orr and Myers, 1986 #7338; Lanka, 1995 #7335; gravity and aeromagnetic data from R. Keller, pers. comm., 1998; Koning, 1999 #5535).
Length (km)	This section is 35 km of a total fault length of 130 km.
Average strike	N9°W (for section) versus N10°W (for whole fault)
Sense of movement	Normal
Dip Direction	W *Comments:* Suspected to be a high-angle, normal, dip-slip fault from regional geologic studies and other faults associated with downdropping of the Tularosa Basin.
Paleoseismology studies	
Geomorphic expression	Scarps along this section are quite obvious on aerial photographs (even where they as little as 1–2 m high), suggesting recent movement. West-facing piedmont scarps are as much as 18-m-high on Quaternary alluvium. Scarps at the bedrock/alluvial contact along the western side of the Phillips Hills have steep scarp angles (>33°) where only 1–2 m high, which suggests Holocene displacement, at least in the Phillips Hills area. Such young movement is harder to detect on the larger (composite) scarps south of the Phillip Hills.
Age of faulted surficial	The compilation geologic map of Koning and others (2014 #7379) indicate that the fault scarps of this section are in early to

deposits	late Quaternary alluvium. The high scarps on Quaternary alluvium (e.g., north of Three Rivers) probably reflect a minimum amount for surface offset owing to pervasive burial on the downdropped side of the fault. The youngest faulted deposits are certainly of middle or late Quaternary age, but Holocene deposits may be faulted along the northern part of the section.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Timing poorly controlled but based on scarp's fresh morphology along the Phillip Hills, continuity in faulting, and on suspected age of faulted deposits. No detailed studies have been conducted to confirm this age estimate.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Low slip-rate category assigned based on 2- to 3-m-high scarps on late Pleistocene deposits and on 18-m-high scarps on Quaternary (?) alluvium.
Date and Compiler(s)	2016 Daniel J. Koning, New Mexico Bureau of Geology & Mineral Resources Michael N. Machette, U.S. Geological Survey, Retired Keith I. Kelson, William Lettis & Associates, Inc.
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