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Quaternary Fault and Fold Database of the United States

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Grapevine fault (Class A) No. 184

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Compiled in cooperation with the California Geological Survey

citation for this record: **Machette, M.N., Klinger, R.E., and Piety, L.A., compilers, 2002, Fault number 184, Grapevine fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:25 PM.**

Synopsis	The Grapevine fault is a range-bounding normal fault along the southwestern side of the Grapevine Mountains and along the northeastern side of Death Valley between about Titanothere Canyon Red Wall Canyon. As such it parallels but lies east of the Northern Death Valley fault zone, which has predominately lateral slip. The structural relationship between these two faults is largely unknown, but the Grapevine fault forms the eastern margin of a structurally downdropped block comprised by the northern part of Death Valley. The total vertical separation on the Grapevine fault could be at least 4,270 m (14,000 ft). The Cenozoic displacement seems to be greatest at the southern end of the Grapevine fault, where the vertical separation may as much as

	427 m (1,400 ft), and decreases northwestward toward Red Wall Canyon. Part of the Grapevine fault is characterized by a topographic lineament that bounds the front of the Grapevine Mountains. Where preserved, fault scarps reportedly slope angles of 44? to 75? SW. However, morphometric studies of these scarps have not been performed, nor have surface offsets been reported. The fault is generally considered to be have late Quaternary (<130 ka) movement, but it may in fact be younger (<15 ka). No slip rate or recurrence interval data have been reported, nor have any paleoseismic studies been conducted owing to the fault's location within Death Valley National Park.
Name comments	The Grapevine fault is located along the southwestern side of the Grapevine Mountains and along the northeastern side of Death Valley between about Titanothere Canyon on the south and north of Red Wall Canyon on the north. Originally named the Grapevine fault zone by Reynolds (1969 #1613), the simpler name Grapevine fault is used following that of Piety (1995 #915). The total length of the Grapevine fault between Titanothere Canyon and north of Red Wall Canyon is 20 km as estimated from Reheis (1991 #1602). Reynolds (1976 #1614) reported that alluvium adjacent to the Grapevine Mountains is not faulted south of Titanothere Canyon to at least Boundary Canyon, but that the alluvium in this area is locally warped. The length of this section is about 10 km, so that the total length of the Grapevine fault could be close to 30 km. **Fault ID:** Refers to fault GV (Grapevine fault) of Piety (1995 #915).
County(s) and State(s)	INYO COUNTY, CALIFORNIA
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:100,000 scale. *Comments:* The fault was first suggested by gravity data (Mabey, 1963 #1566) and then mapped in reconnaissance (1:96,000 scale) by Hunt and Mabey (1966 #1551), but was named and mapped at 1:62,500 scale by Reynolds (1969 #1613). It has been shown on other maps by Reheis (1991 #1602) (pl. 1, 1:100,000 scale) and Reynolds (1976 #1614). It was not shown by Hart and others

	(1989 #1532). The fault extends through USGS Fall Canyon and Thimble Peak 7-1/2' quadrangles. The trace used herein is based on mapping by Reheis (1991 #1602) who used 1:24,000 to 1:80,000 scale aerial photographs. The fault has been examined in the field by Reynolds (1969 #1613; 1976 #1614).
Geologic setting	The Grapevine fault has a curving, generally northwest strike. Reynolds (1969 #1613) noted that individual fault traces strike N. 30? W. to N. 35? W., which is parallel to the front of the Grapevine Mountains and nearly parallel to the Northern Death Valley fault zone [141], which is located about 3 km southwest of the Grapevine fault in the central part of northern Death Valley. Reynolds (1969 #1613) reported that the total vertical separation on the Grapevine fault could be at least 4,270 m (14,000 ft). This estimate assumes that the oldest Cenozoic rocks on the hanging wall in Death Valley are correlative with the Titus Canyon Formation, which is now at elevations >1,220 m (>4,000 ft) in the Grapevine Mountains on the footwall. Reynolds (1969 #1613) suggested that displacement is greatest at the southern end of the Grapevine fault, where is he reported the vertical separation to be as much as 427 m (1,400 ft), and decreases northwestward toward Red Wall Canyon. Reynolds (1976 #1614) also suggested that warping has accounted for a substantial portion of the structural relief along the front of the Grapevine Mountains. Likewise he concluded that folding along the range front and at the eastern edge of Death Valley accounts for some of the apparent displacement across the Grapevine fault. According to Reynolds (1976 #1614) and Mabey (1963 #1566), the vertical separation on a pre-Tertiary surface between Death Valley and the Grapevine Mountains may be at least 4.3 km (down to the west), an estimate that is based on the distribution of Tertiary rocks in the southern part of the Grapevine Mountains along with gravity data. Reynolds (1976 #1614) concluded that the apparent vertical separation on the Grapevine fault diminishes north of Fall Canyon, where right-lateral displacement becomes more important on faults within the Grapevine Mountains. Reynolds (1976 #1614) noted that displacements on small faults vary between a few meters to about 76 m (a few feet to 250 ft). The Grapevine fault is located about 3 km northeast of the northwest-striking, chiefly right-lateral strike-slip Northern Death Valley fault zone [141] in the central part of northern Death Valley. Reynolds (1976 #1614) reported that Death Valley between Titus and Titanothere Canyons (adjacent to the southern

part of the Grapevine fault) appears to have been tilted downward to the east toward the Grapevine Mountains. Several north- to north-northwest-striking fault traces have been mapped by Reheis (1991 #1602) on surfaces of Quaternary deposits in Death Valley between the Grapevine fault and the Northern Death Valley fault zone [141]. The Grapevine fault may continue to the northwest along the same strike into the Grapevine Mountains or the fault may step westward and join the Northern Death Valley fault zone (Reheis, 1991 #1602). The exact structural relationship between the Grapevine fault [184] and the Northern Death Valley fault zone [141] has not been determined.

Reynolds (1969 #1613) concluded that the Grapevine fault "is superimposed across [an] older fold system and appears to truncate [a] set of north-south-[striking] Cenozoic faults characteristic of the . . . northeastern Grapevine Mountains." He also suggested that the Grapevine fault is a "structural hinge" between Death Valley to the west and the Grapevine Mountains to the east. He noted that displacement along the Grapevine fault may "represent surficial failure under gravity in response to arching which accompanied uplift of the mountain block relative to the Death Valley block," which is described below.

Reynolds (1969 #1613) proposed that the Grapevine fault bounds the eastern side of a triangular block (Death Valley) that is bounded on the south by an east-northeast-striking fault mapped by Hunt and Mabey (1966 #1551) (the Towne Pass fault [97] of this compilation) and on the west by a fault along the western side of the Cottonwood Mountains (not included in this compilation). The triangular block is lowest both structurally and topographically at its southern end (at Mesquite Flats) where Death Valley is the widest, and it slopes upward to the north where Death Valley is the narrowest (Reynolds, 1969 #1613). Reynolds (1969 #1613) further proposed that strike-slip displacement on the Northern Death Valley fault zone [141], in combination with northeast-southwest-directed regional compression, has resulted in normal displacement along the Grapevine fault and on the other two faults bounding the Death Valley block. Furthermore, the normal displacement on these three faults has resulted in the triangular-shaped pull-apart basin (Reynolds, 1969 #1613).

The Grapevine fault is located about 15 km northwest of the Keane Wonder fault (not included in this compilation) that has a

	strike and sense of displacement similar to those of the Grapevine fault. Several northwest-trending, down-to-the-northeast (uphill-facing) lineaments and scarps are preserved between the Grapevine fault and Keane Wonder fault near Mud Canyon as reported by Reheis (1991 #1602) and Reheis and Noller (1991 #1195). The exact structural relationship between the Grapevine fault and Keane Wonder fault has not yet been determined.
Length (km)	29 km.
Average strike	N35°W
Sense of movement	Normal *Comments:* Although Reynolds (1969 #1613) concluded that displacement on the Grapevine fault occurred primarily on a single fault trace, he noted that the Grapevine fault does include many closely spaced, northwest-striking fault traces and that total displacement is likely cumulative across these. Displacement on these traces is dominantly dip slip (normal) and down to the southwest. Evidence for horizontal displacement on the Grapevine fault is rare. Horizontal slickensides were observed by Reynolds (1969 #1613) on fault surfaces at two localities. He also noted that evidence of horizontal displacement is rare and has apparently been minor; demonstrable horizontal separation on the Grapevine fault is about 2 m (8 ft) at most. This value is based on slickensides observed on the fault surfaces at two localities.
Dip Direction	W *Comments:* The main trace of the Grapevine fault is dominantly west dipping; traces thought to be antithetic to the main trace are east dipping (Reynolds, 1969 #1613).
Paleoseismology studies	
Geomorphic expression	Part of the Grapevine fault is shown by Reheis (1991 #1602) as a topographic lineament bounding the front of the Grapevine Mountains. Reynolds (1969 #1613) reported that fault scarps slope 44? to 75? SW toward Death Valley and that antithetic fault scarps slope NE into the Grapevine Mountains. However, morphometric studies of these scarps have not been performed, nor have surface offsets been reported.

Age of faulted surficial deposits	Reheis (1991 #1602) interpreted part of the Grapevine fault having as moderate to prominent lineaments or scarps on surfaces of Quaternary deposits. Reynolds (1969 #1613) inferred recurrent Quaternary displacement on different sections of the Grapevine fault between Titanothere and Red Wall Canyons, because Quaternary alluvium that was subdivided into at least four different age groups by Hunt and Mabey (1966 #1551) and Reynolds (1969 #1613) is faulted against the range front at some localities and deposited against fault scarps at other localities.
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Reynolds (1969 #1613) concluded that displacement on the Grapevine fault, especially on the fault's southern end, occurred primarily during the late Pliocene and early Pleistocene, but has recurred throughout the Quaternary. He based this conclusion on (1) the steepness of the front of the Grapevine Mountains (tectonic geomorphology); (2) the small size of the alluvial fans on the eastern side of Death Valley compared to the size of those on the western side (downdropping); (3) the possible Pliocene gravels that overlap Cambrian rocks along the range front, which suggests pre-Pliocene(?) displacement on the Grapevine fault, but that are tilted by post-Pliocene displacement on the Grapevine fault; (4) the presence of Pleistocene and Holocene alluvial deposits faulted against older rocks along the Grapevine fault south of Titus Canyon; and (5) the location of Pleistocene and Holocene playa sediments immediately against the front of the Grapevine Mountains (Reynolds, 1969 #1613). He also noted the eastward migration of playa sediments toward the Grapevine Mountains, which he concluded was the result of the eastward tilt of Death Valley by displacement on the Grapevine fault. North of Red Wall Canyon, Reynolds (1969 #1613) notes that rocks of possible Pliocene age overlie the Grapevine fault. Reynolds (1969 #1613) later reported that alluvium adjacent to the Grapevine Mountains south of Titanothere Canyon is not displaced by the Grapevine fault although this alluvium is warped. Recent studies of the Northern Death Valley fault zone [141] by Klinger (2001 #4770) indicates that there is evidence for late Quaternary (<130 ka) movement along the Grapevine fault. He cites evidence from faulted alluvial-fan sediments that were first noted by Chester Beaty in 1961. Observations by the compiler indicate that alluvial-fan sediments of late Pleistocene to

	possibly latest Pleistocene age are clearly offset south of Titus Canyon, thus we categorize the faulting as late Quaternary (<130 ka), but suspect that movement might be even younger (<15 ka), perhaps in sympathy with major dislocations along the more active Northern Death Valley fault zone [141].
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* There are no published information on the size of fault scarps, age of deformed surficial deposits, or timing of net displacement along the fault. Owing to the relatively discontinuous (preserved?) nature of the fault scarps, we suspect that the slip rate is probably <0.2 mm/yr, in accord with other less active faults in the Basin and Range.
Date and Compiler(s)	2002 Michael N. Machette, U.S. Geological Survey, Retired Ralph E. Klinger, U.S. Bureau of Reclamation Lucy A. Piety, U.S. Bureau of Reclamation
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	#915 Piety, L.A., 1995, Compilation of known and suspected Quaternary faults within 100 km of Yucca Mountain, Nevada and California: U.S. Geological Survey Open-File Report 94-112, 404 p., 2 pls., scale 1:250,000. #1602 Reheis, M.C., 1991, Aerial photographic interpretation of lineaments and faults in late Cenozoic deposits in the eastern parts of the Saline Valley 1:100,000 quadrangle, Nevada and California, and the Darwin Hills 1:100,000 quadrangle, California: U.S. Geological Survey Open-File Report 90-500, 6 p., 2 pls., scale 1:100,000. #1195 Reheis, M.C., and Noller, J.S., 1991, Aerial photographic interpretation of lineaments and faults in late Cenozoic deposits in the eastern part of the Benton Range 1:100,000 quadrangle and the Goldfield, Last Chance Range, Beatty, and Death Valley Junction 1:100,000 quadrangles, Nevada and California: U.S. Geological Survey Open-File Report 90-41, 9 p., 4 sheets, scale 1:100,000. #1613 Reynolds, M.W., 1969, Stratigraphy and structural geology of the Titus and Titanothere canyons area, Death Valley, California: Berkeley, University of California, unpublished Ph.D. dissertation, 310 p., 10 pls. #1614 Reynolds, M.W., 1976, Geology of the Grapevine Mountains, Death Valley, California—A summary, *in* Troxel, B.W., and Wright, L.A., eds., Geologic features, Death Valley, California: California Division of Mines and Geology Special Report 106, p. 19-25.