Jump to Navigation

# Quaternary Fault and Fold Database of the United States

**As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.**

## Echo Canyon thrust (Class A) No. 182

**Last Review Date: 2002-02-19**

## 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 182, Echo Canyon thrust, 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.**

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| **Synopsis** | This northwest-trending thrust fault is expressed by relatively small (1- to 5-m-high) scarps on uplifted late Quaternary gravels, larger eroded scarps that form the southwestern fronts of hills underlain by early to middle Quaternary alluvium, and alignment of travertine springs and mounds on the southwest margin of the Texas Springs syncline [181]. Movement has been continual in the Quaternary, and may be continuing in the Holocene. The Echo Canyon thrust and associated Texas Springs syncline may be aseismic structures (Class B) that are being formed by compression associated with uplift of the Black Mountains along the range-bounding Black Mountains fault [142]. Ground-water leakage along the thrust controls the location of Travertine |

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| | Springs, one of two main sources of potable water that National Park Service provides to the Furnace Creek Ranch and Hotel and its own facilities in the immediate area. |
| **Name comments** | This feature was first mapped and named by Klinger and Piety (1996 #3873) for exposures of the fault adjacent to the Echo Canyon road, which provides one of the few access points to Echo Canyon and the Funeral Mountains. The fault extends along the southwest margin of the Texas Springs syncline, and forms scarps, travertine mounds, and lineaments for at least 2.2 km on the north side of U.S. Highway 190 (Stop B4.1, Machette and others, 2001 #4771). |
| **County(s) and State(s)** | INYO COUNTY, CALIFORNIA |
| **Physiographic province(s)** | BASIN AND RANGE |
| **Reliability of location** | Good<br>Compiled at 1:100,000 scale.<br><br>*Comments:* This feature was mapped by Klinger and Piety (1996 #3873) for exposures of the fault adjacent to the Echo Canyon road. It was not recognized during detailed mapping by McAllister (1970 #1572). It has been shown on a number of sketch-type geologic maps and figures derived from this first publication (Machette and others, 2001 #4771; Klinger and Piety, 2001 #4774) at varying scales, but has yet to be shown on a geologic quadrangle map. Trace used herein is from Machette and others (Stop B4.1, 2001 #4771), transferred to 100,000 scale topographic map for digitization. |
| **Geologic setting** | The Echo Canyon thrust is associated with flexure of the Texas Springs syncline, a the major fold within a broader group of folds that lie between the Funeral Range to the northeast and the Black Mountains to the southwest. The syncline is probably a Pliocene to Pleistocene feature, and thus is well expressed by sediments and sedimentary patterns with in the Pliocene Furnace Creek Formation. The syncline and thrust trend northwest, subparallel to other (lesser) folds and faults as originally mapped by Hunt and Mabey (1966 #1551). Numerous springs along the west and southwest margin of the syncline provide potable water sources for the National Park Service; the syncline itself seems to be the main sump for the springs with a threshold discharge elevation of |

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| | about 400 ft ASL (122 m) (Machette and others 2000 #4917).<br><br>Large-scale dextral slip between the Death Valley basin, Black Mountains (along the Black Mountains fault [142], and the Funeral Range (along the Furnace Creek fault [144]) probably has produced a strong component of compression between the Black Mountains and the Funeral Range, thus resulting in folding and thrusting of the sedimentary fill of the intervening Furnace Creek basin (Klinger and Piety, 2001 #4774). Further to the northwest, fault-bounded folds in the Mustard Hills transition zone [142a] have the same general trend as the Texas Springs syncline (McAllister, 1970 #1572). The southeastern end of the Texas Springs syncline is cut off by the northeast-trending Cross Valley fault [183], whereas the southwestern flank of the syncline is coincident with the Echo Canyon thrust fault [182], an out-of-syncline fault that may represent bedding plane slip induced by folding (Machette and others, 2001 #4771; Klinger and Piety, 2001 #4774). |
| **Length (km)** | 2 km. |
| **Average strike** | N49°W |
| **Sense of movement** | Thrust<br><br>*Comments:* Exposures north of the Echo Canyon road and further northwest around Travertine Springs show clear thrust geometry. |
| **Dip** | 30° NE<br><br>*Comments:* Klinger and Piety (fig. 19, 1996 #3873) and Machette and others (fig. B4-3 2001 #4771) show an apparent near-surface dip of about 30° NE. |
| **Paleoseismology studies** | |
| **Geomorphic expression** | The morphology of the scarps on gravels along the thrust suggests that deformation has occurred repeatedly during the late Pleistocene. The well developed rock varnish and desert pavement that is characteristic of the uplift, faulted surface (unit Q2c ? of Klinger and Piety, 1996 #3873) has been disturbed by faulting, and the rock varnish is poorly developed to nonexistent on the scarps themselves. Klinger and Piety (1996 #3873) reported a scarp height of 5.4 m and maximum scarp-slope angles |

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| | of 22–25° near Echo Canyon—morphology that suggested Holocene movement along the thrust. The size of the fault scarp is probably the product of multiple faulting events (p. 53, Klinger and Piety, 1996 #3873) and may correspond to about 10 m of horizontal slip assuming that the fault has an angle of 30° (Machette and others, 2001 #4771). Smaller scarps along the fault are commonly less than 1 m high and have relatively steep scarp slopes, suggesting that they may reflect younger movement than the larger scarps. Figure 19 in Klinger and Piety (1996 #3873) shows a cross-sectional representation of the typical geologic relations; gravel is thrust over itself and wedge(s) of colluvium that result from degradation of the fault scarp. |
| **Age of faulted surficial deposits** | At the surface, the thrust is expressed as a series of subparallel, anastomosing scarps preserved on uplifted gravels. The scarps are commonly less than 1 m to about 5 m high, and are quite obvious on the smooth, well-varnished gravel surfaces, which Klinger and Piety (1996 #3873) considered to be underlain by unit Q2c ? (late Pleistocene, 12–70 ka). From Travertine Springs northwest, the fault forms larger (8- to 15-m-high) dissected scarps on the southwest front of rounded gravel hills, which are probably underlain by middle to early Quaternary gravels (Machette and others, 2000 #4917). Further northwest, the compiler has traced the thrust fault into sedimentary rocks of the Furnace Creek Formation (Pliocene) as mapped by McAllister (1970 #1572) in this area, large mounds of high-level travertine seem to be associated with ground-water leakage from the Texas Springs syncline (Machette and others, 2001 #4771). |
| **Historic earthquake** | |
| **Most recent prehistoric deformation** | late Quaternary (<130 ka)<br><br>*Comments:* Klinger and Piety (1996 #3873) consider the extensively faulted surfaces along the Echo Canyon thrust to be underlain by Q2c ? gravel (late Pleistocene, 12–70 ka). In addition, they infer that Holocene movement may have occurred on the basis of the fault scarp morphology (p. K188 in Klinger and Piety, 2001 #4774). In addition, by comparison to other thrust faults, they suspect that the large (5.4 m) scarp may be the result of 6-8 movements (approximately 1.2–1.6 m each) but associate the faulting with continued uplift of the Black Mountains along the Black Mountains fault [142], hence sympathetic movement. As such, the Echo Canyon thrust may be a relatively shallow |

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| | feature that is not capable of generating a large seismic moment (and hence, large earthquake) on its own. |
| **Recurrence interval** | *Comments:* There are no individually dated events along the Echo Canyon thrust, but Klinger and Piety (2001 #4774) suspect that the 5.4-m-high late Pleistocene scarp may be the result of 6–8 movements (with approximately 1.2–1.6 m horizontal displacement per event) associated with continued uplift of the Black Mountains. As such the recurrence interval for faulting events on the Echo Canyon thrust might be equivalent to that of the Black Mountains fault [142]. |
| **Slip-rate category** | Between 0.2 and 1.0 mm/yr<br><br>*Comments:* The slip rate for the thrust in the vicinity of the Echo Canyon Road is generally constrained by 5.4 m of vertical uplift and as much as 10 m of horizontal slip over the past 12–70 k.y. (Klinger and Piety, 2001 #4774). Although this data has been published, none of the authors has chosen to calculate a slip rate for the fault. Nevertheless, the data incicate that probable dip-slip rates are within the assigned slip-rate category. |
| **Date and Compiler(s)** | 2002<br>Michael N. Machette, U.S. Geological Survey, Retired<br>Ralph E. Klinger, U.S. Bureau of Reclamation<br>Lucy A. Piety, U.S. Bureau of Reclamation |
| **References** | #1551 Hunt, C.B., and Mabey, D.R., 1966, Stratigraphy and structure, Death Valley, California: U.S. Geological Survey Professional Paper 494-A, 162 p., 3 pls., scale 1:96,000.<br><br>#3873 Klinger, R.E., and Piety, L.A., 1996, Evaluation and characterization of Quaternary faulting on the Death Valley and Furnace Creek faults, Death Valley, California: U.S. Bureau of Reclamation Seismotectonic Report 96-10, 97 p.<br><br>#4774 Klinger, R.E., and Piety, L.A., 2001, Late Quaternary flexural-slip folding and faulting in the Texas Spring syncline, Death Valley, *in* Machette, M.N., Johnson, M.L., and Slate, J.L., eds., eds., Quaternary and late Pliocene geology of the Death Valley region—Recent observations on tectonics, stratigraphy, and lake cycles (Guidebook for the 2001 Pacific Cell, Friends of the Pleistocene Fieldtrip): U.S. Geological Survey Open-File Report 01-51, p. K185-K192. |

#4771 Machette, M.N., Menges, C., Slate, J.L., Crone, A.J., Klinger, R.E., Piety, L.A., Sarna-Wojcicki, A.M., and Thompson, R.A., 2001, Field trip guide for Day B, Furnace Creek area, *in* Machette, M.N., Johnson, M.L., and Slate, J.L., eds., eds., Quaternary and late Pliocene geology of the Death Valley region—Recent observations on tectonics, stratigraphy, and lake cycles—Guidebook for the 2001 Pacific Cell, Friends of the Pleistocene Fieldtrip: U.S. Geological Survey Open-File Report 01-51, p. B51–B88.

#4917 Machette, M.N., Stephenson, W.J., Williams, R.A., Odum, J.K., Worley, D.M., and Dart, R.L., 2000, Seismic-reflection investigations of the Texas Springs syncline for ground water development, Death Valley National Park: U.S. Geological Survey Open-File Report 00-106, 26 p.

#1572 McAllister, J.F., 1970, Geology of the Furnace Creek borate area, Death Valley, Inyo County, California: California Division of Mines and Geology Map Sheet 14, 9 p. pamphlet, 1 sheet, scale 1:24,000.