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.**

## Sevier/Toroweap fault zone, central Toroweap section (Class A) No. 997c

**Last Review Date: 2006-04-17**

## Compiled in cooperation with the Arizona Geological Survey

***citation for this record:*** **Black, B.D., Hylland, M.D., and Hecker, S., compilers, 2006, Fault number 997c, Sevier/Toroweap fault zone, central Toroweap section, 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 03:11 PM.**

| | |
|---|---|
| **Synopsis** | **General:** The Sevier/Toroweap fault zone is a long, north- to northeast-trending structure near the western margin of the Colorado Plateaus that has had substantial Cenozoic normal displacement. It extends from south of the Grand Canyon to north of Panguitch, Utah. The fault has generated a west-facing bedrock escarpment along the east side of Toroweap and Prospect Valleys, Ariz., and Long Valley, Utah. Detailed studies indicate that about 50 km of the fault, centered approximately on the Colorado River, ruptured during the middle to late Holocene. There is clear |

| | |
|---|---|
| | evidence for recurrent late Quaternary displacement events on this section of the fault. The high, relatively linear fault escarpment continues about 10 km south of the young rupture, suggesting that the southern section of the fault zone has also been quite active during the Quaternary. The northern section of the fault zone on the Kanab Plateau has probably been less active during the Quaternary because there is minimal topographic relief across the fault, but there may have been late Quaternary displacement on this section as well.<br><br>**Sections:** This fault has 4 sections. The sections are defined based on changes in geomorphic expression and recent rupture history of the fault along strike. The northernmost section is entirely in Utah. The next one to the south spans the State line and the southern two sections are entirely in Arizona. The northern two sections are probably late Quaternary, the central section is Holocene, and the southern section appears to be significantly older. |
| **Name comments** | **General:** This fault is traditionally known as the Sevier fault in Utah and the Toroweap fault in Arizona. The Sevier fault in Utah as depicted by Hecker (1993 #642) consisted of two parts separated by a 50-km-long gap in surface faulting. Based on this gap and differences in displacement style and age of most recent movement, the northern part of the fault appears to be a different fault and is discussed separately as the Sevier fault [2355]. Thus, the southern part of Hecker's Sevier fault and the Toroweep fault are regarded here as the same fault.<br><br>**Section:** This name applies to the part of the Toroweap fault from the northern end of Toroweap Valley to the southern end of Holocene rupture in Prospect Valley. This section corresponds to "segment A\B" of Jackson (1990 #2181). |
| **County(s) and State(s)** | MOHAVE COUNTY, ARIZONA<br>COCONINO COUNTY, ARIZONA |
| **Physiographic province(s)** | COLORADO PLATEAUS |
| **Reliability of location** | Good<br>Compiled at 1:250,000 scale.<br><br>*Comments:* Mapped at 1:24,000 scale, transferred to 1:250,000-scale topographic base map for digitization. |

| | |
|---|---|
| **Geologic setting** | The Sevier/Toroweap fault zone is located near the western margin of the Colorado Plateaus Province. Displacement on the fault generally increases from south to north. At the southern end, displacement is generally low and similar to that of the northern part of the Aubrey fault zone [995], with which it merges. As much as 300 m of Cenozoic normal displacement has occurred across the fault zone near the Grand Canyon. Total normal displacement decreases to less than 100 m on the Kanab Plateau north of Toroweap Valley, but then dramatically increases to nearly 500 m north of the Utah-Arizona stateline. On the basis of three-point solutions and projections to the fault, Anderson and Christenson (1989 #828) estimated 475 m of throw at the Coral Pink Sand dunes, north of the Utah-Arizona stateline. Seismic-reflection data (E. Lundin, written commun. to R.E. Anderson) indicate about 900 m of throw on the basement at Red Canyon east of Panguitch, Utah. |
| **Length (km)** | This section is 60 km of a total fault length of 250 km. |
| **Average strike** | N10°E (for section) versus N15°E (for whole fault) |
| **Sense of movement** | Normal<br><br>*Comments:* Based on regional relations and normal displacement of Paleozoic bedrock, Quaternary basalt and alluvium across the fault zone. |
| **Dip Direction** | W |
| **Paleoseismology studies** | |
| **Geomorphic expression** | Faulting has generated a high, moderately steep, fairly linear, west-facing escarpment on Paleozoic bedrock in Prospect Valley and northern Toroweap Valley. The escarpment is sinuous in southern Toroweap Valley, probably due in part to damming of the valley by Pleistocene basalt flows. Alluvial fault scarps exist downslope from the bedrock escarpment in Prospect and Toroweap Valleys. Alluvial scarps formed on Holocene coarse gravel deposits in Prospect Valley range in height from about 2 to 4.5 m and have maximum slope angles of 14° to 24°, respectively. Diffusion-based morphologic analysis of 39 scarp profiles suggested an age of about 2–5 ka (Jackson, 1990 #2181). Alluvial scarps formed on fine-grained Holocene deposits in Toroweap Valley range in height from about 1 to 3.5 m and have maximum slope angles of 7° to 16°, respectively. Diffusion-based age |

| | |
|---|---|
| | estimate based on 8 scarp profiles suggests a scarp age of 15 ka (Jackson, 1990 #2181). However, Jackson (1990 #2181) argued that the fault ruptured in Toroweap and Prospect Valleys during the middle Holocene. Additional studies of the Quaternary history of the fault are by Koons (1948 #2182), Hamblin (1970 #2184), Huntoon (1977 #2185), Menges and Pearthree (1983 #2073), Pearthree and others (1983 #2083), and Jackson (1990 #2181). |
| **Age of faulted surficial deposits** | Paleozoic, Mesozoic, middle Pleistocene, late Pleistocene, early to middle Holocene. Geologic maps by Billingsley and Huntoon (1983 #2183), Billingsley and others (1986 #2179) and Jackson (1990 #2181) cover much of the fault zone. |
| **Historic earthquake** | |
| **Most recent prehistoric deformation** | latest Quaternary (<15 ka)<br><br>*Comments:* Based on the estimated age of young alluvial fans that are faulted, and from morphologic analyses of fault scarps profiled in Prospect Valley, Jackson (1990 #2181) suggests faulting occurred 3.1±1.6 ka. However, the cosmogenic age of an unfaulted debris flow at Prospect Canyon was 3.0±0.6 ka (Fenton and others, 2001 #5031). |
| **Recurrence interval** | *Comments:* Recurrence intervals are unknown but could be 10–30 k.y. for the past 25–100 k.y. This estimate is based on about 2 m of vertical displacement during the youngest faulting event and about 6.5 m of displacement recorded by a late Pleistocene alluvial fan, estimated to be 25 to 100 ka (Jackson, 1990 #2181). |
| **Slip-rate category** | Less than 0.2 mm/yr<br><br>*Comments:* A low long-term slip rate is suggested by 6.5 m of vertical displacement of late Pleistocene (~25-100 ka) alluvium, 15 m of displacement of a 200 ka basalt flow, and 36 m of displacement of a 600 ka basalt flow. Jackson (1990 #2181) suggests that slip rate has increased over time. The long-term slip rate for the Toroweap fault is 0.02 mm/yr (from 10 Ma to 600 ka), 0.056 mm/yr (from less than 600 to 40 ka), and 0.11 mm/yr (from 40 ka to 3 ka). However, Fenton and others (2001 #5031) present five average displacement rates from sites within 25 km of the Colorado River. They used published displacements primarily |

| | |
|---|---|
| | from Jackson (1990 #2181) and new and published ages for the offset deposits to show the displacement rate does not appear to vary over the past 400 k.y. All of the newly obtained 3He ages are comparable to previous TL ages, but are younger than K-Ar or $^{39}Ar/^{40}Ar$ ages for the same deposits; thus, the difference in interpretation. Their preferred vertical displacement rate is 0.111±9 mm/yr. Preliminary $^{39}Ar/^{40}Ar$ ages from offset Quaternary basalts also suggest that slip rate on this fault is less than 0.1 mm/yr for the past 500 ka. McIntosh and others (2002 #6885) indicate that the Upper Prospect flow (mean age 509±30 ka) is offset 48 m yielding an average slip rate of 0.095 mm/yr. Pederson and others (2002 #6886) report a slip rate of 0.094±0.006 mm/yr. |
| **Date and Compiler(s)** | 2006<br>Bill D. Black, Utah Geological Survey<br>Michael D. Hylland, Utah Geological Survey<br>Suzanne Hecker, U.S. Geological Survey |
| **References** | #6887 Amoroso, L., Pearthree, P.A., and Arrowsmith, J.R., 2004, Paleoseismology and neotectonics of the Shivwits section of the Hurricane fault, northwestern Arizona: Bulletin of the Seismological Society of America, v. 94, p. 1919-1942.<br><br>#828 Anderson, R.E., and Christenson, G.E., 1989, Quaternary faults, folds, and selected volcanic features in the Cedar City 1° x 2° quadrangle, Utah: Utah Geological and Mineral Survey Miscellaneous Publication 89-6, 29 p., 1 pl., scale 1:250,000.<br><br>#2183 Billingsley, G.H., Jr., and Huntoon, P.W., 1983, Geologic map of Vulcan's Throne and vicinity, western Grand Canyon, Arizona: Grand Canyon Natural History Association, 1 sheet, scale 1:48,000.<br><br>#2179 Billingsley, G.H., Wenrich, K.J., and Huntoon, P.W., 1986, Breccia pipe and geologic map of the southeastern Hualapai Indian Reservation and vicinity, Arizona: U.S. Geological Survey Open-File Report 86-458B, 26 p., 2 pls., scale 1:48,000.<br><br>#5031 Fenton, C.R., Webb, R.H., Pearthree, P.A., Cerling, T.E., and Poreda, R.J., 2001, Displacement rates on the Toroweap and Hurricane faults—Implications for Quaternary downcutting in the Grand Canyon, Arizona: Geology, v. 29, p. 1035-1038.<br><br>#2184 Hamblin, W.K., 1970, Structure of the western Grand |

Canyon region, *in* Hamblin, W.K., and Best, M.G., eds., The western Grand Canyon district—Guidebook to the geology of Utah, n. 23: Salt Lake City, Utah Geological Society, p. 3-20.

#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000.

#2185 Huntoon, P.W., 1977, Holocene faulting in the western Grand Canyon, Arizona: Geological Society of America Bulletin, v. 88, p. 1619-1622.

#2181 Jackson, G.W., 1990, Tectonic geomorphology of the Toroweap fault western Grand Canyon, Arizona—Implications for transgression of faulting on the Colorado Plateau: Arizona Geological Survey Open-File Report 90-4, 67 p., 2 pls., scale 1:24,000.

#2182 Koons, D., 1948, Geology of the eastern Hualapai Reservation: Plateau, v. 20, p. 53-60.

#6885 McIntosh, W.C., Peters, L., Karlstrom, K.E., and Pederson, J.L., 2002, New $^{40}Ar$-$^{39}Ar$ dates on basalts in Grand Canyon—Constraints on rates of Quaternary river incision and slip on the Toroweap fault and implications for lava dam: Geological Society of American Abstracts with Program, v. 34, no. 4, p. 61.

#2073 Menges, C.M., and Pearthree, P.A., 1983, Map of neotectonic (latest Pliocene-Quaternary) deformation in Arizona: Arizona Geological Survey Open-File Report 83-22, 48 p., scale 1:500,000.

#2083 Pearthree, P.A., Menges, C.M., and Mayer, L., 1983, Distribution, recurrence, and possible tectonic implications of late Quaternary faulting in Arizona: Arizona Geological Survey Open-File Report 83-20, 51 p.

#6886 Pederson, J., Karlstrom, K., Sharp, W., and McIntosh, W., 2002, Differential incision of the Grand Canyon related to Quaternary faulting; constraints from U-series and Ar/Ar dating: Geological Society of American Abstracts with Program, v. 30, no. 8, p. 738-742.