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Quaternary Fault and Fold Database of the United States

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Sevier/Toroweap fault zone, northern Toroweap section (Class A) No. 997b

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Compiled in cooperation with the Utah Geological Survey and the Arizona Geological Survey

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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. **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. **Section:** This section corresponds to "segment A" of Jackson (1990 #2181). The northern Toroweap section of the Sevier/Toroweap fault extends from where the trace of the fault makes a left step near Mount Carmel Junction, about 20 km north of the Utah-Arizona border south to about 6 km southwest of June Tank.
County(s) and State(s)	KANE COUNTY, UTAH MOHAVE COUNTY, ARIZONA
Physiographic province(s)	COLORADO PLATEAUS
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* Mapped on large-scale aerial photos (Hamblin, 1970

	#2184), transferred to 1:250,000-scale topographic base map for digitization. Location of fault in Utah from 1;250,000-scale mapping of Anderson and Christenson (1989 #828). Additional information on the fault in Utah from Cashion (1961 #4446), Carpenter and others (1967 #4445), Anderson and Miller (1979 #4494).
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 81 km of a total fault length of 250 km.
Average strike	N17°E (for section) versus N15°E (for whole fault)
Sense of movement	Normal *Comments:* Striations with a southerly component of rake indicate that the southern part of the fault in Utah has left-lateral oblique slip.
Dip Direction	NW; W
Paleoseismology studies	
Geomorphic expression	In Utah, the section is expressed as low scarps in Mesozoic bedrock buried in much of the area by sand dunes. In Arizona, faulting is expressed as low to moderately high, west-facing escarpments in Paleozoic bedrock, low fault scarps on undated but probable Pleistocene basalts, and low, gentle fault scarps on upper (?) Pleistocene alluvium. North of Cedar Knoll on the

	Kanab Plateau, where less resistant Mesozoic rocks are at the surface of the footwall, there is very little relief across the fault. An alluvial fault scarp profiled south of Pipe Springs is about 3.5 m high and has a maximum slope angle of 7.5°, suggesting a late Pleistocene time of youngest rupture (Pearthree and others, 1998 #2945). Studies of the Quaternary history of the Toroweap 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, late (?) Pleistocene. 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	late Quaternary (<130 ka) *Comments:* A small closed basin adjacent to a left step at the northern end of the section is consistent with dilation due to left-lateral slip, and indicates that subsidence and fault activity (due either to surface-faulting earthquakes or low-level seismicity/aseismic creep) are likely late Pleistocene in age. This is supported by the estimated age of faulted alluvium and a single fault scarp profile in Arizona.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* A low long-term geologic slip rate is indicated based on 2 m of vertical displacement of late Pleistocene (~50–150 ka) alluvium in Arizona (Pearthree and others, 1998 #2945).
Date and Compiler(s)	1997 Bill D. Black, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#4494 Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Long Beach, California, Fugro, Inc, 35 p. pamphlet, scale 1:500,000. #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.

#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.

#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.

#4445 Carpenter, C.H., Robinson, G.B., and Bjorklund, L.J., 1967, Ground-water conditions and geologic reconnaissance of the upper Sevier River Basin, Utah: U.S. Geological Survey Water-Supply Paper 1836, 91 p.

#4446 Cashion, W.B., 1961, Geology and fuel resources of the Orderville-Glendale area, Kane County, Utah: U.S. Geological Survey Coal Investigations Map C-49, scale 1:62,500.

#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.

	#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. #2945 Pearthree, P.A., 1998, Quaternary fault data and map for Arizona: Arizona Geological Survey Open-File Report 98-24, 122 p., 1 sheet, scale 1:750,000. #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.