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Quaternary Fault and Fold Database of the United States

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

Last Review Date: 1997-04-03

Compiled in cooperation with the Utah 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:** The Sevier section of the Sevier/Toroweap fault zone extends from near Panguitch, Utah, south to the Utah-Arizona State line where the trace of the fault makes a left step near Mount Carmel Junction, about 20 km north of the Utah-Arizona border. However, no detailed studies have been completed, so little is known whether this section boundary is a likely segment boundary.
County(s) and State(s)	KANE COUNTY, UTAH GARFIELD COUNTY, UTAH
Physiographic province(s)	COLORADO PLATEAUS
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* Location of fault from 1;250,000-scale mapping of

	Anderson and Christenson (1989 #828). Fault also documented by 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 89 km of a total fault length of 250 km.
Average strike	N18°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
Paleoseismology studies	
Geomorphic expression	The fault strikes north-northeast and consists of numerous right- and left stepping generally echelon faults on which rocks are typically downthrown to the west-northwest (Hintze, 1980 #5536). The escarpment on the upthrown block of the fault is on bedrock, and along much of its length, bedrock is also exposed in the downthrown block. Spectacular bedrock scarps in the Orderville-Glendale area are largely the result of erosion of the relatively weak Cretaceous rocks that are downfaulted against the resistant Navajo Sandstone (Cashion, 1967 #5539).

	Southeast of Panguitch, 200 m (Anderson and others, 1978 #4548) of offset in the 560 ka (Best and others, 1980 #5537) Red Canyon volcanic flow suggests faulting during late Pleistocene time. Quaternary basalts at Black Mountain, northeast of Glendale, are possibly faulted up to 23 m (Cashion, 1961 #4446), but the amount of displacement is difficult to determine due to uncertainties in distinguishing scarps related to landslides, pre-flow topography, and faults. Near Alton, differential erosion of indurated Quaternary deposits and relatively weak Cretaceous rocks formed a southeast-facing fault scarp. An unfilled sediment trap formed against a small (<5-m-high), 2-km-long, west- (uphill-) facing scarp on the main trace suggests an age of only a few thousand years, but the scarp is believed to be related to gravity-driven subsidence rather than surface faulting because ridgelines cut by the scarp show little or no tectonic throw. Hecker (1993 #642) also notes it seems unlikely that 5 m of seismogenic surface displacement on a major block-bounding fault would be restricted to such a short segment. Near the north end of the Sevier/Toroweap fault zone, Anderson and Miller (1979 #4494) and Carpenter and others (1967 #4445) show the fault as several dashed traces that terminate to the north in bedrock. An aerial-photo study by Anderson and Christenson (1989 #828) in this area indicates that the fault traces are expressed only as aligned drainages in bedrock, and that no through-going scarps occur on the irregular mass of Quaternary deposits. The north end of the fault is expressed as a youthful range front, and forms a possible en echelon left step shown as questionable Quaternary fault in compilation by Hecker (1993 #642). North of Red Canyon, the main branch of the fault trends into the volcanic bedrock of the Sevier Plateau and dies out (Doelling, 1975 #5538; Hintze, 1980 #5536).
Age of faulted surficial deposits	Quaternary
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* The time of the most recent movement is based on characteristics such as range-front steepness and linearity along the fault suggest recent movement; although locally these are likely fault-line characteristics resulting from juxtaposition of

	resistant and nonresistant rocks. A small closed basin adjacent to a left step at the south 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. Southeast of Panguitch, 200 m of offset in the 560 ka Red Canyon volcanic flow suggests faulting during late Pleistocene time.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Lund and others (2008 #7197) suggest late Quaternary vertical displacement rates are low in contrast to prior results. The only offset Quaternary deposits are at Red Canyon southeast of Panguitch where 560 ka basalts (Best and others 1980 #5537) are offset 200 m (Anderson and others, 1978 #4548). Anderson and Christenson (1989 #828) infer most of the 200 m displacement to be distributed throughout the middle and late Pleistocene; thus, resulting in a geologic slip rate that is within the above stated bounds.
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. #4548 Anderson, R.E., Bucknam, R.C., and Hamblin, W.K., 1978, Road log to the Quaternary tectonics of the Intermountain seismic belt between Provo and Cedar City, Utah: Geological Society of America, Rocky Mountain Section Annual Meeting, Provo, Utah, Field Trip no. 8, 50 p. #5537 Best, M.G., McKee, E.H., and Damon, P.E., 1980, Space-time-composition patterns of late Cenozoic mafic volcanism, southwestern Utah and adjoining areas: American Journal of

Science, v. 280, p. 1035–1050.

#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.

#5539 Cashion, W.B., 1967, Geologic map of the south flank of the Markagunt plateau northwest Kane County, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations I-494.

#5538 Doelling, H.H., 1975, Geology and mineral resources of Garfield County, Utah: Utah Geological and Mineral Survey Bulletin 107, 175 p.

#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.

#5536 Hintze, L.F., compiler, 1980, Geologic map of Utah: Utah Geological and Mineral Survey Map, scale 1:500,000.

#7197 Lund, W.R., Knudsen, T.R., and Vice, G.S., 2008, Paleoseismic reconnaissance of the Sevier fault, Kane and Garfield Counties, Utah: Utah Geological Survey Special Study 122, 31 p., http://ugspub.nr.utah.gov/publications/special_studies/SS-122.pdf.