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.

Hurricane fault zone, Whitmore Canyon section (Class A) No. 998e

Last Review Date: 2006-04-17

Compiled in cooperation with the Arizona Geological Survey

citation for this record: **Pearthree, P.A., compiler, 2006, Fault number 998e, Hurricane fault zone, Whitmore Canyon 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 Hurricane fault is a long, generally north-trending fault zone with substantial Quaternary normal displacement near the western margin of the Colorado Plateaus province in Arizona and Utah. The Hurricane Cliffs are a fault-generated steep, curvilinear, west-facing bedrock escarpment several hundred meters high. Displacement decreases southward; there has been 200–400 m of Cenozoic normal displacement across the fault zone along most of its length in Arizona. Near the Utah border, displacement increases to at least 450 m and probably continues to increase into Utah.

	Sections: This fault has 6 sections. The Hurricane fault is divided into sections based on gross geomorphic expression, structural characteristics, and what is known about the recent rupture history of the fault. Although parts of the Hurricane escarpment south of the Colorado River is fairly linear and steep, no definitive evidence of Quaternary activity on this southern section [998f] of the fault has been reported. The Whitmore Canyon section [998e], between the Colorado River and the Mt. Trumbull area, last ruptured in the latest Pleistocene to early Holocene and has had recurrent late Quaternary activity. The escarpment associated with the fault in this section is steep, but is sinuous and erosionally embayed. The Mt. Trumbull area is probably a section boundary, because there is very little topographic relief across the Hurricane fault and Pliocene volcanic rocks have only been displaced a moderate amount. Northward along the Shivwitz section [998d], the curvilinear fault escarpment (the Hurricane Cliffs) increases to several hundred meters in height. Low fault scarps on colluvium, alluvium, and bedrock are common along the base of the Cliffs in this section, and record late Quaternary fault activity. The northern end of the Shivwitz section is defined by a major convex bend in the fault zone, across which total fault displacement increases by at least 50 percent. The Anderson Junction section [998c] begins at this convex bend and continues north into Utah. The fault escarpment is very steep and curvilinear, and scarps along the base of the Cliffs record at least 20 m of late Quaternary displacement. The youngest rupture on this section was probably in the early Holocene, but the northern extent of this rupture is uncertain. The next section to the north, the Ash Creek section [998b] is exhibits more complex fault geometry along the steep base of the Hurricane Cliffs. The northernmost section, Cedar City section [998a] is defined based on the timing of the most recent event. The major section boundaries are at zones of structural complexity.
Name comments	**General:** Early work by Gardner (1941 #2190) refers to the "Hurricane fault." The fault extends from about 2 km east of Cedar City, Utah, to about 5 km west of Peach Springs, Arizona, on U.S. Highway 66. **Section:** This name applies to the part of the Hurricane fault from the Mt. Trumbull area south to the Colorado River. This section corresponds with the "Whitmore Wash segment" and part of the "Hells Hole segment" of Menges and Pearthree (1983 #2073). It is separated from the section of the fault south of the Colorado River because of the definitive evidence of late Quaternary on the Whitmore Canyon section.
County(s) and State(s)	MOHAVE COUNTY, ARIZONA
Physiographic province(s)	COLORADO PLATEAUS

Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* Mapped at 1:48,000 scale, transferred to 1:250,000-scale topographic map for digitization.
Geologic setting	The Hurricane fault zone is one of several long, down-to-the-west, normal faults located in what is effectively a 150-km-wide transition zone between the Colorado Plateaus and Basin and Range. Substantial late Cenozoic displacement on the Grand Wash [1005], Washington [1004], Hurricane, and Sevier/Toroweap [997] faults has resulted in the formation of a series of broad plateaus and escarpments that step down to the west. Along most of its length, the Hurricane fault is marked by a high, steep bedrock escarpment with relatively thin Quaternary deposits along its base. Paleozoic strata have been vertically displaced by hundreds of meters across the Hurricane fault. Pliocene and Quaternary basalt flows have been displaced by substantial amounts, and upper Quaternary alluvium and colluvium have been faulted as well. Stewart and Taylor (1996 #3473) document 450 m of stratigraphic separation in Quaternary basalt displaced by the fault, and a total separation of 2,520 m across a portion of the Hurricane fault near Anderson Junction. Cenozoic displacement is only 200–400 m across the fault zone along most of its length in Arizona. Several swarms of historical seismicity have occurred adjacent to, but cannot be correlated directly with, the north end of the Hurricane fault. The earliest of these swarms (1942) included two approximately magnitude 5 earthquakes (Arabasz and Smith, 1979 #4438; Richins and others, 1981 #4443). The 1992 M5.8 St. George earthquake was likely on the Hurricane fault (Pechmann and others, 1995 #4442).
Length (km)	This section is 29 km of a total fault length of 238 km.
Average strike	N2°W (for section) versus N11°E,N39°E,N39°E,N39°E (for whole fault)
Sense of movement	Normal *Comments:* Based on regional relations and normal displacement of Paleozoic bedrock and Quaternary alluvium and basalt across the fault zone.
Dip	Near vertical to 55° W. *Comments:* Dip angles were reported by Hamblin (1965 #1522). Relatively steep dips exist at higher stratigraphic levels and at higher

	altitudes. Shallowest dips were measured near the bottom of the Grand Canyon.
Paleoseismology studies	
Geomorphic expression	Faulting has generated a moderately high, steeply embayed, west-facing escarpment on Paleozoic bedrock in Whitmore Canyon. Alluvial fault scarps that have been mapped downslope from the base of the bedrock escarpment along most of this section record recurrent late Quaternary faulting events. Late Quaternary alluvial fans have vertical displacements of 2-8.5 m. Scarps that may record the youngest paleoevent only have heights of 4-6 m, with estimated vertical displacements of 2-3.5 m and maximum slope angles of 21–31°. Morphologic analyses based on about 13 scarp profiles suggest a latest Pleistocene to early Holocene time for the youngest fault rupture (Pearthree and others, 1983 #2083; Jackson, 1990 #2181). Older alluvial scarps have vertical displacements of 3.5-5 m, and the oldest alluvial scarps have displacements of 5-8.5 m. Older Pleistocene basalts exposed at the mouth of Whitmore Canyon are displaced 23 m (Huntoon, 1977 #2185), whereas younger basalt flows (approximately 29-177 ka) are displaced by 3 to 15 m (Fenton and others, 2001 #5031).
Age of faulted surficial deposits	Paleozoic bedrock; middle to late Pleistocene sediment and basalt flows, and latest Pleistocene to early Holocene (?) alluvium.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* This timing estimate (about 5-15 ka) is based on morphologic fault-scarp analyses and a rough age estimate of the age of the youngest faulted alluvial deposits based on soil development (Pearthree and others, 1983 #2083). Fenton and others (2001 #5031) used cosmogenic exposure dating to show that the most recent event is older than 8.5±0.2 ka.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* A low latest Pleistocene to Holocene vertical displacement rate indicated based on data presented by Stenner and others (1999

	#4444); they document 4 m of displacement of a 20- to 40-ka alluvial fan, 7 m of displacement of a 60- to 90-ka alluvial fan, 7-13 m of displacement of a 75- to 100-ka basalt flow; and 12-18 m of displacement of a 170- to 185-ka basalt. In contrast, Holmes and others (1978 #2192) estimated larger vertical displacements for the basalt flows, and obtained vertical strain estimates of 0.14 to 0.25 mm/yr. The lowest slip-rate category is assigned here based the predominance of results of less than 0.2 mm/yr. Fenton and others (2001 #5031) present six average displacement rates from sites within 25 km of the Colorado River. They used published displacements and new and published ages for the offset deposits to show the displacement rate does not appear to vary over the past 200 k.y., which is contrary to previous studies to the north. All of their newly obtained ^{3}He ages are comparable to previous thermoluminescence ages, but are younger than K-Ar or ^{39}Ar/^{40}Ar ages for the same deposits. Their preferred vertical displacement rate is 0.081±6 mm/yr.
Date and Compiler(s)	2006 Philip A. Pearthree, Arizona Geological Survey
References	#4438 Arabasz, W.J., and Smith, R.B., 1979, The November 1971 earthquake swarm near Cedar City, Utah, *in* Arabasz, W.J., Smith, R.B., and Richins, W.D., eds., Earthquake studies in Utah, University of Utah Seismograph Stations: University of Utah, Department of Geology and Geophysics, p. 423-432. #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. #2190 Gardner, L.S., 1941, The Hurricane fault in southwestern Utah and northwestern Arizona: American Journal of Science, v. 239, no. 4, p. 241-260. #1522 Hamblin, W.K., 1965, Origin of "reverse drag" on the downthrown side of normal faults: Geological Society of America Bulletin, v. 76, p. 1145-1164. #2192 Holmes, W.K., Best, M.G., and Hamblin, W.K., 1978, Calculated strain rates and their implications for the development of the Hurricane and Toroweap faults, Utah and northern Arizona, *in* : U.S. Geological Survey Technical Report Summaries, Earthquake Hazards Reduction Program v. VII, p. 44-50.

#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.

#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.

#4442 Pechmann, J.C., Arabasz, W.J., and Nava, S.J., 1995, Seismology, *in* Christenson, G.E., ed., The September 2, 1992 ML 5.8 St. George earthquake, Washington County, Utah: Utah Geological Survey Circular 88, p. 1.

#4443 Richins, W.D., Zandt, G., and Arabasz, W.J., 1981, Swarm seismicity along the Hurricane fault zone during 1980-81—A typical example for SW Utah [abs.]: Eos, Transactions of the American Geophysical Union, v. 62, no. 45, p. 966.

#4444 Stenner, H.D., Lund, W.R., Pearthree, P.A., and Everitt, B.L., 1999, Paleoseismic investigation of the Hurricane fault in northwestern Arizona and southwestern Utah: Arizona Geological Survey Open-File Report 99-8, 137 p., http://repository.azgs.az.gov/sites/default/files/dlio/files/2010/u14/OFR99-8Hurricanefault.pdf.

#3473 Stewart, M.E., and Taylor, W.J., 1996, Structural analysis and fault segment boundary identification along the Hurricane fault in southwestern Utah: Journal of Structural Geology, v. 18, p. 1017-1029.