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.

Washington fault zone, northern section (Class A) No. 1004a

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

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Synopsis	**General:** The Washington fault is a long, north- to northeast-trending fault zone with substantial Cenozoic normal displacement that straddles the western margin of the Colorado Plateaus province. It extends from the Shivwitz Plateau into the St. George basin in southern Utah. The fault zone has generated two prominent, west-facing bedrock escarpments in the southern St. George basin as a result of several hundred meters of normal

	displacement. The high, linear escarpments are formed by the two faults and its morphology suggests that this part of the fault zone has been fairly active during the Quaternary. Pleistocene deposits are faulted in a few places, but no definitive evidence of Holocene faulting has been discovered. Farther south, the Washington fault zone forms the westernmost of several grabens that cut the Shivwitz Plateau. The fault zone has a moderately high, west-facing escarpment and a narrow, shallow graben on the plateau; vertical displacement across the fault zone is less than 100 m. Along this part of the fault zone, upper Pleistocene deposits are displaced by a few meters, and Holocene deposits are not faulted. **Sections:** This fault has 3 sections. The sections (northern, Mokaac, and Sullivan Draw) are defined on the basis of structural geometry and geomorphic expression of the fault zone. The northern section encompasses the main Washington fault zone from the pass between Seegmiller and Wolf Hole Mountains north to the Utah border; this section was called the Washington fault by Billingsley (1990 #2079; 1992 #2077). The Mokaac section is subparallel with and northwest of the Washington section in the southern St. George basin. It was called the Mokaac Wash segment by Menges and Pearthree (1983 #2073) and the Mokaac fault by Billingsley 1990 #2079; 1992 #2077). It merges with the Washington section about 5 km south of the Utah border. The Sullivan Draw section is farther south on the Shivwitz Plateau, and total displacement across the fault is much less. Along much of this section, there is a companion, east-dipping fault to the west of the Washington fault. Together, they form the Sullivan graben of Billingsley (1991 #2081; 1991 #2082).
Name comments	**General:** **Section:** This informally named section applies to the main Washington fault from the pass between Seegmiller and Wolf Hole Mountains north to the Utah border. The fault continues several kilometers north of the border in Utah, through the town of Washington, Utah.
County(s) and State(s)	MOHAVE COUNTY, ARIZONA WASHINGTON COUNTY, UTAH
Physiographic province(s)	BASIN AND RANGE COLORADO PLATEAUS
Reliability of location	Good Compiled at 1:250,000 scale.

	Comments: Mapped at 1:24,000 scale; the traces were transferred from Anderson and Christenson (1989 #828) to 1:250,000-scale topographic base map for digitization. Location of fault in Utah is from 1:250,000-scale map of Anderson and Christenson (1989 #828). Fault also mapped or discussed by Earth Science Associates (1982 #4447), Menges and Pearthree (1983 #2073), Peterson (1983 #2084), Scarborough and others (1986 #4449), Anderson and Christenson (1989 #828), Willis and Higgins (1995 #4450), and Higgins (1998 #4448). Lund (2004 #6733) indicates that insufficient paleoseismic data exist to determine the timing, number, or recurrence of surface-faulting earthquakes along the Washington fault zone.
Geologic setting	The north- to northeast-trending Washington fault zone straddles the margin of the Colorado Plateaus province in northwestern Arizona. Paleozoic rocks are displaced vertically by several hundred meters across each of the two major fault strands in the southern St. George basin. Tertiary basalt is also displaced by substantial amounts across these fault strands, and upper Quaternary alluvium is displaced several meters (Billingsley, 1990 #2079; 1992 #2077). Vertical displacement of Paleozoic rocks is less than about 100 m across the southern section of the fault on the Shivwitz Plateau; upper Pleistocene to Holocene (?) alluvial deposits are displaced by as much as 3 m along this section of the fault. The fault has an estimated maximum throw of 750 m in Arizona, but displacement decreases northward in Utah. The fault displaces pre-existing geologic structures and has normal-drag and reverse-drag folding genetically associated with it (Anderson and Christenson, 1989 #828).
Length (km)	This section is 36 km of a total fault length of 72 km.
Average strike	N11°E (for section) versus N23°E,N11°E,N11°E (for whole fault)
Sense of movement	Normal *Comments:* Based on regional relations and normal displacement of bedrock and alluvium across the fault zone. Hecker (1993 #642) indicates slip on the main and subsidiary faults ranges from pure dip slip to left-lateral, oblique slip.
Dip	80° W. to vertical

	Comments: Higgins (1998 #4448)
Paleoseismology studies	Earth Sciences Associates (1982 #4447) excavated trenches across lineaments of uncertain origin at three flood-control dams near the Washington fault, including Gypsum Wash Dam, Warner Draw Dam, and Stucki Dam. Relative ages of Quaternary deposits were estimated from soil development and stratigraphy; no radiometric dating was performed. The trenches at the Warner Draw and Stucki Dam sites revealed no evidence of faulting. At Gypsum Wash Dam (site 1004-1), five trenches were excavated near the south end of the dam. Trenches G-1, G-4, and G-X, excavated along lineaments about 45 m west of the main fault trace, revealed a wide zone of high-angle shears that form a series of horsts and grabens with a net down-to-the-west displacement. Faulted alluvial-fan deposits estimated to be 5–10 ka are overlain by unfaulted alluvial-fan deposits. Trenches G-2 and G-3 were excavated across the main fault trace and revealed bedrock in fault contact with late Pleistocene (?) alluvial-fan deposits, showing at least 1.2 m of offset. Younger alluvial-fan deposits, estimated to be no older than 1–1.5 ka, showed only 5 cm of vertical displacement; this displacement could be the result of one of several possible non-tectonic processes, including differential settlement due to gypsum dissolution.
Geomorphic expression	Faulting has generated moderately high, steep, west- to northwest-facing escarpments on resistant Paleozoic bedrock. Escarpment height decreases dramatically toward the Utah border, where less resistant Mesozoic bedrock is exposed in the footwall. Upper Quaternary alluvium is displaced several meters (Billingsley, 1990 #2079; 1992 #2077), but no detailed analysis of fault-scarp morphology has been made. Upper Quaternary talus and landslide deposits are probably faulted near the northern end of this section. The Washington fault in Arizona has been studied by Peterson (1983 #2084) and Menges and Pearthree (1983 #2073). The fault zone has generated two prominent bedrock escarpments and shows several hundred meters of normal displacement in the St. George basin. North of Washington, a Pleistocene pediment deposit (tentatively estimated to be roughly 300 ka in age), which underlies a 8-m-high scarp, does not appear to be displaced. Here, and along much of the fault, scarp development is largely the result of differential erosion of contrasting lithologies on the upthrown and downthrown blocks

	(Petersen, 1983 #2084). Near Washington, a subsidiary fault displaces an early Pleistocene basalt flow (the Washington flow) as much as 4.5 m. Small (<5 cm) displacements of "younger" alluvium may be due to differential compaction rather than coseismic surface faulting (Earth Science Associates, 1982 #4447). A single profile of a southern scarp on a highly dissected pediment indicates a morphologic age comparable to the Bonneville shoreline (Anderson and Christenson, 1989 #828).
Age of faulted surficial deposits	Paleozoic, Mesozoic, Tertiary, late Pleistocene. The geology of the fault zone was mapped by Billingsley (1990 #2079; 1990 #2080; 1991 #2081; 1991 #2082; 1992 #2077).
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* The recency of movement appears to be poorly constrained. At the Utah-Arizona border, Menges and Pearthree (1983 #2073) estimated a late Pleistocene to early Holocene age range for faulting based on scarp morphology, and Scarborough and others (1986 #4449) placed the fault in an age category of less than 30 ka for most recent rupture. Anderson and Christenson (1989 #828) considered the age uncertainty to be greater and recommended a middle to late Pleistocene age for the part of the fault in Utah. We conservatively assign an age of less than 130 ka based on estimated age of faulted alluvium.
Recurrence interval	*Comments:* Lund (2004 #6733) indicates that insufficient paleoseismic data exist to determine the timing, number, or recurrence of surface-faulting earthquakes along the Washington fault zone.
Slip-rate category	Less than 0.2 mm/yr *Comments:* South of Washington near Warner Draw, subsurface investigations by Earth Science Associates (1982 #4447) indicated more than a meter of displacement in undated "older" alluvium (estimated from uncertain evidence to be 10–25 ka in age). A low, long-term slip rate is suggested by 200 m of offset of a 3.5 Ma basalt. Lund (2004 #6733) concludes that insufficient paleoseismic data exist to make a reliable slip rate estimate.

	However, low geologic slip rates are suggested by 5 cm of displacement since approximately 1.5 ka, 1.2 m since m of displacement across the Washington basalt flow, K-Ar dated at 1.7±0.1 Ma (Best and others, 1980 #6739).
Date and Compiler(s)	2004 Bill D. Black, Utah Geological Survey Christopher B. DuRoss, Utah Geological Survey Greg N. McDonald, Utah Geological Survey Philip A. Pearthree, Arizona Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#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. #7313 Biek, R.F., Rowley, P.D., Hacker, D.B., Hayden, J.M., Willis, G.C., Hintze, L.F., Anderson, R.E., and Brown, K.D., 2010, Geologic map of the St. George and east part of the Clover Mountains 30' x 60' quadrangles, Washington and Iron Counties, Utah: Utah Geological Survey Map 242DM, scale 1:100,000. #2079 Billingsley, G.H., 1990, Geologic map of the Lizard Point quadrangle, northern Mohave County, Arizona: U.S. Geological Survey Open-File Report 90-643, 1 sheet, scale 1:24,000. #2080 Billingsley, G.H., 1990, Geologic map of the Wolf Hole Mountain East quadrangle, northern Mohave County, Arizona: U.S. Geological Survey Open-File Report 90-644, 1 sheet, scale 1:24,000. #2081 Billingsley, G.H., 1991, Geologic map of the Sullivan Draw North quadrangle, northern Mohave County, Arizona: U.S. Geological Survey Open-File Report 91-558, 10 p., 1 pl., scale 1:24,000. #2082 Billingsley, G.H., 1991, Geologic map of the Sullivan Draw South quadrangle, northern Mohave County, Arizona: U.S. Geological Survey Open-File Report 91-559, 9 p., 1 pl., scale 1:24,000. #2077 Billingsley, G.H., 1992, Geologic map of the Yellowhorse Flat quadrangle, northern Mohave County, Arizona: U.S. Geological Survey Open-File Report 92-442, 17 p., 1 pl., scale

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