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.

Steens fault zone, Mann Lake section (Class A) No. 856b

Last Review Date: 2016-04-18

citation for this record: **Personius, S.F., compiler, 2002, Fault number 856b, Steens fault zone, Mann Lake 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 03:16 PM.**

Synopsis	**General:** The nearly 200-km-long Steens fault zone is the most topographically prominent normal fault system in the northern Basin and Range province of western North America. The fault separates the eastern flanks of Steens Mountain and the Pueblo Mountains from the western margins of the Alvord Desert and Pueblo Valley in southern Oregon and northern Nevada. Steens Mountain and the Pueblo Mountains are west-tilted fault blocks comprised of Miocene volcanic rocks, whereas the adjacent Alvord Desert and Pueblo Valley are structural basins filled with thousands of meters of Tertiary-Quaternary sedimentary fill. **Sections:** This fault has 6 sections. Although detailed studies along the entire fault zone have not been reported, six sections are inferred based on geometry and timing of most-recent surface faulting at selected sites (but not on all sections) along the zone.

	Hemphill-Haley and others (1999 #4038) proposed that the Steens fault zone in Oregon be divided into five segments. Herein we retain the five segment names delineated by Hemphill-Haley and others (1999 #4038) as section names, and add a sixth, northernmost section based on mapping of Pezzopane (1993 #3544). From north to south, these sections are the Crowley [856a], Mann Lake [856b], Alvord [856c], Fields [856d], Tum Tum [856e], and Denio [856f] sections. At the north end of the zone, faults in the Crowley section [856a] offset Miocene volcanic rocks a few hundred meters, and may have moved as recently as the middle and late Quaternary. Faults in the adjacent Mann Lake section [856b] offset Miocene volcanic rock a minimum of 1600 m, and also may have moved as recently as the middle and late Quaternary. The adjacent Alvord section [856c] forms the steep eastern flank of the High Steens, and has offset Miocene volcanic rock 2–4 km. Trench and fault scarp investigations indicate one or more Holocene surface-faulting events along the Alvord section, so both the long-term (Miocene) and Quaternary slip histories indicate that this section is the most active part of the Steens fault zone. Slip apparently decreases south of the Alvord section. Faults in the adjacent Fields section [856d] offset Miocene volcanic rock a minimum of 1400 m, and show their youngest movement (latest Quaternary) on short faults that lie on the playa east of the range front. Faults in the Tum Tum section [856e] appear to be slightly older than the youngest movement on the playa strands of the Fields section [856d], but are younger than the latest movement on the range front strand of the Fields [856d] and Mann Lake [856b] sections. Trenching of the fault in the Denio section [856d], which is the southernmost part of the Steens Mountain fault zone, clearly demonstrates Holocene movement.
Name comments	**General:** The Steens fault zone forms a steep escarpment between the uplifted Steens Mountain and Pueblo Mountains, and the western margin of Pueblo Valley and the Alvord Desert. These faults have been mapped by Willden (1964 #3002), Slemmons (1966, unpublished Vya 1:250,000-scale sheet), Greene (1972 #3560), Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Hemphill-Haley (1987 #3960), Walker and MacLeod (1991 #3646), Dohrenwend and Moring (1991 #281), Pezzopane (1993 #3544), Madin and others (1996 #3479), Weldon and others (2002 #5144), and Personius and others (2006 #7386). The fault zone includes faults mapped as the Alvord-Steens fault zone of Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149), and the Steens fault, Alvord Desert graben,

	and Pueblo Mountain faults of Pezzopane (1993 #3544). Geomatrix Consultants, Inc. (1995 #3593) used the name Steens-Alvord Graben faults for all structures in the Alvord Desert area, and delineated three fault source zones: the northern segment, the Western Margin fault zone, and the East Alvord graben fault. The Steens fault zone extends into northern Nevada as the Pueblo Mountains fault zone of dePolo (1998 #2845). Hemphill-Haley (1987 #3960) named several small structures in the zone (Alvord, Dune Field, Embayment, Kueny Ditch, Serrano Point, Serrano Springs, Smyth Wells, and Wildhorse Creek faults), and included them in a larger Steens fault zone. Hemphill-Haley and others (1989 #3958, 1999 #4038) later proposed that the Steens fault zone be divided into five segments. Herein we retain the name Steens fault zone for the entire structure in Oregon and Nevada, and use the five segment names delineated by Hemphill-Haley and others (1999 #4038) as section names. A sixth, northernmost section is informally defined herein on the basis of mapping by Pezzopane (1993 #3544) and Weldon and others (2002 #5144). **Section:** This section was informally named the Mann Lake segment by Hemphill-Haley and others (1989 #3958; 1999 #4038) after Mann Lake, which is located near the southern end of the section. This section was informally named the northern segment of the Steens-Alvord Graben faults by Geomatrix Consultants, Inc. (1995 #3593). **Fault ID:** These structures are fault numbers 47, 48, and 49 of Pezzopane (1993 #3544), fault number 62 of Geomatrix Consultants, Inc. (1995 #3593), and fault number V9 of dePolo (1998 #2845).
County(s) and State(s)	HARNEY COUNTY, OREGON MALHEUR COUNTY, OREGON
Physiographic province(s)	COLUMBIA PLATEAU BASIN AND RANGE
Reliability of location	Good Compiled at 1:100,000 scale. *Comments:* Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).
Geologic setting	The Steens fault zone is marked by nearly continuous range-

	bounding faults on the east side of the Pueblo Mountains and Steens Mountain. The fault zone extends from near Crowley, Oregon, to the southern end of Bog Hot Valley in northern Nevada. The Pueblo Mountains and Steens Mountain are major west-tilted fault blocks (Stewart, 1978 #2866); the adjacent Alvord Desert and Pueblo Valley are structural basins (grabens) filled with 1–2.5 km of Tertiary-Quaternary sedimentary fill (Cleary and others, 1981 #7385, 1981 #5649; Oldow and others, 2005 #7388). The region is underlain by Miocene volcanic rocks, primarily the Steens Basalt (Willden, 1964 #3002; Walker and Repenning, 1965 #3559; Greene and others, 1972 #3560; Brown and Peterson, 1980 #3585; Minor and others, 1987 #3746; Minor and others, 1987 #3747; Walker and MacLeod, 1991 #3646). The Steens fault zone is the longest, most prominent normal fault zone in the Basin and Range province of eastern Oregon, and appears to truncate the southeastern end of the northwest-trending Brothers fault zone (Lawrence, 1976 #3506). Total Miocene vertical displacement of 1.75±0.25 km is reported for a location near Baltazor Hot Spring (Personius and others, 2007 #7387), and Brown and Peterson (1980 #3585) estimated offsets of 2,100–3,000 m in Miocene rocks at the southern end of the Alvord section.
Length (km)	This section is 43 km of a total fault length of 197 km.
Average strike	N29°E (for section) versus N12°E (for whole fault)
Sense of movement	Normal *Comments:* Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Greene (1972 #3560), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Hemphill-Haley and others (1989 #3958; 1999 #4038).
Dip Direction	SE
Paleoseismology studies	
Geomorphic expression	Faults in the Mann Lake section form a northeast-trending range front escarpment between the eastern margin of northern Steens Mountain, and a narrow unnamed valley (Hemphill-Haley and others, 1989 #3958; 1999 #4038). No late Quaternary fault scarps have been found along the main faults in the section, but late Quaternary scarps may be present on the east side of the valley

	(Hemphill-Haley and others, 1989 #3958; Pezzopane, 1993 #3544; Hemphill-Haley and others, 1999 #4038). The southern end of the section coincides with a 2-km-wide left step in the range front fault zone; at this location, Holocene faulting appears to make a right step from the north end of the Alvord section of the Steens fault zone to the west-down fault bounding the western margin of the Mickey basin (Hemphill-Haley and others, 1989 #3958; 1999 #4038).
Age of faulted surficial deposits	No fault scarps on late Quaternary deposits have been reported (Hemphill-Haley and others, 1989 #3958; 1999 #4038).
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Pezzopane (1993 #3544) used air photo analysis to infer that latest movement on faults in the Mann Lake section occurred in Quaternary (<1.6 Ma) or middle to late Quaternary (<700 ka) time; Weldon and others (2002 #5648) also inferred youngest movement in the Quaternary (<1.6 Ma) or the middle to late Quaternary (<780 ka). Hemphill-Haley and others (1989 #3958; 1999 #4038) did not estimate an age of most-recent faulting, but ranked their Mann Lake segment as having the oldest age of faulting of all their five segments. Madin and others (1996 #3479) mapped faults in the Mann Lake section as active in the Quaternary.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* No slip studies have been reported on faults in the Mann Lake section. Walker and Repenning (1965 #3559) show a minimum offset of about 1,600 m of Miocene Steens Basalt across the southern part of the section; these rocks have K-Ar ages of 15-17 Ma (Sherrod and others, 1989 #3745). These data suggest low rates of long-term slip.
Date and Compiler(s)	2002 Stephen F. Personius, U.S. Geological Survey
References	#3585 Brown, D.E., and Peterson, N.V., 1980, Preliminary

geology and geothermal resource potential of the Alvord Desert Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-10, 57 p., 2 pls., scale 1:250,000.

#5649 Cleary, J., Lange, I.M., Qamar, A.I., and House, H.R., 1981, Gravity, isotope, and geochemical study of the Alvord Valley geothermal area, Oregon: Geological Society of America Bulletin, Part II, v. 92, p. 934-962.

#2845 dePolo, C.M., 1998, A reconnaissance technique for estimating the slip rate of normal-slip faults in the Great Basin, and application to faults in Nevada, U.S.A.: Reno, University of Nevada, unpublished Ph.D. dissertation, 199 p.

#281 Dohrenwend, J.C., and Moring, B.C., 1991, Reconnaissance photogeologic map of young faults in the Vya 1° by 2° quadrangle, Nevada, Oregon, and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2174, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants, Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#3960 Hemphill-Haley, M.A., 1987, Quaternary stratigraphy and late Holocene faulting along the base of the eastern escarpment of Steens Mountain, southeastern Oregon: Humboldt State University, unpublished M.S. thesis, 84 p., 1 pl., scale 1:24,000.

#4038 Hemphill-Haley, M.A., Carver, G.A., and Burke, B., 1999, Late Quaternary stratigraphy and Holocene faulting along the eastern margin of Steens Mountain, southeastern Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene field trip guide, September 24-26, 1999, Appendix 5, p. 1-26.

#3958 Hemphill-Haley, M.A., Page, W.D., Burke, R., and Carver,

G.A., 1989, Holocene activity of the Alvord Fault, Steens Mountain, southeastern Oregon: Technical report to Woodward-Clyde Consultants, under Contract Grant No. 14-08-0001-G1333, March 1989, 45 p.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company—Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3746 Minor, S.A., Rytuba, J.J., Goeldner, C.A., and Tegtmeyer, K.J., 1987, Geologic map of the Alvord Hot Springs quadrangle, Harney County, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1916, 1 sheet, scale 1:24,000.

#3747 Minor, S.A., Rytuba, J.J., Meulen Vander, D.B., Grubensky, M.J., and Tegtmeyer, K.J., 1987, Geologic map of the Wildhorse Lake quadrangle, Harney County, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1915, 1 sheet, scale 1:24,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D. dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3745 Sherrod, D.R., Minor, S.A., and Vercoutere, T.L., 1989, Geologic map of the Sheepshead Mountains, Harney and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-2079, 1 sheet, scale 1:50,000.

#2866 Stewart, J.H., 1978, Basin-range structure in western North America—A review, *in* Smith, R.B., and Eaton, G.P., eds., Cenozoic tectonics and regional geophysics of the western cordillera: Geological Society of America Memoir 152, p. 1-31,

	scale 1:2,500,000. #3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000. #3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000. #5144 Weldon, R.J., Fletcher, D., Scharer, K.M., and Weldon, E.M., 2002, New map of active faults in central and eastern Oregon: Geological Society of America Abstracts with Programs, v. 34, no. 5, p. A-106. #3002 Willden, R., 1964, Geology and mineral deposits of Humboldt County, Nevada: Nevada Bureau of Mines and Geology Bulletin 59, 154 p., scale 1:250,000.