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Quaternary Fault and Fold Database of the United States

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Steens fault zone, Tum Tum section (Class A) No. 856e

Last Review Date: 2016-04-18

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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 Tum Tum segment by Hemphill-Haley and others (1989 #3958; 1999 #4038) after Tum Tum Lake, which is located near the northern end of the section. This section was included in the informally named West Margin fault zone 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 HUMBOLDT COUNTY, NEVADA
Physiographic province(s)	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 18 km of a total fault length of 197 km.
Average strike	N24°W (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), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Hemphill-Haley and others (1989 #3958; 1999 #4038).
Dip Direction	NE
Paleoseismology studies	
Geomorphic expression	Faults in the Tum Tum section form a north-northwest-trending range front escarpment between the eastern margin of the northern Pueblo Mountains and the western margin of Pueblo Valley (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The section has an older, eroded, nearly continuous range-bounding scarp, and a younger, discontinuous set of scarps on

	younger alluvial and lacustrine sediments slightly east of the range (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The southern end of the section is marked by a small gap in Quaternary faulting at the promontory of Red Point, where the fault strike changes from northwest on the Tum Tum section to a northeast strike on the Denio section (Hemphill-Haley and others, 1989 #3958; Pezzopane, 1993 #3544; Hemphill-Haley and others, 1999 #4038; Weldon and others, 2002 #5648).
Age of faulted surficial deposits	Older, eroded scarps are reported along the range front part of the Tum Tum section; these scarps do not appear to offset "recent" alluvial fans (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The younger set of scarps offset "younger" alluvial fans and "intermediate" aged lacustrine beach bars (Hemphill-Haley and others, 1989 #3958; 1999 #4038).
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Faults in the Tum Tum section have been mapped with latest movements in the middle and late Quaternary by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648), although other studies suggest younger movement. Hemphill-Haley and others (1989 #3958; 1999 #4038) report that the youngest movement on the section appears to be slightly older than the youngest movement on the Fields section, but younger than latest movement on the range front strand of the Fields and Mann Lake sections. Hemphill-Haley and others (1989 #3958) concluded that with the exception of their Mann Lake segment, all of their segments are marked by Holocene fault scarps. Madin and others (1996 #3479) mapped some faults in the Tum Tum section as active in the Holocene.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* No slip studies have been reported on faults in the Tum Tum section. Walker and Repenning (1965 #3559) show a minimum offset of about 1,400 m of Miocene Steens Basalt across the northern 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
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