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Metolius fault zone, northwest rift zone section (Class A) No. 853c

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Synopsis	**General:** The Metolius fault zone is comprised of several mostly southwest-dipping, northwest-trending normal faults that offset volcanic rocks and sediments along the eastern margin of the Cascade Range in central Oregon. The structural setting of the Metolius fault zone is open to interpretation, but the fault zone probably forms part of the eastern boundary of the Cascades graben in a structural transition zone at the northern end of the right-lateral (?) Brothers fault zone. **Sections:** This fault has 3 sections. Following Hawkins and others (1988 #2946, 1989 #2947), the Metolius fault zone is divided into the Green Ridge, the Rimrock-Tumalo, and the Northwest Rift zone sections.
Name	**General:** The Metolius fault zone of Hawkins and others (1988

comments	#2946, 1989 #2947) is a zone of primarily down to the west and southwest normal faults that extend from Green Ridge on the north to Newberry Volcano on the south. Named faults in this fault zone are, from north to south, the Green Ridge, Rimrock, and Tumalo faults and the Northwest Rift zone near Newberry volcano (Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; 1983 #3485; Hawkins and others, 1988 #2946; Goles and Lambert, 1990 #3763; Mimura, 1992 #3590; Taylor and Ferns, 1994 #3759; MacLeod and others, 1995 #3557; Sherrod and others, 2004 #5172; Wellik, 2008 #7383). This fault zone should not be confused with the Metolius fault located along the Metolius River northeast of Green Ridge (U.S. Army Corps of Engineers, 1983 #3485), which has not been included in recent Quaternary fault compilations (Hawkins and others, 1988 #2946; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Fault strands in the Metolius fault zone are parallel to and have been included by various authors in the nearby Sisters and Brothers fault zones [852 and 819, respectively], but we include these faults in the Metolius fault zone of Hawkins and others (1988 #2946) because of their consistent slip direction. **Section:** This section consists of the Northwest Rift zone of Peterson and Groh (1965 #3768) and MacLeod and others (1981 #4308; 1981 #4309; 1982 #3722); this structure is also known as the northwest fissure system (Goles and Lambert, 1990 #3763). This northwest-trending zone of mostly down-to-the-southwest faults and aligned volcanic vents on the northwest flank of Newberry volcano was originally mapped by Peterson and others (1976 #3735) and MacLeod and others (1982 #3722; 1995 #3557). **Fault ID:** This fault zone is comprised of fault numbers 24, 25, and 26 of Pezzopane (1993 #3544), fault numbers 44, 46, and 47 of Geomatrix Consultants, Inc. (1995 #3593), and NWR1–NWR9 of Wellik (2008 #7383).
County(s) and State(s)	DESCHUTES COUNTY, OREGON
Physiographic province(s)	COLUMBIA PLATEAU
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Fault traces are from mapping of Wellik (2008

	#7383); the location of the two southernmost faults is from Weldon and others, (2002 #5648), mapped at 1:100,000 scale.
Geologic setting	The Metolius fault zone of Hawkins and others (1988 #2946) is comprised of several mostly southwest-dipping, northwest-trending normal faults (Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1990 #3550; Walker and MacLeod, 1991 #3646, 1995 #3593; Sherrod and others, 2004 #5172; Wellik, 2008 #7383) that offset volcanic rocks and sediments along the eastern margin of the Cascade Range in central Oregon. Individual faults are closely associated with cinder cones (Wellik, 2008 #7383) and cumulative vertical displacement across the entire zone is likely 20 m (Geomatrix Consultants Inc., 1990 #3550). The structural setting of the Metolius fault zone is open to interpretation, but the fault zone probably forms part of the eastern boundary of the Cascades graben (Taylor, 1981 #4306; 1981 #4307; Sherrod and Smith, 2000 #5165), in a structural transition zone at the northern end of the right lateral (?) Brothers fault zone (Lawrence, 1976 #3506; Hawkins and others, 1988 #2946).
Length (km)	This section is 43 km of a total fault length of 94 km.
Average strike	N26°W (for section) versus N22°W (for whole fault)
Sense of movement	Normal *Comments:* Faults in the Northwest Rift zone section are mapped as high angle or normal faults by most workers (Peterson and others, 1976 #3735; MacLeod and others, 1982 #3722; U.S. Army Corps of Engineers, 1983 #3485; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557; Geomatrix Consultants Inc., 1995 #3593; Sherrod and Smith, 2000 #5165; Sherrod and others, 2004 #5172).
Dip Direction	SW; NE *Comments:* Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their analysis of earthquake hazards associated with faults in the Northwest Rift zone section.
Paleoseismology	

studies	
Geomorphic expression	The discontinuous en echelon faults in the Northwest Rift zone section are marked by 2- to 25-m-high scarps on Tertiary and Quaternary volcanic rocks (Hawkins and others, 1988 #2946). In addition to fault scarps, numerous Pleistocene and Holocene volcanic vents are aligned along the fault trends, thus all these features may be surface expressions of dikes at depth, formed in response to the regional stress field (MacLeod and Sherrod, 1988 #3770; Ake and others, 2001 #5035; Hemphill-Haley, 2001 #5036).
Age of faulted surficial deposits	Faults in the Northwest Rift zone offset older Plio-Pleistocene through middle to late Pleistocene volcanic rocks (MacLeod and others, 1995 #3557). Offset deposits include the Tumalo Tuff and Bend Pumice, which are thought to have been deposited 0.4–0.3 Ma (Sarna-Wojcicki and others, 1987 #1707; 1989 #3725), and the Shevlin Park Tuff, recently dated at approximately 170 ka (D.R. Sherrod, pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593). Some basaltic andesites that overlie these deposits on the northwest flank of Newberry volcano are younger than the last major glaciation, and thus were deposited <15 ka (MacLeod and others, 1995 #3557). Middle Holocene (Chitwood and others, 1977 #3779; MacLeod and others, 1995 #3557) basalt flows are present along much of the section; most workers agree that these flows are not offset by faults in the Northwest Rift zone, but the source vents for these flows are aligned along the faults, so the faults probably served as magma conduits during an episode of crustal extension (Hawkins and others, 1988 #2946). The U.S. Army Corps of Engineers (1983 #3485) note lineaments on airphotos and possible fault scarps in the middle Holocene Lava Butte basalt flow near the northern end of the section; they admit the flow may be draped over an existing fault scarp, but favor a post-flow faulting interpretation.
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Little detailed information on the age of most recent faulting has been published, but mapping and reconnaissance studies clearly indicate offsets of middle and probably late Pleistocene volcanic rocks, and alignment of Holocene volcanic vents and possible fault scarps in Holocene deposits suggest

	possible Holocene displacements (Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; MacLeod and others, 1995 #3557). Thus, Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) delineate several fault strands with geomorphic expressions suggestive of latest Quaternary or Holocene displacement. However based on detailed mapping, Wellik (2008 #7383) concludes that Holocene deposits containing 7-ka Mazama ash are not faulted and 39–200 ka deposits are faulted. We conservatively assign the middle to late Quaternary age category based on detailed mapping of Wellik (2008 #7383).
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Geomatrix Consultants, Inc. (1995 #3593) used slip data and age estimates from Hawkins and others (1988 #2946) and L.A. Chitwood (pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) to estimate slip rates of 0.01–0.1 mm/yr on faults in the Northwest Rift zone section.
Date and Compiler(s)	2016 Stephen F. Personius, U.S. Geological Survey Kathleen M. Haller, U.S. Geological Survey
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