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Winter Rim fault system, Ana River section (Class A) No. 831c

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Synopsis	**General:** This north and northwest trending, down-to-the-east normal fault syste forms the western margin of a large graben or half graben that confines the Chewaucan-Summer Lake basin. The fault is marked by prominent escarpments (Winter Rim) in Miocene volcanic and volcaniclastic sedimentary rocks. The Wi Rim fault system is divided into three sections herein, a southern section, the Slid Mountain section, and two northern sections, the Winter Ridge section and the A River section. All sections show evidence of latest Quaternary displacement. **Sections:** This fault has 3 sections. The Winter Rim fault system is divided into t sections herein, primarily based on mapping of Pezzopane (1993 #3544)—a sout section, the Slide Mountain section, and two northern sections, the Winter Ridge section and the Ana River section; all sections in part show evidence of latest Quaternary displacement.

Name comments	**General:** The Winter Rim fault system is a group of normal faults that bound the western flank of the Chewaucan-Summer Lake basin; parts of these faults were originally mapped by Walker (1963 #3565) and Walker and others (1967 #3564). Pezzopane (1993 #3544) named the northern parts of this fault system the Winter Ridge and Ana River faults, and the southern part the Slide Mountain fault. Kling and others (1996 #3729) used the names Winter Ridge and Summer Lake faults f northern and southern parts of this system. Herein we retain the names of Pezzop (1993 #3544) as sections of the informally named Winter Rim fault system of Sir (1990 #3504). **Section:** This part of the fault system was named the Klippel Point fault by Simp (1990 #3504), but was renamed the Ana River fault by Pezzopane (1993 #3544); Langridge (1998 #3970) added a southern extension, the Schoolhouse Lake segm to the Ana River fault of Pezzopane (1993 #3544). The name Ana River section i herein for all of the mapped trace of the Ana River fault of Simpson (1990 #3504 Pezzopane (1993 #3544), Langridge (1998 #3970), and Langridge and others (20 #5092). **Fault ID:** This group of structures consists of fault numbers 34, 35, and 36 of Pezzopane (1993 #3544) and fault number 57 of Geomatrix Consultants, Inc. (19 #3593). This section is fault number 35 of Pezzopane (1993 #3544).
County(s) and State(s)	LAKE COUNTY, OREGON
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:100,000 and 1:250,000 scale. *Comments:* Location of fault from ORActiveFaults (http://www.oregongeology.org/arcgis/rest/services/Public/ORActiveFaults/MapS downloaded 06/02/2016); the northern part of the fault trace is attributed to 1:250 scale mapping of Walker and others (1967 #3564).The southern part of the fault (Schoolhouse Lake segment) is from the approximately 1:30,000 scale figure of Langridge (1998 #3970). All traces are summarized at 1:100,000-scale by Weldo others (2002 #5648).
Geologic setting	This north and northwest trending, down-to-the-east normal fault system forms th western margin of a graben or half graben that confines the Chewaucan-Summer basin in the Basin and Range of south-central Oregon. The fault zone is marked b prominent escarpments (Winter Rim) in Miocene volcanic and volcaniclastic sedimentary rocks (Walker, 1963 #3565; Walker and others, 1967 #3564; Walker MacLeod, 1991 #3646).

Length (km)	This section is 8 km of a total fault length of 58 km.
Average strike	N15°W (for section) versus N38°W (for whole fault)
Sense of movement	Normal, Left lateral *Comments:* This section is mapped as a normal or high-angle fault by Donath (19 #3771), Walker (1963 #3565), Walker and others (1967 #3564), Walker and Mac (1991 #3646), Simpson (1990 #3504), Pezzopane (1993 #3544) Madin and other (1996 #3479), and Langridge (1998 #3970). Pezzopane and Weldon (1993 #149) interpret the steep dip and anastomosing character of the fault in a trench exposu evidence of a minor oblique component of slip, and Langridge (1998 #3970) note apparent left-lateral offset of bedrock and lacustrine shorelines along the fault tra
Dip Direction	E *Comments:* No structural data on the dip of this fault have been published, but tre exposures show steep east dips (Pezzopane and Weldon, 1993 #149; Pezzopane, #3544; Langridge, 1998 #3970). Geomatrix Consultants, Inc. (1995 #3593) used estimated dip of 70° in their modeling of earthquake potential of the Winter Rim system.
Paleoseismology studies	Pezzopane (1993 #3544), Pezzopane and Weldon (1993 #149), and Pezzopane an others (1996 #3532) conducted a trench investigation on the Ana River section ne southern end of Klippel Point (site 831-3). Langridge (1998 #3970) conducted tw trench investigations at the southern end of the fault near the Ana River (sites 831 and 831-5). Weldon and others (2009 #7165) conducted trench investigations and reported preliminary results, but the specific location of these trenches has not be reported. The following descriptions are from Pezzopane (1993 #3544), Pezzopa Weldon (1993 #149), Pezzopane and others (1996 #3532), Langridge (1998 #397 Langridge and others (2001 #5092) and Weldon and others (2009 #7165). Site 831-3. The Ana fault (Klippel) trench of Pezzopane (1993 #3544), Pezzopan Weldon (1993 #149), Pezzopane and others (1996 #3532), and Langridge and oth (2001 #5092) was excavated in 1992, and exposed a broad deformation zone but relatively narrow fault zone in beveled and deformed pluvial lake deposits which contained four late Pleistocene tephras; projections of these tephras across the fau zone suggest offsets of 5–18 m during multiple events that occurred underwater v pluvial Lake Chewaucan stood at some level above the trench site. These deposit overlain by two units of scarp colluvium separated by a caliche soil horizon; the o of these deposits appears to have been reworked and eroded during the waning st of desiccation of Lake Chewaucan, 13 ±3 ka. The youngest wedge post-dates the highstand of Lake Chewaucan, and predates the 4200-foot shoreline that cuts allu fan deposits dated at 2,130 ±90 yr BP along the Slide Mountain section to the sou

	Site 831-4. The River trenches (RT1 and RT2) of Langridge (1998 #3970) and Langridge and others (2001 #5092) were excavated in July 1997 and September 1 respectively, across the Ana River fault near the southern end of the trace mappec Pezzopane (1993 #3544); the trenches exposed a broad, complexly deformed faul zone in a shallow to deep water lacustrine section containing numerous late Quat tephra. Lacustrine erosion prevented determination of precise offsets, but evidenc multiple late Quaternary faulting events was described in the River trenches. The interpreted number and ages of events appears to have evolved; The following da event timing are from the most recent summary of Langridge and others (2001 #5 The two youngest events post-date the latest Pleistocene desiccation of pluvial La Chewaucan, and have inferred ages of 4–7.6 ka and 12–13 ka. Calculated sedimentation rates and tephra correlations were used to date four previous sublacustrine events: 29 ±2.0 ka, 49 ±5 ka, and 70 ±6 ka, and 81 ±6 ka. Site 831-5. The Lower trench of Langridge (1998 #3970) was excavated near the of a northwest-trending fault that crosses the southern end of the Ana River fault mapped by Pezzopane (1993 #3544), about 35 m east of the River trenches. The t was located near the base of a southwest-facing escarpment thought to be related secondary, down-southwest faulting, but no evidence of faulting was found in the exposure. The trench exposed an undeformed sequence of post-Lake Chewaucan (Holocene) colluvium, alluvium, and pond deposits associated with Holocene per of lacustrine regression and readvance. Weldon and others (2009 #7165) reports preliminary results from trenches loggec 2009 buy the University of Oregon Neotectonics and Field Camp classes. These trenches were located along the Ana River fault in the Summer Lake Basin (speci site locations were not reported).
Geomorphic expression	The Ana River section of the Winter Rim fault system extends for 3–5 km along t prominent east-facing escarpment of Klippel Point. The fault extends southward a the basin floor as a 2- to 5-m-high fault scarp on pluvial lake deposits (Simpson, 1 #3504; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Langridge, 1 #3970; Langridge and others, 2001 #5092). The fault scarp is beveled in places, suggesting recurrent late Quaternary displacement, and in places has been repeate eroded during pluvial lake highstands (Pezzopane and Weldon, 1993 #149; Pezzo 1993 #3544; Langridge, 1998 #3970; Langridge and others, 2001 #5092). The sh length of this fault suggests that it may connect to or be a splay of other parts of t Winter Rim fault system (Pezzopane, 1993 #3544) or other faults in the region (Langridge, 1998 #3970; Langridge and others, 2001 #5092). Simpson (1990 #35 2001 #5093), Langridge (1998 #3970), and Langridge and others (2001 #5092) described extensive compressional folds and faults in pluvial lake sediments in an uplifted (?) area exposed by incision of the Ana River near the southern end of th River section. Simpson (1990 #3504; 2001 #5093) attributed these features to lar scale mass movements and/or soft-sediment deformation associated with range-fr

	faulting along the Winter Ridge section. Pezzopane (1993 #3544) suggested a pos relationship between these features and fault movements along the Ana River fau this latter relationship is explained in detail by Langridge (1998 #3970). Scarp heights range from 2.6 m to 4.6 m along a short (3.5-km-long) extent of the that has scarps, with an average of 2.8 m, along this part of the fault (Egger, 2015 #7766); estimates of average slip include 11.0 m, 9.7 m , and 10.7 m, assuming th fault dips 60°.
Age of faulted surficial deposits	Faulted deposits exposed in the Ana River (Klippel) trench of Pezzopane (1993 # and Pezzopane and Weldon (1993 #149) include pluvial lake sediments that conta numerous Pleistocene tephra, the youngest of which was identified as the 22–23 k Trego Hot Springs ash. Regional relations indicate that the fault offsets latest Pleistocene (approximately 16 ka) pluvial lake sediments, and deposits that may l been reworked during desiccation of pluvial Lake Chewaucan about 13 ±3 ka (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Pezzopane and oth 1996 #3532). Faulted deposits described in natural exposures and the River trencl Langridge (1998 #3970) and Langridge and others (2001 #5092) consist of shallo deep water lacustrine sediments and include numerous middle and late Quaternar tephra. Youngest faulted sediments include detrital Mazama ash, and thus were deposited since 7 ka (Langridge, 1998 #3970; Langridge and others, 2001 #5092)
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The Ana River section of the Winter Rim fault system offsets Trego H Springs tephra (22–23 ka); most recent faulting must post-date the desiccation of pluvial Lake Chewaucan (13 ±3 ka), and predates the formation of the 4200-foot shoreline of the lake, which post-dates 2,130 ±90 yr BP (Pezzopane and Weldon, #149; Pezzopane, 1993 #3544; Pezzopane and others, 1996 #3532). Langridge (1 #3970) inferred an age of 4–7.6 ka for the latest event, based on faulting of Maza ash-bearing sediments. Madin and others (1996 #3479) also infer Holocene displacement on the Ana River fault.
Recurrence interval	7–21 k.y. *Comments:* Langridge (1998 #3970) used calculated sedimentation rates and teph correlations from trench and natural exposures to determine the ages of eleven mi and late Quaternary faulting events that he assigned to the Ana River section: 4–7 7.6–14 ka, 12–15 ka, 25.5 ±1.0 ka, 27–31 ka, 51 ±5 ka, 73 ±7 ka, 81 ±6 ka, 130 ± 160 ±10 ka, and 167 ±10 ka. Langridge (1998 #3970) interpreted the first eight ev as a probable complete record of faulting; these events yielded an average recurre interval of about 11 ka, with evidence of shorter (5-6 ka) and longer (19-20 ka)

	intervals between events. Langridge and others (2001 #5092) modified these resu somewhat, to infer 6 paleoseismic events (4-7.6 ka, 12-13 ka, 29 ±2.0 ka, 49 ±5 k and 70 ±6 ka, and 81 ±6 ka), which yield five intervals of about 7–21 k.y. and an average recurrence interval of about 15 k.y. The latter results are the most recentl published and thus are used herein. Egger (2015 #7766) suggests that three earthquakes occurred in the past 14 k.y. on this part of the fault; longer recurrence intervals (7_20 k.y.) are suggest if the entire 85 k.y. record is considered. Substantiation of these interpretations are pending peer review.
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Pezzopane (1993 #3544), Pezzopane and Weldon (1993 #149), and Pezzopane and others (1996 #3532) projected tephra across the fault zone expose the Ana River Trench to calculate a range of deformation rates of 0.1–0.6 mm/yr, preferred rate of 0.3 mm/yr. Langridge (1998 #3970) calculated a long-term (<87 rate of about 0.12 mm/yr, based on assumed offsets of 1.2–1.4 m per event, and interval slip rates of about 0.07–0.3 mm/yr. Langridge and others (2001 #5092) modified these results to estimate a slip rate of 0.2–0.1 mm/yr for the Ana River f
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