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Quaternary Fault and Fold Database of the United States

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Grass Valley fault zone (Class A) No. 1135

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Synopsis	The Grass Valley fault zone includes both range-front and intra basin faults. Along the northwest and west flanks of the Sonoma Range, the fault separates the Sonoma Range from the basin beneath Grass Valley and is a typical range-front fault. Near Leach Hot Springs, the fault zone splays out into a horsetail pattern and veers away from the range into Grass Valley (its namesake); farther south, the main trace again veers away from the range into and across Grass Valley to near the eastern base of the Goldbanks Hills in the west. The geomorphic expression of the range front along the southernmost part of the fault is conspicuously more subdued than along the north part, especially in the "transition" area (drainage divide) between Pleasant and Grass Valleys. Other than a 10-km-long bedrock-alluvium faulted contact along the northernmost part, the fault is marked by west-facing scarps on surficial deposits or erosion surfaces ranging from middle and early Pleistocene (0.13–1.5 Ma) to Holocene (0–

	10 ka). The southern end of the fault overlaps with the 1915 rupture of the Pleasant Valley fault zone [1136b), to the east. No details are reported on the geomorphic expression of these scarps, but it is estimated that the last surface-rupturing event was about 12 ka.
Name comments	dePolo (1998 #2845) referred to it as Grass Valley fault zone (his fault WI3), the name this is used herein. Wallace (1979 #203) referred to the fault as the "west flank Sonoma Range scarps". The fault zone extends from Water Canyon in the northern Sonoma Range generally in a south-southeast direction to near Goldbanks Windmill east of the Goldbanks Hills. **Fault ID:** Referred to as fault WI3 by dePolo (1998 #2845)
County(s) and State(s)	HUMBOLDT COUNTY, NEVADA PERSHING COUNTY, NEVADA
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:100,000 scale. *Comments:* Most of the trace is taken from Wallace (1979 #203) 1:125,000-scale map of young fault scarps, which was compiled mostly from a combination of photogeologic and field mapping on 1:60,000 aerial photographs. The north-most trace was compiled from the 1:250,000-scale map of Dohrenwend and Moring (1991 #284), which was produced by analysis of 1:58,000-nominal-scale color-infrared photography transferred directly to 1:100,000-scale topographic quadrangle maps enlarged to scale of the photographs.
Geologic setting	Ferguson and others (1951 #4354) 1:125,000-scale geologic map indicates that neither the East Range nor the Sonoma Range shows continuous frontal fault scarps although they recognized evidence for "recent movement" along the western base of both ranges. Along the western base of the Sonoma Range, they showed Quaternary faults as short (< 8 km) and discontinuous. The Grass Valley fault zone includes both range-front and intra basin parts. Along the northwest and west flanks of the Sonoma Range, the fault separates the strongly uplifted Sonoma Range from the deep Grass Valley, which is estimated to contain more than 5,000 ft of sedimentary fill (Grannell and Noble, 1977

	#4326). The fault zone is a typical range-bounding structure that can be divided into two broadly convex-westward parts which join in the Elbow Canyon area. The northern part, between Water and Elbow Canyons, is convex west, possibly suggesting a convex-upward fault shape at depth. At Elbow Canyon, the fault appears to step east across a fan complex to a southern part at the base of an en echelon bedrock escarpment that also has a slightly convex-west shape. Farther south, near Leach Hot Springs, a splay veers away from the range into Grass Valley, and farther south the main trace veers away from the range into and across Grass Valley to near the east base of the Goldbanks Hills. These splays may mark a reduction of total displacement toward the southern end of the fault. Alternatively, the splaying of the fault near its southern end may reflect transfer of displacement eastward to the Pleasant Valley fault zone [1136b], which lies at the western base of the Tobin Range. The Grass Valley fault zone has been proposed to have a high potential for rupture in the near future on the basis of its location within the northern extension of the central Nevada seismic belt and its lack of historic faulting (Whitney, 1985 #4328; Thenhaus and Barnhard, 1988 #4327; Ramelli and dePolo, 1996 #2577). However, the structural relations between the range-front faults of the Sonoma and Tobin Ranges are not clear.
Length (km)	53 km.
Average strike	N2°W
Sense of movement	Normal *Comments:* No specific data available; sense inferred from location in extensional tectonic province.
Dip Direction	W
Paleoseismology studies	Site 1135-1, Elbow Canyon. A trench was excavated along the Grass Valley fault zone as part of a larger study of the paleoseismic characteristics of the Pleasant Valley fault zone and 1915 earthquake (Machette and others, 1993 #596). Results from this study remain mostly unpublished, but are summarized herein owing to the importance of reporting these paleoseismic investigations.This trench is located about 1.5 km south of Elbow Canyon along the central part of the Grass Valley fault zone. At this site, a 2.5- to 4-m-deep, 38-m-long trench was excavated across a 4.4-m-high scarp (3.6 m offset) that is formed on late

	Pleistocene alluvial-fan deposits. Two to three surface-faulting events were recognized in the trench, the middle of which has a maximum age limit of about 25 ka. The second (middle) event is recorded by a large block of material that was exposed in a fault free face by the faulting event. This block collapsed, came to rest at the base of the scarp, and was later buried by a wedge of fault scarp colluvium and eolian sand and silt. This block has a well developed Av horizon (silt with small bubbles). Thermoluminescence (TL) dates from the Av horizon are about 25±3 ka, whereas the underlying surface has an age of about 29 ka. Since Av horizons generally require several thousands of years to form, these TL dates provide a maximum time limit of about 20–25 ka for the older (penultimate) event. The younger (first) event is recorded by a tapered-wedge of fault scarp colluvium in the trench. Overlying this second wedge is more eolian sand and silt (unfaulted) that contains disseminated ash, probably the 6.9 ka Mazama ash from Crater Lake, Oregon (Nelson and others, 1988 #5039). No datable organic material (charcoal or humus) was found in the trench, nor has cosmogenic dating been performed on the alluvial fan at the site. Site 1135-2 Sonoma trench at Bacon Canyon (Wesnousky and others, 2006 #7559) exposed evidence of one coseismic surface rupture that occurred about 20,027±674 cal yr BP. The resulting fault scarp is 2.4 m high; vertical displacement measured in the trench was 4.5 m.
Geomorphic expression	The steep escarpment at the northwest and western margins of the northern Sonoma Range has geomorphic expression typical of major range fronts in the region including abrupt piedmont slope/bedrock escarpment transitions, high-gradient narrow transverse canyons, upland wineglass valleys, and faceted spurs (Dohrenwend and Moring, 1991 #282). The range-bounding fault can be divided into two broadly convex-west parts that join in the Elbow Canyon area. The part north of Elbow Canyon has general geomorphic expression suggestive of a more active range-front fault than the part directly south of the canyon. Ramelli and dePolo (1996) recognized two splays of the fault (which they referred to as the Grass Valley fault). The northwestern of their two splays crosses the piedmont slope and comes to within 2.5 km of Winnemucca. The geomorphic expression of the range front along the southernmost part of the fault is conspicuously more subdued, especially in the "transition" area (drainage divide) between Pleasant Valley and Grass Valley. Other than a 10-km-

	long bedrock-alluvium faulted contact along the northernmost fault, it is typically marked by west-facing scarps on Quaternary surficial deposits or erosion surfaces (Dohrenwend and Moring, 1991 #282). No details are reported on the geomorphic expression of these scarps, but Wallace (1979 #203) estimated that they formed about 12 ka on the basis of their general appearance. The scarp that was excavate by Machette and others is about 4.4 m high and has a maximum scarp-slope angle of 15.8°. When plotted on empirical graphs of scarp height versus maximum slope angle (Bucknam and Anderson, 1979 #332), the scarp resembles the 15-ka highstand of Lake Bonneville. However, this comparison is deceiving (too old) because the lower portion of the scarp is buried by eolian silt and sand derived from lacustrine deposits of Lake Lahontan, which are exposed several kilometers to the west. dePolo (1998 #2845) reported a preferred maximum basal facet height of 98 m (73–122 m) for the fault, although the location of this measurement was not reported.
Age of faulted surficial deposits	On the basis of photogeologic reconnaissance, Dohrenwend and Moring (1991 #282) estimated ages of middle and early Pleistocene (0.13–1.5 Ma) to Holocene (0–10 ka) for deposits or erosion surfaces on which the scarps are formed.
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* The timing of the most recent event is basee on Wesnousky and others (2006 #7559). Wallace (1979 #203) suggested the last scarp-forming event occurred about 12 k.y. ago. Dohrenwend and Moring (1991 #282) estimated from photogeologic reconnaissance that short (<2 km) piedmont scarps on splays in southern Grass Valley are formed on Holocene deposits or erosion surfaces. Based on morphometric comparisons of scarp profiles near Leach Hot Springs, Pearthree (1990 #148) suggests the timing of the most recent event was 13–30 ka. In contrast to Dohrenwend and Moring (1991 #282), Pearthree clearly indicates that Holocene terraces are not faulted.
Recurrence interval	10–25 k.y. (<25 ka) *Comments:* Ramelli and dePolo (1996 #2577) reviewed evidence bearing on the seismic potential of the Grass Valley fault zone and concluded that the seismic hazard posed to Winnemucca should

	be considered very high. Preliminary results from the trenching at Elbow Canyon revealed two events in less than 25 k.y. (maximum). If one considers the time necessary to form the TL-dated Av horizon (several thousand years) and the apparent antiquity of the fault scarp (as determined from fault scarp profiling, then the time between events may be as little as 10,000 years.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Few studies of this fault have been conducted to date, so estimates of slip and timing of faulting events are poorly constrained. dePolo (1998 #2845) assigned a reconnaissance vertical slip rate of 0.199 mm/yr based on an empirical relationship between his preferred maximum basal facet height and vertical slip rate. The size of the facets (tens to hundreds of meters, as measured from topographic maps) indicates they are the result of many seismic cycles, and thus the derived slip rate reflects a long-term average. The late Quaternary characteristics of this fault (overall geomorphic expression, continuity of scarps, age of faulted deposits, etc.) support a low slip rate during this period. Accordingly, the less than 0.2 mm/yr slip-rate category has been assigned to this fault.
Date and Compiler(s)	2006 R. Ernest Anderson, U.S. Geological Survey, Emeritus Kathleen M. Haller, U.S. Geological Survey
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