Jump to Navigation

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Pleasant Valley fault zone, Tobin section (Class A) No. 1136b

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Synopsis	**General:** The M7+ 1915 Pleasant Valley earthquake formed four right-stepping en echelon surface ruptures with down-to-the-west displacement. The fault zone is located in part of the Basin and Range that is generally characterized by down-to-the west faults that may be linked in the subsurface by a through-going zone of extension accommodated by a series of right steps. The local geologic setting is slightly different for each section. The two central sections have the most prominent historical fault scarps and are marked by prehistoric scarps indicating multiple late Quaternary displacements. Return periods on these sections are probably measured in many thousand years, but the slip rate on the Pearce section may be high. The two end sections are less active and contain only sparse evidence of prehistoric displacements. Five trenches have been excavated along the central sections, but the results remain largely unpublished.

	Sections: This fault has 4 sections. The four sections correspond approximately to the four main scarps formed during the 1915 Pleasant Valley earthquake. From north to south, they are the China Mountain [1136a], Tobin [1136b], Pearce [1136c], and Sou Hills [1136d] sections.
Name comments	**General:** Name applied here to the four main faults that were activated in the 1915 Pleasant Valley earthquake to form the "1915 scarps" mapped by Wallace (1984 #169). dePolo (1998 #2845) referred to three of the faults, and a fourth not activated in 1915, as the Pleasant Valley fault system (his faults WI7A, -7B, -7C, and ?7D, respectively). He did not include the northernmost 1915 fault rupture (his China Mountain fault, WI6) in the system. As used here, the Pleasant Valley fault zone extends from the north end of China Mountain (which is also the north end of the Tobin Range) about 60 km S25!W to the area between the Sou Hills and the Stillwater Range. The four sections form a right-stepping echelon pattern in a belt of deformation about 6 km wide and 60 km long. The fault referred to as WI7D by dePolo, is described as unnamed faults [1145]. **Section:** Referred to as the Tobin scarp by Wallace (1984 #169) and as part of the Pleasant Valley fault system by dePolo (1998 #2845). The historic rupture extends from Jim Creek (near the R. 39/40 E. boundary) southward to about 1 km south of Cherry Creek. Older piedmont and range-bounding scarps are included as a northern extension of the section. They extend from Panther Canyon in the north, south past Jim Creek to Sheep Creek (Dohrenwend and Moring, 1991 #282), where they appear to merge with the 1915 ruptures. **Fault ID:** Refers to fault WI7A of dePolo (1998 #2845).
County(s) and State(s)	PERSHING COUNTY, NEVADA
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:100,000 scale. *Comments:* Traces of the 1915 rupture taken from Wallace (1984 #169) who mapped them in detail at scale of 1:62,500. Older piedmont and range-bounding scarps are 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	The four sections of the Pleasant Valley fault zone form a right-stepping echelon pattern. The primary sense of movement is down-to-the-west. According to Muller and others (1951 #4357), the Tobin Range is bounded on both sides by well defined fault scarps, but along the eastern front the fault is overlapped by Tertiary gravel, whereas on the western side there is evidence of progressive fault-related east tilting of Tertiary lavas. Rupture on the four sections during the 1915 Pleasant Valley earthquake may reflect failure on a deep crustal zone of extension oriented about N25?E (Wallace, 1984 #169). Despite their displacement-sense similarity, the geologic setting is different for each section. The Tobin and Pearce sections, the two central sections, are both major range-front faults that bound the ranges and place bedrock against basin-fill sediment of the Pleasant Valley. The Tobin section, along the main Tobin Range block, has a strongly convex-west trace. In contrast, the Pearce section is comparatively straight and bounds an east-tilted block that is secondary to the main Tobin Range block. Despite the presence of historic rupture, it is not clear how movement was transferred between the Pearce and Tobin sections, the ends of which overlap about 1.5 km but are separated by about 3.5-km-wide right step. The Sou Hills section, the southern section, bounds the Sou Hills on the west and extends north into the medial part of Pleasant Valley. It is part of a structural transfer zone where the predominant sense of late Cenozoic displacement changes from down-to-the-east at the east base of the Stillwater Range to down-to-the-west at the western base of the Tobin Range. As the Sou Hills are approached along these opposed-sense major range-front faults, fault throw and continuity decrease and the timing and average strike changes (Fonseca, 1988 #134). The China Mountain section at the northern end of the Tobin Range is one of several north-striking normal faults that cut the Paleozoic and Mesozoic rock of China Mountain. It may bound the China Mountain block and place bedrock against basin fill in the southernmost part of Pumpernickel Valley (Stewart and Carlson, 1978 #3413). The surface trace of the 1915 surface rupture along China Mountain is actually located 200-300 m upslope of the base of the west-facing bedrock escarpment. The main 1915 rupture

	[1136b, 1136c] has a convex-west trace, possibly suggesting convex-upward fault geometry rather than the listric geometry tentatively suggested by Wallace (1984 #169).
Length (km)	This section is 18 km of a total fault length of 70 km.
Average strike	N13°W (for section) versus N13°E (for whole fault)
Sense of movement	Normal
Dip Direction	W
Paleoseismology studies	Three trenches were excavated in the summer of 1992 by the U.S. Geological Survey (Machette and others, 1993 #596) to determine the movement history of the 1915 rupture trace and the older piedmont traces to the northwest of the 1915 rupture. Results from this study remain mostly unpublished, but are summarized herein owing to the importance of reporting these paleoseismic investigations. Site 1136-1, Lower Jim Creek. This trench was located several hundred meters north of the road that leads southeast to Jim Creek Ranch (abandoned) and then northeast to the mouth of Jim Creek. This site is along the southern part of the prehistoric piedmont scarps that are included within this section. The trench crossed a moderately large fault scarp and exposed faulted alluvial-fan deposits that are considered to be late Pleistocene in age. Multiple events were recognized (K.M Haller, oral commun., 2001) in the trench, but no datable materials (organics or ash) were found. Site 1136-2, Upper Jim Creek. This trench was located about 35 m south of the north edge of the piedmont that is entrenched by Jim Creek, at the northern end of the 1915 rupture. At this site, a 2- to 3-m deep trench was excavated across a prominent graben that existed prior to 1915. The 1915 rupture is about 0.6 m high on the main fault, and about 0.2-0.3 m high on the graben-bounding antithetic fault. The main composite scarp is about 1.5 m high. Two events were recognized in the trench. Fault-scarp colluvium from the penultimate event is buried by thick massive loess, but no datable organic material or ashes were found. Thermoluminescence dates from the loess are latest Pleistocene and Holocene, are generally stratigraphically consistent (older down). Site 1136-3, Sheep Creek. This trench was located about 60 m

	south of the northern fork of Sheep Creek, along the north-central part of the 1915 rupture. At this site, a 2- to 3-m-deep, 25-m-long trench was excavated across large rounded 7-m-high composite scarp that has a prominent graben. The 1915 rupture is about 2 m high on the main fault, and about 0.5 m high on the graben-bounding antithetic fault. Several events were recognized in the trench. Fault-scarp colluvium from the penultimate and older events is buried by thick massive loess. Machette and others (1993 #596) reported the presence of an ash and speculated that it may be the Wadsworth (late middle Pleistocene), although on further examination it appears to be hydrated, glassy and much younger (Andre Sarna-Wojcicki, oral commun. 1995). This ash has not been typed to a source area, nor has distinctive mineralogic or chemical characteristics and thus is not helpful for determining an age. Mazama ash (6.9 ka, Nelson and others, 1988 #5039), which is located both to the north and south of the trench site, was not encountered in the trench.
Geomorphic expression	The Tobin scarp forms the western flank of the Tobin Range. The range front is characterized by a rounded (in the north) to precipitous (in the south) bedrock escarpment incised by narrow high-gradient transverse streams separated by ridges that extend down from the range crest to the fault, where they terminate in fault facets. The escarpment and the 1915 scarp take a sharp left bend at the boundary between Sections 29 and 19 and continue northwest. From this point, the 1915 scarps only continue northwest for about 4 km, but Quaternary scarps extend northwest for tens of kilometers across the piedmont and along the front of the Sonoma Range [1135]. dePolo (1998 #2845) reported a maximum preferred basal facet height of 183 m (171-195 m) for the Tobin section (his fault WI7A). The piedmont slope beneath the facets may be oversteepened, suggesting syntectonic tilting away from the range. The 1915 rupture is at the base of the facets and extends across the alluvium of intervening valleys (Wallace, 1978 #2648, 1984 #169). Scarp produced by the 1915 earthquake range from 0.3-4.9 m high and approximate the vertical displacement (Wallace, 1984 #169) during the event. The prehistoric scarps that extend north and northwest from the 1915 rupture are formed on moderately west-sloping alluvial fans and piedmont deposits. These scarps are multiple event features, but have rounded crests and toes suggesting substantial antiquity to their formation.

Age of faulted surficial deposits	On the basis of reconnaissance photogeologic study, Dohrenwend and Moring (1991 #282) estimate that scarps are formed on late Pleistocene (10-130 ka) surficial deposits or erosion surfaces. Fonseca (1988 #134) indicated that unfaulted soils are middle Holocene; however, Wallace (1979 #203) mentioned the 6.9 ka (Nelson and others, 1988 #5039) Mazama ash is exposed in the north-bank terrace of the north fork of Sheep Creek. This terrace appears to be deformed by only the 1915 surface rupture.
Historic earthquake	Pleasant Valley earthquake 1915
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Late Quaternary age is assumed on basis of estimate by Dohrenwend and Moring (1991 #282) that scarps are formed on late Pleistocene deposits or surfaces. On the basis of 7 scarp profiles, Pearthree (1990 #148) estimated the age of the last prehistoric event on the Pleasant Valley fault (either the Tobin or Pearce sections) to be about 18.3 ka. Wallace (1979 #203) did not assign the prehistoric scarps to an age category as he did for other young fault scarps in the region, but we consider the most recent prehistoric rupture to be older than the 6.6 ka (Nelson and others, 1988 #5039) based on Mazama ash exposed along Sheep Creek. The latest Quaternary (<15 ka) category was not chosen, because the penultimate event may be only a bit older than that.
Recurrence interval	*Comments:* A minimum age for the penultimate surface faulting event is established by the presence of 6.6 ka (Nelson and others, 1988 #5039) Mazama ash in the free face of the 1915 scarp (Wallace, 1984 #169). In a summary of the significance of the ash and other diverse features along the Tobin and Pearce sections, Wallace (1984 #169) suggested return periods measured in many thousands of years, but probably less than 12 k.y. Machette and others (1993 #596) reported that recurrence intervals for 1915-like earthquake ruptures are at least 10-20 k.y., an estimate that was made mainly on the basis of soil development and unpublished thermoluminescence dating.
Slip-rate category	Less than 0.2 mm/yr *Comments:* No detailed data exists to determine slip rates for this fault. dePolo (1998 #2845) assigned a reconnaissance vertical slip rate of 0.335 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. However, the late Quaternary characteristics of this fault (overall geomorphic expression, continuity of older composite scarps, age of faulted deposits, etc.) suggest the slip rate during this period is of a slightly lesser magnitude. Accordingly, the less than 0.2 mm/yr slip-rate category has been assigned to this fault.
Date and Compiler(s)	2000 R. Ernest Anderson, U.S. Geological Survey, Emeritus Michael N. Machette, U.S. Geological Survey, Retired
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