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Pleasant Valley fault zone, Pearce section (Class A) No. 1136c

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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 Five trenches have been excavated along the central sections, but the results remain largely unpublished.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 Pearce scarps by Wallace (1984 #169) and as part of the Pleasant Valley fault system by dePolo (1998 #2845). The section extends from about 1 km south of Cherry Creek (about 1 km northeast of the Siard Ranch) south to the vicinity of Spring Creek, about 3 km west of an airway beacon in the southern part of the Tobin Range. **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 taken from Wallace (1984 #169) who mapped them in detail at scale of 1:62,500.
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 31 km of a total fault length of 70 km.
Average strike	N23°E (for section) versus N13°E (for whole fault)
Sense of movement	Normal

	Comments: Although the main displacement is normal, some left-stepping scarp patterns produced by the 1915 earthquake suggest a component, at least locally, of right-lateral displacement (Wallace, 1984 #169).
Dip	47°-65° *Comments:* Measured at the surface and reported on the map of fault scarps by Wallace (1984 #169).
Paleoseismology studies	Three exploratory trenches have been excavated across the Pearce section. The northern one was mapped by Bonilla and others (1984 #112) as part of Wallace's (1984 #169) investigation of fault scarps formed during the October 2, 1915, Pleasant Valley, Nevada, earthquakes. The two other trenches were excavated along the central and southern part of the section 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. Results from this later study remain mostly unpublished, but are summarized herein owing to the importance of reporting these paleoseismic investigations. Site 1136-4, North of Siard Ranch. A 30-m-long, 2- to 4-m-wide trench was excavated across the 1915 rupture where at least two pre-1915 scarp facets were defined (Bonilla and others, 1984 #112). The trench was about 1.3 km northeast of the Siard Ranch and near the at the north end of the Pearce section. Bonilla and others (1984 #112) mapped 16 late Quaternary units, only the uppermost of which could be correlated across the fault zone. Although none of the units were dated, general geomorphic and stratigraphic relations at the trench suggested several small (< 1 m) late Pleistocene and Holocene(?) displacement events. Two of the small displacements (0.2 and 0.3 m) may have occurred in the past 5,000 years (relative time estimate). The small size is clearly related to the location of the trench near the northern end of the fault section, where displacement rapidly decreases. Site 1136-5, Siard Creek. A 23-m-long, 2- to 3-m-deep trench was excavated across the 1915 rupture along the north-central part of the Pearce section, where pre-1915 scarp facets were clearly defined. The trench was located about 45 m north of South Siard Creek. At this site, the 1915 rupture produced a 2-m-high main scarp and a 0.4-m-high antithetic scarp, resulting in about 1.6 m of normal down-to-the-west displacement. The larger, composite

	scarp is about 6 m high and is related to about 3-4 m of normal displacement across a 20-m-wide graben. Deposits related to several faulting events were recognized in the trench, and a tephra tentatively correlated with the 6.9 ka (Nelson and others, 1998 #5039) Mazama ash, appears to be disturbed by only the 1915 event (also see site 1136b-2). Site 1136-63, Miller Canyon. A 20-m-long, 2- to 3-m-deep trench was excavated across the 1915 rupture along the southern part of the Pearce section, where a 13-m-high compound scarp is well preserved on the south bank of Miller Creek. The center of the trench is about 30 m south of the stream bed, in the middle and best preserved portion of this relatively small remnant of late to middle? Pleistocene fan alluvium. At this site, the 1915 rupture produced a 3-m-high main scarp, but no recognizable antithetic scarp. Several faulting events were recognized in the trench, but no datable materials were collected.
Geomorphic expression	The Pearce section is a major range-front fault with fresher appearing geomorphic expression compared to the Tobin section, but typical of active faults in the region. Although irregular in map plan with branches, bends, and discontinuities, it has an overall strike of N25?E. Roughly 30 km in length, it is the longest of the four sections and has the largest scarps (5.8 m) in the 1915 earthquake. Grabens are common along the base of the bedrock escarpment, and locally there is a left-stepping pattern of en-echelon fractures. Near the southern end, widely distributed scarps outline broad grabens oriented N30?E, probably normal to the regional direction of extension (Wallace, 1984 #169). Geomorphic evidence of pre-1915 late Quaternary faulting, such as compound scarps indicating at least two movements, is locally common. Some of these older scarps have maximum scarp-slope angles much lower than wave-cut shorelines of Lake Lahontan and are clearly much older. Conversely, some of scarps have slope angles similar to those of Lake Lahontan shorelines, suggesting a major surface-faulting event of about that age (approximately 13 ka). On the basis of seven scarp profiles, Pearthree (1990 #148) estimated that the last prehistoric event on the Pleasant Valley fault (either the Tobin or Pearce sections) was about 18.3 ka (average time). The preferred maximum basal fault facet is reported as 207 m (183-232 m) by dePolo (1998 #2845).
Age of faulted surficial	Most of the deposits along this section are Holocene colluvium deposited at the base of the steep Pierce Range. Alluvium along

deposits	the fault consists of modern to Holocene stream deposits, Holocene to late Pleistocene alluvial-fan deposits (alluvium and debris flows), and sparse middle(?) Pleistocene alluvial-fan deposits preserved adjacent to some streams.
Historic earthquake	Pleasant Valley earthquake 1915
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* A latest Quaternary (<15 ka) time is estimated by Bonilla and others (1984 #112) from studies at a trench site near the north end of the section. On the basis of seven scarp profiles, Pearthree (1990 #148) estimated the timing of the last prehistoric event on the Pleasant Valley fault (either the Tobin or Pearce sections) to be latest Pleistocene (about 18.3 ka). In contrast, Fonseca (1988 #134) indicated that the youngest prehistoric faulting along the Pearce section is probably early Holocene. Wallace (1979 #203) did not assign the prehistoric scarps to an age category as he did for other young fault scarps in the region.
Recurrence interval	*Comments:* The timing of surface faulting events prior to 1915 are unconstrained. If the 1915 rupture was preceded by two surface displacements in the past 5,000 years, as suggested by Bonilla and others (1984 #112), recurrence times would be in the range of a few thousand years. In a summary of the significance of the ash and diverse other 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. Conversely, 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 0.389 mm/yr to this section (his fault WI7B) 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, scarcity of older compound scarps, age of faulted deposits, etc.) suggest the slip rate during this period is of a 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
References	#112 Bonilla, M.G., Villalobos, H.A., and Wallace, R.E., 1984, Exploratory trench across the Pleasant Valley fault, Nevada, *in* Faulting related to the 1915 earthquakes in Pleasant Valley, Nevada: U.S. Geological Survey Professional Paper 1274-B, p. B1-B14, 1 pl. #2845 dePolo, C.M., 1998, A reconnaissance technique for estimating the slip rate of normal-slip faults in the Great Basin, and application to faults in Nevada, U.S.A.: Reno, University of Nevada, unpublished Ph.D. dissertation, 199 p. #134 Fonseca, J., 1988, The Sou Hills—A barrier to faulting in the central Nevada seismic belt: Journal of Geophysical Research, v. 93, no. B1, p. 475-489. #4357 Muller, S.W., Ferguson, H.G., and Roberts, R.J., 1951, Geology of the Mount Tobin quadrangle, Nevada: U.S. Geological Survey Geologic quadrangle Map GQ-0007, 1 sheet, scale 1:125,000. #5039 Nelson, C.H., Carlson, P.R., and Bacon, C.R., 1988, The Mount Mazama climactic eruption (approximately 6900 yr B.P.) and resulting convulsive sedimentation on the Crater Lake caldera floor, continent, and ocean basin, *in* Clifton, H.E., ed., Sedimentologic consequences of convulsive geologic events: Geological Society of America Special Paper 229, p. 37–57. #148 Pearthree, P.A., 1990, Geomorphic analysis of young faulting and fault behavior in central Nevada: Tucson, University of Arizona, unpublished Ph.D. dissertation, 212 p. #3413 Stewart, J.H., and Carlson, J.E., 1978, Geologic map of Nevada: U.S. Geological Survey, Special Geologic Map, 1, scale 1:500,000.

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