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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Surprise Valley fault (Class A) No. 4

Last Review Date: 2000-04-04

Compiled in cooperation with the California Geological Survey

citation for this record: **Bryant, W.A., compiler, 2000, Fault number 4, Surprise Valley fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 03:10 PM.**

Synopsis	The Surprise Valley fault is an active (Holocene) down-to-east normal fault bordering the eastern side of the Warner Mountains. There has been detailed reconnaissance-level mapping by Hedel (1980 #1339; 1984 #5098) and Bryant (1990 #5097), based mainly on aerial photographic interpretation and reconnaissance field mapping. No detailed site studies have been conducted.
Name comments	Russell (1884 #5099; 1885 #3549) first named and mapped the fault as bordering the western side of Surprise Valley in Modoc County. **Fault ID:** Refers to number 7 (Surprise Valley fault) of Jennings

	(1994 #2878), and number NE05 (Surprise Valley fault) of Working Group on Northern California Earthquake Potential (1996 #1216).
County(s) and State(s)	LASSEN COUNTY, CALIFORNIA MODOC COUNTY, CALIFORNIA
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:62,500 scale. *Comments:* Based on digital revisions to Jennings (1994 #2878), using original mapping by Hedel (1980 #1339; 1984 #5098) and Bryant (1990 #5097) at 1:62,500.
Geologic setting	The Surprise Valley fault, which can be considered the boundary of the Modoc Plateau (to the west) and Basin and Range (to the east) geomorphic provinces in northeastern California. It bounds the Warner Mountains to the west, and displaces late Quaternary lacustrine beds and recent alluvial slopes by as much as 15 m (Hedel, 1980 #1339; 1990 #5097). Hedel (1980 #1339) estimated that the Surprise Valley fault has about 3,800 m of cumulative down-to-the-east vertical displacement, based on the summation of the height of the southern crest of the Warner Mountains above Surprise Valley and the estimated depth of Quaternary alluvial fill in Surprise Valley.
Length (km)	86 km.
Average strike	N8°W
Sense of movement	Normal *Comments:* Russell (1884 #5099; 1885 #3549) recognized that the Warner Mountains is a west-tilted fault block bounded on the east by the Surprise Valley fault. The Surprise Valley fault is delineated by geomorphic evidence of late Pleistocene down to the east normal faulting (Hedel, 1980 #1339; 1984 #5098; Bryant, 1990 #5097). A gravity survey by Chapman and Bishop (1968 #5218) showed a steep gravity gradient between the Warner Mountains (positive anomaly) and Surprise Valley (negative anomaly), indicating substantial vertical displacement, which is reiterated in Hedel (1980 #1339).

Dip	60° to 67° E. *Comments:* Hedel (1980 #1339; 1984 #5098) reported 60? to 67? E. dips from bedrock exposures of Surprise Valley fault.
Paleoseismology studies	
Geomorphic expression	The Surprise Valley fault zone is delineated by geomorphic features indicative of Holocene normal faulting, including abundant scarps on Holocene alluvial fans, incised or vertically offset drainages, and vegetation contrasts on young alluvium (Hedel, 1984 #5098; Bryant, 1990 #5097). Faceted spurs along most of the eastern side of the Warner Mountains are indicative of repeated normal displacement.
Age of faulted surficial deposits	Fault offsets lacustrine deposits of late Pleistocene Lake Surprise and post-lake Holocene alluvial fan deposits. Hedel (1980 #1339; 1984 #5098) based relative age assessments on analogy to the history of Lake Lahontan. Tephra deposits interbedded with lacustrine deposits were tentatively correlated with Trego Hot Springs tephra, a unit stratigraphically above the 24.5 ka Wono tephra (J.O. Davis, written communication to Hedel, cited in Hedel, 1980 #1339).
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Hedel (1980 #1339) proposed that two surface-rupturing events occurred in the past 11 k.y. (one event at 8-11 ka and one event <5 ka). This timing is based on the presence of relatively sharp fault scarps that record different amounts of vertical displacement. Larger fault scarps on Pleistocene deltaic deposits are between 12 and 14 m high and have compound (multiple-event) profiles. Fault scarps on Holocene alluvium generally are about 4 m high have a simple, probably single-event profile. Hedel (1980 #1339) postulated that, because the larger fault scarps are not wave-modified, they postdate the latest high stand of Lake Surprise and are probably early Holocene.
Recurrence interval	

Slip-rate category	Between 1.0 and 5.0 mm/yr *Comments:* Slosson (1974 #5101) estimated a long-term slip rate of 0.6 to 1 mm/yr, based on cumulative vertical offset of about 4.3 km in the past 6 to 8 Ma. Hedel (1980 #1339) estimated a maximum Holocene slip rate of 1 mm/yr on the basis of measured fault scarp heights, an assumed fault dip of 60?, and estimates of the age of faulted alluvium related to late Pleistocene Lake Surprise. Clark and others (1984 #2876) used a fault scarp reported in Hedel (fig. 27, 1980 #1339), an assumed fault dip value of 50? to 70?, and an age of offset of 5.6 to 13 ka to calculate a slip rate of 0.75 to 2.7 mm/yr, with a preferred slip rate of 1.0 mm/yr. Although the published slip rates span two slip-rate categories, we assign the higher of of the two herein.
Date and Compiler(s)	2000 William A. Bryant, California Geological Survey
References	#5097 Bryant, W.A., 1990, Surprise Valley and related faults, Lassen and Modoc Counties: California Department of Conservation, Division of Mines and Geology Fault Evaluation Report 217. #5218 Chapman, R.H., and Bishop, C.C., 1968, Bouguer gravity map of California—Alturas sheet: California Division of Mines and Geology, scale 1:250,000. #2876 Clark, M.M., Harms, K.H., Lienkaemper, J.J., Harwood, D.S., Lajoie, K.R., Matti, J.C., Perkins, J.A., Rymer, M.J., Sarna-Wojcicki, A.M., Sharp, R.V., Sims, J.D., Tinsley, J.C., III, and Ziony, J.I., 1984, Preliminary slip rate table and map of late Quaternary faults of California: U.S. Geological Survey Open-File Report 84-106, 12 p., 5 plates, scale 1:1,000,000. #1339 Hedel, C.W., 1980, Late Quaternary faulting in western Surprise Valley, Modoc County, California: San Jose, California, San Jose State University, unpublished M.S. thesis, 113 p., 2 pls., scale 1:62,500. #5098 Hedel, C.W., 1984, Maps showing geomorphic and geologic evidence for late Quaternary displacement along the Surprise Valley and associated faults, Modoc County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1429, 2 sheets, scale 1:62,500.

	#2878 Jennings, C.W., 1994, Fault activity map of California and adjacent areas, with locations of recent volcanic eruptions: California Division of Mines and Geology Geologic Data Map 6, 92 p., 2 pls., scale 1:750,000. #4860 Petersen, M.D., Bryant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Lienkaemper, J.J., McCrory, P.A., and Schwartz, D.P., 1996, Probabilistic seismic hazard assessment for the State of California: California Department of Conservation, Division of Mines and Geology Open-File Report 96-08 (also U.S. Geological Open-File Report 96-706), 33 p. #5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464. #3549 Russell, I.C., 1885, Geological history of Lake Lahontan—A Quaternary lake of northwestern Nevada: U.S. Geological Survey Monograph 11, 288 p. #5101 Slosson, J.E., 1974, Surprise Valley fault: California Geology, v. 27, no. 12, p. 267-270. #1216 Working Group on Northern California Earthquake Potential (WGNCEP), 1996, Database of potential sources for earthquakes larger than magnitude 6 in northern California: U.S. Geological Survey Open-File Report 96-705, 40 p.