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Big Pine fault zone, Lockwood Valley section (Class A) No. 86c

Last Review Date: 2017-03-01

citation for this record: **Bryant, W.A., compiler, 2017, Fault number 86c, Big Pine fault zone, Lockwood Valley section, 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 03:16 PM.**

Synopsis	**General:** Significant east to northeast-striking fault zone along the northern Transverse Range-southern Coast Range margin. Fault zone has not been studied in detail until recently. Originally thought by Hill and Dibblee (1953 #923) to be a major, through-going sinistral strike-slip fault, but Onderdonk and others (2005 #7913) have shown the fault to consist of three distinct structures: the Western Big Pine, Eastern Big Pine, and Lockwood Valley faults. Only the easternmost Lockwood Valley fault exhibits predominantly sinistral strike-slip offset. The Western Big Pine fault is a north-dipping reverse fault and the Eastern Big Pine fault is characterized by south-dipping reverse displacement. Direct evidence of Holocene displacement has not been observed except for the eastern Lockwood Valley fault near the San Andreas fault (Smith, 1977 #7914; Bryant-Park and Assoc., 1975 #7901). DeLong and others (2007 #7903) inferred that the central

	reach of the Eastern Big Pine fault may have evidence of Holocene displacement. At a site near Camp Scheideck, DeLong and others (2007 #7903) estimated an age of about 14–25 ka for an offset stream terrace, based on OSL dating; the terrace is vertically displaced about 10 m. Using an average dip of 50°, they estimated a dip-slip rate of about 0.9 mm/yr. They argued that the 10 m vertical displacement probably did not occur in a single rupture event but ruptured several times since 14–15 ka. **Sections:** This fault has 3 sections. Following the structural nomenclature of Onderdonk and others (2005 #7913) the Big Pine fault zone is divided into three sections. From west to east the sections are: Western Big Pine section, Eastern Big Pine section, and Lockwood Valley section. The boundary between the Western and Eastern Big Pine sections is delineated at the intersection with the Pine Mountain fault [261] where the fault dip changes from north (Western Big Pine fault) to south (Eastern Big Pine fault). The boundary between the Eastern Big Pine and Lockwood Valley sections marks the change from predominantly south-dipping reverse displacement along the Eastern Big Pine section to predominately sinistral strike-slip displacement along the Lockwood Valley section.
Name comments	**General:** Big Pine fault first mapped and named by Nelson (1925 #7912), based on north-dipping reverse fault along the south side of Big Pine Mountain. Onderdonk and others (2005 #7913) suggested that Big Pine fault zone actually was three distinct faults they termed the Western Big Pine fault, Eastern Big Pine fault, and Lockwood Valley fault. **Section:** The Lockwood Valley section extends for about 23 km northeastward from the eastern Cuyama Badlands, bounds the north side of Lockwood Valley and terminates at the San Andreas fault [1g] about 3.5 km west of Frazier Park. The western end of the Lockwood Valley section is delineated by a change in style of displacement from predominantly sinistral strike-slip to predominantly south-dipping reverse displacement to the west along the Eastern Big Pine section [86b]. **Fault ID:** Refers to numbers 307 (Big Pine fault, western part) and 318 (Big Pine fault, eastern part) of Jennings and Bryant (2010 #7904).
County(s) and State(s)	KERN COUNTY, CALIFORNIA VENTURA COUNTY, CALIFORNIA

Physiographic province(s)	PACIFIC BORDER
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Digital compilation is based on 1:24,000-scale mapping by Carman (1964 #7902), Minor (1999 #7908), Kellogg and Miggins (2002 #7906), and Kellogg (2003 #7907).
Geologic setting	The Big Pine fault zone is an east to northeast striking fault zone that extends for about 80 km from the Big Bend of the San Andreas fault zone [1] westward along the boundary between the northern Transverse Ranges and the southern Coast Ranges. Displacement along the Big Pine fault zone originally was thought to have been predominantly sinistral strike-slip displacement (*e.g.*, Hill and Dibblee, 1953 #923). Hill and Dibblee (1953 #923) postulated about 16 km of cumulative sinistral displacement. In contrast, Onderdonk and others (2005 #7913) consider the Big Pine fault zone to consist of three separate structures, from west to east: the Western Big Pine fault, Eastern Big Pine fault, and Lockwood Valley fault. The Western and Eastern Big Pine faults are characterized by predominantly reverse displacement and the Lockwood Valley fault displays predominantly sinistral strike-slip offset (Onderdonk and others, 2005 #7913). Cumulative displacement for the Western Big Pine fault is not known due to the discontinuity in structural grain and stratigraphy across the fault (Onderdonk and others, 2005 #7913). Cumulative displacement across the Eastern Big Pine fault is not well constrained due to incomplete exposures of older units in the footwall and erosion of younger units in the hanging wall, but Onderdonk and others (2005 #7913) estimate between 3 and 4 km of reverse separation has occurred. Cumulative displacement along the Lockwood Valley fault has not been reported.
Length (km)	km.
Average strike	
Sense of movement	Left lateral, Reverse *Comments:* Onderdonk and others (2005 #7913) reported that most of the Lockwood Valley section is characterized by sinistral strike-slip displacement, consistent with previous workers such as Hill and Dibblee (1953 #923), Crowell (1962 #7855) and Carman

	(1964 #7902). However, Onderdonk and others (2005 #7913) and Kellogg and Minor (2005) reported that the sense of displacement along the western end of the Lockwood Valley section is predominantly due to north-south contraction, resulting in reverse-sinistral displacement.
Dip Direction	N *Comments:* Fault is steeply dipping (Onderdonk and others, 2005 #7913).
Paleoseismology studies	
Geomorphic expression	Onderdonk and others (2005 #7913) reported that the Lockwood Valley section is delineated by geomorphic features such as linear mountain fronts indicating up on the north Quaternary displacement. Weber and others (1975 #7918) noted faceted spurs, a locally beheaded drainage, south-facing fault scarps, and linear tonal contrasts. Smith (1977 #7914) mapped modified southeast-facing scarps in young alluvium near the eastern end of the Lockwood Valley section.
Age of faulted surficial deposits	Lockwood Valley section juxtaposes late Oligocene sedimentary and volcanic rocks on the northwest against younger Miocene sedimentary rocks on the southeast. Smith (1977 #7914) reported that a fault investigation (Bryant-Park and Assoc., 1975 #7901) near the eastern end of the Lockwood Valley section exposed a fault that juxtaposed granitic basement rocks against alluvium of possible Holocene age. Here Bryant-Park and Assoc. (1975 #7901) observed an offset sand lens they noted as a brown to gray soil, but could be alluvial deposits. No age dating was reported.
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Timing of the most recent paleoevent is not constrained. The offset alluvium reported by Bryant-Park and Assoc. (1975 #7901) indicates late Quaternary displacement.
Recurrence interval	

Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Petersen and Wesnousky (1994 #6024) reported a preferred sinistral slip rate of 4 mm/yr, based on the assumption that the Big Pine fault sinistrally offsets the Ozena fault [256] on the north from the San Guillermo fault on the south about 13–19 km in the last 6–18 Ma (based on Molnar, 1991 #7910). Bird and Rosenstock (1984) estimated a late Pliocene to Quaternary sinistral slip rate of at least 0.8 mm/yr, based on about 4.8 km offset of a 1.8–5.9 Ma deposit (Morales Formation) reported by Kahle (1966 #7905). However, Onderdonk and others (2005 #7913) argue that the Eastern Big Pine section is characterized by predominantly reverse displacement and mapping by Minor (1999 #7908) has shown that the San Guillermo fault is continuous with the Eastern Big Pine section, negating the argument of significant sinistral displacement. DeLong and others (2007 #7903) reported a dip-slip rate of about 0.9 mm/yr for a strand of the Eastern Big Pine section near Camp Scheideck. A 14–25 ka (OSL age) terrace deposit is offset about 10 m (vertical) near the southern margin of the Cuyama structural basin near the Cuyama River. Using a 50° dip, DeLong and others (2007 #7903) calculated a dip-slip separation of about 13 m. Although these values suggest a dip-slip rate of about 0.7 mm/yr, DeLong and others (2007) consider the 25 ka OSL age to be spurious and used 14 ka as the age of the deposit. However, even excluding the 25 ka age for sample OSL11, the remaining samples suggest an average age of about 18 ka for the sandy deposits. What is not known is the age of displacement relative to the terrace deposit.
Date and Compiler(s)	2017 William A. Bryant, California Geological Survey
References	#7901 Bryant-Park and Associates, Inc., 1975, Geologic investigation of the Seventh Day Adventist church and school site, Lake of the Woods, Kern County, California: Unpublished consulting report dated February 1975, 7 p., 3 figures (CGS file number AP 72), *in* Fault Investigation Reports for development sites within Alquist-Priolo earthquake fault zones in southern California, 1974–2000: California Geological Survey CGS CD 2003-02 (2003). #7902 Carman, M.F., Jr., 1964, Geology of the Lockwood Valley area, Kern and Ventura Counties, California: California Division of Mines and Geology Special Report 81, 62 p.

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#7903 DeLong, S.B., Minor, S.A., and Arnold, L.J., 2007, Late Quaternary alluviation and offset along the eastern Big Pine fault, southern California: Geomorphology, v. 90, p. 1–10.

#923 Hill, M.L., and Dibblee, T.W., Jr., 1953, San Andreas, Garlock, and Big Pine faults, California: Geological Society of America Bulletin, v. 64, p. 443–458.

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	Taking apart the Big Pine fault—Redefining a major structural feature in southern California: Tectonics, v. 24, TC6002, doi:10.1029/2005TC001817, 11 p. #6024 Petersen, M.D., and Wesnousky, S.G., 1994, Fault slip rates and earthquake histories for active faults in southern California: Bulletin of the Seismological Society of America, v. 84, no. 5, p. 1,608-1,649. #7914 Smith, T.C., 1977, Big Pine fault (eastern segment): California Division of Mines and Geology Fault Evaluation Report FER-17, 12 p., 5 plates, map scale 1:24,000 *in* Fault Evaluation Reports Prepared Under the Alquist-Priolo Earthquake Fault Zoning Act, Region 1 – Central California: California Geological Survey CGS CD 2002-01 (2002). #7918 Weber, F.H., Jr., Kiessling, E.W., Sprotte, E.C., Johnson, J.A., Sherburne, R.W., and Cleveland, G.B., 1975, Seismic hazards study of Ventura County, California: California Division of Mines and Geology Open-File Report 76-5 LA, 396 p., 9 plates, scale 1:48,000