

Quaternary Fault and Fold Database of the United States

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Pisgah-Bullion fault zone, Pisgah section (Class A) No. 122a

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Compiled in cooperation with the California Geological Survey

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Synopsis

General: The Pisgah-Bullion fault zone is a more than 100-km-long, northwest-trending dextral strike-slip fault zone that is part of a complex of similarly oriented dextral faults within the Eastern California (or Mojave) Shear Zone (Dokka and Travis, 1990 #3188). Elements of the fault zone have been recognized since at least the map of Jenkins (1938 #5628) and have been mapped in successively more detail by Kupfer and Bassett (1962 #6697), Dibblee (1966 #1346; 1967 #6688; 1968 #6708) and Hart (1987 #6694). An East and West Bullion fault were distinguished by Bacheller (1978 #6675). In its northern reaches, the fault zone

displaces volcanic and volcanoclastic rocks of Pleistocene age along the Pisgah fault and of Tertiary age along the Bullion fault. Also affected are younger fan deposits, with multiple indicators of late-Pleistocene to Holocene dextral displacement. The southern branches of the fault zone (East and West Bullion faults) are not as well defined and are largely concealed by late-Quaternary deposits, except near their northern juncture where historic ground rupture (1–2 m on each fault) has helped define their location. The East Bullion fault regains definition at its southern end as it approaches the Pinto Mountain fault [118]. Limited paleoseismic studies in the central part of the fault zone (Lindvall and others, 2000 #6698) plus observations of Hart (1987 #6694) suggest there have been several Holocene displacements in the northern sections of the fault zone. The only estimate of slip rate comes from offset lava flows along the Pisgah fault which suggest a dextral rate of 0.8 mm/yr (Hart, 1987 #6695). Slip rate is probably divided to some extent between the two southern sections [122c and 122d].

Sections: This fault has 4 sections. The fault is divided here into sections based strictly on geometry (abrupt change in trend and major branching). Wesnousky (1986 #5305) had four sections (A–D) for the Bullion fault (including the southern part of the Lavic Lake fault [351] as section D), with the Pisgah fault listed separately. Petersen and Wesnousky (1994 #6024) also had four similar, but less clearly delineated, sections of the Bullion fault zone, in addition to the Pisgah fault, but including the Lavic Lake fault [351] as their section A. Both Wesnousky (1986 #5305) and Petersen and Wesnousky (1994 #6024) made two sections of what is considered here the East Bullion section. The West Bullion fault has generally been ignored in these evaluations, but the 1999 Hector Mine earthquake demonstrated the importance of this strand (Treiman and others, 2002 #6692). The Lavic Lake fault [351] is herein listed separately from the Pisgah-Bullion fault zone.

**Name
comments**

General: Parts of the unnamed fault zone were depicted by Jenkins (1938 #5628). Pisgah and Bullion faults (including the present East Bullion fault) were first named and mapped (as separate faults) by Kupfer and Bassett (1962 #6697). Both faults were included, along with the Mesquite Lake fault [123], as the Pisgah-Bullion-Mesquite Lake fault by Petersen and others (1996 #4860). Pisgah and Bullion faults are grouped here, as a zone, based on Dibblee (1966 #1346) who mapped the two faults with a significant overlap, and based on Hart (1987 #6694) who

identified and mapped a complex zone of interaction between these two faults. Both fault names have been applied to at least some of the traces in the overlap area (Dibblee, 1966 #1346; Morton and others, 1980 #6636). The fault zone extends southward to include two branches of the Bullion fault mapped in different configurations by Kupfer and Bassett (1962 #6697), Dibblee (1967 #6688; 1968 #6708), Bortugno (1986 #6676) and Hart (1987 #6694). Mesquite Lake fault [123] is parallel to Bullion fault and is considered separately.

Section: Pisgah fault named by Kupfer and Bassett (1962 #6697) and includes parallel strand included by some (Dibblee, 1966 #1346; Bortugno, 1986 #6676) as part of the Bullion fault. South section boundary at change in trend from about N. 20° W. to N.45° W.

Fault ID: Refers to numbers 378 (Bullion fault) and 418 (Pisgah fault) of Jennings (1994 #2878).

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|----------------------------------|---|
| County(s) and State(s) | SAN BERNARDINO COUNTY, CALIFORNIA |
| Physiographic province(s) | BASIN AND RANGE |
| Reliability of location | <p>Good Compiled at 1:62,500 scale.</p> <p><i>Comments:</i> Location based on mapping at 1:62,500 by Dibblee (1966 #1346) and Dibblee and Bassett (1966 #1344) and aerial photo interpretation plotted at 1:24,000 by Hart (1987 #6694).</p> |
| Geologic setting | <p>The Pisgah-Bullion fault zone is within the Eastern California Shear Zone, within the Mojave Desert (Dokka and Travis, 1990 #3188). It is a continuous zone of Holocene and late Pleistocene dextral faults that extend about 100 km southeastward from the west edge of the Hector quadrangle to the Humbug Mountain quadrangle, southeast of Twentynine Palms, where it intersects the Pinto Mountain fault zone [118]. The fault zone delineates the western margin of the Bullion Mountains and is parallel to other major northwest-trending fault zones in the Eastern California Shear Zone, including the Calico-Hidalgo fault zone [121] and the Camp Rock-Emerson-Copper Mountain fault zone [114]. Dokka (1983 #6632) reported 6.4–14.4 km of cumulative dextral displacement along the Pisgah-Rodman faults based on offset of</p> |

| | |
|--|--|
| | <p>Miocene Kane Spring transfer fault. Dokka and Travis (1990 #3188) indicated about 10.5 km of dextral offset. Locally, and with regard to recent tectonic activity, it appears to have a right-stepping relationship between the Lavic Lake fault [351] to the north and the Mesquite Lake fault [123] to the south as it accommodates shear within the Eastern California Shear Zone (Treiman and others, 2002 #6692). Ground rupture in 1999 (Treiman and others, 2002 #6692) affected primarily the middle portion of the fault zone (northern part of the East and West Bullion faults). At least in this historic event the West Bullion fault appears to primarily participate in the stepover to the Mesquite Lake fault [123].</p> |
| Length (km) | This section is 32 km of a total fault length of 97 km. |
| Average strike | N24°W |
| Sense of movement | <p>Right lateral</p> <p><i>Comments:</i> Dextral sense of movement is based on mapping of Dibblee (1966 #1346) and dextrally offset drainages and alluvial units (Hart, 1987 #6694).</p> |
| Dip Direction | <p>V</p> <p><i>Comments:</i> Fault is inferred by Hart (1987 #6694) to be "steeply dipping", high-angle to vertical as shown in cross-section by Dibblee (1966 #1346); possible west-dip suggested by outcrop around Sunshine crater.</p> |
| Paleoseismology studies | |
| Geomorphic expression | Pisgah fault is well expressed by scarps, abrupt topographic contrasts, sidehill benches and dextrally deflected drainages (Hart, 1987 #6694). |
| Age of faulted surficial deposits | Fault offsets Pleistocene to late-Pleistocene basalt flows from the Sunshine and Pisgah craters as well as coeval and younger fan deposits (Dibblee, 1966 #1346; Hart, 1987 #6694; Hart, 1987 #6695) and Holocene alluvium (Hart, 1987 #6694). |
| Historic earthquake | |
| Most recent | latest Quaternary (<15 ka) |

| | |
|--------------------------------|--|
| prehistoric deformation | <i>Comments:</i> Most recent event probably occurred in past 3,000 yr (Bull, 1978 #6613). |
| Recurrence interval | <i>Comments:</i> Recurrence of surface faulting events not explicitly documented; however, inference might be made based on Bull's (1978 #6613) supposition that "perhaps of several movements during the Holocene". |
| Slip-rate category | Between 0.2 and 1.0 mm/yr <i>Comments:</i> Slip rate of 0.8 mm/yr preferred by Hart (1987 #6695) based on 0.8 km dextral offset of Lavic flow, which is thought to be about 1 Ma. Slip rate assigned by Petersen and others (1996 #4860) for combined Pisgah-Bullion fault zone [122] and Mesquite Lake fault for probabilistic seismic hazard assessment for the State of California was 0.6 mm/yr (with minimum and maximum assigned slip rates of 0.2 mm/yr and 1.0 mm/yr, respectively). |
| Date and Compiler(s) | 2003 Jerome A. Treiman, California Geological Survey |
| References | <p>#6675 Bacheller, J., III, 1978, Quaternary geology of the Mojave Desert-eastern Transverse Ranges boundary in the vicinity of Twentynine Palms, California: Los Angeles, University of California, unpublished M.S. thesis, 157 p., scale 1:24,000.</p> <p>#6676 Bortugno, E.J., 1986, Map showing recency of faulting, San Bernardino quadrangle, California: California Division of Mines and Geology Regional Geologic Map Series San Bernardino quadrangle, Map 3A, sheet 5, scale 1:250,000.</p> <p>#6613 Bull, W.B., 1978, Tectonic geomorphology of the Mojave Desert: Technical report to U.S. Geological Survey Earthquake Hazard Reduction Program, Reston, Virginia, under Contract 14-08-001-G-394, 176 p.</p> <p>#1346 Dibblee, T.W., Jr., 1966, Geologic map of the Lavic quadrangle San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-472, 5 p. pamphlet, 1 sheet, scale 1:62,500.</p> |

#6688 Dibblee, T.W., Jr., 1967, Geologic map of the Deadman Lake quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-488, scale 1:62,500.

#6708 Dibblee, T.W., Jr., 1968, Geologic map of the Twentynine Palms quadrangle, San Bernardino and Riverside Counties, California: U.S. Geological Survey Miscellaneous Investigations Map I-561, 1 sheet, scale 1:62,500.

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#6632 Dokka, R.K., 1983, Displacements on late Cenozoic strike-slip faults of the central Mojave Desert, California: *Geology*, v. 1, p. 305-308.

#3188 Dokka, R.K., and Travis, C.J., 1990, Late Cenozoic strike-slip faulting in the Mojave Desert, California: *Tectonics*, v. 9, p. 311-340.

#6694 Hart, E.W., 1987, Pisgah, Bullion and related faults, San Bernardino County, California: California Division of Mines and Geology Fault Evaluation Report FER-188, April 17, 1987, 14 p.

#6695 Hart, E.W., 1987, Pisgah, Bullion and related faults, San Bernardino County, California, Supplement No.1: California Division of Mines and Geology Fault Evaluation Report FER-188, supp. 1, August 5, 1987, 4 p.

#5628 Jenkins, O.P., 1938, Geologic map of California: California Division of Mines, scale 1:500,000.

#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.

#6697 Kupfer, D.H., and Bassett, A.M., 1962, Geologic reconnaissance map of part of the southeastern Mojave desert, California: U.S. Geological Survey Mineral Investigations Field Studies Map MF-205, scale 1:125,000.

#6698 Lindvall, S., Rockwell, T., and Rubin, C., 2000, Collaborative paleoseismic studies along the 1999 Hector Mine earthquake surface rupture and adjacent faults: Southern California Earthquake Center Annual Report, 6 p.

#6636 Morton, D.M., Miller, F.K., and Smith, C.C., 1980, Photoreconnaissance maps showing young-looking fault features in the southern Mojave Desert, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1051, 7 sheets, scale 1:24,000 and 1:62,500.

#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.

#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.

#6692 Treiman, J.A., Kendrick, K.J., Bryant, W.A., Rockwell, T.K., and McGill, S.F., 2002, Primary surface rupture associated with the Mw 7.1 16 October 1999 Hector Mine earthquake, San Bernardino County, California: Bulletin of the Seismological Society of America, v. 92, p. 1,171-1,191.

#5305 Wesnousky, S.G., 1986, Earthquakes, Quaternary faults, and seismic hazards in California: Journal of Geophysical Research, v. 91, no. B12, p. 12,587-12,631.

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