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

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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:** Bullion fault was named by Kupfer and Bassett (1962 #6697). This section of the fault was labeled section "A" by Wesnousky (1986 #5305) who also included part of the East Bullion fault. Petersen and Wesnousky (1994 #6024) labeled the same section "B". The section extends southeastward for about 20 km from the bend at the Pisgah fault [122a] to the split into the East and West Bullion faults. **Fault ID:** Refers to numbers 378 (Bullion fault) and 418 (Pisgah fault) of Jennings (1994 #2878).
County(s) and State(s)	SAN BERNARDINO COUNTY, CALIFORNIA
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location based on aerial photo interpretation and mapping at 1:24,000 by Hart (1987 #6694).
Geologic setting	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 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].
Length (km)	This section is 19 km of a total fault length of 97 km.
Average strike	N40°W
Sense of movement	Right lateral *Comments:* Dextral sense of movement is based on mapping by Dibblee (1966 #1346) and observations by Morton and others (1980 #6636) and Hart (1987 #6694).
Dip Direction	V *Comments:* Fault is shown in cross-sections as high-angle to vertical (Dibblee, 1966 #1346). Steep dip is also indicated by minor seismicity shown in section by Hauksson and others (2002 #6696).
Paleoseismology studies	Sites 122-1 and 122-2 by Lindvall and others (2000 #6698) include two trenches across the fault, northwest of the junction with the Lavic Lake fault [351]. There was no coseismic surface rupture of the fault at the trench site in 1999; the exposures revealed evidence of an older event within the past 2,000 yr. Age-dating method is not detailed.
Geomorphic expression	Bullion fault is well expressed by scarps, aligned notches, sidehill benches and dextrally deflected drainages (Hart, 1987 #6694; Treiman, 2002 #6701).
Age of faulted surficial	Fault offsets Tertiary volcanic rocks and Pleistocene to late Pleistocene alluvial deposits (Dibblee, 1966 #1346) and inferred

deposits	Holocene alluvium, including debris-flow deposits (Hart, 1987 #6694); historic rupture of young alluvial fan deposits.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Most recent prehistoric event occurred less than 2,000 yr ago (Lindvall and others, 2000 #6698).
Recurrence interval	 *Comments:* Rockwell and Lindvall (2001 #6700) suggests one event during the past 7,000 yr.
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Slip rate assumed to be the same as for the Pisgah section [122a]; probably "low slip rate" per Rockwell and Lindvall (2001 #6700). 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
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