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

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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:** East Bullion fault was named by Bacheller (1978 #6675). This section includes the Valley Mountain fault (also named by Bacheller, 1978 #6675) at its southeastern-most extent and extends for nearly 60 km from the split with the West Bullion fault [122d] in the Deadman Lake NW quadrangle southeastward to the Humbug Mountain quadrangle. The section roughly corresponds with sections "B" and "C" of Wesnousky (1986 #5305) and "C" and "D" of Petersen and Wesnousky (1994 #6024). This portion of the fault zone was identified as part of the Bullion fault [122b] by Kupfer and Bassett (1962 #6697). **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 1:62,500 scale. *Comments:* Northern end is well located based on mapping (1:24,000) by Treiman (2002 #6701), which included historic rupture traces (Treiman and others, 2002 #6692). Southern extent from mapping by Moyle (1961 #6699) at 1:62,500. Intervening poorly located traces largely concealed and inferred as mapped at 1:62,500 by Dibblee (1967 #6688; 1968 #6708) and partially modified by Treiman (2002 #6701).
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 54 km of a total fault length of 97 km.
Average strike	N36°W
Sense of movement	Right lateral *Comments:* Sense of movement based on mapping by Dibblee (1968 #6708), dextrally offset features (Hart, 1987 #6694), and historic displacement (Treiman and others, 2002 #6692).
Dip Direction	E *Comments:* High-angle dip to the east is suggested by seismicity in cross-section by Hauksson and others (2002 #6696); near vertical fault interpreted by Dibblee (1967 #6688) in cross section.
Paleoseismology studies	
Geomorphic expression	Northernmost part of the section is expressed by scarps, sidehill benches, truncated spurs, and offset drainages (Hart, 1987 #6694; Treiman, 2002 #6701). The rest of the secrtion does not have

	geomorphic expression that suggests recent displacement. Although, there is a possible scarp on a bedrock outlier east of Deadman Lake (Treiman, 2002 #6701) and the fault in the Valley Mountain area may define local sedimentary basins and bound some bedrock outliers (Moyle, 1961 #6699).
Age of faulted surficial deposits	Fault offsets older Quaternary gravels (Dibblee, 1967 #6688) and alluvium (Moyle, 1961 #6699); historic rupture (Treiman, 2002 #6701) offsets youngest alluvium and all older deposits.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Hart (1987 #6694) suggests there possibly were multiple Holocene events based on dextrally offset drainages.
Recurrence interval	
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Slip-rate category assigned based on assumed continuity with the Pisgah section of the Pisgah fault [122a]; however, it is likely that slip is divided between East and West Bullion faults along the southern extension of the Pisgah fault. 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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