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Panamint Valley fault zone, Brown Mountain section (Class A) No. 67d

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Compiled in cooperation with the California Geological Survey

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Synopsis	**General:** Major Holocene active oblique-slip range-front fault zone characterized by both Holocene normal dip-slip and dextral strike-slip offset (Smith, 1976 #1646; Bryant, 1989 #1459; Zhang and others, 1990 #199). Panamint Valley fault zone is divided into sections in this compilation, from north to south: Northern Panamint Valley [67a], Wildrose [76b], Southern Panamint Valley [67c], and Brown Mountain [67d]. The fault zone extends from the complex left compressional step over to the Hunter Mountain-Saline Valley fault zone [66] southeast along the eastern side of Panamint Valley and complexly intersects with the Garlock fault

	zone [69] along the Brown Mountain fault. Reheis (1991 #1602) suggested that the southern end of the Hunter Mountain fault zone extended into northern Panamint Valley and ends just north of Wildrose graben. Smith (1976 #1646) and Zellmer (1980 #1705) considered the junction between the Hunter Mountain [67] and Panamint Valley faults to be at the northern end of Panamint Valley south of Hunter Mountain. In this compilation the northern end of the Panamint Valley fault zone is considered to be delineated by the shallow northeast-dipping thrust fault along the south side of Hunter Mountain mapped by Smith (1976 #1646). The Panamint Valley fault zone is delineated by well-defined geomorphic features indicative of Holocene dextral and normal faulting (Smith, 1979 #1647; Bryant, 1989 #1459; Zhang and others, 1990 #199). Burchfiel and others (1987 #1454) reported a long term slip rate of 2-3.2 mm/yr for the Hunter Mountain-Saline Valley fault zone, based on dextral displacement of Hunter Mountain batholith contact. Zhang and others (1990 #199) reported latest Pleistocene to Holocene minimum dextral slip rates of 1.74?0.65 mm/yr and 2.36?0.79 mm/yr for the Panamint Valley fault zone (Southern Panamint Valley section [67c]), although ages of offset deposits are not well-constrained. Zhang and others (1990 #199) reported that large surface-rupturing earthquakes may occur as characteristic 3-m events, based on their observations of dextrally offset stream channels in multiples of 3 m. Zhang and others (1990 #199) concluded that the average recurrence interval for large surface-rupturing earthquakes on the Southern Panamint Valley section [67c] is between 860 yr and 2,360 yr, based on an assumed 3.2?0.5-m characteristic event and a Holocene slip rate of 2.36?0.79 mm/yr. **Sections:** This fault has 4 sections. There is insufficient evidence to delineate seismogenic segments. The sections defined in this compilation are based on geomorphic expression, style of faulting, and geometry. From north to south the sections are: Northern Panamint Valley [67a], Wildrose [67b], Southern Panamint Valley [67c], and Brown Mountain [67d].
Name comments	**General:** Panamint Valley fault zone was first described and named by Noble (1926 #1592), who considered the fault to be a normal dip-slip range-front fault. The Brown Mountain fault was first mapped and named by Muehlberger (1954 #6065). **Section:** Brown Mountain section, proposed in this compilation, is delineated by the Brown Mountain fault, which was first mapped and named by Muehlberger (1954 #6065). The section

	extends from the vicinity of Brown Mountain southeast to the vicinity west of Quail Spring. The Brown Mountain fault was considered possibly to be a branch of the Panamint Valley fault zone by Muehlberger (1954 #6065). Bryant (1989 #1459) inferred that the Brown Mountain fault may complexly join with the southern Panamint Valley fault zone along a left-compressional step south of Brown Mountain. The southern Brown Mountain fault complexly joins with the Garlock fault zone [69] (Clark, 1973 #483; Bryant, 1989 #1459). **Fault ID:** Refers to numbers 247 (Panamint Valley fault) and 269 (Brown Mountain 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:* Locations based on digital revisions to Jennings (1994 #2878) using original mapping by Bryant (1989 #1459) at 1:62,500, mapping by Muehlberger (1954 #6065) at 1:48,000, and mapping by Clark (1973 #483) at 1:24,000.
Geologic setting	Major oblique-slip fault characterized by both dextral strike-slip and normal dip-slip faults. Panamint Valley fault zone is located within the Death Valley extension region, the most active part of the southern Basin and Range province (Zhang and others, 1990 #199). The Panamint Valley fault zone is a Holocene active range-front fault that extends from the northern Panamint Valley southeast to the Garlock fault zone [69]. Dextral slip is probably transferred northward to the Hunter Mountain-Saline Valley fault zone [66] along a complex compressional left step at the northern end of Panamint Valley indicated by north-dipping Quaternary thrust faults (Smith, 1975 #1219; Smith, 1976 #1646). Reheis (1991 #1602) suggested that the southern end of the Hunter Mountain fault zone [66] extended into northern Panamint Valley and ended just north of Wildrose graben. Smith (1976 #1646) and Zellmer (1980 #1705) considered the junction between the Hunter Mountain [66] and Panamint Valley faults to be at the northern end of Panamint Valley south of Hunter Mountain. In this compilation, the northern end of the Panamint Valley fault zone is

	considered to be delineated by the shallow northeast-dipping thrust fault along the south side of Hunter Mountain mapped by Smith (1976 #1646). To the southeast, the Panamint Valley fault zone complexly joins the sinistral strike-slip Garlock fault zone [69] along the dextral Brown Mountain fault [67d]. Late Quaternary and Holocene displacement is characterized by both normal dip-slip and dextral strike-slip displacement. Dip-slip faults commonly occur along the range front and dextral strike-slip faults occur west of the range front. Johnson (1957 #6513) estimated that cumulative down-to-west vertical displacement may total as much as 1,800 m. Smith (1979 #1647) reported that 300-600 m of Quaternary dextral offset and as much as 3-4.5 km of cumulative dextral strike-slip displacement characterize the Panamint Valley fault zone. Normal dip-slip displacement may total as much as 10 km (Smith, 1976 #1646). Burchfiel and others (1987 #1454) reported that cumulative dextral strike-slip displacement may total as much as 8-10 km since late Miocene time.
Length (km)	This section is 17 km of a total fault length of 104 km.
Average strike	N57°W (for section) versus N22°W,N36°W (for whole fault)
Sense of movement	Right lateral, Reverse *Comments:* Brown Mountain fault is delineated by geomorphic evidence consistent with dextral strike-slip displacement (Clark, 1973 #483; Bryant, 1989 #1459). Muehlberger (1954 #6065) reported that the Brown Mountain fault is characterized by a steeply northeast-dipping reverse fault with at least 90 m of vertical displacement.
Dip Direction	V; NE *Comments:* Northeast dip is inferred based on geometry of compressional left step between Brown Mountain section and Southern Panamint Valley section [67c].
Paleoseismology studies	
Geomorphic expression	Brown Mountain fault is delineated by geomorphic features indicative of Holocene dextral slip such as closed depressions, linear scarps on alluvium, dextrally deflected drainages, shutter ridges, sidehill benches, and linear troughs (Clark, 1973 #483;

	Bryant, 1989 #1459).
Age of faulted surficial deposits	The Brown Mountain fault offsets debris flow deposits that are probably Holocene age (M.M. Clark, personal communication in Bryant, 1989 #1459).
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Timing of most recent paleoevent is poorly constrained. Geomorphic expression of Brown Mountain fault is indicative of Holocene dextral slip (Clark, 1973 #483; Bryant, 1989 #1459). Fault dextrally offsets debris flow deposits of probable Holocene age (M.M. Clark, personal communication in Bryant, 1989 #1459).
Recurrence interval	 *Comments:* Recurrence intervals for the Brown Mountain section have not been determined. Zhang and others (1990 #199) identified dextral displacements in multiples of 3: the youngest offset is 3 m and dextral offsets of 6 m and 12 m were observed at many places between Manly Peak Canyon and Goler Wash Canyon (Southern Panamint Valley section [67c]). Zhang and others (1990 #199) concluded that the average recurrence interval for large surface rupturing earthquakes on the Southern Panamint Valley section [67c] is between 860 and 2,360 yr, based on a 3.2?0.5 m characteristic event and a Holocene slip rate of 2.36?0.79 mm/yr. Smith (1979 #1647) estimated a mean recurrence interval of about 700-2,500 yr for the Panamint Valley fault zone, based on an assumed 1.4-2.6 m offset per event and 20 m total offset in the past 10-20 ka.
Slip-rate category	Between 1.0 and 5.0 mm/yr *Comments:* The Holocene slip rate for the Brown Mountain section is not known. Zhang and others (1990 #199) reported latest Pleistocene to Holocene minimum dextral slip rates of 1.74?0.65 mm/yr and 2.36?0.79 mm/yr for the southern Panamint Valley section [67c]. Petersen and others (1996 #4860) assigned a slip rate of 2.5 mm/yr (with minimum and maximum assigned slip rates of 1.5 mm/yr and 3.5 mm/yr, respectively) to the entire fault for probabilistic seismic hazard assessment for the State of

	California.
Date and Compiler(s)	2000 William A. Bryant, California Geological Survey
References	#1459 Bryant, W.A., 1989, Panamint Valley fault zone and related faults, Inyo and San Bernardino Counties, California: California Division of Mines and Geology Fault Evaluation Report FER-206, 33 p., 1 pl., scale 1:62,500. #1454 Burchfiel, B.C., Hodges, K.V., and Royden, L.H., 1987, Geology of Panamint Valley-Saline Valley pull-apart system, California—Palinspastic evidence for low-angle geometry of a Neogene range-bounding fault: Journal of Geophysical Research, v. 92, no. B10, p. 10,422-10,426. #483 Clark, M.M., 1973, Map showing recently active breaks along the Garlock and associated faults, California: U.S. Geological Survey Miscellaneous Geologic Investigations I-741, 3 sheets, scale 1:24,000. #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. #6513 Johnson, B.K., 1957, Geology of a part of the Manly Peak quadrangle, southern Panamint Range, California: University of California Publications in Geological Sciences, v. 30, no. 5. #6065 Muehlberger, W.R., 1954, Geology of the Quail Mountains, San Bernardino County: California Division of Mines Bulletin 170, Geology of Southern California Map Sheet 16, scale 1:48,000. #1592 Noble, L.F., 1926, The San Andreas rift and some other active faults in the desert region of southeastern California: Carnegie Institution of Washington Year Book 25, p. 415-428. #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.

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#1705 Zellmer, J.T., 1980, Recent deformation in the Saline Valley region, Inyo County, California: Reno, University of Nevada, unpublished Ph.D. dissertation, 168 p., 7 pls., scale 1:50,000.

#199 Zhang, P., Ellis, M., Slemmons, D.B., and Mao, F., 1990, Right-lateral displacements and the Holocene slip rate associated with prehistoric earthquakes along the southern Panamint Valley fault zone—Implications for southern Basin and Range tectonics and coastal California deformation: Journal of Geophysical Research, v. 95, no. B4, p. 4857—4872.