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Mission Ridge fault system, Santa Ana section (Class A) No. 88d

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Synopsis	**General:** East-striking system of generally moderately to steeply south-dipping reverse to reverse sinistral oblique faults and associated folds. Fault system reported to be mostly blind at the western end (Keller and Gurrola, 2000), but is mostly a surface fault along the eastern extent. Mission Ridge fault system is characterized by late Pleistocene, and locally Holocene displacement (Minor and others 2009; Gurrola, 2006; Keller and Gurrola, 2000; Weber and others, 1975; Chauvel, 1958; Kahle, 1985 #7940; Rockwell and others, 1984). Mission Ridge fault system divided into 4 sections in this compilation, generally following the segmentation first proposed by Keller and Gurrola (2000). The Ellwood Mesa site (88-1) exposed evidence of three events, the most recent occurring after 36 ka. The penultimate event occurred about 37 ka and the pre-penultimate event occurred between 37 ka and 47 ka (Keller and Gurrola, 2000;

	Gurrola, 2006). Gurrola (2006) calculated a minimum dip slip rate of 0.4 mm/yr at the Ellwood Mesa site, based on a vertically offset 47 ka wave cut platform. The Santa Barbara Mission scarp site (88-2) exposed evidence of two events that offset latest Pleistocene to Holocene stream channel and floodplain deposits (Gurrola, 2006). Gurrola and Keller (2003) reported a vertical uplift rate of 0.75 mm/yr at the Sheffield Reservoir site (88-3), based on 90 m uplift of a 125 ka alluvial fan deposit. Assuming a 45° dip for the Mission Ridge section, a dip-slip rate of about 1 mm/yr is indicated. Gurrola and Keller (2003) reported progressive deformation of young fluvial deposits indicating multiple events across the northern limb of the Mission Ridge anticline at the Sheffield Reservoir site (88-3), but no dates or event horizons were determined. **Sections:** This fault has 4 sections. There is insufficient data to delineate seismogenic segments. Keller and Gurrola (2000) defined three segments that define their Mission Ridge fault system based on differences in geometric, geomorphic, and structural style. From west to east they defined the More Ranch segment, Mission Ridge segment and Arroyo Parida segment. The Arroyo Parida segment included the Santa Ana fault. The segments defined by Keller and Gurrola are adopted in this compilation, although they are considered sections and the Santa Ana fault is separated into a forth section.
Name comments	**General:** Mission Ridge fault system first introduced by Gurrola and Keller (1999) and Keller and Gurrola (2000) for the zone of surface faults and near surface blind faults consisting of (from west to east) the More Ranch, Mission Ridge, Arroyo Parida, and Santa Ana faults (referred to by Gurrola and Keller as fault segments). The More Ranch fault was first mapped and named by Hill (1932). The Mission Ridge fault, named for the low, north-facing scarps along the north side of Mission Ridge, was first inferred to be a fault and was named by Dibblee (1966). Arnold (1907) first described the Arroyo Parida fault. Putnam (1942) may have been the first to map the Santa Ana fault. **Section:** The Santa Ana section was considered as part of the Arroyo Parida segment by Keller and Gurrola (2000). However, in this compilation the Santa Ana section, which is delineated by the Santa Ana fault, is considered as a separate section because of the documented evidence, locally, for Holocene displacement (Kahle, 1985 #7940; Rockwell, 1983; Buena Engineers, 1981). The Santa Ana section extends from just west of the Ventura

	River eastward forming the southern margin of Ojai Valley and is truncated at its eastern end by the San Cayetano fault zone [95]. **Fault ID:** Refers to numbers 322 (More Ranch fault), 327 (Mission Ridge fault and Arroyo Parida fault) and 329 (Santa Ana fault) of Jennings (1994) and numbers 46 (Mission Ridge–Arroyo Parida fault zone), 47 (More Ranch fault), and 56 (Santa Ana fault) of Ziony and Yerkes (1985).
County(s) and State(s)	VENTURA COUNTY, CALIFORNIA
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location of fault from Qt_flt_ver_3-0_Final_WGS84_polyline.shp (Bryant, W.A., written communication to K.Haller, August 15, 2017) attributed to 1:48,000-scale mapping by Dibblee (1987 #7933, 1987 #7934), Weber and others (1975) and 1:24,000-scale mapping by Clark (1972), and Kahle (1985 #7939, 1985#7940).
Geologic setting	Mission Ridge fault system is a generally east-striking zone of faults and associated folds that extend on land for about 68 km from the Ellwood Mesa area west of Isla Vista east to the San Cayetano fault [95]. Keller and Gurrola (2000) stated that the Mission Ridge fault system extends offshore west of Ellwood Mesa. Mission Ridge fault system is considered by Keller and Gurrola (2000) to be a major structure of the Santa Barbara Fold Belt, which is located on the south side of the Santa Ynez anticlinorium. Keller and Gurrola characterized the Santa Barbara Fold Belt as a linear zone of active folds located along the southern flank of the western Transverse Ranges. They reported that the Mission Ridge fault system is comprised of shallow subsurface folding developed on the hanging-walls of blind reverse and thrust faults, although generally north-vergent reverse faults locally extend to the surface or very near surface. Farther east the Mission Ridge fault system is expressed by surface faults and folds that offset or deform late Pleistocene alluvium and terrace deposits. Maximum displacement is not well-constrained for the Mission Ridge fault system. Chauvel (1958) postulated that the Arroyo Parida section [88c] may have up to 825 m of dip

	separation and between 0.8 to 1.2 km of sinistral displacement, based on an offset contact between Eocene Coldwater Formation and Oligocene Sespe Formation. Dibblee (1966) reported that the Arroyo Parida section is characterized by up to 300 meters of up on south vertical displacement and a possible, though unknown, component of sinistral displacement. Jackson and Yeats (1982) argue that subsurface data do not support a large component of sinistral offset.
Length (km)	km.
Average strike	
Sense of movement	Reverse *Comments:* Clark (1982) and Rockwell and others (1984) reported that Santa Ana fault is predominately reverse.
Dip	70° to near vertical *Comments:* Clark (1982) depicts the Santa Ana fault as near vertical in cross sections A-A', B-B', and C-C'; Rockwell and others (1984) show the Santa Ana fault dipping steeply to the south. Trench excavations show dips between 70–85° N. (Buena Engineers, 1981, 1982 #7922).
Paleoseismology studies	
Geomorphic expression	Santa Ana section locally is delineated by north-facing scarps on late Pleistocene alluvial and terrace surfaces, and linear tonal contrasts in late Pleistocene alluvium (Weber and others, 1975; Rockwell, 1983; Kahle, 1985 #7940; Clark, 1982).
Age of faulted surficial deposits	Fault offsets Tertiary Sespe Formation, Quaternary alluvium, and late Pleistocene terrace deposits. Turner (1971) reported that the Santa Ana fault offsets water-bearing late Pleistocene alluvial gravels in the southern Ojai Valley region. Trenches by Buena Engineers (1981, 1982 #7922, 1982 #7923; described in Kahle, 1985 #7940) show that the Santa Ana fault offsets Qt5b terrace deposit mapped by Rockwell (1983) and overlying soil deposits. Rockwell and others (1984) estimated the age of the soil developed on the Qt5a surface to be 15–20 ka.
Historic	

earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Age of the most recent event is poorly constrained. Trenches across the Santa Ana fault near Mira Monte exposed offset soils developed on Qt5b surface. Rockwell (1983) estimated that age of the Qt5b terrace surface to be late Pleistocene.
Recurrence interval	
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Clark and others (1984) reported a minimum vertical displacement rate of 0.35 mm/yr and a maximum vertical displacement rate of 0.4 mm/yr, based on vertical separation of fluvial terrace surfaces dated by soil profile development and 14C dating. A 28.5–30.9 ka surface was vertically displaced 10.7–11.3 m and a 36.5– 39.5 ka terrace was vertically displaced 13.7–14.3 m along the Ventura River near Mira Monte (Rockwell, 1983; Rockwell and Keller, 1984). Kahle (1985 #7939, 1985 #7940) did not verify the amount of offset reported by Rockwell (1983). Trenches were excavated in the Qt5b terrace of Rockwell (1983), exposing faulted terrace gravels and overlying soil. However, the observed vertical displacement was about 0.5 m, south side up, suggesting a displacement rate significantly less than 0.1 mm/yr (Kahle, 1985 #7940; Buena Engineers, 1981, 1982 #7922, 1982 #7923, 1986).
Date and Compiler(s)	2017 William A. Bryant, California Geological Survey
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