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Quaternary Fault and Fold Database of the United States

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Santa Cruz Island fault (Class A) No. 93

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Synopsis	The Santa Cruz Island fault is a sinistral strike-slip fault with a small reverse component of displacement. Patterson (1979) documented geomorphic evidence of late Pleistocene sinistral displacement along the Santa Cruz Island fault; Pinter and Sorlien (1991) presented evidence that Santa Cruz Island fault offsets latest Pleistocene and Holocene deposits. Pinter and others (1998) excavated one trench across the Santa Cruz Island fault at the Christy Beach site and reported that the most recent event occurred about 5 ka, based on offset of the base of a debris flow deposit. Pinter and others (1998) documented evidence of at least six surface-rupturing earthquakes in the past about 35 ka at the Christy Beach site. Clark and others (1984) estimated a minimum sinistral slip rate of 0.86 mm/yr, based on a 600 m sinistral offset of an abandoned stream channel assumed to be no greater than late Quaternary (700 ka) in age. Pinter and others (1998) reported a preferred sinistral slip rate of 0.8 mm/yr and a maximum

	sinistral slip rate of 1.1 mm/yr, based on sinistrally offset drainages incised into a marine terrace deposit that is tentatively correlated with oxygen isotope stage 11 (400 ka).
Name comments	Fault probably first recognized by Goodyear (1890), who described the islands Central Valley as a line of demarcation between volcanic terrain to the north and sedimentary/metamorphic terrain to the south. Santa Cruz Island fault first mapped and named by Rand (1931). **Fault ID:** Refers to number 334 of Jennings (1994) and number 77 (Santa Cruz Island fault) of Ziony and Yerkes (1985).
County(s) and State(s)	VENTURA COUNTY, CALIFORNIA (offshore)
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Good Compiled at 1:24,000 (onshore), 1:250,000 (offshore) 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 1:24,000 scale mapping by Patterson (1979). Offshorelocation based on mapping by Junger (1979) and Vedder and others (1986) at scale of 1:250,000.
Geologic setting	The Santa Cruz Island fault is an east-southeast striking sinistral strike-slip fault that extends on land for about 21 km along the northern margin of Santa Cruz Island's central valley, forming a major lithologic boundary. The fault continues offshore both east and west of Santa Cruz Island. To the west the fault extends for about 17 km and offsets Miocene volcanic rocks against Pleistocene and Holocene deposits (Junger, 1976). East of Santa Cruz Island the fault extends for about 38 km and locally offsets Holocene sediments (Vedder and others, 1986). Santa Cruz Island is part of the Northern Channel Islands that represent the southernmost range of the western Transverse Ranges. Several west-striking faults, including the Santa Cruz Island fault, Santa Rosa Island fault [92], and Dume fault [100], parallel the Channel Islands trend. Pinter and Sorlien (1991) and Pinter and others (1998) suggest that that these faults may connect with predominantly sinistral strike-slip faults—the Malibu Coast [99],

	Santa Monica [101], Hollywood [102], and Raymond [103] faults—forming a semi continuous fault zone that delineates the boundary between the western Transverse Ranges and the northwest-trending Peninsular Ranges. Weaver and others (1969) reported that the Santa Cruz Island fault has cumulative post-Miocene slip of 1.6 km, based on displacement of a distinct volcanic feature. Cumulative late Quaternary horizontal offset is reported by Patterson (1979), who mapped a stream channel sinistrally displaced about 600 m.
Length (km)	83 km.
Average strike	
Sense of movement	Left lateral *Comments:* Displacement is predominately sinistral, but a minor down-to-south reverse component is indicated by vertically displaced marine terrace shoreline angle (Pinter and others, 1998).
Dip Direction	V *Comments:* Ziony and Yerkes (1985) reported a 70–75° north dipping fault. Patterson (1979) observed dips ranging from 70° to near vertical in exposures of the fault. Junger (1979) depicted a near vertical south-dipping fault in seismic profile OC-97 located offshore east of Santa Cruz Island. Junger and Wagner (1977) depicted a near vertical fault in seismic reflection profile A-A' offshore east of Santa Cruz Island. The fault west of Santa Cruz Island is near vertical, based on high resolution seismic reflection profile shown in Junger (1976, 1979).
Paleoseismology studies	Site 93-1 (Pinter and others, 1998) involved the excavation of one fault normal trench at the Christi Beach site. Trench and arroyo wall excavations in a fill terrace exposed fluvial fill deposits documenting periods of aggradation alternating with periods of incision and soil formation. Trench exposure documented a 35 ka record of surface-rupturing earthquakes along the Santa Cruz Island fault, including the most recent event.
Geomorphic expression	Fault is delineated by geomorphic features indicative of late Pleistocene and Holocene sinistral strike-slip displacement such as sinistrally deflected and offset drainages, sinistrally offset ridges, shutter ridges, back-facing scarps, scarps and deflected

	drainages in late Pleistocene terrace surfaces, linear ridges and valleys, and linear tonal contrasts (Patterson, 1979).
Age of faulted surficial deposits	Santa Cruz Island fault separates Miocene Santa Cruz Island Volcanics and Monterey Formation north of the fault against pre-Jurassic Santa Cruz Island Schist, Jurassic Willows Diorite, and Tertiary clastic and volcanoclastic rocks south of the fault (Pinter and others, 1998). The fault offsets a 125 ka marine terrace shoreline angle and offsets the base of a 5 ka debris flow deposit on the west side of Santa Cruz Island (Pinter and others, 1998). Pinter and others (1998) reported that strands of the Santa Cruz Island fault offset the Valley Anchorage landslide at the eastern end of Santa Cruz Island. Age of the landslide mass is 12, 789±390 yr BP (Sorlien, 1994) and sinistral offset of stream channels incised into the slide mass postdate the landslide deposit.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Pinter and others (1998) reported the youngest surface-rupturing earthquake occurred about 5 ka, based on the offset of the base of a debris flow deposit containing material radiocarbon dated between 5.0 ka and 5.4 ka.
Recurrence interval	*Comments:* Pinter and others (1998) identified at least 6 surface-rupturing earthquakes in the past about 35 ka. They note that this is a minimum and additional events may not have been preserved due to the long depositional hiatuses in the stratigraphic record. Pinter and others (1998) estimated an average recurrence interval of at least 2.7 k.y. and probably 4–5 k.y. This approximation is based on the assumption that displacement along the Santa Cruz Island fault is 3–4 m per event (Patterson, 1979) and a late Quaternary displacement rate of 0.8–1.1 mm/yr.
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Patterson (1979) estimated a vertical displacement rate based on a 25 m apparent vertical separation of the base of a 125 ka wave cut platform. Patterson recognized that the vertical separation could in part or in whole be due to strike-slip displacement of a west-dipping surface. Pinter and others (1998)

	re-evaluated the vertically offset wave cut platform and, instead, located exposures of the 125 ka terrace shoreline angle about 1 km north and about 1.5 km south of the Santa Cruz Island fault, reasoning that the measurement of differences in elevation of the shoreline angle is better interpreted as a vertical offset value. The 125 ka shoreline angle is about 12 m higher north of the fault, indicating a minimum vertical slip rate of 0.1 mm/yr. Pinter and others (1998) could not rule out a larger difference in elevation closer to the fault, so they concluded that the vertical displacement rate component was between 0.1 mm/yr and 0.2 mm/yr. Clark and others (1984) estimated a minimum sinistral displacement rate of 0.86 mm/yr, based on a 600 m sinistral offset of an abandoned stream channel assumed to be no greater than late Quaternary (700 ka) in age. Pinter and others (1998) reported a preferred sinistral displacement rate of 0.8 mm/yr and a maximum sinistral displacement rate of 1.1 mm/yr. They measured several sinistrally offset drainages. Sinistral displacement ranged from 289 m to 351 m. The mean value of 322 m resulted in the best alignment when the offset drainages were restored. The drainages were incised into Pinter and others' (1998) T3 terrace surface. The age of the terrace surface is not well-constrained and the age is based on indirect correlation. Pinter and others (1998) first estimated a 1.75 Ma age for the T3 terrace surface using a relative-elevation method described in Muhs (2000). This method, assuming a constant uplift rate, uses a dated terrace surface and infers that the age of higher or lower terraces are proportional to the magnitude of uplift since terrace formation. However, Pinter and others argued that the method is probably inappropriate because the uplift rate for Santa Cruz Island terraces is probably episodic rather than constant. They assumed that the T3 terrace may be correlated with either oxygen isotope stage 9 (315 ka) or stage 11 (400 ka), preferring stage 11. Therefore, the 0.8 mm/yr preferred sinistral displacement rate was based on 322 m displaced drainages channels incised into a stage 11 (400 ka) marine terrace surface.
Date and Compiler(s)	2017 William A. Bryant, California Geological Survey
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