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Sierra Madre fault zone, Santa Susana section (Class A) No. 105a

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Synopsis	**General:** In general the Sierra Madre-Cucamonga fault zone marks the southern margin of uplift of the San Gabriel Mountains, although the Santa Susana fault extends the zone of south-vergent uplift west of these mountains. Only local portions of the fault zone have had detailed paleoseismic investigations, and those have had fairly limited results. Published slip rates vary widely along the fault zone. The best-understood part of the fault is the easternmost section, the Cucamonga fault zone, with excellent geomorphic expression, several trenches, and age control from radiocarbon and soil stratigraphic studies. These studies have demonstrated multiple Holocene events on several strands of the Cucamonga fault and a minimum slip rate of 4.5 mm/yr. Two studies on the central and eastern portions of the Sierra Madre fault zone have indicated that recurrence intervals between large events (M greater than or equal to 7) seem to be long (perhaps 7–

	8 k.y. or longer). The slip rate on the Sierra Madre fault appears to be considerably less than the Cucamonga fault, perhaps as low as 1 mm/yr or less. Studies on the San Fernando fault zone indicate a somewhat shorter recurrence interval of perhaps as much as 4,000 yr. The Santa Susana fault is less well understood, but has been inferred to have a slip rate greater than 5 mm/yr. **Sections:** This fault has 8 sections. The Santa Susana, San Fernando, Sierra Madre and Cucamonga fault zones are four basic units of this fault zone. Santa Susana, itself, has been divided structurally into three parts (Yeats, 1987 #6113; Yeats and others, 1994 #6114, see discussion of section 105a) but is treated here as one section. The Sierra Madre fault zone, along with the San Fernando fault zone, has been divided into three to seven elements. Segmentation of the Sierra Madre fault has been proposed based on the identification of several, convex-to-the-south, "salients" (Proctor and others, 1972 #6100; Ehlig, 1975 #6088; Wesnousky, 1986 #5305; Petersen and Wesnousky, 1994 #5962). However, it has not been demonstrated that rupture would be restricted to an individual segment in an earthquake. Sierra Madre segment A (Wesnousky, 1986 #5305) is not considered by Crook and others (1987 #5956) as part of the Sierra Madre fault zone, but rather is called the Vasquez Creek fault (after Miller, 1928 #5961), a southern branch of the San Gabriel fault. Segments B through E of Wesnousky (1986 #5305) after Proctor and others (1972 #6100) and Ehlig (1975 #6088) are retained in this compilation as sections. Morton and Matti (1987 #6099) discuss possible segmentation of the Cucamonga fault zone (but it is treated here as one section). Walls and others (1997 #6110) suggest at least two and possibly three segments for the San Fernando-Sierra Madre-Cucamonga fault zone (San Fernando, Sierra Madre and Cucamonga) based on differing uplift rates. In support of a lesser number of segments, Tucker and Dolan (2001 #6107) suggest that the entire Sierra Madre section, from Altadena to San Dimas, may rupture in single events.
Name comments	**General:** **Section:** The Santa Susana fault was named by Kew (1924 #6014). Yeats (1987 #6113) and Yeats and others (1994 #6114) include three subsections separated by lateral ramps near Gillibrand Canyon and San Fernando. Although Yeats and others (1994 #6114) term these parts "segments" there is little evidence that they are seismogenically separate, and the fault zone is treated here as one section. This section extends westward from

	near the south-dipping Oak Ridge fault [94] to the northern part of the Sylmar Basin, overlapping to some extent the San Fernando section [105b] of the Sierra Madre fault zone. The fault zone includes the Olive View and North Olive View faults at its eastern end (Proctor and others, 1972 #6100). **Fault ID:** Refers to numbers 344 (Santa Susana fault), 355 (unnamed faults), 356 (San Fernando fault), 357 (Sierra Madre fault), 385 (Clamshell and Sawpit Canyon faults), 395 (Duarte fault), and 399 (Cucamonga fault) of Jennings (1994 #2878). Also refers to numbers 68 (Santa Susana fault), 69 (San Fernando fault), 83 (Sierra Madre fault), 84 (Duarte fault), 85 (Clamshell-Sawpit fault zone), and 86 (Cucamonga fault) of Ziony and Yerkes (1985 #5931).
County(s) and State(s)	VENTURA COUNTY, CALIFORNIA LOS ANGELES COUNTY, CALIFORNIA
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Poor Compiled at 1:750,000 scale. *Comments:* Western traces taken from 1:750,000 map of Jennings (1994 #2878). Eastern traces are well located and were transferred by inspection from 1:18,000 map by Barrows and others (1975 #6082).
Geologic setting	Sierra Madre fault zone, within the eastern part of the Transverse Ranges, refers to the entire 125-km-long complex zone of mechanically related thrust and reverse faults that grossly demarcate the base of the San Gabriel Mountains from San Fernando Pass on the west to Cajon Pass on the east, and also includes the Santa Susana fault to the west (Ehlig, 1975 #6088; Crook and others, 1987 #5956; Morton and Matti, 1987 #6099; Yeats, 1987 #6113). Reverse slip on this fault zone has contributed to the 2–3 km elevation of the mountain range (Walls, 2001 #6109).
Length (km)	This section is 35 km of a total fault length of 128 km.
Average strike	N89°W (for section) versus N86°W (for whole fault)
Sense of movement	Reverse

	Comments: Ziony and Yerkes (1985 #5931) describe fault as reverse, left-oblique
Dip	85° N. *Comments:* Ziony and Yerkes (1985 #5931) describe near-surface dips of 0–30° and 55–-60° N. at depth; Shields (1978 #6102) describes dip at depth to 85°.
Paleoseismology studies	Site 105-6, Tapo Canyon: 12 excavations included exposure of Tertiary bedrock faulted over Quaternary terrace deposits, but both overlain by unfaulted fan deposits that were considered older than nearby alluvium 14C-dated at 10,101±580 yr BP (Lung and Weick, 1987 #6096).
Geomorphic expression	Poorly expressed due to the low angle of the fault and widespread landsliding. Topographic contrasts may have as much to do with juxtaposition of contrasting lithologies as with fault displacement.
Age of faulted surficial deposits	Late-Quaternary older alluvium and terrace deposits; Pleistocene Saugus Formation and Tertiary units (Lung and Weick, 1987 #6096; Yeats, 1987 #6113).
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* possibly Pico Canyon 1893 (Yeats, 1987 #6113); some surface rupture in 1971 (including seismicity on San Fernando lateral ramp) although oil-well casings were not sheared (Ziony and Yerkes, 1985 #5931; Yeats, 1987 #6113); western portion of fault shows no evidence of surface displacement "in at least 10,010±580 yr" (Lung and Weick, 1987 #6096).
Recurrence interval	
Slip-rate category	Greater than 5.0 mm/yr *Comments:* Working Group on California Earthquake Probabilities (1995 #4945) expressed a preferred rate of 6.2±0.5 mm/yr, apparently based on the work of Huftile (1992 #6092); Yeats (1987 #6113) suggested 8 mm/yr based on displacement of

	the late Pleistocene Saugus Formation. Slip rate assigned to the Santa Suzanna fault by Petersen and others (1996 #4860) for probabilistic seismic hazard assessment for the State of California was 5.0 mm/yr (with minimum and maximum assigned slip rates of 3.0 mm/yr and 7.0 mm/yr, respectively).
Date and Compiler(s)	2000 Jerome A. Treiman, California Geological Survey
References	#6080 Arnold, R., and Strong, A.M., 1905, Some crystalline rocks of the San Gabriel Mountains, California: Geological Society of America Bulletin, v. 16, p. 183-204. #6082 Barrows, A.G., Kahle, J.E., Saul, R.B., and Weber, F.H., Jr., 1975, Geologic map of the San Fernando earthquake area, *in* Oakeshott, G.B., ed., San Fernando, California, earthquake of 9 February 1971:California Division of Mines and Geology Bulletin 196, Pl. 2, scale 1:18,000. #5956 Crook, R., Jr., Allen, C.R., Kamb, B., Payne, C.M., and Proctor, R.J., 1987, Quaternary geology and seismic hazard of the Sierra Madre and associated faults, western San Gabriel Mountains, *in* Recent reverse faulting in the Transverse Ranges, California: U.S. Geological Survey Professional Paper 1339, p. 27–63, scale 1:24,000. #6088 Ehlig, P.L., 1975, Chapter 2-Geologic framework of the San Gabriel Mountains, *in* Oakeshott, G.B., ed., San Fernando, California, earthquake of 9 February 1971:California Division of Mines and Geology Bulletin 196, p. 7-18. #6092 Huftile, G.J., 1992, Convergence rates across the Ventura Basin, California: Corvalis, Oregon State University, Ph.D. dissertation, 279 p. #6093 Jahns, R.H., and Proctor, R.J., 1975, The San Gabriel and Santa Susana—Sierra Madre fault zones in the western and central San Gabriel Mountains, southern California: Geological Society of America Abstracts With Programs, v. 7, no. 3, p. 329. #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.

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