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Calaveras fault zone, Central Calaveras fault section (Class A) No. 54b

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Compiled in cooperation with the California Geological Survey

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Synopsis	**General:** Historically active major dextral strike-slip fault that is part of the larger San Andreas fault system. The fault zone extends for about 150 km from the San Ramon area southeast to about 30 km south of Hollister. The fault has a complex linkage to the San Andreas fault zone [1] along the subparallel Paicines fault, herein considered to be the southernmost part of the Calaveras fault zone. In general, the Calaveras fault zone is expressed as numerous strands that form a zone tens of meters to more than 500 m in width (1982 #5521). Locally the Paicines fault is expressed as a zone as much as 2 km wide. Various

segmentation models have been proposed by Simpson and others (1992 #5527), Taylor (1992 #5531), Petersen and others (1996 #4860), Working Group on Northern California Earthquake Potential (1996 #1216), and Kelson and others (1998 #5518). In this compilation the fault is divided into 4 sections: from north to south they are the Northern Calaveras [54a], Central Calaveras [54b], Southern Calaveras [54c], and Paicines [54d] sections. There is a distinct change in slip rate and fault behavior north and south of the vicinity of Calaveras Reservoir. North of Calaveras Reservoir, the fault [54a] is characterized by a slip rate of 5–6 mm/yr (Kelson and others, 1996 #5284; Simpson and others, 1999 #5528), sparse seismicity, and it probably ruptures to the surface in moderate to large earthquakes based on interpretation of trench exposures by Kelson and others (1996 #5284) and Simpson and others (1999 #5528). South of Calaveras Reservoir, the fault zone [section 54b] is characterized by historic surface fault creep of as much as 15 mm/yr near the southern end of the central Calaveras fault (Galehouse and Lienkaemper, personal commun. reported in Kelson and others, 1998 #5518). The preferred late Holocene slip rate is 14±5 mm/yr (Kelson and others, 1998 #5518) for the central part of the Calaveras fault [54b]. No slip rates have been reported for the southern part of the Calaveras fault [54c], but historic surface fault creep rates of 4–12 mm/yr have been reported in the Hollister area (Schulz, 1989 #5526; Galehouse, 1999 #5500). The Paicines fault [54d] locally has evidence of historic fault creep at about 5 mm/yr (Harsh and Burford, 1982 #5323), although a partial Holocene dextral slip rate of 9 mm/yr was reported by Perkins and Sims (1988 #5522). An average recurrence interval of between 125 and 850 years was determined for the northern part of the Calaveras fault [54a] (Kelson and others, 1996 #5284; Simpson and others, 1999 #5528). Kelson and others (1998 #5518) reported a preliminary recurrence interval estimate of about 530 yrs for the central part of the Calaveras fault [54b]. No recurrence intervals have been determined for the southern part of the Calaveras fault [54c] and the Paicines [54d] fault. The central part of the Calaveras fault has had two moderate magnitude historical earthquakes (Mw 5.8 1979 Coyote Lake; Mw 6.3 1984 Morgan Hill) associated with minor surface fault rupture (Armstrong, 1979 #5501; Harms and others, 1984 #5511; Hart, 1984 #5517). A moderate magnitude earthquake may have occurred along the northern Calaveras fault in July 1861 according to Rogers and Halliday (1992 #5523) as suggested by a zone of cracking as much as 13 km long. Alternatively, the area where the cracking was reported is

	characterized by large-scale landsliding and the fractures could be interpreted as secondary shaking or landsliding rather than primary surface fault rupture. **Sections:** This fault has 4 sections. There is insufficient data to document seismogenic segments. Petersen and others (1996 #4860) and the Working Group on Northern California Earthquake Potential (1996 #1216) proposed two segments for the Calaveras fault: a northern segment from Calaveras Reservoir north to the San Ramon area, and a southern segment from Calaveras Reservoir to south of Hollister. Taylor (1992 #5531) previously had proposed a similar segmentation model. Simpson and others (1992 #5527), proposed that the Calaveras fault north of the Calaveras Reservoir could be divided into three shorter segments: the Sunol segment, the San Ramon segment, and the Alamo segment. The Working Group on Northern California Earthquake Potential (1996 #1216) also considered these segments as comprising the Northern Calaveras fault. More recently, Kelson and others (1998 #5518) divided the Calaveras fault zone into 3 sections: the Northern Calaveras fault (Danville to Calaveras Reservoir), the Central Calaveras fault (Calaveras Reservoir to San Felipe Lake), and the Southern Calaveras (San Felipe Lake to just south of Hollister). The section boundaries described by Kelson and others (1998 #5518) are adopted for this compilation with the addition of a fourth section south of Hollister that comprises the Paicines fault. The Paicines section extends from the vicinity of the junction of the San Benito River and Tres Pinos Creek south to the vicinity of Stone Canyon. Thus, from north to south the sections are Northern Calaveras [54a], Central Calaveras [54b], Southern Calaveras [54c], and Paicines [54d].
Name comments	**General:** The Calaveras fault zone was first mapped, but not named, by Lawson (1908 #4969). Wood (1916 #5259) named the structure the Sunol fault. This name was used until about 1951, when Crittenden (1951 #5509) used the combined name Sunol-Calaveras fault. The simpler name Calaveras fault is preferred herein. **Section:** Named by Kelson and others (1998 #5518). The Central Calaveras section extends from Calaveras Reservoir southeast to San Felipe Lake and is characterized by as much as 15 mm/yr of fault creep (Galehouse and Lienkaemper, personal commun. in Kelson and others, 1998 #5518).

	Fault ID: Refers to number 227 (Paicines fault) of Jennings (1994 #2878) and numbers C1, C2, C2a, and C2b of Working Group on Northern California Earthquake Potential (1996 #1216).
County(s) and State(s)	ALAMEDA COUNTY, CALIFORNIA SANTA CLARA COUNTY, CALIFORNIA
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location based on digital revisions to Jennings (1994 #2878) using original mapping by Bryant (1981 #5504; 1981 #5505), Dibblee (1972 #5479; 1973 #4827; 1973 #5480), Radbruch-Hall (1974 #1243), Williams and others (1973 #5533), and Smith (1981 #5530) at 1:24,000 scale and original mapping by Wagner (1978 #5532) and Armstrong and Wagner (1978 #5502) at 1:12,000 scale.
Geologic setting	Major dextral strike-slip fault zone of the larger San Andreas fault system. The Calaveras fault zone is located in the eastern San Francisco Bay region and generally trends along the eastern side of the East Bay Hills, bounds the western side of San Ramon Valley, extends into the western Diablo Range, bounds the eastern side of Santa Clara Valley, extends into Hollister Valley, and eventually joins the San Andreas fault zone [1] along the eastern part of the Gabilan Range. The northern extent of the fault zone is somewhat conjectural. One theory is that the fault zone transfers slip to the Concord fault zone [38] in a right-releasing step-over (Oppenheimer and MacGregor-Scott, 1992 #5520; Working Group on Northern California Earthquake Probabilities, 1996 #1216). Alternatively, the slip may continue northward along reverse and dextral-reverse faults in the East Bay Hills (Page, 1982 #5521). Page (1982 #5521) estimated that cumulative late Cenozoic dextral offset is about 20±4 km. Sarna-Wojcicki (1992 #5265) reported about 13±7 km of cumulative dextral offset in the past 6 m.y. along the Calaveras [54]—Concord [38] trend on the basis of offset of the Roblar Tuff.
Length (km)	This section is 64 km of a total fault length of 156 km.
Average strike	N31°W (for section) versus N31°W (for whole fault)
Sense of	Right lateral

movement	*Comments:* Geomorphic expression, stream channel offsets, and fault creep displacement document predominantly dextral strike-slip displacement (Radbruch-Hall, 1974 #1243; Bryant, 1981 #5504; 1981 #5505; Smith, 1981 #5530; Galehouse, 1999 #5500) on this section. Studies by Kelson and others (1998 #5518) document late Holocene dextral strike-slip displacement at San Ysidro Creek. The 1979 Coyote Lake and 1984 Morgan Hill earthquakes were associated with minor dextral strike-slip displacement (Armstrong, 1979 #5501; Hart, 1984 #5517).
Dip Direction	V *Comments:* Trench exposures at San Ysidro Creek (Kelson and others, 1998 #5518) show near vertical faults in unconsolidated alluvium and poorly consolidated bedrock.
Paleoseismology studies	There is one detailed study for the Central Calaveras section at San Ysidro Creek (site 54-3). A study by Kelson and others (1998 #5518) involved detailed geomorphic mapping, excavation of three fault normal and two fault parallel trenches, and dating of offset fluvial deposits at the San Ysidro Creek site. Kelson and others (1998 #5518) identified as many as four paleoearthquake events along the Central Calaveras section, calculated a late Holocene slip rate, and derived a preliminary average recurrence interval for this section of the Calaveras fault zone.
Geomorphic expression	The Central Calaveras section is marked by geomorphic features characteristic of dextral strike-slip displacement, such as dextrally deflected and offset stream channels and ridges, linear troughs and swales, closed depressions, aligned saddles, linear sidehill benches, linear scarps, beheaded drainages, shutter ridges, aligned saddles, and ponded alluvium (Radbruch-Hall, 1974 #1243; Bryant, 1981 #5504; 1981 #5505; Smith, 1981 #5530).
Age of faulted surficial deposits	Kelson and others (1998 #5518) reported that late Holocene fluvial deposits are offset along the Central Calaveras fault (section) at San Ysidro Creek. These fluvial deposits range in age from 4.1±0.2 ka to 2.5±0.2 ka based on radiocarbon dating of detrital charcoal.
Historic earthquake	

Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Kelson and others (1998 #5518) documented late Holocene displacement along the Central Calaveras section, but reported that there were no data for the most recent earthquake.
Recurrence interval	 *Comments:* Kelson and others (1998 #5518) reported a preliminary recurrence interval of about 530 years for large surface-rupturing events, but this is based on preliminary assumptions of slip behavior and depositional models for the fault at the San Ysidro Creek.
Slip-rate category	Greater than 5.0 mm/yr *Comments:* Kelson and others (1998 #5518) reported a preferred late Holocene horizontal displacement rate of 14±5 mm/yr for the Central Calaveras section at the San Ysidro Creek. East of the fault, San Ysidro Creek has cut a relatively confined channel in moderately to poorly indurated claystone and interbedded sandstone and siltstone of the Pliocene-Pleistocene Santa Clara Formation. Four paleochannels incised into rocks of the Santa Clara Formation are dextrally offset on the west side of the fault. The oldest channel (4.1±0.2 ka, based on radiocarbon dating of detrital charcoal) is dextrally offset 45 m, and the youngest channel (2.5±0.2 ka) is dextrally offset 37 m. Clark (1988 #5508) estimated a maximum dextral displacement rate of about 15 mm/yr based on about 550 m dextral offset of stream terraces in San Felipe Creek. Clark (1988 #5508) assumed that drainage gaps on the northwestern and southeastern sides of the fault originally were aligned at the time of deposition of stream terraces (about 38.4 ka based on radiocarbon dating of detrital charcoal).
Date and Compiler(s)	1999 William A. Bryant, California Geological Survey Sereyna E. Cluett, California Geological Survey
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