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Calaveras fault zone, Paicines section (Class A) No. 54d

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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:** The Paicines section, first mapped and named the Paicines fault by Wilson (1943 #5534), extends from near the junction of the San Benito River and Tres Pinos Creek southeast to near Stone Canyon. The zone of faulting may extend farther southeast along the trend of the San Benito fault as mapped by Wilson (1943 #5534), but this extension of the fault has not been

	evaluated for recency of activity. In addition, Wilson reported that the San Benito fault was primarily a northeast-dipping thrust fault that did not offset rocks of the Pliocene-Pleistocene San Benito Formation. **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)	SAN BENITO 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 (1985 #4803) and Dibblee (1979 #4834; 1979 #4835; 1979 #5510) at 1:24,000 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 26 km of a total fault length of 156 km.
Average strike	N41°W (for section) versus N31°W (for whole fault)

Sense of movement	Right lateral *Comments:* The Paicines section is marked by geomorphic features characteristic of dextral strike-slip displacement (Bryant, 1985 #4803). Paleoseismic investigation by Perkins and Sims (1988 #5522) documented latest Pleistocene and Holocene dextral strike-slip offset. The fault is characterized by historic, dextral surface fault creep (Harsh and Pavoni, 1978 #5513; Bryant, 1985 #4803).
Dip Direction	V
Paleoseismology studies	There is one detailed study along the Paicines section at the Winfield Ranch (site 54-1) where Perkins and Sims (1988 #5522) excavated at least one trench across traces of the Paicines fault. Faulted latest Pleistocene and Holocene terrace deposits were exposed and a partial Holocene slip rate was calculated.
Geomorphic expression	The Paicines section is marked by geomorphic features characteristic of Holocene dextral strike-slip offset, such as dextrally deflected and offset stream channels, side-hill benches, linear troughs, dextrally offset terrace risers and ridges, linear scarps on alluvium, linear ridges, closed depressions, and beheaded drainages (Bryant, 1985 #4803).
Age of faulted surficial deposits	The Paicines fault zone offsets deposits of latest Pleistocene to Holocene age. Harms and others (1987 #5512) reported that terrace deposits offset by the Paicines fault were as young as 2 ka, based on soil development.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The timing of the most recent event has not been determined. Geomorphic features exist in late Pleistocene and Holocene alluvium along traces of the Paicines fault zone and evidence of historic fault creep is locally recognized.
Recurrence interval	
Slip-rate category	Greater than 5.0 mm/yr

	Comments: Perkins and Sims (1988 #5522) reported a preferred slip rate of about 9 mm/yr along a strand of the Paicines fault at the Winfield Ranch (site 54-1}. This rate is based on 125±15 m of dextral offset of a terrace riser associated with the San Benito River. Radiocarbon dates from detrital charcoal yield time estimates of 13.9 ka for formation of the terrace riser. The Paicines fault in the vicinity of the Winfield Ranch site consists of three principal branches that form a 2.1-km-wide zone. Therefore, Perkins and Sims (1988 #5522) determination of 9 mm/yr is a partial rate for this section. Perkins and Sims (1988 #5522) and Sims (1991 #5529) estimated that the total slip rate for the Southern Calaveras section is about 15–20 mm/yr just north of Hollister.
Date and Compiler(s)	1999 William A. Bryant, California Geological Survey Sereyna E. Cluett, California Geological Survey
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