1998 SCEC Annual Report

Timing of the Past Two earthquakes Near Frazier Mountain, Midway Between Pallet Creek and the Carrizo Plain, Southern California

Thomas Rockwell and Timothy Dawson, San Diego State University

Scott Lindvall, William Lettis and Associates

Introduction

The Frazier Mountain site represents the most promising new paleoseismic study site found to date along the San Andreas fault in an area that currently lacks a robust record of prehistoric earthquakes. The primary purpose of this project is to establish a paleoseismic record for this part of the San Andreas fault and compare our results to those obtained at Pallet Creek (Sieh, 1978; Sieh, 1984; Sieh et al., 1989) and the Carrizo Plain (Grant and Sieh, 1994). Such data can be used to better understand the behavior of the San Andreas fault in this area, and address questions such as: 1.) Does the San Andreas fault typically fail in large 1857-type earthquakes or can the segments to the north and south fail independently of one another? and 2.) Did the 1812 earthquake rupture extend as far north as Frazier Mountain?

We report preliminary results of paleoseismic investigations near Frazier Mountain, located about halfway between Pallet Creek and the Carrizo Plain (Figure 1). At the site, a minor right step in the San Andreas fault has formed a closed depression, which has been further enhanced by a small alluvial fan that blocks the drainage outflow (Figure 2). The main strand of the fault bisects the sag, with other strands bounding the northern margin of the sag. This central strand is expressed at the surface by a 30-cm-high scarp, as a vegetation lineament, and a pronounced ground water barrier. We believe that the central scarp formed during the 1857 Fort Tejon earthquake.

Results of 1998 Work

This year's work, a continuation of work that began in the fall of 1997 (see our 1997 Annual Report), was hindered by the record amount of precipitation brought by the 1997-1998 El Nino weather pattern. Our work was delayed by the fact that over the winter the closed depression at the site had filled with water to a maximum depth of ~1.25 meters. Consequently, for most of our field season we were forced to concentrate our efforts on dewatering. Dewatering operations consisted of building a siphon to passively remove the surface water, as well as actively removing the water using a gasoline powered pump. While we were successful at removing the surface water, we could not remove the groundwater and were unable to re-open and extend our original trench as we had planned this year.

This year we also surveyed the site using a total station and constructed a detailed map of the site topography (Figure 2). This was necessary since future excavations and drainage trenches will likely disturb existing geomorphic features, necessitating the documentation of pre-study geomorphology.

Most importantly, we obtained radiocarbon dates from samples collected in our 1997 trench to obtain an age range for the timing of the penultimate event. Nearly 50 samples were collected for radiocarbon dating of which 8 were submitted for AMS and conventional dating. Six of the

samples from units above, below, and within the event horizon (Unit 5) share similar dates, with calendar ages between 1400-1650 AD (2σ) (Table 1) (Figure 3). One of the samples was recovered from an *in situ* burn layer, and another was a fragile, charcoalized twig: we contend that reworking of older detrital charcoal is unlikely and that these dates accurately portray the age of the event horizon. Thus, the penultimate event at Frazier Mountain probably occurred between 1400-1650 AD.

Based on the radiocarbon dates obtained, the penultimate event at the Frazier Mountain site may correlate with a similar aged event at the Bidart site in the Carrizo Plain to the north, as well as event V at the Pallet Creek site to the south (Sieh et al., 1989). Grant and Sieh (1994) dated the penultimate event at Bidart to have most likely occurred between 1405-1510 AD. These new data support the idea that the San Andreas fault may have failed in prior 1857-type earthquakes. Alternatively, the penultimate event observed at Frazier Mountain may be related to event V at Pallet Creek or the penultimate event at Bidart, but not both together. This is suggested by Biasi and Weldon (1998) who, using Baysian statistics for refining layer and event dates, date event V at Pallet Creek to have occurred between 1546-1615 AD. We believe that high precision dating will eventually allow us to better constrain the age of the penultimate event at Frazier Mountain, and help address the question of whether the penultimate event at Frazier Mountain is related to event V at Pallet Creek, the penultimate event at Bidart, or if they are indeed the same event.

Our results to date show no evidence that the 1812 earthquake extended as far north as Frazier Mountain, although paleoseismic evidence for this event may not have been exposed in our original trench. Future excavations at the site will further address this issue as we will eventually excavate across more strands of the fault where paleoseismic evidence for the 1812 earthquake may exist.

References

Biasi, G., and Weldon, R.J., 1998, Paleoseismic date refinement and implications for seismic hazard estimation: in Sowers, J.M., Noller, J.S., and Lettis, W.R. (eds.), Dating and Earthquakes: Review of Quaternary Geochronology and its application to Paleoseismology, p. 3-61 - 3-66.

Grant, L.B., Sieh, K., 1994, Paleoseismic evidence of clustered earthquakes on the San Andreas fault in Carrizo Plain, California: Journal of Geophysical Research, v. 99, p. 6819-6841.

Sieh, K.E., 1978, Prehistoric large earthquakes produced by slip on the San Andreas Fault at Pallet Creek, California: Journal of Geophysical Research, v. 83, p. 3907-3939.

Sieh, K.E., 1984, Lateral offsets and revised dates of large prehistoric earthquakes at Pallet Creek, southern California: Journal of Geophysical Research, v. 89, no. B9, p.7641-7670.

Sieh, K.E., Stuiver, M., and Brillinger, D., 1989, A more precise chronology of earthquakes produced by the San Andreas fault in southern California: Journal of Geophysical Research, v. 94, p. 603-623.

Table 1.

Frazier Mountain ^{14}C dates.

Stratigraphic Unit	Sample Number	Laboratory Number	$\delta^{13}C$ (%)	^{14}C age (^{13}C corrected) B.P. $\pm 1\sigma$	Calibrated Age	Remarks
4	C-41	AA 28795	-25.0 [1]	395±45	1434-1639 AD	Detrital charcoal
5	C-19	AA 28792	-24.6	340±50	1458-1651 AD	Detrital charcoal
5	C-28	AA 9990	-24.7	490±55	1310-1354 AD 1385-1515 AD 1592-1621 AD	Log
6	C-4	AA 28790	-25.2	415±40	1429-1525 AD 1558-1631 AD	Burn layer
7	C-12	AA 28791	-25.0	400±45	1435-1529 AD 1541-1634 AD	Detrital charcoal (twig)
7	C-24	AA 28794	-24.3	405±40	1434-1527 AD 1553-1633 AD	Detrital charcoal
9	C-3	AA 28789	-24.1	465±45	1400-1514 AD 1594-1620 AD	Detrital charcoal
12	C-21	AA 28793	-22.8	160±40	1667-1789 AD 1791-1824 AD 1827-1887 AD 1909-1951 AD 1952-1955 AD	Organic unit

[1] Sample too small, assume $\delta^{13}C$ of -25.0

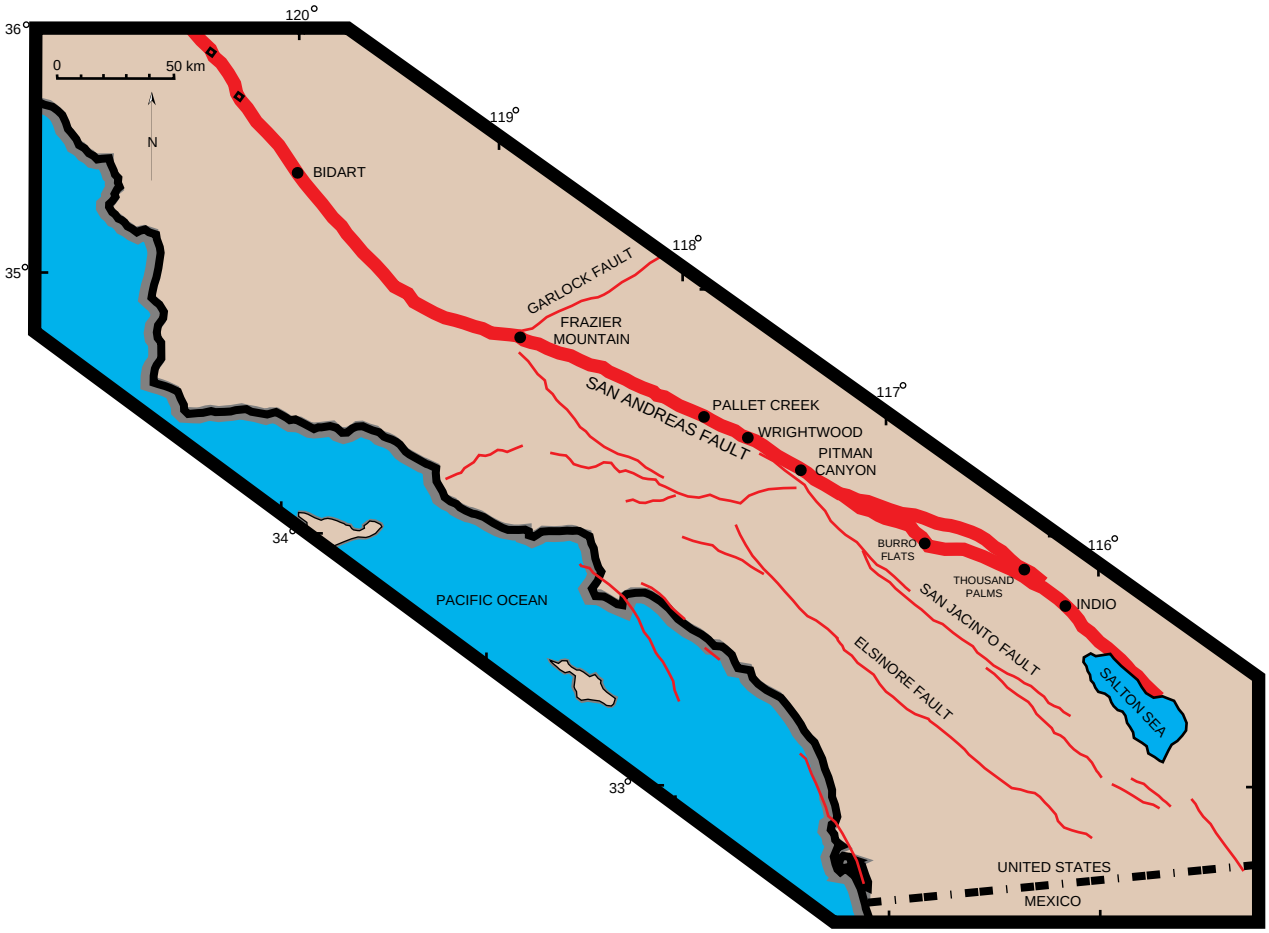
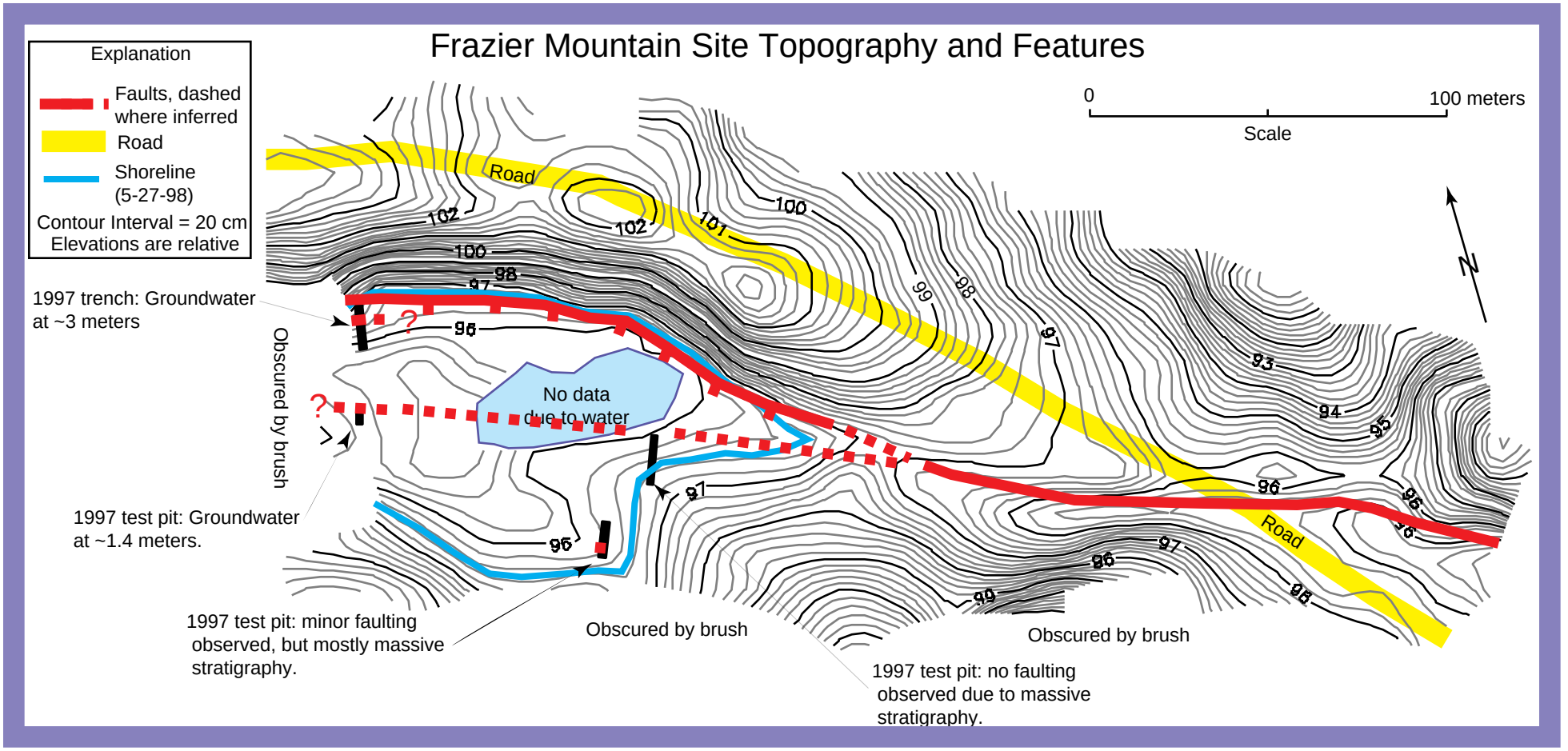


Figure 1. Location of the Frazier Mountain paleoseismic site and other paleoseismic sites along the San Andreas fault with event data.


Frazier Mountain Site Topography and Features
Explanation
Faults, dashed where inferred
Road
Shoreline (5-27-98)
Contour Interval = 20 cm
Elevations are relative
0
100 meters
Scale
N
Road
Road
1997 trench: Groundwater at ~3 meters
Obscured by brush
No data due to water
1997 test pit: Groundwater at ~1.4 meters.
1997 test pit: minor faulting observed, but mostly massive stratigraphy.
Obscured by brush
Obscured by brush
1997 test pit: no faulting observed due to massive stratigraphy.

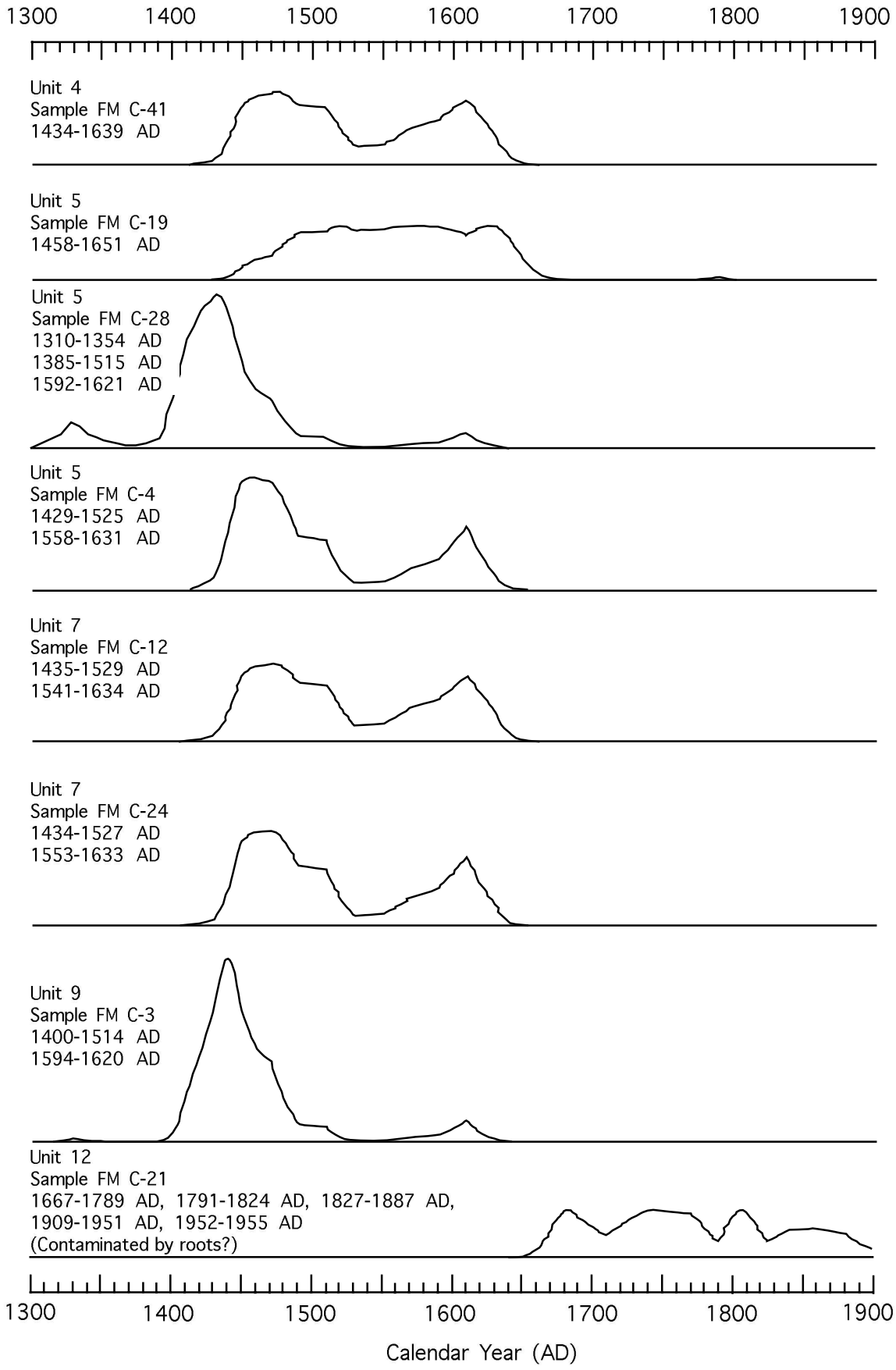


Figure 3. Probability density functions of calibrated radiocarbon dates of detrital charcoal from Trench 1 at Frazier Mountain.