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Paleoseismic Studies of the San Andreas Fault in the San Bernardino Area
Sally McGill
California State University, San Bernardino

I report here results from paleoseismic studies of the San Andreas fault at City Creek and near Plunge Creek. Both sites are located just east of San Bernardino, California

New Results from the City Creek site:

At the City Creek site, a distinctive set of sand and silt layers was offset along four faults. Several radiocarbon dates constrain the age of this event to between AD 1020 and 1260. The four faults are capped by layers that are clearly unfaulted, so it is clear that no younger events have occurred on these strands. However, the projection of the main strand of the fault from air photos intersects the trench within a younger, bouldery channel. Thus, younger events may have occurred within the main fault zone, but the evidence has been destroyed by the incision and filling of the younger channel.

New Results from Trench 7:

During 1998 I received the radiocarbon dating results for samples that I had previously collected from Trench 7 at the Plunge Creek site (Table 1 and Figure 1). After examining these results, I then requested additional radiocarbon analyses on the two charcoal samples that most tightly bracket the earthquake horizon. The additional analyses significantly reduced the error in the ages, and the earthquake horizon is now constrained to be between AD 1440 and AD 1640.

Because the earthquake horizon was located just beneath a bench in the trench, I removed the bench, by having the lower tier of the trench cut back until it was even with the upper tier, and also removed the top part of the upper tier for safety. Safaa Dergham, a SCEC intern, logged both the final exposure of the lower tier and an intermediate exposure. Both of these exposures confirmed the Event A earthquake horizon and also revealed limited evidence for an older event (Event B). Event B immediately post-dates deposition of unit E, which is constrained to be between AD 1235-1410 on the basis of a radiocarbon date on charcoal collected from the original exposure of Trench 7.

Discussion:

The most surprising thing about these results is that there is no evidence for earthquakes younger than AD 1640 at Plunge Creek. Not only is there no evidence for the AD 1812 earthquake that is known to have ruptured the San Andreas fault in Wrightwood (Jacoby and others, 1988), but there is also no evidence for the event that occurred around AD ~1700 at both Wrightwood and Pitman Canyon (Fumal and others, 1993; Seitz and others, 1995). This raises the question: has it really been over 350 years since the most recent earthquake on the San Andreas fault in San Bernardino?

The relationships exposed in Trench 7 are not sufficient to determine whether or not the AD 1440-1640 earthquake is the most recent earthquake that has occurred on the San Andreas fault at Plunge Creek. The portion of Trench 7 that is shown in Figures 1 does not span the entire width of the fault zone. Figure 2 shows that there is also a zone of massive colluvium separating early Holocene alluvium from the latest Holocene alluvium that was shown in Figures 1. This massive zone may be fault-scarp colluvium from an old scarp along the main fault strand. There are no visible faults within the massive colluvium, but it is possible that faults have ruptured this colluvium but are not visible because there is no stratigraphy to show the offset. For this reason,

we can not rule out the possibility that one or more earthquakes have ruptured higher in the stratigraphic section than the AD 1440-1640 event. However, if younger event(s) have occurred, the width of their rupture(s) is constrained to lie within this 1-m wide zone of massive colluvium.

Work in Progress at Plunge Creek:

Our next step was to dig a new trench at a location where young, well stratified sediments span the entire width of the fault zone. We dug Trench 8 recently, on another young fan on the same property. This trench was logged by Safaa Dergham as part of her master's thesis at California State University, Long Beach. Trench 8 has good stratigraphy that spans the entire width of the fault zone and is clearly unfaulted in the top 1.5 m of trench (Figure 3). This indicates that at least 1.5 m of sediment have been deposited since the most recent earthquake at Plunge Creek. On the basis of previous trenching at this site (Suitt, 1992) we are confident that Trench 8 spans the entire width of the fault zone. The projection of the fault from Suitt's Trench 4 intersects the middle of Trench 8. Therefore, the unfaulted sediments in the upper 1.5 meters of Trench 8 were certainly deposited after the most recent earthquake. Radiocarbon dates on the charcoal samples that we have collected from some of the lowest layers that are clearly unfaulted will provide a minimum estimate for the age of the most recent earthquake on this part of the fault. If the radiocarbon age can be determined precisely enough, we may be able to determine whether or not the AD 1812 earthquake rupture extended this far to the southeast.

Unfortunately the stratigraphy in the lower 1.5 m of the trench is less continuous due to bioturbation. Although there is no clear evidence for faulting, the lack of continuous stratigraphy makes it difficult to rule out the possibility of faulting in the lower half of the trench.

Conclusions:

Our work at City Creek and Plunge Creek has begun to fill in the gap in paleoseismic data between Pitman Canyon and Thousand Palms (Figure 4). The most intriguing result is that so far we have found no evidence for the AD ~1700 or AD 1812 earthquakes in the middle part of the San Bernardino segment of the San Andreas fault. We can't yet prove that these earthquakes didn't rupture this portion of the fault, but additional work at Trench 8 should help to resolve this question.

References:

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- Sieh, K. E., Stuiver, M., and Brillinger, D., 1989, A more precise chronology of earthquakes produced by the San Andreas fault in southern California: *J. Geophys. Research*, v. 94, p. 603-623.
- Suitt, S. C., 1992, Feasibility-level geological investigation, 45-acre East Highland parcel, San Bernardino County, California.
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List of New SCEC-supported Publications:

- McGill, Sally F. and Charles M. Rubin, Surficial slip distribution on the central Emerson fault during the June 28, 1992, Landers earthquake, California, *Journal of Geophysical Research*, v. 104, in press. (Will appear in

January 1999 issue).

McGill, Sally F., Dawn Grant, Safaa Dergham, Steven C. Suitt, Ann Meeker and Stephen G. Wells, Prehistoric earthquakes on the San Andreas fault , San Bernardino, California, *EOS, Trans. Am. Geophys. Union*, v. 79, no. 45, p. F611, 1998.

See 1998 Proposal for older SCEC-supported publications.

Table 1: Radiocarbon dates from the Plunge Creek site

Sample	Depth (m)	Unit	Conventional C-14 age, B.P.	Calibrated age
51	1.5	K	308 ± 68	AD 1445-1680, or AD 1758-1804, or AD 1938-1954
53	1.5	K	387 ± 67	AD 1415-1655
55	1.9	Ch	377 ± 40	AD 1441-1643
*****Event A earthquake horizon*****				
29	2.0	G	373 ± 46	AD 1439-1648
26	2.0	G	484 ± 68	AD 1315-1348, or AD 1391- 1517, or AD 1587-1623
21	2.2	F3	405 ± 67	AD 1422-1643
*****Event B earthquake horizon*****				
54	2.6	E	678 ± 67	AD 1235-1410

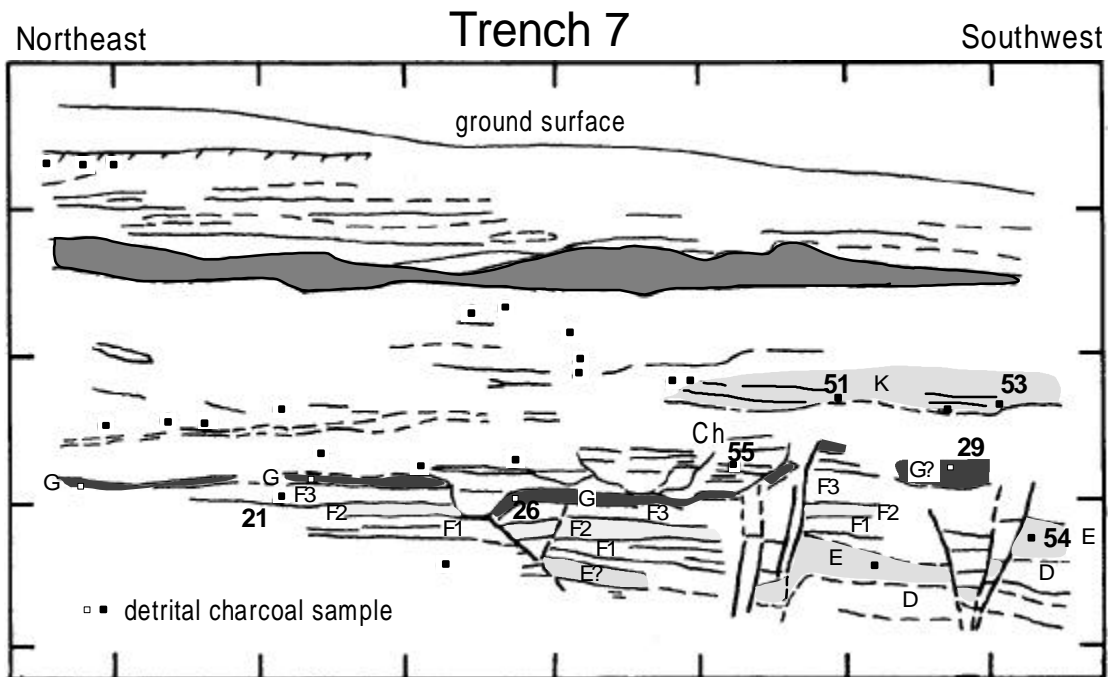


Figure 1: Log of the original exposure of trench 7, showing a paleoearthquake horizon between layers G and K. Bedding within layer F is clearly faulted, and layer G also appears to be faulted. The basal contact of layer K is clearly unfaulted. Tick marks are 1 meter apart. Sample numbers are shown for charcoal samples that have been dated (see table 1 for ages).

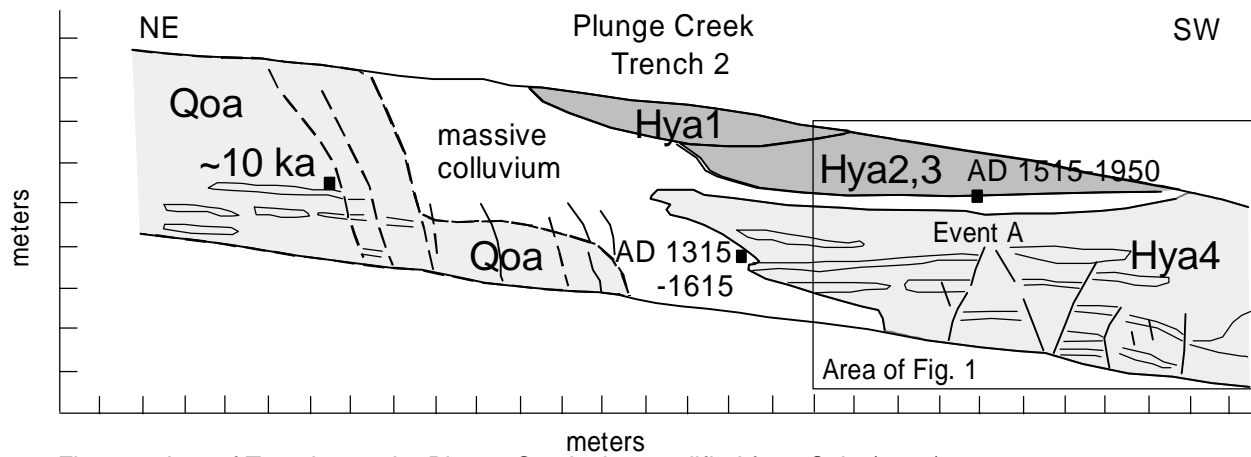


Figure 2: Log of Trench 2 at the Plunge Creek site, modified from Suitt (1992).

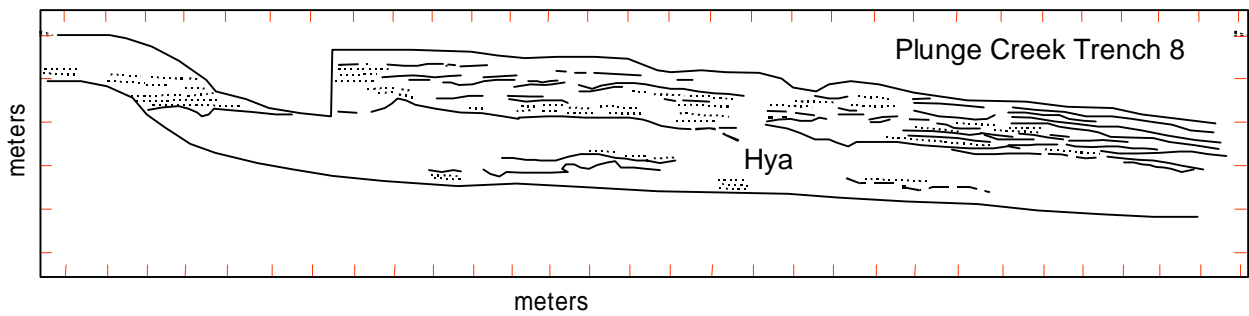


Figure 3: Log of Trench 8 at the Plunge Creek site.

Southern San Andreas Fault: Possible Event Correlations

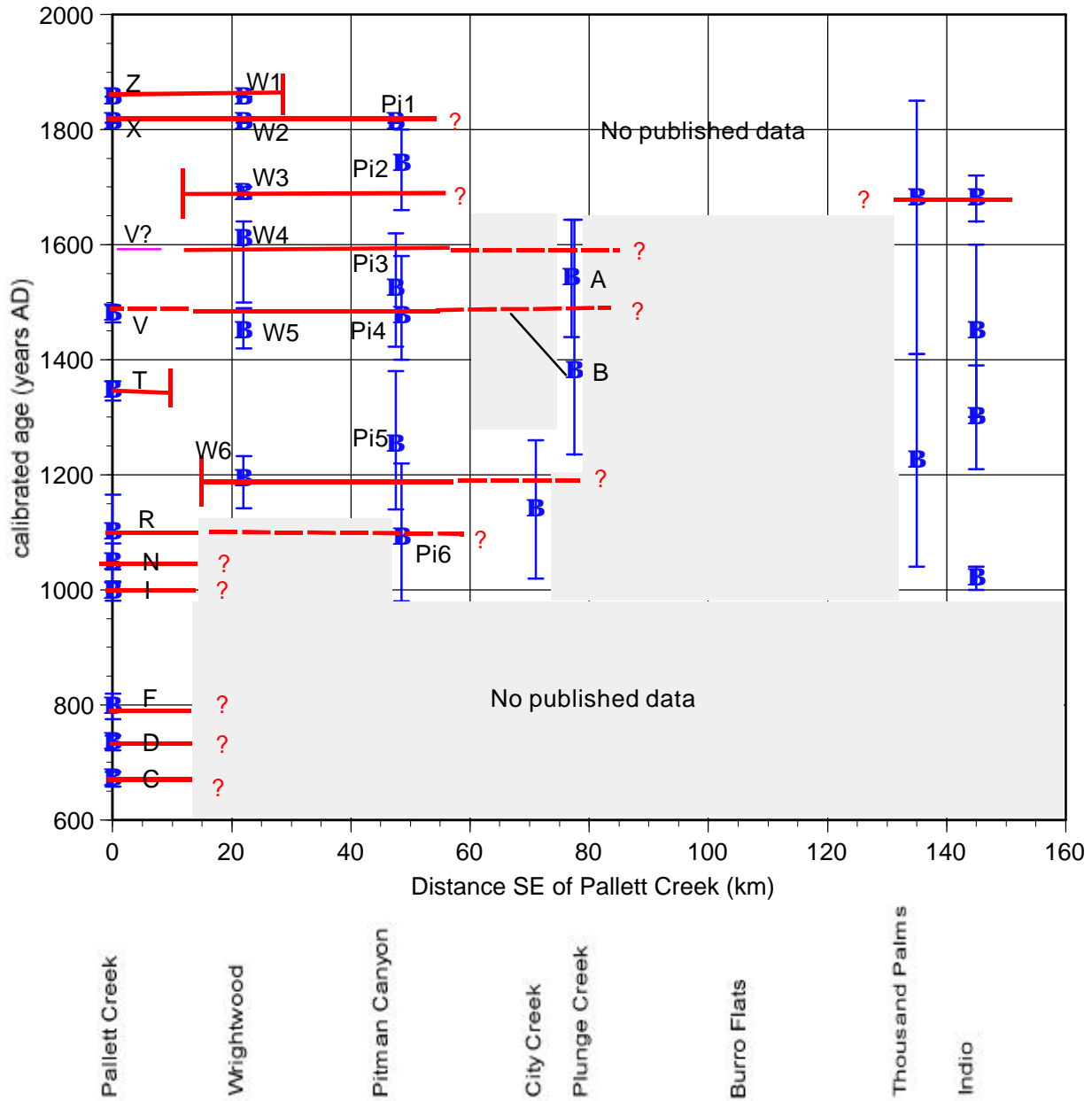


Figure 4: Summary of paleoseismic data for the southern San Andreas fault. One possible correlation of events is shown. Other correlations are also possible. Data from Sieh et al., 1989; Fumal et al., 1993; Seitz et al., 1996; McGill et al., 1998; Rymer and Fumal, 1996; Sieh, 1986.