

## Annual Report 2000

### **Paleoseismology of the San Andreas fault at Plunge Creek, near San Bernardino, southern California**

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We have examined and documented several trenches across the south branch of the San Andreas fault at the Plunge Creek site, near San Bernardino, southern California. Stephen C. Suitt (1992) documented the first five trenches at this site for the purpose of locating active fault strands. We have re-excavated two of Suitt's trenches (T2/T7 and T4) and have also excavated four new trenches (T6, T8, T9 and T10) for the purpose of documenting and dating prehistoric earthquake horizons (Figure 1). During the year 2000, trench 9 was excavated and logged, a deeper level of trench 4 was logged, and trench 10 was excavated. Results from trench 8 were presented at the Cordilleran Section of the Geological Society of America Meeting in 2000 (Dergham and McGill, 2000), and results from the entire site will be presented this year (McGill and Dergham, 2001; Barton and others, 2001). Results from the entire site will also be published in a field trip guidebook for the 2001 Cordilleran Section Geological Society of America Meeting, and will be submitted for publication in a special issue of the Bulletin of the Seismological Society of America on paleoseismology of the San Andreas fault.

A 16- to 2-m wide fault zone is located about 19- to 33-m south of the mountain front in trenches 8, 4 and 9, along strike from the main fault zone within trenches 1-3, 5, and 6 (Figure 1). At this time it is unclear whether or not this represents the entire width of the recently active South Branch San Andreas fault zone, or whether additional fault strands might be located along the mountain front within massive areas at the northern ends of trenches 8 and 4, and north of the northern end of trench 9. If there is a fault at the northern ends of trenches 4 and 8 and north of trench 9, it would either have to end between trenches 8 and 10 or it would have to step southward, west of trench 8, to the main fault zone in trenches 1-3, and 6, which is located south of the mountain front. Trench 10 appears to rule out a westward continuation of any potential fault at the northern ends of trenches 4 and 8, at least within the period of time since the deposition of the (as yet undated) sediments within trench 10.

Stratigraphic relationships and calibrated radiocarbon dates from trenches 7, 8, 4 and 9 all support the occurrence of an earthquake large enough to produce surficial fault rupture on the South Branch of the San Andreas fault between (or shortly after) about AD 1440-1680 (figures 2 and 3). More specifically, the age of the most recent, visible faulting event is about AD 1443-1676 in trench 7, AD 1225-1629 in trench 9, AD 987-1647 in trench 4, and AD 1411-1638 in trench 8. Additional dates from T4 and T9 may tighten the older bound on the most recent earthquake in those two trenches. Assuming that the youngest visible earthquake in all four trenches was the same event, we can constrain the age of that event to be the narrowest subset of the allowable date ranges from all four trenches combined, which is AD 1443-1629. A total of 52 detrital charcoal samples from the trenches have been dated so far, sixteen of these are from the strata that most closely overlie the youngest visible faulting event in trenches 7, 8, 4 and 9. All of the dates on detrital charcoal samples represent maximum ages for the layers from which they were collected. Therefore, the younger bound on the earthquake horizon is not as certain as the

older bound, even though we have only used the youngest samples from each layer to establish that younger bound.

Given the potential lag time between the ages of the charcoal samples and the ages of the layers from which they were collected, the AD 1443-1629 faulting event that is visible in trenches 7, 8, 4 and 9 at Plunge Creek could be the same as the AD 1680-1700 event at Wrightwood and Pitman Canyon (Fumal and others, 1993; Seitz and Weldon, 1994; Seitz, Weldon and Biasi, 1997). Alternatively, this faulting event at Plunge Creek could be the same as either the ~AD1600 or ~AD1480 earthquakes at Wrightwood and Pitman Canyon. It seems extremely unlikely to us that this event could be the AD 1812 event.

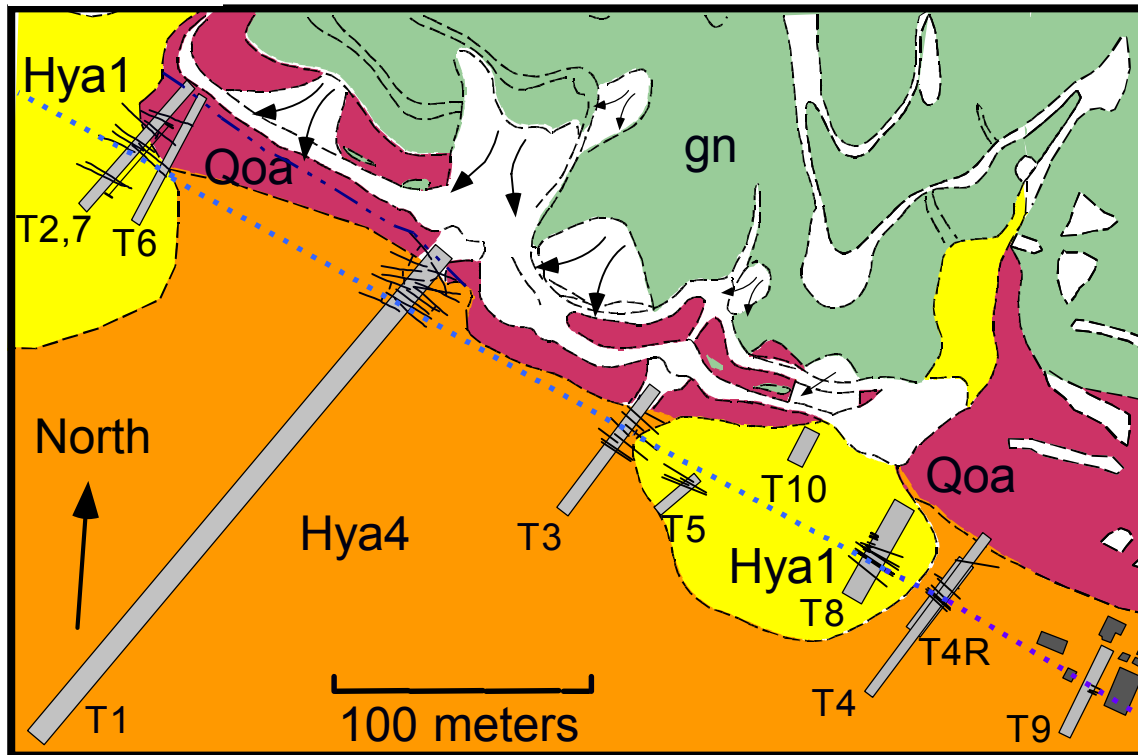
Nonetheless, we can not entirely rule out the possibility that the AD 1812 earthquake ruptured the South Branch of the San Andreas fault at Plunge Creek. In most of the trenches there are one or more zones in which the lack of stratified deposits makes it impossible to rule out the possibility that additional fault strands may be present that may rupture higher in the stratigraphic section than the youngest *visible* earthquake horizon. However, if our interpretation of the radiocarbon dates is correct, the AD 1812 earthquake can only have ruptured through the Plunge Creek site if its rupture was confined to the 1-m-wide massive zone in the middle of trench 7, and it then stepped left (northward) to the mountain front in the vicinity of trench 8. Although this rupture geometry is certainly possible, the lack of any evidence for faulted sediments with ages as young as AD 1812 suggests to us that the simplest interpretation of the existing data from the Plunge Creek site is that the AD 1812 earthquake rupture did not extend as far southeast as Plunge Creek.

### **Education and Outreach:**

Safaa Dergham logged and interpreted trench 8 for her master's thesis. The following undergraduate students assisted with the logging of trenches 7, 4 and 9: Kathy Barton, Todd Berney-Ficklin, Dawn Grant, Constance Hartling, Karen Hobart, Mario Rodriguez, Joanna Russell, Kelly Schmoker, Jennifer Townsend and Jeff Williams.

### **References** (\* denotes works published during the past year as a result of our SCEC funded research)

- \*Barton, K., Berney-Ficklin, T., Hartling, C., Hobart, L., McGill, S., Rodriguez, M., Russell, J., and Stumfall, M., Paleoseismic Studies on the San Andreas Fault in Trench 9 at the Plunge Creek Site, San Bernardino, southern California, *Geological Society of America, Cordilleran Section meeting, Abstracts with Programs*, v. 33, no. 6, in press.
- \*Dergham, S. and S. McGill, 2000, Paleoseismic investigation of the San Andreas fault at Plunge Creek, near San Bernardino, California: Four to five centuries of strain accumulation since the most recent earthquake, *Geological Society of America, Cordilleran Section meeting, Abstracts with Programs*, v. 32, no. 6, p. A10.
- Fumal, T. E., Pezzopane, S. K., Weldon, R. J., II, and Schwartz, D. P., 1993, A 100-year average recurrence interval for the San Andreas fault at Wrightwood, California: *Science*, v. 259, p. 199-203.
- \*McGill, S. F., and S. A. Dergham, 2001, Paleoseismic studies of the San Andreas fault at the Plunge Creek site, near San Bernardino, California, *Geological Society of America, Cordilleran Section meeting, Abstracts with Programs*, v. 33, no. 6, in press.
- Seitz, G. and Weldon, R., II, 1994, The paleoseismology of the southern San Andreas fault at Pitman Canyon, San Bernardino, California, in McGill, S. F. and Ross, T. R., eds., *Geological Investigations of an Active Margin*, Geological Society of America, Cordilleran Section Guidebook: San Bernardino County Museum Association, pp. 152-156.
- Sietz, G., Weldon, R., II, and Biasi, G. P., 1997, The Pitman Canyon paleoseismic record: A re-evaluation of the southern San Andreas fault segmentation, *J. Geodynamics*, v. 24, nos. 1-4, pp. 129-138.
- Suitt, S. C., 1992, Feasibility-level Geological Investigation, 45-Acre East Highland Parcel, San Bernardino County, California, 18 pp.



- ..... Line that passes through each trench at the location of the most prominent fault within that trench.
- . - . - . Topographic break-in-slope at the base of the mountain front (shown only where it diverges from the Qoa/Hya contact)
- Selected buildings

Figure 1: Geologic map of the Plunge Creek site, modified from Suitt (1992). gn, gneiss; Qoa, latest Pleistocene and early Holocene alluvium; Hya4, latest Holocene, flood plain deposits from Oak Creek, and colluvium; Hya1, latest Holocene alluvial fan deposits. Unshaded areas are landslides and artificial fill. Location and orientation of faults exposed within the trenches is shown. T4R is our re-excavation of Suitt's T4. T7 is our re-excavation of Suitt's T2.

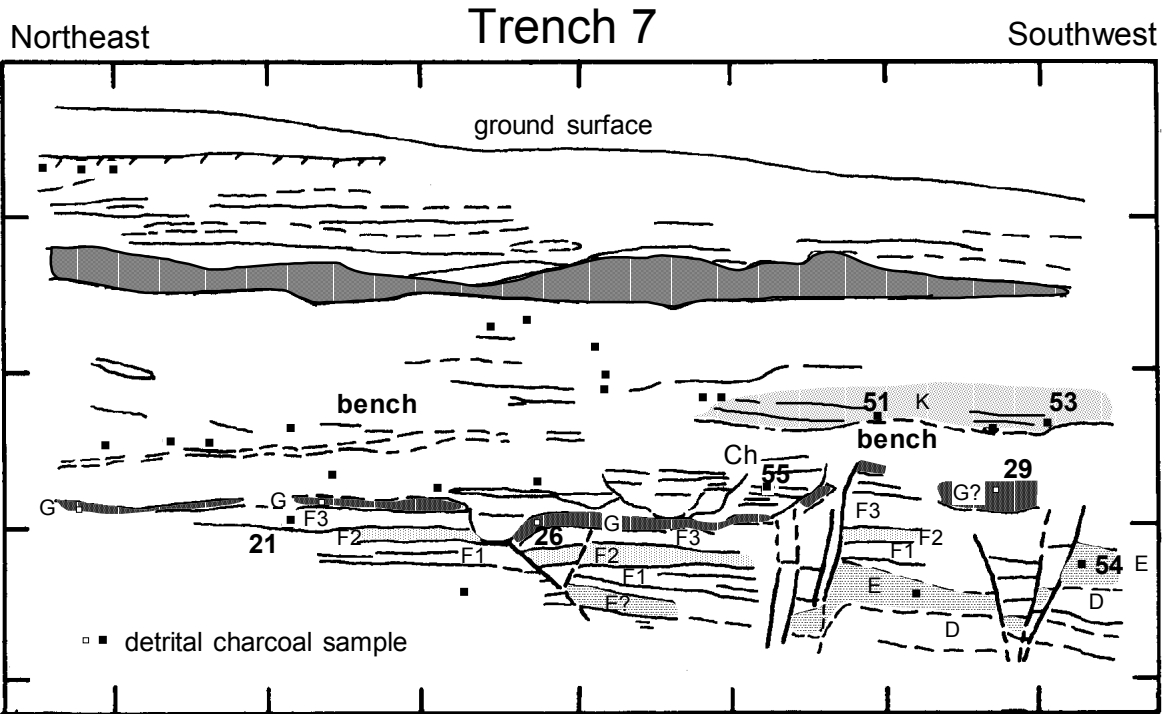


Figure 2: Log of a portion of the original exposure of trench 7 (re-excavation of a portion of Suitt's (1992) trench 2), showing a paleoearthquake horizon between layers G and K. Bedding within layer F is clearly faulted, and layer G also appears to be faulted. The basal contact of layer K is clearly unfaulted. Tick marks are 1 meter apart. Sample numbers are shown for charcoal samples that have been dated.

**Table 1. Dates from Trench 7**

Sample #	Lab #	Conventional radiocarbon age (years BP)	$\delta^{13}\text{C}$	Calibrated age ranges (AD)	Relative probability of age range
PC-7E-51	R24064/2B	308 ± 68	-24.5	1441 1676	94.5%
				1763 1774	0.8%
				1775 1802	4.0%
				1938 1946	0.7%
PC-7E-53	R24064/7	387 ± 67	-26.5	1427 1643	100.0%
PC-7E-55	2R4064/9	377 ± 40	-24.7	1441 1530	56.2%
				1546 1635	43.8%
***** Earthquake Horizon *****					
PC-7E-29	R24064/6	372 ± 46	-24.8	1443 1533	51.7%
				1540 1636	48.3%
PC-7E-26	R24064/5A	484 ± 68	-24.7	1302 1369	16.0%
				1382 1522	76.2%
				1572 1627	7.8%
PC-7E-21	R24064/8	405 ± 67	-25.1	1418 1638	100.0%
PC-7E-54	924064/4	678 ± 67	-21.9	1223 1230	1.2%
				1238 1407	98.8%

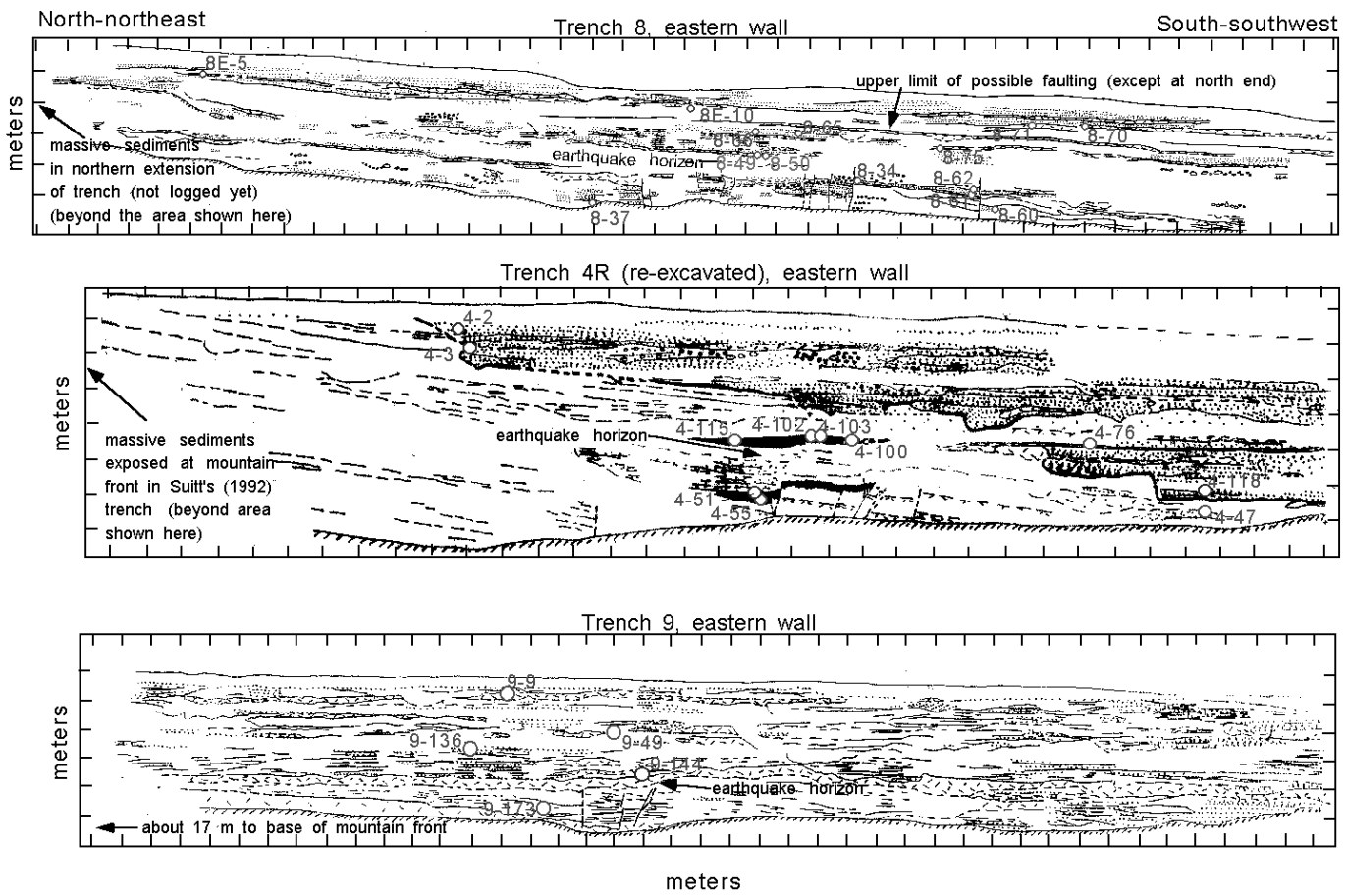


Figure 3: Simplified cross-sections along the eastern walls of trenches 8, 4 and 9.