Annual Project Summary

Paleoseismic Investigation of the Simi fault, Ventura County, California

Program Element: I and II
Key words: Neotectonics, Paleoseismology, Trench Investigations

U.S. Geological Survey
National Hazard Reduction Program

Award Number 99-HQ-GR-0094

Christopher S. Hitchcock[1], Scott C. Lindvall[2], Jerome A. Treiman[3], Kristin D. Weaver[2], John G. Helms[2], and William R. Lettis[1]

[1]William Lettis & Associates, Inc.
1777 Botelho Drive, Suite 262
Walnut Creek, California 94596
phone: (925) 256-6070; fax: (925) 256-6076
e-mail; hitch@lettis.com

[2]William Lettis & Associates, Inc.
25050 Avenue Kearny #108
Valencia, California 91355
phone: (661) 775-4990; fax: (661) 775-4993
e-mail; lindvall@lettis.com

[3]655 S. Hope Street, #700
Los Angeles, CA 90017
phone: (213) 239-0878 fax: (213) 239-0894
Dept. of Conservation, Div. Mines and Geology
e-mail: jtreiman@consrv.ca.gov

NON-TECHNICAL SUMMARY

The Simi fault is a major portion of the Simi-Santa Rosa fault system that extends nearly 40 km from the eastern margin of Ventura County westward through Simi Valley to the Oxnard Plain in southern California. Our studies were designed to better assess the timing of past earthquakes, amount of slip in those earthquakes and the potential earthquake magnitude for this poorly understood fault zone. Results from our earlier study at the Arroyo Simi site demonstrated that the fault is Holocene active. Our ongoing research at this same site, located at the northwest end of Simi Valley, documented that the most recent earthquake occurred between about 1,200 and 5,000 years ago.

INVESTIGATIONS UNDERTAKEN

Our initial 1997 paleoseismic investigation, funded by the Southern California Earthquake Center (SCEC), of a fault exposure of the Simi fault at the Arroyo Simi site in Simi Valley (Figure 1), demonstrated that the Simi fault is Holocene active. This earlier study constrained the timing of the most recent event on the Simi fault between 7666±50 years BP, the age of faulted ponded clay deposits, and 1205±80 years BP, the age of overlying unfaulted colluvium (Hitchcock et al, 1998). Results of our current study include documentation of two additional fault exposures in a new streambank exposure and a fault-perpendicular paleoseismic trench. These new exposures, combined with subsurface borings, provide additional constraints on fault characteristics of the Simi fault.

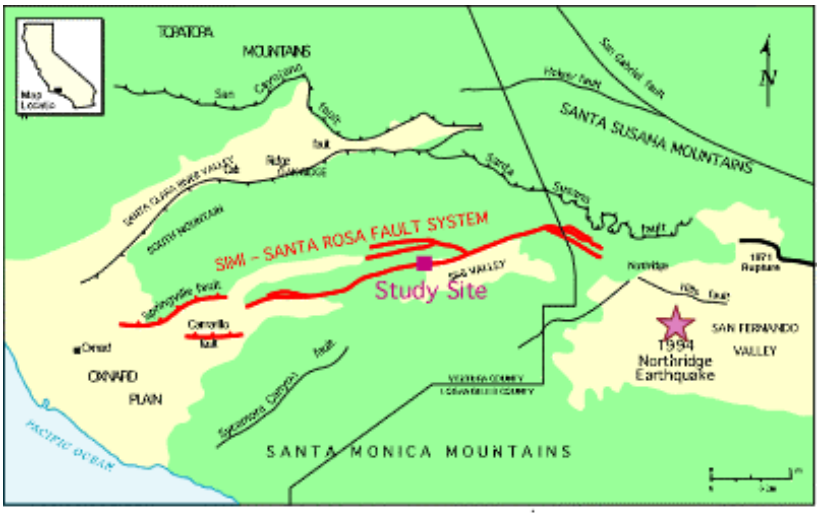

Figure 1. Regional map showing location of the Arroyo Simi study site.

This year, we cleaned and documented a new stream-cut exposure of the Simi fault along the southwest bank of Arroyo Simi. The exposure was cleaned and cut into roughly orthogonal sections for gridding and logging at a scale of 1 in = 0.50 m. We also

conducted limited drilling to constrain the amount of vertical separation of late Pleistocene fluvial deposits across the Simi fault and improve our correlations of stratigraphic units. Seven 24-inch-diameter bucket auger holes were drilled, three within the hanging wall, downstream of the fault, and four within the foot wall, upstream of the fault (Figure 2).

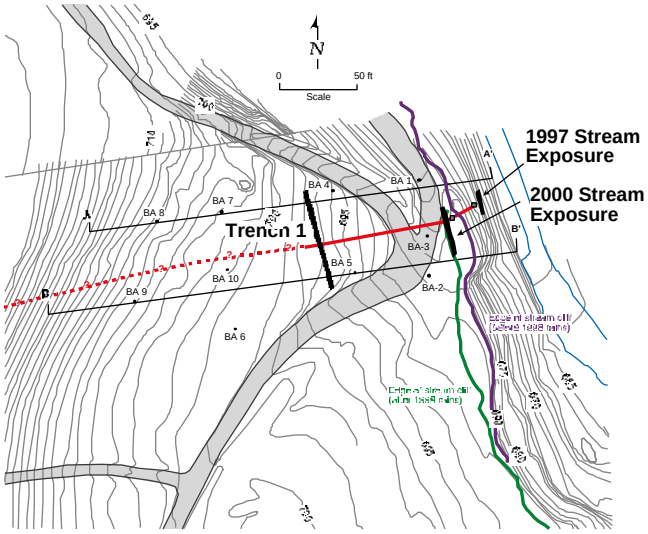

Figure 2. Site map showing location of paleoseismic trench, borings (BA), and stream exposure.

Based on our interpretation of the stream bank exposures and stratigraphic relations revealed by the boreholes, we excavated a fault-perpendicular trench at the Arroyo Simi site in order to document vertical separation of datable horizons across the fault. The trench enabled us to examine sediments covered by colluvium and inset stream terrace deposits within the logged stream bank exposures, thus allowing us to document a more complete event chronology. The ages of deposits at the Arroyo Simi site are estimated based on eleven representive samples of charcoal from the streambank and trench exposures submitted for radiocarbon analysis and four soil profile descriptions.

RESULTS

Results of our paleoseismic investigations provide better constraints on the timing of late Holocene earthquakes on the Simi fault, style of fault deformation, and slip per event. Stream bank and trench excavations reveal a narrow zone of brittle and ductile faulting, at most 3-m-wide, consisting of sub-vertical Holocene-active strands. Warped layers within faulted clay deposits, tilted stratigraphic contacts, and vertical displacement of distinct marker beds document a north-side-up sense of reverse displacement across the

fault. Slickensides on the fault plane show a significant left-lateral component of displacement suggesting that the fault has an overall left-lateral, reverse sense of slip.

In 1998, flooding within Arroyo Simi during an especially wet El Nino winter produced massive erosion of the western stream bank. The 1997 fault exposure that we had previously logged (Hitchcock et al., 1998) was destroyed and near-vertical bank failures exposed a stratigraphically higher geologic section previously obscured by colluvium. We cleaned the vertical face of the stream bank, producing a continuous exposure about four meters high and 12 meters long (Figure 3). The base of this second exposure revealed warped gray-brown to red-brown clay layers similar to those observed at the base of the stream bank in the 1997 exposure. The clay layers, with an age of 6760 to 7240 y.b.p based on radiocarbon analysis, are overlain by gently south-dipping late Holocene fluvial sands and silty sands deposited within an inset stream terrace. These deposits locally contain carbonate nodules, and disseminated carbonate, believed to represent a buried soil. This soil is not preserved on the north side of the fault and appears warped adjacent to the fault. The soil is covered by younger, unfaulted fluvial deposits, likely deposited as during a flood event, that extend to the top of the stream bank exposure.

Our trench excavation, located approximately 90 feet west of the stream bank exposures, exposed gently- to moderately-south-dipping ponded clays and fluvial silts and sands similar to those observed in the arroyo exposures (Figure 4). At the base of the trench, at least five discrete, sub-vertical fault strands have juxtaposed massive ponded clay deposits on the south against red-brown fine- to medium-grained, poorly-sorted clayey sand on the north. Based on correlation between the trench and streambank exposures, we believe the massive clay on the south side of the fault is part of the package of ponded Holocene clay deposits exposed in both streambank exposures. We interpret the clayey sand exposed north of the fault to represent a late Pleistocene soil in which clay has been translocated into a sand. Evidence for Pleistocene age includes the depth of clay laminae, the thickness of argillic horizons, and the volume and depth of translocated clay within the argillic horizons.

These faulted deposits exposed in the trench are overlain by a thin, faulted brown clay layer. Locally, the clay is reddish-brown and contains small-scale flame structures along its upper contact. It is also associated with whitish-gray clayey silt that locally contains fragments of siltstone. The thickness of the unit does not change significantly across the fault strands that cut it, however, it is absent north of the northernmost fault strand (Figure 4). At the southern end of the trench, the thin reddish-brown clay layer is

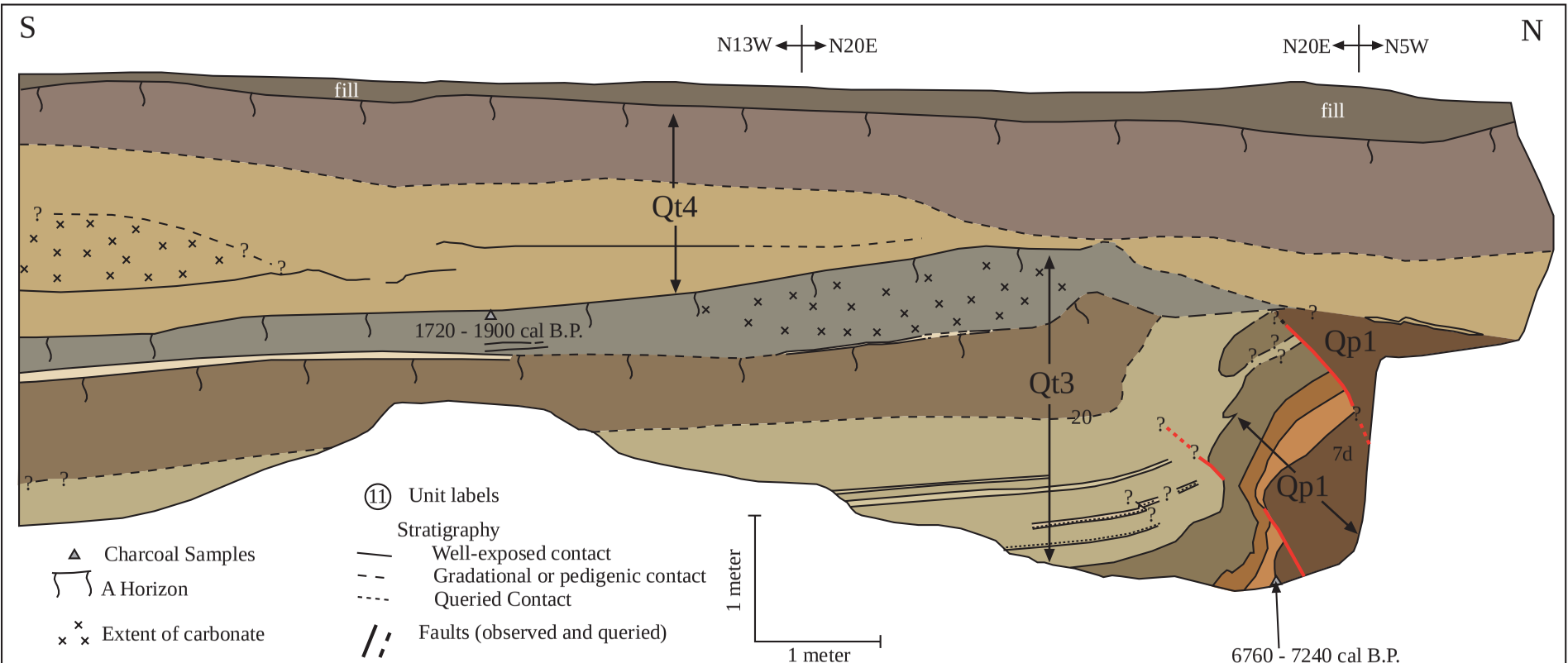

Figure 3. Log of new west streambank exposure of Simi Fault.

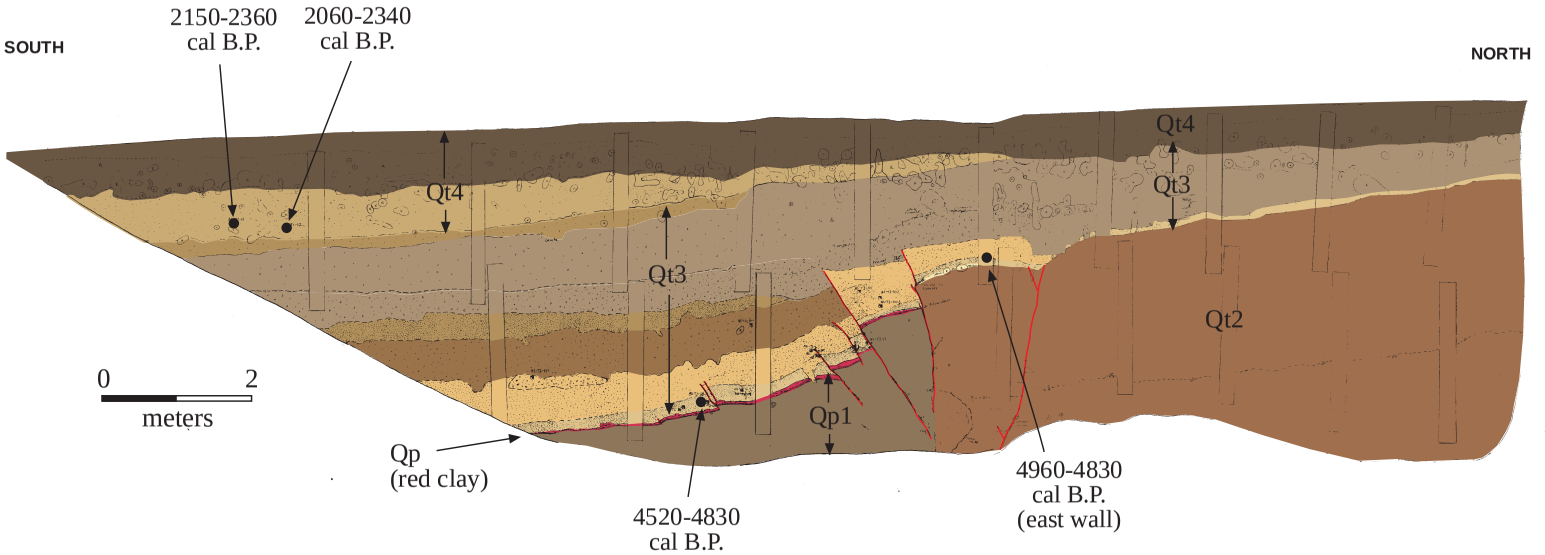

Figure 4. Log of west wall of paleoseismic trench across Simi fault.

overlain by a thick sequence of massive fluvial sands and silty sands. These stream terrace and overbank deposits contain pale yellow to olive brown, moderately to poorly-sorted, massive sand to silty sand with locally coarse-grained sand channels. The upper portions of the fluvial package have been overprinted by at least two episodes of soil development.

The fault zone within the trench consists of five fault splays with a total of 1.1 m of apparent vertical brittle separation of the reddish-brown clay bed. Faults exposed in the trench are thin, discrete planes lacking shear fabric or well developed clay gouge, which suggests that they have seen very few earthquakes, and probably only one or two events.

The most recent event is constrained between about 4520-4830 ybp (age of the faulted sand overlying the reddish-brown clay in the trench) and 1,224-1,324 ybp (age of inset unfaulted fluvial deposits exposed in the first streambank exposure). Reconstruction of the faulted and warped reddish-brown clay marker bed documents 1.4 m of total vertical separation likely associated with the most recent event. This vertical separation and slickensides on the fault plane, documented in the first streambank exposure, are used to calculate a corresponding total displacement of 2.8 m.

TECHNICAL AND NON-TECHNICAL REPORTING

Results of our study will be useful for both deterministic and probabilistic regional and site earthquake hazard characterizations. Target audiences for data derived from this study include the planning and government agencies responsible for earthquake hazards reduction and risk mitigation in the greater Los Angeles Metropolitan area. We anticipate conducting formal and/or informal presentations with local municipalities (e.g., Ventura County, City of Simi Valley, and at USGS-sponsored or other workshops relevant to earthquake hazards). In addition to generating technical and non-technical reports required by the award contract, we anticipate producing a refereed journal article and presenting the results at a major professional society meeting. To ensure that the scientific community will have the opportunity to provide input into our research efforts, we will share our data directly with the U.S. Geological Survey, the California Division of Mines and Geology, and interested university researchers and private consultants.

Data collected for this study includes original borehole logs, trench and stream exposure logs, and digital text and graphic files that will be incorporated in the final NEHRP technical report and peer-reviewed paper. Draft copies of these documents are available in either hard copy format or Microsoft Word and Freehand digital format.

For additional information, please contact:

Scott Lindvall
Senior Geologist
William Lettis & Associates, Inc.
25858 Avenue Kearny #108
Valencia, CA 91355
Phone: (661) 775-4990/ Fax: (661) 775-4993
e-mail: lindvall@lettis.com