U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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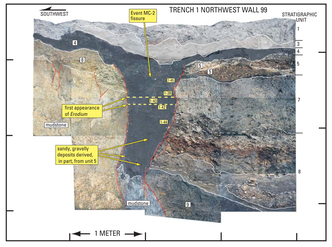
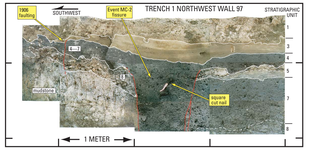
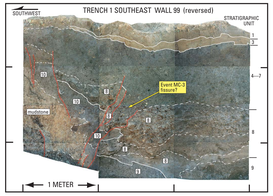
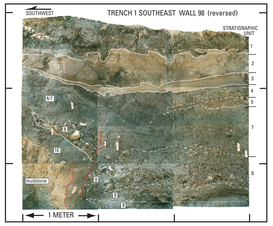
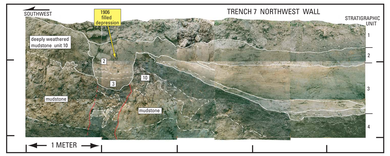
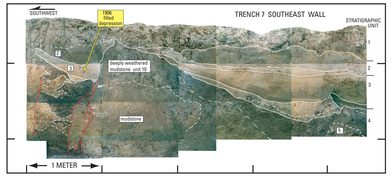


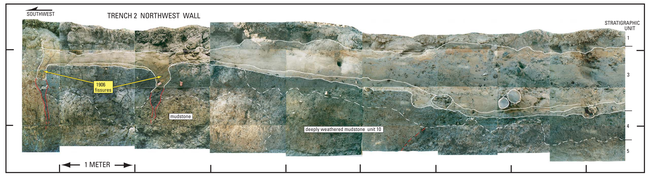


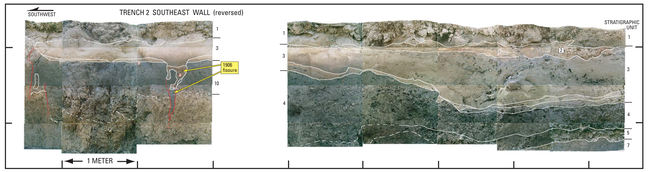












We present photomosaics and logs of the walls of trenches excavated for a paleoseismic study at Mill Canyon, one of two sites along the San Andreas fault in the Santa Cruz Mtns. on the Kelley-Thompson Ranch (Figures 1, 2). This site was a part of Rancho Salsipuedes beginning in 1834. It was purchased by the present owner's family in 1851. Remnants of a cabin/mill operations still exist up the canyon dating from 1908 when the area was logged. At this location, faulting has moved a shutter ridge across the mouth of Mill Canyon ponding Holocene sediment (Figure 3). Recent faulting is confined to a narrow zone near the break in slope.

Methodology

We excavated 7 trenches perpendicular to the fault and 3 trenches parallel to the fault (Fig. 4) in order to resolve evidence for individual surface-rupturing earthquakes. The water table is within 0.5m of the ground surface over the entire site. For this reason we excavated Trench 1 through a low spot in the shutter ridge and connected a trench in bedrock to act as a drain system. Even so, trenches were limited to a maximum depth of 2.5m by the high water table. Trenches 1 and 6 were re-excavated several times and the walls cut back slightly to provide multiple exposures of critical relationships. Both walls of each fault-perpendicular trench and the NW walls of the fault-parallel trenches were photo-logged. For this technique, a 1m-by-0.5m nail and string grid was constructed on the trench walls and each 1m by 0.5m rectangle was photographed with a 35mm film camera fitted with a 20mm rectilinear lens. The camera was mounted on a "Trench-o-matic", a frame constructed of aluminum tubing that acts to keep the film plane parallel to and and equidistant from the trench wall for each photo (Fig. 5). Logging was done on mylar over prints of the photos. Later, the photos were digitized, rectified to the measured string and nail grid visible on each photo, and mosaiced together. Field linework was then transfered to the photomosaics.

The most recent earthquake to cause ground rupture at the site was the 1906 San Francisco earthquake. Post-1906 deposits consist of several layers of well-sorted, graded sand (units 2, 3) capped by a poorly-sorted, gravelly clay loam debris flow (unit 1). Pre-1906 stratigraphy consists of v.dk. grey to black, organic-rich clay loam and clay interbedded with beds of sand and gravel (units 4-9).

We found evidence for four ground-rupturing earthquakes at this site. The 1906 faulting is expressed as a series of left-stepping, en echelon in-filled fissures culminating in a zone of three scarplets each with 10-15 cm of vertical separation. Shortly after the earthquake these scarplets were degraded by rain and/or cattle (Figure 6). We found several old fence posts, bits of glass and numerous animal bones resting on the 1906 ground surface and a piece of flattened metal in one of the fissures. The narrow outlet at the north end of the shutter ridge must have been plugged either as a result of slip or landsliding during the earthquake or shortly after by logging debris as several graded beds of well-sorted sand were deposited in standing water soon after 1906 , filling fissures and preserving the scarplets.

Organic matter is very abundant in all deposits except for unit 8. We obtained 29 AMS 14C determinations from samples of charcoal, sticks, and peat (Table 1). The locations of the samples are indicated on the photomosaics with small yellow boxes.

Acknowledgements

We thank Ed Kelly, Jean Kelly, Colleen Kelly and Tamia Marg-Anderson of the Kelly-Thompson Ranch, Watsonville, California for generously granting access to their property. Radiocarbon analyses were performed by John Southon at the Center for Accelerator Mass Spectrometry (CAMS) at Lawrence Livermore National Laboratory.

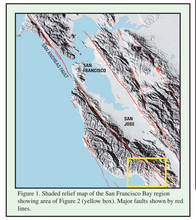


Figure 1. Shaded relief map of the San Francisco Bay region showing area of Figure 2 (yellow box). Major faults shown by red lines.

Figure 2. Perspective view of northern Monterey Bay area showing location of trench sites on the San Andreas fault.

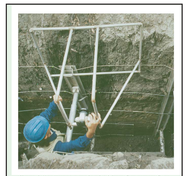


Figure 5. The Trench-o-matic with 35mm-film camera fitted with 20mm rectilinear lens is used to take photos of 1m by 0.5m portions of the trench walls.

Figure 3. View of Mill Canyon site showing shutter ridge and layout of trenches. Stream flows around end of shutter ridge at right edge of photo.

Figure 6. View of 1906 ground surface. Unit 1-3 deposits have been carefully removed to show degraded scarps as they appeared shortly after the earthquake. Degraded scarps involving the top of unit 4 indicate that none of the unit 1-3 deposits were faulted. Scarps can be seen in cross-section on the SE wall of Trench 6.

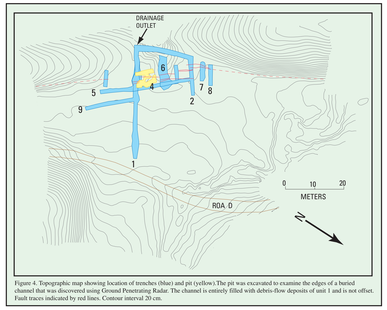
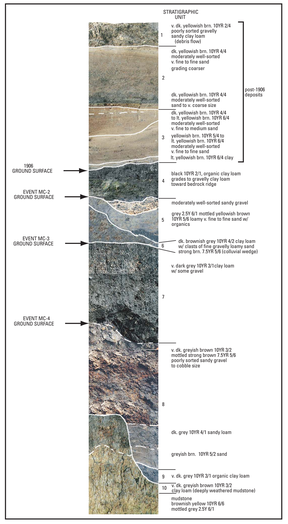
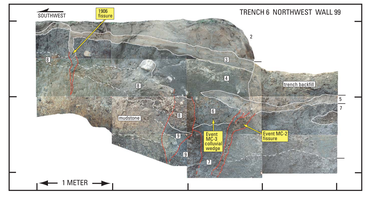


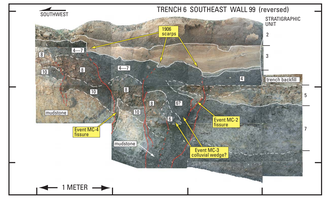
Figure 4. Topographic map showing location of trenches (blue) and pit (yellow).The pit was excavated to examine the edges of a buried channel that was discovered using Ground Penetrating Radar. The channel is entirely filled with debris-flow deposits of unit 1 and is not offset. Fault traces indicated by red lines. Contour interval 20 cm.

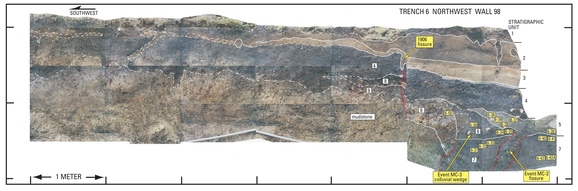
TABLE 1. MILL CANYON RADIOCARBON AGES

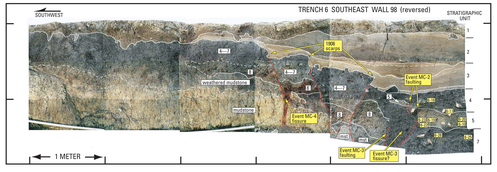
UNIT	SAMPLE #	14C AGE	MATERIAL
4	MC6-11	160±40	charcoal
	MC6-16	190±40	charcoal
	MC1-28	120±40	charcoal
	MC1-45	160±40	charcoal
	MC1-44	190±40	charcoal
	MC1-43	210±40	charcoal
	MC1-42	420±40	charcoal
5	MC6-23	80±40	charcoal
	MC6-2	130±40	charcoal
	MC6-36	150±50	charcoal
	MC6-22	250±40	charcoal
	MC6-38	300±40	charcoal
	MC6-10	340±40	charcoal
	MC6-39	420±50	charcoal
	MC6-37	630±40	charcoal
	MC6-19	890±40	charcoal
6	MC6-35	140±40	charcoal
	MC6-34	330±50	charcoal
	MC6-30	660±50	charcoal
7	MC6-41	90±90	charcoal
	MC6-42	180±50	charcoal
	MC6-42A	220±30	charcoal
	MC6-42A	270±40	charcoal
	MC6-28	340±30	charcoal
	MC6-40	420±40	charcoal
	MC6-33	640±40	charcoal
	MC6-31	710±50	charcoal
	MC6-25	960±60	charcoal
	MC6-32	1220±40	charcoal

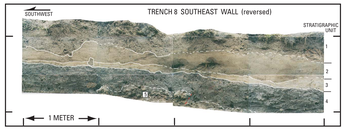


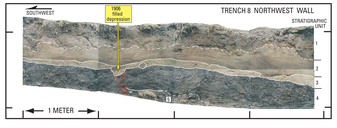


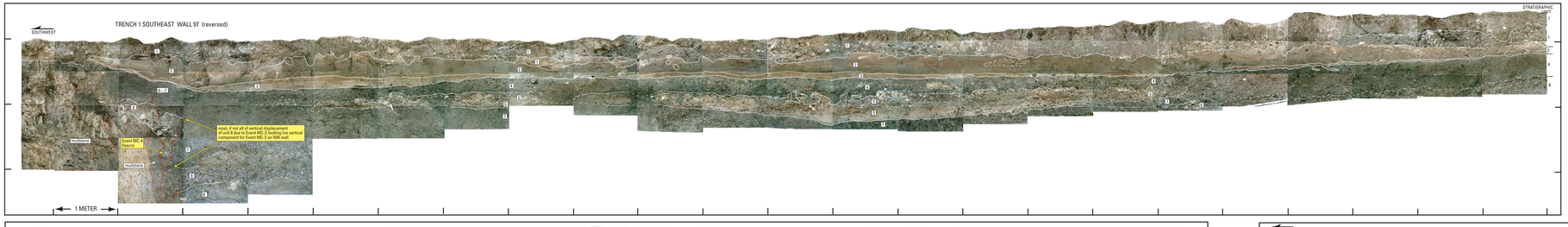


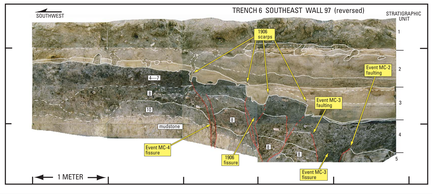


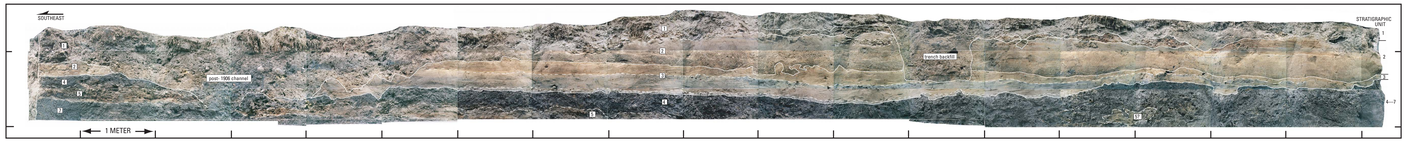


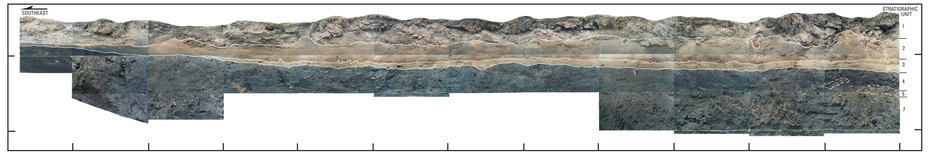












PHOTOMOSAICS AND LOGS OF TRENCHES ON THE SAN ANDREAS FAULT AT MILL CANYON NEAR WATSONVILLE, CALIFORNIA

by

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