Holocene and Latest Pleistocene slip rate of the San Andreas fault in the San Bernardino Valley

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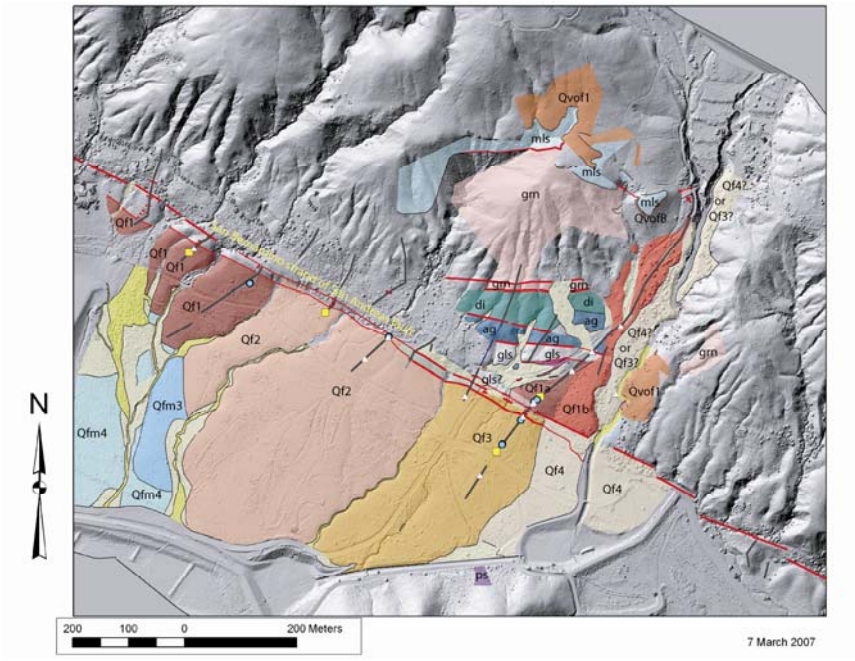
We have used the B4 LiDAR imagery set for our work at two slip-rate sites, at Plunge Creek and at Badger Canyon along the San Bernardino strand of the San Andreas fault, California. The LiDAR data have tremendously aided both the conduct and the presentation of our research. At the Badger Canyon site, I am using the LiDAR imagery as a base map on which to conduct my geologic mapping of the site (Figure 1). This provides a much higher resolution base map than the 1:24,000-scale topographic quadrangle, and has advantages over available aerial photographs in that it is georeferenced and includes accurate and detailed topographic information. At both sites I have also used the LiDAR digital elevation models to construct numerous topographic profiles and detailed topographic maps (with 1-meter or 2-meter contour intervals) that have aided me in interpreting and correlating the stream terraces and alluvial fans that have been offset by the San Andreas fault. Finally, I have used the LiDAR imagery to present the results of our work at the 2006 meetings of the Seismological Society of America and the Southern California Earthquake Center, as well as at other meetings.

At the Badger Canyon site, in San Bernardino, a large alluvial fan complex, containing fans of at least four different ages, has been offset by the San Andreas fault (Figure 1). I examined trenches that were excavated by a consulting firm at this site and was able to document the subsurface stratigraphy and to collect samples for radiocarbon and optically stimulated luminescence dating (currently in progress by Lewis Owen). Katherine Kendrick also described soil profiles on 4 surfaces. The availability of Airborne Laser Swath Mapping (ALSM) data (funded by NSF and conducted by The Ohio State University and U.S. Geological Survey) allowed rapid, accurate measurement of the offsets. The apex of a large alluvial fan (Qf2) has been right-laterally offset about 345-410 meters from Badger Canyon (Figure 1). In addition, the apex of the Qf3 fan appears to be offset about 135 meters, and the riser between the Qf3 and Qf4 fans appears to be offset about 85 meters. Older fan remnants (Qf1) can be brought into alignment by restoring about 690 meters of right-lateral slip. Comparison of the soil profile descriptions from Qf1, Qf2 and Qf3 with dated soils in Cajon Pass, Highland (Plunge Creek), San Timoteo Canyon and Anza, suggest that these fan surfaces are about 30 ka, 12 ka and 4-5 ka, respectively. These very preliminary data suggest slip rates of 23, 29-34 and 30 mm/yr for those three time periods, respectively. These rates are similar to or somewhat higher than the 25-mm/yr rate reported by Weldon and Sieh (1985) to the northwest in Cajon Pass, and are much faster than the 4-18 mm/yr rate estimated to the southeast, at Plunge Creek. It should be noted that the rates estimated for Badger Canyon are very preliminary and may change when the results of pending radiocarbon and optically stimulated luminescence dating become available, and as further work refines the offset estimates and their uncertainties.

At the Plunge Creek site, a truncated channel edge of Plunge Creek is preserved on the southwestern (downstream) side of the fault, and it correlates with a terrace riser on the northeast side of the fault (labeled in yellow in Figure 2). Geologic mapping indicates that the amount of offset is about 270 (+266, -150) meters along the San Andreas fault. The age of incision of this riser is constrained by radiocarbon dates from the colluvial wedge that buries the high terrace northeast of the fault. Three dates on detrital charcoal from near the base of this colluvial wedge are 29,400 ± 500, 31,400 ± 200 and 36,400 ± 4900 radiocarbon years before present. These dates probably slightly post-date the incision of the terrace riser and abandonment of the upper terrace surface by the amount of time required for progradation of the colluvial wedge. To minimize the impact of reworked charcoal with an inherited age, we use the youngest date, 29.4 ka, which is from a stratigraphic position that appears to be from a portion of the colluvial wedge of similar age to the other two dates. In combination with our preferred 270-meter offset, this yields a preferred right-lateral slip rate of 9.2 mm per radiocarbon-year. Using the minimum and maximum allowable offsets and the 29.4 ka age, allowable slip rates extend from 4 to 18 mm per radiocarbon year. This rate is consistent with geodetic modeling of the San Bernardino segment (Meade and Hager, 2005), and is much lower than the 24.5 mm/yr rate at Cajon Creek and is also lower than the 14-25 mm/yr rate in Yucaipa. A faster slip rate is possible if all three of the dated detrital charcoal samples (including the 29.4 ka sample) were reworked from an older deposit. Preliminary results from two of five OSL samples suggest a younger age for the colluvial wedge, closer to 20 ka, but complete analysis of the OSL samples is still pending. Soil development on the colluvial wedge, including the thickness and abundance of clay films, structure and rubification, is consistent with an age at least as old as that indicated by the radiocarbon dates.



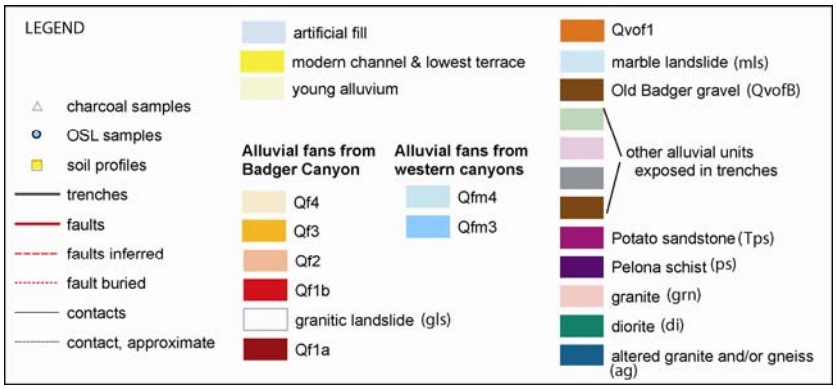


Figure1: Preliminary geologic map of the Badger Canyon site showing a set of offset alluvial fans. Base map is an Airborne Laser Swath image from the B4 project.

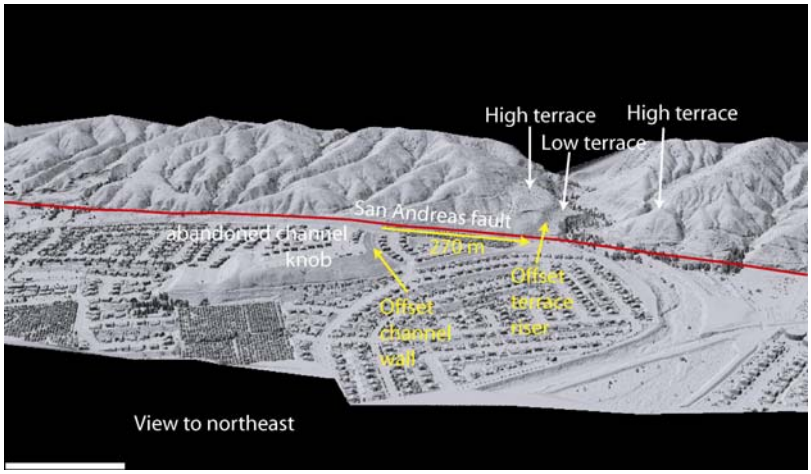


Figure 2: Annotated Airborne Laser Swath image of the Plunge Creek site, showing a truncated channel wall southwest of the fault that is offset from a terrace riser northeast of the fault.