Using B4 LiDAR and CRN age data to constrain slip rates along the San Andreas Fault System at Millard Canyon, San Gorgonio Pass

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Fault scarps cut a series of Holocene alluvial fan surfaces in Millard Canyon, within the San Gorgonio Pass (SGP). These fault scarps are likely the result of coseismic slip along the San Andreas Fault system during potentially large magnitude (Mw7+) earthquakes. Here we provide new ages for Holocene surfaces Qf2, Qf3, and Qf4. Charcoal fragments beneath Qf2 limits the surface to 1270 ± 80 years before present (ybp) and new 10Be exposure ages from the two older Holocene surfaces provide age constraints of 4800 ± 1600 ybp for Qf3 and 6800 ± 550 ybp for Qf4. These new ages provide limits on the timing of slip through the San Gorgonio Pass. Airborne LiDAR from the B4 dataset was used to identify and measure preserved scarps that cut the terrace surfaces. The northernmost fault (F1) with an observed northward dip of 45° vertically offsets units Qf2 and Qf3 by 1.4 ± 0.7m and 3.1± 0.7m respectively. The southern fault (F2), a 30° north dipping active oblique strike slip thrust fault, vertically offsets units Qf1 and Qf4 by 1.5 ± 0.6m, and 12.7 ± 1.4m respectively. We then mathematically resolve these vertical slip parameters onto their respective fault plane geometries to evaluate the net slip component of motion along the N45W slip vector of the San Andreas Fault. The net slip component, in conjunction with the age constraints gives the following Holocene slip rates: northern fault (F1): 1.8 ± 0.7 mm/yr; southern fault (F2): 8.8 ± 1.6 mm/yr. Summation of these rates across the study area yields 10.6 ± 2.3 mm/yr for the Holocene slip rates through the San Gorgonio Pass. These faults, suspected of carrying the majority of San Andreas motion through the SGP are interpreted to release interseismic strain during large magnitude earthquakes of Mw 7 or greater (Yule and Sieh, JGR 2003).

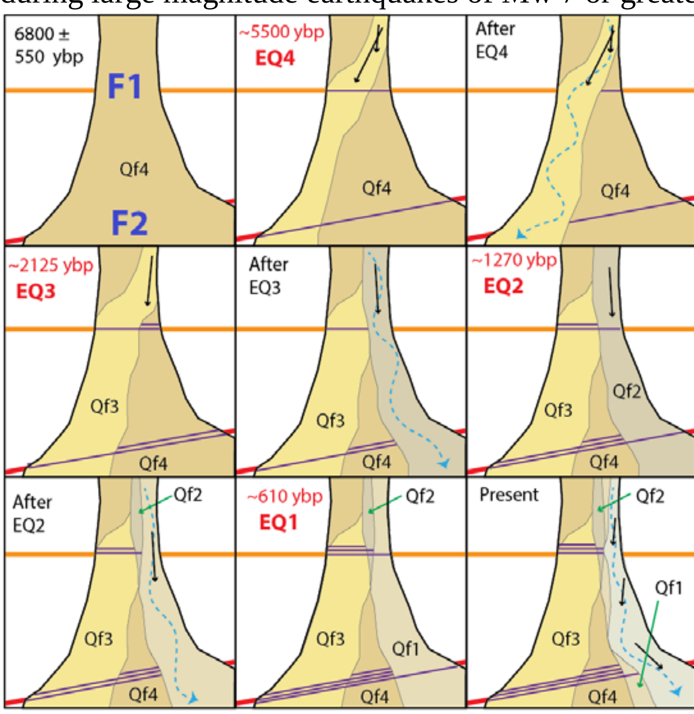

Figure 1. Schematic interpretation showing geomorphic evolution of Millard Canyon surfaces through time with cumulative imprint of (what may be an incomplete) paleoseismic record obtained from nearby trenching activities (McBurnett, 2011; Wolf et al., in progress). Model assumes contemporaneous rupture on northern and southern faults, however this behavior has not been proven to occur. Up to 2 seismic events may have occured between EQ4 and EQ3, but were not confirmed in this study. Ruptures represented as purple lines, showing known earthquakes 1-4. Disappearance of line illustrates erosion of scarp due to fluvial processes in active channel. Dashed blue line illustrates fluvial activity in channel. Black arrows illustrate suspected direction of hydrologic forces pertinent to morphology of channel. Text in red designates the time frame in which the earthquake occurred. Qf1, Qf2, Qf3, Qf4: faulted alluvium; Q: undifferentiated. See Figure 6 of Yule and Sieh, (2003) for detailed geologic map. Slip rates are determined by dividing the cumulative kinematics by the interpreted ages of the surfaces cut.