

Estimating variations in locking depth for the Mojave segment of the San Andreas fault over the past 1500 years from paleoseismic stress drop

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The recurrence and slip of earthquakes along active fault systems such as the San Andreas Fault System (SAFS), to first order, should depend largely on the stress that accumulates between slip events and the release mechanism, or stress drop, of a fault segment. This model, however, often fails to explain the large differences in earthquake recurrence intervals and slip for published paleoseismic datasets: why do events sometimes rupture on the order of 10s of years, and other times require 100s of years to accumulate substantial stress before failing in a large earthquake? Previous work suggests that the rate of stress accumulation is highly sensitive to fault locking depth, where shallowly locked faults accumulate stress at higher rates than deeply locked faults. Following this idea, we investigate variations in stress accumulation due to changes in paleoseismic locking depth spanning multiple earthquake cycles of the Mojave segment of the SAFS. We use published date and slip estimates spanning the last 1500 years [Weldon *et al.*, 2004] and a 4-D earthquake stress model [Smith-Konter and Sandwell, 2009] to tune model-derived stress drops (Figure 1) for each earthquake cycle to fit stress drop estimates derived from paleoseismic data. For each earthquake cycle, we assume a constant slip rate and systematically adjust the locking depth of the Mojave segment to best match the paleoseismic data. We find that realistic variations in locking depth (5-25 km) spanning the 14 earthquake cycles of the Mojave segment could have generated enough variation in earthquake cycle stress rate to support non-characteristic stress drop behavior. We also identify five paleoseismic events that require anomalously high stress rates (> 5 MPa/100 years) to explain the earthquake recurrence and slip data.

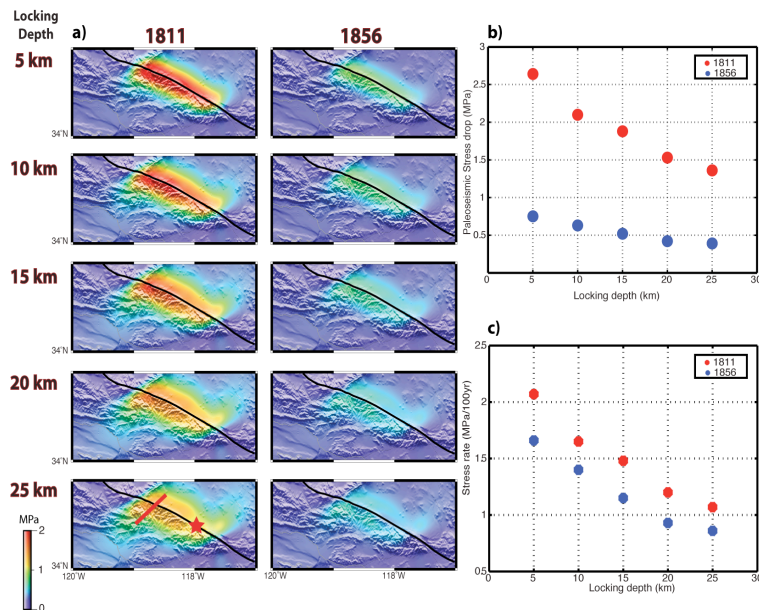


Figure 1. Modeled stress drop for the 1812 and 1857 events as a function of locking depth. (a) Snapshots of stress accumulation (approximating coseismic stress drop) for the Mojave segment as a function of fault locking depth. Red star denotes Wrightwood paleoseismic site. (b) Model-derived stress drops as a function of fault locking depth. (c) Model-derived stress rates, obtained by dividing stress drop from (b) by the recurrence intervals of 1812 (127 yrs) and 1857 (45 yrs) events, respectively.