Geodetic pursuit of aseismic forces for micro-earthquake processes

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Geodetic and seismological observations provide complimentary information about strain and seismicity evolution in the Earth's crust, which are key ingredients in regional seismic hazard models. While small earthquakes (i.e., microseismicity) are frequently observed as seismic signatures of natural fault zones, the slow fault slip process and potential aseismic driving forces of seismicity are often unknown and difficult to characterize. Here I present examples from the San Andreas Fault System, where we seek to connect microseismic and geodetic observations of fault zones over different spatiotemporal scales to better understand seismogenesis of crustal faults. Over longer timescales (years to decades), we compare geodetically estimated locked-creeping transitional depths and seismicity patterns on mature fault segments to suggest that microseismicity is influenced by aseismic tectonic stressing, subject to large earthquake history and fault zone structure. Over shorter time scales (minutes to months), we analyze the coseismic-to-postseismic phase of the 2004 Parkfield earthquake to suggest that earliest afterslip and aftershocks exhibit a time-synchronous, depth-dependent relation, pointing to dynamic responses of a post-rupture fault zone. Preliminary analysis of early postseismic observations of other major events in Southern California further suggests complex connections between seismic and aseismic phenomena. These examples demonstrate that improved geophysical observations are crucial to revealing a more complete picture of seismic and aseismic fault behavior and constraining in situ fault zone properties and heterogeneities.

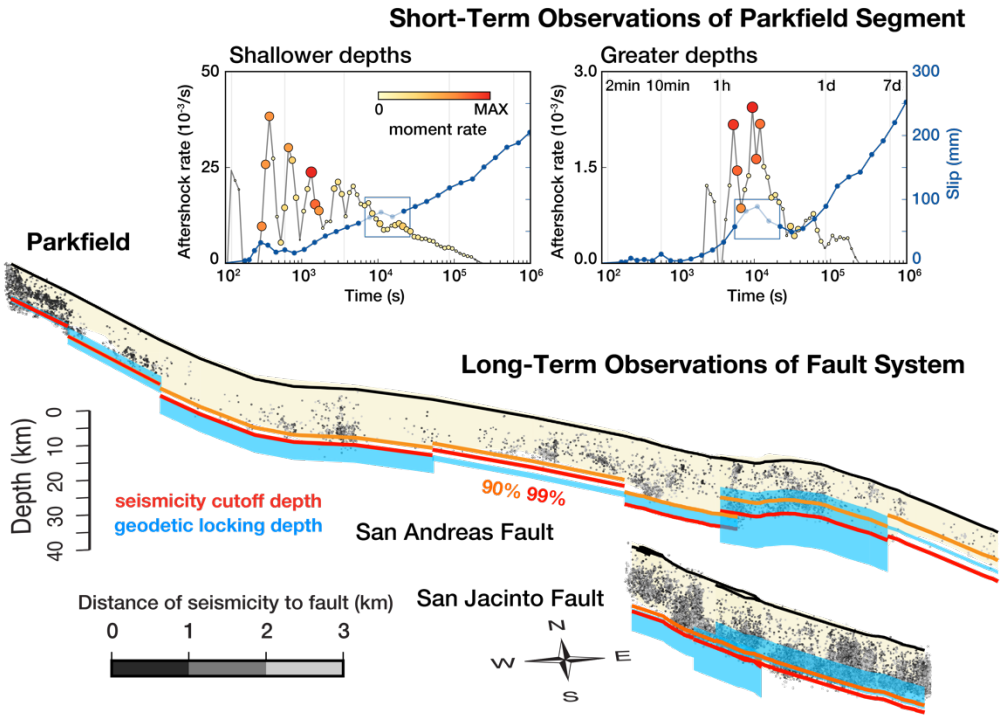

Figure 1. Geophysical observations of seismic and aseismic fault behavior across scales. (Top panel) Inferred fault slip and aftershock rates at different depths during the earliest postseismic period (2 min to 1d) of the 2004 M6 Parkfield, California, earthquake, modified from *Jiang, Bock, and Klein* (2021). (Bottom panel) Estimates of long-term geodetic locking depths and seismicity cutoff depths on the San Andreas and San Jacinto faults in Southern California, modified from *Jiang and Lapusta* (2017).