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Changes in Rates of Moderate-Size Earthquakes Before and After the 1992 Landers Earthquake

Du and Sykes (2001) examined changes in the rates of moderate-size earthquakes before and after the 1992 Landers event. While moderate activity increased in the 10 years prior to Landers at distances of 80 to 160 km, no significant change occurred within 80 km, leaving us doubtful if the increase at larger distance was, in fact, precursory to Landers. Increases, such as those preceding the 1948 Desert Hot Springs and 1989 Loma Prieta events, however, were found, in the vicinity of faults of high long-term slip rate. The failure to find such changes close in during the decades before Landers is in accord with the idea that tectonic stress built up very slowly along that fault of low long-term slip rate. The increases at larger distance as well as the occurrence of the Landers sequence and the 1999 Hector Mines event may instead represent a regional buildup to a future great earthquake along the southern San Andreas fault.

Triggered Aseismic Fault Movements from Nearby Earthquakes, Static or Dynamic Effect?

The occurrence of a large earthquake can affect either the seismic or aseismic slip behavior of nearby faults in southern California. Two stress triggering models are often used in the studies of changes in seismicity after a significant event. One is the static stress triggering mechanism that is associated with static co-seismic fault displacements. The other is the dynamic stress triggering model, which is usually attributed to ground shaking during the passage of the largest seismic waves. These two mechanisms also are used to explain the phenomenon of triggered fault slip or creep, which is a form of aseismic fault movement coinciding closely in time after a large nearby event on a different fault. For example, parts of the San Andreas fault moved aseismically at the surface following the 1968 and 1992 earthquakes.

We examined the possible triggering role of static stress changes for seven observed cases in California. The changes in static shear stress, normal stress and Coulomb Failure stress from each mainshock were resolved on those nearby fault segments, which are known to exhibit creep. We examined the characteristics of the computed static stress changes relative to whether triggered slip took place on the faults or not. We found that although most of the nearby fault segments slipped aseismically in the sense that they were encouraged to move by the imposed changes in static CFS, three segments were not in accord with the predictions of that model. One example of each type is shown in Figures A and B. Two cases that did not fit the static Coulomb calculations involve the southern part of the San Andreas fault after the 1987 Elmore Ranch and Superstition Hills earthquake sequence; the other one involves the southern Calaveras fault

segment after the 1989 Loma Prieta event. These three examples imply that static stress triggering is not the sole, and may not be the actual, mechanism responsible for causing the observed triggered aseismic slip.

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Selected Previous Publications from a Total of 10 Supported by SCEC

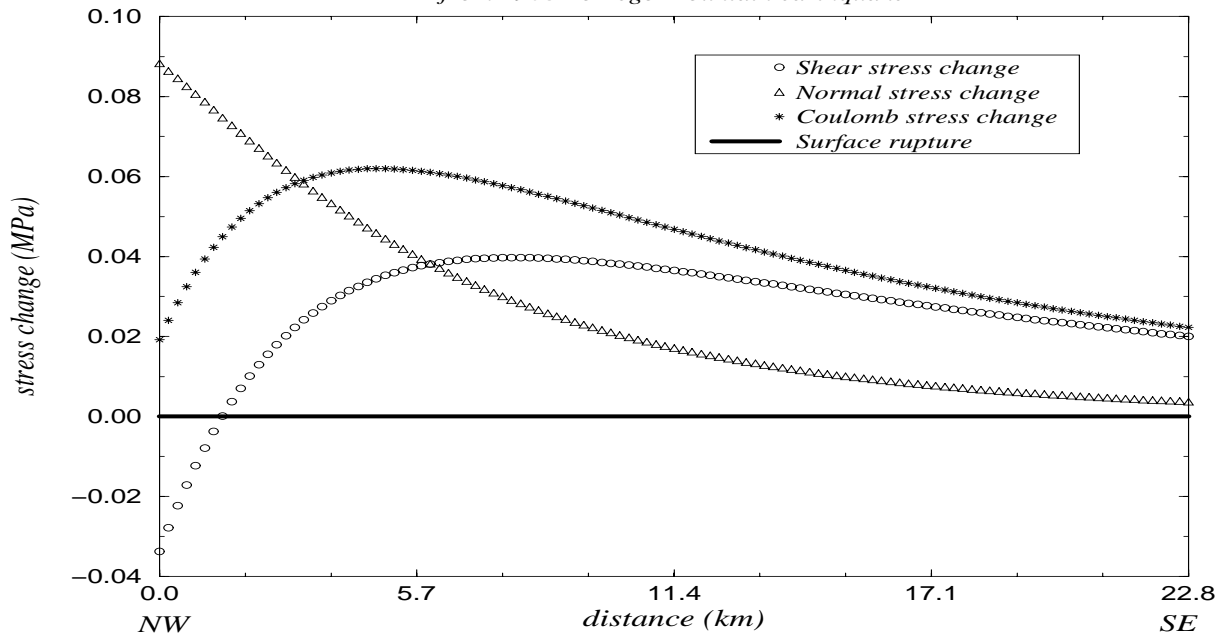
Deng, J., and L. R. Sykes, Evolution of the stress field in southern California and triggering of moderate-size earthquakes: a 200-year perspective, J. Geophys. Res., 102, 9859-9886, 1997a.

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Static stress changes at the surface of Superstition Hills fault

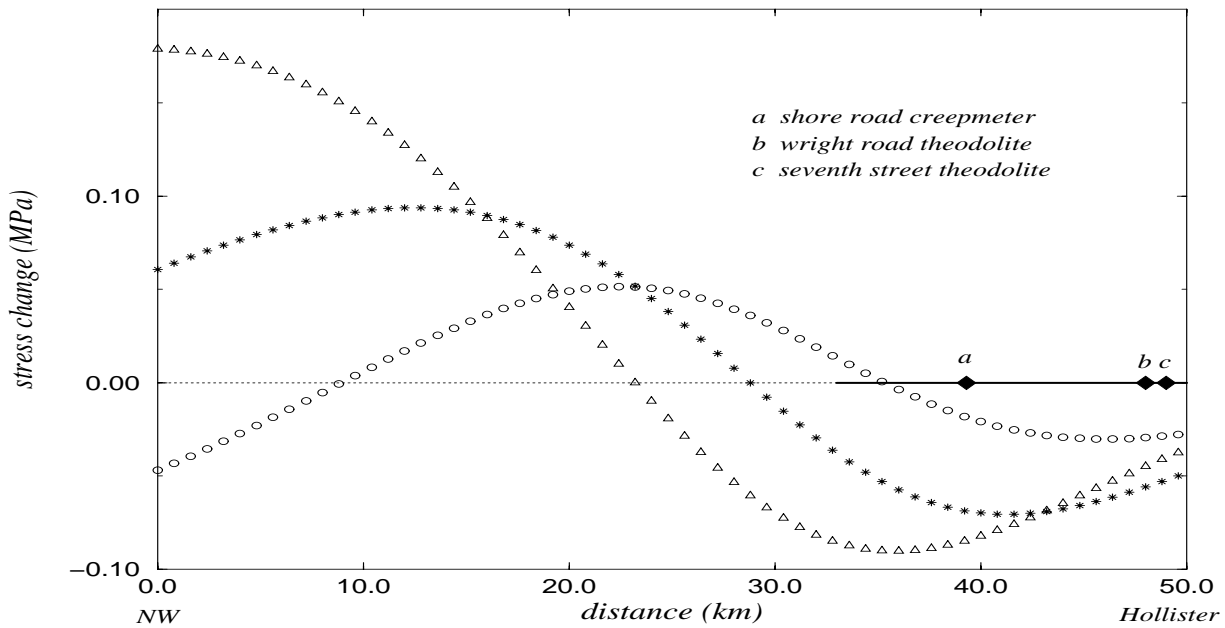
from 1968 Borrego Mountain earthquake



(A)

Static stress changes at the surface of Southern Calaveras fault

from 1989 Loma Prieta earthquake



(B)

Figure A. Static stress changes from 1968 Borrego Mountain earthquake are resolved at the surface of entire Superstition Hills fault (22.8 km).

Figure B. Static stress changes from 1989 Loma Prieta earthquake are resolved at the surface of the southern Calaveras fault segment (50 km long extending northwest from Hollister).