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Physical Mechanisms Causing high b-value Regions in Aftershock Zones

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Aftershock zones present an ideal environment for studying physical mechanism influencing the earthquake size distribution, or b-value, because of the high seismic activity and the sudden changes caused by a main shock. Several recent studies have documented dramatic temporal and spatial heterogeneity of b within aftershock sequences of recent large events such as Landers, Hector Mine, Denali, and Western Tottori with b-values ranging from 0.5 to above 1.5. To improve our understanding of the link between main shock slip, resulting stress changes, aftershock occurrence and their size distribution, we investigate the fine scale b-value distribution within several aftershock zones and compare it with results from stress tensor inversions. Some recent studies indicated that areas of high slip of large events subsequently show high b-values and vice versa. A first order observation is that regions of high slip during the main shock are also regions of high heterogeneity, in agreement with the heterogeneous post-seismic stress field hypothesis defined by Michael. We map the rotations of the stress field near the rupture zone, observing significant rotations which are consistent with the predicted coseismic rotations of the principal stress axes in an elastic half space under an assumption of a 30-bar uniaxial NE-SW compression. In contrast, a region wedged between the Landers and Joshua Tree rupture zones, in which Coulomb stress increases for pre-existing strike-slip faults, show less rotation and low b-values. We propose a conceptual model where stress perturbations caused by main shocks are on the order of the background regional stress field, thus allowing faults or cracks near the rupture zone to be activated which are in principal unfavorable oriented for rupture given the regional stress field. These events, however, occurring in a heterogeneous stress field, are generally small, leading to high b-values. Contrary, stress transfer to the surrounding areas mainly beyond the edges of the source fault

increases differential stress, which promotes ruptures of moderate-to-large scale matured faults that are consistent with the tectonic stress field. This results in low b-value. The recovery with time of the stress field near the rupture zone