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Resolving stress heterogeneity along fault zones through b-value analysis

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Four lines of evidence suggest that the inverse relation between the relative applied shear stress and the average earthquake size distribution (b-value) observed in laboratory-scale acoustic emission experiments is also valid in the Earth Crust: 1) b-values vary systematically between faulting regimes; 2) b-values vary systematically with depth and 3) b-values vary systematically with pore pressure changes; 4) known asperities and creeping segments correlate with low and high b-value regions, respectively. Systematically mapping b-values along seismically active fault systems is therefore a powerful tool to learn more about the contemporary state of stress on fault segments. Here we present the results and analysis of a first systematic survey of b-values along known faults in California, and along the subduction zones offshore Japan. The b-value imaging reveals a highly heterogeneous state of stress along fault zones, with dramatic variations on the scale of a few kilometers. We propose that the results of our imaging can be used to set the currently unknown initial state of stress for earthquake simulators. In a second step, we then analyze the temporal evolution of the b-value along selected fault zones with the aim of resolving transients related to the loading cycle. Our results suggest that differences in pre- and post-mainshock b-values can be well resolved and are meaningful indicators of the current loading state; however, a systematic decrease of b as the fault approaches failure cannot be detected universally.