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Investigation on the effect of viscoelastic deformation on the temporal evolution of stress heterogeneities along fault zones

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Earthquake fault slips are driven by stresses acting on the fault plane. Therefore, while the physical properties (e.g. frictional, elastic, transport) of fault zone materials determine fault instabilities required for an earthquake rupture growth, the stress condition along faults prior to an earthquake also has bearing on how an event may grow. Final sizes of a single earthquake vary by orders of magnitudes. Geophysical studies of large earthquakes reveal heterogeneous patterns of slip along faults. These observations are likely manifests of the spatially heterogeneous nature of stress along faults and their influence on the rupture behavior of earthquakes.

The build-up of shear stress on faults between earthquakes is typically considered to be the result of steady tectonic elastic loading on frictionally locked fault interfaces. However, many rocks exhibit viscoelastic behavior over geological time scales. Thus if fault rocks and the surrounding host rock exhibit such time-dependent behavior, tectonic loading of stresses along faults may not be as simple as described by friction between elastic mediums. Time-dependent viscoelastic deformation relaxes stress over time and can alter the spatial pattern of stress heterogeneity along faults. We investigate such effects through finite element numerical models. Focus will be on the difference in outcomes between different constitutive models and loading conditions. Preliminary results suggest that spatial diffusion of stress heterogeneities can occur due to viscoelastic effects.