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Earthquakes Below the Brittle-Ductile Transition: The Role of Grain Size Assisted Thermal Runaway

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Great earthquakes with magnitudes larger than 8.0 commonly occur in the vicinity of plate boundaries. Most of those earthquakes occur in subduction zones in compressive settings, but others have also been observed to occur on strike slip faults. Fault slip in those earthquakes is on the order of tens of meters, while fault length ranges from ∼100-1000 km. This implies that a significant slip may have occurred at temperatures and pressures where brittle failure is unlikely and alternative failure mechanisms may have to operate to allow for localized slip.
Previous studies have shown that grain size assisted runaway (GSATR) is a viable mechanism to create localized shear zones and possibly also earthquake-like rupture. Here we investigate the potential of this mechanism to extend earthquake rupture to depth below the brittle-ductile transition. To this end, we employ 2D numerical models that couple the evolution of stress, temperature and grain size evolution and systematically explore the parameter space to determine the efficiency of the GSATR mechanism.