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## Going from stable creep to aseismic slow slip events in the ductile realm

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The accommodation of motion on faults spans a large spectrum of slip modes, ranging from stable creep to earthquakes. While seismic slip modes certainly have the largest impact on the surface due to the induced ground shaking, it has been recognized that slow aseismic slip modes relax most of the accumulated stresses on a fault. It has also been suggested that aseismic slip controls seismic events, thus making this kind of slip mode key for earthquake prediction.

Despite the importance of aseismic slow slip, its underlying physical mechanisms are still unclear. Commonly, slow slip events are modeled in terms of frictional failure, employing a rate-and-state model of fault friction, often also invoking fluids that alter frictional properties on the fault. However, at larger depths, frictional processes become increasingly difficult to activate due to the increase in ambient pressure and ductile processes are more likely to dominate deformation.

Here we therefore investigate deep aseismic slip processes governed by ductile deformation mechanisms using 2D numerical models, where we employ a composite viscoelastic rheology combined with grain size reduction and shear heating as weakening processes. We show that the collaborative action of these two weakening mechanisms is sufficient to create the entire spectrum of aseismic slip, ranging from stable creep to long-term slow slip events. The results show that ductile deformation does not necessarily result in stable slip and induces slip modes with considerably larger velocities than the far-field plate velocities. Moreover, the propagation of ductile ruptures induces large stresses in front of the rupture tip which may also trigger short-term seismic events.