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Grain size reduction and shear heating: a recipe for intermediate-depth earthquake generation?

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The mechanisms resulting in intermediate-depth earthquakes remain enigmatic, with two processes - dehydration embrittlement and thermal runaway – being the most promising candidates. Using a simple shear one-dimensional model, *Thielmann et al. (2015)* have shown that the feedback between grain size evolution and shear heating significantly reduces the stress needed to initiate thermal runaway.

However, at intermediate depths, Peierls creep as well as dislocation accommodated grain boundary sliding (dis-GBS) are also viable deformation mechanisms. Here we investigate the impact of those additional creep mechanisms (grain boundary sliding and Peierls creep) on the formation of shear zones. As in *Thielmann et al. (2015)*, we consider both thermal and microstructural damage mechanisms (shear heating and grain size reduction).

Depending on material and deformation parameters different creep mechanisms are dominant during deformation, which affects the occurrence and timing of thermal runaway (e.g. at low temperatures and/or high strain rates Peierls creep is dominant and limits the strength of the material which delays thermal runaway). We derive regime diagrams and from them regime boundaries that allow for easy determination of the governing mechanisms and of the localization potential for given material parameters.

In one-dimensional models however, the shear zone - once formed – extends infinitely. In nature however, this is not the case. This has potentially a large impact on rupture velocities during shear zone formation. For this reason, we compare the 1D predictions to 2D simulations where fault length is finite.