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Results from a systematic analysis of fully coupled Thermo-Hydro-Mechanical-Chemical rock models

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The rheology/mechanical behavior of rock is controlled by several processes including thermal, hydraulic, mechanical, and chemical conditions. (Braeck et al., 2009; Kiss et al., 2019)

We conduct a systematic parametric study within a fully coupled Thermo-Hydro-Mechanical-Chemical (THMC) numerical rheological model to identify regions of stable and unstable (brittle?) deformation. The rheological model assumes incompressible viscous deformation and is governed by the equations of conservation of mass, linear momentum, and energy; a constitutive equation, and a creep flow law. Three parameters control the deformation: background strain rate, shear heating, and a Brinkman number that captures the interplay between viscosity and temperature.

We setup a grid of points using these parameters, use each grid point as a starting instance of the rheological model, and let each instance evolve with time. We are able to perform a fine-grained study of the parameter space by using a high-performance GPU cluster. Our initial results show that the background strain rate requires relatively low values (near 1) for the computation to remain stable. While keeping a constant (low) strain rate, we next observe how each model instance evolves with respect to shear heating and Brinkman values. This approach allow us to map stable/unstable regions in the 3-parameter space.

Next we analyze the rheological conditions of each model instance (in the stable and unstable regions) and its potential as a rock-weakening mechanism.

References

Braeck, S., Podladchikov, Y., & Medvedev, S., 2009. Spontaneous dissipation of elastic energy by self-localizing thermal runaway, Phys. Rev. E , 80, 046105, doi:10.1103/PhysRevE.80.046105.

Kiss, D., Podladchikov, Y., Duretz, T., & Schmalholz, S., 2019. Spontaneous generation of ductile shear zones by thermal softening: Localization criterion, 1D to 3D modelling and application to the lithosphere, Earth Planet. Sci. Lett., 519, 284–296, doi:10.1016/j.epsl.2019.05.026.