Geophysical Research Abstracts
Vol. 21, EGU2019-6705, 2019
EGU General Assembly 2019

Parallel open source numerical modelling of deformation dynamics across scales

Mauro Cacace and Antoine Jacquey
GeoForschungsZentrum GFZ Potsdam, Dept 4 Geosystems, Potsdam, Germany (cacace@gfz-potsdam.de)

Understanding the key physical processes controlling the different deformation modes of sedimentary, crustal and mantle rocks is crucial to assess the strength and long-term behavior of the lithosphere, as well as to characterize emplacement conditions for georesources and their evolution in space and time. Successfully addressing these questions requires to quantify the details of the non-linear dynamics controlling (semi)brittle and (semi)ductile processes under different tectonothermal conditions as also locally influenced by the specific geological conditions. Due to the disparate length and temporal scales involved and to the high non-linearity of these processes, numerical simulators have become increasingly of help in such studies. Despite recent advances, models of the rheology and mechanical properties of the lithosphere remain particularly challenging. This is mainly due to the multiphysics tight coupling among the processes controlling deformation of lithospheric rocks and their inherent multiscale behavior, ranging from scales typical of grain size processes to the km scale of shear zone in the deep crust and mantle.

We present a new simulator (LYNX = Lithospere dYnamics Numerical toolboX), which relies on an implicit multiphysics coupling of the physics describing visco-elastic-plastic deformation modes including thermal and hydraulic feedback processes. Its extension to consider the retro feedback from poro viscoplastic damage (brittle) mechanics are presented in a separate contribution (Jacquey and Cacace, 2019). The numerical core of LYNX is based on the Multiphysics Object-Oriented Simulation Environment (MOOSE), which provides a powerful and flexible platform to solve for multiphysics problems implicitly and in a tightly coupled manner on unstructured meshes which is of interest for the considered non-linear context. In addition, the use of high-level nonlinear solvers allow us to tackle these complex multiphysics problems with high accuracy in three dimensions.

In this contribution we describe the basics of the numerical implementation by giving a special focus on aspects related to the tight, across-scale coupling among the different processes (explicit viscoelastoplastic implementation). In a second part, we present a suite of applications testing the robustness and capability of the simulation environment to (1) consistently integrate physical processes as observed in the field and/or in the laboratory, and (2) reconcile these observations across different scales, and to investigate (3) first order aspects of the present thermo-mechanical states of natural systems, and, (3) its dynamic evolution due to different forcing conditions.

References:

Jacquey, A.B., and Cacace, M. (2019): How porosity and damage evolutions influence the deformation modes within the lithosphere. Geophysical Research Abstracts, vol. 21, EGU2019-1514, 2019, EGU General Assembly, 2019.