2D Numerical modelling of a porous flow in a deforming viscoplastic matrix with finite differences and marker-in-cell techniques

Diana Dymkova[1], Taras Gerya[1], Yuri Podladchikov[2]
(1) ETH Zurich, Institute of Geophysics, Zurich, Switzerland, (2) University of Oslo, PGP, Oslo, Norway

Numerical modelling of a porous flow has a wide range of applications in geosciences and industrial engineering.
We created a two-dimensional model of a two-phase flow in a porous media solving a coupled Darcy-Stokes system of equations for two incompressible media for the case of visco-plastic rheology of solid matrix. We use a finite-difference method with fully staggered grid in a combination with marker-in-cell technique for advection of fluid and solid phase. We performed a comparison with a simple benchmark of a thermal convection in a closed bottom-heated box to verify the interdependency of Rayleigh and Nusselt numbers with a theoretical one.
We also demonstrate stability and robustness of the algorithm in case of strongly non-linear visco-plastic rheology of solid including cases with localization of both deformation and porous flow along spontaneously forming shear bands.
In the future we plan to include elasticity, fluid/solid compressibility and melting in our numerical model as a function of pressure, temperature, water content and composition.
Ultimate goal is to simulate in a realistic self-consistent manner fluid and melt generation and transport in subduction zones including fluid/melt focussing phenomena.