# Permeability benchmark using 3D numerical modelling

*Wakana Fujita[1], Philipp Eichheimer[2], Marcel Thielmann[2], Anton Popov[3], Gregor Golabek[2], Boris Kaus[3]

1. Graduate School of Science, Tohoku University, 2. Bayerisches Geoinstitut, University of Bayreuth, 3. Johannes Gutenberg Universität Mainz, Institute for Geosciences

Migration of geological fluids is an important process controlling chemical transport and mechanical properties in the Earth’ s interior (e.g. melt segregation from partially molten region; segregation of dehydrated fluid from a subducting slab).

Geological fluids percolate upwards due to their buoyancy and permeability is a key factor that controls the flow rate. Therefore the effective permeability depends on the microscopic pore fluid connectivity.

Here we calculate permeability numerically for high resolution CT scans of rocks. For this purpose we use the 3D thermomechanical code LaMEM (Lithospheric and Mantle Evolution Model) (Kaus et al., 2016). We compute the flow velocities and then plug them into Darcy’ s law. For benchmarking, we calculate fluid flow through single and multiple pipes using LaMEM. We compare the resulting permeabilities using different grid resolutions against the analytical solution for Hagen-Poiseuille flow.

In a next step we computed the permeability of Fontainbleau sandstone digitalized by Andra et al., 2012. We obtained 2171mD which is higher than 1100mD from laboratory measurement (Keehm 2003). However, our result is almost consistent with numerical results by Andra et al., 2012 which are 1503mD for Lattice-Boltzmann method and 1914mD for Explicit Jump method respectively.

(This work was supported by the JSPS Japanese-German Graduate Externship)

Andra et al,(2013). Digital rock physics benchmarks-Part I: Imaging and segmentation Computers and Geoscience, 50 25-32

Andra et al,(2013). Digital rock physics benchmarks-part II: Computing effective properties Computers and Geoscience, 50 33-43

Kaus, B et al, (2016). Forward and inverse modeling of lithospheric deformation on geological timescales. In: Binder, K., Mller, M., Kremer, M., Schnurpfeil, A. (Eds.), NIC Proceedings. Vol. 48. pp. 299–307.

Keehm, Y., (2003). Computational Rock Physics: Transport Properties in Porous Media and Applications. Ph.D. Dissertation, Stanford University. 135 pp.

Keywords: digital rock, permeability, sand stone, numerical simulation

 