Geophysical Research Abstracts
Vol. 21, EGU2019-15835, 2019
EGU General Assembly 2019

Permeability of matrix-fracture system under mechanical loading – constraints from laboratory experiments and 3D numerical modelling

Guido Blöcher, Christian Kluge, Harald Milsch, Mauro Cacace, and Antoine Jacquey
GFZ German Research Centre for Geosciences, Potsdam, Germany (bloech@gfz-potsdam.de)

Commonly, the permeability of fractures is approximated using the cubic law assumption, which is only valid under the strict assumption of laminar flow between parallel plates. However, fracture flow is influenced by the surface roughness and the relative shear displacement and the amount of flow exchange between the matrix and the fracture itself. In order to quantify the relationships among the aforementioned aspects, we have conducted flow through experiments of a porous rock samples (Flechtinger sandstone) having one single macroscopic fracture. Based on these experiments we obtained range of variations of intrinsic rock parameters, permeability and stress-strain relationships of the combined matrix-fracture system under hydrostatic loading. Based on the strain measurements we derived the mechanical aperture change of the fracture. The results of these experiments demonstrated that the cubic law does not represent the processes occurring in these stressed matrix-fracture systems.

In order to quantify the processes behind the laboratory observation we carried out hydraulic and poroelastic simulations of the matrix-fracture system. Navier-Stokes flow was solved for the 3-dimensional rough fracture, which was back coupled to the (Darcy) flow and poroelastic behaviour of the rock matrix. The preliminary results demonstrate that the elastic behaviour and the related permeability alteration of the fracture domain could be captured by the numerical simulation. Furthermore, the obtained stress-strain values nearby of the fracture asperities give some indications of additionally inelastic deformation modes of the combined system. An attempt is made to quantify this inelastic deformation by Mohr-Coulomb failure criterion (whether tensile, shear or UCS or a combination of those). Finally, the information on the changes of the fracture geometry combined with the simulated matrix-fracture flow enable us to better understand the permeability evolution of the overall system due to the imposed mechanical loading conditions.