Geophysical Research Abstracts
Vol. 19, EGU2017-14691, 2017
EGU General Assembly 2017

Hydraulic Properties of Fractured Rock Samples at In-Situ Conditions – Insights from Lab Experiments Using X-Ray Tomography

Mathias Nehler (1), Ferdinand Stöckhert (1), Mandy Duda (1), Jörg Renner (2), and Rolf Bracke (1)
(1) International Geothermal Centre, Hochschule Bochum, Bochum, Germany (mathias.nehler@hs-bochum.de), (2) Geophysics, Ruhr-Universität Bochum, Bochum, Germany (joerg.renner@ruhr-uni-bochum.de)

The hydraulic properties of low-porosity rock formations are controlled by the geometry of open fractures, joints and faults. Aperture, surface roughness, accessible length, and thus, the volume available for fluids associated of such interfaces are strongly affected by their state of stress. Moreover, these properties may evolve with time in particular due to processes involving chemically active fluids. Understanding the physico-chemical interactions of rocks with fluids at reservoir conditions will help to predict the long-term reservoir development and to increase the efficiency of geothermal power plants.

We designed an x-ray transparent flow-through cell. Confining pressure can be up to 50 MPa and pore fluid can currently be circulated through the sample with pressures of up to 25 MPa. All wetted parts are made of PEEK to avoid corrosion when using highly saline fluids. Laboratory experiments were performed to investigate hydraulic properties of fractured low-porosity samples under reservoir conditions while x-rays transmit the sample. The cell is placed inside a μCT scanner with a 225 kV multifocal x-ray tube for high resolution x-ray tomography. Samples measure 10 mm in diameter and 25 mm in length resulting in a voxel resolution of approximately 10 μm.

Samples with single natural as well as artificial fractures were subjected to various confining pressures ranging from 2.5 MPa to 25 MPa. At each pressure level, effective permeability was determined from steady-state flow relying on Darcy's law. In addition, a full 3D image was recorded by the μCT scanner to gain information on the fracture aperture and geometry.

Subvolumes (400x400x400 voxels) of the images were analyzed to reduce computational cost. The subvolumes were filtered in 3D with an edge preserving non-local means filter. Further quantification algorithms were implemented in Matlab. Segmentation into pore space and minerals was done automatically for all datasets by a peak finder algorithm. For all samples, the threshold value was set as a fixed value between the two determined main peaks. A fracture is separated from pores using a connectivity filter. The overall porosity and the fracture volume are calculated. The mean aperture is used to calculate the in-situ fracture permeability according to the cubic law. First results indicate a strong dependency of the calculated permeability on pressure, especially for partly closed fractures, that is associated with an increasing contact area of the fracture.