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Experimental study of the fracture permeability evolution due to brine/rock interactions

Arnold Blaisonneau, Mariane Peter, and Sylvie Gentier
BRGM, Orléans, France (a.blaisonneau@brgm.fr)

The understanding of the flow paths in the rock reservoir is a key point for the exploitation of deep geothermal reservoir. In this framework, the study of fluid/rock interactions in fractures is fundamental for the development of Enhanced Geothermal System (EGS) exploitation. Indeed, after the phase of stimulation of the fractured rock reservoir, the fractures permeability evolution depends on the chemical processes due to fluid/rock interactions. These chemical processes can lead to an evolution of permeability depending on the dissolution/precipitation processes in the fracture submitted to thermal, mechanical and hydraulic loading conditions.
In order to improve the understanding of fluid/rock chemical interactions and their influence on the flow in fracture, reactive percolation tests under Thermo-Hydro-Mechanical conditions have been developed. The principle of such percolation tests is to inject a reactive fluid in a natural fracture cutting a cylindrically cored rock sample. The flow in the fracture is radial diverging and the injection flow rate is controlled. The chemical composition of the fluid synthesized for the injection reproduces the brine flowing in contact with the rock cored in the geothermal reservoir. A constant normal stress is applied on the fracture during the test and the pressurized chamber makes the temperature constant. The experimental device allows to measure the opening/closure of the fracture (displacement LVDT sensors) and the evolution of the injection pressure at the centre of the fracture. All around the fracture, the fluid is collected and the experimental device, outside of the pressurized chamber, allows to check the output flow rate. Moreover, the fluid is sample to realise the chemical analyses, in addition of pH and Eh potential continuous measurements.
Associated to this percolation test, a set of characterisations is performed, before and after the test, in order to determine physicochemical evolutions due to the reactive percolation test in the fracture and on it walls (morphology of the walls, map of the fracture voids, map of the chemical elements and description of the minerals on the fracture walls, testing of hydromechanical behaviour of the fracture). The whole measured data and characterisations should lead to an assessment of the fracture permeability evolution.
A percolation test has been performed on a fractured granite sample from the Soultz geothermal reservoir. The results show that dissolution chemical reactions occurred during the 17 days of the test lead to an increase of the fracture permeability. Moreover, an evolution of the hydromechanical behaviour of the fracture has been highlighted showing a decrease of the flow sensitivity to normal stress level. The evolution of the permeability and of the hydromechanical behaviour can be explained by a digging of the initial flow paths in the fracture due to chemical processes.