Geophysical Research Abstracts
Vol. 18, EGU2016-6234, 2016
EGU General Assembly 2016

Temperature dependence of hydraulic properties of Upper Rhine Graben rocks at conditions modelling deep geothermal reservoirs

Mariela Carolina Hernández Castañeda (1), Joerg Renner (1), and Thomas Mueller (2)

(1) Institute of Geology, Mineralogy and Geophysics, Ruhr-Universität Bochum, 44780 Bochum, Germany (mariela.hernandezcastaneda@rub.de, joerg.renner@rub.de), (2) Institute of Geophysics and Tectonics, School of Earth and Environmental Sciences, University of Leeds, Leeds, LS2 9JT, UK (T.Mueller@leeds.ac.uk)

The evolution of reservoir rocks' hydraulic properties critically affects the operation and long term sustainability of geothermal and petroleum reservoirs. Mechanical and chemical effects modify the permeability and the storage capacity of a reservoir, whose time characteristics have remained poorly constrained up to now. The permeability (k) and specific storage capacity (s) of the rocks constituting the geothermal reservoir are important parameters controlling the extent of the space-time characteristics of the pressure drawdown (or buildup at the reinjection site). To study the evolution of permeability and specific storage capacity as a function of pressure, temperature, and time, we performed oscillatory pore pressure tests. Experiments were performed using samples collected at surface outcrops representing the lithological sequence of the Upper Rhine Graben reservoir in southern Germany, i.e. sandstone and limestone, as well as Padang granite, representing a homogeneous, crystalline reservoir rock. Experiments were run at temperatures between 20 and 200 ˚C, confining pressures between 20 and 110 MPa, and a fixed fluid pressure of 10 MPa, modeling characteristic conditions of deep geothermal reservoirs. Intact samples of granite, limestone and sandstone yield permeability and specific storage capacity of about 10^{-18}, 10^{-15}, and 10^{-14} m^2, and 10^{-10}, 10^{-11} and 10^{-8} Pa^{-1}, respectively, with modest dependence on temperature and effective pressure. In addition, longitudinally fractured samples were prepared by simple splitting or cutting and grinding. Grinding was performed with sandpaper of different ISO grits designations (P100, P600, and P1200) to systematically vary the surfaces' roughness. Fractures cause an increase in room-temperature permeability up to 3 and 2 orders of magnitudes for samples of granite and limestone, respectively. Their pressure dependence corresponds to a reduction in permeability modulus by about one order of magnitude. However, the fractured samples have a similar permeability as the intact when the temperature is increased to 200 ˚C at the maximum explored effective pressure, i.e., the artificial fractures are effectively closed at these conditions. Repeating experiments at room temperature after the thermal treatment revealed a permanent reduction of permeability at 10 and 30 MPa effective pressure for granite and limestone. We did not observe a systematic relation between determined hydraulic properties and nominal roughness. Apparently, the fracture surfaces are rapidly altered during the oscillatory test, changing the preexisting roughness either by mechanical or chemical processes. At this point, we cannot, however, exclude that the different treatments resulted in similar surface topography. To test for this, we started measuring the surfaces after preparation and after testing with a digital microscope. Surface topography will then be evaluated using a Fourier transformation in order to characterize their alteration accompanying the oscillatory test.