Geophysical Research Abstracts
Vol. 19, EGU2017-5277, 2017
EGU General Assembly 2017

Insight into subdecimeter fracturing processes during hydraulic fracture experiment in Äspö hard rock laboratory, Sweden

Grzegorz Kwiatek (1), Patricia Martínez-Garzón (1), Katrin Plenkers (2), Maria Leonhardt (1), Arno Zang (1), Georg Dresen (1), and Marco Bohnhoff (1)

(1) GFZ German Research Centre for Geosciences, Geomechanics and Rheology, Potsdam, Germany, (2) GMuG Gesellschaft für Materialprüfung und Geophysik mbH, 61231 Bad Nauheim, Germany

We analyze the nano- and picoseismicity recorded during a hydraulic fracturing in-situ experiment performed in Äspö Hard Rock Laboratory, Sweden. The fracturing experiment included six fracture stages driven by three different water injection schemes (continuous, progressive and pulse pressurization) and was performed inside a 28 m long, horizontal borehole located at 410 m depth. The fracturing process was monitored with two different seismic networks covering a wide frequency band between 0.01 Hz and 100000 Hz and included broadband seismometers, geophones, high-frequency accelerometers and acoustic emission sensors.
The combined seismic network allowed for detection and detailed analysis of seismicity with moment magnitudes MW<-4 (source sizes approx. on cm scale) that occurred solely during the hydraulic fracturing and refracturing stages. We relocated the seismicity catalog using the double-difference technique and calculated the source parameters (seismic moment, source size, stress drop, focal mechanism and seismic moment tensors). The physical characteristics of induced seismicity are compared to the stimulation parameters and to the formation parameters of the site. The seismic activity varies significantly depending on stimulation strategy with conventional, continuous stimulation being the most seismogenic. We find a systematic spatio-temporal migration of microseismic events (propagation away and towards wellbore injection interval) and temporal transitions in source mechanisms (opening – shearing - collapse) both being controlled by changes in fluid injection pressure. The derived focal mechanism parameters are in accordance with the local stress field orientation, and signify the reactivation of pre-existing rock flaws. The seismicity follows statistical and source scaling relations observed at different scales elsewhere, however, at an extremely low level of seismic efficiency.