Geophysical Research Abstracts
Vol. 21, EGU2019-7369, 2019
EGU General Assembly 2019

Seismic Response to Hydraulic Fracturing in Anisotropic Rock

Katrin Plenkers (1), Grzegorz Kwiatek (2,3), Felix Blümle (2), Joerg Renner (4), Georg Dresen (2,5)

(1) GMuG - Gesellschaft für Materialprüfung und Geophysik mbH, Bad Nauheim, Germany (k.plenkers@gmug.eu), (2) GFZ - Geoforschungszentrum Potsdam, Germany, (3) Freie Universität Berlin, Germany, (4) Ruhr Univerität Bochum, Germany, (5) Universität Potsdam, Germany

The STIMTEC project is a joint project by RU Bochum, GFZ Potsdam, TUBA Freiberg, and Geomecon. The project aims at characterizing the evolution of fracture networks during hydraulic stimulation as commonly used in the production of geothermal energy. The observations from an in-situ experiment are expected to form the basis for an optimization of stimulation procedures. The mine-back experiment is located in the underground laboratory “Himmelfahrt-Fundgrube” (Schacht “Reiche Zeche“) in Freiberg. The testing was performed at the -147 m depth level (+281 m NN, approx. 120m below surface), accessible via shaft from the surface. Small seismic events (picoseismicity) were recorded using an in-situ AE monitoring network with twelve in-situ AE sensors and three high-frequency accelerometers. All sensors were installed in eleven monitoring boreholes at distances of 5.3 m to 19.7 m from the injection borehole. The sensors are located above the 63 m long injection borehole that is dipping downwards with about 15°. Seismic waveforms were recorded both in trigger-mode recording (sampling frequency 1 MHz) and recorded continuously (sampling frequency 200 kHz) throughout the project. Monitoring periods include two 2-week long intervals before and after the stimulation, respectively, aiming to characterize potential background seismicity.

We present preliminary results from the analysis of more than 10,000 recorded seismic events. So far, seismic activity was not identified before or significantly after the pumping sequence; all seismic events correlate to ongoing fluid-injection cycles, e.g. during pressurization, or shortly after shut-in, i.e. the pressure-decay phase after termination of pumping. Most seismic events are recorded from injection intervals at 22.4 m, 24.6 m, and 28.1 m injection borehole depth, i.e. the three stimulated intervals that, out of the 10 in total, are closest to the sensor array. Few seismic events are recorded from injection borehole depth 33.9 m, and 37.6 m. No triggered events were recorded from injection intervals at a borehole depth > 40 m. This apparent difference in seismic activity likely correlates to recording limitations (e.g. due to intrinsic damping) or changes in rock properties. Seismic events outline complex structures both with vertical and horizontal orientation pointing towards (re-)activation of a fracture network.