EGU2020-22444
https://doi.org/10.5194/egusphere-egu2020-22444
EGU General Assembly 2020

Characteristics of induced seismicity during hydraulic stimulations

Georg Dresen[1,3], Stephan Bentz[1], Grzegorz Kwiatek[1,2], Patricia Martínez-Garzón[1], and Marco Bohnhoff[1,2]
[1]Helmholtz Centre Potsdam, German Research Centre for Geosciences GFZ, Section 4.2: Geomechanics and Scientific Drilling, Potsdam, Germany
[2]Department of Earth Sciences, Freie Universität Berlin, Berlin, Germany
[3]Institute of Earth and Environmental Sciences, Universität Potsdam, Potsdam, Germany

Near-realtime seismic monitoring of fluid injection allowed control of induced earthquakes during the stimulation of a 6.1 km deep geothermal well near Helsinki, Finland. The stimulation was monitored in near-real time using a deep seismic borehole array and series of borehole stations. Earthquakes were processed within a few minutes and results informed a Traffic Light System (TLS). Using near-realtime information on induced-earthquake rates, locations, magnitudes, and evolution of seismic and hydraulic energy, pumping was either stopped or varied. This procedure avoided the nucleation of a project-stopping red alert at magnitude M2.1 induced earthquake, a limit set by the TLS and local authorities. Our recent studies show that the majority of EGS stimulation campaigns investigated reveal a clear linear relation between injected fluid volume, hydraulic energy and cumulative seismic moments suggesting extended time-spans during which induced seismicity evolution is pressure-controlled. For most projects studied, the observations are in good agreement with existing physical models that predict a relation between injected fluid volume and maximum seismic moment of induced events. Some EGS stimulations however reveal unbound increase in seismic moment suggesting that for these cases evolution of seismicity is mainly controlled by stress field, the size of tectonic faults and fault connectivity. Transition between the two states may occur at any time during injection, or not at all. Monitoring and traffic-light systems used during stimulations need to account for the possibility of unstable rupture propagation from the very beginning of injection by observing the entire seismicity evolution in near-real-time and at high resolution could possibly provide a successful physics-based approach in reducing seismic hazard from stimulation-induced seismicity in geothermal projects.