Geophysical Research Abstracts
Vol. 17, EGU2015-1997, 2015
EGU General Assembly 2015

Rate- and state-dependent seismicity during fluid injection in rocks

Friedemann Wenzel
Karlsruhe Institute of Technology, Geophysical Institute, Karlsruhe, Germany (friedemann.wenzel@kit.edu)

Dieterich (1994) developed a theoretical frame of seismicity evolution due to stress changes in a medium based on rate- and state-theory of frictional fault motion. The theory assumes a volume density of seismic faults with a specific initial slip velocity distribution upon which the stress changes act. Each fault then follows the rate- and state-dependent frictional law where instabilities develop not as Coulomb failure. The evolution is expressed in the form of a differential equation, which can be used for aftershock generation after a shear stress change caused by a main shock but equally well for normal stress changes on faults caused by fluid pressure changes resulting from injection. For a constant injection rate the seismic activity increases at a given distance from the injection point once the pressure exceeds a threshold value. If the pressure rate is high enough the seismic activity becomes proportional to the local pressure rate in accordance with criticality theory of Shapiro (2002). Once the rate drops the seismicity reduced to lower levels. Shut off and variable injection rates must be evaluated numerically but lead to results comparable to the criticality theory. The presentation outlines the physical concept of the rate- and state-approach in comparison to the criticality approach and shows the main analytic and numerical results.