Geophysical Research Abstracts
Vol. 21, EGU2019-15530, 2019
EGU General Assembly 2019

A volume-based approach for modelling the reactivation of faults using the stress drop

Martin Beck and Holger Class

University of Stuttgart, Institute for Modelling Hydraulic and Environmental Systems, Department of Hydromechanics and Modelling of Hydrosystems, Stuttgart, Germany (martin.beck@iws.uni-stuttgart.de)

The current world's energy consumption relies heavily on the utilisation of the Earth's subsurface. Often the extraction of the raw materials requires fluid injections into the subsurface, be it in the context of the production of shale gas through hydraulic fracturing or in form of the disposal of waste-water from conventional and unconventional oil and gas production. Furthermore, geothermal power generation or the storage of carbon dioxide also involve the injection of fluids. Such injections have an effect on the pressure field of the fluids present in the subsurface as well as on the stress and the deformation of the reservoir rocks. This could become a critical issue when earthquakes are induced by these injections. Thus, it is important to understand the interaction of the hydraulic and geomechanical processes. Numerical simulations are a powerful tool for this purpose but require to choose an appropriate modelling concept. Using the Mohr Circle and the Mohr–Coulomb failure criterion to evaluate failure is a fairly undisputed approach, but different representations of the fault (e.g. by phase-field models, discrete surfaces or finite-thickness elements) and the physics during a seismic event (e.g. rate and state dependent friction, friction reduction independent of the slip rate) compete with each other.
Here, we propose a volume-based concept, where a seismic event is modelled by a characteristic drop in shear stress on the fault. This combines the use of finite-thickness elements with the rather confined range of stress drops independent of the scale known from observations. This new approach produces consistent and plausible results, is applicable to field-scale scenarios and capable of capturing effects observed in reality. The most interesting finding with respect to the processes that lead to fault reactivation is that a higher permeability of the fault zone could possibly result in a larger earthquake.