Description of doctoral project and research results achieved to date

By injecting fluids into the subsurface, many technologies linked with underground resources change the stress state. In the context of applications such as hydraulic fracturing, geothermal stimulation or waste water injection, this can lead to the reactivation of pre-existing faults. This may sometimes be a desired result to enhance the productivity of the reservoir exploitation, but can become crucial for the public perception of a project (e.g., Kölb et al. (2013)). This highlights the necessity to increase the knowledge base of coupled hydraulic and geomechanical modelling to better understand the relevant processes that lead to fault reactivation. Within the scope of this doctoral thesis, we work along the hypothesis that this goal can be achieved by using a volume-based approach, which does not require to model the fault as a discrete surface but as an element representing a fault zone instead.

Currently, an approach has been developed, which is based on the energy balance during slip events from Kanamori (2001) and the observation, that seismic data (e.g., Abercrombie and Leary (1993)) allows to infer a constant stress drop over a wide range of scales. By using the viscoelastic Maxwell model as a phenomenological equivalent to the stress dissipation during fault slip, these characteristics could be reproduced with the model. This, in turn, provided the opportunity to gain new insights into the circumstances that lead to the reactivation of faults. While the first simulation results mainly served as plausibility checks, the recent work is directed towards comparing the model approach with established schemes developed by other groups, e.g. by Rutqvist et al. (2013) and Cappa and Rutqvist (2010). The anticipated goal of the doctoral theses is to intensify these efforts and to conduct a benchmark study on fault reactivation using different simulation tools and approaches.

References:


