Master Thesis Proposal

Temperature induced fault slip experiments

Background and motivation

Injection-induced seismicity poses a great challenge to the sustainable development of unconventional geo-energy systems, and this is especially the case for enhanced geothermal systems (EGS) (Elsworth et al. 2016; Zang et al. 2014). The mechanisms underpinning injection-induced seismicity in geothermal reservoirs can be different from other settings involving fluid injection, such as the shale oil- and gas- producing and wastewater disposal cases, presumably due to the temperature effects. In deep geothermal reservoirs, cold-water injection can increase the pore pressure and thus reduce the effective normal stress in the reservoir, promoting the occurrence of injection-induced fault instability (Ji and Wu 2020). Moreover, thermal contraction of the reservoir due to the cooling effect of cold-water circulation and evaporation further reduces the normal stress and encourages the injection-induced fault failure (Im et al. 2021). The magnitude of effective normal stress is also an important factor governing the mode (aseismic v.s. seismic) and magnitude of seismic moment release (Scholz 1998). In addition, the fluid thermodynamics plays a significant role in controlling the fault weakening mechanisms during dynamic failure (Acosta et al. 2018). Nevertheless, the processes that causes critically stressed hot faults to slip under cold-water injection are poorly constrained.

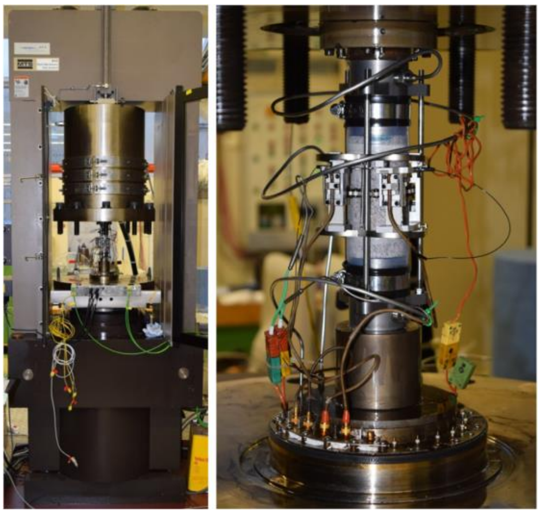

Fig.1. Triaxial test cell with sample (left) and close-up on a sample installed in the triaxial test cell (right).The sample is equipped with one circular and two axial extensometers (Hofmann et al. 2016).

Tasks and work program

In this study, we propose to conduct a series of laboratory experiments in a triaxial cell (Fig. 1) to systematically investigate the controls of cold-water injection and injection rate on fault slip. Fiber optic sensors will be used to measure the local temperature and fluid pressure near the fault wall during the experiments. The results harvested from this study are expected to shed light on the thermal-hydro-mechanical (THM) mechanisms underlying injection-induced seismicity in deep geothermal systems and provide implications for seismic risk management.

References

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