



Preliminary stress characterization for an in-situ stimulation experiment at the Grimsel Underground Laboratory

Hannes Krietsch (1), Joseph Doetsch (1), Valentin Gischig (1), Florian Amann (1), Mohammadreza Jalali (1), Claudio Madonna (1), Keith Evans (3), Benoit Valley (5), Domenico Giardini (3), Stefan Wiemer (2), Hansruedi Maurer (3), and Simon Loew (4)

(1) Swiss Competence Center of Energy Research (SCCER-SoE), ETH Zurich, Switzerland(hannes.krietsch@erdw.ethz.ch), (2) Swiss Seismological Service, ETH Zurich, Switzerland, (3) Institute for Geophysics, ETH Zurich, Switzerland, (4) Institute for Engineering Geology, ETH, Zurich, Switzerland, (5) University of Neuchâtel, Neuchâtel, Switzerland

A decameter-scale in-situ stimulation experiment is currently being executed at the Grimsel Test Site in Switzerland, spanning from hydraulic fracturing to controlled fault-slip experiments. For the feasibility of this project the in-situ stress tensor is of foremost importance. Therefore a unique stress characterization campaign combining stress relief methods (overcoring of USBM and CSIRO-HI probes) with hydraulic fracturing (HF) and hydraulic testing on pre-existing fractures (HTPF) in three boreholes was conducted in a first phase of this project. During all hydraulic stress measurements, micro-seismicity was monitored and localized in real time utilizing a dense network of piezo-electric sensors.

In this contribution, we present preliminary results of the stress characterization and compare the derived stress tensor with previous estimates of the stress state. The stress characterization campaign was conducted in three boreholes, one sub-vertical and two sub-horizontal boreholes, assuming that the sub-vertical and one sub-horizontal are parallel to a principal stress component. A major task in this contribution is the integration of the different stress characterization methods.

Our results of the different methods (overcoring and HF) are largely consistent, but disagree with some of the previous stress orientation estimates. From the new campaign the overcoring measurements indicate a sub-horizontal σ_1 of 17.3 MPa with a strike of 145° , a σ_2 of 9.7 MPa with $241^\circ/69^\circ$ and a σ_3 of 8.3 MPa with $055^\circ/21^\circ$ using an isotropic approach for inversion calculation. Whereas the USBM-Probe measures a projection of the principal stresses in a plane normal to borehole axis, the CSIRO-HI Probe provides the real 3D stress tensor. The HF and HTPF measurements indicate a far-field minimum horizontal stress between 8.7 and 9.1 MPa, consistent with the overcoring. Principal stresses, estimated by location of micro-seismic events during HF and HTPF, suggest that the maximum horizontal stress strikes EW, the minimum horizontal stress strikes NS and σ_2 stress direction is sub-vertical dipping towards south. One sub-horizontal borehole dedicated to stress characterization penetrates one of the fault zones targeted for a future fault-slip experiment. Results reveal a significant drop in the minimum stress component towards the fault zone. This stress information will be critical for the planning of the stimulation phase of the project.