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Stress inversion using borehole images and geometry evolution of the fractures in the Rittershoffen EGS project (Alsace, France).

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In the Upper Rhine Graben, several deep geothermal projects based on the Enhanced Geothermal System (EGS) exploit local geothermal reservoirs. The principle underlying this technology consists of increasing the hydraulic performances of the reservoir by stimulating natural fractures using different methods, in order to extract hot water with commercially flow rates. In this domain, the knowledge of the in-situ stress state is of central importance to predict the response of the rock mass to stimulations.
Here we characterized the stress tensor from Ultrasonic Borehole Imager (UBI) in the open hole section of the EGS doublet located in Rittershoffen, France (in the Upper Rhine Graben). Interestingly extensive logging programs were leaded at different key moments of the development of the injection well using hydraulic, thermal and chemical stimulation (Baujard et al., 2017)1. The time lapse UBI dataset consists of images of the injection well before, shortly and lastly after the stimulation.
The geometry of the induced fractures in compression (breakouts) picked on the UBI images are used to determine the orientation of the in-situ stress tensor. The magnitude of the principal stresses is deduced from the drilling data. The magnitude of the maximum horizontal principal stress is evaluated using an inversion method with three failure criteria (Mohr-Coulomb, Mogi-Coulomb and modified Hoek-Brown criterion) and under the assumption of a vertical or a deviated well.
Moreover, the characteristic of the dataset enables the analysis of the evolution of the borehole fracturing, as the deepening or widening of the induced fractures. The correlation of the UBI image allows firstly to determine the tool trajectory and to adapt the post and pre-stimulation images. It secondly leads to the estimation of a complete displacement field which characterizes the deformation induced by the stimulations.
Even if the variable image quality deeply conditions the comparison, the considered dataset enabled a consistent evaluation of the in-situ stress field taking place in the underground of the EGS plant, as showed by the comparison to results obtained in the vicinity. Moreover, the study of the evolution of fracturing shows the influence of the stimulation process on the fractures geometry.

1(Baujard, C., Genter, A., Dalmais, E., Maurer, V., Hehn, R., Rosillette, R., Vidal, J., Schmittbuhl, J., 2017). Hydrothermal Characterization of wells GRT-1 and GRT-2 in Rittershoffen, France: Implications on the understanding of natural flow systems in the Rhine Graben, Geothermics, 65, 255–268.