EGU22-12768
https://doi.org/10.5194/egusphere-egu22-12768
EGU General Assembly 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Constraining horizontal stress orientations from acoustic borehole televiewer logs in Högsbo, Southwest Sweden: geothermal exploration

Maria Ask[1,2] and Simona Pierdominici[3]
[1]Uppsala University, Earth Sciences, Uppsala, Sweden (Maria.Ask@geo.uu.se)
[2]Luleå University of Technology, Civil, Mining and Environmental Engineering, Luleå, Sweden (maria.ask@ltu.se)
[3]Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum - GFZ, Potsdam, Germany

There is an increased interest in Scandinavia for development of deep geothermal energy as fossil-free heat-source of district heating system. As part of exploration for Enhanced Geothermal System (EGS) to 5-7 km depth where the groundwater temperature is 120°C can potentially be extracted at 5-7 km depth, Göteborg Energi AB has cored a 1 km deep borehole in Högsbo, southwest Sweden. The objectives of testing was to (1) measure in situ temperatures and derive the geothermal gradient, (2) measure thermal properties of the bedrock, and (3) constrain hydrogeological and mechanical properties of the fracture zone.

The target for drilling and a subsequent EGS facility, is a heat-producing granite that is overlain by a regional fracture zone with inferred elevated permeability. The in-situ temperature of this type granite is boosted by radioactive gamma-ray decay from heat producing elements (K, U, Th).

Knowledge of the state of stress is central to understand bedrock stability, induced seismicity and fluid flow patterns. Acoustic borehole televiewer logging was conducted to map fracture occurrence and their geometry, as well as to investigate of stress-induced failure has occurred in the wellbore. For vertical boreholes, drilled parallel with a principal (vertical) stress, borehole breakouts and drilling induced tensile fractures reveal the orientation of minimum- and maximum horizontal stress, respectively, if the tangential stress concentration generated by the borehole overcomes the compressional and tensile strength of the rock mass, respectively.

An unexpected large number of stress indicators has been observed, both borehole breakouts and drilling induced tensile fractures. We observed two types of borehole breakouts: (1) Well-developed borehole breakouts that are clearly visible on both travel-time and amplitude logs; and (2) Poorly-developed borehole breakout that are best visible on the Amplitude log. The shallowest stress indicators are observed from 172-174 m depth, where both types of indicators show NNW-SSE orientation of maximum horizontal stress. This orientation is confirmed from deeper observation, regardless of type of stress indicator. It appears that the regional fracture zone is not influencing the orientation of the stress field in the borehole.

The observations of overlapping drilling induced tensile fractures and borehole breakouts, from

such a shallow depth is interesting. It raises questions regarding the magnitudes of stress and the strength of the rock mass. We note that elevated temperature during drilling may induce thermal stresses that favors the formation of drilling induced tensile fractures. On the other hand, the heat producing granites also are known to be probe to weathering. Further studies are required to understand the observed stress indicators, but it appears that the stress orientation is uniform.