Geophysical Research Abstracts
Vol. 16, EGU2014-1514, 2014
EGU General Assembly 2014

Pre-drilling calculation of geomechanical parameters for safe geothermal wells based on outcrop analogue samples

Dorothea Reyer and Sonja Philipp

Georg-August Universität Göttingen, Geoscience Centre, Structural Geology and Geodynamics, Göttingen, Germany (dorothea.reyer@geo.uni-goettingen.de)

It is desirable to enlarge the profit margin of geothermal projects by reducing the total drilling costs considerably. Substantiated assumptions on uniaxial compressive strengths and failure criteria are important to avoid borehole instabilities and adapt the drilling plan to rock mechanical conditions to minimise non-productive time.

Because core material is rare we aim at predicting in situ rock properties from outcrop analogue samples which are easy and cheap to provide. The comparability of properties determined from analogue samples with samples from depths is analysed by performing physical characterisation (P-wave velocities, densities), conventional triaxial tests, and uniaxial compressive strength tests of both quarry and equivalent core samples. "Equivalent" means that the quarry sample is of the same stratigraphic age and of comparable sedimentary facies and composition as the correspondent core sample.

We determined the parameters uniaxial compressive strength (UCS) and Young's modulus for 35 rock samples from quarries and 14 equivalent core samples from the North German Basin. A subgroup of these samples was used for triaxial tests. For UCS versus Young's modulus, density and P-wave velocity, linear- and non-linear regression analyses were performed. We repeated regression separately for clastic rock samples or carbonate rock samples only as well as for quarry samples or core samples only. Empirical relations were used to calculate UCS values from existing logs of sampled wellbore. Calculated UCS values were then compared with measured UCS of core samples of the same wellbore. With triaxial tests we determined linearized Mohr-Coulomb failure criteria, expressed in both principal stresses and shear and normal stresses, for quarry samples. Comparison with samples from larger depths shows that it is possible to apply the obtained principal stress failure criteria to clastic and volcanic rocks, but less so for carbonates. Carbonate core samples have higher strengths and develop larger angles between fault normal and main principal stress than quarry samples. This considerably reduces the residuals between quarry failure criteria and core test results. Therefore, it is advised to use failure criteria, expressed in shear and normal stresses, for prediction of core sample failure conditions.

We conclude that it is possible to apply failure criteria to samples from depth if the comparability, especially textural comparability, of chosen outcrop analogues samples is ensured. Applicability of empirical relations of UCS with Young's modulus and P-wave velocity for pre-drilling calculation of UCS from logs of existing adjacent wellbores is expected. Presented results may help predict mechanical properties of in situ rocks, and thus develop suitable geomechanical models for the adaptation of the drilling strategy on rock mechanical conditions.

Acknowledgements

The authors appreciate the support of 'Niedersächsisches Ministerium für Wissenschaft und Kultur' and 'Baker Hughes' within the gebo research project (http://www.gebo-nds.de).