GeoTHERM expo & congress

Freitag, 27. Februar 2026, 9.50 Uhr
Ortenauhalle Kongress 1
Tiefe Geothermie

Friday, 27 February 2026, 9.50 am
Ortenauhalle Congress 1
Deep geothermal energy

Integrated static, dynamic, and geomechanical modeling of an EGS site: the Utah FORGE case study

Integrierte statische, dynamische und geomechanische Modellierung eines EGS-Standorts: die Fallstudie Utah FORGE

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Enhanced geothermal systems (EGS) have the potential to accelerate geothermal energy development beyond the traditional hydrothermal regions. However, the understanding, characterization, and modeling of EGS are challenging because of geological, structural, and mechanical complexity, before and after injection, production, and stimulation operations. Forecasting energy production and injection operations requires robust characterization and modeling approaches within the different geosciences and engineering disciplines. The integrated multidisciplinary approach accounts for key aspects of the geoscience and engineering domains while preserving consistency across multiple modeling stages.

We will describe an integrated workflow to characterize the properties and behavior of an enhanced geothermal system (EGS) in four steps, applied to the Utah FORGE dataset (Moore et al., 2020). The FORGE project was selected for its public access to geothermal data resources, which are shared to promote the understanding of EGS worldwide.

The first step of the workflow is generating a 3D geological model (Mulyani et al., 2023), comprising the site's geological structure, including faults and lithological boundaries, as a 3D grided model. Well and surface data are used to model the lithology distribution and to predict the temperature. A discrete model of natural fractures is constructed with a tectonic-based prediction algorithm and used in turn to derive permeability distributions.

The second step is stimulation design (Khan et al., 2024), based on reservoir mechanical properties and natural fracture geometry and incorporating stimulation engineering constraints (pumping strategy, fluid and proppant properties) which allows for forecasting hydraulic fracture propagation and selecting the most effective stimulation strategy. The results show that the choice of a more complex model, together with the incorporation of the natural fracture network model, allows obtaining a more accurate model of the hydraulic fractures.

Dynamic heat and fluid flow simulations then calibrate the permeability of the natural and hydraulic fractures, as well as the initial temperature distribution, by matching them to a circulation test and to the temperature gradient respectively. At this stage, the model is considered representative and used to run 30-year forecasts of heat production.

Finally, the flow simulations are coupled with a geomechanical model to compute stress changes over time. These results will be used to analyze the stability of the wellbore trajectories and the integrity of cement and completions, as well as the occurrence of rock failure and fault/fracture reactivation due to temperature and pressure changes, which in turn allow estimating induced seismicity.

References

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Moore, J., McLennan, J., and Pankow, K. (2020): The Utah Frontier Observatory for Research in Geothermal Energy (FORGE): A Laboratory for Characterizing, Creating and Sustaining Enhanced Geothermal Systems. In: 45th Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, February 10-12, SGP-TR-216.

Mulyani, S., Aulia, A.B., Wisnubroto, B., Widiatmoko, W., Pradana, A., Trikukuh, J.S., and Puspa, M.A. (2023): Comprehensive Study of Geology to Geomechanics for Delineating a Sweet Spot Map in a Geothermal Field. Study Case: Utah FORGE, USA. GRC Transactions, Volume 47