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Modelling Hydraulic and Thermal Responses in a Benchmark for Deep Geothermal Heat Production

E. Holzbecher and P. Oberdorfer
Germany (eholzbe@gwdg.de)

Geothermal heat production from deep reservoirs (5000-7000 m) is currently examined within the collaborative research program "Geothermal Energy and High-Performance Drilling" (gebo), funded by the Ministry of Science and Culture of Lower Saxony (Germany) and Baker Hughes. The projects concern exploration and characterization of geothermal reservoirs as well as production. They are gathered in the four major topic fields: geosystem, drilling, materials, technical system. We present modelling of a benchmark set-up concerning the geothermal production itself.

The benchmark model "Horstberg" was originally created by J. Löhken and is based on geological data, concerning the Horstberg site in Lower Saxony. The model region consists of a cube with a side length of 5 km, in which 13 geological layers are included. A fault zone splits the region into two parts with shifted layering. A well is implemented, reaching from the top to an optional depth crossing all layers including the fault zone. The original geological model was rebuilt and improved in COMSOL Multiphysics Version 4.2a.

The heterogeneous and detailed configuration makes the model interesting for benchmarking hydrogeological and geothermal applications. It is possible to inject and pump at any level in the well and to study the hydraulic and thermal responses of the system. The hydraulic and thermal parameters can be varied, and groundwater flow can be introduced. Moreover, it is also possible to examine structural mechanical responses to changes in the stress field (which is not further examined here).

The main purpose of the presented study is to examine the dynamical flow characteristics of a hydraulic high conductive zone (Detfurth) in connection to a high conductive fault. One example is the fluid injection in the Detfurth zone and production in the fault. The high conductive domains can provide a hydraulic connection between the well screens and the initiated flow circuit could be used for geothermal heat production. The dependence of the flow regime and heat production on parameters like pumping rate, aquifer velocity and well position is demonstrated.

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