

EGU21-12419

<https://doi.org/10.5194/egusphere-egu21-12419>

EGU General Assembly 2021

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Predicting Optimal Borehole Locations for Parameter Estimation in Geothermal Reservoirs Using Optimal Experimental Design

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Drilling boreholes during exploration and development of geothermal reservoirs not only involves high cost, but also bears significant risks of failure. In geothermal reservoir engineering, techniques of optimal experimental design (OED) have the potential to improve the decision making process. Previous publications explained the formulation and implementation of this mathematical optimization problem and demonstrated its feasibility for finding borehole locations in two- and three-dimensional reservoir models that minimize the uncertainty of estimating hydraulic permeability of a model unit from temperature measurements. Subsequently, minimizing the uncertainty of the parameter estimation results in a more reliable parametrization of the reservoir simulation, improving the overall process in geothermal reservoir engineering.

Various OED techniques are implemented in the Environment for Combining Optimization and Simulation Software (EFCOSS). To address problems arising from geothermal modeling, this software framework links mathematical optimization software with SHEMAT-Suite, a geothermal simulation code for fluid flow and heat transport through porous media. This contribution shows how to determine experimental conditions such that the uncertainty when estimating different parameters of model units from temperature measurements in the borehole is minimized. Numerical simulations of synthetic geothermal reservoir scenarios are presented to demonstrate the OED workflow and its applicability to geothermal reservoir modeling