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Better temperature predictions in geothermal modelling by improved quality of input parameters: a regional case study from the Danish-German border region

Sven Fuchs, Thue S. Bording, and Niels Balling
Aarhus University, Department of Geoscience, Aarhus, Denmark (fuchs@geo.au.dk)

Thermal modelling is used to examine the subsurface temperature field and geothermal conditions at various scales (e.g. sedimentary basins, deep crust) and in the framework of different problem settings (e.g. scientific or industrial use). In such models, knowledge of rock thermal properties is prerequisites for the parameterisation of boundary conditions and layer properties. In contrast to hydrogeological ground-water models, where parameterization of the major rock property (i.e. hydraulic conductivity) is generally conducted considering lateral variations within geological layers, parameterization of thermal models (in particular regarding thermal conductivity but also radiogenic heat production and specific heat capacity) in most cases is conducted using constant parameters for each modelled layer. For such constant thermal parameter values, moreover, initial values are normally obtained from rare core measurements and/or literature values, which raise questions for their representativeness. Some few studies have considered lithological composition or well log information, but still keeping the layer values constant.

In the present thermal-modelling scenario analysis, we demonstrate how the use of different parameter input type (from literature, well logs and lithology) and parameter input style (constant or laterally varying layer values) affects the temperature model prediction in sedimentary basins. For this purpose, rock thermal properties are deduced from standard petrophysical well logs and lithological descriptions for several wells in a project area. Statistical values of thermal properties (mean, standard deviation, moments, etc.) are calculated at each borehole location for each geological formation and, moreover, for the entire dataset. Our case study is located at the Danish-German border region (model dimension: 135 x115 km, depth: 20 km).

Results clearly show that (i) the use of location-specific well-log derived rock thermal properties and (i) the consideration of laterally varying input data (reflecting changes of thermofacies in the project area) significantly improves the temperature prediction. Thus, the prediction error can easily be reduced by up to 75 % (not calibrated) and up to 50 % (calibrated models), respectively.