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Estimating the subsurface temperature of Hessen/Germany based on a GOCAD 3D structural model – a comparison of numerical and geostatistical approaches

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Based on a 3D structural GOCAD model of the German federal state Hessen the subsurface temperature distribution is computed. Since subsurface temperature data for greater depth are typically sparse, two different approaches for estimating the spatial subsurface temperature distribution are tested.
One approach is the numerical computation of a 3D purely conductive steady state temperature distribution. This numerical model is based on measured thermal conductivity data for all relevant geological units, together with heat flow measurements and surface temperatures. The model is calibrated using continuous temperature-logs. Here only conductive heat transfer is considered as data for convective heat transport at great depth are currently not available.
The other approach is by 3D ordinary Kriging; applying a modified approach where the quality of the temperature measurements is taken into account. A difficult but important part here is to derive good variograms for the horizontal and vertical direction. The variograms give necessary information about the spatial dependence.
Both approaches are compared and discussed. Differences are mainly related due to convective processes, which are reflected by the interpolation result, but not by the numerical model. Therefore, a comparison of the two results is a good way to obtain information about flow processes in such great depth. This way an improved understanding of this mid enthalpy geothermal reservoir (1000 – 6000 m) is possible.
Future work will be the reduction of the small but - especially for depth up to approximately 1000 m - relevant paleoclimate signal.