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Temperature predictions for geothermal exploration – a lithospheric-scale 3D approach applied to the northern Upper Rhine Graben

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The Upper Rhine Graben and its prolongation, the Hessian depression, were formed as part of the European Cenozoic Rift System in a complex extensional to transtensional setting. At present-day, the Upper Rhine Graben is one of the regions in Germany that are well suitable for deep geothermal exploitation. In the framework of the EU-funded project "IMAGE" (Integrated Methods for Advanced Geothermal Exploration) we aim to contribute to the development of an integrated and multidisciplinary approach for the exploration of geothermal reservoirs by understanding the processes and properties controlling the spatial distribution of key parameters such as the underground temperature.

Typically, reservoir-scale numerical models are developed for predictions on the subsurface hydrothermal conditions and for reducing the risk of drilling non-productive geothermal wells. One major problem related to such models is setting appropriate boundary conditions that define, for instance, how much heat enters the reservoir from greater depths. To understand the deep thermal field of the northern Upper Rhine Graben in the federal state of Hessen, we first develop a 3D structural model that differentiates the main geological units of the lithosphere including the shallow sedimentary fill. This model allows to solve the steady-state conductive heat equation and understand the first-order controlling factors of the regional thermal field.

We present the database (e.g. seismic reflection data) and the methodological workflow (involving, e.g., 3D gravity modelling) that were used to develop the lithospheric-scale 3D structural model. Furthermore, we show how certain features of the structural model such as thickness variations of the radiogenic-heat-producing crystalline crust control the temperature distribution in the subsurface.