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3D thermal modelling of the Upper Rhine Graben

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The Upper Rhine Graben (URG) is a promising target for deep geothermal energy production. As part of the EU-funded project “IMAGE” (Integrated Methods for Advanced Geothermal Exploration, grant agreement no. 608553), we aim to understand the processes that control the temperature distribution in the subsurface of the URG by using numerical simulations.
Reservoir-scale numerical models are often used to predict the hydrothermal conditions and to reduce the risk of drilling non-productive geothermal wells. One major problem related to such reservoir-scale models is setting appropriate boundary conditions that define, for instance, how much heat enters the reservoir from greater depths. To overcome this problem, we combine lithospheric-scale 3D structural and thermal modelling with higher resolved hydrothermal models of the sedimentary basin fill in a workflow of successive modelling steps. After model parameterization with thermal rock properties we solve the steady-state conductive heat equation first to calculate the 3D conductive thermal field and to understand the first-order controlling factors of the regional temperature distribution.
In a second step we took into account the fluid flow due to permeability variations in the porous media and the influence of major faults, which locally change the temperature distribution. These numerical simulations of coupled heat and fluid transport were performed on smaller and higher resolved models of the basin fill for which the conductive thermal model provide the thermal boundary conditions.
We present the methodological workflow, the developed 3D structural and thermal models, and assess how heat transport mechanisms in response to lithological and structural features on different scales control subsurface temperatures.