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From 3D gravity to coupled fluid and heat transport modelling - a case study from the Upper Rhine Graben

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Numerical models that predict and help to understand subsurface hydrothermal conditions are key to reduce the risk of drilling non-productive geothermal wells. Such simulations of coupled fluid and heat transport need a reliable 3D structural model. Therefore, we use an integrated approach of data-based 3D structural, gravity, conductive thermal and thermo-hydraulic coupled modelling.

The Upper Rhine Graben (URG) is known for its large potential for deep geothermal energy that is already used in e.g. Soultz-sous-Forêts. In the frame of the EU-funded project “IMAGE” (Integrated Methods for Advanced Geothermal Exploration, grant agreement no. 608553), we assess the dominant processes and effective physical properties that control the deep thermal field of the URG. Therefore, we have built a lithospheric-scale 3D structural model of the URG by integrating existing data-based 3D models, deep seismic reflection and refraction profiles, as well as receiver function data. 3D gravity modelling was used to assess the internal configuration of the upper crystalline crust in addition to deep seismic lines. The resulting gravity-constrained 3D structural model was then used as base to calculate the 3D conductive thermal field. An analysis of deviations between measured and calculated temperatures revealed that heat transport connected to fluid circulation is probably relevant at depths above 2500 m. To test this hypotheses smaller-scale and higher resolution models for coupled fluid and heat transport were simulated.
We present the results from this combined workflow considering 3D gravity and 3D thermal modelling.