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Depth Dependence of Geothermal Reservoir Parameters - Examples from the Rotliegend and Buntsandstein of the Northern Upper Rhine Graben (Germany)

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For the Federal State of Hesse the deep geothermal potential was quantified and assessed in a qualitative analysis within the scope of the research project "3D-modelling of the deep geothermal potentials of Hesse". The quantification of the heat stored in the subsurface and the qualitative analysis was done for different geothermal systems such as hydrothermal and petrothermal systems, as well as fault zones and deep borehole heat exchangers. In Hesse the clastic reservoir formations of the mesozoic Buntsandstein and the paleozoic Rotliegend in the subsurface of the northern Upper Rhine Graben are most promising for deep geothermal usage.

For the assessment of the deep geothermal potential of the clastic reservoir rocks of the northern Upper Rhine Graben, knowledge of their geothermal properties is indispensable. Therefore, a data set of outcrop analogue studies, borehole data and core investigations as well as hydraulic test data at the eastern and western graben shoulder has been compiled for both formations. Systematic measurements of thermophysical and hydraulic rock properties such as thermal conductivity, heat capacity, permeability and porosity of rock samples as well as the hydraulic test data have been combined with in-situ temperature measurements, hydrothermal upwelling zones and characteristics of geological faults and were incorporated into a structural 3D model (cf. Arndt et al. 2011). Since both the hydraulic and thermophysical properties strongly depend on the in situ conditions of the reservoir, the lab and field data need to be adapted considering the temperature and pressure within the reservoir. Therefore, the outcrop analogue data was compared with in situ data from old hydrocarbon exploration wells within the graben and from deep wells in adjacent regions to develop empiric functions for the depth and temperature dependence of the different parameters.

The resulting geothermal model, which incorporates the compiled thermophysical and hydraulic properties of the different reservoir formations including their depth and temperature dependence, is an important tool, which can be used at an early stage of the planning phase for the design of geothermal power plants. Furthermore, it allows quantification of the deep geothermal potential and can be used as a basis for detailed numeric reservoir models of distinct geothermal projects.