Geophysical Research Abstracts
Vol. 20, EGU2018-14676, 2018
EGU General Assembly 2018
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Determining deep geothermal potentials based on integrated multi-scale datasets and models: case study of the Federal State of Hesse (Germany)

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For the Federal State of Hesse so far no regional assessment of petrothermal or medium deep geothermal resources for direct heat use and underground thermal energy storage (UTES) are available. The project “Hessen 3D 2.0” aims to bridge this gap to significantly enhance the assessment of the prospective risk (‚Fündigkeitsrisiko) for geothermal projects in Hesse.
The project is focused in a first step on developing and extending a database on the physical rock-, fluid- and reservoir properties based on lab measurements on cores from deep wells and outcrop analogues, hydraulic test data from boreholes and borehole geophysical logs. In a second step borehole data, cross sections, seismic profiles and geological maps are combined to significantly increase the detail of existing 3D geological models of Hesse to be able to distinguish both the petrological units of the basement and the potential reservoir formations in the sedimentary cover. The comprehensive geothermal database is used in a third step to attribute the geological model and allows for geothermal resource assessment and thermohydraulic subsurface modelling.
Thermohydraulic modelling considering the variation of rock and reservoir properties will provide a much better understanding of the subsurface temperature distribution and the dominant heat transport processes. This approach will significantly increase the reliability of subsurface temperature predictions compared to purely interpolative approaches in areas or depths where temperature measurements are sparse or simply not available.
The 3D model based assessment of hydrothermal, petrothermal and UTES potentials will consider both technical and economic boundary conditions and of course the statistics for the different relevant reservoir properties of the different geological units. This will allow for stochastic assessment of the potentials including the determination of the probability of success, which is one of the key requirements for risk insurance (‘Fündigkeitsrisikoversicherungen’) and will provide the necessary numbers to attract investors to geothermal projects.
Eventually, the geothermal potentials will be linked to the heat demand of cities (e.g. Frankfurt a.M.), which helps identifying economically suitable locations for geothermal projects. Furthermore, the results will be published online and as open-access information so that project developers, planers, local or regional energy companies, government institutions as well as scientists can interactively access and use all provided information.