Assessment of Petrothermal Potentials: An Exploration Scheme for Mid-German Crystalline High Basement Rocks

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Key requirement for geothermal power production are temperatures of at least 100°C, while the obtainable flow-rate mainly controls the economic viability. Many geotectonic settings only provide such reservoir temperatures in depths of 3 km or more. Hydrothermal systems reach such temperatures only in specific geotectonically active settings, e.g. the Upper Rhine Graben or the Molasse basin in Germany, and usually are already under exploration and exploitation. Besides these easily accessible hydrothermal systems, which only make up a small share of the overall geothermal potential, petrothermal systems in crystalline or metamorphic basement rocks provide a much larger and ubiquitous resource. Locating and quantifying these petrothermal potentials is still a challenging task.

A newly developed exploration scheme for petrothermal potentials is proposed and applied to the crystalline basement of the Mid-German Crystalline High in the federal state of Hesse, Germany. The exploration is composed by three tiers and subdivided in an outcrop analogue study, a conceptual geological 3D-structural model and the estimation of petrothermal potentials based on the comprehensive geothermal 3D-model composed as result of the first two tiers.

On the example of the Mid-German Crystalline High basement rocks, the assessment scheme is demonstrated. Therefore, the geological 3D-structural model which is based on geophysical, structural geological and well data is presented. Petrophysical rock properties such as porosity, grain and bulk density, compressional wave velocity but also thermal conductivity and thermal diffusivity are measured on outcrop analogue samples and fed into a custom-made weighting matrix as basis for a multi-criteria decision making system. Together with additional criteria such as reservoir geometry, rock mechanical and structural geological features, qualitative potential assessment is performed. Quantification of the petrothermal potentials will be applied by the volumetric method and assumption of recovery factors for petrothermal systems based on operating systems worldwide.

Petrothermal potentials are displayed in the geological model.