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Geothermal reservoir properties of the Rotliegend (Permocarboniferous) sediments in the Saar Nahe Basin (South-West Germany)

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The geothermal potential of the Rotliegend (Permocarboniferous) in the Northern Upper Rhine Graben and the Saar-Nahe-Basin (Germany) has been shown in large scale regional studies. To further assess the geothermal potential of the different lithostratigraphical units and facies types within this Variscan intramontane basin, knowledge of their thermophysical and hydraulic properties is indispensable.

Where the Cenozoic Upper Rhine Graben crosses the Permocarboniferous molasse basin, the top of the up to two kilometers thick Permocarboniferous deposits is located at a depth of one to three kilometers and is overlain by Tertiary and Quaternary sediments. Therefore, the reservoir temperatures exceed 150°C, making it suitable for geothermal power production. Lithologically the Permocarboniferous deposits consist of different formations and facies types including fine, middle and coarse grained sandstones, arcosic sandstones, siltstones, volcanics and carbonates.

Within the framework of the study presented here, outcrop analogue studies west of the Graben in the Saar-Nahe-Basin, and east of the Graben in the Wetterau and the Wetterau-Fulda-Basin are conducted. Each lithostratigraphic formation and lithofacies type is sampled in various outcrops to generate a statistically sufficient amount of samples of the different sedimentary rocks in order to determine their petrophysical, sedimentological and geochemical characteristics. The petrophysical parameters measured include the porosity, permeability, density, thermal conductivity, thermal diffusivity and uniaxial compressive strength. So far, the petrophysical properties of samples of more than 70 locations have been measured in our lab facilities, showing a clear correlation with the facies type. Excluding the coarse grained sandstones of the Donnersberg formation at the beginning of the Nahe-subgroup of the Upper Rotliegend, the geothermal reservoir properties are more suitable in the Glan-subgroup of the Lower Rotliegend due to the increasing fraction of fluviatil facies with low sinuosity meander belts, that transported coarse grained and feldspar-rich sediments from along the basin axis. The next steps will include geochemical as well as petrographic-sedimentological analysis of each sample to study the mineral composition, the intergranular volume and diagenesis. Furthermore, the rock mass permeability is evaluated using hydraulic test data of wells intersecting the Permocarboniferous in the Saar Nahe Basin and other analogue areas, already showing a link between hydraulic conductivity and fault structures within the basin.

Based on drilling and seismic data as well as geological maps together with the compiled petrophysical and hydraulic data, it is planned to establish a 3D reservoir model of the Northern Upper Rhine Graben and the western Saar-Nahe-Basin. Due to the importance of fault zones, lithostratigraphical units and facies types, detailed modelling will allow a more reliable assessment of the geothermal potential. This model could be used for a better prediction of reservoir temperatures and production rates and will decrease the exploration risk.