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Exploring the Buntsandstein as geothermal reservoir unit - A case study from northeastern Hesse on the influence of lithofacies on petrophysical properties

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Within the scope of the joint research project “Hessen 3D 2.0” the medium deep geothermal potential for direct heat use and heat storage is assessed for the Federal State of Hesse. A geological-geothermal 3D model is constructed based on well data, geological cross sections, existing 3D models and measurements of the relevant petrophysical, thermal and hydraulic rock properties and used as a basis for the regional evaluation of the geothermal potential. Therefore, hydraulic and thermophysical properties are investigated by means of core samples from deep wells, outcrop analogue studies and hydraulic test data. The results of this study on rock and reservoir properties serve to parametrize the model units.

In northeastern Hesse the Lower and Middle Triassic Buntsandstein comprise alternating sandstone and sandstone-pelite layers, which act as multi-level aquifer and aquiclude horizons. In certain regions these layers are located at depths suitable for geothermal heat extraction and storage by either borehole thermal energy storage or aquifer thermal energy storage systems.

Results of petrophysical analyses on Buntsandstein samples from northern and eastern Hesse indicate a significant impact of the depositional environment and diagenesis on thermophysical and hydraulic rock properties. Therefore, in the geological-geothermal 3D model the Buntsandstein units need to be distinguished according to facial aspects, depositional environment and basin position. The lithofacies-based geothermal parametrization allows for the designation of the geothermal potential in northeastern Hesse for direct heat use and seasonal heat storage with open and closed geothermal systems.