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Statistically significant data base of rock properties for geothermal use

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The high risk of failure due to the unknown properties of the target rocks at depth is a major obstacle for the exploration of geothermal energy. In general, the ranges of thermal and hydraulic properties given in compilations of rock properties are too large to be useful to constrain properties at a specific site. To overcome this problem, we study the thermal and hydraulic rock properties of the main rock types in Germany in a statistical approach. An important aspect is the use of data from exploration wells that are largely untapped for the purpose of geothermal exploration. In the current project stage, we have been analyzing mostly Devonian and Carboniferous drill cores from 20 deep boreholes in the region of the Lower Rhine Embayment and the Ruhr area (western North Rhine Westphalia). In total, we selected 230 core samples with a length of up to 30 cm from the core archive of the State Geological Survey.

The use of core scanning technology allowed the rapid measurement of thermal conductivity, sonic velocity, and gamma density under dry and water saturated conditions with high resolution for a large number of samples. In addition, we measured porosity, bulk density, and matrix density based on Archimedes' principle and pycnometer analysis.

As first results we present arithmetic means, medians and standard deviations characterizing the petrophysical properties and their variability for specific lithostratigraphic units. Bi- and multimodal frequency distributions correspond to the occurrence of different lithologies such as shale, limestone, dolomite, sandstone, siltstone, marlstone, and quartz-schist. In a next step, the data set will be combined with logging data and complementary mineralogical analyses to derive the variation of thermal conductivity with depth. As a final result, this may be used to infer thermal conductivity for boreholes without appropriate core data which were drilled in similar geological settings.