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New approaches in the indirect quantification of thermal rock properties in sedimentary basins: the well-log perspective

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Numerical temperature models generated for geodynamic studies as well as for geothermal energy solutions heavily depend on rock thermal properties. Best practice for the determination of those parameters is the measurement of rock samples in the laboratory. Given the necessity to enlarge databases of subsurface rock parameters beyond drill core measurements an approach for the indirect determination of these parameters is developed, for rocks as well a for geological formations. We present new and universally applicable prediction equations for thermal conductivity, thermal diffusivity and specific heat capacity in sedimentary rocks derived from data provided by standard geophysical well logs. The approach is based on a data set of synthetic sedimentary rocks (clastic rocks, carbonates and evaporates) composed of mineral assemblages with variable contents of 15 major rock-forming minerals and porosities varying between 0 and 30%. Petrophysical properties are assigned to both the rock-forming minerals and the pore-filling fluids. Using multivariate statistics, relationships then were explored between each thermal property and well-logged petrophysical parameters (density, sonic interval transit time, hydrogen index, volume fraction of shale and photoelectric absorption index) on a regression sub set of data (70% of data) (*Fuchs et al., 2015*). Prediction quality was quantified on the remaining test sub set (30% of data). The combination of three to five well-log parameters results in predictions on the order of <15% for thermal conductivity and thermal diffusivity, and of <10% for specific heat capacity. Comparison of predicted and benchmark laboratory thermal conductivity from deep boreholes of the Norwegian-Danish Basin, the North German Basin, and the Molasse Basin results in 3 to 5% larger uncertainties with regard to the test data set. With regard to temperature models, the use of calculated TC borehole profiles approximate measured temperature logs with an error of <3°C along a 4 km deep profile. A benchmark comparison for thermal diffusivity and specific heat capacity is pending.

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