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Facies-related trends of rock thermal conductivity and the impact on temperature prognosis for geothermal target reservoirs

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To characterize the temperature regime in a sedimentary basin, knowledge of the rock thermal conductivity (TC) is vital. This also pertains to temperature prognosis for geothermal target reservoirs based on modelling, which in turn requires an assignment of TC values to model units. Those model units can consist of single lithotypes but are mostly composed of different lithotypes or different geological formations. It is common procedure in numerical modelling to use one single (average) value for a certain model unit only, i.e. ignoring spatial TC variations owing to changes in lithofacies.

This study addresses the shortcomings of the common parameterization of geothermal models with such TC averages. We show for two different geological settings, and exemplarily for specific geological formations, how strong geological-facies changes across a sedimentary basin can affect the TC. Especially for sedimentary basins of heterogeneous composition, the facies-related trends of TC may be significant. We demonstrate the impact of such TC variations on temperature by calculation of temperature profiles for a synthetic stratigraphic profile, considering different probable average in-situ TC values for the various stratigraphic units. This approach results in a broad envelope of temperature profiles. Considering the inner 50 % interval of the envelope, the uncertainty in depth estimation for a 70°C subsurface-temperature amounts to approximately 500 m. Likewise, the uncertainty for a 120°C temperature is on the order of 1,000 m.

Thus, the use of average formation TCs for a large sedimentary basin may cause big errors in temperature-depth predictions that affect the search for geothermal prospects and, consequently, may be of serious economic impact. A detailed analysis of facies types, related lithotype changes, and associated variations of thermal parameters is, therefore, indispensable to improve the understanding of the thermal pattern in a sedimentary basin.