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Thermal Conductivity Determination in the North German Basin: New Approaches - New Results.

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Thermal properties of rocks are first-order controls on the thermal structure of sedimentary basins. Reliable basin models therefore need to be based on credible in situ thermal conductivity values. Until today, no cost-efficient method for in-situ borehole measurements of thermal conductivity exists, and drill core samples on which thermal conductivity could be measured are rare and often limited to special exploration targets.

We report new results from thermal-conductivity measurements performed on drill core samples from five Mesozoic formations of the North German Basin. A total of 650 samples from nine boreholes were measured in the laboratory under ambient conditions using the TCS method (Fuchs et al., 2012a, in prep.). In order to fill the data gaps for the remainder of the Mesozoic and Cenozoic geological section a well-log based approach was developed and applied (Fuchs et al., 2012b, in prep.) The thermal conductivities resulting from this approach then were compared to those resulting from other published well-log based approaches. The applicability and performance of all these approaches was evaluated on two borehole locations by comparison with measured laboratory values.

Bulk thermal conductivity, corrected for in situ temperature, ranges between 2.7 and 3.7 $Wm^{-1}K^{-1}$ (sandstone), 1.6 and 3.2 $Wm^{-1}K^{-1}$ (siltstone), 1.4 and 2.8 $Wm^{-1}K^{-1}$ (claystone), 2.2 and 2.6 $Wm^{-1}K^{-1}$ (limestone) and 1.7 and 3.1 $Wm^{-1}K^{-1}$ (dolomite), respectively. Highest average sandstone values were observed in the Jurassic Aalenian (3.3 $\pm$ 0.7 $Wm^{-1}K^{-1}$) and in the Triassic Postera sandstone (3.3 $\pm$ 0.6 $Wm^{-1}K^{-1}$) and the lowest in the Triassic Stuttgart Formation (2.0 $\pm$ 0.1 $Wm^{-1}K^{-1}$), respectively.

The new well-log based approach applied to data sets from two borehole locations results in a linear prediction equation that is based on volume fraction of shale, neutron porosity and sonic travel time as descriptors. The approach applied to the Stuttgart Formation at Ketzin (the location of the CO_2SINK project), made up of muddy sandstone, marl, siltstone and claystone, shows the predicted thermal conductivity to be in error by 0.19 $Wm^{-1}K^{-1}$ (RMS-error). In general, the new equation provides a better fit (error reduction: 33-65%) to measured values as previously published prediction equations.