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Prediction of thermal conductivity of sedimentary rocks from well logs

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The calculation of heat-flow density in boreholes requires reliable values for the change of temperature and rock thermal conductivity with depth. As rock samples for laboratory measurements of thermal conductivity (TC) are usually rare geophysical well logs are used alternatively to determine TC. A common procedure in the latter approach is the use of empirical relations between TC and different petrophysical properties. Although numerous prediction equations were developed in the past five decades, none of these seem to be universally applicable for all major types of sedimentary rocks (clastics, carbonates and evaporites). In addition, these relations mostly are suitable only for regions and lithotypes for which they were originally developed. A new set of predictive equations is presented which overcomes these limitations and which allows the prediction of the rock matrix TC based on different combinations of standard geophysical well-logs. In combination with a feasible mixing-model (i.e. geometric mean model) bulk TC is computed along borehole profiles. The underlying approach was proposed by Fuchs & Förster (2014) and rests upon the detailed analysis of the interrelations between major physical parameters (i.e. thermal conductivity, density, hydrogen index, sonic interval transit time, gamma-ray response, photoelectric factor) of artificial mineral assemblages consisting 15 rock-forming minerals that are used in different combinations to typify sedimentary rocks. The predictive capacity of the new equations is evaluated on subsurface data from four boreholes drilled into the Mesozoic sequence of the North German Basin, including more than 1700 laboratory-measured thermal-conductivity values. Results are compared with those from other approaches published in the past. The new approach predicts TC with a mean error between 10 and 15 % compared to earlier approaches of much higher error of 15-35 % (and sometimes higher).