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Using Neural Networks to Predict Thermal Conductivity from Well Logs

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Terrestrial heat-flow is important to predict present-day basin temperatures and hydrocarbon maturation. Reliable heat-flow estimates can be obtained from oil exploration well data, providing that thermal conductivity is obtained with a sufficient accuracy. Previous methods involve (1) correlations between well logs and calibrated thermal conductivity, (2) empirical models based on mineral or lithological content. None of these methods gives objective or universal outcomes.

In order to obtain such a general process, we have developed a new method based on the neural network technique, which relates directly a set of geophysical well logs to thermal conductivity. The method has been calibrated on ODP data, which accounts for several thousands of conductivity measurements and five types of geophysical well logs (Sonic, Density, Neutron, Resistivity and Gamma-ray). This set has been used to train multi-layer perceptrons (MLP) and find an empirical relationship between well logs (MLP inputs) and thermal conductivity (MLP output). MLP are a class of neural networks that can perform efficient function approximation without any a priori knowledge, providing that a sufficiently large number of data exists. Validation tests suggest that thermal conductivity can be obtained with a 10-15% level of confidence.

The method is applied in the ongoing GATOR project (Global Analysis of Temperature from Oil Exploration) to characterize the worldwide thermal regime of continental margins. Examples on the South African and Australian margins will be presented.