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Thermal properties of shales in the Upper Yangtze Area, South China

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Thermal properties of rocks are important parameters for studying the present-day geothermal regime and tectono-thermal evolution of sedimentary basins, which would provide key information for basin oil and gas resources assessment and exploration. The Upper Yangtze Area currently is one of the important target areas of shale gas exploration and development in China. However, the complete measurement of thermal properties of shales in this area is still rare. Herein we collected 38 shale samples from this area and measured their thermal properties.

Our results show that the ranges (mean values) of thermal conductivity, radiogenic heat production, density, specific heat capacity (in 20°) and thermal diffusivity (in 20°) are from 1.67 to 3.57 W/(m·K) (2.64 $\pm$ 0.50 W/(m·K)), 1.42 to 15.14 μW/m^3 (4.57 $\pm$ 3.44 μW/m^3), 2.12 to 2.76 g/cm^3 (2.53 $\pm$ 0.17 g/cm^3), 0.70 to 0.87 kJ/(kg·K) (0.80 $\pm$ 0.03 kJ/(kg·K)) and 0.91 to 1.98 mm^2/s (1.42 $\pm$0.31 mm^2/s), respectively.

The thermal properties of shale samples are slightly different, so they are not available to distinguish lithological types. The thermal conductivity decreases with increasing porosities. With the increasing of temperature from 0 to 275°, the specific heat capacity increases, but the thermal diffusivity decreases. More importantly, compared to other sedimentary rocks, shale rocks have unique thermal properties with a lower thermal conductivity and a higher radiogenic heat production. Therefore, the thermal properties of shale rocks could cause temperature anomaly, which would change the distribution of temperature field in deep formation. The contrasting thermal properties of shale rocks must be taken into account in the basin modeling for the evaluation of shale gas resources.