Estimation of subsurface formation temperature in the Upper Yangtze Area, Southwest China

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Subsurface formation temperature in the upper Yangtze area, southwest China, is significant for assessment of hydrocarbon generation and preservation, especially that of shale gas. The upper Yangtze area, with well-developed marine carbonate rocks, is one of the important preferred areas of shale gas exploration and development in China. Previous studies have analyzed the accumulation mechanism, development characteristics, hydrocarbon generation potential and occurrence modes of shale gas. However, the analysis of subsurface formation temperature is rare due to a lack of highly accurate temperature data. Here we combined new steady-state temperature logging data, drill-stem test temperature data and measured rock thermal properties, to investigate the geothermal regime and to estimate the formation temperature at specific depths in the range 1000~6000 m in this area.

Our results show that the present-day geothermal gradient for this area ranges from 10 to 74°C/km, with a mean of 24°C/km; While the heat flow varies from 27 to 118 mW/m², with a mean of 64 mW/m², indicating a moderate-high geothermal regime. Formation temperature at the depth of 1000 m is estimated to be between 26°C and 71°C, with a mean of 40°C; the temperature at 2000 m ranges from 36°C to 125°C with an average of 64°C; 45°C~180°C is for that at the depth of 3000 m, and the mean is 88°C; the temperature at 4000 m varies from 88°C to 235°C, with a mean of 112°C; 65°C~290°C is for that at 5000 m depth, with a mean of 136°C; 75°C~344°C is for that at the depth of 6000 and the mean is 160°C. Generally, the pattern of the estimated subsurface temperatures in different depths is similar and has an obvious sub-area characterization, showing a trend of gradually increasing of temperature from northeast to southwest area. Most areas in the south and southeast of Sichuan Basin are with moderate temperature area, which maybe is the “sweet spot area” for shale gas exploration.