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Discussion on upper limit of maturity for marine shale gas accumulation

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Abstract: The sedimentary formations of marine shale in China are widely distributed and are characterized by old age, early hydrocarbon-generation and high thermal evolution degree, strong tectonic deformation and reformation and poor preservation conditions. Therefore whether commercial shale gas reservoirs can be formed is a critical issue to be studied. The previous studies showed that the upper threshold of maturity (Ro%) for the gas generation of marine source rocks is 3.0%. Based on comparative studies of marine shale gas exploration practices at home and abroad and reservoir experimental analysis results, we proposed in this paper that the upper threshold of maturity (Ro%) for marine shale gas accumulation is 3.5%. And the main proofs are as follows: (1) There is still certain commercial production in the area with the higher than 3.0% in Marcellus and Woodford marine shale gas plays in North America; (2) The Ro of the Silurian Longmaxi shale in the Sichuan Basin in China is between 2.5% and 3.3%. However, the significant breakthrough has been made in shale gas exploration and the production exceeds 7 billion m3 in 2016; (3) The TOC of the Cambrian Qiongzhusi organic-rich shale in Changning Region in the Sichuan Basin ranges 2% to 7.1% and the Ro is greater than 3.5%. And the resistivity logging of organic-rich shale appears low-ultra low resistivity and inversion of Rt curve. It's suggested that the organic matters in Qiongzhusi organic-rich shale occurs partial carbonization which leads to stronger conductivity; (4) Thermal simulation experiments showed that the specific surface of shale increases with Ro. And the specific surface and adsorptive capacity both reach maximum when the Ro is 3.5%; (5) The analysis of physical properties and SEM images of shale reservoirs indicated that when Ro is higher than 3.5%, the dominant pores of Qiongzhusi shale are micro-pores while the organic pores are relatively poor-developed, and the average porosity is less than 2%.