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Occurrence characteristics and quantitative evaluation of micro-nano pore shale oil: A case study of Lianggaoshan Formation shale strata in northeast Sichuan, China

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The reservoir space of shale series is mainly composed of micro and nano pores. It is significance to carry out the occurrence characteristics and quantitative evaluation of shale oil with micro- nano pores for the study of shale oil rich and integrated reservoirs. In 2020, Well Ping'an 1, located in the northeastern region of Sichuan Basin, achieved a high yield of 100 tons in Jurassic Lianggaoshan Formation shale, realizing a major breakthrough in shale oil and gas exploration of Lianggaoshan Formation in Sichuan Basin and showing a broad exploration prospect of shale oil in this area [1]. However, the rapid sedimentary facies change, complex and diverse lithofacies, large maturity distribution range (Ro: 0.9%-1.9%), and multiple oil types of the shale strata in the Lianggaoshan Formation lead to unclear occurrence characteristics and content of micro-nano pore shale oil, which seriously restricts the optimization of favorable zones in this area [2]. Therefore, taking the medium-high mature shale strata of Lianggaoshan Formation in northeast Sichuan area of China as an example, this study carried out experimental analysis of conventional core and preserved core samples in the study area, such as scanning electron microscopy, low-temperature nitrogen adsorption, high-pressure mercury injection, nuclear magnetic resonance, multi-step pyrolysis, and original oil and gas chromatography. The results show that oil film/carbon slag is widely developed in the micro-nano pores of shale, and the lower limit of free oil pore size is ~3nm. The occurrence (oil) volume of organic-rich layered clay shale and organic-low layered felsic shale is the largest. TOC, clay content and maturity are the main control factors of oil adsorption in Lianggaoshan shale. Combined with light hydrocarbon recovery and heavy hydrocarbon correction, the total oil content calculation model of the original formation in the study area is determined. The total oil content of the organic-rich layered clay shale and organic-low layered felsic shale is higher than that of other rock facies, which can be used as a favorable oil reservoir for research.

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