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The Wettability Evolution Process and Mechanism of Deep Tight Sandstones Controlled by Diagenesis: A Case Study from the Dongying Sag, Bohai Bay Basin

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Abstract: Wettability plays a crucial role in the percolation capacity of deep tight sandstone reservoirs. Due to great variations in fluid properties, mineral types, and compositions during diagenetic evolution processes, the wettability evolution process and its control mechanism remain unclear, which limits the understanding of hydrocarbon accumulation in deep tight sandstones. In the present study, the upper submember of the 4th member of Shahejie Formation in Dongying Sag, Bohai Bay Basin is targeted to systematically analyze the influence of diagenesis on deep tight sandstone reservoir wettability. A combined method including cast thin sections, X-ray diffractions, high-temperature and high-pressure Amott wettability experiments attached to a nuclear magnetic resonance equipment, and high-temperature and high-pressure solid-oil-water contact angle experiments. The results show that the different types of pores have been generated in different diagenetic stages. From A-stage eodiagenesis to B-stage mesodiagenesis, the compaction residual pores, dissolution pores in feldspar and dissolution pores of carbonate, dissolution pores of quartz margin, dissolution pores in feldspar and dissolution pores of carbonate, fractures wee formed in sequence. With the ongoing diagenesis, the water wetability of residual intergranular pores, the dissolution pores of quartz margin and the dissolution pores in feldspar are enhanced, while the dissolution pores of calcite become more oil wetting, and the dissolution pores of dolomite change from water wetting to intermediate wetting. In addition, the main pore types developed at different diagenetic stages and their surface wetting characteristics determine the overall wettability of deep tight sandstone. Overall, the deep tight sandstone is mainly characterized by water ettability, which is changed from strong water wetting, weak water wetting, water wetting, intermediate wetting, to water wetting from A-stage eodiagenesis to B-stage mesodiagenesis. A wettability evolution model for deep tight sandstone reservoirs controlled by diagenesis is established, which holds significant implications for predicting sweet spots in deep tight sandstone reservoirs.
Key words: Jiyang Depression; Beach-bar Sand; Deep Reservoirs; Diagenesis; Magnetic Resonance Imaging

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