

The control mechanism of pore structure and mineral composition of lacustrine shale reservoirs on shale oil mobility: a case study of Jiyang Depression in Bohai Bay Basin, China

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This project focuses on the scientific issue of how pore structure and mineral fabric in shale reservoirs affect shale oil mobility. Taking the shale in Zhanhua Sag of Jiyang Depression, Bohai Bay Basin as the main research object, we systematically investigated the mineral-pore-fluid coupling mechanisms in the reservoir. Through geochemical analyses including XRD whole-rock diffraction, rock pyrolysis, total organic carbon (TOC) analysis, and vitrinite reflectance measurement, we characterized the mineral composition and sedimentary structure types in the study area, while clarifying the oil-bearing characteristics and hydrocarbon generation potential of shale oil. Experimental techniques such as scanning electron microscopy, high-pressure mercury intrusion, nuclear magnetic resonance, and spontaneous imbibition were employed to investigate the pore structure and fluid mobility characteristics of the Shahejie Formation shale reservoir. The results reveal: Five lithofacies types developed in the study area: organic-rich massive calcareous mudstone, organic-rich laminated argillaceous limestone, organic-rich laminated calcareous mudstone, organic-rich laminated argillaceous limestone, and organic-bearing laminated argillaceous limestone; An oil-bearing evaluation criterion for the lower Es3 sub-member was established based on TOC, S1 content, and oil saturation index (OSI), classifying Zhanhua Sag shale oil into four categories: enriched resources, effective resources, inefficient resources, and ineffective resources; Calcite in the study area exhibits oil-wet characteristics, with its intercrystalline-dissolution pore composite system significantly enhancing shale oil mobility. In contrast, the water-wet nature of quartz and clay minerals inhibits oil phase migration. Pore structure analysis indicates that argillaceous limestone demonstrates superior pore size distribution and percolation capacity compared to calcareous mudstone. Structural types exert differential control on fluid mobility, showing a descending order of effectiveness: laminated > layered > massive structures. These findings hold significant implications for improving shale reservoir evaluation systems and guiding shale oil exploration and development practices.