Lacustrine Shale-Oil Accumulations in the Permian Lucaogou Organic-Rich Mudstones Formation, Junggar Basin: A Self-Contained Source-Reservoir System

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Abstract

Success in marine shale-oil systems in North America has stimulated the interest in efforts to produce oil in lacustrine shale-oil systems in China. Shale-oil resource system are organic-rich mudstone units which have generated oil that is retained in situ or migrated into juxtaposed organic-lean intervals. The Permian Lucaogou Formation in the Jimusaer Sag of the southeastern Junggar Basin, is a typical hybrid lacustrine shale-oil resource system with a combination of interbedded organic-rich mudstones and relative organic-lean carbonates or siltstones. The database from 514 core samples illustrates the variability in various geochemical characteristics of the Lucaogou mudstones. The average TOCpd value is 3.83% in this database, but the range is 0.21 to 15.51% with a low standard deviation of 2.83%. The S2pd and HIpd are also highly variable, with HIpd value averaging 334 mg HC/g TOC, with a range of 36 to 795 mg HC/g TOC. Based on element analysis and organic petrographic features, the OM is rich in oil-prone Type I and Type II1 kerogen. Thermal maturity in this area, as indicated by vitrinite reflectance values and T_{max}, suggests thermal maturity levels spanning the entire oil window with the early oil window at 2000 m (6600 ft) and latest oil window at 4200 m (14000 ft). Under the influence of the high frequency lake level, 3 fine-grained facies within source rocks are recognized: laminated mudstone, massive mudstone and interlaminated siltstone and mudstone. Although far from homogenous, the laminated mudstone systems appear to display the highest hydrocarbon-

generation potential, expulsion efficiency and pore network system than other counterparts, which are favorable for lacustrine shale-oil accumulation. In order to further explore the accumulation characteristics of shale-oil, some typical well geochemical characteristics are analyzed in detail. Based on source rock sequences and source-reservoir assemblages, the Lucaogou petroleum system is divided into two subsystems (the upper and the lower). Crude oil in the lower subsystem is relatively dense and viscous and has higher non-hydrocarbon content. Geochemical fingerprinting techniques indicates crude oil from the upper or lower subsystem mainly originate thin-bedded excellent mudstones near sweet spots. Despite being thicker, mudstones between two subsystems serve only as a seal. Thus, exploration risk in the self-contained source-reservoir system mainly relates to excellent source rocks and source-reservoir assemblages.

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