
Unconventional Reservoir Characterization of the Brown Dense Mudstone (Lower Smackover Formation), Gulf Coastal Plain, South Arkansas

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ABSTRACT

Upper Jurassic Brown Dense Mudstone, a lower member of the Smackover Formation, has been of interest as an unconventional oil reservoir in southern Arkansas and northern Louisiana since 2009. Cores and crude oil of the Brown Dense were collected from the Betsy Sessions No. 1 well in Union County, Arkansas, and were analyzed for evaluating the unconventional reservoir characteristics and oil biomarker component features. Slightly silty/sandy mudstone to wackestone is primarily present in the thin sections. Brown Dense exhibits fair to good source potential. The majority of organic matter (OM) is type II, oil-prone kerogen. The thermal maturity data indicates that the OM is in oil window, which is consistent with the observations from biomarker data. Field emission scanning electron microscopy (FE–SEM) analysis was conducted to examine the matrix-related pore networks in mudstones. The dominant porosity is found to be hosted within the OM with some intra/interparticle mineral pores present in the matrix of the Brown Dense Mudstone. All pore sizes observed in the samples fall into the micro- to nanopore range. OM pores appear to be associated with the migrated OM which provides more contiguous permeability pathways than isolated depositional OM alone. Rock mechanics testing data show high Young's moduli, low Poisson's ratios, and high ultrasonic velocities, suggesting that the Brown Dense samples are pretty brittle. The correlation of dynamic and static Young's Moduli further supports the high brittleness. Porosity and permeability (P&P) values measured from shale rock properties (SRP) analysis are much lower than the conventional P&P data. Biomarker components of the crude oil suggest the oil was derived a carbonate source rock with no significant

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terrestrial organic matter contribution and deposited in a marine environment under highly reducing, anoxic conditions.