Petroleum Potential of the Codell Sandstone, Northern Denver Basin

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ABSTRACT

The Upper Turonian Codell Sandstone Member of the Carlile Shale in the northern Denver Basin is a hydrocarbon-bearing sandstone that has produced primarily from the Wattenberg Field, northeastern Colorado, since the early 1980s. Until recently, attempts to produce from the Codell Sandstone north of Wattenberg Field have resulted in promising hydrocarbon shows with minimal to no economic value. Current horizontal drilling and multistage fracturing technology is proving the Codell Sandstone can be produced from outside of Wattenberg Field with exceptional potential hydrocarbon recoveries. A significant area between Wattenberg Field and Silo Field in southeast Wyoming remains unproven. The Codell Sandstone is a low resistivity, low porosity, and low permeability argillaceous sandstone. The large clay content of the Codell Sandstone is responsible for masking typical well log readings of sandstones and hydrocarbon rich zones. The clays are also the cause for the difficulty in completing and producing from the sandstone by conventional means. Understanding the properties of the Codell Sandstone and the clays within its matrix is crucial to deciphering well logs and determining where the sandstone is rich in hydrocarbons in the northern Denver Basin. Outcrops along the Colorado Front Range and multiple cores deeper in the basin illustrate how the Codell Sandstone was deposited in a shallow marine environment. A series of storm events during the Turonian separated the Codell Sandstone into three facies. Tempestite laminae are sandwiched between lower and upper heavily bioturbated facies of the skolithos ichnofacies. The three facies can be recognized in well logs and mapped as three individual lithofacies. Thin section analysis, SEM imaging, and regional mapping show that the Codell Sandstone did not travel great distances during deposition from a northwestern source. XRD measurements characterized authigenic clays, which further explains high gamma and neutron density readings in the argillaceous sandstone and suppressed resistivity measurements in hydrocarbon- bearing zones. Analysis of heat distribution and synthetic vitrinite reflectance throughout the region more accurately identify where Niobrara Formation source beds have the greatest potential to generate oil and gas and where migration is occurring. Basin modeling of structure, burial depth, thickness, and effective porosity in proximal relation to source rocks within the vicinity of anomalously high heat and thermal maturity designate zones of greater probability for the successful production of hydrocarbons north of the Wattenberg Field.