Pore-Size Distributions from Nuclear Magnetic Resonance and Corresponding Hydrocarbon Saturations in the Devonian Three Forks Formation, Williston Basin, North Dakota

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ABSTRACT

Pore-size distributions of four lithofacies from the Three Forks Formation were obtained using nuclear magnetic resonance (NMR). The upper Three Forks was divided into three lithofacies with the fourth coming from the uppermost section of the middle Three Forks. In ascending order the lithofacies studied were: 1) massive green to greenish-gray mudstone, 2) highly deformed, interlaminated pinkish-tan silty dolostone and green to greenish-gray mudstone, 3) thinly laminated pinkish-tan silty dolostone and 4) interlaminated green to greenish-gray mudstone and pinkish-tan silty dolostone. Core samples (one sample per lithofacies) of various sizes and shapes were selected for six western North Dakota wells. Samples were prepared for NMR by saturating with 300,000 ppm NaCl brine solution under 100 psi of compressed air for a minimum of 60 days. Pore size distributions were obtained from NMR transverse relaxation (T2) analysis via Oxford Instruments GeoSpec2 core analyzer coupled with Green Imaging Technology software. Pore size distributions were calculated using T2 cutoff values to partition total porosity measurements into micropores (less than 0.5 microns), mesopores (0.5 to 5 microns), and macropores (greater than 5 microns). Although average core measured porosity and permeability values (5.5% to 7.5% and 0.02 mD to 0.09 mD respectively) remain relatively consistent in each lithofacies, average water saturations increase from 30% to 40% in the upper Three Forks to over 60% in the massive green mudstone of the middle Three Forks. NMR T2 data averaged within each lithofacies suggest that fluid saturations are related to pore size distributions. As mesopore and macropore percentages of total porosity increase, oil saturations increase. As micropore percentages of total porosity increase, water saturations increase.