Regional Characterization of the Woodford Shale Organic Matter Content and Thermal Maturity Variability along the State of Oklahoma, USA — A Look at How Different the Woodford is Between the Oklahoma Petroleum Provinces (STACK-MERGE-SCOOP-ARDMORE-MARIETTA

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Abstract

A unique statewide organic matter and thermal maturity study of The Woodford Shale was conducted between the Institute of Reservoir Characterization (IRC) and Organic Geochemistry Group (OG2) of the University of Oklahoma, USA. This analysis allowed us to identify critical variabilities between the different Oklahoman Petroleum Provinces. Slatt and Rodriguez (2012), and Miceli and Philp (2012) mention that at original immature conditions, the prolific Woodford shale intervals are usually characterized by Type II kerogens (oil and gas prone) with high organic richness (usually > 3% Total Organic Carbon -TOC-) and Hydrogen Index (HI) values > 350 (mg HC/g rock). Peters and Cassa (1994) defined for a common source rock that the threshold for typical immature oil-prone kerogen has High TOC (>2% wt), High HI (>400 mg HC/g rock), low Oxygen Index (OI) and generally low sulfur (S) content. These screening parameters aid in identifying possible zones of higher unconventional pay (sweet spots of oil vs. gas), where the rock intervals with these characteristics will screen the probable GOR level of any specific producing acreage location. Analyses were performed on

thousands of samples of core, cuttings, and outcrops gathered from data donations and 600 measured samples. These measurements were corrected to original (immature) TOC and HI conditions, based on Jarvie's (2012). Analyses were performed on approximately 2g of each sample and represented the screening parameters of organic facies, and thermal maturity reached in hundreds of locations. The TOC values reflect the amount of organic carbon, including kerogen and bitumen, in a source rock and are interpreted into the regional depositional IRC model of The Woodford shale for understanding the differences in burial histories (thickness and present-day depths) and organic facies distribution in the state of Oklahoma (kerogen type lateral and vertical variability within the Woodford Shale beds). In conclusion, in the State of Oklahoma, the Woodford Shale members have: (1) for the Lower member TOC from 0.07% to 16.90% (7.06% TOC average); (2) the Middle Woodford member from 0.09% to 15.60% (average of 6.31% TOC); and (3) for the Upper member from 0.07% to 15.70% (with average 6.00% TOC). Some anomalous values in the Upper Woodford Shale member at specific outcrops range from 12-31% of TOC and are related to Woodford sourced hydrocarbon migration, and was confirmed by fluid inclusion analysis (Woodford shale charging itself from deeper to shallower locations). A total statistical average of 6.38% for all samples is indicative of very good to the excellent potential for oil and gas generation, and that there still exists remaining areas to explore and develop, that economically vary due to the maturity, depths (pressured or under pressured reservoirs) and thickness in specific petroleum province locations. State regional maps will be shown.