Solid Kerogen Analysis of a Carbonate Source Rock: Implications on Hydrocarbon Maturity Analysis and Reservoir Characterization in Jafurah Basin, Saudi Arabia

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ABSTRACT

Lying east of the great Ghawar field, the Jafurah basin hosts the upper Jurassic Tuwaiq Mountain Formation which contains one of the richest hydrocarbon producing source rocks in the world. The Proper understanding of the kerogen distribution and maturity across this frontier basin is focused key for prospectivity and future development. An evident correlation between total organic carbon (TOC) and various reservoir characterization properties such as porosity, saturation and pore distribution has been observed. Gas Research Institute (GRI) porosity and LECO-TOC measurements show an association between TOC and porosity in this organic-rich reservoir. However, this correlation appears highly irregular; possibly due to an incorrect density measurement of solid TOC. Significant amounts of liquid hydrocarbons have been recorded in this prolific source rock from Pyrolysis (SRA) sampling, which makes up a significant portion of the measured LECO-TOC. This represents a significant issue when considering petrophysical log calibration for TOC, saturation analysis and pore volumes. In this study, a workflow was established to remove the free hydrocarbon and bitumen from the TOC samples. Each sample after splitting to two parts, one used for analysis on the LECO-TOC, and the other part was used for SRA pyrolysis. The initial run was conducted using an industry standard sample preparation method. In the second run, sample preparation included a DCM solvent extraction. The organic solvent was used to remove the free hydrocarbons and mobile bitumen, thus taking away the SRA S1 values and oil shouldering effects on the S2 emission peak. The resulting data sets were compared and showed a net reduction in TOC between the unextracted and the extracted methods. Produced oil samples throughout the basin show thermal maturity differential, which is observed on the free hydrocarbon saturation of samples. Accordingly the level of extracted hydrocarbons decreases with increased thermal maturity. Results from this detailed and thorough analysis have yielded a new set of thermal maturity maps which greatly enhanced the understanding of potential hydrocarbon distribution in the basin. In addition, log-derived TOC calculations have been recalibrated resulting in a more accurate petrophysical model. While aberration between the TOC and porosity correlation is still present, the source of potential error has been significantly reduced.