Reservoir Productivity Prediction through Geochemical Analysis and NMR Measurements in Source Rock Plays

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Abstract

Characterization of Unconventional resources has gained attention in the last decade. Identifying reservoir productivity was a challenge for the industry and required integrating geological and engineering input. Today, organic geochemistry is being utilized in source rock plays to predict their productivity by determining the amount of free hydrocarbons.

Source rock pyrolysis combined with nuclear magnetic resonance (NMR) can be employed to characterize the retained hydrocarbons and estimate volumes. This study aims to assess the portion of moveable hydrocarbon, within the retained fraction, and to predict its producibility prior to hydraulic fracturing.

Core samples were selected on a one-foot scale from wells for pyrolysis analysis. In addition, laboratory NMR, including longitudinal relaxation time (T1) and transverse relaxation time (T2), were acquired on plug samples from wells in the vicinity. T1-T2 two dimensional (2D) NMR maps on core plugs samples from the same wells were used for fluid typing and appropriate cutoffs were established. T2 distribution was plotted against time to identify the different fluid types and their mobility.

Results show a good correlation between pyrolysis-based oil saturation and NMR-based movable hydrocarbon intervals. Programmed pyrolysis provides a measure of free hydrocarbons retained in the rock. The volume of oil trapped in organic pores is assumed to occupy the remaining portion of the Total Organic Content (TOC).

Subtracting free hydrocarbons from the TOC results in a volume estimate of the trapped oil in organic pores. The retained oil portion varies across different depositional areas for the same stratigraphic interval. Furthermore, T2 distribution from NMR measurements across the same stratigraphic interval shows good correlation with direct pyrolysis rock measurements, building more confidence in the method.

In conclusion, in the area of study, hydrocarbon molecules are trapped in the organo-pores. Thus, applying this technique to identifying areas with higher portions of moveable hydrocarbons would indicate more productive zones.