Spatial and Temporal Maturity Variations of the Bakken Shale Using True Kinetic Parameters

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The Bakken shale in the Williston Basin of North Dakota is considered a world-class source rock with organic content exceeding fifty per cent by volume. It is now a very active unconventional oil play.

Coskey and Leonard (2009) demonstrated that Bakken production is related to both the temporal and spatial rate of generation and expulsion, coupled with the spatial distribution of maturity forming a productive fairway. This fairway is located in a thermal transition zone between immature Bakken to the east and highly mature Bakken to the west.

The trapping mechanism is likely due to the physical characteristics of the Bakken and its position within both the thermal window and the thermal transition zone. Those areas that have recently entered the oil window are micro-fractured and retain overpressure, whereas where the Bakken is above the oil window the system is pliable, normally pressured, and acts as a barrier to migration. This is considered a maturation trap. Clearly, the necessity for accurate maturity information is essential for future definition of these maturation traps.

Unfortunately, there is a severe lack of accurate maturity indicators.

Only single run Rock-Eval information was available. The regional, single run Rock-Eval data were not specifically obtained for kinetics determination. A new technique developed by Waples et al. (2002) was utilized to determine the kinetic parameters for over 200 locations from the single run Rock-Eval pyrograms.

This new kinetic information shows that all samples from the Bakken represent a single organofacies. The narrow distribution of activation energies indicates that the kerogen is classified as Type II. The samples analyzed represent a wide range of mappable maturities, as indicated by the significant variations in both the Hydrogen Index and mean activation energy. These results confirm the proposal of Waples et al. (2002) that within a single organofacies mean activation energy (and HI) can be used as an indicator of thermal maturity, conceptually similar to but more sensitive and accurate than using Tmax.

We will show our new high resolution models of Bakken maturation, generation, and expulsion, and demonstrate the application of these methods for other unconventional plays worldwide.