Defining the Onset of Oil Generation in the Bakken Formation Using Thermal Maturity Series Obtained from Nonisothermal Experiments and an Extended Kinetic Method

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Abstract

The early development of the Bakken Petroleum System recognized the critical importance of the relationship between production and the onset of oil generation. This study presents an additional metric that appears capable of establishing whether or not a specific well has reached the point of oil generation. We use nonisothermal kinetic experiments of natural and experimentally matured examples of the Bakken, that when evaluated using an extended kinetic method, show the development and evolution in kinetics that suggest a means of evaluating the point at which oil generation is initiated. Two endmember sets of kinetic trends are present based on 78 analyses consisting of splits of single samples, multiple samples from individual cores and single core samples from wells distributed across the North Dakota portion of the Williston Basin. Two end member trends or maturation series are evident as linear compensation effects between the activation energy (Ea) and natural logarithm of the frequency factor (A). The end members are distinguished on the basis of the slope of the compensation effect that in both cases are significantly different than a compensation effect caused by statistical aberrations in the data. Nonlinear intermediate examples are bowed upwardly or downwardly with the limbs distributed parallel to subparallel to the trends produced by the end member examples. From these analyses and their geographic relationship to production, it would appear that the critical kinetic parameters that accompany oil generation occur at the point where the two linear compensation effects intersect. This point tends to also correspond with the point of inflection that is associated with the nonlinear compensation effects. Calibration of Rock Eval Tmax to the extended kinetics data is obtained by mapping Tmax onto Ea-ln(A) space and noting the corresponding point of intersection between immature and mature compensation effects.

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