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Improved models for estimating TOC in shale resource play: An example from Duvernay Formation, Western Canada Sedimentary Basin

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Abstract

Determination of total organic content (TOC) is essential in source rock study and unconventional shale resource play evaluation (Jarvie et al., 2007; Rokosh et al., 2012). An indirect method, such as the petrophysical approach, does not require laboratory tests and can provide a fast, convenient and cost efficient means for TOC estimation when well log data are available. Among the publically available approaches, the ΔlogR method proposed by Passey et al. (1990) is proven to be useful and widely accepted. In recent source rock evaluations in the Western Canada Sedimentary Basin (WCSB) and elsewhere, we found that mineral composition and rock texture of the organic rich shales vary considerably from play to play. With fixed parameters pertaining to mineral composition, compaction and rock texture, the original ΔlogR method may result in biased estimates when the target source rock differs significantly from the one that was used to derive the equations. Other limitations of the ΔlogR method include restricted ranges of resistivity and sonic transit time because a linear approximation of the ratio of resistivity to porosity logs and inconvenience of converting commonly used thermal indicators, such as Ro% or Tmax to LOM (organic metamorphism units).

This study attempts to improve the ΔlogR method by 1) introducing flexible petrophysical parameters specific to the target source rock and drop the linear approximation, 2) replace LOM with commonly used thermal indicator Tmax, and 3) include an ?additional log curve (Gamma Ray) to improve TOC estimation. We present the models with an application example from the Devonian Duvernay shale of WCSB to demonstrate the improved ΔlogR method. The TOC estimates derived from the revised models (sonic- and density-based models) show much high correlation coefficients (R^2 = 84% and 86% respectively) with the measured TOCs from core samples, as compared with R^2 of 67% and 59% for sonic- and density-based models respectively from the original ΔlogR method.

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