Generalized Method for the Estimation of TOC from GR and Rt

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Determination of TOC is critical to the evaluation of every shale resource. The ideal method for determining the TOC fraction within shale formations would utilize common well log data, and not require manual interpretation for each depositional layer. Methods which are dependent upon extensive laboratory testing are limited by the availability and integrity of the rock samples. Well log data will generally be available for the majority of wells being evaluated.

The well log methods commonly used to estimate TOC utilize resistivity and porosity logs. Porosity logs incorporate a lithology response in addition to porosity, plus the complication of borehole related errors. These methods require the user to manually interpret and calibrate for each depositional layer.

The two most common and reliable log curves are the Gamma Ray (GR) and Resistivity (Rt). Experience has shown there is an inverse relationship between these curves. The GR typically decreases in a clean matrix, whereas the Rt increases. In "non-source" shale (i.e., no TOC,) the GR increases while the Rt decreases. These two log curves tend to "hour-glass" when plotted using conventional scales. Reversing one of the scales causes the GR and Rt curves to track. The exception to these observations occurs where TOC is present. There the GR and Rt both increase.

A relationship was developed to model these log curves in the absence of TOC. In simple terms we can state that GR is a function of Rt. This relationship should hold true throughout the section, except in shale intervals where TOC is present. There GR should be greater than the function of Rt.

Recognizing the increase in GR and Rt to be related to TOC within the shale, it is possible to estimate the weight percent of TOC present. The TOC effect is the difference between the actual GR and Rt response and the GR and Rt relationship for non-source rocks.

This method of estimating TOC avoids the tedium and potential errors of log overlay techniques, providing consistent results across the field, and even regionally.