## Core-Calibration of NMR log interpretation models for an improved determination of irreducible water saturation and permeability

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Large errors in irreducible water saturation and permeability can result from the indiscriminate use of generalized NMR log interpretation models that use default input parameters. Such errors can be greatly reduced by using core data to tailor the NMR models' input parameters to a particular field or formation.

Accurate determination of T2 cutoff value is a vital step for the estimation of bulk volume irreducible water (BVI) and movable fluids (BVM), as well as permeability from NMR data. However, the use of generalized T2 cutoff values for clastics (33ms) and carbonates (92ms) can be unrealistic for log interpretation. This is due to mineralogy-dependent pore surface relaxivity effects which shift the T2 spectra.

Thus, it is often desirable to determine the T2-cutoff value using core NMR measurements for calibration. However, we have found that the different signal-to-noise ratio (SNR) between the NMR core and log measurements can result in core NMR-based T2-cutoff values which are inappropriate for application to NMR log data.

In this paper, we describe a method for directly calibrating NMR log T2-cutoff values using BVI values from core capillary pressure measurements. The BVI and BVM values derived from this method can be combined with the log NMR effective porosity into a Coates Permeability Model.

Coates Model:

$$PERM = \left(\frac{\phi_{NMR}}{C}\right)^{m} * \left(\frac{BVM}{BVI}\right)^{n}$$

The Coates Permeability Model has been adopted as the standard model used to compute permeability from NMR data. In the absence of core or test data to calibrate the Coates model parameters, a set of default values (C=10, m=4 & n=2) are typically applied which can result in significant errors in permeability. We describe the use of multiple linear regression to find the best model parameters to match log permeability to the core data. Once these parameters have been computed, we can exclude outliers and rerun the regression to optimize the Coates model.

The result is a core-calibrated reservoir description model which provides an improved determination of irreducible water saturation and permeability from NMR log data.



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