Improved permeability prediction in highly complex Middle East Reservoirs using underused NMR data.

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Permeability is one of the most important parameters in the hydrocarbon reservoir. However, it is notoriously difficult to measure using sub-surface logging devices. Therefore, it is predicted using empirical equations like the "Kozeny-Carmen" from knowledge of its main controlling factors e.g., grain size and porosity.

Here we introduce the RGPZ model for predicting permeability, which relies upon electro-kinetic theory and offers much hope for permeability prediction,

$$K_{RGPZ} = \frac{d^2 \phi^{3m}}{4am^2}$$

Where, d = mean grain diameter (microns), ϕ = porosity (frac), a = packing parameter, m = Archie's cementation exponent.

We test it upon RCAL data for clastics and carbonates from Middle East Reservoirs and it performs better than existing methods over several orders of magnitude (fig. 1).

To test this method on NMR log data we have devised a method to obtain grain sizes from T_2 distributions. It is now possible to predict K_{RGPZ} from NMR log data and we compare it to the standard models (fig. 2). Overall it performs better than the Coates and SDR (mean T_2) models and better in certain intervals than fuzzy logic and genetic algorithm predictions.

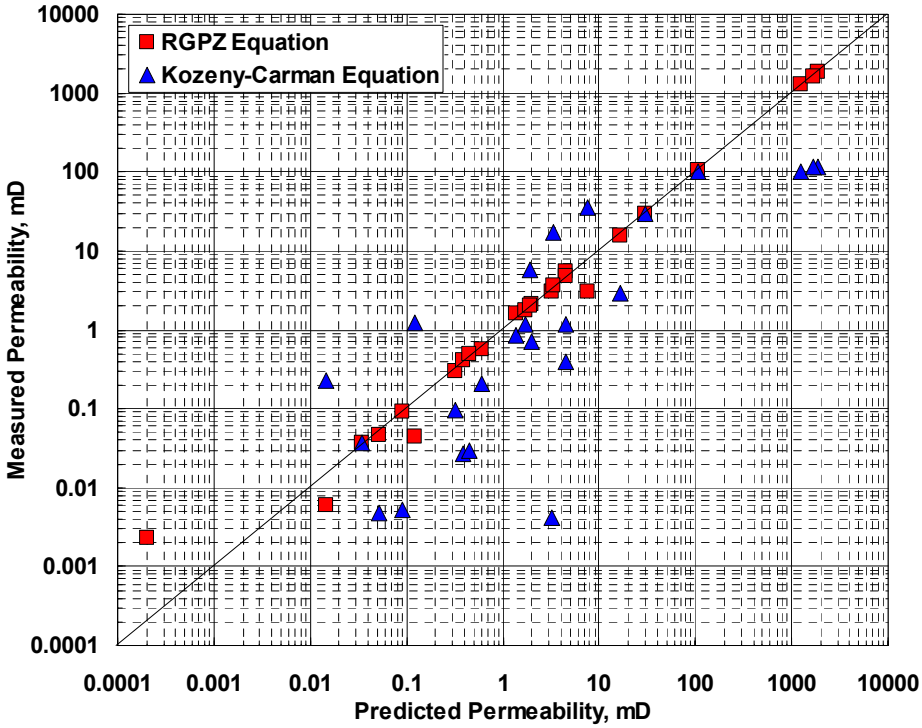

Figure 1. Permeability prediction using the Kozeny-Carmen equation and the new RGPZ equation for a range of cemented and uncemented clean sandstones, limestones and shaly sandstones.

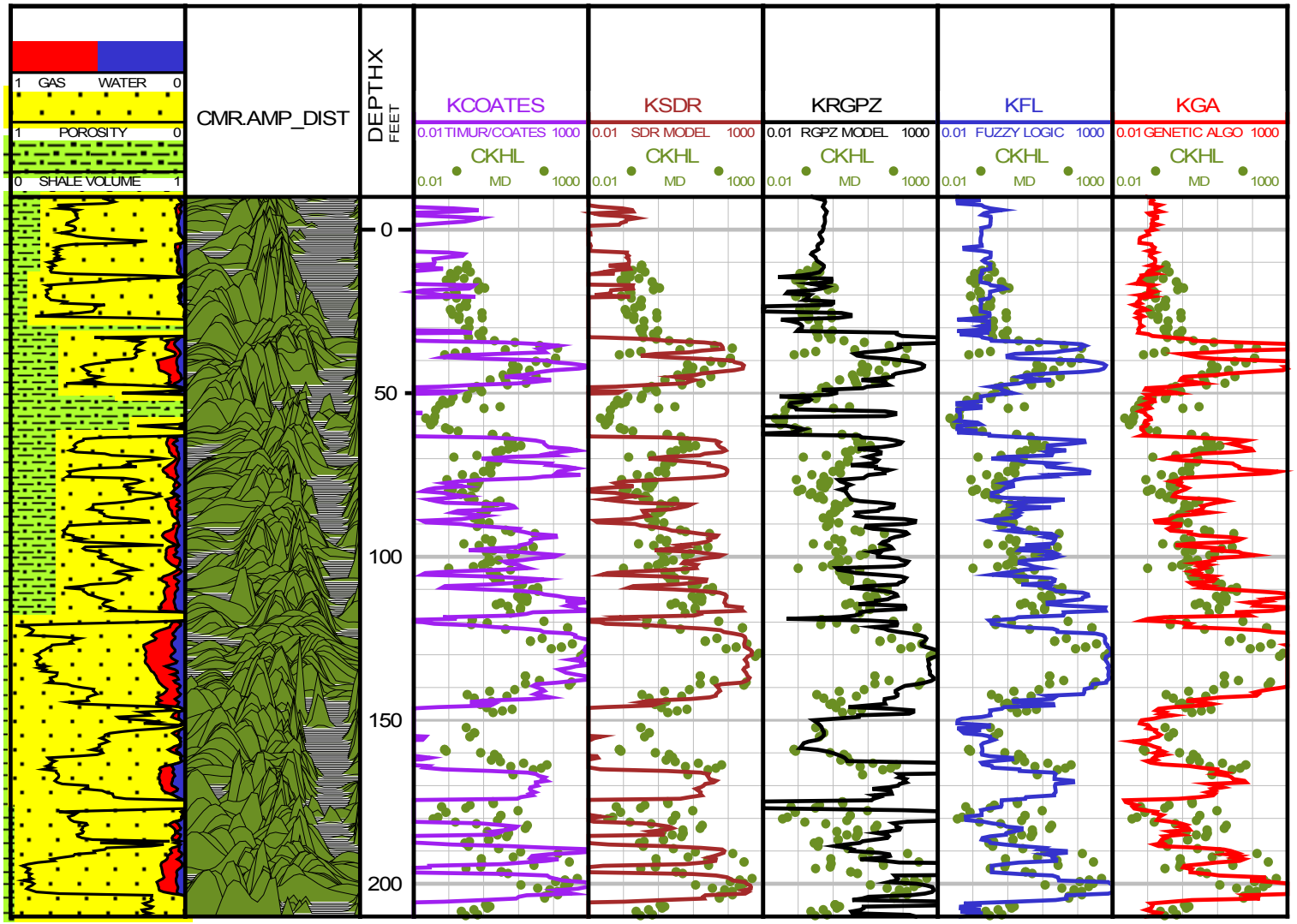

Figure 2. NMR Permeability predictions from a clastic interval in the studied well (track 1). The RGPZ model (track 5) performs better overall than the standard Coates and SDR models (tracks 3 and 4). It performs better in certain intervals than fuzzy logic and genetic algorithm predictions (Tracks 6 and 7). Therefore, the RGPZ model may require refining for certain rock facies.