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Logging Prediction of Total Organic Carbon Content of Source Rocks in Lacustrine Rift-Basins

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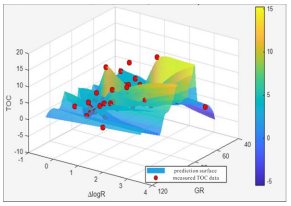

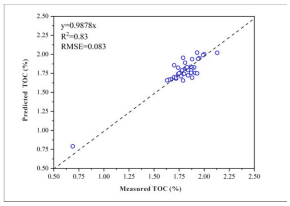

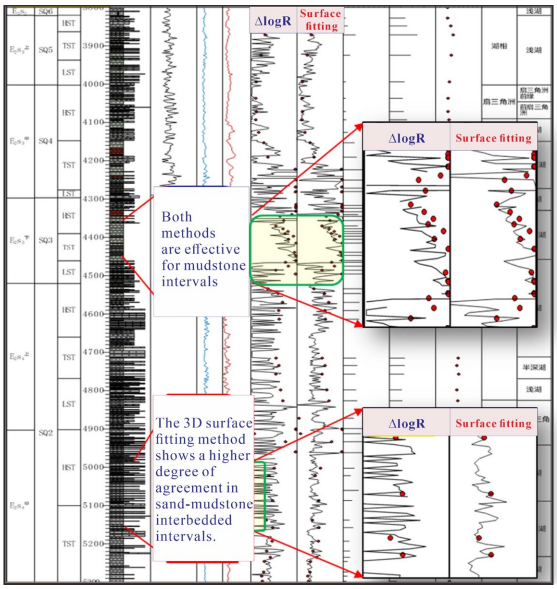

Accurately evaluating and predicting the total organic carbon (TOC) content of hydrocarbon source rocks is of great significance for petroleum resources assessment and the optimization of unconventional oil and gas exploration targets in deep intervals with limited core samples. Lacustrine rift-basins are characterized by complex tectonic-depositional evolution, multiple and proximal sediment sources, and frequent sand-mud interbeds, which result in extremely strong heterogeneity in the distribution and geochemical properties of source rocks, bringing great challenges to fine-scale exploration and quantitative resource evaluation.

Traditional evaluation methods use the average of limited measured TOC data to represent the whole well interval, and this "point-to-line" approach inevitably causes large errors and fails to depict the continuous vertical variation of TOC in the profile. Meanwhile, the conventional ΔlogR method for TOC prediction struggles to effectively unify the mudstone baseline in continental lacustrine basins with rapid facies changes and frequent sand-mud interbeds, and evaluating organic matter abundance via the average of a small number of measured TOC points often leads to obvious overestimation or underestimation.

This paper integrates multidisciplinary methods including geochemistry, sedimentology, geophysics and statistics, proposes a 3D surface fitting TOC logging prediction method based on Biharmonic interpolation, and optimizes a model suitable for frequent sand-mud interbeds by comparing with ΔlogR prediction results. The technical framework introduces GR parameter into the improved ΔlogR model, establishes a 3-axis spatial rectangular coordinate system with ΔlogR, GR and TOC, obtains the 3D prediction surface through Biharmonic interpolation, and determines TOC content based on actual logging data. Applied in the Es3 and Es4 Members of Baxian and Langgu Depressions, the model yields a coefficient of determination (R^2) of 0.83 and root mean square error (RMSE) of 0.083 between predicted and measured TOC, showing excellent consistency(Fig. 1). This reliable model provides a valuable reference for TOC prediction of source rocks in other lacustrine rift-basins(Fig. 2).

References:

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