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New NMR Service Maps Complex Eagle Ford Fluid Distributions Without Resistivity-Based Uncertainty

CMR-MagniPHI high-definition service identifies fluids—even in organic micropores—to select landing point

CHALLENGE

Separate potentially moveable from nonmoveable fluids to guide the selection of the horizontal well landing point.

SOLUTION

Acquire continuous T_1 and T_2 measurements with CMR-MagniPHI* high-definition NMR service for quantifying porosity and fluid distributions in combination with other formation evaluation methods.

RESULTS

Accurately mapped fluid distributions, as verified by core analysis, to revise reservoir volumes and identify zones with the highest producibility as lateral landing targets.

Challenges in resistivity-based saturation determination

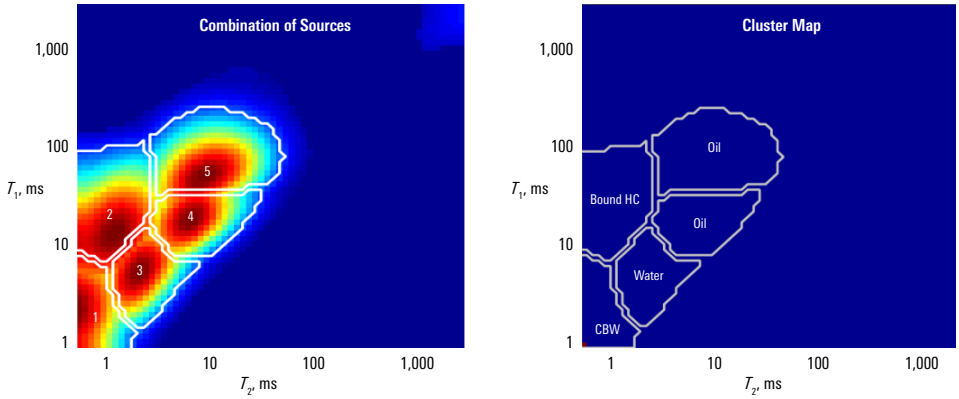
Even in clean, well-sorted sandstone reservoirs, traditional fluid saturation evaluation using resistivity-based methods can have a high degree of uncertainty because of potential unknowns, such as formation water salinity. The same evaluation in unconventional reservoirs is further complicated by the presence of kerogen, high-viscosity hydrocarbons, and solid hydrocarbons, affecting the quantification of porosity and producibility.

An operator in the Eagle Ford wanted a more reliable approach to identifying moveable hydrocarbon and other reservoir fluids and mapping their distribution for defining the best landing point for horizontal wells.

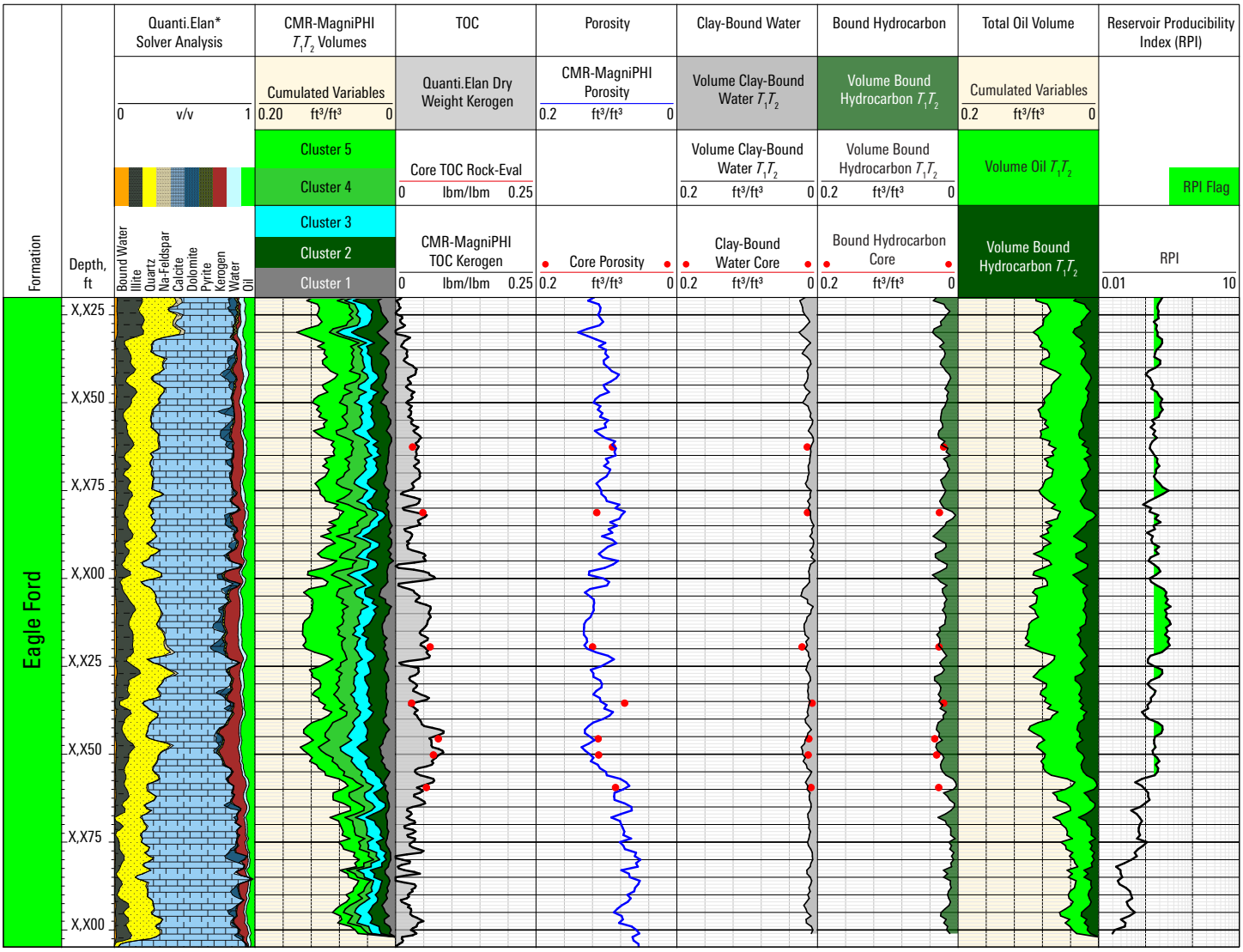
A new dimension for fluid mapping in unconventional reservoirs

Schlumberger recommended CMR-MagniPHI* high-definition NMR service as uniquely suited for the evaluation of unconventional reservoirs. With the industry's shortest echo spacing at 200 us, the service measures T_1 and T_2 simultaneously and continuously. This capability provides a high sensitivity to fluid contrasts, even in micropores, and is tolerant of the typical low porosity and high formation water salinity of shale reservoirs. The continuous acquisition of T_1 and T_2 data by CMR-MagniPHI service enables an independent assessment of the fluid volumes and distributions, highlights wettability contrasts, and quantifies bitumen content as an alternative to resistivity-based calculations that conventionally inform the petrophysical model.

Integrating data from CMR-MagniPHI service and Litho Scanner* high-definition spectroscopy service accurately defines the kerogen fraction and reservoir producibility index. The NMR measurement responds to the fluids in the pores and is not influenced by the kerogen content. To differentiate the kerogen portion of the total organic carbon (TOC), the porosity determined with CMR-MagniPHI service is compared with the total density porosity corrected for the matrix density obtained from Litho Scanner service. This approach benefits from the accurate matrix density output from Litho Scanner service. The difference between the two porosity curves identifies the amount of kerogen in the TOC determination, and hence the remainder is the volume of producible liquid hydrocarbon.



Mapping of continuously acquired T_1T_2 obtained with CMR-MagniPHI service over a 195-ft interval reveals the complex distribution of fluids within the Eagle Ford Formation.



The petrophysical model for this Eagle Ford well was developed using measurements from CMR-MagniPHI and Litho Scanner services and traditional triple-combo logging. The results are in good agreement with those from core analysis. The refined reservoir volumetrics identify potential landing targets on the basis of the reservoir producibility index and permeability from the CMR-MagniPHI service.

Saturation interpretation verified by core analysis

The saturation interpretation from the T_1T_2 maps agreed well with core analysis. The petrophysical model was then revised with the saturation data to recalculate the reservoir volumes. Bitumen, which is not readily quantified in conventional approaches, was quantified using the maps, and those values agreed well with retort analysis of the core to further refine the volumetric analysis.

Having established a more accurate, insightful understanding of the Eagle Ford, the operator was able to identify targets for lateral landing points in the zones with the highest producibility.

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