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# Producible Hydrocarbons Identified in Low-Resistivity Reservoir by Combining Litho Scanner Service and NMR

## TOC from Litho Scanner spectroscopy service and NMR pore-size distribution identify the sweet spot for optimal horizontal landing point, Bone Spring Sand

### CHALLENGE

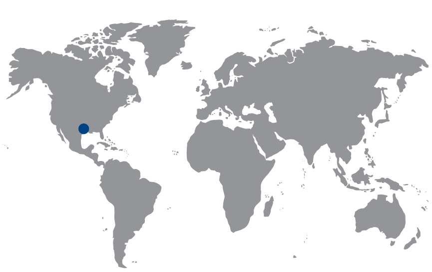
Identify movable hydrocarbon in reservoirs with low resistivity and low porosity that bias the computation of water saturation to pessimistically high values.

### SOLUTION

Determine intervals with producible hydrocarbon by differentiating the kerogen content of the total organic carbon (TOC) determined by Litho Scanner* high-definition spectroscopy service in comparison with porosity and fluid content measurements from the CMR-Plus* combinable magnetic resonance tool.

### RESULTS

Successfully completed and produced from the optimal interval identified by confirmation of the presence of liquid hydrocarbon from Litho Scanner service's carbon measurement and higher permeability shown by the CMR-Plus tool's porosity distributions.



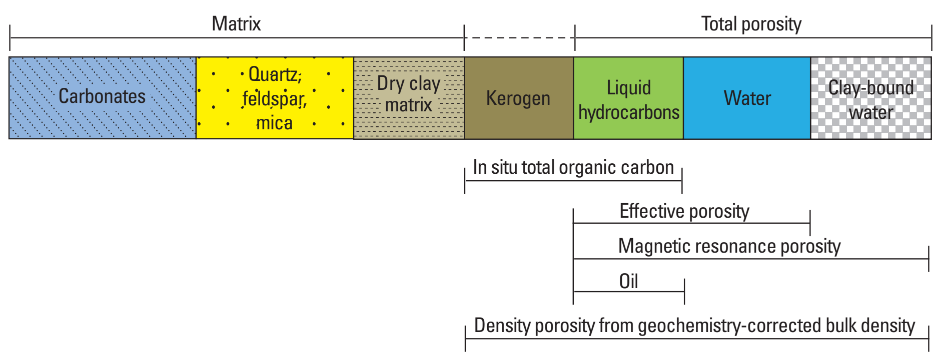
### Low-resistivity bias in finding pay

Pay zones in thinly laminated reservoirs are typically difficult to identify. The interbedded sands and shales suppress the measured resistivities, and the water saturation conventionally computed from these low values is usually pessimistically high, resulting in bypassed oil. This is the case for the self-sourcing Bone Spring "sands," which contain organic-rich shale laminae that are the source for the productive sand and silt layers. An operator needed a better way to identify movable hydrocarbon that was not biased by the low resistivity.

The Bone Spring reservoirs require more than just the presence of hydrocarbon to make a viable producing well. Low permeability is also a predominant concern, so intervals with movable hydrocarbon would also need confirmation of sufficient permeability.

### Quantified spectroscopy and NMR measurements for identifying producible hydrocarbon

The combination of Litho Scanner high-definition spectroscopy service and the CMR-Plus combinable magnetic resonance tool does not rely on conventional resistivity-based calculations. Litho Scanner service precisely measures a large set of key elemental yields, including carbon, to accurately quantify the mineralogy. The in situ TOC is directly determined by subtracting the amount of inorganic carbon (IC) associated with carbonate minerals from the total inelastic measurement of carbon. Thus Litho Scanner service's TOC is the carbon contributed by all organic matter present in the formation, whether solid kerogen or liquid hydrocarbon.



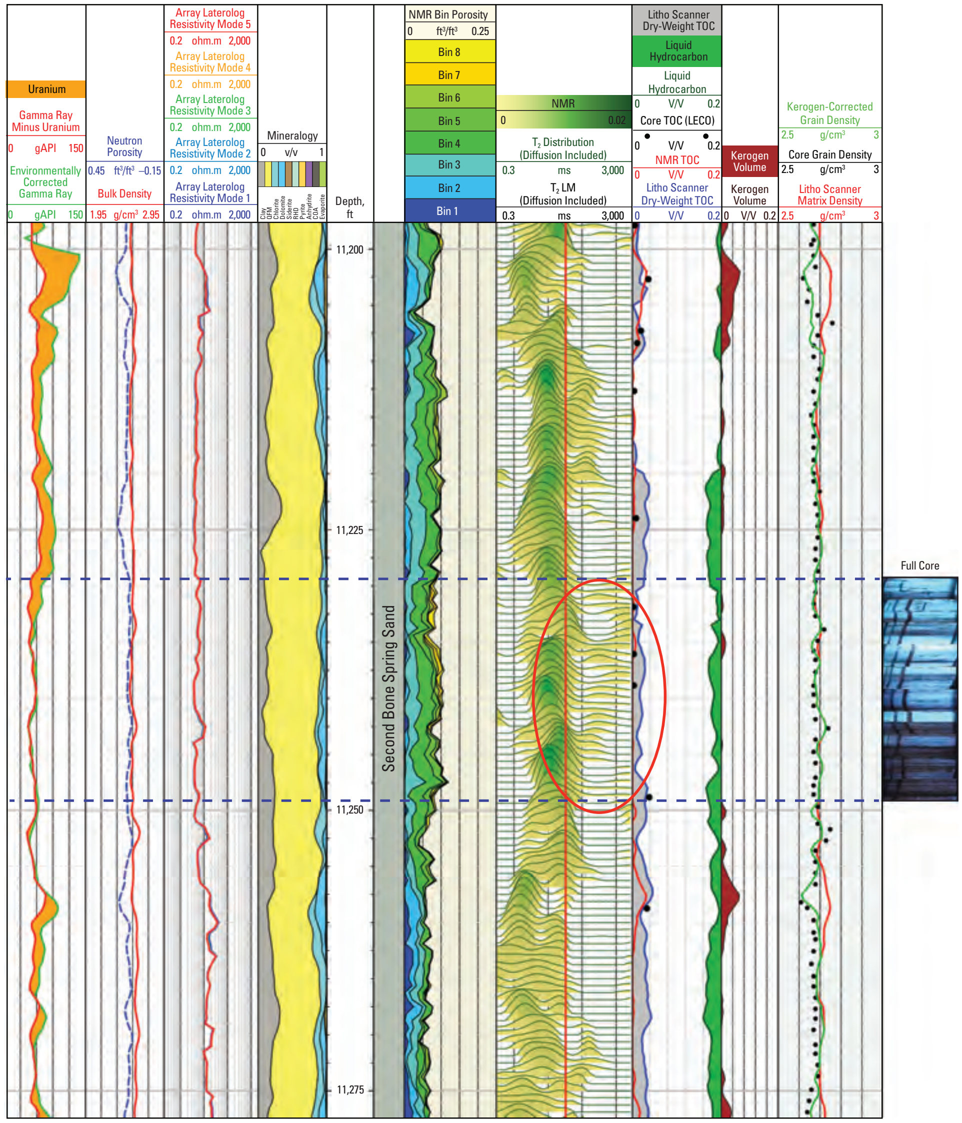

*Litho Scanner spectroscopy service accurately quantifies all the dry-weight components of the matrix and delivers a stand-alone in situ determination of TOC, which incorporates the reservoir contents for kerogen and liquid hydrocarbon. The CMR-Plus magnetic resonance measurement sees all the fluids and is not influenced by kerogen. This difference in measurement enables easily dividing the TOC into kerogen and liquid contents.*

The CMR-Plus tool's measurement responds to the fluids in the pores and is not influenced by the kerogen content. To differentiate the kerogen portion of the TOC, the porosity determined with the CMR-Plus tool is compared with the total density porosity corrected for the matrix density obtained from Litho Scanner service. This approach benefits from the accurate grain density output from Litho Scanner service, which is comparable to core grain density measured in the laboratory. The computed TOC attributed to kerogen is used to correct the matrix grain density in the presence of kerogen. The difference between the two porosities identifies the amount of kerogen in the TOC determination, and hence the remainder is the volume of producible liquid hydrocarbon.

## Advanced measurements for targeting the sweet spot

Petrophysical integration of the density log corrected with Litho Scanner service's matrix measurements and the CMR-Plus tool's porosity logs definitively identified Bone Spring intervals with liquid hydrocarbon. But did they have adequate permeability to be produced? The binned porosities from the CMR-Plus tool indicated that larger pores were present in one of the intervals in the Second Bone Spring Sand, suggesting higher permeability.

The operator selected the landing point for the lateral at ~11,235 ft in the Second Bone Spring Sand, and the well was successfully completed to flow oil on a 26/64-in choke at a rate of 472 bbl/d after 60 days of production.




*The computed kerogen volume (third track from the right) was confirmed by the core grain density (second track from the right) in the Second Bone Spring Sand, which is in good agreement with the kerogen-corrected grain density. The remaining TOC is attributed to liquid hydrocarbon (green shading, fourth track from the right), the presence of which is verified by the core UV photograph on the far right. The CMR-Plus tool's binned porosity (Track 6) indicates the presence of large pores (yellow) suggesting more permeable rock than the other intervals in the Second Bone Spring Sand. The combination of TOC determined from Litho Scanner service and the CMR-Plus tool's distribution of transverse relaxation time ($T_2$) values (red circle in Track 7) was used by the operator to select the successfully produced lateral landing point at ~11,235 ft.*

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