CHALLENGE
Quantify mineralogy, total organic carbon (TOC), kerogen, and porosity to enhance well placement and guide completion design in prolific unconventional play in the USA.

SOLUTION
Use the diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS) component of the LithoFlex service to accurately determine key proxies in near-real time.

RESULTS
- Identified formation tops and target zone.
- Landed the well in the condensate fluid window.
- Provided accurate kerogen density and maturity measurements to better estimate shale porosity.

Improve formation evaluation in an unconventional shale play
An operator needed to drill a lateral well within organic-rich shale in the USA, with >10% TOC. To place the well within the target zone and enhance completion design, the operator needed to identify and analyze key parameters, such as shale lithofacies, organic richness, and kerogen content, as well as obtain more accurate porosity evaluation than those derived from LWD measurements.

Porosity is a fundamental parameter for oilfield formation evaluation yet is challenging to determine in shale formations, especially in horizontal wells. Conventional methods for obtaining porosity measurements are based on analyzing core samples using gas immersion or liquid saturation. However, these techniques are time-consuming and limited to evaluation in the laboratory, and— for wells drilled laterally—core is typically not recovered. In lateral wells, porosity is assessed through LWD measurements, and the main challenge is the abundance of kerogen that is part of the solids matrix but has log responses similar to or indistinguishable from pore fluids. Without accurately characterizing the kerogen content, it is difficult to estimate porosity in shale.

Determine key rock properties in near-real time
Schlumberger recommended using DRIFTS, a cost-efficient component of the LithoFlex service. The LithoFlex service provides near-real-time formation evaluation in water- and oil-based mud for both wellsite and remote data monitoring and interpretation. Using the LithoFlex service, key measurements can be obtained from cuttings, including kerogen density, for improved porosity calculations derived from bulk density measurements.

LithoFlex Service and LWD Porosity

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 Logs from the LithoFlex service enhanced understanding of the formation. Quantification of kerogen density (Track 3) led to more accurate porosity estimates when combined with conventional LWD methods (Track 6).
Accurately characterized shale formation to identify target zone, determine kerogen maturity, and provide true shale porosity

The LithoFlex service characterized the shale formation by identifying mineralogical as well as TOC variation at every depth along the lateral, identifying the target zone. The LithoFlex service estimated more accurate kerogen density and maturity corresponding to the condensate window and provided a matrix-adjusted density measurement to obtain the true shale porosity.

Whereas 1.2 g/cm³ is commonly used to represent the kerogen density value in shale plays where kerogen density and maturity are otherwise unknown, DRIFTS—with a unique calculation process—yielded a consistent set of higher kerogen density values between 1.41 and 1.46 g/cm³, indicating thermal maturity that corresponds to condensate, thus identifying the target zone.

The cuttings matrix density (including kerogen density) and bulk density measurements were integrated to then determine shale porosity by isolating kerogen as part of the solids matrix and not pore fluids. This led to more accurate shale porosity quantification as compared with conventional LWD methods, enhancing well placement.

By accurately measuring TOC, the LithoFlex service indicates when the well is being drilled out of zone.