

# Slim Cased Hole Lithology and Anisotropic Mechanical Properties with One Toolstring, West Texas

No rig required for obtaining a complete dataset in a horizontal well by tractor conveyance of Pulsar spectroscopy service and ThruBit Dipole acoustic service

## CHALLENGE

Better understand the variability of rock properties along a lateral of a drilled but uncompleted (DUC) well without adversely affecting the operator's drilling schedule.

## SOLUTION

Deploy the slim Pulsar\* multifunction spectroscopy service and ThruBit Dipole\* through-the-bit acoustic service in a single logging run on wireline tractor to obtain a complete set of high-quality petrophysical and geomechanical formation properties data.

## RESULTS

Efficiently and confidently made completion decisions with confidence on the basis of accurate reservoir quality (RQ) and completion quality (CQ) determined from the detailed lithology and anisotropic mechanical properties obtained in a single rigless trip.



## Reservoir variability along the lateral

An operator in West Texas needed to design a completion that would account for the variability of rock properties along a 4.5-in-diameter horizontal well. However, the well was already cased, so conducting logging conventionally on pipe would require deploying a rig, which would delay the drilling schedule for the field. An additional concern was that the estimated clay volume provided by standard pulsed neutron tools can be misleading if used as an analogy for stress in determining RQ and CQ.

## Slim cased hole measurements for one-run formation evaluation

New Pulsar multifunction spectroscopy service enables stand-alone cased hole petrophysical volumetric interpretation by obtaining the standard formation evaluation suite with a single 1.72-in tool. This pulsed neutron tool incorporates the proven cerium-doped lanthanum bromide (LaBr<sub>3</sub>:Ce) gamma ray detector introduced by Litho Scanner\* high-definition spectroscopy service to similarly obtain highly accurate elemental concentrations for a robust determination of mineralogy—including total organic carbon (TOC)—in addition to traditional sigma, porosity, and carbon/oxygen ratio measurements. Pulsar service also delivers the new fast neutron cross section (FNXS) measurement for differentiating gas-filled porosity from liquid-filled zones and tight formations.

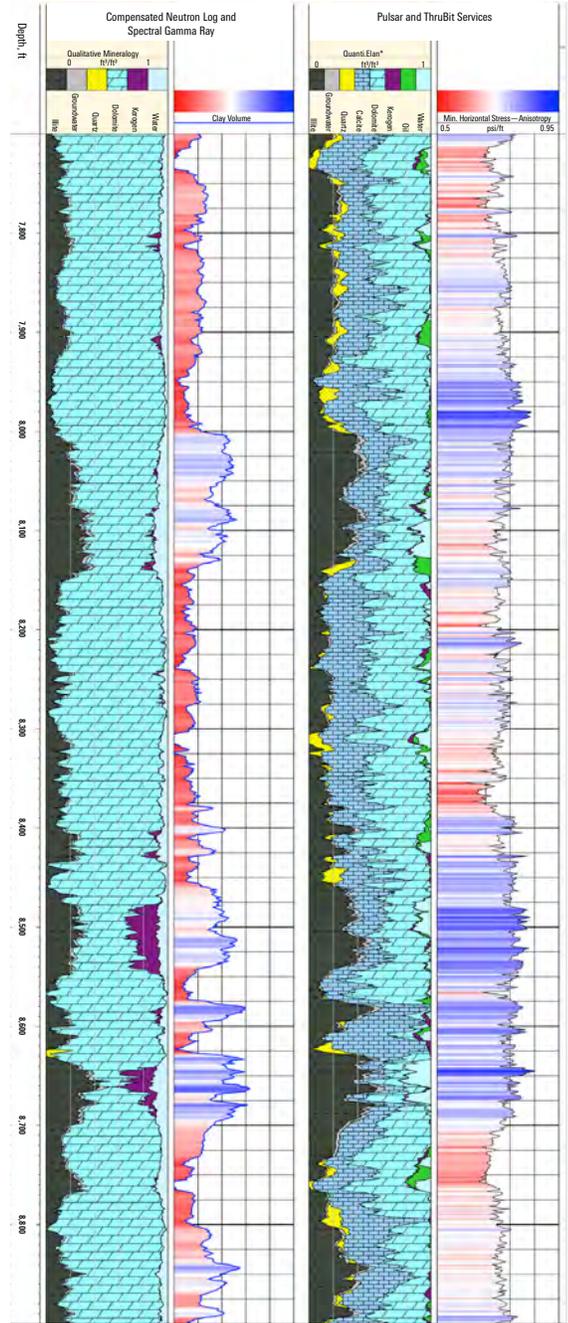
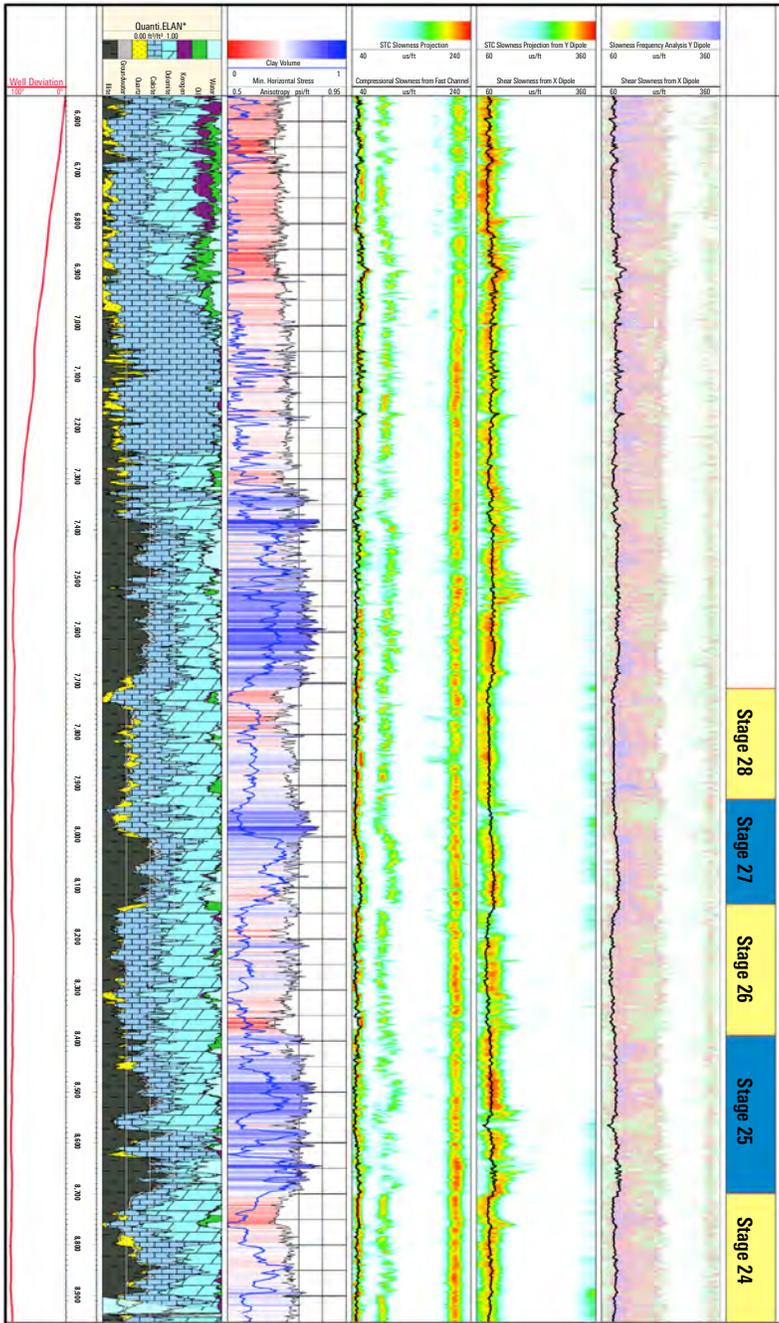
With a diameter of only 2.125 in, ThruBit Dipole through-the-bit acoustic service acquires both monopole and cross-dipole waveforms and Stoneley waves that are processed with a 3D anisotropy algorithm to obtain anisotropic moduli referenced to the borehole axes. These are used to classify the formation as isotropic or anisotropic and determine whether the anisotropy is intrinsic or caused by drilling-induced stress. In combination with bulk density derived from Pulsar service's volumetric interpretation, the resulting refinement of the determination of mechanical properties provides critical information for guiding well completion in shale reservoirs, designing fracturing stages in laterals, understanding wellbore stability, and planning future well paths.

## Accurate clay volume and stress regime from a single tractored run

Because Pulsar and ThruBit services were conveyed as a single slimhole toolstring on tractor, a rig did not need to be redeployed to the DUC wellsite and therefore no delay was introduced to the operator's drilling schedule. The elemental yields from Pulsar service were processed to provide a detailed representation of the lithology, including clay volume, dolomitization, and kerogen and hydrocarbon contents, for assessing RQ. ThruBit service's dipole sonic data was used to determine the anisotropic mechanical properties as the basis for CQ.

With RQ and CQ accurately calculated from the wealth of logging information retrieved in a single logging run, the operator had a better understanding of reservoir variability along the lateral for confidently designing an effective completion.

CASE STUDY: RQ and CQ for slim cased well in one run of Pulsar and ThruBit Dipole services, West Texas



The single-run combination of Pulsar and ThruBit services is especially useful for the comparison in Track 3 of clay volume (blue curve) and minimum horizontal stress ( $\sigma_{Hmin}$ , black curve) as an indicator of anisotropy. As clearly shown, the two curves do not consistently track well, which emphasizes that clay volume is not a reliable substitute for in  $\sigma_{Hmin}$  designing an effective completion.

For comparison, a conventional compensated neutron log and spectral gamma ray (Tracks 1 and 2) were also acquired in the cased 4.5-in lateral well and processed for the clay volume and mineralogy. The contrast with the answers provided by Pulsar and ThruBit services (Tracks 3 and 4) clearly shows that the advanced pulsed neutron measurement of Pulsar service delivers much higher-resolution lithology. The  $\sigma_{Hmin}$  curve derived from ThruBit service's dipole data demonstrates that clay volume cannot be assumed to always be analogous to stress.

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