CASE STUDY

Pulsar Multifunction Spectroscopy Logging Differentiates Gas and Tight Zones in Cased Well

Single-tool, one-run FNXS measurement accurately quantifies gas volumes in shaly sand despite cement thickness greater than 2 in, US land

CHALLENGE
Accurately differentiate and evaluate alternating gas-bearing low-porosity zones and tight shaly sand zones in a cased well with cement more than 2-in thick.

SOLUTION
Efficiently obtain a full petrophysical volumetric interpretation from a single run of Pulsar* multifunction spectroscopy service, which does not require openhole log data for a complete analysis.

RESULTS
Identified and quantified the gas-filled porosity zones to reliably differentiate them from a similar zone with very low porosity.

Shaly sand with intermixed low-porosity gas-filled zones and tight zones
A US land well was drilled with an 8¾-in bit size and completed with 4½-in 11.6-lbm/ft casing. As a result of the difference between the hole and casing diameters, the completion has a relatively large cement volume, with a cement thickness greater than 2 in. The formation lithology is shaly sand, with alternating low-porosity gas-filled zones and very low porosity zones. Although openhole logs had been run, the operator was interested in obtaining an interpretation that would provide greater insight to the formation and its fluid contents.

A new measurement to identify and quantify gas-filled porosity
Schlumberger recommended running new Pulsar multifunction spectroscopy service. In addition to providing stand-alone petrophysical volumetric interpretation incorporating high-fidelity mineralogy and lithology for cased holes, Pulsar service also introduces the new fast neutron cross section (FNXS) measurement to definitively differentiate gas-filled porosity from liquid-filled zones and tight formations. The fast neutron inelastic scattering response used to calculate FNXS is not dominated by particular elements, which is the case for conventional neutron logging. With its measured values for rock matrix and water in the same range, FNXS is insensitive to variation in liquid-filled porosity but highly sensitive to variation in gas-filled porosity.

Differentiation of gas-filled porosity and tight zones
Logging the shaly sand revealed two zones of interest at X,160 to X,180 ft and X,270 to X,330 ft. The environmentally corrected FNXS curve and the gas ratio curve it is calculated from (Tracks 7 and 6, respectively) show that the lower zone contains gas—unlike the very low porosity upper zone. The stand-alone volumetric interpretation performed using a linear solver with Pulsar service’s sigma, FNXS, and TPHI measurements (Tracks 10 and 11) is validated by the previously obtained openhole logs (Tracks 8 and 9).

With this one-run, one-tool solution to logging cased wells, the operator can streamline operations to a single log obtained in the more stable cased well.
**CASE STUDY:** Pulsar multifunction spectroscopy service differentiates gas and tight zones in cased well, US land

The large annular volume of light cement had to be accounted for in quantifying the gas-filled porosity. In the left-hand crossplot of Pulsar service’s FNXS and thermal neutron porosity (TPHI) measurements, FNXS has the standard wellbore correction applied. However, the cement used in developing the characterization database was heavier, causing FNXS to clearly read too low compared with the expected value. An additional offset correction was applied for the effect of the light cement, which adjusted the FNXS value close to the theoretical value for the very low porosity shaly zones. As shown in the right-hand crossplot, the additional offset produced environmentally corrected FNXS values that are much more consistent with the sandstone envelope and thus are appropriate for use in a quantitative interpretation.

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**Pulsar service’s FNXS measurement was environmentally corrected for the large volume of light cement in the annulus to differentiate the dry tight zone at X,160 to X,180 ft from the gas-filled porosity zone at X,270 to X,330 ft. A conventional cased hole pulsed neutron log, as approximated by the near/deep count ratio in Track 5, would read gas in the upper tight zone.**

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