LateralScience℠ Method Compares Favorably to a Full Suite of Wireline Logs

The strength of MSE interpretation is put to the test beside an openhole suite that includes density/neutron/GR, dipole sonic and resistivity images.
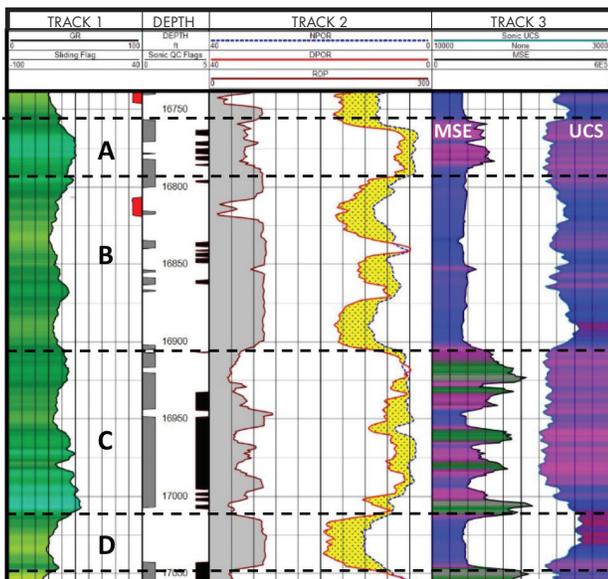
Background

In a Powder River Basin subject well, the operator had acquired openhole wireline logs across the entire lateral. Logs included density/neutron/gamma ray (GR), full-wave dipole sonic, and resistivity-based images. The neutron/density/GR readings showed significant lateral heterogeneity. This made the subject well an excellent candidate to benchmark the ability of sonic logs against the MSE-based LateralScience process to detect facies changes and to characterize the lateral.

For an explanation of the log presentation format, please refer to the bottom of Page 2.

### Interval 1: Measurements Are in Good Agreement

In this sample interval of approximately 300 ft, the density (DPOR) and neutron (NPOR) logs show highly porous facies in sections B and D and lower-porosity facies in sections A and C. The GR log is in close agreement, showing lower GR values in higher-porosity zones. The correlation between mechanical-specific-energy (MSE) and sonic unconfined-compressive-strength (UCS) readings is excellent, with both showing lower values in the higher-porosity (blue) facies and higher values in the lower-porosity (magenta) facies. With all measurements in agreement, confidence is high across this interval.

Interval 2: GR Is Ineffective for Facies Detection

In the second interval, the density, neutron, MSE and sonic UCS values indicate that this interval is broken into six different facies. Sections A, C and E are high-porosity rock with lower MSE and UCS values. Sections B, D and F are lower-porosity rock with higher MSE and UCS values. While sonic UCS and MSE are in excellent agreement, GR readings are completely "lifeless" through this section and ineffective for facies detection. This proves that, while GR can be valuable in some intervals, it cannot be relied on as a stand-alone tool.
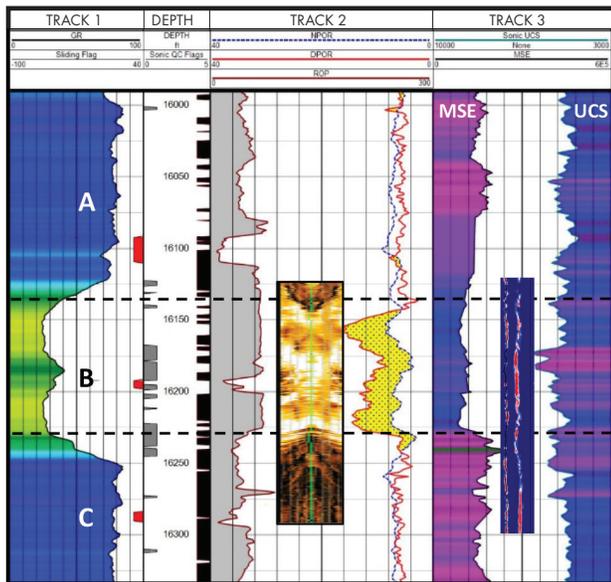

Interval 1: All measurements in agreement and detecting the same facies variations.
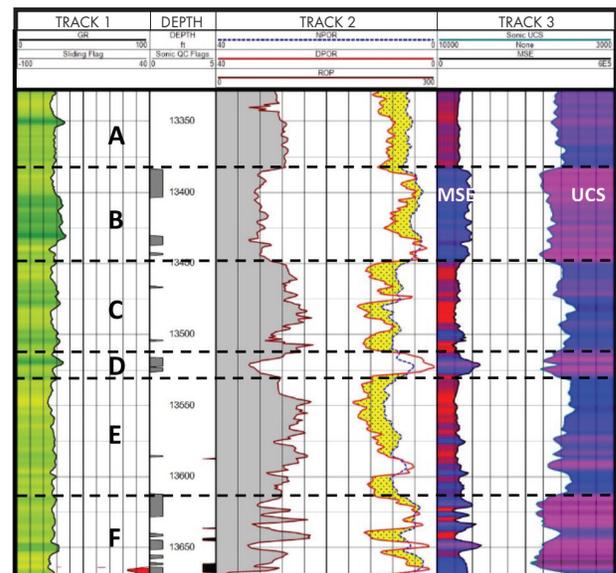
Interval 2: Sonic UCS and MSE readings agree with porosity logs. GR is inactive and ineffective in picking up the facies variations.

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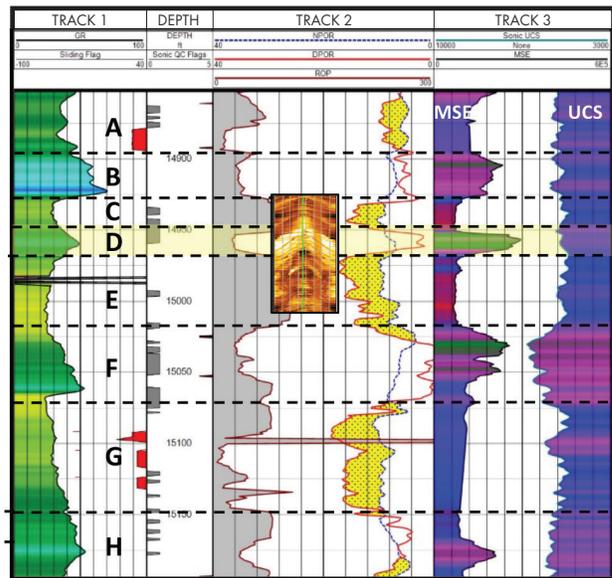## Interval 3: Sonic Quality Impacts UCS Result

This is a relatively simple interval with one facies change between 16,140 and 16,230 ft. The neutron/density/GR and MSE track each other very consistently. However, the sonic UCS does not correlate with the rest of the measurements. The sonic-quality flags suggest that a poor signal-to-noise ratio is the likely cause of a substandard UCS computation. The sonic-semblance map – shown in the lower portion of Track 3 – confirms that the DTc detection is suffering from poor signal quality. The resistivity image in Track 2 lends additional support to the MSE facies result.

Interval 4: Highly Laminated Interval Demonstrates MSE Superiority

With eight obvious facies changes across a short section of the lateral, Interval 4 is particularly interesting. The correlation between density, neutron and MSE readings is obvious, with high-porosity zones C, E and G all showing low MSE values. Zone D is highlighted because GR, density and MSE all agree that this is a 15-ft stringer that is particularly hard, while the UCS computation missed this completely. Once again, the quality flag suggests that a weak sonic signal has caused a low-quality UCS computation. The resistivity image in the middle of Track 2 confirms the MSE response.

Interval 3: The sonic-quality flags shown in the depth track suggest that poor signal-to-noise ratio is preventing UCS from detecting an obvious facies change.

Interval 4: In this highly laminated interval, the MSE does an excellent job tracking density log response. In section D, poor sonic quality negatively impacts the UCS result once again.

Log Presentation Format

Track 1: Color-coded GR log, along with red flags that indicate drilling data has been compromised by sliding events.

Depth Track: Flags indicate where the dipole sonic-semblance quality is triggered due to weak signal strength. DTc flags are gray, and DTsh flags are black.

Track 2: Drilling ROP (shaded gray) and density/neutron porosity logs (with yellow shading when DPOR > NPOR). Porosity increases to the left.

Track 3: MSE increases to the right, and sonic-based UCS increases to the left. Both are similarly color coded to facilitate the comparison.

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