

Using Multiple Data Types in San Andres Stimulation



CHALLENGE

In the San Andres formation of the Permian Basin, an operator needed cluster placement in the transition zone to minimize fracture growth into the water zones below. Twenty stages were scheduled in a 5,000-foot lateral, with all stages having a similar pump schedule. Chemical tracers monitored production from each completion stage.

TASK

- ✔ Determine correlation of breakdown pressures with OmniLog® mechanical specific energy (MSE) at perforation depths, to see if MSE enabled a predictable response to fracturing.
- ✔ Incorporate OmniLog profile into the completion plan and check post-stimulation to determine if the MSE values accurately represented the stimulation treatment and production performance.
- ✔ Examine pressure responses from the individual stimulation treatments and compare to large-scale heterogeneity – visible in the gamma ray (GR) and MSE profiles.

SOLUTION

- ✔ Use OmniLog® profile with drilling data, to identify relative rock-strength heterogeneity.
- ✔ Incorporate client's mud-gas mass spectrometry data to identify hydrocarbon rich areas in perforation placement.
- ✔ Use Drill2Frac PerfAct™ calculation engine integrating a weighted OmniLog profile and mass spectrometry inputs.
- ✔ Position perforation clusters within rocks according to the predicted hydraulic fracturing response.

Moderate Heterogeneity

OmniLog showing the MSE profile for the entire lateral.

MSE is higher at the toe and heel of well.

This well can be separated into three distinct sections with similar MSE.

OmniLog trajectory plot – showing rock hardness heterogeneity. Perforations are placed in rock with similar characteristics. Stages with two perf clusters are shown in blue. Three cluster stages are in red.

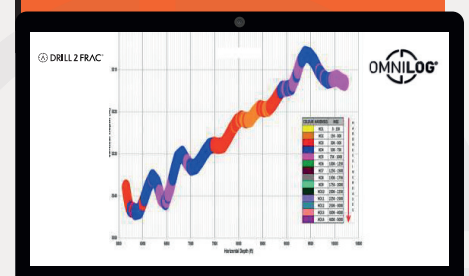


The San Andres, first produced in 1920, has produced over 30-billion barrels of oil from vertical wells drilled on structural highs with columns of oil saturated rock.

The area between these structural highs frequently shows a thick transition zone of oil to water. Recent focus of horizontal drilling has targeted the upper part of the transition zone between the larger structures. By drilling horizontally and fracturing higher in the section, operators are producing commercial volumes of oil with large amounts of formation water.

A key to future horizontal success is to avoid fracturing down into the water of the residual oil zone (ROZ). Typically with only gamma ray and mud logs, it is difficult to consistently avoid runaway fractures that go into the lower part of the transition zone, water-bearing.

Runaway fracs are commonly caused by differentials in rock strength. Thus, the amount of fracture energy and proppant placed in the reservoir rock, depends on its degree of heterogeneity. If heterogeneity is addressed in the design, it is more likely that fractures will be contained in the rock with more desirable fluid saturations.





Results & Validation

There was better agreement with pressure profile responses when the well was segmented using MSE, and very good correlation of average perforation MSE with breakdown pressures. Evidence that increased MSE heterogeneity contributed to elevated treatment pressures.

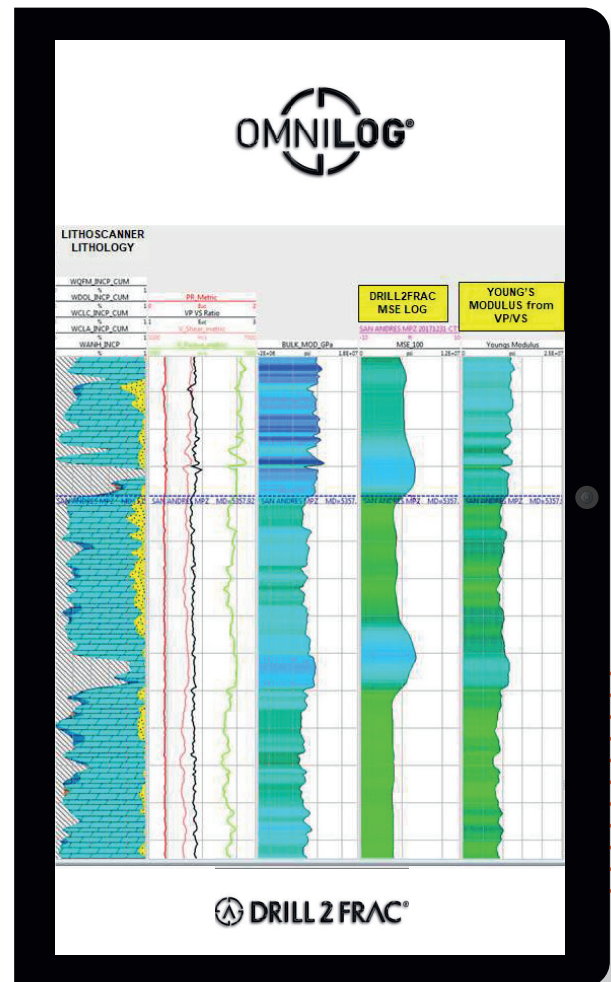
All stages contributed to production, but individual stage contributions varied greatly. The data showed that best results occurred where gas shows were highest, although gas shows alone did not completely predict individual stage contributions.

Observing correlations between Young's Modulus and vertical OmniLog® values, the operator stated, "The Drill2Frac mechanical properties log exhibits a reasonable correlation to the calculated Young's modulus in the pilot well, verifying that the log is a good proxy for log-derived, rock strength calculations."

Right Image: Log analysis across the San Andres landing zone shows lithology and sonic log properties in the first two tracks from the left.

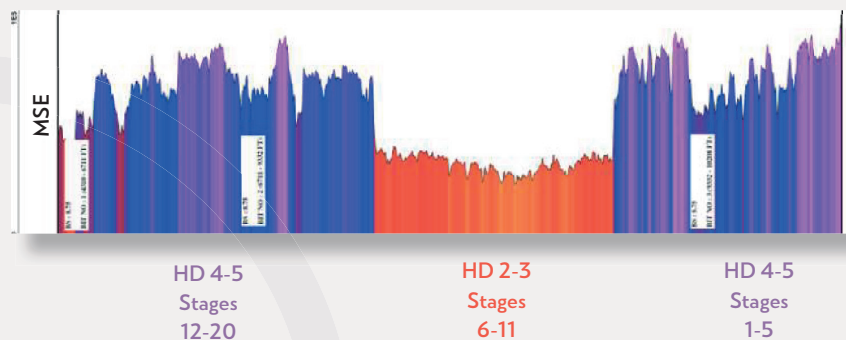
The three tracks on the right show OmniLog® MSE in the center, flanked by sonic derived Bulk modulus, and Young's modulus on either side. Visual correlation between OmniLog profile and the moduli is good.

Cross-sectional view showing comparison of gamma ray, lithology, OmniLog profile, and Young's modulus calculated from sonic logs



Wellbore Segmentation based on MSE

The wellbore segmentation based on the MSE profile groups stages 1 through 5 in harder rock, stages 6 through 11 in rock with lower MSE, and the remaining stages 12 through 20 in rock with higher hardness.



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