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Measuring Uncertainty in Seismic Lithology Prediction Using Statistical Rock Physics: Application to Heavy Oil Orinoco Belt of Eastern Venezuela

We apply statistical rock physics methods to estimate uncertainty in lithology predictions from seismic attributes, in the Orinoco Belt (Eastern Venezuela). We analyzed only seismic attributes that are physically related with interval reservoir properties.

To avoid pitfalls in lithology delineation from seismic, it is essential to understand the seismic signatures of lithologic, and possible pore fluid variations in the study area. We use a strategy for quantifying uncertainties that combines multivariate statistical techniques with deterministic rock physics. Therefore, we can handle conditions not represented in the well training data. Monte-Carlo simulation based Bayesian classification was applied to investigate how different seismic attributes (acoustic-impedance, P-to-S converted wave pseudo-impedance, $\lambda\mu-\rho\mu$) can discriminate lithology. The methods allow us to quantify the classification success rate (CSR) when using different attributes.

Major productive units in the study area are early to middle Miocene fluvial-deltaic sandstones with thin impermeable layers, resulting from channel migration over the delta plain. The Heavy oil production is mainly through horizontal wells; hence, precise definition of sandstone units is critical.

The main conclusions from the uncertainty analysis are: Density has the best ability to discriminate sands and shales, with a CSR of 95%, but density is very difficult to estimate reliably from seismic data. It is easier to estimate impedance attributes. A single impedance-related attribute gives a CSR of 70-75%. Using two impedance attributes or $\lambda\mu-\rho\mu$ together, can increase it to about 80-85%. Although these estimates apply to the region and depth studied, the methodology can be applied in any reservoir.