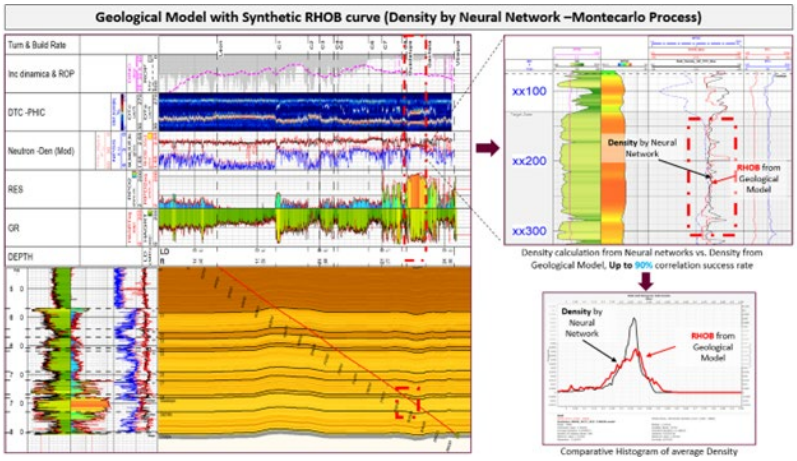
ShockWave® Sonic Tool, Neural Network-Generated Density Characterized Reservoir, Detected Faults Without Radioactive Sources



Well placement model representation, showing correlation update between synthetic curves responses in the target Guadalupe Formation.

Objectives

- Identify formation tops and a local structural change zone (a possible fault zone) to help directional drilling engineers understand the sudden change in behavior of the bottomhole assembly (BHA).
- Acquire compressional slowness and a variable density log (VDL) in real time to be used as the main input to update the model and calculate porosity and the formation's acoustic velocity.
- Determine if the dip formation would be affected around the fault zone.

Our Approach

- In collaboration with the customer, the Weatherford drilling team, supported by Interpretation and Evaluation Services (IES) experts, defined the analysis and engineering challenges.
- Because of the regional limitations on radioactive sources, Weatherford recommended replacing the RHOB bulk density log (which measures the density of a borehole penetrated by a drill bit) in the BHA with a unipole sonic tool. The ShockWave sonic LWD tool provides reliable, real-time data in a wide range of downhole conditions.
- The BHA featured an LWD package consisting of the HAGR™ high-temperature azimuthal gamma ray sensor, the ShockWave sonic tool, the MFR™ multifrequency resistivity sensor, and a thermal neutron porosity sensor.

LOCATION
Colombia

WELL TYPE
Exploratory, deviated

HOLE SIZE AND ANGLE
6-3/4 in., 33°

TEMPERATURE
151°F (66°C)

LINER SIZE
9-5/8 in. at 1,183 ft (360 m) MD

TOTAL DEPTH
7,617 ft (2,321 m)

LOGGING INTERVAL (MEASURED DEPTH)
1,183 to 8,800 ft (360 to 2,682 m)

PRODUCTS/SERVICES
- ShockWave sonic tool
- HAGR high-temperature azimuthal gamma ray sensor
- MFR multifrequency resistivity sensor
- Hostile-environment-logging (HEL™) measurement-while-drilling (MWD) system
- Thermal neutron porosity tool

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Our Approach (continued)

- The drilling crew deployed the BHA into the wellbore and, in real time, identified one fault zone which was not clear to the customer from the pre-drill analysis.
- Based on the preliminary analysis, up to 90% of the actual formation had the same expected thickness as the geological model and the calculated RHOB values had good correlation to the offset well.
- This accurate analysis helped the directional drilling crew reduce the impact of sliding operations and projected a possible final drilling depth according to the stratigraphic sequence, enabling the customer to reduce the associated risks.

Value to Customer

- Weatherford experts mapped the uncertain fault zone using LWD conventional measurements and the unipole sonic tool, complementing the analysis by comparing the BHA behavior and the VDL tool.
- The well placement model helped define the target zone, calculate the RHOB synthetic curve, and compare it to sonic measurements and thermal neutron porosity as a standalone sensor.
- The job proved that the gamma ray, resistivity, and ShockWave sonic tool could be used as an accurate and reliable alternative BHA to calculate porosity and a RHOB synthetic model in the field without using radioactive sources. This BHA configuration demonstrated that it would not affect the performance of the operation and minimized risks in wells where the rate of possible differential sticking and the condition of the hole are relatively high or of greater impact, which may make the use of radioactive sources difficult.
- The log reconstruction process for estimating the RHOB by the Neural Network–Montecarlo Process showed a good value for the RHOB density curve as compared with the RHOB calculated for the well placement model. The K.mod performs the parameter prediction and log reconstruction using multilayer perceptron technology and has several learning cycles and nondeterministic behavior. For the same data, K.mod does not show the same results twice.
- This will empower the customer to adjust trajectories and better position the next wells, anticipating high risk zones for operations due to the presence of the fault and optimizing operative costs.

