Shell Accurately Steers Horizontal Well Sections in Deepwater Reservoir Offshore Brazil

Reservoir mapping-while-drilling service guides steering of horizontal drainholes to intersect reservoir targets

**CHALLENGE**

Steer horizontal well sections to keep them within deepwater reservoirs offshore Brazil.

**SOLUTION**

Use the GeoSphere* reservoir mapping-while-drilling service to guide steering decisions.

**RESULTS**

- Optimized reservoir steering within multiple fault blocks to avoid unplanned exit from target reservoir.
- Provided information for optimizing production management and for refining geological and structural models.
- Delineated reservoirs, providing opportunity for improved subsurface characterization.

**Steer well sections to stay within reservoirs**

Shell Brasil Ltda.’s deepwater campaign required drilling horizontal production sections of two wells in different fields offshore Brazil that were believed to have structural areas with stacked turbidite reservoir sands. It aimed to maximize production by steering the horizontal sections to keep them within the reservoir’s sweet spots and to improve reservoir understanding by mapping the sand packages. Multiple fault blocks in the planned well paths and depth uncertainty in the available seismic data made achieving those objectives a challenge.

**Detect reservoir boundaries more than 100 ft from wellbore**

To meet the objectives of both wells, the GeoSphere reservoir mapping-while-drilling service was selected for its ability to resolve the positions of reservoir boundaries in excess of 100 ft [30 m] from the wellbore. The service’s deep, directional electromagnetic measurements are used to guide steering decisions and delineate intrinsic layering of contrasting resistivity within the reservoirs.

The BHA included a point-the-bit rotary steerable system for precise trajectory control and advanced LWD tools to acquire petrophysical information for reservoir evaluation.

The plan for the first well called for steering the 8½-in production section to intersect two structural areas believed to contain the same stacked turbidite reservoir sands. This drainhole was to enter and exit the reservoir in the first structural area, transit a shale zone, and enter the reservoir in the second structural area.

In the first well, when the GeoSphere service showed the top of the reservoir to be lower than indicated by the original reservoir model, the trajectory was altered to intersect the second structural area.
Upon exiting the casing shoe in the second well, the inversion mapped the reservoir top about 13-ft [4-m] TVD above the wellbore while simultaneously mapping the base of the reservoir along the horizontal section. The wellbore crossed a fault, and the deep electromagnetic inversion showed good delineation of the reservoir, correlating to what was expected from the initial model of the lower fault block. In the upper fault block, the GeoSphere service revealed unexpected geometry and previously unknown stratigraphic events.

The GeoSphere service guided steering in these two wells and several additional wells in this campaign. As a result, Shell optimized reservoir exposure and avoided unplanned exits from the target reservoirs, despite depth discrepancies in the reservoir models. Additionally, the service provided information for refining geological and structural models and for optimizing production management and ROI.

In the second well, the depth of investigation of the GeoSphere service allowed access to reserves on both sides of the fault.

The plan for the second well was to steer the horizontal production section to access reserves on both sides of a secondary fault. Proceeding from the landing point, the planned horizontal well path would first traverse the reservoir in the lower fault block and then cross a normal fault into the upper fault block, where the reservoir was expected to narrow.

**Optimized well placement with real-time data**
In the first well, the GeoSphere service mapped the top of the reservoir in the first fault block, revealing the reservoir top 46-ft [14-m] TVD lower than initially expected. A dip in the top reservoir structure not inferred from seismic data was also detected. Further interpretation showed a fault in this area. After exiting the first lobe in the shale zone, the trajectory was adjusted downward to find the second reservoir lobe. Upon approaching the second reservoir lobe, the top of the reservoir was detected from about 30-ft [10-m] TVD below the wellbore.

In the second well, the depth of investigation of the GeoSphere service allowed access to reserves on both sides of the fault.