Reservoir Heterogeneity Study Improves Well Planning Efficiency

Challenge
The field consists of massive, homogeneous marine turbidite sandstones with excellent reservoir properties; however postdepositional faulting and deformation resulted in highly deformed reservoir boundaries. These features complicate well placement. On some wells, more than 33% of injection shales were crossed on the horizontal section, affecting borehole stability and impacting well production. The primary objective was to develop the resource safely and with the least number of wells.

Solution
A reservoir heterogeneity study was conducted over the field to understand the shale and the sand injection distribution, based on the combination of four component and Q-Marine* surface seismic data.

Results
The results of this study encouraged the use of specialized technology; for example, an ultradeep resistivity LWD tool was particularly useful in addressing the specific challenges of the field.

Steering in complex sandstone formations
The field under study consists of massive, homogeneous marine turbidite sandstones with excellent reservoir properties. The reservoir is located in a Tertiary formation, providing stratigraphic traps consisting of massive, medium-grained, homogeneous turbiditic sandstones and enclosed by shales. The deposition and geometry of the turbidite sand lobes were primarily controlled by the original basin morphology, which forced the sand to deposit along a main axis parallel to a structural high.

The postdepositional faulting and deformation resulted in highly deformed reservoir boundaries, where shales have been squeezed into the sand and sand has been injected into the overlying shales in the form of dikes and sills. These features complicate well placement and make it even more important to steer the wells accurately. On some wells, more than 33% of injection shales were crossed on the horizontal section, affecting borehole stability and impacting well production.

3D seismic facies analysis
A reservoir heterogeneity study was conducted over the field to understand the shale and the sand injection distribution, based on the combination of four component and Q-Marine surface seismic data. The results of this study encouraged the use of specialized technology, for example, an ultradeep resistivity LWD tool was particularly useful in addressing the specific challenges of the field.

Heterogeneity mapping confirmed the shale injections at the well location.
In this field, the turbidite sand lobes have undergone syn- and postdepositional deformation generating a complex geometry of the main reservoir sands. This geometry is characterized by a shale streak coming from beneath the reservoir and sand injectites distributed above the reservoir and on both margins of the main sand lobe.

The general inversion scheme involves 3D seismic facies analysis, which is a powerful quantitative technique derived from seismic stratigraphy. Seismic facies are groups of seismic reflections with parameters such as amplitude, continuity, reflection geometry, and frequency. These are distinct from adjacent groups.

This approach consists of a 3D classification of the seismic texture attributes using a proprietary algorithm. The geological derivation of the classes is determined by investigating the character of the seismic data and the lateral-vertical associations of seismic facies, using well calibration and rock physics analyses.

The heterogeneity classes are extracted as a 3D geobody and sampled as a grid. The geobody grid is populated with rock physics properties, which add a qualitative measurement to the heterogeneous bodies. 3D geobodies include a risk scale that converts the classification results into a 3D drilling risk map.

**Well planning process improved**

The primary objective of asset teams is to develop the resource safely and with the least number of wells. Predrill seismic assessment of drilling hazards has become an essential part of the well planning process. 3D reservoir heterogeneity mapping leads to a better understanding of the geometry of the reservoir interval and increases the efficiency of the well planning process.

E-mail dcs@slb.com or contact your local Schlumberger representative to learn more.