Schlumberger

Mapping While Drilling Improves Geosteering

GeoSphere 360 service maximizes North Sea well placement

An operator wanted to integrate data from multiple scales of measurement well in the North Sea to enable strategic geosteering decisions. Using GeoSphere 360* 3D reservoir mapping-while-drilling service helped reduce uncertainties, improve geosteering, and optimize well placement within the oil leg.

Improve geosteering and enhance well placement

An operator recognized significant static and dynamic uncertainties throughout the well design and execution phases, including fluid distribution and structural geometry, and wanted to integrate data from multiple scales of measurement, such as borehole-scale and borehole-derived near-seismic-scaled LWD, with attribute analysis of surface seismic. The objective was to improve geosteering and enhance well placement, which contains an oil accumulation with a gas cap. The reservoir comprises sandstones of a deepwater turbidite channel system. The geological structure was a complex, four-way dip closure anticline with bounding faults and expected subseismic faulting, increasing the level of uncertainty and complexity. An area of bypassed oil identified on the eastern flank of the structure was the target for an infill well.

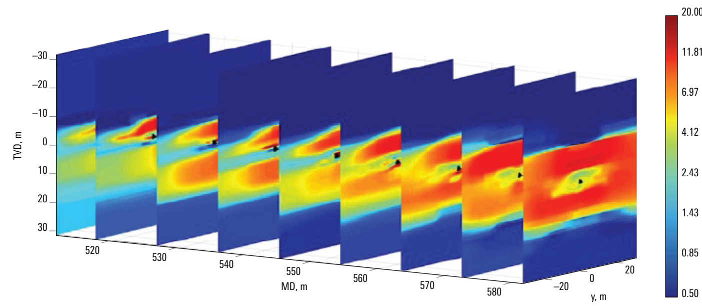
Produce 3D resistivity volumes to understand near-wellbore resistive geobodies

GeoSphere 360 service acquires 360° tensor data and sends it uphole in real time via mud pulse telemetry or wired drillpipe. Using cloud computing resources, Schlumberger inverted the large datasets using a 2D azimuthal pixel-based algorithm. GeoSphere 360 service produces 3D resistivity volumes that can be filtered to understand the geometrical relationship of the resistive geobodies around the wellbore, calibrating the seismic and feeding into reservoir modeling workflows.

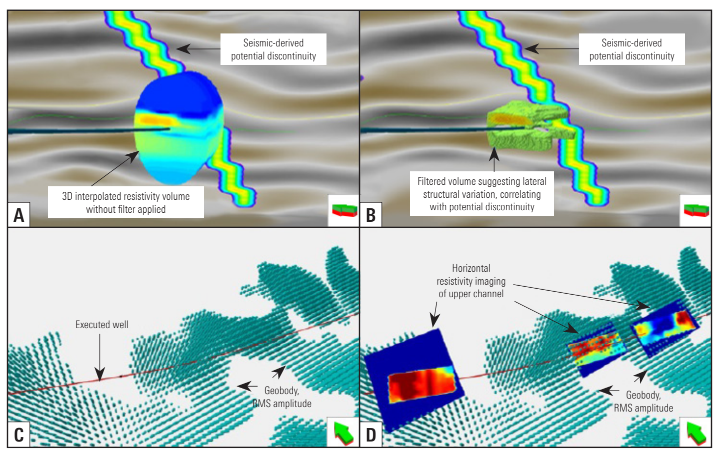
Make strategic geosteering decisions

The interpretation of the 2D inversion is integrated with the 1D GeoSphere HD* high-definition reservoir mapping-while-drilling service inversion interpretation, illustrating the vertical separation between the two resistive bodies in the lateral plane. The 2D azimuthal inversion slices also illustrated where the lateral variation in the resistive bodies was apparent, with the prominent truncation of the upper resistive body imaged. Such truncation is consistent with interpreted seismic discontinuities, further aiding in the structural interpretation of the subsurface. Combining all the data and interpreting all inversions in tandem and in real time enables highly educated geosteering decisions at realistic drilling ROPs.

Because the full 3D data had significantly more datapoints, the predrill predicted seismic and geobody extraction was calibrated much more accurately than would have been possible with conventional technology. Converting the 3D resistivity volume to a SEG-Y and visualizing a z-slice made it possible to understand and interpret the relationship between the variation of the raw non-1D measurements along hole and the resistive features inverted for around the borehole. Comparing all data sources enabled further validation of the interpretation. Finally, subsurface geomodels were updated in real time to a high resolution, affording a high confidence for strategic geosteering decisions in 3D if required.



2D azimuthal inversion slices every 10 m from a 75-m MD section, looking north. The upper resistive red body is truncated in the earlier slices, with the truncation reducing along hole. The inversion also images the stacked reservoir channels, yielding important information on vertical connectivity in the lateral direction.



Interpolated 3D volume from azimuthal inversion slices every 10 m from the 75-m MD section is shown in Figure A, looking to the southern side of the well and resistive body. (A) This image is unfiltered. (B) The same aspects are filtered to show resistivities above 2.5 ohm.m. Also shown is the seismic discontinuity derived from the advanced seismic attribute analysis, visualized on a random line perpendicular to the well trajectory. The position of the resistive body truncation correlates well with this seismic discontinuity. (C) Geobody extraction from the RMS amplitude attribute (green points), (D) with z-slices of 3D interpolated volume from the 2D azimuthal inversions, showing a strong correlation between the distribution of resistive (red) packages relative to the wellbore and the position of extracted geobodies.