CASE STUDY

Schlumberger

3D Far-Field Sonic and Borehole Imaging Confirm Fault in Lieu of Seismic Data

Automated workflow for structural dip and azimuth in complex carbonate reservoir resolves modeling uncertainties, Middle East

CHALLENGE

Resolve structural uncertainties resulting from the lack of a surface seismic survey to define the appraisal target in a carbonate reservoir.

SOLUTION

- Perform 3D far-field sonic service on waveforms acquired by the Sonic Scanner* acoustic scanning platform by applying automated event identification and analysis to map and characterize the corresponding reflectors.
- Integrate the 3D sonic imaging results with wellbore images from the FMI* fullbore formation microimager to confirm fault delineation.

RESULTS

Confirmed the presence of the possible fault through abrupt changes in reflector dip and a drag effect, in alignment with the wellbore images, to resolve uncertainty in updating the structural model.

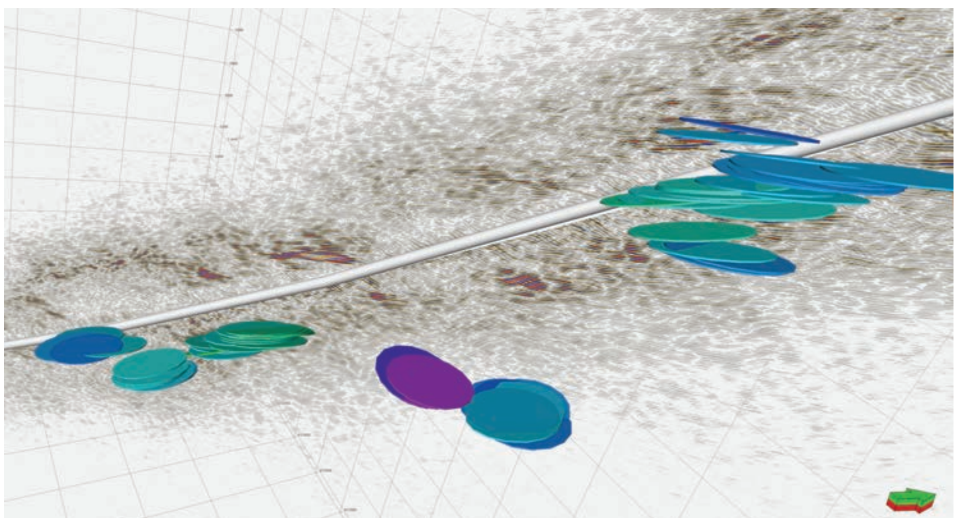
Structural uncertainty without surface seismic data

Surface seismic surveys had not been conducted in a Middle East field because of surface constraints. This lack of data created uncertainties in the structural setting for defining the appraisal target in the carbonate reservoir.

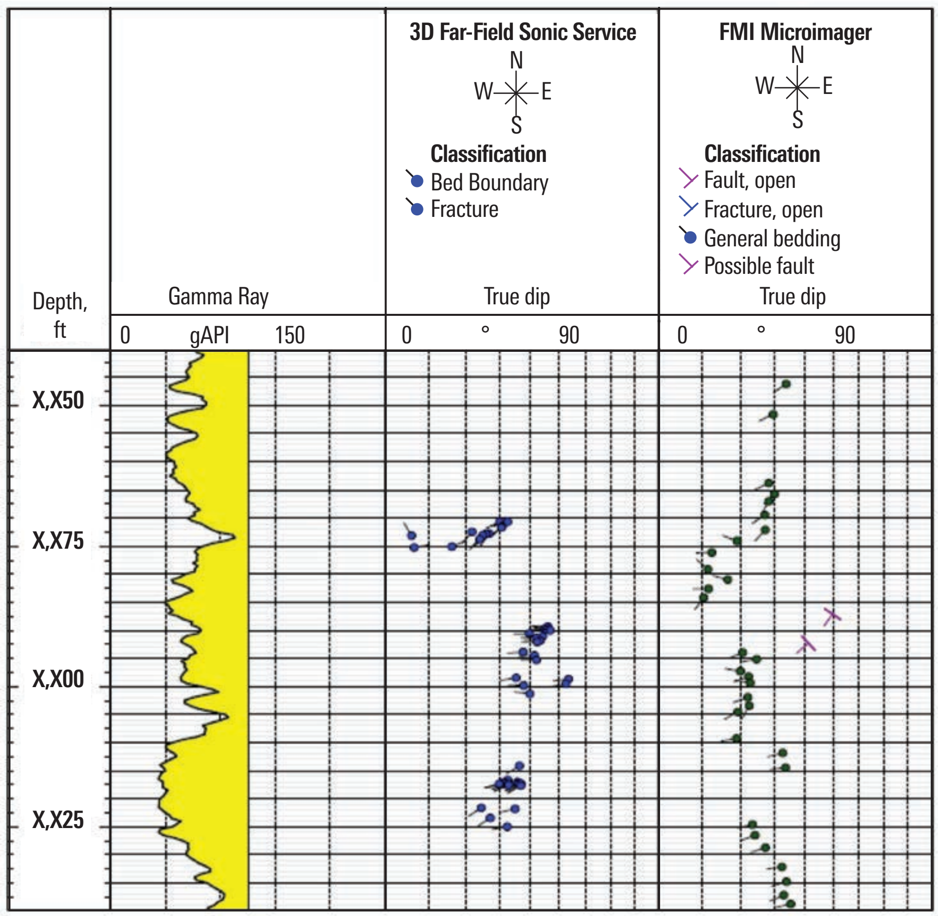
Automated time picking, ray tracing, and 3D STC

FMI microimager logs in the main well and sidetrack showed the depth and orientation of a possible fault cutting across both wells. To pinpoint the position of the fault away from the wells and deep into the reservoir, Schlumberger proposed conducting 3D far-field sonic service. The service applies a patented end-to-end workflow to data obtained with eight azimuthal sensors at 13 receiver stations of the Sonic Scanner platform.

The 3D far-field sonic service automates time picking to rapidly and consistently analyze thousands of shot gathers to identify reflection events. Ray tracing inversion of the time picks and 3D slowness-time-coherence (STC) analysis of the underlying arrival event determine each event's type and position to efficiently guide the smart migration workflow. The resulting 3D sonic image produced in the Techlog* wellbore software platform is consistent with the event type and orientation of the true reflections, with their direct association providing strong quality control.



The 3D STC reflector discs imaging the dip and azimuth are shown with the migrated monopole image along the wellbore.



Dip and azimuth from 3D sonic imaging in Track 3 confirm far-field structural changes interpreted in Track 2 from the FMI microimager above and below the fault identified at about X,X85–X,X95 ft.

Fault projection from the wells across the reservoir

The results of 3D far-field sonic service and the near-wellbore image logs were integrated to trace the possible fault across the reservoir. One of the projected surfaces from the main well matched the expected depth of the formation top in the sidetrack but two were offset due to the possible presence of the fault.

The fault's presence was confirmed by parallel evaluation of the azimuthal sonic-imaging data acquired in the main well that showed an abrupt change in the relative dip of reflectors above and below the possible fault plane using the service's 3D STC analysis and ray tracing. Dip patterns from both wells also showed a drag effect around the offset formation tops, providing further confirmation.

With the fault's position determined, the uncertainty in the structural model could be resolved in the Petrel* E&P software platform.

For additional details, see N. Bennett et al., "Borehole Acoustic Imaging Using 3D STC and Ray Tracing to Determine Far-Field Reflector Dip and Azimuth," Petrophysics 60, no. 2 (April 2019), 335–347.

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