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ADNOC Maps Natural Fractures with 3D Far-Field Sonic Service to Predict Gas Production

Near- and far-field fracture imaging comparison improves reservoir knowledge in Khuff carbonate formation, Abu Dhabi

CHALLENGE

Explain unexpected gas flow from three zones—two lower than expected and one much higher—in a hot, complex, naturally fractured carbonate reservoir.

SOLUTION

Compare near-wellbore and far-field reservoir fractures by using 3D far-field sonic service to integrate results from the FMI* fullbore formation microimager and Sonic Scanner* acoustic scanning platform.

RESULTS

Determined that the thin, high-flowing zone had excellent continuity between near- and far-field natural fractures, whereas the two low-producing zones had poor fracture connectivity.

Gas production from exploration well challenges expectations

When ADNOC started producing gas from an exploration well in the Khuff Formation in Abu Dhabi, the initial production results were puzzling. Two zones with good porosity and low water saturation were not producing gas. Instead, 70% of the production from the well was coming from a 5-ft interval that was far exceeding expectations. Furthermore, well test results indicated that the small zone was connected to a conduit with significantly higher flow potential.

To improve reservoir knowledge for optimization of subsequent wells in the formation, ADNOC engineers wanted to understand why the well did not produce as expected.

Acoustic imaging looks at fractures beyond the wellbore

ADNOC routinely runs the FMI microimager to acquire high-resolution resistivity images at the borehole and acquires standard dipole anisotropy and Stoneley fracture analysis from the Sonic Scanner platform. However, Schlumberger recommended also acquiring acoustic imaging data to detect reflections from natural fractures deeper in the formation—in the far field of the reservoir—to assess their contribution to production.

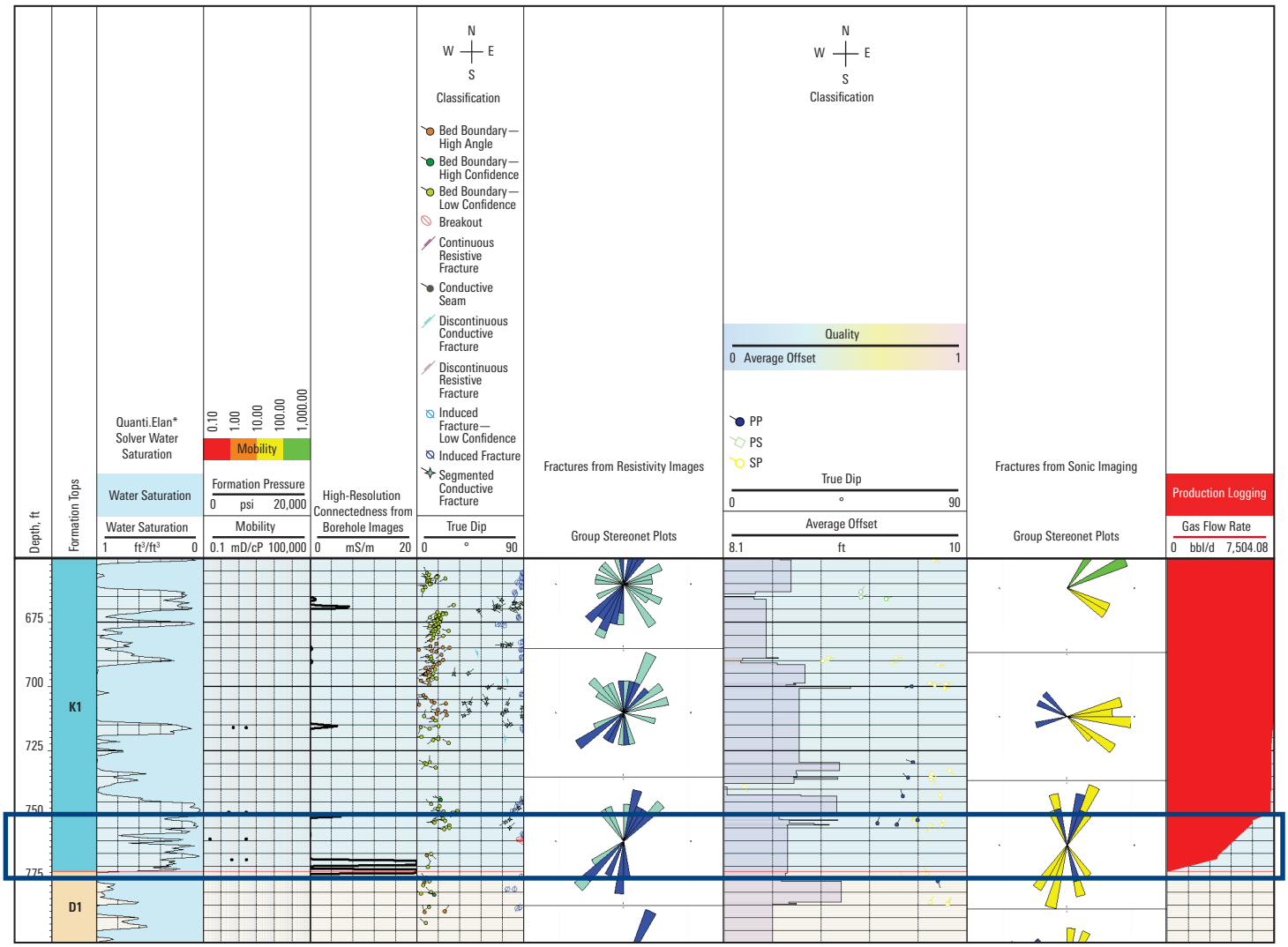
In comparison with standard sonic logging, the imaging mode records sonic waveforms for an extended listening time on eight azimuthal receivers at each of the Sonic Scanner platform's 13 receiver stations. The 3D far-field sonic service then uses the data to automatically determine the true dip and azimuth of each reflector for interpretation.

Matching near- and far-field fractures explains gas production

The results from the analysis by 3D far-field sonic service showed that the natural fractures in the zone of high gas flow are more consistent—from the near-wellbore to far-field reservoir, in the direction of the maximum horizontal stress—than the fractures in the zones that had low or no gas flow.

This quantitative integration of fracture dip and azimuth from sonic imaging results and image log interpretation explained the production log data from the well test, helping guide future completion and stimulation optimization efforts.

For more details of the case study, see SPE-192809.



As shown in the processed data displayed in the Techlog wellbore software platform, 3D far-field sonic service quantified that the natural fractures in the high-productivity zone (blue box) are more directionally consistent from the near- to the far-field reservoir, as compared with the larger zones above.*

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