

Operator Proves Cost Savings With LWD High-Resolution Imaging Service

QUAD-COMBO AND AFR™ SERVICES DELIVER HIGH-RESOLUTION IMAGES IDENTIFY FRACTURES, FAULTS, AND BOREHOLE BREAKOUTS IN ONLY ONE RUN

OMAN

CHALLENGE

Acquire high-quality, high-resolution images to characterize fractures and borehole breakouts in a low-permeability formation

- » BHA stick-slip behaviors caused poor high-resolution images

SOLUTION

- » Utilize LWD solution with AFR™ high-resolution borehole-imaging sensor to identify detailed formation and borehole features
- » Optimize logging speed and string rotation to provide a constant and smooth string movement, aiming for highest-quality image
- » Carefully monitor and mitigate vibration in real time.

RESULT

- » Provided a high-quality image to help locate fractures and their orientations
- » Obtained high-quality image comparable to wireline-quality image
- » Performed operation in one run, proving cost savings for this operation and for future runs
- » Minimized chance of poor image because of stick-slip occurrences

OVERVIEW

Borehole imaging is one of the most rapidly advancing technologies in wireline logging and logging while drilling (LWD). In an onshore horizontal well in Oman, an operator needed more details of the geology in the reservoir in order to gain a better understanding of the distribution of faults, natural fractures, borehole breakouts, and drilling-induced fractures along the well path.

LOW PERMEABILITY AND LOGGING IN HIGHLY DEVIATED HOLES POSE MAJOR CHALLENGES

Previously, the operator had used a combination of LWD and wireline logging runs to acquire the necessary formation evaluation (FE) data. The LWD run provided quad-combo measurements, while the wireline run provided only high-resolution borehole-imaging data. In a horizontal well, deploying a wireline run is more difficult than an LWD run and can double the logging time needed, resulting in more rig time and costs. Due to low permeability, the operator needed to identify the location and orientation of fractures and borehole breakouts in order to predict the well production and understand the horizontal stress orientation, which would aid in proper well completion design. After collaborating with the operator about these challenges at pre-job meetings, the Sperry Drilling team set out to prove that its logging and imaging capabilities could meet the operator's needs.

QUAD-COMBO SERVICE AND AFR™ SOLUTION PRODUCE COMPREHENSIVE SET OF FORMATION EVALUATION DATA WITH HIGH-RESOLUTION IMAGING

The Sperry Drilling team suggested an LWD quad-combo plus AFR™ azimuthal focused resistivity sensor solution – including azimuthal lithodensity (ALD™) sensor, compensated thermal neutron (CTN™) porosity sensor, electromagnetic wave resistivity (EWR®-PHASE 4™) sensor, and dual gamma ray (DGR™) sensor for critical FE data in the 6½-inch hole, plus a QBAT™ multipole LWD sonic sensor to measure formation mechanical properties. The AFR sensor provided high-resolution formation images to locate the fractures, faults, and borehole breakouts.

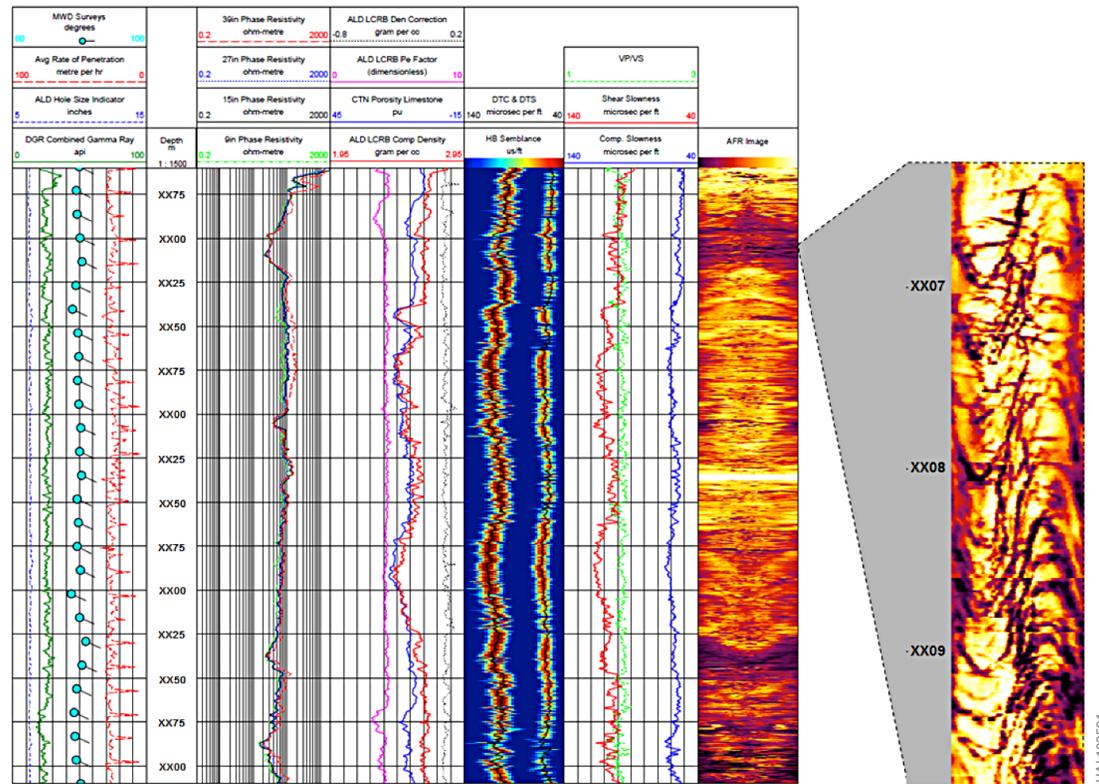
The logging was acquired after drilling in a wash-down mode, per the operator's requirements. To minimize the chances of acquiring a poor image due to bottomhole assembly (BHA) stick-slip behavior, the Sperry Drilling team monitored and mitigated vibration closely in real time, while optimizing logging parameters to a maximum logging speed of 98 feet/hour (30 meters/hour) and string rotation speed of up to 120 rpm. All of these considerations resulted in a high-quality, high-resolution image. As this was the first

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time the operator had utilized the AFR sensor, the operator decided to run a wireline resistivity image log simultaneously with the LWD run to compare their respective image qualities, which would determine the path forward in future wells, where high-resolution images are required.

AFR™ SERVICE DELIVERS HIGH-RESOLUTION WIRELINE-QUALITY IMAGE LOG IN FIRST RUN

The quad-combo BHA delivered a high-quality formation evaluation log, with very good sonic arrivals from the QBAT sonic tool. The AFR sensor provided a high-quality, high-resolution image, which was comparable to the wireline image acquired on back-to-back runs, enabling the operator to successfully characterize the fractures, optimize completion design, and successfully predict well production. Sperry Drilling delivered the solution in one run, proving economic savings of both rig time and costs for potential future runs, especially when running the AFR service while drilling rather than using a wash-down mode.



Quad-Combo Service and AFR™ solution delivers critical formation evaluation data with wireline quality high-resolution images, saving costs and time in a horizontal well.

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