Case study: Queensland, Australia

RNS with AziTrak inversions used to assist real-time interpretation in Australia coal seam

A customer in the Bowen basin, onshore Queensland, Australia, selected Baker Hughes to drill a 6 1/8-in multilateral well.

Using the **AziTrak™ deep azimuthal resistivity logging-while-drilling system** in conjunction with real-time **multicomponent-while-drilling (MCWD) inversion software**, Baker Hughes Reservoir Navigation Services team continuously mapped the top and bottom of a thin coal seam while drilling, maximizing reservoir exposure.

Sizing up the challenges

The well design had removed the need for a vertical production well. The target was a thin coal seam, 1.1 m (3.6 ft) TVD thick in the motherbore and varied between 0.9 m and 1.3 m (3 ft and 4.2 ft) thick along the horizontal.

The coal seam had multiple faults that provided a challenging geological structure in which to maintain the wellbore.

The operator chose to drill the well using a motor instead of a rotary steerable system (RSS). An RSS allows the directional sensors to be positioned closer to the bit.

Faults and other variations in the formations can be detected sooner, thereby allowing the required directional changes to be made quickly, in order to maintain the wellbore in the target formation.

In the motor BHA used in this well, the resistivity, gamma ray, and directional sensors were ~14 m (46 ft) from the bit. This created a lag before faults and other features could be detected, resulting in a delay in identifying the need to change direction.

BHA optimization

Experience gained from the first lateral allowed the telemetry for the subsequent well to be modified for both deep and shallow azimuthal components, which were used in the MCWD inversion software. The use of the shallower azimuthal component improved the resolution with which the roof and the floor of the coal seam could be detected given its limited thickness (1.1 m).

MCWD allows mathematical equations to create a visual and qualitative geological model based on the real-time data. The comparison of the realtime MCWD results with the synthetic data allows the geological model to be updated real time as drilling progresses.

The updated geological model is then used to inform steering decisions to ensure the well trajectory is maintained within the desired formation.

The results

Real-time inversions resulted in confirmation and accurate interpretation of structural changes while drilling.

Challenges

- Thin undulating coal seam approximately 1.1 m TVD thick
- Multiple faults encountered
- Moderate to poor conductivity contrast across beds
- Directional package was 14 m from the bit, which means you need to drill over a stand to see any effect of slides
- No azimuthal data while sliding
- Strong tendency for the BHA to build while rotating due to the formation

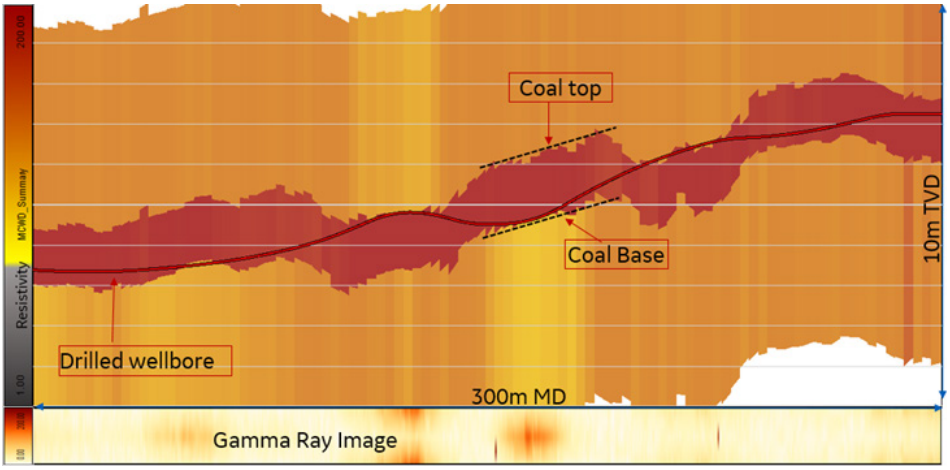
Results

- Successfully drilled the entire 6 1/8-in section (>1500 m MD) in one run with an ROP of 20 to 40 m/hr
- Reported 55 observations or geosteering decisions during the real-time operations
- Simultaneously mapped roof/base while within coal seam
- Depth of detection from within the shale was approximately 1 m

By combining the AziTrak service with the real-time MCWD inversion service, the top and bottom of the coal seam were mapped continuously while drilling. Additionally, quadrant gamma ray images were used to identify multiple faults.

Thus, Baker Hughes RNS supervisors were able to navigate the borehole continuously along the coal seam except for an interval that was exited with an estimated ~3 m (~10 ft) throw.

This was achieved despite the limitations of the BHA configuration mentioned earlier. The offset seam was detected from within the conductive shale from approximately 1 m.



AziTrak multicomponent-while-drilling inversion results over a 300-m (984-ft) MD section show undulating reservoir formation with maximum reservoir exposure.

Baker Hughes

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