Geosteering through Challenging Fractured Limestone Reservoir Becomes Achievable Utilizing High Definition Multi-Layer Boundary Mapping Technology – A Case Study from a Deep Gas Reservoirs

Saad A. Al-Ajmi[1], Chinmaya Pattnaik[1], Ahmed E. Al-Dawood[1], Qasem Dashti[1], Abdul Aziz H. Al-Failakawi[1], Sandeep Chakravorty[2], Chandan J. Keot[2], and Khaled M. El-Derini[2]

[1]Kuwait Oil Company
[2]Schlumberger

Abstract

Kuwait Oil Company is currently engaged in an early phase development of deep sub-salt tight naturally fractured carbonate reservoirs. These reservoirs has been tested and found to be gas bearing. They are uniquely characterized by dual porosity nature where natural fracture network systems are the primary flowing mechanism. The foremost challenge to produce from these reservoirs is the wellbore interaction with the natural fracture network systems. Despite drilling around 85 vertical and slightly deviated wells in this large challenging HP/HT reservoir complex, understanding and characterization of fractures is a challenge in the absence of horizontal wells, though fracture understanding has improved over time through careful integration and interpretation of logs, core, and seismic data. To achieve the dual objective of characterizing the fractures and to boost production, asset team recently embarked on the strategy to drill horizontal wells targeting these challenging tight reservoirs.

As a fit for purpose solution to address these challenges, "High Definition Deep Directional Multi Boundary Detecting Technology" was incorporated in the drilling plan so that horizontal producers could be geosteered in the desired target intersecting as much fractures as possible. This technology, an advancement on the 1st generation "Distance to Boundary" technology is characterized by its extended capability to detect multiple bed boundaries based on resistivity contrast up to 20ft around the wellbore. The significantly improved new multilayer stochastic inversion also solves for structural dip along the wellbore azimuth (longitudinal dip). In the lateral section, this technology successfully mapped the reservoir roof as well as multiple thin intra layers inside the target reservoir along with information on longitudinal dips which helped immensely to optimize trajectory inclination and spatially position the wellbore across different layers as per plan. Apart from detecting reservoir boundaries, the inversion also mapped conductive and resistive fractures cutting wellbore at high angle for the first time, while trajectory was drilling across a fracture corridor. This further added confidence to geo-steering while drilling as wellbore cutting through such a fracture corridor was highly anticipated in predrill planning. Drill-pipe conveyed borehole images acquired after drilling the well confirmed the presence of large swarms of fractures detected through inversion.

The effective integration of data from different fields in a single platform, like LWD logs, boundary information, dip information, drill cuttings information and decisions taken based on the interpreted information paved the way for the successful drilling of this well and achieve the predrill objectives.