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Advanced Borehole Imaging Technology in Oil Based Muds to Enhance Carbonate Reservoir Characterization, Interpretation of Faults/ Fractures and Texture, Comparison with Core Description – A Case Study from Offshore Abu Dhabi

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Abstract

The Cretaceous shallow marine carbonates of Abu Dhabi are studied in this work with the help of a new borehole imaging technology for wells drilled with oil-bae mud (OBM). The lithology mainly comprised of a higher energy Grain/Packestone to lower energy Wackestone/ mudstone which exhibits a high heterogeneity in facies distribution within gently dipping strata in an offshore field in Abu Dhabi. The reservoir quality shows a wide ranges of porosity and permeability varying from low to very high (vugs) and resistivity variations in the range of 8 – 30 ohm-m.

The well was cored for objectives to perform a pilot study for enhanced oil recovery (EOR). The interpretation objective comprises (1) Detailed sedimentary and structural features interpretation (2) Diagenetic features analysis (3) Integration with core data (4) Creation of near-well 3D structural model using high resolution bedding information from image log, and (5) Advanced textural analysis.

Challenges posed by the limitation of resolution and borehole coverage in OBM, resulting in constrained textural, sedimentology and structural characterization have now been overcome with the entry of advanced OBM imager that provides a quantum leap with photorealistic geology. The high resolution image log acquired in OBM with advanced technique allows for better resolution, more coverage and increased confidence of interpretation, along with the wealth of down-hole geological information that it brings.

Fine-scale structural, sedimentary and diagenetic features were interpreted with precision, where conventional logs read monotonously. Structural dip was computed accurately from more planar beds, which could be separately classified. High resolution dip data has been used to create a near-well 3D structural model using newly developed plug-in in Petrel software. Solution seams (including stylolites) were observed occurring as isolated events and in bunches. These features can act as barriers / baffles to vertical flow. An intensity log for stylo-seams has been extracted.

Fracturing associated with stylolites has been interpreted. These mostly hairline, stubby fracture segments could be picked confidently – thanks to higher resolution and better borehole image coverage. Some of these stylo-fractures seem to be cutting across cemented stylolite horizons. The post-inversion stand-off images and resistivity images helped to classify open vs. closed fractures; and moldic porosity.

The results were compared with the core photographs for validation of the interpretation. The high resolution heterogeneity indicators derived from the inverted images provided a means of high-resolution facies typing; thereby providing four different electrofacies to be tied to petrophysical response for further reservoir rock-typing. Although, the textural analysis part using high resolution OBM images is still under research and non-commercial, it still offers a method to comprehend reservoir quality variation with depth.