Advanced Application of LWD Resistivity Images in Delineating Reservoir Dispersion Pattern and High-Resolution Sequences Stratigraphic Analysis: A Case Study from the Krisna Field, Sunda Basin, Offshore, Indonesia

Laila Warkhaida[1], Ivan Wu[3], Reza Widiatmo[2], Sarvagya Parashar[3], Yessica F. Sthepani[1], Nikolai Sirait[1], Pipit Harinursari[2], Dwi Cahyono[2], Ifan Rahmansyah[2], Ardian Aby Santosa[2]

[1]Halliburton
[2]PHE OSES
[3]Halliburton

Abstract

The Krisna Field is located in the western part of the offshore Southeast Sumatra (SES) Block in the Sunda Basin, Indonesia. The main productive zone in the Krisna field is the Baturaja carbonate reservoir. This sandstone unit within Baturaja carbonates is historically not considered as a potential reservoir since the underlying Gumai shale is believed to be a regional seal and would therefore prevent charging of this shallow sandstone unit.

However, recent exploration activity in the area has provided evidence for hydrocarbon in this sandstone. The Krisna Sand member of Air Benakat is about 180-240 ft thick, composed of poor to moderate-quality sandstone, representing the shallowest reservoir in the Sunda Basin. The Krisna Sandstone is not laterally extensive within the basin, hence, to understand the characteristics of each sand sub-unit, a novel approach of utilizing a high-resolution LWD resistivity image log was adopted. The present study demonstrates a comprehensive analysis using LWD open-hole logs in combination with high-resolution resistivity images, supported by geological data, mud logs, mineral composition analysis, sidewall cores, and geophysical logs to decipher the small-scale variations in the sand-dispersal pattern, paleo-slope, and changes in the vertical succession across the drilled section.

A deviated well X-XX3 with maximum deviation of 54° was drilled to penetrate the Krisna Sand packages. High- quality LWD resistivity images with 0.4-in. vertical resolution were acquired in combination with a quad-combo and mud-motor bottomhole assembly (BHA). Prominent, thin lamination features were revealed by the resistivity images that were not resolved by conventional logs and could hence easily be overlooked. The bedding, structural, and sedimentological features were interpreted alongside log measurements and sidewall cores. An advanced facies modelling technique was utilized, based on high-resolution self-organising maps (SOM);, a mathematical technique to enable data to be organised into groups to produce a map. SOMs are a form of neural network but are self-trained (normal neural networks are trained on a calibrations curve). The SOM was calibrated so it could be used to output either a facies type curve or to predict a continuous varying curve such as facies and their distribution across the drilled section.

The paleo-slope orientation was observed towards the south-west, followed by detailed analysis of vertical stacking of various succession and associated facies. The structure was interpreted as a lower-shoreface to marginal marine transition with a laminated sedimentary bedform

governing the overall morphofacies. Detailed gross sand thickness was calculated and compared between conventional and high-resolution methodologies to obtain robust reservoir characteristics.

The analysis provided valuable geological information for the Krisna Sandstone members, as their characteristics are poorly understood due to the limited extension of these sandstones within the region. A new exploration and development opportunity can be re-evaluated across the Krisna Sand member of the Air Benakat Formation by utilizing high-resolution sedimentological analysis to trace the sand dispersion pattern and predicting the extent of depositional settings.