A New Stratigraphic Framework and Correlation Scheme for the Lower Shuaiba Formation, Block 60, Central Oman

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Abstract

This study proposes an alternate correlation workflow for the Aptian lower Shuaiba Formation in the central Oman "pancake area". Previous models depict an epeiric carbonate platform with subtle dips and wide facies belts; however, both seismic and well data indicate significantly greater lithological heterogeneity and variation in stratal geometries at the field scale, indicative of local differences across the platform in sedimentation rates and accommodation. The resultant depositional geometries include aggradational algal mounds (Lithocodium Bacinella) and high-energy rudist shoals, which appear to thicken away from the underlying mounds and may have been deposited in a shallower water environment on the platform. This study aims to define a stratigraphic framework to capture the mesoscale variations that occurred on the platform, which are relevant to the scale of field development and the construction of geocellular models.

The study integrated wireline well logs from fifty-five vertical wells, fifty meters of whole core from two wells, 3D wide azimuth seismic data, all subsequently validated with production trends. The vertical wells were used to devise the stratigraphic framework through detailed correlation of wireline-log responses. Despite sparse detrital clay, the gamma-ray log response reveals diagnostic variations that were used to pick the tops of the main sequence boundaries within the reservoir, notably the base Nahr Umr shale disconformity. A regional maximum flooding surface (MFS) that marks the transition from a transgressive to a highstand system tract is also identified within the Shuaiba, as is the top of the underlying Kharaib Formation, which defines the base of the reservoir.
The main wireline-log signature that showed the greatest stratigraphic correlation potential was the resistivity derived water saturation log. By analyzing this log response, the internal genetic elements were mapped, as was a distinctive karstified hardground on top of the reservoir. The strong correlation between facies and water saturation is due to the different allochem assemblages resulting in different pore structures, which in turn affect the electrical tortuosity of the rock. Two algal mounds were interpreted using the Late Jurassic Top Hanifa Formation reflector and subsequently tied to the MFS well tops. The base of the Albian Natih Formation was also interpreted as a proxy for the disconformity that exists at the top of the Shuaiba. Between the disconformity and MFS, a highstand system tract is represented by high-energy reworked rudist shoal deposits. Four distinct shoal bodies have been interpreted from wireline logs; these may downlap on to the underlying MFS; they record possible progradation and thickening towards the northwest of the field. Wells penetrating shoal bodies 2 and 3 appear to produce the best oil rates at low water cut when corrected for variable onstream dates. Shoal body 1
is relatively thin but has better permeability resulting in short-lived, high initial oil rates followed by an increase in water cut. Shoal 4 appears to represent more marginal facies with poor well performance.

This study is building more robust static models of the Shuaiba Formation, which will enhance further field developments, such as Enhanced Oil Recovery and Carbon Capture and underground storage applications.