

An Integrated Approach for the Identification of Stratigraphic Potential in the Mishrif Sequence, Middle East

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Abstract

The Mishrif Sequence in the Middle East is deposited on a stable carbonate platform setting. It produces oil from several fields from four-way structural closures formed by the Hormuz (Cambrian) salt tectonics. However, some of the oil fields are considered as combinational traps. Future focus of the exploration should be directed to explore the stratigraphic potential of the Mishrif Sequence by recognising stratal geometries of different facies using sequence stratigraphic principles. In this study, an integrated data-driven approach is applied using well logs, core data, test results and 2D seismic, which helped in understanding and finding potential stratigraphic traps in the Mishrif Sequence. The sequence is subdivided into five informal stratigraphic units from bottom to top: Mishrif-A to Mishrif-E. The deposition of the lower two units began with a regional regression (early highstand with aggradational patterns on the seismic data). At this time a shallow-water carbonate environment was established throughout the region. This is marked by gradational shoaling-upward log motifs. The Mishrif-B unit possesses good reservoir properties; however, it has poor stratigraphic trapping potential. The vertical resolution of the 2D seismic data is insufficient to image the internal reflection patterns and to investigate the mechanism for stratigraphic trapping within these units. The Mishrif-C unit, however, is formed as a result of an increase in carbonate growth in combination with minor changes in water-depth. It shows aggradational to progradational patterns and is interpreted as a late highstand shelf. The net prograding direction is towards an interior-platform depression, which is thought to be formed as a result of the Hormuz salt-withdrawal. The depression is filled with the Mishrif-D and Mishrif-E units. The Mishrif-D unit is comprised of two intervals: regressive below and transgressive above. The lower interval is a lowstand stage. At this time, the Mishrif-C is sub-aerially exposed which shows a huge non-depositional gap (Intra-Cenomanian unconformity) on the Wheeler diagrams. The upper interval of the Mishrif-D unit is interpreted as a back-stepping (transgressive) system often onlapping onto the Mishrif-C shelf. Following the Mishrif-C unit, another regressive unit (Mishrif-E) is deposited over the area that shows seismic scale clinoforms. The top of the Mishrif Sequence is defined by the regional Turonian Unconformity that is overlain by the siliciclastic Laffan shales, which regionally seals the Mishrif Sequence. Two important units of the Mishrif Sequence are found promising for stratigraphic trapping potential, both lie close to the seismically defined platform edge developed at the time of the Mishrif-C unit. These are the shoals and pinch-outs of the Mishrif-C and Mishrif-E respectively. The study concludes that the Mishrif-C shoals have an excellent potential for stratigraphic exploration.