Hanifa-Tuwaiq Mountain Zone: The edge between conventional and unconventional systems?

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Abstract

Hanifa-Tuwaiq Mountain zone is a Jurassic-age section of dark, organic rich carbonates and thick, slightly dolomitized shallow marine limestone that serves as a source rock to the overlying Jurassic and Cretaceous conventional reservoirs. Hanifa formation is slightly younger than Tuwaiq Mountain formation, however; in Bahrain both formations coexist and act as one self-sourcing system. Conventionally, this system has relatively lower hydrocarbon storage capacity and deliverability, whereas unconventionally, the system appears to be prospective over a regionally broad area, lies within the oil maturity window and has good organic richness. Although, in areas like Awali field, Hanifa-Tuwaiq Mountain zone acts as a moderate-quality conventional reservoir, the average reservoir properties such as porosity and permeability are considerably higher than typical unconventional set-ups. Therefore, it is thought that Hanifa-Tuwaiq Mountain zone sits at the edge between conventional and unconventional systems. Basin modeling, petrophysical and geomechanical analyses were performed to evaluate the potential of the source rock intervals in Hanifa-Tuwaiq Mountain zone. Basin modeling along with present day TOC and HI measurements from a number of wells were used to evaluate the maturity of the unconventional intervals at varying depths. The results suggest that these zones have unconventional, self-sourcing reservoir potential with zones of good organic richness, oil saturations and porosities. Petrophysical and mineralogical analysis show that Hanifa-Tuwaiq Mountain zone is dominated by carbonate minerals with very low clay content. Based on the carbonate mineralogy and the anisotropic stress models built to understand the geomechanical characteristics and fracture stimulation potential, it is expected to be highly conducive to hydraulic fracture stimulations. Porosities and permeabilities of Hanifa-Tuwaiq Mountain zone were also analyzed using core and cutting samples. In addition, the reservoir intervals within Hanifa-Tuwaiq Mountain zone were evaluated using 3D seismic vintages by extracting attributes from interpreted horizons and seismic time-slices. This approach enabled mapping the distinctively strong seismic amplitude response interpreted as porous facies within the zone.