

A Synopsis of Stratigraphic Framework and Gross Depositional Environments of the Tuwaiq Mountain and Hanifa Formations, Saudi Arabia

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ABSTRACT

The Middle and Upper Jurassic (late Callovian-Oxfordian-early Kimmeridgian) Tuwaiq Mountain and Hanifa formations contain significant oil reservoirs (Hanifa and Hadriya reservoirs) and world-class hydrocarbon source rocks. Unravelling the sequence stratigraphic architecture and gross depositional environments (GDEs) are essential for unlocking the exploration potential of the Jurassic petroleum systems. These objectives were achieved by integrating seismic interpretations, isochore/isochron mapping, core/drill cutting sedimentology, well-log electrofacies, and seismic attributes across the eastern Arabian and Rub' al-Khali basins. Integrated results suggest that a renewed differential subsidence in the early Callovian established the Late Jurassic Arabian carbonate platform along the southwest margin of the Neo-Tethys Ocean. Two major intrashelf basins were developed within the Arabian carbonate platform interior: the central Arabian intrashelf basin and the north Arabian intrashelf (Najmah) basin. The organic-rich mudstones of the Tuwaiq Mountain and Hanifa formations were deposited in much deeper water environments of the intrashelf basins. Grainier carbonate shoaling complexes were deposited along the margins of the intrashelf basins. An early Kimmeridgian base-level fall terminated the Hanifa carbonate platform and resulted in substantial subaerial exposure along the proximal areas, and prograding carbonate clinoforms basinward. A renewed regional transgression occurred post-Hanifa time, leading to deposition of the Jubaila Formation and infilling the remaining accommodation space. The GDE maps of the Tuwaiq Mountain and Hanifa formations depict evolving depositional environments from the Callovian to early Kimmeridgian. Newly integrated results shed light on the architecture of the Tuwaiq Mountain intrashelf basin, i.e., a much deeper basin extending from eastern Arabia into the northeastern Rub' al-Khali Basin and southern United Arab Emirates, whereas a much shallower lagoonal sub-basin occurred to the west of the Rub' al-Khali Basin. The partitioned intrashelf basin configuration provided many insights for understanding the source rock distribution, and revealing exploration potential of the Jurassic petroleum systems.