Quantitative Stratigraphy Of The Middle To Upper Jurassic Carbonate System In The Arabian Intrashelf Basin Using 3D Stratigraphic Forward Modeling

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Objectives/Scope: The middle-upper Jurassic carbonate system plays a crucial role in the development of extensive hydrocarbon fields across the Arabian platform, particularly within the intrashelf basin. Although the Arabian intrashelf basin study had been attracted many researchers over the years and have interpreted that the intrashelf basin is controlled by carbonate production or subsidence, no documentation has been made to test the primary control of intrashelf basin development and evolution of sequence architecture across different carbonate formations. Therefore, the main objectives focused on testing multiple scenarios that provide quantitative understanding the development and evolution of Arabian intrashelf basin and building the predictive sequence architecture model across the Arabian intrashelf basin.

Methods, Procedures, Process: Recently, complex geology can be tested with several scenarios in a stratigraphic forward modeling approach. In this study, the data set and conceptual model are built from a compilation of previously published studies. The simulated area spans 1400 km x 400 km with 5 x 5 km grid cells, which are covered the Dharma outcrop at the eastern part of the intrashelf basin to Qatar at the western part of the intrashelf basin. Haq’s (2018) sea level changes were incorporated in this research to assess the global impact of sedimentation in the basin during the middle to early Jurassic period.

Results, Observations, Conclusions: The simulated model is represented in a 3rd-order scale sequence (1-10 Myr duration) that accurately reproduces the geometries and stratigraphic architectures of the Jurassic Arabian Platform and Intrashelf Basin. The lowermost sedimentary unit (Tuwaiq - T1-T2) was deposited during a transgressive cycle. The second unit (Tuwaiq-T3) exhibits steep angle prograding onto Tuwaq T1-T2 member, followed by a thick, asymmetrical pattern of Hanifa Hawtah member, also showing aggrading- retrograding deposited during the transgressive cycle. Hanifa - Ulayyah members are composed mainly of prograding geometries and during transgressive cycle, deposited Jubaila J1 with a thin interval of the retrograding pattern. During the last regression in Jubaila - J2 deposited in a prograding pattern. The intrashelf basin model based on stratigraphic forward modeling reaches good calibration with the well data across the Arabian intrashelf basin (Khurais well, North Ghawar well, and Qatif well) with average thickness matched up to 85% while the lithology matched is up to 90%.

Novel/Additive Information: Stratigraphic forward modeling approach is proven powerful to provide quantitative information and predictive scenarios to better understand the development of the basin and sequence architecture by honoring data and conceptual model. The new insight from stratigraphic forward modeling proposes an alternative model with carbonate production and subsidence controlling the development of the intrashelf basin. Consequently, conducting such research will lead to an improved understanding and reduced uncertainty in exploring the petroleum system in the Arabian intrashelf basin.