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Using Sequence Stratigraphy to Resolve Depositional Misconceptions on the Arabian Plate – The Example of the Gotnia Basin Creation and Infill

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Summary

The Jurassic stratigraphy of the Middle East includes the world's most economically significant petroleum systems, containing multiple world-class source and reservoir packages. Yet in regional context, these depositional systems are still not fully understood, leading to inconsistencies in lithostratigraphic nomenclature across international boundaries and misconceptions in stratigraphic architecture limiting exploration and production success.

Theory / Method / Workflow

Applying sequence stratigraphic principles across the Jurassic strata of the eastern Arabian Plate increases stratigraphic understanding and helps resolve some of the common misconceptions. This provides robust age-based framework to reduce lithostratigraphic uncertainty across international boundaries and provides predictive capabilities into the temporal and spatial distribution of source, reservoir, and seal facies. Application of a globally calibrated sequence stratigraphic model can distinguish between global eustatic and local tectonic control. The combination and re-interpretation of old and recently published data has identified misconceptions and proposes new interpretations that have consequences for understanding of the petroleum systems.

Results, Observations, Conclusions

A good example of a common misconception cited by many authors (e.g Jassim and Buday, 2006; Aqrawi et al., 2010, de Cabrera et al., 2019) is that the development and sedimentary infill of Late Jurassic Gotnia Basin is entirely tectonically controlled. In this interpretation, south-west to north-east and north-west to south-east orientated lineaments control the extent and depth of the Gotnia Basin. Our interpretations, which concur with a recently published seismic study (Wharton, 2017) from Saudi Arabia and includes re-interpreted well log information from Kuwait (de Cabrera etal 2019,2020) instead suggests that eustatic sea level change-driven response of the carbonate system had major influence upon sedimentary infill and architecture.

Prior to Gotnia Basin creation, a regional carbonate ramp developed in earliest Callovian, which can be correlated from Oman-Kuwait. On top of this marker bed, locally carbonates aggraded, creating the Rimthan Arch, whereas north and south of this feature, basin starvation led to the development of intra-shelf basins. The intra-shelf basins were subsequently filled by deposition of the Arab Members and Hith Formation, and shelf margin wedges of evaporates and halites of

the Gotnia Formation (Figure 1). Regionally, stratigraphic thicknesses through this interval are variable for the individual depositional facies, but total accommodation did, however, not vary significantly. Together with a revision of the depositional environment interpretation of the sedimentary facies, these observations imply that there was only a minor influence of tectonics and rather a dominant control on deposition by eustatic sea level and response of the carbonate factory.

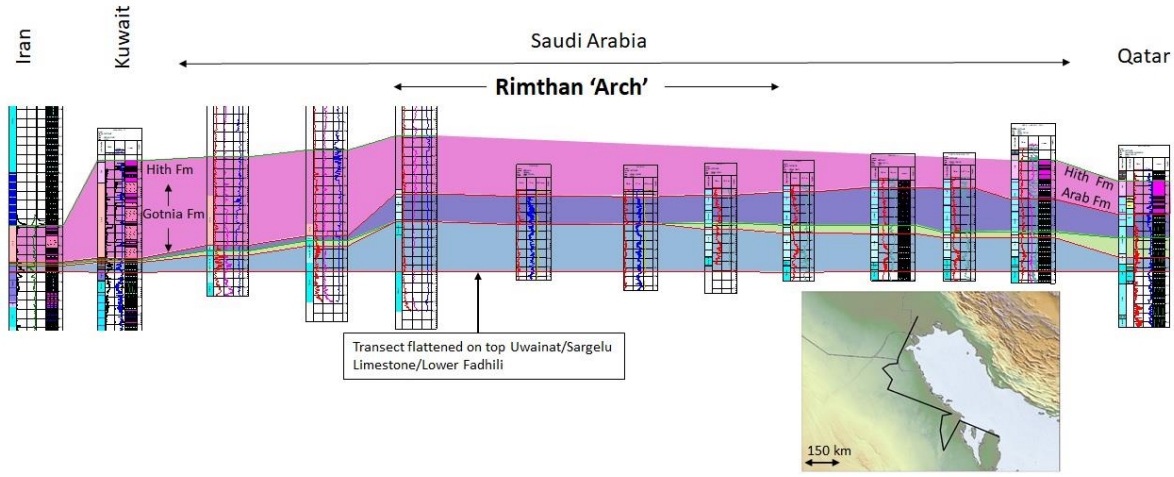

Figure 1 – Regional log correlation highlighting the variation in facies and thicknesses of the stratigraphic packages between the Rimthan 'Arch' and adjacent Hanifa and Gotnia basins. Aggradation of the Callovian and Oxfordian carbonate in light blue. Early Kimmeridigian lowstand in light green. Early Kimmeridigian highstand in dark blue. Upper Kimmeridigian evaporitic sequences in pink.

Novel/Additive Information

The Gotnia Basin is an example of some of the misconceptions still widely accepted within published literature. Using sequence stratigraphy to better understand depositional architectures and stratigraphy across international borders, we are able to challenge long held interpretations. At the exploration scale, this enables important predictions regarding geometric juxtaposition of source, reservoir, and seal facies in the search for future hydrocarbon-bearing intervals in the Middle East.

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