A Structure-Based Dynamic Depositional Model within Carbonate Platform Interiors - A Case Study from the Khuff Sequences in Saudi Arabia

Wenbin Tan[1], David Tang[1]

[1]Saudi Aramco, Dhahran, Saudi Arabia.

ABSTRACT

The Khuff second-order sequence is composed of shallow-water carbonates and evaporites deposited during a major transgression of the Neo-Tethys Ocean onto eastern margins of the Arabian plate. Development of each of the Khuff-A, B and C third-order sequences underwent transgressive and regressive phases. Maximum transgression facies is represented by a grain-dominated facies association, i.e., reservoir facies, which is capped by muddy carbonate-evaporite facies resulting from regression. This paper summarizes regional mapping results of the Khuff A, B, C sequences and proposes a new depositional model to help predict time-spatial facies distributions within the platform interior environment. A structure-based dynamic depositional model is constructed through regional facies mapping for Khuff-A, B and C sequences. The model considers tectonic/structural elements, i.e., paleohighs and lows, which originally governed the thicknesses variations and facies distributions of each third-order sequence. Reginal facies population and mapping are made possible by careful calibration between well logs and core-derived facies. The characteristic responses of cyclic facies stacking pattern of each sequence to well logs are used for consistent sequence boundary identification and correlation. The result is a model that contains multiple shoaling and tidal complexes, which is different than a conventional ramp model. Shoaling complexes were associated with paleo-highs that are controlled by deep-rooted structures. This new model accommodates both carbonate and evaporite depositional systems in each third-order of the Khuff sequence. This study revealed that during transgressive phase grain-dominated reservoir facies is preferentially deposited over paleo-highs, whereas mud dominated facies is more abundant in paleo-lows. During regressive phase, with cut-off of normal circulation, the proximal areas of shoaling complexes turn into supratidal environments of sabkha and salina. Evaporite deposited at this stage thins over paleo-highs, but thickens in paleo-lows of hyper saline lagoonal environment. Such a structure-based dynamic depositional model also can be applied to better understand similar depositional system with carbonate and evaporite such as the Jurassic and Cretaceous carbonate-evaporite sequences over Arabian Platform interiors. Implementation of this new model enhances predictability of the reservoir and seal fairways, therefore reducing exploration risks.