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Integrating Forward Stratigraphic Modeling Predicted Facies into 3D Basin Modeling: A Case Study for Exploring Jurassic Stratigraphic Traps

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ABSTRACT

Regional 3D basin models are generally lower resolution models, which may cover vast areas (e.g., 250,000 km2). These models typically involve several sub-basins and provide an overview of the basin evolution and its thermal history. A basic understanding of play elements of given petroleum systems and hydrocarbon migration can be achieved by integrating a regional chronostratigraphic framework, gross depositional environments (GDEs) and lithofacies maps. Subsequently, such regional models may not be sufficient for providing local or prospect scaled geologic phenomena such as proper geometry, and detailed lithology and facies distribution. Assessing hydrocarbon migration and charge into stratigraphic traps requires a different approach than a low-resolution regional model. Advanced basin modeling techniques, such as facies and local grid refinements, are essential to address local and prospect level objectives.

A sub regional 3-D basin model has been built including high resolution facies maps (e.g., 100,000 years in time). This refined model in turn was embedded into the regional model. The subsurface facies prediction was derived from forward stratigraphic modeling for Middle and Upper Jurassic carbonate sequences in Eastern Arabia. These models describe in detail the stratigraphic architecture, and therefore predict potential stratigraphic traps in space and time.

An advanced understanding of the lateral and vertical facies distributions is crucial for modeling fluid flow, especially in cases where the source kitchen is far away from potential reservoirs. By simulating hydrocarbon migration within the detailed stratigraphic architecture, enhanced capability can be achieved for predicting filling histories for potential stratigraphic traps.

This integrated 3-D basin modeling has resulted in significant insights into hydrocarbon migration and charge of potential Jurassic stratigraphic traps in Eastern Saudi Arabia. It contributes to the understanding of fluid flow within a detailed chronostratigraphic network of a carbonate system and can be used for de-risking potential exploration targets.