Process-Based Modeling of Early Cretaceous (Albian) Delta Systems, Saudi Arabia

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ABSTRACT

The Albian basin fill of Saudi Arabia includes large deltaic systems, which prograded into open marine shelf-interior basins located at the western Tethyan margin. A lower progradational retrogradational cycle (Khafji Mb.) of 4 Ma includes three 3rd order sequences. It is bounded at the base by the pre-Wasia unconformity and at the top by the peak transgressive interval of the Dair limestone. The upper progradational retrogradational cycle (Safaniya Mb.) of 4.3 Ma includes four sequences and is bounded at its top by the peak transgressive interval of the Mauddud Mb. An integrated approach of subsidence modeling, mass balancing and depositional forward modeling has been applied to develop a quantitative sequence stratigraphic model of eustatic sea level changes, regional subsidence, sediment input volumetrics and source points. The numerical model presented is limited to basin-scale and is calibrated to a large number of wells and to depth grids for key bounding surfaces. Amplitudes of eustatic sea level changes range between 40 m to 80 m. Subsidence shows significant spatial temporal variations with rates of 20 m to 65 m/Ma. They were triggered by differential loading, compaction and salt flow in the (deeper) subsurface. Structural segmentation by Triassic to Early Cretaceous N-S oriented fault systems may have attributed to spatial subsidence variations. Sediment input from western continental hinterlands to the area of interest (150 km x 140 km) varied between 350 km3 to 750 km3/Ma. Peak input occurred during the earliest Middle Albian and the early Late Albian. Total sediment input to the eastern Saudi Arabian basins reached 4 km3 x 105 km3 over an area of 1,100 km x 400 km during Khafji time (4 Ma). Sediment input decreased to 1.7 km3 x 105 km3 during Safaniyah time (4.3 Ma). Mass balancing indicates two major input source areas for the Khafji and three to four for the Safaniyah delta systems. The integrated process-based modeling workflow developed for the Albian delta systems improves the understanding of depositional systems, basin development, and at significantly higher resolutions than presented here, reservoir characterization and prediction.