3D Stratigraphic Forward Modeling of Mixed Carbonate-Clastics Succession, Saudi Arabia

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Abstract

In mixed carbonate-siliciclastic systems there are high levels of lateral and vertical heterogeneity in facies distribution. This complexity makes it challenging to understand the sequence stratigraphy of successions comprising strata deposited in these systems. The Triassic in Saudi Arabia represents an example of such a succession, in which stratigraphic interpretation is further complicated by the sparsity of well data. In this study, we used stratigraphic forward modeling (SFM) to create a predictive model of the 3D facies distribution within the succession, through which we gained sequence stratigraphic insights.To better control the model results and improve confidence, the modeled succession was divided into four intervals, classified based on palynology data. This division helped lower the uncertainty of modelling inputs and better control the parameters of the intervals. Each interval was calibrated using lithology logs, well based thickness maps, and seismic based thickness maps. The resulting modeled 3D facies distribution was validated using gross depositional environment (GDE) maps and blind wells. In the model, the succession comprised four main facies, grainstones, mudstones, anhydrite and shale. Time slices from the model showed changes in facies through time, with a general trend from clastic dominant to carbonate dominant. These slices agreed well with GDE maps for time-equivalent sequence stratigraphic intervals, with modeled facies proportions and distributions aligned well to depositional environments and shoreline trends interpreted on the maps. The modeled vertical facies distribution also correlated well to lithology log data in the blind wells, further validating the 3D facies model.The stratigraphic forward modeling results complemented the findings of previous work and helped to enhance our sequence stratigraphic understanding of this complex mixed carbonate-siliciclastic system. The SFM-based approach applied in this study shows promise for improving sequence stratigraphic understanding in other areas challenged by stratigraphic complexity and sparse well data.