Integrated Chemostratigraphy and Facies-Based Sequence Stratigraphic Framework for Reservoir Characterization of Lower Cretaceous Aptian Shuaiba Reservoir, Shaybah Field, Saudi Arabia

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The Early Cretaceous (Aptian) Shuaiba Formation, Shaybah field, formed on a ramp bordering an intra-shelf basin. The succession records one large-scale composite sequence (5-7 m.y) with transgressive and regressive carbonate on the platform and prograding wedges on the flanks. Seven higher frequency sequences (~ 1 m.y duration) are identified on the platform with an additional sequence in the wedge. Sequences 1 and 2 are sheet-like units forming the TST. Aggradational sequences 3 to 5 and slight progradational sequences 6 and 7 comprise the HST. Sequence 7 marks the deterioration of the rudist barrier and widespread deposition of lagoonal facies. Sequence 8 is a basinward prograding sequence on the northeastern part of the field. The succession is overlain by major unconformity and karst filled with shale of the overlying Nahr Umar Formation. High-resolution carbon isotope data (1 sample per meter) were collected from the mud matrix of cores and integrated with core descriptions and wireline logs to develop a higher-resolution framework, especially in slope/open marine settings where clinoforms occur and the sequence boundaries are correlative conformities. The Shuaiba Formation carbon isotopes range from + 2.5 and + 6% (per mil) and can be correlated with the standard Tethyan isotope curves, providing time constraints beyond the current biostratigraphic resolution. Higher carbon values on the platform, especially in the rudist buildups suggest slight resetting during diagenesis or platform waters of slightly different composition than basin waters.

The positive carbon isotope values in the lower part of Shuaiba Formation are related to the TST with its argillaceous Orbitolina packstone and Lithocodium dominated facies. Aggrading rudist bank facies with skeletal rudstone/grainstone has relatively uniform isotopic composition. The upper part of Shuaiba Formation has a negative isotope excursion associated with a sea level fall. The lower/upper Aptian boundary is identified by the isotopes on the northeastern side of the field and correlated with the Tethyan isotope curves. This boundary corresponds to a minor negative shift in carbon isotope values and a shift in facies from slope derived fine skeletal packstone to relatively deeper, and dark colored argillaceous mudstone with high density and very low porosity. The gradual increase of isotope values in the lower part of Shuaiba Formation may be related to the global Oceanic Anoxic Event OAE1.