Facies Distribution and Sequence Stratigraphy of the Permian-Triassic Upper Khuff Carbonates, Ghawar Field, Saudi Arabia

Raed Al-Dukhayyil [1], Aus Al-Tawi [1], and J. Fred Read [2]
[1]Reservoir Characterization, Saudi ARAMCO, Dhahran, Saudi Arabia.
[2]Geosciences, Virginia Tech., Blacksburg, VA.

The Permo-Triassic Upper Khuff carbonate-evaporite succession (up to 210 m thick) in Ghawar field has a well developed unconformity at the P/T boundary; elsewhere it is conformable (Insalaco et al., 2006). The succession formed on an arid carbonate ramp with supratidal nodular anhydrite, sub-aqueous laminated anhydrite, tidal flat laminites, lagoon mudstone-wackestone, ooid-peloid grainstone shoals, and fore-shoal lime-mudstone. The succession has abundant meter-scale parasequences, and several semi-regional exposure surfaces with paleosols and breccias. Up to six sequences make up the Upper Permian Khuff B/C interval (up to 105 m thick) capped by the P/T unconformity. The lower sequence is dominantly peritidal dolo-mudstone parasequences capped by sequence boundary zone. In the other sequences, abundant grainstone shoal facies shallow up into restricted lagoon dolo-mudstones, tidal flat facies and/or exposure surfaces. The upper sequence (Northern Ghawar) has bryozoan-crinoid-bearing lime-grainstones that mark a significant flooding below the P/T unconformity. The Triassic Khuff carbonates (up to 105 m thick), consist of Khuff B and overlying Khuff A sequences. The Khuff B has three High Frequency Sequences (HFS) that thin upward (decreasing accommodation). The Khuff B Transgressive Systems Tract (TST) has retrograding distal carbonate lime-mud marking the maximum flooding event for the entire Triassic Khuff. Highstand organic rich, black laminated anhydrite formed in a mega-salina bounded to the South by supratidal displacive anhydrite and marine dolomite. The Khuff A has two HFSs with upward decreasing accommodation. It has initial retrograding laminated anhydrite, deepening to grainstone shoal facies capped by restricted peritidal facies. The parasequence stacking is strongly aggradational with only subtle lateral facies changes, reflecting the immense, flat-topped platform and extremely low platform top slopes. Overall accommodation rate of 3 cm/k.y. would imply that the submeter scale cycles are likely precessional. The abundant meter scale parasequences are strongly suggestive of greenhouse precessional forcing. The regional paleosols probably mark times of significant sea level drop, and relate to most of the parasequence boundaries. These parasequences result from progradation followed by flood-back associated with more typical small precessional sea level fluctuations.