Sequence Stratigraphy of the Permian–Triassic Upper Khuff Carbonates, Ghawar Field, Saudi Arabia

Raed K. Al-Dukhayyil (Saudi Aramco <dukhayrk@vt.edu>, <dukhayyilrk@yahoo.com>),
James F. Read (University of Vermont, USA), and Aus A. Al-Tawil (Saudi Aramco,
<aus.tawil@aramco.com>)

Over 1,500 meters of Upper Permian Khuff B/C and Early Triassic Khuff A and B cores and wire-line logs from 16 wells in Ghawar Field were studied. The carbonate-evaporite successions are interpreted to be arid epeiric ramp facies, which include: subaqueous laminated-and supratidal nodular- to massive anhydrite, tidal flat laminites, lagoonal mudstone, (with thrombolites restricted to Triassic), ooid-peloid shoal complexes, and subtidal off-shoal mudstone. Facies are packaged into meter-scale parasequences, often separated by exposure surfaces at sequence boundaries.

The Khuff B/C interval (up to 105 m thick) is a third-order sequence with nine high-frequency sequences (HFS) capped by the Permian–Triassic (P/T) unconformity. The transgressive systems tracts (TST) of most of the HFS are grainstone-dominated, while the highstand systems tract (HST) deposits are dolomudstone, laminite and/or paleosols. Carbon-isotope values commonly decrease beneath the sequence boundaries, whereas the oxygen-isotope values increase. The P/T boundary in Ghawar is marked by regional exposure with a marked increase in total GR beneath the surface and a significant decrease above it. The P/T boundary has a significant negative carbon excursion (reflecting global input of light carbon) and the overlying Triassic section has an abrupt decrease in faunal content (following the P/T extinction).

The Early Triassic Khuff A and B carbonates and evaporites are up to 105 m thick. The Khuff B sequence is composed of four high-frequency sequences, comprised of cyclic off-shoal lime-mudstone and oolitic grainstone (TST) and HST grainstone and peritidal carbonate-evaporite deposits, evaporites including laminated and nodular types (HFS 3), and laminated types only (HFS 4). The lower Khuff A sequence, contains a basal laminated anhydrite, and has three high-frequency sequences composed of evaporites, peritidal and oolitic carbonates (TST), and an HST that is oolite-prone and capped by laminites and local exposure breccia. The upper Khuff A sequence has digitate stromatolites at the base and is dominated by peritidal carbonates with thin grainstone, but systems tracts are difficult to define.