

Sequence Stratigraphic Framework of the Khuff C Carbonates in Central Ghawar Field, Saudi Arabia

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Abstract

The Khuff C Carbonate Member of the Khuff Formation is a long-term composite depositional sequence. It is made up of four, 4th order, shallowing-upward high-frequency sequences (HFSs), identified as KC1, KC2, KC3 and KC4. Each sequence is made up of a transgressive systems tract (TST) and a highstand systems tract (HST), separated by a mappable maximum flooding surface (MFS). Systems tracts are made up of mappable meter-scale shallowing-upward high-frequency cycles (HFCs).

This study identified thirty-two HFCs, most of which can be correlated across the Ghawar Field area.

The first HFS, KC1, is composed of ten, meter-scale, shallowing-upward HFCs. The TST is characterized by storm beds and ooid-peloid grainstones overlying up-dip restricted dolomudstones, deepening into ooid-peloid grainstones that mark the MFS. The HST is made up of prograding tidal flats. Localized exposure features that overlie the down-dip restricted dolomudstone and grainstone cycles define the sequence boundary of the KC1 HFS. The overlying KC2 HFS consists of five, meter-scale, shallowing-upward HFCs. The initial TST is defined by a transgressive set of restricted cycles with storm-influenced facies in a relatively low structural position. The late TST of this sequence is defined by a vast transgressive distal lime mudstone with bryozoa that passes into peloid grainstone and burrowed shallow subtidal pellet dolo-wackestone/packstone of the MFS. The HST is made up of prograding restricted and rare tidal flat dolomudstones that prograde over down-dip shallow subtidal dolo-wackestone to dolo-packstone facies. These are capped by a Ghawar-wide paleosol that represents the KC3 sequence boundary.

The third HFS, KC3, is made up of ten HFCs. The TST is defined by back-stepping meter-scale restricted cycle sets, overlain by back-stepping grainstone shoal and fore-shoal (shoal flank), storm-influenced facies with up-dip shallow subtidal and locally restricted cycles. The cycles continue deepening to open marine distal lime mudstone with open marine biota (mostly bryozoa and crinoids) of the MFS. The HST is characterized by prograding distal lime mudstone that shallow upward into shallow subtidal and tidal flat cycles that are capped by an exposure surface at the sequence boundary. The fourth and last HFS of the composite Khuff C depositional sequence is made up of five, meter-scale, shallowing-upward HFCs. The TST is represented by transgressive peritidal cycles of storm deposited grainstones that shallow upward into restricted, tidal flat dolomudstones. The HST is represented by the prograding Khuff C anhydrite over down-dip regressive grainstones, marking the upper most boundary of the Khuff C composite sequence.