A reservoir scale case study: Facies geometries, cyclicity, and depositional environments of the heterogeneous oolitic Miocene sequence, Wadi al-Qattarah formation, Cyrenaica platform, northeast Libya

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Five detailed field sections of 31 m maximum thickness, along 3.5 km distance were measured in the Middle to Late Miocene carbonate succession of Wadi al-Qattarah Formation. Five distinctive sedimentary facies associations were distinguished in the oolitic Miocene shallowing upward sequence. The facies associations are: 1) transgressive phase facies association, 2) Tidal shoal sand bar facies associations, 3) tidal shoal channels facies associations, 4) tidal spillover lobe sand-belt facies associations and 5) interchannel 'bay' pond facies association. Moreover, interchannel flats or levees are regarded as subfacies and incorporated in tidal channels facies associations and interchannel pond filling facies associations. The W-E stratigraphic cross section highlighted geometries and vertical heterogeneity of these facies. The transgressive phase facies associations form a fining upward cycle that is made up of skeletal conglomeratic-lime, limesand fragments of coralline red algae, gastropods, echinoids and other shell fragments. It is graded, laminated and well bedded. This unit rests unconformably above the older Eocene rocks. The tidal sand bar facies associations form a coarsening upward cycle of non-skeletal and skeletal limesand, and oncolitic-ooloids. Gastropods, benthic forams and shell fragments are common in this unit. It is graded, laminated, cross laminated, well bedded, and burrowed at the top. Tidal spillover lobe sand-belt facies associations form a uniform cycle of oolitic grainstone. It has a few echinoids shell fragments. The unit is graded, laminated, well bedded, and cross bedded with imbrications structures at the base. Tidal shoal channels facies associations form a fining upward cycle of skeletal and non-skeletal conglomeratic-lime, limesand, and pure limemud, and oncolitic-ooloids. Gastropods, benthic forams and shell fragments are common in this unit. It is graded, laminated, cross laminate, well bedded, and burrowed at the top. Tidal spillover lobe sand-belt facies associations form a uniform cycle of oolitic grainstone. It has a few echinoids shell fragments. The unit is graded, laminated, cross laminated, well bedded, and cross bedded with lens shape channels that show soft sediment deformation and sharp basal surfaces. This sand waves and sand bars unit is characterized by a composite set of large planar and trough crosses bedding overlain by a small scale planar and trough cross bedding and then capped by wave-formed ripples. Interchannel 'bay' pond facies associations form a coarsening upward cycle of skeletal and non-skeletal limesand includes ooids and pellets. This unit contains bivalves, gastropods, and benthic forams. It is graded, laminated, cross laminated, and well bedded. The heterogeneous oolitic Miocene shallowing upward sequence was deposited in a tidal environment as indicated by its facies associations and the herring-bone cross bedding. This outcrop case study covered a limited portion of the oolitic Miocene sequence that extends for more than 150 km along a dip profile and its excellent 3-D exposure makes it an analogue for ooid grainstone carbonate reservoirs in the subsurface within the Mediterranean region and globally.

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