Sedimentological and Diagenetic Characterization of the Mauddud Member (Wasia Formation, mid-Cretaceous), Saudi Arabia

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Abstract

The Mauddud Member (late Albian) encompasses carbonate deposits forming part of a large-scale transgressive trend that continued until the end of the Cenomanian. The aims of this study were (1) to understand facies variations, and (2) to characterize the diagenetic overprint that affected the Mauddud Member during its burial history. Several hundred feet of core were sedimentologically described, along with thin-sections and integrated with digital rock physics, seismic and log data in order to establish a new facies scheme and to incorporate the diagenetic history in a robust sedimentological framework. Overall, the Mauddud Member comprises shallow marine carbonates with isolated rudist patches that increase in size towards the prograding platform margin. In more detail, the most proximal facies are characterized by low to moderate-energy inner ramp peloidal wackestones to floatstones with flora-faunal assemblages dominated by green algae, benthic foraminifera, echinoderms, bivalves (including reworked rudist debris) and gastropods. Bioturbation is locally pervasive and bed boundaries are marked by bioturbated surfaces, hardgrounds and erosive surfaces (the latter likely showing evidences of storm events). Clastic incursions are locally observed, indicating either local regressive trends or climatic variations towards more humid periods. Rudist patches are characterized by skeletal floatstones and rudstones with variably well preserved rudist shells mixed with large benthic foraminifera, echinoderms and peloids. Those rudist-rich banks are inferred to increase in size towards the platform margin, which progrades towards an intrashelf basin located outside of the area of interest. The subsequent diagenetic overprint includes several phases of dissolution and cementation. Dissolution events are likely to be initially related to meteoric fluids percolating from the top of the Mauddud Member (regional unconformity associated with exposure), dissolving biological aragonite. Calcite cements are present in variable abundance and locally occlude macro-pores. In more detail, phreatic marine fibrous cements developed likely during deposition, while pore-lining and pore-filling rhombic and blocky cements were potentially precipitated either from early meteoric fluids or later on during the burial history. Pore-filling dolomite cements are also locally observed and inferred to be a burial-related phase. The integration of 3D X-ray microscopy data shows that inner ramp wackestones are usually associated with more pore-filling cements and a reduced pore system, while rudist-bearing facies are typically less cemented and associated with larger, better connected macro-pores.