Early dolomitisation of Valanginian Strata on the Arabian Platform. A Case Study from the Buwaib Formation, Saudi Arabia

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Abstract

Dolomitisation is a very common process within the Mesozoic strata of the Arabian Platform. Those dolomites, however, are usually interpreted as burial diagenesis phases, and when they show petrographical evidence of early diagenesis their isotope signature typically indicates some degree of recrystallization. In this study, we document the rare preservation of synsedimentary dolomites within the Early Cretaceous of Saudi Arabia. Early Valanginian sediments of the Buwaib Formation are dominated by intertidal facies deposited in the initial stage of a 3rd order transgressive interval above the regional early Valanginian Unconformity. Those facies include bioturbated mudstones, microbial-laminated bindstones along with minor skeletal wackestones, and show abundant fenestrae structures, teepee and rootlets, while being affected by common desiccation surfaces. The top of the studied interval is a likely 4th order sequence boundary marked by a thick stylolite. At the platform-scale, the most proximal sections located close to the paleo-shoreline, are pervasively dolomitized, microporous with a chalky texture, and locally associated with the precipitation of synsedimentary evaporites such as anhydrite nodules and gypsum crystals. Under SEM, dolomite rhombs have a euhedral shape and are very fine-crystalline (average size <8µm). Minor to common detrital clays (including illite and possible palygorskite) are also present. Stable isotope measurements on those dolomite show $\delta^{18}O$ values that range between -1‰ V-PDB and +3.8‰ V-PDB, which support a synsedimentary evaporation to seepage reflux dolomitisation model. Very negative $\delta^{13}C$ values in sections closest to the paleo-shoreline (reaching -4.5‰ V-PDB) suggest the influence of organic carbon from paleosoils (also indicated by the presence of rootlets and green clays). Those $\delta^{13}C$ values progressively increase away from the paleo-shoreline, along with the reduction of dolomite abundance. Indeed, the sections located the most distally show a drastic facies change towards green algae-rich inner ramp deposits, with dolomitisation limited to possible 4th order sequence boundaries. There, $\delta^{13}C$ values within the dolomite sections are in line with Valanginian marine values, confirming a synsedimentary precipitation. In those weakly dolomitized sections, $\delta^{18}O$ values measured on the micritic matrix are systematically negative (reaching -4.2‰ V-PDB) and $\delta^{13}C$ is dominantly negative (reaching -3.8‰ V-PDB). This support an early recrystallization of the micritic matrix from meteoric fluids influenced by paleosoils. The variations in dolomite intensity are likely to reflect a partitioning in the Magnesium availability on platform, while the broad variations of the $\delta^{13}C$ values can be used as a tool to understand palaeoenvironment variations within a broad intertidal to low-energy shallow marine carbonate system.