

# **Sedimentology and Stratigraphy of a Mid-Cretaceous Prograding Carbonate Platform. New Insights from The Wasia Formation of Saudi Arabia**

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## **Abstract**

The aim of this study is to provide a clearer understanding of the sedimentological variations (facies, depositional environments, cyclicity, etc) that can be observed in the Cenomanian-Turonian Wasia Formation (Mid-Cretaceous) of Saudi Arabia in the context of fluctuating sea level. This study focuses on the characterization of the carbonate-dominated Mishrif Member and is primarily based on detailed sedimentological descriptions from more than 3000 ft of core. 400 thin-sections were prepared for microfacies determination and biostratigraphic investigations in order to identify and refine depositional environments and potential age dating. Bulk carbon isotope analyses were also conducted to identify intraformational exposure surfaces. Those data have been integrated with wireline logs in order to provide a clear stratigraphic framework and estimate vertical and lateral facies and environmental variations across the area of interest. The Wasia Formation encompasses seven members dominated by shallow marine carbonate facies, with the exception of the Khafji and Wara members. The top of the Wasia is marked by a platform-scale unconformity associated with exposure. The Mishrif Member is regionally dated from the Cenomanian-Turonian and represents the youngest part of the Wasia Formation. The deposits of the Mishrif Member are characterized by shallow marine and rudist-bearing platform-top sediments. Low to moderate-energy platform-top facies are dominated by skeletal wacke-packstones with benthic foraminifera, green algae and gastropods. Rudist floatstones are sporadically observed, with sheet-like geometry, and are likely to form small banks developed on the margin of the Shilaif intrashelf basin, though they also might be the product of storms reworking rudist debris in the more proximal area of the platform. Carbon isotope variations indicate the presence of several high frequency exposures probably corresponding to 4<sup>th</sup> or 5<sup>th</sup> order sequence boundaries. The studied section is likely to be part of a large-scale sequence (likely 3<sup>rd</sup> order) in which the maximum development of the rudist deposits marks the maximum flooding of the platform. Basinward, the deposits evolve to low-energy, pervasively bioturbated deep marine deposits with abundant planktonic foraminifera, calcareous dinocysts and pelagic crinoids, which are almost certainly part of the southern margin of the Shilaif Basin. The Mishrif Member is bounded at the top by a regional exposure surface. Negative carbon isotopes below this unconformity suggest the presence of palaeosols on top of the Pre Aruma Unconformity, in line with regional reconstructions. Overall, this study provides a clearer understanding of the lateral variations in facies and depositional environment across the Arabian Platform during the Mid-Cretaceous times.