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The Role of Paleoclimate, Eustasy, and Basin Configuration in Governing Mixed Clastic–Carbonate Deposition: Insights from the Zubair Formation, Southern Iraq

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Abstract

The Zubair Formation, of Barremian age, is a key stratigraphic unit in southern Iraq, deposited along the northeastern margin of the Arabian Plate between the Ratawi and Shuaiba formations. It displays a vertical facies transition from carbonate-dominated deposits at the base to clastic-rich units in the middle, followed by a return to carbonate deposition in the upper intervals. This study investigates the interplay of palaeoclimate, sea-level change, and basin configuration in controlling this mixed carbonate–clastic succession.

Data from eight wells near the city of Basra were used, integrating borehole images, gamma ray logs, core descriptions, petrophysical logs, and mud logs. Borehole images were primarily used for facies description. However, they also revealed the absence of faulting and extensive deformation throughout Zubair suggesting deposition on a tectonically stable, low-gradient shelf. Local soft-sediment deformation features suggest limited gravitational reworking, particularly within prodelta environments.

Facies were classified using borehole image textures and porosity responses, while depositional environments were interpreted through GR log motifs and facies associations. Cyclicity in these motifs was used to infer relative sea-level trends, which were then correlated with the global eustatic sea-level curve of Haq (2014). An increase in clastic input during mid-deposition is linked to intensified hinterland runoff, interpreted as a proxy for wetter climatic conditions (Hay and Floegel, 2012).

The central clastic-dominated interval is interpreted as a fluvially influenced delta system, regionally correlatable, and indicative of a high-discharge river with proximal sediment sources. This, combined with eustatic sea-level rise, suggests a warm, humid palaeoclimate during mid-Barremian times. The alignment between eustatic trends and observed stratigraphic cyclicity further supports eustasy as a primary control on deposition. This study highlights the significance of integrating sedimentological, stratigraphic, and palaeoclimatic proxies in reconstructing the depositional history of mixed carbonate–clastic systems.