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Reservoir Heterogeneity of the Early Cretaceous Yamama Carbonate Formation: Impact of Depositional Facies and Diagenetic Processes in Southern Iraq

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Abstract : Evaluating carbonate rocks is crucial for the petroleum industry as they often serve as major hydrocarbon reservoirs, where understanding their depositional and diagenetic characteristics directly influences exploration, production, and field development plans. The Early Cretaceous Yamama carbonates Formation in southern Iraq exhibits significant reservoir but heterogeneous. Detailed sedimentological investigations of drill cores and well logs have identified 14 distinct facies/microfacies within both reservoir and non-reservoir units, deposited in a shallow carbonate ramp setting. The grain-supported facies such as intertidal peloidal oncoidal grain/rudstones, backshoal pelletal pack/grainstones, shoal ooidal-peloidal grainstones, cortoidal-peloidal grainstones, in addition to the Lithocodium-Bacinella float/boundstones, and the reefal skeletal rudstones facies display favorable reservoir properties due to preserved interparticle porosity (reaches 25%) at depths greater than 4000 m. This preservation is attributed to early diagenetic circumgranular calcite cementation and limited scattered equant and syntaxial calcite overgrowths, which protected the grains from physical compaction. In contrast, mud-supported facies such as lagoonal skeletal mud/wackestones, skeletal cortoids wacke/packstones, skeletal dasyclads wacke/packstone, middle-ramp miliolidal pack/grainstone, bioturbated dolomitic wackestones, skeletal foraminiferal mud/wackestones, and outer-ramp spiculitic skeletal mud/wackestones exhibit reduced reservoir quality due to a combination of their fine-grain texture, physical and chemical compaction, and substantial amounts of equant calcite cement. This cement fills interparticle and moldic pores, and significantly reducing porosity and permeability in these facies. Reservoir heterogeneity of the formation is attributed to depositional facies, which control the texture of the sediments, and various types of diagenetic alterations. Particular attention to be directed toward the Lithocodium-Bacinella facies deposited as build-ups and the shoal barrier grain-supported facies. These findings underscore the importance of adapting exploration and development strategies to specific facies distributions and diagenetic pathways to mitigate heterogeneity risks. While potential limitations include the extrapolation of core and well log data to field-scale reservoir modeling and the challenge of investigating diagenetic variations at finer scales, the study provides a valuable framework for integrating facies and diagenetic analysis into hydrocarbon exploration workflows.

Keywords : depositional facies, grain-supported limestones, lithocoduim-bacinella, reservoir heterogeneity, yamama formation
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