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Integration of Facies Architecture, Geochemical Signatures and Ooid Granulometrey for Reservoir Quality Prediction, Lower Triassic Khuff Formation, Central Saudi Arabia

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Abstract

The stratigraphic records of many Permian-Triassic carbonate sequences are composed of extensive oolite-microbialite deposits, many of which contain major hydrocarbon-producing reservoirs. To improve our understanding of these deposits, this study investigates outcrops of the Lower Triassic Upper Khuff Formation (the Khartam Member) in central Saudi Arabia using sequence stratigraphy, chemostratigraphy and ooid granulometry. The succession includes lithofacies that are interpreted to have been deposited in four broad depositional environments: foreshoal, shoal complex, backshoal and tidal flat. The lithofacies comprising shallowing-upward successions are bounded by erosive surfaces or by facies offsets stacked into sub meter to meter-scale cycles. The Upper Khartam Member is a composite of five, 4^{th} -order sequences, which are bounded by abrupt, prominent surfaces that can be correlated over several kilometers. Geochemical and sedimentological attributes vary systematically within the sequence stratigraphic framework. Integrated sedimentological and chemostratigraphic analysis reveals that the geochemical signatures, ooid grain size, morphology and mineralogy of the carbonate lithofacies within the Upper Khartam composite sequence vary markedly with the depositional environment. Ooid grain size increases with water energy and follows the shallowing upward pattern of the succession. The interpretation of the ooid morphology within a sequence stratigraphic framework reveals that the distribution and pore structure of oolitic units are substantially controlled by sea-level fluctuations. This study presents techniques to correlate lithofacies and subaerial exposures using geochemical data and provides insight into how the subaerial exposure, stratigraphic position and ooid mineralogy control the complexity of the pore system morphology in oolitic reservoir analogs.