

The Jurassic Biofacies and their Implications in the Unconventional Reservoirs: A Case Study from Jafurah Basin, Saudi Arabia

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ABSTRACT

High-resolution optical studies reveal that carbonate source rock facies have sedimentological complexity and textural heterogeneity, despite their apparent homogeneity. Using a thin-section micropaleontological study of high-resolution sampling approach has provided valuable insights into fundamental controls on these microfacies variability such as subtle depositional environment variables and components. Micropaleontological study of the unconventional reservoirs facies of the Jafurah Basin has recognized three main biofacies ranging from distal to proximal basinal facies. These are in descending order, oxic, dysoxic and anoxic biofacies. Each of these biofacies has several sub-biofacies that signify different processes, component types and bathymetries. The anoxia biofacies is characterized by lamination facies of suspension fallout components with minor bottom currents driven deposits. This biofacies has been subdivided into eight sub-biofacies based on different size, orientation and stacking patterns of biocomponents. The dysoxic biofacies is dominated by weakly, graded lamination with individual lamina sets consisting of a scoured base comprising silt-size fecal pellets, pyrite and small shallow marine foraminifera. This lamina is capped by homogeneous mudstone with small horizontal burrows and rare vertical thin burrows that represent escape paths or traces result from oxygen depletion. This biofacies has six sub-biofacies based on the proportion of thin light-colored laminae to the dark laminae and biocomponent types. These grainy, light-colored laminae may represent distally thinned sheets of storm trickle debris flows that swept down-dip into low-gradient distal outer ramp strata by gravity-driven debris flows. The last biofacies is lack of lamination and dominated by various size and type of bioclastics arranged without preferential orientation. It has bioturbated facies and admixture of deep marine biocomponents with allochthonous shallower forms. This biofacies has five sub-biofacies and it may suggest a proximal outer ramp setting within the storm wave base. These biofacies represent a significant contribution toward a more complete understanding of sediment-driven process and depositional cyclicity of deep marine facies. They also provide additional insights into how these muddy successions in the Jafurah Basin are typically organized into packages that can be predictable and further subdividing unconventional reservoir facies.