

Diagenesis and Reservoir Quality of the Late Neoproterozoic Buah Formation Based on Core Data from East Central Oman

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Abstract

Major accumulations of world class hydrocarbons are hosted in carbonate rocks with underexplored potential for further discoveries. Diagenetic processes affect carbonate rocks from the depositional stage and throughout their burial history, producing significant alterations to the original textures and thus raising many challenges in predicting reservoir quality. The Buah Formation is a dolomitic carbonate unit in the upper clastic-carbonate cycle of the Nafun Group, which accumulated during the Late Neoproterozoic, Ediacaran age (635-541 Ma), with variation in thickness ranging from 50m up to around 400m. The few published studies on the Buah Formation that have been published cover mainly the lithofacies and depositional settings based on outcrops, with much less focus on the diagenesis. To address this issue, core samples from the Buah Formation of east Central Oman have been examined to identify the depositional facies distribution, to understand the diagenetic alterations and to evaluate the controls on reservoir quality. Four cored wells from the study area covering different intervals within the Buah Formation were selected for this study. Eighty-two carbonate-stained thin sections from these four wells have been used for the petrographic study. Six-core chip samples have been collected from the Well R core for SEM and EDS analysis.

Eight lithofacies have been identified from the studied cores representing mainly middle ramp and tidally influenced inner ramp facies: (1) crinkly laminated dolomudstone, (2) microbial dolostone, (3) dolograinstone, (4) dolostone breccia, (5) crystalline dolostone, (6) argillaceous mudstone with anhydrite, (7) red mudstone to siltstone, and (8) red mudstone breccia. These lithofacies were interpreted to be deposited on a broad carbonate ramp with variable subsidence rates across Oman, resulting in variations in the depositional facies and thickness. The main diagenetic alterations observed in the studied samples are micritization, multiple phases of cementation (dolomite, silica, and anhydrite), at least two generations of dolomitization, dissolution, mechanical and chemical compaction, and various fracturing phases. A combination of these factors led to both enhancement and degradation of porosity and permeability over time.

Despite the long and varied diagenetic history of the Buah Formation depositional porosity has been preserved in some of the dolograinstones for around 550 million years where early cementation and hydrocarbon migration have contrived to prevent porosity reduction during burial. The main porosity creator however in all lithologies is related to burial dissolution of grains and cement. Depositional facies, diagenetic alterations and tectonic fracturing were all factors controlling the ingress of corrosive fluids to effect this dissolution.