Lithofacies and Paleoenvironments of the Late Ordovician Sarah Tight Sand, Subsurface of the Rub' Al-Khali Basin, Saudi Arabia

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ABSTRACT

The Late Ordovician Sarah Formation is considered as a potential tight gas sand reservoir in the Rub' Al-Khali basin, Saudi Arabia. Exploration work carried out on the formation in the basin revealed challenges that are related to the heterogeneity of lithofacies, paleoenvironments, paleogeography and deep burial. This study investigates the lithofacies and depositional environments of the Sarah Formation from core samples retrieved from six exploratory wells in the Rub Al-Khali basin. We conducted detailed sedimentologic core description and petrographic analysis and defined four lithofacies associations (FA) including fine to medium-grained, massive sandstones (FA1), grayish, medium to coarse-grained, massive, partially deformed sandstones (FA2), diamictites (FA3), and partially deformed, medium to coarse-grained, graded to massive sandstones with minor amount of granular size grains (FA4). The lithofacies associations are interpreted as a braided glaciofluvial (FA1), a glaciolacustrine delta (FA2), a subglacial tillites (FA3), and another braided glaciofluvial outwash (FA4) deposits. The Sarah Formation is characterized by a variety of lithofacies reflecting various depositional environments. In the proximal part situated in the western margin of the basin, the Sarah Formation was deposited in a braided glaciofluvial environment. However, basin-ward, the sediments were deposited in a distal braided glaciofluvial setting. In the medial part, the sediments were deposited within glaciolacustrine-delta and subglacial environments. The glacial deposits are identified by the diamictites exhibiting various characteristics including the ground mass matrix type (mud and sand), clasts content, and the presence or absence of stratification. Based on these observed characteristics, they are classified as massive matrix-supported, stratified matrix-supported, massive clast-supported, and massive sandy matrix-supported diamictites. All the diamictites reveal that a glacial advance of the Late Ordovician glaciations extended to the Rub' Al-Khali basin. The deformed lithofacies observed in the cores and thin sections might be related to glacial movements during a period of glacial retreats. The lithofacies heterogeneity of the formation is expected to impact reservoir quality and architecture. Understanding the heterogeneity of the Sarah reservoir within integrated lithofacies depositional models would help to identify sweet spots and to provide guides to enhance exploration and development of the Sarah reservoir.