STRATIGRAPHIC AND ARCHITECTURAL ANALYSIS OF THE HIRNANTIAN GLACIAL DEPOSITS OF THE SARAH FORMATION: AN ANALYSIS OF THE RAHAL DHAB PALEOVALLEY IN TABUK BASIN, NORTHWEST SAUDI ARABIA

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ABSTRACT

The Late Ordovician (Hirnantian) continental-scale ice sheet that existed over Gondwana's south pole circa 445 Ma left its imprints over modern-day Southern Europe, South America, North Africa and the Arabian Peninsula in various forms of glacial features. In Saudi Arabia, outcrops of the Sarah Formation (Hirnantian age) form a belt of sinuous and elongated deposits extending from Tabuk Basin in the northwest to Widyan Basin in central Saudi Arabia, while dipping in the E-NE direction. In the subsurface, paleovalley sediments form hydrocarbon reservoirs of the Paleozoic petroleum system that is sourced by the overlaying Qusaiba hot shale.

This study conducted a surface to subsurface analysis of the variations in depositional settings associated with the creation and filling of Hirnantian subglacial paleovalleys in northwestern Saudi Arabia by examining Rahal Dhab paleovalley in Tabuk Basin. Eight outcrop measured sections and 297 m of core description, along with outcrop photomosaics, satellite images and paleoflow measurements were used in this study. Facies of various depositional environments were identified, and multiple stages of valley evolution have been recognized such as preglaciation, glacial advance, glacial retreat, early marine transgression and established marine transgression stages. Mixed subglacial, ice-marginal glaciofluvial, glaciomarine and transitional marine sedimentation processes dominated during filling of the valley. In addition to sedimentary facies, stratigraphic observations such as thickening of the paleovalley towards the center, multiple cycles of ice advance and retreat, and reworking of the top paleovalley deposits by waves and tidal currents have been used to build a conceptional model for the valley evolution. This study proposes a new evolution model for paleovalleys of the Sarah Formation suggesting mostly a glaciofluvial depositional environment that transitions into marine influenced in the distal part of the paleovalley.

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