

# **Late Ordovician Pre-Glacial and Syn-Glacial Deposits from NW Saudi Arabia: Insights Into Facies Analysis, Depositional Models and Present-Day Analogues**

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## **Abstract**

The objective of this study is to characterize the depositional facies of the Middle to Late Ordovician Qasim Formation and the latest Ordovician Sarah Formation using drill cores from the subsurface of northwest Saudi Arabia. The study also utilizes the published depositional models and satellite images concerning the glacial and shoreface sedimentations. The Qasim Formation from northwest Saudi Arabia (Middle to Late Ordovician) represents a package of sediments lying above the fluvial to marginal marine deposits of the Saq Formation (Late Cambrian to Middle Ordovician) and below the base of the Sarah Formation (Hirnantian, latest Ordovician) erosional unconformity. The Qasim Formation consists of two siliciclastic coarsening-upward progradational sequences, each with a basal shale/siltstone member and an overlying sandstone member reflecting eustatic sea level changes. These sediments were deposited in a low relief, regionally extensive and stable shelf regime that characterized the northern Gondwana platform from Mauritania in the west to the Arabian Peninsula in the east. The accommodation space was available for the deposition of a major marine prograding clastic sequence, reaching a maximum thickness of 3,500 feet. This resulted in a layer cake stratigraphy of pre-glacial deltaic to shoreface environments. Periods of channelized erosions of the underlying Qasim and Saq formations mark the onset of the sub-glacial processes of the Sarah Formation. The Upper Ordovician Sarah Formation sediments represent lowstand deposits that are attributed to Hirnantian Gondwana glaciation. These glaciation events covered North Africa and advanced into western Saudi Arabia. The described sediments from drill cores consist of sub-glacial clastics deposited in deep tunnel valley incisions during the glacial maximum phase. However, ice recession and ice minimum phase facies were also deposited in an unconfined glaciomarine outwash fan setting away from the retreating ice front. These glaciomarine outwash fan facies were sourced by material from the erosion of tunnel valleys in ice proximal areas as a result of glacial and fluvial processes. The Sarah Formation glaciers retreated at the end of the Ordovician in conjunction with a rise in sea level resulting from the melting of the ice cap. This resulted in widespread flooding of the Arabian platform marking the deposition of the Lower Silurian Qusaiba Member of Qalibah Formation.