

Ichnology of the Upper Unayzah Reservoirs in the Subsurface of Saudi Arabia: The Record of Animal- Sediment Interactions in Tidally Influenced and Shallow-Marine Settings

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ABSTRACT

Ongoing and evolving studies of subsurface core material from upper Unayzah reservoirs (Nuayyim Formation, Early to Middle Permian) across central Saudi Arabia are revealing considerable complexity within the depositional facies mosaic. Thus rocks are identified that are characteristic of eolian dune and interdune settings, with fluvial deposits and widespread soils also widely distributed. Crucially, and somewhat controversially, at a number of discrete levels within this formation, there is also evidence for tidally influenced, marginal marine sedimentation. This study documents trace fossil faunas from these latter facies of the Nuayyim Formation. It thereby confirms marine influence on sedimentation. Furthermore, it allows reconstruction of the benthic communities and provides insights on ecological and paleoenvironmental conditions at the time of sediment deposition. Burrowed intervals within the Nuayyim Formation, (formerly identified as Unayzah-A) consist of very fine- to medium- grained sandstones with wavy-, low angle- and planar-lamination. Some segments display coal beds, syneresis cracks and reactivation surfaces. Sediment deposition took place mostly in brackish waters and shallow marine settings, mostly within fair-weather wave base along the marine shelf. The trace fossil suite displays a diminutive, locally monospecific assemblage dominated by infaunal dwelling and grazing structures of ichnogenera suggesting mixed deposit-feeding behaviors (e.g. Planolites, Palaeophycus, Thalassinoides, Teichichnus, Bergaueria) and subordinate dwellings of suspension feeders (e.g. Skolithos, Gyrolithes, Arenicolites and Ophiomorpha). This assemblage resembles an impoverished, low-diversity mixture of the archetypical Skolithos ichnofacies and proximal Cruziana ichnofacies. Paleoecological conditions such as salinity fluctuations, moderately well oxygenated sediment- water interfaces, moderate energy levels in form of waves and tidal currents, and food resources mostly but not exclusively suspended in the water column in nearshore to tidal flat settings are interpreted from this assemblage. Colonization by bioturbating infauna in the upper Unayzah is interpreted to be the consequence of sea level rise that flooded low lying topographic relief, coastal embayments and interdune playa lakes farther inland. The trace fossil associations can be used to delineate the terrestrial extent of marine incursions and the distribution of continental facies. Sedimentation is interpreted to have been marginal to shallow-marine, mostly tidally influenced. Ichnofossils documented in this study are significant because (1) they refine existing interpretations of the paleoenvironmental history in the study area; (2) they provide evidence for marginal-marine and tidal processes at the time of sediment deposition; (3) the recognition and delineation of discrete marine incursions by using trace fossil evaluation provides a tool to understand the distribution of reservoir facies within the Unayzah Formation; and 4) recognition of such marine incursions may assist in correlating marine and non-marine stratigraphy. Furthermore, bioturbated intervals are likely to be genetically related and can potentially be used regionally as stratigraphic surfaces.