EAGE

AP39

High-Resolution Lithofacies Analyses of Predominantly Organic-Rich Carbonates from the Natih-B Intrashelf Basin, North Oman

S.A.K. Al Balushi* (University of Manchester/PDO), J.H.S. Macquaker (Memorial University of Newfoundland) & C. Hollis (University of Manchester)

SUMMARY

Recent research, utilizing high-resolution petrographic and geochemical analyses on samples collected from North Oman, has revealed that the predominantly fine-grained carbonates of the Natih-B Member contain a great deal of previously unrecognized lithofacies variability, developed at cm to sub-mm scales. Most geologists have largely overlooked the significance of this small-scale variability, attributing changes observed to either influence of varying primary production or oxygen concentration in the water column. Detailed analyses of the textures (e.g., relict thin beds, burrow mottles, organo-mineralic aggregates and lenticular laminae) and components (including fossil and mineral assemblages) present at these small scales suggest that this lithofacies variability reflects bed-scale processes. Moreover, it indicates that many of the Natih-B intrashelf-basinal sediments, rather than being deposited directly from suspension settling under predominantly low-energy conditions, were actually deposited, at least partially, by episodic and advective events. These sediments, following compaction, developed thin beds and then were subsequently burrowed by diminutive infauna. Furthermore, analyses of successive samples within laterally-equivalent intervals suggest that there was significant temporal and spatial variability in sediment supply and accommodation availability, in addition to local changes in primary production, sediment accumulation and burial rates that fundamentally controlled organic-matter enrichment in the Natih-B Member.

During the Late Albian to Early Turonian, a major phase of carbonate platform growth took place in North Oman, which recorded the deposition of the Natih Formation over siliciclastic sediments of the Nahr Umr Formation. Seven lithostratigraphic units have been identified in the Natih Formation (members Natih-A to Natih-G downward, reflecting major changes in relative sea level that mainly controlled their deposition). Uplift and erosion in the Turonian ended the development of this carbonate platform, which enabled the influx of fine-grained terrigenous material of the Fiqa Formation from the Arabian craton.

Intra-shelf basin environments developed twice in the extensive carbonate platform of the Natih Formation (upper Natih-B and lower Natih-E) as a result of major transgressions, enhanced by differential sedimentation rates. This study is focused on the Middle – Late Cenomanian Natih-B Member because the intra-shelf basin within it includes more organic-carbon-rich sediments (up to 40-m-thick source-rock interval, average about 4% total organic carbon (TOC)) that have sourced hydrocarbons to the adjacent Natih Formation reservoirs. Examples of time-equivalent intra-shelf-basinal carbonates to those of the Natih-B Member in the Arabian Plate include the Shilaif/Khatiah Formation of United Arab Emirates, Rumaila Formation of eastern Saudi Arabia, Kuwait and southern Iraq, and upper Sarvak Formation of southwestern Iran.

Our research, utilizing high-resolution petrographic (optical and backscattered electron-optical) and geochemical (X-ray diffraction (XRD) and TOC) analyses on samples collected from North Oman (Adam Foothills and Natih field), has revealed that the predominantly fine-grained carbonates of the Natih-B Member contain a great deal of previously unrecognized lithofacies variability, developed at cm- to sub-mm scales. Most geologists have largely overlooked the significance of this small-scale variability, attributing changes observed to either influence of varying primary production and/or oxygen concentration in the water column, or differential effects of weathering once the sediment had been subaerially exposed.

Detailed analyses of the textures (e.g. relict thin beds, burrow mottles, organo-mineralic aggregates, lenticular laminae and scoured surfaces) and components (including both fossil and mineral assemblages) present at these small scales suggest that this lithofacies variability reflects bed-scale processes. Moreover, it indicates that many of the organic-carbon-rich intra-shelf-basinal sediments, rather than being deposited in predominantly low-energy settings as a result of a continuous rain of detritus to the sediment-water interface, were actually deposited, at least partially, by episodic and advective events and then were subsequently disrupted by diminutive burrowing organisms. Bioturbation, although subtle, is widespread in these sediments, which also contain evidence of in-situ fauna (including thick-shelled oysters, flattened pectens and benthic foraminifera) suggesting that during deposition, bottom-water conditions were most likely oxic to dysoxic rather than persistently anoxic. These sediments, following compaction, developed thin depositional beds that might have been mistaken for depositional laminae by some geologists.

Furthermore, analyses of successive samples within laterally-equivalent intervals suggest that there was considerable temporal and spatial variability in sediment supply and accommodation availability, in addition to local changes in primary production, sediment accumulation and burial rates that fundamentally controlled organic-matter enrichment in the Natih-B Member.