

Repeating Lithological Diversity of Clastics, Carbonates and Evaporites as Herald of Depositional Instability: An outcrop-based interpretation of Nari Formation from Northern Ranikot Anticline, Sindh, Pakistan

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We systematically analyzed the vertical stacking of lithofacies and made high-resolution outcrop-observations and interpretations of the Nari Formation from Northern Ranikot Anticline, Sindh, Pakistan. A total 65m thick sequence of Nari Formation from top Kirthar Formation (Upper Eocene) to base Manchar Formation (Neogene, Siwalik Group) is measured in the study area. Interbedded strata of limestone, gypsum, gypsiferous shale, oxidized shale, cross-bedded sandstone and oxidized sandstone were identified. Abundant fossils were identified in limestone, which include worm burrows, echinoids, gastropods, pelcypods, turritella and larger benthic foraminifera, particularly discocyclina. Orientation of gypsum laminations and veins were also noted to understand their syn-depositional or post-depositional relationship with other lithologies. Paleo-current data of elongated fossils and cross-bedding in sandstone was also recorded to interpret current direction and hence paleo-slope during the deposition of Nari Formation. Nari Formation has transitional lower contact with Kirthar Formation. Lower 35m of the Nari Formation in study area consists of four distinct lithofacies associations, which are ramp-deposited limestone facies, sabkha-deposited gypsiferous shale and gypsum facies, flood plain-deposited variegated shale facies and delta/fluvial -deposited thick and cross-bedded sandstone facies. Upper part of the formation is dominantly composed of delta/fluvial-deposited oxidized and cross-bedded sandstone facies. This lithological diversity indicates a wide range of depositional environments ranging from shallow-marine ramp, sabkha to deltaic and fluvial settings. Majority of the bedding planes in the study area are erosional in nature, indicating frequent emergence and erosion episodes. Paleo-current analysis indicates dominant paleo-

flow direction towards NW. Besides the vertical lithological diversity, Nari Formation also exhibits lateral variations in lithology. Present interpretations propose that the study area was initially part of Nari Sea that was opening to the west. The study area experienced gradual emergence due to regression caused by uplifting of northern and western margins of Indian Plate. Therefore, marine fossiliferous limestone was replaced by evaporite gypsiferous shale and gypsum, which in turn were replaced by deltaic and fluvial oxidized and cross-bedded sandstone.