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Unusual occurrence of some sedimentary structures and their significance in Jurassic transgressive clastic successions of Northern Ethiopia

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Mesozoic sedimentary successions produced by marine transgression and regression of sea in northeastern part of Africa are well preserved in Mekelle basin of Ethiopia. Here, a typical second order sequence is well developed and preserved overlying the Precambrian basement rocks or patchy Palaeozoic sedimentary successions. Initiation of Mesozoic sedimentation in Mekelle basin has started with deposition of Adigrat Sandstone Formation (ASF). It is a retrogradational succession of siliciclastics in coastline/beach environment due to transgression of sea from southeast. ASF is followed by Antallo Limestone Formation (ALF)- an aggradational succession of carbonates in tidal flat environment; Agula Shale/Mudstone Formation (AMF); and Upper/Ambaradom Sandstone Formation (USF)- a progradational succession formed during regression in ascending order (Dubey et al., 2007). AMF is deposited in a lagoonal evaporatic environment whereas USF in a fluvial coastal margin.

ASF is an aggregate of cyclically stacked two lithologies ASF1 and ASF2 produced by sea-level rise and fall of a lower order mini-cycle. ASF1 is a thick, multistoried, pink to red, friable, medium to fine grained, cross-bedded sandstone deposited in a high energy environment. ASF2 is a thin, hard and maroon colored iron-rich mudstone (ironstones) deposited in a low energy environment. ASF1 has resulted during regressive phase of the mini-cycle when rate of sedimentation was extremely high due to abundant coarser clastic supply from land to the coastal area. On the other hand, ASF2 has resulted during transgressive phase of the mini-cycle which restricted the supply of the coarser clastic to the coastal area and deposited the muddy ferruginous sediments in low energy offshore part of the basin where sedimentation rate was very low. Apart from these two major lithologies, there are also few other minor lithologies like fine-grained white sandstone, carbonate (as bands), claystone and mudstone present in ASF.

ASF is a well developed lithostratigraphic unit of northern Ethiopia and represents the Jurassic transgressive clastic succession of Mekelle basin. The physical and biogenic sedimentary structures reported in this paper are observed from the terminal part of ASF. Their occurrence is unusual, rare, unknown so far and unreported. It includes (i) mud cracks (including their casts filled with overlying lithology) representing subaerial exposure which is unusual during transgressive phase, (ii) vertical traces of Skolithos burrows in ASF2 produced by suspension feeders in high energy environment of deposition (Dubey et al., 2007), (iii) tiny bivalve moulds and casts (external- and internal-moulds) of body fossils, and (iv) elliptical negative epirelief (potato shaped empty depressions - external moulds of eggs or nodules?). Fifty two such randomly oriented external moulds are noticed within 2 m2 area on an upper bedding plane of thin, white and fine- grained sandstone. Their in- fills are missing/removed as they are present on a gently dipping bed. Therefore, it is difficult to ascertain their biogenic (egg) or abiogenic (nodule) origin. Their detail investigation is under progress.

Since ASF developed during marine transgression, presence of mud cracks in its terminal part indicates subaerial exposure. This provides suitable sites for nesting eggs (reptile?) in wet sands. Removal of such preserved eggs can provide potato depressions. Though it is difficult to relate these moulds to the eggs because of the missing in-fills, their shape, size and restricted occurrence supports biogenic origin.

Reference

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