An Interdisciplinary Approach for Interpreting the Paleoenvironment of the Upanema Member, Alagamar Formation (Lower Cretaceous), Offshore Potiguar Basin, Brazil

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Abstract

To better understand the paleoenvironment of the Upper Aptian Upanema Member, Alagamar Formation (offshore Potiguar Basin), an interdisciplinary analysis of core samples from well 3-RNS-159-RN was performed. It involved interpreting facies associations, defining ichnofabrics, and inferring conditioning patterns, combined with petrographic and palynological data to characterize depositional environments and paleoclimatic aspects. Using ichnofacies and ichnofabric characterization methods, the trace fossils were categorized into nine groups. The Mermia and Scoyenia ichnofacies, specific to non-marine environments, were identified, as well as the Skolithos ichnofacies, which occur in marine, coastal, and non-marine settings. The results show deposition in channels and floodplains during high accommodation conditions and rapid aggradation, with initial hydromorphic paleosol development. The evidence for this hypothesis includes: (1) Basic characteristic of trace fossils: one of the basic principles of ichnology is that trace fossils represent the in-situ record of biogenic activity and do not undergo secondary displacement, consequently revealing an intimate relationship with the host substrate. These characteristics highlight the application of trace fossil studies for paleoecological and paleoenvironmental reconstructions, as emphasized by various authors. (2) Non-marine context: the recognition of the non-marine ichnofacies Scoyenia and Mermia characterizes a non-marine context for the cored interval from Upanema, as well as the sedimentological, paleoecological, and petrographic data. (3) Terrestrial context: subaerial exposure is evident in deposits showing the Scoyenia Ichnofacies, characterized by trace fossils with meniscate fill (Taenidium barretti and Scoyenia gracilis), produced by terrestrial insects. (4) Influence of pedogenetic processes: evidence includes organic fragments with cellular structures, root traces exhibiting siderite/ferroan dolomite and ankerite on the exterior, with the interior filled with fine-grained material or irregular voids, and nodules of pyrite and siderite. The characteristics of the root traces found indicate the presence of plants in waterlogged areas, i.e., poorly drained paleosols. Palynological data indicate the great dominance of spores from hygrophilous plants, such as spores of the genus Cicatricosisporites, as well as psilate and verrucate trilete spores, and notable percentages of perisporate spores (Crybelosporites spp. and Perotilites spp.) produced by hydrophilous plants. The interdisciplinary analysis provides evidence of deposits associated with channel fill, abandonment, crevasse splay and interdistributary bays within a deltaplain. These deposits suggest a poorly drained area, flat/smooth relief and hygrophilous and hydrophilous vegetation with prolonged periods of flooding and feature coniferous vegetation in the higher interior regions, as indicated by the prevalent presence of Araucariacites pollen, the most representative genus of the upland humid flora. The study conducted has significant implications

for understanding an exploratory frontier area and demonstrates the applicability of interdisciplinary analysis in the development of depositional models.