

Title of Thesis: EVOLUTION OF LATE CRETACEOUS KALLANKURICHCHI LIMESTONE FORMATION, ARIYALUR GROUP, CAUVERY BASIN, INDIA: A PHYSICO CHEMICAL INVENTORY

ABSTRACT

The present thesis delves into sedimentological context, both physical and chemical characteristics of Kallankurichchi Limestone Formation, Ariyalur Group, built up within the Pondicherry sub-basin of the Cauvery Basin, South India. The motivation of the study was lack of sedimentological insight of the Kallankurichchi Formation of the Ariyalur Group which has so far yielded huge number of publications on its paleontological aspects. Its objective is to enhance the sedimentological and stratigraphic comprehension, addressing issues of both local and global significance. A high-resolution state-of-art facies analysis, integrated with petrographic and geochemical investigation for the ~60 m thick Kallankurichchi Formation has been the mainstay of this research work. It is sandwiched between two siliciclastic formations namely Sillakuddi and Kallamedu Sandstone Formation respectively.

This limestone formation was initiated with the repetitive influx of the coarse clastic of mixed siliciclastic and carbonate composition, which is unique and rarely documented, specifies a resurgence of tectonic unrest in the Cauvery rift basin. The study meticulously delineates the depositional history of these basin-margin coarse clastics, characterized by clast-supported, angular, extremely poorly sorted conglomerate horizons deposited under the sea, accompanied by sporadic marine fossil occurrences. These conglomerates grades into mass flow conglomerates and eventually massive calc-arenite, collectively forming wedge-shaped basin-margin scree fans. It can be presumed that these flows were triggered by subsidence, which resulted from renewed gaps in the formation and led to the collapse of scree cones. Contemporaneous tectonic events, marked by abundant slide planes, suggested continuous sagging of the basin, causing oxygen-depleted bottom water conditions favored a rare green marine clay formation, namely berthierine (identified by the strong ~7 Å basal spacing), hosted in ~3.5 m thick dark grey limestone, associated with scree conglomerates. It is formed by the alteration of metastable framework grains e.g., palagonitized sideromelane glass, along grain boundary of quartz and feldspar cleavages, suggesting its authigenic origin. Eventually, this scree derivatives and its associated facies passes laterally into the carbonate formation basinwards.

The state of art facies analysis and sequence building pattern for the rest of the formation broadly divides it into two facies associations, viz., (1) Wave-dominated and (2) Tide-dominated. Started with a tide dominated succession above the scree derivatives, followed by the wave dominated facies association towards the top (likely to be a transgressive system tract/ TST) and dominated again by a shallowing upward succession where tides were the prevalent process for their formation (likely to be a highstand system

tract/ HST). Petrographic study shows that the lower tidal part is repleted by quartz flux, then quartz content diminishes which strongly suggests progressive shift of paleogeography from shoreward to basinward and again shallowing up indicated by high silicic input. The TST is topped by a 'thin muddy facies' demarcated the boundary between these two associations likely to be the maximum flooding surface (MFS). Detailed geochemical analysis supplements paleoenvironmental reconstruction, paleo-redox and salinity conditions across different facies associations. The Kallankurichchi Formation exhibits LREE and MREE enrichments in tide-dominated and wave-dominated parts respectively. The lowest REE content in the maximum flooding surface (MFS) aligns with its most distal paleogeography of deposition. Paleoredox data suggests anoxic conditions in the lower part, while the wave-dominated middle part indicates oxic conditions, supporting the proliferation of organisms. Paleosalinity increases with the deepening of facies, with the lower salinity index of the tidal facies association reasserting its comparatively shoreward position.

Additionally, the identification of shellbank horizons and their association with storm-dominated facies provides insights into localized depositional conditions. Four shellbank horizons have been identified within this fossiliferous limestone formation, predominantly consisting of Gryphaeidae bivalves *Pycnodonte* sp. In contrast to the shellbanks, the fossils present in other parts of the formation are fragmented in nature and haphazardly oriented, particularly those closely associated with the shellbanks, identified as storm-dominated facies. The shellbanks possibly deposited in some restricted conditions developed behind the large-scale bars. Paleoproductivity values are higher in the shellbanks compared to other facies. Calculating paleo-ocean temperatures for the reconstruction of paleoclimatic conditions, oxygen isotope analysis has been conducted within the successive growth laminae of rudist bivalve *Pycnodonte* sp. (low-Mg calcitic shell) collected from the shellbanks. The average paleotemperature, calculated from the $\delta^{18}\text{O}$ values, was around 24.8°C, supporting Late Cretaceous warming conditions.

The overall deposition apparently took place in a shallow marine to shelf-lagoonal condition. The tide amplitude accentuated in comparatively constricted parts while the wave dominated facies present relatively in open shelf part. The faunal distribution varies throughout the formation incorporates varieties of foraminifera, echinoids, brachiopoda, cephalopoda and bivalves (most dominantly *Gyphea* and *Inoceramus*). All the relevant datasets cumulatively unveil the paleoenvironmental record and enrich the sequence stratigraphic framework of the Formation through space.

The multipronged study of the Kallankurichchi Limestone Formation of Ariyalur Group reveals a colourful history of the then Cauvery basin, starting from renewed rifting to the deposition of the entire limestone and their sequence building with change in hydrodynamic conditions, sediment supply in a warm and humid climate.

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17.5.2024

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17.5.2024