

LITHOFACIES OF THE LOWSTAND FRINGING REEF FROM OFFSHORE MOZAMBIQUE

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KEY FINDINGS

- A 65 m core through the coral reef that grew during the Last Glacial Maximum (LGM) retrieves a highly diverse reef and microbialite facies.
- Five lithofacies were defined, differentiated by depositional texture, fabric, and diagnostic biotic components.
- A consistent pattern of corals debris encrusted by coralline algae and overgrown by microbialite is observed throughout the core.
- Numerous microbialite classes were identified, highlighting extensive microbial influence throughout the core.

BACKGROUND

The fringing reef system offshore northern Mozambique initiated growth during the Last Glacial Maximum (LGM), around 20,000 years ago, and persisted into the early deglacial period before becoming submerged due to post-glacial sea-level rise. Similar lowstand reef systems have been documented in select locations, such as offshore Tahiti and the Great Barrier Reef. However, the cores recovered from the Mozambique margin exhibit significantly higher recovery (86%) and superior preservation, offering an exceptional opportunity to study in situ reef development during a period of rapid environmental change.

Because the reef remained submerged below the influence of meteoric groundwater, it has undergone minimal freshwater diagenesis, preserving delicate sedimentary fabrics, framework components, and early marine cement phases. These well-preserved reef successions, recovered from depths approaching 94 meters below modern sea level, offer a unique sedimentological and diagenetic record of lowstand carbonate platform development. Below we describe the lithofacies of the 65-meter-long core and document lithofacies variability, microbialite diversity, and vertical changes in reef composition across the stages of reef development and subsequent drowning.

DATA SET AND METHODS

Core 103 (ES-103-BH) represents a 65-meter shallow fringing reef succession recovered offshore northern Mozambique as part of a ten-core regional suite. The core was cut, slabbed, and photographed, then examined on a flat surface. Lithologic descriptions were compiled from core slabs, thin sections, and bulk sediment samples to characterize lithofacies. Descriptions and photographs were synthesized across all core sheets, allowing the section to be subdivided into facies-bounded units. Five lithofacies were defined based on depositional texture, fabric, and biological components. Microbialite textures were classified using the mesoscale framework proposed by Braga et al. (2019), which defines five primary

categories: laminated, structureless, digitate, microbialite-coated debris, and intraskeletal/boring-filling microbialite.

LITHOFACIES

Lithofacies (Figure 1) are presented in the order they appear from top to bottom in the core, though their recurrence at multiple depths suggests a complex, cyclic history and a non-linear pattern of deposition and facies development.

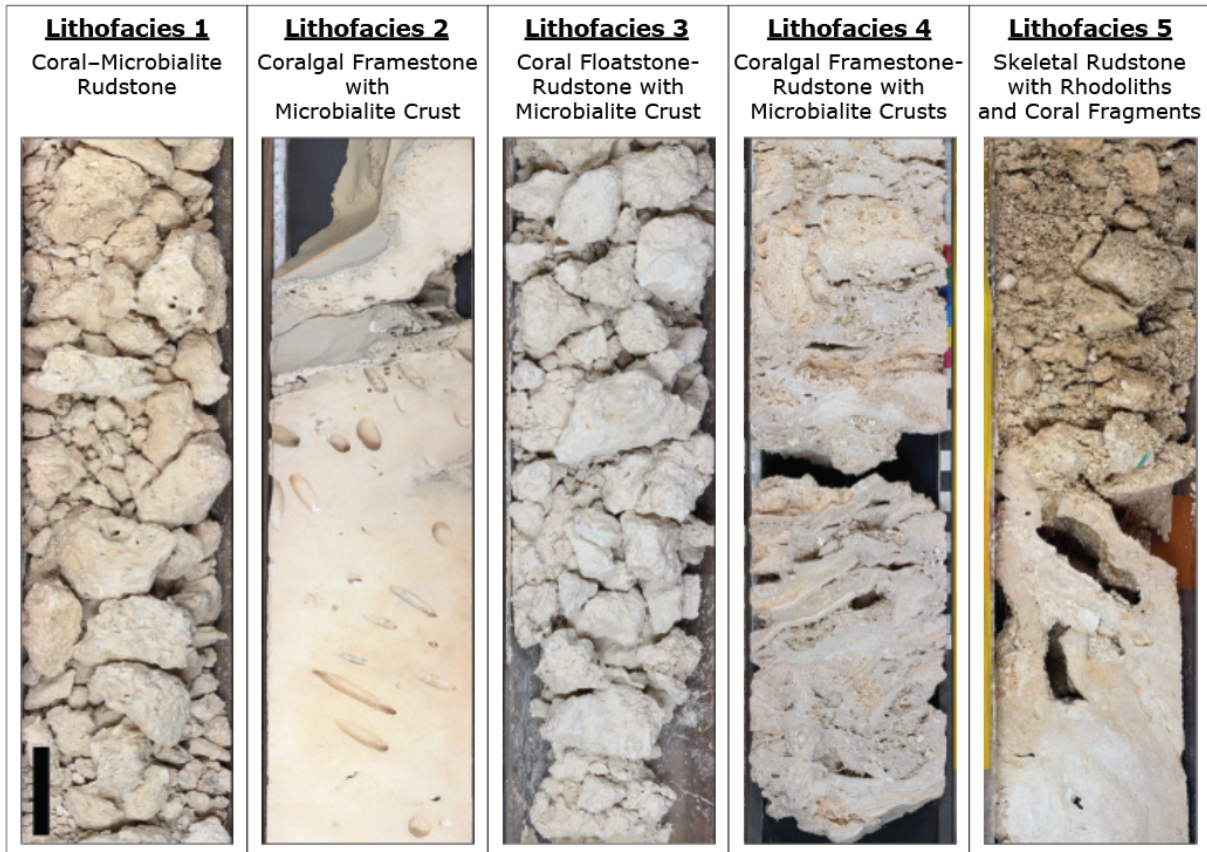


Fig.1 Representative core slab images of the five identified lithofacies (1–5) from Core 103 offshore Mozambique. Each lithofacies exhibits distinct textures, biotic components, and degrees of microbialite encrustation. Black scale bar = 5 cm.

Lithofacies 1 – Coral-Microbialite Rudstone

The uppermost lithofacies is characterized by a rudstone dominated by fragmented coral and microbialite clasts interspersed with finer, muddier sediment. Coral fragments are frequently encrusted with thin microbialite coatings, and microbialite clasts commonly exhibit a dense, structureless micrite. The finer-grained matrix is fossiliferous and includes diverse bioclasts such as serpulid worm tubes, *Halimeda* plates, bryozoans, and bivalves distributed throughout the interval.

The abundance of bioclasts and fine sediment, combined with the fragmented nature of coral and microbialite clasts, suggests this facies most likely accumulated in a back reef setting. This facies is also marked by numerous dark,

possibly phosphatic, surfaces and localized orange to reddish staining, which may reflect iron oxide precipitation. These features occur throughout the interval. While their exact origin remains uncertain, their frequent recurrence suggests repeated environmental fluctuations.

Lithofacies 2 – Coralgall Framestone with Microbialite Crust

This lithofacies is dominated by large, massive coral heads, one exceeding one meter in thickness, forming a rigid framework typical of a coralgall framestone (Tomchovska et al., 2022). The framework is consistently encrusted by successive layers of crustose coralline algae (CCA) and laminated microbialite, reflecting a characteristic encrusting succession (Figure 2). The laminated microbialite consists of thin micritic layers, generally less than 3 mm thick, that vary subtly in color and thickness. These laminae are typically arranged parallel to the underlying substrate. Also present in this interval is relatively rare digitate microbialite. Fossil assemblage includes corals, gastropods, Halimeda, Homotrema, serpulid tubes, and echinoid fragments. Lithophaga borings are



Fig.2 Core photograph showing a coralgall framestone encrusted by successive layers of crustose coralline algae (CCA) and laminated microbialite. The coral framework (blue arrow) is consistently coated by a characteristic encrusting succession: CCA (green arrow) overlain by microbialite (red arrow)

common within the massive coral heads. In core 25, the various components of this corallgal framestone facies are 53.6% coral, 14.1% microbialite crust, CCA 3.8%, and 28.5% skeletal rudstone and grainstone (Tomchovska et al., 2022). This facies is interpreted to represent the reef crest environment.

Lithofacies 3 – Coral Floatstone to Rudstone with Microbialite Encrustation

This lithofacies consists of an abundance of large coral fragments that are encrusted by both CCA and microbialite. Unlike the massive coral framework observed in Lithofacies 2, the corals in this interval are notably more fragmented, forming a floatstone to rudstone fabric.

Skeletal clasts in this facies are encrusted by micritic microbial coatings that correspond to the microbialite coated-debris fabric. These coatings exhibit fine micritic textures and contribute to lithification of the surrounding sediment. Some intervals also contain packages of skeletal rudstone that are partially or fully cemented by microbialite. The associated fossil assemblage includes gastropods, *Homotrema*, serpulid tubes, bivalve fragments, and echinoids. This facies represents a transitional setting between the reef front and reef crest environments.

Lithofacies 4 – Corallgal Framestone to Rudstone with Microbialite Crusts

This corallgal framestone with CCA and microbialite crusts is the most vertically extensive facies observed in the core. It resembles the corallgal framestone with microbialite crust (Lithofacies 2) but it differs in coral morphology and internal architecture. The interval is dominated by alternating layers of platy and branching corals, in contrast to the massive coral heads of Lithofacies 2. These corals form a complex interframe network with significant porosity and cavities, which are frequently infilled by skeletal rudstone to grainstone. While the abundance of CCA varies within the interval, it is consistently present and continues to play a critical role in the encrusting succession.

The fossil assemblage includes serpulids, *Halimeda*, gastropods, bivalves, echinoid spines and tests. The rudstone is variably encrusted by microbialite, which corresponds to the microbialite-coated debris classification. Layers of dense, micritic microbialite lacking internal structure are present within cavities and appears to aid in localized lithification. Iron-stained and blackened surfaces are intermittently distributed throughout the facies. This facies is interpreted as a reef front environment and exhibits a shallowing-upward trend expressed through the progressive vertical stacking of coral morphotypes, reflecting gradual shifts in depositional conditions.

Lithofacies 5 – Skeletal Rudstone with Rhodoliths and Coral Fragments

This facies partially cemented to uncemented skeletal rudstone with sparse, irregular coral fragments is predominantly observed near the base of the core. Rhodoliths are abundant throughout the interval and often appear as irregular nodules dispersed within the skeletal matrix. The fossil assemblage includes corals, rhodoliths, bivalves, serpulid tubes, *Halimeda*, echinoid spines, and gastropods. Isolated coral fragments occur intermittently, and a few localized framestone-like intervals are present near the base of the core. Rather than representing in-place reef growth, these accumulations may reflect coral debris

shed from the reef crest or upper slope and deposited downslope. This interpretation is consistent with a forereef setting, where transported coral fragments become embedded within skeletal rudstone, reflecting downslope sediment transport and localized depositional variability. Given its composition, textural fabric, and limited coral framework development, this facies is interpreted as a forereef deposit.

SIGNIFICANCE AND IMPLICATIONS

The preliminary observations from Core 103 reveal a diverse array of reefal lithofacies and microbialite types preserved within a 65-meter fringing reef succession offshore Mozambique. These findings capture early post-LGM reef development in a setting unaffected by meteoric diagenesis, providing a rare opportunity to study microbialite–coral interactions, reefal facies transitions, and sediment stabilization processes in pristine conditions. While interpretations remain early and largely observational, the variability in facies, encrustation styles, and fossil content suggests a complex and dynamic reef history. These initial results offer a foundation for future high-resolution work aimed at constraining reef growth patterns and microbialite genesis during deglacial sea-level rise.

REFERENCES

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