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QUATERNARY MICROBIALITE FACIES OF EASTERN CAPE OF SOUTH AFRICA

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Background and Rationale

In the last 20 years, since their first description by Smith and Uken (2003), tufa microbialites and associated deposits, accreting in the supratidal rock coast environment and associated with carbonate-bearing groundwater springs, have been increasingly recognised globally (Cooper et al., 2022, 2013; Forbes et al., 2010; Perissinotto et al., 2014; Rishworth et al., 2020b; Smith et al., 2011). While modern accreting and inactive systems are being studied, their relevance as Quaternary palaeo-shoreline indicators requires investigation (Garner et al., 2024; Rishworth et al., 2020a). Following the discovery and recognition of such deposits defining a MIS 11 shoreline during the EPStromNet (Underwood et al., n.d.) Western Australia field campaign (Garner et al., 2024), further pre-Holocene deposits are sought.

The QRA New Researchers Award was used for field visits to map and sample living, Holocene and potentially Pleistocene, spring-fed peritidal tufa microbialites in the Eastern Cape of South Africa in October 2023, collaborating with researchers at Nelson Mandela University and University of KwaZulu-Natal. Fieldwork involved:

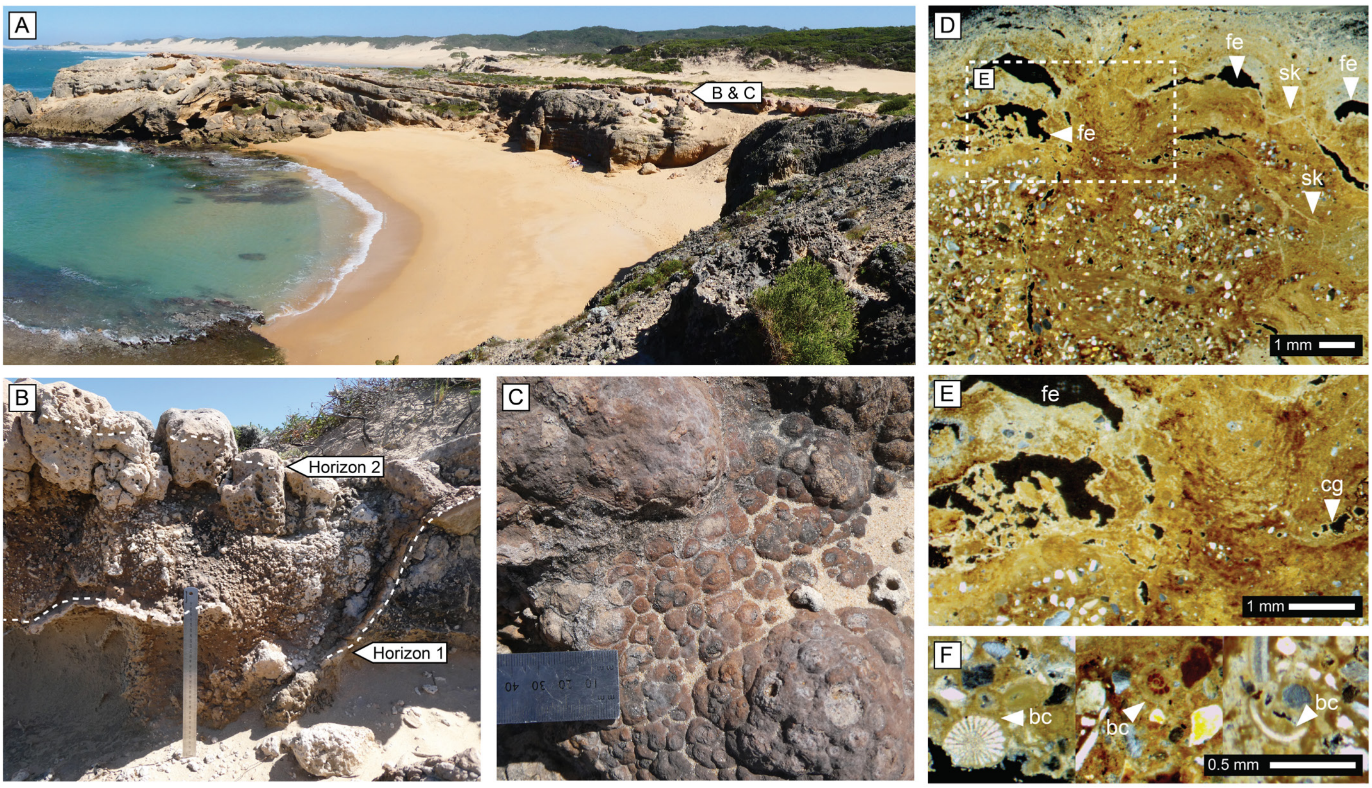

Figure 1. Laminar calcrete microbialite facies at Shelly Bay, Kenton-on-Sea. A: View of Shelly Bay looking SW; B: Profile of two horizons of laminar calcrete C: plan view of colloform surface topography; D-F: thin section of columnar-stacked hemispheroid mesostructure: E: development on calcarenite with fenestral (fe) and shrinkage (sk) porosity; F: inset detail of pores with circumgranular cements (cg) and intercolumn laminae; G: marine bioclasts (bc) within basal calcarenite (echinoid spine, formanifera test, and shell fragment).

Part I: the investigation of a potential Quaternary occurrence that had been reported (Smith and Anderson; pers. comm.) at Shelly Bay, Kenton-on-Sea.

Part II: the study of living and Holocene spring-fed peritidal microbialite system facies at St Francis Bay, east of Gqeberha (Port Elizabeth), South Africa, focused on facies description and preservation potential.

Part I: Shelly Bay, Kenton-on-Sea

Results

This site (Fig. 1A) is located in an aeolian calcarenite outcrop (Fig. 1F), with subfossil terrestrial gastropods (cf. *Achatina*) and calcretised rhizoliths. The reported microbialite deposit was investigated and found to consist of multiple horizons of laminar calcrete (Fig. 1B), occurring as laterally continuous, indurated sheets, visible in section, associated with undulatory karstified surfaces. Mesostructure is variable, comprising flat-laminar sheets with a planar surface topography to columnar-stacked hemispheroids with a colloform topography. Hemispheroids contain large fenestral cavities and shrinkage cracks with circumgranular and gravitational cements (Fig. 1D, E).

Interpretation and discussion

The potential microbialite facies at Shelly Bay, Kenton-on-Sea did not form in the same environment as contemporary rock coast spring-fed microbialites and is, instead, of vadose origin developing on palaeo-karst surfaces and cavities of the basal calcarenite. The discrimination of terrestrial stromatolites and laminar calcretes is problematic and multiple attempts have been made to identify distinguishing criteria (e.g., Read, 1976; Wright, 1989). Laminar calcretes vary from abiogenic to fully biogenic (Wright, 1989; Wright and Tucker, 1991), termed terrestrial and subaerial stromatolites (Riding, 2000)). Comparable facies have been reported from the mid-Late Pleistocene and Holocene of Australia, notably the Bridgewater and Tamala Limestone Formations as karstic cavities and solution pipe rims within aeolianites (Lipar et al., 2017, 2015). These comparable 'microbialites' are interpreted as being formed within karst voids through microbial vadose (subaerial) cementation in glacial conditions following aeolianite dissolution and karstification during interglacial-glacial transitions (Lipar et al., 2017).

Unlike rock coast tufa microbialites, this facies does not appear to have any reliable relationship with sea-level, with multiple profile development, due to prograding dune development (Read, 1976). This

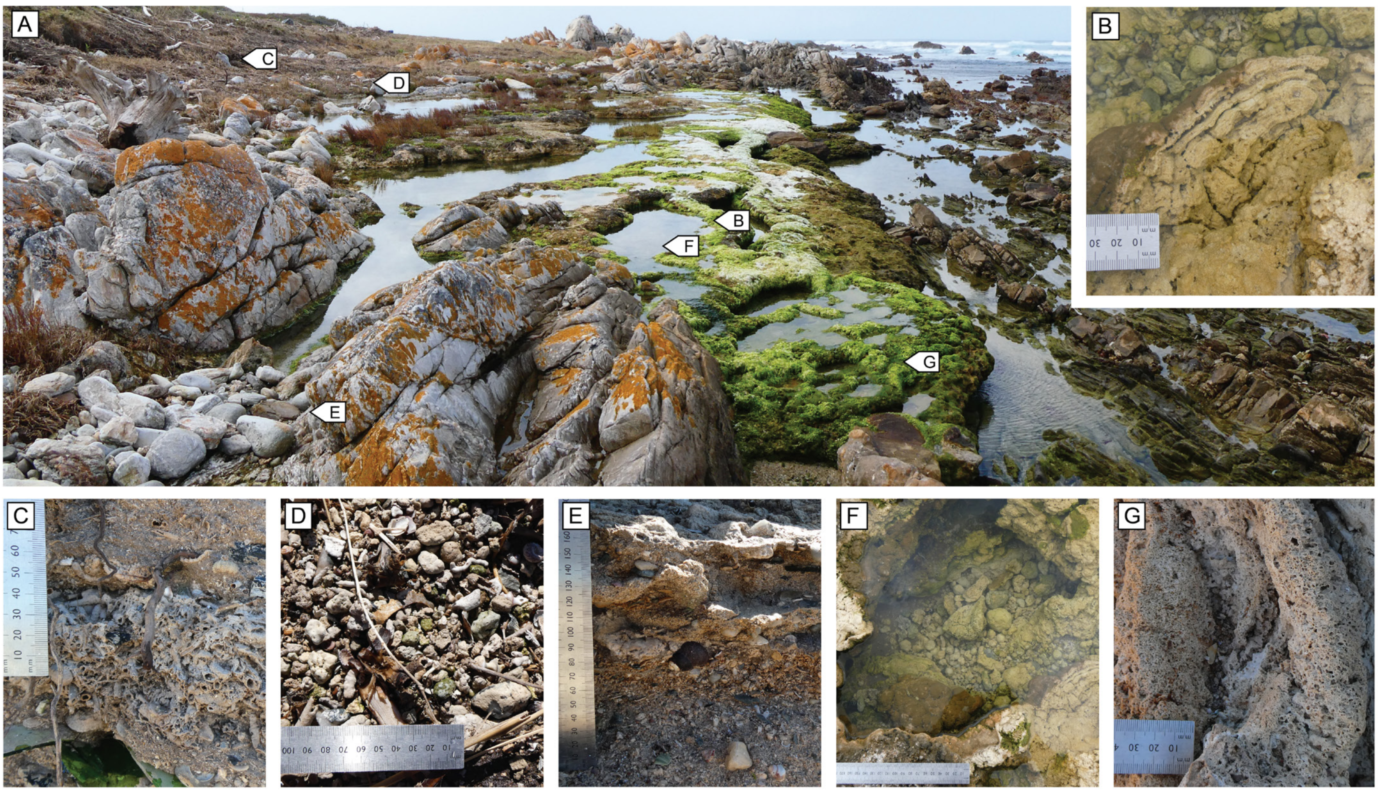

Figure 2. Figure 2. Tufa microbialite and associated marginal marine carbonate facies: A: example of tufa microbialite bearing groundwater-spring at Lauries Bay with inset B: stromatolite facies (in section); C: rhizoliths or root casts at the back of the beach; B: *Phragmites*-associated oncoids; E: beachrock; F: barrage-pool-associated oncoids; G: thrombolite (cm metal ruler for scale).

is also noted elsewhere, occurring at all elevations within the Tamala Limestone of Australia (Lipar et al., 2017).

Part II: St Francis Bay

Results

A large number of microbialite-bearing groundwater spring systems were observed, focused around four main areas in St Francis Bay (Fig. 2A). Stromatolite and thrombolite microbialite facies were common (Fig. 2B, G) forming a variety of macro-structures/ morphologies, commonly barrage, as well as lacustrine crusts and cascades. Within some barrage pools, oncoids were also noted (Fig. 2F). While much attention has been given to microbialite facies in coastal groundwater springs, a variety of other terrestrial carbonate facies were also present. Rhizoliths were present proximal to the spring discharge point, within paludal deposits (Fig. 2C); oncoidal tufas were present within *Phragmites australis* beds (Fig. 2D). Distal to the discharge point was cemented 'beachrock', that formed where the groundwater flowed through unconsolidated beach sands and gravels (Fig. 2E).

Interpretation and discussion

The contemporary microbialites of St Francis Bay and the Eastern Cape are some of the most extensive and best developed microbialite systems globally. A variety of microbialite and associated marginal marine to terrestrial carbonate facies were present, comparable to those described in other global localities and those by Edwards et al., (2017). A spring high tide and high ocean swell event resulting in an 8 m storm surge 2 weeks prior to fieldwork lead to the discovery of previously undescribed *Phragmites*-associated oncoids in the backing beach and barrage pool-associated oncoids due to damage to the coastal vegetation and microbialite systems. This also provided some insight into long-term preservation potential.

Conclusions

In conclusion, while the laminar calcrete facies described from Shelly Bay, Kenton-on-Sea were formed in an environment that lies outside the wider PhD project focus, it is still worthy of further future study, especially given their relevance to Quaternary climate and environmental reconstruction as demonstrated by other global sites (Lipar et al., 2017, 2015; Lipar and Webb, 2014). Fieldwork producing description and sampling of living and Holocene spring-fed supratidal microbialites will facilitate greater global comparison, allow for greater understanding of their preservation potential and delimitation with associated facies in future research.

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