MICROBIAL MEDIATION ON EARLY CEMENTATION PROCESSES

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PROJECT OBJECTIVES

- To elucidate whether initial stabilization and cementation of carbonate grains are mediated by microbial interactions of indigenous microbial communities.
- To study whether EPS exudates play an imminent role in the early stages of sediment stabilization and cementation by cohering sediment particles and providing a template for nucleation to occur.
- To identify textural forms and mineral microstructure composition of early marine cementation areas using petrographic thin-sections, SEM-EDS and X-Ray diffraction analyses.

PROJECT RATIONALE

A growing number of studies suggest that cementation is not a strictly inorganic process as microbial binding in micritic bridging and fringing cements have strengthened the notion regarding the involvement of microbes in initial cementation and stabilization of sediments (Dravis, 1979; Hillgärtner et al., 2001). These observations are further supported by our preliminary experiments that use in-vitro incubations of ooids in the presence and absence of indigenous microbial populations (Fig. 1). Based on the growing evidence supporting the biological mediation theory, this study aims to evaluate whether first cements in marine ooid grains are largely the result of microbial binding and/or microbially induced precipitation.

APPROACH

To assess the impact of microbial precipitation in early cementation processes experiments will be undertaken using incubation chambers containing freshly collected ooids from an area of active ooid formation on Schooners Cay (Bahamas). Two cohorts of treated and untreated groups of ooids will be incubated under conditions of no agitation to emulate the quiescent conditions of the flank areas of the shoals. The untreated group represents ooids with their indigenous microbial communities while the treated group comprises sterilized ooids devoid of any microbial influence. The detection of indigenous microbial communities and formation of early precipitates on inter/intragranular contact areas will be monitored at various time intervals (ranging from 0 to 6 months) using SEM and stereo-microscopy. SEM image analysis will reveal the presence and potential involvement of biofilm extracellular polymeric substances (EPS) in carbonate precipitation at grain-to-grain contacts and non-contact areas of the grains. Given that EPS matrix can act as a template for carbonate mineralization via the formation of amorphous calcium carbonate (ACC), we will explore whether ACC nanograins can intervene in the initial process of cementation of ooids. ACC will be detected with morphological attributes based on the SEM image analysis.

Textural forms and mineral microstructure compositions of early marine cements will be analyzed using petrographic thin-sections, SEM-EDS and X-Ray diffraction analyses.

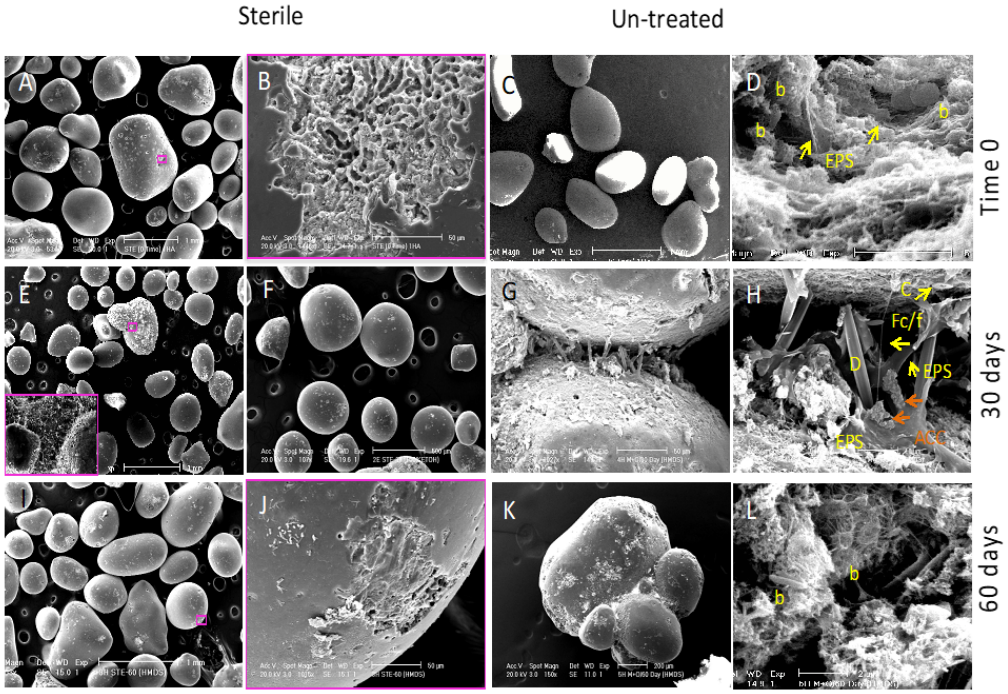

Figure 1. Incubation Experiments. A) Sterilized ooids from Schooner Cay denoting an admixture of polished and bored ooids at time=0; B) Higher magnification image of panel A showing micritization at the periphery of the ooid cortex; C) Well-sorted and polished ooids at time=0, (untreated samples); D) Indigenous bacterial (b) flora and organic mucilage (EPS) in a shallow depression of an ooid cortex at time = 0; E-F) Sterilized ooids after 30 days' incubation. Note the unconsolidated nature of the grains. Inset is a heavily micritisized grain at contact area. G) Microbial lodging and EPS at grain contact area of two un-treated ooids after 30 days' incubation; H) Magnification of panel G depicting adjacent grains being colonized by EPS, diatoms (d), coccolithophore (C), filamentous cyanobacteria/fungi (Fc/f) and ACC; I) Sterilized ooids after 60 days' incubation. Ooids are loosely packed; J) Magnification of panel I showing erosion of the outer cortex and microborings; K) A firm aggregate of grains after 60 days' incubation; L) bacterial colonization in intergranular areas after 60 days.

KEY DELIVERABLES

High-resolution images using SEM will provide insights on the processes that lead to cementation of carbonate grains and biogenicity origins of the precipitated material and preferential location within the rock framework.

REFERENCES

Dravis, J., 1979, Rapid and widespread generation of recent oolitic hardgrounds on a high energy Bahamian platform, Eleuthera Bank, Bahamas: Journal of Sedimentary Petrology 49, 195-207.

Hillgärtner, H., Dupraz, C., Wolfgang, H., 2001, Microbially induced cementation of carbonate sands: are micritic meniscus cements good indicators of vadose diagenesis?: Sedimentology 48, 117-131.