PELOIDS AS MICROBIAL CARRIERS FOR ORGANOMINERALIZATION IN OOIDS

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PROJECT OBJECTIVES

- To test the hypothesis that peloids, which form the majority of nuclei in ooids, carry the microbial communities for organomineralization in ooids.
- To compare the organic and mineral composition within peloidal nuclei of ooids and fecal pellets by integrating RAMAN spectroscopy for the characterization of biomolecules (e.g. lipids and carbohydrates) and SEM/EDX for the mineral phases.

PROJECT RATIONALE

Ooids are very important non-skeletal carbonate grains whose accumulations produce prolific and large carbonate reservoirs. Recent studies have shown that they form via organomineralization from a highly diverse microbial community that inhabits the ooids (Diaz et al., 2017). The origin of the microbial community is unknown. Nobody has documented such a large species diversity in sea water as is observed in ooids and thus seawater can be excluded as the source. It is more likely that the nucleus of the ooid is the carrier of microbes. In the modern ooid shoals of the Bahamas, the nuclei of the ooids are predominantly peloids (Diaz et al., 2022). SEM images of peloids from Great Bahama Bank document abundant decaying EPS (Extracellular Polymeric Substances) lined with nanograins, in a similar manner to that observed in the accreting cortices of ooids, where nanograins have been identified as ACC (amorphous calcium carbonates), the precursor to aragonite needles (Diaz et al., 2017). Likewise, nanograin clusters in peloids are also likely of biological origin. Together, these observations indicate that fecal pellets harbor a

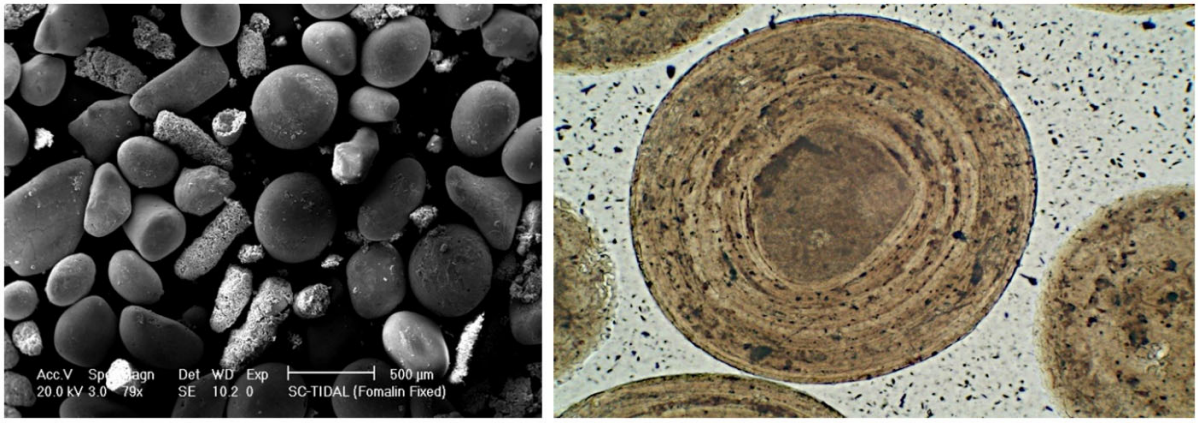

Figure 1: Left; SEM image of soft fecal pellets and hardened peloids. Right; Photomicrograph of an ooid with a peloidal nucleus and aragonitic cortices. SEM images display similar microbially induced precipitation in peloids as are observed in ooids, indicating that the microbes responsible for organomineralization in ooids are carried by the fecal pellets.

microbial community that is likely introduced into the fecal pellet via the digestive system of the burrowing shrimp. This microbial community transfer from organisms to ooids has been documented in ooids in the Great Salt Lake (Paradis, 2019). This project aims to test this potential microbial transfer in the marine environment by analyzing both fecal pellets and ooids with regards to their microbial composition and mineral phases.

APPROACH AND METHODOLOGY

We will collect samples of mud, newly formed fecal pellets, hardened peloids and ooids from the same area with an established protocol that preserves the indigenous microbial communities in each sample set.

To establish the source of peloidal nuclei and the role of fecal pellets as seeds for the first nucleation step in ooid formation, microbial and biogeochemical analyses will be undertaken. These analyses will elucidate any commonalities among fecal pellets and ooids. Any relatedness in genetic-make up or microbial composition will be assessed through sequencing of 16S rRNA, the gene that encodes the rRNA component of the smaller subunit of the bacterial ribosome. In addition, we will integrate petrographic analysis, RAMAN spectroscopy–a powerful tool for the characterization of biomolecules (e.g. lipids and carbohydrates) – and SEM/EDX analyses to characterize the organic and mineral phase composition within peloidal nuclei of ooids and mud fecal pellets.

In order to gain further insights into the nucleation process that leads to the initiation and hardening of fecal pellets, we will use SEM and elemental mapping analysis via wavelength-dispersive x-ray spectroscopy - coupled with an electron microprobe. This analysis will enable us to understand early diagenetic precipitation of minerals and whether initial crystallization on unhardened and hardened fecal pellets occurs through a pre-nucleation cluster pathway involving a metastable mineral phase.

Characterization of the sedimentary grains will be done on epoxy-impregnated thin sections. Snapshots of up to five different random areas – per thin section – will be taken with an Olympus BH2 petrographic camera. The grains, and the composition of ooid nuclei, will be quantified and classified (ie. ooid, peloids, skeletal grains) using Image J. Plugin/ Manual Counting.

SIGNIFICANCE

This project addresses a fundamental question regarding the source and transfer of microbial communities in the carbonate system to determine those responsible for organomineralization in carbonates. Here the pathway of the microbial vector for the formation of ooids is explored.

REFERENCES

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