GEOMICROBIOLOGY OF HOLOCENE FRESHWATER MICROBIAL MUD IN THE FLORIDA EVERGLADES

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PROJECT OBJECTIVES

- Link depositional and diagenetic signatures to microbial communities and metabolic processes (sulfate reduction, denitrification, etc.) using high throughput DNA sequencing of *in-situ* sediment samples.
- Characterize the textural evolution of modern and recently buried freshwater carbonate mud in south Florida.
- Evaluate the primary depositional signature and early diagenetic changes using geochemical analyses of sediments, organics, and pore waters.

PROJECT RATIONALE

As microbial processes can affect both the precipitation and dissolution of carbonate grains, their importance in diverse depositional settings is increasingly recognized. The Florida Everglades is a site of fine-grained carbonate production via microbial processes within a palustrine setting. However, while microbial communities have been shown to play a role in carbonate precipitation, their effect on early diagenetic alteration of the resultant calcitic mud is poorly known and largely undocumented. The objective of this project is to better characterize the secondary processes occurring in various early burial environments in order to evaluate the preservation potential of original geochemical and textural signatures in palustrine carbonates.

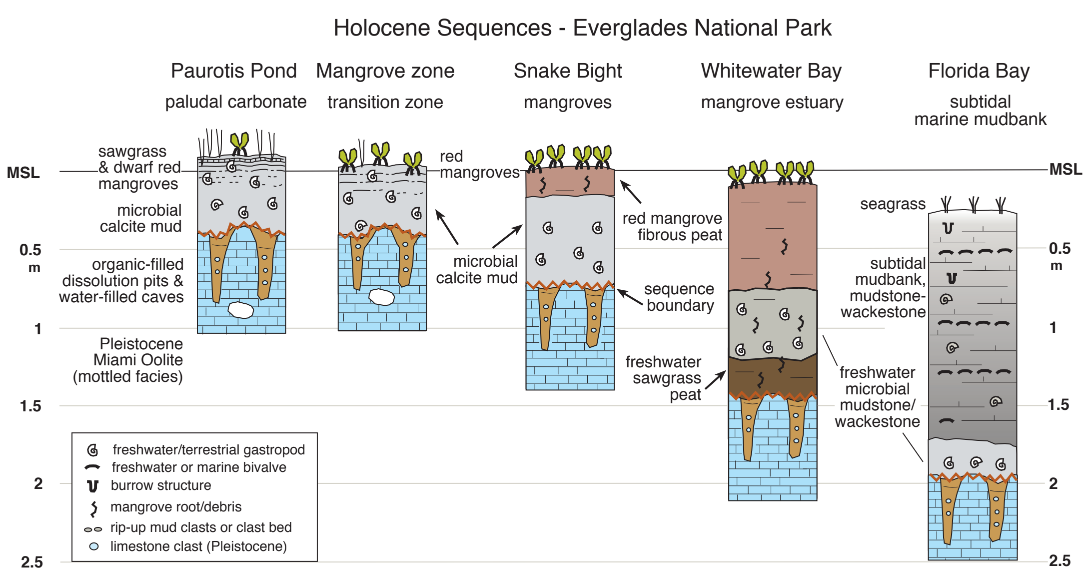

Figure 1. Schematic transect of variations in early burial of Holocene freshwater muds; freshwater (Paurotis Pond) to marine (Florida Bay) transition.

In south Florida, Holocene freshwater microbial mud is found overlying Pleistocene limestone bedrock from inland sites (currently forming), seaward to Florida Bay (Fig. 1) where it is buried by marine sediment. Progressively buried during the marine transgression, the carbonate mud is now subjected to various pore fluid regimes: freshwater, brackish, and full marine along the transect. The inland sites host active microbial carbonate formation. The brackish zone has formed as microbial deposits were buried during the Holocene transgression. Overlying brackish deposits include organic-rich sediments and surface seasonal salinity changes. At Florida Bay, freshwater muds were identified beneath both the coastal levee and mangrove-capped islands in the Bay. Analyzing the muds and pore waters in these various environments will help assess the impact of microbial metabolisms and changes in pore water chemistry on carbonate crystals during the early burial process. These diagenetic environments can be assessed for changes to organic matter composition, carbonate texture, and geochemical signatures.

SCOPE OF WORK

Textures— In order to best identify changes in textures during the burial process, we will analyze sediment from six different burial environments including the modern freshwater zone, the brackish transition zone, and the fully marine environment. Grain-size analyses along with scanning electron microscopy will be used to assess textural changes to the carbonate mud.

Geochemistry— Analyses will be run on sediments, organics, as well as interstitial pore water in order to best characterize the primary and diagenetic signals of the Holocene mud deposits. Analyses will include mineralogy, inorganic $\delta^{13}C$ and $\delta^{18}O$, total organic carbon (TOC), organic $\delta^{13}C$ and $\delta^{15}N$, trace element composition using standard ICP-OES methods, alkalinity, and dissolved inorganic carbon (DIC).

Geobiology— We will analyze the microbial communities and their effect on carbonate diagenesis across varying surface sediments and in core profiles of the Holocene deposits. Microbial communities will be documented across the laterally heterogeneous environments. Genomic DNA will be extracted and sequenced using Metagenomic Illumina techniques to characterize total DNA in each sample, providing information on both the community structure, as well as the microbial metabolisms (i.e. photosynthesis, sulfate reduction, denitrification) occurring within the sediment.

SIGNIFICANCE

The integrative nature of this project will allow linkage of textural and geochemical signatures to depositional and diagenetic processes. This will change our understanding of how freshwater microbial muds are deposited and altered over time, and with respect to burial environment. This will help evaluate the preservation potential of primary depositional markers, and allow for more accurate interpretation of the depositional setting in which freshwater palustrine carbonates have formed.