Click to view poster. (20 MB)

PSThe Onset of Biogenic Calcium Carbonate Precipitation in Hypersaline Microbial Mats (Eleuthera, Bahamas)*

Christina B. Glunk[1], Christophe Dupraz[2], Olivier Braissant[2], Eric P. Verrecchia[1], and Pieter T. Visscher[2]

Search and Discovery Article #50225 (2009)
Posted November 20, 2009

*Adapted from poster presentation at AAPG Annual Convention, June 7-10, 2009

[1]Institute of Geology and Paleontology, University of Lausanne, Lausanne-Dorigny, Switzerland (christina.glunk@unil.ch)
[2]Center for Integrative Geosciences, University of Connecticut, Storrs, CT.

Abstract

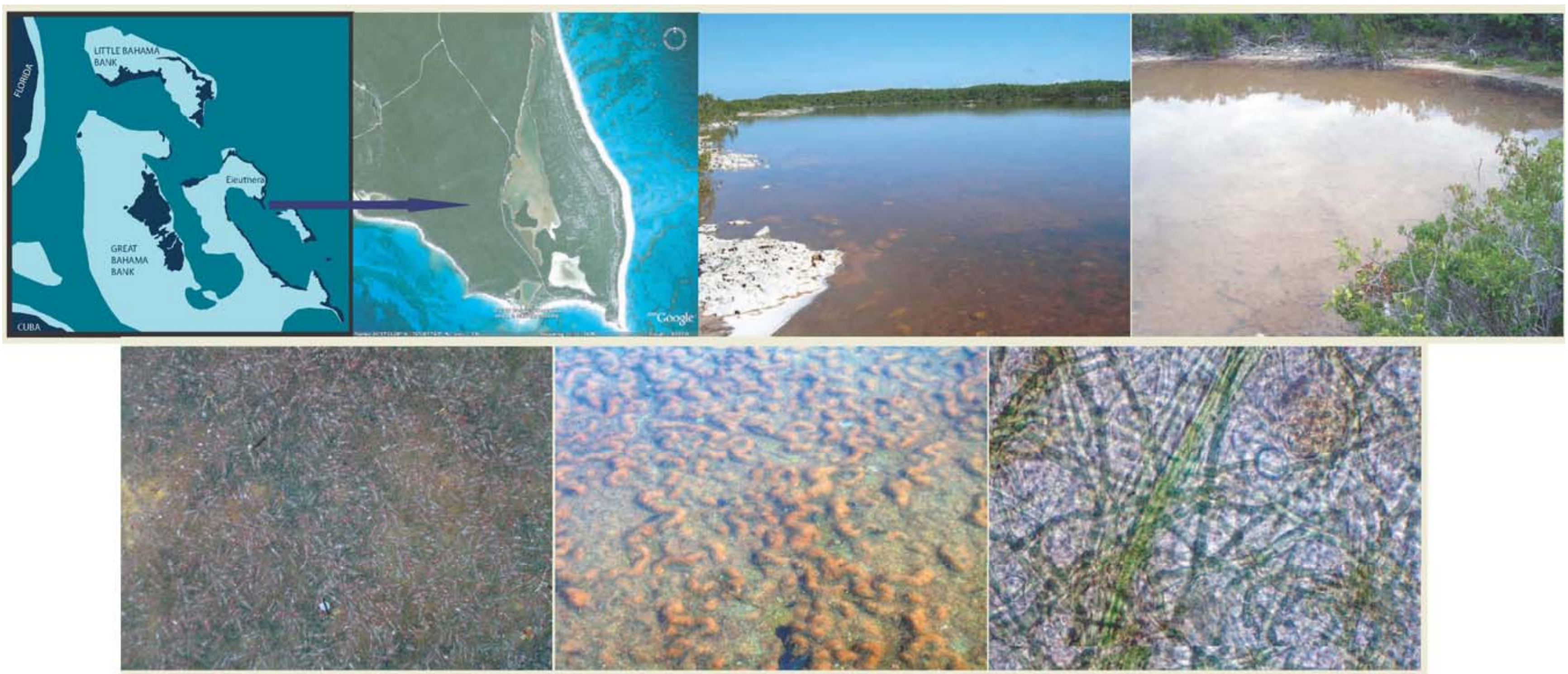
The global carbon cycle is driven by redox processes at the lithosphere-biosphere interface. Microbial mats are key players of this element cycling. They are characterized by high turnover rates of biomass and influence the surrounding physicochemical microenvironment by their metabolic activities. Hence they can favor carbonate precipitation. However, precipitation within microbial mats can also be due to physicochemical carbonate oversaturation of the macroenvironment. The study of mechanisms of calcium carbonate precipitation in modern microbial ecosystems can provide valuable information for the interpretation of the rock record. Still today, processes leading to microbial carbonate formation, as well as the incorporation of key cations (e.g., Mg) in the crystal structure are not fully understood at the molecular level.

Big Pond, a hypersaline lake situated on Eleuthera Island (Bahamas), harbors a microbial mat, precipitating large amounts of $CaCO_3$. The $CaCO_3$ minerals form well defined layers, which are preserved in the sediment record.

Single-layer investigations, using X-ray diffraction, thin sections, isotopic signature ($\delta^{13}C$, $\delta^{18}O$) and electron microscopy reveal that the precipitated minerals are a calcite-dolomite solid solution and show different macro- and micromorphologies. Mineralogical and microbiological investigations were complemented with physicochemical characterization of the environment.

Big Pond is a system that is highly oversaturated with respect to carbonates. However, carbonate precipitation is strongly inhibited by inorganic molecules and EPS functional groups, chelating cations like Ca^{2+} and Mg^{2+}. Although carbonate deposition in evaporitic systems is often reduced to evaporation/dilution events, hypersaline Big Pond represents a more complex biologically induced or

biologically influenced precipitation scenario. Our data suggest that degradation of EPS by heterotrophic microbial activity (e.g., sulfate reducers) may reduce inhibition, resulting in subsequent calcification of the EPS matrix. These data, as well as abiotic mineralization experiments, suggest a strong control of EPS functional groups (e.g., -COOH, - SH -OH, $-NH_2$) on the mineralogy and the morphology of biogenic carbonate minerals. We believe that these functional groups catalyze the incorporation of Mg into carbonates, a process that is otherwise kinetically inhibited under Earth-surface physicochemical conditions (i.e., the so-called 'dolomite problem').



Microbial mats, Eleuthera, Bahamas—from location to microscopic view.

Reference

Braissant, O., A.W. Decho, C. Dupraz, C. Glunk, K.M. Przekop, and P.T. Visscher, 2007, Exopolymeric substances of sulfate-reducing bacteria: Interactions with calcium at alkaline pH and implication for formation of carbonate minerals. Geobiology, v. 5, p. 401-411.