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Formation of lithified micritic laminae in modern marine stromatolites (Bahamas): The role of sulfur cycling

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ABSTRACT

Microbial mats on the surfaces of modern, marine stromatolites at Highborne Cay, Bahamas, were investigated to assess the role of microbial processes in stromatolite formation. The Highborne Cay stromatolitic mats contain *Schizothix* as the dominant cyanobacterium and show millimeter-scale lamination: Some layers in the mat are soft (unlithified), whereas other layers are crusty (lithified). Lithified layers within the mats correspond to micritic horizons composed of thin (20–50 μm) micritic crusts, which commonly overlie truncated, micritized carbonate sand grains. These features are identical to lithified laminae in the underlying stromatolite; the micritic crusts are similar in thickness to micritic laminae in many ancient stromatolites. Biogeochemical parameters in a representative stromatolitic mat from Highborne Cay were measured to identify the role of bacteria in precipitation and dissolution of $CaCO_3$. Depth distributions of O_2, HS^-, and pH were determined with microelectrode measurements in the field. Oxygen profiles were used to calculate photosynthesis and aerobic respiration. Sulfate reduction was determined using $^{35}SO_4^{2-}$ and sulfide oxidation potential was measured in homogenized samples. Our results indicate that cyanobacterial photosynthesis, sulfate reduction, and anaerobic sulfide oxidation in stromatolitic mats at Highborne Cay are responsible for $CaCO_3$ precipitation, whereas aerobic respiration and aerobic sulfide oxidation cause $CaCO_3$ dissolution. A close coupling of photosynthesis and aerobic respiration in the uppermost few millimeters of the mats results in no, or very little, net lithification. Sulfur cycling, on the other hand, shows a close correlation with the formation of lithified micritic layers. Photosynthesis, combined with sulfate reduction and sulfide oxidation results in net lithification. Sulfate reduction rates are high in the uppermost lithified layer and, on a diel basis, consume 33–38% of the CO_2 fixed by the cyanobacteria. In addition, this lithified layer contains a significant population of sulfide-oxidizing bacteria and shows a high sulfide oxidation potential. These findings argue that photosynthesis coupled to sulfate reduction and sulfide oxidation is more important than photosynthesis coupled to aerobic respiration in the formation of lithified micritic laminae in Highborne Cay stromatolites.