Microbial beachrock formation: Implications for island stability in the Great Barrier Reef

JENINE MCCUTCHEON*[1] LUKE NOTHDURFT[2], GREGORY E. WEBB[1], JEREMIAH SHUSTER[1], LINDA NOTHDURFT[1,2], DAVID PATERSON[3], AND GORDON SOUTHAM[1]

[1] School of Earth Sciences, The University of Queensland, St Lucia, QLD 4072, Australia
[2] Earth, Environmental and Biological Sciences School, Queensland University of Technology, Brisbane, QLD 4000, Australia
[3] Australian Synchrotron, Clayton, Melbourne, VIC 3168, Australia

Beachrock forms through carbonate cementation of sediments in the intertidal zone of low-latitude beach environments. These lithified units play a key role in stabilizing sand cays in reef environments, and may become increasingly important to the existence of these islands as sea level rises. Although beachrock formation is influenced by many chemical and biological factors, the primary cause of this contemporary geological process has not been identified. In this study, the role of microorganisms in beachrock cement precipitation was investigated by synthesizing new beachrock using samples of beach sand, beachrock and associated microbial communities from Heron Island, Great Barrier Reef, Australia. Cements in natural and synthesized beachrock were characterized using synchrotron-based, X-ray fluorescence microscopy (XFM). The results of this study suggest that microbial recycling of ions within beach sediments plays an important role in cement precipitation. Dissolution of sand grains via boring by endolithic cyanobacteria generates high concentrations of soluble calcium and other cations. Cation enrichment combined with the highly alkaline microenvironments generated through cyanobacterial photosynthesis results in supersaturation conditions with respect to carbonate minerals. The microbial community also aids cement formation through the generation of extracellular polymeric substances that provide nucleation sites for carbonate mineral precipitation. Examination of this microbe-mineral interaction using high-resolution microscopy has allowed for the characterization of previously undetected features of beachrock cements. Understanding, and potentially accelerating, the processes responsible for early marine diagenesis and cementation may become vital to reef island stability and preservation in the near future.