From Western Australia to the Atacama Desert: Lessons about the past from Modern Microbialites

Erica P. Suosaari[1,2*], Ioan Lascu[1], R. Pamela Reid[2], Amanda Oehlert[2], Brooke Vitek[2], Paola Parlanti[3]

[1]Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, DC, 20560, USA
[2]Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida 33149, USA
[3]Istituto Italiano di Tecnologia, Center for Materials Interfaces, Electron Crystallography, 56025, Pontedera (PI), Italy

Microbialites are structures formed by a combination of sedimentation and biological processes through sediment trapping and binding and/or mineral precipitating activities of microorganisms (Burne and Moore 1987). As living representatives of Earths earliest ecosystems, modern microbialites and the minerals produced within microbial mats represent remarkable archives of biologic activity and physicochemical conditions through time, thereby providing a window to the past. In order to use these modern structures as analogs for ancient deposits, we need to be able to interpret the relative influence of microbial processes, physicochemical pressures, and diagenetic processes on microbialite formation from macro- to nano- scales. Recent research in Hamelin Pool, a hypersaline embayment in the Shark Bay area of Western Australia, which hosts the world's most extensive accumulation of living marine microbialites, and in the Puquios of the Salar de Llamara, small lakes that are the surficial expression of the local water table in the Atacama Desert, Northern Chile, have advanced our understanding of the precipitation of carbonate minerals and the construction of microbialites. Although the Shark Bay and Atacama environments are vastly different, microbes in both locales are intimately involved in carbonate mineral formation. Using traditional petrographic and "wet" thin sections, as well as advanced high resolution imaging techniques, such as scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDS) and focused-ion beam (FIB) SEM tomography, we are able to document minerals in context with microbes at nano- and micro-scales. These investigations of microbe-mineral interactions provide insight into the formation of microbialite structures throughout geological time. Results allow us to speculate on why some microbial mats precipitate minerals without building structures, while at other times, mineral precipitation results in the formation of microbialite buildups. These findings have important implications for recognizing microbial deposits in the rock record.