Arsenic and Sulfur Cycling in Mircobialites of La Brava, Atacama: Analog-extraordinaire for Precambrian Biogeochemistry?

VISSCHER, P.T.[1*]; PHILIPPOT, P.[2] ***SANCHO-TOMÁS, M.***[2,3]***; SOMOGYI, A.***[3], FARIAS, M.E.[4], GONZALEZ, A.F.[4] RASUK, C.[4], CONTRERAS, M.A.[5]

[1] Department of Marine Sciences, University of Connecticut, Groton, CT 06340, USA (pieter.visscher@uconn.edu)
[2]Institut de Physique du Globe de Paris, 75005 Paris, France
[3]Synchrotron Soleil, 91192 Gif-sur-Yvette, France
[4]LIMLA - PROIMI - CONICET, Tucumán, Argentina
[5]Centro Ecologia Aplicada, 2-2741872 Santiago, Chile

The geomicrobiology, molecular biology and geochemistry of sulfur and arsenic cycling has been extensively studied in modern sediments and a potential role for both sulfur arsenic metabolism in the Precambrian has been proposed. Specifically, sulfide and arsenite oxidation and, similarly, sulfate and arsenate reduction may have played an important biogeochemical role in benthic microbial mats and microbialites (their lithified counterparts) before oxygenation of the oceans. Here, we present evidence for extensive sulfur and arsenic cycling, both coupled to calcium carbonate precipitation, in microbial mats of the Atacama desert in Chile. Gelatinous mats containing thin layers of carbonate precipitates photosynthesized but did not produce oxygen. However, sulfide and arsenite oxidation were stimulated in the light. Nitrate additions also supported sulfide and arsenite oxidation but at much lower rates. Sulfate and arsenate reduction were major respiration pathways in these permamently anoxic mats. Calculations show that arsenic and sulfur cycling both played a potential role in microbialite formation (i.e., calcium carbonate precipitation). Laboratorium experiments revealed that anoxyphototrophs were stimulated slightly more by sulfide than by arsenite, but that the potential of organic carbon turnover was equally supported by arsenate and sulfate. Complex As-S complexes, resembling polysulfides were formed in the field and in the laboratory. A previous investigation using Synchrotron-based X-ray fluorescence found evidence for arsenic cycling in 2.7 Ga stromatolites (Tumbiana formation, Pilbara, Western Australia). Although we cannot draw firm conclusions from our Precambrian analogs in the Atacama, a careful evaluation of the role of arsenic biogeochemistry in microbialite formation has merit.