Cyanobacterial diversity and activity in modern hot spring conical stromatolites

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Conical stromatolites are thought to indicate past microbial activity in sediments as old as 3.4 billion years, but biological processes leading to the conical shape are not well understood. We compare and contrast the cyanobacterial diversity and activity in coniform photosynthetic mats from Yellowstone National Park and laboratory enrichment cultures. The analysis of cyanobacterial diversity based on the 16S rRNA gene among morphologically different cones from different pools show similar diversity patterns. While twelve *Oscillatorean* species dominate the cones, only five can be found in the flat mat. Two non-filamentous cyanobacterial phylotypes can be detected in cones, while an additional four phylotypes are present in the mats. These results support the role of filamentous cyanobacteria as primary builders of cones. The spatial localization of different phylotypes in cones and mats will be determined by FISH. Using high-resolution mapping (NanoSIMS), we relate the morphology of these conical stromatolites to the spatial differences in the uptake of labeled inorganic carbon by thin filamentous *Oscillatorean* cyanobacteria. These microbes in cone tips actively concentrate carbon and form thick porous laminae by orienting themselves randomly with respect to the growth surface. Although morphologically and phylogenetically indistinguishable *Oscillatorean* cyanobacteria are also present around individual cones, fewer are active and do not form thick porous laminae. Instead, the dense laminae in topographic lows contain numerous mineralized and degraded cells and occasional, spatially heterogeneous clusters of active non-filamentous cyanobacteria. These relationships between the growth of coniform stromatolites and topography-dependent differences in microbial activity and composition are consistent with the morphological and microfossil records associated with small coniform stromatolites of all ages.

Diffusion-driven kinetic magnesium and iron isotope fractionation in Hawaiian basalts and olivines

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With increasing temperatures, equilibrium isotope fractionation generally decreases and becomes insignificant at high temperature. Recent experimental studies however show that kinetic isotope fractionation associated with chemical diffusion and Soret effect can be extremely large at high temperatures relevant to magmatic systems [1]. Previous studies on Mg and Fe isotopes in Kilauea Iki lava lake have revealed little Mg isotope fractionation [2] but large Fe isotope fractionation in bulk rocks [3]. Separated olivine also showed large Fe isotopic variation but Mg was not analyzed [2, 3]. This contrasting behaviour of Mg and Fe isotopes in bulk rocks is difficult to explain by equilibrium isotope fractionation. Some of the large Fe isotopic variations could reflect kinetic isotope effects, possibly associated with diffusion in olivine [3]. A critical test to address the origin of the large isotopic variation in Kilauea Iki lava lake is to measure Mg isotopes in olivine [1].

Magnesium and ferrous iron have similar ionic radii and identical charges and can substitute for each other in minerals during magmatic differentiation. During this process, large and coupled kinetic isotope fractionation of Mg and Fe may occur before the system reaches equilibrium. Here we report high-precision Mg and Fe isotopic data for a set of (~100) Hawaiian basalts and olivines. Both basalts and olivine separates display large Fe isotope fractionation (up to ~1.5 ‰) and measurable Mg isotope fractionation (up to ~0.4‰). The isotopic compositions of Mg and Fe are strongly correlated. Comparison of these results with model predictions indicates that the large isotopic fractionation measured in olivine is due to kinetic isotope fractionation associated with inter-diffusion of Mg and Fe in olivine. Our study shows that diffusion-driven kinetic Mg and Fe isotope fractionation in natural samples may provide a tool to constrain the mechanisms of magmatic differentiation.

[1] Richter et a. (2009) *Chem. Geol.* **258**, 92–103. [2] Teng *et al.* (2007) *Earth Planet. Sci. Lett.* **261**, 84–92. [3] Teng *et al.* (2008) *Science*. **320**, 1620–1622.