Hidden microbial cycling of iron in an Archean ocean analogue

J. S. BERG*, D. MICHELLOD, J. MILUCKA AND M. M. M. KUYPERS

Max Planck Institute for Marine Microbiology, 28359 Bremen, Germany (*correspondence: jberg@mpi-bremen.de)

At oxic-anoxic interfaces within the photic zone, microbial competition with chemical and photochemical reactions governs the cycling of iron. We attempted to disentangle these various processes using the chemocline of Lake Cadagno (Switzerland) as a model system where coinciding light, sulfide, oxygen, and bacteria determine iron chemistry. Often cited as an Archean ocean analogue, this meromictic lake is characterized by a sulfidic hypolimnion separated from an oxic epilimnion by a ~2 m thick layer of anoxygenic purple and green sulfur bacteria. The chemocline contains 3-5 umol/l of iron, mostly in the reduced FeII form. Although FeIII does not accumulate anywhere in the water column, we found evidence for light-driven microbial iron oxidation. In enrichment cultures from the Cadagno chemocline, we could show that the phototrophic bacteria *Rhodomicrobium vannieli* and *Thiodyction syntrophicum* fixed CO_2 in the presence of light and added Fe^{2+} and FeS. Nevertheless, no net iron oxidation was observed. Heterotrophic bacteria such as *Albidiferrax* and *Geobacter* in co-culture with the iron oxidizers presumably reduce the FeIII products. A wide diversity of both iron oxidizing (i.e. *Rhodomicrobium*, *Ferriphaselus*, *Sideroxydans*) and iron-reducing (i.e. *Geobacter*, *Albidiferrax*) bacteria were identified in 16S TAG sequence libraries from the chemocline, supporting the tight coupling of microbial iron oxidation and reduction in Lake Cadagno. Photochemical and/or sulfide-driven iron reduction also likely play a role in transforming iron to its more soluble, reduced form, thus maintaining bioavailable iron in the water column. Our data suggest that the importance of microbial iron cycling may have been overlooked in such environments where the oxidative and reductive sides are tightly coupled.