Rates of microbial sulfur oxidation in low oxygen environments

SEAN A. CROWE[1], DONALD E. CANFIELD[2], ARNE STURM[3], RAYMOND P. COX[2], STEVEN J. HALLAM[1], MARC LLIROS[4], CARRIAYNE JONES[1], OSVALDO ULLOA[5], FRANCOIS DARCHAMBEAU[6], ALBERTO BORGES[6], TAMARA GARCIA-ARMISEN[7], SERGEI KATSEV[8]

[1] *Microbiology & Immunology, and Earth, Ocean, and Atmospheric Sciences, University of British Columbia, Canada*

[2] *Biology, University of Southern Denmark, Denmark*

[3] *Oceanography, University of Hawaii, USA*

[4] *Genetics and Microbiology, Autonomous University of Barcelona, Spain*

[5] *Oceanography, University of Conception, Chile*

[6] *Chemical Oceanography, University of Liege, Belgium*

[7] *Ecology of Aquatic Systems, Free University of Brussels, Belgium*

[8] *Large Lakes Observatory, University of Minnesota, USA*

As one of the great biogeochemical cycles, the S cycle intimately couples with the C and N cycles [Garrels and Perry, 1974]. Microbial sulfide oxidation, in particular, likely represents a globally important yet poorly constrained source of biological carbon production and fixed nitrogen loss in many low oxygen environments [Walsh et al. 2009, Lavik et al. 2009, and Canfield et al. 2010]. Rates of microbial sulfide oxidation, however, are infrequently measured, likely due to the lack of standardized methods and protocols for these measurements. Bottle experiments yield information on the sulfide oxidation activity [Zopfi et al. 2001, Canfield et al. 2010], yet their coarse temporal resolution limits the extent to which reliable kinetic data can be extracted. We present here two novel methods for the determination of microbial sulfide oxidation rates in environmental systems: 1) based on the incubation of water samples in gas-tight glass syringes with sulfide determinations by the standard spectrophotometric technique; and 2) near real time measurement of sulfide oxidation using voltammetric techniques with Au/Hg amalgam microelectrodes. We have used these techniques individually and in concert to probe sulfide oxidation rates in diverse environments ranging from stratified East African lakes to marine oxygen minimum zones to laboratory cultures. Our measurements indicate that microbial sulfide oxidation is widespread in low oxygen environments, and is characterized by sulfide uptake with high affinity kinetics.

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