Entire community of microbes lacks phospholipids

JONES, C.[1], CROWE, S.A.[1], VIEHWEGER, B.[2], HINRICHS, K.-U.[2], MARESCA, J.A.[3], DELONG E.[4], NOMOSATRYO, S.[5], FOWLE, D.A.[6], AND CANFIELD, D.E.[1]

[1]NordCEE, U. Southern Denmark, Odense, Denmark
[2]MARUM, U. Bremen, Bremen, Germany
[3]Civil and Env. Eng., U. Delaware, Newark, USA
[4]Civil and Env. Eng., Mass. Inst. Tech., Cambridge, USA
[5]LIPI, Indonesian Inst. of Science, Cibinong, Indonesia
[6]Geology, U. Kansas, Lawrence, USA

Phosphorus is an essential nutrient for life, and aquatic microorganisms have strict P requirements for cellular structure, energy, function, and replication. We examined the physiological capacity of a microbial community to cope with extreme P limitation. This community lives in the surface waters of Lake Matano, an ultra-oligotrophic, stratified, ferruginous, ancient lake situated on Sulawesi Island, Indonesia. Based on dissolved nutrient concentrations in the surface waters, the elemental composition of microbial biomass, alkaline phosphatase enzyme assays, metagenomic analyses, and C-fixation assays with and without added P, we show that biomass production is P limited in the surface waters (0-100 m). The planktonic microbial community has responded to the extreme scarcity of available P through increased bulk C:P ratios (>1000), an order of magnitude higher than the Redfield ratio of 106:1. Such high C:P ratios are in part explainable by a lack of detectable phospholipids in the microbial biomass. Instead, abundant and structurally diverse betaine and glycolipids substitute for phospholipids, reducing the cellular P demand of the Lake Matano microbial community. With this observation, we show that this ability is not restricted to autotrophic organisms[1] but is universally distributed among different microbial taxa stressed by extremely low concentrations of available P. Such extreme P limitation in Lake Matano suggests that ferruginous conditions in general may lead to P limited ecosystems. This is consistent with previous work indicating P limitations on primary production during ferruginous Precambrian ocean chemistry[2].

[1] Van Mooy *et al*. (2009) *Nature* **458**, 69-72. [2] Bjerrum and Canfield (2002) *Nature* **417**, 159-162.

Microbial phosphate release from marine sediments: Transcriptomics and geochemistry

D.S. JONES*, B.E. FLOOD AND J.V. BAILEY

[1]Dept. of Earth Sci., University of Minnesota, Minneapolis, MN 55455, USA (*correspondance: dsjones@umn.edu,)

Hydrolysis of intracellular polyphosphate (polyP) by benthic marine microorganisms is a potentially significant mechanism for phosphorus (P) flux from sediments to the water column. Additionally, polyP utilization by large sulfur (S) bacteria has been linked to phosphogenesis in episodically anoxic marine settings. Here, we combined incubations of sediment-hosted microbial communities with geochemical measurements and comparative metatranscriptomics in order to identify important polyP accumulating organisms in different marine environments and compare their activities under distinct redox conditions. We incubated sediments from two locations: (i) methane-seep sediments near Barbados that included a *Thiomargarita*-like bacterial biofilm; and (ii) sulfidic Santa Barbara Basin (SBB) sediments with no visible S oxidizing bacteria. P release from sediments of both localities was observed under anoxic conditions (Fig. 1), with and without additions of sulfide and acetate. Following incubations, sediments were immediately preserved for RNA extraction and sequencing. Metatranscriptomic analysis of the Barbados incubations revealed that, based on rRNA and *rpoB* transcripts, active microbial populations included diverse representatives of the Methanosarcinales, Bacteroidetes, and Delta-, Gamma- and Epsilonproteobacteria. However, based on identification and taxonomic classification of polyP kinase and exopolyP-ase transcripts, only certain gamma- and epsilonproteobacteria appeared to be metabolizing polyP under incubation conditions. Comparative analysis of metatranscriptomes from Barbados (where S bacteria were abundant) with metatranscriptomes from SBB (rare S bacteria) will provide insight into the identities and activities of key marine polyphosphate-metabolizing organisms, and further define their contributions to the global P cycle.

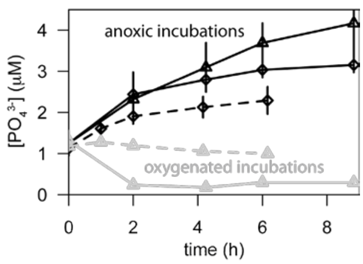

Figure 1: Dissolved phosphate changes during incubation experiments with marine sediments from Barbados (dashed lines) and the Santa Barbara Basin (solid lines).

DOI:10.1180/minmag.2013.077.5.10