Microbial biogeochemistry of a meromictic blue hole

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Competition between oxygenic and anoxygenic phototrophs has been proposed as a mechanism that delayed the oxygenation of the earth's oceans and atmosphere in the Proterozoic [1]. Factors affecting the outcome of competition among bacterial phototrophs in the Proterozoic are not well understood, and can be approached using pure cultures and field studies of modern analog sites. Sawmill Sink (Abaco, Bahamas) has a stable chemocline with an upper boundary at ~10 m water depth, with oxic freshwater above and anoxic seawater below [2]. This boundary coincides with turbidity and chlorophyll/bacteriochlorophyll maxima as well as steep changes in pH, oxygen, and sulfide concentrations. Sulfide concentrations in the photic zone range between 0-1 mM. Cells from 10 and 12.5 m water depths were collected during winter on ashed glass fiber filters for nucleic acid, microscopy, and pigment analyses. At 10 m depth, bacterial 16S rDNA clones were primarily phototrophic Chlorobi, with smaller numbers of Deltaproteobacteria and relatives of the phototrophic genus *Allochromatium* (Gammaproteobacteria). No cyanobacterial sequences were retrieved. However, cyanobacteria are present based on epifluorescence imaging of the autofluorescent cyanobacterial pigment phycoerythrin. Quantitative HPLC-MS analyses of solvent extracted filters revealed that bacteriochlorophyll *e* is the primary photosynthetic pigment. Okenone, isorenieratene, chlorophyll *a*, pheophytin *a*, and bacteriopheophytin *a* were detected in much smaller amounts. Selective enrichment cultures inoculated from Sawmill Sink water collected at the chlorophyll maximum have *in vivo* absorption spectra that most closely match pure cultures of phototrophic Chlorobi. Preliminary data comparing winter and summer populations suggest that there may be a significant seasonal oscillation in the phototroph community. These data suggest that Sawmill Sink and other meromictic Bahamian blue holes may harbor unique phototrophic microbial communities whose temporal dynamics will provide valuable insights into competition between oxygenic and anoxygenic phototrophs in both modern and ancient environments.

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Biogenic hydroxyapatite: New nanophase material for radiodionuclide removal

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Bacterial biomineralisation removes radionuclides from solution, e.g. by enzymatic formation of metal phosphates to treat mine waters [1] and nuclear wastes [2]. Bio-Uranyl phosphate (HUO_2PO_4. nH_2O) comprises stacked lamellae of uranyl and phosphate groups with interstitial water molecules and mobile protons. Metals (M^{2+}) are exchanged with $2H^+$ and held within the biogenic mineral [2]; the potential capacity is higher than commercial formulations [3]. Decontamination of potable water following a hypothetical radioterrorist incident, and also *in situ* biomineral barriers, require an alternative to U. Biogenic zirconium phosphate (Zr-P) has a similar ion exchange property [3]. Bacterial growth is highly scalable using a cheap phosphate source such as phytic acid [4] found in biodiesel wastes. However, rapid sourcing of large quantities of zirconium may be problematic and Zr-P biomanufacture is laborious [3]. We focussed on calcium phosphate (hydroxyapatite, HA) as a potential alternative. Apatites are well known sorbents of metals [5]. Bio-HA was developed as a potential biomaterial [6] where its nano crystalline nature (15 nm) [7] confers a potentially large surface area. Sr^{2+} was taken up by Bio-HA ~10 times faster than by commercial HA (C-HA). PO_4^{3-} and Ca^{2+} dissolution was higher in C-HA, indicating a more stable Bio-HA. We compare Bio-HA made by different methods, and ground bone, relating metal uptake and mineral stability to its crystallographic nature.

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