Metabolically versatile cyanobacterial mats in Great Lakes sinkholes: Analogs of the Proterozoic

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Extensive benthic microbial mats recently discovered in submerged sinkhole ecosystems of Lake Huron [1] are novel analogs of Proterozoic mat ecosystems. These mats are bathed in venting groundwater rich in sulfate and low in oxygen. Vertically stratified microbial communites display sharp redox gradients and are host to methanogens, sulfate-reducing and sulfur-oxidizing bacteria, and versatile photosynthetic cyanobacteria [2]. Between the mat and organic-rich sediments is a carbonate-rich mineral layer [2].

We conducted ^{14}C bicarbonate uptake incubation experiments on the mats under light and dark treatments with killed and DCMU controls. Results showed significant contributions to autotrophic production from oxygenic and anoxygenic photosynthesis as well as chemosynthesis. We hypotheisze that *Phormidium autumnale* cyanobacteria that dominate the photosynthetic mat [2] are capable of facultative anoxygenic photosynthesis as reported for various *Phormidium* species. We found that these species are remarkably motile, being capable of rapid reaggregation following dispersal and acension following burial.

This system is an excellent analog of Proterozoic microbial mats because the mats (i) occur at an oxic/anoxic interface and are exposed to fluctuating redox conditions; (ii) are dominated by filamentous facultiative anoxygenic cyanobacteria that may have sustained low oxygen conditions through the Proterozoic [3]; and (iii) harbor *Phormidium* spp. that are abundant in Precambrian stromatolites. Current and future work is focused on uncovering metabolic capabilities of the cyanobacteria (cultivation, single cell genomics, metagenomics) and evaluating geochemical and mineralogical signatures relevant to interpretation of the geologic record.

[1] Biddanda *et al*. (2009) *Eos* **90**. [2] Nold *et al*. (2010) *Appl. Env. Microbiol*. **76**: 347–351. [3] Johnston *et al*. (2009) *PNAS* **106**: 16925–16929.

Land-sea transport of terrestrial carbon in the Fraser River, British Columbia

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A suite of geochemical measurements are used to characterize the transport of organic carbon from the Fraser River watershed to the coastal ocean. The Fraser River drains a geologically and biologically diverse region which includes some areas of significant human impact but no dams on its main stem, a rare feature among large rivers in North America. Along with five other major world river systems being studied (Lena, Kolyma, Yangtze, Ganges-Brahmaputra, Congo) in this NSF-ETBC-funded study, understanding the current state of carbon cycling within and through the Fraser drainage basin is critical to predictions of future effects of climate change.

Both organic and inorganic geochemical measurements are combined to shed light on biogenic and lithogenic sources of carbon in the Fraser watershed. During a field campaign on the main stem and many tributaries in the summer of 2009, we collected samples of river water, suspended sediments, and bank sediments for measurement of terrestrial biomarkers, bulk organic carbon and radiocarbon content, and dissolved and particulate trace elements and radiogenic isotope systematics. A second field campaign will be carried out during the fall 2010 low-flow period. In addition to the spatially comprehensive sampling of the field campaigns, we have established time series sampling locations upstream of the delta through the participation of collaborators at the University of the Fraser Valley in Abbotsford, B.C. Through monthly-to-weekly sampling of suspended sediments and dissolved trace metals at these downstream sites, we hope to characterize the temporal variability of the river system.

Preliminary results from bulk organic carbon analyses of suspended sediments, biomarker analysis of solvent-extracted bed sediments, and measurements of dissolved $^{87}Sr/^{86}Sr$ (0.704 to 0.752) and particulate organic carbon (POC) $\delta^{13}C$ (-25.1 to -30.4‰) demonstrate the heterogeneity of the Fraser drainage basin with respect to vegetation and lithology. Radiocarbon data will soon be available for POC and dissolved inorganic carbon.