Shedding light on microbially driven biogeochemical cycles in freshwater sediments

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Earth's large lakes unique aqautic ecosystems, yet little is known of the microbial life that drives biogeochemical cycles, especially in sediments. In several of these large lakes, water column productivity is constrained by limitations of elements such as phosphorus and iron. Thus, creating oligotrophic water column conditions and sediments that are low in organic matter. Yet, these sediments are biogeochemically active and interestingly have been shown to have oxygen consumption rates akin to pelagic ocean sediments. Thus, these large oligotrophic lakes provide an unique and interesting biogeochemical contrast to highly productive freshwater and coastal marine systems.

Using Lake Superior (LS) as our study site, we collected sediment cores from six stations across the western arm of the lake with varying depths and proximity to shore. Microbial communities, sediment carbon and nitrogen were similar but were clustered depending on sampling site. The variability observed likely stems from land influence, as some stations are more coastal, thus have higher rates of sedimentation, allochthonous carbon inputs and productivity than pelagic sites. Pelagic stations show a steady decline in both carbon and nitrogen with core depth. Microbial communities, from the pelagic sediments are quite different from coastal communities. However, more interesting is that microbial community composition turnover occurs abruptly with depth in the sediment, suggesting that steep gradients in sediment chemistry may be responsible. We see evidence of both denitrification processes in metagenome assembled genomes and 16S rRNA gene libraries. Additionally, methanogen abundance generally increases with depth, while sulphate reducing bacteria peak and decline mid-core. Several novel genome bins were recovered from these cores and show variable genome coverage with depth. Suggesting these novel microorganisms are keying in on specific geochemical zones within the sediments. Together, LS sediments offer a unique glimpse into microbial metabolism in carbon limited environments, and show that microbial biogeochemical cycling is, in part, performed by novel microorganisms.