Associations between redox-sensitive trace metals and microbial communities in a Proterozoic ocean analogue

KATHRYN I. RICO[1*], NATHAN D. SHELDON[1]

[1]Earth and Environmental Sciences, 1100 N. University Ave, Ann Arbor, MI 48109, USA, [*correspondence: krico@umich.edu; nsheldon@umich.edu]

The Proterozoic is bookended by two major shifts in atmospheric oxygenation that correspond to major biological innovations. However, the direct relationships between microbes, their metabolisms, and Proterozoic ocean chemistry remain elusive. Understanding how microbial mats interact with their surrounding environments, and leave a marker of their activities on their environments, is necessary to tease apart the complexity of abiotic-biotic relationships in Proterozoic oceans. The low-oxygen, high salinity Middle Island Sinkhole (MIS) has microbial communities that exhibit diverse metabolic functions at the sediment-water interface as has been inferred for the Proterozoic. Associations between sediment trace metal contents, known redox chemistry, nutrient availability, and microbial community composition of both MIS and a fully oxygenated Lake Huron control site (LH) can help to infer mechanisms for different abiotic and biotic controls on elemental burial and microbial community structure defined through operational taxonomic units (OTUs). Principal Component Analysis (PCA) results demonstrate a clear difference in nutrient and metal burial, and OTU abundance as a function of depth below the sediment-water interface. While sediment burial in LH is dominated by aerobic respirators and does not covary with redox- or sulfide-sensitive metals, metal burial is still dependent on productivity as metals and organic matter are both sourced authigenically in the water column. Trace metal burial in MIS mat is also coupled with organic matter; macronutrients and sulfide-sensitive metals covary with OTUs of the MIS mat, tying the mat's productivity to sulfate reduction and sulfide oxidation. Conversely, trace metal burial in MIS sediments is governed by redox. The OTUs of MIS sediments covary with redox-sensitive trace, coupling anaerobic OTUs with the preservation of sediments under anoxic conditions. Together, these results indicate that bulk sediment elemental composition may record information about the composition of ancient microbial mat systems.