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Was early photosynthesis constrained by ferruginous conditions?

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Precambrian oceans were rich in iron (Fe) and largely anoxic, marking them geochemically distinct from modern, iron poor and oxygenated oceans. To understand how this environment influenced carbon fixation and oxygen production by early phototrophs, it is necessary to study in environments with analogous aquatic geochemistry. Deming Lake in Minnesota is redox stratified and ferruginous and has N:P ranging from approximately 42 to 88 in the photic zone, favoring Cyanobacteria over other eukaryotic phytoplankton. A subsurface chlorophyll maximum layer (SCML; where the photosynthetic pigment chlorophyll *a* reaches its maximum abundance) occurs in the summer months at the base of the redoxcline where dissolved Fe concentrations increase, suggesting that Fe availability controls Cyanobacterial distribution.

16S rRNA gene amplicon sequencing and fluorometer profiles have shown that the microbial community within the SCML is dominated by Cyanobacteria. Cell counts using flow cytometry confirm that the SCML represents a maximum in Cyanobacterial cells, rather than an increase in pigments per cell, indicating that the conditions within the redoxcline are favorable to photosynthesis despite low light levels. We are currently conducting bottle experiments for carbon fixation, intracellular Fe measurements, and photosynthetic activity to determine how these parameters vary above, within, and below the redoxcline and SCML. From this data, we will gain insight into how photosynthesis took place in Archaean Oceans stratified with respect to Fe and O_2 and the implications for productivity of the early marine biosphere.