Microaerophilic iron-oxidizing bacteria and oxygenic phototrophs in the Chesapeake Bay: Implications for microbial roles in the production of ancient iron formations

E. K. FIELD[1]*, S. KATO[1], A. J. FINDLAY[2], D. J. MACDONALD[2], G. W. LUTHER III[2]* AND C. S. CHAN[12]^

[1]Department of Geological Sciences, University of Delaware, Newark, DE, 19716, USA (*ekfield@udel.edu, ^cschan@udel.edu)

[2]School of Marine Science and Policy, University of Delaware, Newark, DE, 19716, USA (*luther@udel.edu)

A commonly postulated model of BIF formation involves Fe(II)-rich water upwelling onto continental shelves, bringing Fe(II) into the vicinity of oxygenic phototrophs and microaerophilic, chemolithotrophic iron-oxidizing bacteria (FeOB). This creates an Fe(II)/O_2 interface where these iron-oxidizers may played a role in precipitating iron minerals planktonically in the water column. However, little is known about FeOB in marine water columns. The goals of this study were to confirm the presence of planktonic FeOB in a saline, redox stratified system, identify these bacteria, and determine any associations with their presence and corresponding geochemical conditions. Water samples from the Chesapeake Bay, a redox stratified ancient ocean analog, were collected at various depths for geochemical analyses and inoculation of iron-oxidizer culture medium. Detection of microaerophilic FeOB correlated with regions in the water column where oxygen was below the detection limit ($< 3\ \mu$M) and particulate Fe(II) was greatest. These results demonstrate that iron-oxidizers may be particle-associated and active at lower oxygen concentrations than previously documented. Microaerophilic enrichment cultures were dominated by *Zetaproteobacteria*, a known marine iron-oxidizer, though unlike other *Zetaproteobacteria* cultures, no extracellular iron oxyhydroxide structures in the form of stalks or sheaths were observed. Anoxic phototroph enrichments were positive for growth and iron oxidation from all depths, and were comprised largely of *Cyanobacteria*, with a small proportion of *Zetaproteobacteria*. The *Cyanobacteria* produced oxygen that could directly oxidize iron, but may also support microaerophilic iron oxidation at the oxic-anoxic interface and anoxic zone. Overall these results support a revised conceptual model for the role of microorganisms in BIF precursor genesis that includes the potential cooperation between oxygenic phototrophs and microaerophilic, chemolithotrophic iron-oxidizers.