LINKING IRON REDUCTION TO ANAEROBIC METHANE OXIDATION IN AN ANCIENT OCEAN ANALOG. M. S. Bray[1], B. C. Reed[1], J. Wu[1], C. B. Kretz[2], F. J. Stewart[1], T. J. DiChristina[1], J. A. Brandes[3], D. A. Fowle[4], S. A. Crowe[5], J. B. Glass[1, 2*]

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The Archean ocean was likely O_2-poor but rich in CH_4 and dissolved Fe(II). Methane and Fe(III), generated from photoferrotrophy or aerobic Fe(II) oxidation, could have been used by ancient microorganisms as energy sources. Modern species of bacteria and archaea that couple anaerobic oxidation of CH_4 (AOM) to NO_x^- and SO_4^{2-} reduction, respectively, have been characterized. AOM coupled to Fe(III) reduction (Fe-AOM) is a thermodynamically favorable reaction that might support microbial growth. This reaction may have operated in the Archean oceans, and geochemical evidence suggests it plays a role in CH_4 oxidation in modern ecosystems. However, characterization of the microbes that perform this putative metabolism remains elusive. Isolation of extant microorganisms mediating Fe-AOM would demonstrate the reaction and its microbial mediation, and would provide insight into the possible mechanisms of ancient CH_4 cycling.

In this study, we attempted to enrich for microorganisms mediating Fe-AOM in sediments from Lake Matano, Indonesia, a stratified tropical lake with anoxic CH_4-rich deep waters. Lake Matano sediments receive abundant Fe(III) due to erosion of lateritic soils and scarce (<100 nM) SO_4^{2-} and NO_x^-, making this environment an excellent Archean ocean analog. Fe(III)-amended Lake Matano sediments were incubated in the presence and absence of CH_4. CH_4 stimulated Fe(III) reduction in initial incubations by 8-fold over N_2 controls. The dominant 16S rRNA gene sequences in CH_4-amended enrichments (79, 40 and 27% in sediment layers from 0-5, 5-10 and 10-15 cm depth, respectively) were Betaproteobacteria in the Rhodocyclaceae family. Cultured species of Rhodocyclaceae perform diverse metabolisms, including respiration of O_2, NO_3^-, ClO_3^-, ClO_4^-, SeO_4^{2-} or Fe(III), and oxidation of a wide range of organic electron donors. Some aerobic Rhodocyclaceae species oxidize C1 compounds including methanol, methylamines, formate and formaldehyde, but none are known to oxidize CH_4. The enrichment with highest AOM activity measured by $^{13}CH_4$ incorporation into dissolved inorganic carbon was dominated by 16S rRNA gene sequences with highest similarity to the ClO_4^--reducing bacterium *Azospira suillum* strain PS. Ongoing work is focused on culture isolation and characterization by coupling metagenomics, metatranscriptomics and microscopy.