Cryptic Iron Cycling in Biogenic Iron Oxide Deposits

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Although the oxidation of iron in circumneutral environments has long been thought to occur by abiotic processes, iron oxidizing bacteria (FeOB) have been shown to promote iron mineral formation at redox gradients. The resulting bacterial biomats contain complex mixtures of poorly ordered minerals, detrital and biogenic organic matter, and metabolically diverse bacteria.

In the present study, we collected natural bacteriogenic oxides from surface waters in the North Carolina Piedmont physiographic region. A suite of spectroscopic and scattering techniques suggest that biogenic iron oxyhydroxides (BIOS) in these deposits are poorly-ordered, aggregated iron oxyhydroxide nanoparticles that have unique sorption reactivities. Interestingly, sorption experiments with Cr(VI) suggested that these deposits produce Fe(II) during incubations, even under aerobic conditions.

To better understand the rates and mechanism of Fe(II) production from biomats, we conducted incubations in the dark with unaltered and γ-irradiated BIOS deposits in the absence and presence of a Fe(II) trapping agent (ferrozine) under mixed gas (5% H2/95% N2) and ambient aerobic atmospheres. Results are in agreement with Cr sorption experiments in that Fe(II) is produced by these deposits under both atmospheres. Furthermore, differences in rates between unaltered and irradiated samples indicate key roles for iron reducing bacteria native to BIOS deposits. The results indicate that these deposits may continually produce Fe(II) even under oxygen-saturated conditions.