Coupled Processes Involving Nitrate Reduction and Iron(II) Oxidation in Soil

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The biological reduction of nitrate is due in part to low dissolved oxygen concentrations and the presence of organic carbon. In reduced soils and sediments, iron(II) can promote nitrate reduction as well. This overall process contains elements of biological and abiotic pathways which interact in a complex fashion. Here we report nitrate-dependent iron(II) oxidation in surface soil microcosms preincubated for 28 d to reduce all microbially reducible soil iron(III) to iron(II). Addition of nitrate to reduced soil slurries resulted in immediate dissolved iron(II) oxidation with concurrent nitrate reduction. Nitrite and nitrous oxide were identified as reaction products and there was a negligible change in ammonium levels. One potential source of iron in this system is derived from phyllosilicate minerals based on x-ray diffraction and Fourier Transform infrared spectroscopy. Surprisingly, dissolved manganese(II) was also removed from solution during nitrate reduction. Additional batch experiments were performed by adding ferrozine to block reactivity of iron(II) and assess the contribution of organic carbon and manganese(II) to nitrate reduction. Our work indicates that despite the greater abundance of soil organic carbon when compared with total iron and manganese in this surface soil, these latter inorganic elements contribute greatly to nitrate reduction.