Oxidation of glucose in biogenic MnO_2 suspensions

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Laboratory and field studies have shown that manganese oxides (MnO_2) can oxidize a range of organic molecules, highlighting its potential to influence organic matter dynamics in soils. Naturally occurring MnO_2 is precipitated by microorganisms, and therefore often occurs admixed with metabolically active cells. Consequently, changes in biogeochemical conditions induced by the cells can enhance the reactivity of MnO_2 particles. For example, the addition of bioavailable C substrates to bacterial cultures can result in extracellular acidification. From the perspective of redox processes, decreasing pH conditions implies enhanced abiotic oxidation of organic molecules coupled to more favourable reductive dissolution of MnO_2.

This study aimed to characterise the oxidation of glucose, a readily bioavailable carbon source, by MnO_2 in the presence and absence of *Pseudomonas putida* biomass. We measured changes in pH in stationary-phase biomass suspensions spiked with 0.1 – 5.5 mM glucose over 24h. We then characterized the abiotic and mixed abiotic-biotic oxidation of glucose in abiotic MnO_2 and *Pseudomonas putida*-MnO_2 suspensions respectively, at pH values ranging from 4.0 – 6.5.

Glucose addition to biomass suspensions caused a decrease of up to 2.5 pH units, which was sufficient to favour reductive dissolution of MnO_2. Coupled ATR-FTIR spectroscopy of the supernatant and aqueous Mn(II) measurements showed partial oxidation of glucose, with more than 2 electrons transferred per glucose molecule, as well as the appearance of oxidation products. Our results suggest that in natural systems exposed to pulses in labile C, bacterial C metabolism may lower the pH and thus enhance significant abiotic oxidation of C substrates by MnO_2.