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Dynamics of carbon cycling by soil bacteria in presence of manganese oxides

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The accumulation of organic matter in soil (SOM) and its oxidation to CO_2(g) depends on interactions between organic molecules, mineral surfaces and microbes. Manganese oxides (MnOx) are among the strongest oxidants in soils and play a central role in SOM decomposition. Here, we investigated how the redox reactivity of MnOx affects carbon consumption by soil bacteria. We compared the kinetics of glucose consumption by *Pseudomonas putida* KT2440, in the presence and absence of δ-MnO_2. We performed kinetic experiments by adding glucose ($\delta^{13}C$ = - 11.41 ± 0.11 ‰) to: i) δ-MnO_2 suspension, ii) *P. putida* KT2440 suspension, and iii) a mixture of *P. putida* KT2440-δ-MnO_2, under controlled conditions (pH = 7.00 ± 0.1, t = 20 ± 1°C). The reduction of in δ-MnO_2 was tracked by quantification of $Mn(II)_{aq}$ and solid-phase Mn(III). The oxidation of glucose was monitored during six days by the concentrations of oxidation products (i.e., formate, gluconate), dissolved organic carbon (DOC) and the head space concentration and carbon isotope composition ($\delta^{13}C$) of the evolved CO_2.

Results showed that under abiotic conditions, DOC content remained constant over time, whereas glucose was oxidized to formate, matching $Mn(II)_{aq}$ and $Mn(III)_s$ concentration, with no CO_2 release. Glucose consumption in *P. putida* KT2240 led to full consumption of the DOC after two days and the $\delta^{13}C$-CO_2 values varied from -23.2 to -8.4 ‰. In *P. putida* KT2440 - δ-MnO_2 assemblages only half of the total DOC was consumed. However, the abiotically-produced formate was completely consumed after 4 hours and $\delta^{13}C$-CO_2 values evolved from -28.0 to -21.9 ‰ during the same time. The $\delta^{13}C$-CO_2 reached a maximum value of-6.4 ‰ after 40 hours, and decreased again to -13.1 ‰ after 4 days.

These results suggest that MnOx led to the production of small organics that may fuel other bacterial metabolisms, changing bacterial glucose fixation and respiration.