Contribution of bacterial biomass components to the formation of refractory soil organic matter

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In general, plant material is regarded as the main precursor of soil organic matter (SOM). Recently however, evidence has been shown that also microbial compounds contribute to the formation of refractory SOM. Although microbial biomass in soils is regarded as rapidly decomposable, about 50% of the C derived from ^{13}C-labelled Gram-negative bacterial biomass (*Escherichia coli*) persisted in soil after 224 days of incubation. About a fifth of this C was channelled into the microbial food web, the remainder was stabilized in non-living SOM. Further studies of this process are needed to elucidate the consequences for the chemical composition and the stability of SOM. We therefore studied the fate of *E. coli*-derived fatty acids and amino acids in soil. For both compound groups we distinguished the microbial fraction from the bulk soil fraction. Total amino acids did not decline during degradation, but we found a shift from the microbial to the non-living fraction at the beginning of the incubation. During this process, neither the amino acid pattern nor the isotopic composition of the amino acids changed. This suggests that whole peptides were transformed by the microorganisms, that *E. coli*-derived peptides were not utilized preferentially and that peptides are potentially refractory. The ^{13}C declined in both the total fatty acids and the microbial (PLFA) fraction by about 80%. Also here a shift from the microbial to the non-living fraction was observed, which continued until the end of the experiment. The isotopic composition of the PLFA shows the redistribution of the labelled C from *E. coli* to the members of the soil microbial community. The half lives of the ^{13}C-labelled compounds, in particular those of the non-living fractions show that both amino acids and fatty acids derived from *E. coli* contribute to the formation of refractory SOM thus imprinting a microbial-derived chemical structure on it. The distribution between the microbial and the non-living fraction was compound-specific with the proteins tending more strongly to accumulate in the non-living fraction. Together with the stabilization of compounds which are readily degradable as monomers, this shows that both the chemical structure and the molecular environment of a compound determine its fate in the soil.

Oxidative dissolution of $Cr(OH)_3(s)$ by manganese oxides under circumneutral conditions

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Chromium generally exists in the +VI and +III oxidation states under surface and subsurface conditions. Cr(VI) is highly mobile and has deleterious health effects. Cr(III), by contrast, is generally immobile in the subsurface under neutral to alkaline conditions because it precipitates as sparingly soluble Cr(III)- or mixed Cr(III)-Fe(III) hydroxides. However, when these solids may be a potential source of toxic Cr(VI) under natural conditions when they are exposed to oxidants. Among the oxidants in nature, manganese oxides are ubiquitous and known to readily oxidize dissolved Cr(III).

This study investigates a possible pathway for the release of Cr(VI) to groundwater through the oxidative dissolution of $Cr(OH)_3(s)$ by manganese oxides under circumneutral conditions. In this study, dissolution of synthetic $Cr(OH)_3(s)$ was conducted in the absence or presence of $MnO_2(s)$ at pH~8 in 0.01 M $NaNO_3$. The concentrations of dissolved Cr(VI) was determined by diphenylcarbazide method using UV-vis spectrophotometer and those of total Cr and Mn by atomic absorption spectrometry (AAS). During the dissolution of $Cr(OH)_3(s)$ for 165 h, the concentrations of dissolved Cr(VI) were all below detection limit (50 μg/L) in the absence of MnO_2, whereas it increased with time and reached up to ca. 500 μg/L in the presence of MnO_2. The results of this study indicate that a small amount of dissolved Cr(III) ($[Cr(OH)_3{}^\circ] = K_{sp}^{conc} < 10^{-6.84}$) in equilibrium with $Cr(OH)_3(s)$ is readily oxidized to Cr(VI) by MnO_2 and that this process can accumulate dissolved Cr(VI) in usual groundwater systems.