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Mineral-organische Wechselwirkungen: Bildung, Eigenschaften und Auswirkungen auf Stoffkreisläufe

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## Titel
Stabilization of microbial residues by co-precipitation with Fe and Al oxyhydroxides

## Abstract
It is now widely accepted that microbial residues are a significant source for soil organic matter (SOM) formation. This material must be stabilised in soil in order to persist. A potential mechanism for stabilisation of organic materials in soil is co-precipitation with metal oxyhydroxides (Fe and Al), which, however, may be affected by redox transitions. We thus evaluated the mineralisation of $^{14}$C-labelled bacterial residues (Escherichia coli cells and cell envelope fragments) and their co-precipitates with Fe or Al oxyhydroxide under different redox conditions in a laboratory incubation experiment. The co-precipitates or untreated microbial residues (control) were mixed with soil and incubated in sealed vessels under either fully aerobic or under oxygen-limited conditions for up to 345 days. To achieve oxygen limitation, incubation was conducted under an $N_2$ atmosphere for the first 100 days. The redox potential was further decreased by waterlogging the samples (from day 100) and by substrate and nutrient additions (from day 290), to increase electron acceptor consumption by the soil microbes. Mineralisation of the microbial residues was quantified by liquid scintillation counting. The data were fitted to different types of models, depending on the experimental phase. Co-precipitation with Fe and Al oxyhydroxides decreased mineralisation of both intact cells and cell envelope fragments significantly, indicating strong protection of biomass and its fragments. Mineralisation of intact cells was slightly faster than that of cell envelope fragments, indicating higher recalcitrance of the latter material, which therefore may be enriched in SOM. Strongly reducing conditions resulted reductive dissolution of Fe oxyhydroxide and thus in a loss of the stabilising effect of the co-precipitation. We conclude that co-precipitation with and incrustation of organic material by Fe and Al oxyhydroxides provide significant stabilisation of microbial residues. However, environmental conditions, e.g. the redox potential, modify the extent of this stabilisation. Fitting the mineralisation data to the models indicated that initially mainly pool sizes were affected by the factors studied, whereas later in the experiment the rate constants were more sensitive. The results improved significantly our understanding how organic materials, in particular microbial residues, are stabilised in soil.