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Organomineral interactions as an important mechanism for stabilisation of bacterial residues in soil

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Although plant material is the original input of organic matter to soils, microbial residues have been identified to contribute to a large extent to soil organic matter. However, until now it is unclear how microbial residues are stabilised in soil and protected from degradation. We hypothesised that organomineral interactions, in particular encrustation by oxides, may play an important role, which might vary depending on environmental conditions, e.g. redox potential. Therefore we produced ^{14}C-labelled *Escherichia coli* cells and cell envelope fragments and coprecipitated these materials with Fe oxide or Al oxide. Mineral-free (control) and mineral-encrusted bacterial residues were incubated for 345 days at 20˚C under either oxic or oxygen-limited conditions, and mineralisation was quantified by scintillation counting of the CO_2 produced during incubation. Oxygen limitation was achieved by first exchanging the atmosphere in the incubation vessels with dinitrogen gas. After 100 days of incubation, the anoxic treatments were waterlogged to further decrease the redox potential, and after 290 days, glucose and nutrients were supplied to all treatments in order to foster microbial activity and consumption of electron acceptors. The mineralisation curves were fitted by double-exponential (0-100 days), first-order kinetic (100-290 days) and linear (290-345 days) models. The model parameters were tested for significant differences between the treatments by three-way ANOVA with post-hoc Bonferroni t-test. We found that encrustation by the oxides significantly reduced mineralisation of the bacterial residues. This effect was inversed by reductive dissolution of Fe oxides after substrate and nutrient addition to the oxygen-limited treatments, suggesting a significant role of the encrustation in stabilisation of the bacterial residues. We also observed that bacterial cell envelope fragments were generally slightly more resistant to mineralisation than whole cells. The results indicate that bacterial residues, in particular cell envelope fragments, may be stabilised in soil by organomineral interactions as long as the minerals are stable in soil.