Stabilization of ferrihydrite-associated soil organic matter

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Iron oxides can bind particularly large amounts of organic matter (OM) and seem to control OM storage in many soils. Degradation of the mineral-bound organic matter can proceed via microbial mineralization of the OM, but can also be triggered by dissolving the mineral substrate.

Here we investigated both processes on ferrihydrite-OM associations: (1) Liquid phase incubation experiments were carried out under oxic conditions to quantify the mineralization of adsorbed and coprecipitated organic matter. The inoculum was a microbial consortium extracted from a forest-floor. (2) Microbial reduction experiments were performed using liquid cultures of *Geobacter bremensis* and quantifying the formation of Fe(II) in solution with the phenantroline method. Solid remnants were investigated by X-ray diffraction.

Biodegradation experiments showed that the extent of mineralization was 2-3 times lower, while the mean residence time was 6-15 times higher for ferrihydrite-associated OM in comparison to dissolved OM. Time-lags before the onset of mineralization of the ferrihydrite-associated OM suggest that the microbial community of the forest floor was not able to immediately mineralize the ferrihydrite associated OM, but needed adaption before starting a slow degradation.

Microbial reduction experiments showed that increasing amounts of mineral-associated OM led to decreasing initial reaction rates and a decreasing degree of dissolution. The secondary formation of Fe minerals was also influenced by the amount of mineral-bound organic matter. Goethite was only found after reduction of the organic matter-free ferrihydrite and siderite was only detected when ferrihydrites with relatively low amounts of mineral-bound organic matter were reduced.

Our data demonstrate that the association with ferrihydrite can effectively stabilize soil organic matter. Vice versa, sorbed soil organic matter may protect ferrihydrite from reduction by *Geobacter*-like bacteria.