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"Death in soil" or what can we learn from groundwater for the genesis of soil organic matter

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Soil microorganisms do not only catalyze the transformation of plant residues to soil organic matter, but also serve as considerable carbon source for the formation of refractory soil organic matter by providing cell fragments as structural interfacial surfaces in soil systems.

After incubation of ^{13}C-labeled Gram negative bacteria in soil for 224 days, we could show that 44% of the bulk carbon remained in soil. 30 – 35 % of the remaining bulk C from Gram negative microbial biomass was stabilized in non-living soil organic matter (SOM). Surprisingly, the added labeled biomass proteins remained in soil almost completely which clearly indicates the stabilization of proteins in cell aggregations being more resistant to biodegradation than free proteins and amino acids. Scanning electron micrographs of the soil showed very rarely intact cells but highly abundant patchy organic cover material of 20 to 50 nm^2 size on the mineral surfaces.

A possible mechanism for this stabilization and the observed material could be found by analyses of microbial communities and biofilms developing on Biosep? beads within in situ microcosms exposed to contaminated aquifers. Scanning electron micrographs of the developing biofilms on the beads showed the formation of such patchy material found in the soil by fragmentation of empty bacterial cell envelopes (cell walls) and all stages of decay. The fragmentation of these cell walls provided a mechanistic explanation for the observed stabilisation, the genesis of SOM derived from dead bacterial cells, and the enzyme activity always found associated to SOM.