

Succession of soil microbial communities and enzyme activities in artificial soils

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Microorganisms colonize selectively minerals and organo-mineral complexes. Less well known is whether the complexity of mineral composition of soils might determine microbial communities. The use of artificial soils that differ only in their mineral composition, but not in their organic composition, offers a unique possibility to study these microorganisms-mineral-interactions in soils. For the current study, a series of artificial soils of eight different compositions was designed from simple 2 component systems to more complex 3 to 4 component systems. The components used were the clay minerals illite and montmorillonite, ferrihydrite and boehmite as representation of iron and aluminum oxides, and charcoal. The formation of artificial soils was initiated by incubating these materials with sterilized manure as organic C source and a microbial community extracted from a natural arable soil for up to 18 months at 20°C in the dark. We quantified the enzyme diversity and the abundance of eight groups of bacteria at the phylum or class levels by using qPCR to characterize the function and structure of the microbial community of the original artificial soils. Simple 2 component systems using either illite or montmorillonite as clay component as well as treatments including charcoal showed a trend for lower abundance of soil microorganisms and lower enzyme activities. We detected a microbial succession of the soil microbial community from a dominance of *r* strategist (e.g. β -proteobacteria) during the first six months of the incubation towards systems with a higher dominance of *K* strategist (e.g. acidobacteria). The succession of enzyme activities gave clear evidence that nutrient limitations developed over time. Multivariate analysis of phospholipid fatty acid patterns revealed that nutrient limitation might also change the specificity of microbial colonization of different artificial soils towards more similar microbial population in all treatments at the end of the incubation.

Analysis of minerals in biofilms Using atomic force microscopy and raman spectroscopy.

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Although biofilms play a significant role in geochemical cycling, the detailed structure and composition of biofilms is not known. Minerals within biofilms may be crucial for the transport of contaminants as surface reaction sites, e.g. for adsorption. A better understanding of these processes at the molecular scale will generate the basis for predictions at larger scales. An additional benefit of this approach will be an improved insight into the consequences that these processes have concerning the fate of inorganic pollutants in natural environments.

In order to obtain a better understanding of the structure of biofilms, spatially resolved chemical information is needed. Therefore, biofilms from different origins, e.g. grown in hot springs, and the precipitates from biofilms at the iron-rich spring, Bonifazius-spring (Scuola, Switzerland) were examined by atomic force microscopy (AFM) and Raman spectroscopy.

AFM images of the Fe-precipitates showed that the precipitates size can be from tens of nanometers to tens of micrometers, and their shapes of the precipitate varied from spherical, leaf-shape to irregular polygon. Raman spectra indicate that the spectral features of the precipitate are different, but are originated mainly from Goethite structure (FeOOH).

The AFM images resolved cell and extracellular polymeric substances (EPS) structures in the case of cyanobacterial biofilm. With the distinct Raman spectra, differentiation between EPS and cell material was possible. The Raman spectra at the supposed cell regions showed beta-carotene bands, whereas the other regions did not show any bands or much weaker beta-carotene bands. The obtained Raman map composed of specific marker bands was in good agreement with the different topological features of the AFM image, thus combining topographical and chemical information.