

Clay mineral protects microbial-derived organic matter as macromolecular structures under the harshest possible environmental conditions

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Soil microbial biomass is a primary component of SOM and is therefore expected to play a crucial role in the biogeochemical cycling of carbon. Ubiquitous and abundant in soils, clay minerals are important natural adsorbents of SOM, and therefore, serve as natural modulators of the rate and extent of soil-atmospheric carbon fluxes. Although such effects have been noted, the spatial distribution of OM on clay surfaces and the factors controlling it remain poorly understood.

In attempting to address these knowledge gaps, HR MAS NMR spectroscopy and allied analytical techniques are applied to provide molecular-level information on which organic structures preferentially associate with clay minerals, which may be accessible to decomposers; and which are physically protected from biodegradation and acid hydrolysis—the harshest possible condition such complexes are likely to experience in the environment.

Surface and interlayer interactions of soil microbial biomass with montmorillonite have been confirmed by SEM and XRD, respectively. Further, elemental X-ray analysis of SEM images shows spatial co-variations of microbial-derived OM with Fe, Al and Si, suggesting important roles of these mineral components in clay-microbial interactions. There is also good evidence to suggest that aliphatic components preferentially adsorb to the mineral and remain dominant after degradation and acid hydrolysis. Acid hydrolysis using 6M HCl is a chemical degradation approach frequently used to depolymerize SOM to yield monomers suitable for chemical analysis and thereby provides a means to distinguish between labile and sorptive protected fractions of microbial-derived OM. Although not as abundant as aliphatic components, proteins/peptides and carbohydrates are also strongly adsorbed and are protected as macromolecular structures.