Rhizosphere Control of Soil Carbon Association with Fresh Minerals

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The rhizosphere - the nexus of plant-soil-microbe interactions - is the largest active terrestrial C reservoir. As roots transfer organic compounds to the soil, the fate of this SOM is determined by (i) *who* is there (which microbial taxa), (ii) *what* chemical form the C is in, and (iii) *where* C is associated within the soil physical environment. We aim to develop a mechanistic understanding of plant-derived C association with soil minerals, investigating how SOM is protected from microbial degradation during growth of *Avena barbata*, a Mediterranean annual grass. We grew *A. barbata* with 99 atom% $^{13}CO_2$ and tracked ^{13}C-labeled photosynthates into soil microcosms where three minerals types were incubated: FeO-coated quartz, kaolinite, and ferrihydrite, representing a spectrum of reactivity and surface area. Mineral samples were collected at four timepoints during plant growth, ending at senescence. In the second phase of our experiment, ^{13}C-labeled roots from the initial study were ground and mixed with soil to represent root litter created during the long period of Mediterranean dry-season senescence. Again, the three mineral types were incubated in soil, with CO_2 collected throughout the incubation. Mineral microbial communities and C associations were characterized using bacterial and archaeal 16S and fungal ITS Illumina sequencing, total C and ^{13}C, ^{13}C-NMR, and FTIR. To investigate C-mineral associations at the scale of individual soil microorganisms, we used combined STXM and NanoSIMS molecular/isotopic imaging to measure the distribution of specific C functional groups and ^{13}C enrichment on the mineral surfaces. Our findings suggest that (1) while mineral reactivity enchances SOM association, the presence of even relatively non-reactive surfaces allows for SOM accumulation, (2) growing roots host fungal partners which directly shunt C to minerals, and (3) microbial colonization of fresh minerals differs depending on mineralogy.