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Microbe mineral effects on SOM formation and persistence

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The biodiversity and biogeochemical attributes of the soil microbiome are widely celebrated, particularly in their contributions to soil organic matter (SOM) formation. Yet the mechanisms and pathways leading to microbe-mineral interactions that support SOM accrual and persistence remain elusive. Here we present a multi-omic, isotope informed investigation of the microbial contributions to persistent SOM using incubations of soils from two long-term ecological experiments. Both sandy and silty loams were planted with annual and perennial monocultures, resulting in distinct microbiomes, yet the microbial pathways and mechanisms driving persistent microbial residues was surprisingly consistent. Multi-omic analyses demonstrated the relative importance of microbial metabolites, proteins, and lipids as potential precursors to persistent SOM, yet the majority of microbial ^{13}C was recovered in the light fraction of mineral associated organic matter (MAOM). Within the light MAOM, ^{13}C enrichment was most abundant in samples rich in amorphous Fe-bearing minerals, as revealed by XRD analysis and Mössbauer spectroscopy. In contrast we found less retention of microbial residues in soils high in quartz and kaolinite. NanoSIMS analyses revealed ^{13}C hotspots of highly enriched necromass coinciding with distributions of Fe, Al and Ca, providing further evidence of the importance of microbe-mineral interactions. Our results are among the few empirical findings supporting conceptual models of the importance of microbe-mineral interactions in generating persistent SOM and provide a quantitative understanding of the ecological interactions that may regulate microbial necromass persistence in sandy and silty soils.