How to Increase Mineral-Associated Organic Matter Formation in Organic-Rich Soils?

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Mineral-associated organic matter (MAOM) serves as a critical reservoir for long-term soil carbon (C) stabilization due to its strong physicochemical binding to minerals, which resists decomposition from microbial and enzymatic activity. This research explores the mechanisms underlying MAOM formation broadly, focusing on interactions between soil organic matter (SOM) and mineral surfaces influenced by factors like SOM source, minerals properties, and pathways (derived from microbial or plant derived processes). To analyze these mechanisms, we reviewed literature on different types of soils, identifying key features of minerals or other relevant soil amendments that promote MAOM stabilization. Results indicate that while existing studies focus on MAOM formation in mineral-rich soils from upland systems, there are significant knowledge gaps in how these processes translate to organic-rich soils, such as histosols, where unique factors—such as high organic content, redox dynamics, and specific microbial communities—impact MAOM stabilization. In response, we emphasize the distinguishing features of organic-rich soils and subsequently propose potential amendments for enhancing MAOM in cultivated histosols and similar soils that exist in less aerobic environments. We highlight short- and long-term impacts of these amendments on MAOM stabilization, underscoring the importance of addressing confounding factors like mineralization, CO_2 release, and environmental conditions, including temperature, precipitation, and soil moisture. In conclusion, this review provides insights for future research to stimulate MAOM formation in organic-rich soils, offering implications into effective strategies for enhancing soil C storage and contributing to climate mitigation efforts.