Organometal complexes link soil development and carbon cycling

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Soil development and carbon cycling are linked through the input and transport of reactive organic compounds, such as low molecular weight organic acids. These compounds form stable 'organometal' complexes with many dissolved inorganic ions. The formation of these compounds influences the effective solubility of chemical weathering products including Al and Fe. As a result, the formation and transport of organometal complexes are a control on secondary mineral accumulation. Conversely, the persistence of organometal complexes may stabilize soil organic carbon from microbial degradation or leaching losses. The goal of this work is to evaluate the importance of organometal complexes across a range of environmental conditions.

We use a combination of field sampling, laboratory extraction and modeling to assess the role of organometal complexation in soil carbon cycling and soil development. Specifically, we compare data from three temperate soil chronosequences. Our results imply that organometal complexes play a significant role in the storage of soil organic carbon. For example, proxies for organometal complexation (i.e., sodium pyrophosphate extractions) are significantly correlated with total organic carbon storage across all study soils. Furthermore, evidence suggests the long-term stability of carbon associated with organometal complexes may arise from subsequent formation of secondary minerals with high reactive surface area.

To better assess these interactions, we employed a quantitative framework linking soil development, including time dependent mineralogical and hydrologic evolution, and carbon cycling. This framework is used to evaluate how the formation, transport and reactivity of organometal complexes influence soil development. Results suggest rates of soil mineral weathering are reduced in the presence of significant organometal formation and the spatial extent of secondary mineral formation is highly sensitive to organometal transport and stability. The nature of these interactions imply thresholds of soil development may be triggered by changing biological activity or through climatic or land use changes. Overall, this work highlights complex nature of biotic/abiotic interactions in soils and provides an alternative view of the link between soil development and carbon cycling.