Organo-mineral interactions in tropical soils of the Albertine Rift Valley, Uganda

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Soils of the Albertine Rift Valley

The Albertine Rift represents the western branch of the African Rift. The region has sustained extensive recent tectonic and geologic activity including significant Quaternary volcanism. These events have created important variations in weathering and soil formation environments, yet the implications for contemporary biogeochemical processes remain unexplored. The objective of this study was to determine the influence of mineralogical differences on soil organic matter dynamics under different land use.

We sampled 23 soil profiles in the Kabarole district of western Uganda and analyzed the samples for pH, texture, mineralogy, soil organic carbon (SOC), and major elements concentrations. We also used RockEval pyrolysis to characterize the thermal stability of organic matter. Finally, we performed sequential density fractionation on selected samples to separate organo-mineral complexes according to their mineralogy. The density fractions were then subjected to joint characterization of the mineral and organic components.

Mineralogical control on SOC accrual

Soils showed strong mineralogical differences within a small geographical area (~20 km), ranging from highly weathered lateritic plinthite to young soils rich in primary weatherable minerals. Organic C concentration was strongly correlated to soil texture, mineralogy and geochemistry but varied little across land uses (forest or small-holder farming), indicating that organic matter accrual and persistence was primarily controlled by edaphic factors and only secondarily by management and vegetation type.

Soil organic C correlated positively with sesquioxides. Hematite was a better predictor of SOC than goethite, and plinthite-derived soils had the highest concentration of SOC. This challenges the idea that highly weathered soils are necessarily infertile and unable to withstand land use change.

Analysis of density fractions showed that organo-mineral association is highly preferential and dependent on the presence of specific reactive phases, rather than texture. This advances our fundamental understanding of the mechanisms of organo-mineral interaction and has implications for our understanding of natural soil fertility in the area.