

VIRET Fanny (2018) : Soil organic matter dynamics in three contrasted ferralsols from western Uganda

Résumé

This research aims to unravel and compare organo-mineral associations in soils with contrasting mineralogy from the Albertine Rift Valley in Western Uganda, on the western border of Kibale National Park (KNP). To do so, 70 bulk soil samples collected in 2015 from three sites within 25 km of each other (Kanyawara: 8 profiles, Isunga: 8 profiles, Kajimiro: 7 profiles) have been analyzed for their mineralogy (XRD), geochemical composition (XRF), particle size (PSA) and carbon concentration (CHN). Based on these results, three soils, one from each site, were selected for a comparative study of their organo-mineral associations. Physical fractionation was applied on 6 bulk samples representing topsoil and subsoil horizons (KAN-A, KAN-B, ISU-A, ISU-B, KAJ-A, KAJ-B); each bulk sample was separated by density and/or size in 6 subsequent fractions in 4 replicates. The free organic matter, free light (fL) and occluded light (oL) fractions, were separated at 1.62g/cm^{-3} , the heavy fractions (fine silicates, coarse silicates, fine iron oxides, coarse iron oxides) were separated first by sedimentation at $8\ \mu\text{m}$ and then by density at 2.78g/cm^{-3} . The resulting 144 fractions (+ the 6 bulk samples) were analyzed with Rock Eval (RE) pyrolysis for soil organic matter (SOM) characterization. Selected RE parameters discussed here are total organic carbon (TOC), mineral carbon (MINC), oxygen and hydrogen indices, and the more recent thermal stability I/R indices (Sebag et. al, 2016).

Results from 70 bulk KNP samples highlighted a site-based contrast in mineralogy. Kanyawara (KAN) and Kajimiro (KAJ) are highly weathered tropical humid soils, developed on quartzite and old gneissic and granitic substrate. Isunga (ISU) developed on petro-plinthic and plinthic substrate resulting from a much older pedogenetic phase (partly indurated paleo-laterite). Soil organic carbon (SOC) distribution was observed to be primarily site dependent and only secondarily land-use dependent. The three soils selected for fractionation were classified as **Ferralsol** for KAN and KAJ, and as **petroplinthic Ferralsol** for ISU. Their average TOC concentration varied greatly between soils (KAN: 1.6%, ISU: 6.2%, KAJ: 1.8%) but also between horizons. Size and density fractionation results and subsequent TOC analyses on the fractions showed that the majority of SOC mass is found within the heavy fractions (89.3%). The light fractions (fL and oL) accounted only for a minimal SOC mass (10.7%). Within the heavy fractions, silicates contained 85% of total SOC mass while iron oxides accounted for only 4.3%. RE results showed distinctive SOM signatures, especially among the oxide fractions in which SOM was highly resistant to thermal cracking. This suggests a very stable (old) SOM, but in a relatively small absolute amount. The free light SOM had a labile and immature signature, while the occluded light SOM signature was much more diverse, ranging from labile and immature to highly resistant. Silicates showed very little diversity in their signature. The bulk sample signatures were carried by the silicate fractions. An additional density separation in the silicate fractions would allow a finer resolution in this dominant SOM pool. Among the fraction signatures, secondary site and horizon differences were also noted, suggesting that each site carries its own signature. In conclusion, the findings indicate that the SOM stabilization mechanisms in three *Ferralsols* are primarily defined by their association with specific mineral pools, and only secondarily by sites or horizons. However, absolute carbon content stocks remain dependent on the abundance of mineral phases known to be effective at sorbing SOM. The lateritic plinthic substrate of Isunga is abundant in highly reactive mineral phases and could be used as a natural mineral input to help more depleted soils better stabilize SOM which is the fertility reservoir of tropical soils.

Keywords: Soil organic matter, organo-mineral association, Rock-Eval pyrolysis, size and density fractionation, reactive mineral phases, mineralogy