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Mechanisms for SOC stabilization in a Volcanic Andosol: topsoil vs subsoil

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Soil organic matter has a critical role in agricultural productivity and climate. Thus, understanding C stabilization mechanisms in soils becomes increasingly important. Subsoil C stabilization has been recognized as an important agent for C offset. However, there is still a lack of studies at the microscale demonstrating differences on how C is stabilized in subsoils compared to topsoils. Therefore, we investigated a Volcanic Andosol, recognized by its extraordinary C storage capacity, aiming to differentiate process for C storage in surface and deeper layers. The experimental area is located at Kohala region, north Hawaii at the Pololu Lava Flow. We conducted soil organic matter fractionation, X-ray absorption near edge structure (XANES) and Focused Ion Bean (FIB) followed by Scanning Electron Microscopy (SEM-EDX) analysis on soil samples from 0 – 0.1 and 0.8 – 0.95 m depths. In addition, we incubated these samples for 30 days with labeled 13C biomass. Soil respiration was measured with a δ13C CO_2 Isotope Analyzer. After the incubation period, the samples were analyzed with Nanoscale secondary ion mass spectrometry (NanoSIMS) to observe the fate of 13C in the different soil layers. In the topsoil, most (61% of total SOC) of the total soil organic carbon content (SOC) was concentrated in the occluded particulate organic matter fraction (oPOM), while in subsoil layers, the small microaggregates of < 2 μm were responsible for most of the SOC storage (59% of total SOC). FIB followed by SEM-EDX shows evidence of SOC concentrations in clusters inside microaggregates ($< 20\mu$m) in topsoil layers, which could possibly be one of the main mechanism responsible for SOC stabilization in the topsoil. The XANES analysis also demonstrated distinct differences in Fe speciation in top- compared to subsoil samples in both bulk soil and clay fraction. Our results demonstrate a useful combination of SOC fractionation with spectroscopic analyses to evaluate mechanisms for SOC stabilization at the microscale.