Multi-level radiocarbon analysis of Hawaiian SOC

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In volcanic soils, organic carbon (OC) stabilization occurs concurrently with pedogenesis which can increase the interaction of mineral matrix and OC. This interaction contributes to the preservation of carbon from 10^2 to 10^4 of years. We studied a transect on Kohala Mountain (Island of Hawaii), where soils have formed on a 400 ka basaltic substrate. A precipitation gradient leads to systematic changes in soil properties along the transect; soil moisture (30%-70%), pH (7.0 -3.7), Fe content ($\tau_{Fe/Nb}$ = 1.2 to -0.9), and Al content ($\tau_{Al/Nb}$ = 1.2 to -0.9). 17 sites along the gradient were sampled for genetic horizon (~1m depth).

To examine the stability of the SOC as soil conditions change, we utilized a series of radiocarbon measurements. There is no sedimentary or ^{14}C 'dead' carbon to skew measurements and C inputs are relatively simple with two dominate plant species: *Metrosideros p.* and *Cibotium s.* We analyzed radiocarbon measurements from bulk soils, thermal fractions collected from ramped pyrolysis/oxidation (RPO), and compound-specific lipid biomarkers. This approach allowed us to interpret high resolution bulk ^{14}C measurements along the transect. As expected organic horizons are modern (Fm > 0) across the gradient. Below 40 cm, mineral soils change from Fm = 0.69 to Fm = 0.18 from the driest to wettest sites. Using the 'rampedpyrox' model, we can calculate activation energy distributions p(0,E) from RPO data within each sample. Our analysis shows mean E is clustered in two distinct groups. Where $\tau_{Fe/Nb} \geq 0$ mean E is lower (<150 kJ mol^{-1}); where $\tau_{Fe/Nb} < 0$ we found higher mean E values (>150 kJ mol^{-1}), indicating two distinct mechanisms of stabilization. Lipid biomarkers were used to constrain the endmembers of SOC at these sites. Long-chain *n*-alkanoic acids were older than both RPO fractions and bulk ^{14}C values. This effect was site-specific, so irrespective of actual age, plant waxes are much younger in soils where Fe is no longer abundant indicating Fe plays an important function in OC stabilization in volcanic soils. This approach allowed us to use three separate types of radiocarbon measurements to elucidate how SOC evolves and ages in a changing soil environment.