Iron loss promotes SOC turnover on a Hawaiian soil gradient

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Soil organic carbon (SOC) is a heterogeneous mixture of carbon compounds with varying reactivity. Changing environmental conditions can lead to destabilization of SOC through disruption of protection mechanisms, but this process is incompletely understood. We can test the impact of soil redox variability using Hawaiian andisols derived from a 400 ka Pololu (basaltic) lava flow formed on a precipitation gradient on Kohala Volcano, HI. Increasing precipitation with elevation leads to more frequent saturation and extensive iron loss. Two soil profiles, where differences in MAP lead to markedly different levels of Fe depletion (τ_{Fe}), were sampled by genetic horizon (~1m). Mineral soils (50-70cm) were freeze-dried, homogenized and analyzed on the Ramped PyRox (RPO) system at Woods Hole NOSAMS facility and isotopic analysis of lipid biomarkers was carried out at ETH Zurich. Carbon isotopes were measured on each RPO fraction and the *n*-alkanoic acids. Additionally, bulk ^{14}C, ^{13}C, TOC was measured. Each technique aims to dissect the complex mixture of SOC components in a given sample, either by thermal separation or specific chemical extraction.

RPO analysis gives an activation energy distribution for each thermal fraction collected and is a measure of thermochemical stability. RPO analyses at the two sites have uniform age distributions, meaning the ^{14}C age of low and high temperature components is nearly identical, suggesting that each thermal fraction contains a mixture of carbon compounds with the same activation energy distributions ($p_0(E)$). Calculated mean $p_0(E)$ range from 150kJ/mol at the Fe enriched site to 171kJ/mol at the Fe depleted site. The short chain fatty acids (SCFA) (C_{16}-C_{18}) and long chain fatty acids (LCFA) (C_{24}-C_{32}) were measured for ^{14}C. At both sites, average SCFA are younger with *Fm* values of 0.90 and 0.76 than the average LCFA of 0.63 and 0.18 respectively. However, at the Fe depleted site, the *Fm* values of both the SCFA and the LCFA are much higher indicating faster turnover of microbial-derived and plant-derived SOC. Combining RPO and biomarker analysis gives a thermal, age, and structural spectrum, which provide a powerful new perspective on SOC stability.