Complex non-crystalline mineralogy protects soil carbon from temperature-dependent decay

SUSAN E. CROW[1], CASEY MCGRATH[1], CAITLIN HICKS PRIES[2], NHU NGUYEN[1], MICHELLE LAZARO[1], CHRISTIAN GIARDINA[3], CREIGHTON LITTON[1]

[1]University of Hawaii Manoa, Honolulu, HI, USA (crows@hawaii.edu, mcgrathc@hawaii.edu, nhu.nguyen@hawaii.edu, mlazaro@hawaii.edu, litton@hawaii.edu)

[2]Dartmouth College, Hanover, NH, USA (caitlin.pries@dartmouth.edu)

[3]USDA USFS - PSRS IPIF, Hilo, HI, USA (christian.p.giardiana@usda.gov)

Mineral control on soil carbon (C) storage is well established, including the overarching role of poorly- or non-crystalline minerals (P-NCM) in C accumulation and stabilization. In volcanic ash-derived soils sampled from an undisturbed tropical montane wet forest along a 5.2°C mean annual temperature (MAT) gradient on the windward slopes of Mauna Kea on the Island of Hawaii, we observed variations in forms of P-NCM and crystalline iron (Fe)-oxides that significantly explained C storage and turnover, while other variables including MAT did not. In a batch sorption experiment based on these soils, high concentrations of P-NCM increased sorption of dissolved organic C, and the degree of organo-Al complexation was positively related to preferential sorption of aromatics. High P-NCM concentrations decreased the amount of labile C respired, and a high index of organo-Al complexation decreased its apparent temperature sensitivity during incubation. Finally, recent studies show a strong, positive response of deep soil respiration to artificial warming. We installed a novel system of heaters and sensors to monitor real-time soil temperatures in a network across a hillslope of volcanic ash-derived soils at the Lyon Arboretum on the Island of Oahu. One year of warming did not affect soil C efflux on a hillslope past a depth of 40 cm. High concentrations of P-NCM, high organo-Al complexation index, and protection within concretions of crystalline Fe-oxides that collectively results in high soil C storage is likely to protect that soil C against loss under future anthropogenic stressors such as increased temperature.