Impact of mineral-organic associations on CO_2 flux during soil moisture transitions

MICHAEL V. SCHAEFER[1], MARCO KEILUWEIT[2], CLAUDIA CHRISTINE AVILA[3], SAMANTHA C. YING[4], SHAWN G. BENNER[5], SCOTT FENDORF[6]

[1]University of California, Riverside; mschaef@ucr.edu
[2]Univ. of Massachussetts, Amherst; keiluweit@umass.edu
[3]University of California, Riverside; cmari009@ucr.edu
[4]University of California, Riverside; samying@ucr.edu
[5]Boise State University; sbenner@boisestate.edu
[6]Stanford University; fendorf@stanford.edu

Soils contain the largest terrestrial carbon pool, and carbon residence/turnover times range from years to millennia. Wetland soils contain 20-25% of global soil organic matter (SOM), but it is uncertain how wetland SOM will respond to altered hydrologic conditions arising from perturbations of river systems through dam construction, land-use change, and climate change. Wetland drainage leads to increased O_2 diffusion to soil, resulting in faster and more extensive carbon oxidation through aerobic metabolism. Increased O_2 diffusion also leads to precipitation of Fe minerals and formation of mineral-organic associations (MOA) that impede carbon oxidation. We sought to determine controlling factors on SOM mineralization during wetland drying events and specifically examined the role of O_2 diffusion to soil and formation of MOAs in tropical, periodic wetland soils from the Upper Mekong Delta, Cambodia, that experience annual flooding and drainage. We collected wetland soil cores (10 cm diameter) during initially flooded conditions and subjected them to drying conditions of oxic (ambient air), anoxic (O_2-free environment), and oxic+Fe (ambient air with addition of Fe(II)) conditions. High temporal resolution soil CO_2 flux measurements during drying under each condition show that addition of Fe and absence of O_2 reduce SOM oxidation by 50% and 75%, respectively, relative to the oxic condition. Density separation of soil following drying showed that the proportion of carbon contained in intermediate density fractions (1.6-2.4 g cm^{-3}), indicitive of MOAs, increased with addition of Fe and can explain the decrease in SOM oxidation. Our findings illustrate that MOA formation may exert a controlling force on soil CO_2 emissions in redox-transition environments, although the stability of MOAs is currently being assessed during periodic soil wetting and drying.