Carbon in transit – implications of microbial energetics for carbon and contaminant fate in transitory systems

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Organic carbon stocks in soils and sediments are impacted by redox transitions through wet-dry cycles. The fate of carbon within soils and sediments has important impacts on climate, water quality, and physical-chemical properties of soils. Importantly, carbon also provides energy for microbially mediated processes that transform nutrients and contaminants between redox states and, consequently, between solid and soluble phases. Traditionally, the energetics of microbial respiration in reducing conditions have focused on the available electron acceptors and largely overlooked the carbon compounds acting as electron donors. In part, this is due to the enormous heterogeneity of natural organic matter, which further poses analytical challenges to identify carbon compounds that then allow for thermodynamic calculations. Taking advantage of recent advancement in analytical capabilities for deciphering soil/sediment organic carbon (*e.g.,* FT-ICR-MS, C XAS) and theoretically demonstrated links between the nominal oxidation state of carbon (NOSC) and microbial energetics, we investigate how the electron donor pool (*i.e.* soluble organic carbon compounds) affects the trajectory of microbial respiratory pathways in relation to available electron acceptors. Through spatially and temporally resolved field sampling and laboratory mesocosm experiments, we examine organic carbon chemical composition across redox transitions in floodplain systems. We focus on active microbial respiratory pathways and mesoscale implications for carbon and metal(loid) contaminant fate. We provide field evidence that anaerobic conditions selectively prevent oxidation of soluble organic compounds that are insufficent to provide favorable energy gains in respiration. The results of our findings have far ranging implications on carbon preservation and downstream aquatic environments.