Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36454

Necromass Decomposition and Implications for Carbon cycling and Microbial Dynamics in Subsurface Low-Nutrient Ecosystems

BRIANNA FINLEY, MINGFEI CHEN, MINXI JIANG, MARKUS DERAAD, LUCY ZENG, HASAN YASINI, TRENT NORTHEN AND **ROMY CHAKRABORTY**

Lawrence Berkeley National Lab

Microbial necromass (microbial biomass from dead lysed cells) is increasingly recognized as a significant contributor to dissolved organic matter (DOM) in the environment especially in oligotrophic environments. However, the biogeochemical processing , or recycling of this carbon source under different redox conditions and its subsequent impact on microbial community dynamics and function remains poorly defined. As freshly lysed cell materials are transformed, the organic matter composition shifts from readily available cytoplasmic components (proteins, nucleic acids, and lipids) to more recalcitrant structural components (peptidoglycans, membrane fractions and protein aggregates). These shifts of DOM during necromass recycling, amplified by the redox conditions present during the decomposition, create distinct substrate pools that likely dictate the fate and functions of native microbiomes and subsequently, carbon and nitrogen cycling in the subsurface.

We investigated how redox conditions (oxic vs. nitrate-reducing) regulate microbial succession and resource utilization in oligotrophic groundwater environments using fresh and recycled necromass. While oxic conditions generally supported higher transformation and oxidation of this carbon to CO_2, the substrate quality strongly modulated this response. Faster microbial growth and CO_2 emision was observed from the fresh necromass inputs compared to the recycled necromass relative to nitrate-reducing conditions. Analysis of metabolites indicated broader transformation of complex carbon under oxic conditions compared to nitrate-reducing conditions. Under nitrate-reducing conditions utilization of fresh necromass occurred concurrently with rapid nitrate consumption and accumulation of nitrite as a transient intermediate. Nitrate reduction was minimal in the recycled necromass treatments. These observations were supported by lower microbial growth under anerobic conditions. Interestingly, the substrates exhibited distinct temporal signatures. With fresh necromass, microbial biomass and CO_2 respiration decreased before recovering again, while with recycled necromass the distinct microbial communities maintained slower but steady growth and CO_2 production over time. This indicates a shift in microbial community function as preferential, labile necromass components are depleted from fresh necromass. This work provides critical insights into the reciprocal relationship between DOM availability, turnover and cycling, offering a more nuanced understanding of carbon cycling and microbial metabolism strategies in the subsurface.