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Does the distribution of the size and functions of microbial community in soil particles follow the pattern of organic C turnover?

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Soil micro-habitat is important for soil organic carbon (SOC) stabilization, because of the physical isolation by soil aggregates and chemical sorption onto soil minerals. These mechanisms are responsible for SOC turnover times that vary significantly across soil particles. Although microbes mediate SOC turnover, it remains unclear how microbial communities vary among soil particles. Do microbial communities in soil particles follow the same pattern as SOC turnover? Are there potential links between microbial community and SOC turnover of soil particles? Therefore, quantifying the distribution of microbial community in soil particles will advance our understanding of the controls on SOC dynamics in soil micro-habitat, and further inform us how to present microbial communities and C stabilization mechanisms to SOC models.

In this study, we aim to quantify the distribution of the size (i.e. microbial biomass C: Cmic) and functions (i.e. enzyme activity) of microbial community in soil particles of different size. We hypothesize that (1) with decreasing soil particle size, as SOC becomes more stable, Cmic per soil particle generally decreases, C- and N- related enzyme activity decreases, and P- related enzyme activities increase, (2) the relative contributions of each soil particle to Cmic and enzyme activity of bulk soil would not follow the above patterns when the mass proportion of coarse soil particle was increased by disturbance or management, because the relative contribution is governed by Cmic and enzyme activity per soil particle and their mass proportions.

Methods: We searched for studies that meet the following criteria: (1) conducted physical soil fractionation to generate a series of soil particles of different size, (2) assessed Cmic of each soil particle using chloroform fumigation extraction, (3) measured enzyme activity for each soil particle.

We found 42 articles about Cmic and 65 articles about enzyme activity in different soil particles, and synthesized results from these studies. The preliminary results show that Cmic per soil particle reduced with decreasing soil particle size as predicted, but this pattern depends on land use and vegetation types. We also observed that P related enzyme activities increased with deceasing soil particle size, but C and N related enzyme activity did not follow the similar pattern.

Our further analyses will quantify the relative contribution of soil particles to Cmic and enzyme activity of bulk soil across climate, land use, and soil types, and identify the controls of the relative contributions of soil particles. Synthesizing microbial community distribution in soil particles globally will give hints about the links between C turnover, chemistry, and microbial community, and illustrate microbial roles in Corg in the soil micro-habit.