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# Extracellular enzymes and soil carbon dynamics: exploring the effects of soil clay minerals

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The importance of extracellular enzymes (EEs) in soil biogeochemical processes is well established. EEs are particularly decisive for carbon cycling through decomposition of organic matter (OM). The effectiveness of EEs in the soil depends on a number of factors including the amount and composition of clay minerals. However, the impact of interactions between clay minerals and EEs on the turnover rate of soil OM vis-a-vis carbon cycling in the soil is still poorly understood. Effects of clay minerals on activities of EEs have been mostly studied using clay minerals isolated from the soil matrix. Thus, it is not well elucidated how representative these results are for in-situ conditions. In this study, we analyzed the effect of different amounts of clay minerals added to soil on the activities of EEs towards understanding the role of interaction between clay minerals and EEs in soil carbon dynamics.

We investigated three enzymes, $\alpha$-glucosidase (AG), $\beta$-glucosidase (BG) and cellobiohydrolase (CB), which are important for soil carbon cycling. All assay preparations and measurements were carried out using fluorometric methods (MUF based substrates). A clay mineral (montmorillonite) was added to soil materials at four levels increasing the clay content in a logarithmic scale: +0% (control); +0.1%; +1% and +10%. The effects of clay minerals on EEs were analysed in two phases: firstly, the effects on the enzymes present in the soil were determined, and secondly the effect on a commercial enzyme (AG) added to the soil was tested.

First results revealed that increasing the clay content in the soil led to a reduction in the activity of EEs. For AG and BG, significant reduction in activity was noted ($P < 0.05$) when the soil enriched with clay minerals was compared to the control (no clay addition). The CB, on the other hand, showed no statistical differences between the control and all treatments with addition of clay minerals. Similarly, in the second experiment with the commercial enzyme AG, the enzyme activity was significantly reduced comparing the +10% clay treatment and the control. There was no significant different between the other two treatments and the control.

Overall, our study demonstrated that the activity of EEs decreases with increasing clay contents in soils. In a further experiment using the same soil, we determined the activity of enzymes produced by microorganisms in response to OM addition. In this experiment we found the opposite, i.e. increasing activity of EEs with increasing clay content, possibly pointing to a higher investment by the microorganisms in soils with higher clay contents. Our results represent important baseline knowledge towards understanding the linkages between clay minerals and the activity of EEs in soils. The experimental work is ongoing to further shed light on what the current results mean for soil OM decomposition and subsequent carbon dynamics in soil.