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PROJECT ABSTRACT

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The effects of aluminum oxides and soil structure on the potential of carbon sequestration in Swedish agricultural soil.

Stabilizing soil organic carbon (SOC) is essential for maintaining soil structure and carbon sequestration. However, understanding the mechanism and influencing factors of SOC stabilization is still limited. Soil structure through organic-mineral associations and pore size distribution helps to protect SOC from microbial decomposition physically. This physical protection of SOC has been suggested to have a maximum capacity that cannot be exceeded. If soils had a maximum capacity, then both the build-up and the decomposition of the soil would be controlled by the degree of saturation of SOC in relation to the maximum capacity analogous to the degree of physical protection. This is based on the assumption that clay has a dominating role in the physical protection of SOC. Recent research has challenged this view and shown that the interactions between SOC and reactive aluminum phases (Al) may be central for aggregation in acidic soils and, hence, for the physical protection of SOC. Therefore, we hypothesize that Al largely controls the physical protection of SOC, hence the decomposition of SOC for acidic soils under a humid continental climate facilitated through silt-sized aggregation. Similarly, as was done for clay, we also assume that the capacity of Al to associate with SOC is limited. SOC in soil well below this "SOC-Al saturation" (i.e., has a large Al-saturation deficit) is assumed to be physically protected from microbial degradation to a larger extent than the SOC in soil that is close to or above saturation. To test this hypothesis, we will 1) carry out long-term incubation experiments to determine the decomposition of SOC in relation to the Al-saturation deficit, both with intact soil columns and sieved soil from a field at Bjertorp with large natural variation in SOC, Al and clay contents. To enable interpretation of the results, we will also measure root input, root phenotypic properties, and column scale soil structure (i.e., characteristics of the macropore networks), which exerts a firm control on microbial accessibility to SOC. Macropore networks will be quantified by X-ray tomography and image analysis. Additionally, the role of reactive Al phases in protecting SOC on a national level in Sweden is unclear.

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Swedish arable soils have relatively low pH; therefore, we hypothesize that Al metal phases may be a useful predictor for SOC nationally across different soil types and climates. To test this hypothesis, we 2) assess the general observed correlations between SOC and Al by measuring the Al content in stored samples from the Swedish soil monitoring program "Soil and crop inventory of Swedish arable soils." Interpretation of the results will be facilitated by quantification of silt-sized aggregation, which governs the physical protection of SOC. The results from this project will facilitate more climate-smart agricultural management where investments in management for enhanced carbon sequestration are directed to soils where they will be most efficient.