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Weathering of soil parent material controls quantity and quality of soil organic carbon in alpine ecosystems

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In the global carbon cycle, organic matter in soils represents the major terrestrial pool of carbon, storing roughly twice the amount of carbon as do the atmosphere and vegetation combined. However, under changing environmental conditions, it remains unclear whether soils act as sources or sinks of carbon. Especially soils in alpine ecosystems are subject to undergo changes in their soil organic carbon (SOC) stocks. To disentangle the possible effects of climate change on SOC stocks in alpine environments, the factors which contribute to SOC stabilization have to be known and understood. Recent studies indicated the importance of soil physicochemical parameters governed by weathering of parent material.

To attain a better understanding of how parent material may influence SOC stabilization in alpine ecosystems, five alpine sites in Europe with varying parent material (i.e., Dolomite, Flysch, Gneiss, Greenschist, and Marl) were investigated. Similar climatic conditions, aspect, and slope allowed to analyze the impact of different parent materials on SOC stocks. The geochemical composition of the parent material and the soil, exchangeable cations and effective cation exchange capacity, pH, pedogenic oxides, soil texture, organic carbon and nitrogen contents, and SOC fractions were determined for all soil horizons (i.e., Oh, Ah, Bv, and Cv). The following SOC fractions were physically separated: unprotected, coarse particulate organic carbon (>250 µm), SOC occluded in microaggregates (53 – 250 µm), and SOC in the silt and clay fraction (<53 µm), which is assumed to be predominantly protected via minerals. Linear and non-linear models were computed in order to distill the relative importance of the geochemical parameters on SOC concentrations in the bulk soil (SOC_{bulk}) and the silt and clay fraction (SOC_{s+c}).

Preliminary findings point at the importance of soil depth, texture, and organically complexed oxides as these parameters were found to be among the best predictors for SOC_{bulk}. The concentrations of poorly crystalline aluminum, magnesium, and exchangeable manganese gained importance when predicting SOC_{s+c}. These results align with previous research which has shown the influence of pedogenic oxides on SOC stabilization, Furthermore, the significance of soil depth supports the increasing call of soil scientists to take the entire soil profile into account when analyzing SOC dynamics since large amounts of carbon are stored at depth below the commonly analyzed first 30 cm.