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Effect of permafrost on the formation of organic carbon pools and their physical-chemical properties in the Eastern Swiss Alps

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Alpine soils contain a relatively large amount of organic matter (OM) even at elevations above the present-days timberline. Current climatic conditions and the occurrence of discontinuous and sporadic permafrost in the mountains result in a low turnover rate and therefore accumulation of OM. Alpine ecosystems are highly sensitive to environmental changes and therefore may become a potential source of atmospheric carbon dioxide (CO_2) due to global warming. The expected changes in thermal and hydrological conditions in permafrost soils will not only influence OM degradation processes within the soil. Especially in alpine regions, soil erosion processes might be affected and potentially promote the mineralization of OM. However, the knowledge about the biogeochemistry and OM-stabilization processes and rates in permafrost soils in alpine regions is scarce, which makes it difficult to predict climate-carbon feedbacks.

Our aim is to determine and compare the quantity, allocation and mean residence time of OM and the potential erosion processes in permafrost soils and adjacent unfrozen soils (distance between permafrost/non-permafrost soils max. 200m) at three locations in the Eastern Swiss Alps (Val Bever, Albula). Bulk soil, labile (oxidized by H_2O_2) and stable fractions (H_2O_2-resistant) were analyzed for their C-content and characterized using DRIFT (Diffuse Reflection Infrared Fourier Transform). Additionally, selected soil samples were 14C-dated. This approach has been applied for the first time in high alpine regions. To estimate the degree of disturbance, soil erosion has been qualitatively assessed by relating the OM-delta13C values of the soil profiles of interest to undisturbed reference profiles.

We found rather well-developed soil profiles and a relatively high amount of OM at both types of sites (permafrost/non-permafrost), leading to the assumption that these soils developed over a certain period under a different (warmer) climate. This fact is supported by radiocarbon dating. Our assumption that a large amount of OM in the permafrost soils persists as easily degradable OM, as it is shown for north-exposed soils in the Alps has still to be evaluated. Due to cryoturbation, the determination of physical erosion in permafrost-affected soils is rather difficult because also organic matter is redistributed along the profile that affects the delta13C signal.