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Black carbon as a carbon source for young soils in a glacier forefield?

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Most evident changes in Alpine soils today occur in proglacial areas where existing young soils are continuously developing. Due to climate change, additional areas will become ice-free and subject to weathering and new soil formation. The glacier forefields of the European Alps are continuously exposed since the glaciers reached their maximum expansion in the 1850s. In these proglacial areas, initial soils have started to develop so that they may offer, under optimal conditions, a continuous chronosequence from 0 to 150 year-old soils.
The buildup of organic carbon (Corg) in soil is an important factor controlling weathering and the formation of soils. Not only autochthonous but also distant (allochthonous) sources may contribute to the accumulation of soil organic carbon in young soils and surfaces of glacier forefields. Black carbon could be an important component in Alpine soils. However, only little is known about black carbon in very young soils that develop in glacier forefields.
The aim of our study was to examine whether black carbon as an allochthonous source of soil organic matter can be detected in the initial soils, and to estimate its relative contribution (as a function of time) to total organic carbon. We investigated surface soil samples (topsoils, A or AO horizon) from 35 sites distributed over the whole proglacial area of Morteratsch, where ideal conditions for a soil chronosequence from 0 to 150 years can be found. Along this sequence, bare till sediments to weakly developed soils (Leptosols) can be encountered. Black carbon concentrations were determined in fine-earth using the benzene polycarboxylic acid (BPCA) marker method as described by Brodowski et al. (2005).
We found that the proportion of BPCA-C to total Corg was related to the time since the surface was exposed. The youngest soils (younger than 40 years) contained the highest proportion of BPCA-C (up to 120 g BPCA-C/kg Corg). In these soils, however, the Corg concentrations were very low (2-4 g/kg). The absolute concentrations of BPCA in fine-earth were low and did not show any trend with time. We presume that the deposition of charred organic matter is distributed evenly over the whole area and, therefore, is a main compound in young soils where total Corg concentrations are very low. Our results have shown that the investigated soils are to a certain extent also a passive collector of organic matter. Specific initial microbial communities consequently may profit from this additional C source during the first years of soil evolution and potentially promote soil development in its early stage.