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"Fast pedogenesis" on proglacial areas: examples from the north-western Italian Alps

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Climate changes have huge impacts on alpine ecosystems. One of the most visible effects is glacial retreat since the end of the Little Ice Age (LIA: 190-190 years ago), which caused the exposure of previously glaciated surfaces. These surfaces are open-air laboratories, verifying theories regarding ecosystem and soil development. In order to increase our knowledge on the effect of time and vegetation primary succession on soil development in proglacial areas, we sampled soils and surveyed plant communities on stable points on the proglacial areas of the Lys and Verra Grande glaciers, in the Italian north-western Alps (Valle d'Aosta). Sampling sites were located on dated sites (6-260 years), on the basis of literature or historical photographs).
Glacial till is attacked by weathering processes immediately after deposition and stabilization, such as loss of soluble compounds, acidification, primary mineral weathering. The speed of these processes are largely increased after the establishment of a continuous vegetation cover, thanks to surface stabilization, organic matter accumulation caused by litter input and root decomposition below the soil surface.
On sialic glacial tills (Lys forefield), below timberline and under a larch – Rhododendron forest, a fast and steady decrease in pH values, increase in organic matter content and horizon differentiation were observed. In particular, genetic eluvial horizons formed in just 60 years, while diagnostic albic horizons were developed after ca. 90 years, evidencing an early start of the podzolization processes. Cheluviation of Fe and, secondarily, Al were analytically verified. However, illuviation of Fe, Al and organic matter in incipient B horizons was not sufficient to obtain diagnostic spodic horizons on LIA materials.
Under grazed grassland below timberline and alpine prairie above timberline, acidification and weathering were slightly slower, and no redistribution with depth of Fe and Al oxi-hydroxides was observed. A cambic Bw horizon developed on the oldest LIA moraines.
On ultramafic materials (Verra Grande glacier forefield), vegetation succession was inhibited by toxic concentration of available Ni and Mg and scarcity of nutrients; this inhibited the organic matter input on the soil surface, slowing down acidification, base leaching and mineral weathering. However, soon after the establishment of the typical subalpine larch-Rhododendron forest on 190-260 years old moraines, a visible E horizon could form, overlying an organic matter and metal-enriched incipient Bs horizon.