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Soil development along a glacial chronosequence (Pré de Bar glacier, NW Italy)

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After the maximum expansion phase of the Little Ice Age, soils located in proglacial areas in the Italian Alps evolved over a time span of about 190 years. In the future, as a consequence of climate change, additional areas will become ice-free and therefore subject to pedogenesis. In such conditions, ice retreat time and topography are expected to play a major role among soil formation factors. Due to extreme environmental characteristics, soil evolution will be rather slow, and heavily influenced by severe soil loss phenomena (e.g. water erosion due to extreme rainfall event and snowmelt, avalanche erosion).
We investigated the soil formation along a glacial chronosequence of an Alpine glacier foreland. The Pré de Bar glacier is located in North West Italy (Aosta Valley Region), in the Mont Blanc massif, between 3750 and 2150 m a.s.l. and it covers an area of 340 ha. The glacier was chosen because of the availability of old photographs documenting the glacier retreat phases starting from 1820. At the present time, the cumulative retreat length of the Pré de Bar glacier has reached 1600 m.
Along this length, sampling sites were established at 6 successional stages from 6 to 189 years since deglaciation, from 2100 to 1880 m a.s.l.. Soil profiles were opened and sampled according to diagnostic horizons, then they were characterized by means of standard chemical and physical methods. Moreover, as recently deglaciated soils, characterized by incipient pedogenesis, may be particularly vulnerable from the physical point of view, the Atterberg Limits (LL, Liquid Limit; and PL, Plastic Limit) and the WAS (Water Aggregate Stability) index were determined, as indicators of soil physical quality. Soil samples were also subjected to organic matter density fractionation to assess the role of organic C in structure development.
All the analyzed soils were classified as Lythic Cryorthents (higher elevation) or Typic Cryorthents (lower elevation) (USDA - Soil Taxonomy), with depth ranging between 25 and 40 cm, regularly increasing with years since deglaciation. A similar trend was observed for the organic C content. A true organo-mineral horizon (A) was first identified approximately 65 years after deglaciation. We observed a general increase of soil physical quality along the chronosequence. Recently deglaciated soils displayed higher vulnerability to aggregate and consistence losses, i.e. lower LL and scarce or no plasticity, while the profiles at lower altitudes, on the oldest surfaces, displayed better properties, i.e. more developed structure and consistence, even for relatively young soils. Therefore in this area the stabilization of the material after the deglaciation resulted relatively fast, with a reduction of its vulnerability to mass and erosive processes, through soil development.
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