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Hidden paleosols at high elevation in the Alps (Stolenberg Plateau - NW Italy): evidence for a Lateglacial Nunatak?

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In the framework of climate change research, alpine soils may provide excellent paleoenvironmental information, thus representing a powerful tool for paleoclimate reconstruction. However, since Pleistocene glaciations and erosion-related processes erased most of the pre-existing landforms and soils, reconstructing soil and landscape development in high-mountain areas can be a difficult task.

This study was performed in the periglacial environment of the Stolenberg Plateau (LTER site Istituto Mosso), located on the watershed between Valsesia and Lys Valley, at the foot of the southern slope of the Monte Rosa Massif (Western Italian Alps, elevation: ca. 3030 m a.s.l.). The plateau is covered by thick periglacial blockfields and blockstreams, with a plant cover that reaches no more than 3-5% of the surface.

These periglacial landforms unexpectedly revealed well-developed soils below the superficial coarse deposits. In particular, below the stone layer, thick (between 30 and 65 cm) umbric horizons were observed, under which discontinuous cambic Bw ones were developed. In contrast, the surrounding snowbed communities (Salicetum herbaceae) were characterized by Regosols or Cambisols with 10-15 cm thick A horizons and weak signs of cryoturbation.

Despite the sparce plant cover, the organic carbon (C) stocks were surprisingly high (above 5 $kg*m^{-2}$), comparable to vegetated and even forest soils at lower elevation. In addition, geophysical investigations showed that these soils are widespread under the stony cover, with a thickness ranging between 20 and 90 cm.

Radiocarbon dating (^{14}C) indicated that these soils are paleosols, probably originated during the main warming phases/interstadials occurred between the end of Last Glacial Maximum and the beginning of the Neoglacial. In particular, the ages of the oldest samples were 20.5-20 ka cal. BP (values obtained from two independent and blind datings performed in different moments), others were dated ca. 17.5, 13, 8.5, 6.5, 5.7 ka cal. BP, while the youngest ages were 4.4-4.1 ka cal. BP.

These dates, particularly the oldest ones, show that the Stolenberg Plateau was presumably free of ice at the beginning of the Early Lateglacial, and its summer temperatures were already

compatible with some kind of vegetation development. The origin of these unexpected high-elevation soils, below blockstreams and blockfields, is of great relevance for unraveling the climatic history in the Western Alps. The results, including the soil characteristics, the geomorphological framework and the specific local landform setting, aspect, and position, suggest that the plateau may have been a Nunatak, which acted as a refugium for alpine vegetation during the last glacial pulses, serving as a hot-spot for the rapid reoccupation of deglaciated high-elevation landscapes.