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Combined use of relative and numerical dating techniques for detecting signals of Alpine landscape evolution during the late Pleistocene and early Holocene in Val di Rabbi (Trentino, northern Italy)

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A combined use of relative and absolute dating techniques was applied on nine soil profiles in order to reconstruct late Pleistocene and early Holocene landscape evolution in an Alpine environment located in Val di Rabbi (Trentino, northern Italy). The degree of podzolisation, clay mineral evolution and element mass balances of each site were investigated. Furthermore, the stable fraction of the soil organic matter (SOM) was extracted from selected horizons with 10% H2O2 and 14C-dated. The ages of the organic residues were compared with the ages of charcoal fragments found in one of the studied soils and with the ages of rock boulders obtained by the surface exposure dating (SED) method with cosmogenic 10Be. The combination of 14C dating of SOM and SED indicated that deglaciation processes in Val di Rabbi were very much advanced around 14000 cal BP and that glacier oscillations have affected the highest part of the region until about 9000 cal BP. The development of clay mineral reflects weathering intensity. We found a close link between secondary clay minerals like smectite and vermiculite and soil age as obtained by H2O2. The degree of podzolisation is time dependent and was used as an evidence of surface stability. The amount of Fe and Al forms that migrated and accumulated in the illuvial horizon correlated well with the time of soil development. Element mass balance calculations strongly correlated with the ages derived from 14C measurements. Old soils have lost a major part of base cations (up to 75%), Fe and Al. Chemical and mineralogical analyses were in good agreement with numerical dating techniques, showing the dynamics of an Alpine landscape within a relatively small area and enabling a relative and absolute differentiation of landscape elements. The combination of relative and numerical dating techniques is a promising tool to understand landscape evolution and to provide absolute chronologies of the Late glacial in high-elevation Alpine areas with siliceous parent material.