Late-glacial to Holocene sediment dynamics in high Alpine regions
Insights from multimethodological approach on aeolian deposits (Sanetsch Pass, Switzerland)

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Introduction

Widespread loess deposits accumulated during the last glaciations in low-elevation regions of Europe and are often used as paleo-environmental archives[1, 2].

High-elevation aeolian deposits occur also in the European Alps (Sanetsch Pass, Switzerland, Fig. 1) where they have been interpreted as result of Late-glacial (19-11.6 ka) glacier retreat[3, 4]. However, active geomorphic processes and related complex sediment dynamics occurring in high Alpine regions may prevent the direct use of high-elevation aeolian deposits as paleo-environmental indicators.

Research questions

- Which are the pre- and post-depositional histories of high-altitude aeolian deposits?
- Can they be used as paleo-environmental archives to reconstruct paleo-climate and paleo-atmospheric circulation pattern?

Multi-methodological approach

- **Sediment stratigraphy:** log, grain-size and micromorphological analyses
- **Sediment geochemistry:** XRD, TC and TOC analyses
- **Sediment dating:** conventional and portable luminescence measurements

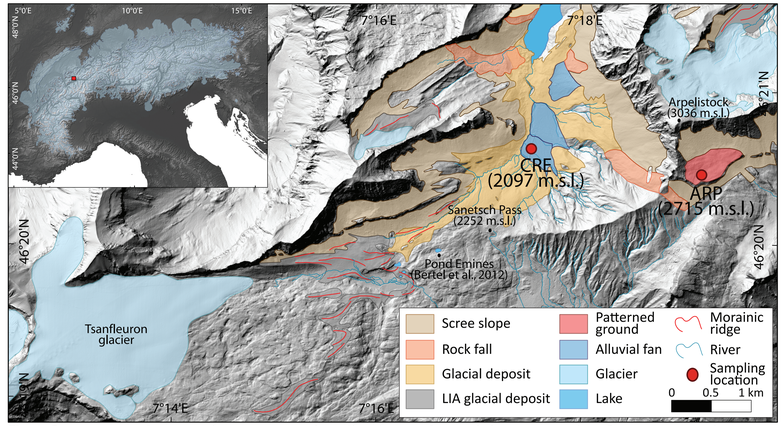
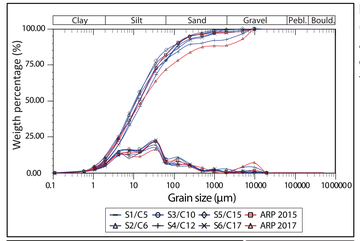
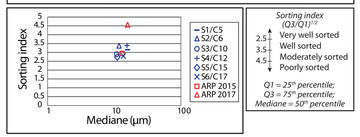


Fig. 1 Geomorphological map of the study area (modified from swisstopo). Among the various Quaternary deposits occurring at the Sanetsch Pass, this study focuses on a high-elevation platform covered by patterned ground (ARP, results in the light red box) and on an alluvial fan located in the fluvio-glacial plain (CRE, results in the light blue box), since aeolian sediments were identified in the stratigraphy of both deposits (Fig. 2). Inset: location of Sanetsch Pass within the Alps, with the Last Glacial Maximum ice extent[5].





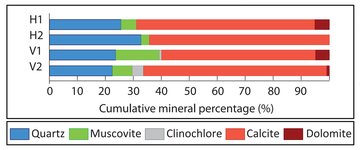
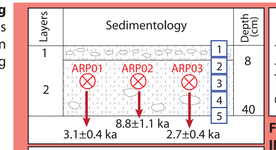


Fig. 2 Grain size distribution and sorting (ARP and CRE). Both grain size distributions and sorting indices suggest an aeolian origin of ARP and the fine layers of CRE, confirming the on-field logging.

Fig. 3 Local bedrock XRD analyses. The local bedrock is mainly composed of Hauterivian grey siliceous limestone (H1, H2) and Berriasian and Valenginian calcareous shales (V1, V2), both units belonging to the Wildhorn nappe of the Helvetic Alps. Quartz up to 20-30% occurs in both the lithologies.



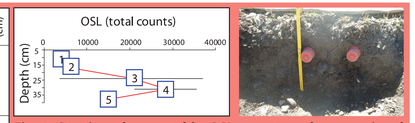


Fig. 4 Stratigraphy, portable OSL counts and conventional IRSL ages of the high-elevation aeolian deposits (ARP). A complex picture emerges from the luminescence analyses. Aeolian sediments were probably deposited before or during the Younger Dryas and then reworked by periglacial processes.

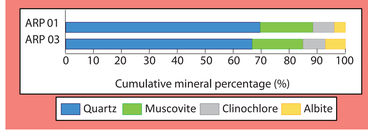
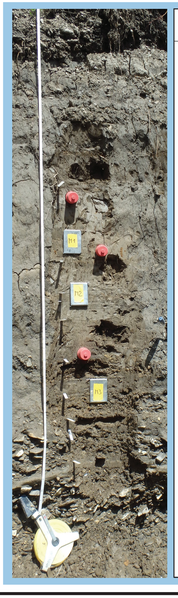


Fig. 5 XRD analyses (ARP). The presence of albite in the aeolian sediments and its absence from the bedrock (Fig. 3) suggests an allochthonous origin of the ARP deposit.

Conclusions

· The deposit from the high-elevation platform is a primary aeolian deposit with allochthonous origin, deposited before or during Younger Dryas (YD) and then reworked by cryoturbation.
· After YD glacier retreat, aeolian deposits, bedrock derived and glacial deposits were transported away from the slopes and deposited in the fluvio-glacial plain, rapidly building up an alluvial fan.
· This study highlights the dynamic and complex post depositional processes experienced by aeolian sediments deposited in high elevation Alpine settings, preventing their direct use as paleo-environmental proxies.
· This study shows the importance of a multimethodological approach to reconstruct sediment dynamics and connectivity.



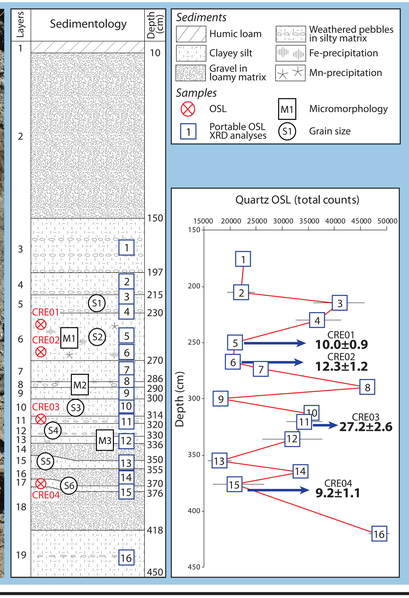


Fig. 6 Stratigraphy of the alluvial fan (CRE). An alternance of fine and coarse sediment layers was identified. Samples for the different methodologies were collected in order to better understand their origin and the possible connectivity with the ARP deposit.

Fig. 7 Portable and conventional quartz OSL (CRE). Two populations of low and high OSL counts can be identified within the stratigraphy, corresponding respectively to fine and coarse sediment layers. Conventional OSL ages suggest that the fan was deposited rapidly soon after the Younger Dryas. The higher luminescence signals and age (CRE03) of the layers containing lithic fragments is probably due to partial bleaching of the quartz grains (Fig. 8) contained in the weathered clasts.

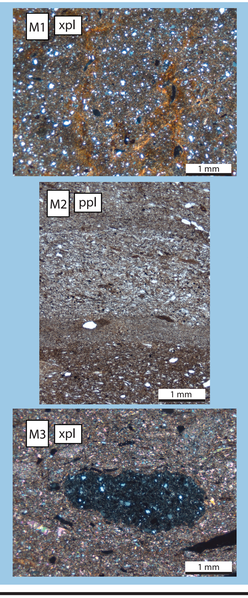
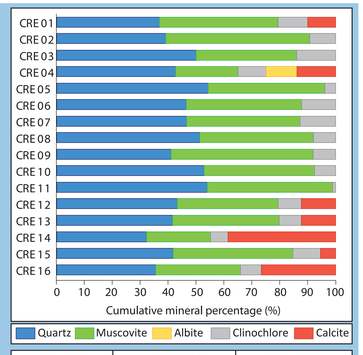


Fig. 8 Micromorphology of sediment thin sections (CRE). Three samples for micromorphological analyses were collected from the alluvial fan in order to better understand the depositional environment of the different layers.
M1 shows reworked loessic deposit with sub-angular blocky microstructure. **M2** exhibits a well-developed horizontal parallel lamination which supports decantation of the sediment in a lacustrine or fluviatile environment. **M3** shows weathered, completely decarbonated, lithic fragment containing quartz grains in a fine silty carbonated matrix, which probably derives from local bedrock or remobilization of slope and glacial deposits.



TC Wt%	TOC Wt%	TIC Wt%
0.5 - 4.9	0.3 - 1.2	0 - 4.6

Fig. 9 XRD, TC and TOC analyses (CRE). Fine layers contain around 50% of quartz and 50% of micas, while calcite occur in the coarse layers (10-40%). This further demonstrates a connection between the fine layers of the fan and the aeolian deposits (Fig. 5) and between the coarse layers of the fan and the bedrock derived/glacial deposits (Fig. 3).
The low TOC content demonstrates the absence of paleo-soils in the fan layers, further suggesting that the alluvial fan deposition occurred rapidly.

References

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