

Schmidt hammer exposure-age dating of large rock slope failure deposits in the Southern Swiss Alps

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In an Alpine environment, the occurrence of large rock slope failures is largely conditioned by glacial and paraglacial processes, which role on the timing of slope collapse has not been fully understood yet. To comprehend the strong relationship between the deglaciation and the large rock slope failures following it, a detailed geochronological assessment of both processes is essential. In the Southern Swiss Alps, between the five valleys north of Bellinzona (Riviera, Valle Leventina and Valle di Blenio in Canton of Ticino, Val Calanca and Valle Mesolcina in Canton of Graubünden), several debris accumulations of large rock slope failures can be observed. The objective of this research is to define the age of failure of four rockslide/rock avalanche deposits located close to the villages of Ludiano (Valle di Blenio), Bodio-Cauco (Val Calanca), Norantola and Centena (Valle Mesolcina) through Schmidt hammer exposure-age dating (SHD).

The Schmidt hammer, also called concrete sclerometer, measures a rebound value (R-value) which is proportional to the compressive strength of the rock surface. For a given lithology subject to similar climate conditions, the R-value can be considered as proportional to the weathering degree of the rock surface. As a consequence, R-values allow to determine a relative exposure-age of the rock surface, with high values indicating young ages, and vice versa. In case of R-values determined on two or more rock surfaces of known age, an age-calibration can be performed by regression analysis.

In this study, we performed a calibration curve thanks to cosmogenic nuclide dating of the surfaces of 4 erratic boulders deposited by the Ticino glacier in Riviera valley (Scapozza et al. 2022) and 13 boulders of the prehistoric rock avalanche of Chironico (Claude et al. 2014).

By linear regression, we calculated the following SHD of the investigated rock slope deposits: 17.90–15.86 ka for the Centena rockslide, 17.14–15.17 ka for the Ludiano rock avalanche; 17.00–14.93 ka for the Norantola rock avalanche, 15.24–12.72 ka for the Bodio-Cauco rockslide, 13.86–12.25 for the Chironico rock avalanche (Fig. 1).

Considering that the Last deglaciations of the Ticino and Moesa valleys started between 16.94 and 16.39 ka b2k and ended between 15.96 and 14.87 ka b2k, it is possible to observe two clusters of rock slope deformations: Centena, Ludiano and Norantola took place immediately during the deglaciation (delay of 0 to 2.03 ka according to the dating uncertainties) and represent an “early paraglacial” response (Cat. A in Fig. 1) occurred during the Greenland Stadial GS-2.1a of the INTIMATE event stratigraphy, dated between 17.48 and 14.69 ka b2k (Rasmussen et al. 2014). Bodio-Cauco and Chironico occurred 1.03 to 4.16 ka after the deglaciation, and represent a few millennia “delayed response”

to the deglaciation (Cat. B in Fig. 1). Indeed, these two rockslides fell during the Greenland Interstadial GI-1 (14.69–12.90 ka b2k), which was characterized by the first significant temperature increase after the Last Glacial Maximum. If we consider also four rock slope deformations fell in historical times (Monte Crenone, Sasso Rosso, Valegión) or not yet collapsed (Simano), it is possible to observe a third cluster (Cat. C in Fig. 1), with a very long delay (more than 14 millennia) after the deglaciation.

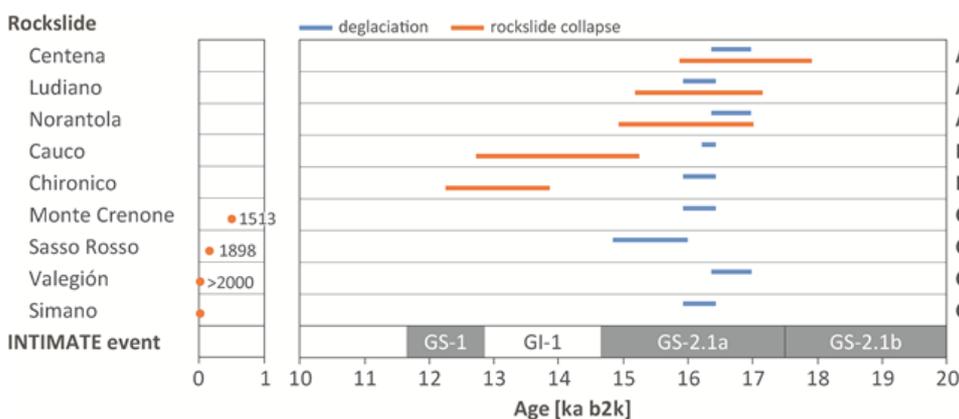


Figure 1. Comparison between the ages of rockslide collapses for 9 sites of the Lepontine Alps and the age of deglaciation of the valley slope that generated the instability. INTIMATE events from Rasmussen et al. (2014).

REFERENCES

Claude, A., Ivy-Ochs, S., Kober, F., Antognini, M., Salcher, B., & Kubik, P.W. 2014: The Chironico landslide (Valle Leventina, southern Swiss Alps): age and evolution, *Swiss Journal of Geosciences*, 107, 273–291.
<https://doi.org/10.1007/s00015-014-0170-z>

Rasmussen, S.O., Bigler, M., Blockley, S.P., Blunier, T., Buchard, S., Clausen, H.B., ... & Winstrup, M. 2014. A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy, *Quaternary Science Reviews*, 106, 14–28.
<https://doi.org/10.1016/j.quascirev.2014.09.007>

Scapozza, C., Giacomazzi, D., Czerski, D., Kamleitner, S., Ivy-Ochs, S., Mazzaglia, D., Patocchi, N., & Antognini, M. 2022: Timing of deglaciation and Late Glacial and Holocene infilling of the Ticino valley between Biasca and Lago Maggiore (Southern Switzerland), ICG2022-118.
<https://doi.org/10.5194/icg2022-118>