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SCHWEIZERISCHE GEOMORPHOLOGISCHE GESELLSCHAFT
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20th swiss geoscience meeting 2022 lausanne

# Schmidt hammer exposure-age dating of the debris accumulation of three large rock slope failures in the Southern Swiss Alps

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## Introduction

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 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, several debris accumulations of large rock slope failures can be observed

## Material and methods

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

## Objective

The objective of this research is to define the age of failure of four rockslide/rock avalanche deposits 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).

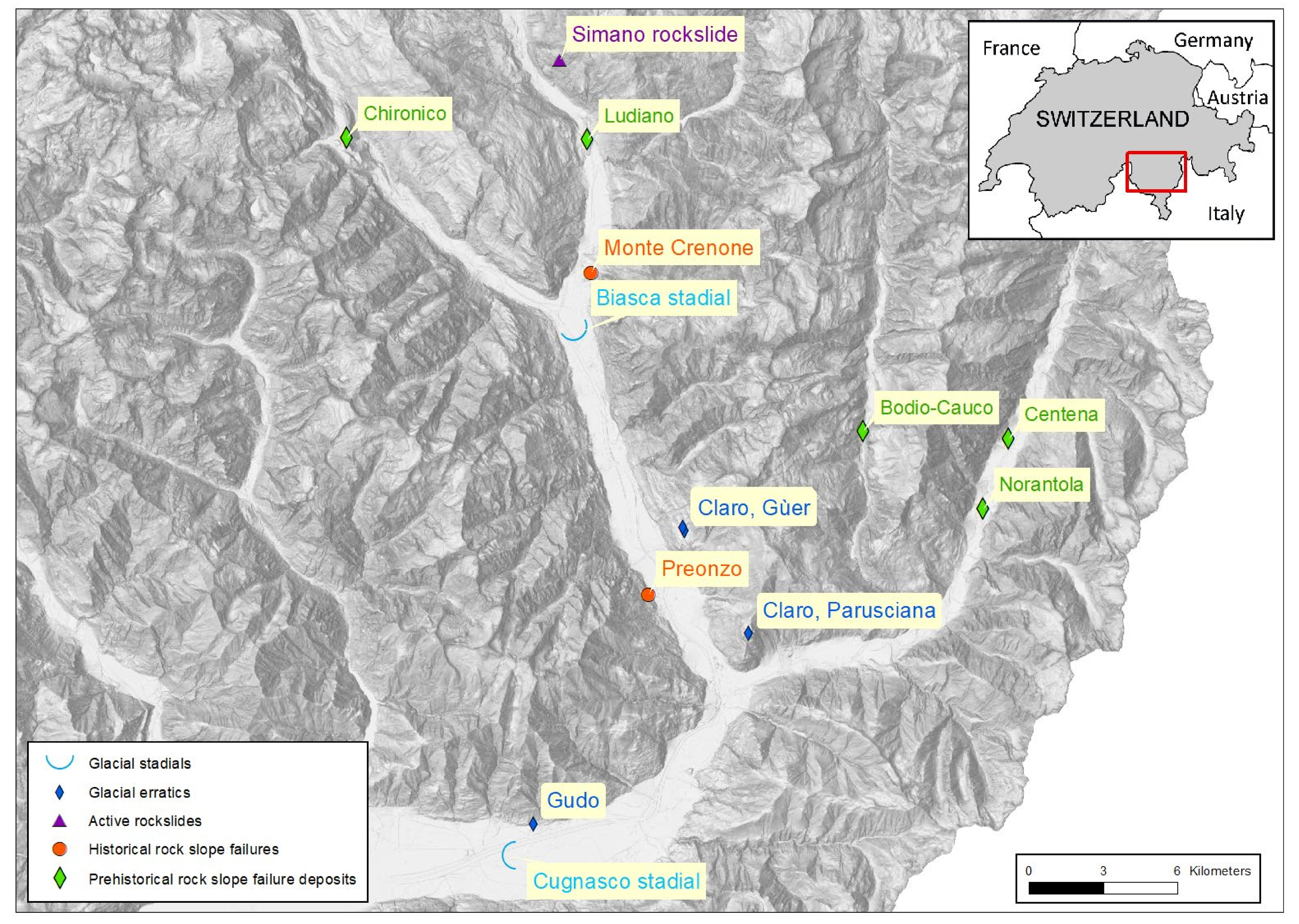


Figure 1. Distribution of the sites of analysis in Canton of Ticino and Canton of Graübundern, Southern Swiss Alps.

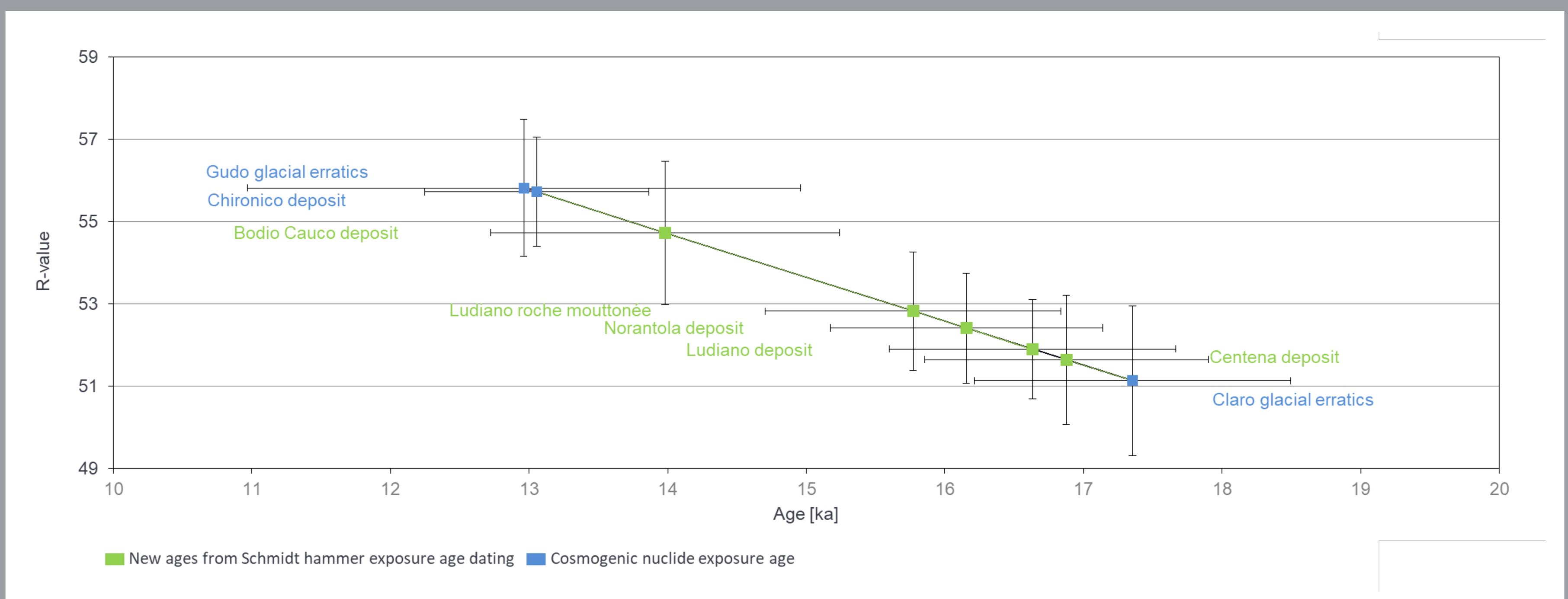


Figure 2. Linear regression from the ages of Gudo erratic (Scapozza et al. 2022) and Chironico deposit as younger constrain (Claude et al. 2014), and glacial erratics from Claro (Scapozza et al. 2022) as older constrain.

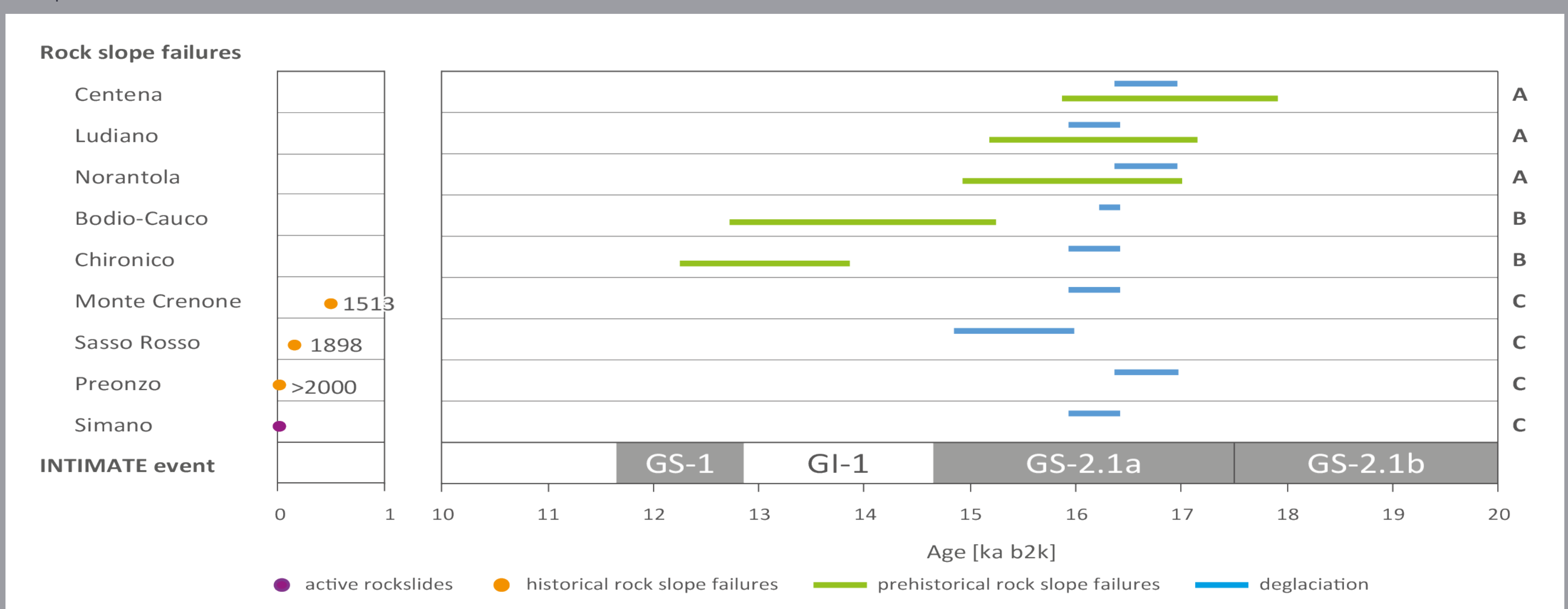


Figure 3. Comparison between the timing of rock slope failures and age of deglaciation.

Figures 4. Ground survey pictures. A: Block signed by the Schmidt hammer impacts. B: Schmidt hammer and Cosmogenic nuclide sampling point on glacial erratic at Claro. C: Glacial erratic close to Claro. D: Block of the deposit of Norantola.
E: Block of the deposit of Monte Crenone rock avalanche. F: Block of the deposit of Bodio-Cauco. G: Block of the deposit of Chironico. H: Block of the deposit of Ludiano.

## Results

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 ka for the Chironico rock avalanche.

## Conclusions

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. 3) 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. 3). 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, Preonzo) or not yet collapsed (Simano), it is possible to observe a third cluster (Cat. C in Fig. 3), with a very long delay (more than 14 millennia) after the deglaciation. Considering collapse volumes of about 2 M m³ for Centena, 4 M m³ for Ludiano, 21 M m³ for Norantola, 10 M m³ for Bodio-Cauco and 530 M m³ for Chironico, it is possible to state that the early paraglacial collapses involve smaller volumes than collapses with delayed response. However, a larger dataset of volumes and age of collapses would support or deny their relation.

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