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Geomorphology and Landscape Evolution at the Chironico Landslide (Leventina Valley, Swiss Alps)

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Introduction

The Chironico landslide is located in the Leventina Valley in the Swiss Alps. About 500 million m³ (Schardt, 1910) of crystalline granitic gneiss, belonging to the Lower Penninic nappes, detached from the eastern valley wall, slid along valleyward dipping foliation of 25-30 degrees and smashed into the Ticinetto stream mouth.

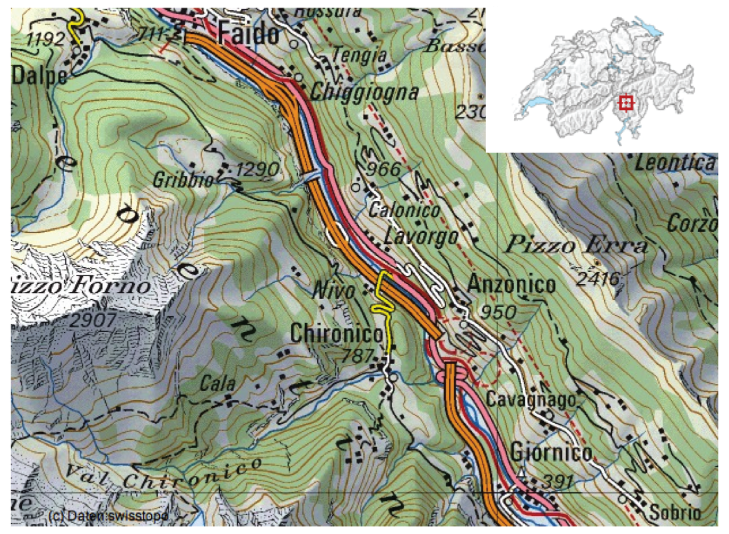

Fig 1. Location map of the study area *(Swisstopo 1:80'000)*

This project should help to understand the driving mechanisms of large rockslides in the Alps and to clarify at which time period the large post-glacial-prehistoric rockslides were triggered.

^{14}C ages of about 13'500 cal yr BP (Antognini and Volpers, 2002) were obtained from wood in a sediment core in an upstream-dammed lake, north of the landslide. Through dating with the cosmogenic nuclide ^{10}Be an absolute failure date can be assigned to the Chironico landslide, which then allows the comparison to the obtained ^{14}C ages.

Approach and methods

Field work

- Mapping the landslide and other Quaternary depositional and erosional landscape elements.
- Sampling eleven suitable boulders for surface exposure dating from both lobes of the accumulation area.


Fig 2. Sampling a quartz vein

Laboratory work and surface exposure dating

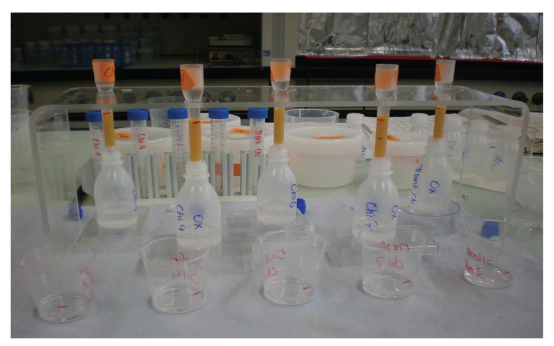
Fig 3. Be extraction through ion exchange columns

The radionuclide ^{10}Be is used for dating as numerous quartz veins are found in the landslide boulders consisting of crystalline gneissic rock. The ^{10}Be concentrations are measured by AMS (accelerator mass spectrometry) at the ETH Zurich.

Modeling

- Reconstruction of the Leventina Valley before the impact of the rockslide with the help of a GIS-based landscape analysis of a high resolution DEM and by subsurface data illustration of drill core logs with the program RockWorks.
- Run-out modeling of the landslide with the DAN3D program.

Result: mapping

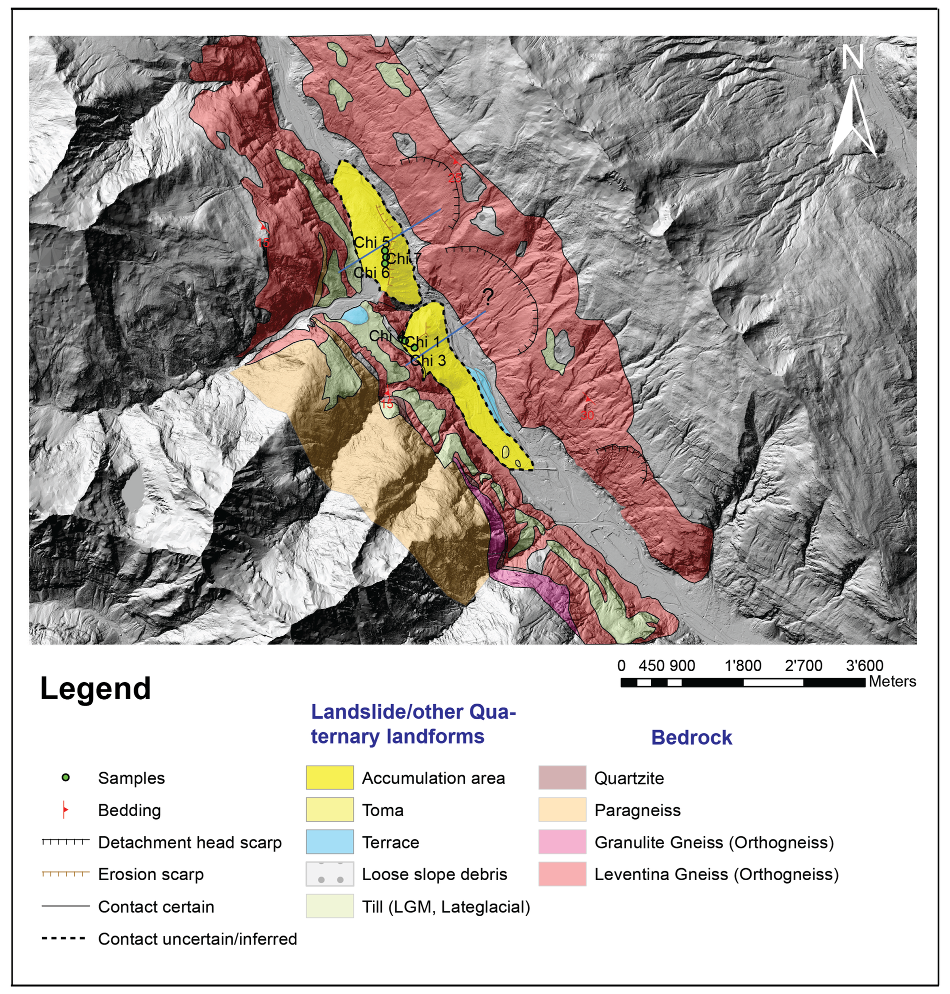

Fig 4. Mapping of the study area in GIS

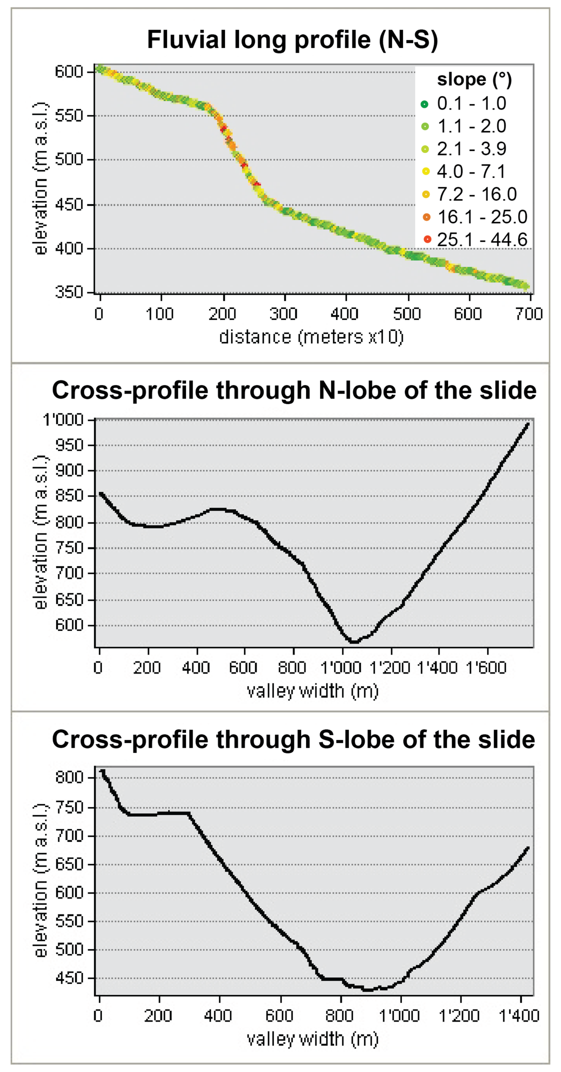

Fig 5. Profiles through/across the valley.

On the N-S fluvial long profile a knickpoint is observable between 450-560 m; it separates the incised from the aggraded area (Korup, 2006).

The profile across the northern lobe of the landslide shows a convex shape of the slope and a V-shaped valley bottom that is due to the incision of the Ticino river.

In contrast the cross-profile through the southern part illustrates a more concave slope shape with no erosion traces. The widening of the valley shows the undercutting of the southern lobe.

Result: surface exposure dating

Sample name	Weight (g)	Exposure age (yr)	External uncertainty (yr)
Chi-1	32.24	13'911	1'013
Chi-4	30.33	13'107	974
Chi-6	31.71	12'808	968
Chi-7	29.61	12'765	951
Chi-3	10.86	13'195	1'306
Chi-5	6.79	14'658	1'775

The ages are calculated with the NE North America developmental version of the CRONUS-Earth online calculator (Balco et al. 2009) using the time-dependent model of Lal (1991)/Stone (2000) with P_{sp} = 3.88 ^{10}Be atoms/g/yr.

The production rate of 3.89 ± 0.23 atoms/g/yr was calculated based on a ^{14}C age of 13'161 cal yr BP (Antognini and Volpers, 2002) and an uncertainty of 1%.

Result: modeling the pre-slide valley

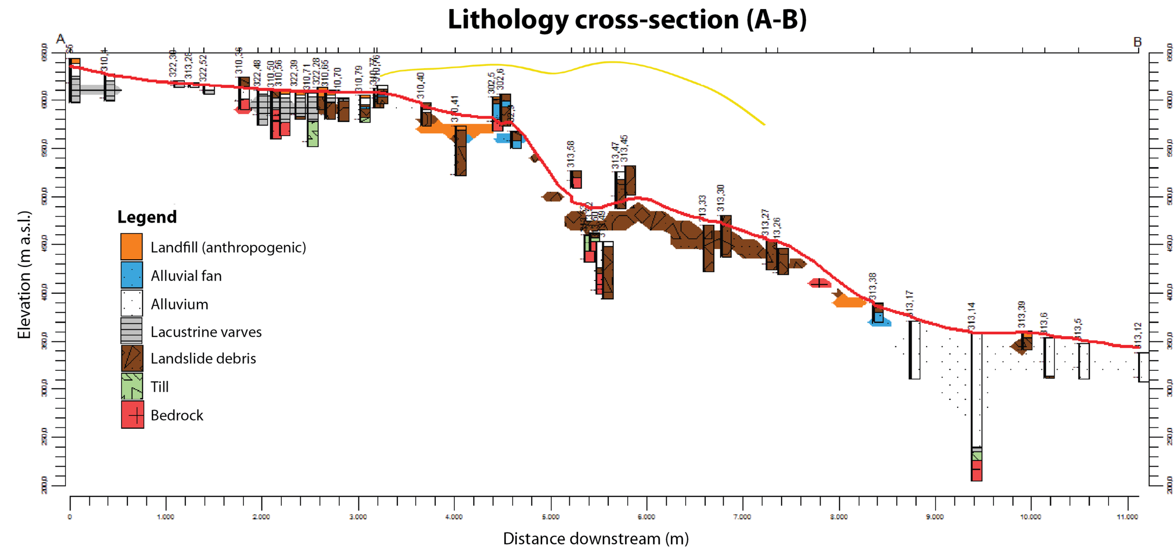

Fig 6. Subsurface data illustration of 40 drill core logs with the program RockWorks

The following model of the pre-slide valley is realized in ArcGIS and is based on the information gained from the core logs drilled in the valley between Calonico and Giornico.

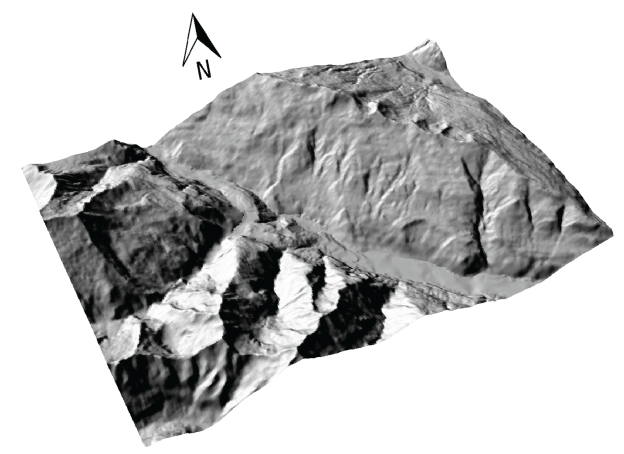
Fig 7. Hillshade of the actual Leventina Valley

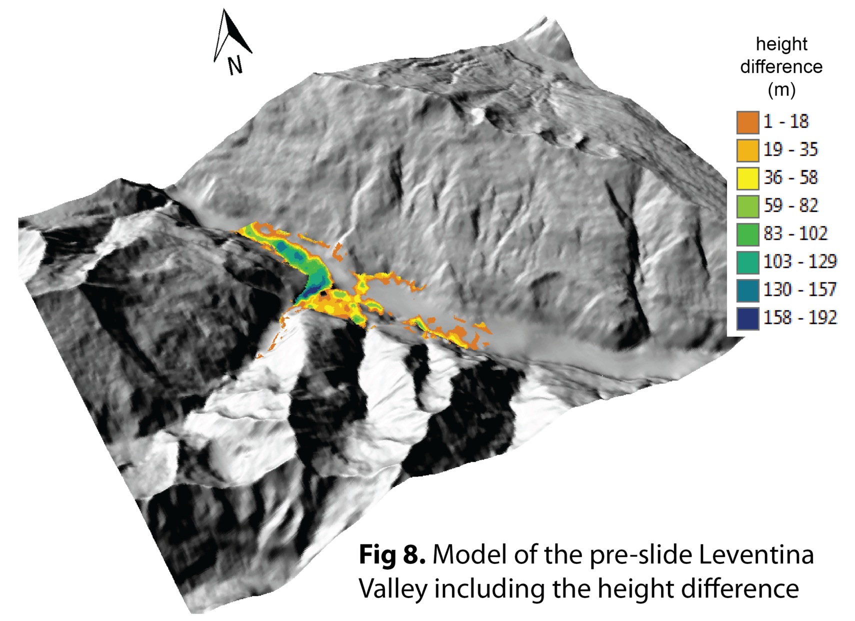

Fig 8. Model of the pre-slide Leventina Valley including the height difference

Outlook

The preliminary results indicate that the Chironico landslide was released during the Bølling-Allerød interstadial between 14'700 and 12'700 yr BP. The exposure dates show that within the measurement errors the N and S lobes are a single landslide. As the subsurface data illustration of the core logs shows, lacustrine sediments with varves were deposited to the North on top of the landslide. We can therefore conclude that the sliding mass dammed the Ticino river and therefore a lake could build up.

A runout model of the landslide will be generated with the DAN3D program to get a runout distance, which thus helps to better characterize the release area.

References

Antognini, M. and Volpers, R. (2002). A Late Pleistocene Age for the Chironico rockslide (Central Alps, Ticino, Switzerland). Bull. appl. Geol., 7 (2): 113-125.

Balco, G. et al. (2009). CRONUS-Earth online calculator: http://hess.ess.washington.edu/math/index_dev.html

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