A new approach to dating carbonate-lithic rockslides

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Large-scale rockslides exceeding 10^6 m^3 in volume not only are a major process of mountain erosion and orogenic mass balance but, in densely populated regions such as the Alps, also represent a major threat to humans and facilities. Establishing the distribution of rockslides in time is a prerequisite of hazard assessment for future events and for a better understanding of potential triggers, such as climatic change or phases of enhanced earthquake frequency and post-glacial stress relaxation (e.g. Erismann & Abele, 2001).

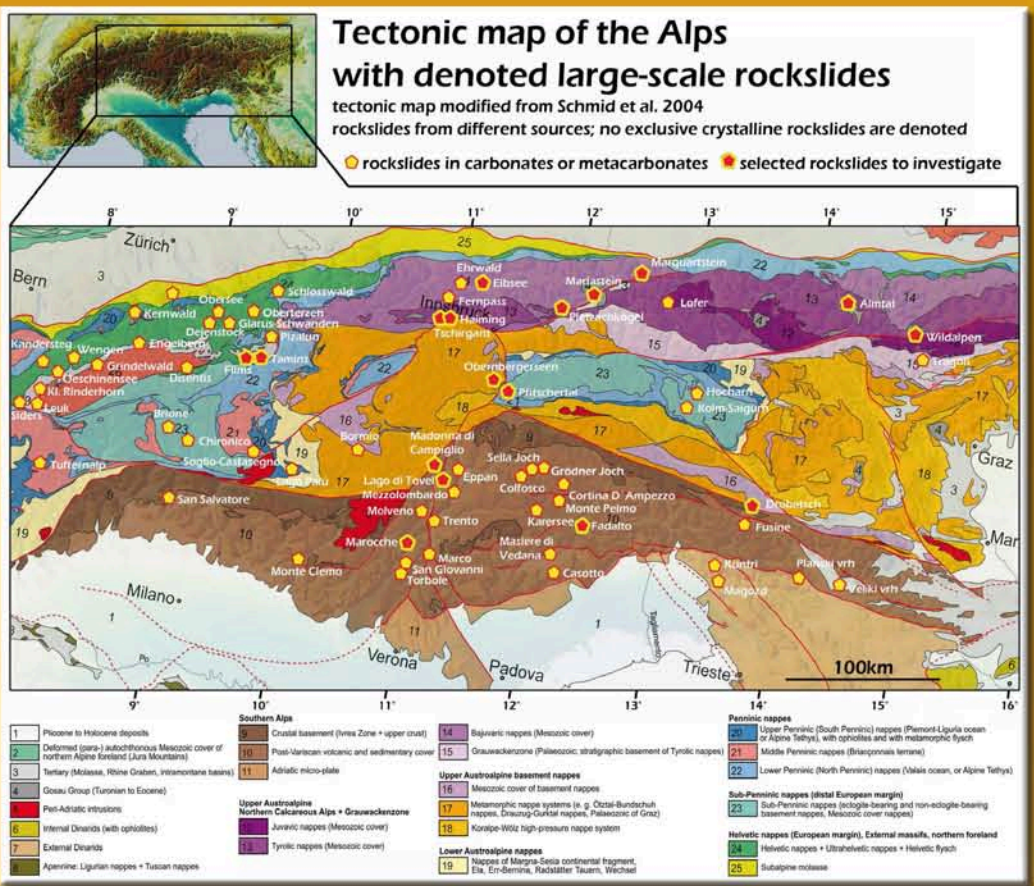

Figure 1: Overview map of the Eastern, Southern and most of the Western Alps with prominent carbonatelithic rockslide deposits. Rockslide deposits chosen for further investigation are highlighted by yellow framed pentagons.

In the last decades, rockslide deposits were dated by ^{14}C age determination of wood fragments that are preserved (a) in lacustrine or fluvial successions underneath the rockslide mass, (b) within the rockslide mass, or (c) in newly-formed lakes on top of the sturzstrom (e.g. Wassmer et al., 2004). In each case, the ^{14}C age provides a different constraint for the age of the rockslide event, that is, in case (a) the ^{14}C age represents a maximum age limit for the event, in case (b), which is very rare, the ^{14}C age is a good proxy age of the event, and in case (c) the ^{14}C age provides a minimum age limit. Unfortunately, the ^{14}C approach to age-dating often cannot be applied because of absence of suited deposits or exposures thereof, lack of organic remnants or of remnants suited for age-dating, and/or because the resulting ^{14}C age is fraught with marked imprecision (e. g. Prager et al., 2008a).

Figure 2: Calcite sinter beneath a big boulder at Tschirgant rockslide suitable for $^{34}U/^{230}Th$ dating

Figure 3: Calcite cements from Pfitsch rockslide (metacarbonates, Bündnerschiefer)

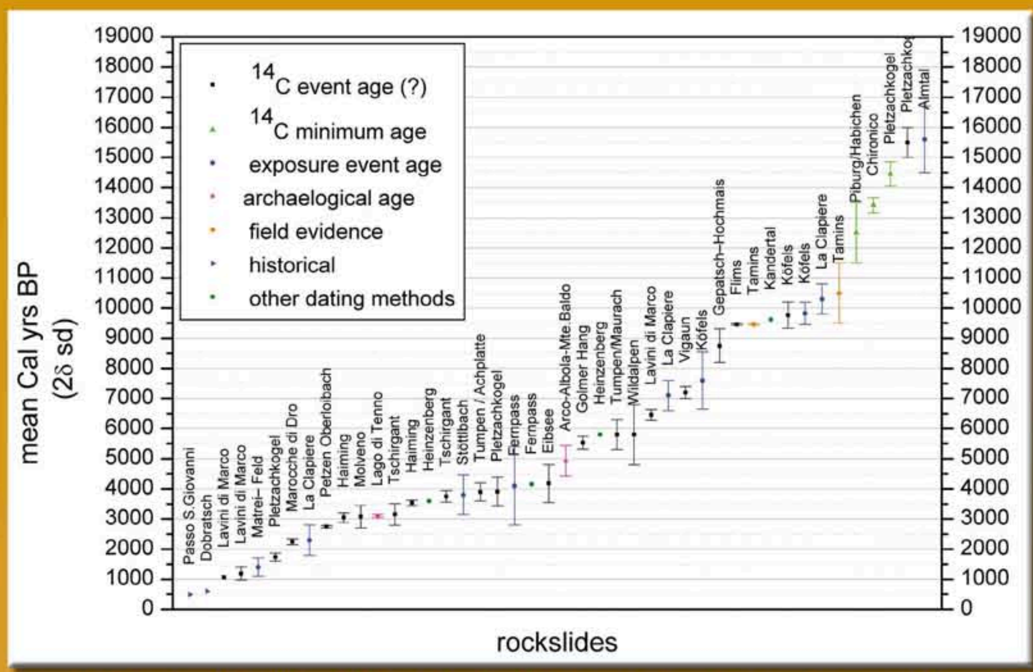

Figure 4: Temporal distribution of dated rockslides in Austria, in southern Germany, in eastern Switzerland and in the eastern Italian Alps (modified according to the dates published by Prager et al. 2008b, Appendix. vertical axes: calibrated years BP; horizontal axes: name of rockslides, n= 44.

In the past decade, an increasing number of sturzstroms have been dated by ^{36}Cl exposure dating of detachment scars and/or of surfaces of boulders within the sturzstrom deposit (Ivy-Ochs et al., 1998). At the present state, thus, an increasing number of the numerous Alpine rockslides that hitherto could not be determined by the ^{14}C method will foreseeably be dated by exposure dating, but a cross-check with another method of age determination is desirable in each case.

Our preliminary investigations of major carbonate-lithic rockslides of the Alps revealed that indeed nearly all of them contain pockets, thicker crusts and patches wherein the rockslide material underwent cementation into a breccia. These breccia cements can provide a proxy age of the sturzstrom event by dating the cement with the $^{234}U/^{230}Th$ disequilibrium method (Ostermann et al., 2007). To this end, careful petrographic analysis of samples is necessary to distinguish different generations and types of cement.

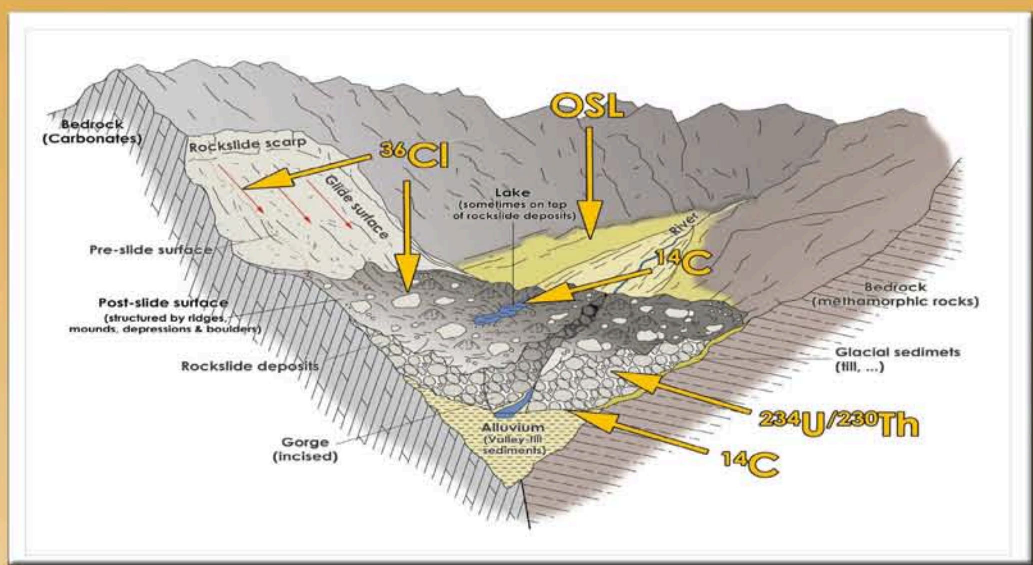

Figure 5: Possible methods and locations to age-date a rockslide

Within the research project: Catastrophic Rockslides in the Alps, funded by the Austrian Science Fund, age determination of 17 selected rockslides (Fig.1) shall be done by both $^{234}U/^{230}Th$ dating of cements and by surface exposition dating with cosmogenic radionuclides. Yet exposition dating has the undisputed advantage that it is the only method that veers for the 'real' age of a sturzstrom event. Combining the precision of $^{234}U/^{230}Th$ ages with the correctness of (often more blurred) exposition ages was, therefore, the ideal approach to determine most precise ages for selected Alpine rockslides.

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