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The potential of historic rockfalls as CRONUS-EU calibration sites: Chlorine-36 data from the Alps

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In-situ produced cosmogenic nuclides have proved to be valuable tools for environmental and Earth sciences. Progress in the field of accelerator mass spectrometry (AMS) allows the determination of radionuclide concentrations as low as of 10^4-10^5 atoms/(g rock) that makes quantifying Earth's surface processes possible. But accurate application of this method is only possible, if production rates in a certain environment over a certain time period are exactly known. Unfortunately, the necessary data found in the literature differ quite a lot (up to several tens of percent).

One of the European project "CRONUS-EU" goals is the high quality calibration of the ^{36}Cl ($t_{1/2}$=0.3 Ma) production rate by spallation at independently dated surfaces. As part of fulfilling this task we took calcite-rich samples from four medieval landslide areas in the Alps: "Mont Granier" (N 44.6˚, E 5.5˚, 330-420 m, 1248 AD), "Le Claps" (N 45.5˚, E 6.0˚, 800-900 m, 1442 AD), "Dobratsch" (N 46.6˚, E13.7˚, 547-581 m, 1348 AD), and "Veliki Vrh" (N 46.4˚, E14.3˚, 757-1620 m, 1348 AD).

AMS of ^{36}Cl was performed at the 10 MV accelerator at the Lawrence Livermore National Laboratory (LLNL) and the 6 MV accelerator of PSI/ETH Zurich for the first three sampling sites. Measurements for "Veliki Vrh" are foreseen for spring 2008. Due to the use of a ^{35}Cl-enriched spike, we were able to apply directly the isotope dilution technique giving us natural chlorine concentrations from 6-200 μg/g. Mea-

sured ^{36}Cl/^{35}Cl ratios were found to be in the range of 2.5-11$\cdot 10^{-14}$ and, therefore, distinguishable from the corresponding processing blanks (0.5-0.8$\cdot 10^{-14}$). Resulting ^{36}Cl concentrations were calculated to 20-192 kiloatoms/gram of rock dissolved.

In contrast to usual applications of in-situ produced cosmogenic nuclides on longer time-scales, we experienced severe difficulties to calculate precise ^{36}Cl production rates from calcium spallation. Those effects, which are small and mostly negligible for prehistoric times, are significantly influencing the precision of our data.

As e.g. for “Le Claps”, calculations have shown that in the bedrock at a shielding depth of 17 m (before the rockfall – V$\sim$2$\cdot 10^{6}$ m^{3} – happened) ^{36}Cl by muon-induced nuclear reactions at steady-state was produced to a level of 10-90 % of the overall measured concentration. As this ^{36}Cl-inheritance is highly dependent on the erosion rate, it seems unlikely to constrain an adequate precise ^{36}Cl spallation production rate from the corrected concentrations.

The sampling campaign at “Mont Granier” have proven that even for large rockfalls (V$\sim$5$\cdot 10^{8}$ m^{3}) the changes for the occurrence of inheritance for shortly exposed boulders are very high, i.e. 5 out of 8 samples. For this reason, a more extensive sampling strategy is needed to ensure good statistics on zero-inheritance samples.

All boulder samples taken from “Dobratsch” have high ^{nat}Cl concentrations (90-200 μg/g) arising two problems: First, it diminishes the ^{36}Cl/^{35}Cl ratios, taking them near the blank value. Second, it enlarges ^{36}Cl production by thermal neutron capture. Both introduce large uncertainties for the calculation of the ^{36}Cl spallation production rate.

It remains yet unclear how many of our chosen historic landslides have the potential for CRONUS-EU calibration sites. Further work is in progress.

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