

A Multi-Radionuclide Approach for In-situ Produced Terrestrial Cosmogenic Nuclides ^{10}Be , ^{26}Al , ^{36}Cl and ^{41}Ca \diamond

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In-situ produced cosmogenic nuclides have proved to be valuable tools for quantifying Earth’s surface processes. Here, the work-horses are ^{10}Be and ^{26}Al in quartz-rich minerals, and ^{36}Cl in Ca- or K-rich minerals. Several attempts to find new matrix-product pairs have been undertaken, especially with respect to broaden the time-scale to both more ancient [1] and more recent (historic) times. Thus, we have investigated other nuclides than ^{36}Cl as possible dating tools by cross-calibration in accompanied calcite- and quartz-rich samples from Antarctica (DV3 & Joh) and Southern France (Ciot).

AMS measurements of ^{10}Be and ^{26}Al have been performed at the French 5 MV-AMS facility ASTER, ^{36}Cl at CAMS, Lawrence Livermore National Laboratory, USA, and ^{41}Ca at the Maier-Leibnitz-Laboratory. As we could only perform a single run for ^{41}Ca measurements, all results can be regarded as preliminary. A modification of the set-up described by Wallner *et al.* [2] has been used. Ions have been extracted as CaH_3^- with currents as high as $1.5 \mu\text{A}$. The tandem has been at a terminal voltage of 12 MV corresponding to 131.25 MeV of Ca^{10+} . Results are calculated based on the TUM in-house standard, which had been produced by thermal neutron activation, with a nominal value of $(1.95 \pm 0.20) \times 10^{-11}$ $^{41}\text{Ca}/\text{Ca}$ [2].

Ratios between different nuclides from the same matrix (CaCO_3) and ratios of ^{10}Be or ^{26}Al from CaCO_3 and SiO_2 can be compared with pure physical model calculations [3] giving us experimental terrestrial production rates for ^{10}Be , ^{26}Al and ^{41}Ca from Ca and CaCO_3 .

As shown earlier [4], cosmogenic ^{10}Be is highly contaminated with atmospheric ^{10}Be and cannot be removed quantitatively from calcite samples, even by an improved chemical cleaning procedure [5]. Only working on clay-free calcite provides correct ^{10}Be data, giving a 2.7 times higher production rate of ^{10}Be from CaCO_3 than from SiO_2 . Though, the production rate of ^{26}Al is only 4.6% (CaCO_3 relative to SiO_2), ^{26}Al can be easily determined in calcite, as the low intrinsic ^{27}Al concentration yields nearly as high $^{26}\text{Al}/^{27}\text{Al}$ ratios as within corresponding quartz.

The measurement of ^{41}Ca , mainly produced via ther-

mal neutron capture, is hindered by very low $^{41}\text{Ca}/\text{Ca}$ ratios: $< 5 \times 10^{-15}$. Of course, ^{41}Ca counting statistics are poor: Measured $^{41}\text{Ca}/\text{Ca}$ ratios are based on a total of 1–5 counts. Nevertheless, the reproducibility (Joh & Joh-WC) is good. Our data are in the range of or lower than the already published one from rock samples, i.e. lower than the six surface samples ($3\text{--}63 \times 10^{-15}$) of Henning *et al.* [6] and Kutschera *et al.* [7] and lower than the surface and strongly shielded sample at 11 m depth ($3.4\text{--}7.6 \times 10^{-15}$) of Middleton *et al.* [8].

Calcite sample	$^{41}\text{Ca}/\text{Ca}$ [10^{-15}]	^{41}Ca [10^7 atoms/g Ca]
Joh	2.4 (+1.9 -1.6)	3.7 (+2.8 -2.4)
Joh-WC	2.4 (+1.4 -1.1)	3.6 (+2.1 -1.7)
DV3	0.8 (+0.9 -0.5)	1.2 (+1.3 -0.8)
Ciot1 (8.5 cm)	1.5 (+1.2 -1.0)	2.3 (+1.8 -1.5)
Ciot3 (96.5 cm)	2.8 (+1.9 -1.2)	4.2 (+2.9 -1.8)
Ciot9 (353 cm)	0.4 (+0.7 -0.3)	0.6 (+1.1 -0.4)

Table 1: Measured isotope ratios (non-blank-corrected) and calculated concentrations (blank-corrected). All samples are taken from the surface if not otherwise identified.

The low $^{41}\text{Ca}/\text{Ca}$ ratios make it very unlikely that ^{41}Ca could be generally used for in-situ dating of calcareous environments, especially as there is little hope that background level for CaF_2 -targets will improve, thus asking for very sophisticated and time-consuming CaH_2 -target preparation and handling [9].

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