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^{53}Mn development at CologneAMS and its application to cosmogenic nuclide burial dating

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Age determination of sediments in arid and hyper-arid regions poses challenges due to the absence of age-indicating fossils. As part of the collaborative research cluster 1211 of the German Research Foundation "Earth - Evolution at the Dry Limit" we are improving cosmogenic radionuclide dating in order to gain a better insight into the geological dynamics of, e.g., the Atacama Desert or the Namib.

In this contribution we discuss a novel approach using Accelerator Mass Spectrometry (AMS) to measure the cosmogenic ^{53}Mn/^{3}He concentration in iron-titanium oxides (hematite, magnetite, titanomagnetite, ilmenite). ^{53}Mn, with a half-life of T $\approx$ 3.7 Ma, has the potential to extend the upper limits of cosmogenic nuclide burial dating into the Miocene, as compared to the typically Pliocene upper limit of the more commonly used ^{26}Al/^{10}Be pairing.

^{3}He is measured using noble gas mass spectrometry whereas ^{53}Mn requires AMS with a tandem accelerator of high terminal voltage, exemplified by the 10 MV FN tandem accelerator at the University of Cologne. The system consists of a multi cathode SNICS ion source by NEC, a low and a high energy mass filter containing a magnet and an electrostatic analyzer each, a gas-filled magnet for suppressing the isobar ^{53}Cr and a gas ionization detector. The sample preparation is done in-house at the institute for Geology and Mineralogy.

Systematic optimization, including the development of a Bragg-type gas ionization detector and enhanced stability of the accelerator voltage via position measurement of the ^{55}Mn beam in the offset cup, has resulted in stable conditions for the measurement of ^{53}Mn, achieving a low blank level of ^{53}Mn/^{55}Mn = $(3.3 \pm 3.4) \cdot 10^{-14}$.

Our contribution includes an overview of the sample preparation, the current limits in terms of age determination, ^{53}Mn results from Namibian and Chilean iron oxide surface samples and a discussion of their implications for advancing our understanding of the geomorphological dynamics.

Student Submission

Yes

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