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Assessing contamination risks and sampling strategies for reliable age constraints of Alpine ice samples by novel 39Ar-ATTA

Content

Radiometric age constraints of Alpine ice cores are urgently needed not only at the base but more frequently also at the surface, in view of wide-spread negative surface mass balance. In this context, ^{39}Ar closes an important gap in radiometric ice dating between ^{3}H, ^{210}Pb and ^{14}C. The ^{39}Ar isotope with its half life of 269 years uniquely enables dating in the age range between 50 and 1000 years. The very low isotopic abundance of about 10^{-15} of ^{39}Ar however sets high demands on the measurement method. The quantum technological Argon Trap Trace Analysis (ArTTA) method reduces the required amount of ice to a few kilograms, hence making the application to Alpine glaciers finally feasible.

This work aims at fully developing the application of the ArTTA dating tool to glacier ice after pilot studies have proven the successful application of the method to ice blocks. Important next steps are assessment of contamination risks and the adaption of an according sampling strategy. This involves in particular issues concerning possible contamination by diffusion of atmospheric air and strategies for obtaining sufficient ice for the measurement. In order to do this, a first sampling campaign to Jamtalferner, Austria was conducted in September 2021 and first measurement results were obtained. At this site, the open lying and well preserved stratigraphy of the ice offers the opportunity to compare ice block samples from the surface to ice core samples for a time range of several centuries. First dating results lie well in the expected range and show no sign of any unexpected bias. Ages between 130 and 260 years were measured, showing similar ages as moraine dating has provided for this glacier. Continuing the work, more sites for sampling will be selected with similar criteria and more sampling and measurements will be conducted in order to develop routines and gain confidence in their implementation. Additionally, experiments investigating the risk of atmospheric contamination during core retrieval and storage due to diffusion were conducted. Results are still somewhat ambiguous, however, point towards a non-problematic handling of the ice cores. Ultimately, we discuss the future potential of ^{39}Ar dating of ice cores, further restricting the available sample volume.

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