Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33867

Update from the Heidelberg ATTA facility – 39Ar dating in various environmental systems and the development of a Dual-ATTA setup.

FLORIAN MEIENBURG[1,2], DAVID WACHS[1,2], INIGO ARNEDO[1,2], ALEXANDER JUNKERMANN[1], NICLAS MANDARIC[1], WERNER AESCHBACH[2] AND MARKUS OBERTHALER[1]

[1]Kirchhoff-Institute for Physics, Heidelberg University
[2]Institute of Environmental Physics, Heidelberg University

Radioisotopes are a widely used and important tool for dating environmental systems. The development of Atom Trap Trace Analysis (ATTA) enables the application of the valuable noble gas radioisotopes 39Ar, 81Kr and 85Kr in various systems, notably where achievable sample sizes are small. This includes, but is not limited to, paleoclimate studies with ice cores, large-scale ocean surveys and groundwater studies including low-yield bores.

The ATTA method relies on the isotopic shift in the resonance frequency of the respective isotope together with multiple resonant scattering processes, which grants perfect selectivity. Using well known laser cooling methods enables to trap and count single 39Ar atoms in a magneto-optical trap (MOT).

As one of two ATTA labs in the world capable of measuring 39Ar on a routine basis, the ATTA facility in Heidelberg, Germany, historically focused on the application of 39Ar in various environmental systems. This contribution will briefly showcase the value of 39Ar in ice, ocean and groundwater systems by presenting recent studies. This includes the determination of depth-age relationships of alpine glaciers [1] and ice deposits, a study of the ventilation of the Arctic Ocean and the resulting implications for its role as an anthropogenic carbon sink, as well as a PFAS characterisation study in groundwater based in Oakey, Australia.

Furthermore, this contribution presents the major technical developments made over the last few years within the ATTA group in Heidelberg. Thereby, a focus lies on the efforts to build a Dual-ATTA system, with the final, so far unreached goal to measure 85Kr and 39Ar within a single ATTA machine and from the same environmental sample. For this purpose, a complete redesign of the laser system was necessary, including automatic switching between argon- and krypton-specific laser paths. Here, we show the achieved milestones to date, including trapping of the rare isotopes from bottle gas. The successful implementation of a Dual-ATTA machine will further expand the applicability of radio noble gas isotopic tracers by increasing the worldwide measurement capabilities and points the way towards a more compact, cost-effective, and labour-efficient generation of ATTA devices.

[1] Wachs, D. et al., (2026). EGUsphere