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First dating of groundwater with Atom Trap Trace Analysis of ^{39}Ar - technique

Florian Ritterbusch (1), Sven Ebser (1), Joachim Welte (1), Thomas Reichel (2), Arne Kersting (2), Roland Purtschert (3), Werner Aeschbach-Hertig (2), and Markus K. Oberthaler (1)

(1) Kirchhoff-Institut fuer Physik, Heidelberg University, Germany , (2) Institut fuer Umweltphysik, Heidelberg University, Germany, (3) Climate and Environmental Physics, University of Bern, Switzerland

The importance of ^{39}Ar as a dating tracer for the time range between 50 and 1000 years has clearly been identified [1]. So far, it has been routinely accessible only by Low-Level-Counting (LLC) in the underground laboratory in Bern requiring a sample size of several tons of water and a measuring time of several weeks [2]. Here we report on the first dating results with ^{39}Ar using an atom optical technique known as Atom Trap Trace Analysis (ATTA). This method has been developed for rare krypton isotopes in the past decade and is now available for routine analysis [3]. However, the applicability of ATTA to ^{39}Ar has only been demonstrated in a proof of principle experiment [4].

We will discuss the essential experimental improvements that were necessary for bringing this method to the level of dating real samples. Our apparatus achieves an atmospheric ^{39}Ar-count-rate of 4.1(3) atoms/h, which corresponds to an 18-fold improvement over the reported results in [4]. Based on that, we dated a groundwater sample of the upper Rhine Graben to 360(68) years within one day of measurement. Further samples of the investigated aquifer system are dated similarly in order to obtain the age information for a comprehensive hydrological study.

The apparatus has the potential to measure ^{39}Ar-concentrations on small samples down to less than 1 ccSTP of Argon, corresponding to about 100 ml of air, 2.5 l of water or 1 kg of ice. This opens up the way for a broader application of ^{39}Ar as a tracer e.g. in oceanography or glaciology, where the sample sizes are typically limited to 10 l of water or 1 kg of ice respectively.

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