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Advances in Atom Trap Trace Analysis for Radiokrypton Dating

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Atom Trap Trace Analysis (ATTA) is a highly selective and sensitive atom counting technique based on laser cooling and trapping. It has now been established as a routine tool in the geosciences for radiokrypton dating of ancient groundwater and glacial ice samples on timescales of a few ten thousand to a couple million years. The isotope of interest is the cosmogenic krypton-81 with its half-life of 230,000 years and its isotopic abundance at the parts-per-trillion level in the atmosphere. ATTA has the unique advantage of being able to detect this rare isotope completely free of background from any other isotopes, isobars, or molecular interferences. Here, we will highlight recent advances of the ATTA technique that are aimed towards improving the precision of measured isotope ratios and towards enhancing the sample throughput of an ATTA instrument. The first will particularly help address to resolve apparent age differences at the younger end of the effective dating range, e.g., for samples originating from around the period of the last glacial maximum. These advances will be put in context with precise measurements of the absolute krypton-81 abundance in the atmosphere and the recent realization that underground production of krypton-81 can be significant under certain conditions and needs to be carefully considered. Finally, current sample requirements and specifications for radiokrypton analysis at Argonne's Trace Radioisotope Analysis Center will be discussed.

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