Radiokrypton Dating using Atom Trap Trace Analysis

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Long-lived Radioactive Noble Gas (RNG) isotopes, such as ^{85}Kr and ^{81}Kr, are ideal tracers of environmental processes due to their low chemical interactivity and appropriate half lives for dating over time-scales ranging up to around a million years. These tracers have been used in a range of applications including the dating of groundwater, atmospheric samples within ice cores, and ocean samples [1]. Such measurements are required for improving climate models and informing decisions around sustainable usage of water resources [2].

Widespread application of RNG tracers has been historically limited due to their low abundances, typically less than parts per trillion. These low abundances result in the requirement for sample sizes on the order of thousands of litres of water using conventional methods, which can be prohibitively large in many cases. Atom Trap Trace Analysis (ATTA) is a method for measuring trace concentrations of RNG isotopes with a reduction in the required sample volumes and processing times by multiple orders of magnitude [3]. These improvements are achieved primarily through the use of laser cooling and atom trapping which provides a high degree of isotopic selectivity.

We report here on the progress towards an Australian ATTA facility, one of only four such facilities worldwide. The first measurements by an ATTA facility in the Southern Hemisphere of ^{85}Kr and ^{81}Kr in an atmospheric air sample will be presented, along with progress towards the measurement and dating of groundwater samples taken from the Eromanga Basin.

[1] S. Ebser *et al*, *Nature Communications* **9**, 1-7 (2018).
[2] L. Condon *et al*, *Water Resources Research* **57**, 1-27 (2021).
[3] W. Jiang *et al*, *Geochimica et Cosmochimica Acta* **91**, 1-6 (2012).