Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19008

Assessing groundwater time scales at and beyond $^{36}Cl/Cl$ using ^{81}Kr and radiogenic noble gas isotopes in Australia.

AXEL O. SUCKOW[1], ALEC DESLANDES[1], CHRISTOPH GERBER[1], PUNJEHL CRANE[1], CORNELIA WILSKE[1], MATTHIAS RAIBER[1], GUO-MIN YANG[2], WEI JIANG[2] AND KARINA MEREDITH[3]

[1]CSIRO
[2]Hefei National Laboratory, University of Science and Technology of China
[3]ANSTO

Presenting Author: axel.suckow@csiro.au

The arid and flat inland of Australia relies heavily on groundwater supplies with old groundwater beyond ^{14}C the timescale. Appropriate for determining these timescales in groundwater is ^{36}Cl – a dating technique applied and developed in Australia. Difficulties with interpretation of $^{36}Cl/Cl$ relate to spatially variable initial values and unknown possible temporal variations of $^{36}Cl/Cl$. For example, variations in Earth's magnetic field and paleoclimatic influences such as proximity to the coast affect initial values.

Since 2016 CSIRO Australia operates a facility to routinely measure noble gases, adding two further elements with radiogenic isotopes in this time range (^{4}He and ^{40}Ar). Furthermore, applications of ^{81}Kr become more and more routine at CSIRO since 2016, with samples taken and purified at CSIRO and measured in Hefei. The Australian ATTA facility at The University of Adelaide will soon also have capability for ^{81}Kr. But for the near future, ^{36}Cl will be easier to sample and cheaper to analyse than ^{81}Kr. Therefore, the present study evaluates whether the difficulties of ^{36}Cl can be mitigated calibrating it with the more reliable dating tracer ^{81}Kr and whether the timescales of ^{81}Kr and ^{36}Cl can be extended using the radiogenic noble gas concentrations and isotopes. Studies from CSIRO in the eastern Great Artesian Basin (GAB) and published studies in the western GAB resulted in a total of 49 existing samples combining ^{81}Kr and ^{36}Cl. Most of these samples also include noble gas results. Therefore, this study addresses the question: Is it possible to calibrate the time dependent ^{36}Cl input with ^{81}Kr, use both to get a better understanding of the sources of radiogenic isotopes and finally, possibly extend the groundwater timescales with helium and argon?

Regional differences in initial $^{36}Cl/Cl$ over Australia found in several studies – with and without ^{81}Kr – will be presented. The comparison between ^{81}Kr and ^{36}Cl suggests time variation in the $^{36}Cl/Cl$ input, with a peak in $^{36}Cl/Cl$ at ^{81}Kr activities of 70-90pmKr. Our first analyses of radiogenic ^{40}Ar in groundwaters, for which ^{36}Cl is at natural equilibrium, point towards a mechanism of sediment-stored radiogenic argon released into these groundwaters.