THE UNIVERSITY of ADELAIDE

RADIOACTIVE NOBLE GASES: WATER SAMPLING

The noble gas radioisotopes are ideal tracers of groundwater movement, they are chemically inert and provide the most reliable assessment of groundwater residence time. Krypton-85 (half-life 10.7 years) is most suitable for short-term hydrological process of decades; argon-39 (half-life 269 years) is the only tracer for groundwater residence times on the century timescale; and krypton-81 (half-life 229,000 years) is a near-ideal tracer to characterize ancient groundwater. The isotopes Krypton-85 and Krypton-81 can now be measured at The University of Adelaide using the state-of-the-art technique Atom Trap Trace Analysis (ATTA). Argon-39 capability will be available in the near future.

When sampling groundwater for measurement of radioactive noble gases, it is important that the sample is always sealed from atmospheric contamination, and therefore specialist sampling methods are used. For the radioactive noble gases, evacuated propane gas bottles, with a three-way valve or T-piece connected to the inlet, are filled with groundwater that can be extracted from the well with a submersible pump.

Alternatively, large volumes of groundwater can be field degassed using a custom built membrane contactor. This sampling method is based on the principle that when water is pumped through the membrane contactor, dissolved gases diffuse through the walls to the gas side of the contactor where they can be collected. This requires that the gas side is kept at low pressure using a vacuum pump; as a result this sampling method is relatively complex compared to the propane gas bottle method.

For simplicity, we recommend sampling using standard 20L propane gas bottles. Samples are then sent to the lab for gas extraction, purification, and measurement using ATTA.

Sampling made easy with standard 20 litre propane gas bottles

The following can be used as a guide for sampling and the UofA-CSIRO team may assist in the preparation (steps 1-3). Krypton-81 requires two 20 L propane gas bottles per sample. For more information please contact us directly.

1. 20 L propane gas bottles are evacuated to below 1 mbar, flushed with pure nitrogen and then evacuated again.

2. The bottles are then filled with nitrogen at above atmospheric pressure for shipping to the field.

3. Once onsite, the bottles are checked for leaks (loss of nitrogen pressure), and evacuated to be ready for sampling.

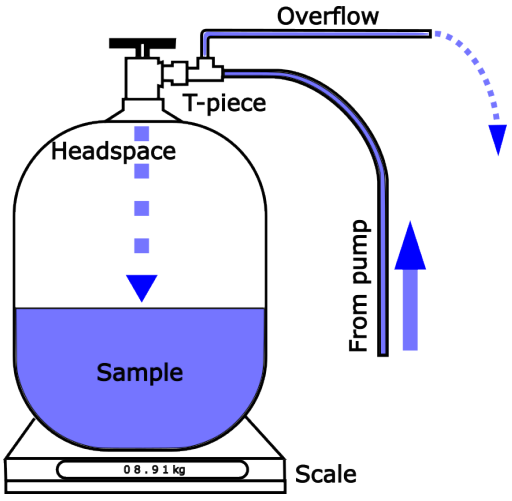
4. Groundwater is collected with a submersible pump. We recommend the Grundfos MP1 or similar. Compressed air pumps with direct contact between compressed air and pumped water are NOT suitable.

5. The well, tubing, and other sampling equipment should be flushed before attaching the propane gas bottle.

6. A three way valve or a T-piece is attached to the inlet of the bottle. This allows the water to continue flowing while sampling and ensures that no atmoshperic contamination can enter the propane bottle.

7. The pipes are flushed before opening the bottle to avoid contamination from between the bottle inlet and the junction of the T-piece.

8. The sampling process can be monitored using a scale to measure the amount of water collected. There must be sufficient water (18 L) to provide gas for a measurement while also having a large enough head space to allow for efficient degassing in the lab.



Ocean Water

Sampling ocean water for ^{85}Kr and ^{39}Ar can also be done using standard Niskin bottles. Approximatley 10-20L of seawater is collected at depth in two Niskin bottles. The sample is then transferred to 20L propane gas bottles prepared using the same method as for groundwater. The air inlet on the top Niskin bottle is opened to allow for a water flow through the valve at the bottom into the propane bottles. The first few hundred mL are used to flush the connections between the Niskin bottle and the propane gas bottle and the last 2-3 litres are discarded due to their contact with atmosphere and the risk of contamination.

The Australian ATTA facility

The University of Adelaide and CSIRO operate a joint sovereign facility for measuring stable and radioactive noble gases in the environment. Samples can be collected from water, the atmosphere, or ice and analysed at our facility. Gas is extracted and purified at the CSIRO Waite campus in Adelaide and measured for ^{85}Kr and ^{81}Kr at the University of Adelaide ATTA facility. The facility is one of only four locations on the globe that offers measurement using the ATTA technique and is the only facility in the southern hemisphere offering this service.

FOR FURTHER ENQUIRIES:

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