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Towards a mobile Membrane Inlet Mass Spectrometry (MIMS) system for the detection of atmospheric noble gases in groundwater

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Noble gases provide valuable insight in the recharge conditions (temperature, water table fluctuations) and flow patterns (travel times) of groundwater. Because of low abundances and the volatility of the (lighter) noble gases, sampling and analysis involves clamping copper tubes and diligent separation of the noble gases from the abundant atmospheric gases present in groundwater. Membrane Inlet Mass Spectrometry (MIMS) systems provide real-time dissolved gas analysis of water flowing across a membrane. The small size and portability of MIMS systems would offer great advantages for fieldwork involving in situ noble gas studies and long-term tracer monitoring. However, with the exception of argon, noble gases have not been measured at atmospheric equilibrium levels in groundwater on a MIMS system so far.
The aim of our work is to develop a MIMS capable of the detection of helium and neon at atmospheric equilibrium concentrations, and quantification above that level. The purpose of the NG-MIMS is to be used for active (helium) tracer studies in groundwater, fast detection and detailed profiling of radiogenic helium and the study of excess air formation and noble gas transport at high temporal resolution.
At this moment, helium at $\sim$250 times the atmospheric equilibrium concentration can be detected on the MIMS system with a simple water trap and without getters or other gas processing. Neon-20 is obscured by double charged argon (at 8% of the argon pressure) equivalent to $\sim$750 times the atmospheric equilibrium neon concentrations. At this level of sensitivity, complete degassing of 15 ml groundwater per minute would be required to detect atmospheric equilibrium concentrations helium and neon. A high-throughput membrane gas exchange system in combination with various traps and getters are tested to reduce the limit of detection and quantification to achieve the objectives of the NG-MIMS system.

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