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Multi- Tracer study, including ^{39}Ar, enables the characterization of PFAS plume transport in groundwater

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Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals used mainly due to their durability. However, despite the usefulness of these compounds, negative effects on human health become increasingly evident [Kotthoff et al., 2020]. Problematically, PFAS are nowadays found not only confined to the original products but have been intruding various environmental systems. In the case of groundwater systems, this is critical, especially if the water is used for drinking or irrigation. However, the transport characteristics of PFAS and its metabolites in groundwater are largely unknown and restricted to column experiments [Nguyen et al., 2022; Niarchos et al., 2022].

This study aims to make use of age tracers to investigate the PFAS plume in Oakey, Australia, to produce real-world data for estimating retardation factors as well as predictions of future well contamination. Age tracers are substances present in the natural water cycle (often dissolved in water from the atmosphere) and whose concentration in a water package is dependent on the time since that last exchange with the atmosphere, either due to concentration changes in the atmosphere, radioactive decay or radioactive ingrowth. Here, we present new ^{39}Ar concentrations measured by Atom Trap Trace Analysis (ATTA), which together with a wide variety of other age tracers (^{3}H, $^{3}H/^{3}He$, CFC-s, SF_6, Halon, ^{14}C, ^{4}He) allows us to compute transit time distributions (TTDs). ATTA relies on the isotopic shift in the resonance frequency of the atoms to manipulate the targeted ultrarare isotopes together with multiple resonant scattering processes, which grants perfect selectivity, ultimately enabling to measure natural abundances of ^{39}Ar of $8x10^{-16}$ [Chen et al., 1999].

Combining the calculated TTDs with concentration measurements of different PFAS compounds ultimately allows to quantify field-scale retardation factors and furthermore, is the basis to accurately model plume transport through a groundwater system and future well contamination. As both final goals are still work in progress, this contribution summarizes the existing data, first interpretations and highlights the upcoming steps.