Goldschmidt 2022 Abstract
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New noble gas isotope tracers for groundwater hydrology

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Dissolved noble gases in groundwater are useful tracers of processes and properties related to groundwater recharge and flow. For decades, measurements of the elemental abundances of He, Ne, Ar, Kr, and Xe and the $^{3}He/^{4}He$ ratio have provided a toolkit for quantitatively determining recharge temperatures [e.g., 1-4], residence times from both tritiugenic ^{3}He and radiogenic ^{4}He [e.g., 5-6], mountain-front recharge components [e.g., 7-8], injection of excess air through bubble dissolution [e.g., 9] and geological sources of volatiles [e.g., 10], among other applications.

Over the past ~5 years, we have developed a dynamic mass spectrometry approach that allows for order 0.001‰ u^{-1} precision analyses of Ar, Kr, and Xe isotopes in groundwater [11]. At this level, we are able to resolve the influence of gravitational settling in the vadose zone, which generates a ~0.004‰ u^{-1} m^{-1} signal of water table depth that is transmitted to groundwater during equilibrium dissolution [12]. We are also able to detect radiogenic ^{40}Ar at the sub-‰ level, providing a new potential dating tool that complements radiogenic ^{4}He [13].

At Goldschmidt 2022, we will present a conceptual overview and share new data from California, Arizona, and Oregon (USA). We will also share results from recent efforts to better understand fractionation in water at the 0.001‰ u^{-1} level from laboratory experiments and molecular dynamics simulations. Finally, we will discuss how water-table depth reconstruction (i) provides crucial new constraints for noble gas thermometry and (ii) can be combined with groundwater modeling to quantitatively estimate past changes in recharge, with relevance to long-term hydroclimatic trends.

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