Goldschmidt 2023 Abstract
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Unraveling the paleo-hydrology of the Nubian Sandstone Aquifer using dissolved noble gases

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Dissolved noble gases are ideal tracers for deconvoluting hydroclimatic signals preserved in groundwater. First, radioactive and radiogenic noble gas isotopes serve as proxies for groundwater residence time [e.g., 1], and second, stable noble gas abundances and isotope ratios are sensitive indicators for past temperatures and water-table fluctuations [e.g., 2]. The current study takes advantage of recent analytic developments [1,3] for reconstructing the hydroclimatic signal preserved in the deep confined Nubian Sandstone Aquifer (NSA) of the hyper-arid Negev Desert (Israel).

High amounts of dissolved noble gases (excess Ne of ~300%) were identified in ^{81}Kr-depleted (~350-kyr-old) groundwater. This 'excess air' signal is interpreted as a record of large-scale (tens of m) water-table rise during past pluvial epochs [4]. Noble gas recharge temperatures (NGTs) of ca. 25–30 °C were computed using the closed-system equilibration model [2], 5–10 °C higher than the current mean annual surface temperature (MAST) over the recharge area. The NGT–MAST discrepancy is even more significant if considering recharge during glacial epochs [5]. In theory, the ultimate gas entrapment and equilibration take place at the unsaturated zone and the water-table interface. The NSA is characterized by a hundreds-of-m-deep water table, and therefore, a translation of NGT into past surface temperature requires knowledge of the paleo water-table depth and a correction for the geothermal heating effect and depth-dependent diffusive fractionation processes in vadose zone air [6]. Quantitative information on past water-table depth can be achieved by measuring Kr and Xe stable isotope ratios [3], whereby gravitational settling fractionates noble gases, increasing heavy-to-light isotope ratios with vadose zone depth. At Goldschmidt 2023, we will present preliminary Kr and Xe stable isotope ratio measurements, which, together with noble gas bulk contents and radioisotope activities, further illuminate the NSA's paleo-hydroclimatic signals.

[1] Lu *et al.* (2014), *Earth Sci. Rev.* 138*,* 196–214. [2] Aeschbach-Hertig *et al.* (2000), *Nature* 405, 1040–1044. [3] Seltzer *et al.* (2019), *Earth Planet. Sci. Lett.* 514, 156–165. [4] Ram *et al.* (2022), *J. Hydrol.* 612, 128114. [5] Yokochi *et al.* (2019), *Proc. Natl. Acad. Sci.* 116, 16222–16228.[6] Seltzer *et al.* (2017), *Water Resour. Res.* 53, 2716–2732.