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# Constrains on fluid sources and reactivity at a $H_2$-bearing aquifers in the Perth basin (Western Australia).

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Groundwater characterization is often overlooked in geologic hydrogen exploration, despite providing valuable data to understand $H_2$ generation, transport, and consumption mechanisms. The Perth basin (Western Australia), from which $H_2$ emissions have been detected, is filled by multiple deep aquifers, connected through faults to an underlying Archean basement.

To better constrain the origin and transformation processes of volatiles in these $H_2$-bearing aquifers, fluids have been sampled for geochemical analyses of dissolved gases (noble gases: He, Ne, Ar, Kr, Xe, including $^3He/^4He$ isotope ratios, $CH_4$, H2, C1, $C_2$–$C_5$, $N_2$, $O_2$) and key solutes (Fe, Cl, $SO_4$, $HCO_3$, $H_2S$, $NO_3$, $NH_3$). Redox and acid–base conditions (Eh, pH) were also measured. The resulting dataset was merged with available data on basin-scale CSIRO groundwater geochemical database (Gray, 2019) to identify gas sources and reactivity processes. Geochemical maps across the basin were produced, and geostatistical modelling is applied to characterize spatial structures and interpolate key parameters. Machine-learning methods are used to reduce data gaps to detect missing variables like Eh.

Noble gas concentration and isotopic composition constrain groundwater provenance, recharge conditions, and physical processes such as degassing, and provide complementary constraints on the origin, flux, and thermal history of $H_2$, including noble-gas-based palaeothermometry. Isotopic and quantitative analyses of associated volatile compounds further constrain gas sources and secondary transformations.

Gray, D.J. et al. (2019). Hydrogeochemical Mapping of the Australian Continent. 110 p.
CSIRO, Australia. EP195905