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Natural hydrogen resource accumulation and helium-rich gas field analogues

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The two dominant sources of hydrogen in the continental crust are water reactions with common rock types containing reduced Iron (Fe^{2+}) and radiolysis of water from the natural decay of uranium and thorium [1]. On average, the crust has generated enough hydrogen over the last billion years to supply the present day global energy use of hydrocarbons for 170,000 years [1]. Nevertheless, hydrogen must be released from the source lithologies, focused through geological processes into locations that make it commercially viable and preserved to form a key no-carbon chemical feedstock or energy resource. This requires consideration of the complete 'hydrogen system' from source rock generation rate, release, transport and trapping.

Helium, as part of the hydrogen system and with similar diffusive properties provides a critical analogue to understand the temporal and physical contexts that favour gas field formation. A recent conceptual breakthrough in gas field formation provides the framework for critically assessing different geological environments' capacity to balance gas flux with gas phase formation [2]. The bioavailablity of hydrogen remains poorly constrained, with subsurface gas bio-utilisation rates occurring on anthropogenic to geological timescales [3,4,5]. Nevertheless, hydrogen preservation is observed in locations worldwide [1,4,6], and gas field formation from only a fraction of this mobile/diffusive and bioavailable gas will provide a substantial societal resource.

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