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Editorial: Natural hydrogen in different contexts: geological, cosmochemical, and biological

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Editorial on the Research Topic
Natural hydrogen in different contexts: geological, cosmochemical, and biological

The di-hydrogen H_2 is assuming a growing role in the energy mix, or, more exactly, it is expected to play a key role in the energy transition by the middle of this century. H_2 could be seen as an energy vector when it is used to store electricity using the power-to-gas approach. It is also a primary source of energy when we manage to find and produce natural H_2 generated in the subsurface. However, there are still some uncertainties about the generation and accumulation of natural H_2 in the subsurface, and research is underway to better understand how to explore and store H_2. This Research Topic was conceived in this context.

Today, the list of H_2-generating rocks has started to become reasonably established. H_2 is produced naturally from water through oxido-reduction or radiolysis (Larin et al., 2015; Truche et al., 2020; Leila et al., 2022). Another alternative is the late maturation of organic matter (Horsfield et al., 2022). Some authors suggest a long list of favorable settings mixing geological context and reactions, while others propose a more synthesized view with only four H_2-generating rock types. However, many questions remain to be answered about the generation mechanisms of natural H_2 and about its transport and accumulation in the subsurface. If high-temperature serpentinization has been largely studied (Klein et al., 2009), the significance of oxidation in other iron-rich rocks, such as banded iron formation "BIF," or biotite-rich rocks is still poorly-explored (Murray et al., 2020; Geymond et al., 2022). The work conducted by Geymond et al. is particularly important in this respect since it demonstrates that the concept of high-temperature conditions for rapid redox reactions is not at all necessary. The magnetite produced during redox reactions generates a large quantity of H_2 at 80°C. This has implications for BIF oxidation and also for ophiolites.

Since E&P is just starting up, there are still little data available, and the companies that acquire these data are not always willing to release them to the public. The work conducted by Lévy et al. on gas springs in the Dinarides shows the heterogeneity of H_2 content at the scale of an ophiolitic nappe and provides guidelines to focus on the most prospective zones.

The occurrence of subcircular depressions with vegetation anomalies, also informally called fairy circles, has demonstrated its worth for a long time as indications for subsurface hydrogen seepage; first in Russia and then in the United States and Brazil. Its systematic use in conjunction with satellite data to select prospective areas has been proposed by Moretti et al. (2021a, b), Moretti et al. (2022) for the Australian and Namibian H_2-rich provinces. However, not all depressions are related to H_2 emanations. In desert areas where salt pans may have a similar morphology, Aimar et al. have aimed to discriminate between these features based on a case study in the southwest Australian craton.

The biosphere is also known to impact H_2 generation and consumption. The fact that the biosphere can have a positive effect on the creation of H_2 accumulation is debated; the consumption of this gas is not in doubt. Warr et al., using data from the Kidd Creek observatory—an almost 3 km-deep mine—to study the deep biosphere in Canada, propose a quantitative approach through Monte Carlo modeling to understand the cycle of H_2 and other gases, such as helium and argon, in the first kilometers.

Similarly to the generation and accumulation of H_2, its storage is also a complicated task due to its small size and high diffusivity. Moreover, a wide-scale implementation of a H_2-based economy requires a medium giga-to-tera-scale storage capacity, which requires specific geological conditions to effectively store H_2 in the subsurface. Alanazi et al. investigated the capability of Saudi basalt to store H_2 in underlying clastic depleted reservoirs based on an evaluation of the wettability of the basalt/H_2/brine system of two basalt samples from Harrat Uwayrid, a Cenozoic volcanic field in Saudi Arabia.

The exploration of H_2 has begun, and we hope that these articles will enable everyone to take part.

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