

The microbiology of natural hydrogen and underground hydrogen storage

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Hydrogen, whether produced from renewable energies, through stimulating serpentinization, or harvested from natural geological reservoirs, represents a key energy vector and source for the ecological transition toward a net-zero carbon society [1,2]. Molecular hydrogen is also a key electron donor in diverse microbial metabolisms, and many microorganisms use it as an energy source and convert it into a variety of compounds [3]. Over the last decades of research, we have discovered that subsurface environments harbor a diverse microbial community capable of interacting with hydrogen and other volatiles. These communities are present in virtually all rock types and extend to depths of 5 kilometers or more. The storage of hydrogen underground, whether natural or engineered, presents several challenges, primarily due to its interaction with a diverse and ubiquitous subsurface biosphere [3]. In this talk, I will review our current understanding of the microbiology of natural hydrogen and underground hydrogen storage, highlighting the existing gaps in our knowledge and identifying areas to focus basic and industrial research to make a hydrogen-based society a reality. While natural hydrogen prospecting, orange hydrogen, and underground hydrogen storage have diverse challenges, their microbiology is deeply intertwined and can inform each other reciprocally. I will present new, unpublished microbiology data from hundreds of natural hydrogen springs sampled globally and compare their microbiology with that of porous reservoirs and laboratory experiments, integrating efforts across geosciences, biosciences, and engineering.

1. Tarkowski, R. & Uliasz-Misiak, B. (2022). *Renewable and Sustainable Energy Reviews* 162, 112451.
2. Milkov, A. V. (2022). *Earth-Science Reviews* 230, 104063 (2022).
3. Cascone, M. et al. (2025). *EarthArXiv* 8350, 1–35.