frontiers | Frontiers in Ecology and Evolution

TYPE Editorial
PUBLISHED 02 December 2024
DOI 10.3389/fevo.2024.1527156

OPEN ACCESS

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RECEIVED 12 November 2024
ACCEPTED 22 November 2024
PUBLISHED 02 December 2024

CITATION
Gulliver DM, Barnhart EP, Schweitzer HD, Smith HJ and Midgley D (2024) Editorial: Subsurface microbiology within hydrocarbon resources or stored gases.
Front. Ecol. Evol. 12:1527156.
doi: 10.3389/fevo.2024.1527156

Editorial: Subsurface microbiology within hydrocarbon resources or stored gases

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KEYWORDS

subsurface microbial community, subsurface microbial ecology, subsurface microbial ecosystem, oil and gas microbiology, carbon storage (CS), hydrogen storage

Editorial on the Research Topic
Subsurface microbiology within hydrocarbon resources or stored gases

A Research Topic on the microbiology of hydrocarbon and gas storage reservoirs has far reaching industrial applications. In recent decades, there has been a growing interest in understanding microbial communities in subsurface energy reservoirs, such as coal, oil, and shale beds. This area of research has broadened to include gas storage reservoirs for hydrogen and CO_2. Scientists are beginning to unravel the unexpected impact microorganisms have on these systems, through changing the fluid geochemistry, the gas content, and even the permeability. By recognizing the influence of these tiny organisms on our engineered environments, we can develop better risk assessments, target mitigation strategies, expand energy production, and refine operational guidance, ultimately contributing to a more sustainable energy future.

As important as this work is to drive innovation in the energy sector, this work also deepens our understanding of subsurface microbial dynamics and these unique, extreme ecosystems. Earth's subsurface environments are one of the largest, yet least studied biomes, due in part to the inability to access relevant biological samples from these uncharted depths. With an industrial motive, however, wells are drilled, and subsurface material is collected with the potential for research collaboration. With advancements in DNA/RNA sequencing and innovative sampling methods, scientists are now able to explore the microbial communities in the hard-to-access geomicrobiological systems. Subsurface microbial communities have evolved adaptations for survival in nutrient-limited, high-pressure, and low-oxygen conditions, offering insights into ecology, evolution, and metabolic pathways in deep biospheres. Recent studies have broadened our knowledge of microbial diversity and function in geological environments, informing fields from astrobiology to environmental science. As we uncover the metabolic networks of these subsurface communities, we find new understanding in microbial genetics and taxonomy that contributes fresh data and novel diversity to our growing catalogue of microbial life.

The aim of this Research Topic was to shed light on microbial ecology and physiology in subsurface energy environments, driving new discoveries in biotechnology and insight in microbial interactions of the deep biosphere. The articles presented here did not disappoint in revealing novel findings of the biological subsurface.

Two of the manuscripts found surprising microbial impacts in traditional hydrocarbon reservoirs. Stemple et al. identified a newly documented Clostridia species that was highly abundant in the severe conditions of a hydraulically fractured shale reservoir and demonstrated the functional potential of this selected microorganism to drive well souring, biocorrosion, and biofouling. Nai et al. investigated the microbiome of Qinshui Basin coal seams, indicating the unexpected contribution of biogenic processes for methane production on high-rank coals.

Two additional manuscripts delve into the unknown effects of microorganisms on subsurface gas storage through investigation of under-characterized subsurface biospheres. Jia et al. identified the importance of rare methanogenic Archaea from the CO_2-rich Eger Rift, offering new insights for underground carbon storage. In the pioneering study by Bellini et al., the microbial activity from inoculum of four Italian natural gas reservoirs elucidated much needed insight in the effect native microbial communities may have during underground hydrogen storage.

The last two manuscripts touch on the opportunities to use our knowledge in subsurface microbiomes to drive innovative approaches to methane recovery. Platt et al. focuses on testing a promising low carbon renewable coalbed methane enhancement technique using algal amendment across a diverse range of coal ranks. Harirforoush et al. simulated methane gas leakage in Persian Gulf sediments to identify microbial communities consuming methane, enhancing gas exploration.

This Research Topic aims to merge the satisfying application of microbiology research to our engineered energy environments with the excitement of novel discovery in the subsurface biosphere. Overall, the findings contribute valuable knowledge for biotechnological applications and gas exploration, as well as new understanding of the capability and contribution of microorganisms in the subsurface. As the subsurface remains the largest and least studied biome, this field of research aims to advance an expected growing awareness of the power microbial communities have within these under-characterized environments.

Author contributions

DG: Writing – original draft. EB: Writing – review & editing. HS: Writing – review & editing. HJS: Writing – review & editing. DM: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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