ID de Contribution: **98** Type: **Poster**

Microbial community responses to repetitive heating and cooling in high-temperature aquifer thermal energy storage

jeudi 22 mai 2025 13:15 (15 minutes)

Storing seasonal energy in the subsurface using High-Temperature Aquifer Thermal Energy Storage (HT-ATES) can significantly reduce the energy consumption and greenhouse gas emissions of the heating sector. Compared to conventional ATES, which operates at lower temperatures (25–30℃), HT-ATES can store water heated up to 90℃. While higher temperatures improve efficiency, they also induce significant thermal and biogeochemical changes in the reservoir.

Elevated temperatures alter geochemical equilibria, affecting groundwater composition, mineral stability and overall water quality. While geochemical impacts of HT-ATES have been thoroughly investigated, the effects of repeated thermal fluctuations on aquifer microbial communities and functions remain poorly understood. Microbial activity can influence groundwater chemistry, mineral dissolution and precipitation, enhance clogging through biofilm formation or accelerate corrosion of infrastructures. Better understanding these mechanisms, particularly via groundwater sampling, laboratory experiments and field tests (push pull tests), is essential to tackle operational and environmental challenges.

In this framework, the Horizon Europe PUSH-IT project (https://www.push-it-thermalstorage.eu/) is aiming to demonstrate the feasibility of large-scale high-temperature heat storage solutions through six pilot and demonstrator sites in order to generalise their utilisation throughout Europe. One demonstrator site, located in TU Delft (Delft, Netherlands), will be a HT-ATES well storing water up to 90℃.

We first monitored the groundwater in order to describe the initial biodiversity of the aquifer before any heat storage process and gain insight on the natural baseline. In parallel, various microbial sampling, preservation and analysis methods were performed and tested to help future monitoring efforts.

Secondly, the effects of temperature variations induced by this HT-ATES on microbial communities in the reservoir are characterized by simulating HT-ATES conditions in the laboratory using a pressurised flow-through cell with BRGM's high-temperature high-pressure BioREP platform. Groundwater from the TUDelft monitoring well is injected through aquifer sediments with cyclic temperatures ranging from ambient levels to 90℃. A first phase of inoculation of the sediments takes place for three months with continuous circulation of groundwater at the aquifer's ambient temperature of 12℃. Following steps expose sediments to series of thermal cycles to gain insight into reservoir processes. Geochemical parameters (pH, redox potential, conductivity, key redox-sensitive compounds) and microbial community composition (qPCR, 16S rRNA Illumina sequencing) in both water and sediments are monitored over time to track their evolution in response to temperature variations.

In the last stage of the project, the microbial diversity evolution will be monitored under conditions more representative of the final storage process, during an initial hydraulic and thermal pumping test (hot push-pull test).

Acknowledgements: Funded by the European Union under grant agreement 1011096566 (PUSH-IT project). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor CINEA can be held responsible for them.

Speaker information

PhD 2nd year

Author: WATKINSON, Maud

Co-auteurs: STEPHANT, Sylvain; BATTAGLIA-BRUNET, Fabienne; LOSCHETTER, Annick; VAN DER SCHANS, Martin; REGENSPURG, Simona; RAD, Sétareh

Orateur: WATKINSON, Maud

Classification de Session: Posters

Classification de thématique: Earth, Environment and Space Sciences: Geobiology