

The fate of dissolved organic matter in energy-limited deep subsurface groundwaters

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The deep terrestrial subsurface is of interest to nuclear waste organizations as the deep groundwaters therein host a large biodiversity of microbes. These populations include sulfate reducing bacteria that form sulfide, which corrodes the copper canisters used to house the spent fuel. The groundwater sulfide levels are in part controlled by the availability of electron donors for sulfate reducing bacteria such as dissolved organic carbon (DOC), H₂, and CH₄. In principle all DOC in groundwaters can be involved in microbial processes and therefore, a better understanding of its bioavailability is needed to predict the potential sulfide production.

This investigation was performed on groundwaters from the Äspö Hard Rock Laboratory (HRL) on the Swedish Baltic Sea coast that has been used as a study site for a spent fuel repository. In combination with the aliphatic character, depleted $\delta^{13}\text{C}$ signatures in the dissolved organic matter (DOM) indicated recent microbial production in the oldest, saline groundwater. Removal of easily degraded carbon and corresponding microbial community assembly processes likely resulted in the highly similar DOM signatures across the different water types. The high percentage of retained molecular formulas suggested that although DOM was present, the large majority was recalcitrant to microbial degradation. This supported the calculated extremely long cell turnover times in the range of 100–1000s of years for the deep marine biosphere and that the microbial community in terrestrial deep saline waters have been described as in “metabolic standby”.

The fate of the DOM and changes in microbial communities in Äspö HRL modern marine and old saline groundwaters were further studied via incubation experiments. Under in-situ conditions, amendment of the natural DOM background with three carbon sources (concentrated natural organic matter, necromass, acetate) was performed to further explore the substrate limitations of the deep microbial communities. Preliminary results indicated changes in relative abundance of the microbial populations and DOM, which in extension will at least locally affect the groundwater composition and potentially the copper canister integrity.