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Implications of CO2 Geological Storage on Aquifers Autotrophic Communities

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In a global strategy of carbon emission reduction, a study about CCS (Carbon Capture and Storage) feasibility in the case of a French beet sugar factory and distillery in the Parisian basin was undertaken by regional and state authorities. Besides, economical, geological and engineering questions, microbial interactions were also studied since the potential contribution of the deep biosphere on the storage zones appears to be an essential factor in terms of injectivity and CO_2 mobilization. Biological processes like biofilm formation, biomineralization and carbon assimilation may hinder the injections or, to the contrary, improve the stability of the sequestration by shifting CO_2 into more stable forms like carbonates and organic matter. Regarding those possibilities, it is thus mandatory to establish how the subsurface biosphere will react by determining which metabolisms will be able to sustain the stress due to high concentrations of CO_2 and the resulting acidification. In that case, the study of autotrophic communities reactivity is essential because they are the only entrance for CO_2 assimilation in the SLiMEs (Subsurface Litho autotrophic Microbial Ecosystems) and thus are accountable for the general biomass and biofilm production in the deep subsurface. Nevertheless, a simple assessment of the toxical effect induced on these strains cannot be representative of the possible interactions at the scale of a long term storage where adaptations should play a major role. For that reason, we decided to choose different strains, namely autotrophic methanogens (*Methanothermococcus thermolithotrophicus* and *Archeoglobus fulgidus*) and sulfate reducing bacteria strains (*Desulfotomaculum geothermicum* and *Desulfotomaculum kuznetsovii)*, that best characterize the autotrophic communities of our injection site (aquifer of the Triassic Keuper sandstones) and to make them undergo a test of selection/adaptation toward a sequential increase of CO_2 partial pressure from 0.05 to 5 bar. Artificial ground water was formulated in order to mimic the local compositions and implemented in accordance with the organic matter (50 ppm) that does correspond to the residues of volatil organic carbon present in the injected gas and originating from the beet fermentative processes. Strains were tested separately and together in order to assess competitive and symbiotic effects, chemistry and microbial activities were measured at each step. At the end of this process, the combinations that have succeeded to reach the highest levels of CO_2 were inoculated into a bioreactor and submitted to a test of CO_2 injection in conditions that are similar to what is expected in practice (pressures superior to 100 bar). General results conclude on the importance of microbial influence in such systems, especially in regards of their adaptation.

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