Microbial metabolic processes in the deep subsurface - impact on geological energy storage

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Enhanced process understanding of engineered reservoirs is a prerequisite to optimize the operation of geological storage, to increase the reliability as well as to assess the risks involved. Since microorganisms are very effective geochemical catalysts and their contribution to the mineral alteration and dissolution needs to be investigated.

The microbial diversity of a different reservoirs in the North German Basin, the Upper Rhine Graben, the Molasse Basis and the Styrian Bassin was analysed with molecular biological and geochemical methods. Interactions of microbial activity with the geotechnical use of the reservoirs were studied in a pilot plant for CO_2 storage, in bypass systems of a geothermal heat store and in long-term laboratory experiments with rock cores and reservoir fluids. Genetic fingerprinting analyses revealed distinct microbial communities in fluids depending on the temperature, the salinity and the availability of electron donors like organic substances or hydrogen. Cell counting and quantification of 16S rRNA genes and dissimilatory sulfite reductase (dsrA) genes by real-time PCR proved different population sizes in fluids, showing higher abundance of Bacteria and sulfate reducing bacteria (SRB) in systems influcenced by corrosion. SRB were accounted for corrosion damage and iron sulfide precipitates in the near wellbore area that affected plant reliability adversely.

Geoneutrino detection in the future low-energy neutrino observatory LENA

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The next-generation liquid-scintillator detector LENA (Low Energy Neutrino Astronomy) will be a versatile tool for the study of low-energy neutrino fluxes. Following up on the first successful measurements of geoneutrinos by the KamLand and Borexino experiments, LENA is aiming at a high-statistics measurement of the geoneutrino flux above 1.8 MeV. Like its predecessors, LENA will profit from the low energy threshold and the excellent background discrimination capabilities of the liquid scintillator technique, but above all from its in comparison considerably larger target mass of 50 kiloton.

For the preferred experimental site, the Pyhäsalmi mine in central Finland, we expect about 1000 inverse beta decay events per year. Far from the majority of nuclear power plants, the expected geoneutrino signal to reactor neutrino background ratio at this site is of the order of 2:1. Based on the predicted event rate and 10 years of exposure, the geoneutrino flux could be determined at 1% level. This will open the door for a precise determination of the radiogenic contribution to the terrestrial heat flow and the discrimination of geological models. Moreover, the detected geoneutrino spectrum can be evaluated to determine the relative contributions of beta-decays from the uranium and thorium decay chains to the overall neutrino flux. After 10 years, an accuracy of 5% could be reached for the U/Th ratio, thereby reaching a level of precision relevant for the study of terrestrial models.

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