Microbial uptake of phosphate during anaerobic oxidation of methane

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Sulfate-coupled anaerobic oxidation of methane (AOM) in sediments is considered a major sink of methane in the ocean and plays an important role in sedimentary biogeochemical cycling of carbon and sulfur [1]. The *Deltaproteobacteria* (DSS) associated with the methanotrophic archaea (ANME) mediating AOM are capable of polysulfide disproportionation and couple the carbon and sulfur cycles during AOM [2].

Investigations using transmission electron microscopy/energy-dispersive X-ray analysis showed amorphous particles, enriched in iron and phosphorus, only present in the cytoplasm of the *Deltaproteobacteria* bacterial partner [2]. The function of these particles is yet unknown. We investigated the microbial uptake of phosphate during AOM using $^{33}P_i$ radiotracer experiments. In our studies we used highly enriched AOM cultures originating from sediments of the Mediterranean mud volcano Isis. These sediments were enriched during 9 years of continuous cultivation and consist mainly (>95%) of ANME-2 and DSS cells as determined by CARD-FISH [3].

Radiotracer incubations on our AOM cultures lasting seven days showed an accumulation of $^{33}P_i$ tracer in the biomass and a decrease of tracer in the medium in the presence methane. In controls without methane $^{33}P_i$ uptake was minimal. In methane amended samples there was a linear correlation between sulfate reduction and the disappearance of $^{33}P_i$ radiotracer in the medium. The specific activity of $^{33}P_i$ in the medium decreased (phosphate concentration remained constant) suggesting phosphorus turnover at a significant rate of ~ 3% of the sulfate reduction rate.

[1] Reeburgh, WS (2007) *Chem. Rev.* **107** (2), 486 – 513. [2] Milucka J *et al.* (2012) *Nature* **491**, 541-546. [3] Schreiber L *et al.* (2010) *Environ. Microbiol.* **12**, 2327 - 22340

Nuclear Waste disposal: from geosciences to multigenerational safety and society

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A very large quantity of highly radiotoxic nuclear waste has been accumulated worldwide in the last 30 years constituing health risks for many thousands of generations. Isolation in futur deep geological disposal facilities is considered today by national and European legislation, by governmental commissions international agencies and large parts of the scientific community as the best strategy to reduce the long term risk. Nevertheless, serious doubts remain in the public and by NGOs.

Scientific proof for the safety of long term waste isolation is provided in particular by the geosciences by detailed site characterisation, comparaison of disposal concepts to natural analogues and by ellucidating detailed process understanding for mineral dissolution, mass transfer resistance for exemple of clays, geomechanics, hydraulics of site evolution etc.

Using examples from waste form dissolution in confined space, from the geochemistry of radionuclide migration and from water transport in clays, the paper presents how scenarios for potential radionuclide release to biosphere and potential doses to future generations can be obtained. Safety analyses generally show that doses will remain always (up to millions of years) lower than today legal limits. The validity and credibility of such analyses can be increased by qualitative lines of evidence, demonstrating the safety case.

From a societal point of view there are however a certain number of questions:

1) The focus on the long term risk is based on the fact that most analyses show zero risk for the first 1000 of years. However in case of reversible disposal, the repository will remain open for more than hundreds of years, with associated risks for todays generations similar to that of typical nuclear installations. Incorrect repository closure after the end of reversibility period may increase the long term risk.
2) The meaning of risk of very low doses to thousands of generations is chalanged the societal debate on low doses in particular after the Chernobyl desaster.
3) The horizon of responsibility for thousands of generations has no paralel in any human ethics

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