Doctoral Thesis at IFA-Tulln
Environmental Biotechnology | Geobiotechnology

in close cooperation with
ACIB GmbH, K1-MET, Energie AG and RAG Austria AG

Development of a molecular toolset for monitoring metabolic proficiencies of anaerobic microbes in underground gas storages

Background and Mission Statement:

Replacing fossil energy carriers with renewable energy is one crucial step to mitigate the effects of global climate change. One major hurdle of transforming our current energy system relates to the inherent volatility of renewable energy production: Peak energy production does not coincide with its consumption, raising the demand for **capacitive energy storage technologies**. In Austria, pumped storage hydroelectricity has almost reached its full potential for storing electricity, bringing up the need for alternative, complementary large-scale energy storage solutions. The *Power to Gas* technology approaches this problem by converting electrical energy into chemical energy carriers such as hydrogen or further methane. These gases can be then collected in porous underground gas storages. Two major strategies have recently emerged in this context:
Biogenic *in situ* geomethanation based on *methanogenic communities* is used to convert hydrogen, which is generated by solar and wind power, and carbon dioxide to methane. This technology holds the advantage of providing a versatile energy carrier (methane) that is fully compatible with the pre-existing natural gas grid. The second approach focuses on the **storage of pure hydrogen in subsurface gas reservoirs**, which is of particular interest for energy-demanding industries such as the steel industry.
Our workgroup is primarily involved in the development and optimization of both such storage and conversion technologies for renewable energy. Being involved in several related flagship projects, we aim to elaborate and advance practical solutions for a more sustainable future.

Objectives:

To further optimize methane production in depleted gas storages, we will systematically investigate the effects of several critical parameters on the volumetric production rates and the stability of the process. We conduct miniaturized conversion experiments in high-pressure bioreactors, which in return inform the process control of an ongoing, large-scale field study. Additionally, our bioreactors provide experimental data for the collaborative development and parameterization of computational models. Furthermore, we intend to perform hydrogen storage experiments in high-pressure bioreactors to identify potentially occurring hydrogen-consuming reactions.

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The following research questions will be addressed:

(a) What are the effects of using alternative carbon substrates of industrial origin (containing novel components such as e.g. carbon monoxide) applied at different pressures on the geo-methanation process or respectively the underlying microbial community? How do potential inhibitory components such as CO, H_2S or O_2 affect the long-term stability of geomethanation and what chemical mechanisms are involved?

(b) Optimization of applied substrate gas (H_2 and CO_2) ratios and their partial pressures with respect to overall methane production rates via geomethanation.

(c) What biochemical pathways are competing for the available substrates in the given ecosystems? Which functional marker genes can be used for a quantitative description of the catalytic proficiency of the microbiome (both DNA/RNA-based)?

The major emphasis of this doctoral thesis will be laid on the development of quantitative molecular tools, which will be complementary to our ongoing research ambitions in the field of next generation sequencing. However, our overall scope is the elaboration of a profound understanding of all relevant processes associated to geomethanation and the storage of hydrogen. Therefore, a wide portfolio of chemical analytic methods will also be adapted.

Methods:
Molecular methods to characterise the microbial consortium in both rock and in formation water (with special emphasis on quantitative PCR). Sequence analysis and bioinformatic methods for the development of widely-applicable functional marker genes. Sampling and cultivation techniques for obligate anaerobic microbes. Analytical methods based on ion, gas and high performance chromatography will be used to monitor biocatalytic processes.

Candidate Profile:
The candidate should hold a degree in either molecular biology, biotechnology or a related discipline. We are looking for an intrinsically motivated and cooperative team player, who is also willing to take up rigorous coordinative duties within their assigned projects. The candidate should be able to work in a well-structured, goal-oriented way to successfully accomplish project milestones in a reliable and independent manner.

Duration: 3 years (start possible from May 2021)

Employment: 30 h/week as an early stage researcher

Salary: ~ 2.200 EUR gross salary/month
(Collective Contract: Verwendungsgruppe B1, § 30 Abs. 2 in combination with § 32 Z. 1 applies)

Application deadline: **31.03.2021**
Please send a single pdf file including a letter of motivation and your CV; include a certificate of graduation; if available, provide copies of master's thesis and research papers.

Information and Contact:
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