

Microbial activity in gas field fluids and in laboratory experiments simulating geological CO₂ storage

ANDREA KASSAHUN^{1*}, CLAUDIA GNIESE²,
MICHAELA HACHE¹, THOMAS MUSCHALLE³
AND NILS HOTH³

¹Dresdner Grundwasserforschungszentrum, 01217 Dresden, Germany (*correspondence: akassahun@dgfz.de)

²TU Bergakademie Freiberg, Inst. of Biosciences, 09599 Freiberg, Germany (claudia.gniese@ioez.tu-freiberg.de)

³TU Bergakademie Freiberg, Inst. of Drilling and Fluid Mining, 09596 Freiberg, Germany

Microbial activity in gas field fluids from two natural gas fields in Germany was assessed for evaluation of possible biochemical transformation of injected CO₂. 16S rDNA clone library construction revealed the presence of bacteria (*Thermoanaerobacterium* sp., *Petrotoga* sp. *Desulfotomaculum* sp.) in both gas fields and archaea (*Methanolobus*, *Methanoculleus*) in one gas field [1]. Gas field fluids of both fields contain free amino acids, polysaccharides, carbonic acids (formic acid, acetic acid) and alcohols (methanol, ethanol). Bio-molecules and metabolites form 25 to 50% of the total dissolved organic carbon of 2 to 10 μM. Moreover, both gas field fluids contain 0.1 to 250 μM dissolved H₂.

Laboratory experiments for simulation of geological CO₂ storage were conducted in high-pressure reactors (autoclaves) for 6 to 12 months. Gas field fluids and milled rock material from exploration drilling cores were reacted at p_{CO₂}=6.5 bar, p_{H₂}=3.5 bar, p_{N₂}=4 bar and T=40°C. During the experiments, cell numbers of the reactor fluids rose and CO₂ and H₂ were consumed. DOC concentrations increased up to several hundred mM, while its composition remained comparable to the gas field fluid DOC. For one gas field, sulphate reduction was observed. Fatty acids, saturated hydrocarbons and elemental sulphur (in sulphate reducing systems) were detected in the sediments after the experiment. Fluorescence microscopy was used for visualisation of polysaccharides, proteins and calcium in the sediment samples. Both protein-calcium and polysaccharide-calcium associations were detected. REM-EDX analysis revealed biogenic sulphides and carbonates in sulphate reducing systems. Microbial activity at simulated CO₂ geological storage resulted in elevated concentrations of dissolved organic carbon, production of EPS and precipitation of biogenic minerals and thus might influence CO₂-storage capacities and rock physical properties of CO₂ storage units.

[1] Ehinger *et al.* (2009) *Geomicrobiology Journal* **26**, 326–338.

Analysis and application of water-rock-CO₂ reaction using basalt to underground CO₂ sequestration

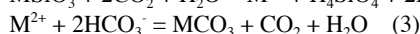
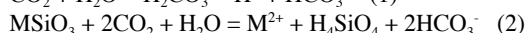
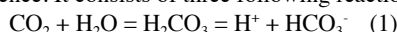
T. KATAYAMA¹, N. SHIKAZONO¹, Y. TAKAYA²
AND Y. KATO²

¹Department of Science for Open and Environmental Systems, School of Science and Technology, Keio University, Kanagawa-ken, 223-8522, Japan

(*correspondence: tomohirokatayama2487@yahoo.co.jp)

²Department of Systems Innovations, School of Engineering, the University of Tokyo, 113-8656, Tokyo, Japan

Water-rock-CO₂ reaction attract attention in many parts of science. It consists of three following reactions:



where M is bivalent metal ion.

There are two steps. First, CO₂ dissolves in the water by (1) or mineral and water react CO₂ by (2). Next, bivalent metal ion and hydrogen carbonate ion generate and carbonate minerals (MCO₃) precipitate by (3).

We are applying them to the CO₂ underground sequestration and the estimate of atmospheric CO₂ concentration of Archean and formation of mineral water, and global carbon cycle in earth system. In this paper we will focus on CO₂ underground sequestration based on experimental water-basalt-CO₂ reaction and computer simulation.

[1] Berger, G. (1994) *Geochimica et Cosmochimica Acta*, **58** (22), 4875-4886. [2] Gislason, S.R. and Oelkers, E.H. (2003) *Geochimica et Cosmochimica Acta*, **67** (20), 3817-3832. [3] Holland, H.D. (2006) *Philosophical Transactions of the Royal Society Section B*, doi:10.1098/rstb.1838. [4] Oelkers, E.H. and Gislason, S.R. (2001) *Geochimica et Cosmochimica Acta*, **65**(21), 3671-3681. [5] Shikazono, N. (2008) *Japanese Magazine of Mineralogical and Petrological Sciences*, **37**(3), 69-77