Daria Morozova[1*], Michael Zettlitzer[3] , Andrea Vieth[2] and Hilke Würdemann[1]

[1]GFZ, Centre for CO_2 Storage,[2]Organic Geochemistry, Potsdam
[3]RWE Dea AG, GeoSupportCentre, Wietze
***Corresponding author: Daria.Morozova@gfz-potsdam.de**

Microbial monitoring during CO_2 storage in deep subsurface saline aquifers in Ketzin, Germany

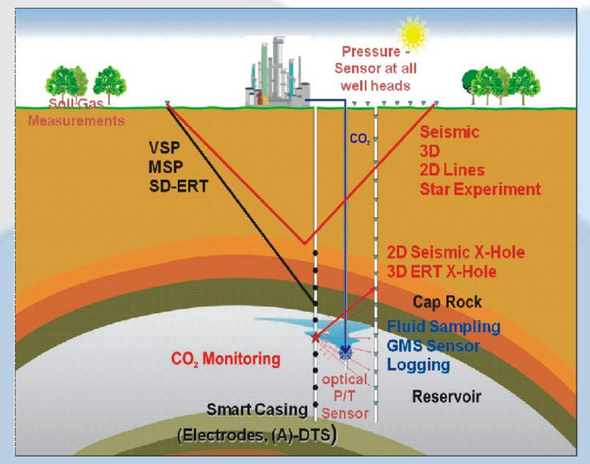

Fig. 1. CO_2SINK operation site in Ketzin with injection and observation wells

Aim

Within the frame of the EU project CO_2SINK a field laboratory near Ketzin, in the west of Berlin, is operated to study CO_2 storage in a saline aquifer. Therefore three 700-850 m deep wells were drilled by mud rotary drilling (**Fig. 1**). Our studies aim at monitoring biological and biogeochemical processes during CO_2 injection in the supercritical state, CO_2 storage and at estimating their impact on the technical effectiveness of the technique. Main emphasis is placed on analysing compositions and activities of the microbial communities, the characterisation of microbial life in extreme habitats and its influence on corrosion and mineral dissolution and precipitation.

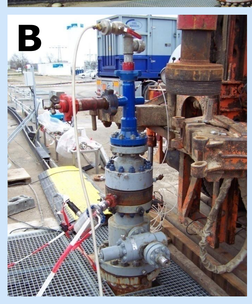

Fig. 2. Down hole sampling technologies (A) and N_2 lift (B) in Ketzin

Temporary injectivity loss due to microbial processes

Formation of iron sulphide (**Fig. 3A**, black) due to microbiological conversion of the organic constituents of the drill mud is regarded as the main reason for the temporary loss of injectivity in the injection well.

- PCR-SSCP analysis of the fluid samples (**Fig. 3C**) revealed haloalkaloplilic fermentative bacteria (yellow) and sulphate reducing bacteria (red), which corresponds with the observed acetate increase, the iron sulphide formation and the decrease of sulphate concentration (**Fig. 3A, B**).
- Up to 10^7 cells ml^{-1} fluid were detected
- Decreasing of SRB amount in fluid samples after N_2 lift from 10^6 to 10^4, detected by FISH (**Fig. 3D**) indicates the effectiveness of the well lifting technique (**Fig. 2B**) for the drill mud removal.

Microbial changes during CO_2 exposure

The microbial community in downhole samples (**Fig. 2A**) was investigated using PCR-SSCP (**Fig. 4A**) and FISH (**Fig. 4B, C**). Quantitative and qualitative changes after CO_2 arrival in Ktzi 200 were detected in the fluid.

- Up to 10^6 cells ml^{-1} fluid were detected
- Dominant microorganisms were haloalkalophilic fermentative bacteria (yellow), *Proteobacteria* (brown) and *Firmicutes* (blue), typical representatives from the deep biosphere (**Fig. 4A, B**).
- Sulphate reducing bacteria (SRB), known to be involved in corrosion, were identified (**Fig. 4A, B, C,** red).
- Enhanced activity of the SRB after five months CO_2 storage (**Fig. 4 B**) indicated that bacterial community was able to adapt quickly to the changed conditions in the habitat.

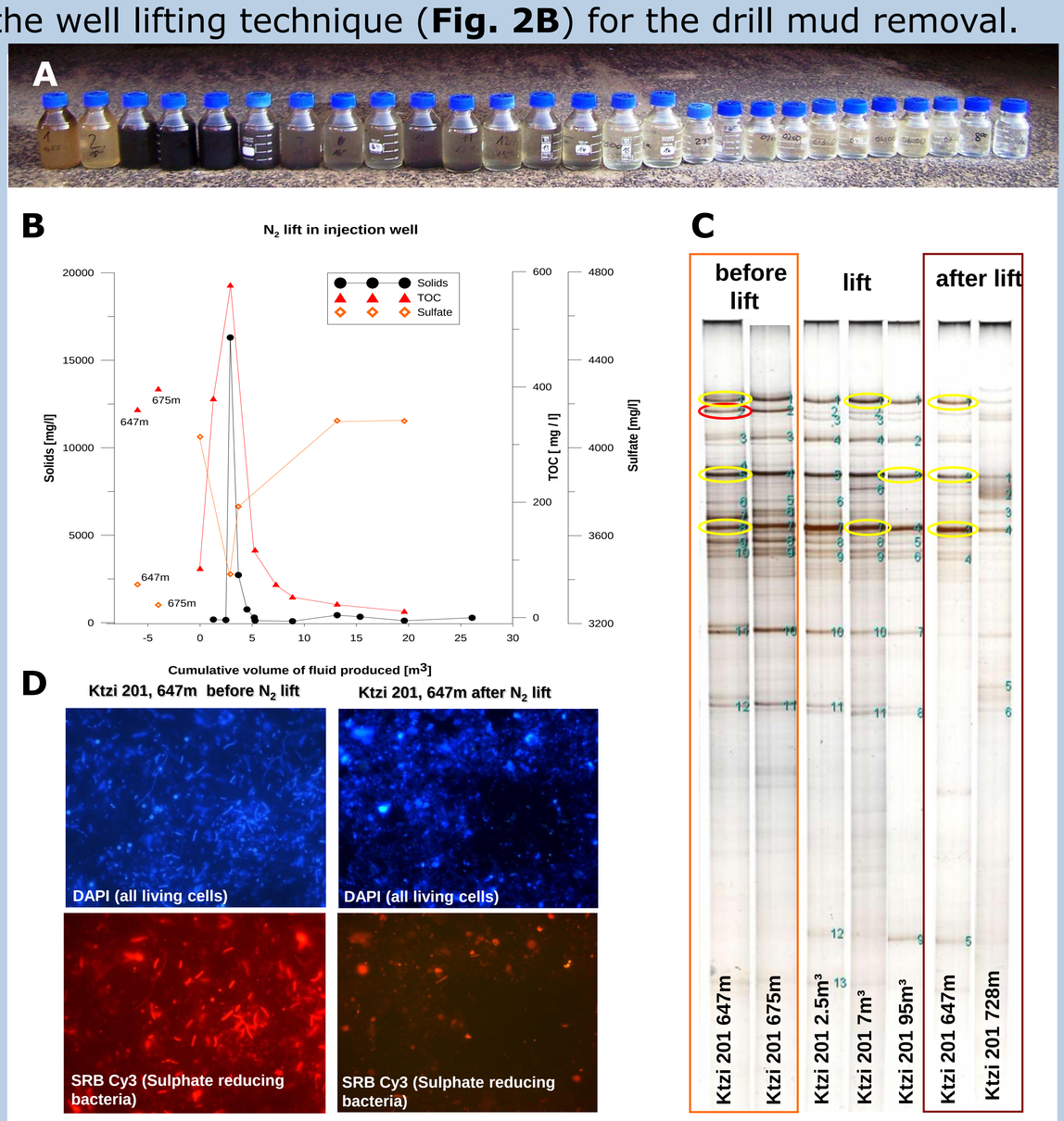

Fig. 3. N_2 lift in the injection well Ktzi 201. **A**, Fluid samples Ktzi 201 N2 lift; **B**, Correlation between the increase of solids, TOC and the decrease of sulfate concentration in fluid samples during N_2 lift; **C**, SSCP analyses of microbial biocenosis; **D**, FISH analyses with a Cy3-labelled SRB probe (red)

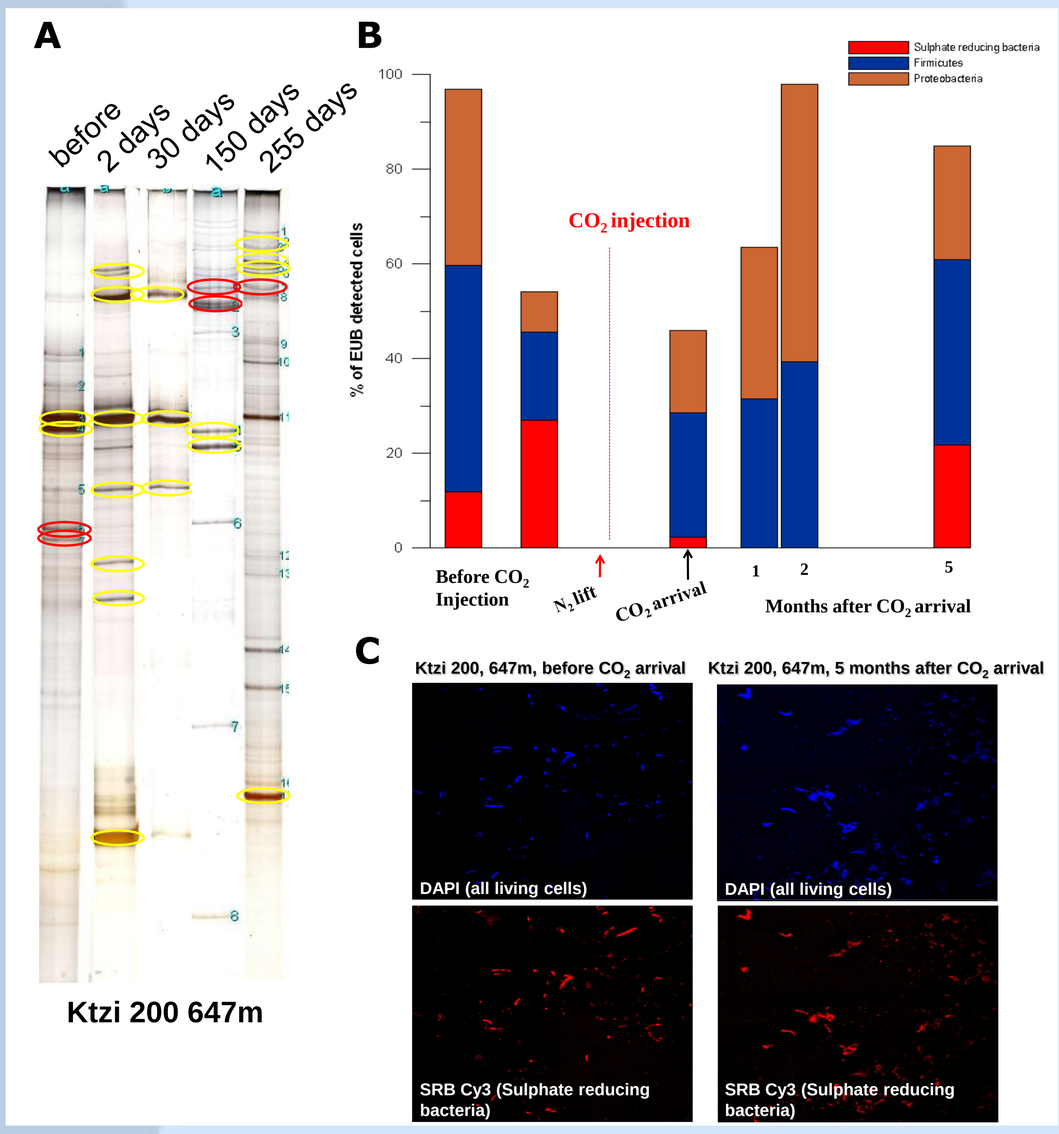

Fig. 4. Microbial monitoring in the fluid downhole samples from the observation well Ktzi 200 during CO_2 injection. **A**, 16S rRNA fingerprinting; **B**, FISH probe specific counts relative to the number of active bacterial cells (EUB-counts); **C**, FISH analyses with a Cy3-labeled SRB probe (red)

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CO_2SINK is founded by the EU Comission, the Federal Ministry of Education and Research (BMBF), the Federal Ministry of Economics and Technologies (BMWi), and the industry.