Injection of new gases (H_2 and O_2) in UGS in deep aquifers

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Acknowledgment

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Clean Hydrogen Partnership

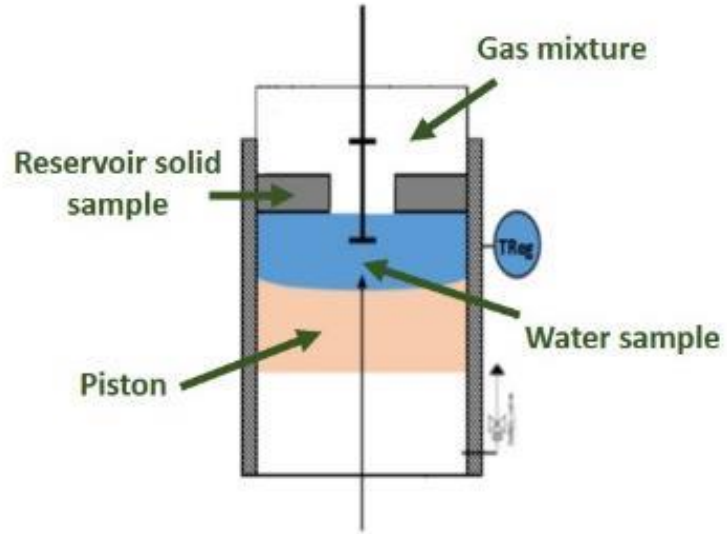
Outline

1. Injection of H_2 (Power-to-gas) and O_2 (biomethane) in the natural gas network
2. Expected arrival of these gases in the UGS
3. Is there a risk to the storage facilities ?
4. How do indigenous microbial communities respond ?
5. Is there an effect on the quality of the stored gas ?

1

Recreating the UGS in situ conditions in a laboratory reactor

Recreating the UGS in situ conditions in a laboratory reactor



→RINGS reactor can work up to 150°C and 150 bars

→Downhole water (containing microorganisms) and rock phases are sampled in the real UGS

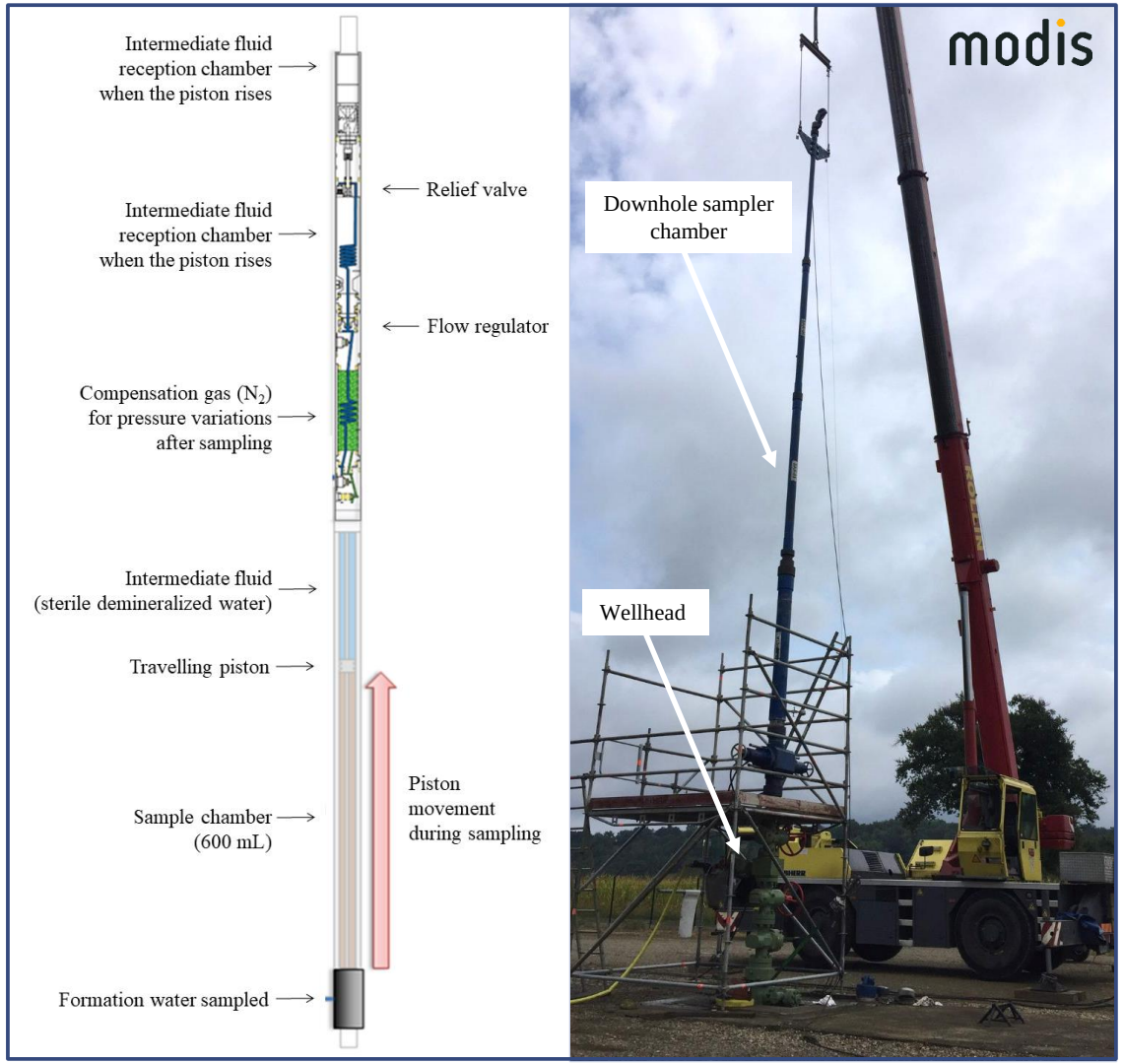
→The initial gas phase is composed of CH_4 (99%), CO_2 (1%) and traces of monoaromatic hydrocarbons (benzene and toluene).

→Deformable reactor (Piston to compensate for the pressure drop)

2

Formation water sampling

Formation water sampling



→ Sampling of the formation water (- 580m to - 1200m)

→ Guarantee the non contamination of the microbial community

→ Control the pressure / depressurization

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A deep continental aquifer downhole sampler for microbiological studies

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3

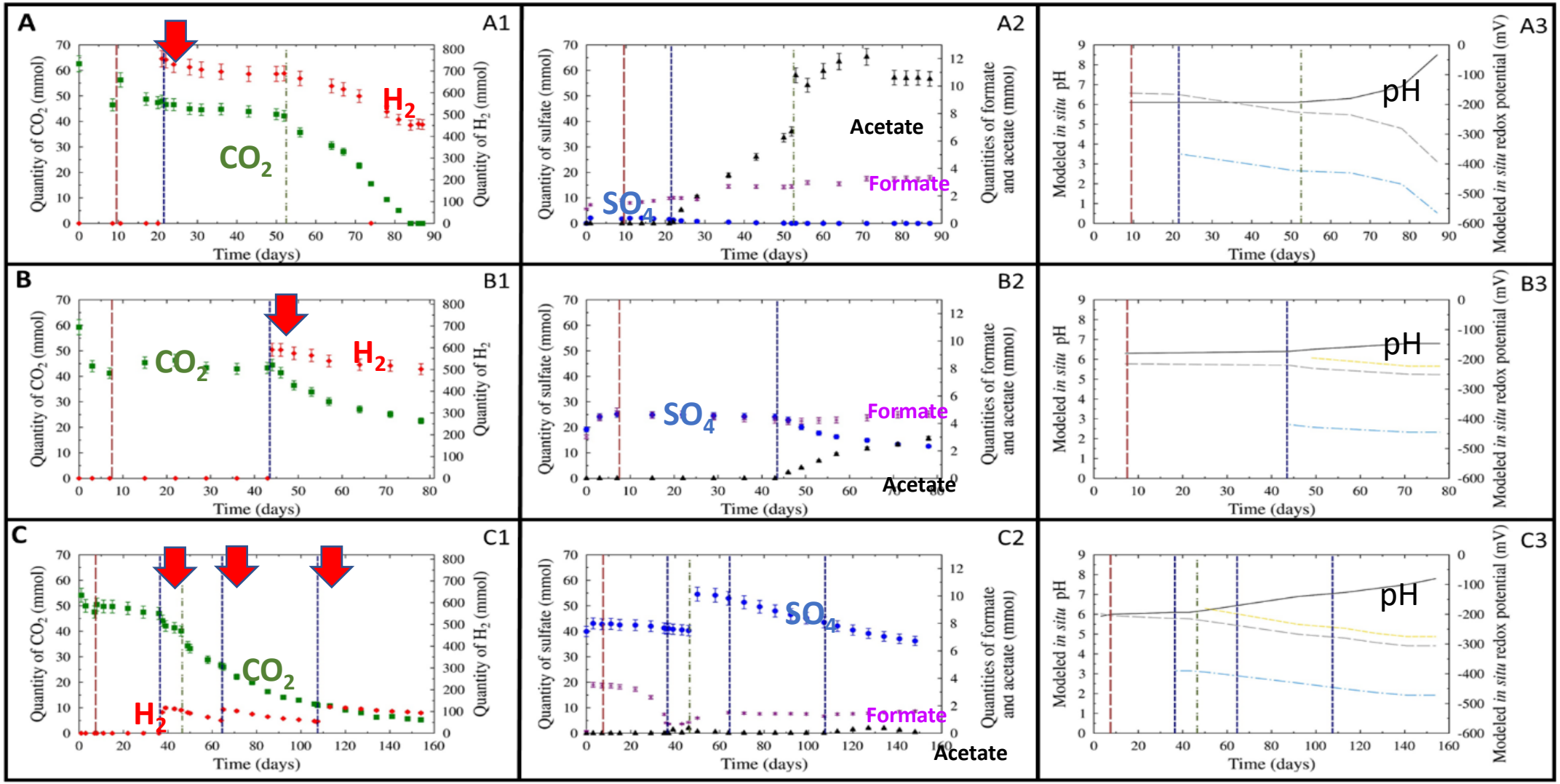
Three aquifers tested for the injection of H_2

Three aquifers tested

Aquifer 1
+ 10% H_2

Aquifer 2
+ 10% H_2

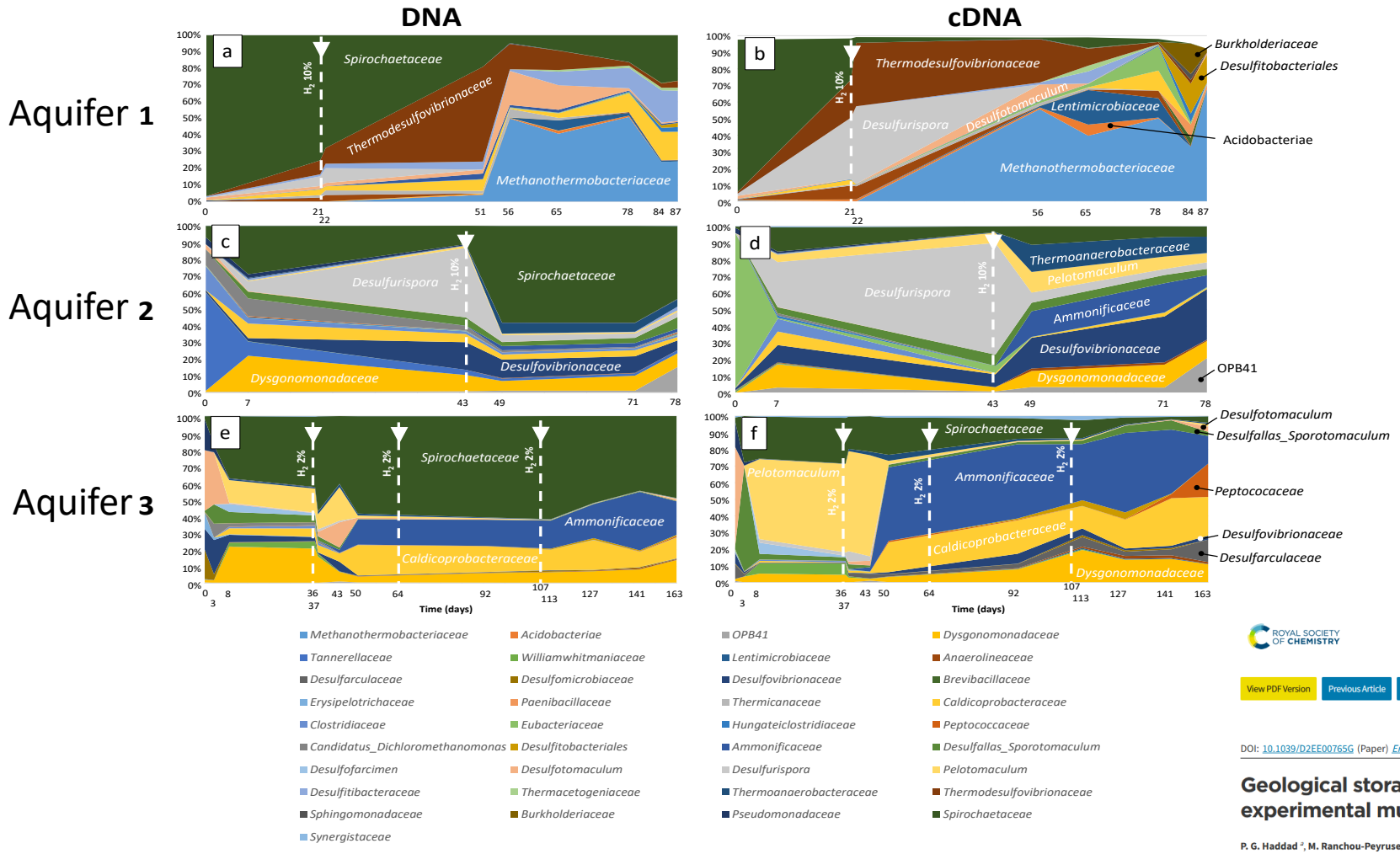
Aquifer 3
+ 3 x 2% H_2



4

Microbial communities monitoring

Microbial communities monitoring

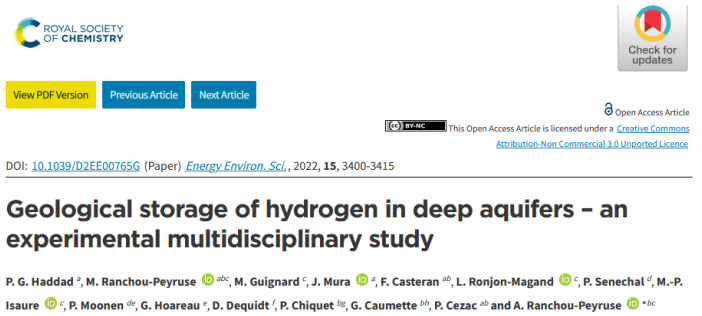


→ A community initially dominated by fermenters and sulfate-reducers

→ The Ammonificaceae family includes sulfate-reducers

→ Formate production (assumed by (homo)-acetogens)

→ Methanogenesis does not necessarily take place

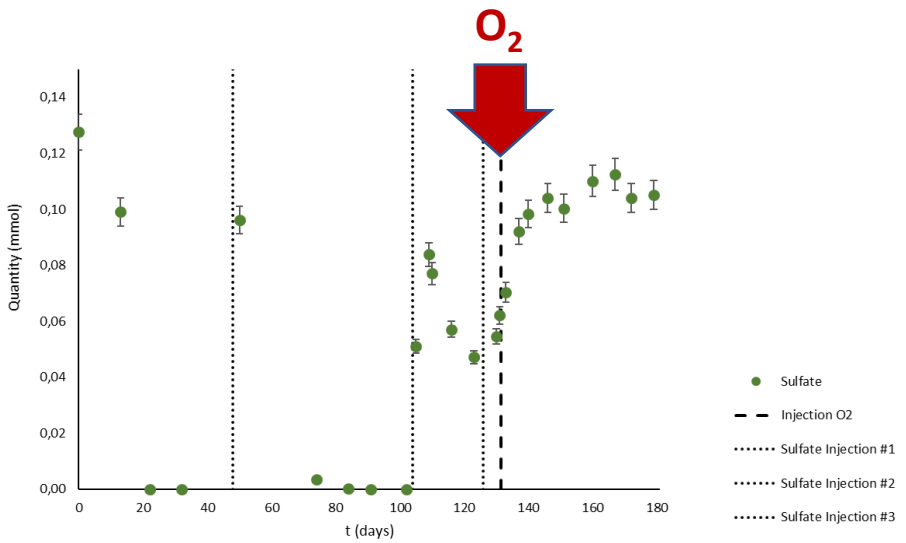


+ Comparative study of three H_2 geological storages in deep aquifers simulated in high pressure reactor (in process)

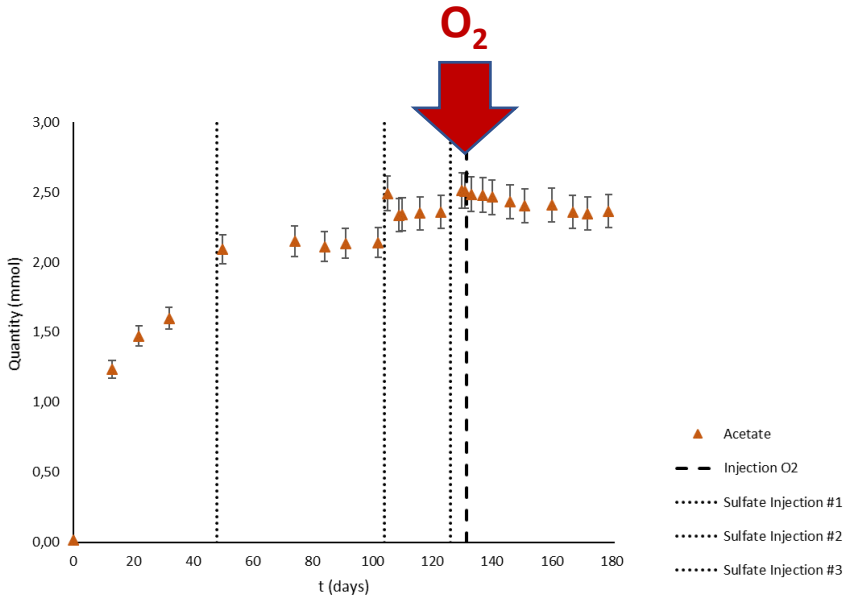
5

An aquifer tested for O_2 injection (1% & 100 ppm)

An aquifer tested for 1% O_2 injection (=10 000 ppm) ➔ changes observed on the water



Sulfate evolution



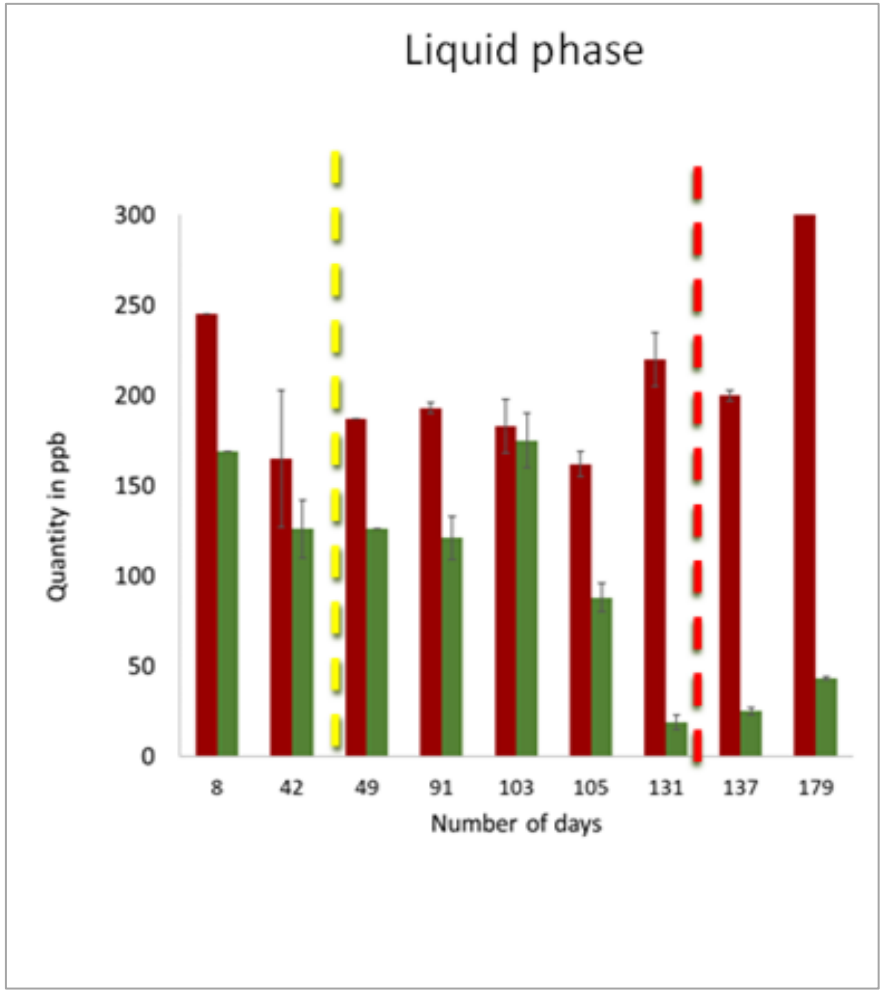
Acetate evolution

→ sulfate was consumed by sulfate-reducers

→ O_2 injection stopped the sulfate consumption (death or inhibition of sulfate-reducers)

→ Acetate is produced from micro-organisms at the beginning of the experiment

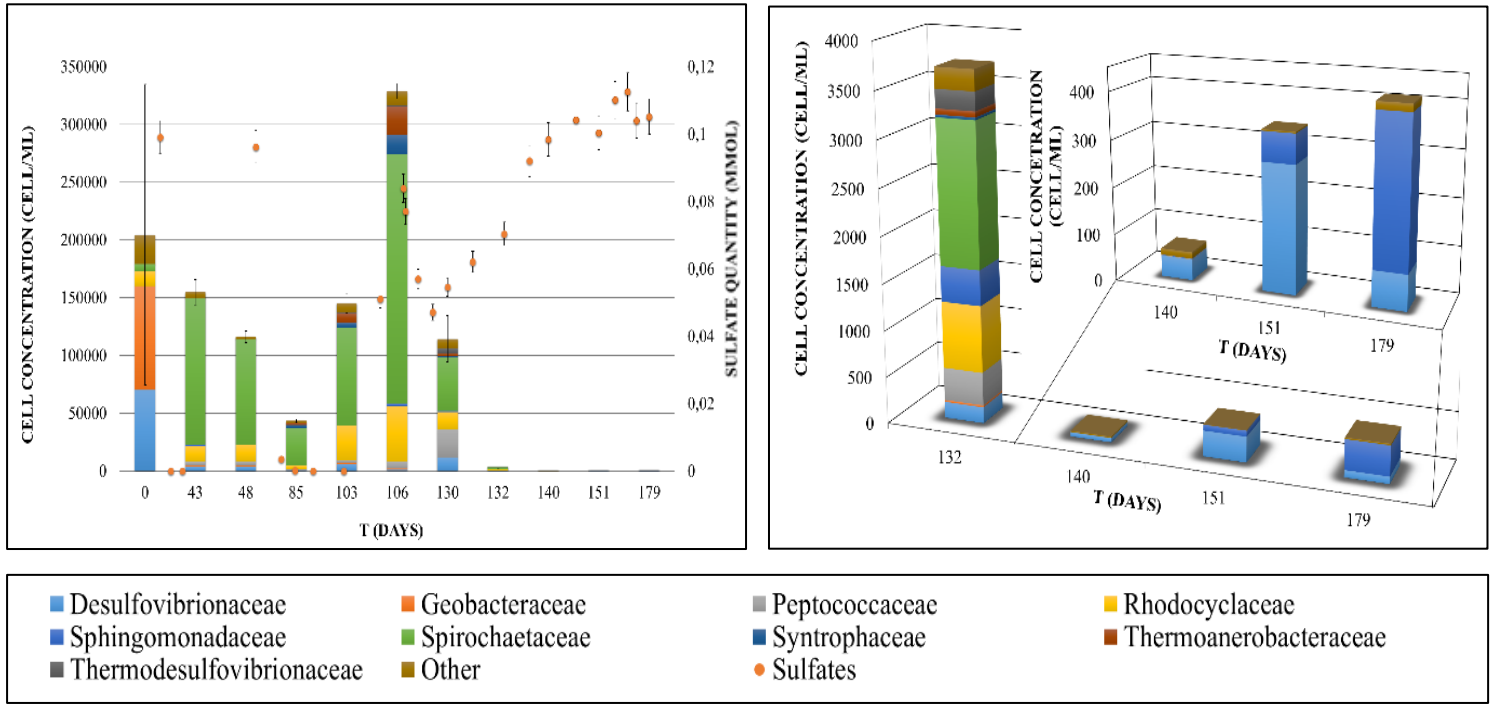
An aquifer tested for 1% O_2 injection (=10 000 ppm) ➔ changes observed on the water



→ Decrease of toluene before O_2 injection

→ 1% O_2 injection stopped the toluene disappearance

An aquifer tested for 1% O_2 injection (=10 000 ppm) ➔ changes observed on the microbial community



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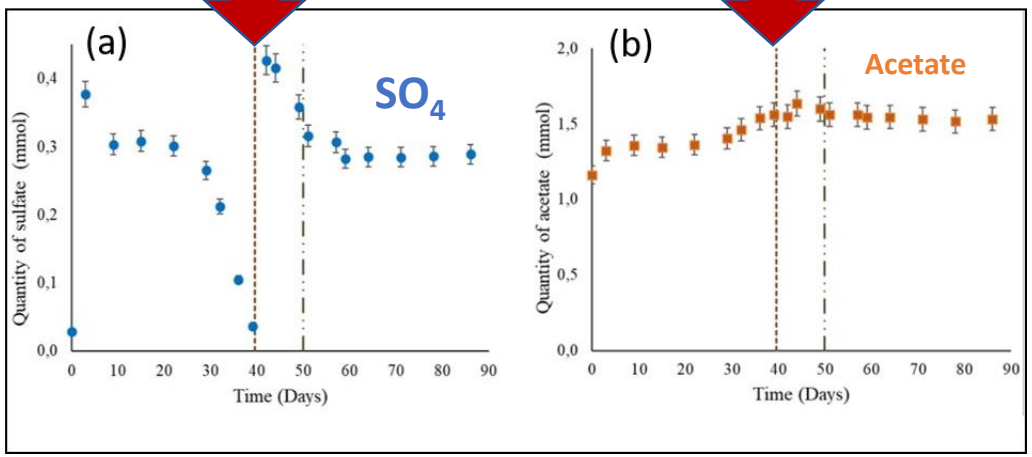
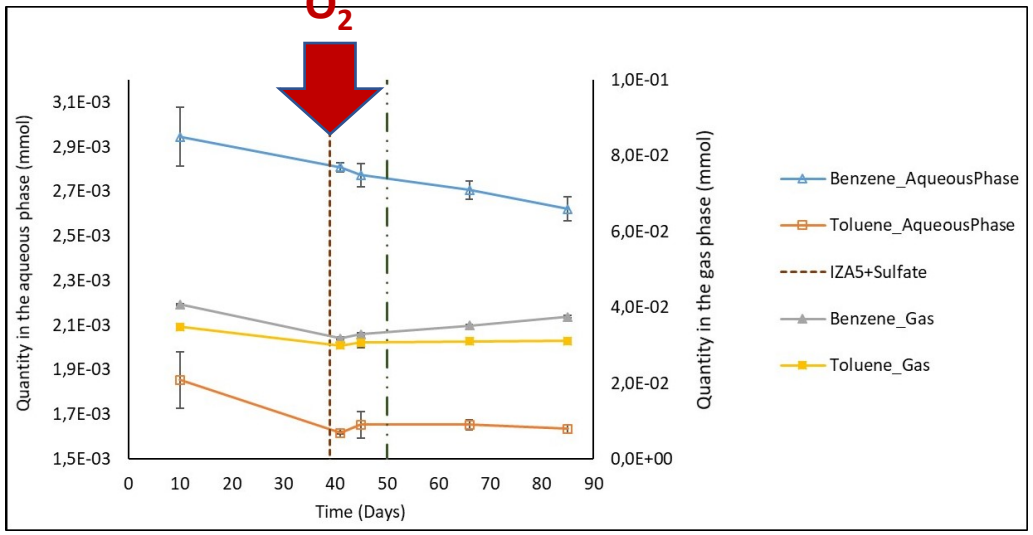
Biological, geological and chemical effects of oxygen injection in underground gas storage aquifers in the setting of biomethane deployment

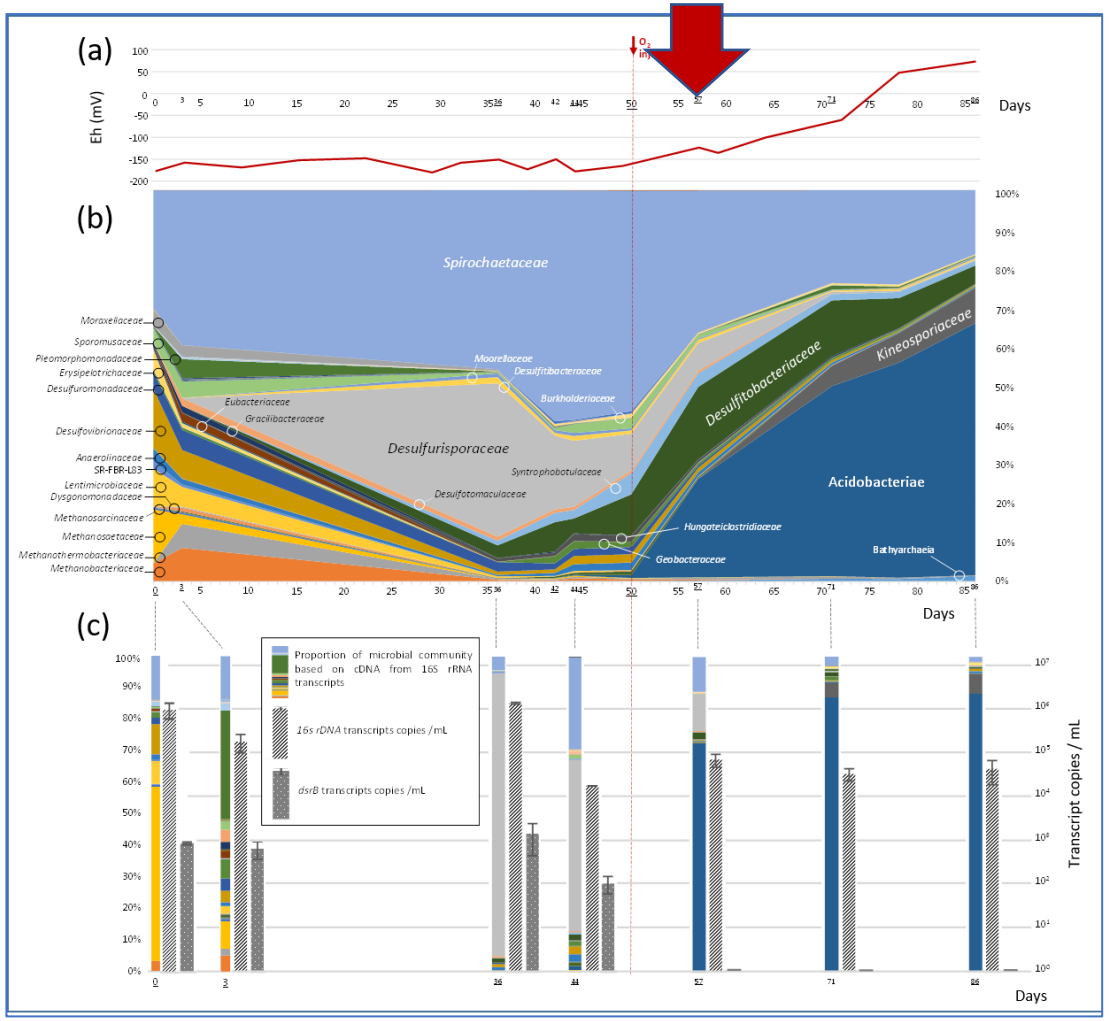
Perla G. Haddad [a], Jean Mura [a], Franck Castéran [a b], Marion Guignard [c], Magali Ranchou-Peyruse [a b c], Pascale Sénéchal [d], Marie Larregieu [c], Marie-Pierre Isaure [c], Isabelle Svahn [e], Peter Moonen [d], Isabelle Le Hécho [b c], Guilhem Hoareau [f], Pierre Chiquet [b g], Guilhem Caumette [b g], David Dequidt [h], Pierre Cézac [a b], Anthony Ranchou-Peyruse [b c]

➔ Negative effect of the 1% O_2 injection on the microbial community = hyperoxic conditions = toxicity

An aquifer tested for 100 ppm O_2 injection ➔ changes observed on the microbial community







Physicochemical and microbiological effects of geological biomethane storage in deep aquifers: introduction of O_2 as a cocontaminant (submitted)

Thank you !

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