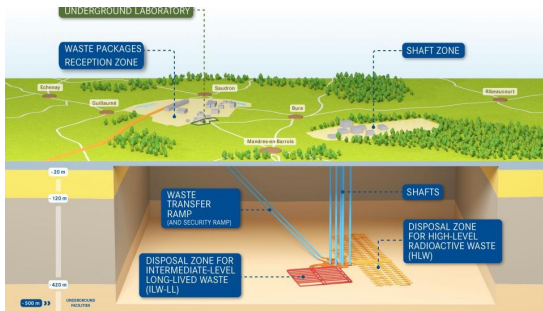


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Anneleen Vanleeuw, Elke Jacops and Kristel Mijndonckx - 22/11/2023

The search for microbial activity

A bit of background



A bit of background

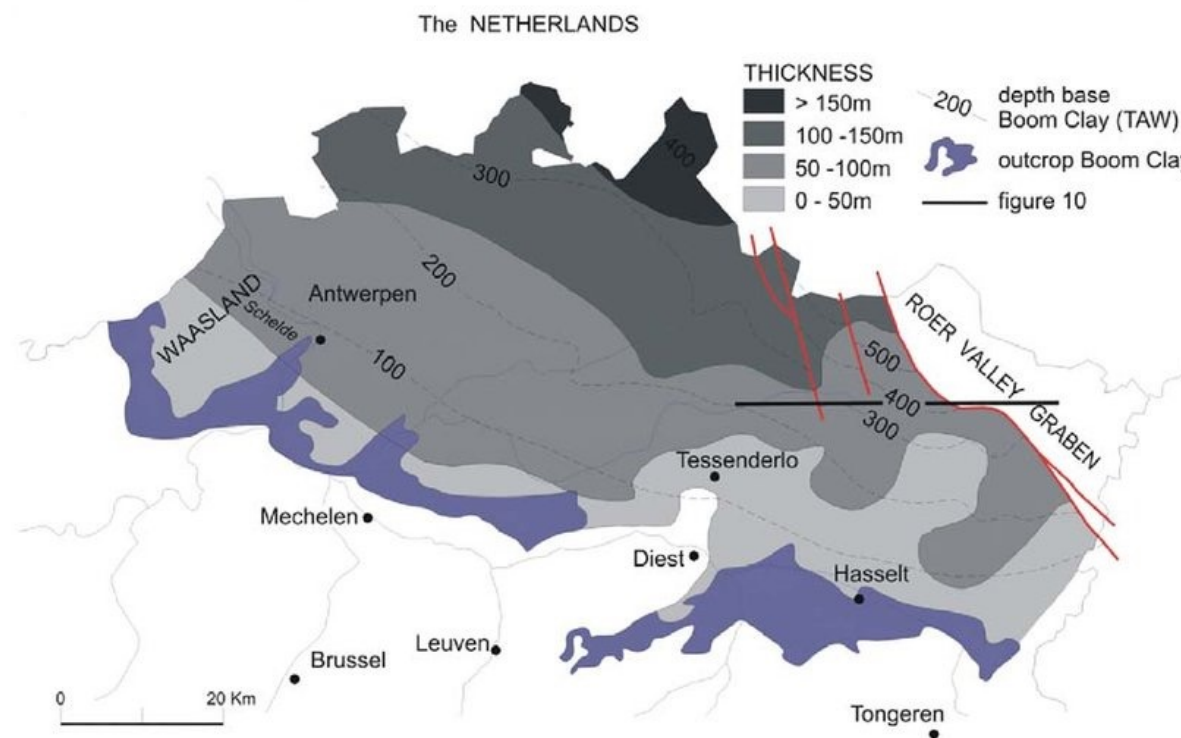
- Disposal in clay
- Why clay?
- Low hydraulic conductivity
- High sorption capacity
- Self sealing



- Reduced mobility of radionuclides



Mobility depends on geochemistry

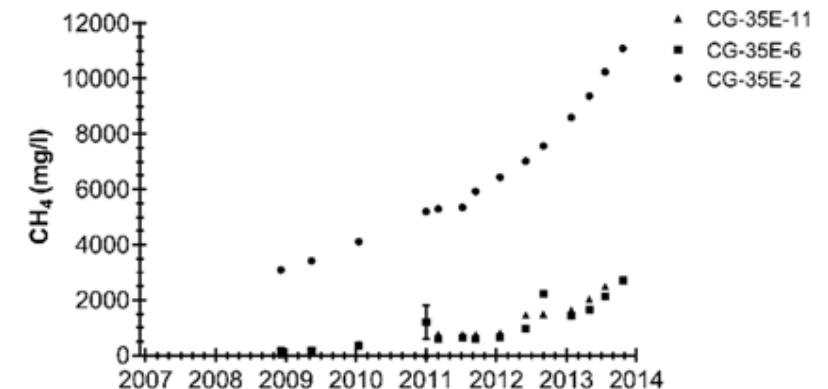
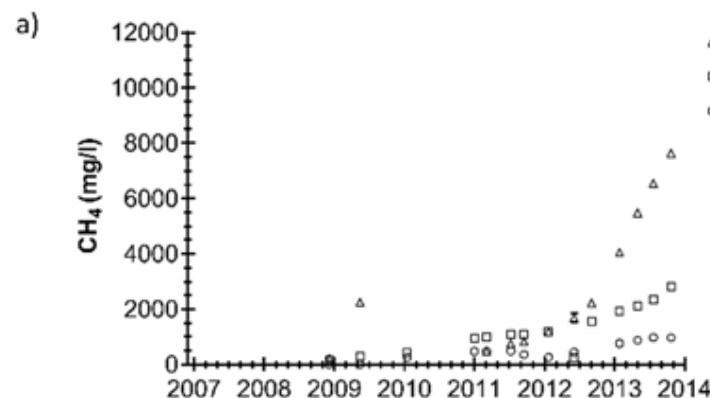
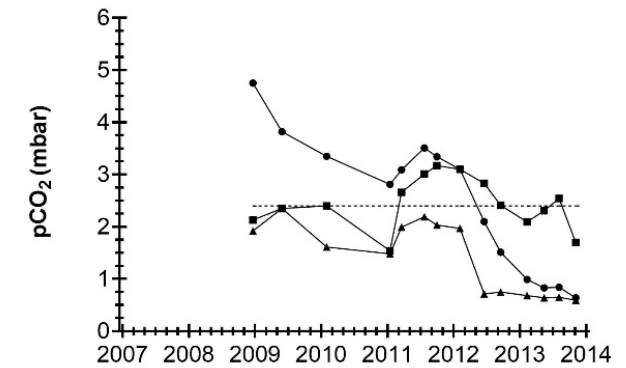
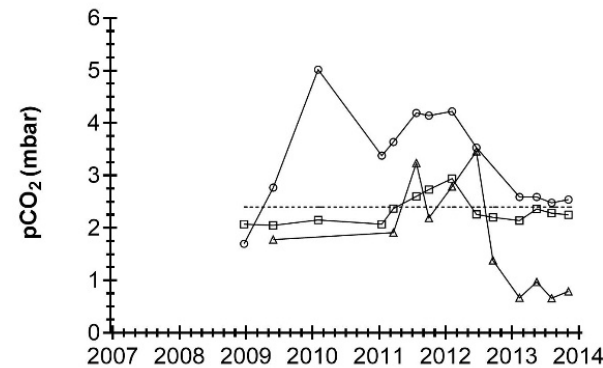


Potential host rock in Belgium: Boom Clay

In situ gas evolution

Evolution of the CO₂ and CH₄ concentration in piezometer filters in HADES URL

- CO₂ ↓
 - CH₄ ↑
 - Microbial conversion
- Impact pore water chemistry



In situ gas evolution

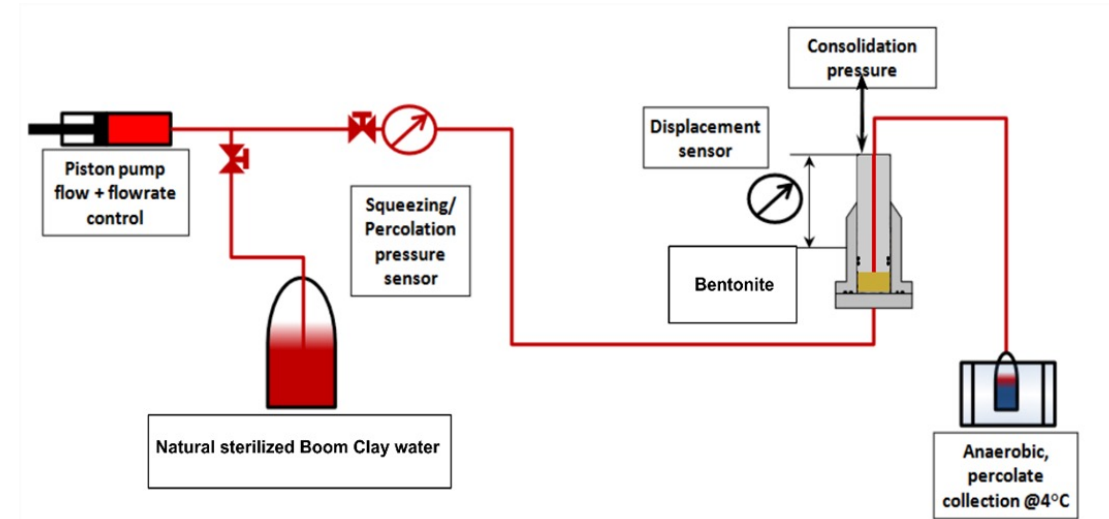
- Need for monitoring of pore water composition, including gas
- Currently:
 - Collection of water samples in stainless steel cylinders
 - Equilibration with inert gas (Ar or N₂)
 - Gas chromatography
- Online measurement possible with Mini Ruedi?
 - Rather small amounts of gas
 - Small water volumes (vessel of 1 liter)
 - Very low flow rates
- Alternatively: head space measurements with Mini Ruedi?

Microbial activity in barrier materials

- Bentonite is widely used engineered barrier material
 - Backfilling
 - Sealing
 - Pure, or mixed (e.g. with sand) – different densities
- Question: can microbes be active in compacted bentonite?
 - Dense material → no space for microbes to grow
 - No adverse effects on corrosion of metals

Microbial activity in barrier materials

- Oedometer experiments:
- Bentonite (MX80 – sterilized or not), dry density 1,6 g/cm³
- With 4 carbon steel coupons added
- Percolated with sterile pore water
- With or without gas (H₂/CO₂ in 80/20 vv% mixture)
- Follow concentration of H₂
 - Production of H₂?
 - Conversion of H₂?



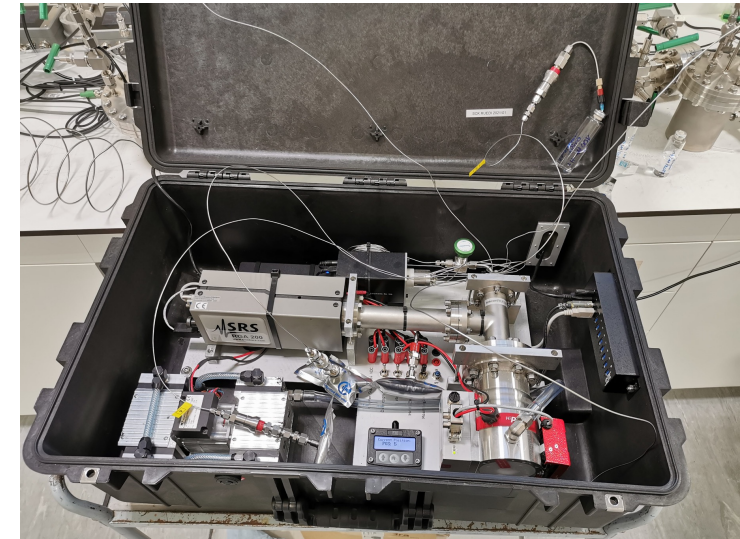
Microbial activity in barrier materials

- Batch reactor experiments:
- Bentonite (MX80 – sterilized or not), slurry
- With or without 4 carbon steel coupons added
- Sterile pore water added
- With or without H₂ gas (H₂/CO₂ in 80/20 vv mixture)
- Follow concentration of H₂
 - Production of H₂?
 - Conversion of H₂?



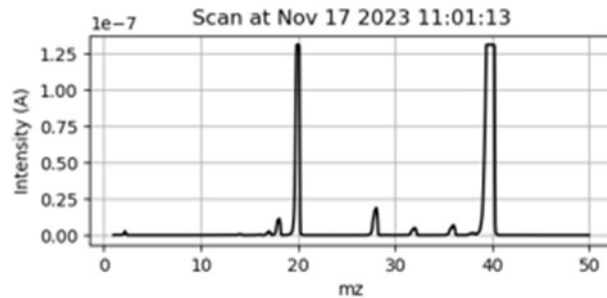
How to measure gases?

- Goal: Measure H₂ concentration in septum bottles via head space
- How:
 1. Connect vial to Mini Ruedi via luer lock
 - i. Check with O₂ if luer lock is leak tight
 2. Load the correct configuration
 3. Measure blanks and standards
 4. Run sample sequence
 5. Use Ruedi-proccess to extract data

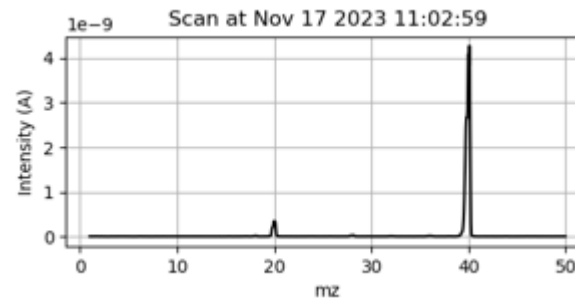


How to measure gases?

- Calibration
 - Calibration: 1000ppm H₂ in Argon
 - Validation: measure controle sample with known conc.
- 2 Detectors
 - M-detector → more sensitive for noble gasses
 - F-detector → multi purpose gas detector



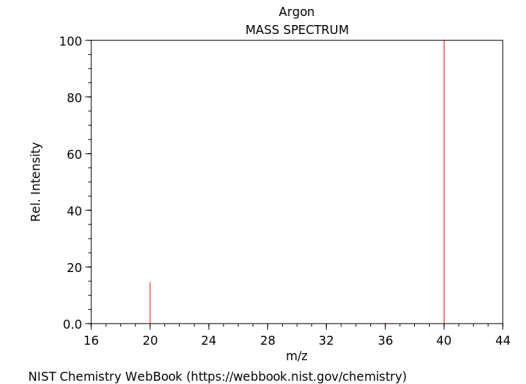
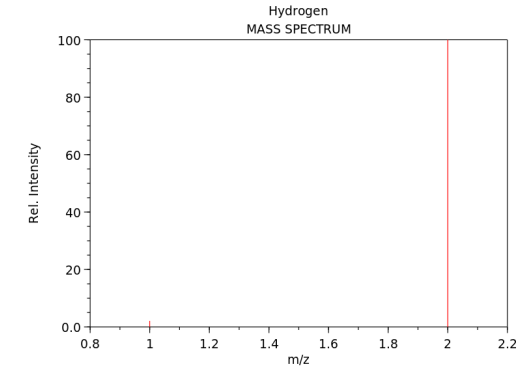
M-detector H₂ 0,1% /Ar



F-detector H₂ 0,1% /Ar

- m/z value H₂: 2

m/z value Ar: 40



Issues

- Pressure in headspace unknown
- Are the vessels leak tight over longer period?
- Too long tubing – need lot of purging to obtain constant results

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Registered Office: Avenue Herrmann-Debrouxlaan 40 – BE-1160 BRUSSELS

Operational Office: Boeretang 200 – BE-2400 MOL