Studying microbial processes under repository relevant conditions

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

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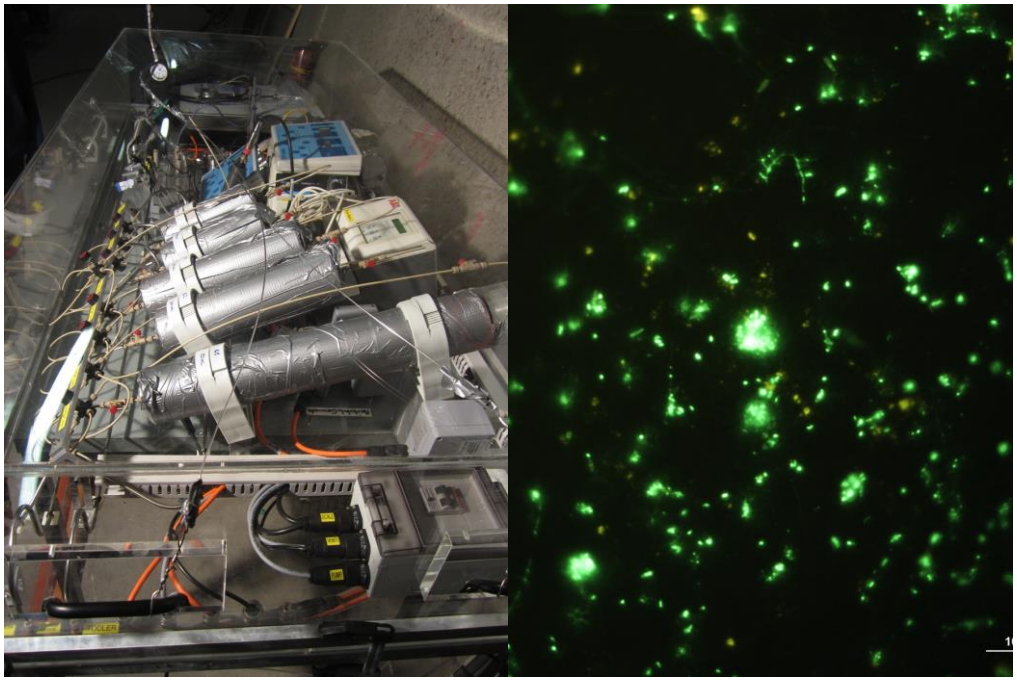

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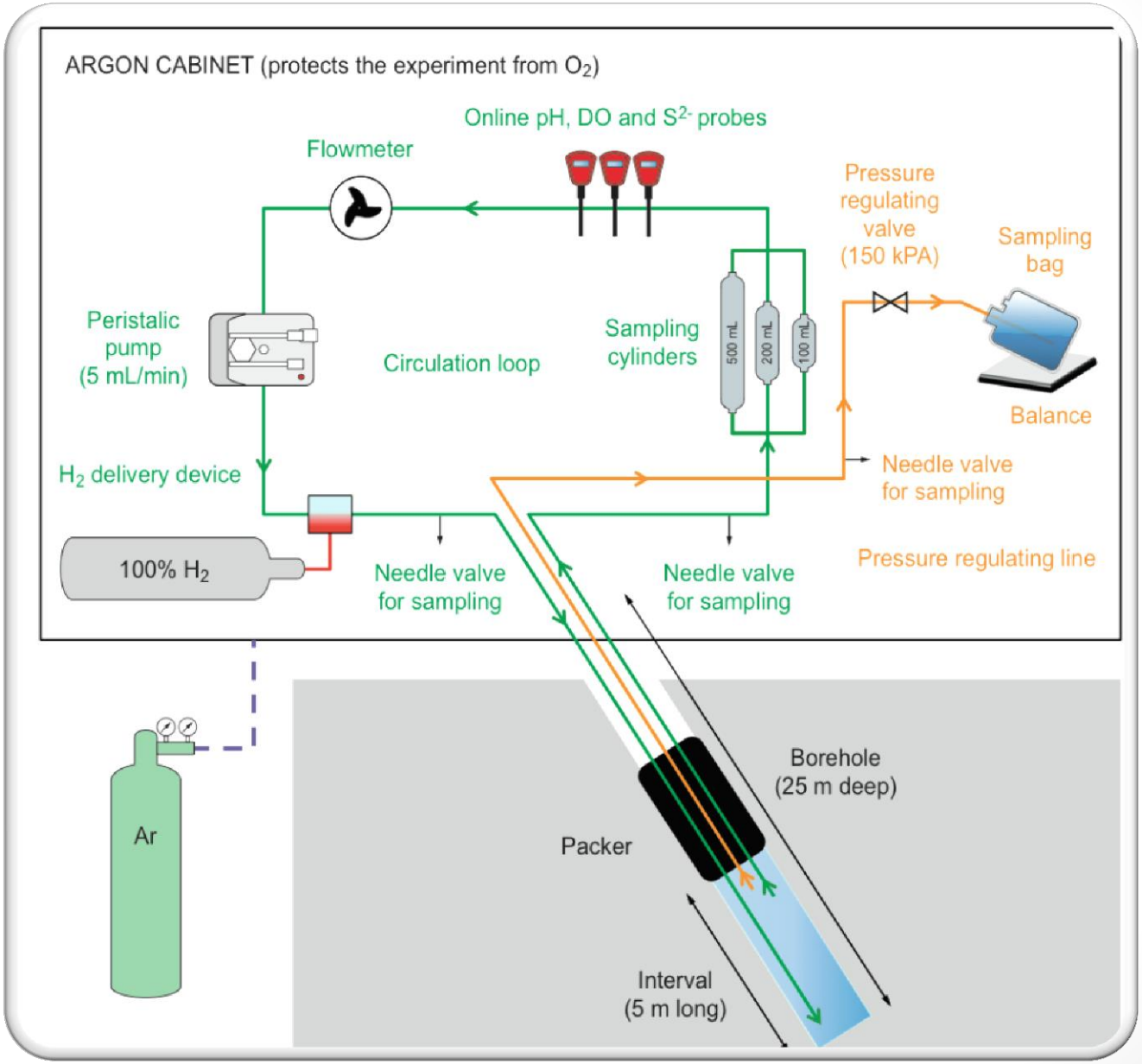
Scientific background

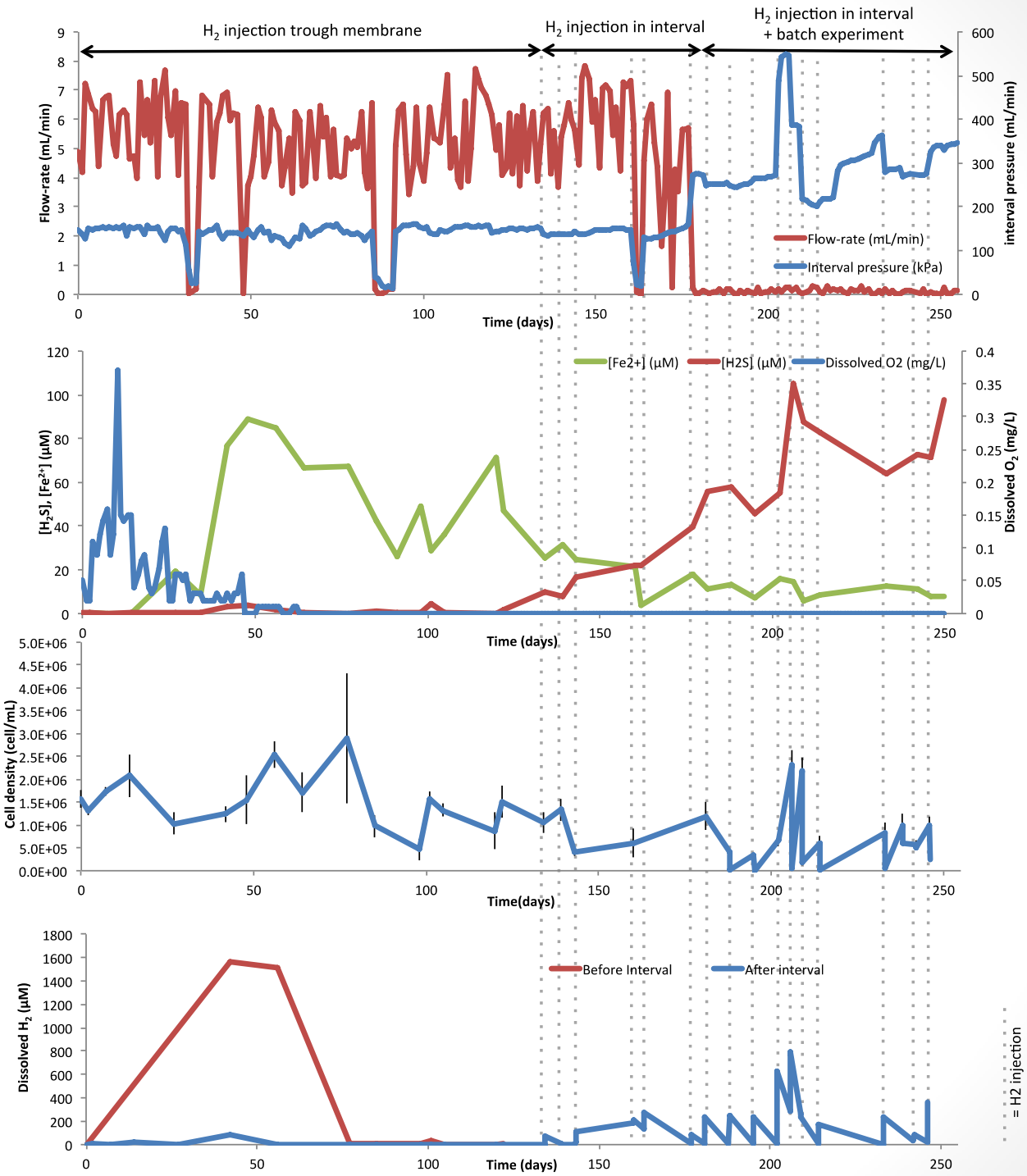
- What we have done
  - *In situ* bioreactor at Mt Terri (CH) to study microbial H_2 oxidation
  - Enumeration of microorganisms in bentonite from an *in situ* experiment

- Future interests
  - Establish a modular platform for the study of microbial processes:
    - provide an H_2 consumption rate in an engineered gas transport system.
    - provide a direct comparison of the rate of steel corrosion under biotic and abiotic conditions.
    - probe the inactivation of microbial activity in a bentonite buffer.

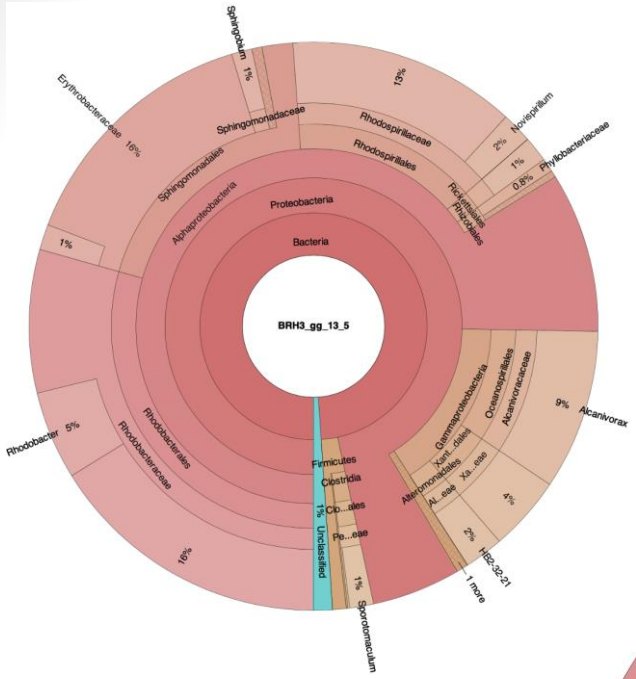
In situ bioreactor: H_2 injection in the subsurface



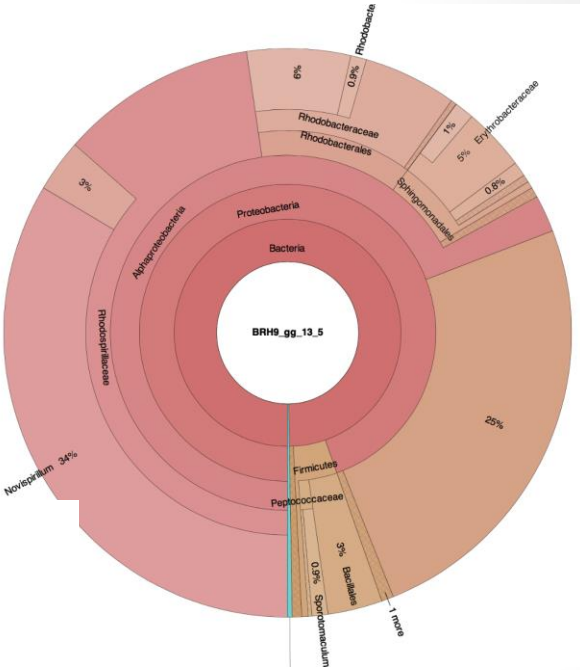
Results


H2 injection trough membrane
H2 injection in interval
H2 injection in interval + batch experiment
Flow-rate (mL/min)
interval pressure (mL/min)
Flow-rate (mL/min)
Interval pressure (kPa)
Time (days)
[Fe2+] (µM)
[H2S] (µM)
Dissolved O2 (mg/L)
[H2S], [Fe2+] (µM)
Dissolved O2 (mg/L)
Time (days)
Cell density (cell/mL)
Time(days)
Before Interval
After interval
Dissolved H2 (µM)
Time (days)
= H2 injection

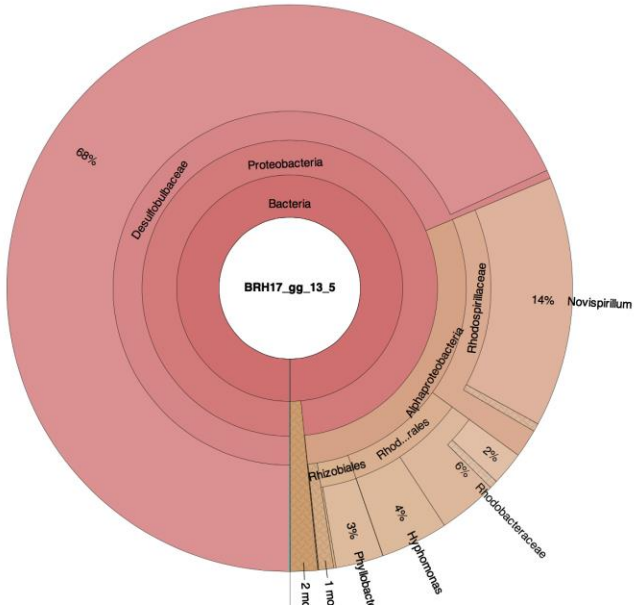
Results



2 days



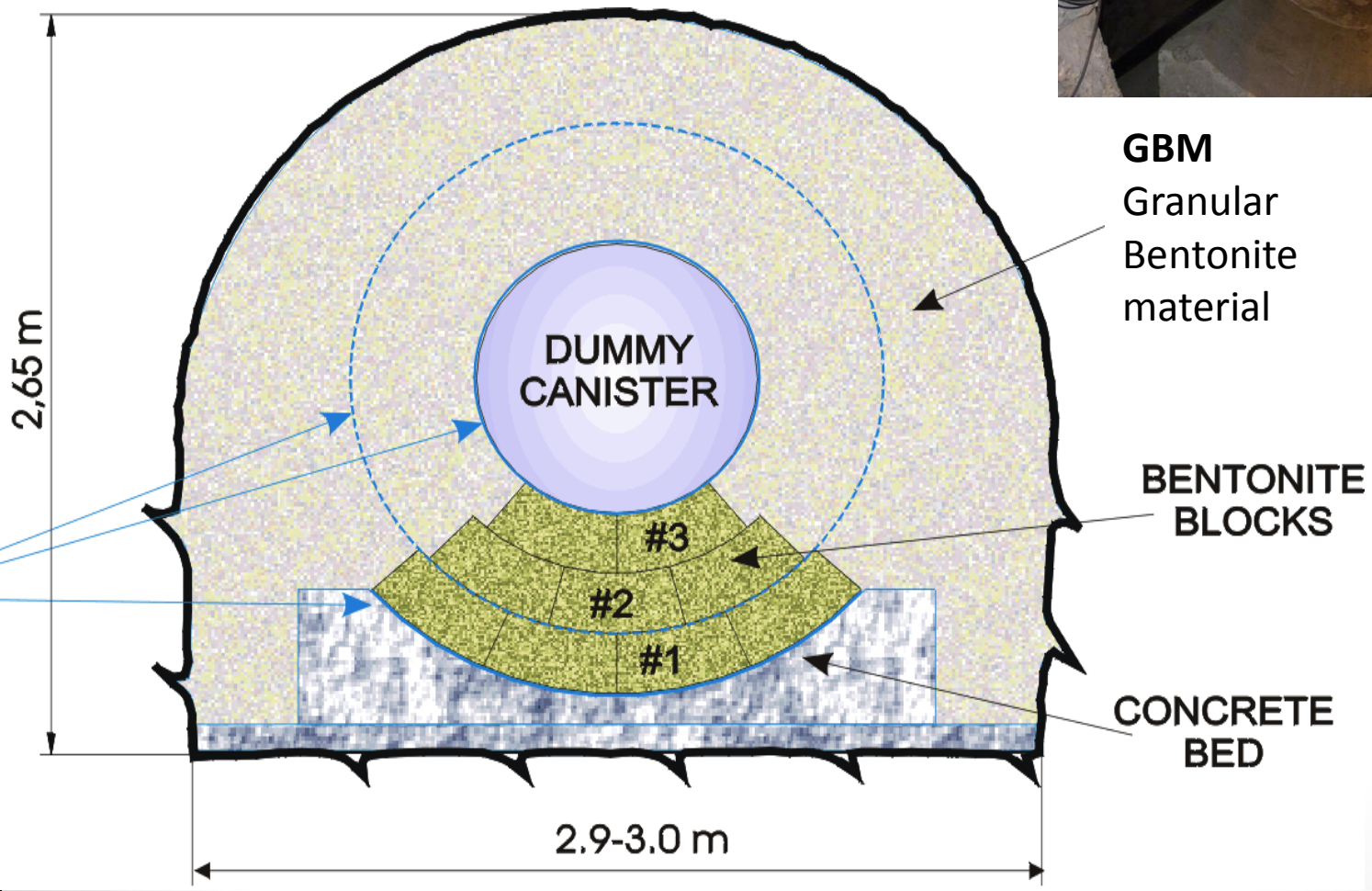
48 days



101 days

Engineered barrier experiment

- Used Febex bentonite



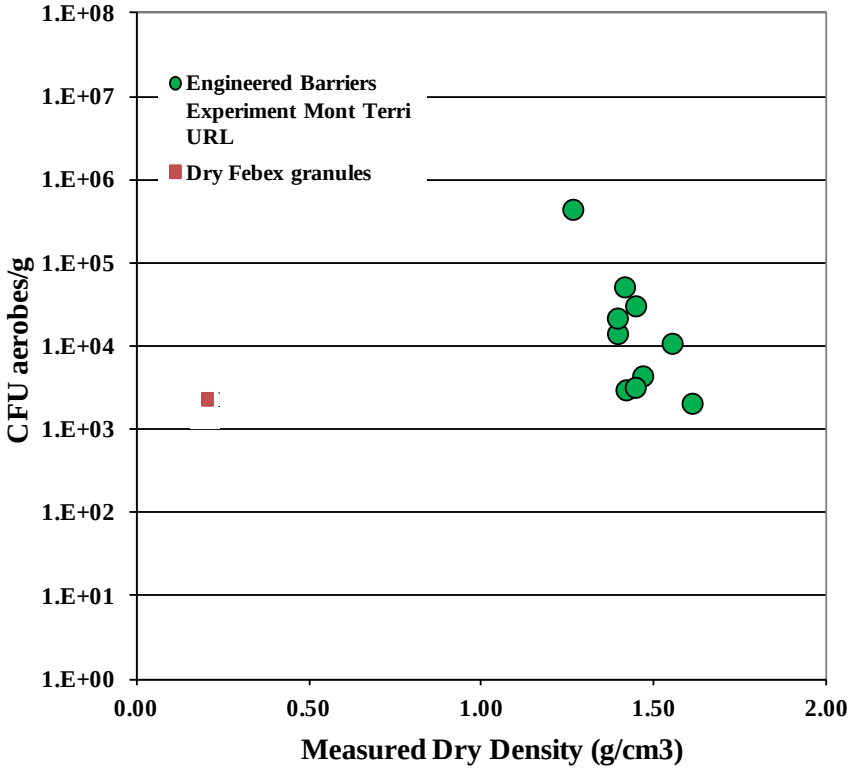
GBM
Granular Bentonite material

BENTONITE BLOCKS

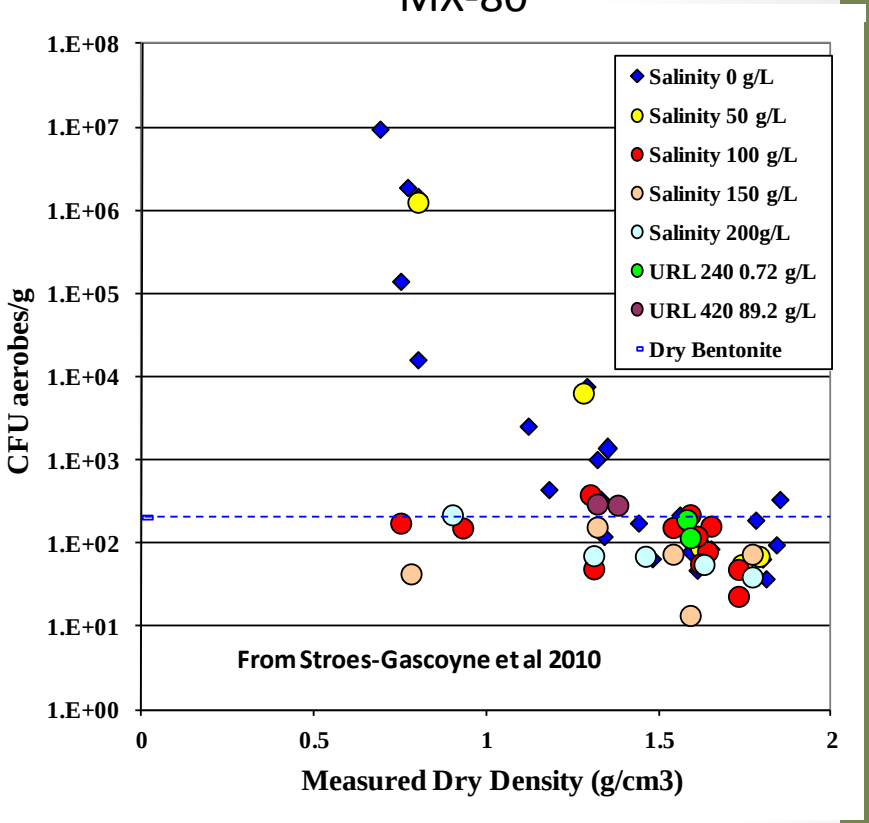
CONCRETE BED

Results

Febex



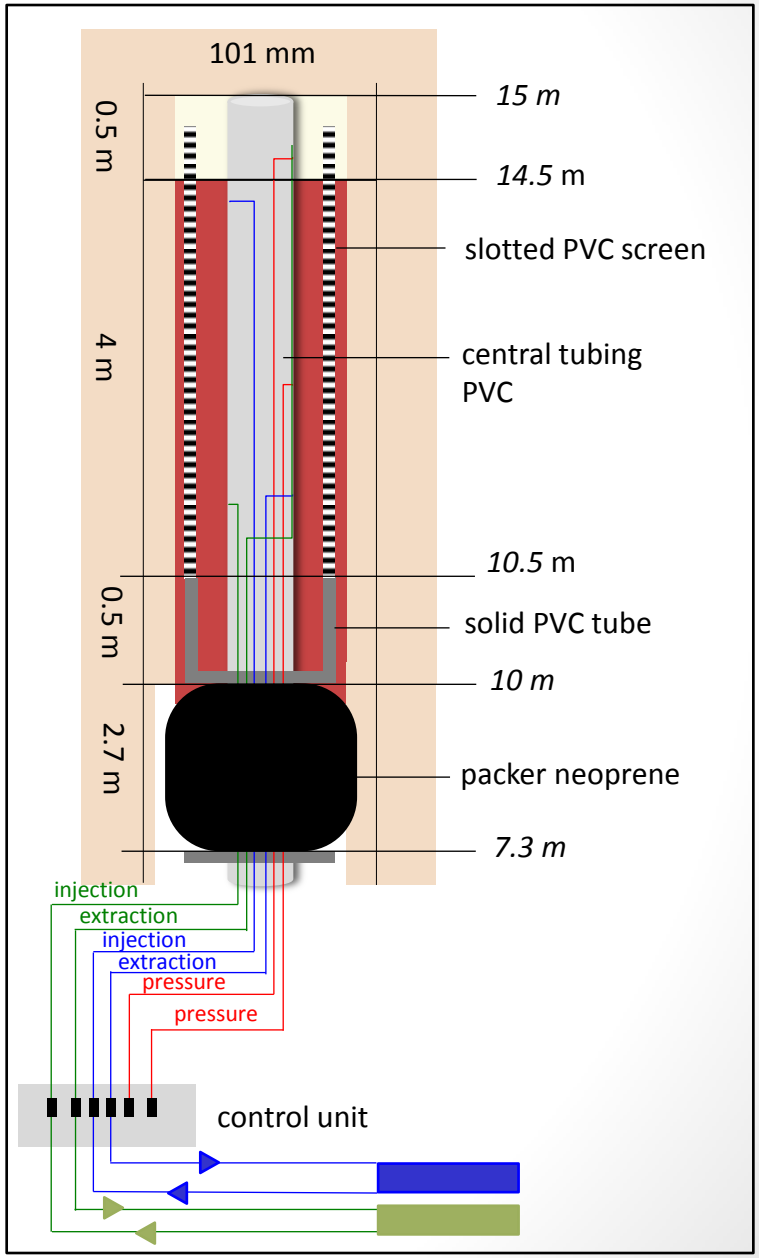
MX-80



- Culturability decreases with dry density (= MX-80)
- But higher level of culturability for the Febex:
  - Different suction properties?
  - Different smectite content and structure?
  - Higher microbial load?

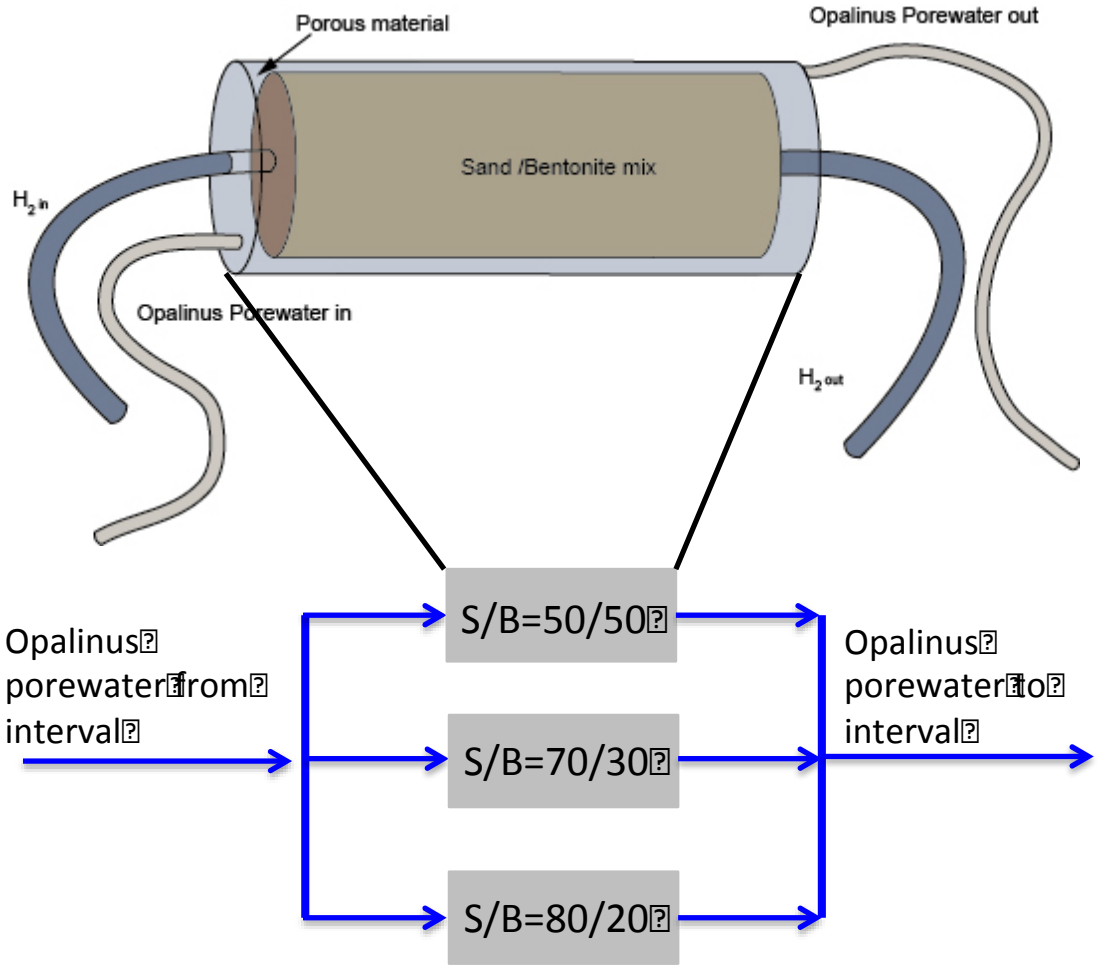
Proposal for future research

- Dedicated experiments for microbial investigations
  - Borehole drilled under anoxic and ‘sterile’ conditions
  - Recirculation of the porewater to the surface for experiments
  - Modular design of experiments allowing easy access for sampling



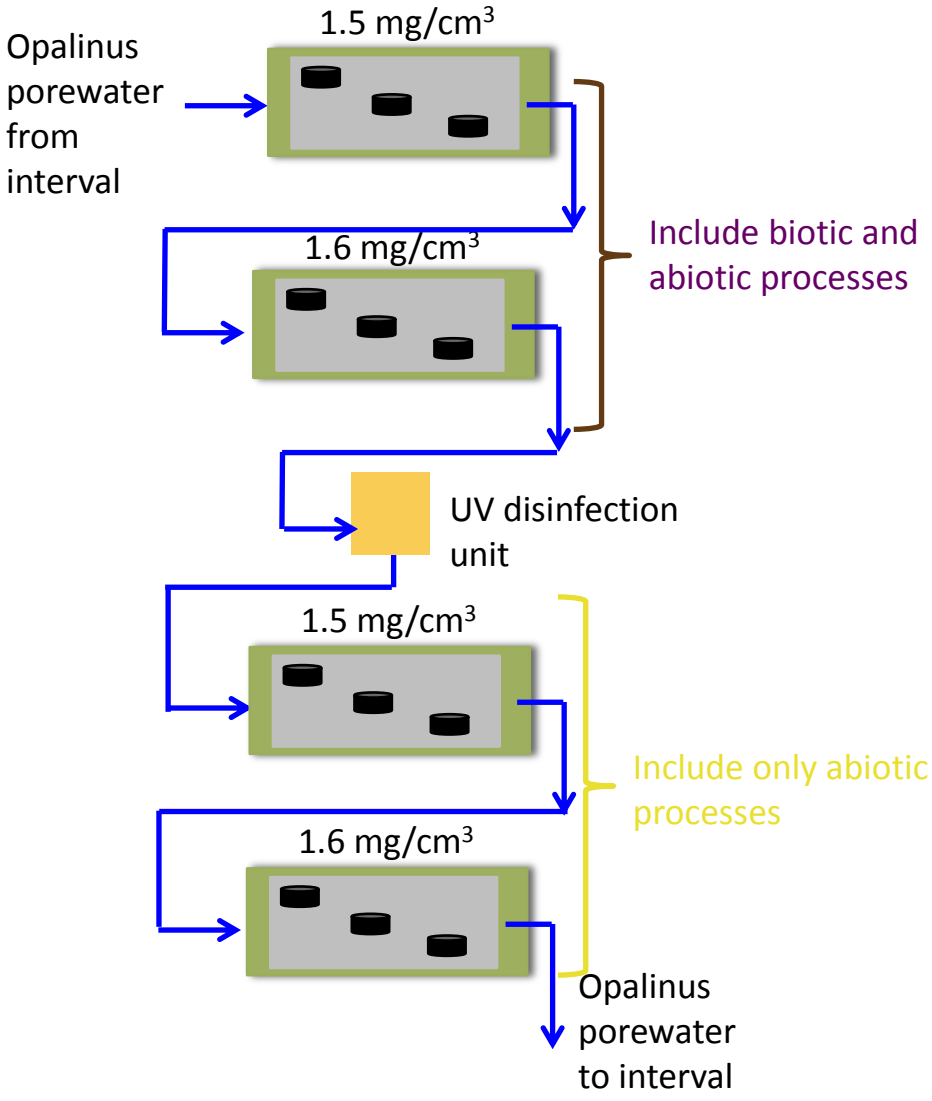
Proposal for future research

- Investigation of the rate of H_2 consumption under repository relevant conditions (engineered gas transport system)



Proposal for future research

- Investigation of the impact of microbially induced corrosion on the rate of steel corrosion



Major issues

- Measure relevant rates for microbial processes so they can be incorporated into models (H_2 consumption, CH_4 production, steel corrosion, organic degradation)
- Quantify microbial survival under repository conditions- need to evaluate changes in the microbial community rather than enumeration
- Common design for experiments related to microbial processes applied to different barrier types, different host rocks, and different waste types
- Key concept: focus on repository relevant conditions and the need for *in situ* experiments designed for microbial investigations