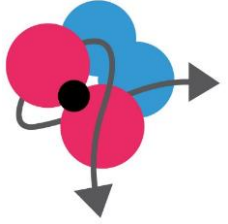




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ELEGANCy

Understanding the hydrogen-stimulated microbial response to CO₂ injection in CCS reservoirs

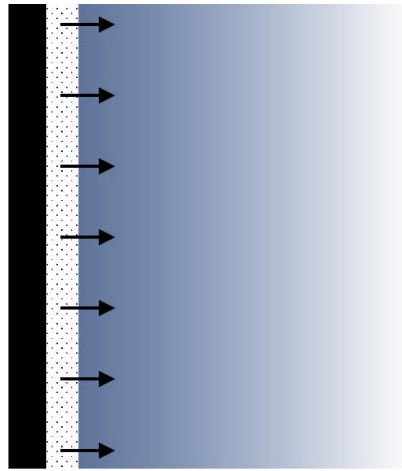
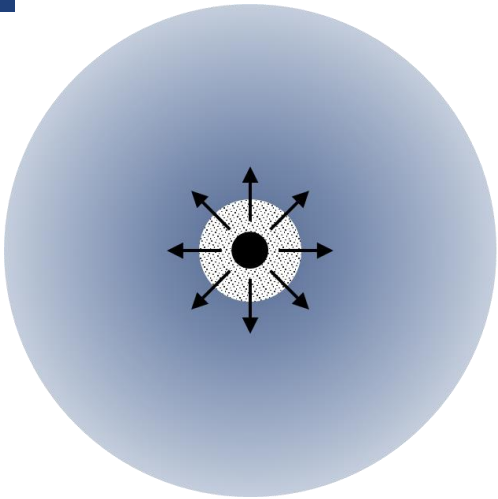
ELEGANCY Webinar 3 - 21st June 2020

Simon Gregory

British Geological Survey

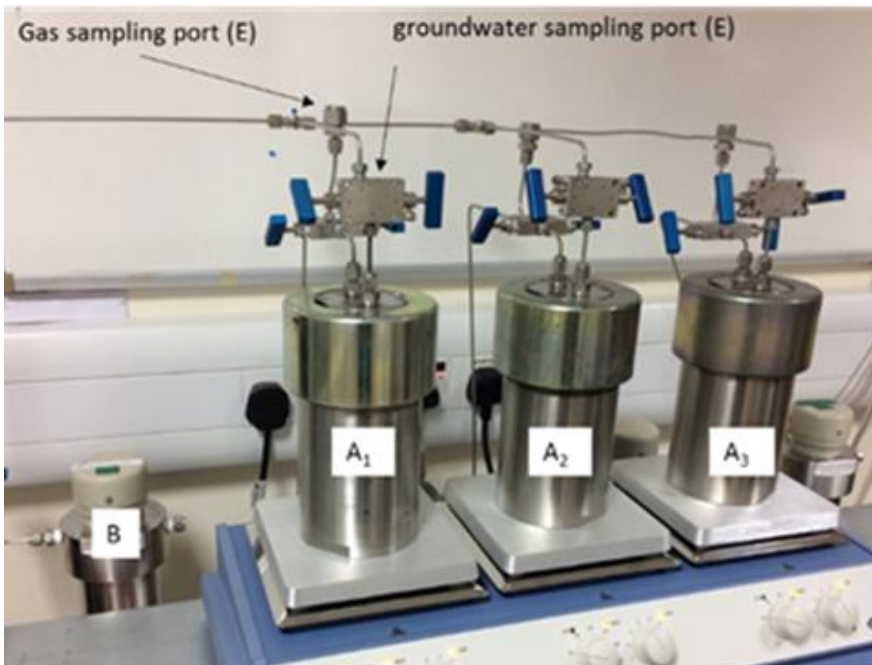


@britgeomicro



Methanogenic microbial activity during the injection of CO₂-H₂ mixtures in the deep subsurface

Anozie Ebigbo, Joan Delort Ylla, Anwar Al-Assadi, Martin O. Saar

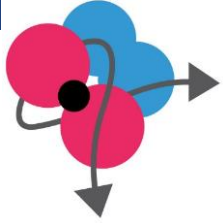


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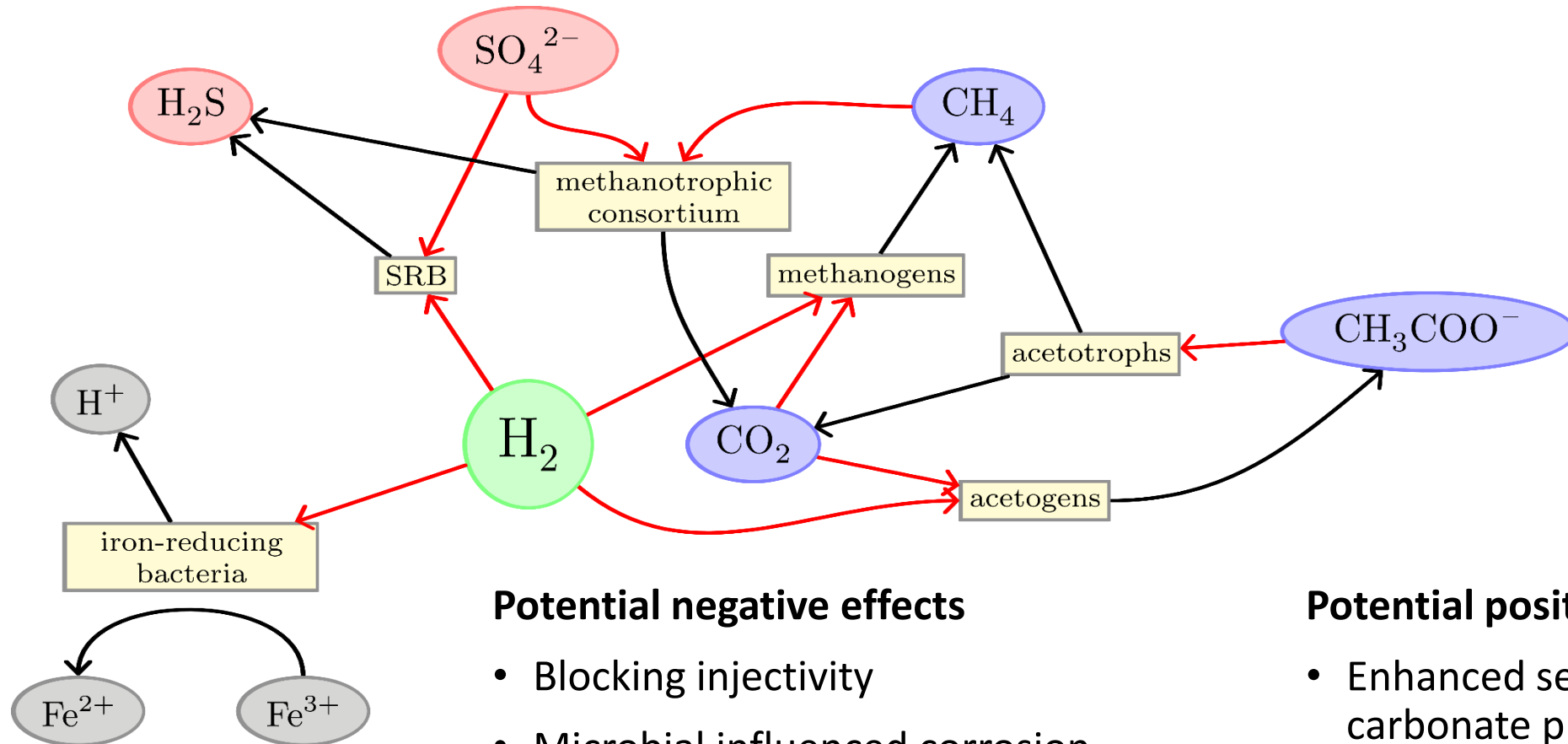
Experimental studies of (sulphate reducing) microbial activity during the injection of CO₂-H₂ mixtures

Simon Gregory, Kay Green, Jess Mackie



Hydrogenotrophy in the subsurface

- Consortia of archaea and bacteria can lead to hydrogenotrophy.

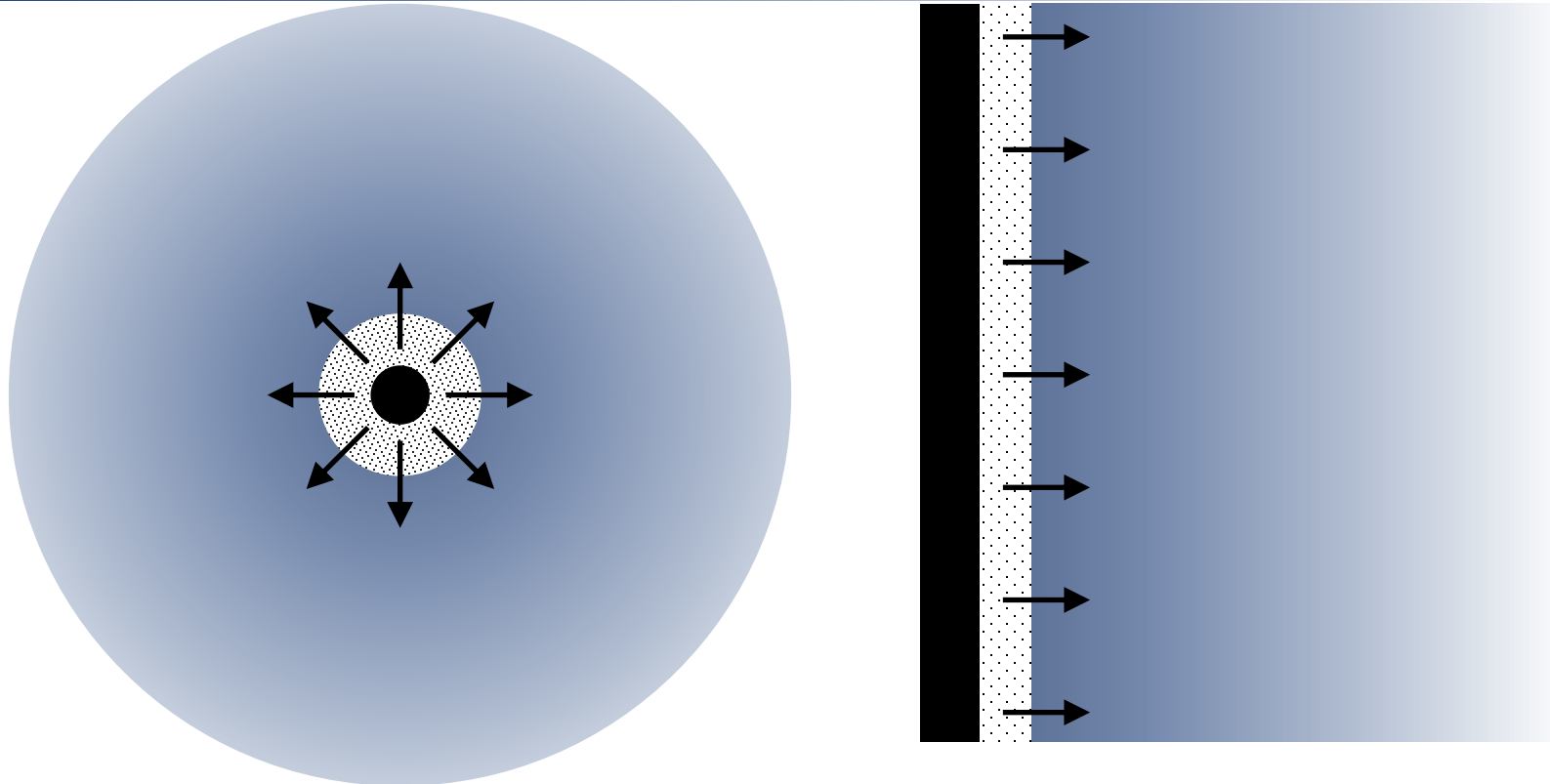


Potential negative effects

- Blocking injectivity
- Microbial influenced corrosion
- Gas consumption and conversion

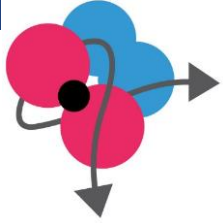
Potential positive effects

- Enhanced sealing through carbonate precipitation

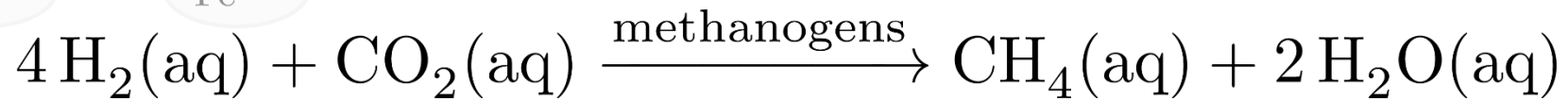
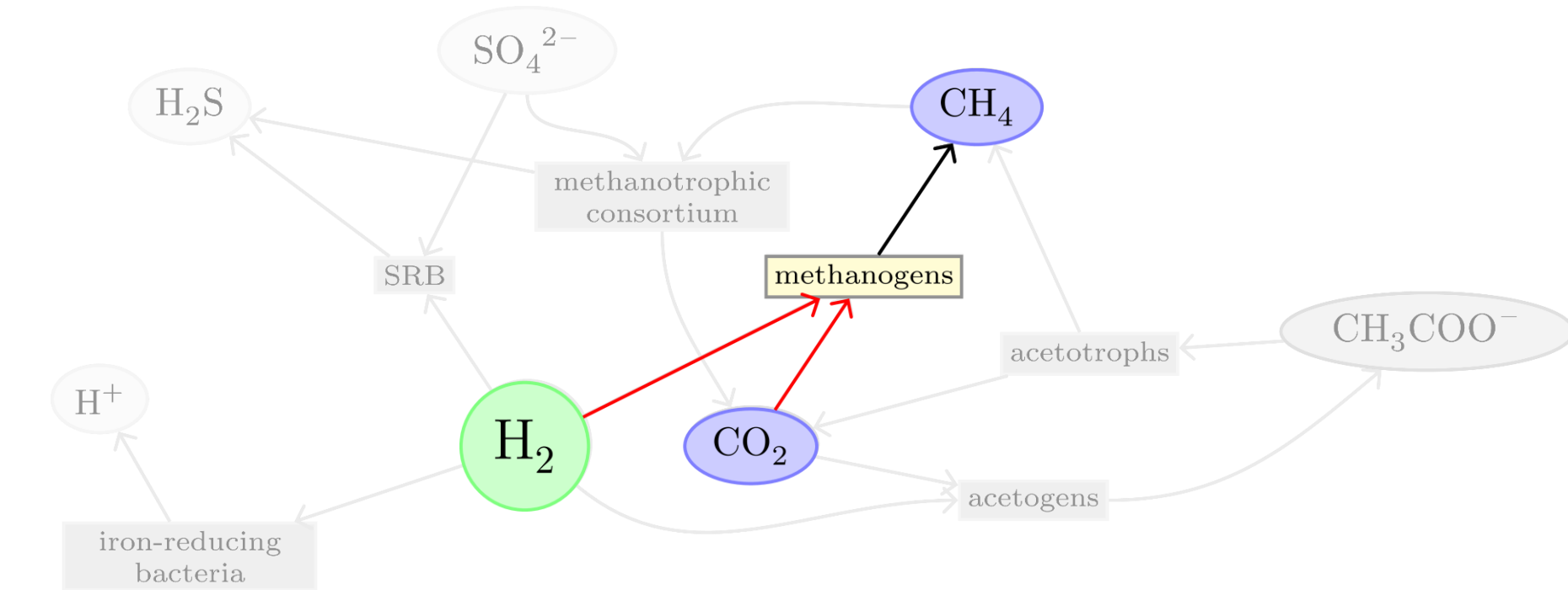


Methanogenic microbial activity during the injection of CO₂-H₂ mixtures in the deep subsurface

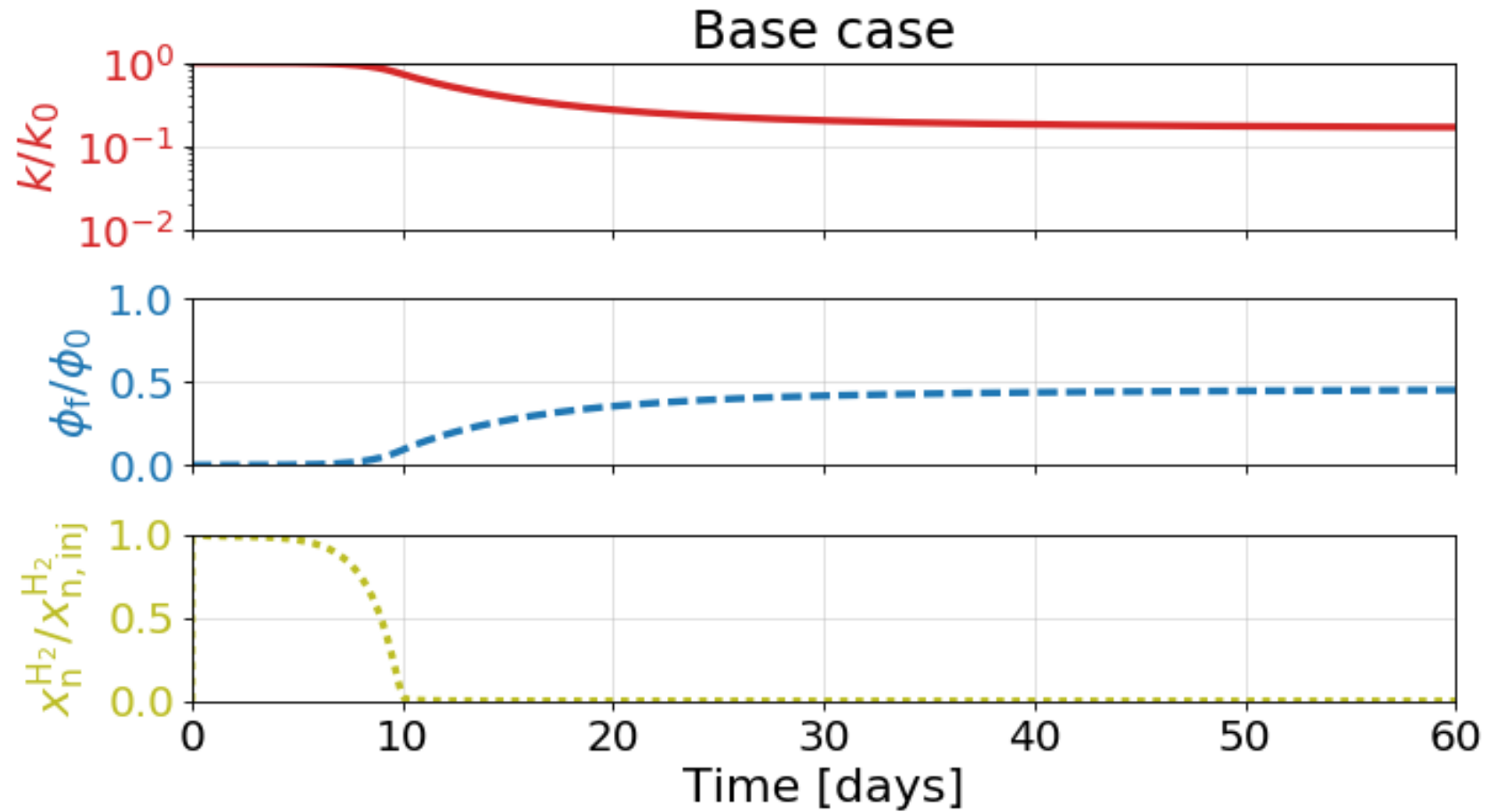
Anozie Ebigbo, Joan Delort Ylla, Anwar Al-Assadi, Martin O. Saar



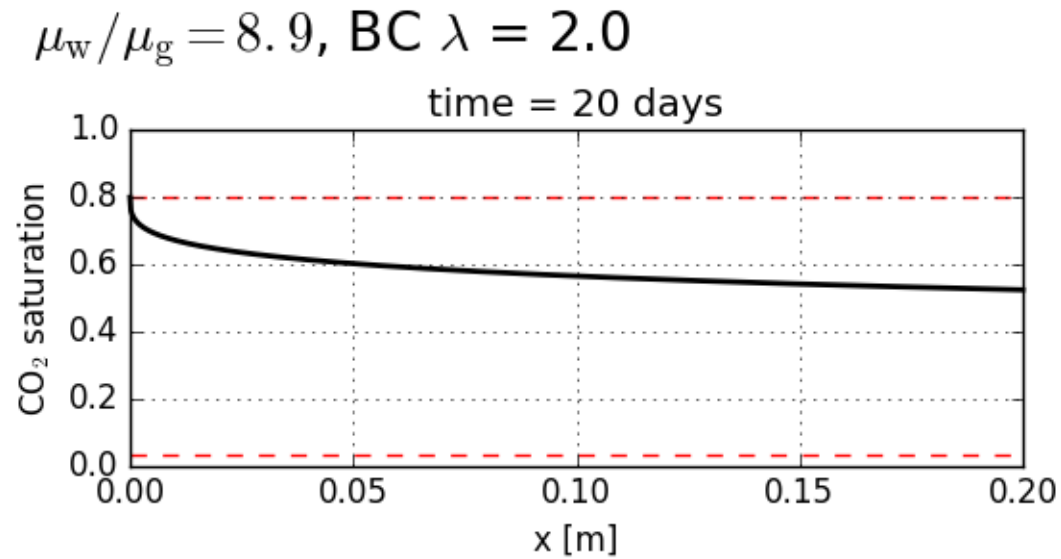
Methanogenesis



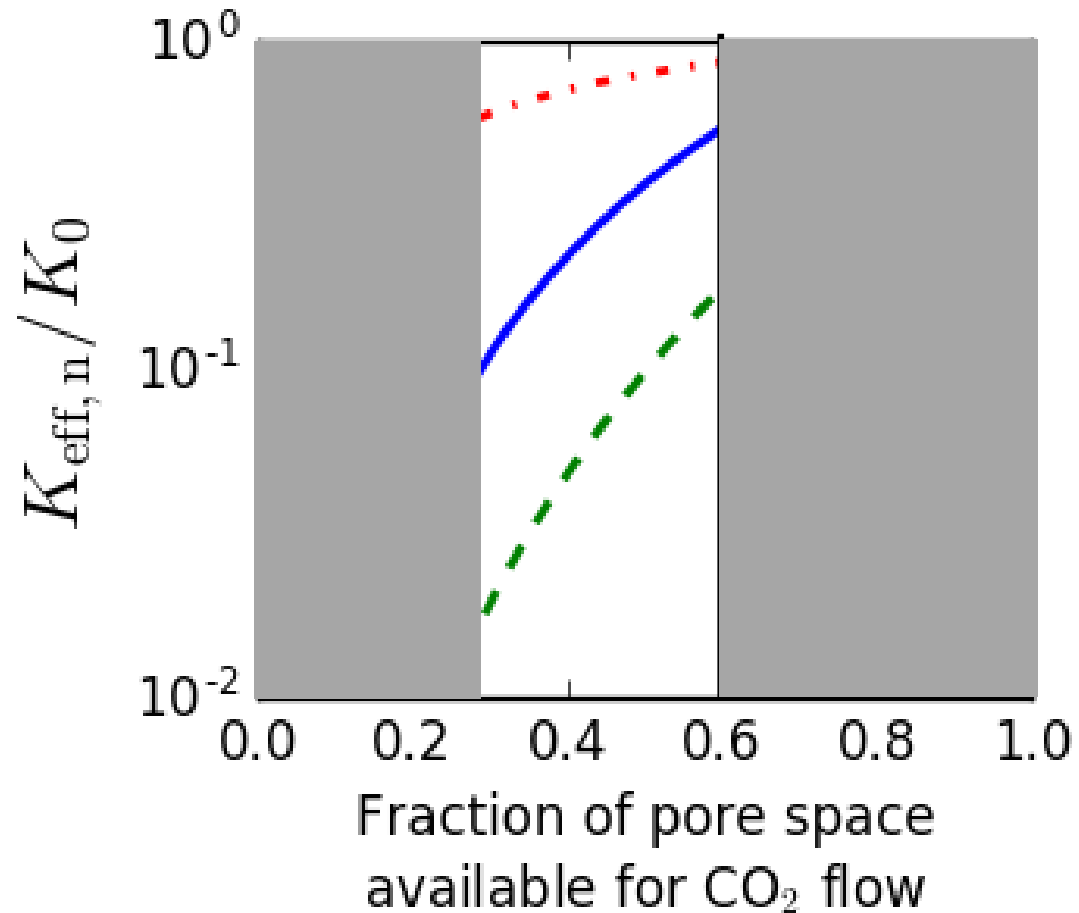
Test simulations



Buckley-Leverett analytical solution



Maximum permeability reduction?



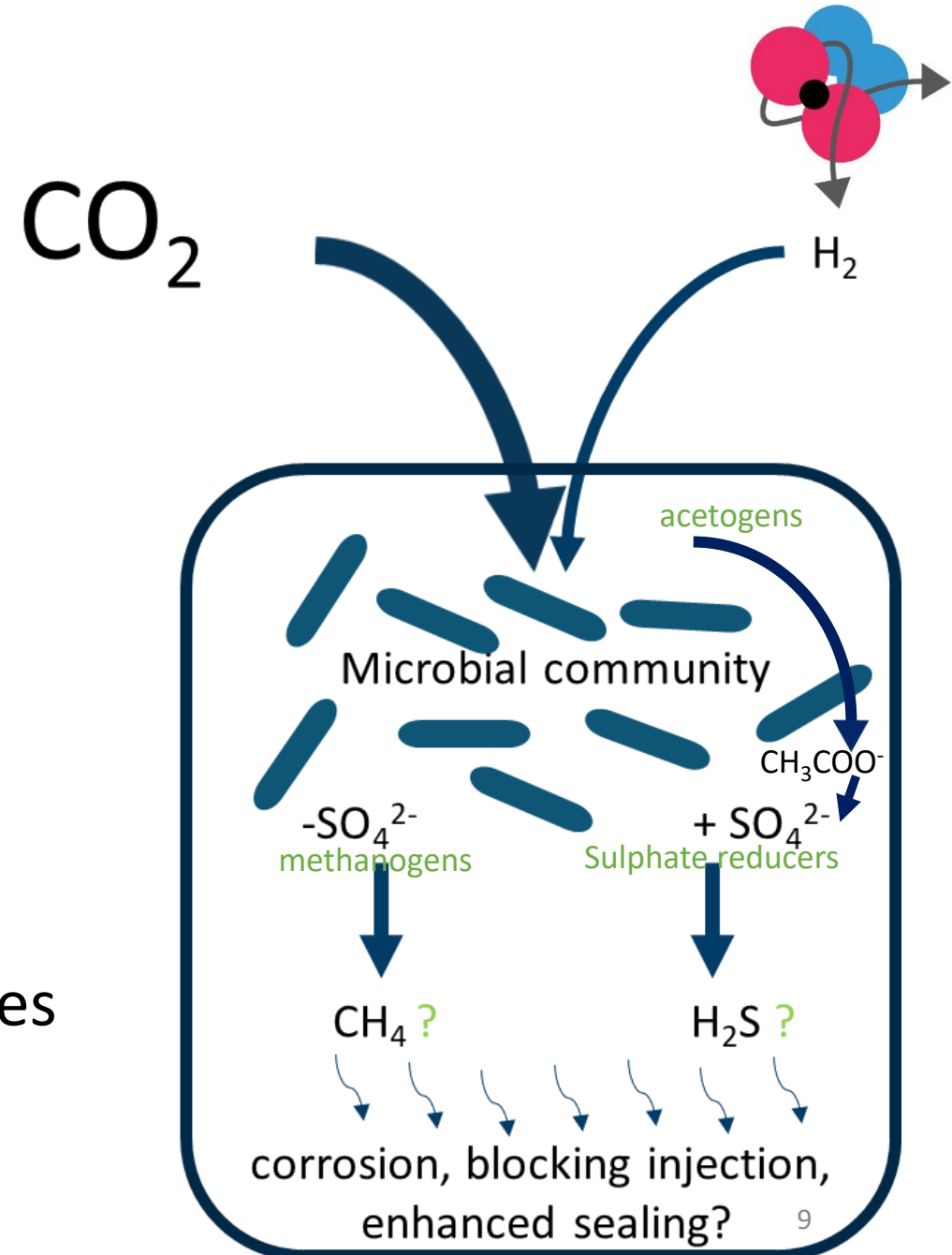
Bundle-of-capillary-tubes model

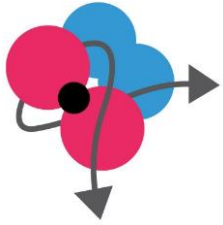
Relative permeability model

Kozeny-Carman model

Experimental work

- Key question: Can microbes use small amounts of H₂ in CO₂ as an electron donor?
- Could the stimulation of microbial activities affect CO₂ storage?



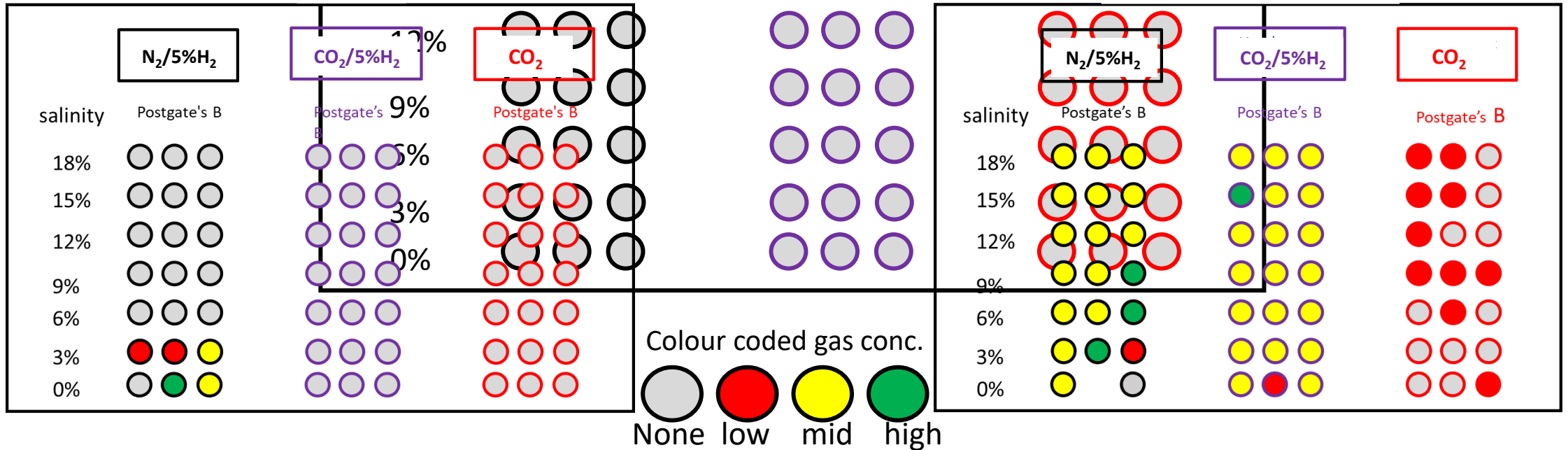


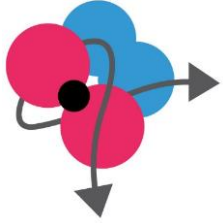
Bottle tests: effect of H₂ and salinity

Identifier	Sandstone	Fluid	35/50/70 °C inoculum salinity	Temp °C	Duration
BUG060-62	Bunter 44/23-3	Postgate's Medium B	none	50	93d
BUG065-67	Endurance	Postgate's Medium B	none	50	94d
BUG068-70	Endurance	Postgate's Medium B	SRB	50	94d
BUG071-73	Endurance	Postgate's Medium B	SRB	50	94d
BUG075-77	Endurance	Artificial Groundwater	SRB	35,50,70	135d
BUG075-77	Endurance	Artificial Groundwater	none	35,50,70	135d

H₂S 5%

Flammable gases





Bioreactor experiments –set-up

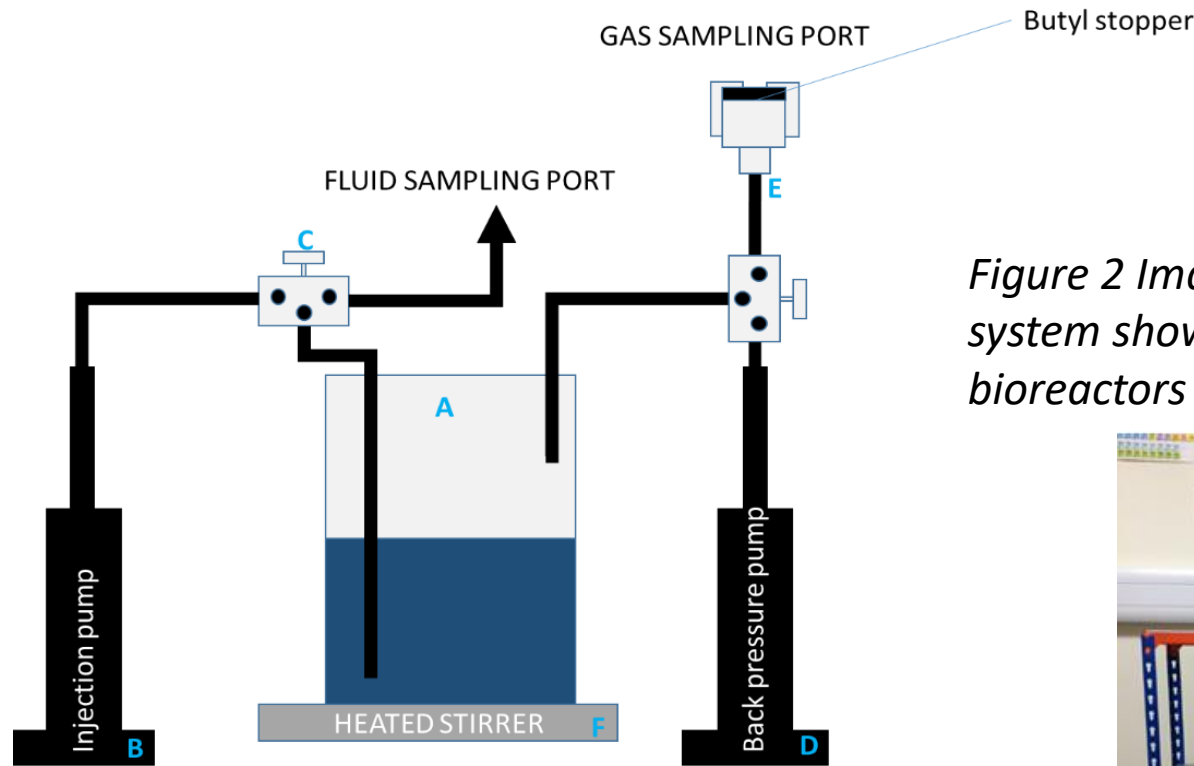


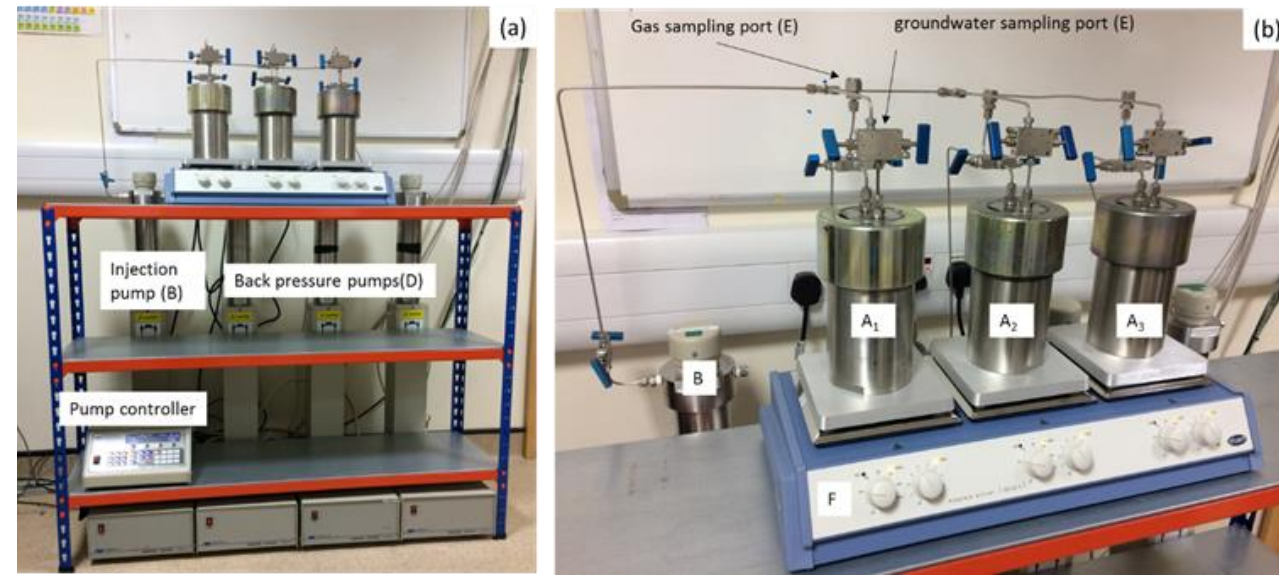
Figure 1 Schematic of set up of one of the three bioreactors

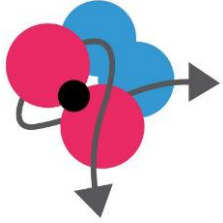
Sample: Endurance storage site 5/42

Several subsamples from below 800m pooled and crushed
Artificial groundwater: based on chemistry from North sea porewater

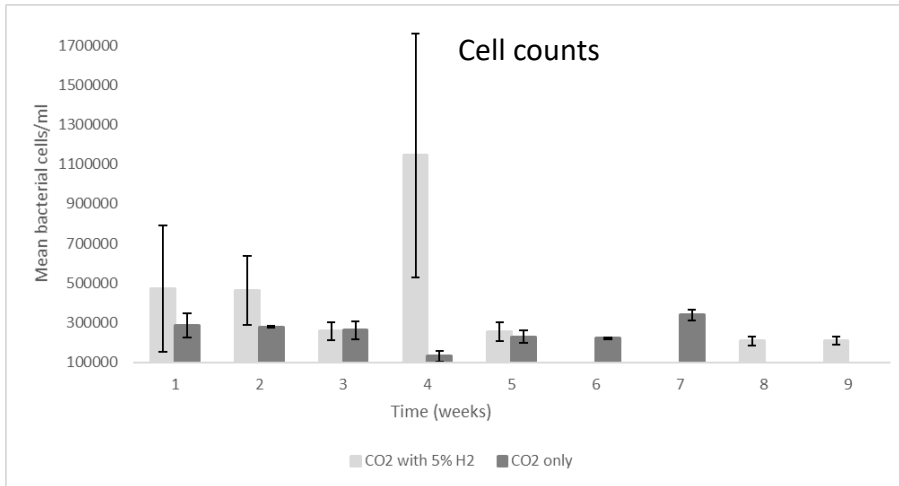
Gas: CO₂ or CO₂/5% H₂

Figure 2 Image of experimental apparatus (a) photograph of the entire system showing the control of four pumps used to operate three bioreactors (b) close up of the bioreactors showing sampling ports

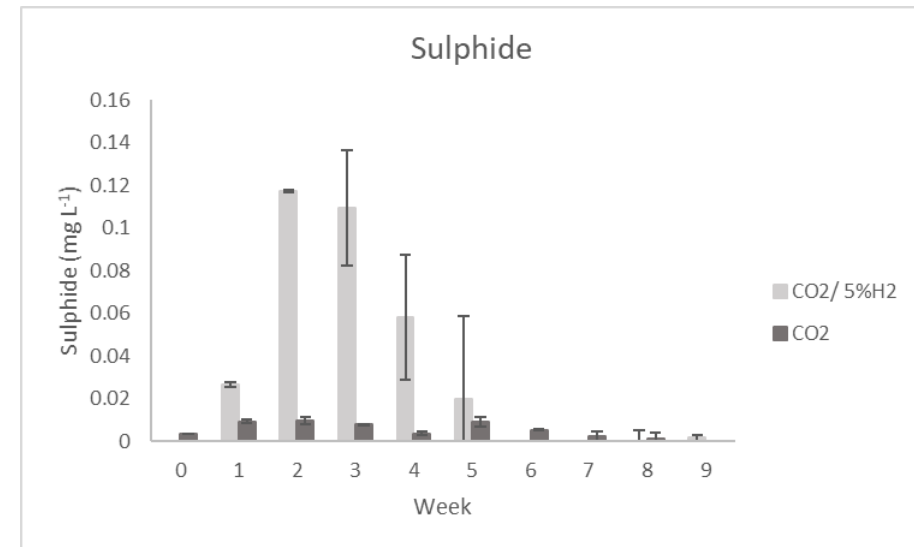
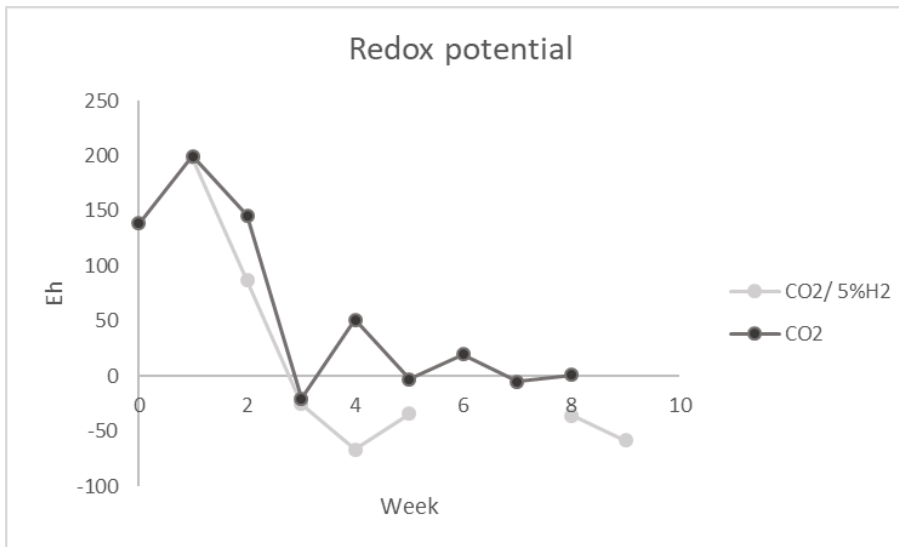


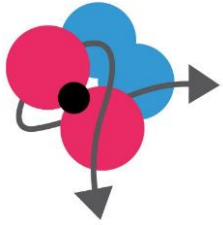


Bioreactor data



- Similar biomass with and without 5% H₂ - initial decrease in bacteria then recovery
- Redox potential drops rapidly in both cases – lower Eh achieved in presence of 5% H₂
- Dissolved sulphide detected in both cases – more with 5% H₂
- Initial gas data shows H₂S and possibly methane produced in both cases





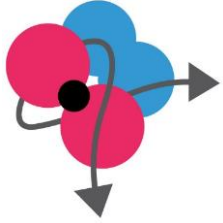
Conclusions

Modeling

- Response of methanogens very rapid (days)
- Affects the area in close proximity of injection well
- Worst case scenario – permeability reduction of less than 2 orders of magnitude

Experimental

- Less microbial activity (SR) with increasing salinity
- No sulphate reduction observed in CO₂ headspace – with or without H₂ in bottle tests
- Sulphate reduction observed in bioreactors – more in presence of H₂. Peaks at 2 weeks
 - A clearer picture will be obtained when DNA analysis and gas chromatography is completed



Acknowledgement

ACT ELEGANCY, Project No 271498, has received funding from DETEC (CH), BMWi (DE), RVO (NL), Gassnova (NO), BEIS (UK), Gassco, Equinor and Total, and is cofunded by the European Commission under the Horizon 2020 programme, ACT Grant Agreement No 691712.

