WG-5

Microbiological studies

WG-5 description

- >27 participants from research and performance assessment – an interdisciplinary group
  - Waste management organisations
  - Technical support organisations
  - Universities
  - Consulting companies
  - National research centers/institutes
- Gender perspective: 50/50
- 9 countries represented
- 9 presentations from 6 countries

Presence of microorganisms

- Microbes are everywhere including the underground – the deep biosphere
- Microbial life change chemical equilibria.
- Microorganisms influence and change the geochemical environment, e.g. pH, E_h

BUT

- Microbial processes are missing in the current strategic research agenda (SRA)

Main microbial processes

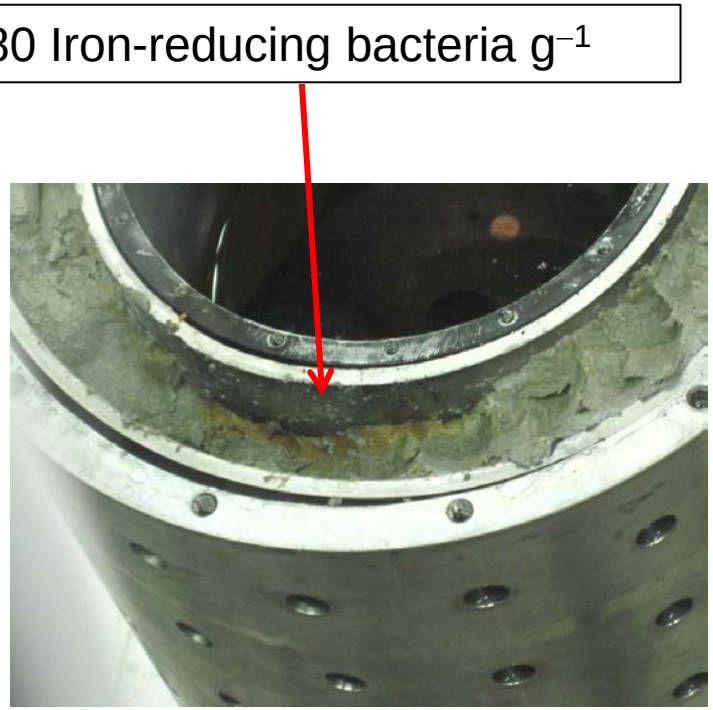
- Microbially induced degradation
  - Corrosion of metal canisters
  - Degradation of buffer, backfill and cement
- Gases
  - Production −
  - Consumption +
- Migration
  - Mobilisation −
  - Immobilisation +

Degradation 1

- Corrosion of metal canisters
  - Sulphide production
    - H_2 from anaerobic corrosion of metals contribute to sulphide production.
- Uncertainties
  - Microbial kinetics
  - Mass balances

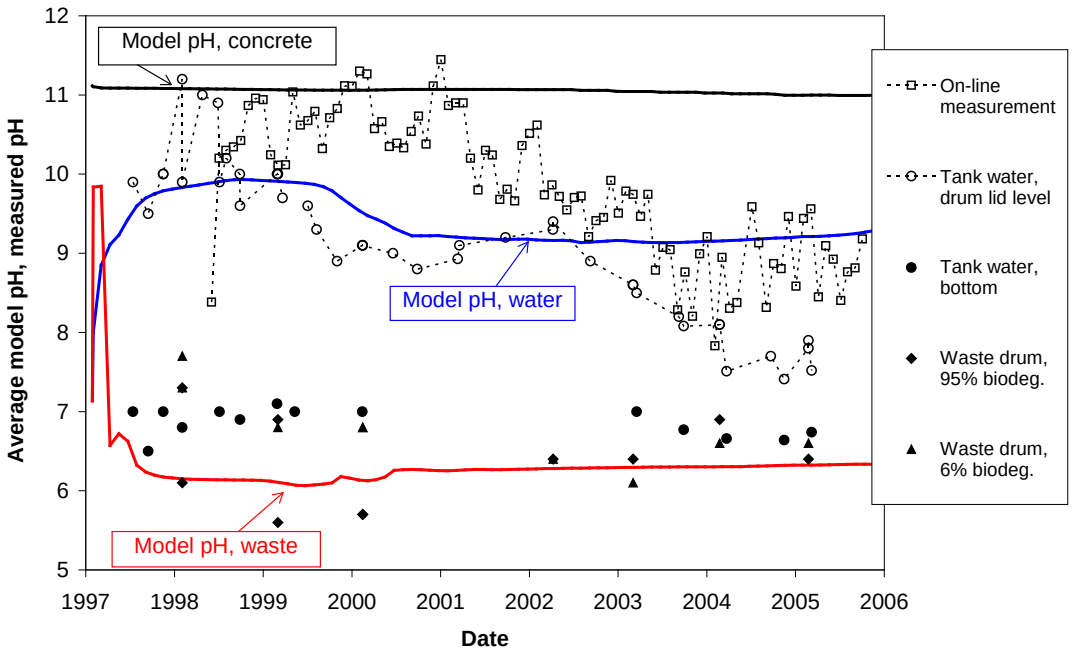
Degradation 2

- Degradation of buffer and backfill
  - Iron-reduction of structural ferric iron in smectite clays – reduced swelling capacity
- Uncertainties
  - Kinetics (metabolism)
  - Mass balances



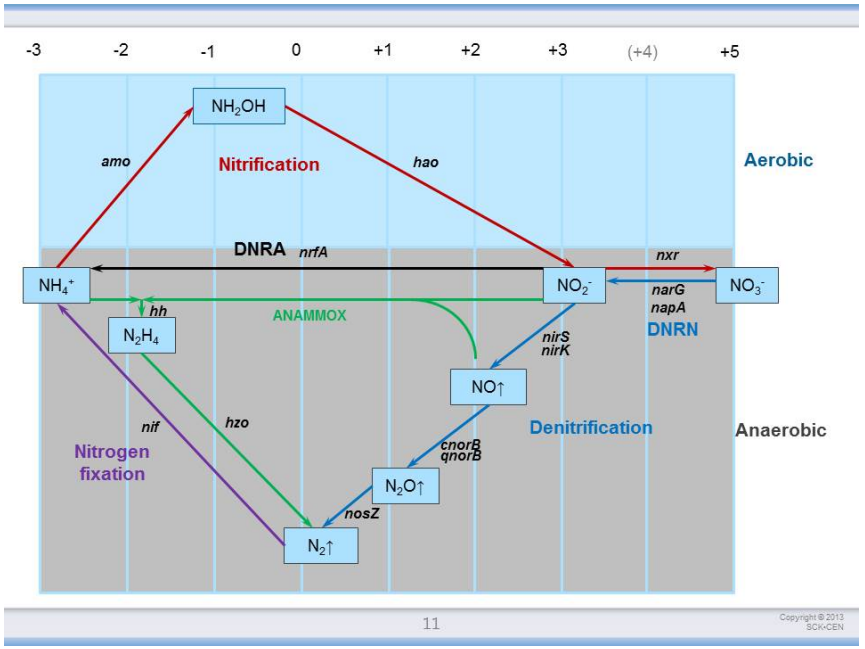
Degradation 3

- Degradation of cement and lowering of pH
  - Heterogeneity in pH allows microbial processes to develop at neutral pH in waste drums
  - Eventually, concrete buffered alkaline water is neutralised
  - Fermenting bacteria produce acids
- Uncertainties
  - Microbial influence on pH?



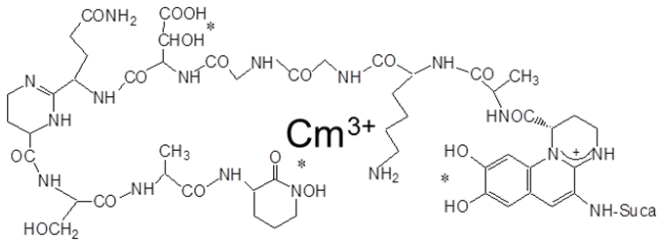
Gases

- Production −
  - CO_2 and CH_4 from
  - organic wastes (analogue: biogas
  - reactor)
  - N_2 and N_2O from some waste forms

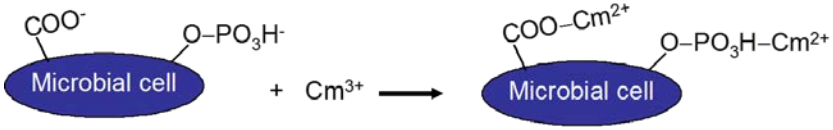


- Consumption +
  - $4H_2 + CO_2 = CH_4 + 2H_2O$ (“5 becomes 1”)
  - $4H_2 + SO_4^{2-} = S^{2-} + 4H_2O$ (“4 becomes 0”)

Migration 1



- Mobilisation –
  - Microbial complex formers
  - Low molecular weight acids
  - Sorption to free-living cells and viruses



- Uncertainty
  - Importance?
  - Impact on the safety case?

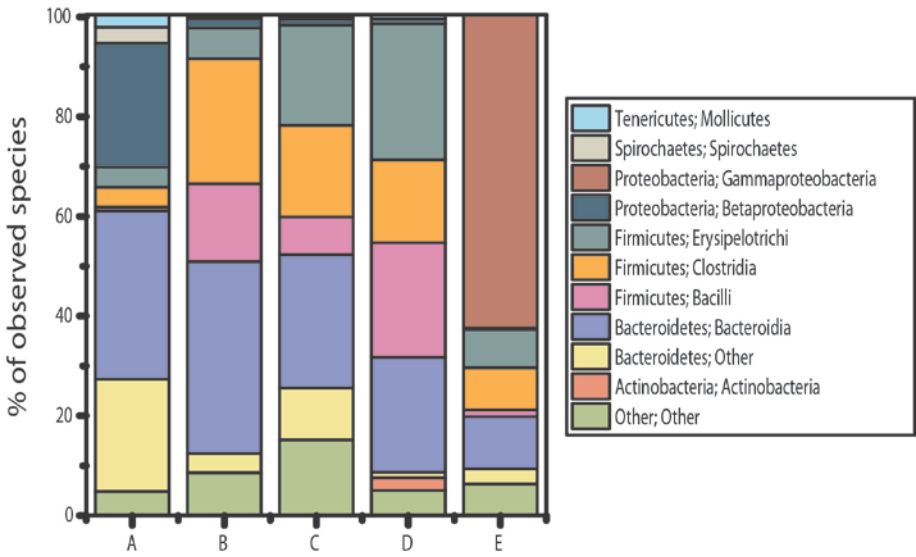
Migration 2

- Immobilisation +
  - Biofilms sorb radionuclides
  - Microbial reduction can immobilize radionuclides, e.g. U, Tc, Np, Se.
  - Degradation of organic complexing agents, e.g. isosaccharinic acids.
  - Coupled processes

- Uncertainty
  - Importance?
  - Impact on the safety case?

The safety case can benefit from:

- New knowledge in geomicrobiology and the deep biosphere
- Probing microbial processes using new and advanced genome technologies
- Advances in imaging and spectroscopy



SRA Key topic 1 safety case

- "*The safety case must be able to describe the evolution of the repository in a way that can be seen as a reasonable representation of what might happen and that also gives a clear indication of uncertainties in the description*".
- WG-5 noted that the SRA lacks representation of microbial processes and indication of uncertainties caused by microbial processes.

A technical and scientific working group (TSWG) on biological processes next?

- Review past and present research and models.
- Understand uncertainties in the safety case caused by microbial processes.
- Evaluate how knowledge about microbial processes can be merged into present safety models and concepts.
- Identify gaps in knowledge and suggest research needs.
- Define a scope of a proposal to be submitted to an EC call or a specific project co financed by the WMOs.