MICROBIOLOGICAL STUDIES OR HOW MICROBIOLOGISTS CAN INCREASE SAFETY CASE ROBUSTNESS

WG2
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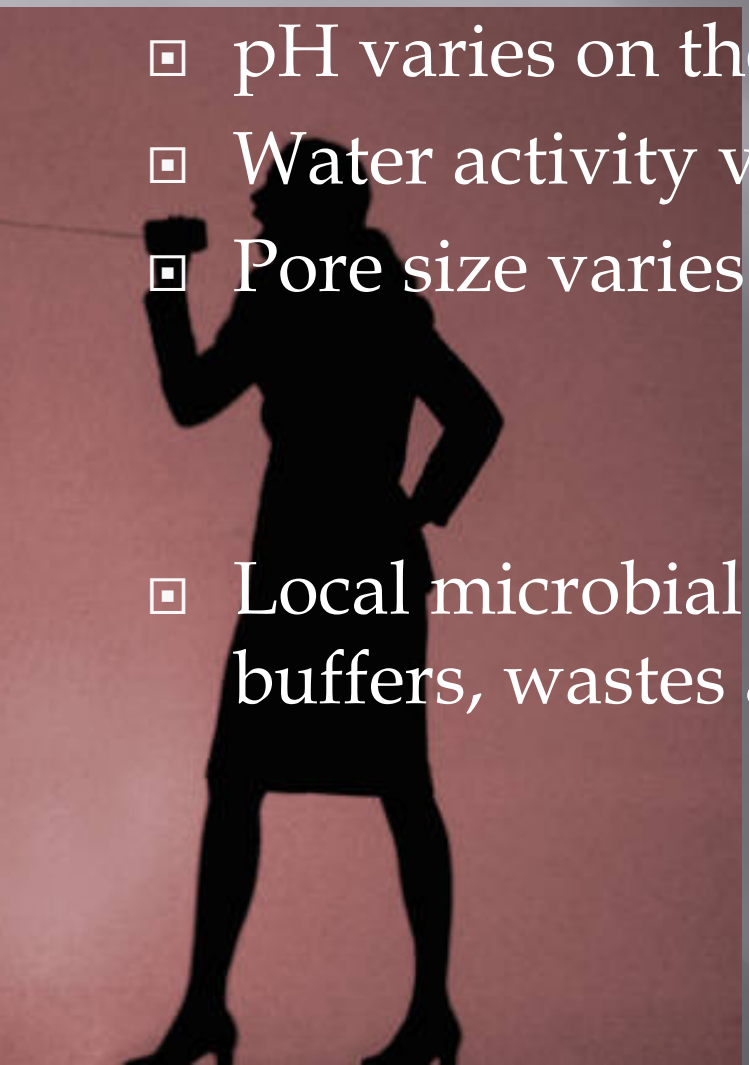
Communication barriers
A common language misssing?

Homogeneous systems

- High pH >12.5
- Low water activity < 0.9
- Pore size > 1 μm

- inhibits microbial activity

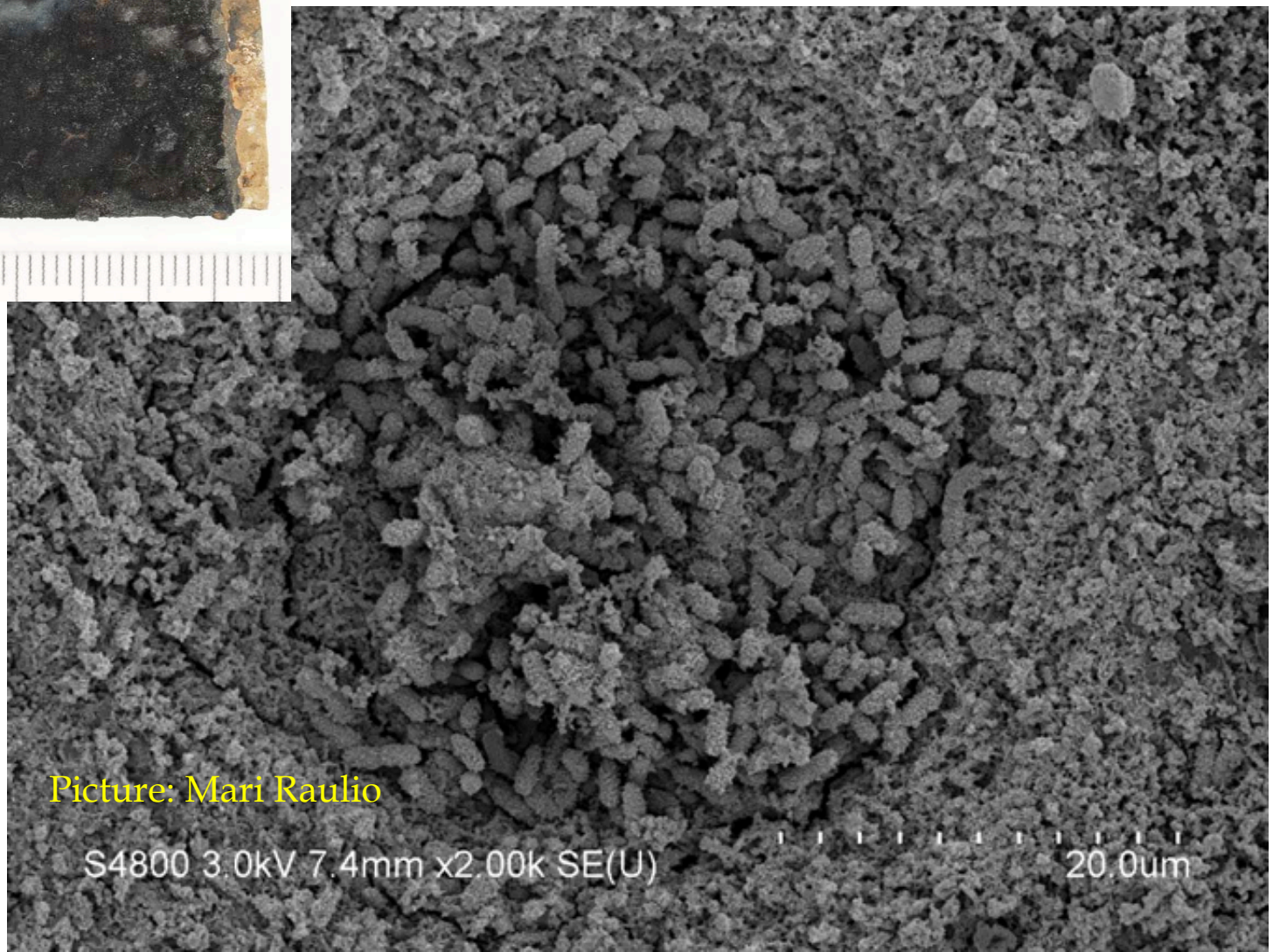
Natural and most engineered systems are heterogeneous



- pH varies on the microscopic scale
- Water activity varies over time
- Pore size varies on the microscopic scale

- Local microbial activity is possible in cements, buffers, wastes and interfaces

Example: Local microbial corrosion of steel at pH 11



Picture: Mari Raulio

The FEPs language

- Features
- Events
- Processes
- =
- **Factors relevant to the assessment of long-term safety of nuclear waste repositories.**

Updated NEA FEPs list

- NEA/RWM/R(2013)8
- Updating the International FEP List:
- Repository Processes (*2.1*)
- 3.2.01 Thermal processes (repository) (*2.1.11*)
- 3.2.02 Hydraulic processes (repository) (*2.1.08*)
- 3.2.03 Mechanical processes (repository) (*2.1.07*)
- 3.2.04 Chemical processes (repository) (*2.1.09*)
- **3.2.05 Biological processes (repository) (*2.1.10*)**
- 3.2.06 Radiological processes (repository) (*2.1.13*)

- Biological processes are on the same level as hydrology, chemistry, mechanics and radiochemistry

  A multi-disciplinary approach to the safety evaluation/assessment

Microbiology in FEPs catalogues

FEPs on microbiological processes:

→ Often vague or crowded wording

- → Difficult to evaluate as isolated processes
- → Relevance for PA unclear

EXAMPLE : "Its complicated……"

2.3.5.2 Microbially/biologically mediated processes (waste package)
Microbiological/biological processes can affect the form or related properties of the waste form. For example, microbial processes can lead to the formation of acidic and oxidizing species that can participate in corrosion of the metals and generation of reducing conditions. Bacteria and microbes may also result in the generation of gases (see FEP 2.3.7.2), and anaerobic bacteria may form biofilms on or around the waste package.

▣

Microbiology in FEPs catalogues

Actions:

- Identify cross links of 'Microbiology FEPs' with other FEPs
- Identify which interactions are important in the safety case

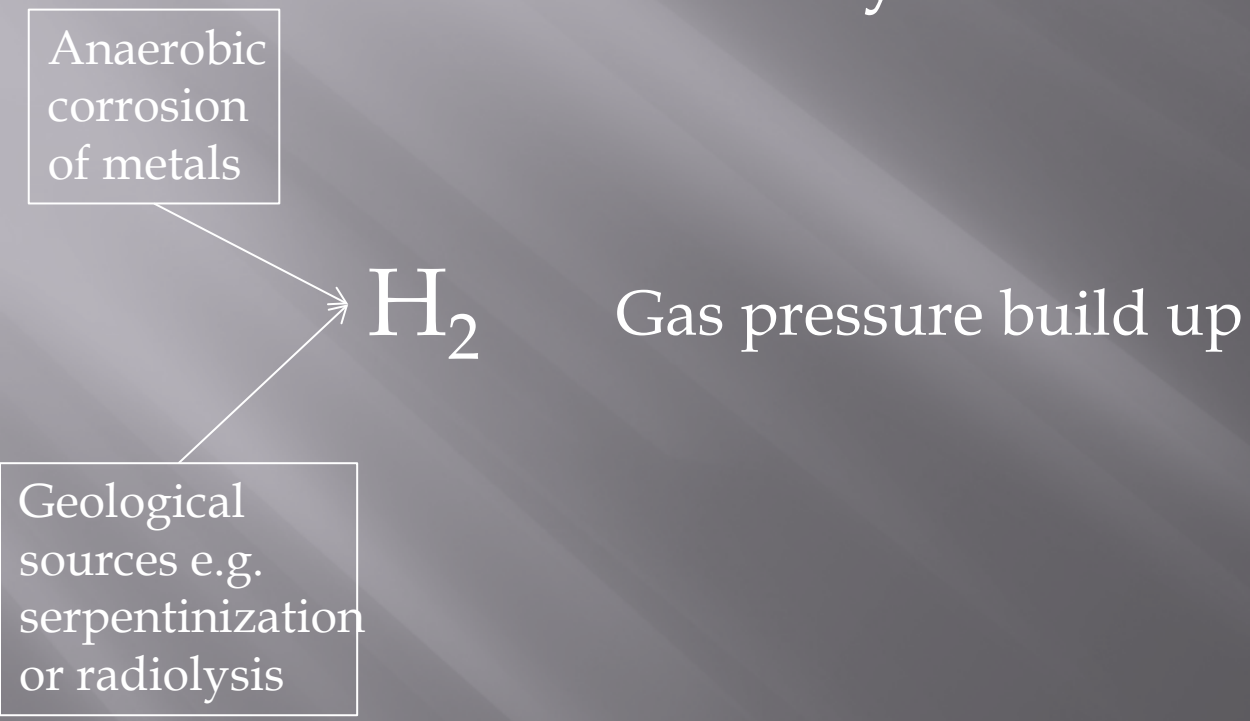
1) Microbial FEPs that are insignificant for performance assessment
2) FEPs that might define the boundary conditions for microbial processes.
3) FEPs that might be influenced by microbial processes

Site specific considerations:

- host rock
- disposal system
- waste form
- time

The lifeless scenario

Safety issue



The living scenario

Anaerobic corrosion of metals

Geological sources e.g. serpentinization or radiolysis

H_2

Microorganisms

Safety issues

$SO_4 \rightarrow H_2S \rightarrow$ corrosion

$CO_2 \rightarrow CH_4 \rightarrow$ pressure change

$CO_2 \rightarrow$ acetate $\rightarrow$ Cu stress corrosion

$Fe(III) \rightarrow Fe^{2+} \rightarrow$ illitization

E_h, denitrification…..and more

Effects on engineered barrier systems and radionuclide mobility

Conclusions

- Microbial processes are in FEP catalogues but rather **outdated**
- Need for closer **link and integration** between the existing FEPs and 'Microbial FEPs'
- Relevance of microbial processes for PA is **poorly understood**
- Assuming **total inhibition** of microbial processes may erode confidence and bias the performance assessment
- Need to update and highlight key FEPs
- Provide guidance for assessments at **relevant scales** and **site specific conditions** such as host rock, disposal system, waste form and time