Understanding the Evolution of the Repository and the Olkiluoto Site

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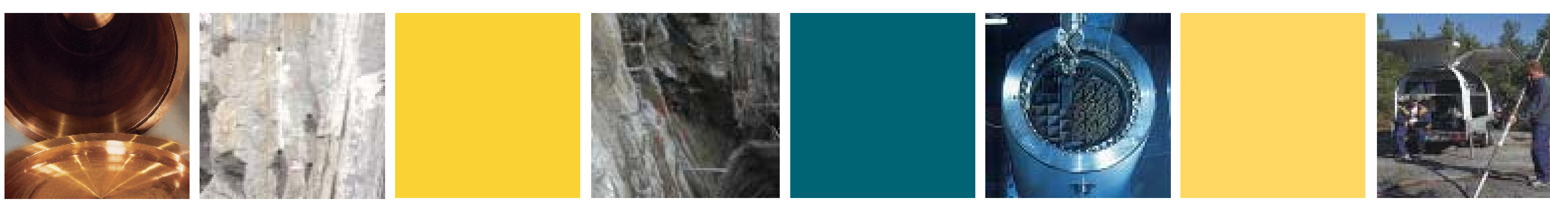
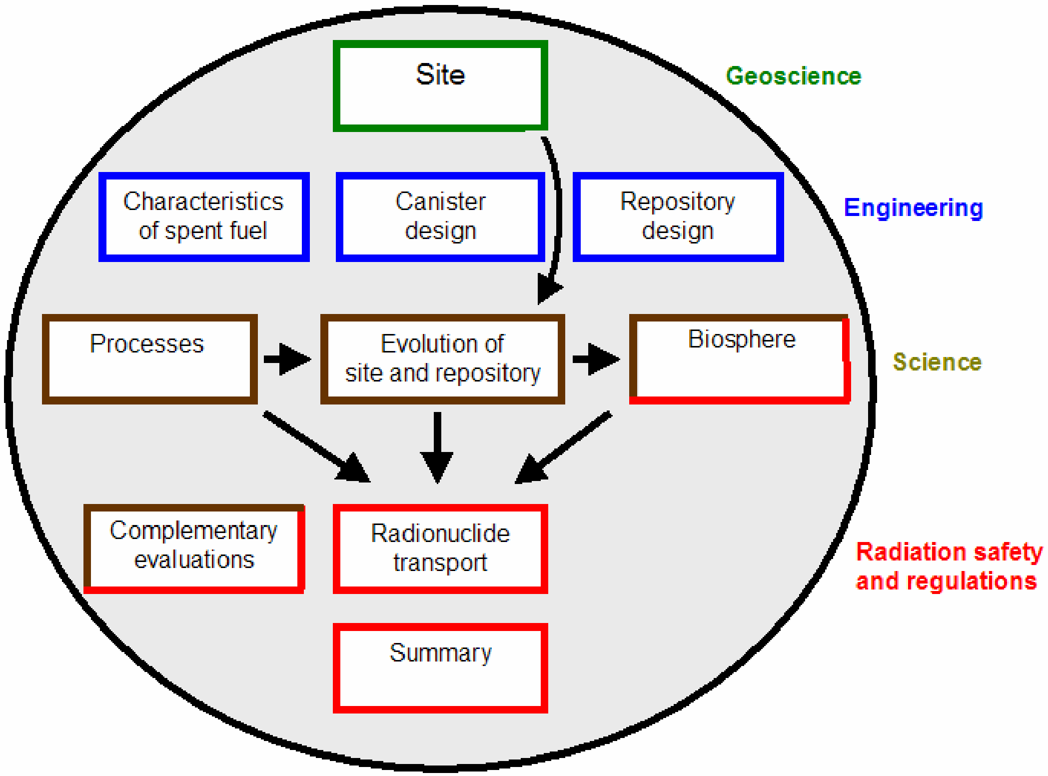


Steps in assessing safety



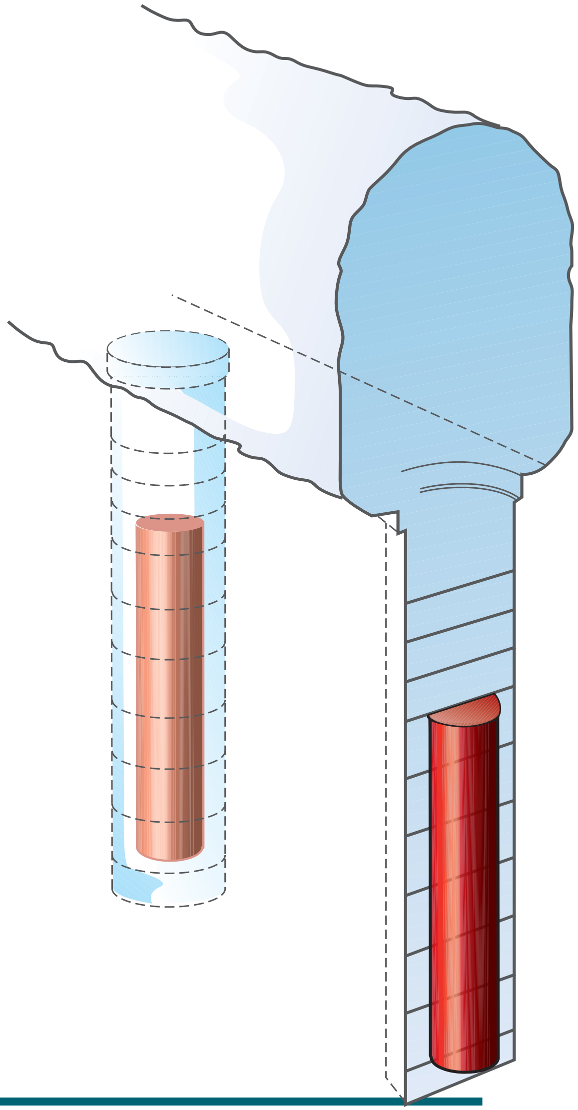
(Vieno & Ikonen 2005 - POSIVA 2005-01)

Safety case plan and Evolution Report

- International consensus: the safety case should contain a description of the ”expected” evolution of the repository and site
- Unexpected events addressed in process report and/or radionuclide transport

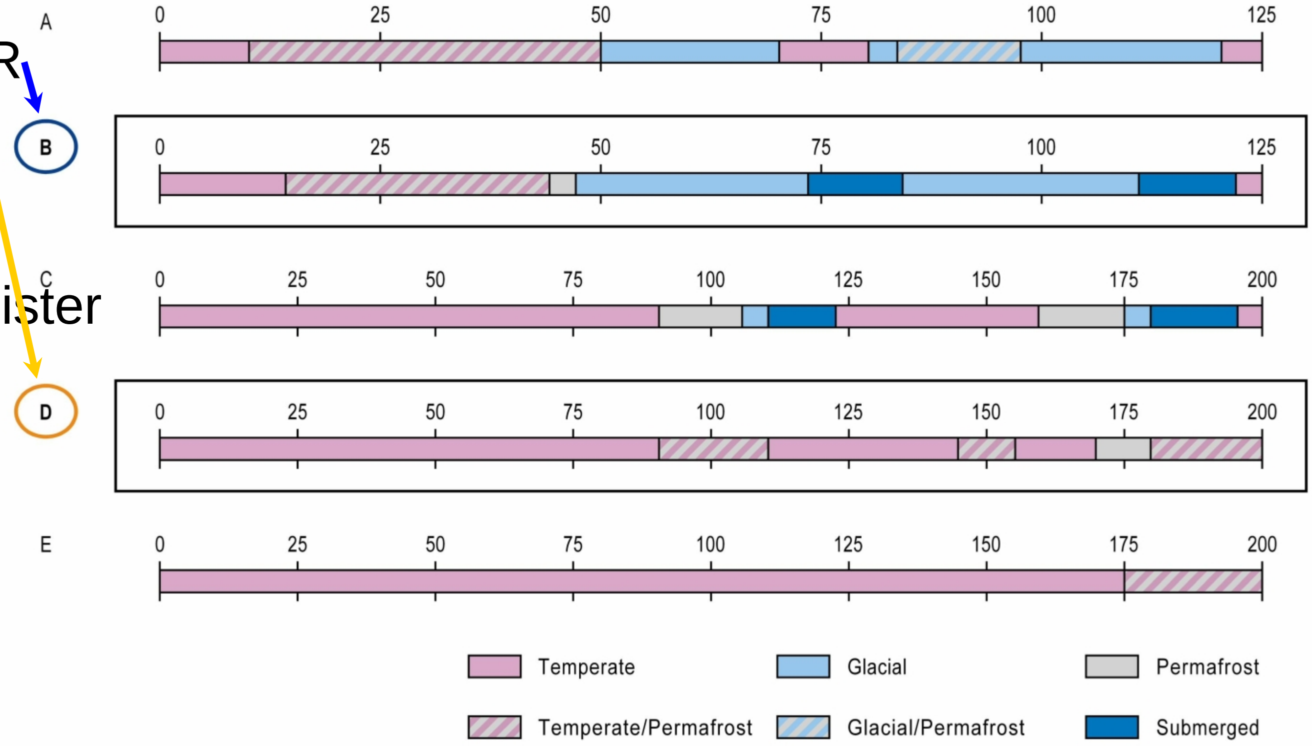
Contents of the Evolution Report

- Introduction
- Site
- Repository design
- System components
- Main scenario and variant
- Evolution
  - Operational phase
  - Postclosure temperate phase
  - Glacial phase
- Defective canister evolution
- Flow and transport modeling
- Canister scale mass balance
- Discussion and path forward

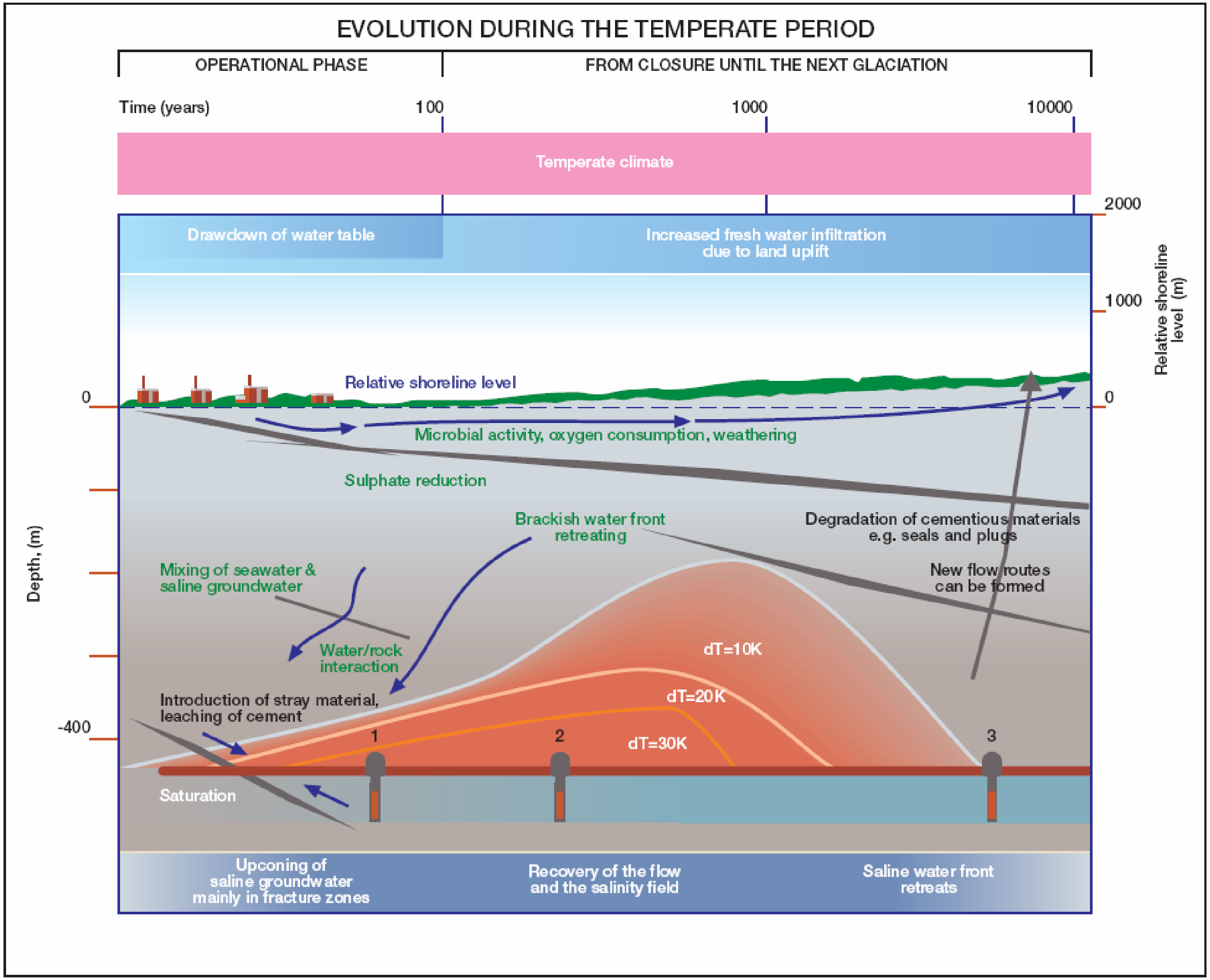


Main scenario of the Evolution Report

- Main (base) scenario: Canisters, buffer, backfill, repository work as designed
- Two climate scenarios:
  - Weichselian-R
  - Emissions-M
- Main variant:
  - Defective canister scenario

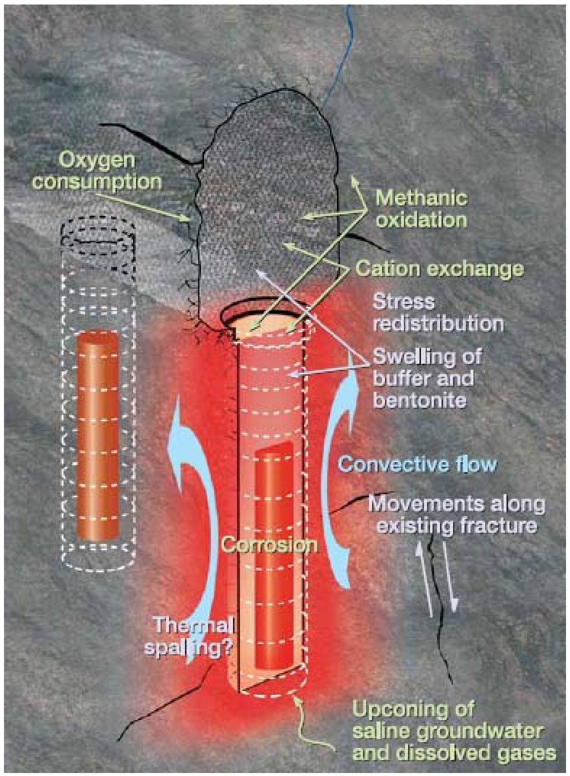


Weichselian-R scenario

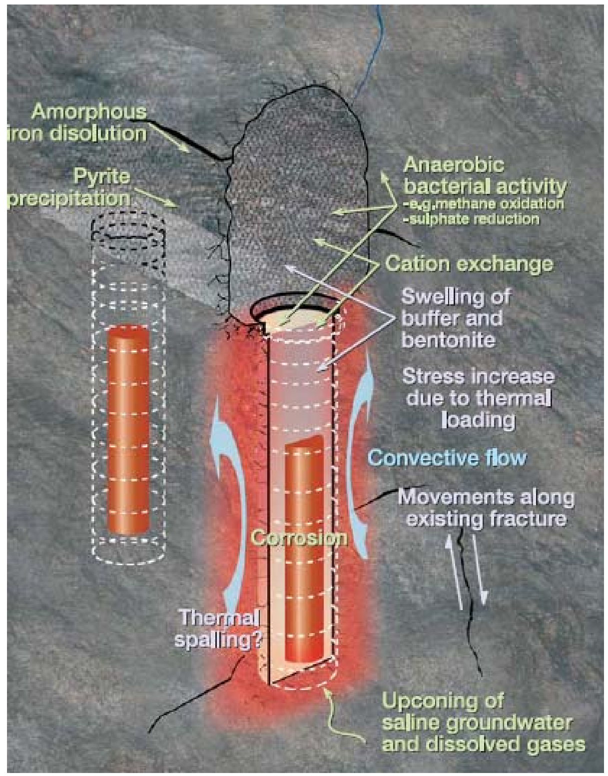


W-R: Evolution during the temperate period

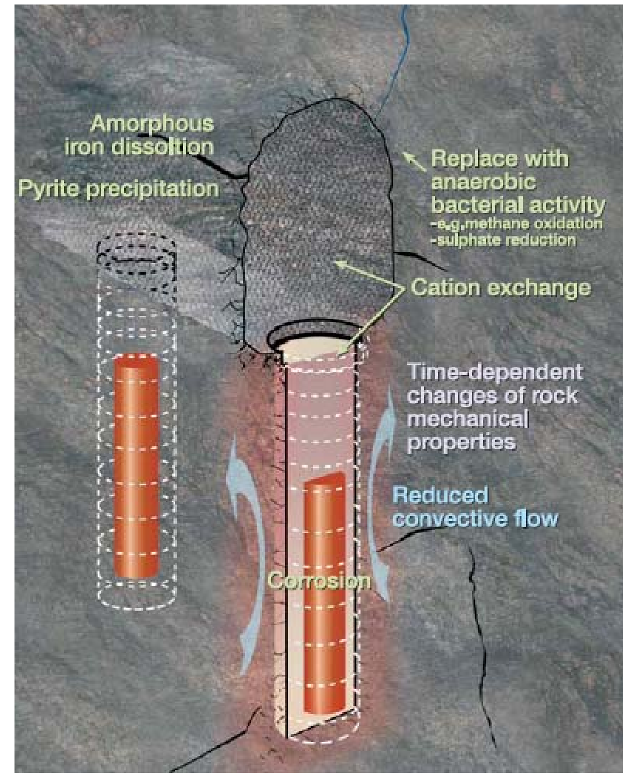
Operational phase



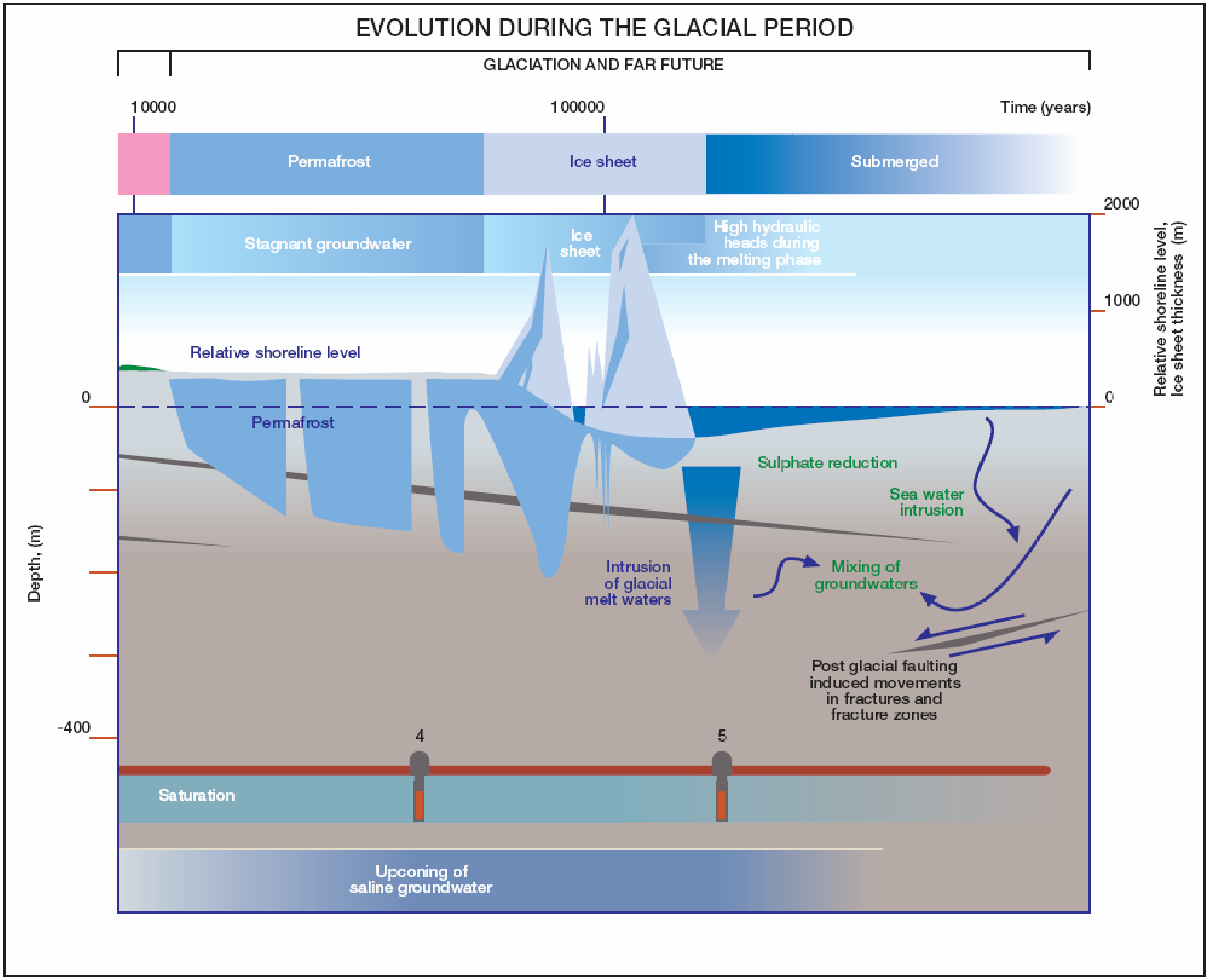
Post-closure before saturation within temperate period



After saturation within temperate period

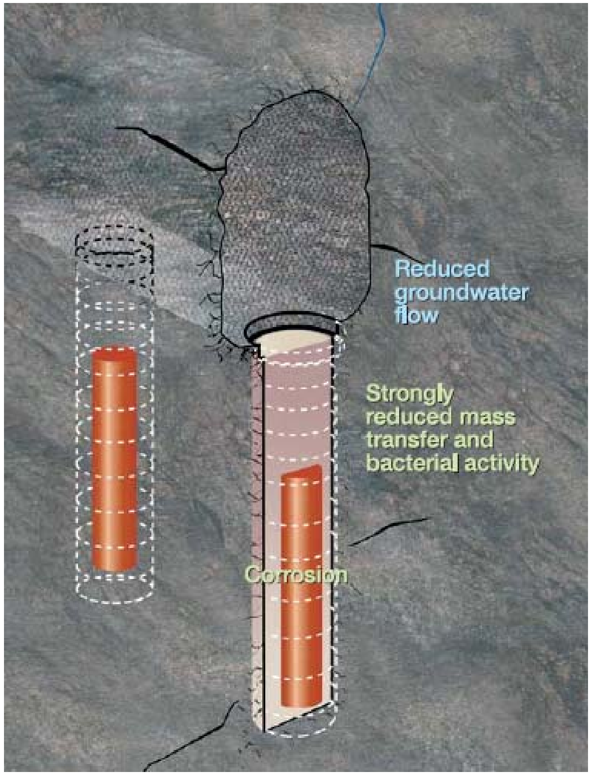


Weichselian-R scenario

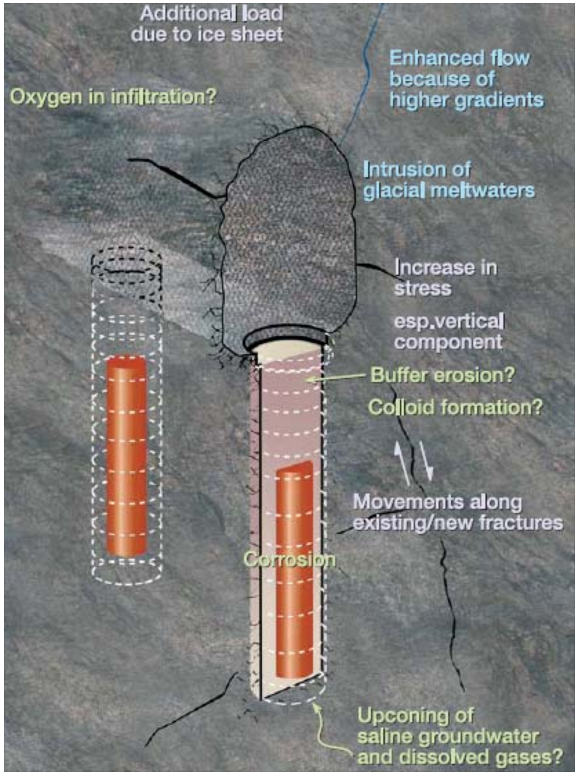


W-R: Evolution during the glacial phase

Permafrost period



Glacial, retreating ice sheet



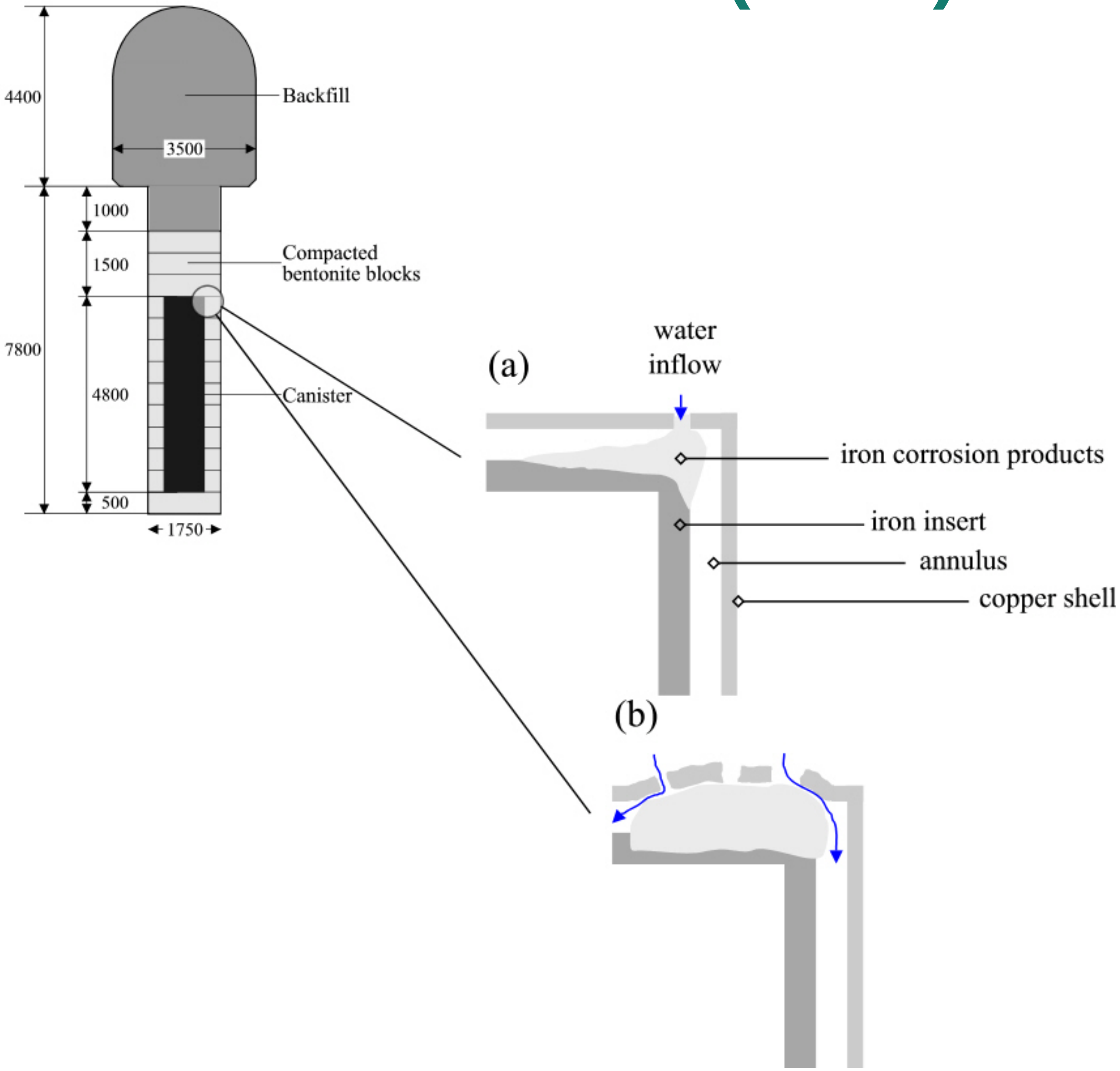
Emissions-M scenario

- Same evolution as W-R until 13000 years
- Continuing land uplift
- Fresh water ”pushes” down saline water
- No issues from L-T safety point of view

Main variant:
Evolution of a defective canister

- Based on SR-Can, it is expected that:
  - 99% of all canisters have a max. defect size smaller than 10 mm
  - 1% of all canisters have a max. defect size smaller than 15 mm
  - no initially penetrating defects
- The evolution of a canister with an initial penetrating defect is, however, considered for the purpose of this chapter (∅ 1mm & 5 mm, ref. to TILA-99)

Defective canister (cont.)



Defective canister (cont.)

- Conclusions:
  - Initial defects are not expected to have any significant influence on canister lifetime
  - The evolution of the canister interior has been described on the hypothetical assumption of a deeper than expected initial defect giving rise to canister failure prior to the next glaciation
  - At most just a few failed canisters are expected within 1 million years
  - No outflow from the canister because the water flowing in will be consumed by corrosion and the resulting pressure inside the canister will be smaller than the “external back-pressure”

Canister-scale mass balances

- Preliminary results for backfill:
  - (Na)-bentonite changes to (Na, Ca)-bentonite within 200 years
  - HS^- precipitates in the tunnel (backfill)
  - O_2 consumed within a few years in the backfill
  - sulphate reduction and methane oxydation by microbial activity
  - Ions, including Cl^- , ”sink” in the diffuse double layers of bentonite during high salinity periods

Canister-scale mass balances (cont.)

- Preliminary results for deposition hole:
  - Should HS^- enter the deposition hole from the backfill→negligible canister corrosion
  - Should HS^- (12 mg/L) penetrate via a fracture intersecting the deposition hole →negligible canister corrosion
- Main uncertainties: local GW flow, GW composition
- Next step: refine input data (GW flow predictions, composition), include effects of cementitious materials, refine deposition hole model

Discussion and path forward

- Main findings from the evolution report
  - The corrosion depth up to 100 000 years is expected to be a few mm out of 50 mm at most
- Issues to be addressed in the future:
  - Evolution of the buffer and backfill
  - Flow paths to and from the repository
  - EDZ effects
  - Cementitious materials effects on EBS
  - Glaciation effects on EBS
  - Closing and sealing issues
- Future updates of the Evolution Report
  - 2009 and 2011

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