



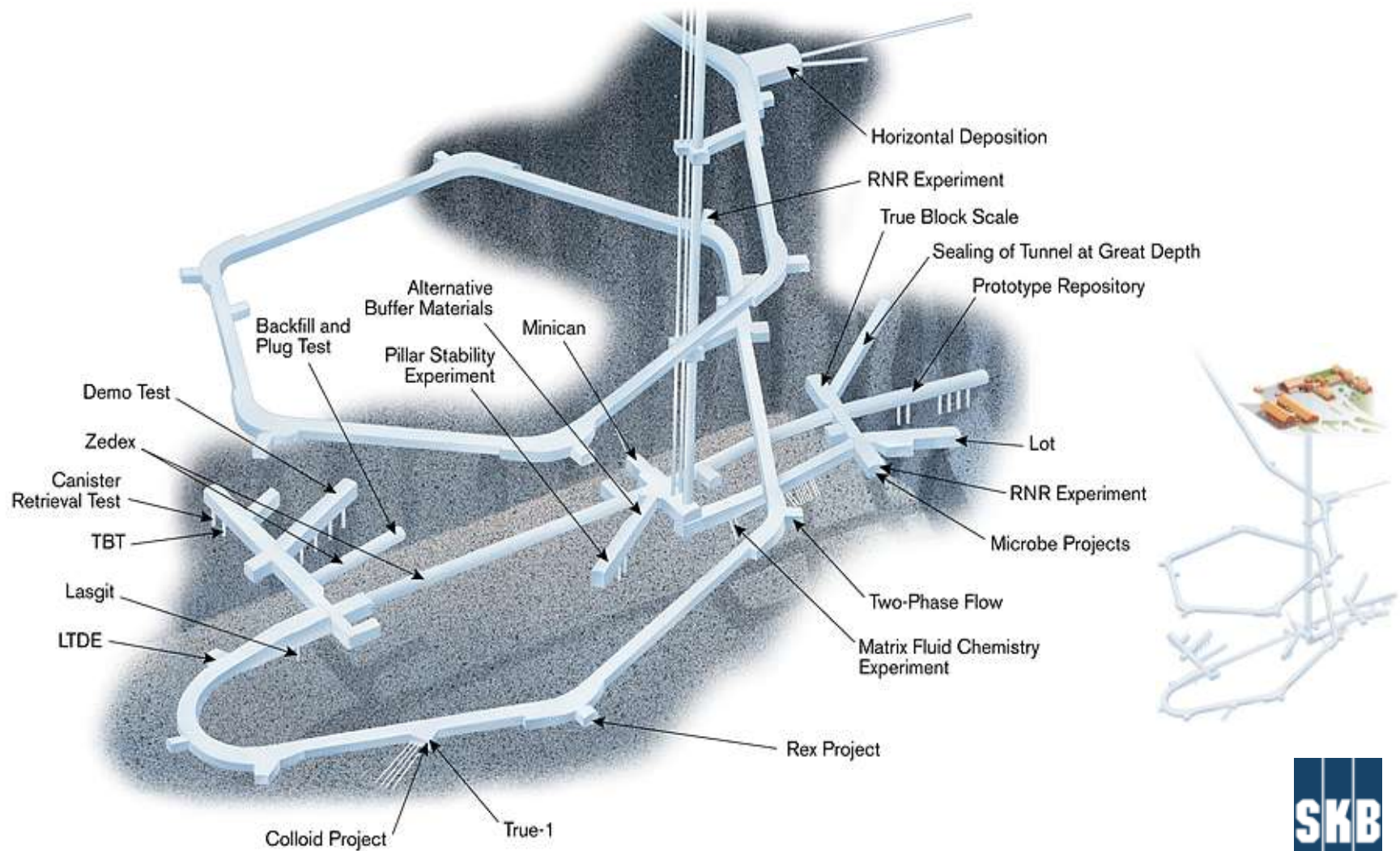
Äspö Hard Rock Laboratory

RD&D experiments

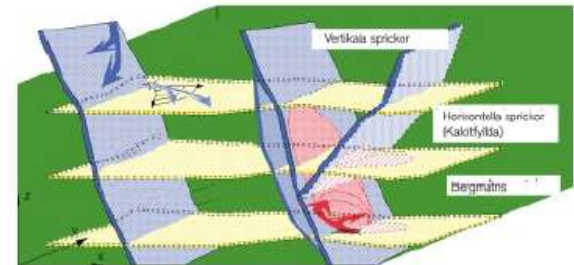
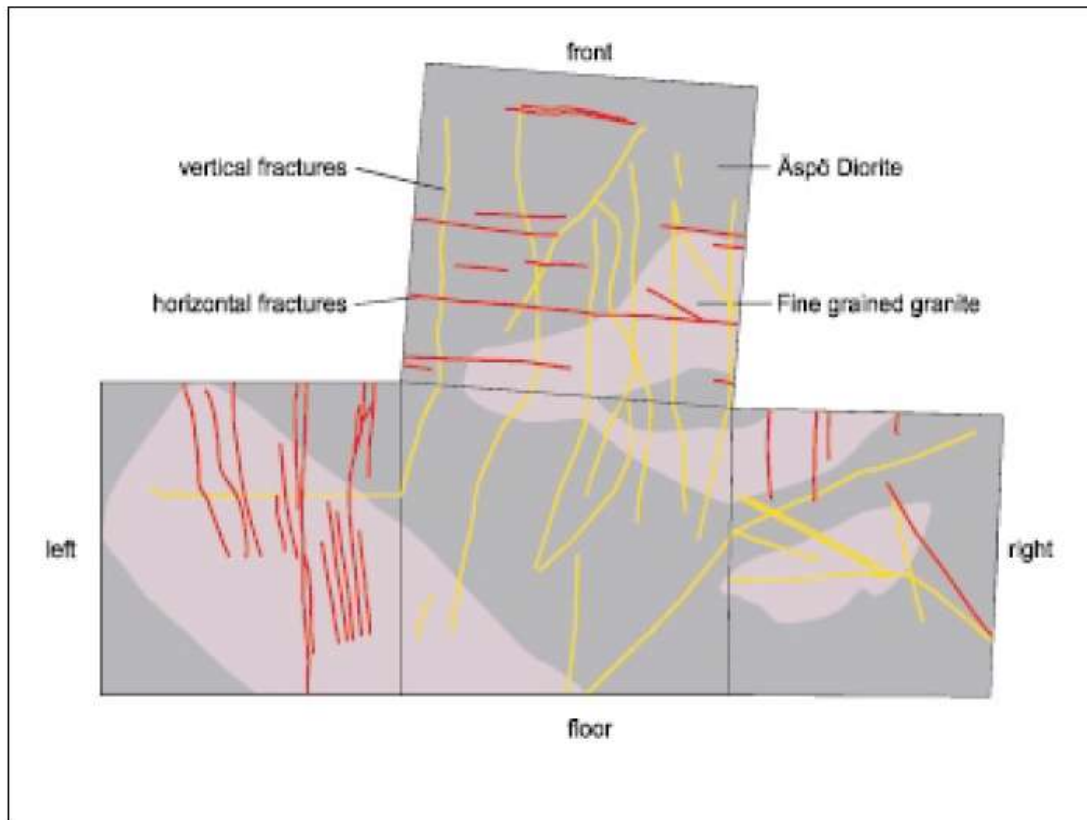
Äspö HRL Annual Report 2010
TR-11-10

Äspö Hard Rock Laboratory

- Experiments related to long term safety

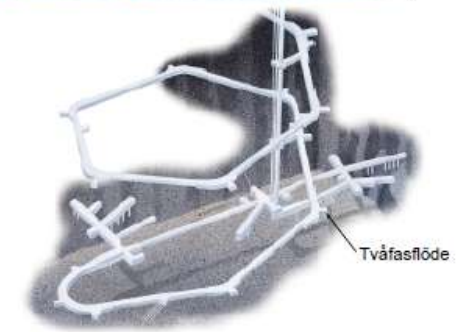


Tvåfasflöde – Two-Phase Flow

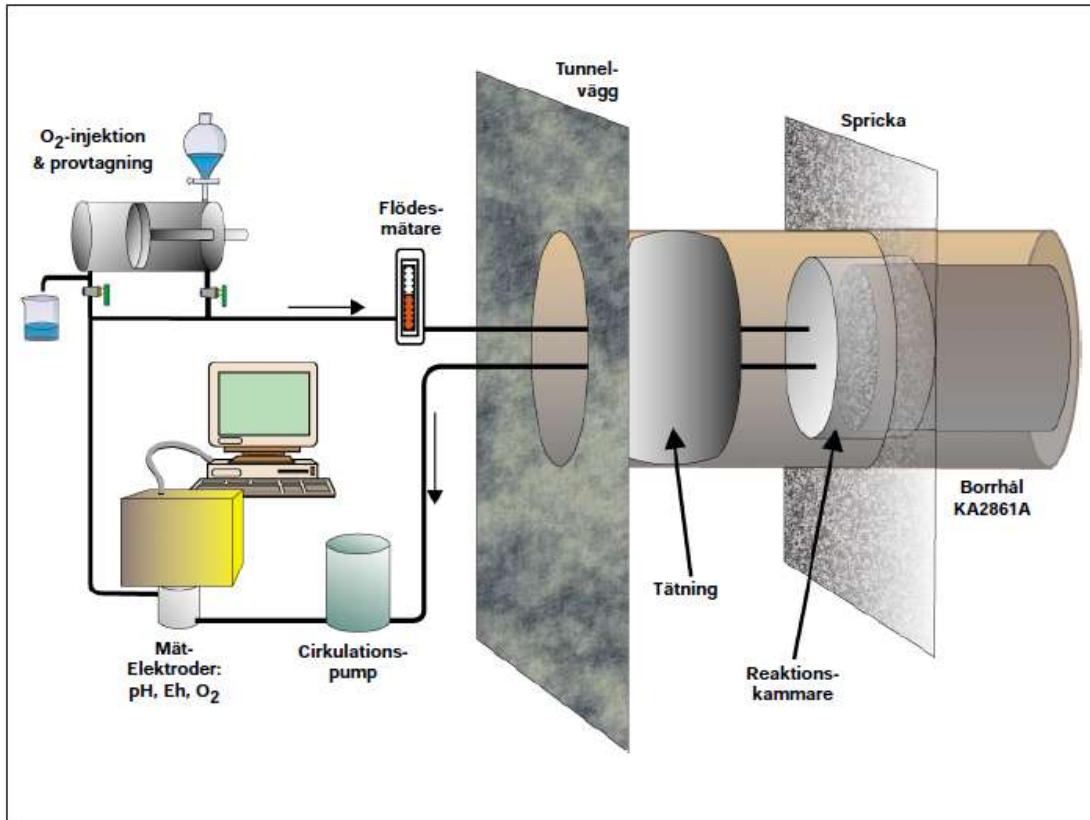


Tvåfasflöde innebär att frigjord gas i grundvattnet strömmar för sig i bergets sprickor. Det leder till att bergets förmåga att släppa igenom vatten minskar.

Two-phase flow means that liberated gas in the groundwater flows separately in the fractures in the rock. This reduces the capacity of the rock to conduct water.

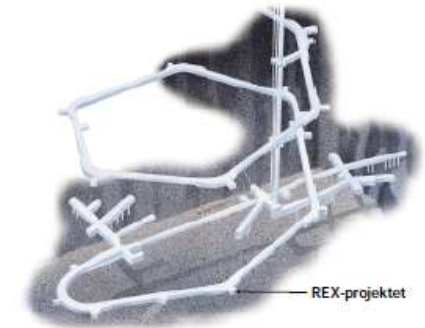


REX-projektet – Redox Experiment in Detailed Scale



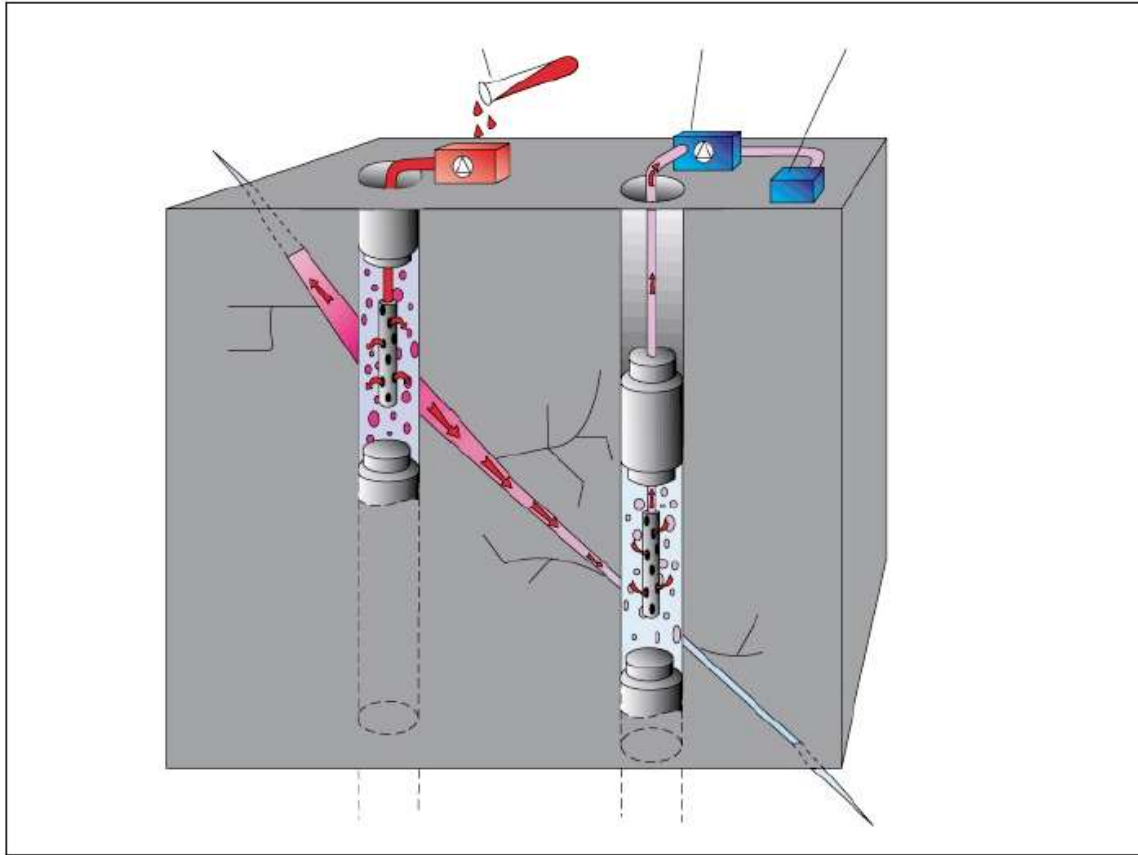
Ungefär ett år efter det att förvaret har förslutits kommer allt syre att ha förbrukats av bergets mineral och bakterier. Främst är det bakterierna som står för förbrukningen.

Approximately one year after the repository has been closed, all oxygen will have been consumed by the minerals and bacteria in the rock. The bacteria in particular are responsible for this consumption.

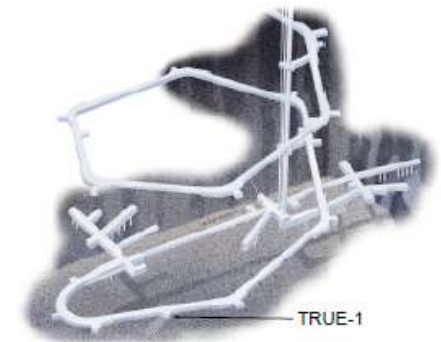


REX-projektet

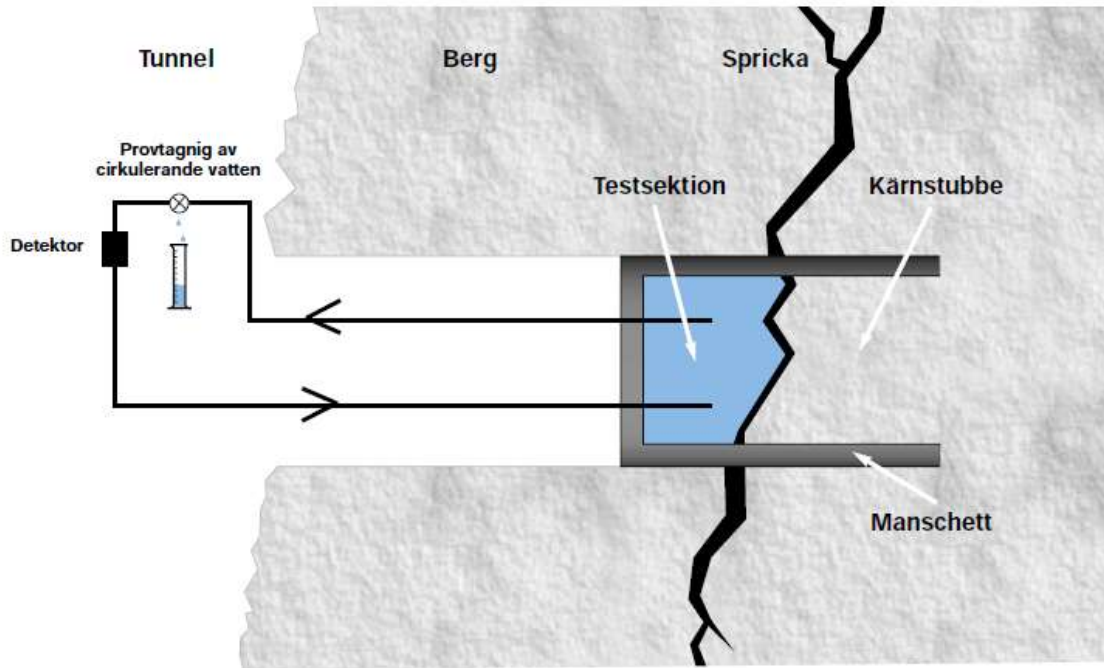
TRUE 1 – Tracer Retention Understanding Experiment 1



Berget fördröjer transporten av olika radioaktiva ämnen.
The rock retards the transport of different radionuclides.

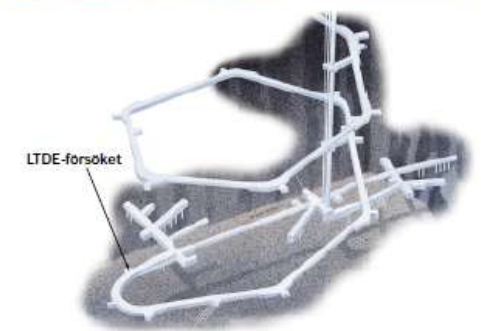


LTDE-försöket – Long Term Diffusion Experiment

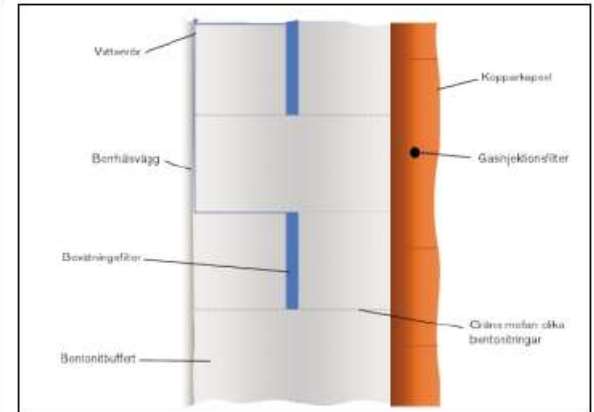
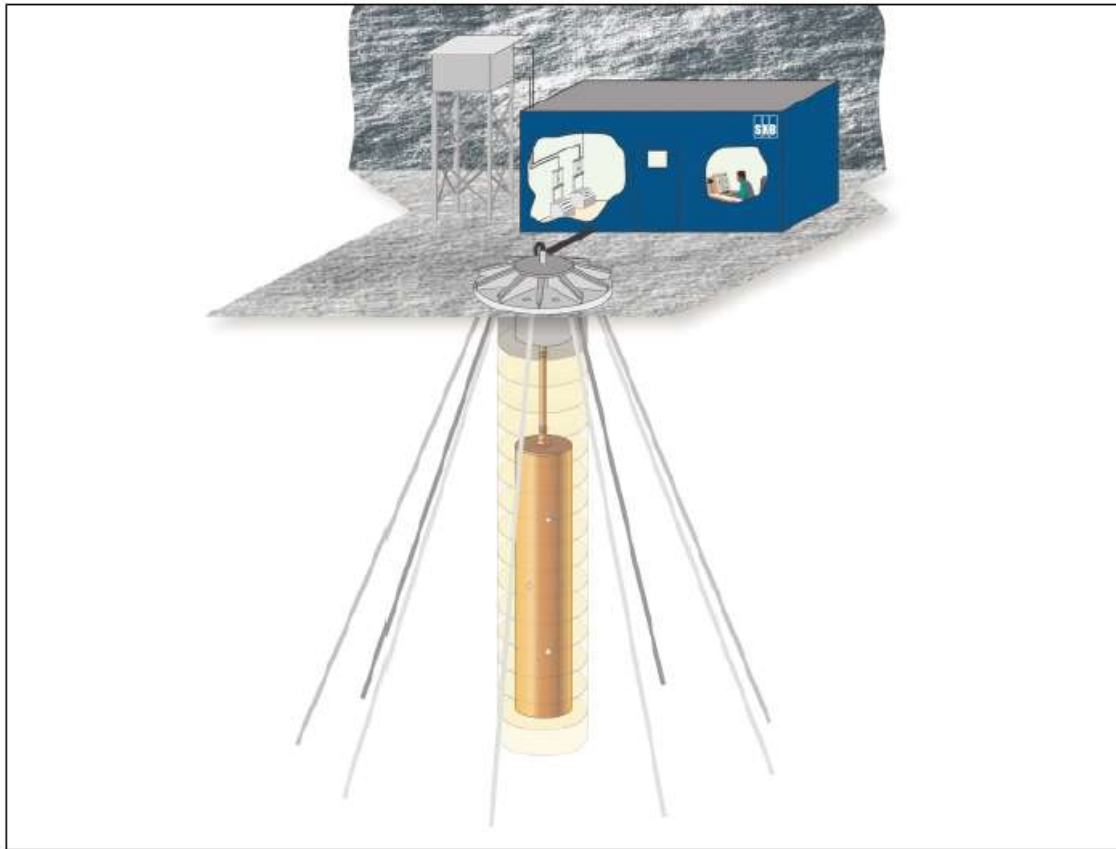


I LTDE-försöket undersöker vi under realistiska förhållanden i vilken utsträckning olika radioaktiva ämnen tar sig in i bergsmatrisen.

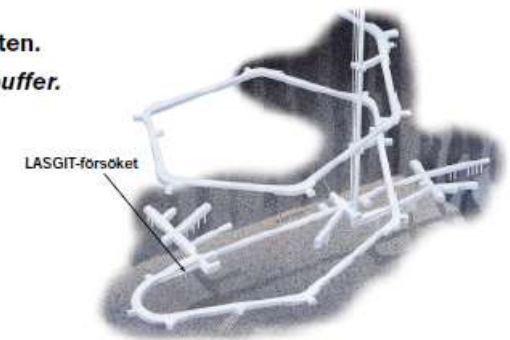
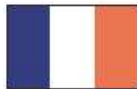
In the LTDE experiment we investigate to what extent different radionuclides migrate into the rock matrix.



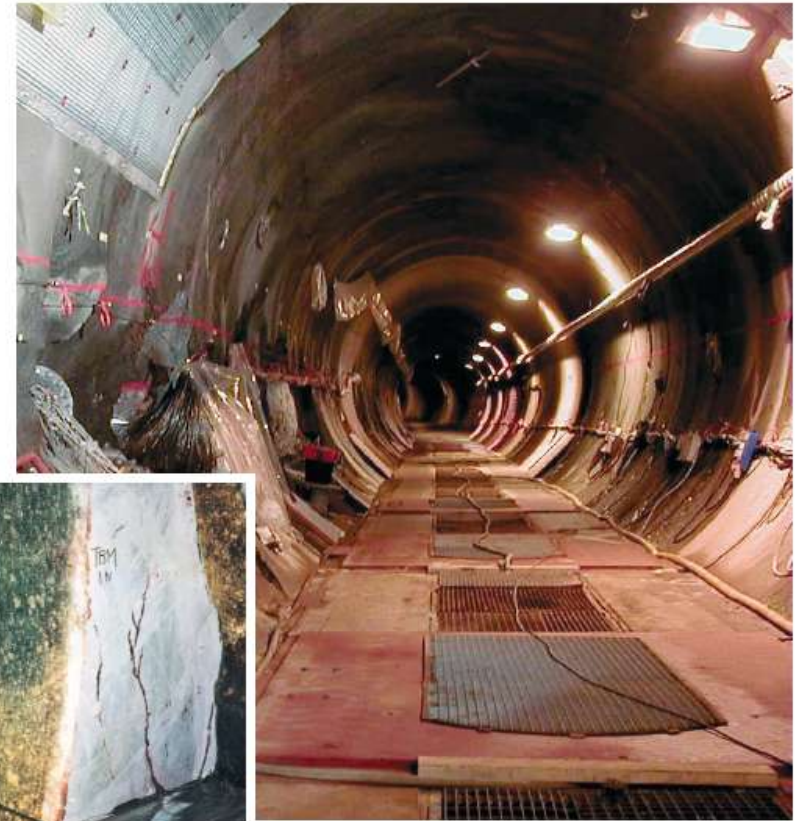
LASGIT - Large Scale Gas Injection Test



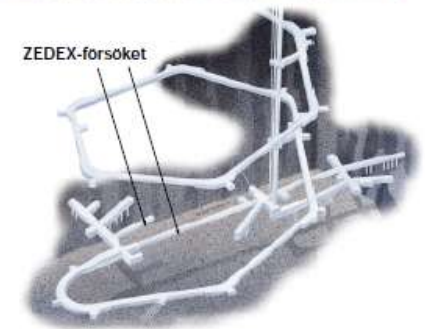
Genom att trycksätta en kapsel med helium kan vi mäta hur gasen tar sig igenom den omgivande bufferten.
By pressurizing a canister with helium, we can measure how the gas moves through the surrounding buffer.



ZEDEX-försöket – Zone of Excavation Disturbance Experiment



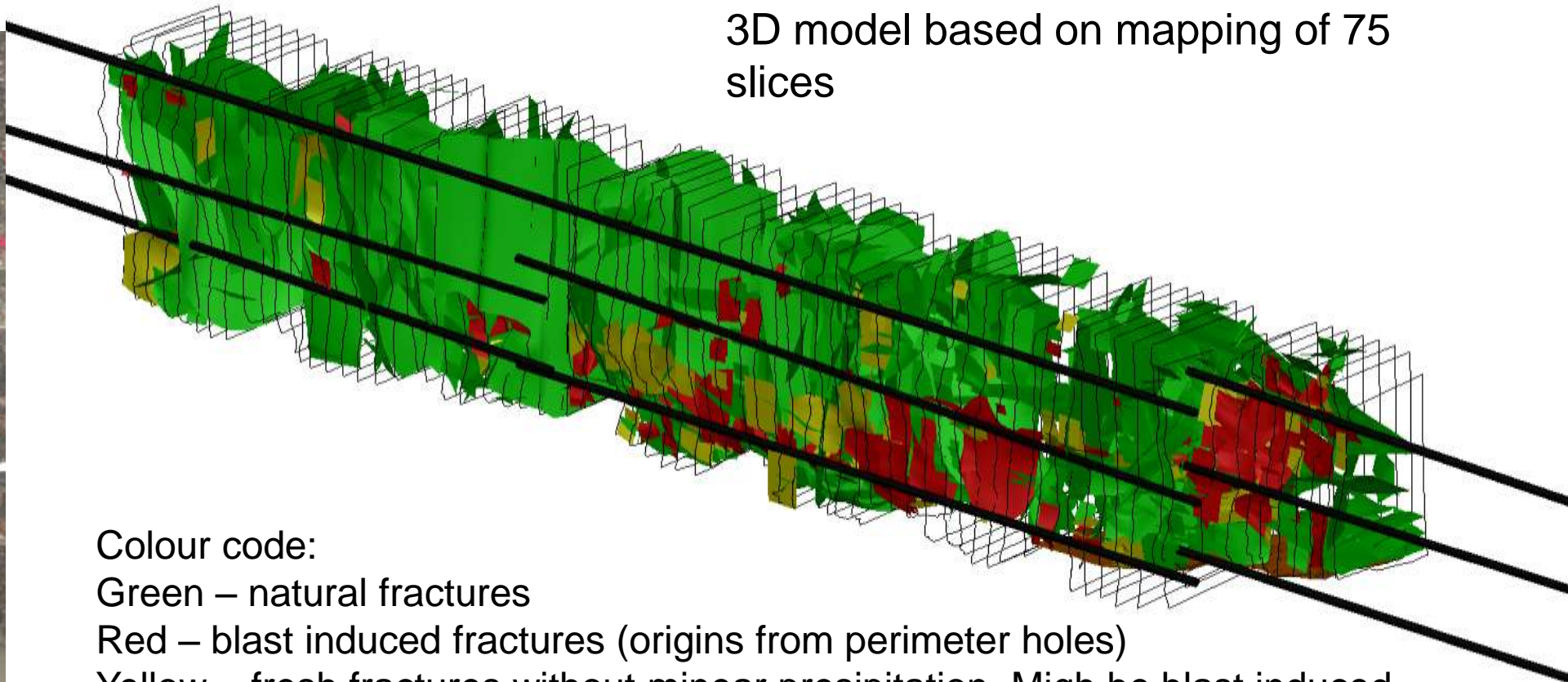
I ZEDEX-försöket har vi jämfört hur berget påverkas runt en sprängd respektive en borrarad tunnel.
In the ZEDEX experiment we have compared how the rock is affected around a drill-and-blast tunnel versus a bored tunnel.



Investigations of the EDZ i TASS

Sample size: 8 x 1.5 m, weight 25 tons

3D model based on mapping of 75 slices



Colour code:

Green – natural fractures

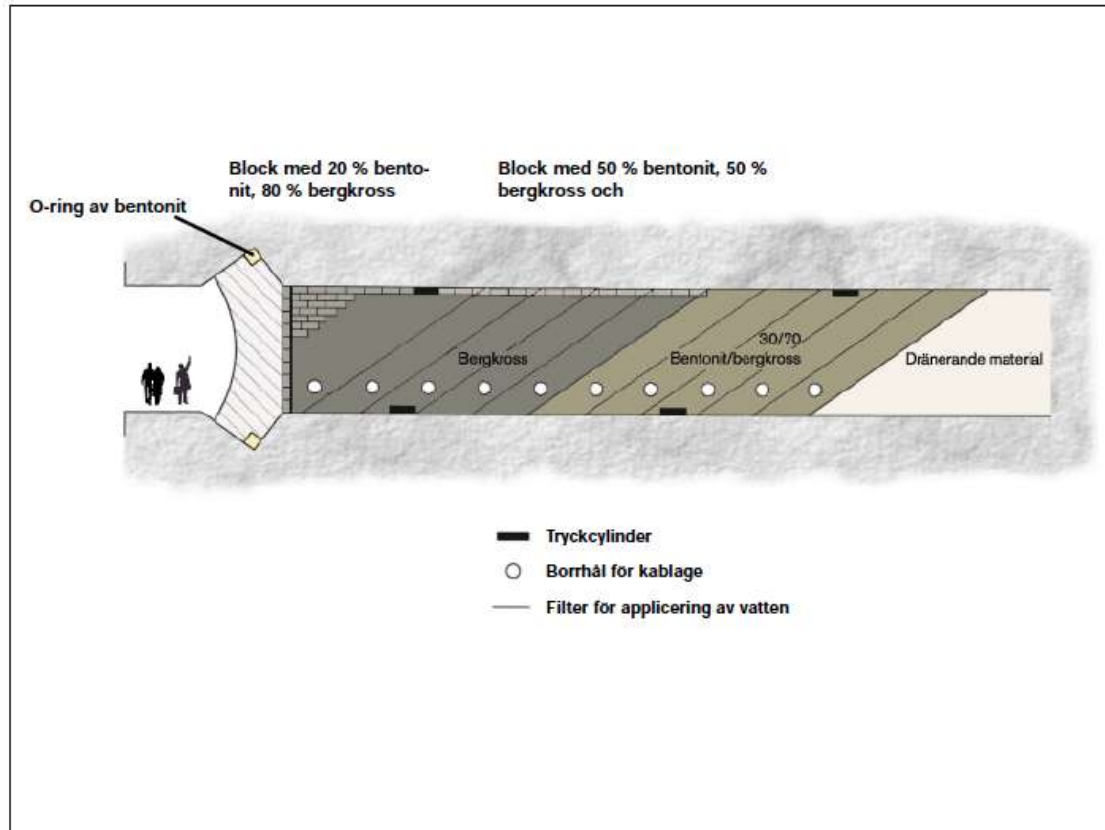
Red – blast induced fractures (origins from perimeter holes)

Yellow – fresh fractures without mineral precipitation. Might be blast induced

Conclusion: modern blast technology can provide a discontinuous EDZ



Återfyllning och pluggning – Backfill and Plug Test



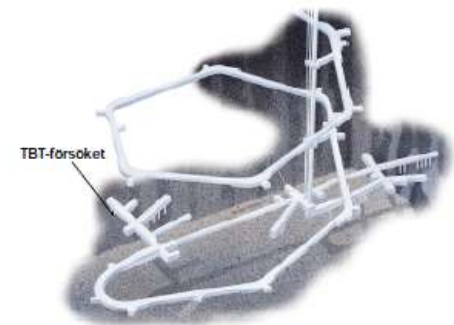
Tunnelarna i det framtida djupförvaret för använt kärnbränsle ska fyllas igen och pluggas.
The tunnels in the future deep repository for spent nuclear fuel will be backfilled and plugged.



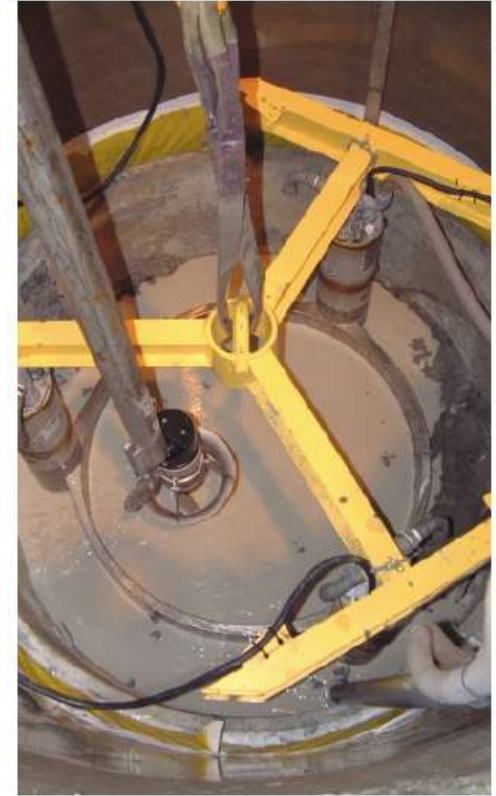
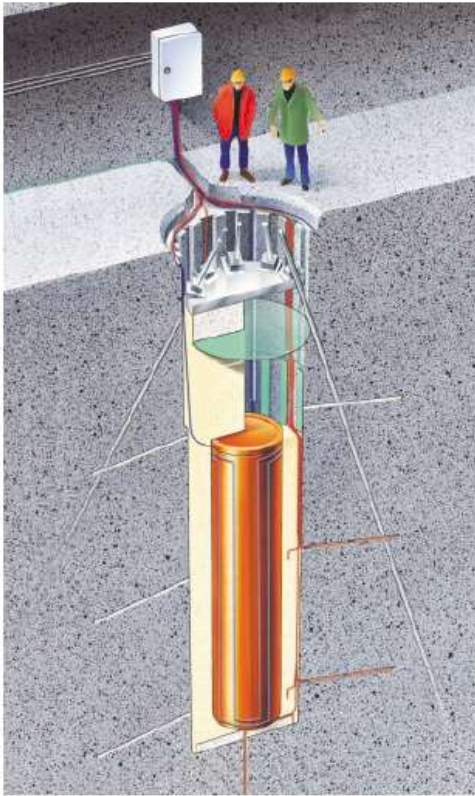
TBT-försöket – Temperature Buffer Test



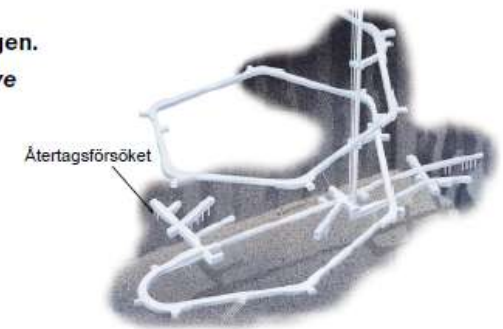
**I TBT-försöket undersöks hur bentonitleran i bufferten påverkas av höga temperaturer.
TBT is testing how the bentonite clay in the buffer is affected by high temperatures.**



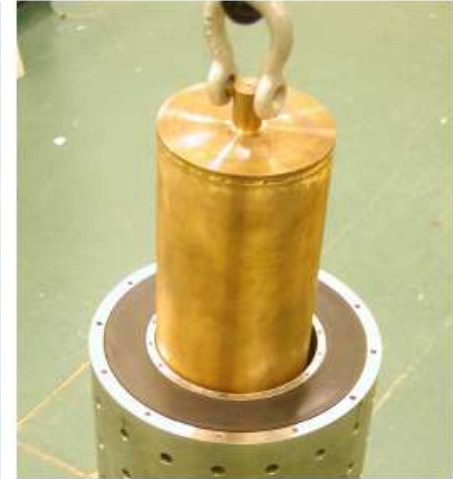
Återtag – Canister Retrieval Test



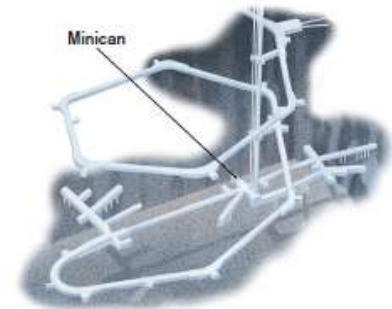
Om djupförvaret av någon anledning inte fungerar vill vi ha möjlighet att ta upp det använda bränslet igen.
If the deep repository should not perform satisfactorily for some reason, we want to be able to retrieve the spent fuel.



Minican



Minican-försöket går ut på att försöka förstå hur korrosion av segjärnsatsen kan påverka kapseln.
The purpose of the minican-project is to obtain a better understanding of the corrosion process of the cast iron insert could affect the canister.



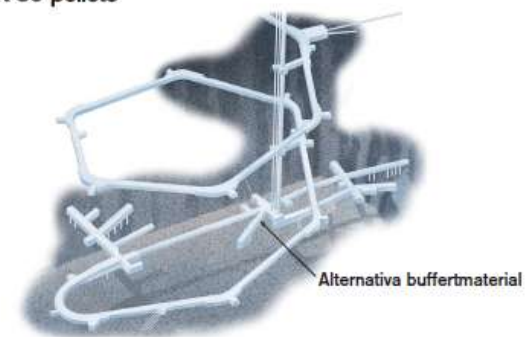
Alternativa buffertmaterial - Alternative Buffer Materials



Installerade material:

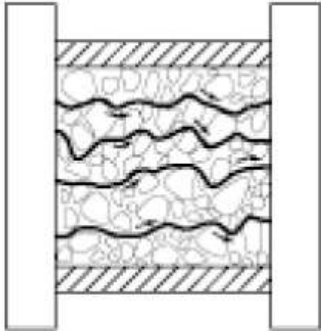
- Ikosorb
- Deponit CA-N
- Ibeco Seal M-90
- Friedland
- Asha 505
- Calcigel
- Febex
- Japansk Na Bentonit
- Callovo Oxfordian kross + skivor
- Rokie
- MX-80
- MX-80 pellets

Det finns många olika leror som kan tänkas användas i det kommande slutförvaret.
There are many different kinds of clays that may be used in the future final repository.

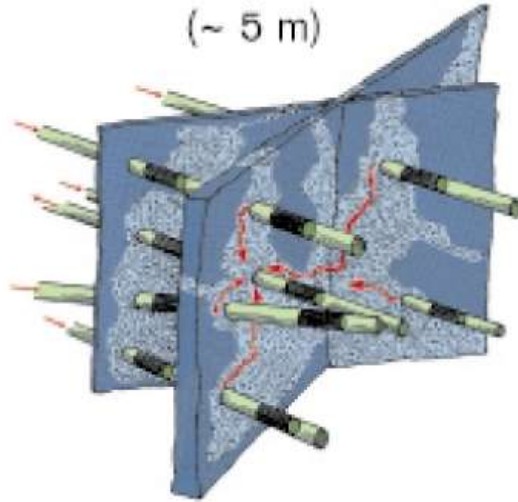


TRUE Block Scale

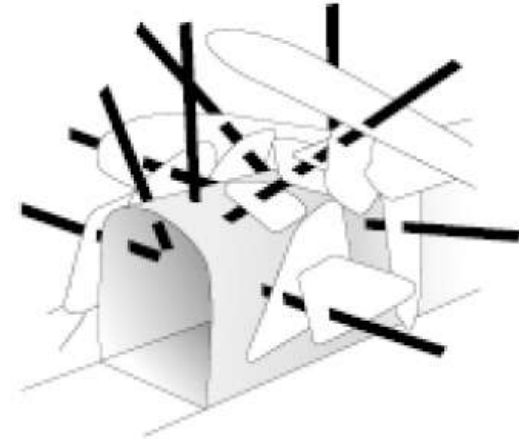
Laboratorieskala
(< 0.5 m)



Detaljskala
(~ 5 m)



Blockskala
(~ 50 m)



TRUE-försöken genomförs i olika skalor.

The TRUE- experiments are conducted on different scales.

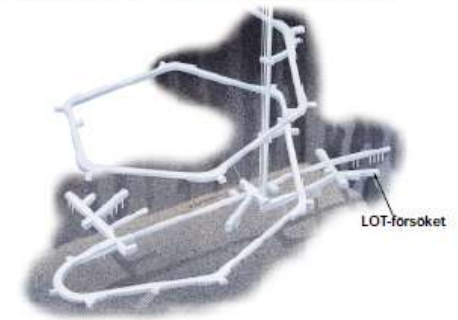


LOT-försöket – Long Term Test of Buffer Material

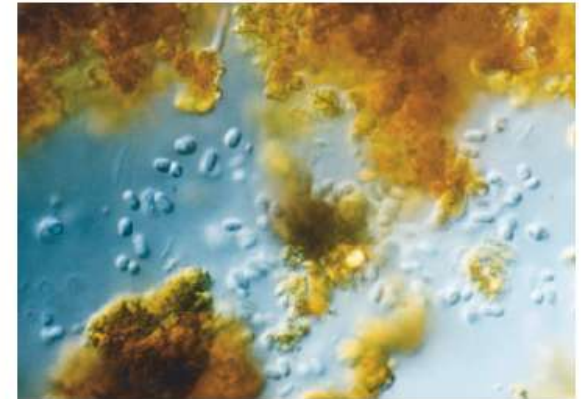
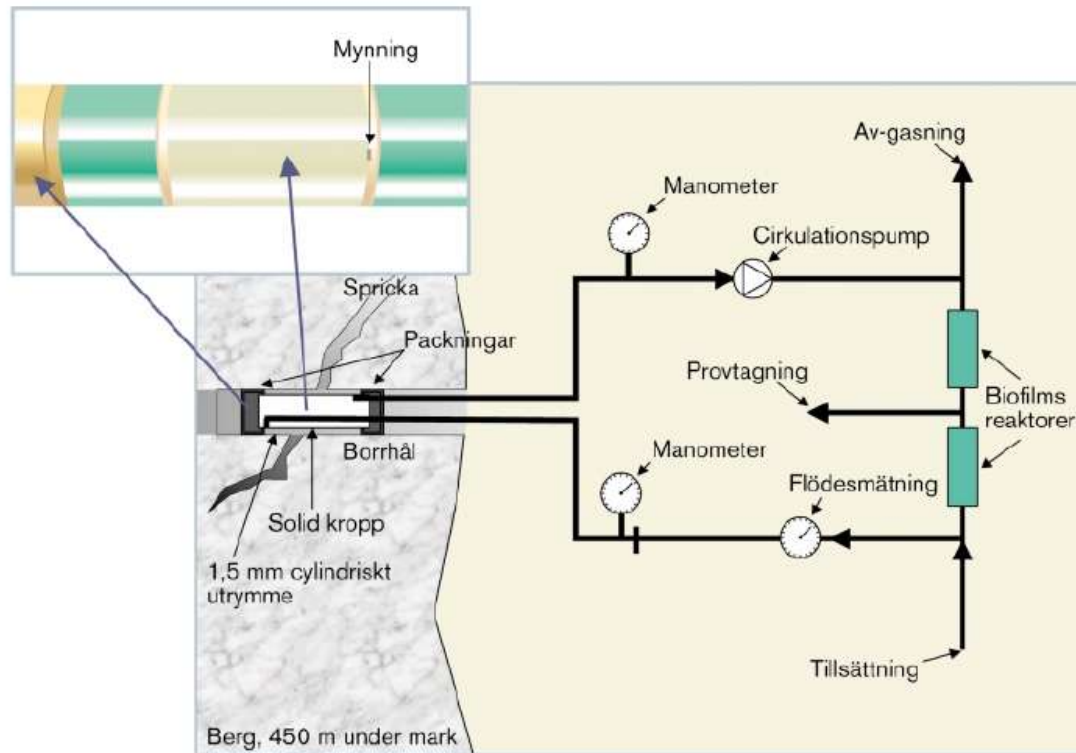


LOT-försöket ska ge svar på frågan hur bentonitleran uppför sig i en miljö som liknar det framtida djupförvaret.

The LOT experiment is intended to show how the bentonite clay behaves in an environment similar to that in the future deep repository.

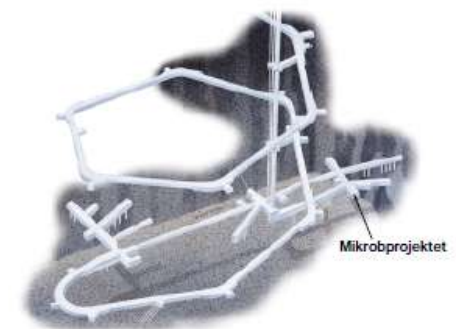


Mikroprojektet – Microbe Project

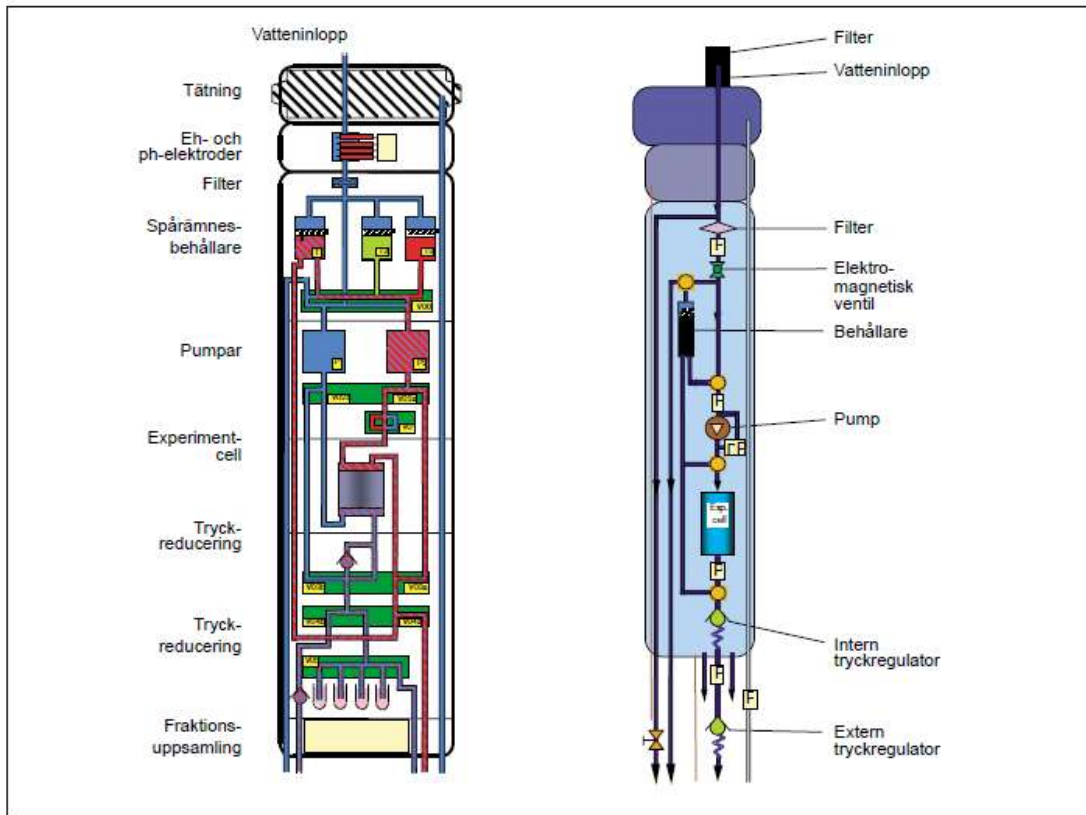


Underjordiska mikrober förbrukar syre och förhindrar därmed att kopparkapslarna korroderar. De kan också producera ämnen som ökar korrosionen.

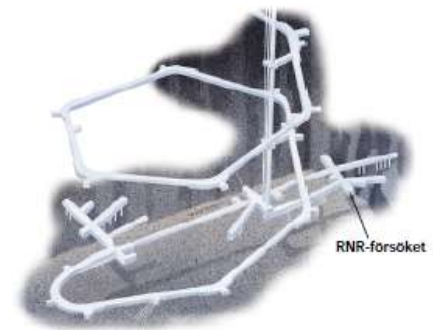
Subterranean microbes consume oxygen, and therefore prevent the copper canisters from corrosion. They can also produce substances that increase the corrosion.



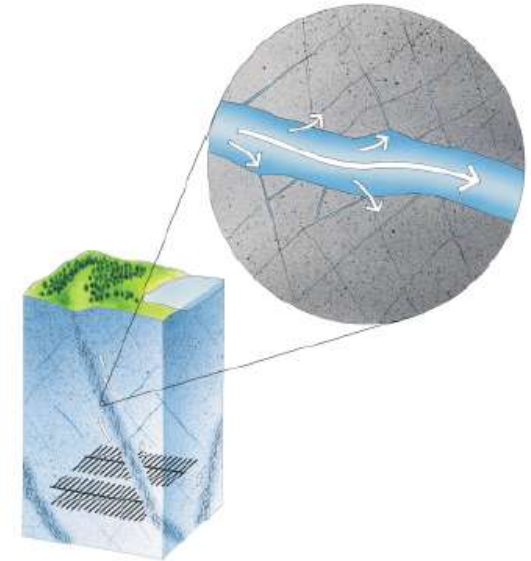
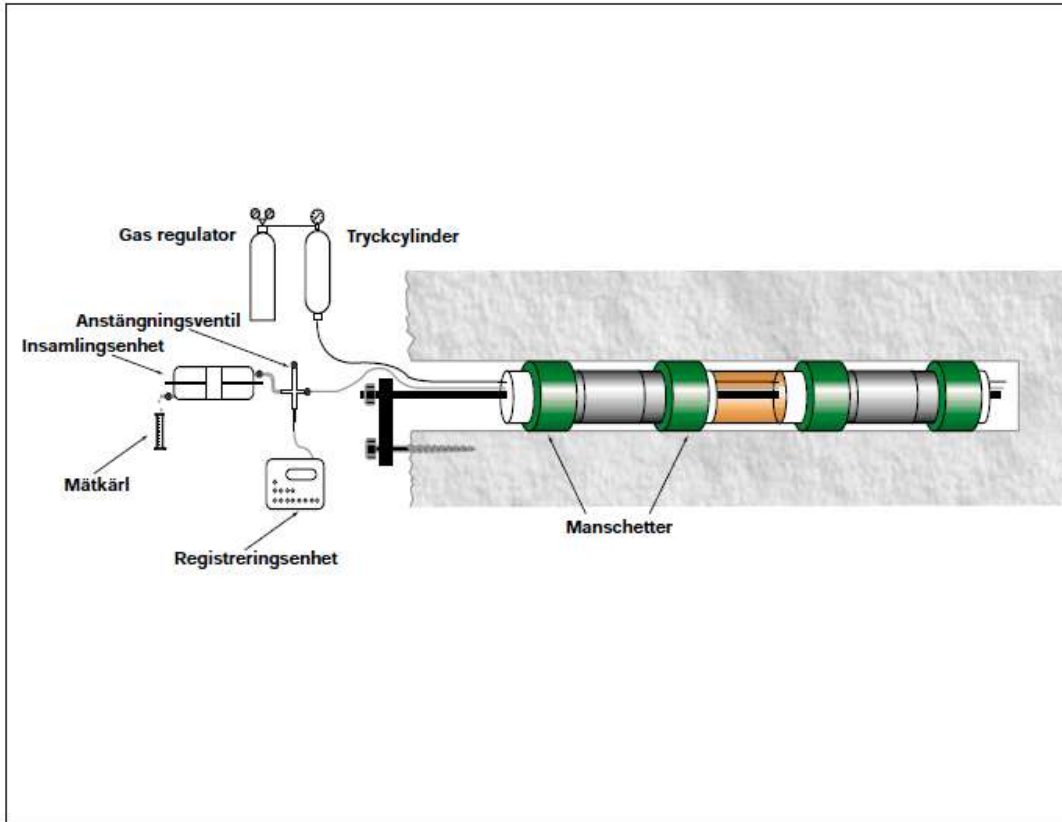
RNR-försöket – Radionuclide Retention Experiment



En utbyttbar cell i en specialbyggd sond gör det möjligt att göra experiment om hur radioaktiva ämnen rör sig.
An exchangeable cell in a specially built probe makes it possible to conduct experiments on how radionuclides move.

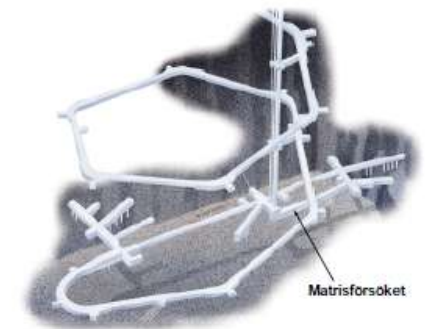


Matrisförsöket – Matrix Fluid Chemistry Experiment



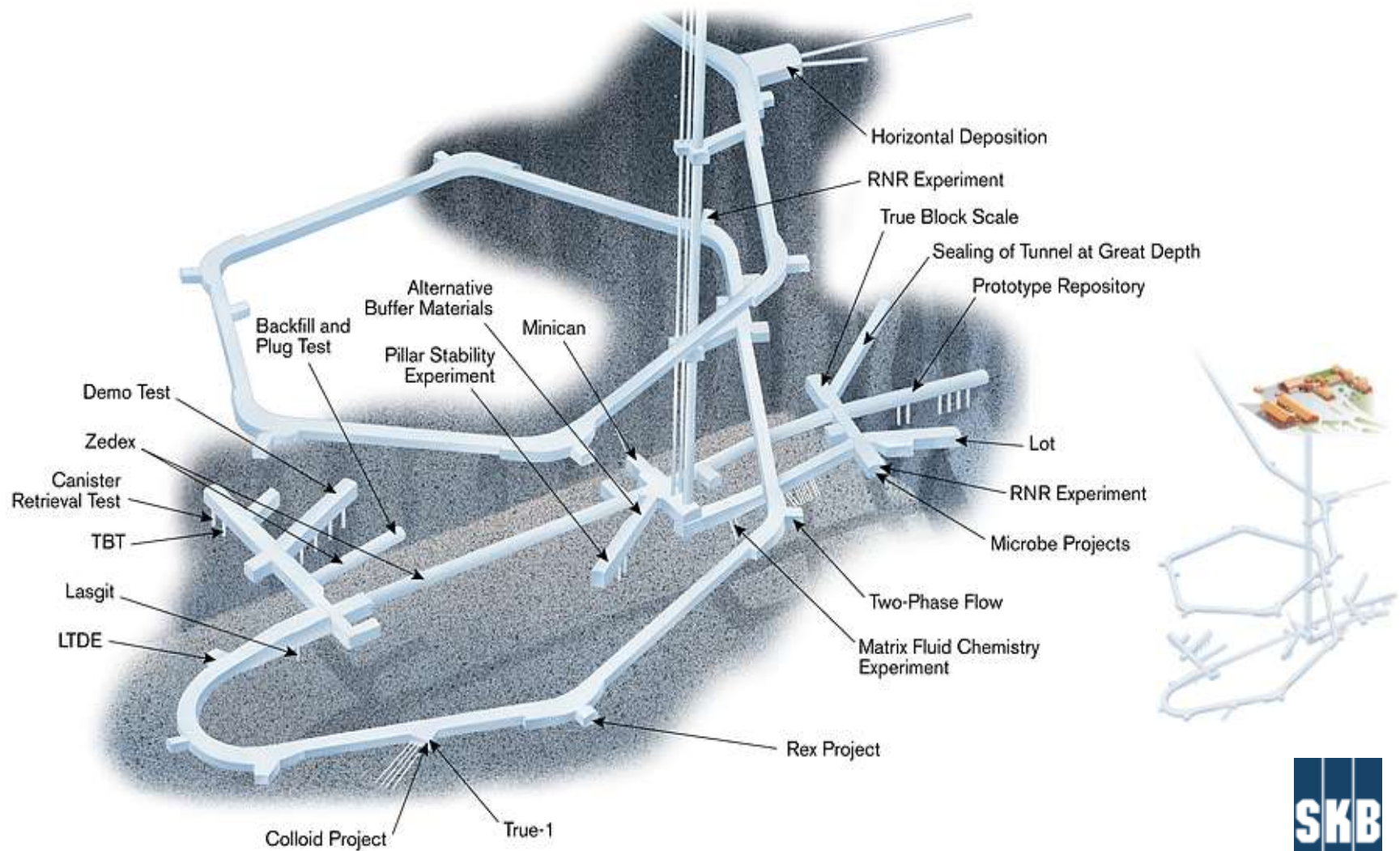
Matrisvatten är det vatten som befinner sig inne i bergmassans porer.

Matrix fluid is water in the pores of the rock matrix.



Äspö Hard Rock Laboratory

- EBS related full-scale tests

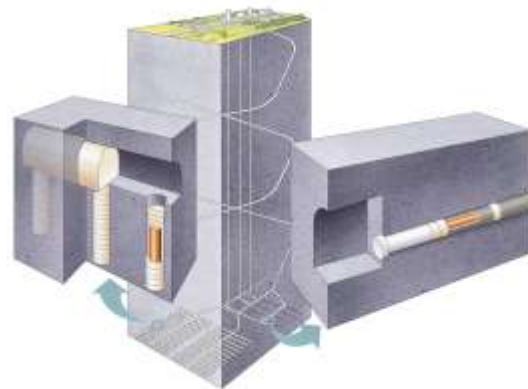


Äspö Hard Rock Laboratory

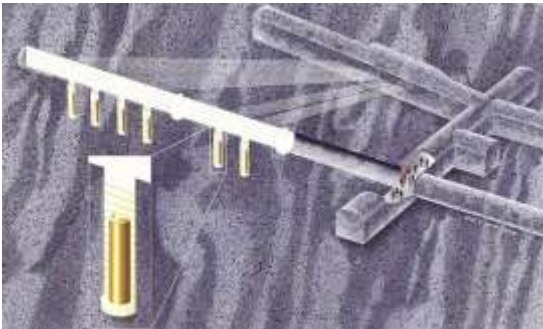
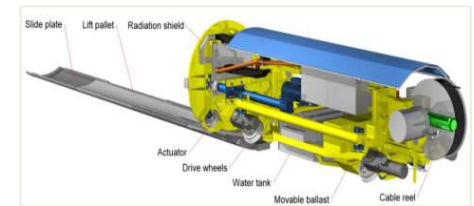
Examples of Large Scale Experiments

KBS-3V

Deposition Machine



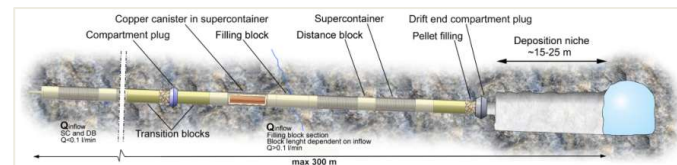
KBS-3H Project



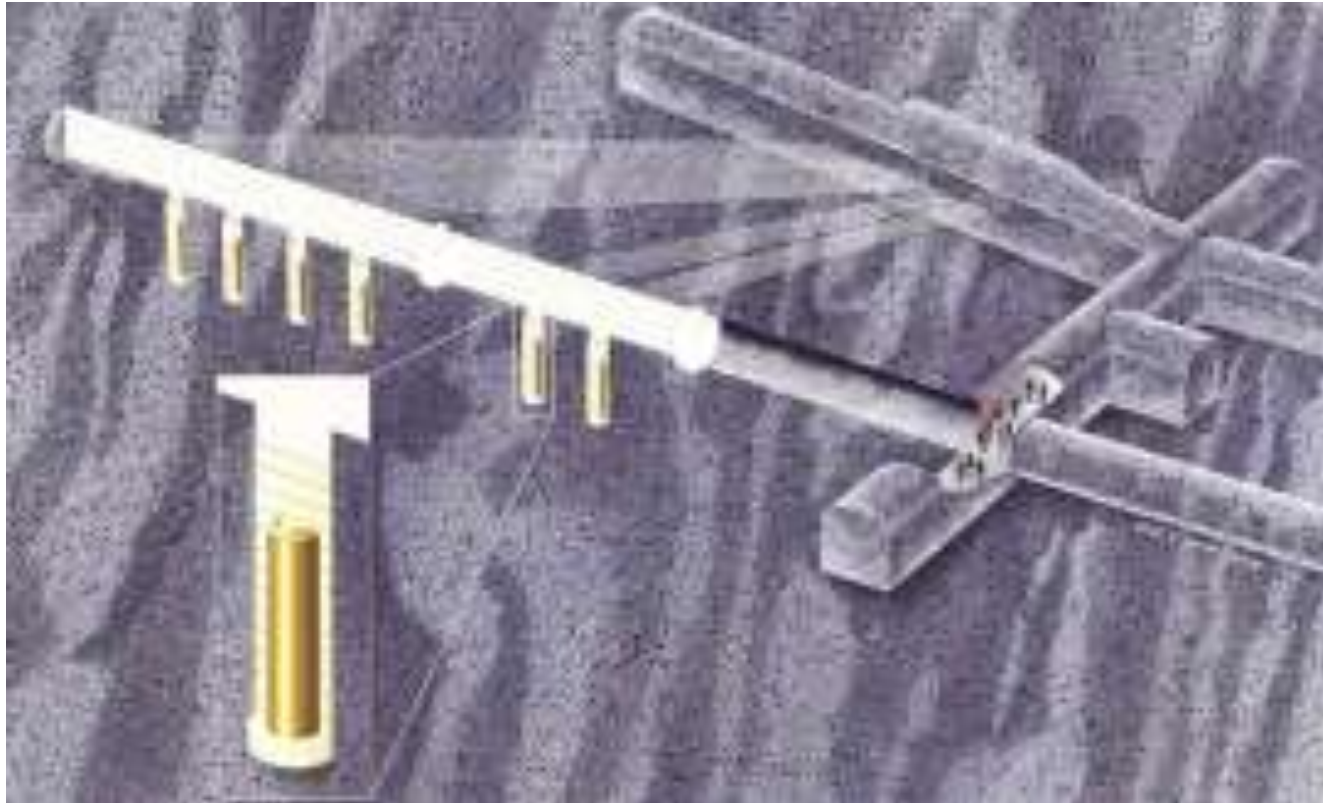
Prototype Repository



Canister Retrieval Test



The Prototype Repository Experiment



Installed instrumentation is used to monitor processes and properties in the canister, buffer material, backfill and the near-field rock.



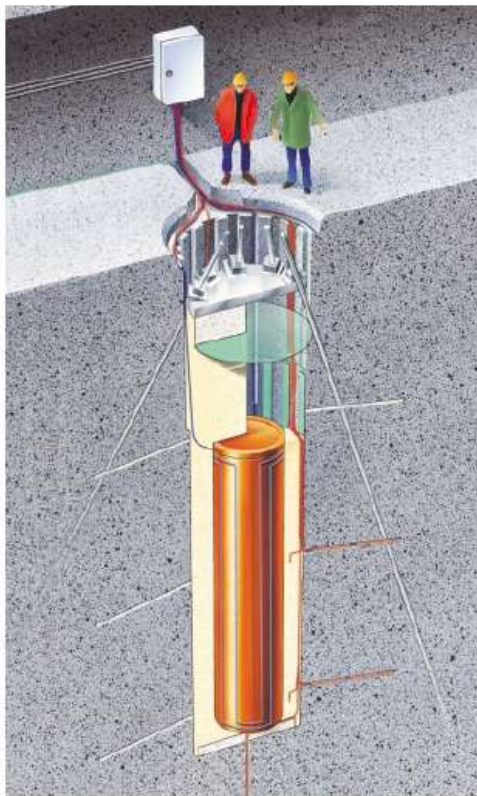
The inner section

- 4 full-scale KBS-3-canisters
- Backfilled and the plug cast in 2001

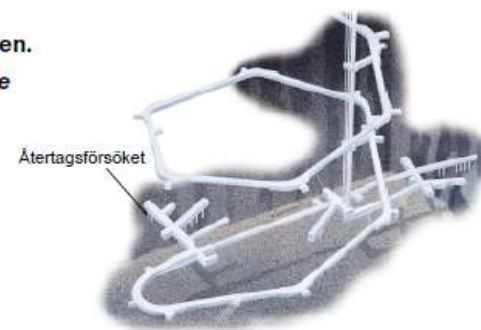
The outer section

- 2 full-scale KBS-3-canisters
- Backfilled and the plug cast in 2003

Återtag – Canister Retrieval Test

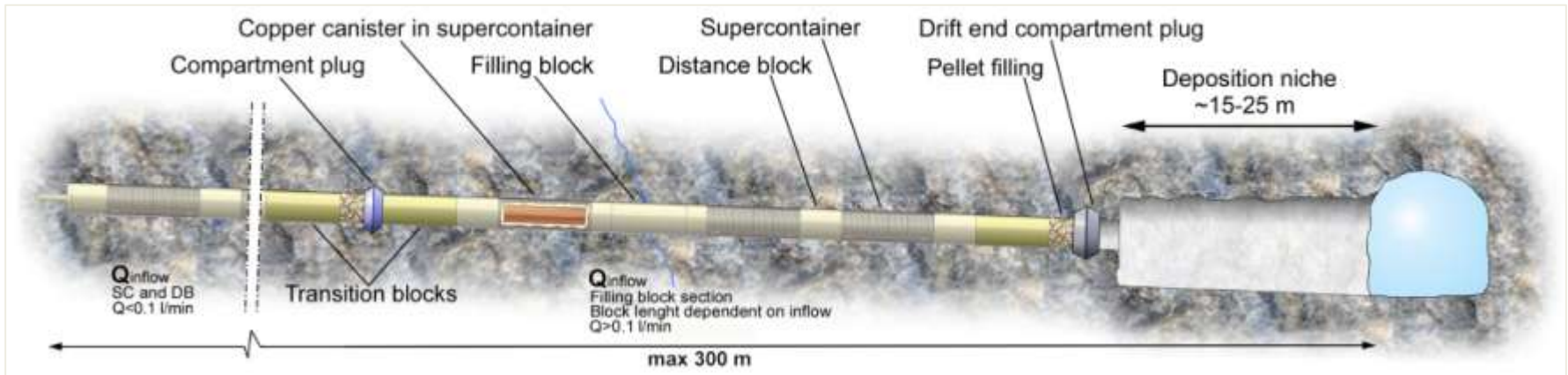
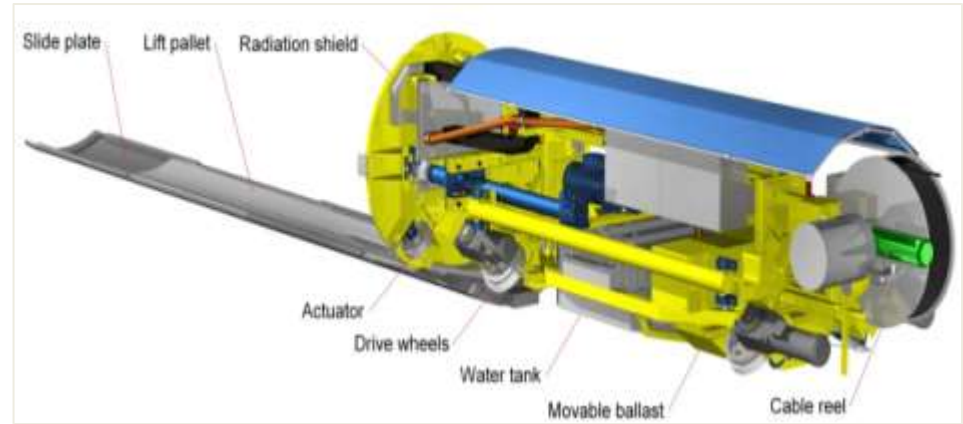
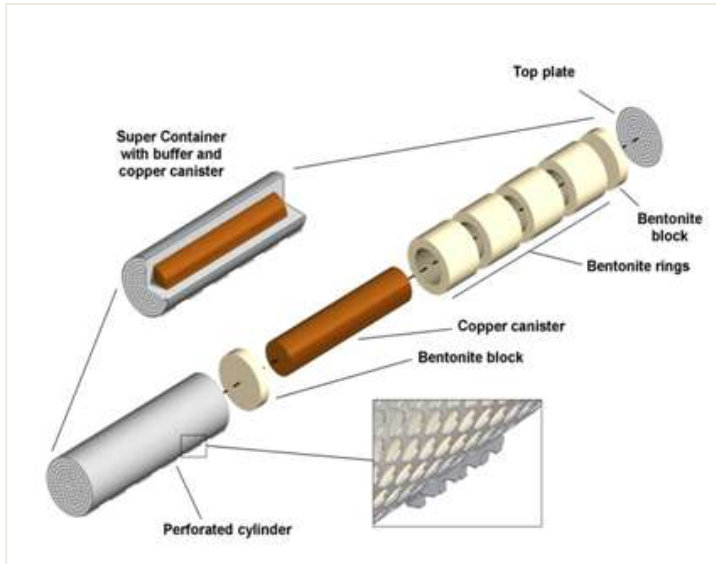


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KBS-3H Project

Key components in the design



KBS-3H Project

The experimental site at the -220 m level / Deposition machine



- The deposition machine has been operated throughout the project phase and the *deposition technique* has proven to be **functional and efficient**.
- Tests and evaluations has identified soft- and hardware updates that should ensure long term performance with further improved reliability.

Mechanical and system engineering

Full scale prototypes of machines and equipments

Deposition Machine



Robot (Backfilling of deposition tunnels)



Self Propelled Modular Transporter

