ONKALO – UNDERGROUND ROCK CHARACTERIZATION FACILITY FOR IN-SITU TESTING FOR NUCLEAR WASTE REPOSITORY

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Nuclear Waste Management of Spent Fuel in Finland

- Finnish programme started 1979
- Desktop studies 1983-1986
- Site investigations 1987-2004 (four phases)
- Olkiluoto site was selected 2001
- **ONKALO construction started 2004, excavations completed 2014**
- Construction licence was submitted 2012
- Finnish Nuclear Safety Authority STUK gave positive statement in February, 2015
- Disposal operation starts ~2022
- Repository sealing/closing by 2120

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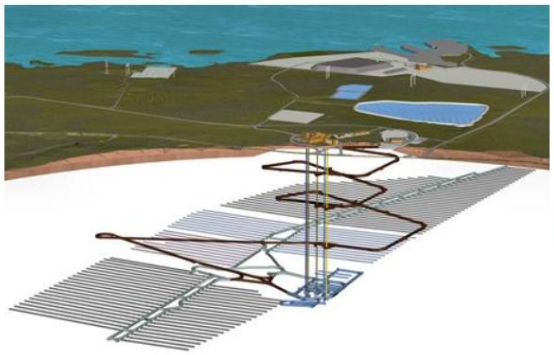
Finnish regulator approves Posiva's waste repository plan

12 February 2015

Finland's radiation and nuclear safety authority (STUK) has given its backing to Posiva's application to construct a final repository and waste encapsulation plant.



The Olkiluoto repository will consist of a network of disposal tunnels up to 450 metres below ground (Image: Posiva)

Related Stories

- Delay in Finnish repository licence review

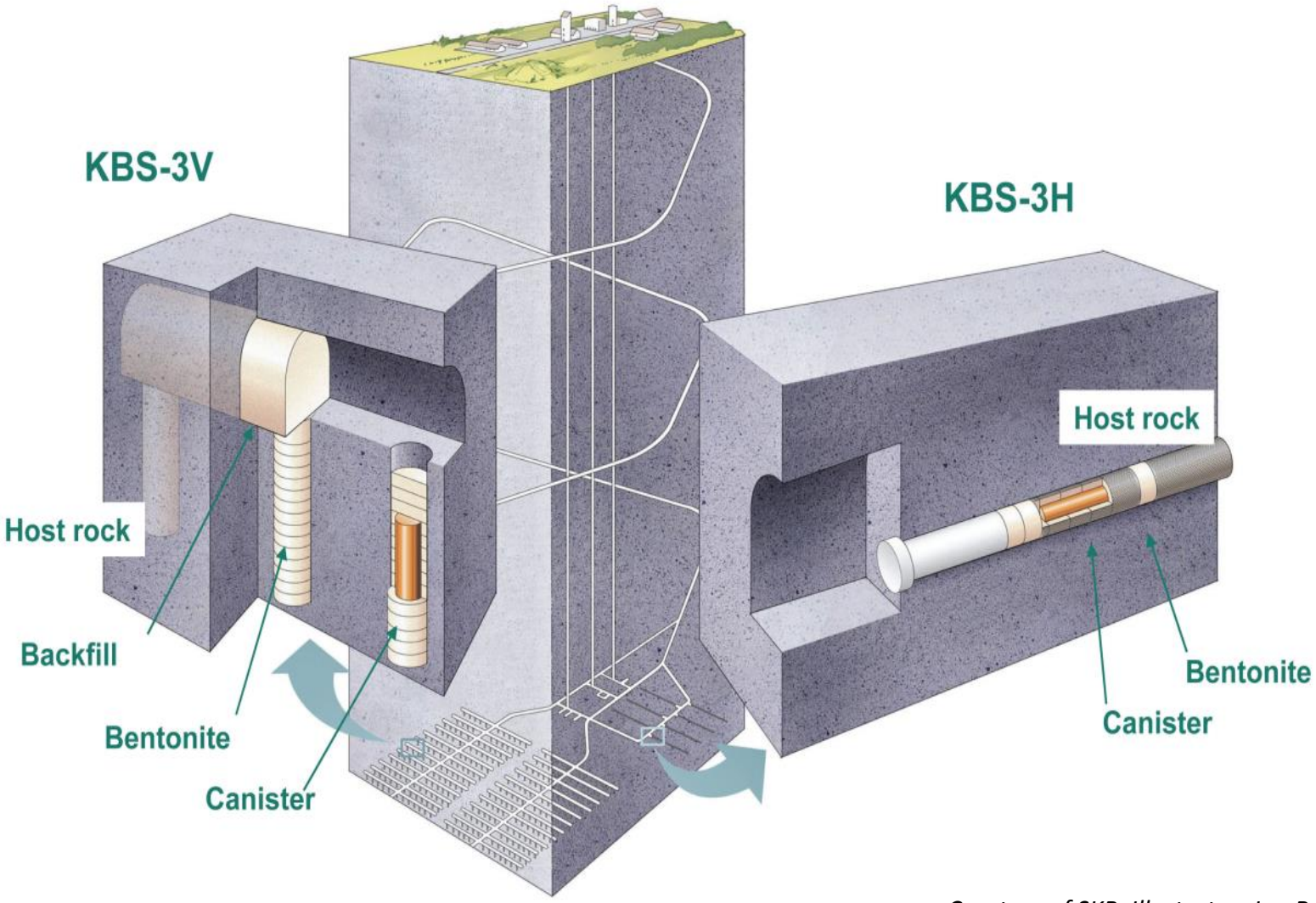
WNA Links

- Nuclear Energy in Finland
- Radioactive Wastes

Related Links

- Finnish Radiation and Nuclear Safety Authority (Stuk)
- Posiva
- Svensk Karnbranslehantering AB (SKB)

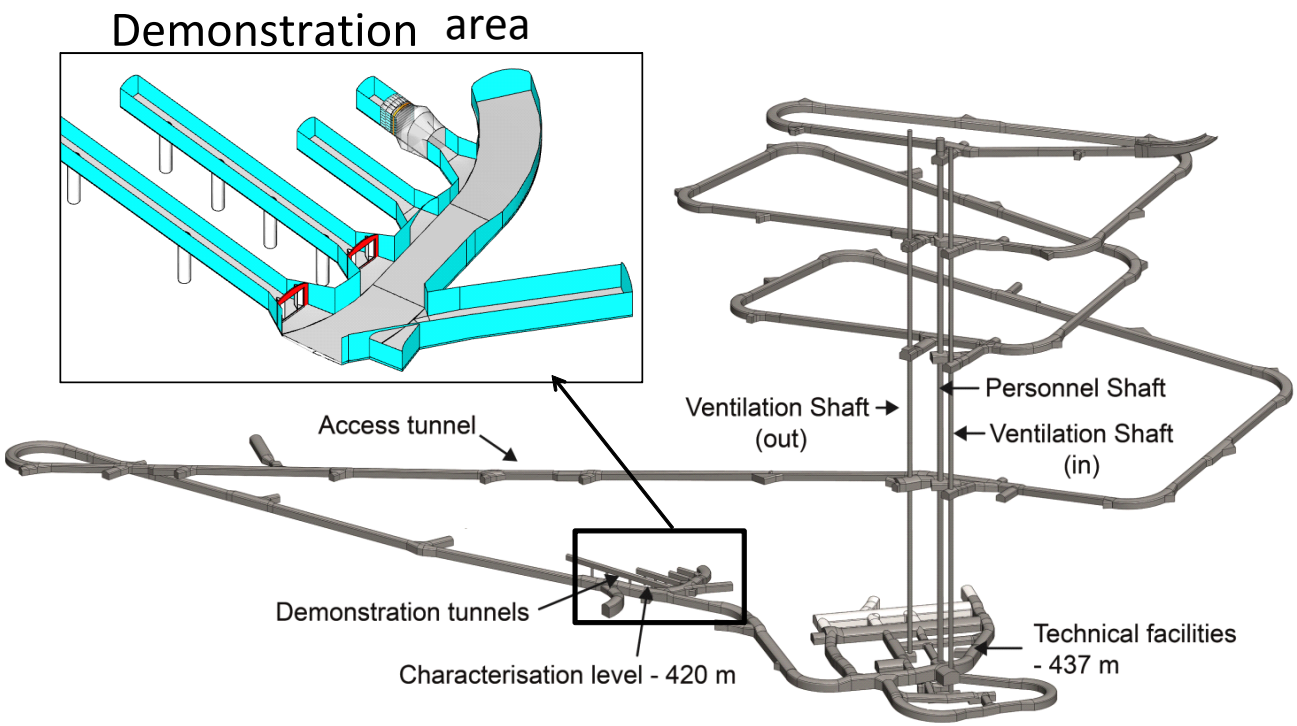
Basic design concept (3V) or alternative concept (3H)



Courtesy of SKB, Illustrator: Jan Rojmar

complete nuclear waste management on one island, Olkiluoto

ONKALO Rock Characterisation Facility



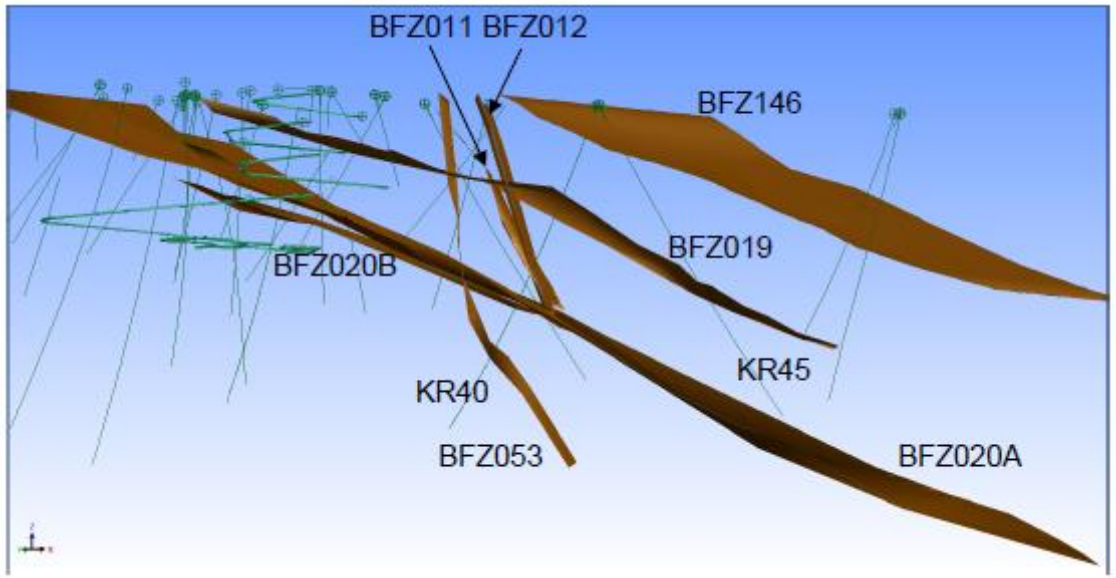
- Excavation method Drill&Blast
- Depth 455 m
- One access tunnel, slope 1:10, 5.5 m wide and 6.3 m high
- Three shafts: a personnel shaft Ø4.5 m and two ventilation shafts Ø3.5 m
- In situ testing, opportunity to develop excavation techniques and final disposal techniques in realistic conditions

Role of ONKALO Underground Characterisation and Research Facility

- ONKALO is a site-specific underground characterisation facility to verify the suitability of the bedrock for final disposal
  - Research is being carried out in different depths during the building of ONKALO
  - Final confirmatory research will be done at final disposal depth
- Objective is to take advantage of ONKALO during the building and use of the final disposal facilities
  - Design, construction conform to nuclear installation standards
- ONKALO provides the opportunity to practice the implementation of final disposal
  - The technology for final disposal can be tested in authentic circumstances

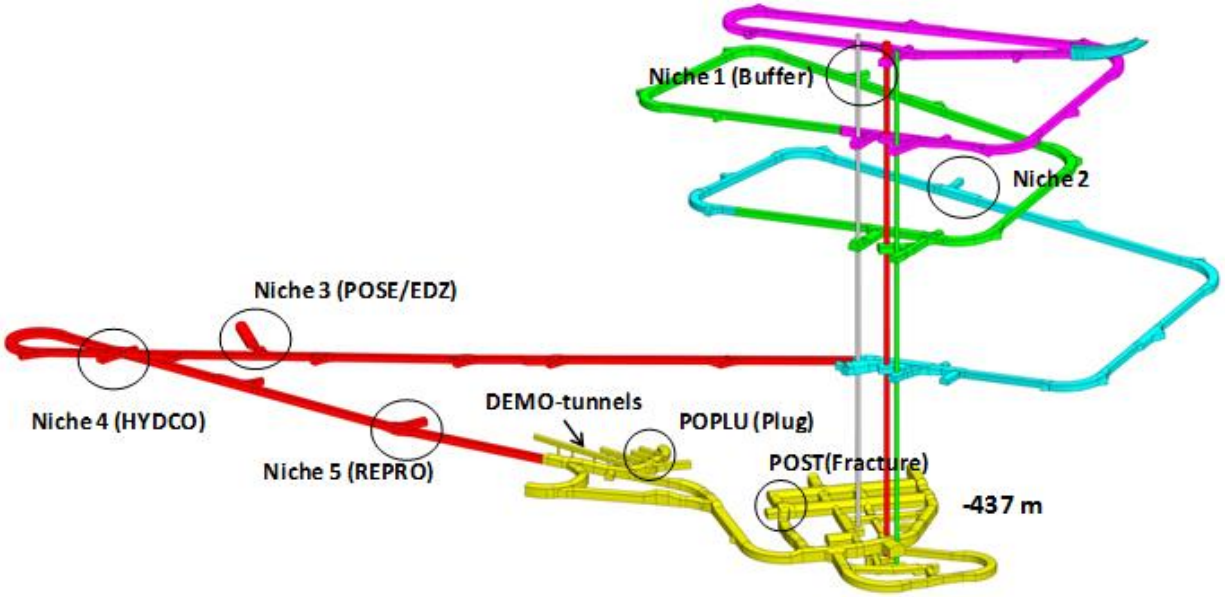
Bedrock in the ONKALO

- Migmatitic, foliated gneiss
- Pegmatitic-granite as dykes
- Sub-horizontal fracture zones

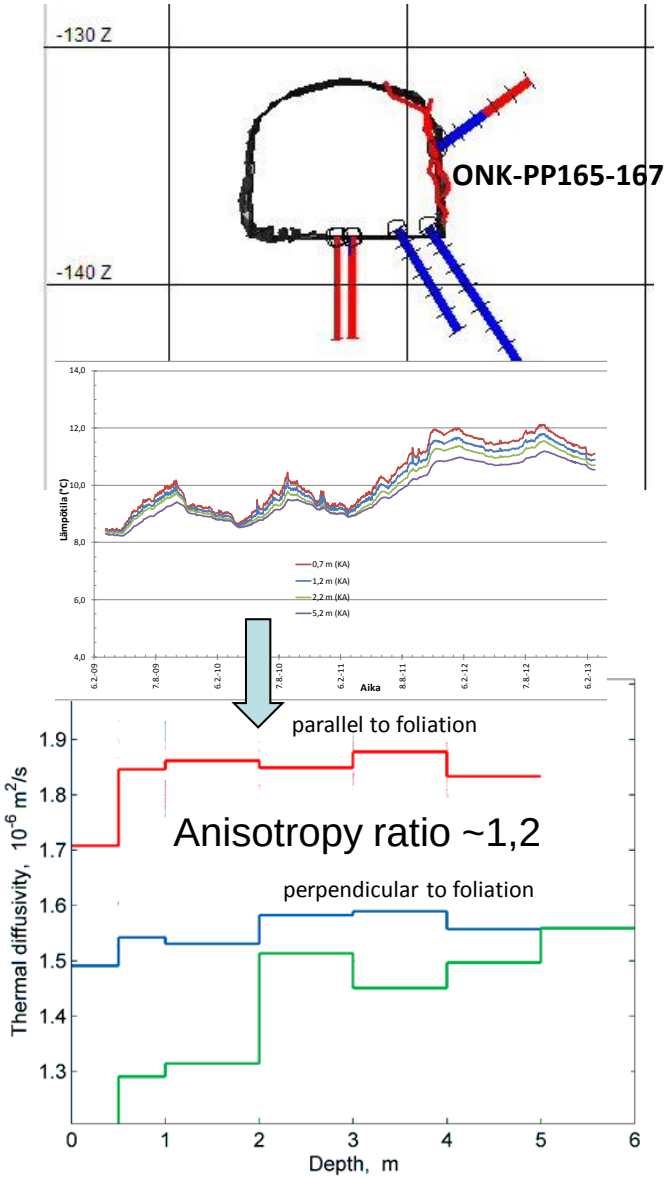


- Thrust faulting stress regime, σ_1 ~ 25 MPa, NW-SE at repository depth
- Peak strengths ~ 90 - 120 MPa, σ_{ci} ~ 50 MPa
- Anisotropy ratio ~ 1.4 (Young's modulus, gneiss)

Research Activities in the ONKALO



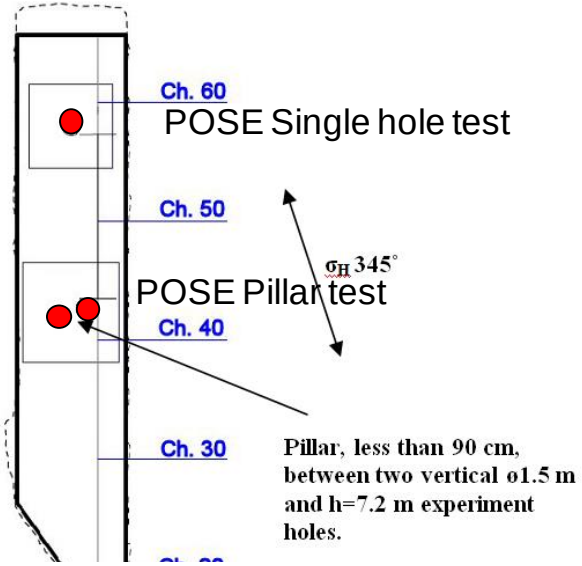
Investigation Niche 1 (-140 m)

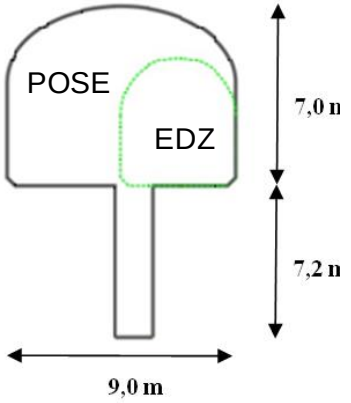


- In-situ test of thermal diffusivity of rock mass 2009 - 2011
- Testing of buffer material 2011 – 2016. Downscaled to 1/3.

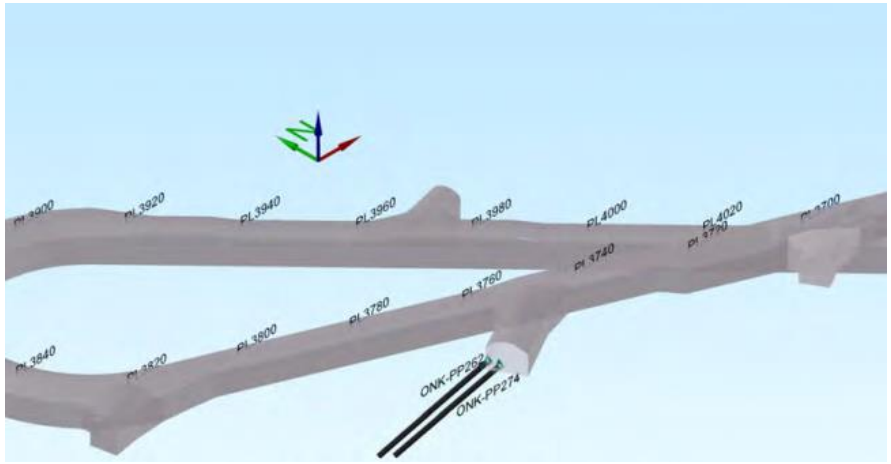
Investigation Niche 3 (-345 m)

- EDZ studies 2009 -
- POSE (POsiva's Spalling Experiment), *in situ* test to determine rock mass strength 2010 – .



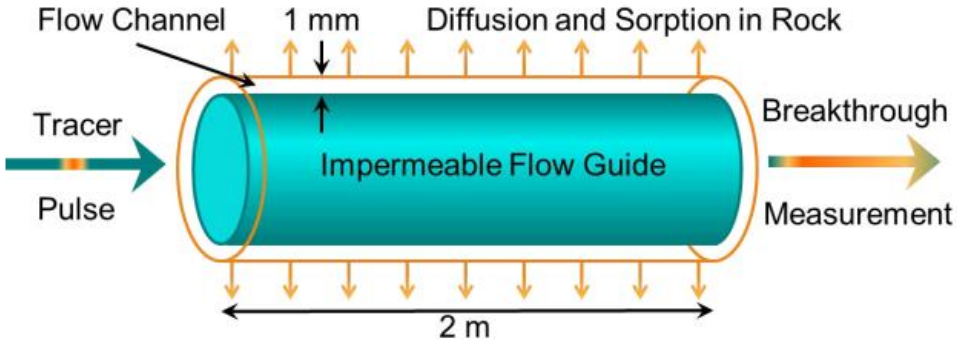


Investigation Niche, 4 HYDCO (-360 m)



- Hydrogeological interference tests, 2010 -
- Study on groundwater flow pattern in poorly conductive fractures.

Investigation Niche 5, REPRO (-400 m)



- To study rock matrix retention properties, 2012 -

1. Water Phase matrix Diffusion Experiment (WPDE),
2. Through Diffusion Experiment (TDE)
3. Gas Phase matrix Diffusion Experiment (GPDE).

Other research activities in the ONKALO (1)

Sulphate reduction experiment (SURE)

To better understand the process and kinetics of the process and the limiting factors (mixing, nutrients etc.) for sulphate reduction involving chemical characterisation and detailed microbiological investigations of groundwaters below 300 m depth.

Prediction-Outcome (P-O) studies

The objective of the work is to:

✓Enhance confidence in the ability to predict rock conditions in general – and especially for the repository volumes.

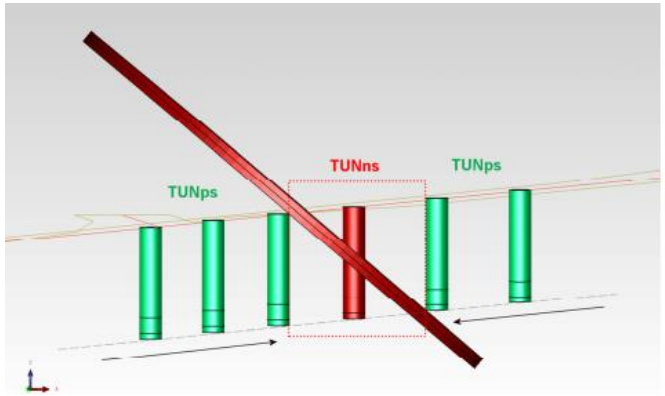
✓Allow testing and verification of repository design rules as it will not be possible to make too many additional drillholes in the repository volume.

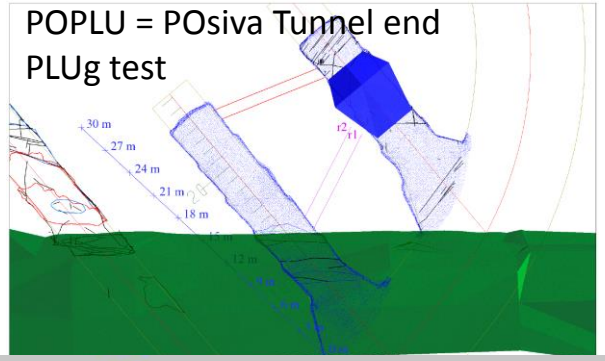
✓Support the on-going construction work and co-ordinate design, investigations and construction.

Other research activities in the ONKALO (2)

Rock Suitability Criteria (RSC)

To ensure the long-term safety of the final repository, bedrock features such as brittle deformation zones, large fractures and fractures with high hydraulic conductivity need to be avoided when locating the deposition tunnels and, especially, individual deposition holes. RSC has been developed and tested in the ONKALO conditions.





Demonstration area

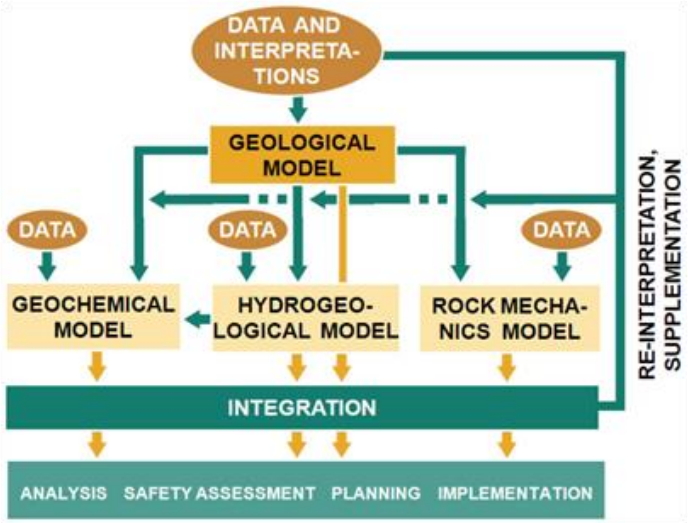
The purpose of the demonstration is both to test and to confirm elements of the KBS-3V final disposal concept and to demonstrate the design, construction and host rock suitability assessment process (RSC) to be utilized during the final disposal.

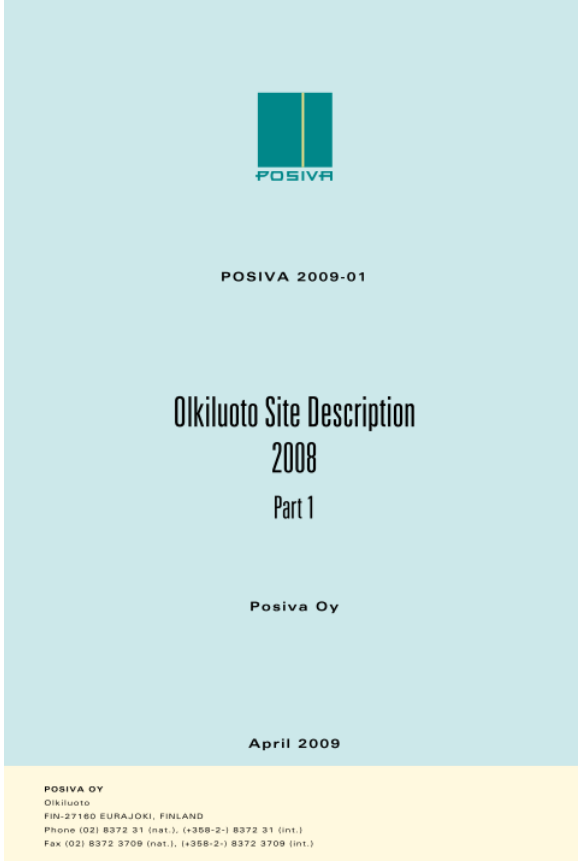
Site Models

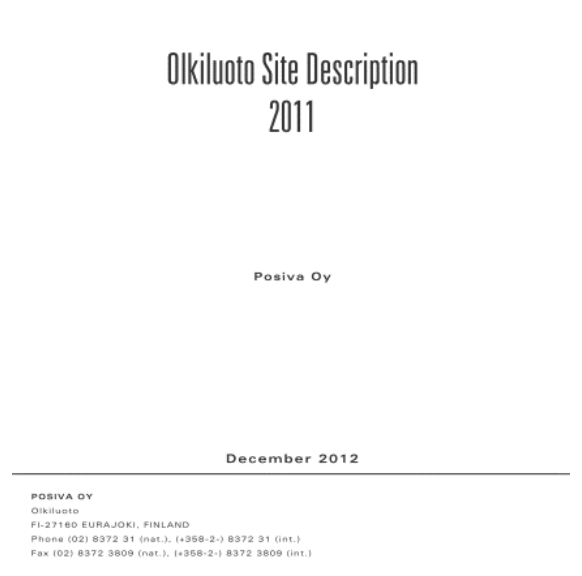
- Results of investigations, tests, mapping and monitoring carried out in Olkiluoto and in the ONKALO are compiled into geological, hydrogeochemical, hydrogeological, rock mechanics and transportation property models.

- Main product of the modelling is a descriptive model of the site, i.e. a model describing the geometry, properties of the bedrock and the groundwater, and the interacting processes and mechanisms that are relevant for understanding the evolution of the site to the present day and the potential for future radionuclide migration.

- Results are published as Olkiluoto Site Description reports.







TURVA-2012

Synthesis

Description of the overall methodology of analysis, bringing together all the lines of arguments for safety, and the statement of confidence and the evaluation of compliance with long-term safety constraints

Site Description	Biosphere Description
Understanding of the present state and past evolution of the host rock	Understanding of the present state and evolution of the surface environment

Design Basis

Performance targets and target properties for the repository system

Production Lines

Design, production and initial state of the EBS and the underground openings

Description of the Disposal System

Summary of the initial state of the repository system and present state of the surface environment

Features, Events and Processes

General description of features, events and processes affecting the disposal system

Performance Assessment

Analysis of the performance of the repository system and evaluation of the fulfillment of performance targets and target properties

Formulation of Radionuclide Release Scenarios

Description of climate evolution and definition of release scenarios

Models and Data for the Repository System	Biosphere Data Basis
Models and data used in the performance assessment and in the analysis of the radionuclide release scenarios	Data used in the biosphere assessment and summary of models

Biosphere Assessment: Modelling reports

Description of the models and detailed modelling of surface environment

Assessment of Radionuclide Release Scenarios for the Repository System	Biosphere Assessment
Analysis of releases and calculation of doses and activity fluxes.	

Complementary Considerations

Supporting evidence incl. natural and anthropogenic analogues

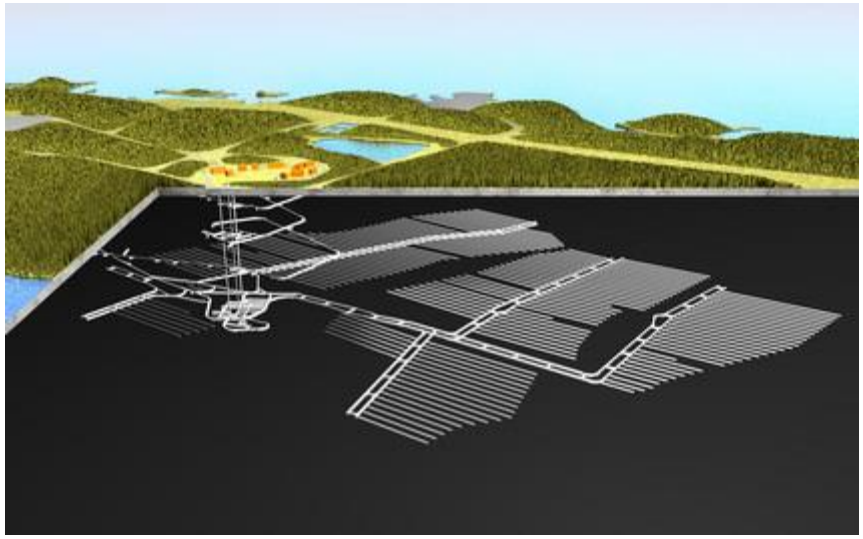
Main reports

Main supporting documents

Multi-scientific research

Summary

- The ONKALO facility plays an important role in Posiva's repository development programme
- The ONKALO has enabled direct in situ measurements, experiments and testing of different investigation tools underground.
- In addition to the in situ tests, all the observations made during the ONKALO excavations and constructions have also provided valuable information for the rock mass property characterisation to build up more reliable site descriptive models.
- The ongoing and future tests will confirm the elements of the final disposal concept and will demonstrate the design, construction and host rock suitability assessment process (RSC) to be utilized during the final disposal.
- All that information is essential for the repository design and the safety analyses.



Reports are available at
www.posiva.fi

Thank you