



Plans for detailed investigations

NEA-IRT - Forsmark, December 14, 2011

Programme for detailed characterisation

Detailed characterisation during construction and operation of the repository for spent nuclear fuel at Forsmark is including:

- Investigations – methods and instruments
- Modelling – methodology and integration
- Monitoring – long term observations
- Datasystems – modelling, QC, etc.
- Documentation - data handling
- Managment system, QA/QC

The report presents:

- overall premises and strategies for the detailed characterisation programme
- how the programme can be applied during construction and operation of the final repository in observance of requirements on long-term safety
- plans for continued development of the characterisation programme, methods and tools for investigations, modelling, data handling and quality assurance

R-11-14

Framework programme for detailed characterisation in connection with construction and operation of a final repository for spent nuclear fuel

Svensk Kärnbränslehantering AB

October 2010

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 250, SE-101 24 Stockholm
Phone +46 8 459 84 00



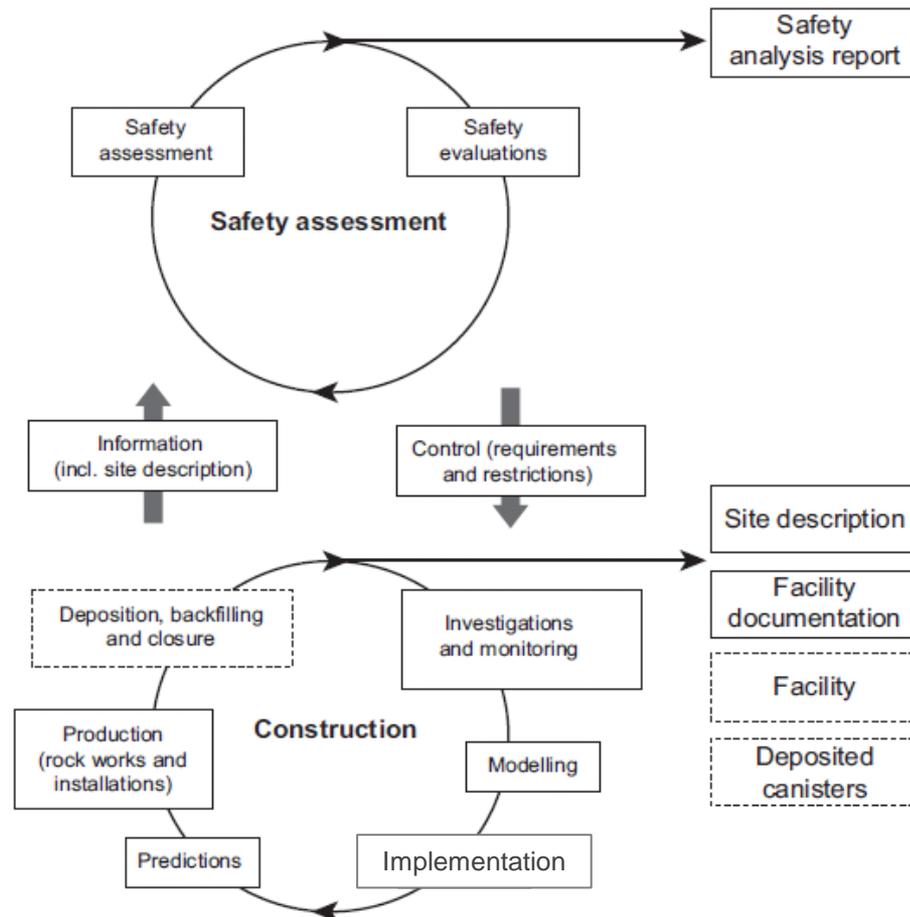
Purpose of detailed characterisation

- To provide a basis for adaptation of the repository to the site-specific conditions in order to meet the design premises, e.g. with respect to long-term safety.
- To provide a basis for engineering-related decisions concerning e.g. grouting and rock support measures.
- To update site descriptive models, which will in turn serve as a basis for long-term safety assessments.

Main clients for investigation and characterisation data

- Safety assesment
- Design

Main processes - Construction and Safety assessment



Reducing uncertainties

The SR-Site safety assessment showed that only certain site-specific properties are of essential importance for long-term safety.

The most important parameters in this category are:

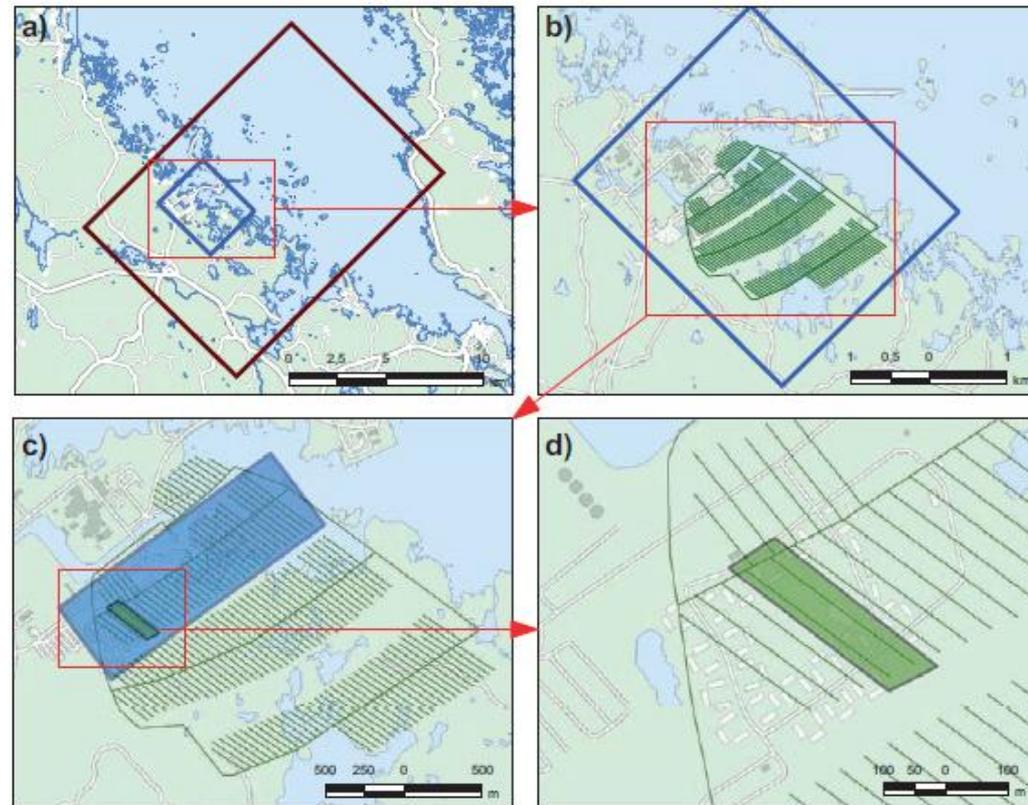
- The frequency and distribution of open water-bearing fractures and their potential influence on groundwater lowering (drawdown) in the vicinity of the shaft and ramp.
- In situ stress magnitudes and orientations at repository level.
- Spatial distribution of deformation zones that can impact the repository layout.
- Spatial distribution of amphibolite with lower thermal conductivity that can be of importance for the distance between deposition holes.

Fulfillment of design premises

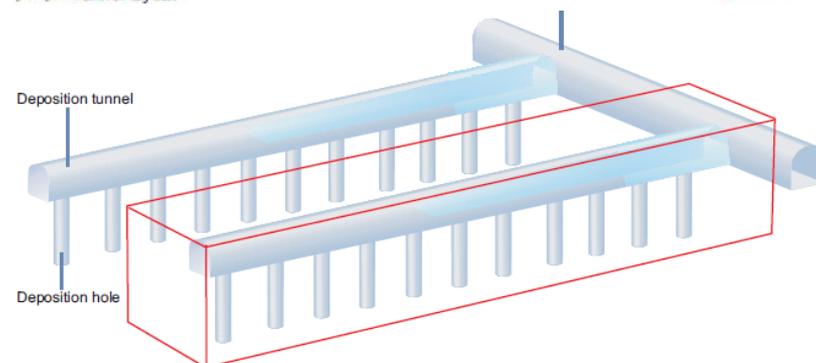
- Distance to deformation zones > 3 km
- “Large fractures” to be avoided
- Rocks with low thermal conductivity
- Groundwater chemistry in deposition volumes
- Water inflow to deposition hole
- Limited excavation damage

Modelling

- At different scales
 - Detailed scale (tunnel scale) updated often
 - Site scale updated based on information from detailed scale model
- Conceptual model
 - Based on existing SDM
 - Revised if data from detailed scale shows a need to that
- Used for
 - Planning/decisions on where to place deposition tunnels and deposition holes
 - Verify fulfilment of design premises
 - Input to Safety Assessment



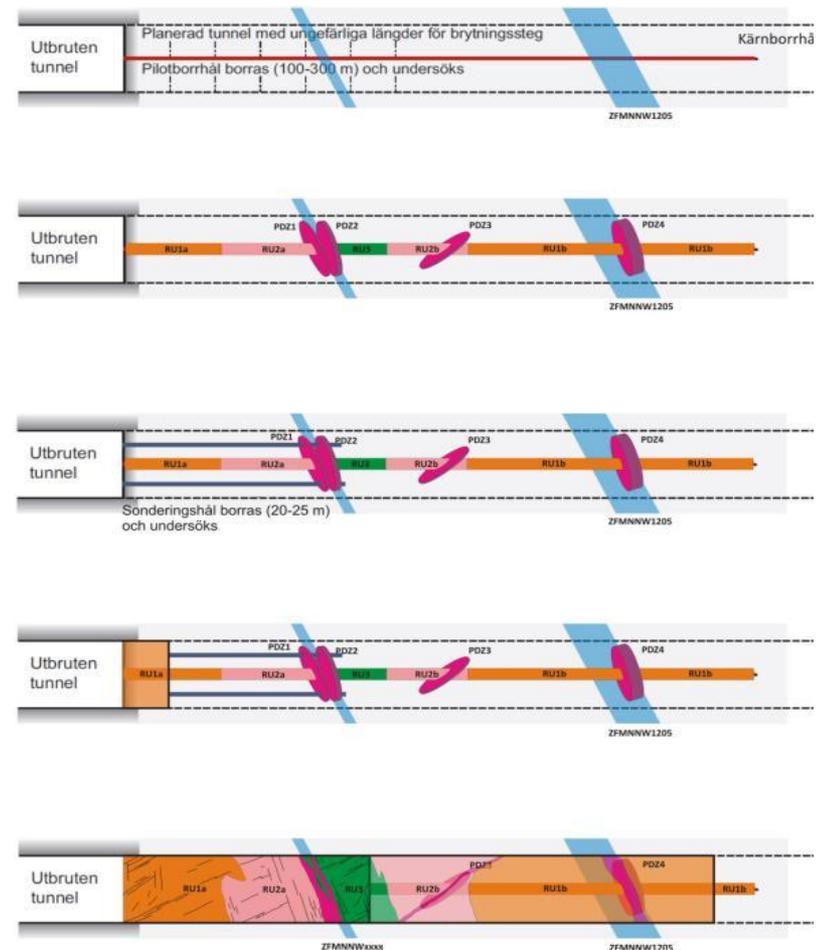
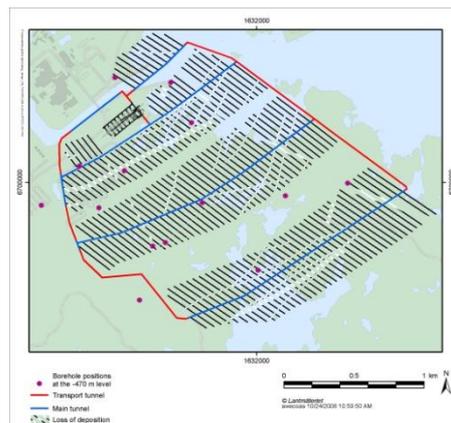
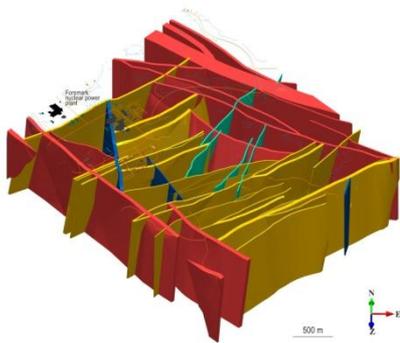
Background maps: © Lantmätarieriet
SKB/swcoas 2010-11-24 10:53
Map ID 01-000379



Detailed investigations

Detailed investigations - part of the cyclic construction process.

- Pilot hole drilling with investigations
- Investigations in probe holes and grouting holes
- Tunnel mapping
- Installations and continued monitoring
- Model updating and documentation



Repository area – Decisions acceptance

Decision on boundaries of the deposition area prior to a build-out step

- **Detailed characterization in conjunction with construction of transport and main tunnels for new deposition area**

Decision on location and construction of deposition tunnels

- **Detailed characterization in conjunction with construction of deposition tunnels**
 - **Pilot drilling for deposition tunnels with associated investigations**
 - **Investigations during and after construction of deposition tunnel**

Decision on deposition positions in deposition tunnels

- **Detailed characterization in conjunction with excavation of deposition holes**
 - **Drilling of and investigations in pilot holes for deposition positions**

Decision on execution of deposition hole

- **Drilling of and verifying investigations in the deposition holes**

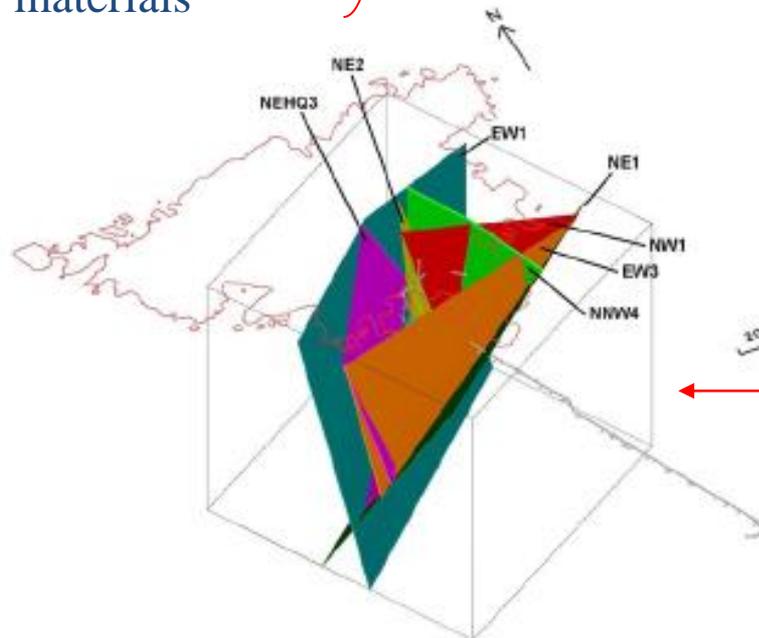
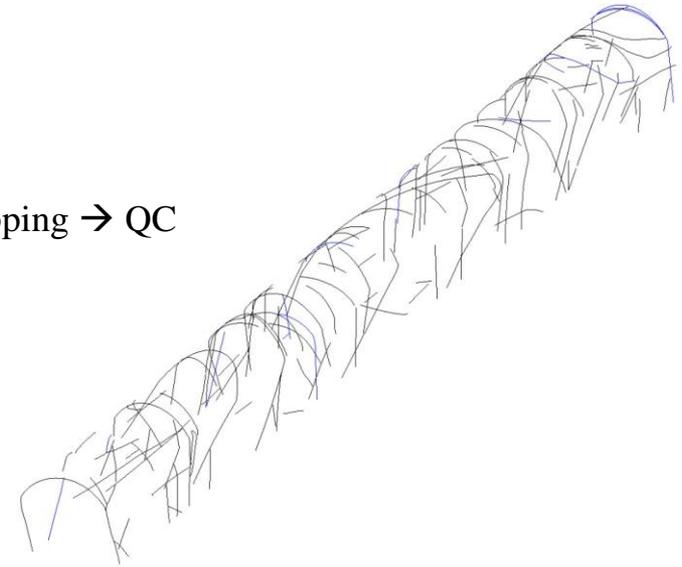
Decision on approval of deposition hole for deposition of canister

- **Documentation of the initial state of the approved deposition holes**

Documentation of tunnels and QA/QC

- rock types
- fractures
 - geometry
 - properties
- deformation zones
- water inflow
- tunnel geometry
- half pipes (blasting)
- stray materials

Results from tunnel mapping → QC



Modelling

Äspö tunnel mapping



Touch screen

TASQ Mapping Section 10-15 - New Feature

Location: Length (m) 190.916
Adjusted 190.979

Feature:
 Drill Induced
 Broken Fracture
 Unbroken Fracture
 Sealed Network
 Crush
 Rock Occurrence
 Rock Type
 Structural Features
 Aberration
 Core Loss
 Sample
 Fracture Freq

Feature Details:
 Surface: [Dropdown]
 Alteration: [Dropdown]
 Aperture: [Dropdown]
 Aperture Confidence: [Dropdown]
 Joint Alteration: [Dropdown]
 Visible in GPS: Yes [Dropdown]
 CentruM Covered: Yes [Dropdown]

Length	Adj Len	Feature	Itag	FR	FR	FR	FR	Alteration	Strike	Dip	Width	Aperture	Aperture	Alpha	Beta	CalcDist	Visible	CentruM	Uncoverd	Uncoverd	Uncoverd	Uncoverd			
190.916	190.979	Unbroken Fr	Overlaid					Slightly A	172.6	89.6	0.5	0	Certain	11.4	132	Dep/Strike	Yes	Yes	1.4	10	171.6	3.5			
190.899	191.263	Rock Occur		Unspecif	S01033	D	Dark Grey Massive	No Intense	Medium-g	Equipmen	354.7	81	82	17.8	21	131	Dep/Strike	77.8	299	1.4	10	11	3.5		
190.890	191.281	Unbroken Fr	Overlaid	Epistax	Pyrite	Calcite		Fresh	345.1	76.8	0.5	0	Certain	22.7	120	Dep/Strike	Yes	Yes	1.4	10	11	3.8			
191.303	191.369	Rock Occur		Unspecif	S01033	D	Dark Grey Massive	No Intense	Medium-g	Equipmen	354.7	81	82	17.8	21	131	Dep/Strike	77.8	299	1.4	10	11	3.5		
191.343	191.413	Broken Fract	Overlaid	Calcite	Chertite			Unlocatd	Rough	Slightly A	13.1	3.3	0.5	0	Certain	75.3	8	AlphaBet	1.5	No	Yes	7.4	76	84.5	22.7
191.204	191.566	Rock Occur		Vein	S11058	G	Light Grey Massive	No Intense	Fine- to m	Equipmen	43.2	58.4	43.2	58.4	51.2	104	Dep/Strike	51.2	184	3	11.6	10.5	3.5		
191.219	191.591	Unbroken Fr	Overlaid	Chertite	Overlaid			Slightly A	44.7	55.4	0.5	0	Certain	52.1	186	Dep/Strike	No	Yes	1.4	76	63.3	16.7			
191.325	191.597	Rock Occur		Vein	S11058	G	Light Grey Massive	No Intense	Fine- to m	Equipmen	43.2	58.4	43.2	58.4	51.2	104	Dep/Strike	51.2	184	3	11.6	10.5	3.5		
191.450	191.813	Unbroken Fr	Overlaid					Slightly A	150.4	171.8	0.5	0	Certain	24.8	209	Dep/Strike	Yes	Yes	1.4	10	12.3	4.3	3.5		
191.455	191.819	Rock Occur		Vein	S11058	G	Light Grey Massive	No Intense	Fine- to m	Equipmen	248.4	87.7	247.4	87.6	13.2	209	Dep/Strike	13.2	209	1.4	10	172.1	2.7		
191.479	191.842	Rock Occur		Vein	S11058	G	Light Grey Massive	No Intense	Fine- to m	Equipmen	248.4	87.7	247.4	87.6	13.2	209	Dep/Strike	13.2	209	1.4	10	172.1	2.7		
191.544	191.930	Rock Occur		Vein	S01061	H	Light Brok Massive	No Intense	Medium Hg	Equipmen	15.2	64.7	25.9	61.9	50.8	147	Dep/Strike	45	162	3	11.6	11.1	4.3		
191.503	191.847	Rock Occur		Unspecif	S01061	H	Dark Grey Crackle St Medium	Unspecif	Unspecif	39.7	61.4	28.7	61.4	48.6	103	Dep/Strike	44.6	183	3	11.6	11.1	3.6			
191.426	191.464	Crack (Reveal)		None	S01061	G	Light Brok Massive	No Intense	Medium Hg	Equipmen	44.9	84.8	84.8	84.8	147	Dep/Strike	44	183	3	11.6	11.1	4.1			



SICADA database

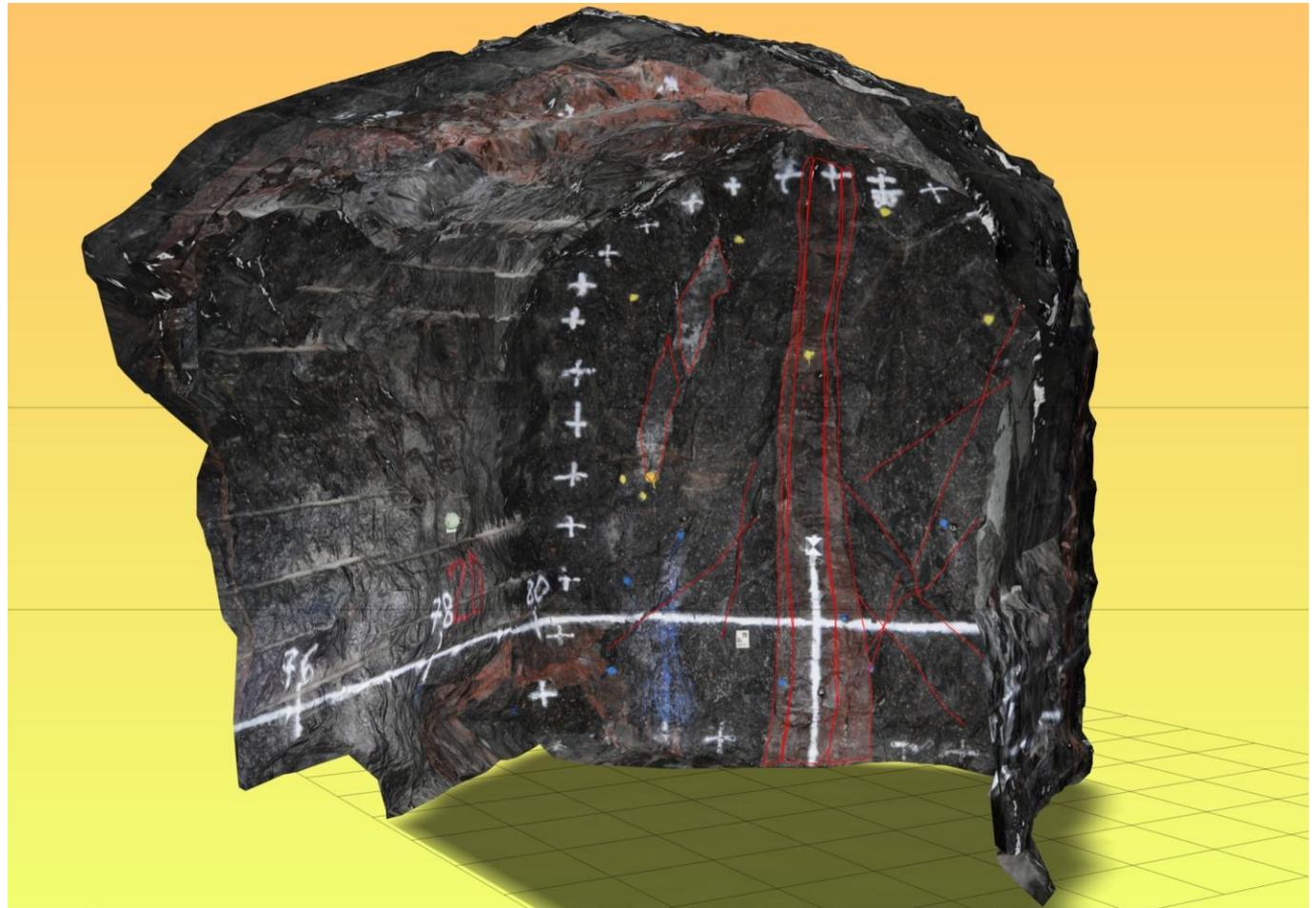


Photogrammetry - simple set-up

- Standard camera and lens
- Led lights
- Wireless transmission – camera computer
- Survey of fix points - not time critical

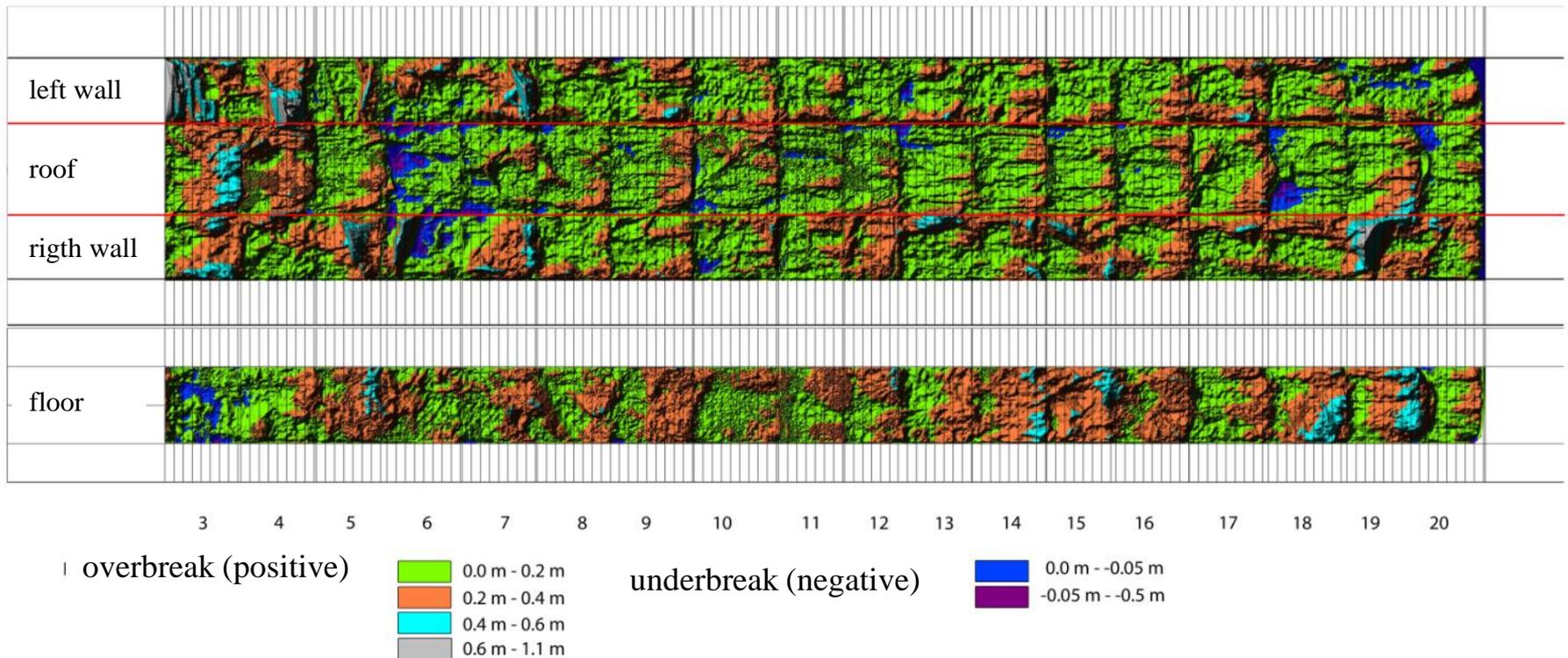


3D image



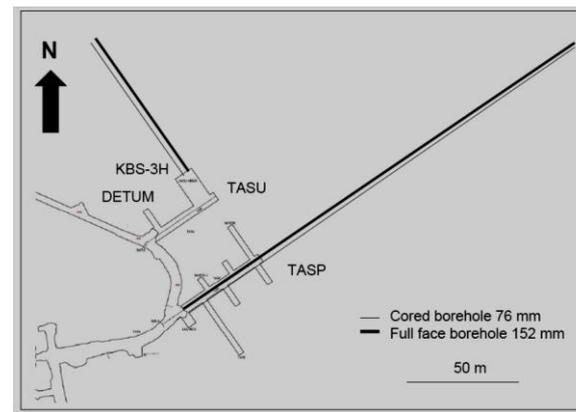
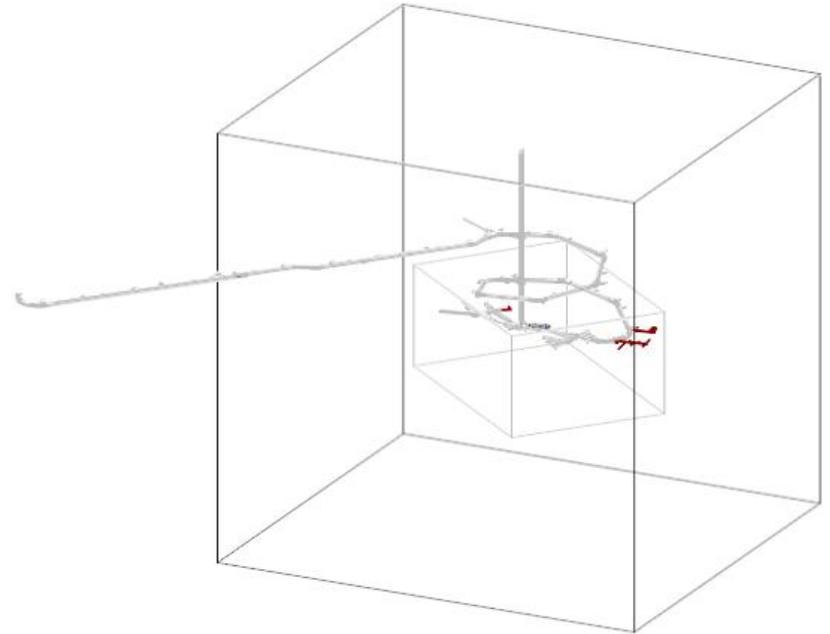
Calculations of over- and underbreak

TASS



Implementation Trial at Äspö HRL

- Test of routines and documentation of investigations and geoscientific predictions during the construction process
- Test and optimization of data management processes data flows and QC in the building process
- Testing of the tunnel mapping system RoCS
- In close collaboration with the OM/ design and rock excavation



Safety In Project - SIP

- Unforeseen events can occur during execution which may have a bearing on long term safety. A function called Safety In Project (SIP) is included to ensure uniform documentation and management of these events.
- To ensure a consistent, documented and controlled handling of safety issues is the function of the Safety In Project (SIP) that puts forward proposals for the project manager for a decision. There are two main objectives of the SIP functionality:
 1. SIP will exercise a continuous control of geoscientific conditions affecting the site adaptation, such as thermal properties, “large fractures”, water inflow, etc. [This control also includes assessing whether the conceptual site model is valid or would need a significant revision.](#) Similarly, a continuous monitoring and reporting, with any non-conformities, the completed underground work.
 2. SIP is an early alert to unforeseen events that may affect the quality of critical phases of the project. SIP shall analyze the significance of the event from a broad perspective and put forward proposals so that the project can take steps to counteract the suffix
- The goal of SIP is that it should exercise continuous monitoring of geoscientific conditions that affect site adaptation, underground work and deposition work (including monitoring and inspection of stray materials). By means of SIP, events that can affect quality-critical elements in the project can be detected and dealt with at an early stage