

## Progress of spent fuel disposal in Sweden

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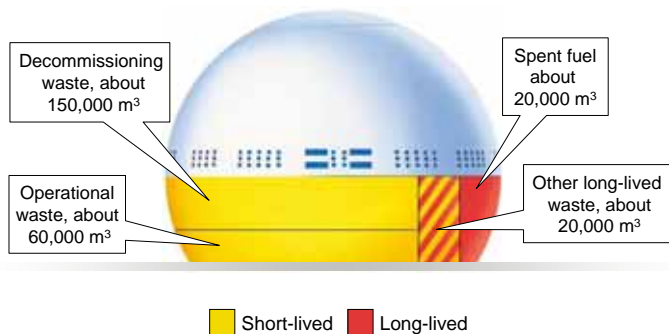
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## Nuclear Facilities in Sweden Transports with m/s Sigyn



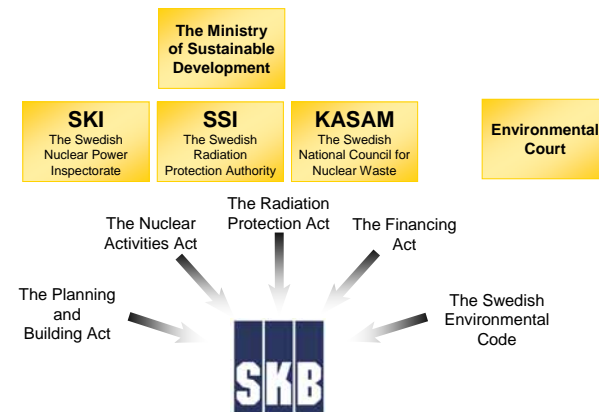
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## Waste volumes



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## Authorities and legislation



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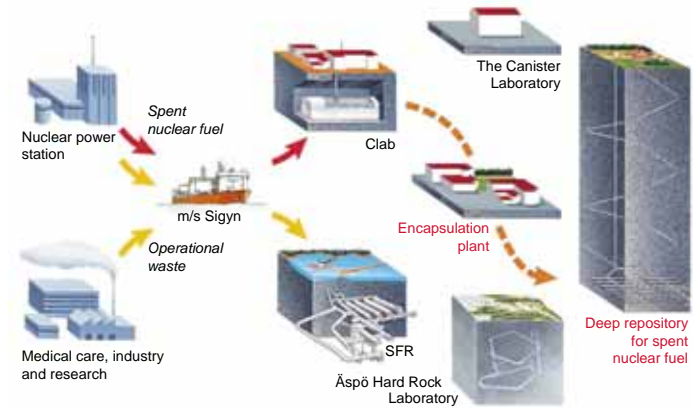
## The Nuclear Waste Fund

Just under  
1 öre per kWh  
of nuclear electricity



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## SKB's facilities



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## Preconditions for a deep repository

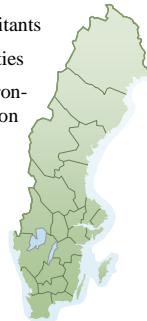
### Geology

- Most of Sweden belongs to the Fennoscandian Shield
- Comprehensive knowledge from study site investigations and underground laboratories
- Regional studies – suitable host rock in all parts of the country



### Society

- 9 million inhabitants
- 290 municipalities
- Extensive environmental legislation
- Municipal veto



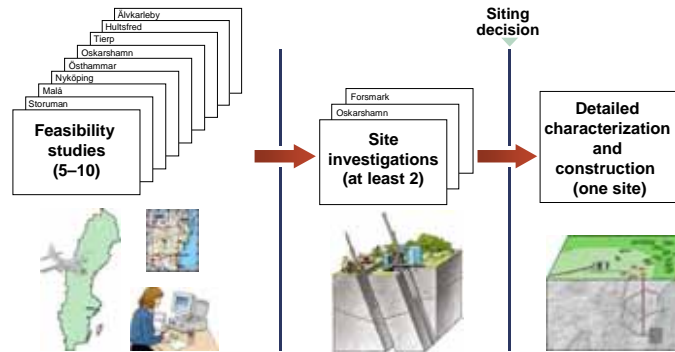
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## The deep repository – three key factors



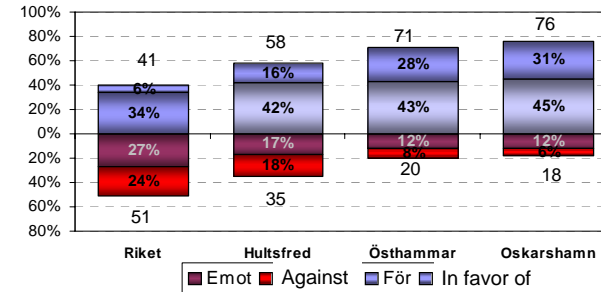
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## The siting process for a deep repository



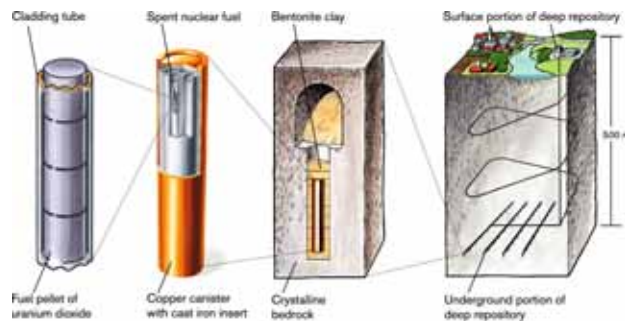
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If a suitable site for a repository is found in .... are then ..... to construction of a repository in your community? (May 2005)



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## The KBS 3 repository



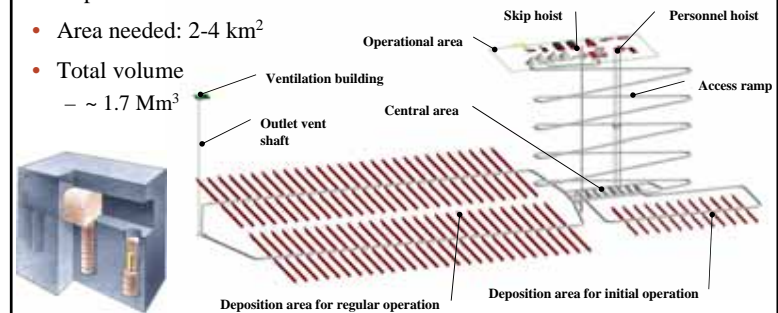
- Primary safety function: Isolation
- Secondary safety function: Retardation



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## Deep repository for spent nuclear fuel

- Design capacity:
  - 9300 tons (U)
- Depth: 400-700 m
- Area needed: 2-4 km<sup>2</sup>
- Total volume
  - ~ 1.7 Mm<sup>3</sup>



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## Safety assessment, methodology (SR-Can)

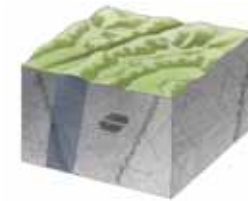
- "Main issue": Does the evolution of the repository over time lead to doses/risks that exceed given criteria? (SSI: Annual risk for individuals less than  $10^{-6}$ )
- Repository evolution determined by
  - Initial state
  - A system of coupled "internal" processes in fuel, canister, buffer, backfill, geosphere and biosphere
  - External influences
- Need to handle uncertainties for all these aspects
- Assessment period: One million years after closure
  - One glaciation cycle



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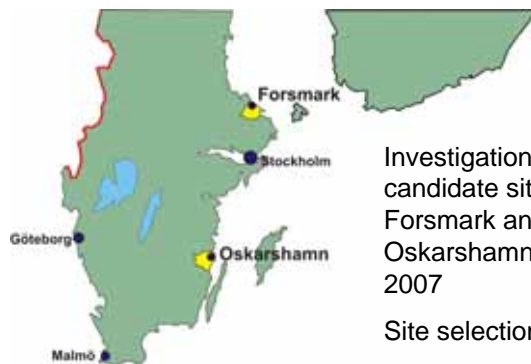
## What properties of the rock are important?

- Rock composition and structure
  - Rock type (common rock type, no ore potential)
  - Presence and location of fracture zones (faults)
  - Heat conductivity – correlated to rock composition
- Groundwater composition
  - Dissolved oxygen, pH, (total) dissolved solids
- Radionuclide transport
  - Transport resistance
  - Hydraulic conductivity
  - Flow velocity
- Construction and work environment
  - Rock strength
  - Rock stress
- Environmental impact
  - Surface hydrology
  - Surface eco systems
  - Quaternary deposits



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## Site investigations in Sweden for a repository for spent nuclear fuel



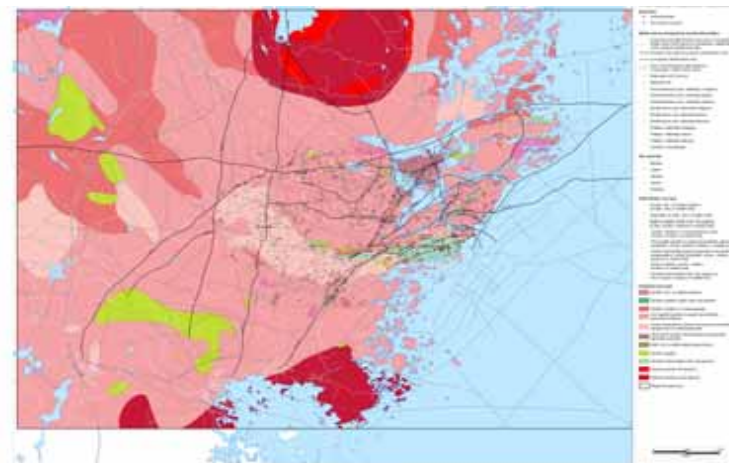
Investigations of two candidate sites, Forsmark and Oskarshamn, 2002-2007

Site selection 2008



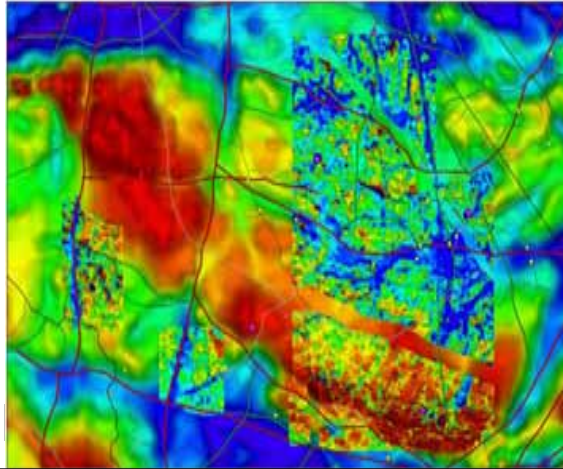
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## Oskarshamn – Geologic map

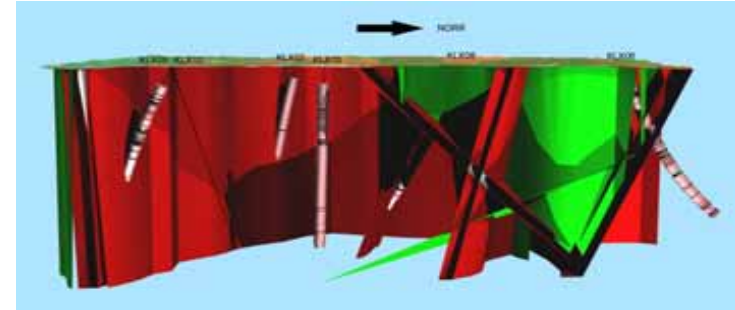


## Surface geophysics at Laxemar

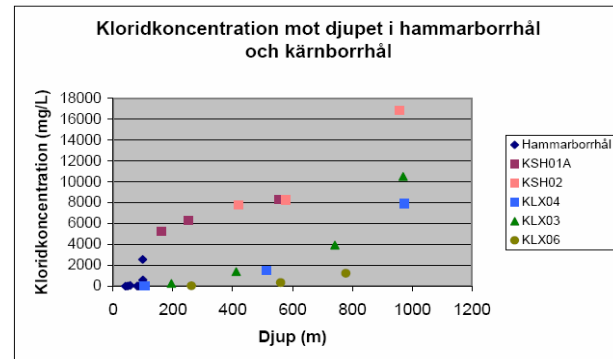
- Detailed magnetic results (preliminary): compared with previous airborne survey results



## Laxemar Profile S-N

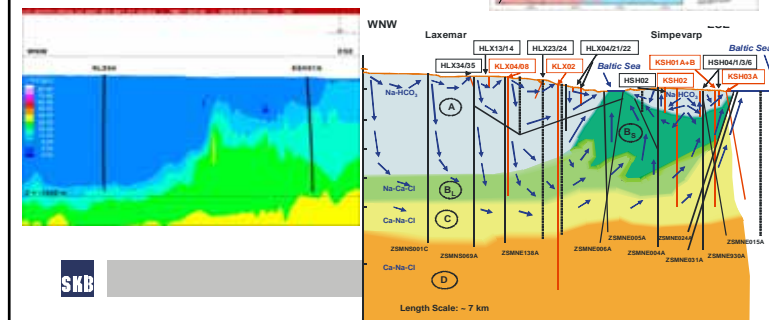


## Chloride concentration vs depth - from CCC and PSS pumping tests



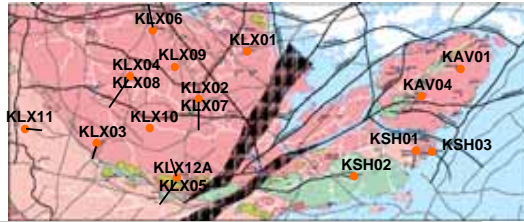
## Regional flow model, Comparison with hydrogeochemistry

- Reference case
- WNW-ESE section
- Flow model: TDS



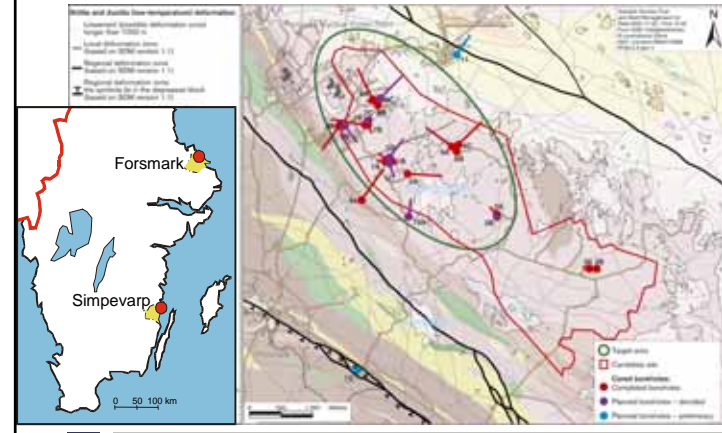
## Oskarshamn

- **Laxemar**
- “Normal” fracture frequency and permeability
- Brittle deformation zones with higher fracture frequency and permeability
- “Normal” rock stress
- Favorable groundwater composition
- Low thermal conductivity, larger space required for repository
- **Simpevarp**
- Lithology more heterogeneous than at the Laxemar subarea
- Limited volumes at Simpevarp subarea results in limited flexibility in design
- Preliminary safety evaluation shows that Simpevarp meets requirements



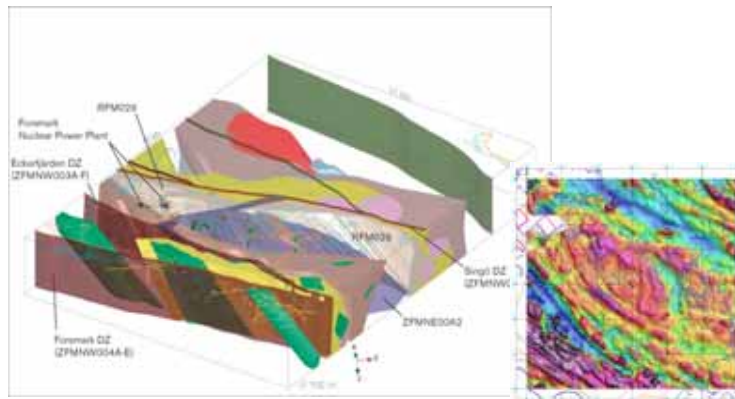
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## Forsmark – Geological map and cored boreholes



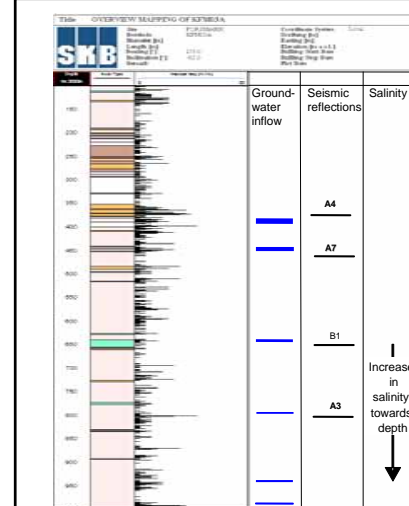
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## 3D picture of rock domains - Forsmark

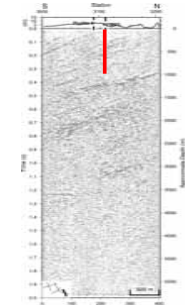


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## KFM03A Overview of core mapping and water inflow



## Seismic reflectors at KFM03A



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### Excavation of lineament AFM001265

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### Brittle structures at the surface

Sheet joints related to relief of stress

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### Intact 3-m cores from boreholes KFM01A and KFM05A

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### Schematic outline of hydraulic conductivity

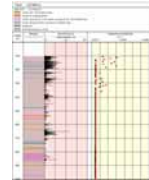
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## Characteristics of the bedrock at Forsmark

**Extensive** horizontal joints near surface - **low** fracture frequency, below c. 200 m



**High** hydraulic conductivity near surface - **low** below c. 200 m

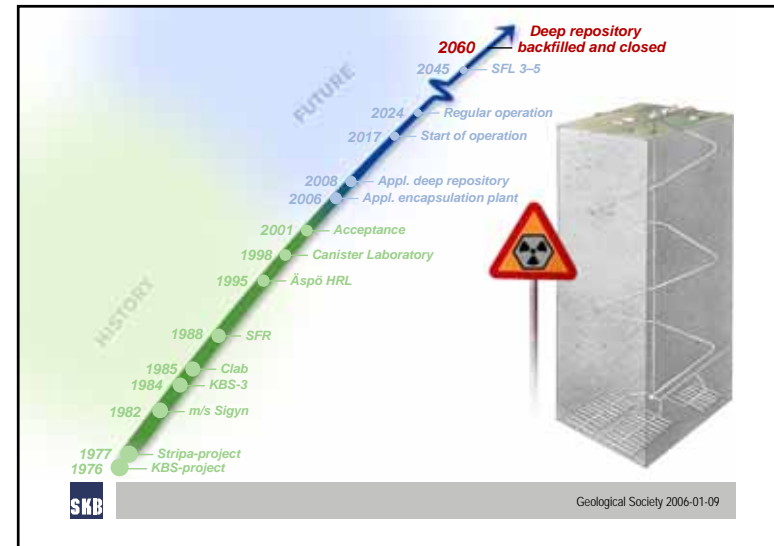


**High** rock stress near surface – **normal** at 1,000 m?



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**High** hydraulic conductivity in gently dipping fracture zones – **low** in steeply dipping zones



## Reports – available in English at [www.skbn.se](http://www.skbn.se)

Annual reports, TR-reports, R-reports, P-reports



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