KALLION IN SITU TUTKIMUKSET
In situ long term diffusion experiments
Radionuclides' migration in bedrock

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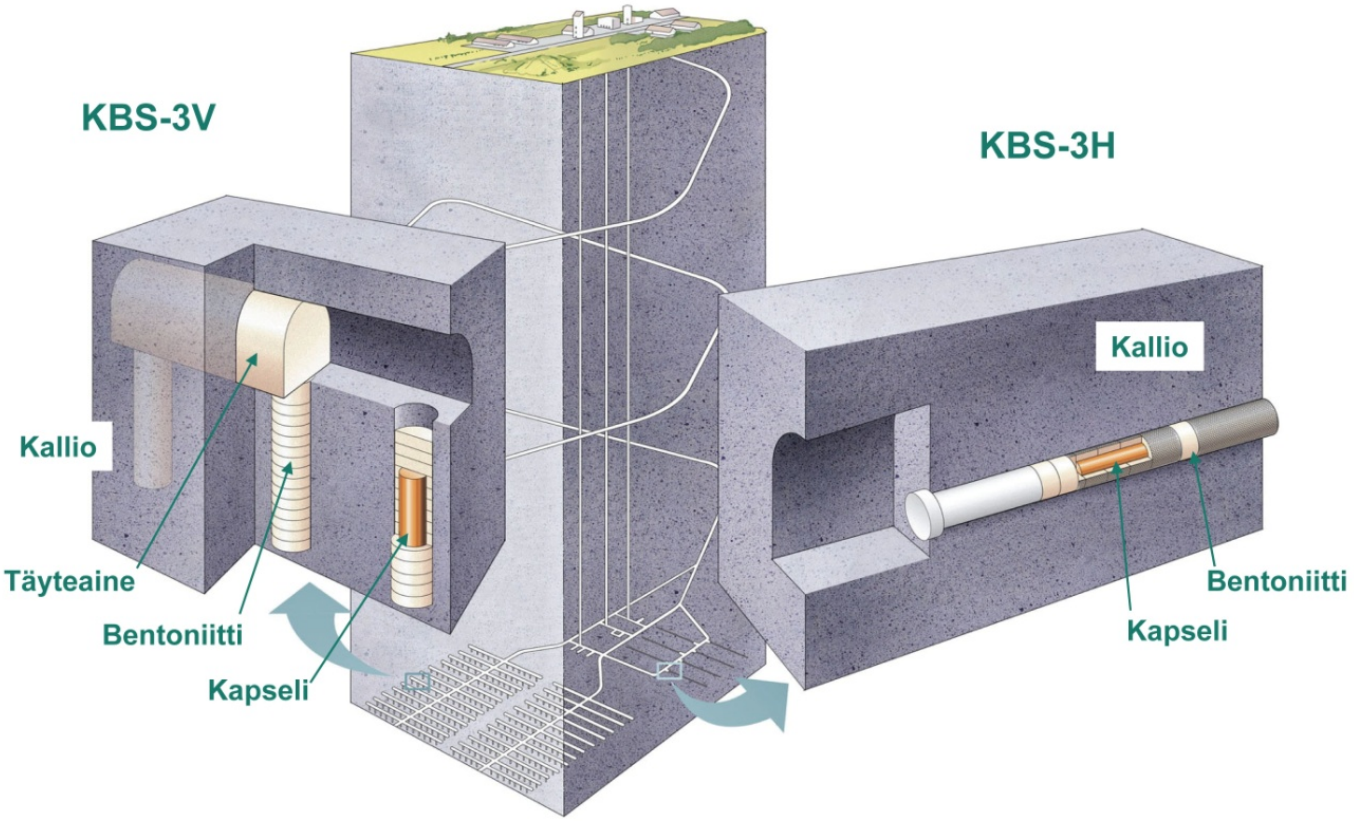
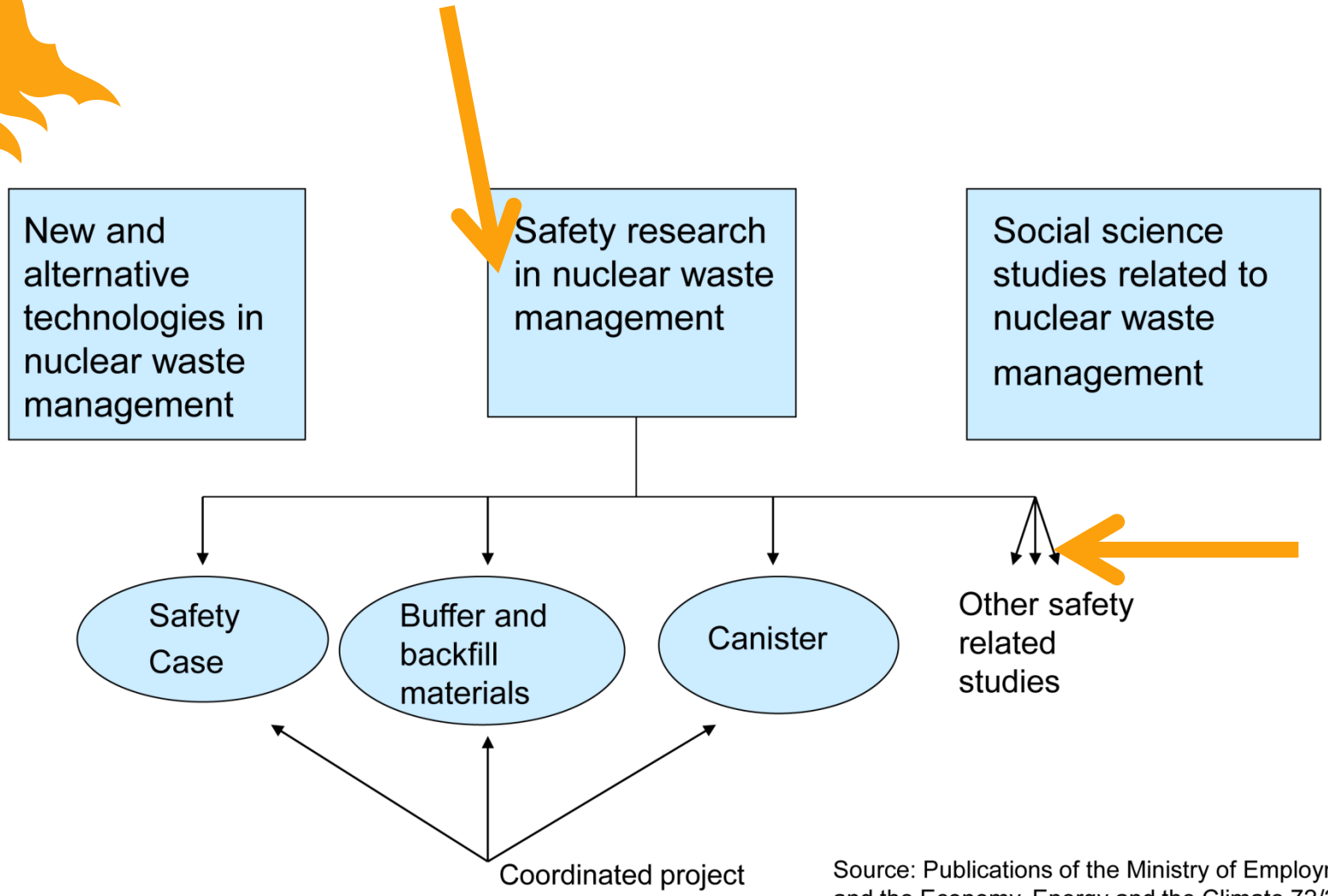


Posiva päätyi vuonna 1999 esittämään valtioneuvostolle jättämässään periaatepäätöshakemuksessa loppusijoituslaitoksen sijoittamista Eurajoen Olkiluotoon ja loppusijoituksen toteuttamista KBS-3 konseptia käyttäen.

MIHIN LIITTYY?



Source: Publications of the Ministry of Employment and the Economy. Energy and the Climate 72/2010

In the Radiochemistry lab it has been studied since 1980's:

radionuclide's migration in flow
radionuclide's matrix diffusion in granitic rock
porosity and pore structure of granitic rock
radionuclide's retardation on granitic rock

Radionuclide's migration in bedrock

MIKSI?

LABORATORY

Matrix diffusion has been assessed on samples disturbed by collection and preparation (stress release and sawing artefacts) which causes:

Overestimation of the rock diffusivity

Overestimation in porosity

-> Leads to an overestimation of matrix diffusion

IN SITU

MITÄ ON TEHTY!
Matrix diffusion, conductive porosity and sorption

$$D_e \qquad \varepsilon \qquad K_d$$

Grimsel Test Site Phase VI

HYRL, JAEA, NRI/RAWRA, AIST, NAGRA

PHASE I	**2006-2009**
PHASE II	**2010-2013**

>>2018

LTD

- **In situ – experiments**
- **Supporting laboratory studies**
- **Modelling**

- Study of radionuclides' *in-situ* diffusion

  -> so called monopole experiments
- Characterisation of pore space geometry

  -> *in-situ* porosity by impregnation techniques
- Natural tracer studies and diffusion process studies

Radionuclides and elements

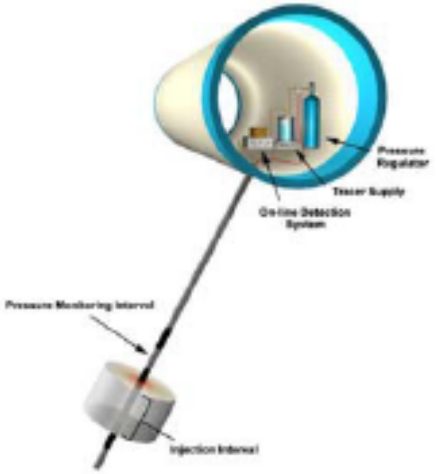
Monopole 1

- **^{3}H, ^{131}I, ^{22}Na ja ^{134}Cs**

Monopole 2

- **^{3}H, ^{131}I, ^{22}Na,^{134}Cs ^{14}C, ^{133}Ba, ^{136}Cl**
- ***Stable Se, analoque for Se-79***

WP-1:IN-SITU DIFFUSION EXPERIMENT

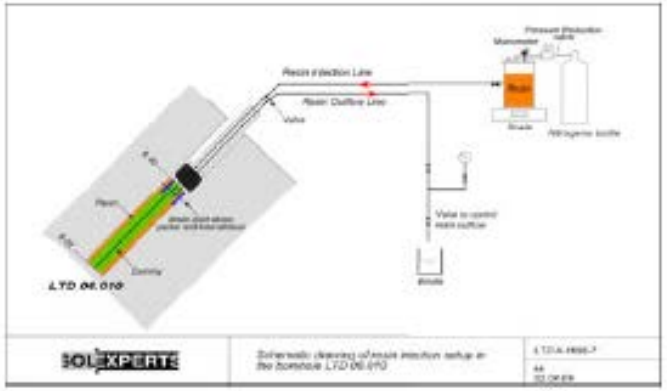


- Demonstration of **in-situ matrix diffusion** in undisturbed rock as a geosphere retardation process
- Develop long term **monitoring** techniques and strategies

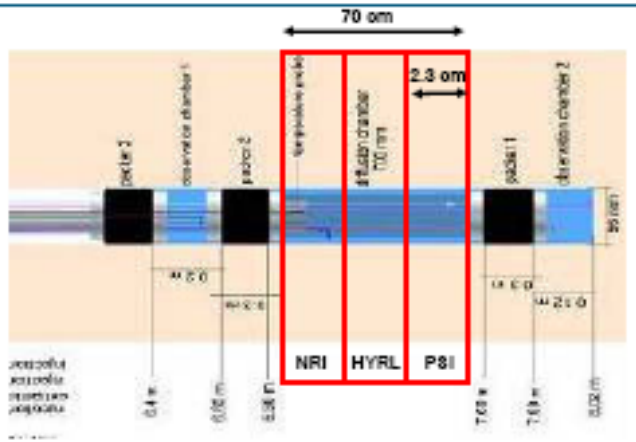
Predictive modelling

- Diffusion depths after 2 years:
  - ^{3}H → up to 30 cm
  - ^{22}Na → several cm
  - ^{134}Cs → few mm (due primarily to sorption)
  - ^{127}I → several cm

Overcoring proposal



Sub-sampling



PHASE I RESULTS OF FIRST IN SITU EXPERIMENT
Nagra / IDAEA-CSIC

	----------ROCK MATRIX----------			----------BDZ (1-2mm thick-----)		
	De (m^2/s)	α (-)	Kd (m^3/kg)	De (m^2/s)	α (-)	Kd (m^3/kg)
^{3}H	2e-13	0.0065	0.0	1e-12	6	2.3e-3
^{22}Na	2e-12	0.2	7.3e-5	3e-12	3	1.1e-3
^{134}Cs	3e-12	5.2	7.6e-3	6e-11	110	4.2e-2

Stronger sorption in BDZ !

Similar to ref. values

Weak sorption (esp. ^{134}Cs)

REFERENCE TRANSPORT AND SORPTION PARAMETERS

Radionuclides	Kd (m^3/kg)	Dp (m^2/s)	De (m^2/s)
^{3}H	0	3.0e-10	1.95e-12
^{22}Na	0.0002	3.0e-10	1.95e-12
^{134}Cs	0.5	3.0e-10	1.95e-12

Deliverables

- J M Soler, J Landa, V Havlova, Y Tachi, T Ebina P Sardini, M Siitari-Kauppi and A Martin (2013) Postmortem modelling of Monopole I, LTD Experiment, Arbeitsbericht NAB 12-53
- B Lanyon, J Rûedi and A Martin (2012) LTD Monopole 2: Conceptual and scoping models of groundwater flow, Arbeitsbericht NAB 12-12
- L Jokelainen, T Meski, A Lindberg, J M Soler, M Siitari-Kauppi, A Martin and J Eikenberg (2012) The determination of ^{134}Cs and ^{22}Na diffusion profiles in granodiorite using gamma spectroscopy, J Radioanal Nucl Chem, DOI 10.1007/s10967-012-2268-y
- J Sammaljärvi, L Jokelainen, J Ikonen, M Siitari-Kauppi (2012) Free radical polymerisation of MMA with thermal initiator in brick and Grimsel granodiorite in Engineering Geology 135-136, 52-59
- M Kelokaski, M Siitari-Kauppi, I Kauppi, K-H Hellmuth, A Möri, C Biggin, W Kickmaier, L Inderbitzin, A Martin, (2010) Characterisation of pore Space Geometry by ^{14}C-MMA Impregnation, Nagra technical report, NTB 05-03, 44+5

Some radionuclide's which are important for safety

(Posiva 2009-02)

Radionuklidi	puoliintumisaika	hajoamistapa
C-14	5730 y	b^-
Cl-36	3.01E+5 y	b^-, $e+b^+$
I-129	1.57E+7 y	b^-
Mo-93	4.0E+3 y	e
Nb-93m	16.13 y	IT
Nb-94	2.03E+4 y	b^-
Cs-135	2.3E+6 y	b^-
Ni-59	7.6E+4 y	$e+b^+$
Se-79	3E+5 y	b^-
Sr-90	28.79 y	b^-
Y-90	64.00 h	b^-
Pd-107	6.5E+6 y	b^-
Sn-126	~1E+5 y	b^-
Sb-126	12.46 d	b^-

KIITOS!