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Development and application of models for the safety analysis of repositories with regard to the clearance of radioactive materials for landfilling

Content

- Introduction
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- Results
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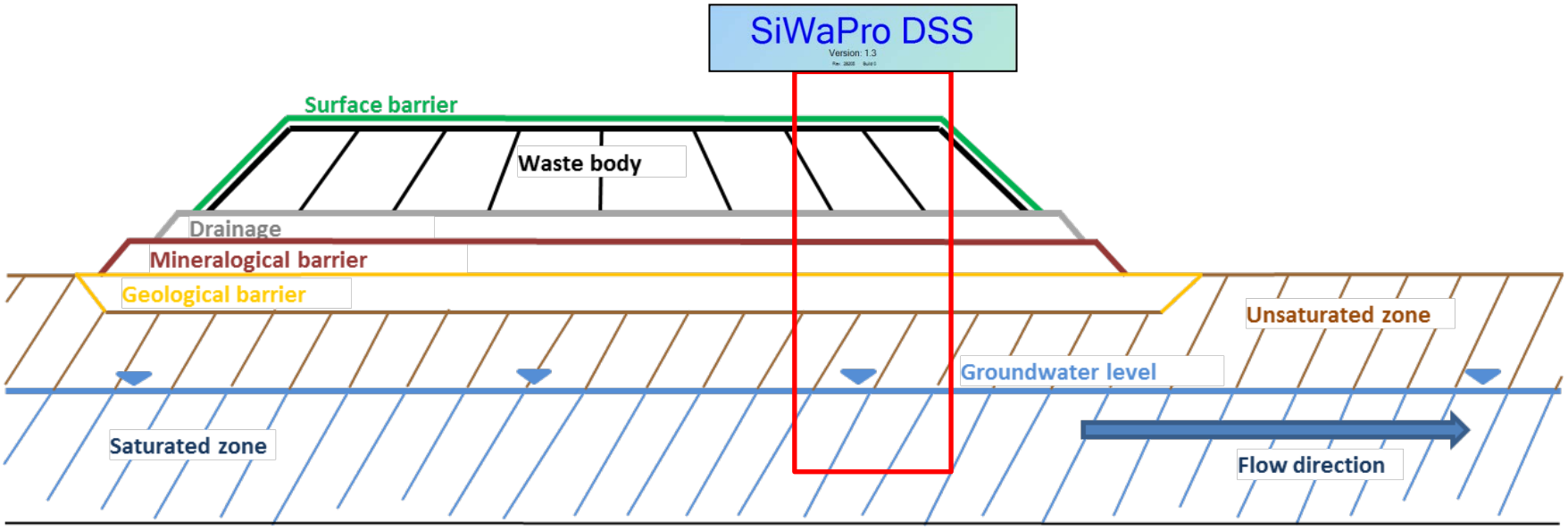
Clearance

- General
- Specific
  - Solid substances for disposal on (conventional) landfills
  - Solid substances and liquids for incineration
  - Buildings for demolition only
  - Metal scrap for Recycling (conventional foundry)
- The specific activities for clearance for landfill disposal are given in the StrlSchV.

Objective

- Assessment of the radiological impact of the disposal of VLLW on landfills without mixing with conventional wastes
- Investigation with models and codes, which were developed for the long term safety assessments of repositories
- Background
  - As a result of the German decision to phase out nuclear power, large quantities of Very Low Level Waste (VLLW) from NPP decommissioning are expected in the near future. This will lead to a shortage of capacity of the landfills.
  - The landfill operators refuse more and more to accept exempt waste from the decommissioning of nuclear facilities.

SiWaPro DSS and SPRING



- **Desorption / Sorption**

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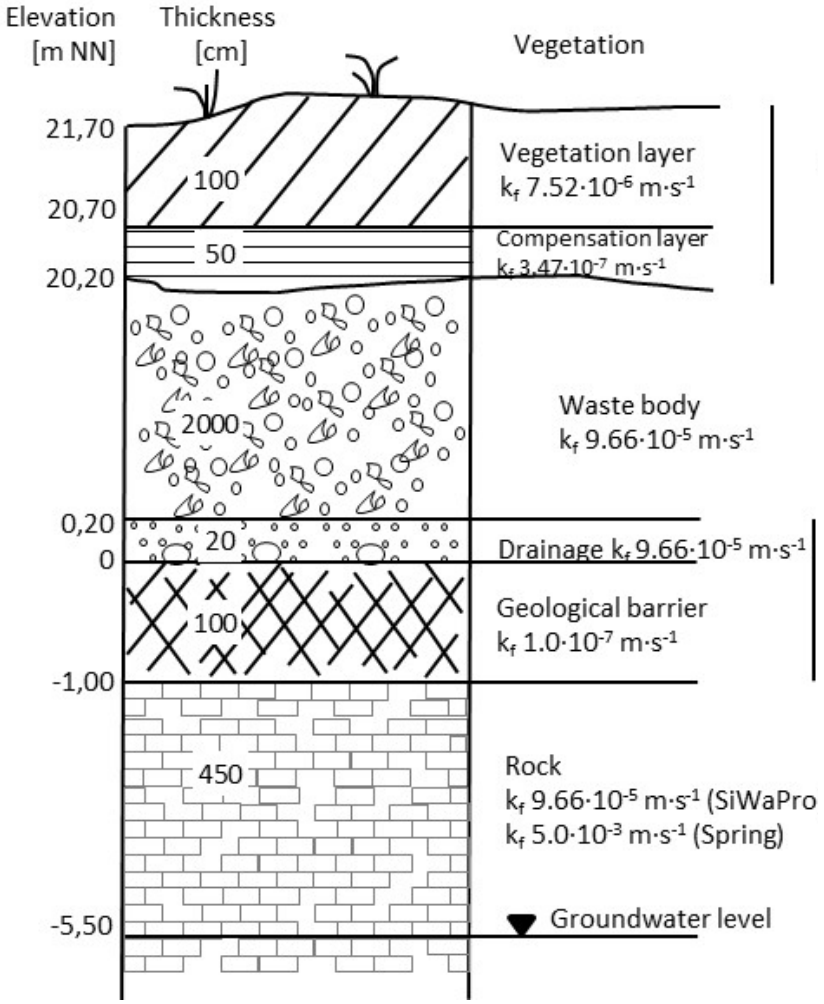
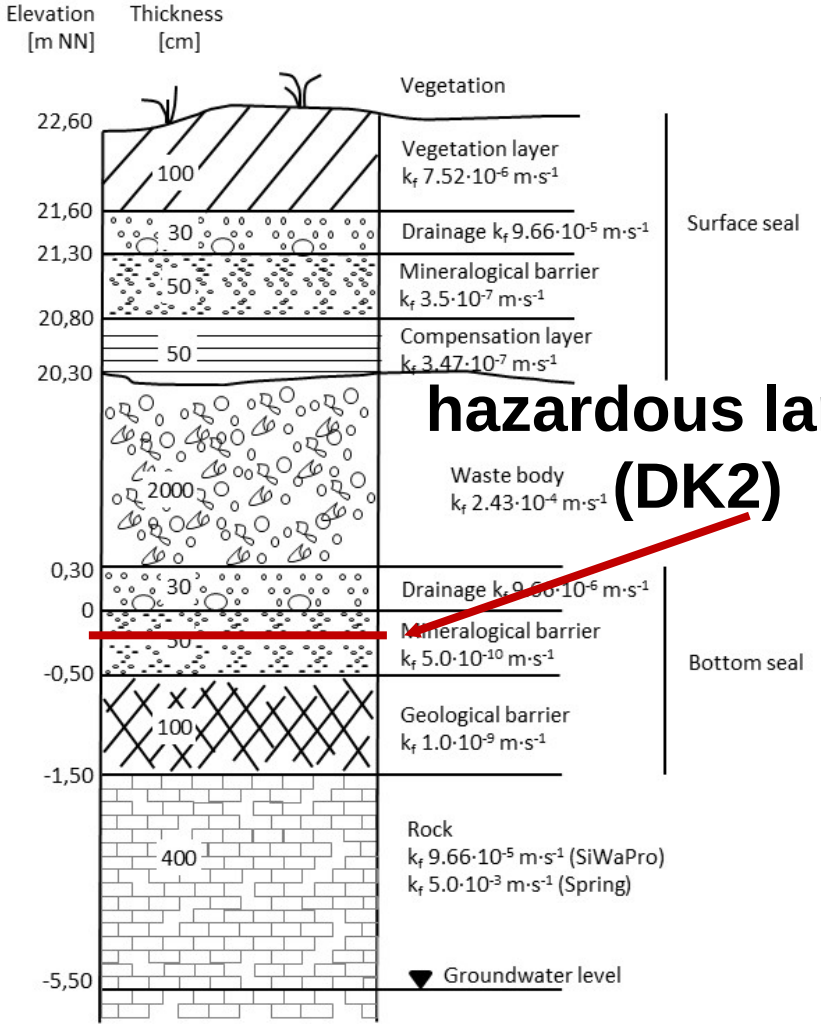
- **Desorption / Sorption**
- **Stationary flow conditions**
- **Non-steady transport**

Landfill design



Inert landfill (DKO)



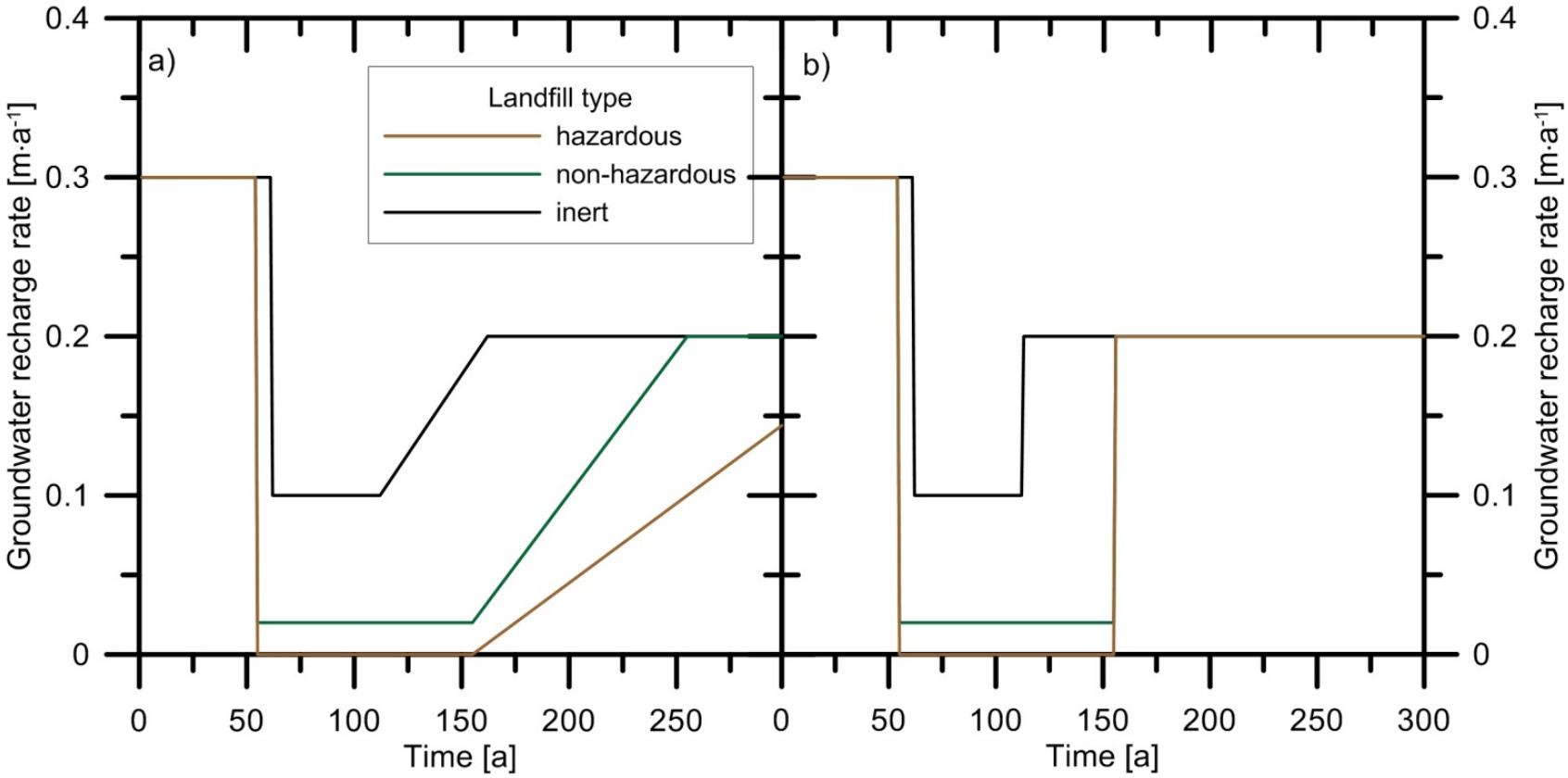
hazardous landfill (DK2)

Non-hazardous landfill (DK1)

Determination of Radionuclides

- Report „Empfehlungen zur Ermittlung der Repräsentativität von Nuklidvektoren bei Freigabemessungen“, Bericht zum Vorhaben StSch4441, February 2008, VKTA Rossendorf e. V.
  - Data and information about 43 decommissioning activities in Germany
  - Nuclear facilities: boiling-water and pressurised water reactors, research reactors, reprocessing plants and other
  - Materials: concrete, heavy concrete, steel, aluminium, copper, graphite, plastic, dust
- Ni-63, Sr-90, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239/240 and Am-241

Groundwater Recharge



Groundwater recharge constant at 0.2 $m \cdot a^{-1}$ and time-dependent

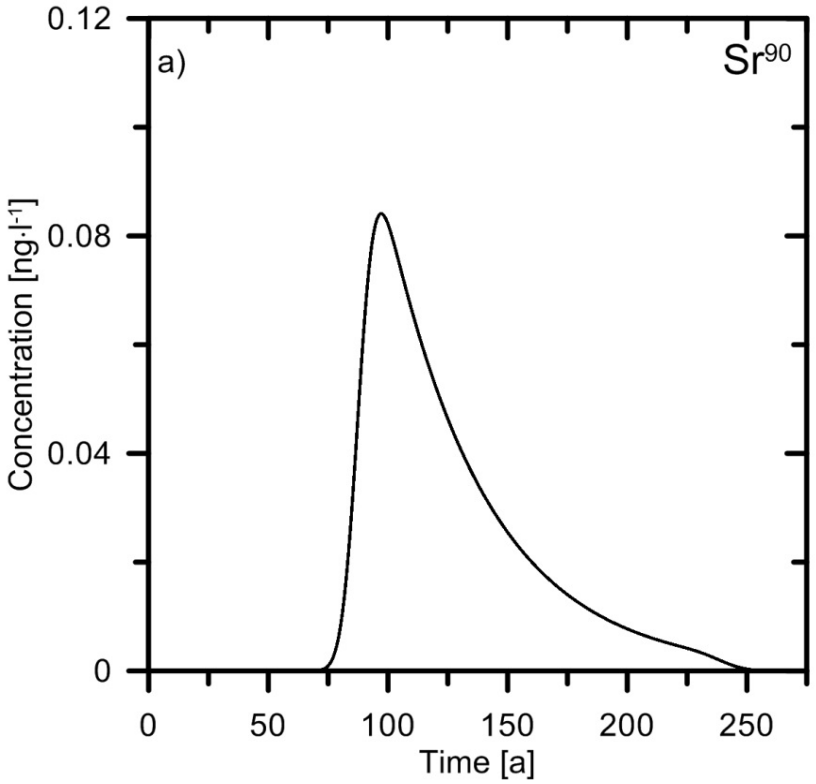
Sorption coefficients of radionuclides

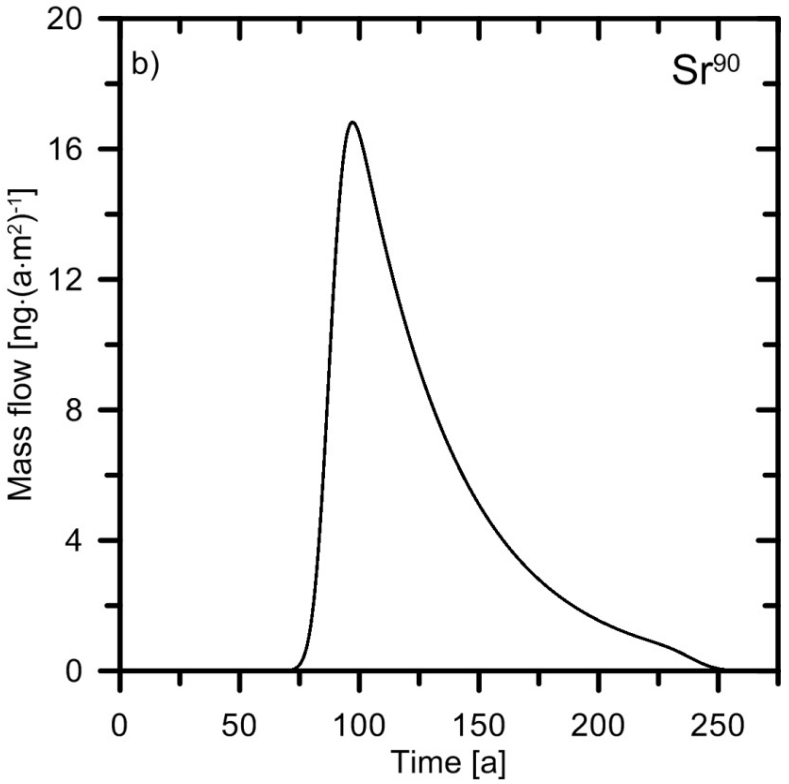
Element	K_d–waste body [$l \cdot kg^{-1}$]	K_d–barrier [$l \cdot kg^{-1}$]	K_d–soil [$l \cdot kg^{-1}$]	K_d–aquifer [$l \cdot kg^{-1}$]
Ni	10	10	1	0,1
Sr	1	10	0,1	0,1
Cs	10	100	10	1
U	10 / 235	10	1	0,1
Pu	10	10	1	0,1
Am	100	1000	100	10

Activity in the Waste Body

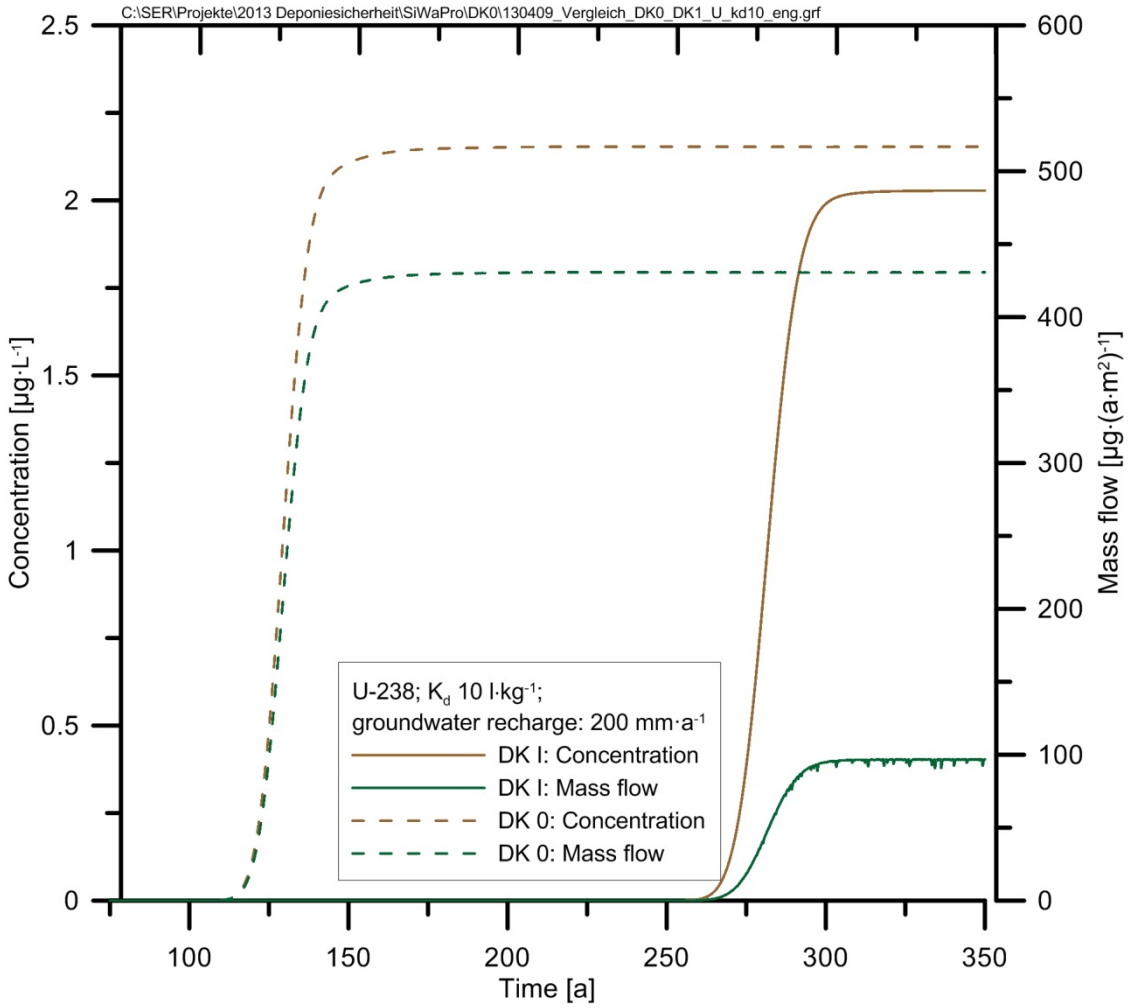
Nuclide	Activity [Bq·kg^{-1}]	Mass Nuclide/ Mass Matrix [mg·kg^{-1}]
Ni-63	8,74E-02	4,16E-08
Sr-90	1,33E+00	2,59E-07
Cs-137	0,43E-01	1,35E-07
U-238	4,14E-04	3,28E-02
Pu-238	7,87E-03	1,24E-08
Am-241	2,91E-01	2,29E-06

Inert landfill: Concentration and mass flow of Sr-90

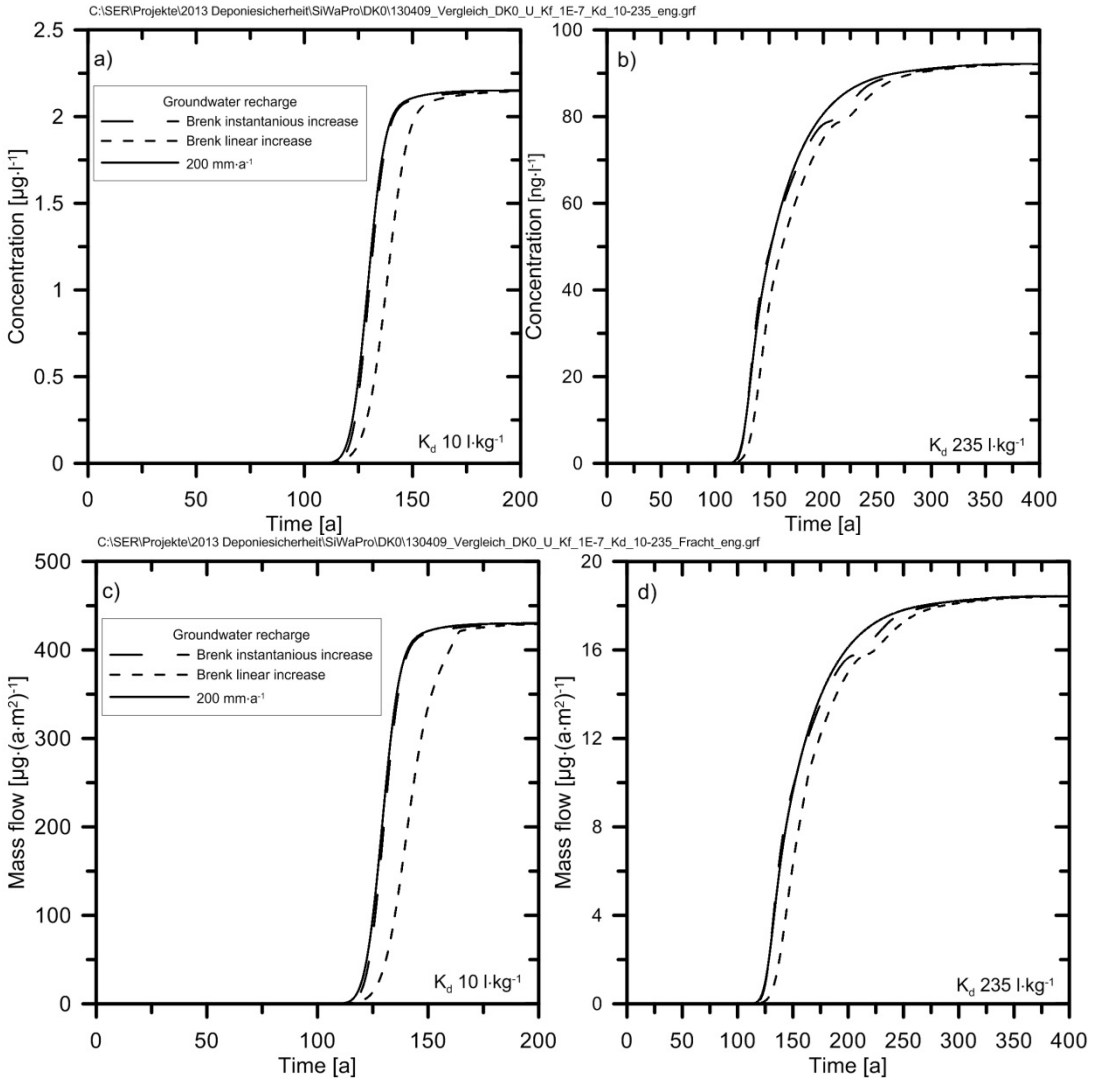




Inert and Non-hazardous landfill: Uranium



Inert landfill : variation of K_d and groundwater recharge



Regional Model in SPRING

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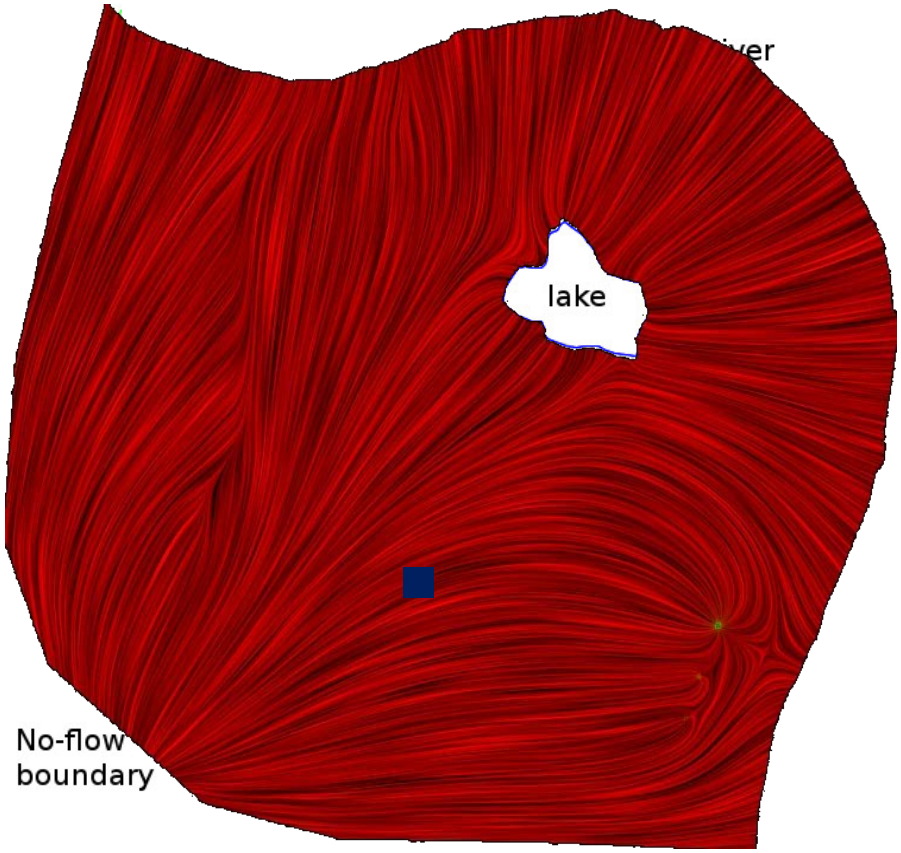
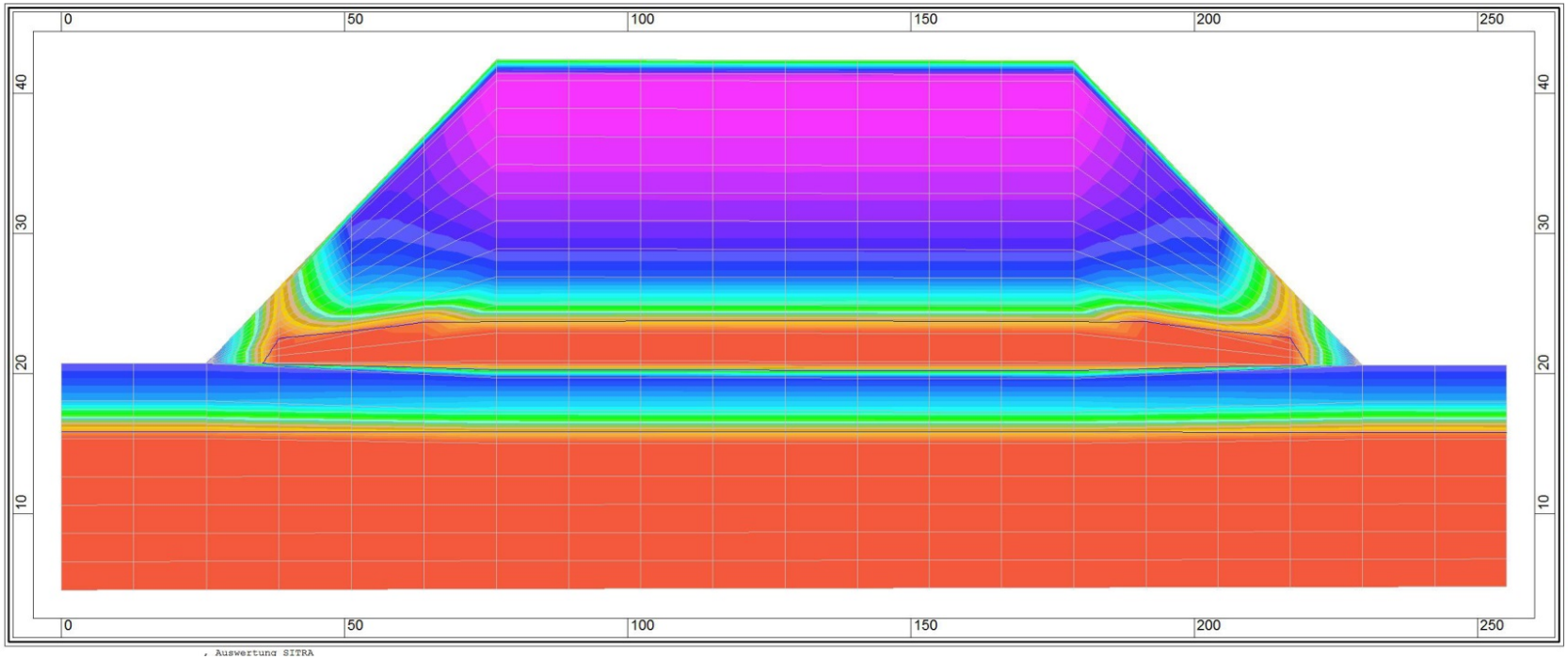


Saturation of inert landfill body after 800 years



Inert and Non-hazardous landfill: Uranium

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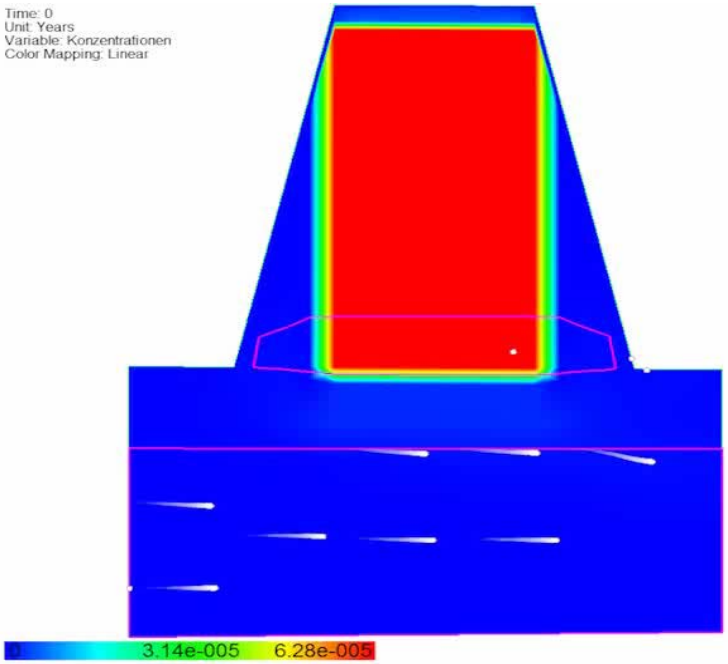
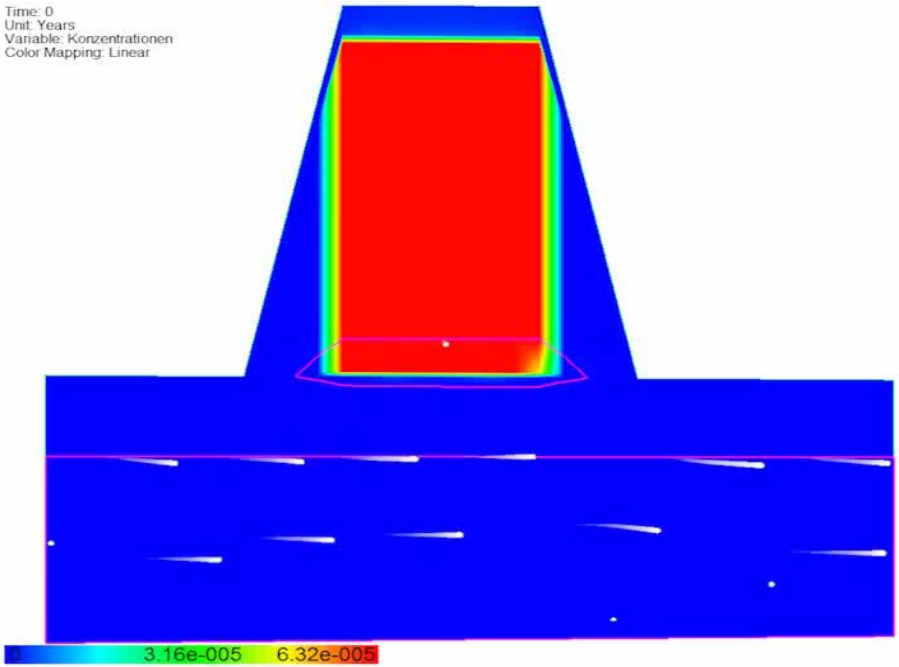
DK0



DKI



Results

- Only a small concentration of Uranium, Ni-63, Sr-90, Pu-238 and Pu-239/240 penetrates through the ground of an inert landfill without technical barriers.
- For non-hazardous landfills and hazardous landfills with technical barriers, the mass transport is lowered by a factor of 10, a concentration breakthrough is still observed.
- For all landfill types, no release of Cs-137 and Am-241 is observed.

Conclusion

- The threshold of 10 μSv/a for a member of the public will not be exceeded in the long term if VLLW from NPP decommissioning is disposed of on non-hazardous landfills (DK I) and hazardous landfills (DK II) constructed on the basis of German technical standards for conventional landfills.

Perspectives

- Licensing conditions
- Inclusion of further relevant long-lived radionuclides
- Dose limit for landfill workers
- Radiological consequences of possible inadvertent intrusions at the site