DOPAS Training workshop 2015

Learning Unit 1 : From Requirement to design basis of plugs and seals

Understanding requirements management and their application for plugs and seals

The role of plugs and seals. Different timelines, different host rocks (case of clay repository concept)

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Summary

Radioactivity and its use in France

Radioactive wastes in France and how to manage them

Deep underground repository and role of seals in france

Other country focusing on Clay type host rock : Switzerland

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Principal types of Use of Radioactivity in France

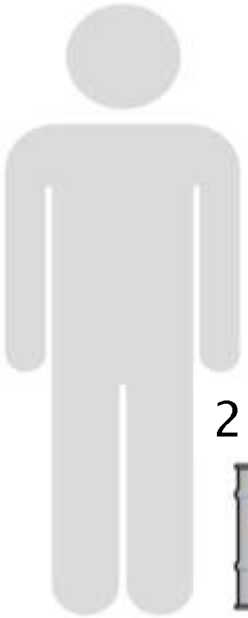
Electricity production

Defense

Industry

Research

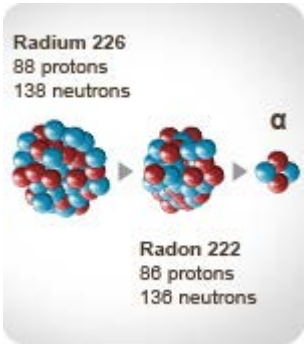
Medicine

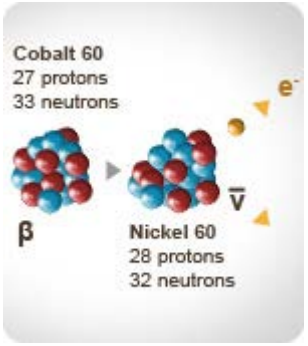


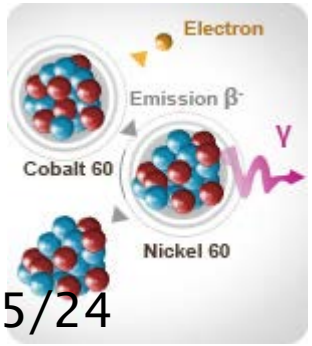
Amount of radioactive waste produced in France annually per inhabitant

2 Kg/year

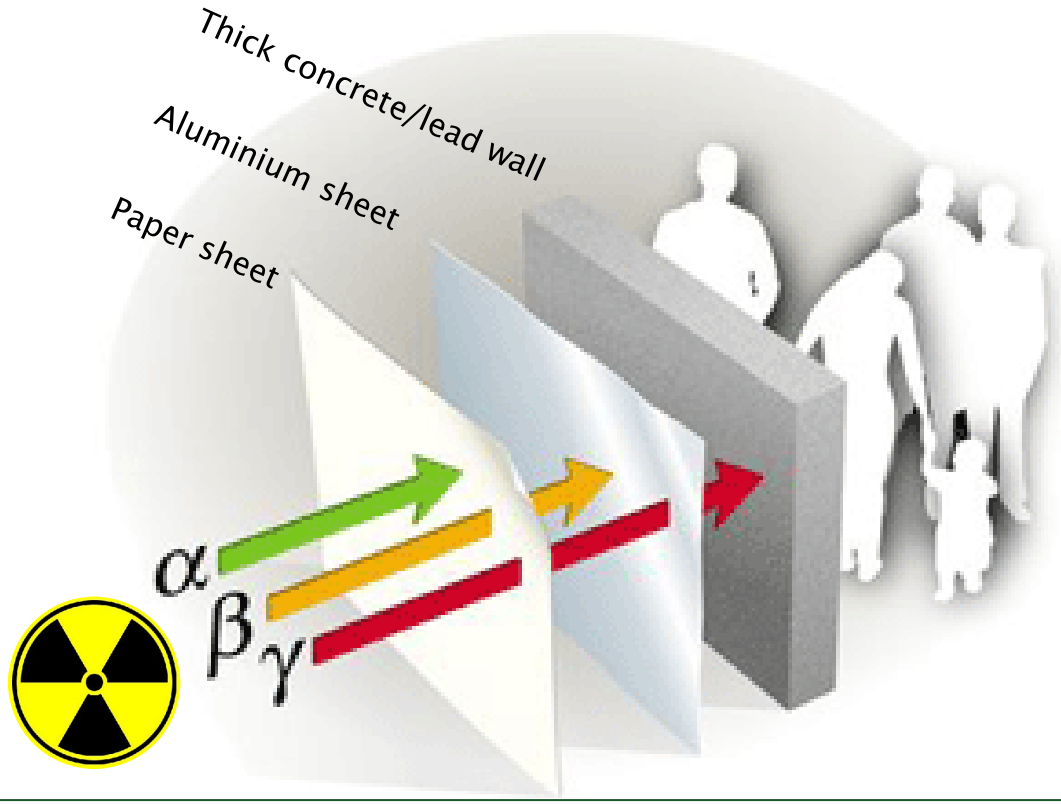
Radioactivity is a natural phenomena (1/2)





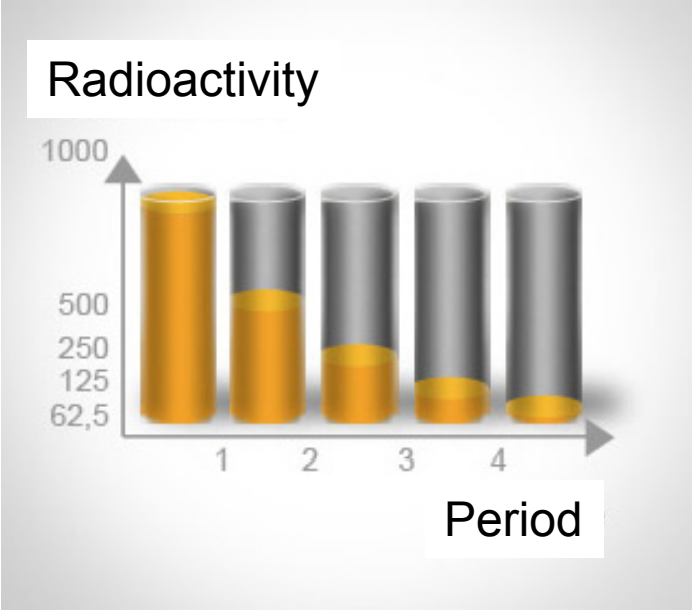


linked to unstable atoms which transforms into slable ones by emiting different types of rays (α, β, γ) more or less dangerous



Radioactivity is a natural phenomena (1/2)

Which decreases more or less rapidly with time



The ½ life period is the duration after which half of the amount of radioactivity of a single radionuclide has naturally disappeared by disintegration

- Iodine 131 : 8 days
- Cobalt 60 : 5 years
- Tritium : 12.3 years
- Césium 137 : 30.1 years

- Carbone 14 : 5 700 years
- Plutonium 239 : 24 000 years
- Choride 36 : 360 000 years
- Iodine 129 : 17 million years
- Uranium 238 : 4.5 billions years

Radioactive wastes in France and how to manage them

What to do with these radionuclides before they become harmless ?

France has choosen a long term solution for all types of wastes implying a multi barrier concept including :

A waste container
- Transport
- Exploitation phase

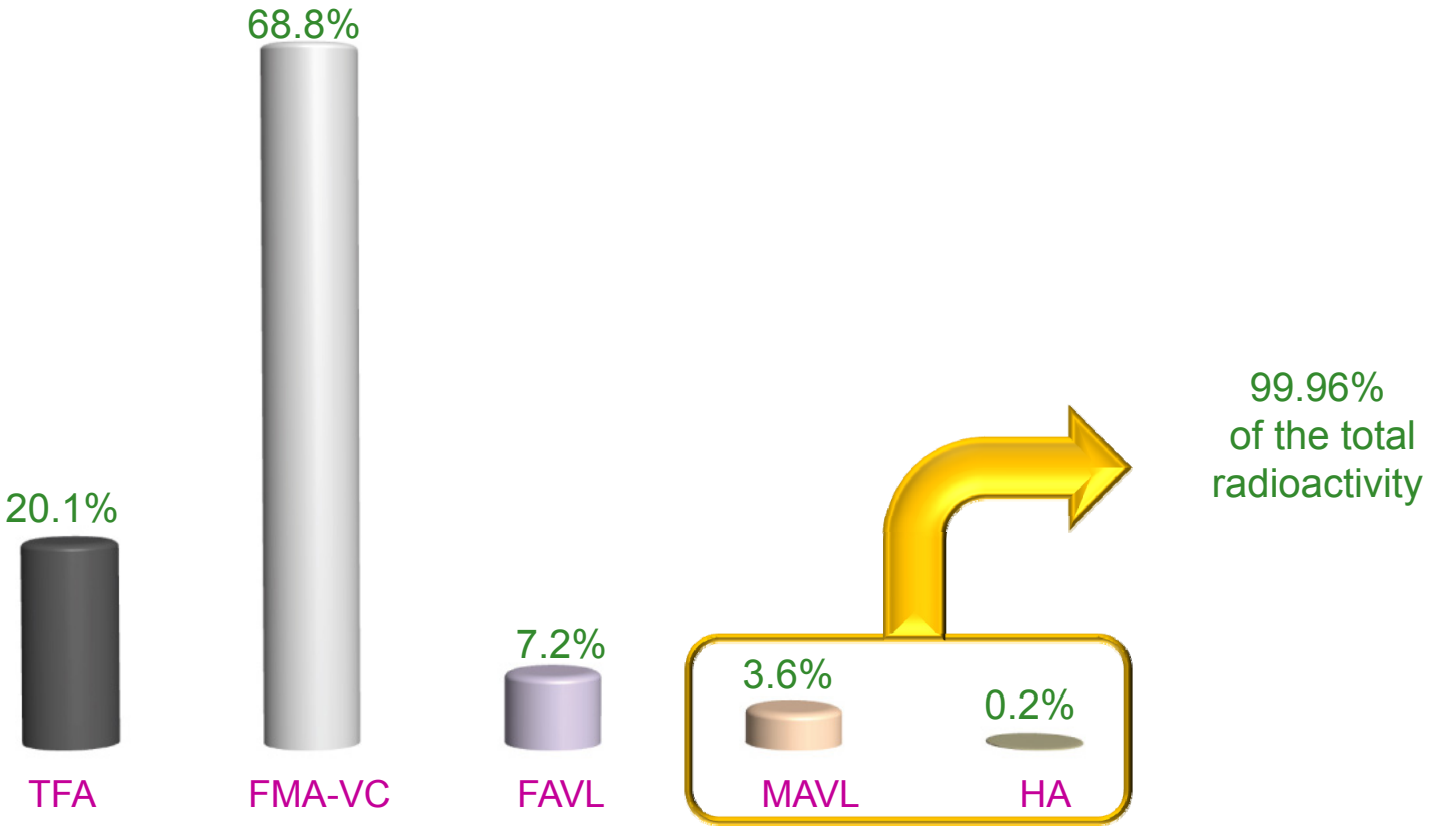
An engineered barrier system (EBS)
- Exploitation phase
- Institutional phase

A geological media
- Long term safety

Classification of radionuclides for storage in France

<table>
<tr><th></th><th>Waste containing mainly RN with Very Short ½ life
period < 100 days</th><th>Waste containing mainly RN with Short ½ Life (VC)
period ≤ 31 years</th><th>Waste containing mainly RN with Long ½ Life (VL)
period > 31 years</th></tr>
<tr><td>Very low activity (TFA)</td><td rowspan="3">Industrial storage during radioactive decrease</td><td colspan="2">Recycling or dedicated surface storage
(Cires, in activity)</td></tr>
<tr><td>Low Activity (FA)</td><td rowspan="2">Surface repository
(CSA, in activity)</td><td>Subsurface repository
(in study)</td></tr>
<tr><td>Intermediate Activity (MA)</td><td rowspan="2">Deep geological repository
(Cigéo, in study)</td></tr>
<tr><td>High Activity (HA)</td><td>No RN in this category</td><td></td></tr>
</table>

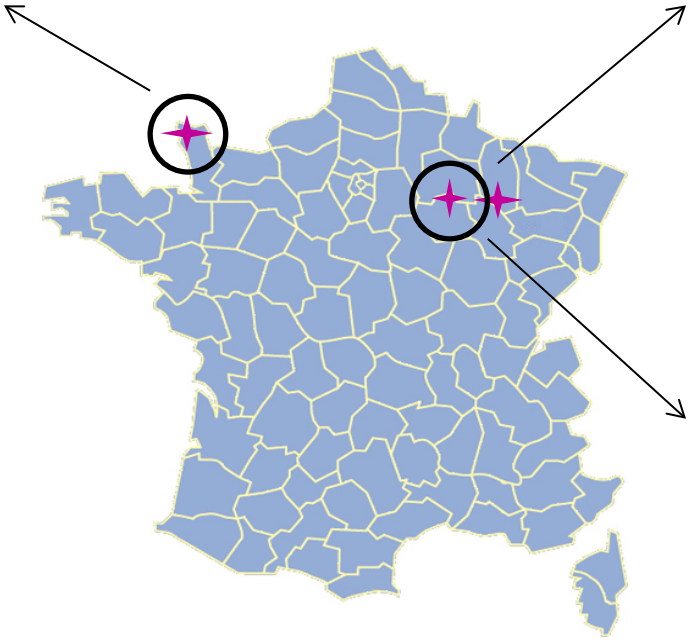
Total volume of radionuclids wastes per categories



End of 2013 the total volume of radionuclids waste was around 1 500 000 m³

➢ 90% of the total amount (volume) of RN has already a long term management solution (repository in activity)

CSM
(already closed)

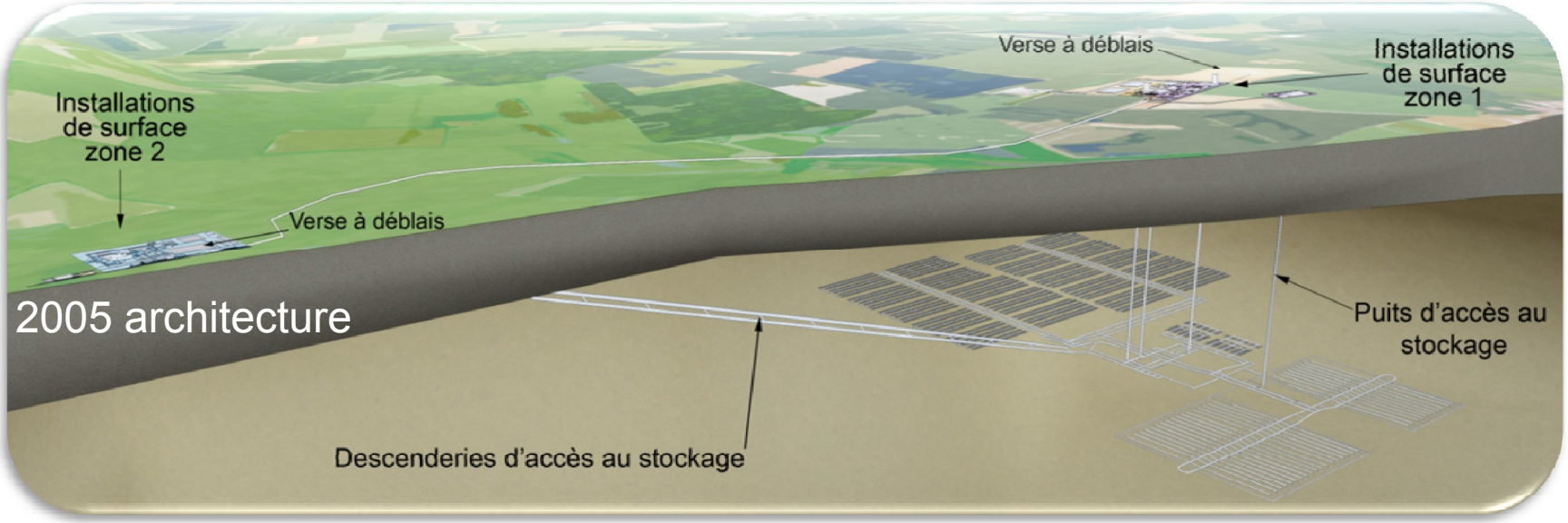


CSA
(in activity)

CIRES
(in activity)

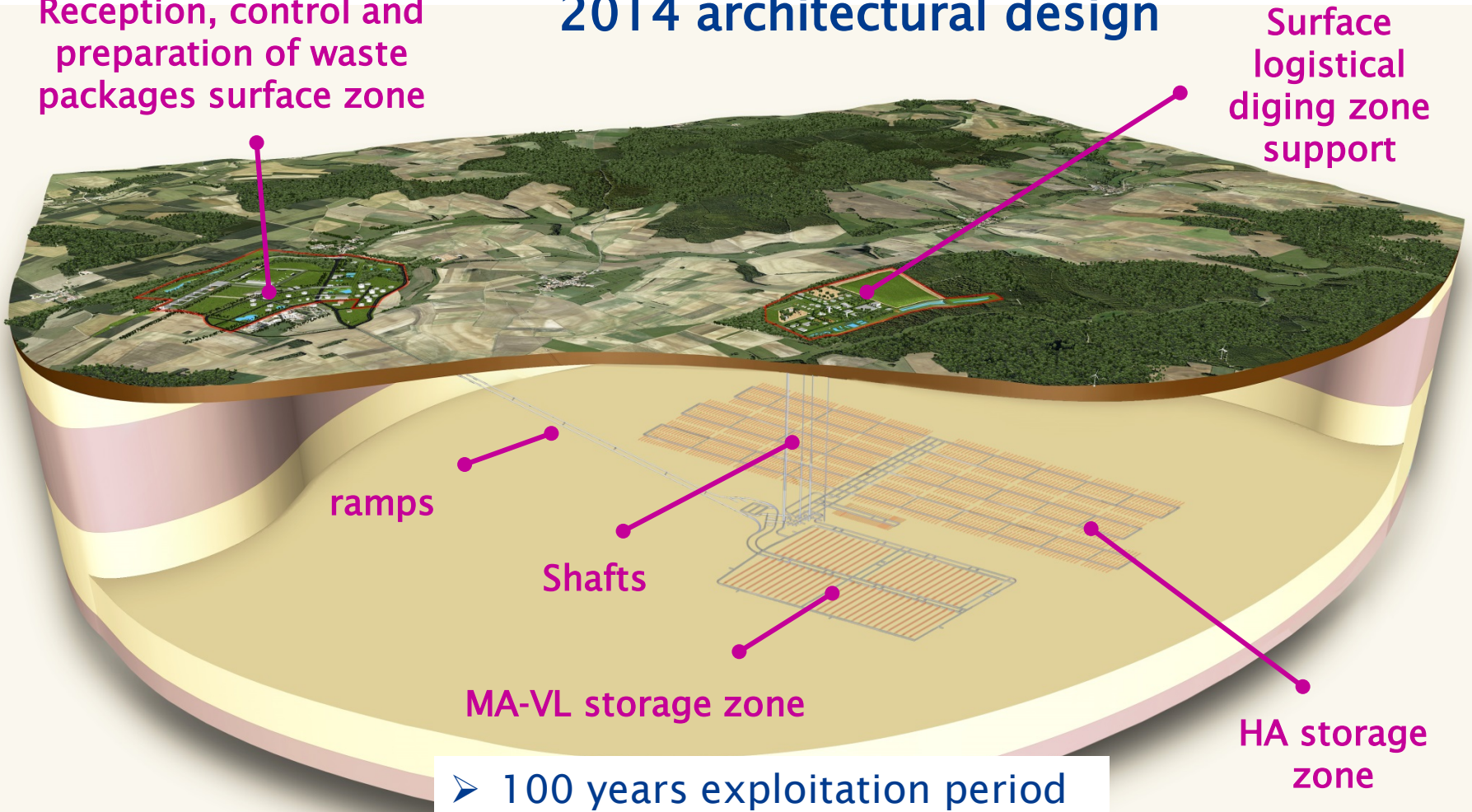
A solution is actually studied for High Level Wastes and Intermediate Level Long Lived Wastes

Cigeo : Deep underground clay host rock geological repository



- Deep underground (500 m): to protect from (limit) human intrusion and natural disasters on surface
- Clay host rock: very low permeability and favorable for RN « trapping » (high cation sorption)
- Geological repository: stable over very long period of time (far beyond human possibilities)

Principle of Cigeo repository 2014 architectural design



- 100 years exploitation period
- Progressive construction

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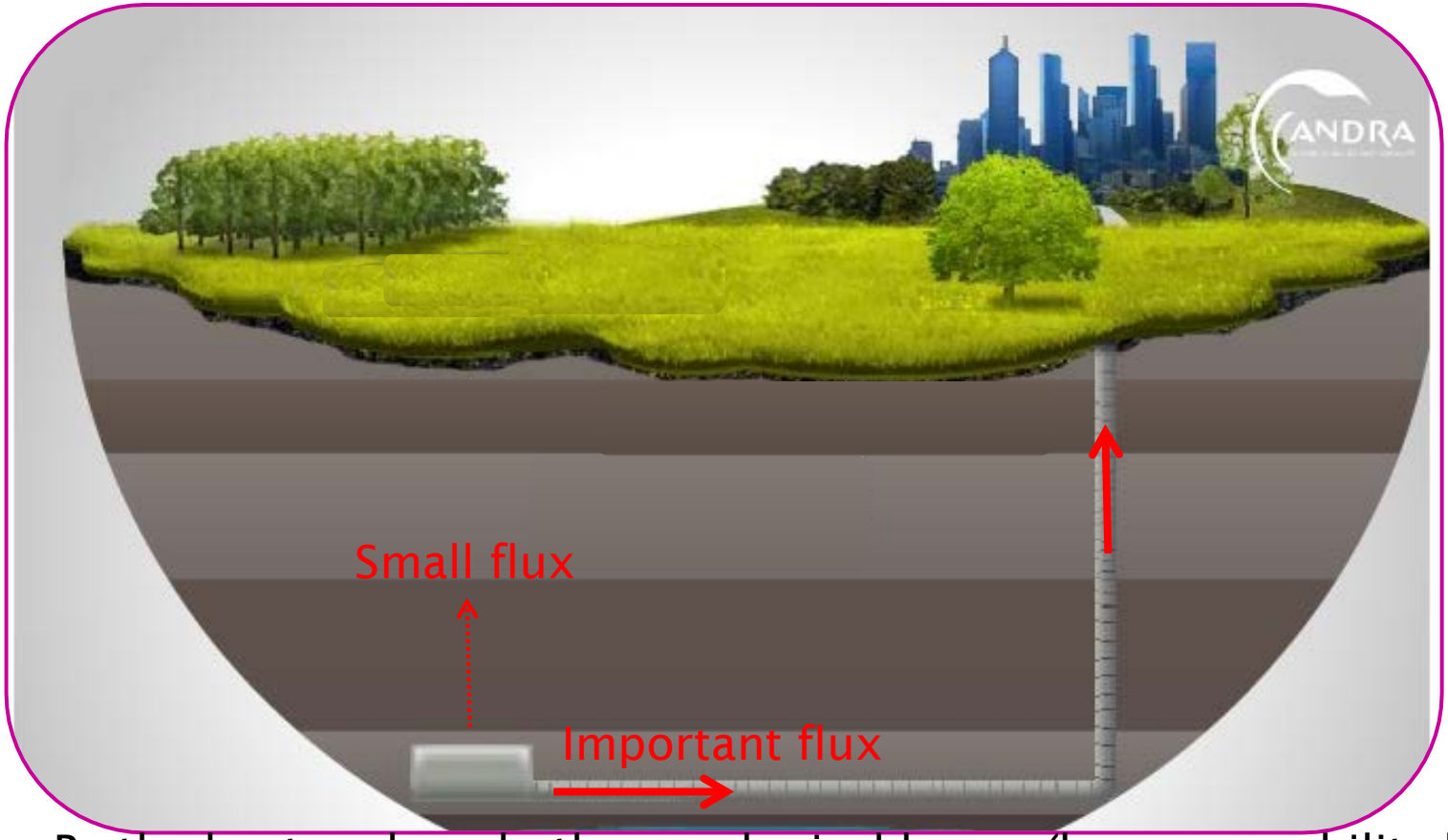
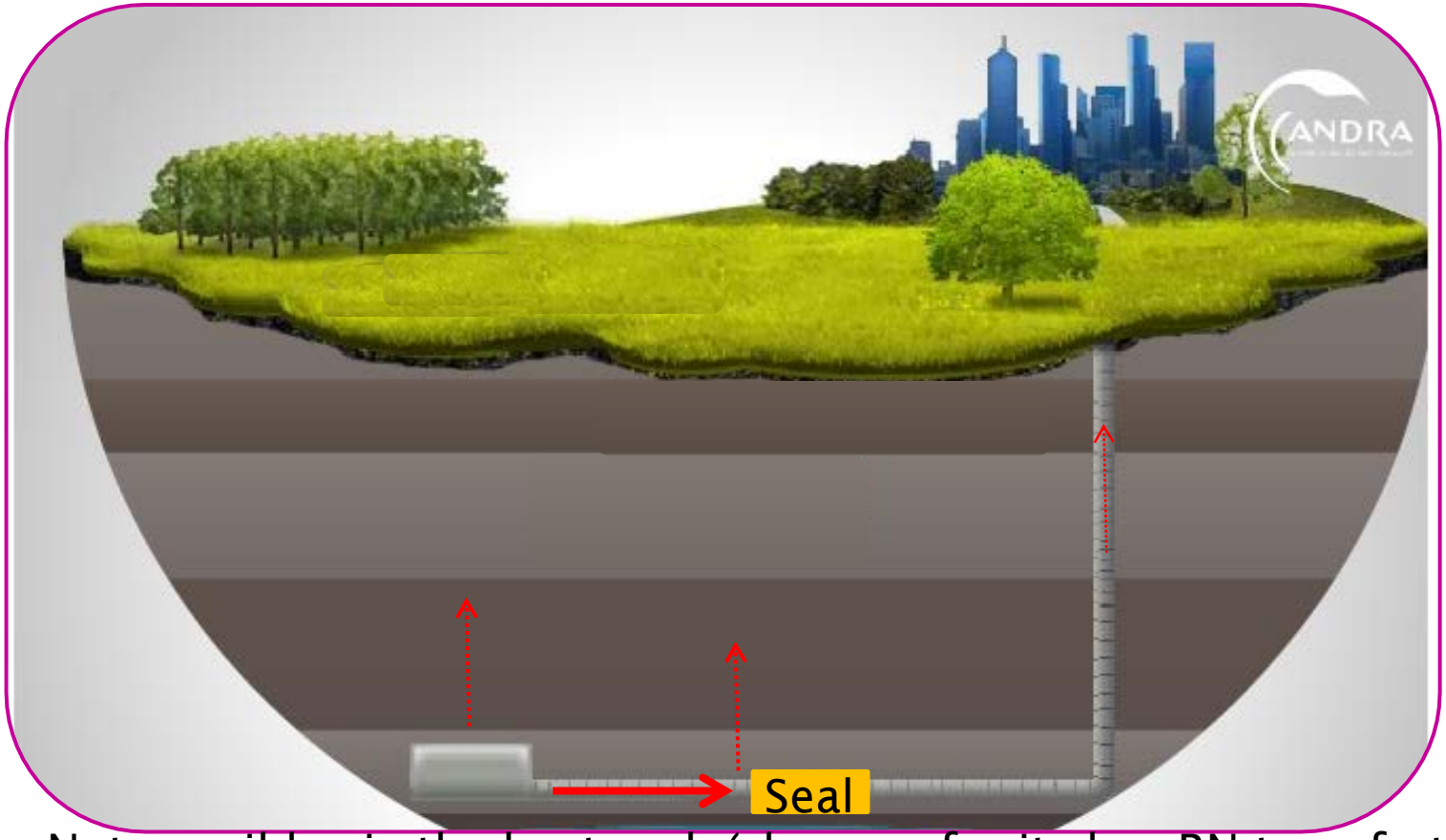
Radionuclides are migrating toward the surface



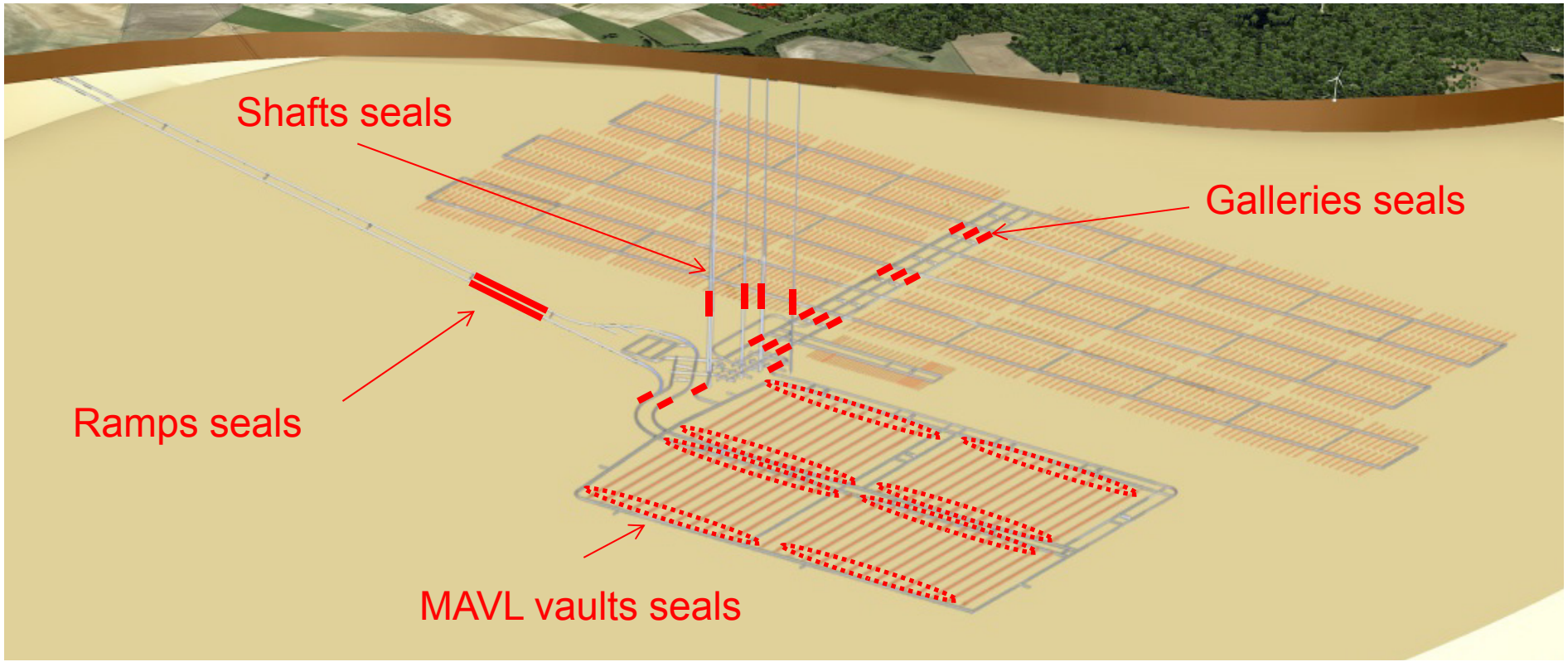
- By the host rock and other geological layers (low permeability host rock: mainly by diffusion)
- Using the excavated gallery network (high permeability: mainly by convection)

How to limit the migration toward the surface ?



- Not possible via the host rock (choosen for its low RN transfert potential: low permeability, high retention for cations)
- Possible in the gallery network: try to come back to the natural (host rock) propeties: “clay type seals”

Actual foreseen emplacement of seals in Cigeo



Seals have to last as long as needed to prevent RN to come to the surface.
Limited at 1 My in practice (duration of the SA calculations)

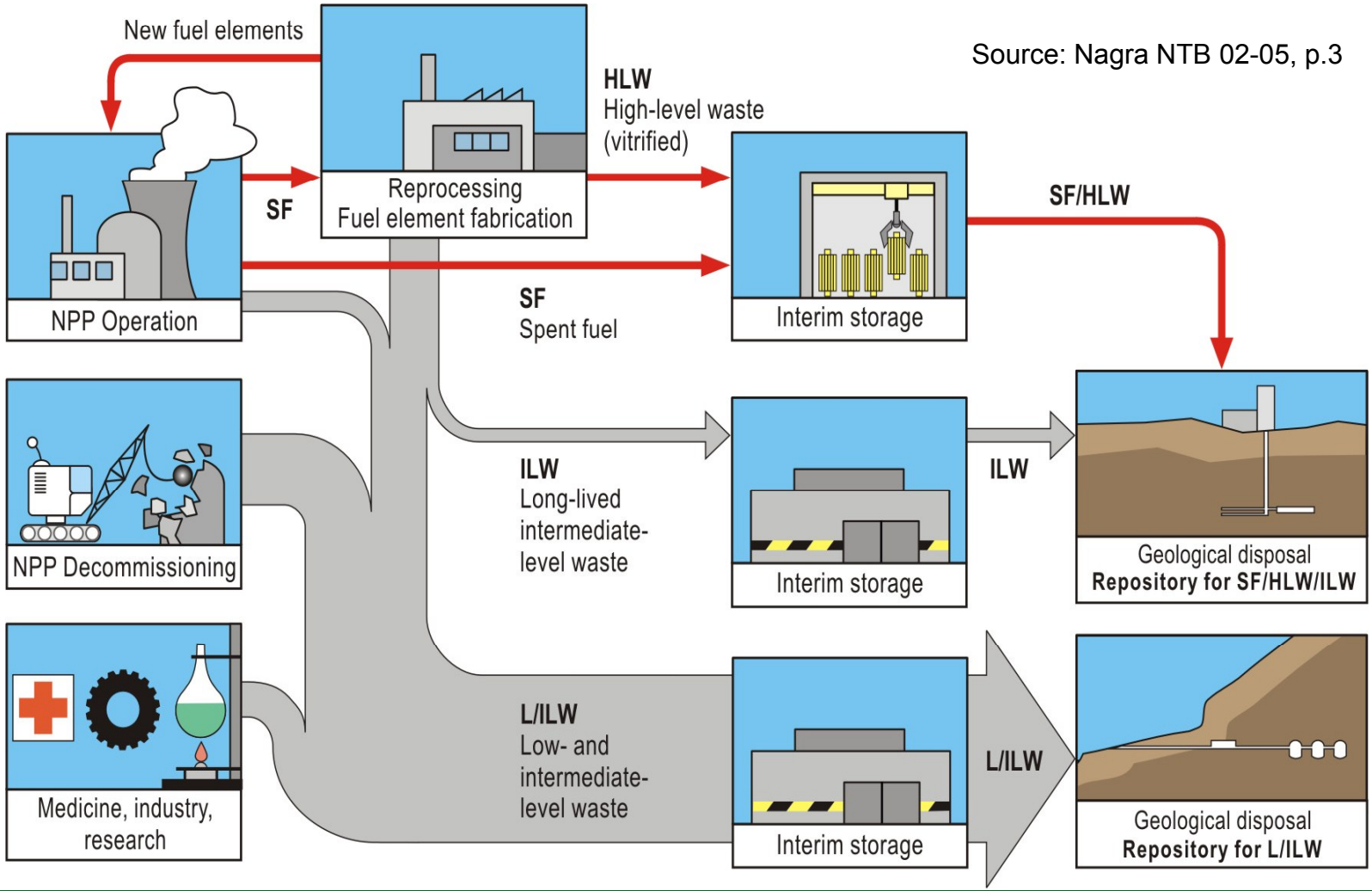
Other country focusing on Clay type host rock

Example of Switzerland

If not otherwise stated, the following material is extracted from Nagra 08-07-2015

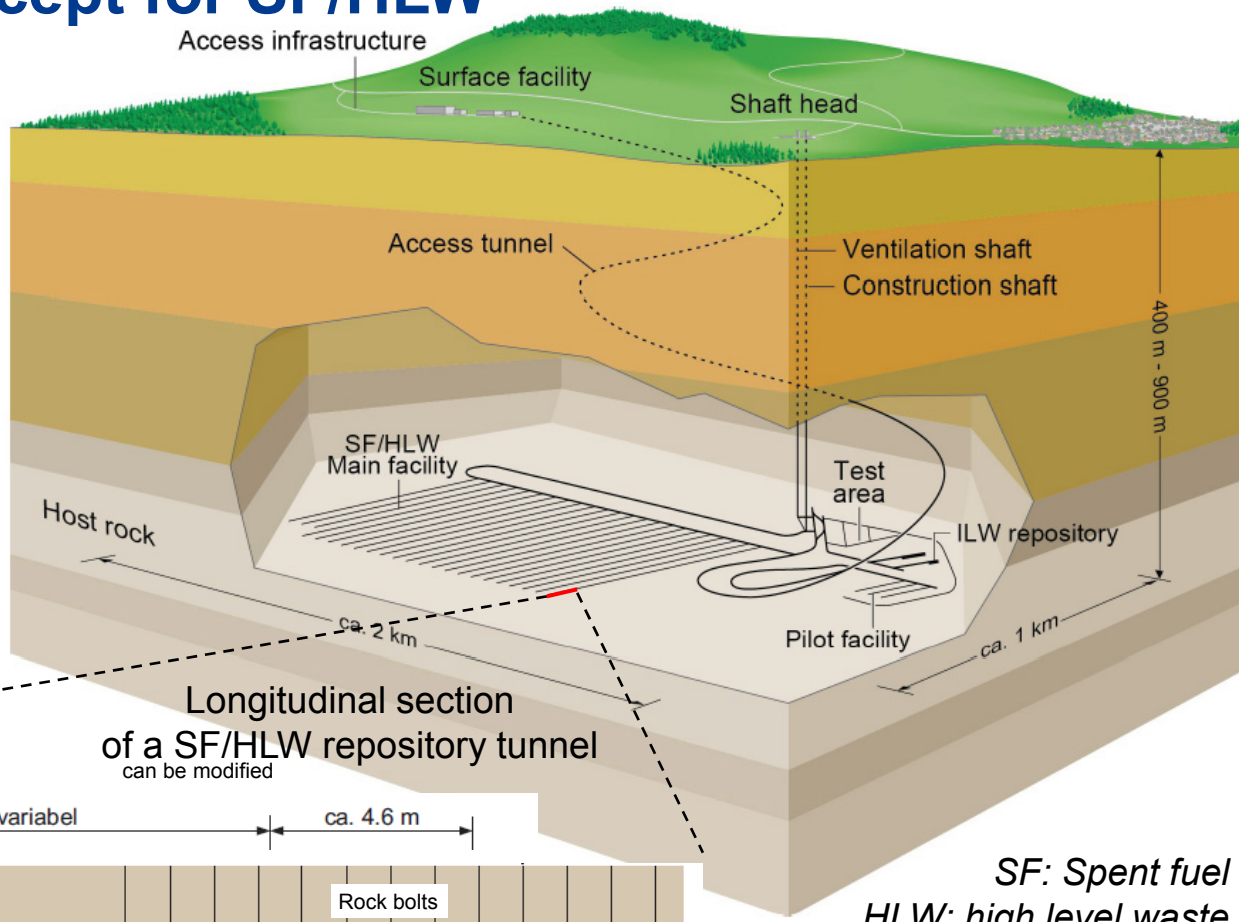
Elements of Swiss Waste Management Concept

Source: Nagra NTB 02-05, p.3

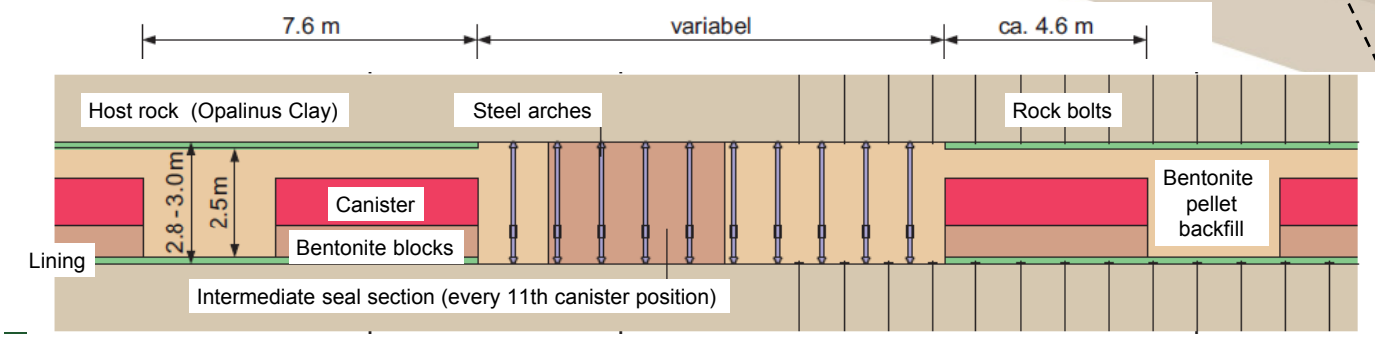


Swiss repository concept for SF/HLW

The period analysed for safety assessment is of 1 My



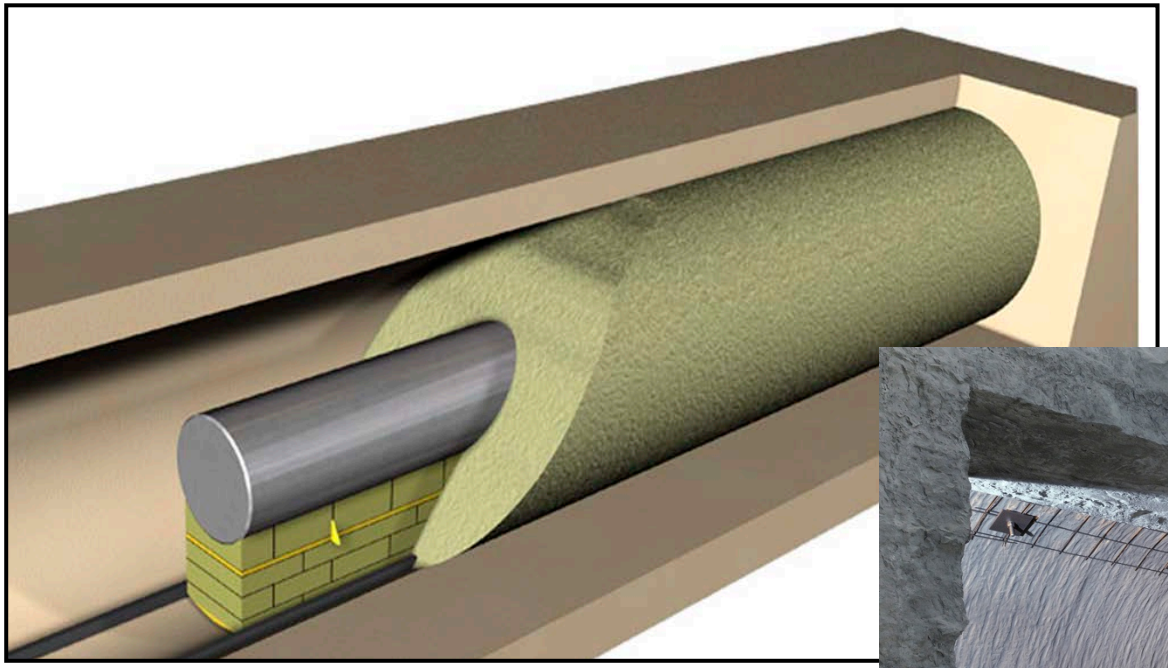
Longitudinal section
of a SF/HLW repository tunnel
can be modified



SF: Spent fuel
HLW: high level waste
ILW: intermediate level waste

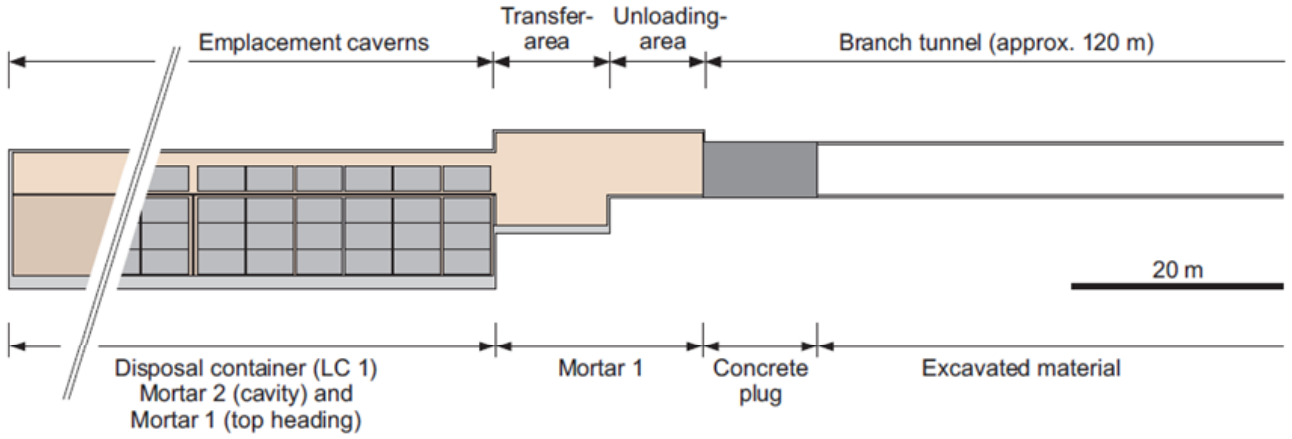
Nagra, 08-July-2015
Poller & al. (2014) p.2 & p. 49

Swiss example : Emplacement tunnel of the SF/HLW repository



Nagra, 08-09-2015

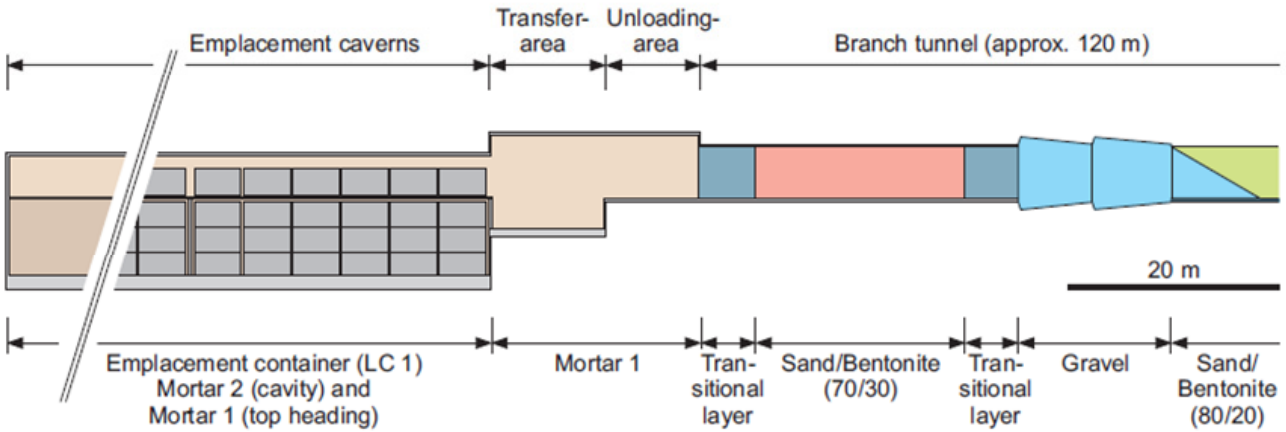
In-tunnel emplacement concept with canister emplaced in tunnel on bentonite blocks, backfilled with granulated bentonite.



a)

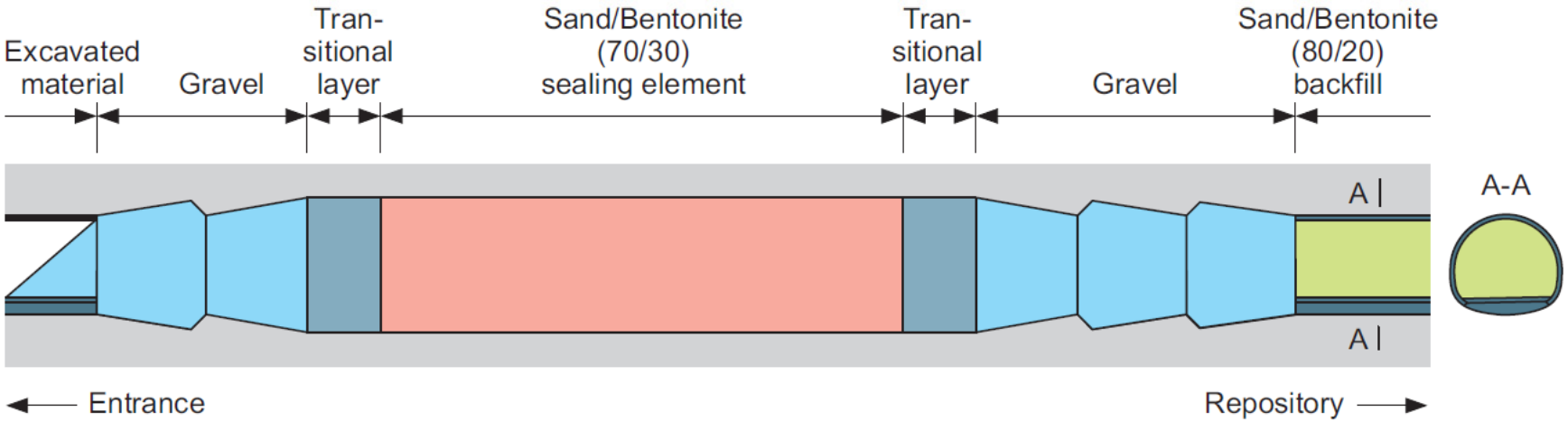
Swiss example : L/ILW emplacement cavern without (a) / with (b) Engineered Gas Transport System (EGTS)

Nagra, 08-07-2015



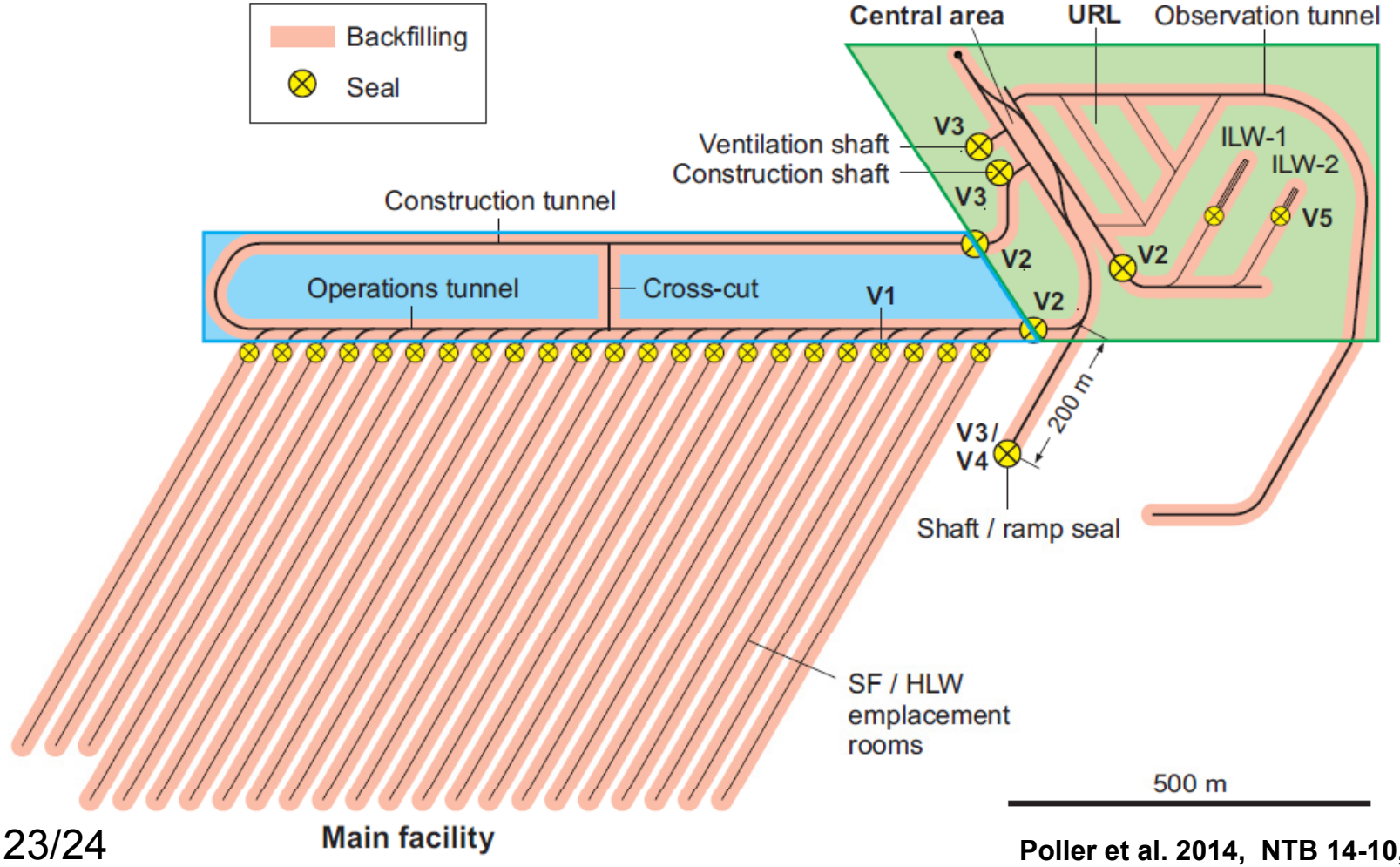
b)

Swiss example : Generic possible layout of a gallery seal



Source: Nagra

Layout of the backfilled/sealed Swiss SF/HLW repository



Poller et al. 2014, NTB 14-10, p. A-21

Thank you

References related to Nagra's concept

Nagra. 2002. Projekt Opalinuston, Konzept für die Anlage und den Betrieb eines geologischen Tiefenlagers – Entsorgungsnachweis für abgebrannte Brennelemente, verglaste hochaktive sowie langlebige mittelaktive Abfälle.Technischer Bericht NTB 02-02

Poller & al. 2014. Modelling of Radionuclide Transport along the Underground Access Structures of Deep Geological Repositories. Nagra. Technical report NTB 14-10. August 2014. ISSN 1015-2636.

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Nagra reports available at
http://www.nagra.ch/de/cat/publikationen/technischeberichte-ntbs/ntbs-2001-2013/downloadcenter.htm