Methodological approach for a safety demonstration and verification concept for a HLW repository in claystone in Germany

M. Jobmann[1], S. Mrugalla[2], A. Rübel[3]

[1]DBE TECHNOLOGY GmbH (DBETEC)
[2]Bundesanstallt für Geowissenschaften und Rohstoffe (BGR)
[3]Gesellschaft für Reaktorsicherheit (GRS)

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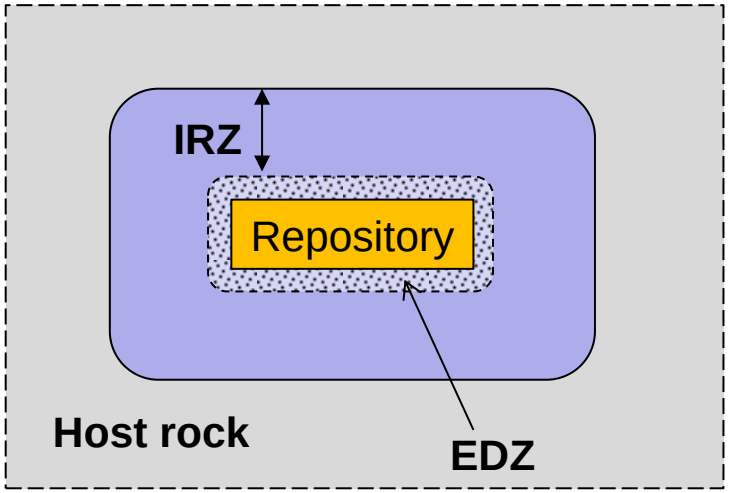
Background – Safety Requirements

The HLW must be concentrated in an **isolating rock zone (IRZ).**

The **isolating rock zone** is part of the repository system which, together with the geotechnical seals (shaft seals, drift seals etc.) ensure containment of the waste.

The safety requirements ask for a suitable:

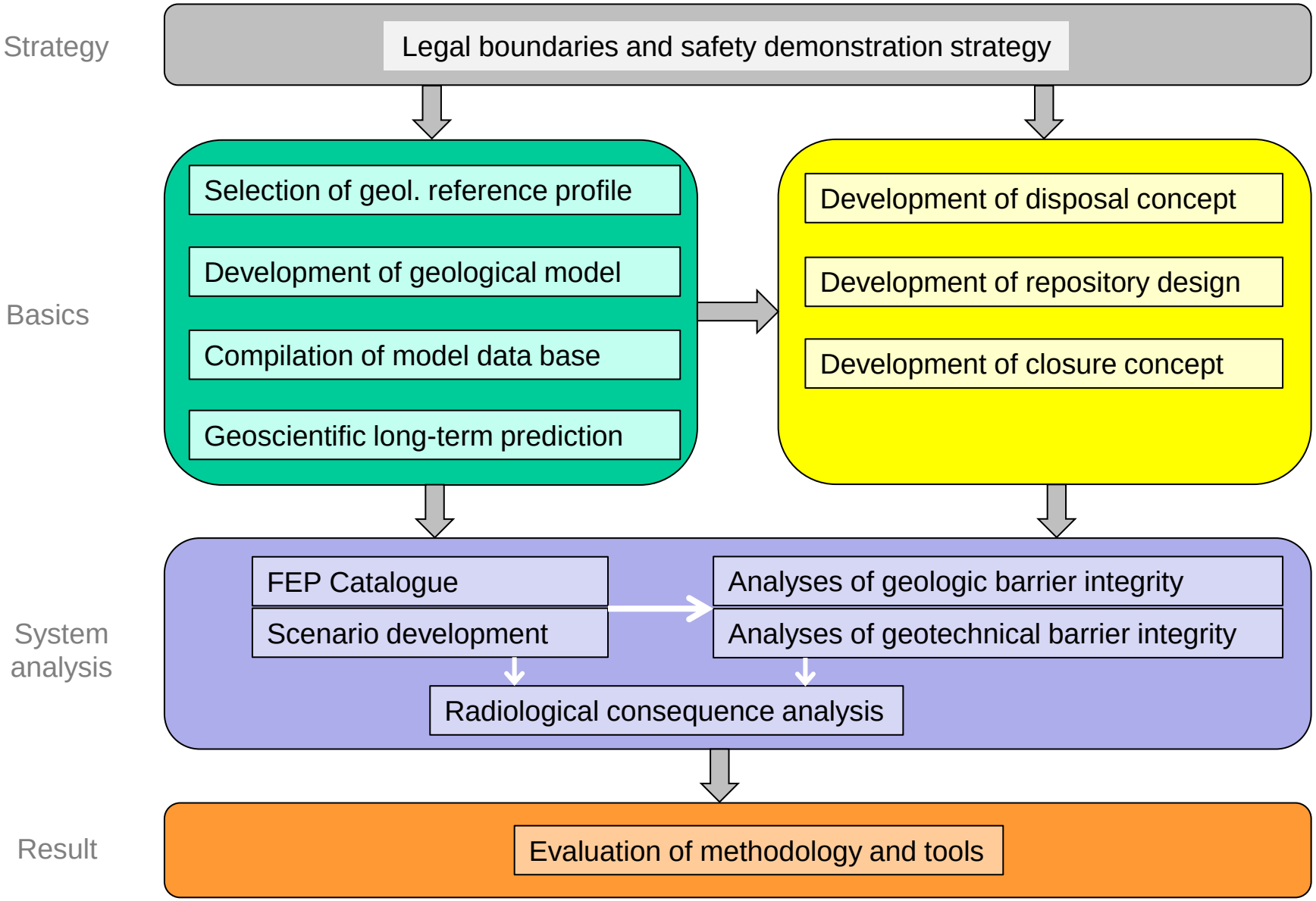
- Repository design
- Disposal concept
- Closure concept
- Dimension of the isolating rock zone (IRZ)

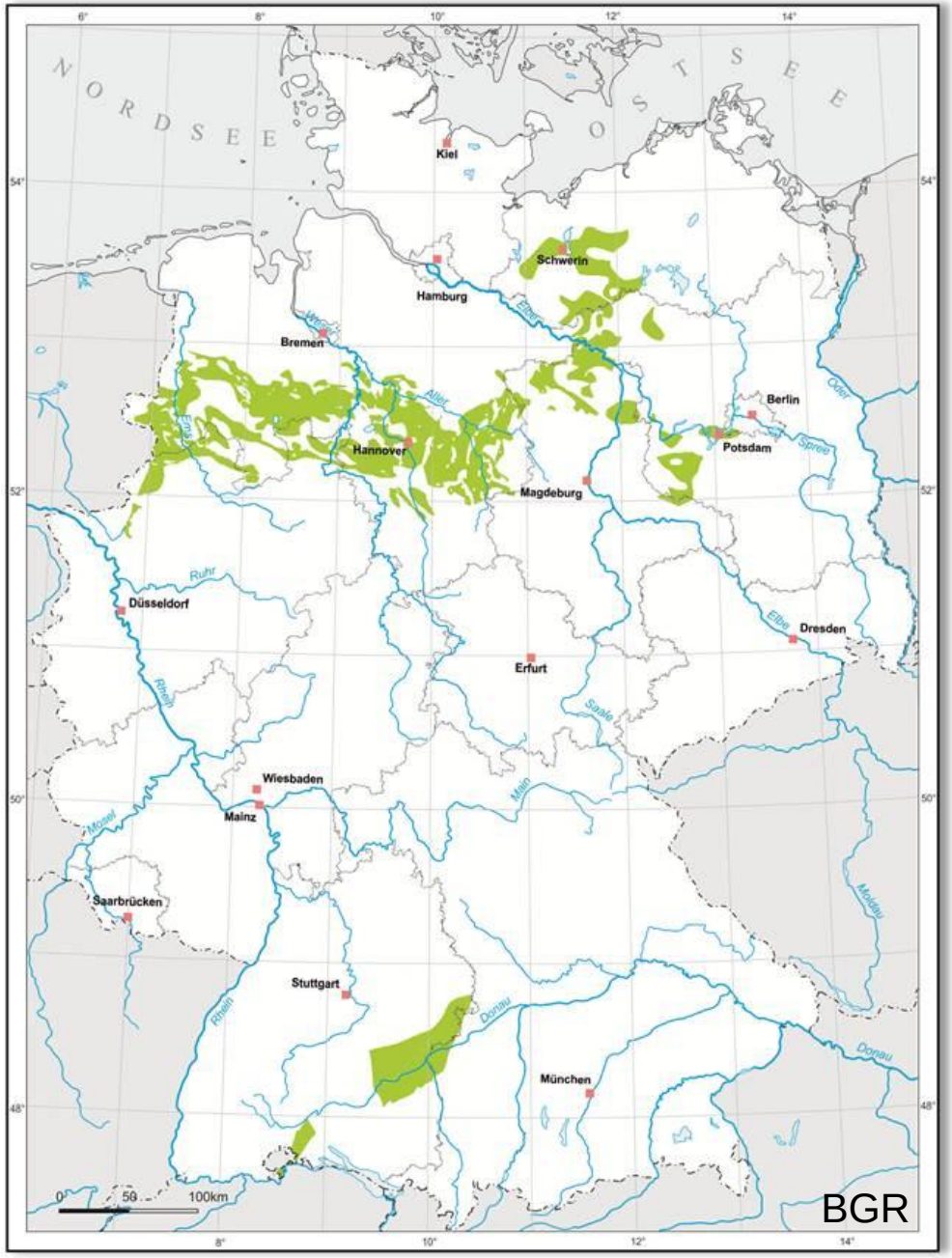


A site-specific safety assessment (1 mill years) must be carried out to provide evidence of

- the integrity of the IRZ
- the limited radiological release
  - for probable (10 µ-sieverts/a) and
  - less probable (100 µ-sieverts/a)

  repository developments


Strategy
Legal boundaries and safety demonstration strategy
Basics
Selection of geol. reference profile
Development of geological model
Compilation of model data base
Geoscientific long-term prediction
Development of disposal concept
Development of repository design
Development of closure concept
System analysis
FEP Catalogue
Scenario development
Analyses of geologic barrier integrity
Analyses of geotechnical barrier integrity
Radiological consequence analysis
Result
Evaluation of methodology and tools



Geology

Clay formations potentially suitable for hosting a repository in Germany

Geologic situation is very different in northern and southern Germany

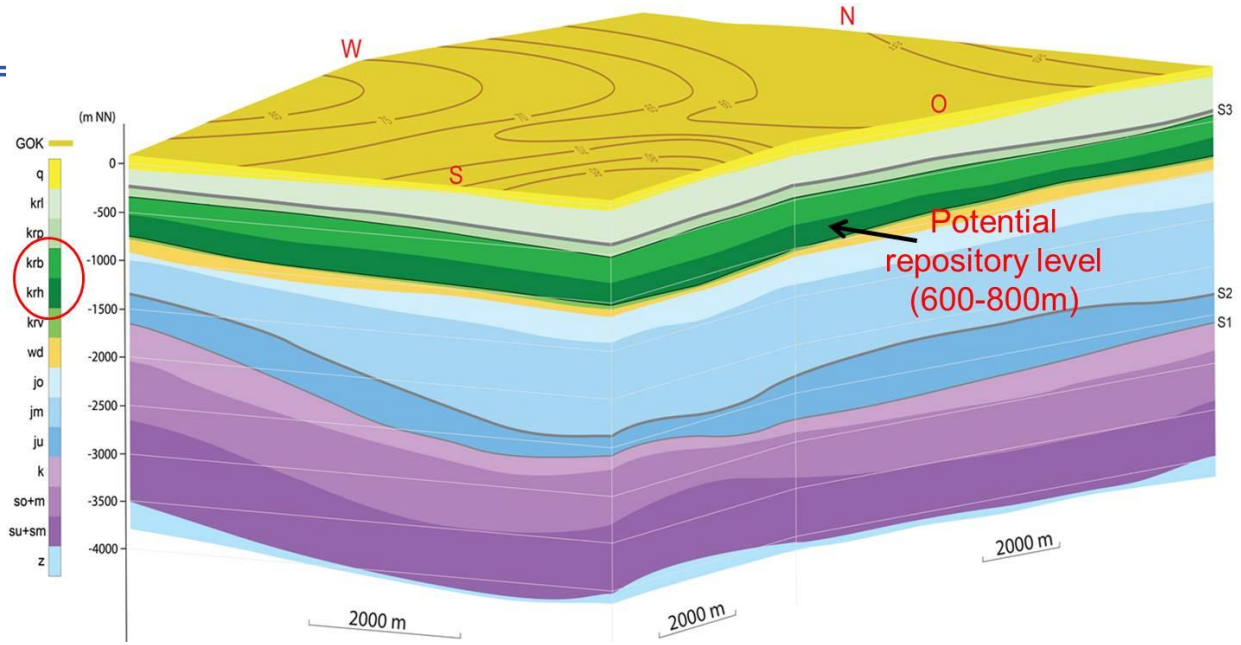
Identification of a single reference geologic situation is not possible

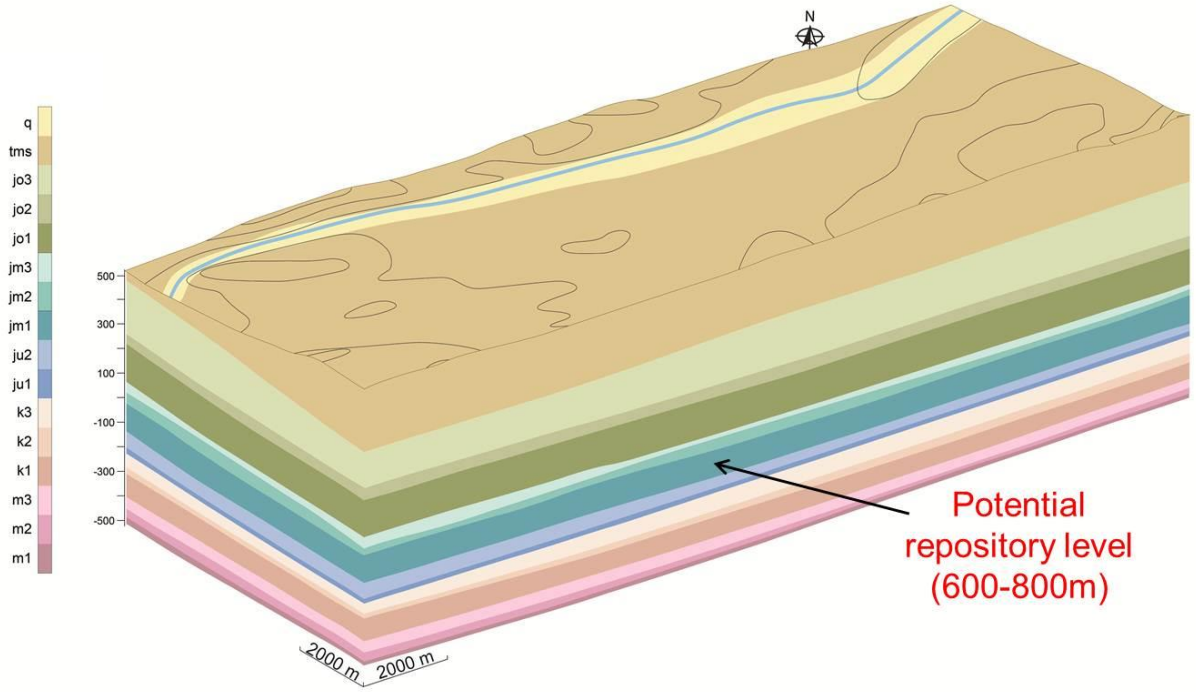
Development of two reference profiles and geological models

(HOTH et al. 2007)

Geology

Model NORTH
Barremium & Hauterivium
(Lower cretaceous clay)





Model SOUTH
Opalinus Clay
(Jurassic clay)

GRS BGR DBE TEC

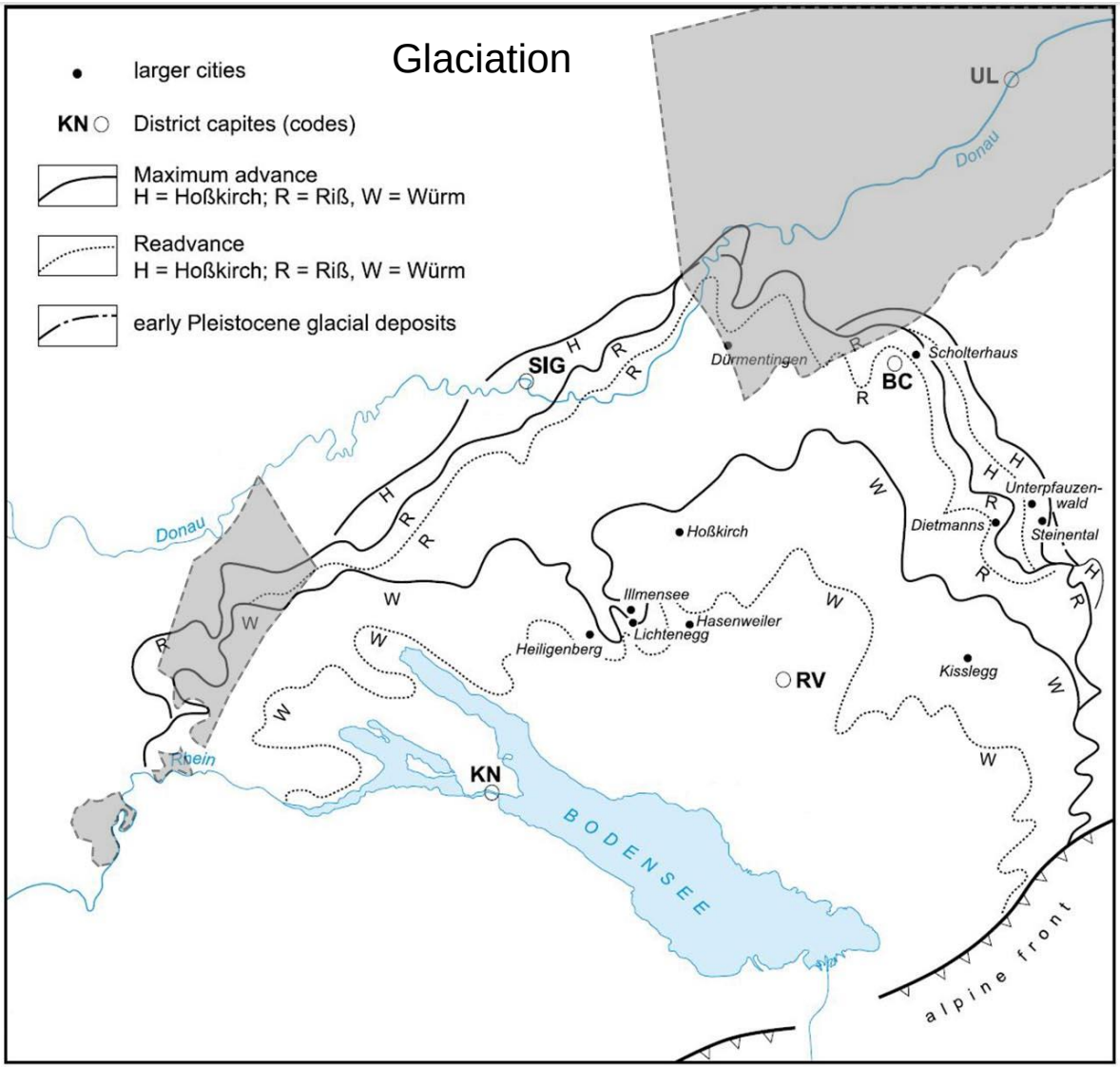
Geology

Geoscientific long-term prediction

Climatic evolutions
Ice ages
Permafrost
Glacial channelling

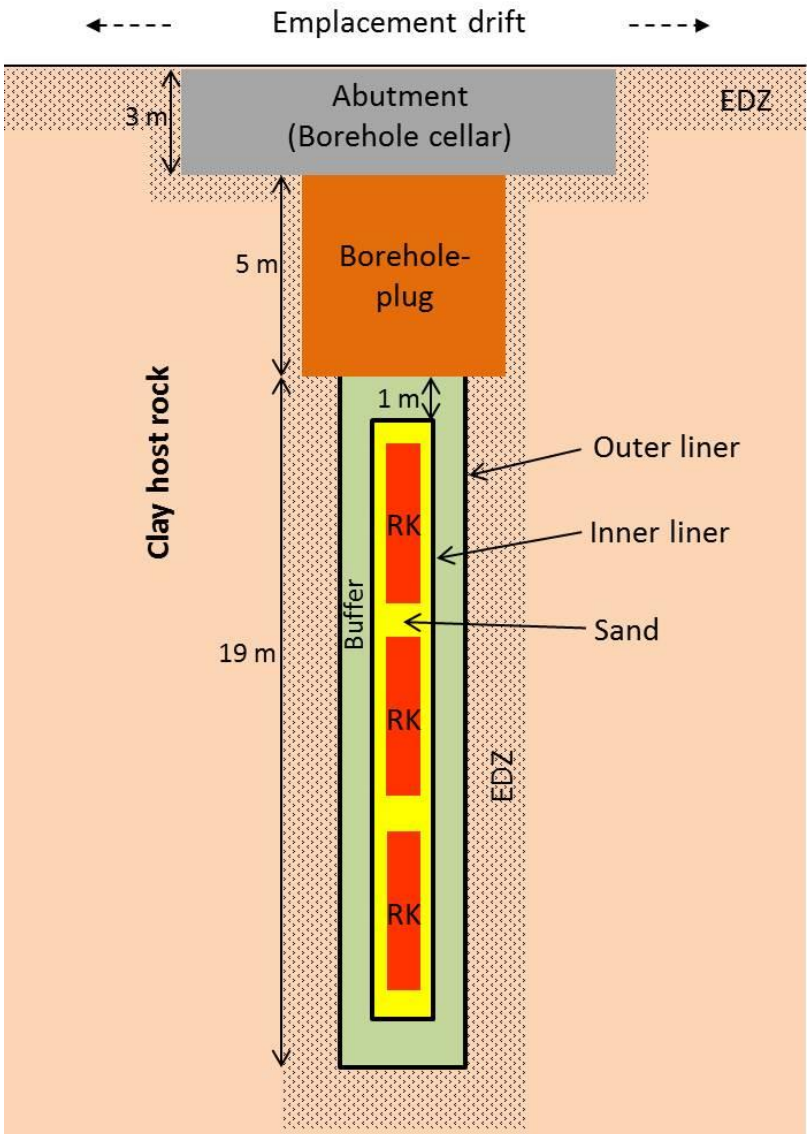
Vertical crust movements
Earthquakes
Geomorphologic evolutions
Tectonic evolutions

Hydrogeological evolutions

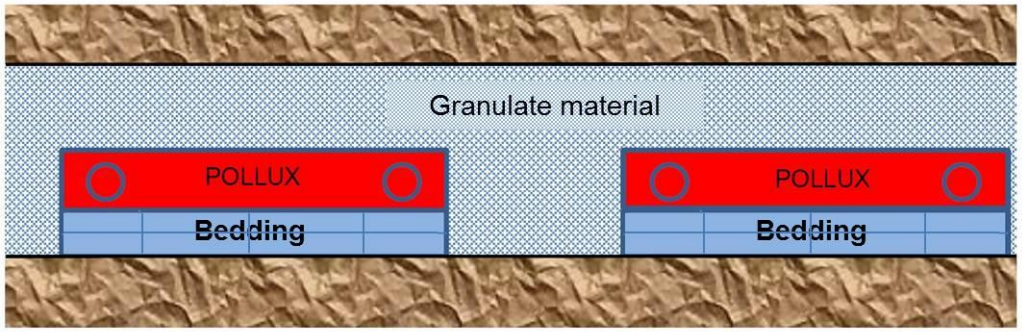


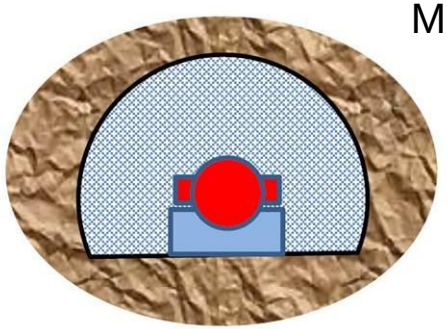
(modified after Ellwanger et al. 2011)

Disposal Concepts



Model NORTH - borehole disposal



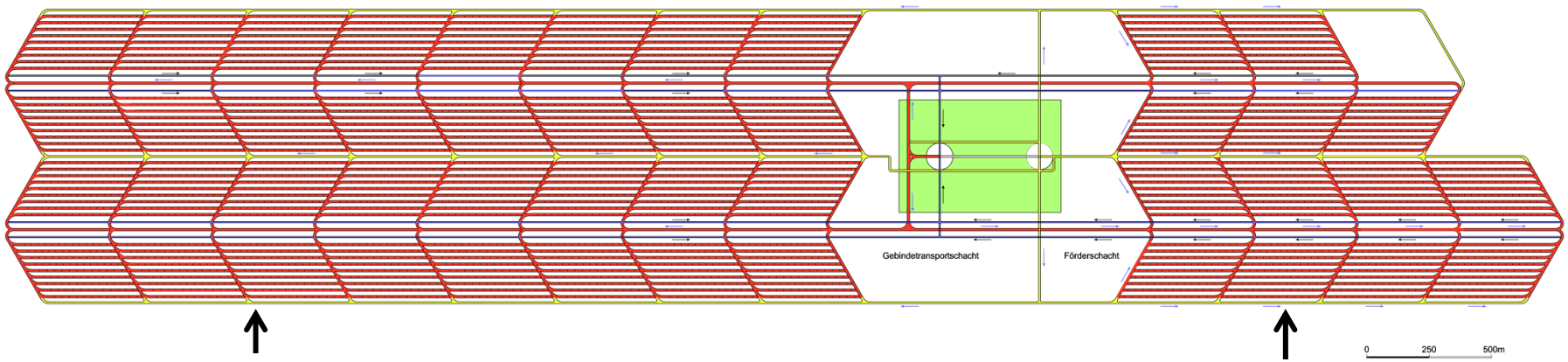


Model SOUTH - drift disposal

Thickness of the Opalinus clay in southern Germany is about 100 m. Thus, vertical borehole disposal is not possible.

Repository Design

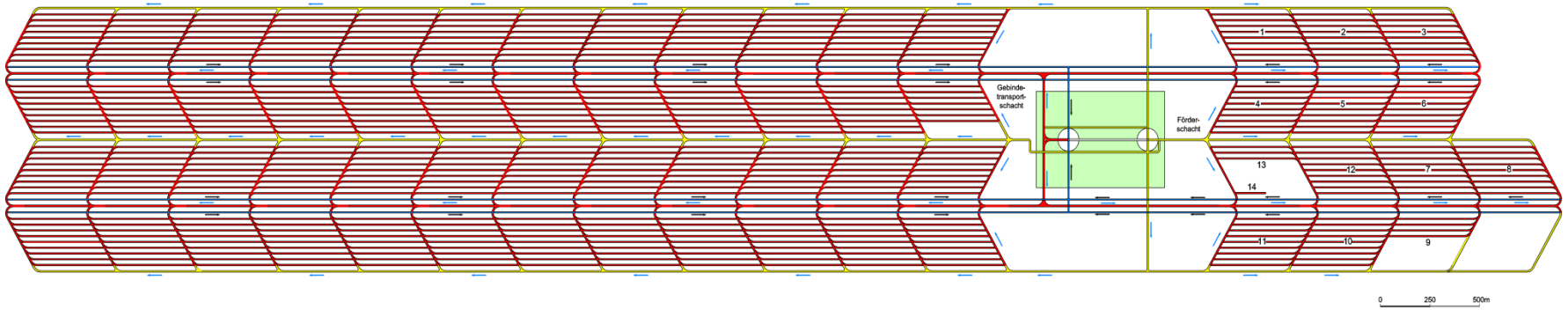
Design NORTH - vertical borehole disposal



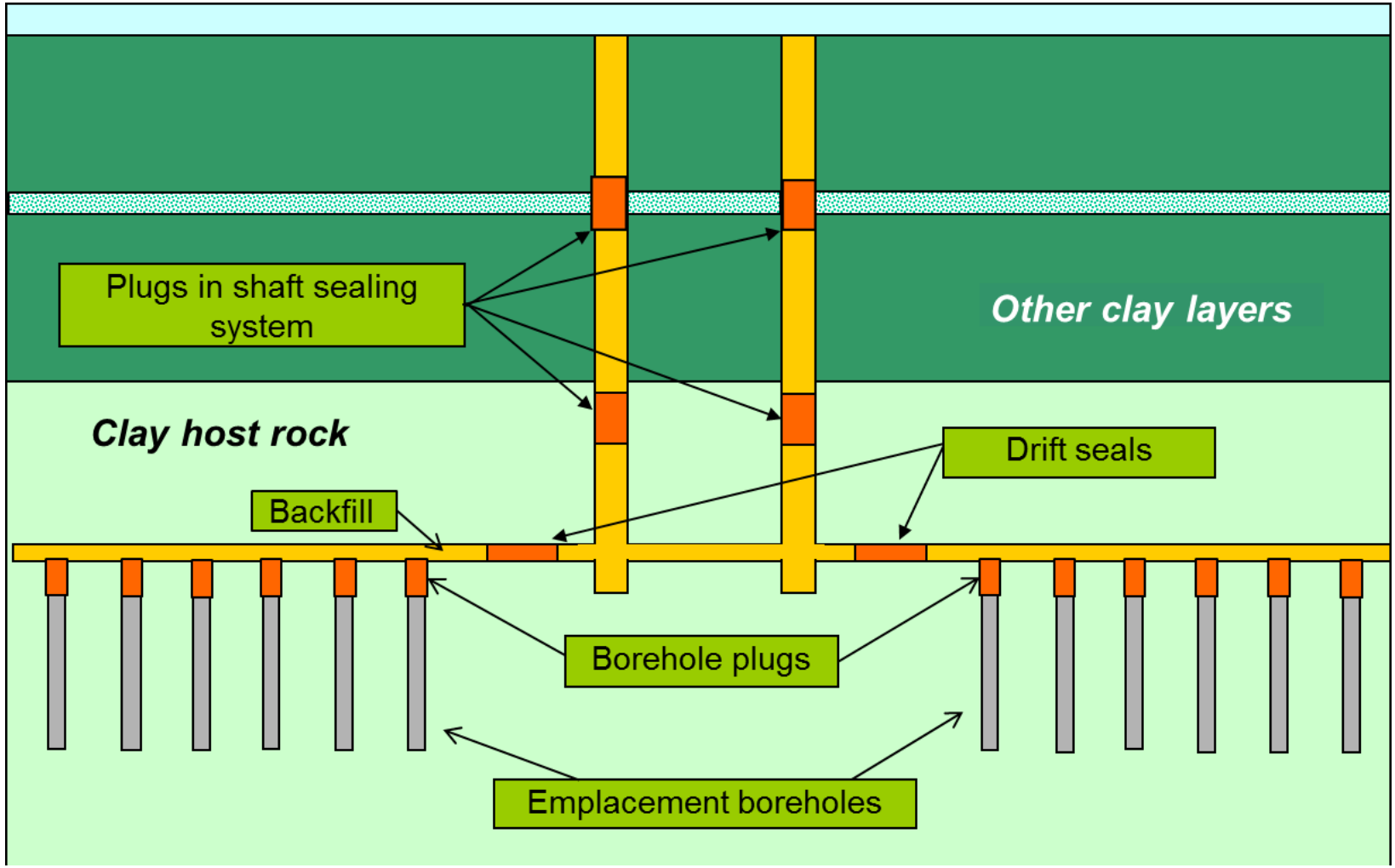
Spent fuel

Vitrified waste

Design SOUTH - drift disposal



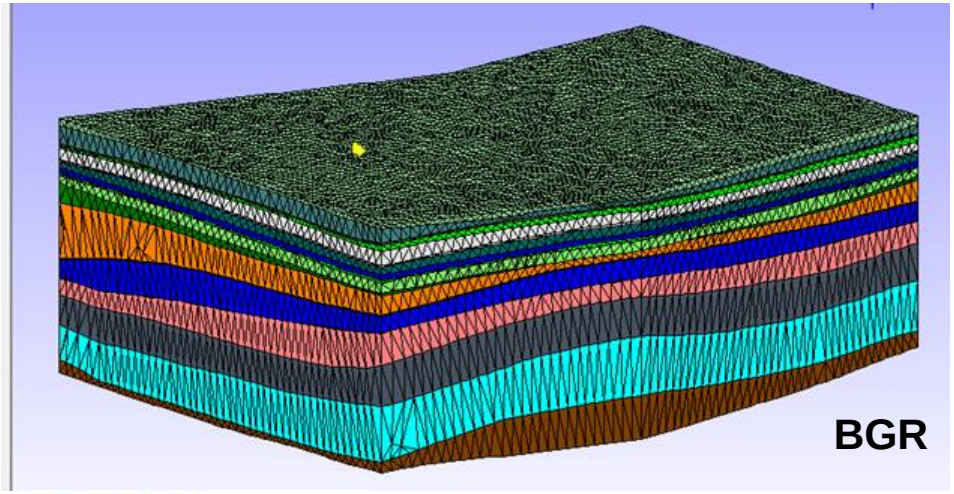
Closure Concept – Schematic Overview (NORTH)

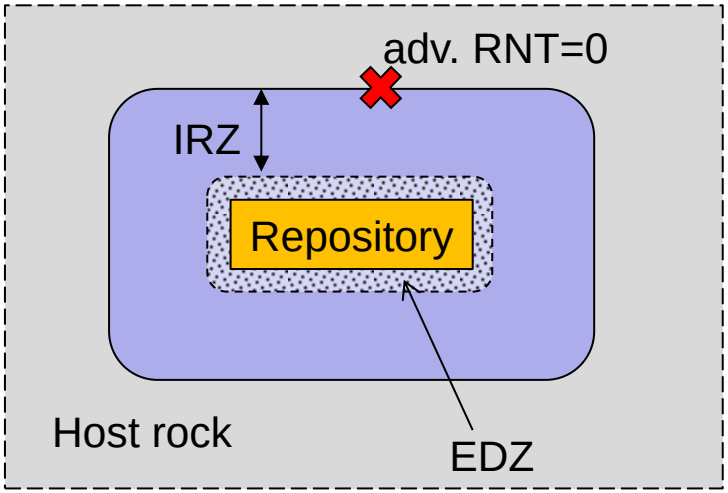


Detailed designs for borehole plugs, drift plugs and for shaft sealing systems are currently under development

The Integrity of the isolating rock zone (IRZ) is assured if the following **4 criteria** are met (preliminary assumptions):

- the advection-criterion: **Adv. RN Transport = 0 at IRZ boundary**
- the temperature-criterion: **T<150°C**
- the fluid pressure-criterion: **($\sigma^{eff} = \sigma^{tot} - \alpha P) > 0$** (no tensile stress)
- the dilatancy-criterion: **$\sigma_D = 0.5 \cdot \sigma_F$**





OpenGeoSys Project
OpenGeoSys

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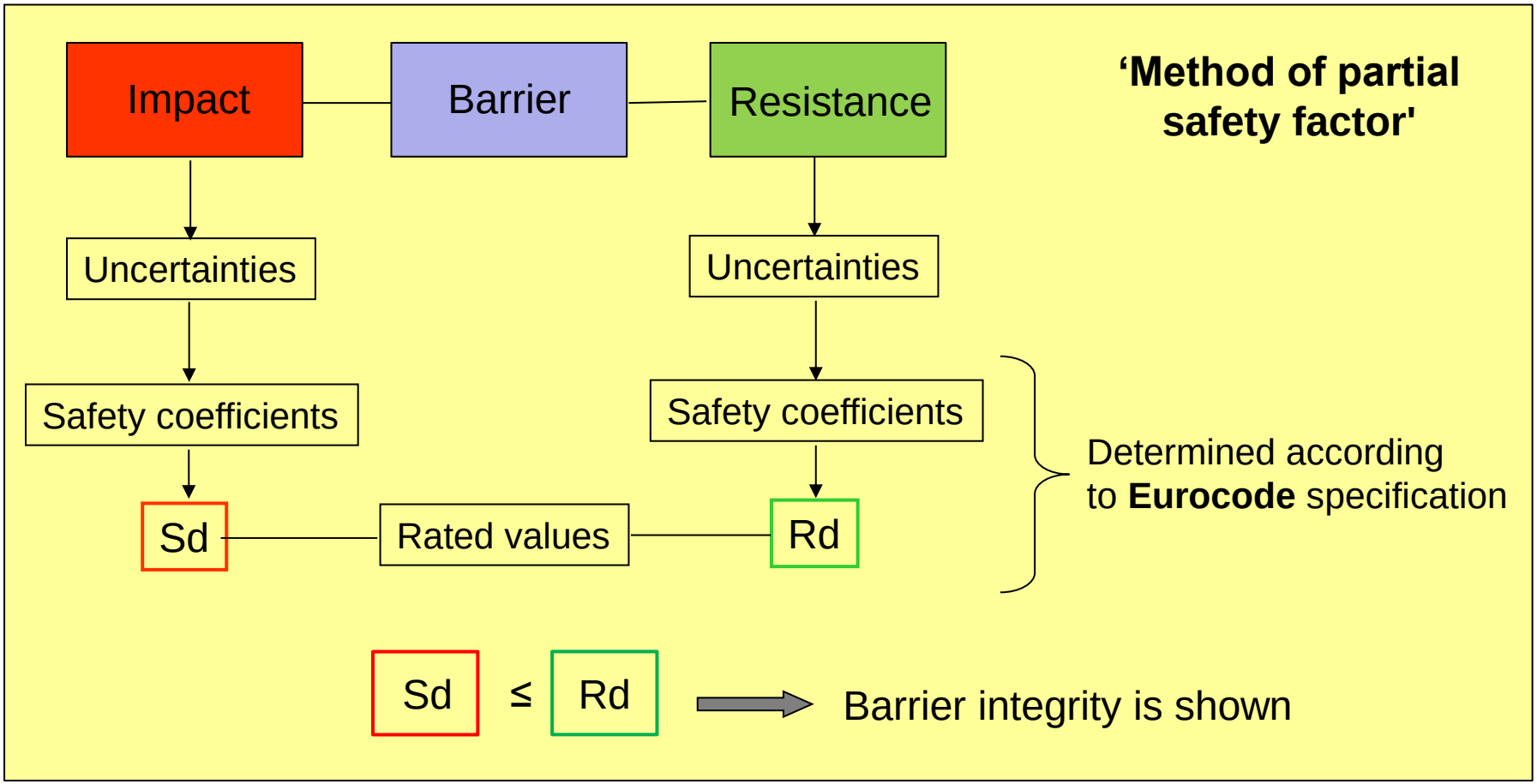
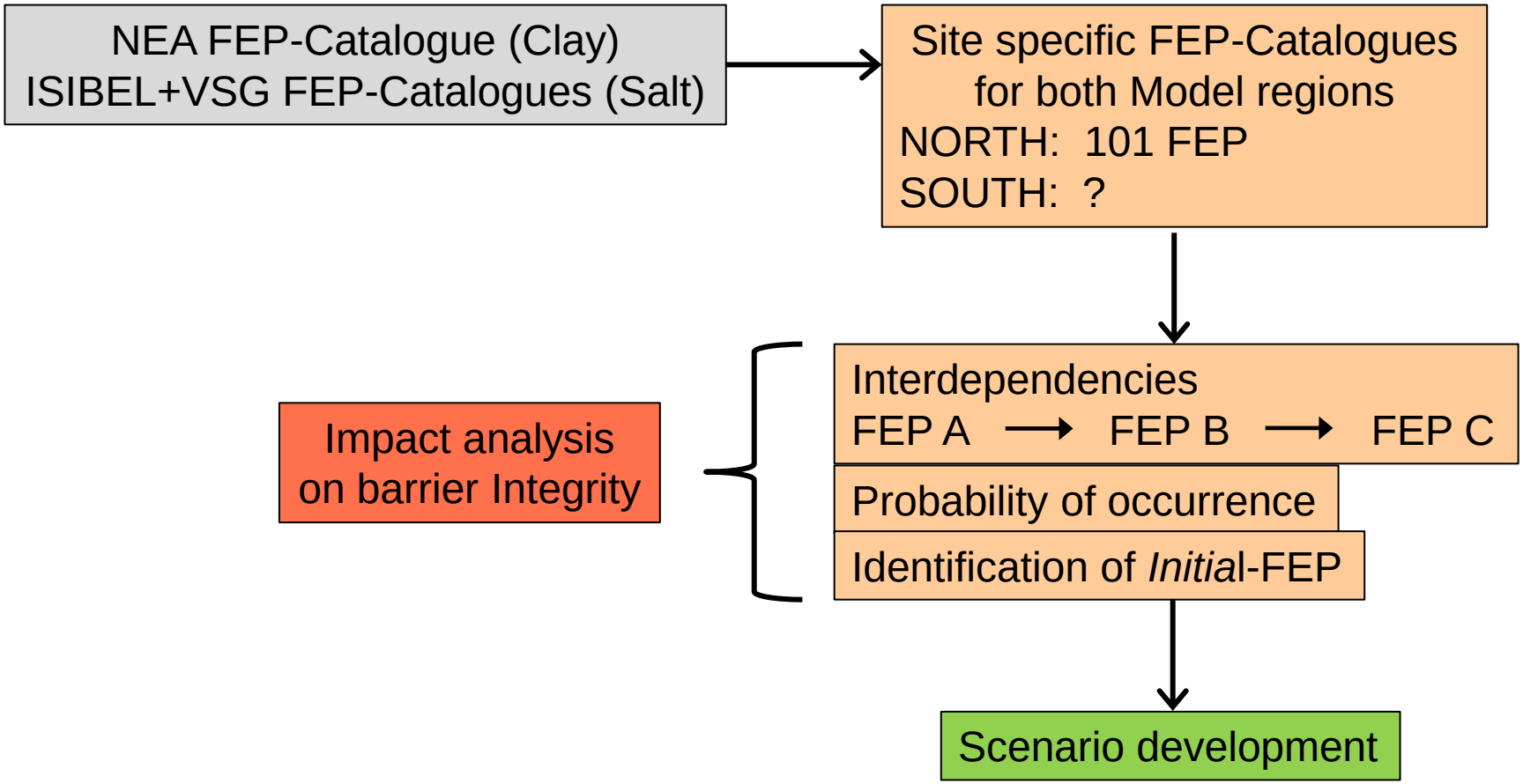


"Non-standard" buildings can be handled by applying the European Standard called EUROCODE which comprises structural engineering rules for individual buildings.

The EUROCODE allows for applying a consistent safety demonstration concept for the different barriers within a repository ⇒ consistent safety evaluation.



Initial-FEPs are FEPs with direct impact on a barrier

probable

- Specific assumptions
- *Initial*-FEPs in probable characteristics
- FEP „Transport of radionuclides“ in a probable characteristic

Reference-scenario

- Alternative assumptions
- *Initial*-FEP with less probable characteristics
- Less probable FEP
- FEP “Transport of radionuclides” with less probable characteristics

Alternative-scenaria

less probable

Conclusions – Current Status

Geological models N/S
Geoscientific long-term prediction N/S

Disposal concepts N/S
Repository design N/S
Closure concepts N/S (Draft versions)

FEP-Catalogue N
FEP-Catalogue S (started)

Analysis of geological barrier integrity N/S (started for N)
Analysis of geotechnical barrier integrity N/S (started for N)

Scenario development N/S
Radiological consequence analysis N/S

Evaluation of the methodology for the safety assessment

Thank You !

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