



Long-term safety approach for the Cigéo disposal

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The safety case is a masterpiece of the license application files

- ◆ Collection of arguments and evidence to demonstrate the safety of a disposal facility

It covers the whole lifecycle of the planned facility (from conception to post closure)

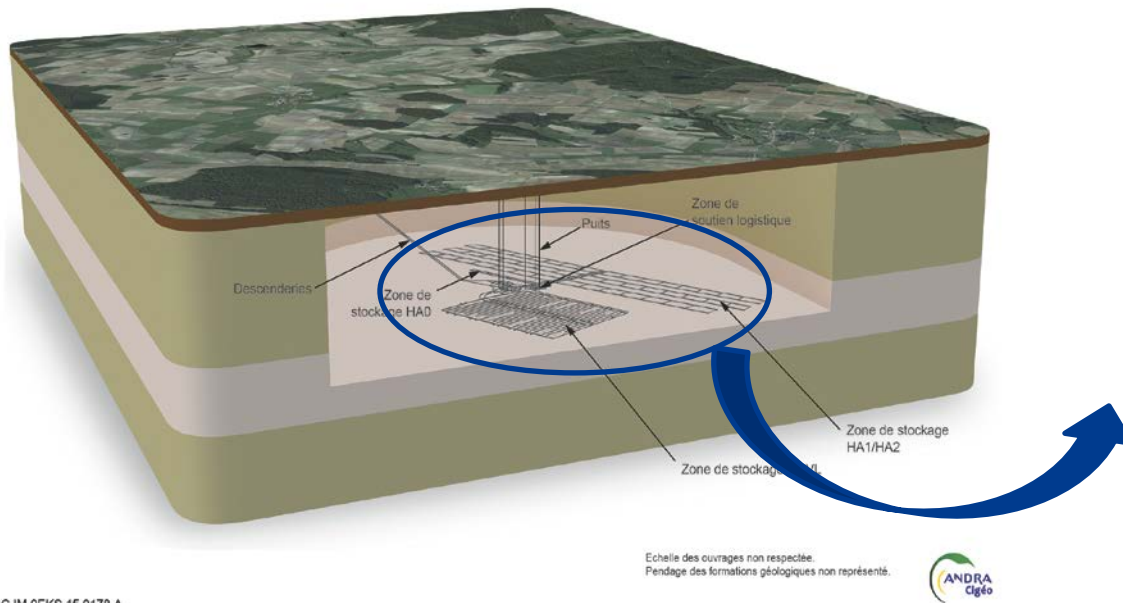
- ◆ It presents assessment of radiological and non radiological risks.

It's periodically reviewed during the operation of the facility to :

- ◆ Update the information about the facility and its operational conditions
- ◆ Check its conformance to regulation requirements and to the safety demonstration
- ◆ Compare the safety level to more recent facilities

1- To isolate the waste from human actions and surface phenomena

- ◆ The site and the depth of implementation of the disposal
- ◆ Design measures
 - example
- ◆ Without to depend onto an institutional control on which it cannot be relied on after a period of time
 - Preservation of the memory, as long as possible after closure of the disposal



A geological disposal :

- Located at depth of about 500m
- Limited and grouped access structures
- Long length vault and galleries

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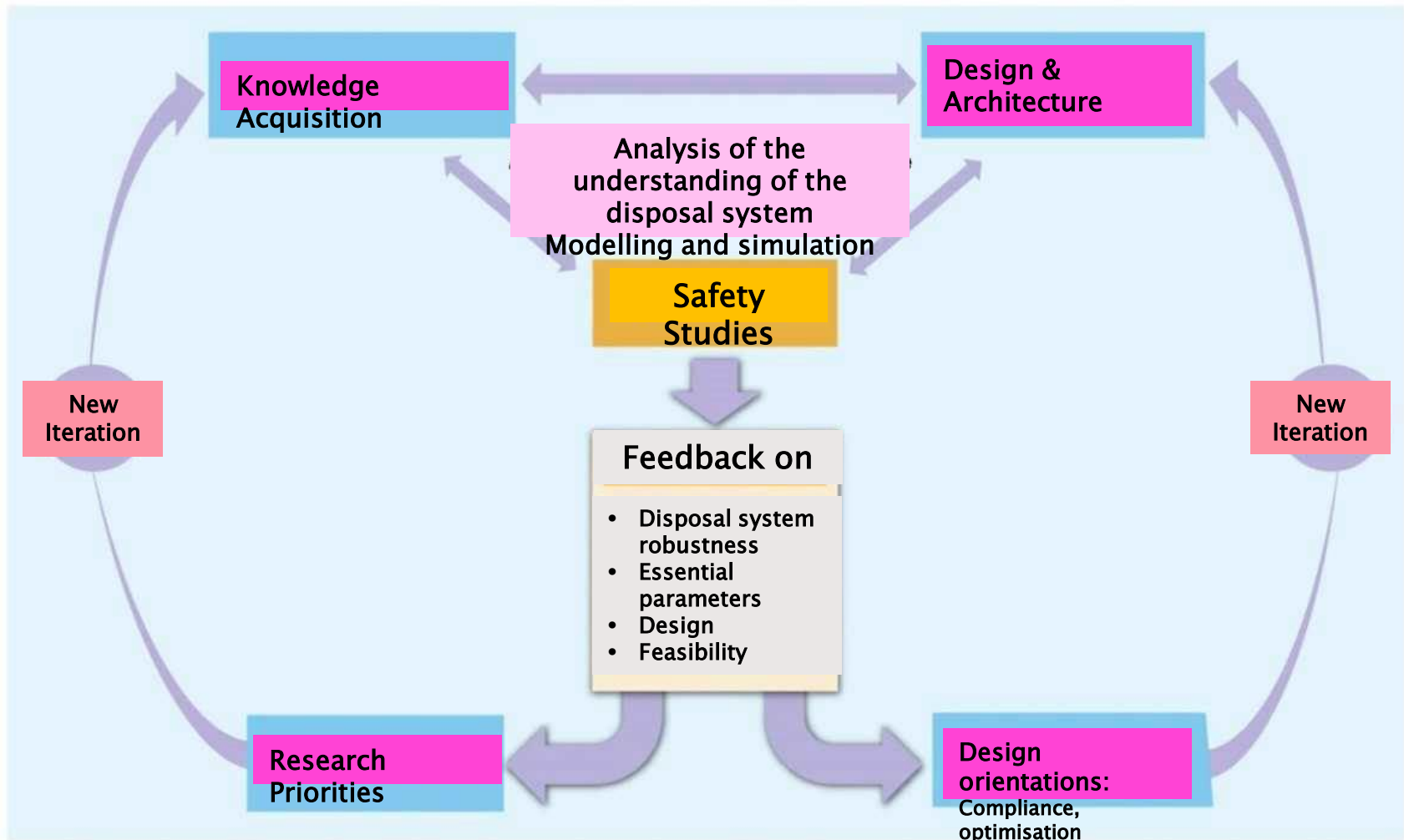
2- To limit the transfer of radionuclides and chemical toxics from the waste to the biosphere

- ◆ To limit the circulation of water
- ◆ To limit the release of radionuclide and chemical toxics from the waste and immobilise them (in the disposal structures)
- ◆ To delay and attenuate the migration of radionuclides and chemical toxics which are potentially released from the waste

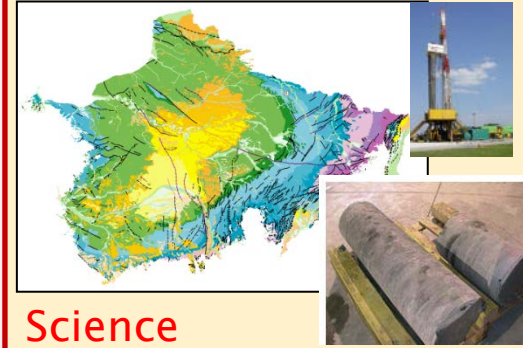
3- To limit physico and chemical interactions in the disposal

- ◆ Use as much as possible well known material
- ◆ Simplification of processes (thermal, mechanical, hydraulic, chemical, radiological) and their coupling to account for

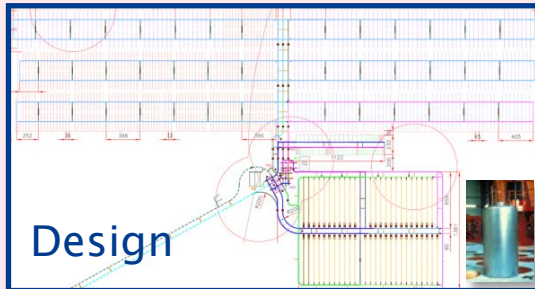
4- To manage criticality



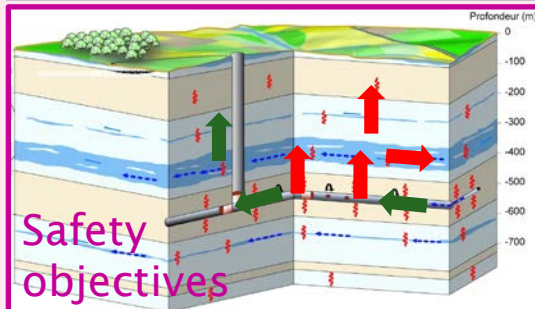
Basic models and data acquisition (wastes, materials, site) from laboratory demonstrators, numerical simulation



Science



Design



Safety objectives

*Integration, analysis, hierarchy
Uncertainties of all kinds models/data*

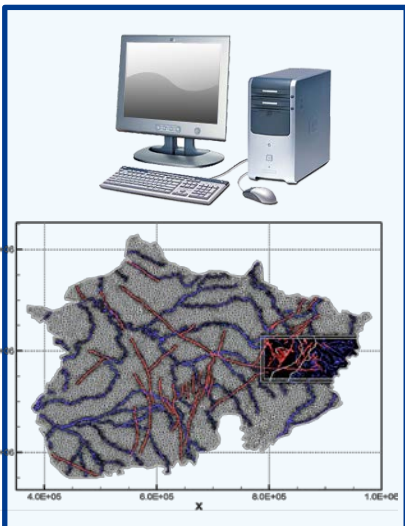
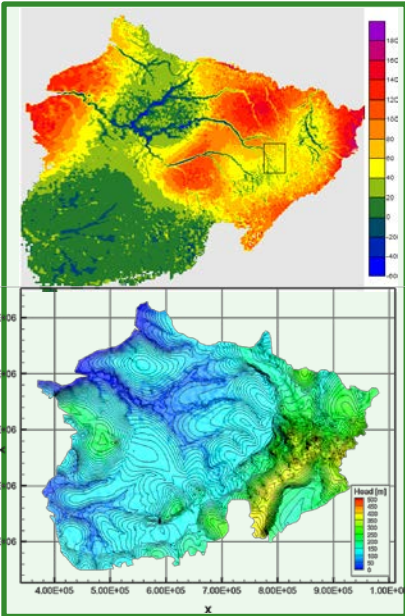
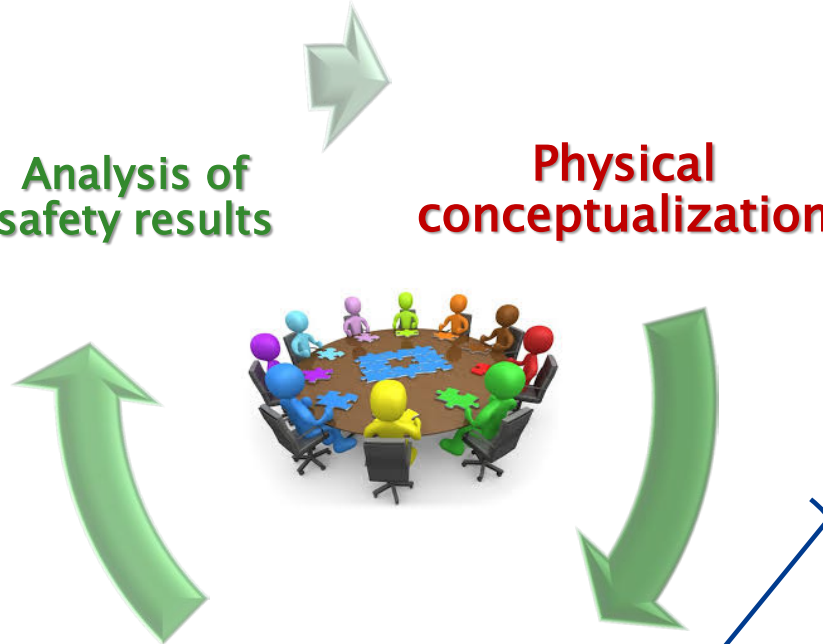
Analysis of safety results

Physical conceptualization

Numerical conceptualization

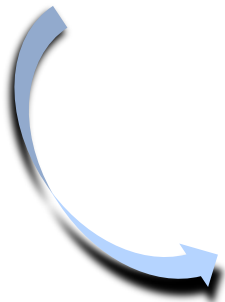
Safety model

Use of codes
Numerical set up



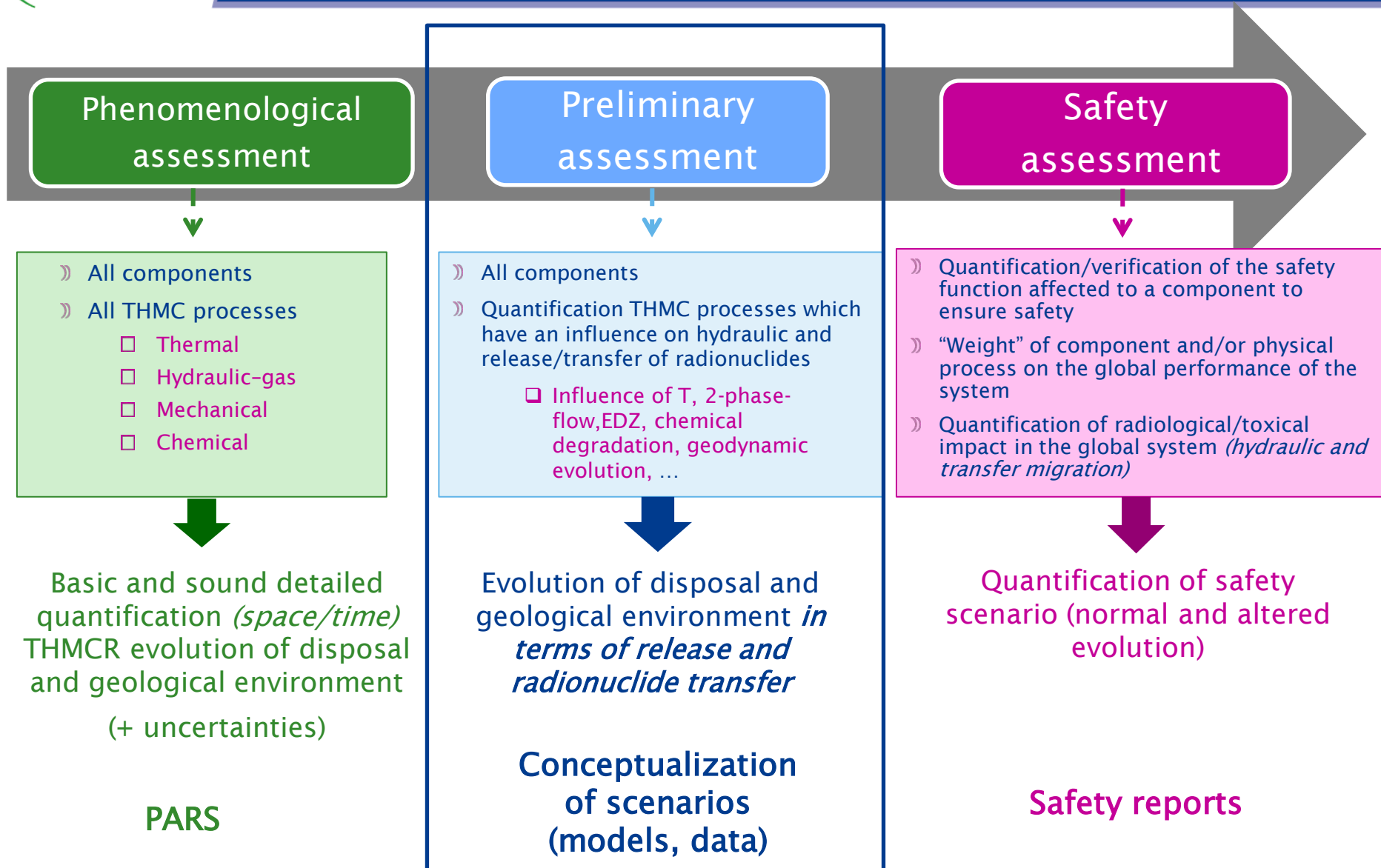
Development of scenarios constitutes the fundamental basis

- » for the quantitative assessment
- » as well as the choice of data and models to assess the scenarios



Types of Scenarios

- » Normal Evolution Scenario
- » Altered Evolution Scenario
- » What if scenarios
- » Human intrusion scenarios

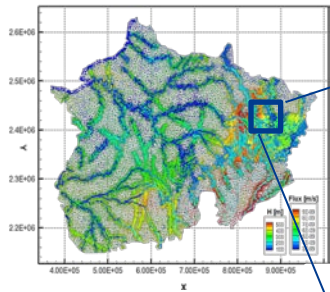


Components of safety model to be taken into account

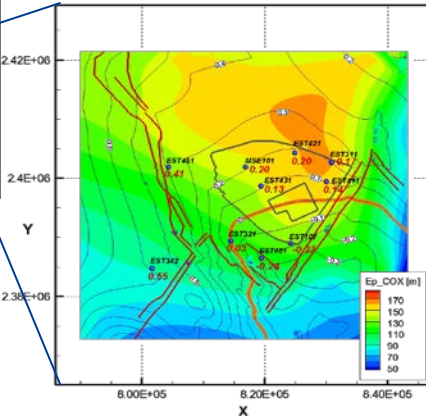
Reference
Hydrogeological
model

Geodynamic evolution

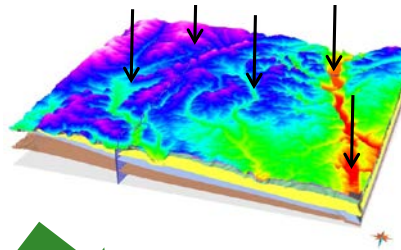
Design option



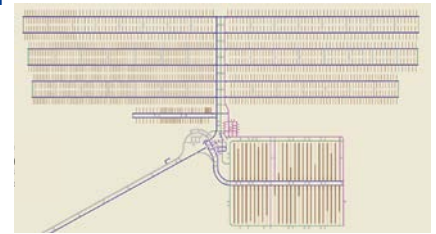
local area



Erosion/uplift/ice phase, ...



Disposal
facility



simplifications

Radionuclide migration

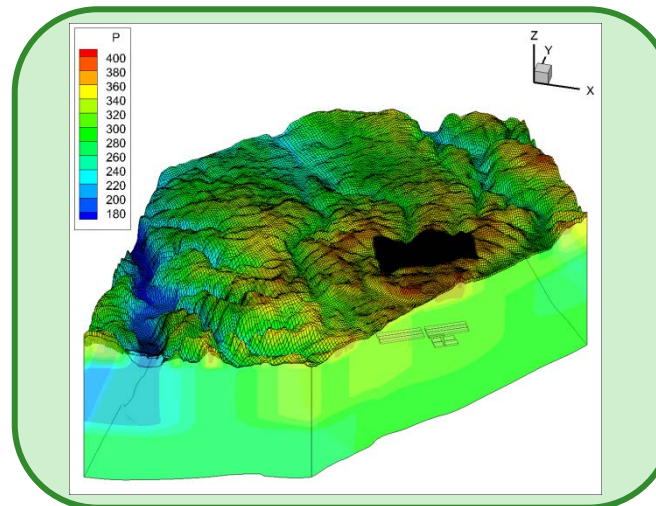
simplifications



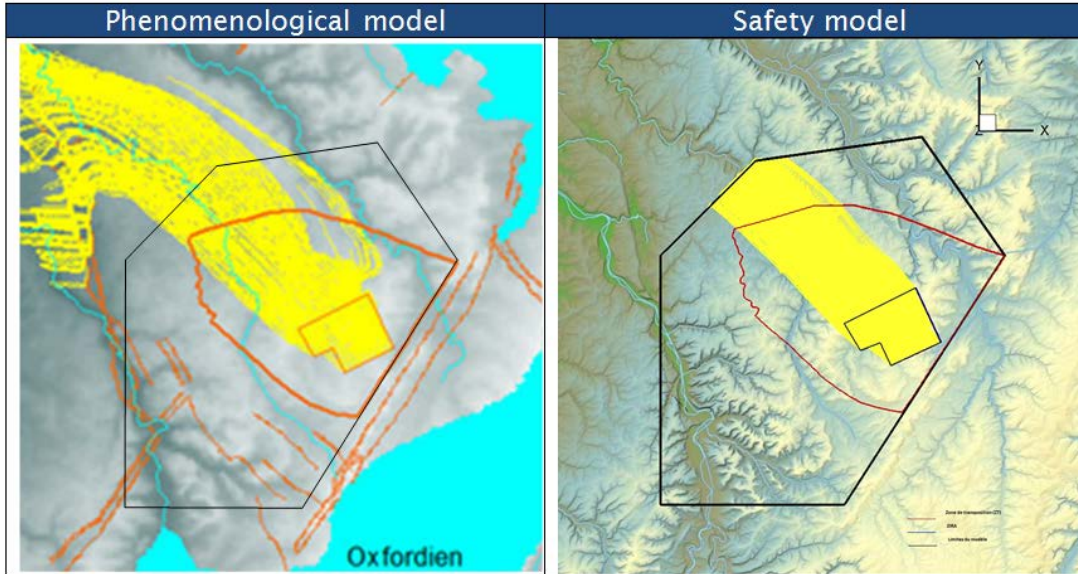
anions/cations/actinides



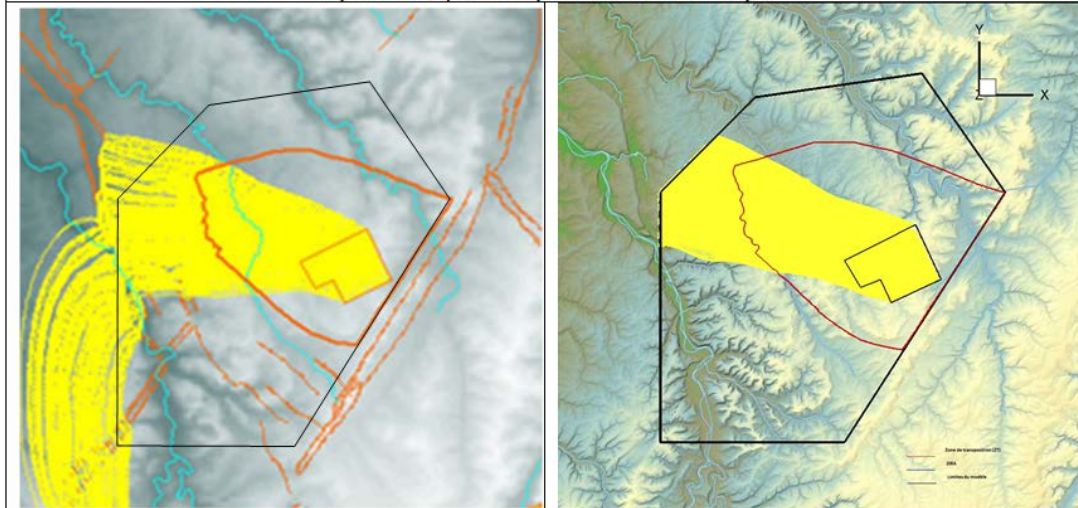
advection, diffusion
Sorption, precipitation



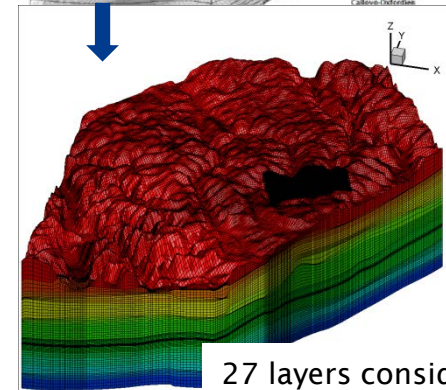
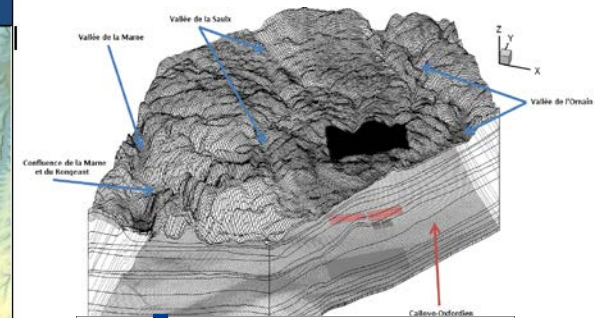
{hydro/transport}
model for safety
calculations



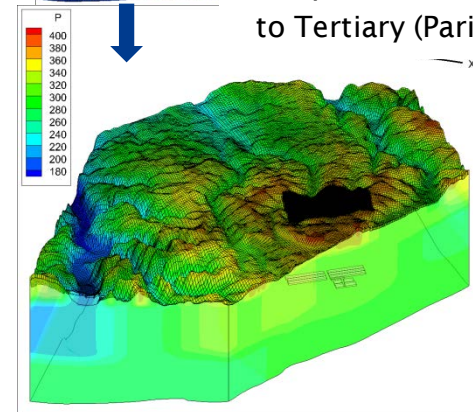
Hydraulic pathway in Oxfordian layer



Hydraulic pathway in Dogger layer



27 layers considered from Trias to Tertiary (Paris Basin)



The post-closure quantitative assessment of Cigéo is based on the values of a set of indicators used:

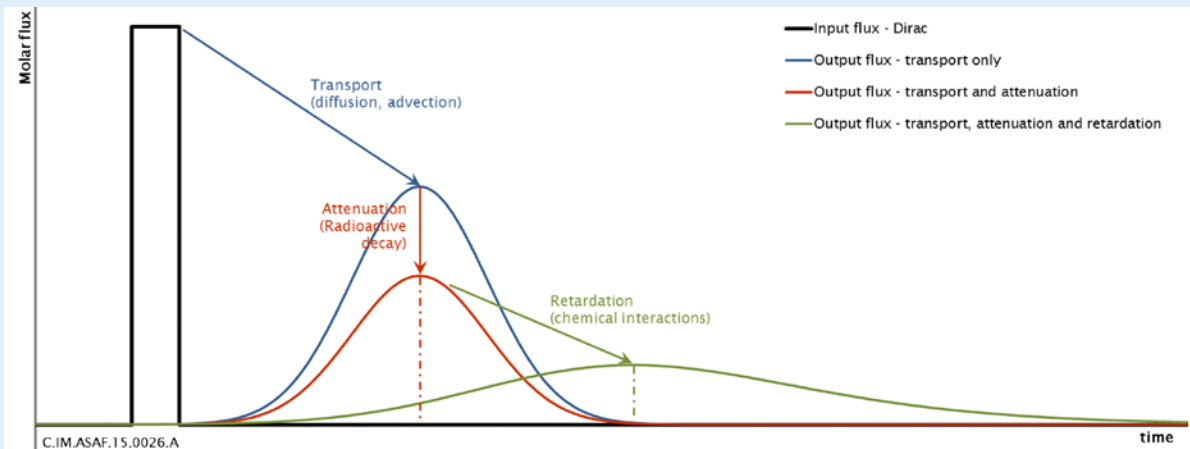
- ◆ to check the individual operation of each component as regards transfers and to assess its performance as regards the post-closure safety functions assigned to it, as well as overall operation
- ◆ to judge the robustness of the repository;
- ◆ to eliminate certain uncertainties. For example, unlike the dose rate, the "radionuclide flow on exit from the host formation" is independent of the uncertainties associated with the surrounding formations and the biosphere.

Examples:

Quantity of radionuclides (and toxic element) releases by the waste over time

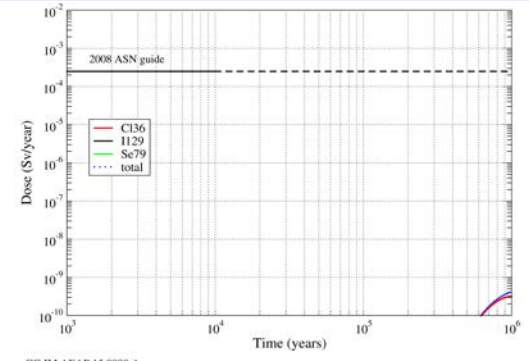
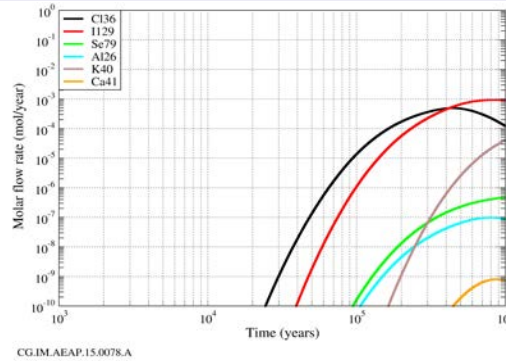
The percentage breakdowns between the water flows and the radionuclide (and toxic element) flows by advection and diffusion within the repository and in the Callovo-Oxfordian

The molar flow rates and activity of the radionuclides (and toxic elements) at the exit from each of the components (package, cell, seals, host formation) over time

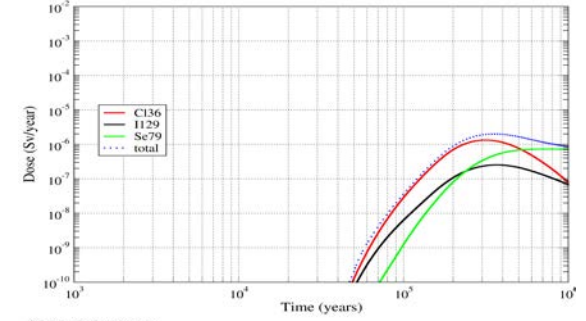
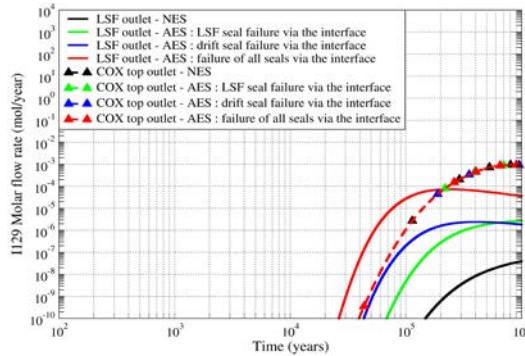


Normal Evolution Scenario

Reference situation



Altered Evolution Scenario Malfunctions of seals



What-if Scenario Malfunctions of all seals

