SITE CHARACTERISATION IN THE FRENCH SEDIMENTARY/CLAY ROCK PROGRAMME, CLOSE TO CONSTRUCTION LICENCE SUBMISSION

J. Delay IGDTP-EF8 04/12/2018

Siting process : general overview (1)

Safety Authority

Safety guidance for each disposal

ASN – Autorité de sûreté nucléaire

Public stakeholders

Decision-making process at the national, regional and local levels
Public inquiry process
National public debate
Economical impacts - benefits

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information and consulting
recommendations

Reviewers

- OPECST (Parliament)
- ASN (Nuclear Safety Authority)
- CNE (National review board): reviews progress and results as provided by the 2006 law, reports to government and parliament.

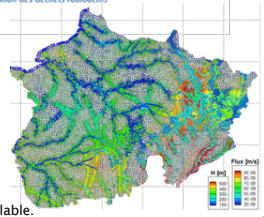
cne²

Assemblée nationale

implementer and operator of radioactive waste disposal

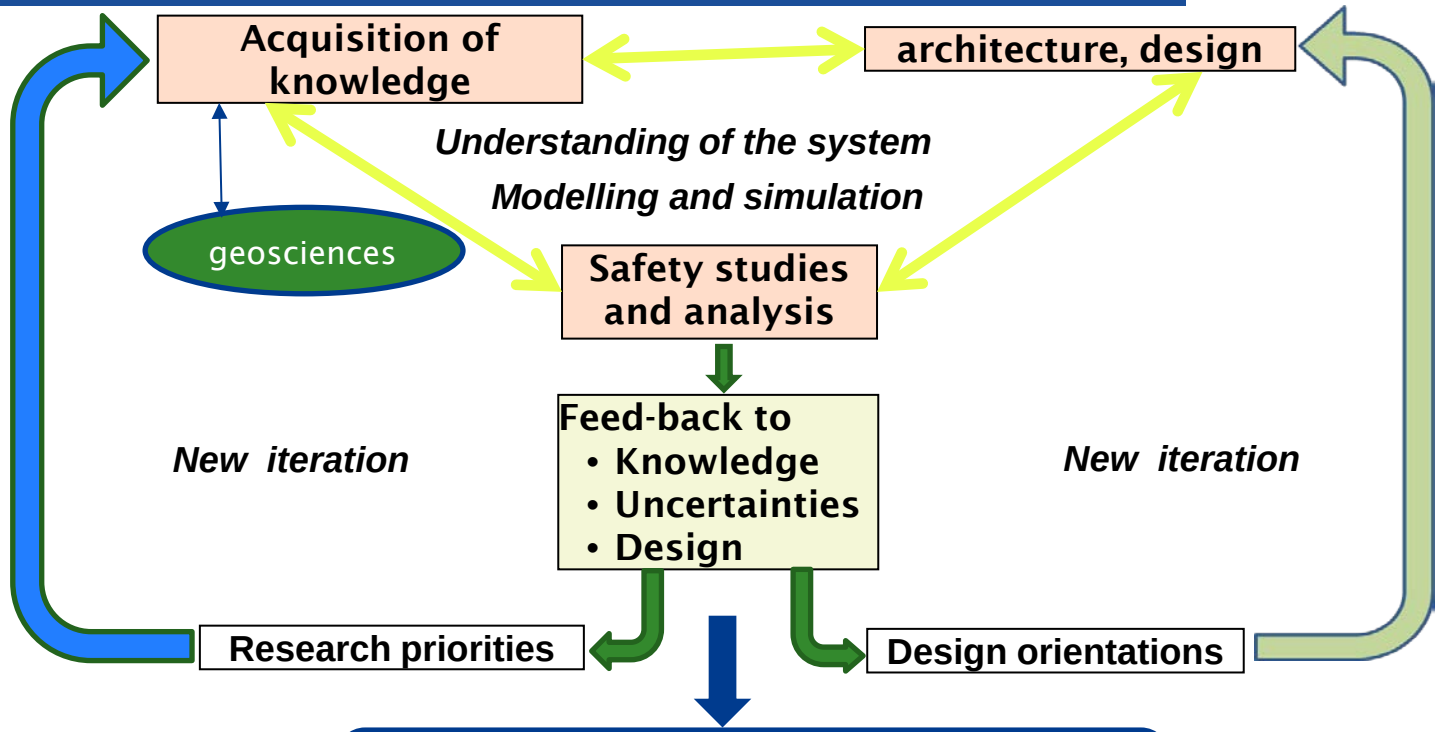
ANDRA – Agence nationale pour la gestion des déchets radioactifs

Responsible for siting



ANDRA

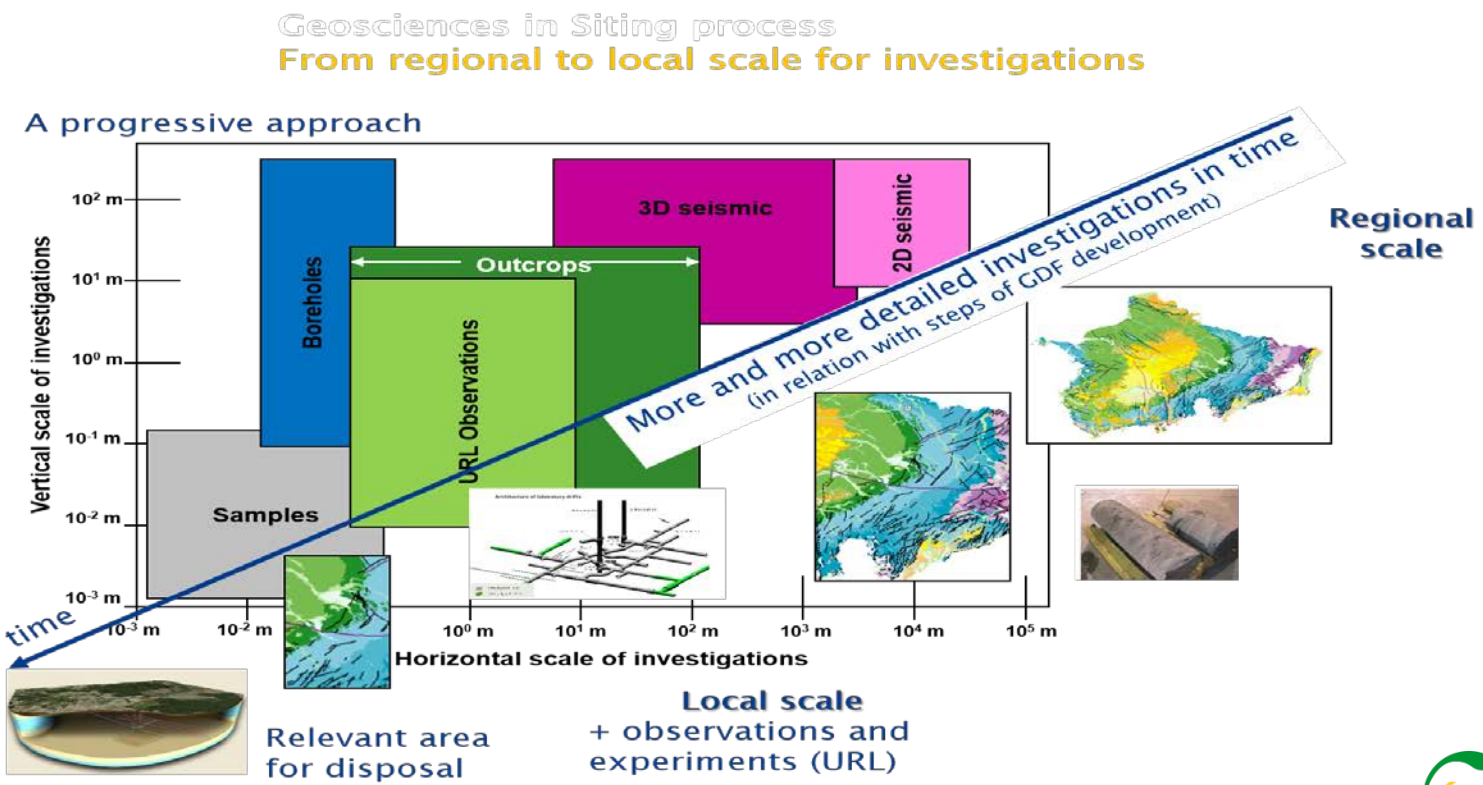
Siting process : general overview (2)



new iteration each 4 years

Siting
Definition of a more and more suitable area according to progress in {science/safety/design}

Geoscience in Siting Process



Early phase : 1992-1998 period
Selection of Meuse/Haute-Marne site for URL

1991

Passing of Law No.91-1381 of December 30, 1991 concerning research on the management of radioactive waste, known as the **« Bataille »** Law.

1994

Geological surveys on 4 sites approved by the Government for the construction of underground laboratories in order to study the feasibility of deep disposal.

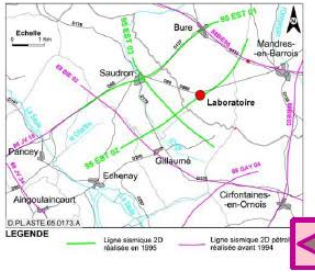
L 1998

The Meuse/Haute Marne site is selected by the Government to host an underground laboratory.

Selection of 4 Haute-Marne, Meuse, Vienne and Gard districts

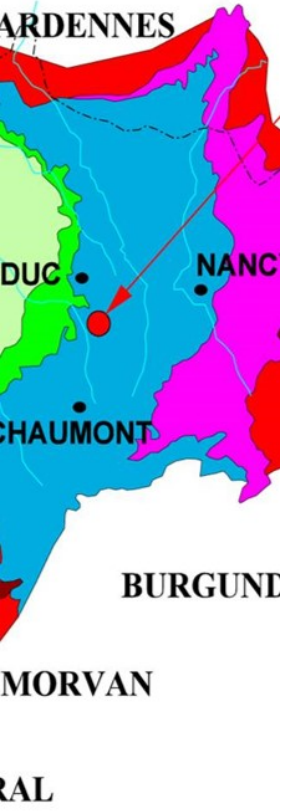
Geoscientific knowledge

- Existing geological data
  - Data from previous exploratory wells for oil and gas industry
  - Re-interpretation of previous seismic profils data
  - Geological/ hydrological databases
- First geological surveys
  - 2D sismeic *(700 km² of mapping, 3 new 2D seismic profiles, …)*
  - Boreholes *(6 wells)*
- First global properties of host rock *(thickness, permeability, diffusion, …)*
- Preliminary safety assessment (DAIE exercise)



Decision to build an Underground Research Laboratory (URL) in Meuse/Haute-Marne districts

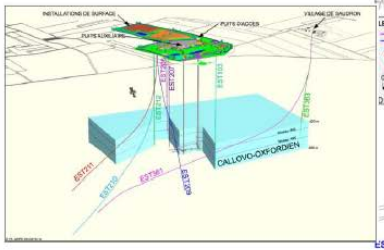
Early phase : 1999-2005 period (1/2)
Definition of « Transposition zone of URL results »

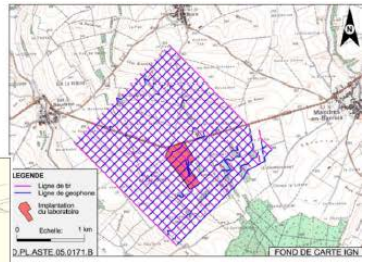


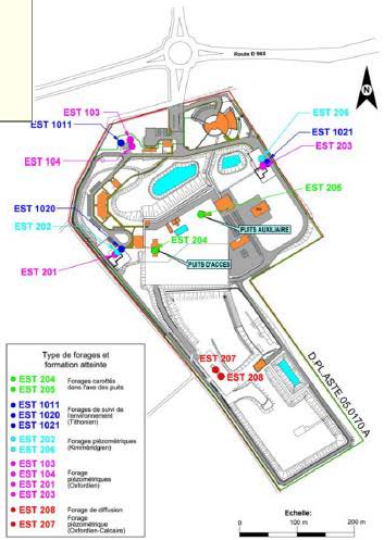
Construction of Laboratory

Increase of Geoscientific knowledge from many means

- 3D seismic survey (4 km²)
- Drilling survey
  - 10 boreholes local area
  - 16 boreholes in/around URL
  - 4 inclined boreholes
- 2 shafts and about 500 m of drifts



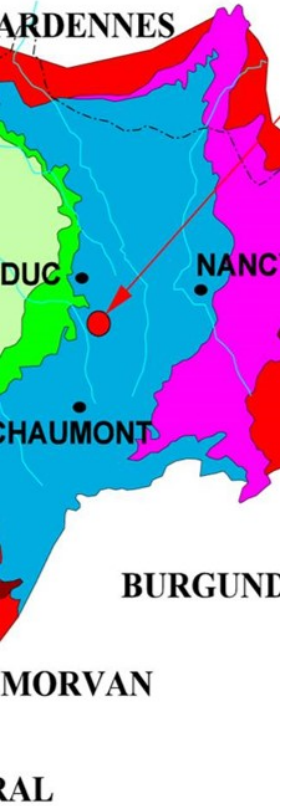


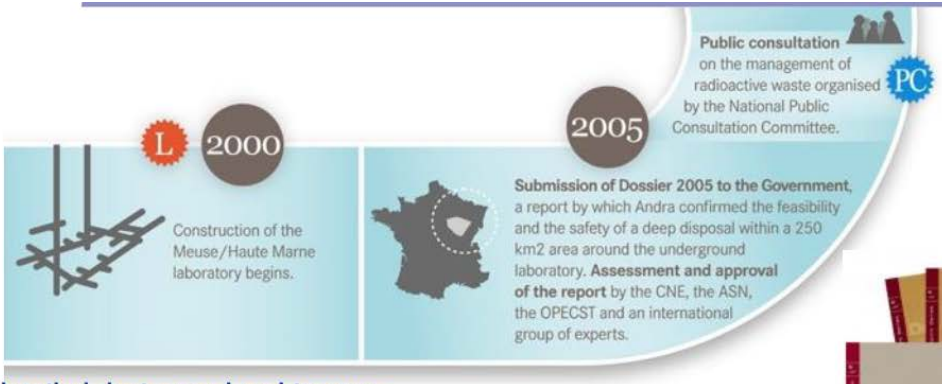


Proposal, approved by government

Definition of « Transposition zone of URL results »
(250 km² geo-properties equivalent to URL)

Early phase : 1999-2005 period (2/2)
Feasibility of deep geological disposal





First detailed design and architecture

Geoscientific knowledge

- Stable geological environment : low probability of seismic events
- Homogenous and fault-free clay layer
- Thick (130 m at the laboratory site) and homogeneous layer
- Depth > 500 m
- Very low permeability and head gradient in host rock
- Clay rock with high level of retention for many RN

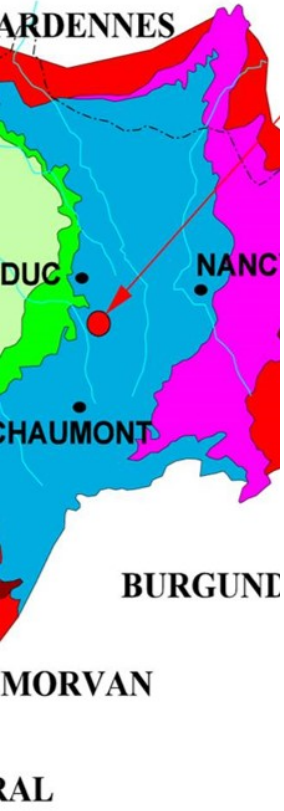
Safety assessment

- Normal and altered evolution scenarios assessed
- Impacts with safety margins

Feasibility of deep geological disposal

Submited to government and reviewers in 2005

Development phase : 2006-2009 period (1/2)
Definition of ZIRA for disposal facility and detailed survey



2006 Law : Disposal concept as the reference solution for the long-term management of HL and IL-LL radioactive waste

Increase of Geoscientific knowledge on "Zone de transposition"

- Reprocessing of previous 2D seismic profils, 140 km
- Aditionnal geological survey
  - 4 boreholes, 10 km drilled dedicated to clay layer, surrouding formations to Trias formation 2000 m deep
- Many THMC data and physical processes from URL and laboratories
- Up-date hydrogeological (regional/local) model and its evolution over 1 MA

Local consultation

Proposal, approved by government

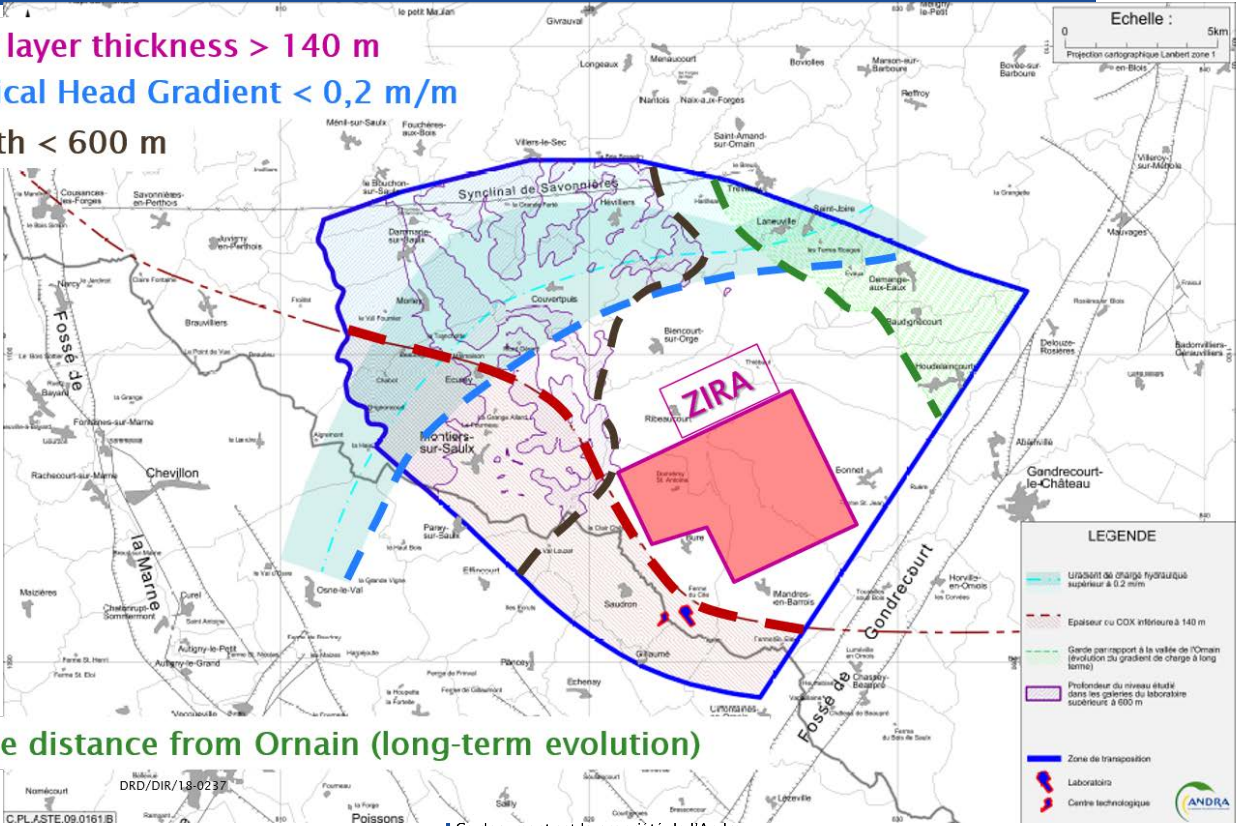
Definition of smaller Area (**ZIRA**) defined for location of disposal facility and detailed geological survey from the surface
(30 km²)

Development phase :selection of the ZIRA

Clay layer thickness > 140 m

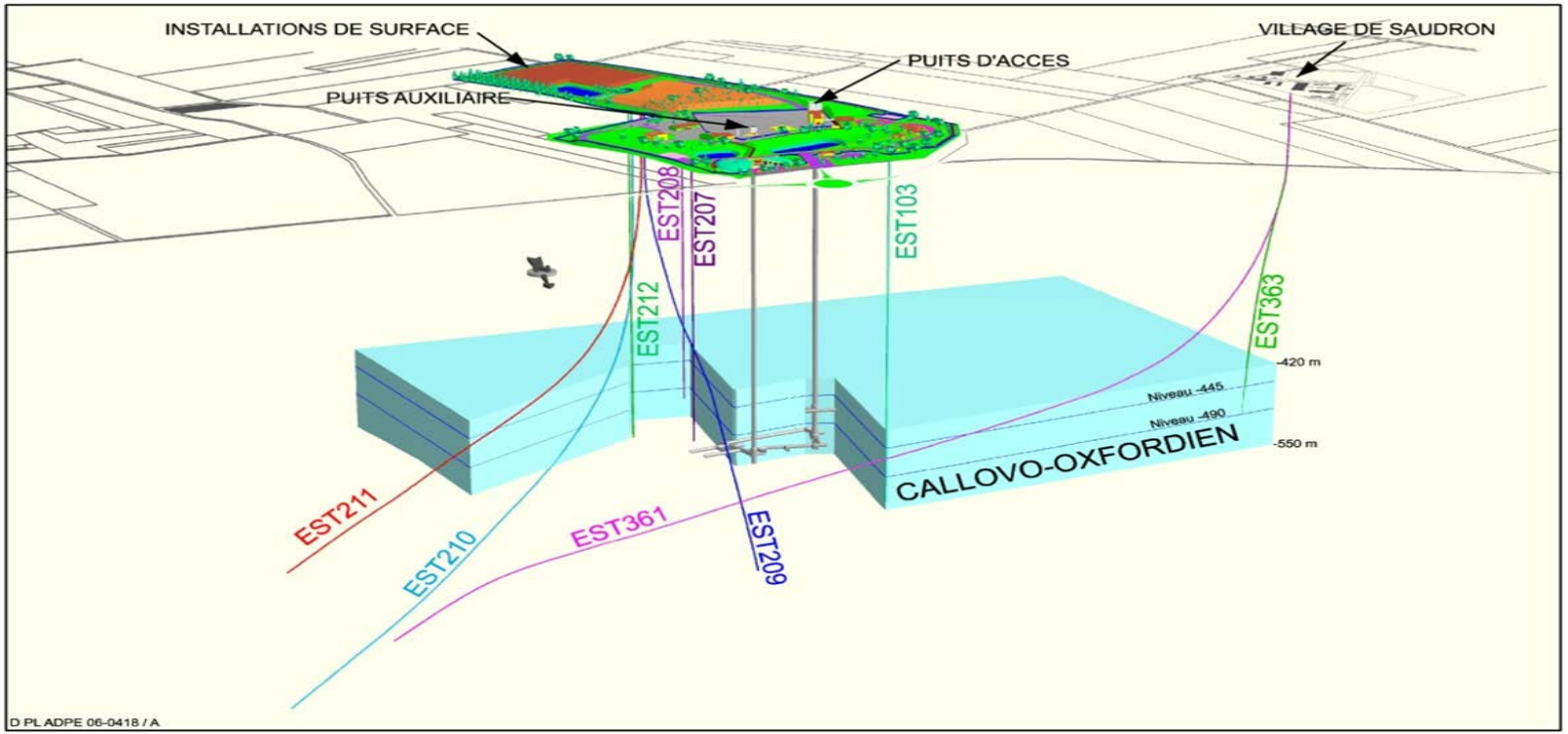
Vertical Head Gradient < 0,2 m/m

Depth < 600 m

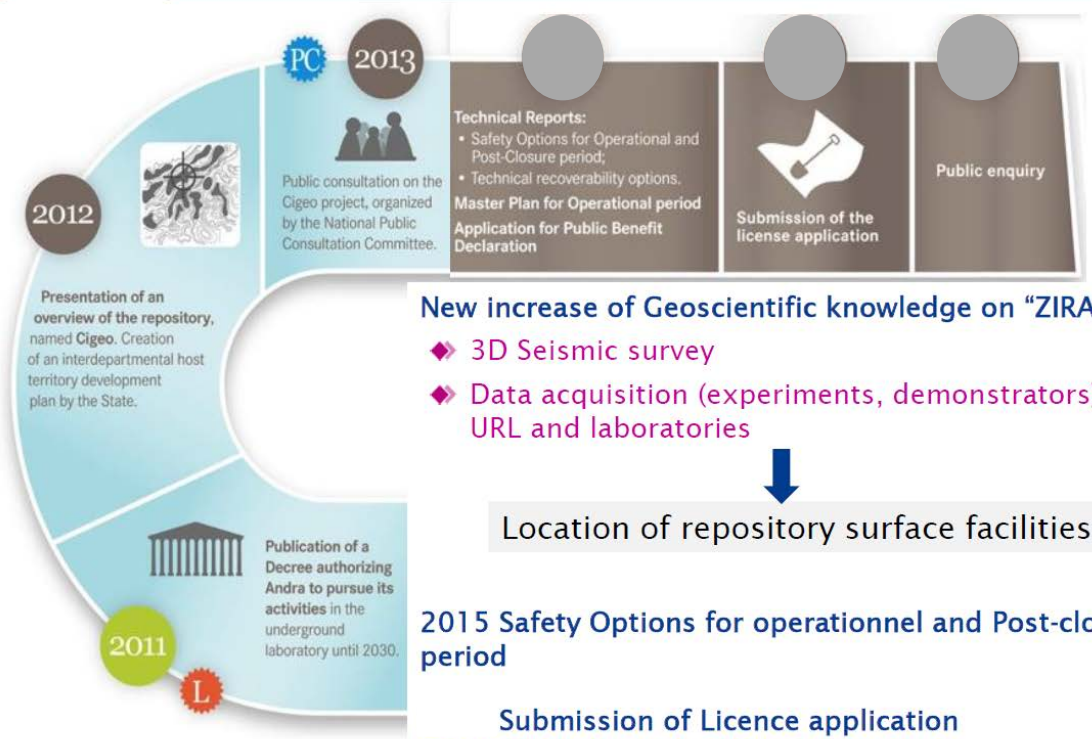


Large distance from Ornain (long-term evolution)

Development phase : Deep boreholes measurements and sampling



Development phase : 2010-2015 period
Location of repository surface facilities



New increase of Geoscientific knowledge on "ZIRA"

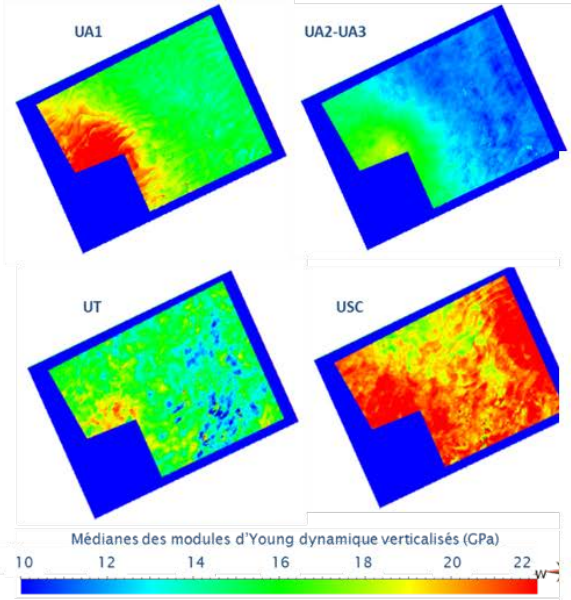
- 3D Seismic survey
- Data acquisition (experiments, demonstrators) from URL and laboratories

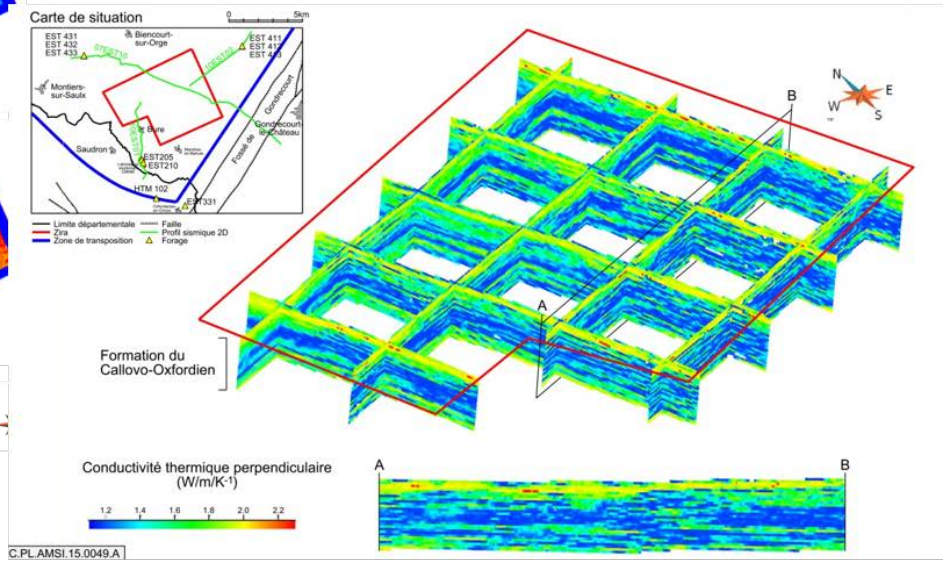
Location of repository surface facilities

2015 Safety Options for operationnel and Post-closure period

Submission of Licence application

Development phase : Main input from seismic 3D interpretation





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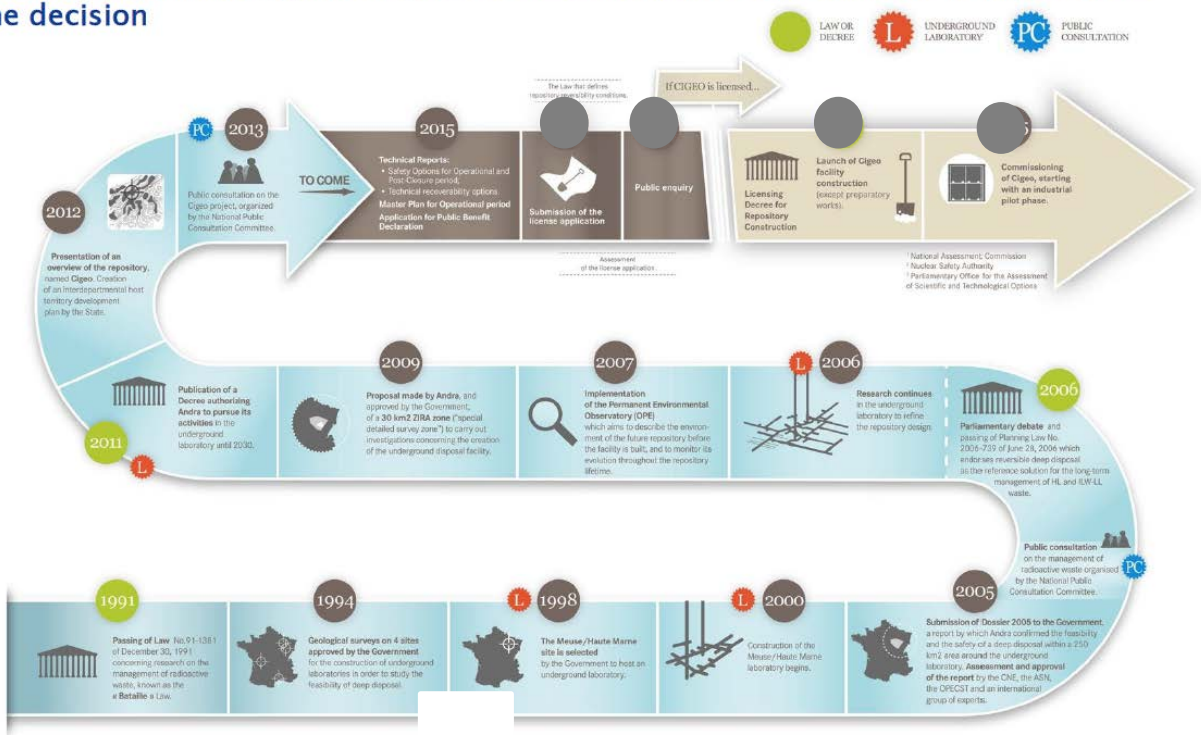
From 1991 to now…
Global overview

At each step of siting process, **geosciences** had, have and will have a **large role in the decision**



Licensing phase and following phases: characterisation driven by construction, operation and safety needs

Characterisation objectives

- Setting up environmental survey network
  - Geological/hydrogeological disturbances,
    - Host layer /Aquifers below and above the host layer
- Monitoring construction and operation of the facility Relevance of safety options for operational and Post-closure period
    - Taking into account development stages of the facility
- Improving modelling : comparison with predictions…
  - Natural/disturbed conditions (Host layer /aquifers; close and far from the facility; Hydro and THM)

Programmes objectives

- Definition of monitoring strategies and tools
- Follow up construction work
- Follow up the incremental development of CIGEO

Characterisation tools : boreholes, monitoring hardware and software…

Conclusion : Feed-back and lessons learnt

A progressive and converging stepwise approach for siting :

- *First step*, Geo-scientific arguments based on « qualitative » criteria (from safety guidance)
  - Geological stability, no fault, « good » hydrogeology », confinement, …

- *Following steps*, definition of geoscientific arguments based on « quantitative » criteria, derived from **geological investigations and increase of scientific knowledge** (Surveys, URL, numerical simulation)
  - Depth, thickness, head gradient, … mainly linked to long-term safety
    - ↳ More and more detailed and suitable area (from regional to local scale)

At each step of siting (about each 4 years), long-term safety assessment is carried out to check global safety

- Checking consistency between {science/safety/design}
  - Quantitative geoscientific arguments plays a major role,

However the characterisation programmes have to take into account local acceptance, local and national administrative requirements…

Conclusion : R&D activities … some thoughts

Horizontal activities

- o Networking (some example)
  - An efficient way to learn is to visit the other sites and meet the people that operated the characterisation programmes
- o Knowledge transfer

Technical improvements

- o Drilling technical progresses (mud, tools, logging probes…)
  - Mont Terri DF experiment
- o Survey technics, sampling and conditioning methods (QA procedures)
- o Development of completions
  - Taking into account all the developments made in URL (Mont Terri, Bure and other…)
  - New transducers and new acquisition chains (Modern 2020)