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

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Siting process: general overview (1)

**Safety Authority**
Safety guidance for each disposal

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

**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.

information and consulting recommendations

implementer and operator of radioactive waste disposal

Responsible for sitting
Siting process: general overview (2)

Acquisition of knowledge

architecture, design

Understanding of the system

Modelling and simulation

geosciences

Safety studies and analysis

Feed-back to
• Knowledge
• Uncertainties
• Design

New iteration

Research priorities

Design orientations

New iteration

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

new iteration each 4 years
Geoscience in Siting Process

A progressive approach

Vertical scale of investigations

10^9 m
10^8 m
10^7 m
10^6 m
10^5 m
10^4 m
10^3 m
10^2 m
10^1 m
10^0 m

Boreholes

Outcrops

3D seismic

2D seismic

Samples

URL Observations

Relevant area for disposal

More and more detailed investigations in time
(in relation with steps of CDF development)

Horizontal scale of investigations

10^9 m
10^8 m
10^7 m
10^6 m
10^5 m
10^4 m
10^3 m
10^2 m
10^1 m
10^0 m

Local scale
+ observations and experiments (URL)

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

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 profiles data
  - Geological/hydrological databases

- First geological surveys
  - 2D seismic (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

- Multi-physical THCM properties on clay layer + geochemistry

HC properties on surrounding formations

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

Submitted 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 profiles, 140 km
- Additional geological survey
  - 4 boreholes, 10 km drilled dedicated to clay layer, surrounding 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 operational and Post-closure period

Submission of Licence application
Development phase: Main input from seismic 3D interpretation
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...
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
- Networking (some example)
  - An efficient way to learn is to visit the other sites and meet the people that operated the characterisation programmes
- Knowledge transfer

Technical improvements
- Drilling technical progresses (mud, tools, logging probes...)
  - Mont Terri DF experiment
- Survey technics, sampling and conditioning methods (QA procedures)
- 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)