OVERVIEW OF THE DISPOSAL FEASIBILITY ASSESSMENT IN MEUSE/HAUTE-MARNE: FROM THE PRELIMINARY GEOSCIENTIFIC SURVEY TO THE SAFETY CASE

P. Lebon
Andra, France

The dossier on disposal Feasibility Assessment in Meuse/Haute-Marne, which was submitted by Andra to the French Government in June 2005, is the result of a long way from the Preliminary Geoscientific Survey in 1994 to the Safety Case. An iterative approach was used, three iteration loops were organised between acquisition of knowledge, architecture and design, safety studies and analysis with milestones in 1996 (URL licensing application), 2001 (intermediary report) and 2005 (Dossier 2005 feasibility assessment). At each step the acquired geoscientific information was used to refine the disposal design and then was transferred to the safety case. Our knowledge has been more and more growing; up scaling and simplification processes have been more and more important issues in qualitative and quantitative safety analyses.

In 1993 the initial selection of potential Underground Research Laboratory sites through proposals from volunteer departments was partly done in regards of the previous potential site inventory. All the volunteer departments were compared wit the areas screened ten years before.

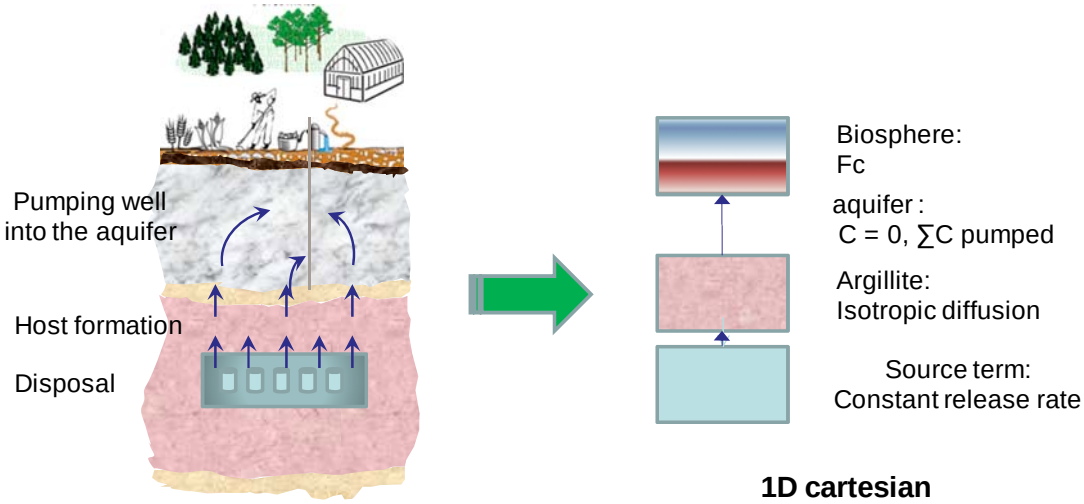
Meuse and Haute-Marne departments cover a main part of “clay” sites with to possible formations the Callovo-Oxfordian argillites and the Toarcian argillites. These formations were studied in 1988-1990 on other site (Aisne). Survey methodology was perfected during this period.

After having compiled all the available data on the Meuse/Haute-Marne site (bibliographic data, boreholes and reflection seismic profiles from oil companies) a preliminary exploratory survey drew on proven methods of prospecting (surface mapping, cored boreholes with wireline logging and hydraulic tests) was carried out from March 1994 to summer 1996. In order to file the licence application of an underground research laboratory, geological features were analysed by reference to Fundamental Safety Rule III.2.f. The essential aspects scrutinised were the site’s internal and external geodynamic stability and its hydrogeological characteristics. The geological context of the sector is:

- A simple and monocline structure (dip: 1 to 1.5° NW).
- An area inside clearly delimited regional faults.
- A sequence barely affected by recurrent tectonics during deposition.
- Tectonics events mainly dated from Tertiary.
- An absence of natural resources.

Robust qualitative arguments were put forward to show the lack of redhibitory element (Lebon and Mouroux, 1999). The other important points highlighted by the FSR (mechanical, thermal and geochemical properties of the rock) were just tackled as a function of depth and used in a brief safety assessment to verify the relevance of the site and to prioritise the researches of the next phase (1997-2001).

Figure 1. **1996 preliminary performance assessment**



Some lessons were learned from this Preliminary Performance Assessment (Lebon, 1999). The radionuclide transport model in argillite seemed robust, but it remained two questions:

- Could EDZ around the disposal drifts change this transfer pathway?
- Could advection be sometimes dominating?

Confidence in PA may increase by confirming the diffusion coefficient values by other ways and using more realistic actinides K_d values than the conservative ones used at this stage. Even if the Callovo-Oxfordian formation is the main isolation barrier, what is a necessary and sufficient transport characterisation for carbonate formations?

The second phase of the programme (1997-2001) concerned the basic design options for the disposal of each waste type (needed surface, cell shape) and required to review the geological data, notably the geometry and variability of the host formation. The hydrogeological and geological data were also used to build a first hydrogeological modelling of the site. The key issues of preliminary performance assessment were addressed to the programme. Notably, to verify if diffusion prevails even locally, because there are certainly some discrete fractures not yet detected, a 3-D seismic-reflection survey was carried out around the URL and two orthogonal URL drifts oriented according to regional faults envisaged to detect fracturation within the Callovo-Oxfordian formation and to measure its transport parameters. To quantify the scale effects on De measurements and the diffusion at other timescales, palaeo-circulations were analysed by means of natural radio-isotope tracers (looking for elements as self-analogues) sampled in the 6 boreholes on the URL site.

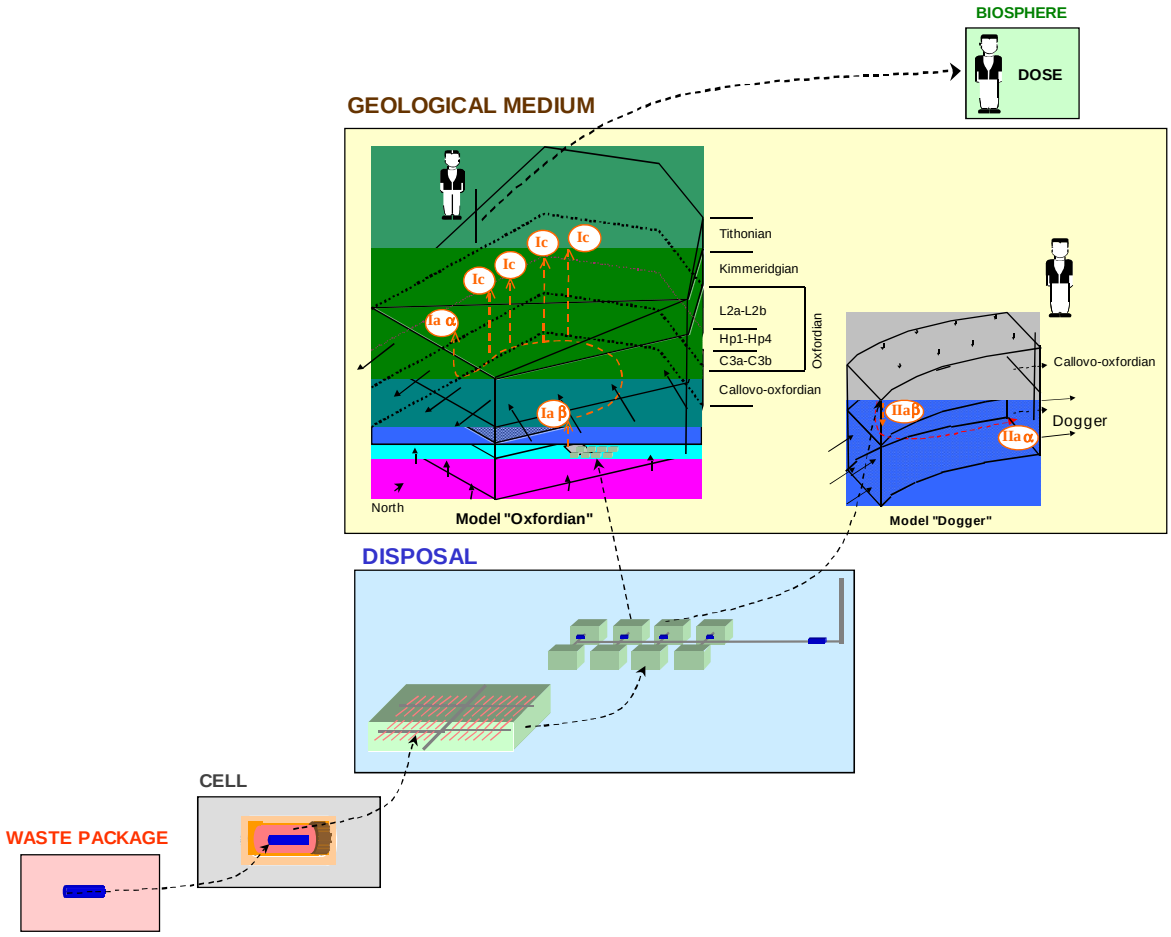
These boreholes allowed also studying in more detail the important parameters from FSR point of view:

- For THM the constitutive behaviour and properties of argillite to assess the drift stability, and to determine the effects of disturbances induced by a repository on the confinement.
- For geochemistry the chemical composition of the pore water and the retention parameters of radionuclides, to determine the confinement capability of the host formation.

This phase ended in December 2001 with a methodological dossier, especially when considering the long-term safety analysis. The safety assessment was based on systematically pessimistic and unfavourable hypotheses, but allowed to identify components with a particularly sensitive role in the

robustness of a repository. This intermediary performance assessment represented a great change in regards of the previous one, even if the geological medium was still very simplified. A modelling line consisting in 1-D to 3-D models was used as shown in Figure 2, helping to select repository concepts amid a fairly wide range considered up to now

Figure 2. **2001 Intermediary performance assessment**



The next research programme was focused on safety key issues (Landais, 2004), e.g. for the geological medium:

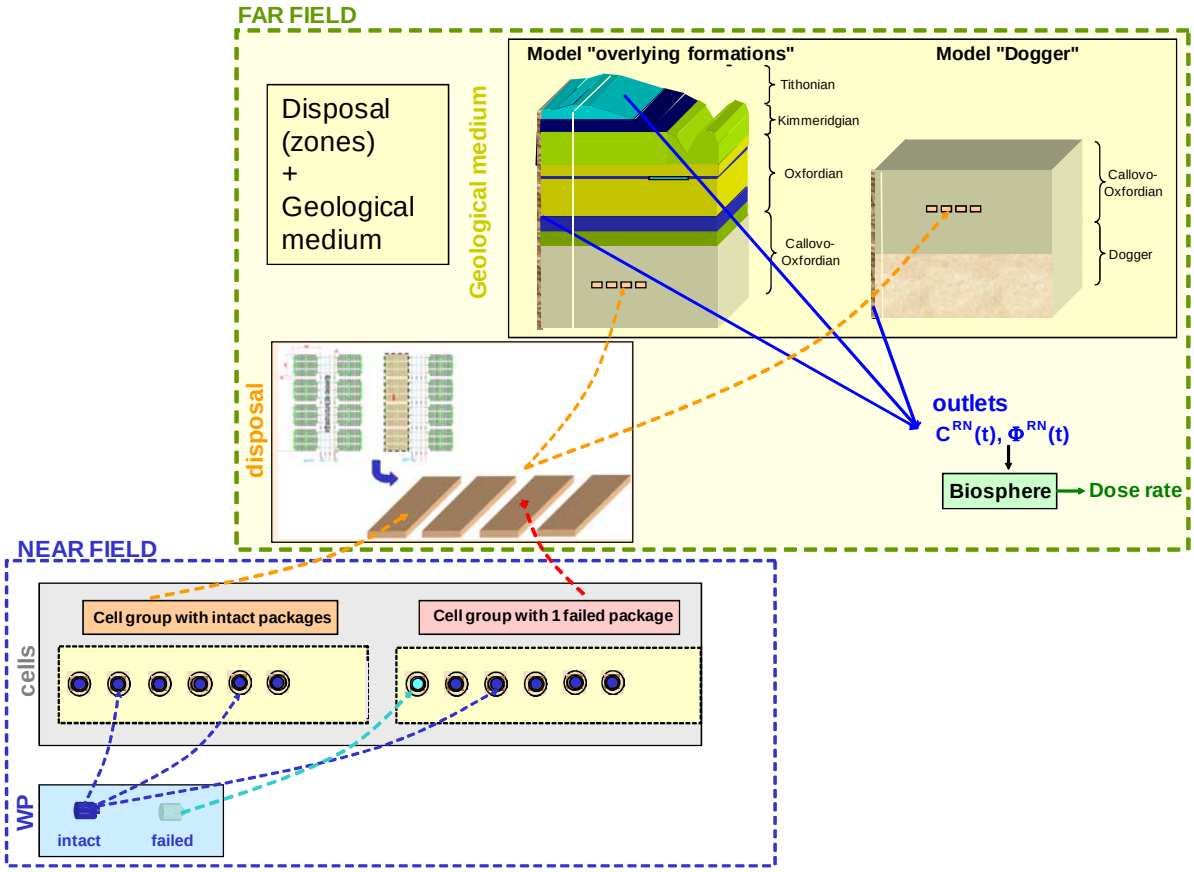
- Behaviour of very mobile radio-elements in solution, in clays or linked with organic matter.
- Retention and transport properties of the disturbed zone so that more realistic performances can be assigned to it.
- Characterisation of impact of temperature and chemical alterations on COX confinement.
- Improved hydrogeological characterisation of the site and evaluation of Earth/Atmosphere/ Ocean dynamics effects.

In the last phase (2002-2005) URL research programme predominated. In this stage of research experiments were limited to answer to the questions concerning the geological medium, as a matter of priority: rock behaviour when shaft and drift are excavated, EDZ transfer properties, rock permeability with its chemical and diffusion properties. An additional drilling programme substitute the two orthogonal reconnaissance drifts for 4 deviated boreholes to track natural fracturing in the vicinity of the URL.

The programme was completed by eight bore-holes covering a broad area around the URL. Hydraulic head, permeability and diffusion coefficient were measured in the limestone formations to improve the hydrogeological modelling of the site.

Based on the scientific data obtained and the proposed repository architecture, an analysis was made of the repository post-closure evolution, reviewing all the phenomena that will occur in it, examining their interactions, modelling the effects of possible disturbances so as to, in fine, predict waste behaviour and appraise the mechanisms capable of leading to a release of radioactivity (Andra, 2005a).

Figure 3. **2005 Performance assessment**



A major achievement of the research is to have built up a history of the repository over the next few hundred thousand years which provides an understanding of the system evolution, key parameters, risks and corresponding uncertainties. It is mainly based on a conceptual model of the geological medium, justified by the acquired data and the common Earth history knowledge.

This led to a new performance assessment using calculation codes linked by the “Alliances” simulation platform. Compared with the intermediary performance assessment, geological medium models were extracted from hydrogeological model; chemical and transport codes were coupled (Andra, 2005b).