

Site selection for a geological repository in France

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ABSTRACT

After 15 years of investigations conducted in France pursuant to the first research law on radioactive waste voted in 1991, reversible deep geological disposal has been recognised by the Planning Act No. 2006-739 Concerning the Sustainable Development of Radioactive Materials and Waste of 28 June 2006 as the reference solution for the long-term management of high-level and intermediate-level long-lived radioactive waste. The Act entrusts upon Andra to continue studies and investigations with a view to selecting a site and to designing the future deep geological waste repository in time for the creation-licence application to be reviewed in 2015 and, subject to its approval, to commissioning that facility in 2025. The repository must be implemented within a deep geological formation that must have been studied through an underground research laboratory. The studies and investigations carried out by Andra until 2005 have demonstrated the feasibility of a repository within the argillite layer of the Callovo-Oxfordian formation that has been investigated at the Meuse/Haute-Marne Underground Research Laboratory, located at Bure. A 250-km² zone was delineated around the Laboratory where the laboratory results from the clay formation may be transposed. Andra has proposed within that transposition zone, in 2009 an interest zone covering an area of about 30 km² in which advanced geological investigations will be performed in order to propose an implementation site for the underground structures of the future waste repository. In the same time, several implementation scenarios for surface installations will be developed and compared. The results of those studies will be presented during the prescribed public debate scheduled in 2013 before submitting the creation-licence application. The selected site will be validated after the public debate has taken place. The licence application will be submitted to territorial communities for comment and to a public inquiry. In order to ensure the best implementation of the future waste repository in its host territory, Andra has established an innovative exchange and dialogue with local stakeholders. The purpose of such approach was notably to identify, as a complement to scientific criteria and other industrial and environmental constraints, specific criteria relating to territorial development and integration to be taken into account in the final delineation of the final implementation scenarios for surface installations.

INTRODUCTION

The waste repository project

As requested by the 2006 French Planning Act [1], high level and intermediate level long lived radioactive waste will have to be disposed of by 2025. The concept and preliminary design supporting the feasibility study as presented by Andra in *Dossier 2005 Argile* [2] consists of a group of surface installations (~300 ha), underground structures located at a depth of 500 m (~1,500 ha) and a series of surface-bottom connections.

Surface installations (Figure 1) include:

- nuclear facilities where waste packages will be received, controlled, stored and conditioned in disposal containers;
- industrial workshops grouping the required support installations for the excavation and maintenance of the site;
- administrative buildings,

- one or several areas for muck stockpiles, about 40% of which will be re-used for backfilling underground structures when the decision will be taken to shut down the facility. Andra is also examining the possibility to recycle the remaining muck.



Fig 1: Stylized diagram of surface installations (~300 ha).

The underground structures (Figure 2) will be expanded as the operation of the waste repository progresses, until it reaches about 15 km² in approximately 100 years. They include disposal areas for high-level (HL) waste and for intermediate-level long-lived (IL-LL) waste, connecting drifts and technical set-ups.

Disposal areas are modular in design in order to allow for the gradual construction of disposal cells and the distribution of waste according to their characteristics.

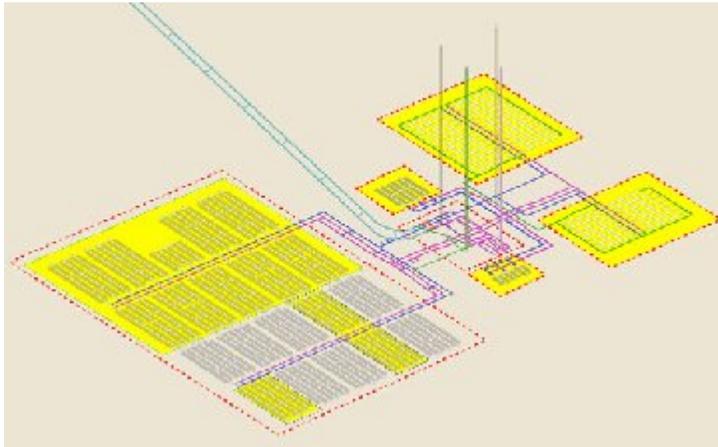


Fig 2: Diagram of underground structures (~ 1 500 ha, ~5×3 km).

Connection infrastructures are required between surface and underground installations in order to transfer disposal containers, workers, equipment and materials, to install various networks and to ensure adequate ventilation. Those connections may be provided by “shaft-type” or “incline-type” infrastructures. In order to ensure the versatility of the site, Andra has reviewed the possibility to implement a straight incline for certain waste streams in order to decouple part of the surface installations from the underground structures

The transposition zone around the Laboratory

In the framework of the studies conducted until 2005 on the feasibility of a deep geological repository, Andra has built an underground research laboratory [URL] (Figure 3) with a view to studying *in situ* the properties and the behaviour of a clay layer dating to Callovo-Oxfordian times (about 150 million years). The underground structures of the URL consist of about 800 m of drifts at a depth of 490 m. They host various phenomenological and technological experiments to confirm the very promising characteristics of the Callovo-Oxfordian formation for the future implementation of a waste repository. The URL constitutes a research infrastructure of primary significance, giving a high scientific added value to the local activities.

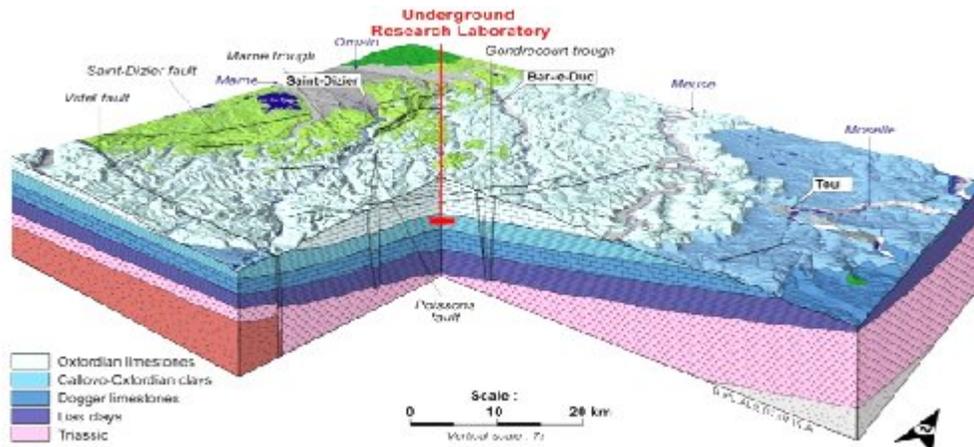


Fig 3: The Meuse/Haute-Marne Underground Laboratory is located at Bure over an area straddling the Meuse and Haute-Marne Districts.

In the course of its investigations, Andra delineated a 250-km² transposition zone (TZ) in which the properties and characteristics of the clay layer are considered as equivalent to those observed and studied in the URL. In that zone, the characteristics of the clay are suitable for the implementation of the underground structures of the waste repository.

The criteria used in 2005 in order to delineate the TZ are exclusive in nature:

- geometrical criteria: an implementation depth for underground structures set at 630 m (thus limiting the TZ to the west) and a thickness of the upper layer set at 130 m (thus limiting the zone to the southwest);
- structural criteria: a distance of over 1 km from major faults (zone of diffuse fracturing and Marne faults to the south and Gondrecourt Rift to the east), and
- lithological criteria: a thickness of the upper level of the clay layer (richer in smectites) exceeding 65 m, and a silt proportion not exceeding 20-30%.

The geological-survey campaign (boreholes, seismics, mapping) carried out in 2007-08 in the zone and its surroundings helped in providing a homogenised knowledge of the layer throughout the zone and in confirming its perimeter.

THE EXCHANGE AND DIALOGUE APPROACH PROPOSED BY ANDRA

With regard to information and communication, Andra intends to offer its various publics all useful means to understand the repository projects, to get involved and to ask questions with a view to launching a true and meaningful dialogue.

In order to develop exchanges with local populations and their representatives throughout the project, Andra has undertaken an approach aiming at inviting local stakeholders and residents to partake in the siting of the future waste repository. The purpose of the approach is notably to consolidate the criteria to be taken into account in the design and implementation of the repository and to promote a collective reflection to specify the scenarios to be reviewed in preparation for the public debate.

The approach may contribute in the drafting of the future law, scheduled in 2016, to set forth the reversibility conditions of the repository before its licence is issued.

Exchanges with local populations

Andra sites are open to all visitors, and temporary scientific, technical or cultural exhibitions are displayed in showrooms on a regular basis. In 2008, for instance, more than 11,500 visitors were greeted at the URL Site and 1,300 people were able to discover its underground drifts.

“Open doors” days are organised once a year on each site and provide an opportunity for the public to meet with the Agency’s staff.

In parallel, clear and educational information is made available through various publications or on the Agency’s Web site www.andra.fr with a view to disseminating essential elements about radioactivity, the nature of the waste, management solutions, etc.

In order to extend its population outreach, Andra also proposes various activities, such as conferences, information and exchange meetings, a mobile exhibition on the repository project, etc.

Exchanges with local actors

At the same time, Andra also develops exchanges with the territorial communities concerned, especially the General Councils, mayors and consular chambers. State services are closely associated with those approaches. Andra also presents progress reports on its investigations to the Local Information and Oversight Committee (CLIS), which has been set in place by law for the URL. Those exchanges provide an opportunity to discuss the project and to bring forward various technical elements to the different actors in order to invite them to reflect on their own on the local stakes of the project, the choices to be made at specific deadlines along the project, public-information requirements, as well as any relevant issues raised by the stakeholders and the public. Those exchanges also allow Andra to improve its information tools by submitting them to the criticism of the stakeholders with a view to enhancing the clarity and relevancy of the information made available by the Agency to its different audiences.

Various actions have been taken already by:

- the CLIS, by implementing thematic committees on the industrial implementation of the repository, reversibility, health and the environment, as well as information and consultation;
- the General Councils, by developing a strategic overview on territorial planning;
- the grouped communalities within the regional area, by setting in place a territorial-coherence scheme, and
- the economic actors of the Meuse and Haute-Marne territories represented within consular organisations (Agriculture, Trade and Industry).

In addition, Andra reinforces dialogue with environmental, heritage and cultural associations.

Those different activities contributed to nurture the technical proposal that Andra submitted by the end of 2009 and that constitutes the first major step towards the selection of a suitable site.

The Expertise and Oversight Committee for the Information and Consultation Approach

Created with a view to accompanying Andra in the implementation of that approach, the Expertise and Oversight Committee for the Information and Consultation Approach intervenes in the Agency’s projects concerning the design, follow-up and assessment of the information and consultation approach.

The Committee consists of experts in the field of citizen participation. It includes not only personalities having had operational responsibilities in the management of radioactive waste, but also recognised scientists on the international scale in the field of humanities and social sciences.

It meets about five times every year and issues an annual opinion.

2009: THE FIRST STEP IN THE SITE-SELECTION APPROACH

The implementation approach for the deep geological repository is divided into several steps:

1. in 2009, the selection of an interest zone to carry out a comprehensive geological survey and the definition of implementation scenarios for surface installations to be reviewed in preparation for the public debate;
2. the presentation of the results of the comprehensive survey and of the development studies during the public debate scheduled in 2013,
3. the selection of the implementation site after the public debate.

Implementation of underground structures

In order to pursue studies and detailed investigations and to prepare the proposal for an implementation site, it is essential to reduce the investigation perimeter to a smaller interest zone in the order of 30 km². That will help Andra in conducting new and more detailed surveys at a reasonable scale by applying heavy technical means, such as 3-D seismics.

The interest zone was proposed to the government end of 2009.

Since the National Review Board (CNE) emphasised that the geological quality must be a determining criterion, Andra first undertook the most comprehensive review as possible of the geological criteria to be taken into account. Contrary to the approach that led to the definition of the transposition zone by means of exclusion criteria, the criteria for defining the interest zone aimed at delineating a potentially more promising area within the transposition zone from a technical or scientific standpoint in order to implement the underground structures. The results from the different geological-survey campaigns show a remarkable lateral continuity and homogeneity of the clay layer and of the containment properties of the rock throughout the zone. Consequently, the properties of the rock (permeability, mechanical properties, etc.) do not constitute at this stage of the project, adequate criteria for the actual location of the interest zone. Nevertheless, by relying on the ALARA principle with regard to long-term safety, it is possible to recognise that:

- the thickness of the layer, with limited amplitude in variations, remains an objective and relevant parameter, and
- certain zones likely to host the highest vertical hydraulic gradients, appear less favourable for the implementation of underground structures under heavily degraded hypothetical conditions.

With respect to the optimisation of operating and operational-safety conditions, it should be noted that the amplitude of excavation-induced damages appears to be more significant beyond 540-590 m in depth and that the zones where the dip of the layer would not complicate excessively the design of the repository may be preferable. As a complement to those elements, the delineation of the interest zone relies on the exchange and dialogue approach. In fact, such approach oriented Andra's proposal by allowing the expression of preferences, either positive (by privileging a certain type of zones for specific reasons) or negative (not laying down underground structures in certain locations for specific reasons).

The more comprehensive surveys launched in early 2010 throughout the interest zone will lead to a proposal regarding the location for the underground structures of the future waste repository.

Implementation of surface installations

Surface installations will be implemented in close association with the construction of underground structures.

In 2005, Andra submitted a concept in which surface installations are located vertically just above the underground structures. According to that technical option, the implementation of underground structures imposes heavy constraints on the implementation of surface installations.

Studies have shown that some concept options offered more versatility than others for implementation purposes. In fact, the use of more or less inclined inclines or a combination of shafts and inclines would probably decouple part of the surface installations (i.e., especially in the case of nuclear facilities) by several kilometres (e.g., about 5 km for a 10% dip) from the underground structures (Figure 4). The other part of the installations will remain vertical to the underground structures for technical reasons (air-return shaft) or industrial reasons (e.g., industrial excavation-related activities). In order to pursue the reflection on the implementation of surface installations, Andra will complement its proposal for a 30-km² interest zone by several implementation scenarios for such installations.

In order to define those scenarios, it is essential first of all to consider the various constraints to which the industrial project is submitted. Those constraints, which are often non-restrictive, but more or less constraining, include notably the integration of the following components:

- the relief: zones with a low dip are preferable for implementing surface installations;
- easily-flooded zones, damp valley bottoms and protection perimeters of drinking-water catchments, as well as criteria with a potential impact on the size of the surface nuclear installations (air-crash risk and flood hazards, etc.);
- urban areas, isolated dwellings and historical monuments,
- outstanding natural sites, natural zones of ecological, faunistic and floristic interest (ZNIEFF), etc.

In parallel, it is necessary to examine connection possibilities with transport infrastructures (road, railroad, navigable waterways) and to take into consideration the local socio-cultural and tourist heritage. Lastly, the implementation scenarios for surface installations under study and the proposed interest zone must be consistent.

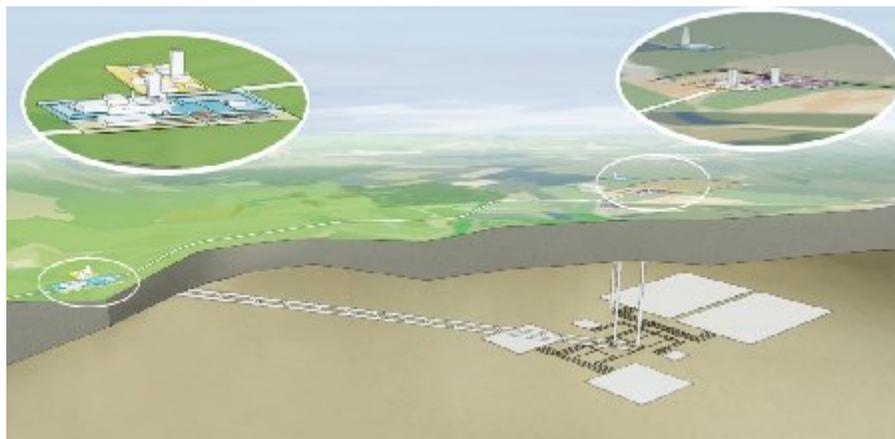


Fig 4: Using straight inclines decouples surface installations and provides more versatility in implementation operations

As in the case of underground structures, the definition of implementation scenarios relies on the exchange and dialogue approach.

2010-12: preparation of the public debate

The geological-survey campaign to be conducted in 2010-11 will cover the 30-km² interest zone. It will provide complementary information to existing data with a view to proposing a more precise location for underground structures. More particularly, it will include the use of the 3-D seismics technique in order to provide an image of the subsoil at the scale of the disposal structures.

In preparation for the public debate, Andra will pursue its exchanges with local stakeholders. Those exchanges will allow for the detailed review of the implementation scenarios for the proposed surface installations. The outcome of that work will be included in the presentation case of the project to be submitted to the National Commission on Public Debate (CNDP), which is responsible for organising the debate.

CONCLUSION

The efforts made over the last 15 years that led to the adoption of a new law were marked with significant landmarks, not only with regard to scientific and technical information, but also to reactions and governance strategies in response to complex social challenges.

Today, new challenges are emerging, but continue in the footsteps of previous ones. The *Planning Act of 2006* has opened the way towards the implementation of a waste repository for high-level and intermediate-level long-lived waste. ANDRA has adopted an approach based on the dialogue with stakeholders and the local public, and first results are very encouraging.

All projects in ANDRA are at present accompanied by sustained efforts in support of information, communication, training and the diffusion of know-how. The endeavour involves a strong implication of every stakeholder with a constant concern for sharing knowledge and new discoveries in order to exploit them efficiently within the framework of a project of national interest.

Lastly, it is important to underline here the importance of international co-operation without which Andra would never had been able to prepare experiments as effectively within its underground laboratory. The Agency maintains close co-operation relationships with many countries. It also plays an extremely active role within a large number of international organisations where it shares its knowledge, its achievements and its methods, while renewing its own reflection.

References

1. Consolidated version of *Planning Act No. 2006-739 Concerning the Sustainable Management of Radioactive Materials and Waste*: <http://www.andra.fr/publication/produit/loi-VA-12122006.pdf>
2. *Dossier 2005 Argile*: Evaluation of the Feasibility of a Geological Repository in an Argillaceous Formation