Andra's Strategy and Approach for Long-Term Memory Preservation of a Deep Geological Repository – 15174

Jean-Noël Dumont*, Patrick Charton*, Fabrice Boissier*

* Andra

ABSTRACT

Andra's approach for memory preservation on the long term is based first on a reference solution, which has been developed and implemented for the Manche disposal facility, the "Centre de la Manche" (CSM). The reference solution is based on three sets of documents ("passive memory" provisions) and on activities involving the public, the local stakeholders and/or experts ("active memory" provisions). The reference solution is perennial for 6 to 10 centuries. Andra has decided to set a target of keeping the memory of the disposal facility for as long as possible. So, a research program to develop memory provisions for several millennia was launched in 2010. The most important and most promising studies come from scientific realms such as linguistics and semiotics, geology and archeology, and feedback from surveys on transmission medium and preservation. Other studies are available in different areas, where social sciences and humanities play a prominent role.

INTRODUCTION

Andra, the French National Radioactive Waste Management Agency, among its duties in management of radioactive waste, has to preserve on a very long term the memory of its radioactive waste repositories. The objective of present paper is to present the overall approach for preserving such long-term memory for the Deep Geological Repository.

Andra's approach for the memory of its radioactive waste disposal facilities is designed to provide future generations all the elements that will allow them to make informed decisions if they wish to act upon and inside the repository before and after closure (change management strategy, close, change oversight strategy...). The transmission of the long-term memory from generation to generation is a key element.

ANDRA'S APPROACH FOR MEMORY PRESERVATION ON THE LONG TERM
The Reference Solution

Work on memory at Andra dates back to its surface disposal facility, the "Centre de la Manche (CSM)" operated from 1969 to 1994, in particular when preparing its closure. For 20 years, the system implemented at CSM has constituted a reference for the long-term memory of all current and future Andra disposal facilities. This system is based on three sets of "passive" memory provisions:

- a "detailed memory" for preserving all the technical documentation necessary for monitoring, understanding and modifying the disposal facility; the constitution of the detailed memory implemented for the CSM relies on selecting and ranking information according to 13 identified risk scenarios that are consistent with the long-term safety approach. A series of research instruments (e.g., inventories, glossary, indices, abstracts) ensures its legibility and understanding. The long-term endurance of the documents is guaranteed by a suitable selection of the ink and permanent paper and the maintenance of two documents on two different sites – the disposal site itself and the French National Archives. Lastly, the validity and updating of the detailed memory are handled by regular inputs every five years until the end of the monitoring phase.

Fig. 1. The Detailed Memory of the CSM is printed on permanent paper and handled with care

- a "summary memory" which is a single document for policy makers and for stakeholders, based on a synthetic approach to technical and historical information. Regular updates are scheduled after each revision of the safety reports. The informative strength of the final version will rest on its broad distribution among relevant city halls, notaries, general councils, prefectures, ministries, and national and international institutions. The "intermediary" summary memory of the CSM, for instance, includes 169 pages and is already available on Andra's website.
- administrative limitations on ownership and use (public easements), including registration on the state of the land use plan (cadaster). The registration of public-utility easements in the cadaster ensures the actual presence on site of appropriate administrative means to warn against the risks involved in conducting any work on the site.

Two "active" memory provisions are added to the passive provisions:
- direct communication between Andra and the stakeholders: the communication policy covers all publics, thanks to the organization of "open-door" days, conferences, exhibits or interviews; specific communication tools on memory are made available, booklets, as well as web pages.
- assessment of the memory provisions and public information by the local information committees (commission locale d'information – CLI) or local information and oversight committees (commission locale d'information et de suivi – CLIS) dedicated to each repository. The memory issue forms an integral part of the topics addressed at CLI and CLIS meetings and should ensure their local survival.

Finally, the reference solution is reviewed periodically by international stakeholders, on a ten-year basis, to ensure its relevance to the needs of future generations, in so far as they can be imagined. This is also a kind of active memory provision. An example of such review is the first international appraisal of the detailed memory of the CSM, which was conducted in 2012. This appraisal led to fruitful conclusions [1]. Improvements of the detailed memory are being implemented, among them a restructuration of the guiding tool for accessing this set of more than 10,000 documents.

The Andra "Memory" Program
The above-described reference solution fulfils French prescriptions. However, it includes some weak points. For example, it is too oriented on preserving the printed documents or data, and does not take sufficiently into account other supports, such as photographs, testimonies, soundtracks, and images that may be of interest to future generations. Another point is that it

may not fulfill the needs of future generations because the relevant information has been mostly selected according to the current state of mind and risks.

Furthermore, for deep geological disposal, although the reference solution Andra is perennial for 6 to 10 centuries, which is longer than the minimum duration required by the safety authority, this is considered too short by some stakeholders of Cigeo, the French deep geological repository project. In coherence with the objective set in the ICRP publication 122, Andra has decided to set a target of keeping the memory of the disposal facility for as long as possible.

For these reasons, Andra felt it would be useful to launch a memory-preservation program with a dual purpose: enhance the robustness and the defense-in-depth of the current reference solution for existing facilities, and develop various points-of-view and studies on memory preservation over several millennia.

Regarding the latter, a research program to develop memory provisions for several millennia was launched in 2010.

Andra takes also part to several initiatives dedicated to memory preservation:
- Three reflection groups are animated by Andra with local populations around Andra sites concerned with memory preservation over the long term (Centre de la Manche Disposal Facility, Centre de l'Aube Disposal Facility for low-level and intermediate-level waste and the Cigéo facility straddling the Meuse and Haute-Marne Districts) with a view not only to attracting the interest of those populations in that issue, but also to collecting their views on the best approach for them to appropriate it locally;
- Andra is a member of the Records, Knowledge & Memory preservation initiative (RK&M) of the Nuclear Energy Agency (NEA) of the OECD, which aim is to establish a benchmark for best practices in participating countries, common definitions and bibliography, and draft recommendations. Andra hosted the "Constructing Memory" conference and dialogue organized by NEA in Verdun (France) in September 2014. The goal of this conference, fully achieved, was to share with a wide audience the results of phase I of the RK&M initiative, which ended beginning of 2014, and to collect ideas for phase II (2014-2017).
- Bilateral cooperation is also conducted with Andra's Swedish counterpart, SKB, with mutual presentations of the ongoing research and development activities.

Consolidating the Reference Solution
Following the appraisal of the CSM Detailed Memory, it was decided to upgrade this set of documents, namely in three directions [1]:

- Improving the search methodology into the Detailed Memory. The new search methodology will merge the various search methodologies presently available, and will be based on the simple and instinctive logic of the Summary Memory, which will also be revised. Improving the Detailed Memory structure and content. A new classification of the archives is being developed, consistent with this restructuring of the logic, in a comprehensive and sustainable perspective over the surveillance period (three centuries). First level documents will be emphasized. Various versions of the same document should be compared in order to select which is the most up-to-date. New documents will be added, namely in order to provide information on the historical context of the disposal process.
- Improving ease of access for all types of audience, by adding pictures for example.

More recently, other enrichments of the reference solution have also been decided:

- A herbarium of the site is being collected. This will constitute a historical recollection of the natural heritage around the site. It will include a very concise description of the repository (approximately one page), and will be kept with other herbaria, building what can be considered as a marker. The one-page description of the repository will not only be

associated with the herbarium, but also spread widely, for any occasion. It could for example be associated to any new marker that would be related to the repository.

- A new document will be elaborated, on the basis of the Summary Memory, in connection with the work on an internationally shared definition of the content of a Key Information File (KIF), to be performed during phase II of the RK&M initiative. It could constitute a first example of a KIF. This document will be shorter than the present Summary Memory.

Regarding "active" memory provisions, it was also decided to perform periodical exercises on memory, and to sustain the reflection group associated to CSM.

The Research Program
Numerous studies are being conducted in the framework of the Research Program, combining various scientific fields: materials science, history, linguistics and semantics, geology, archeology, anthropology, etc.

The most important and most promising studies relate to the triptych language, medium and preservation, illuminated by an archaeological view:

- preliminary results from a study performed for Andra by researchers from the Limoges University show that languages, modern and ancient, are not sufficient because they are part of a civilizational dimension, so we must imagine a more comprehensive and multifaceted system, but also more specific to the thematic, to communicate far into the future [2]. Art, for example, could be part of this system,
- various materials and supports, apart from permanent paper, may be used as carriers of information, particularly to create different sizes of markers on and around the site,
- the feedback of institutional preservation of writings, sounds, images, objects... by specialized public or private organizations, highlights the needs to increase resilience, through communities of interest supporting these institutions and stretching beyond them. Such communities of interest will perpetuate systems and their foundations, according to several levels (local, regional, national, international) [3],
- archeology of technologies and archeology of landscapes, incorporating human and geodynamic evolutions, open memorial perspectives for preservation. Archeology of techniques builds on the fact that technologies that will be used over several centuries will necessarily be very different between the beginning and the end. Landscape archeology focuses on changes related to creation of new long-lasting grounds, which will undergo an evolution over the time different from others around (for example, hillocks resulting from the storage of excavated material, traces left by the backfilling of surface-to-underground drifts).

Other studies are launched in different areas:

- potential societal developments in science, technology, humanity ... considered into three main directions (progression, stagnation, regression),
- integrating the preservation of memory for radioactive waste repositories into educational programs on nuclear, heritage and memory preservation,
- intergenerational transmission of memory via social network, to inform the world about disposal facilities operated not only by Andra, but also by its counterparts over the world,
- perception of long time scales, in general and especially by the stakeholders,
- contributions of social sciences in understanding the issues.

The preliminary results of all these studies show that promising ideas can be developed by combining contributions from various hard sciences as well as social sciences and humanities.

To illustrate this, a focus is made hereunder on the results emerging from the study performed for Andra by researchers from the Lorraine University, on the possible detection of repository traces on the long term, in the geological and climate context of Cigeo [4]:

- Over a larger time range, erosion will gradually remove traces of Cigéo. Lots of them will totally disappear. However, even for a distant future, traces of the heads of shafts and inclined tunnels, and filled excavations, will still exist at surface.
- But, without some detailed observations, such traces will be confused with natural features they could look like. Their current natural analogues correspond to the filled karstic depressions, pits and wells, commonly developed at present time on the Bure plateau. And these natural structures will develop all around Cigéo site. In this way, the traces of Cigeo could be easily mistaken for geomorphological structures of little interest and then not be noticed and studied by future archeologists.
- To allow the detection and the interpretation of these traces in a far future it is essential to tag them. The proposed solution is to mark also the Cigéo site. The concept in progress is to dispose a lot of small long lived anthropological pieces (made of ceramic for example) to indicate the human origin of the structures and to help a correct interpretation. Such small pieces could be mixed with exotic material filling drill holes and/or trenches disposed around the main Cigéo installations (Cf. Fig. 2). The definition of these small markers will require contributions from various scientific realms and may include reflections on art.
- This concept could create detectable soil anomalies and allow pieces distribution at surface over a long time period, despite natural erosion of the site.
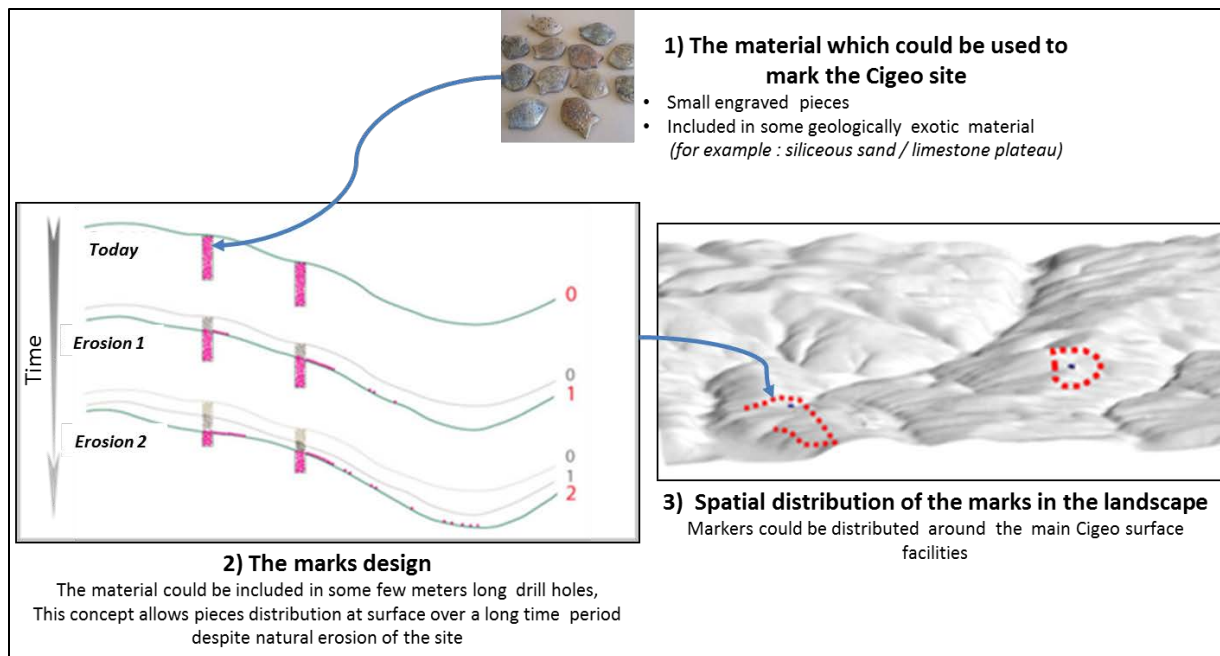

1) The material which could be used to mark the Cigeo site
- Small engraved pieces
- Included in some geologically exotic material
(for example : siliceous sand / limestone plateau)

2) The marks design
The material could be included in some few meters long drill holes,
This concept allows pieces distribution at surface over a long time period despite natural erosion of the site

3) Spatial distribution of the marks in the landscape
Markers could be distributed around the main Cigeo surface facilities

Fig. 2. Distribution of small markers around the shaft and tunnel heads of the Cigeo repository

CONCLUSIONS

In order to both consolidate the reference solution defined on the basis of the memory provisions implemented for the CSM and extend the preservation of memory for millennia, Andra launched in 2010 its "Memory" Program. Preliminary results of this ambitious work have brought to light promising thoughts, which will be further explored in the coming years.

REFERENCES

[1] J.N. Dumont, G. Martin, "The First International Decennial Appraisal of the Detailed Memory of the Manche Disposal Facility", Waste Management Conference, Phoenix, (2014)

[2] E. Mitropoulou, "Towards which communication system in the long term?", Proceedings of the Constructing Memory Conference, Verdun, NEA (to be issued)

[3] C. Jacobs, "Archival and museum curatorship challenges for RK&M preservation", Constructing Memory Conference, Verdun, (2014)

[4] D. Harmand, J. Bruhlet, "Could the landscape preserve traces of a deep underground nuclear waste repository over very long time? What we can learn from the archeology of ancient mines", Proceedings of the Constructing Memory Conference, Verdun, NEA (to be issued)