SELECTION AND CHARACTERIZATION

OF DEEP UNDERGROUND REPOSITORY SITES

R. Andre Jehan, A. Barbreau and P. Peaudecerf

Commissariat à l'Energie Atomique/ANDRA
Commissariat à l'Energie Atomique/IPSN
Bureau de Recherches Géologiques et Minières

ABSTRACT

In the French radioactive waste management program, the selection of repository sites in deep geological formations involves three successive phases: 1) A national inventory in order to identify the zones where the underground characteristics show the greatest likelihood of capatibility with the selection criteria; 2) A local confirmation; 3) A site characterization for final qualification. Objectives and methods for each of the three phases and examples of French geological formations already examined - clay, salt, granite, underwater-tight layers-will be presented.

In the French radioactive waste management program, the approach taken to select repository sites in deep geological formations involves three successive phases: inventory and classification of sites for preselection, confirmation of preselection, and site characterization for final qualification.

The inventory accounts for all the potentially favorable geological formations in continental France from existing documentation. The goal in this first phase is to identify from the knowledge and the available geological and geographic information, the zones where the underground characteristics show the greatest likelihood of compatibility with the site selection criteria.

Concerning methodology, preselection is based on site selection criteria already established, and including technical safety options, characteristics of the different wastes, and interactions between the geological environment and the repository.

Hence a distinction is drawn between the near field of the repository and the corresponding middle and far field. This leads to a somewhat arbitrary separation of functions between the host rocks (near field) and the barrier rocks (middle and far field), which induced us to substitute the concept of favorable site (all near and far rocks associated with the particular hydrogeological characteristics) for the concept of favourable rock type homogeneous material, such as salt, granite or clay.

We also introduce the concept of association of formations presenting different and complementary performance, which corresponds more closely to the multibarrier isolation concept. This idea does not exclude the possibility of considering homogeneous rocks as specific cases where the host rock is similar to the barrier rock. We intend to present several examples among the various structural configurations that we have studied and to point out the main features of the geological materials we examined in this stage of the investigation. This work includes:

- gathering of existing data,
- evaluating the ability of the geological formations to become a waste repository
- establishing a classification of the various inventoried zones in accordance with their probability of coping with the criteria set after different investigations,
- determining the procedures to be implemented in situ to confirm preselection.

During the preselection phase, the configurations taken into account must show a high probability of:

- providing good waste isolation subject to in situ investigations,
- offering easy analysis and modelling at moderate cost.

When all the main technical feasibility and safety requirements are reasonably satisfied, other criteria are introduced passing the selection tests.

This preselection culminates in a list of a few dozen sites classified according to their probability of successfully passing the selection tests.

The objective of the second preselection confirmation phase is to furnish all the information needed to decide to proceed with the characterization of one or more sites. This step is designed to clarify the knowledge of some sites before initiating expensive in situ reconnaissance. It is also intended to substantiate the hypotheses used in the site preselection phase.

It is essential in this phase to check the assumptions and to confirm the absence of latent defects. The kind of work to be performed naturally depends on the geological formations, but also on the hydrogeological environment. The conformation of preselection is carried out on a number of sites with different structures, in order to keep a broad range of options open as long as possible. A specific investigation methodology is set up to account for the specific characteristics of each site considered.

This confirmation involves work on subsurface data as well as field investigations, including surface tests (aerial observation, hydrological data, map

recognition and seismic and gravimetric measurements) and deep exploration.

This second phase should yield a first estimate of the ability of the site. Considering the very wide variety of the criteria and the different site characteristics, a simple ranking may prove difficult but, in any case, it will be possible to point out specific advantages or drawbacks. At this stage, a candidate site will be chosen for detailed characterization, the third phase of the process.

This third phase provides the quantitative data needed to model the geological environment during the life of the repository, and to evaluate the radiological impact on the surroundings.

A large number of different configurations exist in France. Hence it is impossible to describe in detail all the work to be conducted in this step. We shall merely present examples to illustrate our basic plan, goals and *in situ* measurement methods.

Concerning goals, three areas will be presented:

- confirmation of structures identified in the previous phases,
- determination of the numerical data on the site,
- *in situ* measurements of the dynamics of the geological environment.

The first point is related to the identification of the underground organization and the establishment of a three-D model of the different structures. Special attention is paid to deep subsurface hydraulic mechanisms and their relations with the surface.

The numerical data to be obtained serve to describe the behavior of the water and rocks in line with the natural processes and disturbances inherent in the repository and the installation of the wastes. The main parameters taken into account are described with reference to the type, accuracy and experimental method employed.

This is accompanied simultaneously by laboratory measurements and simulation, as well as *in situ* investigations. These serve to confirm the numerical models for the mechanical, thermal, hydraulic and chemical aspects.

On completion of this characterization phase, we have the main elements needed to prepare a complete repository project, together with the corresponding safety report.