

Background

The management of spent nuclear fuel and other long-lived radio active waste is an important environmental issue today. Disposal in deep clay geological formations is one of the promising options to dispose of these wastes. In this context, the related research activities in the Euratom Framework Programme of European Commission are continually taking on an enhanced significance. The TIMODAZ is one of the STREP projects (Specific Targeted Research Project) in the Sixth EURATOM Framework Programme and contributes to the research related to the geological disposal of radioactive waste. The consortium is composed of a strong multidisciplinary team involving both European radioactive waste management organizations and nuclear research institutes, universities, industrial partners as well as consultancy companies (SME's). Totally, 15 partners coming from 8 countries are involved with a total budget of about 4000k€.

Being the coordinator (through the EURIDICE expertise group), SCK•CEN plays the leading role in the project. Meanwhile, SCK•CEN participates the research in different work packages covering the laboratory tests, in-situ tests as well as the integration of TIMODAZ results within the safety case.

Objectives

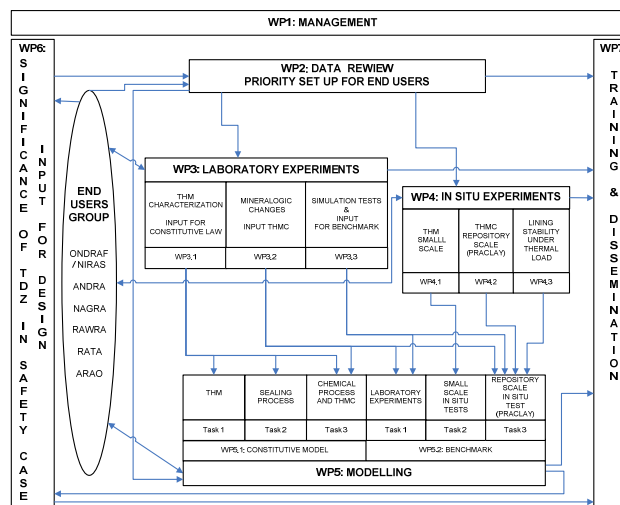
An important item for the long-term safety of underground disposal is the proper evaluation of the DZ (damaged zone) in the clay host rock. The DZ is defined here as the zone of host rock that experiences THMC (Thermo-Hydro-Mechanical-Chemical) modifications induced by the repository, with potential major changes in the transport properties for radionuclides. The DZ is first initiated during the repository construction. Its behaviour is dynamic, dependent on changing conditions that vary from the open-drift period, to initial closure period and to the entire heating-cooling cycle of the decaying waste. The early THMC disturbances created by the excavation, the operational phase and the thermal load might be the most severe transient that the repository will undergo on a large spatial scale and in a relatively short period of time. Consequently the TIMODAZ research priorities are to study the combined effect of the excavation and the thermal output on the host rocks around a radioactive waste disposal.

The knowledge gained will allow an assessment of the significance of the damaged zone in the safety case for disposal in clayey host rock and provide direct feedback to repository design teams.

In order to ensure an appropriate link between end-user needs and the project priorities, an end-user group composed of major national agencies for management of radioactive waste has been formed.

Principal results

The structure of the project is given in the figure below.



Structure of the project

Starting from WP2 - Data review and priority set-up for end-user, participants in TIMODAZ will situate their results in the long-term performance contexts, with the constant support of WP6 - Significance of DZ in safety case. All experimental works to be performed in WP3 - Laboratory experiments and WP4- In-Situ experiments will contribute to a better understanding of the processes occurring within the clay around a disposal system for heat-emitting waste during the thermal transient phase. As this transient should span

over several centuries, the development and testing of sound, phenomenology-based models in WP5 - Modelling is an essential step in meeting the Safety Case requirement of adequate understanding of the long-term evolution. Knowledge management and the dissemination of results are also key elements of the TIMODAZ project and managed in WP7-Training and dissemination.

Three types of clay will be investigated in the project: the Boom Clay (Belgium), the Opalinus Clay (Switzerland) and the Callovo-Oxfordian argillite (France).

The project started in October 2006 and will last 4 years. During the first year of project, the main activities consisted in:

- getting an overview on the State of the Art in the THMC behaviour of three studied clays;
- identification of the end-user needs with respect of the project;
- review and establishing the protocol of the laboratory tests, up-dating/developing the test equipments;
- design and initiation of the in-situ tests.

The state of the art in the field of THMC is mostly related to the laboratory characterization, in-situ investigation and modelling of selected THMC related in-situ tests. This state of the art allows to

- delineate the most important temperature-dependent material properties;
- notice the remaining uncertainties on the THM properties of the clays;
- define the most important THMC coupled processes;
- assess the effect of damage (fracturing) on the effective transport properties (permeability);
- determine the importance of chemical impact;
- derive/evaluate the most appropriate conceptual models and numerical codes.

Consequently, it constitutes a database and a reference document for the present project and provides a guideline to optimize the testing procedures of the laboratory and in situ experiments to be performed in the present project.

Based on the state-of-the-art report, the objectives of the test programme have been reviewed, the protocol of all tests was established and the laboratory apparatus have been developed and/or up-dated. Tests under well controlled temperature/stresses/pore pressure conditions with different loading paths will be performed to determine the parameters of the Thermo-Hydro-Mechanical constitutive models used for the numerical modelling. Some tests consist in simulating the excavation of a gallery in hollow cylinders and the impact of temperature on the excavation damaged zone. Specific tests are planned in order to study the thermally induced modifications of the clay mineralogy, which is a dominant factor influencing the key properties of the clays and their THM behaviour.

Meanwhile, in order to identify the end-user needs with respect to the present project, a first End-User workshop has been organised during which, the end-users have reviewed the general framework of the project as well as the two reports during this first year:

- Deliverable 2: Report on the State of the Art on THMC behaviour;
- Deliverable 4: Significance and Current Handling of the Damaged Zone in Performance Assessment.

The end-users have approved the foreseen programme in the project and recommended to further strengthen the interaction among experimentalists, modellers and performance assessors in order to better integrate the research results of the TIMODAZ project in a broader, safety case oriented context. The end-users believed that the following five key questions, put forward within the Deliverable 4 and need to be answered by the TIMODAZ project from a safety case point of view, gave a good overview of the end-user needs:

1. What is the expected evolution of the DZ around a disposal system for heat-emitting waste during the thermal period?
2. What are the main uncertainties about the DZ evolution and how can these uncertainties be dealt with?
3. Under which thermal, mechanical and chemical conditions can the favourable clay properties be modified during the thermal period and how much can these properties be affected?
4. Under which conditions do the changes in clay properties become irreversible?
5. To which extent can temporary or permanent alterations of favourable clay properties really affect individual barriers and the safety functions of the repository, i.e. to which extent are these alterations significant from a PA point of view?

Future work

The main future work consists in performing laboratory and in situ experiments, developing the constitutive laws and computer codes that can model the complex coupled thermal, hydrological, mechanical and chemical processes that will occur around the radioactive waste repositories.

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Main reference

EURATOM FP6 Research Projects and Training Activities (2007), Project Synopses, Publication by the European Commission – Directorate-General for Research Communication Unit, Volume III. EUR 22385
Website : <http://www.timodaz.eu/>