Földtani Közlöny 130/2 229–237 (2000) Budapest

Romanian LILW disposal – site selection, characterization and investigation programme

Kis- és közepes radioaktivitású hulladéklerakó Romániában – telephely kiválasztási, jellemzési és kutatási program

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(3 Figures)

Key words: Low and intermediate level radioactive waste, surface repository, geological barrier, site investigation

Kulcsszavak: kis- és közepes radioaktivitású hulladék, felszíni tároló, földtani gát, telephely kutatás

Abstract

The first reactor of the Cernavoda NPP was commissioned in 1996, but the radioactive waste programme started in 1992. Geological investigation works have been initiated to select and describe the location for a low and medium radioactive waste final disposal facility. The selection of a surface repository type has taken into consideration the experience of other countries, such as France and Spain, whose positive practice in this field is applicable in Romania as well. IAEA guidelines were also used in this process. The site selection process included 37 potential sites, 2–3 candidate sites and one preferred site (Saligny) and was based on specific criteria: lithological, tectonical, seismological, hydrogeological, climatic, transport facilities and public acceptance (DURDUN & MARUNTEANU 1997). Starting in 1996, a complex and detailed site and laboratory investigation programme has been in progress with the purpose of determining the characteristics of the site and selecting the best area for the construction of the disposal units.

Összefoglalás

A Cernavoda Atomerőmű első reaktorát 1996-ban helyezték üzembe, de a radioaktív hulladék program már 1992-ben elkezdődött. A földtani kutatás célja a kis- és közepes radioaktivitású hulladékok végső elhelyézésére szolgáló telephely kiválasztása és jellemzése volt. A felszíni típusú tárolóra más országok, pl. Franciaország és Spanyolország tapasztalatainak figyelembevételével esett a választás, akiknek az ilyen területen szerzett gyakorlata Romániában is alkalmazható. Az eljárás során a Nemzetközi Atomenergia Ügynökség irányelveit követték. A telephely kiválasztásakor 37 esetleges helyszínt, 2–3 lehetséges helyszínt és egy alkalmas objektumot (Saligny) választottak ki speciális kritériumok – kőzettan, tektonika, szeizmológia, hidrogeológia, klíma, szállítási lehetőségek és lakossági elfogadás – alapján (DURDUN & MARUNTEANU 1997). Az 1996-ban elkezdődött komplex és részletes telephely- és laboratóriumi vizsgálat programnak az a célja, hogy meghatározza a telephely jellegzetességeit és kiválassza a tárolóhely megépítéséhez legmegfelelőbb területet.

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Introduction

In 1992 geological investigation works were initiated in order to select and characterize the location for low and medium radioactive waste disposal.

The main advantages of a surface repository which were taken into consideration were: the possibility of long-term surveillance, a facility for simulating the migration of the specific radionuclides under relatively simple geological conditions, and the possibility of intervention in case of major accidents.

The region of Dobrogea was chosen for the repository and important advantages can be mentioned: the low rainfall as a factor reducing the spread in the environment of the specific radionuclides, and the relatively deep underground water level. Additionally, special consideration was given to the land adjoining the nuclear power plant because of the potential benefits of co-location, particularly in relation to reducing the potential burden of public acceptance and waste transportation requirements.

Disposal system

The disposal system is based on the multi-barrier concept. The first barrier is formed by the immobilization matrix and the concrete container holding the drums. The second barrier is formed by the disposal structures, the cover and the infiltration control system. Finally, the third, or geological barrier is constituted by the surrounding land (the unsaturated zone and the red clay layer, for the preferred site). The new repository, to be built near the Cernavoda NPP site, will receive low and intermediate level waste from power plant operation and plant decommissioning.

Site selection

The site selection process included 37 potential sites, 2–3 candidate sites and one preferred site (Saligny) and was based on specific criteria (lithological, tectonical, seismological, hydrogeological, climatic, transport facilities and public acceptance).

The site selection for the new repository was implemented according to the IAEA Safety Guide and the strategy for the selection and investigation of a surface repository. This followed the programme proposed by GEOTEC Bucharest, in collaboration with other institutions, and is presented in the *Figure 1*.

Site investigation and evaluation

The new site (Saligny) was evaluated according to the IAEA Safety Guide. During the site confirmation stage, the following investigations were available:

DOBROGEA REGION

AREA SURVEY STAGE

REGIONAL MAPPING 1992
Geological map 1:200 000 – characteristic cross section
TEctonic map 1:500 000 – active faults and zones
COLLABORATION:
ROMANIAN GEOLOGICAL INSTITUTE, EARTH PHYSICS NATIONAL INSTITUTE

SCREENING *37 POTENTIAL SITES* – SITE SELECTION PROCESS

3 CANDIDATE SITES: CERNAVODA, SALIGNY, MIREASA

CHARACTERISATION STAGE

GENERAL FIELD INVESTIGATION 1993–1994
3 drillings 1–2 refraction sections
laboratory tests, chemical and deuterium analyses
COLLABORATION: I.N.R. PITESTI, BUCHAREST UNIVERSITY, CITON (RENEL PROGRAMME COORDINATOR). I.T.I.M. CLUJ

2 CANDIDATE SITES: CERNAVODA, SALIGNY

FIELD INVESTIGATION 1995–1996
Piezometric drillings with soil and water sampling
2 groups of 3 drillings with infiltrometric tests, electrometric network (300 m), refraction seismic and crosshole „in situ" tests on experimental areas in loessoid soils (compacted use or no admixtures)
Laboratory geotechnical tests, radionuclide migration test computing: water circulation in unsaturated soils (SUTRA and SWMS-2D software), seismic response
COLLABORATION: I.N.R. PITESTI, BUCHAREST UNIVERSITY, CITON (RENEL PROGRAMME COORDINATOR), ISPIF BUCURESTI, STEVENSON & ASSOCIATES, KARLSRUHE UNIVERSITY
GUIDELINES: IAEA, ANDRA-FRANCE

1–2 SELECTED SITES – CERNAVODA, SALIGNY
1 PREFERRED SITE – SALIGNY – 1997

CONFIRMATION STAGE

DETAILED INVESTIGATIONS 1997–1998

1. Selection of the optimum perimeter for disposal cells – maximum thickness of unsaturated zone including red clay.	2. Stabilization of loessoid soils – experimental area to improve: – bearing capacity – erosion resistance – retention capacity. Admixtures: – cement – CONSOLID – bentonite. Static and dynamic characteristics of geological layers	3. Hydrogeological characteristics: a. unsaturated zone – meteolisimetric measurements. b. local aquifers inside aptian sandy lenses and eocene limestone – special piezometric drillings with permeability tests. c. main aquifer inside barremian limestone – special piezometric drillings with permeability tests.	4. Specific radionuclides migration tests in geological layers – Pitesti NRI collaboration.

5. Modelling of contamined water circulation – CITON, NRI, Bucharest University collaboration Bucharest Technical University in order to approve the PRELIMINARY SAFETY ASSESSMENT

1 CONFIRMED SITE – SALIGNY

Fig. 1 L/ILW near surface repository for the Cernavoda NPP Geotec Investigation Programme

1. ábra A Cernavodai Atomerőmű kis- és közepes aktivitású radioaktív hulladékának felszínközeli tárolására vonatkozó Geotechnikai Kutatási Programja

Hydrogeology

Unsaturated zone:
- water infiltration in natural and compacted loessoid soil by lisimetric measurement;
- permeability tests in boreholes and laboratory tests;
- suction tests on borehole samples.

Saturated zone:
- 50 drillings in the area for the identification of local aquifers and a main aquifer;
- permeability tests on each borehole;
- chemistry of the groundwater;
- 5 drillings for the measurement of the groundwater level in local aquifers;
- 3 drillings for Eocene aquifer;
- 5 specially equipped drillings measuring for the groundwater level in the main aquifers;
- estimation of groundwater flow velocity and direction;
- the inventory of water users;

Geoengineering

- 30 drillings in loessoid soil to perform the compressibility zoning and evaluation of geotechnical parameters;
- experimental area in the field to improve the loessoid soil-bearing capacity, using admixtures;
- a seismic investigation crosshole programme to evaluate dynamic characteristics.

Compliance with safety criteria

The compliance with safety criteria will be demonstrated using:
- computer models for safety assessment of the repository;
- laboratory measurements (natural and engineered barrier performances, solubility and sorption);
- field works (water infiltration rate, groundwater circulation and chemistry, humidity).

The following areas were addressed by laboratory-based experiments:
- solubility and sorption;
- geological media characteristics.

Consideration has been given to following field-based experiments:
- geology identification: (mineralogical and physic-chemical properties of the core samples);

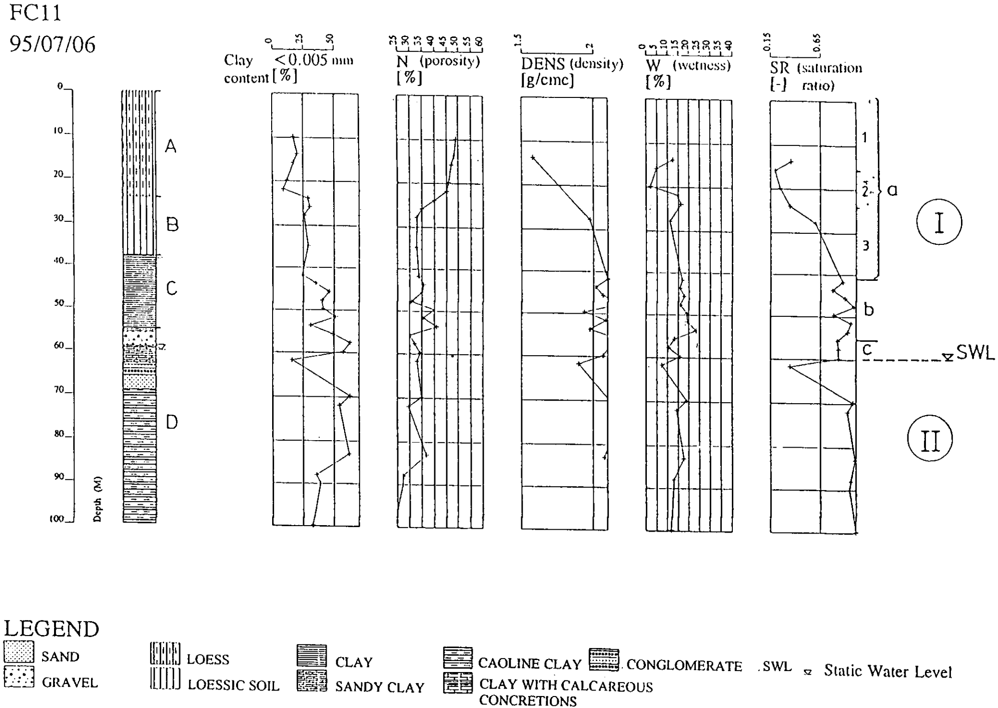


Fig. 2 Variation of some physical properties of the soils in the drilling FC11

2. ábra Az FC11 fúrásból származó talajminták néhány fizikai tulajdonságának változása

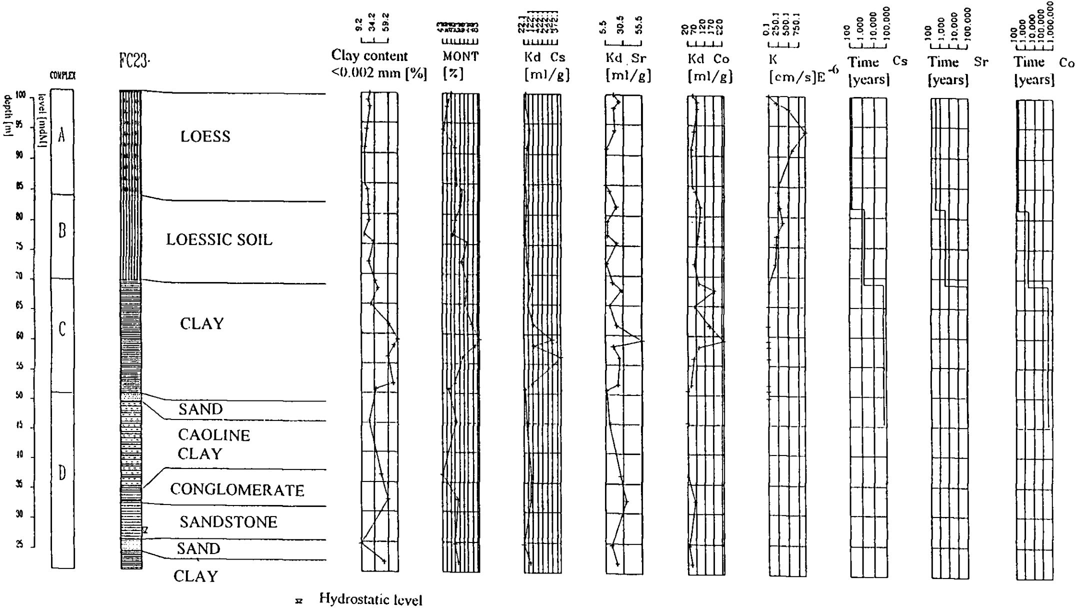


Fig. 3 Variation of some physical parametes of the geological formation and of the distribution coefficient for specific radionuclides in the drilling FC23

3. ábra A földtani képződmények néhány fizikai paraméterének és néhány radioaktív izotóp eloszlási együtthatójának változása az FC23-as fúrásban

- permeability/porosity: (porosity, pore size distribution, permeability and suction data of core samples); variations of some physical properties of soils in a drilling are presented in *Figure 2;*
- water infiltration in loessoid soils;
- underground water circulation test in main aquifer and local aquifer;
- improvement of bearing capacity and erosion resistance of the loessoid soil using compaction with admixtures.

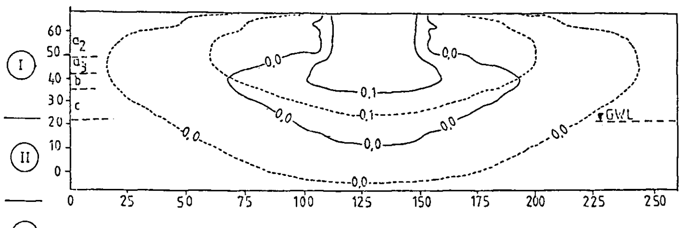
Computational modelling

The computational modelling was based on some modelling programmes:
- DUST (T. Sullivan, BNL – USA) for radionuclide migration modelling;
- SUTRA; CHAIN–2D and SWMS–2D for hydrogeological modelling.

The DUST code was included in the methodology for the safety evaluation of the repository. The code applicability for the source term „modelling" was verified. To increase, the level of confidence, a calibration phase was implemented.

An example of variation in the distribution coefficient for specific radionuclides and of some physical parameters of the geological formations is shown in the *Figure 3.*

Modelling of the near-field (unsaturated zone) was performed using as an input data an infiltration rate of 30% from the multiannual precipitation quantity and the mentioned computer models. It was estimated that Tritium will not reach the groundwater level in 300 years, both with a compacted loess pillow (3 m thickness) as foundation layer and in natural conditions (*Fig. 4*). Using water chemistry data, it was proved that the local aquifers are not linked.



LEGEND

I - Unsaturated zone
a - loess 2 middle S = 0.2-0.4
3 lower S = 0.8
b - quaternary red clay S = 0.9-1.0
c - prequaternary clays

II - Saturated zone
prequaternary clays with sand lenses
III - Main aquifer - barremian limestone
---- Compacted loess effect (3 m thickness)
- - - Natural conditions

GWL Underground water level

Fig. 4 Tritium migration after 300 years

4. ábra A tricium migrációja 300 év alatt

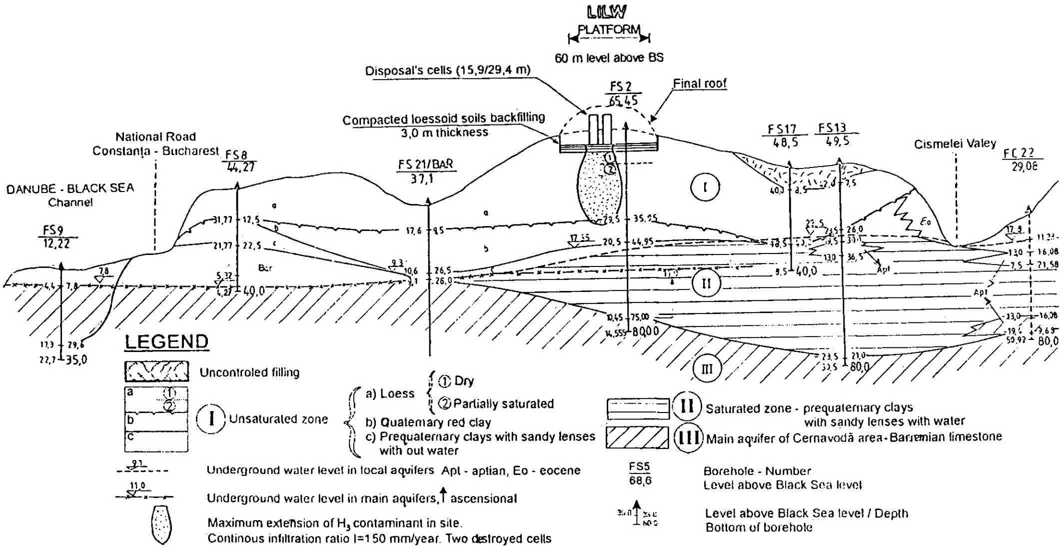


Fig. 5 Maximum extension of H_3 contaminant in the Saligny site (CHAIN–2D software, transverse section)

5. ábra A H_3 szennyeződés maximális elterjedése a Saligny telephelyen (CHAIN–2D software, keresztmetszet)

The maximum extent of 3H contaminant in the Saligny site (CHAIN-2D software, transverse section) is also shown in the *Figure 5*, taking into consideration a continuous infiltration ratio of 150 mm/year and a scenario with two destroyed cells.

Conclusions

Rather than conclusions, one result of our research which has to be emphasised is that the behavior of the geological environment as geological barrier must be considered an important criterion of acceptance for the facilities of a LILW repository.

Reference

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