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Site Selection for Radioactive Waste Management Facilities in Georgia

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1. Introduction

Georgian national strategy on Radioactive Waste Management for 2017-2031 years [1] considers allocation of all radioactive waste management facilities on one site. It means mainly three types of the facilities: storage, processing (where conditioning and treatment of the waste should be conducted) and disposal should be placed on one site. The approach is justified by safety, security and economical point of view; therefore site selection for the proposed facilities is very important issue. As mentioned in IAEA documents [2] during the site selection the following stages should be covered:

- Conceptual and planning stage;
- Area survey stage;
- Site characterization stage;
- Site confirmation stage

All these stages are considered for site selection of deep geological disposal. Of course for predisposal management facilities the situation looks simpler, but placement of the disposal facility also should be considered at the same site, which requires taking into account more specified functions. The situation is hardened by the fact that SHARS (Sealed High Active Radioactive Sources) and waste containing long lived radionuclides are already kept at the storage facility. These waste requires deeper disposal than it is considered for exiting near surface disposal. The main idea of the given article is not detail identifying and description of each stage, but the discussing of exiting situation and providing of some scientific basis for the site selection.

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2. Conceptual and Design Planning

This stage is already covered in Georgia when new Department for Radioactive Waste Management (DRWM) was established and country strategy for radioactive waste management was developed. DRWM was assigned as a state operator for radioactive waste management facilities and as result operation of Centralized Storage Facility (CSF) was transferred from Institute of Physics to DRWM and control on the closed near surface "Radon" type repository was established. This reform was conducted to establish effective state control and ensure safety and security for radioactive waste management. Meantime it is also was considered that conducted safety and seismic assessment of existing CSF building provided not so good results. So the decision was taken to replace the building for the storage and also establish special facility for treatment and conditioning of waste. This option requires especial attention. Georgia has very limited capacities to conduct treatment and condition of its radioactive waste. Only two installations are commissioned in Georgia till now. The first is abrasive cleaning device installed at Applied Research Center and used for decontamination of surfaces of pipes and other devices coming from decommissioning of the Georgian nuclear research reactor. The device is operated manually and used for decontamination of comparably small size objects. The second one is cementation facility established at the site of "Radon" type repository. The facility can be utilized for cementation of liquid and solid waste in drums.

3. Area Survey Stage

The survey for possible site should consider a number of factors such as:

- Geological characteristics
- Hydrology and geochemistry
- Meteorology and seismic data
- Urban situation
- Social impacts
- Transportation routes

For safety and security reason it should be considered that the site should be far from settled place and simultaneously the special road system should exist for transport of radioactive waste and workers of radioactive waste management facilities. It is also should be taken into account that transport of all radioactive waste to new site requires providing of special safety and security conditions. The economic factors for the same activity also should be considered. Taking into mind all these factors, it can be concluded that better to choose the site where radioactive waste are already kept. Georgia has several places, but main candidates are two: The Center of Applied Research of the Intrigued of Physics (former reactor site where CSF is a located) and s.c. Saakadze site, where closed “Radon” type facility is placed. The incapability of CSF to meet with the exiting requirements was mentioned above. The same can be said for the site of Applied Research center due to following main factors:

- The site is very close to Mtsketha, which is assigned as a cultural heritage
- The site is close to strategic road and railway, which is inappropriate for security point of view

At the same time Saakadze site looks more appropriated and can be considered as a site for allocation of all radioactive waste management facilities. The site is far from dwelling places; The site has road connections. (All other characteristics will be discussed at the next part of the article). The additional area survey will be conducted during Environmental Impact Assessment (EIA) for construction of proposed facilities, when scoping should be done and several site should be compared for environmental protection point of view.

4. Site Characterization

The investigation of Saakadze site was started in collaboration with Swedish radiation regulatory body SSM, when radiological survey was conducted and number of samples were taken from the soil surface and deeper in the ground. The special 20m depth hole was drilled to identify the possibility to find underground water and samples from different depths were analyzed for radiological content. It should be noted that Saakadze site consists underground vaults (5m depth) for solid radioactive waste and three underground vessels (maximum volume of each - 200 m^3) for liquid waste. The radium contaminated water was identified in the first vessel.

The comprehensive investigation of the site was conducted within EU project G4.01.08. Geological investigations were done using two nondestructive methods: measuring elctroconductivity of soil in different depths and directions and using georadar device (reflection of electromagnetic waves) [3]. Fig.1 shows identified geological structure of the site.

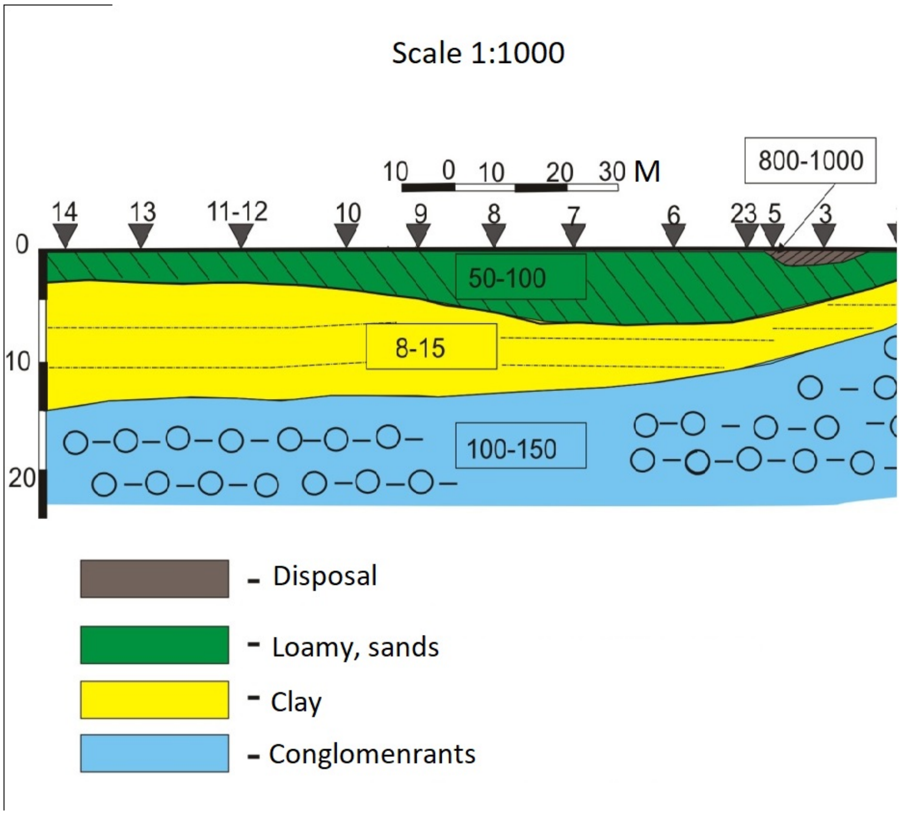

Fig.1 Geological structure of the site

Additionally 16 holes were drilled to looking for underground water and deep soil samples were taken for radiological investigation. The conducted research proved that no underground water is identified until 50m depth, which is very important issue for waste isolation. No penetration of nuclides into soil was identified. As geological data shows the site is appropriated for arrangement of disposal and other waste management facilities. The clay layer together with conglomerates is good isolator.

The followed safety assessment was conducted of the site within EU project G.4.01.09, which proved the safety of the site for 100 years at least with two main condition [3]:

1. Long lived radionuclides should be removed form disposal vaults and repackaged and voids should be filled up. (Due to log live safety no long lived radionuclides can be disposed on the small depth);
2. Contaminated water in the first tank (vessel) should be treated to avoid its penetration in soil.

The task N1 can be assigned as a log term goal and can be done later not jeopardizing the safety of the site. Meantime the second task was identified as the most important considering poor condition of the walls of the tank. The purification of the water was conducted within International Atomic Energy Agency (IAEA) project GEO/9/013 by Russian FSU Radon (as winner of tender conducted by IAEA). Before the starting of puffing activity, the radiological content of water was investigated again using HpGe Detector (Tab.1)

Tab.1 The measured concentration of radionuclides in water from the first tank

Nuclide	Activity, A Bq/kg	Uncertainty U %
Na-22	3.08	43.4
Sc-46	16.45	49.1
La-140	5.33	65.8
Eu-155	15.96	60.9
Pb-214	37.74	1.11
Bi-207	1.71	109.1
Bi-214	8.75	1.42
Ra-226	1215.2	5.2
$A_{ჯამი}$	**1304.22**	4.95

It should be considered that Georgian legislation applies clearance level also for liquids, establishing it unconditional level for Ra-226 as 1000Bq/kg. [4] Based on this data the water can be assigned as a slightly contaminated.

Radiologically also investigated water in other tanks. For instance, tab.2 gives the result for water in the second tank with sufficiently low numbers.

FSUE Radon used two types pf filters for water purification. The first is Russian Know How and the second – resigns to remove radium from water. All filtered water was collected in special tank and analyzed for content (Fig.2). Georgian specialists used HpGe detector to investigate the concentration of different radionuclides in the filtered water. The first express analyze gave unusual results – The filtered water showed increased beta activity in comparison with not treated water.

Tab.2 The measured concentration of radionuclides in water from the second tank

Nuclide	Activity, A Bq/kg	Uncertainty U %
K-40	13.55	98.2
Nd-147	2.34	87.2
Pb-214	3.55	5.4
Bi-214	0.94	5.9
Ra-226	< 25.9	-
$A_{ჯამი}$	**7.98**	29.4

Fig.2 The water purification at Saakadze site

The conducted express analyze, using spectrometer Falcon-5000 (measuring time 10-15 minutes), showed increasing of concentration of Radium daughter radionuclide Bi-214 and dramatically decreased concentration of Ra-226. It means after removing of radium from solution the radiological sequence for decay chain was broken, which provokes temporary increasing of concentration of some short lived radionuclides (half live of Bi-214 is 19.9 minutes). After keeping of filtered water maximum 2- 3 hours the activity is reduced greatly, which was proved by spectroscopy investigations conducted HpGe detector (Tab.3)

Tab.3 The measured concentration of radionuclides in filtered water (The measurement was conducted during 8 hours)

Nuclide	**Activity, A Bq/kg**	**Uncertainty U %**
Na-22	1.08	43.4
K-40	15.12	94.5
Sc-46	12.86	18.6
Cd-109	98.78	22.4
Cs-134	1.34	39.2
Ba-140	3.05	59.6
La-140	2.48	24.5
Ce-143	5.67	49.2
Eu-155	13.92	19.2
Np-237	6.96	97.6
Ra-226	< 23.1	-
$A_{\text{ჯამი}}$	**147.43**	16.8

During the purification process efficiency of the filters were reducing, which was proved by conducted investigations (Tab 4&5), but the replacing of the filter re-increased the efficiency (Tab.6). After completion of the activity all contaminated instruments (pipes, filters and pumps) were immobilized into the concrete and stored safely. So problems with contaminated water was solved, but on the bottom and walls of the tank the contaminated sludge is remained. The same can be said for other two tanks. The situation requires additional activity to remove the sludge, but the main goal is already achieved - no possible penetration of contaminated liquid to soil is possible. It means the site can be assigned as radiologically safe for any activities to establish new facilities.

Meteorological, urbanistic and seismic assessments of Saakadze site [5] also prove th possibility to use the site for allocation of all radioactive waste management facilities.

Tab.4 The measured concentration of radionuclides in filtered water (three days activity)

Nuclide	Activity, A Bq/kg	Uncertainty U %
Sc-46	1.7	93.44
Nd-147	10.0	28.03
Pb-214	10.19	1.96
Bi-214	2.52	2.69
Ra-226	< 33.5	-
$A_{ჯამი}$	**24.41**	13.23

Tab.5 The measured concentration of radionuclides in filtered water (four days activity)

Nuclide	Activity, A Bq/kg	Uncertainty U %
Sc-46	49.35	7.35
Cd-109	44.18	78.52
Sb-125	2.91	104.0
Pb-214	55.64	2.11
Bi-214	23.92	2.35
Ra-226	< 40.1	-
$A_{ჯამი}$	**176.0**	19.91

5. Site Confirmation Stage

The site confirmation can be done, when EIA for the site is finished. This assessment considers also involvement of public and all other stakeholders for the site approval. It is important to consider the disposal option for the site. Up to date only new surface disposal facility exists on the site, but according to the radioactive waste inventory some of the should be disposed on high depths. Of course, Georgia has not capability to arrange deep geological disposal, but taking into account limited number of DSRS, which compile the main part of exiting radioactive waste, it can be concluded that deep bore holes may be good solution for the situation. The conducted investigation proves that no underground water exits until 50m depth, but it is required to assess the geological structures deeper – preferably until 200m. The possibility to arrange bore holes for RTG should be also considered, paying attention to heat generation and their size.

All discussed issues requires conducting of additional investigations, which are the tasks for future activity.

Tab.6 The measured concentration of radionuclides in filtered water (after replacing of the filter)

Nuclide	Activity, A Bq/kg	Uncertainty U %
Sc-46	1.26	84.34
Br-82	1.52	49.31
Nd-147	3.92	40.97
Pb-214	2.97	3.58
Bi-214	0.66	3.71
Ra-226	< 19.3	-
$A_{ეფევ}$	**10.33**	20.03

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