Problems and prospects for construction of radioactive waste disposal sites in Belarus

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Problemy i pespektywy budowy składowisk odpadów promieniotwórczych na Białorusi

*A b s t r a k t. Z chwilą podjęcia decyzji o budowie elektrowni jądrowej na Białorusi (styczeń 2008 r.) pojawił się problem stworzenia podziemnego bezpiecznego składowiska na „gorące" (HRW — Highly Radioactive Waste) odpady promieniotwórcze. Dodatkowo musi ono spełniać wymogi Kodeksu Zasobów Podziemnych Białorusi (*Code of Subsurface of the Republic of Belarus*) ze stycznia 2009 r. Jednym z rozpatrywanych obiektów geologicznych na takie składowisko były utwory solne górnego dewonu w rowie Prypeci (Kudelsky & Samodurov, 2006), porównywalne z dobieranymi pod tym kątem strukturami solnym z Niemiec (Bornemann i in., 2004). Kompleks solny górnego franu, grubości do 1200 m, złożony z przewarstwień soli (4–60 m) i skał płonych (20–30 m), występuje na głębokości 2000–3500 m, co wyklucza jego przydatność jako składowiska. Płycej (350–3000 m) zalegają solne utwory środkowego i górnego famenu, grubości 100–3250 m w części północnej i wschodniej rowu. Składają się z przewarstwień serii soli potasowych (kompleks potasonośny w górnej części profilu ma do 2680 m grubości i występuje na głębokości 350–4050 m), soli kamiennych (kompleks halitowy dolny, grubość 50–3250 m, głębokość zalegania 365–4700 m; pokłady halitu grubości >100 m są rozważane jako potencjalne lokalizacje składowiska) oraz skał płonych (iły, węglany, siarczany). Zaplanowano kolejne etapy prac nad rozpoznaniem, kompleksową charakterystyką geologiczną i wyborem obiektów solnych korzystnych do lokalizacji magazynów HRW.*

When the construction of a nuclear power plant was finally decided (January 2008), the development of measures of secure isolation of future solid highly radioactive waste (HRW) became an evident and burning problem, as is aimed at providing the environmental safety for the country. Some propositions of use of subsurface repositories for waste disposal including radioactive waste as well as conditions necessary to construct such repositories are stated in the *Code of Subsurface of the Republic of Belarus*, which came into force on January 1, 2009 (chapter 12, clause 64, items 3–5). Areas considered unsuitable for subsurface repositories are as follow: 1) seismically hazardous areas situated at intersection or superposition of tectonic deformations in the Earth's crust, indicated by the geophysical field anomalies, as well as in stress zones in mountain massifs; 2) areas where rocks are highly fissured or include components that can enter into reactions with buried waste; 3) areas of occurrence of other minerals suitable for mining or other commercial use; 4) areas which have yet to be geologically explored; 5) specially protected natural areas..

It is obvious that several aspects should be considered when selecting a geological site for HRW disposal. At present the possibility to dispose HRW in Upper Devonian palygorskite clays in the northern part of the Pripyat Trough was being studied in Belarus (Kudelsky & Samodurov, 2006). Selection of salt deposits as host rocks for waste repositories is the very important line of inquiry in Belarus as a numerous large and potentially suitable salt structures are found in the Pripyat Trough where they appear much more abundant than in Germany. Works on possibilities of solid radioactive waste disposal in salt rocks are already carried out in Germany (Bornemann et al., 2004) and USA.

It is obvious that the Upper Frasnian and Mid-Upper Famennian saliferous strata are the main objects to study the possibilities of HRW disposal in Belarus. The Upper Frasnian strata are built of intercalated members of salt and non-salt rocks ranging in thickness from 4 m to 60 m and from 20 m to 30 m, respectively. The total thickness of these strata is 1200 m. However, they occur at depths from 2000 m to 3500 m on the average. Such conditions make impossible their use for hosting a HRW repository, at least, with the currently available engineering approaches.

Mid-Upper Famennian saliferous strata are widespread all over the territory of the Pripyat Trough. Their thickness varies from 100–200 m to 2500–3250 m, increasing from the west to the east as well as towards the north in the central part of the trough. The roof of the strata occurs at depths from 350 m to 3000 m. Regionally, it dips from the west to the east. The strata are represented by intercalated members and beds of salt and non-salt (carbonate-clayey, carbonate, sulfate and terrigenous) rocks. By the structure, rock composition, salt and potassium content the Mid-Upper Famennian saliferous strata are divided into the lower halite and upper potassium-bearing substrata.

Potassium-bearing series occurs in the depth range from 350 m to 4050 m and its thickness varies between 0 m and 2679 m, averaging 900–1000 m. It is represented by intercalated salt and non-salt rock members. Thickness of salts changes from 85 m to 500 m and more and salt content — from 15% to 85%. Non-salt members mainly include carbonate-clayey and carbonate-sulfate-clayey rocks with intercalations and subordinate packets of carbonate, sulfate and terrigenous rocks. The use of potas-

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sium-bearing series for hosting a HRW repository is less probable than of the halite, because the close proximity of the projected repository to potassium-magnesium salt layers may be hazardous to the environment, as it was mentioned by German geologists (Bornemann et al., 2004).

The halite series almost does not contain potassium salt and it is characterized by an extremely high NaCl content ranging from 85% to 90%. Its roof occurs in the depth range from 365 m to 4700 m and thickness varies between 50 m and 3250 m averaging 550 m. The halite sequence is mainly built of rock salt represented by mostly light-grey varieties, poor in KCl, $MgCl_2$, $CaCl_2$, Br and other halophilic minor components. The presence of pure rock salt members more than 100 m in thickness in the halite sequence makes it promising for hosting repositories of nuclear waste.

The plan of activities necessary in selecting a site for HRW geological disposal should comprise the following steps: 1) detailed study of structural and textural features as well as composition of the salt rocks from the Pripyat Trough to provide theoretical grounds of their possible use for hosting subsurface repositories; 2) creation of a data bank of drillings and geophysical investigations of the Upper Famennian strata; 3) selection of criteria that can be used in searching for promising salt structures suitable for hosting radioactive waste repositories; 4) division of the Pripyat Trough territory into regions showing various possibilities of hosting HRW repositories according to the selected criteria; 5) geological, hydrogeological, tectonic and neogeodynamic characterization of promising salt structures; 6) simulation of probable neogeodynamic scenarios of the evolution of salt structures selected for hosting HRW repositories.

References

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