Abstract. Due to the Kozloduy Nuclear Power Plant exploitation, a construction of a low and intermediate level radioactive waste repository is forthcoming. One of the important tasks for its design is the potential site selection. The seismicity impact over the site from the local seismic sources is one of the criteria for analyses of the long-term performance of the repository including a preservation of the engineered barriers integrity. The paper deals with the geotectonic situation and local seismicity of a region near to Kozloduy NPP. An assessment of possible maximum earthquakes accelerations is made by seismotectonic prognostication of a hypothetic site model south of the plant. The presented results show that the terrain near Kozloduy is with low seismicity and some geotechnical measures for soil base improvement may reduce the seismic risk over the repository.


Abstract. Investigations have been carried out on the composition and structure of loess in the vicinity of the Kozloduy Nuclear Power Plant in connection with the long-term disposal of radioactive waste. The thickness of loess in the investigated region is in the range from 10 to 40 m. The loess grain-size composition is characterized by predominating silty fraction reaching up to 80%. The clayey fraction content varies from 10 to 20%. The silty and sandy fractions contain mainly quartz, feldspar, mica and carbonates and the clayey fraction – mainly chlorite and smectite. The most important components of the chemical composition of loess are SiO₂, Al₂O₃, Fe₂O₃ and FeO, CaO and MgO. The amount of the water-soluble salts, presented mainly by carbonates (bicarbonates), sulphates and chlorides, is low. The sorption capacity is about 6 meq/100 g. According to the classification of Minkov the loess structure is granular or aggregate-granular, its basic property being the incomplete consolidation and collapsibility. The dry density is about or less than 1.4 g/cm³, and the degree of water saturation is S_r = 0.30-0.55. The volume of macropores under loading of 0.3 MPa is 6.5 – 7.0%. The hydraulic conductivity varies from 2.10⁻⁵ to 5.10⁻⁶ m/s. The properties of loess are considered in the present report from the viewpoint of safety of both existing and future repositories. The main conclusion of the investigations is that regardless of some suitable qualities, loess in its natural state cannot be an efficient barrier against radionuclide migration. It is necessary to apply methods for its compacting and strengthening. In Bulgaria there is experience in the successful application of such methods, as proved by the operation of the Kozloduy NPP.

Abstract. The loess terrains near “Kozloduy” NPP are among the prospective areas for the disposal of low and intermediate level radioactive waste. The analysis of the loess properties has shown two main problems: a loess collapsibility and water permeability. Using a soil-cement cushion under the repository foundation and a soil-cement backfill between the containers is a possibility to avoid these disadvantages. In this connection loess-cement mixtures with bentonite and clinoptilolite additives have been investigated. The aim of mixtures is to improve the impermeability and sorption properties against radionuclide migration. In the paper strength parameters of two kind of mixtures are discussed. According to their water content some are compacted at the optimum moisture content until the maximum dry density and others are compacted at higher moisture content equal to the liquid limit of loess. For the first type of mixtures the unconfined compressive strength (UCS) varies from 2 to 6 MPa depending on the cement and additives percents. Permeability measurements have shown satisfactory results. The UCS for the second type of mixtures is less than the first type, but is sufficient for a backfill between the waste containers. The conclusion is that the loess-cement mixtures, especially these with clinoptilolite additive, are prospective as barriers of a low and intermediate level radioactive waste repository.

4. Евстатиев, Д., Д. Кожухаров, Д. Антонов. 2004. Изследванията на Геологическия институт при БАН за избор на площадка за хранилище за радиоактивни отпадъци. – Сп. Бълг. геол. д-во, 65, 1-3, 175-179, ISSN 0007-3938, (ref.).

Резюме. Изследванията за избор на площадка за хранилище на ниско- и средноактивни отпадъци (НСРАО) от АЕЦ в България са започнали в края на седемдесетте години под ръководството на акад. Еким Бончев от Геологическия институт при БАН. Като най-перспективни за по-нататъшно проучване в Северозападна България тогава са определени: рудник “Кошаща”, рудник “Смоляновци” и две площадки близо до Козлодуй. В началото на деветдесетте години проучванията са продължени при разработване на Концепцията на БАН за национално хранилище, възложена от Министерския съвет. С помощта на целесъобразна методика, по метода на последователното изключване и посредством системен анализ са локализирани 20 перспективни площи и площадки в различни части на страната, за погребване както на НСРАО, така и на високо радиоактивни отпадъци (ВРАО). В периода 1995-1996 г. съвместно с английската фирма QUANTISCI е разработен проект, финансиран от Научния комитет на НАТО и посветен на методология за избор на площадка за дълбочинно погребване на ВРАО в мергелни терени. През 1996-1997 г. е изпълнен проект "Управление на радиоактивните отпадъци в България", договор с PHARE (BG 9107-02-04-01) с участието на западноевропейските фирми:
CASSIOPEE, AEA Technology, SGN, Ove Arup and Partners and dr. In the context of the paper, the authors conducted analyses of the nearest well, located at 280 m from the repository, for peak values of radionuclide concentrations in the nearest well, located at 280 m from the repository, are

"Abstract. The paper presents an approach for analyzing and modelling of the "geosphere" as one of the main components included in the safety assessment analyses of the Near Surface Repository for Radioactive Waste - Novi Han disposal system. To clarify and facilitate development of the conceptual model for "geosphere" the interaction matrix is constructed. In keeping with the features of the "geosphere", identified during analysis appropriate mathematical models for radionuclide migration through the both zones - unsaturated and saturated, are selected and adapted into using a computer code AMBER. Results for radionuclide release from all disposal units and for peak values of radionuclide concentrations in the nearest well, located at 280 m from the repository, are
presented. It is estimated that maximum concentration values of studied radionuclides are in times less than that regulated in the National Regulation for Radiation Protection. Therefore, the local geological medium is an appropriate barrier against radionuclide migration.


Abstract. According to the International Atomic Energy Agency documents and the current practice, the construction of shallow ground repository is a suitable decision for the disposal of NPP’S low and intermediate level radioactive wastes. The aim of the report is to evaluate the natural conditions of a site situated in loess terrain south-west from the Kozloduy Nuclear Power Plant and the efficiency of the engineering barriers against radionuclide migration by using a safety assessment analyses. For that purpose, an engineering geological site model is created, which includes the next barriers: concrete-steel basement, soil cement cushion and layer of compacted loess. The ground base under the hypothetical repository is presented by 2.5 m thick loess followed by 25 m stratum of Pliocene clays. The model is simulated by the computer code AMBER for the so called "basic scenario" with conservative and simplified condition elements. Calculations are made for the release rate $R$ and concentration $C$ of three radionuclides Cs-134, Sr-9O and Ag-110m after each barrier of the repository. The results demonstrate the efficiency of suggested barriers, which are definitely sufficient for isolation of the studied radionuclides. The release to the environment for the Cs-134 and Ag-110m is close to the zero value and for the Sr-9O it is neglectfully small <10^{-9} Bq/m^3.


Abstract. Loess and loess-like sediments occupy 13% of Bulgarian territory. Their collapsibility predetermined by existence of a great volume of macropores and non-water resistant particle binding substances causes serious problems in the construction activities. To avoid this unfavorable property a lot of research work is being carried out concerning loess origin, stratigraphy, lithology, engineering geological and soil mechanics properties. Loess thickness reaches up to 100 m and the total collapse under conditions of moistening and overburden pressure - up to 170 cm. A specific characteristic of Bulgarian loess is its vertical and horizontal heterogeneity. In North Bulgaria the Aeolian loess covers a dynamic Pliocene relief and this is the prerequisite for the existence of many steppe limpits and other relief lowerings. The silty fraction containing mainly quarts, feldspars and micas predominates in the grain size distribution of loess, reaching up to 80% in the most widely spread varieties. The quantity of the clayey fraction (<0.005 mm) is used as the basic criterion in loess classification according to granulometry. The sandy, silty, clayey type of loess and loess-like clay are
The Russian classification of loess base has been adopted in Bulgaria, which differentiates two types according to the collapsibility after moistening and under overburden pressure. In the case of First type loess base, moistening and additional load practically provoke the collapse of the building. The collapsibility of the Second type loess base is mainly due to the overburden (geological) load. The measures for elimination of the both type loess collapsibility (loaded and unloaded) are briefly discussed in the report.


**Abstract.** In the framework of selecting a suitable site for final disposal of low- and intermediate level short-lived waste in Bulgaria, a site characterization campaign was carried out in 2005 at the Marichin Valog site (town of Kozloduy). Constant-head infiltrometer tests were carried out at several meters below ground surface to determine the hydraulic properties of clayey gravel layers that are believed to be potential pathways for water flow and radionuclide migration. Infiltration tests provided data on cumulative infiltration and progression of the wetting front in the near vicinity of the infiltrometer. Time-domain reflectometry was used to measure water content variations with time. By means of an inverse optimization routine implemented in the finite element code HYDRUS-2D, field-scale soil hydraulic parameters were derived for the clayey gravel layer. Results show a great consistency in the optimized parameter values, although the two test sites were more than 6 m apart. Apparently the size of the affected volume of soil was large enough to reduce the effect of spatial variability and to produce average field-scale hydraulic parameters that are relevant for large-scale predictions of flow patterns and radionuclide migration pathways.


**Abstract.** Chiprovtsi silver-lead and Martinovo iron mines represent the biggest mining area in Northwestern Bulgaria, which was operated till 1999. Their long-lived operation leads to proved pollution of the environment in the vicinity of the mines, especially water and soil. Seasonal monitoring of heavy metal (Cu, Zn, Cd and Pb) and metalloid (As and Sb) concentrations in mine, surface (river) and drinking waters was carried out May and August 2006 to determine the level of contamination of the Chiprovtska Ogosta river basin resulting from the long-lived mining activity and whether these abandoned mines continue to be potential source for water pollution. This study proves significant As concentrations in mine (up to 170 μg/l) and surface waters (between 50 and 621 μg/l). The presence of other heavy metals, such as Cu, Cd, Zn, and Pb, and metalloid – Sb is also recorded. Among them, Pb was found in considerable concentrations – up to 1456 μg/l during May 2006 sampling exhibiting great concentration variability.
between dry and wet sampling seasons. Sb is also determined in mine waters (up to 25 μg/l) but does not exist in surface and drinking water. Drinking water is proved to be free of heavy metals and metalloids.


Abstract. In the framework of selecting a suitable site for final disposal of low- and intermediate level short-lived radioactive waste in Bulgaria, a second characterization campaign was carried out in 2006 at the Marichin Valog site (close to Kozloduy). Constant-head infiltrometer tests were carried out at several meters below ground surface to determine the unsaturated hydraulic properties of clayey gravel layers and silty and clayey loess layers. Infiltration tests provided data on cumulative infiltration and progression of the wetting front in the initially unsaturated sediments surrounding the infiltrometer. A cylindrical time-domain reflectometry TRIME probe was used to measure water content variations with time during progression of the wetting front. The tests carried in the clayey gravel layer were exactly the same of those carried out in 2005, and were done to test the repeatability of the measurement technique since material settlement following infiltrometer installation could possibly affect the filter's hydraulic characteristics. In general a good repeatability was observed, with final steady-state infiltration rates being very similar. By means of an inverse optimization routine implemented in the finite element code HYDRUS-2D, field-scale soil hydraulic parameters were derived of all layers. Results show a great consistency in the optimized saturated hydraulic conductivity parameter values when evaluating the repeatability of the two shallowest infiltrometers. Less consistency was obtained for the curve-shape parameter α, possibly because different material was sampled during the 2006 test. Results for the two deepest infiltrometers reveal parameters typical of fine-textured loess material. Based on all four infiltrometer tests, the variability in saturated hydraulic conductivity for all materials investigated was relatively small, with the maximum being five times larger than the minimum. Apparently the size of the affected volume of soil was large enough to reduce the effect of small-scale spatial variability and to produce average field-scale hydraulic parameters that are relevant for large-scale predictions of flow patterns and radionuclide migration pathways.


Abstract. In the framework of selecting a suitable site for final disposal of low- and intermediate level short-lived radioactive waste (LILW-SL) in Bulgaria, site characterization is ongoing at the Marichin Valog site, North-West Bulgaria.
site is characterized by a complex sequence of loess, clayey gravel, and clay layers, of which the first 30-40 m are unsaturated. Proper knowledge about unsaturated water flow and concomitant radionuclide transport is key input to safety assessment calculations. Constant-head infiltrometer tests were carried out at several meters below ground surface to determine the unsaturated hydraulic properties of silty loess, clayey loess, and clayey gravel layers. Individual infiltrometers were equipped with 0.5-m-long filter sections; the shallowest filter was from 2 to 2.5 m depth, whereas the deepest was from 9.5 to 10 m depth. Infiltration tests provided data on cumulative infiltration and progression of the wetting front in the initially unsaturated sediments surrounding the infiltrometer. A cylindrical time-domain reflectometry TRIME probe was used to measure water content variations with time during progression of the wetting front. Access tubes for the TRIME probe were installed at 0.3 to 0.5 m from the infiltrometer tubes. By means of an inverse optimization routine implemented in the finite element code HYDRUS-2D, fieldscale soil hydraulic parameters were derived for all layers. Results show a great consistency in the optimized parameter values, although the test sites were several meters apart. Apparently the size of the affected volume of soil was large enough to reduce the effect of spatial variability and to produce average field-scale hydraulic parameters that are relevant for large-scale predictions of flow patterns and radionuclide migration pathways.


Abstract. In the framework of selecting a suitable site for final disposal for low- and intermediate level short-lived radioactive waste in Bulgaria, a determination of soil hydraulic properties of two potential sites was made. The investigated samples are from the vadoze zone of the unsaturated deep soil profiles, which are considered as a pathway of eventual radionuclide migration from the disposal facility to the biosphere. The hydraulic parameters are determined from the relationship "soil water content – pressure head" (soil water retention curve). The traditional method of determining the retention function was used - establishing a series of equilibria between water in the soil sample and a body of water at known potential. According to the pressure head value, two types of apparatuses were used – a sand bath and a pressure cell. The hydraulic parameters of the samples were obtained by implementing the optimization procedure for retention curves available in the computer code RETC. The resulting hydraulic parameters can now be used in the simulation models for the prediction of variably saturated water flow and concomitant radionuclide transport in the deep unsaturated sediments of the potential disposal sites. This is important input to an evaluation of the suitability of potential sites for developing a near surface disposal facility.

Abstract. Soils have a buffering capacity to moderate pH changes in soil solutions because of the pH dependent charges. A variable charge model is proposed assuming dissociation and attachment reactions of hydrogen with the hydroxyl reactive groups in soils to evaluate the soil buffering capacity. A titration experiment is conducted for a volcanic-ash soil by adding acid and alkaline solutions to estimate parameter values for the variable charge model using the PHREEQC geochemical database code (Parkhurst and Appelo, 1999). Calcium hydroxide leaching process through the well-buffered volcanic-ash soil is then simulated in accordance with the proposed variable charge model using a numerical code HP1 (Jacques and Šimůnek, 2005), which couples HYDRUS-1D for flow and transport and PHREEQC for chemical reactions. When we take into account a suitable buffering capacity based on the variable charge model, HP1 is a promising tool for quantitative evaluation of the acid or alkaline contaminant transport though well-buffered soils.


Abstract. The HP1 incorporates modules simulating (i) transient water flow in variably-saturated media, (ii) transport of multiple components and (iii) mixed equilibrium/kinetic geochemical reactions. In the HP1 program structure the transport (flow) problems are connected with and described in the HYDRUS-1D module and the geochemical problems are connected with and described in the PHREEQC module. Therefore many of the solute transport features in the HYDRUS-1D code are not considered and the same is true for the advection-dispersion PHREEQC features. The coupling procedure of HP1 is based on the presumption of the sequential independently solving of the two types of processes: physical (flow) process and chemical process. The first one is solved with HYDRUS-1D module and then the second part is solved with PHREEQC module. This procedure is known as weak coupling or sequential approach. In fact, solute transport in the HYDRUS-1D module is modeled as the transport of inert tracers (i.e. no interaction with the solid phase, and no solute sink terms) since reactions are considered in the PHREEQC module. Note that in the HP1 code, interactions with (and thus also diffusion in) the gas phase are not considered. As a conclusion the following aspects of HP1 code research applications are outlined: Tool that integrates physical – chemical – biological aspects of chemical migration in soils; Multiple biogeochemical reactions; Complex flow fields; Spatial variability; Interpretation of laboratory and field data; Tool for understanding qualitatively and quantitatively trends in data; Sensitivity analyses; Permits systematic evaluation of impact of initial and boundary conditions on model output.

**Abstract.** Transport of organic nitrogen fertilizer (Org-N) with steady-state water flow through a soil column of 100 cm length is simulated for 100 days. Governing equations are constituted as follows: the general equation describing the solute transport for steady-state water flow has the form:

\[
\frac{\partial C_{li}}{\partial t} = \frac{\partial}{\partial x} \left( D_w \frac{\partial C_{li}}{\partial x} \right) - \frac{q}{\theta} \frac{\partial C_{li}}{\partial x} + R_i
\]

In the study, the term \( R_i \) includes three types of reactions – first-order decay (degradation), adsorption, and cation exchange processes (Fig. 1):

\[
\begin{align*}
\text{Org-N}_{\text{degradation} \mu_{i1}} & \rightarrow \text{NH}_4^+_{\text{degradation} \mu_{i2}} & \rightarrow \text{NO}_3^-_{\text{degradation} \mu_{i3}} & \rightarrow N_2 \\
\text{SorOrg}_N & \rightarrow \text{NH4-X} & \rightarrow \text{SorNO}_3^-
\end{align*}
\]

Fig. 1. The processes scheme for first-order degradation chain of linearly adsorbed component Org-N, NH4+, NO3-, and N2.

In order to simplify the model we make the following assumptions: Adsorption process of the Org-N is instantaneous and described with the Freundlich equation of linear type; the ammonium ion adsorption is fully described with the cation exchange process and therefore is connected with the value of the Cation Exchange Capacity (CEC); and there is no adsorption of the nitrate ion to the solid phase. The transport equations for each component are then constituted. As a result, the Org-N concentration in the solute phase through the profile; the ammonium ion concentration in the solute phase through the profile; and the nitrate concentration in the solute phase through the profile are determined.


**Резюме.** В статията се излага анализ и обобщение на резултатите от проучване на колектив от Геоложкия институт на БАН в долината на р. Батова (Община Балчик) във връзка с разширяване на курортното строителство, като са изяснени нейните геоморфоложки и геоложки условия и е направено инженерногеоложко райониране. Долината в сегашния си вид е образувана от кряж на площена насам под въздействие на морската и речна ерозия при непрекъснатото издигане на сушата. Тя е изградена от сарматски диатомейни и арагонитни глини, покрити с делапсивни, делувиални и алувиални отложения. Според геоморфоложките и геоложки условия долината е разделена на следните инженерногеоложки участъци: Участък I – плато; Участък II – склонове на долината; Участък II –
плейстоценски тераси: Участък IV – холоценски ниски тераси, лиман “Балтата” и пясчен плаж. Участък I обхваща равнинен терен със скална и полускална земна основа. Най-характерната особеност на Участък II е наличието на стари условно стабилизирани съвлачища. Към участък III принадлежат средно- и късноплейстоценските тераси, изградени от алувиални наслаги с благоприятни инженерногеоложки характеристики. Участък IV, обхваща най-ниските тераси и блатистия терен „Балтата”. Изграден е от водонаситени песъчливи и глинести седименти, и торф, като главният проблем е високото водно ниво. В статията се дават физичните и механични показатели на строителните почви.


Abstract. The importance of the unsaturated zone as an integral part of the lithosphere for water flow and solute transport modelling has long been recognized. The hydraulic properties of the variably saturated zone are often comprehensively described by means of the van Genuchten-Mualem model. This paper deals with an inverse modelling approach using the software code HYDRUS-2D and field infiltration data for determination of the van Genuchten-Mualem parameters. For that purpose laboratory and field hydraulic tests have been performed using respectively undisturbed core samples collected from a multi-layered loess complex and an in-situ borehole infiltration set-up in the same sediments near the town of Kozloduy, North Bulgaria. The obtained data was used to inversely estimate hydraulic properties with HYDRUS-2D at spatial scales much larger than the traditional laboratory-based analysis. The resulting large-scale parameters can be further implemented into water flow and solute transport models for more reliable assessment of radionuclide migration from nuclear facilities in the region of the town of Kozloduy, North Bulgaria.

18. Antonov, D. 2013. Static and dynamic strength parameters of stabilized loess soils from Kozloduy town area. – Engineering Geology and Hydrogeology, 27, 3-12, ISSN 0204-7934, (ref.).

Abstract. The location of the National radioactive waste repository is in the vicinity of Kozloduy NPP (Radiana site). It is important that the loess soils can be easily stabilized with hydraulic binders and it can be transformed in impermeable and strong material. On such material, used as soil cement cushion, were build up all the Kozloduy NPP facilities. This cushion will be also constructed under the modules of the National radioactive waste repository Radiana. The strength parameters and strength-strain behaviour of soil cement cushion both have been object of many publications in the Bulgarian geotechnical literature. In this report are presented the author’s results from investigation of the static and dynamic strength characteristics of loess-cement mixtures and loess-cement mixtures with the addition of some natural sorption materials as zeolite and bentonite, the latter with the task to improve the nuclide retardation
properties of soil-cement in the time and having in mind their use in the foundation work of the Radiana repository. So, the paper deals with the laboratory static strength and seismic waves investigations on mixtures made on the base of loess with a zeolite and bentonite additives, stabilized by ordinary Portland cement. The values of the unconfined compressive strength (UCS) of loess-cement-zeolite and loess-cement-bentonite samples are compared with the values of the UCS of loess-cement mixtures without any additives. The values of the primary ($V_p$) and secondary ($V_s$) waves of the samples are compared with the $V_p$ and $V_s$ values of a natural loess and the loess cement mixtures without any additives. SEM photographs have been made for evaluation of the samples texture. The results have shown that both compositions – with zeolite and bentonite additives are prospective for further investigations.


Abstract. Characterizing hydraulic properties of the unsaturated zone at spatial scales commensurate with the numerical model grid size is key to reliable predictive modeling of the fate and transport of contaminants in the environment. We used the HYDRUS (2D/3D) model and inverse modeling to determine the hydraulic properties of a 10-m deep vadose zone from borehole infiltration tests. The investigated soil profile is located in the Pleistocene loess complex near the town of Kozloduy, Northern Bulgaria, in the vicinity of the Kozloduy Nuclear Power Plant (NPP). Four constant-head infiltrometer tests were carried out several meters below the ground surface to determine the unsaturated hydraulic properties of a silty loess, clayey loess, clayey gravel, and a highly carbonated layer. Infiltration tests provided data on cumulative infiltration and the movement of the wetting front in the initially unsaturated sediments surrounding the infiltrometer. A cylindrical TRIME-IPH/T3 time-domain reflectometry probe was used to measure water content variations with time during the movement of the wetting front. An axisymmetric model was developed in HYDRUS (2D/3D) for each of the four infiltrometer tests. The inverse optimization routine implemented in HYDRUS (2D/3D) was used to determine field-scale soil hydraulic parameters $\theta_r$, $\theta_s$, $a$, $n$, and $K_s$ for all layers of interest. Results suggest the size of the affected volume of soil was large enough to reduce the effect of spatial variability and to produce effective field-scale hydraulic parameters that are relevant for prediction of large-scale, variably-saturated water flow and radionuclide migration pathways at the Kozloduy NPP site.

Abstract. The Repository for Radioactive Waste (RAW) Novi Han of the Russian “Radon” type was built in the middle of 60-es, last century, in the Lozen Mountain near Sofia. Unconditioned wastes from medicine, military sources and scientific research activities are stored in it. The repository site has not been selected after detailed geological, hydrogeological and engineering geological investigations including safety assessment procedures. Such investigations were realized in the early 90-es by institutes of the Bulgarian Academy of Sciences. Later, in 2000–2002 the studies of the site have been enlarged with the authors’ participation. These newly performed investigations have taken into account the requirements of the International Atomic Energy Agency (IAEA) documents. In the paper the results concerning the engineering geological and hydrogeological settings of the site are presented. Its geological and tectonic conditions are discussed as well. The data will be used for future analyses of impact of the Novi Han repository over the environment including radiological safety assessment.


Abstract. This paper is devoted to the objective and progress of the activities undertaken in the frames of the project DFNI ·E02/4. The aim of the project is to quantify water flow within the unsaturated zone of the loess complex, which is widespread in North Bulgaria. With respect to substantial variability of precipitation and evaporation, water fluxes change their direction from downward to upward. This process will be modeled using the HYDRUS-1D software. The field data are necessary to provide both soil hydraulic parameters and time-series for calibration of the model. As a result of the modeling process, components of the water balance could be shown at large time scales - seasonal and multiannual variations. In the frames of the project two experimental sites were established: in Northeast and in Northwest of the country. In this paper, the detailed description is given only for the first site (near to the city Ruse). The equipment of experimental sites consists of a meteorological station with additional sensors installed at three levels below the ground (tensiometers and sensors for soil moisture content). All the data from the sensors can be seen and downloaded from a particular web site in real time. Up to now, the time-series show a stable work of the system and consistent values of the data. During the second stage of the project, the collected data will be analyzed and modeled.


Abstract. The region of the Western Balkan is characterized by its complex geology and the presence of polymetallic ores. Iron and base metal (Pb-Ag)
Deposits are located in the upper valley of the Ogosta River near the town of Chiprovtsi. The local Fe-ores are rich in arsenic and copper, while the Pb-Ag ores contain much zinc and cadmium. The former mining and ore-processing activities have caused widespread environmental contamination with arsenic and heavy metals. Geological mapping, geophysical surveys, drilling, water monitoring and experimental infiltration tests were performed within the alluvial aquifer in the floodplain of the Ogosta River in order to assess and forecast the groundwater pollution. These resulted in delineating the spatial extent of the aquifer, its boundary conditions, hydraulic characteristics and interactions with other hydrogeological units, as well as the position of the water table. Special attention was paid to the vadose zone and its hydraulic characteristics with regard to flow and pollutant transport. The obtained results together with data on pollutant concentration in soil, alluvial deposits, river water and groundwater will allow establishing relevant predictive models of water flow and arsenic migration, in both the saturated and unsaturated zones.


Abstract. The soil-cement cushion represents a compacted and stabilized layer of the soil base, built under the foundation, which is intended to replace a part of the collapsible layer, to increase the bearing capacity of the soil base and/or to play a role of engineering barrier against migration of harmful substances in the geoenvironment. The soil-cement cushion is not a continuation of the foundation, but it is a part of the soil base. A multi-barrier engineering near-surface radioactive waste repository is planned to be constructed in Bulgaria and a loess-cement cushion beneath repository cells is envisaged to be one of the engineering barriers. The cushion is going to be constructed by in-situ compacted mixture of local loess and Portland cement, prepared in a central mixing plant. Initial stage in the overall iterative design process is selection of optimum loess-cement mixture for construction of compacted loess-cement cushion. Actually this includes the determination of the three basic parameters of loess-cement: the minimum cement content needed to harden the loess adequately; the optimum water content of the mixture; the density to which the loess-cement must be compacted. The present paper describes the consecutive steps for determination of the above parameters as following: 1) classification tests of loess to be used for the construction of the loess-cement cushion; 2) moisture-density tests to determine the target values of the optimum water content and standard density of the loess-cement mixture; 3) determination of the unconfined compressive strength and durability for a range of cement contents; 4) selection of optimum loess-cement mixture for construction of compacted loess-cement cushion.

24. Антонов, Д. 2006. Структурни и якостни особености на потенциални екрани от заздравена почва. – Сборник разширени абстракти, Национална конференция “ТЕОНАУКИ 2006”, Д-во на геофизиците в
Abstract. As a result of the whole period of operation of the Kozloduy Nuclear Power Plant, the closing of its first two reactors and the eventual operation of the Belene NPP, it is expected that the low and intermediate level radioactive waste volume in the conditioned state will amount to about 100 000 m³. These wastes are stored at present in temporary storages on the plant territory and it is envisaged a permanent repository to be constructed. The investigations carried out so far both in the country and abroad, proved that some loess areas could be considered as a prospective medium for LILW storing. The loess terrain in the Kozloduy NPP region is among these areas as it offers advantages from the viewpoint of the local population reaction, the hazards related to radioactive waste transport and the natural conditions. The loess can be easily stabilized with hydraulic binders and can be transformed in impermeable and strong material. On such material were founded the quite all Kozloduy NPP facilities. The up-to-date NPP practice has confirmed the loess-cement screen isolation properties. The main task of this study is to investigate the structure and strength properties of loess-cement mixtures with the addition of bentonite and to prove the base for further sorption and retardation property studies.


Резюме. Рудниците Мартиново и Чипровци в Северозападна България са активно експлоатирани в периода от 1950 до 1999 г. От 1999 г. те са в процес на ликвидация и консервация, като до момента са рекултивирани както трите обслужващо хвостохранилища, така и по-голямата част от насипите в отделните участъци на рудниците. Рудничните води от основните извозни галерии в повечето участъци, обаче изтичат навън и се вливат в притоците на р. Чипровска Огоста. Извършените сезонни изследвания на съдържанието на тежки метали (мед, кадмий, цинк, олово) и металоиди (арсен, антимон) в рудничните води и в някои притоци на р. Чипровска Огоста показват незначително сезонно колебане и високи съдържания на тези елементи (до няколко пъти над ПДК по БДС), особено на арсена и оловото, които са основни замърсители на водите и почвите в района, което от своя страна подчертава потенциалната токсичност на рудничните води върху околната среда в непосредствена близост. Изключение правят съдържанията на разтворено олово, които показват значителна сезонна вариация. В участъците Лукина падина и Долич се отбелязва и задоволително постоянно съдържание на разтворен антимон (до 25 μg/l) в изтичащите руднични води.

Резюме. Миграцията на $^{90}$Sr в глините на Брусарската свита в района на гр. Козлодуй е оценена чрез моделиране на водо- и масопреноса във вертикална посока с помощта на компютърния код HP1. Адсорбционните свойства на средата са представени с процеса на образуване на комплексни съединения на стронция с ферооксидите от глините. Резултатите са сравneni с друг модел, при които задържаните свойства на средата са дадени с коефициента на разпределение $K_d$.


Abstract. The article deals with the prediction of conditions for dissolution and deposition of carbonate substance in the Upper Jurassic – Lower Cretaceous aquifer in case of underground gasification of Carboniferous coal deposit in Dobrudza field. The saturation index of carbonate minerals is estimated based on the modelling of temperature change. The increasing value of this index is a prerequisite for minerals deposition in fissures and caverns at the bottom of the Upper Jurassic – Lower Cretaceous aquifer.

28. Антонов, Д., Vl. Hristov, Al. Benderev, Ts. Kotsev. 2015. Comparing the parameters from pedotransfer functions and in situ permeability tests in the vadose zone of the Ogosta River floodplain in connection with validation procedures of contaminant migration modelling. – Peer reviewed short communications of the National Conference with international participation Geosciences 2015, 139-140, ISSN 1313-2377, (ref.).

Резюме. Представят се резултати за коефициента на филтрация $K_{sat}$ на 9 почвени слой, получени чрез използване на статистически функции за трансформиране на почвени данни и резултати за $K_{sat}$ от полеви инфилтрационни тестове за същите разновидности. Отчита се съвпадане и съпоставимост на получените по двата метода стойности, което дава възможност за валидиране на модели на миграцията на арсена на по-голяма територия.

29. Антонов, Д., M. Datcheva, Tz. Iliev, E. Kozhoukharova. 2015. Comparative compact and strength characteristics of loess-cement mixtures with various additives. – Peer reviewed short communications of the National Conference with international participation Geosciences 2015, 137-138, ISSN 1313-2377, (ref.).

Резюме. Определят се уплътнителните характеристики и якостните показатели: якост на едноосен натиск на заздравен с портландцiment фос от района на АЕЦ „Козлодуй“ и с добавка на природни вещества: серпентинит, зеолит (клиноптилолит) и бентонит, съответно 10% и 20%. Сравнява се
Якостта на смеси от песъчлив льос със 7% и 12% цимент, формовани при стандартна плътност $\rho_{ds}$ и оптимално водно съдържание $w_{opt}$, след едномесечно отлежаване с цел отчитане на влиянието на добавките.