5. RADIONUCLIDES IN THE ENVIRONMENT, RADIOECOLOGY (REG)

Lectures

REG.L01 (Id: 256)
IMPACT OF THE CHERNOBYL ACCIDENT ON NORWAY: LESSONS LEARNT

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Norway was one of the European countries most seriously affected by the Chernobyl-accident. According to a nationwide survey in 1986 the total deposition of ^{137}Cs in the country was estimated at 2300 ± 200 TBq and about 10 % of the territory received more than 20 kBq m^{-2} of this radionuclide. This has resulted in significant exposure of wildlife as well as domestic animals grazing in forest and mountain areas and corresponding contamination of meat and milk intended for human consumption. Reindeer were particularly vulnerable due to its lichen feed during large parts of the year, but also sheep (and goats) frequently showed ^{137}Cs activity levels far above the upper limits defined for human consumption. Prognoses based upon on-going monitoring programmes indicate that there will still be problems with high concentrations of ^{137}Cs in animals on rough grazing in Norway for 10-20 years to come. During the first few years after the accident radioecological research had favourable conditions and biologists, chemists, physicists, veterinarians and agricultural researchers were working together to learn about the behaviour of ^{137}Cs in terrestrial and aquatic foodchains. Emphasis was placed on its behaviour in natural soils, uptake in forage, and transfer to animals. Transfer of Cs from soil was studied for a great number of naturally growing plants and fungi, and some mushroom species were found to be extreme Cs accumulators leading to problems in years with abundant mushroom growth. To avoid discarding meat and milk, considerable efforts were done to develop countermeasures reducing Cs activity levels in domestic animals, the most successful being: (1) use of Prussian blue (Gieze salt) to reduce the uptake of ^{137}Cs, (2) providing clean feed a few weeks before slaughter in connection with live monitoring of animals, and solely for reindeer (3) changing slaughter time from February to September, reducing the influence of lichen feeding, which is most important during winter. Prior to the Chernobyl accident food chain transfer was discussed in terms of transfer factors based just on measurements of activity concentrations in the media in question. The research in Norway and elsewhere after Chernobyl has emphasized the importance of chemical speciation of the radionuclides for their behavior e.g. in soil, water, and sediments. The mobility of Cs ions in the boreal soils of Scandinavia with high organic matter content has shown to be much greater than in the previously studied agricultural soils with high content of mineral matter including clay minerals fixing Cs ions strongly. Thus the uptake of Cs in plants from these soils is much greater than previously experienced, and strongly dependent on the chemistry of the soil solution. Particularly high mobility of ^{137}Cs is observed in southernmost Norway where the soils are more acidified than elsewhere. Results from repeated surveys of natural surface soils showed that the decline of ^{137}Cs was greater in coastal regions than in areas farther inland, probably attributable to a greater deposition of Mg^{2+} and Na^{+} in the former areas, replacing Cs ions adsorbed to soil particle surfaces. This effect appeared to be particularly strong near the southern coast where deposition of NH_4^{+} from transboundary pollution is evident in addition to the marine cations. The effect of precipitation chemistry on the ^{137}Cs mobility however is found to decline with time, indicating that the ^{137}Cs cations are gradually moving to sites where they are more strongly bound. Experiments where identical soil columns, containing ^{137}Cs from Chernobyl and freshly added ^{134}Cs, are exposed to precipitation of different quality in amounts corresponding to ten years of deposition, largely confirm the conclusions from the repeated soil surveys.

REG.L02 (Id: 112)
TRITIUM IN THE RAINWATER AROUND THE NUCLEAR POWER PLANT OF PAKS, HUNGARY

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Tritium in the environment has natural and artificial sources. The formers are the nuclear reactions in the upper troposphere and the lower stratosphere, the latter are the various nuclear facilities (fission and fusion reactors, eTc.). In order to investigate the two phenomena separately it is necessary to know the effect of artificial tritium emitters to their surroundings with respect to distance from the source. In the presented study rainwater was collected around the nuclear power plant of Paks, Hungary, by means of special rainwater collectors. The sampling distances were 400 and 800 m from the centre of the plant. The samples were analyzed for tritium with liquid scintillation counting and some samples with the ^{3}He ingrowth method. Results show that the trace of the tritium plume from the plant is clearly detectable in the rainwater. However, the maximum activity of the rainwater is only around 10 and 5 Bq/L at 400 and 800 m distances, respectively. A Gaussian

plume model is fitted to the measured tritium and meteorological data and shows that the influence of the plant on the tritium in rainwater is completely negligible over some kilometers distance.

REG.L03 (Id: 331)
POLONIUM (^{210}Po), URANIUM (^{234}U, ^{238}U) AND PLUTONIUM (^{238}Pu, $^{239+240}$Pu) IN THE BIGGEST POLISH RIVERS

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Radionuclides existing in the environment, both natural and artificial, are accumulated in plants and animals and transferred through the trophic chain. They are also transported with river from their caTchments' areas. The activities of polonium ^{210}Po, uranium (^{234}U, ^{238}U) and plutonium (^{238}Pu, $^{239+240}$Pu) were measured in the biggest Polish rivers with tributaries - the Vistula and the Oder - and 3 small Pomeranian rivers. The Vistula unfiltered water samples were collected from November 2002 to November 2003, the Oder and the Pomeranian samples were collected from October 2003 to July 2004 and all were measured using the α spectrometer. The highest quantity of ^{210}Po was transported from the Vistula caTchments area to the Baltic Sea in spring and the lowest in summer, while the Oder carries the highest amounts during spring time. Annually the southern Baltic Sea is enriched in 94.5 GBq of ^{210}Po (73.7 GBq from the Vistula, 14.8 GBq from the Oder and 6.0 GBq from the Pomeranian rivers). In the study, the highest activities of uranium ^{234}U and ^{238}U in the Vistula River samples was observed in spring, the lowest in summer. The activity of uranium in the Oder was different in all analyzed seasons, the lowest however in summer. In all analyzed river samples uranium isotopes ^{234}U and ^{238}U are not in the radioactive equilibrium state and the values of ^{234}U/^{238}U activity ratio lie between 1.03-1.84. Annually the southern Baltic Sea is enriched in about 750 GBq of ^{234}U and ^{238}U from all analyzed rivers. According to the Vistula River the highest quantity of plutonium ^{238}Pu and $^{239+240}$Pu were transported to Baltic See in spring and the lowest in summer. The highest activities of plutonium ^{238}Pu and $^{239+240}$Pu in the Oder River samples was observed in winter, the lowest in summer. Annually the Vistula River, the Oder River and the Pomeranian rivers enrich the Baltic Sea in 22.2 MBq ^{238}Pu and 137.6 $^{239+240}$Pu.

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REG.L04 (Id: 169)
EXPERIMENTAL STUDY AND MODELLING OF ^{137}Cs SORPTION BEHAVIOUR IN THE BALTIC SEA AND THE CURONIAN LAGOON

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Sorption-desorption behaviour of Cs, Pu and Am in the system was studied using data obtained from different sampling campaigns in the Baltic Sea and the Curonian Lagoon in 1999-2009 as well as from short- and long-term kinetic tracer experiments using natural sea or river water and bottom sediments collected in the Curonian Lagoon or the Baltic Sea. Sorption experiments were carried out with particles of various sizes from 0.2 to 50 μm. Samples of suspended particles and bottom sediments collected during these sampling campaigns were fractionated according to the size. Association of ^{137}Cs with solid phase was studied using sequential extraction. In addition, the in situ distribution of ^{137}Cs between water and suspended particles of various sizes was measured and expressed as K_d. K_d values for suspended particles of > 0.2 μm size ranged from 1000 to 5500 mL/g in the near shore zone of the Baltic Sea and from 1400 to 20000 mL/g in the Curonian Lagoon. The part of ^{137}Cs bound to 0.2-1 μm particles changed from 10% in the near shore waters to about 80% in the open sea. For all studied radionuclides Cs, Pu and Am an increase in mass activities with decrease of bottom sediment particle sizes was determined. Data obtained from tracer kinetic sorption experiments with ^{134}Cs and bottom sediment fractions of different grain size were used for finding a suitable kinetic sorption model, kinetic constants and the corresponding equilibrium K_d values. It has been found that the modelled data best conform with the mechanism of ion diffusion through the so-called inert layer on the surface of the sediment particles. Kinetic sortion experiments with Pu(V) and Pu(IV) at trace initial concentrations were performed with the natural seawater and bottom sediments with the aim of better understanding of plutonium behaviour in the Baltic Sea. Solvent extraction techniques (using TTA, HDEHP, DBM and PMBP) were employed to characterize the oxidation states of the formed plutonium species in the liquid and solid phases. Modelling is in progress.

REG.L05 (Id: 11)
NATURAL RADIONUCLIDES IN SEDIMENTS AND ROCKS FROM ADRIATIC SEA

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During the International Scientific Cruise to Adriatic and Ionian Seas organised by the International Atomic Energy Agency (IAEA), sediment and rock samples were collected at different locations. Sediments were sampled with grab corer at six locations in the middle and south Adriatic Sea. Rocks were collected on three islands (Palagruža, Brusnik, Jabuka) in the Adriatic Sea. In the samples, natural radionuclides ^{238}U, ^{234}U, ^{232}Th, ^{230}Th and ^{226}Ra were determined. Samples were first dried, crushed and homogenised. After that, radiochemical separation procedures were applied. After radiochemical separation, samples were measured by α spectrometry system equipped with PIPS (passivated implanted planar silicon) detectors. Activity concentrations of natural radionuclides in samples ranged from 11.7 to 27.0 Bq/kg for ^{238}U, from 7.9 to 28.1 Bq/kg for ^{234}U, from 13.2 to 31.9 Bq/kg for ^{232}Th, from 17.1 to 40.9 Bq/kg for ^{230}Th and from 8.3 to 52.3 Bq/kg for ^{226}Ra. In the presentation, the obtained values are discussed in detail and compared with results of similar investigations carried out elsewhere.

REG.L06 (Id: 345)
RECENT TRENDS IN RADIOMETRICS AND MASS SPECTROMETRY TECHNOLOGIES - SYNERGY IN ENVIRONMENTAL ANALYSES

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The dominant development in the radiometrics techniques has been the utilisation of large HPGe detectors in underground laboratories with anti-cosmic or anti-Compton shielding for the analysis of short and medium-lived radionuclides in the environment. They have included applications of high efficiency HPGe detectors (up to 200% relative efficiency to a 75 mm diameter, 75 mm long NaI(Tl) detector), often operating at least a few tens of metres underground, where the nucleonic component of cosmic rays is reduced by several orders of magnitude. In the mass spectrometry sector, applications of Inductively Coupled Plasma Mass Spectrometry (ICPMS) and Accelerator Mass Spectrometry (AMS) for the analysis of long-lived radionuclides in the environment are the most important recent achievements. These developments in both sectors did not only considerably decrease the detection limits for several radionuclides (up to several orders of magnitude), but they also enable to decrease sample volumes so that sampling, e.g., of the water column or sediments can be much easier and more effective. A comparison of radiometrics and mass spectrometry results for the analysis of radionuclides in the environment shows a reasonable agreement - within quoted uncertainties, for wide range of activities and different sample matrices analysed. ^{137}Cs, ^{3}H, ^{14}C, ^{129}I and Pu isotopes water profiles recently obtained for the Indian Ocean will be discussed in detail.

REG.L07 (Id: 270)
RADIONUCLIDES IN DRINKING WATER - AN OVERVIEW: THE EU DIRECTIVE, ANALYSIS, THE AUSTRIAN STANDARD, GEOGRAPHICAL DISTRIBUTION, REMOVAL AND WASTE PROBLEMS

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Drinking water is the most important food, therefore special care has to be taken for its purity. The European Union has issued a Directive on the Quality of Drinking Water, which also contains a chapter on radionuclides. The details will be discussed. With rare exceptions only Naturally Ocurring Radioactive Material (NORM) is of importance for the dose from drinking water. NORM usually cannot be determined by putting a sample on the Ge-detector. Radiochemistry is needed. New methods have been introduced and the traditional measurement of ^{222}Rn and ^{226}Ra has been extended to other radionuclides like ^{228}Ra, ^{210}Po and ^{210}Pb. The Austrian standard on compliance with the EU indicative dose will be presented and recommended to be used with country specific adaptions. In this context the geographical distribution of radionuclide concentrations in drinking water are of importance and examples will be given. Finally the question of purification of water arises. The results of a EU-project on removal of NORM (TENAWA) will be presented as well as the logical question of (radioactive) waste from the purification.

REG.L08 (Id: 55)
NATURAL RADIONUCLIDE CONCENTRATIONS IN AUSTRIAN MINERAL WATERS

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As an EU country, Austria has to meet the European Community guideline concerning waters for consumption; here a Total Indicative Dose of 0.10 mSv per year for all nuclides with the exception of tritium, ^{40}K, radon and radon progeny, is fixed. In our investigation we measured the radium isotopes ^{226}Ra and ^{228}Ra, the uranium isotopes ^{248}U and ^{234}U, as well as ^{210}Pb and ^{210}Po; although the latter two are radon daughters and therefore

exempted from the guideline, they can contribute considerably to the committed dose due to their higher dose conversion factors. 1-1.5 L samples of brands from all over Austria were collected from different stores. Radium isotopes were separated by filtering the acidified and degassed mineral water through a Ra extraction disk containing an ion exchange resin [1]. Radium was eluted from the filter with EDTA. The EDTA solution was mixed with a scintillation cocktail and then counted with a low-level counter (Quantulus 1220) using pulse-shape analysis. This procedure collects also the ^{210}Pb, which can be seen in the β-spectrum close to the ^{228}Ra peak. ^{210}Po was spontaneously deposited from the remaining solution onto Cu planchets together with a ^{208}Po tracer and measured α-spectrometrically with a PIPS detector [2]. After adding ^{232}U as a spike uranium was separated by anionic exchange and also measured α-spectrometrically after microprecipitation with neodymium fluoride [3]. From our measured activity concentrations we will give an estimate of the radiological impact of mineral water on consumers. Generally, the calculated annual doses to the adult members of the public are far below the Total Indicative Dose of 0.1 mSv per year.

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REG.L09 (Id: 47)
RADIOLOGICAL CHARACTERIZATION OF DRINKING AND MINERAL WATERS IN SLOVENIA

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It is well known that water contains dissolved radionuclides from uranium and thorium decay chains. Their concentrations are variable and depend on the nature of the aquifer rock types and the prevailing lithology. Quantitative information about the activity concentrations of critical α emitting radionuclides in the food and drink is important in the study of cumulative radiation effects on human beings. Measurements of their levels in drinking water are therefore important to estimate the potential exposure of the public. Due to postulation that the dose coefficient is always related to a specific radionuclide the aim of our study was to determine the activity concentrations of ^{238}U, ^{234}U, ^{226}Ra and ^{210}Po in drinking and mineral waters from different geological or lithological background areas all over the country. For determination of investigated radionuclides α-particle spectrometry was applied. On the basis of radionuclide activity concentration the contribution of each particular radionuclide to internal radiation doses from drinking and mineral water for different groups of people (children, adults) was assessed.

REG.L10 (Id: 276)
RADIATION AND ENVIRONMENTAL MONITORING AT THE SITES FOR THE RW AND SNF TEMPORARY STORAGE IN RUSSIA

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In the light of the operation life termination of the Navy nuclear submarines and their technical service vessels, and because of international obligations of the Russian Federation to reduce armaments, the intensive decommissioning has started since the latter 1980-s. The decommissioning rate was higher than these submarine dismantlement rate limited by the available abilities of the industrial infrastructure. Therefore, radioactive wastes were accumulated at the sites for the RW and SNF temporary storage (STS), like a shot. From this perspective, ex-Navy shore technical bases located in Murmansk region (Andreeva Bay and Gremikha village) and at the Primorsk Territory (Sysoeva Inlet) are the subjects of the highest attention. To gather full information on the current radiation situation, independent in relation to the regulatory bodies, the FMBC specialists carried out radiation and hygienic monitoring. It included dynamic observation both of the radiation-and-hygienic situation parameters and doses to the public living close to the radiation hazardous facilities - STS in Murmansk region and Primorsk Territory. During the expedition travels, samples of environmental media, local foodstuffs and drinking water have been collected. Radiochemical analysis and γ-spectrometry methods were used in the sample examination. The findings of radiation and environmental monitoring confirm considerable exceeding (in comparison with normal background values) of man-made radionuclide contents in seawater, seaweeds, bottom sediments, vegetation and soil at local parts of the coastal stripe of the STS health protection zone. The radionuclide sorption examination in soil and ground water permits to assume effective migration from the contaminated areas via ground water and following radioactivity intake by the marine media at the off-shore water area. Taking into account further contamination of the STS area, observation of the radiation situation dynamic change should be continued both under regular operation mode and during the SNF and RW removal operations.

REG.L11 (Id: 266)
MODEL COMPOUNDS TO UNDERSTAND BACTERIAL SURFACE FUNCTIONALITY

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Of the many factors that influence the transport of actinides in the environment, microorganisms remain among the least understood and most difficult to study. Through a multitude of interactions, bacteria can play a significant role in both the environmental mobilization and immobilization of actinides. This presentation will give an overview of the current status of the field that will be illustrated with example from the literature and with our studies to understand these interactions between a bacterial surface and heavy metal complexation. We are studying a class of single and multifunctional polyelectrolytes as model systems such as propionic acid, 3,3,3-trifluoropropionic acid, phosphoenol pyruvate (PEP), phosphonoacetic acid (PAA), and 3-phosphonopropionic acid (PPA). PEP, PAA, and PPA possess two bifunctional aliphatic organic ligands of different chain lengths, containing each one carboxyl and one phosphate functional group. We are reporting our complexation study of Cm(III) and Eu(III) by time-resolved laser fluorescence spectroscopy (TRLFS) with these ligands. The interactions between species of curium(III)/europium(III) and the various model ligands were investigated as a function of ligand concentration and pH. Thermodynamic stability constants and selected density functional calculations describing the energetically most likely complex configurations will be discussed.

REG.L12 (Id: 102)
COMPLEXATION OF U(VI) WITH NITROGEN AND PHOSPHOROUS CONTAINING LIGANDS IN AQUEOUS SOLUTION

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The long-term safety assessment of nuclear waste disposals requires detailed knowledge of the transport and interaction behavior of actinides within the technical, geotechnical and geological barriers. In the case of accidental release of radionuclides into the surrounding environment, their migration behavior can be effectively influenced by the ambient conditions like pH, temperature, ionic strength and especially the presence of inorganic and organic complexing ligands, e.g. bioligands like humic acids, amino acids or phospholipids. Due to their high complexing capacity towards metal ions these ligands may influence the mobility of actinides. We have studied the U(VI) complexation with nitrogen and phosphorous containing model ligands in order to simulate the functionalities of bioligands. The aim of this work is to determine the influence of various nitrogen and phosphorous containing functional groups on the U(VI) complexation and to evaluate their contribution in comparison to oxygen-containing functional groups. As nitrogen-containing ligands we used the biologically important substances anthranilic acid (AA) and nicotinic acid (NA). Furthermore, phenylphosphonic acid (PPA) was used as aromatic phosphorous-containing ligand. The complexation studies in aqueous solution were performed as a function of pH using time-resolved laser-induced fluorescence spectroscopy (TRLFS). All ligands show a complex formation with U(VI) under the given experimental conditions ([U(VI)] = 0.05 mM, [ligand] = 0 - 0.5 mM, pH 2-4, I = 0.1 M, T = 25 °C). The binding of U(VI) by AA and NA takes place via the carboxylic group of the ligands. It can be concluded that oxygen containing functional groups dominate the U(VI) complexation in the investigated pH range. The nitrogen functionalities of the ligands play only a subordinate role. AA forms a 1:1 complex, with a corresponding stability constant of $\log ß_{11} = 3.14 \pm 0.17$ [1]. The formation of 1:1 and 1:2 complexes was detected for the U(VI)-nicotinate system ($\log ß_{11} = 3.73 \pm 0.30$, $\log ß_{12} = 7.46 \pm 0.17$ [1]) as well as for the U(VI)-phenylphosphonate system ($\log ß_{11} = 3.58 \pm 0.17$, $\log ß_{12} = 6.81 \pm 0.10$). At high U(VI) concentrations (1 mM), a precipitation of the formed complexes was observed for the U(VI) complexation by AA and PPA. The precipitates were analyzed with FT-IR spectroscopy and X-ray diffraction. To study the influence of different functional groups on the complexation of actinides in different oxidation states, comparable complexation studies are performed with Am(III).

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REG.L13 (Id: 179)
MOLECULAR CHARACTERIZATION OF THE SPECIATION OF URANIUM ASSOCIATED WITH THE MARINE BACTERIUM IDIOMARINA LOIHIENSIS MAH

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The present study describes the speciation of uranium associated with Idiomarina loihiensis MAH1, a bacterial strain with biomineralization potential abilities isolated from the Alboran Sea in the west side of the Mediterranean Sea. The interactions of uranium with this marine bacterium was studied both in $NaClO_4$ solution as well as in sea water using a multidisciplinary approach combining X-ray Absorption Spectroscopy (XAS), Transmission Electron Microscopy

(TEM), Energy Dispersive X-ray (EDX) analysis and Time-Resolve Laser-Induced Fluorescence Spectroscopy (TRLFS). The results indicated that the speciation of uranium associated with the cells of the strain studied is highly dependent on the speciation of the background electrolyte used ($NaClO_4$ solution and sea water). In $NaClO_4$ solution (at U concentration of 0.5 mM, pH 4.3), EXAFS spectroscopy analysis indicated that the bacterial cells coordinated U through phosphate groups in a monodentate fashion mode and carboxyl groups in a bidentate binding mode. TRLFS results corroborate the EXAFS analysis showing the main implication of phosphate groups in the coordination of U. The uranium bacterial complexes were located within the extracellular polysaccharides (EPS), at the cell wall and some accumulates were observed intracellularly as was demonstrated by TEM analysis. However, in sea water and at U concentration of $5x10^{-4}$ M (environmentally relevant concentration), TRLFS analysis indicated that the marine bacterium precipitate this radionuclide as U carbonate mineral phases. In addition, a part of the metal was coordinated to phosphate groups. TEM analysis showed that the accumulated U was located only at the cell surface as electro dense precipitates. The results of this study will help to understand the role of microbial process on the transport and mobility of radionuclides in the Alboran Sea as it is the only connection between the Mediterranean Sea and the Atlantic Ocean, and where the transportation of radioactive waste and the traffic of nuclear submarines are very intense.

REG.L14 (Id: 13)
POLONIUM-210 AS A TRACER OF ENERGY TRANSFER IN MARINE FOOD CHAINS

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Generally, in marine biota ^{210}Po concentrations are higher in comparison with those in terrestrial organisms. As a consequence, much attention has been paid to polonium-210 (^{210}Po) and its precursor lead-210 (^{210}Pb), the two radionuclides belonging to the natural uranium series. These radionuclides give a major contribution to the internal radiation dose received by man mainly through ingestion of seafood. High ^{210}Po concentrations in internal organs of some crustacean, molluscs, and fish motivated research on the potential biological effects originated by high radiation doses that may be experienced in some marine species. Analyses of ^{210}Po and ^{210}Pb were made in a plethora of marine species from plankton to whales and from the sea shore organisms to those living in abyssal depths. Concentrations of those radionuclides ranged from very low values, of about 0.5 Bq kg^{-1} (wet wt.) in jellyfish, to very high values of about $3x10^4$ Bq kg^{-1} (wet wt.) in the gut walls of sardines, with the general pattern of $^{210}Po > ^{210}Pb$. ^{210}Po and ^{210}Pb in marine organisms are primarily absorbed from water and concentrated in phyto- and microplankton. Thereafter, these radionuclides are transferred to plankton consumers (herbivores) and to other trophic levels with ingested food, displaying higher yield of ^{210}Po transfer than of ^{210}Pb transfer along marine food chains. Investigation of epipelagic, mesopelagic, bathypelagic and abyssobenthic organisms revealed that ^{210}Po is transferred in marine food webs with transfer coefficients similar to those of energy transfer. ^{210}Po seems to represent the protein transfer in the food chains.

REG.L15 (Id: 32)
IMPACT OF U-MILL TAILINGS OF THE FORMER URANIUM MINE AT ŽIROVSKI VRH (SLOVENIA) ON RADIONUCLIDE ACCUMULATION BY WETLAND PLANTS

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Transfer of radionuclides into the environment is a common phenomenon and due to its potential harmful effect it is of particular scientific interest in the vicinity of uranium mines. Radionuclides, especially uranium and thorium decay products are discharged with U-mill tailings into the soil and water and consequently into vegetation where they accumulate. Radionuclide soil-to-plant transfer was observed in many studies. Uranium mine at Žirovski Vrh in Slovenia, which operated from 1985-1990, processed about 600,000 tons of U-ore. U-milling and mining tailings were deposited at the Boršt and Jazbec sites. Plants that grow in the vicinity of U-mill tailings may accumulate radionuclides in their tissues and thus represent a possible transfer of radionuclides into the food chain. These are so called metal-accumulating plants that developed metal resistance mechanism and may grow on metal-contaminated or metalliferous soil. Plants, such us marsh marigold (Caltha palustris), soft rush (Juncus effusus) and common reed (Phragmites australis) are known as accumulator plants, because they accumulate toxic metals in their above-ground tissues. Other plants, especially grasses, may also grow on metal contaminated soils but do not accumulate metals. Preliminary results of radionuclide accumulation by such plants growing in the contaminated area are presented. A common reed that was grown on the uranium-mill tailings accumulated 0.01 Bq/g d.w. and 0.002 Bq/g d.w. of uranium in leaves and stems, respectively. In contribution, activity concentrations of other nuclides from uranium and thorium decay chains in other plants are also presented and discussed.

REG.L16 (Id: 90)
THE SORPTION PROCESSES OF NP(V) AND U(VI) ONTO METAL OXIDE PHASES. THE FORMATION OF SORPTION COMPLEXES AND MECHANISTIC ASPECTS STUDIED BY IN SITU ATR FT-IR SPECTROSCOPY

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The migration behaviour of actinide ions in the geosphere is generally influenced by sorption processes in aqueous media. These processes occurring at solid/liquid interfaces can be monitored by in situ Attenuated Total Reflection Fourier-transform Infrared (ATR FT-IR) spectroscopy providing structural information on a molecular level.[1] In this work, the sorption of neptunium(V) onto metal oxides was investigated for the first time by ATR FT-IR spectroscopy. From the Np(V) sorption studies on the metal oxides, stable surface species of NpO_2^+ are derived. The type of the sorbed species can be elucidated by a spectral shift (~ 30 cm^{-1}) to lower wavenumbers of the antisymmetric streTching vibration $\upsilon 3(NpO_2^+)$ compared to the aqueous species suggesting an inner-sphere complexation. Outer-sphere complexation is found to play a minor role due to the pH independence of the sorption species throughout the pH range 4 - 7.6. The comparative spectroscopic experiments of Np(V) sorption onto TiO_2, SiO_2 and ZnO indicate structurally similar bidentate surface complexes.[2] A detailed insight into the molecular mechanisms occurring during the formation of ternary actinide complexes at the solid/liquid interface is provided upon formation of uranyl carbonato complexes on ferrihydrite (Fh). The influence of the presence of atmospheric carbon dioxide during the sorption processes of the actinide ions was studied by sorption experiments which were carried out under inert gas conditions and in an ambient atmosphere. From the results, the formation of bidentate [Fh•••UO_2•••O_2CO] complexes can be derived under mildly acid conditions which is in agreement from recent EXAFS results obtained from baTch samples.[3] Furthermore, experiments with ^{13}C-labelled carbonate provide an unequivocal assignment of the spectral features reflecting the structural alterations of the carbonate ions upon sorption of uranyl cations onto Fh. From these assignments, the formation of the ternary uranyl complexes can be described at a molecular level.

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REG.L17 (Id: 194)
URANIUM SORPTION ON VARIOUS FORMS OF TiO_2 - INFLUENCE OF SURFACE AREA, SURFACE CHARGE AND IMPURITIES

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Titanium dioxide has properties that make it an excellent substrate for experimental study and theoretical development of adsorption models, including negligible solubility and a near neutral point of zero charge [1]. A number of different forms of Ti-oxide have been used in experimental studies, including hydrous Ti-oxide, anatase, rutile and various commercially available samples that contain a mixture of anatase and rutile. The aim of our work is to investigate uranium sorption phenomena and the influence of surface area, surface charge and impurities for a range of thoroughly characterised Ti-oxide surfaces. We have undertaken uranium(VI) sorption studies on a number of commercially available Ti oxides, some of which were aggressively pre-treated to remove inherent impurities. Characterisations performed on the various Ti-oxides comprised a range of chemical and physical methods including XRD, XRF, ATR FT-IR, chemical assays, BET determinations, and electroacoustic measurements. The sorption of U on these Ti oxides was studied by a baTch sorption method and the effect of pH, ionic strength, mass loading, and U concentration on uranium sorption was also investigated for several of these Ti-oxides. We found that the sorption of uranium (VI) on these Ti-oxides was extremely strong and much greater than many other common environmental sorbents on a surface area basis. Aggressive pre-treatment of one Ti-oxide significantly altered its isoelectric point, but did not appear to significantly impact its sorption behaviour. Differences in sorption behaviour between the various Ti-oxides were related to the surface area of these materials. The data provide insights into the effect of different source materials and surface properties on radionuclide sorption, and will be useful in assessing data obtained in diverse experimental studies involving Ti oxides.

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REG.L18 (Id: 28)
TRANSPORT OF $^{125}I^-$, $^{137}Cs^+$ AND $^{85}Sr^{2+}$ IN GRANITOIDIC ROCKS AND SOIL

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Transport of $^{125}I^-$, $^{137}Cs^+$ and $^{85}Sr^{2+}$ radionuclides in crushed granitoidic rocks and homogenized soil was studied. Two simple methods for calculation of transport parameters of these radionuclides in flow column experiments with groundwater (GW) as transport medium have been described. The first method is based on the assumption of a reversible linear sorption of reactive solutes (radionuclides) on solid phase (with constant distribution, K_d, and retardation, R_{exp}, coefficients), whereas the second one is based on the assumption of a reversible non-linear sorption (characterized with non-linear sorption isotherm, i.e. with non-constant K_d and R_{exp}). Both methods use the experimental breakthrough curves (BTCs), which are constructed using the measured activities at the outlet from the column. The BTCs are fitted with the integrated form of the simple 1-D advection-dispersion equation (ADE) expressed analytically for pulse application of radiotracer to the liquid phase (GW) before entering into columns. In case of the first method, the integrated form of ADE is modified by two correction coefficients, namely, the peak position and peak height coefficients by means of which the very good agreement between experimental and calculated data is usually obtained. The second method is more sophisticated because not only the calculation of the values of retardation coefficients changing during transport is needed, but also the Freundlich equation parameters of non-linear isotherm have to be sought. Both methods were tested in the evaluation of the transport parameters of a given radionuclides in beds of diorite, gabbro, granite and tonalite granitoides and clayey loamy sandy soils. The results of two different approaches have been compared.

REG.L19 (Id: 62)
SORPTION BEHAVIOUR OF CONTAMINANTS IN SOILS: PH AND HUMIC ACID EFFECTS ON SORPTION OF ON CEC OF CLAY SOILS AND MINERALS, AND THE MOBILITY OF Cd, Cs, Ni AND Sr

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The aim of this study is to use predictive modelling to understand and calculate the sorption behaviour of radionuclide contaminants in complex environments such as clay-based soils. The effects of natural organic matter (NOM) on the cation exchange capacities (CEC) of different characterised clay soils (St Bees and Mercia Mudstones, Boom clay and London clay) and their constituent clay minerals will be determined by "doping" the samples with varying amounts of purified humic acid (not exceeding 15%) and measuring the changes in CEC. This will be followed by an assessment of how NOM affects the mobility of radionuclides (^{109}Cd, ^{137}Cs, ^{63}Ni and ^{85}Sr) through the materials using column and baTch techniques. The experiments will be repeated with each of the constituent clay minerals (montmorillonite, kaolinite, illite, chlorite and bentonite) present in the soils using baTch techniques, and the results obtained used to improve the understanding of the separate effects of each mineral on the overall sorption behaviour of the soils. This will lead to testing to determine if the additivity principle holds for these systems. Radiometric techniques and inductively coupled plasma optical emission spectroscopy (ICP-OES) will be employed in the quantification of radionuclide speciation between the phases, and the samples will be characterised by SEM and XRD with the assistance of BGS.

REG.L20 (Id: 98)
VERTICAL AND HORIZONTAL DISTRIBUTION OF ^{137}Cs IN ZONE OF CHERNOBYL CONTAMINATION IN RUSSIA

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Peculiarity of vertical migration of ^{137}Cs was investigated in zones of Chernobyl contamination (Bryanskaya, Orlovskaya, Tulskaya and Kaluzhskaya districts). Vertical distribution of ^{137}Cs on inviolate localities characterized by minimum penetration of the peak of maximal concentration into the depth of about 2-4 cm in dependence of type of soil and intensity of processes of bioturbation. Practically all quantity of ^{137}Cs in inviolate soils is accumulated in the top-most 0-15 cm. The waterlogged soils as well as acidic soils of the pine forests are exclusion of this rule, where ^{137}Cs may migrate into bigger depth. For example, the sandy soils without feature of podzolic processes contain 97% of the radionuclide in the first 5 cm. In dernovo-podzols the first 5 cm contain only about 60% of ^{137}Cs and a second peak of vertical distribution of ^{137}Cs was observed, related with accumulation of radionuclide in the illuvial horizont. Vertical distribution of ^{137}Cs in arable soils and adjacent slopes of dry valleys is formed greatly by processes of erosion and accumulation. Alternation zones of previous erosion and accumulation inside of the arable slope have been observed. On the flood areas of small rivers accumulation of the radionuclide is discovered on the billow near the river-channel, peak of vertical distribution of ^{137}Cs is in the depth of 5-10 cm. In marshy soils a decrease of ^{137}Cs in 0-25 cm depth relatively of soils of higher geomorphological positions is usually observed, probably because of the penetration of the radionuclide into a greater depth. But, under periodically wet conditions of flood area depressions it can form local spots of contamination 5 times higher than in soils of adjacent dry hills.

REG.L21 (Id: 347)
MIGRATION ABILITY OF PLUTONIUM AND AMERICIUM IN THE SOILS OF POLESSIE STATE RADIATION-ECOLOGICAL RESERVE

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One of the most important factors determining the radioecological situation in the terrestrial ecosystems is the radionuclide species in a soil medium. Radionuclide forms determine the processes of their entrance into the soil solutions, redistribution in soils, migration to the surface, ground and underground waters and spreading outside of the contaminated area. The present work is devoted to investigation of physicochemical forms and migration ability of plutonium and americium in soils of Polessie State Radiation-Ecological Reserve (PSRER), where located the main part of α-emitting radionuclides of Chernobyl origin. The objects of investigation were mineral and organic soils sampled in 2008 with the step of 5 cm to the depth of 25-30 cm. The forms of plutonium and americium distinguishing by association with the different components of soil and by potential for migration in the soil medium were studied using the method of sequential selective extraction according the modified Tessier scheme. Activities of ^{238}Pu, ^{239,240}Pu and ^{241}Am in the samples were determined by the method of radiochemical analysis with α-spectrometer radionuclide identification. A vertical radionuclide distribution in soils and the total radionuclide reserves in the soil profiles were established. Intensities of vertical radionuclides' migration in the soils were estimated. It was shown that the main part of plutonium and americium is in the 0-20 cm soil layer, more often in 0-10 cm layer. Location of the radionuclide weighted mean quantity in the soils is at the depth of 3-15 cm from the soil surface. The average rate of vertical radionuclide migration of this quantity varies from 0.15 to 0.7 cm y^{-1} and is practically the same for plutonium and americium. The main part of plutonium and americium in soils is in immobile forms. Radionuclide portions in water soluble and reversibly bound forms do not exceed 9.4 % of radionuclide content in the soil. In mineral soil samples, the radionuclide portion in these fractions exceeds the corresponding portion in organic ones. In both mineral and organic soils, the portion of mobile americium is higher than plutonium. The portion of biological available forms of plutonium and americium is 2.7-29 % of total radionuclide content in the soils. The higher portion of biological available forms is characteristic for mineral soil (14-29 %) as compared with that in organic one (2.7-18 %). The reserves of mobile and biologically available radionuclide forms increase with the depth of soils. The increase of radionuclide portions in mobile and biologically available forms promotes the radionuclide entrance into the soil solution and enhancing the intensity of migration processes in the soil-plant system. The main control factors of radionuclide migration in soils under consideration are water regime and presence of radionuclide in composition of fuel particles. These factors could be more affective than radionuclide solubility in the soil waters because of some part of radionuclide transfer with the particles.

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Posters

REG.P01 (Id: 8)
TRANSLOCATION OF RADIOACTIVITY FROM SUBSTRATE TO MACROMYCETES IN SOME MINING AREAS

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The present study follows the extent of translocation of radioactivity from substrates of uranium and sulphur mining areas to the macromycetes spontaneously occurred during 2008-2009. To this purpose, radioactivity (gross α+β, ^{226}Ra and ^{137}Cs) of both macromycetes and their substrates was measured. The results obtained were confirmed by FT-IR spectroscopy, evidencing the presence of characteristic bands at about of 910 cm^{-1}, corresponding to the asymmetric streTching vibration of the uranyl unit and to the interaction between the UO_2^{2+} ions and the group belonging to various cellular components.

REG.P02 (Id: 14)
RADIOACTIVITY IN SOILS AND HORTICULTURE PRODUCTS NEAR OLD URANIUM MINING AND MILLING SITES

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Uranium in Portugal was mined mainly in small mines in the Centre-North of the country and lasted for most of the 20th century. Uranium production was discontinued in 2001, but most of the former mining and milling sites were not remediated yet and mining and milling waste heaps remain in surface exposed to weathering. In villages near old uranium mines, soils are used for horticulture production and to provide pasture for livestock grazing. Soil samples as well as agriculture products from the areas around former uranium mines were analyzed for α emitting radionuclides. Samples from other areas far from uranium mining sites were also included in the survey as reference sites. Results of uranium series radionuclides showed that soils of regions with different geology may contain very different baseline radionuclide concentrations. Soils near uranium mining waste piles in several cases displayed enhanced radionuclide concentrations resulting from soil contamination by mining waste. Concentrations of radionuclides in soils and vegetables of reference areas displayed values similar to those near uranium mining sites in the same geological province, indicating that enhancement of radionuclides in the terrestrial food chain, with the exception of ^{226}Ra, is generally not high. Concentrations in soils and horticulture products of these uranium areas in the uranium producing region were generally two orders of magnitude higher than baseline concentrations measured in soils and vegetables in a sedimentary region of the South of Portugal.

REG.P03 (Id: 21)
METHODS AND RESULTS OF THE MAIN NEGATIVE FACTORS OF KOSHKAR-ATA TAILING POND WITH IMPACTS ON ENVIRONMENT

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Ecological situation of Mangystau oblast (Kazakhstan) started aggravating in 1990s with exploitation of uranium ore, oils, mineral raw materials and building of chemical industry in Mangyshlak without paying due attention to environmental issues. According to available data the worsening is connected to number of ecologically unfavorable problems. The KOSHKAR-ATA tailing pond, representing the drain-free settling pool for industrial, toxic, chemical and radioactive wastes, as well as for ordinary domestic drains, is 5 km northward to Aktau (Mangystau oblast), which is situated on the shore of the Caspian sea. Industrial, toxic and radioactive waste, solid sediments of unpurified ordinary domestic drains from a part of the Aktau dwelling region have been drained into the tailing pond since 1965 and have been stored there up to now. Thus, continuous and long-term contamination of the lands around the KOSHKAR-ATA tailing pond and their vegetation unambiguously forces to consider regional ecological situation as critical. That is why it is very important to take immediate measures in order to reduce sequences, eliminate the reasons and sources of contamination and restore natural characteristics of the environment. Field investigations are performed in the scope that assures detailed radiometric surveying of the shore zone of the KOSHKAR-ATA tailing pond and its coast. The field investigations included: mapping of current outline of the coast-line/water edge of the toxic waste storage; footpath γ-surveying of the shore exposed surface (EDR was measured in 150 points) and mapping of the γ-field distribution; assessment of the volume activity for radon over the shore exposed surface of the tailing pond; detailed γ-surveying in the vicinity of surface burial of radioactive waste (RW); monitoring of aerosols at 10 stations; species identification and taking of samples of vegetation at the waste storage in places where soil fill had been previously performed; estimation of the radionuclide accumulation rate by vegetation and their further wind transfer. Analysis showed that there is an increased content of

radionuclides as thorium-234, radium-226, lead-214, bismuth-214, lead-210, uranium-235, thorium-227 in bottom sediment samples. Presence of various forms was studied for isotopes of thorium, radium, ^{210}Pb, ^{238}U. Lead-210 is considered as one of the most biologically hazardous natural radionuclides, even more radio-toxic than ^{90}Sr. Considerable part of ^{210}Pb (up to 53%) is associated with acid-soluble form what demonstrated its high migration abilities. Mobility series for ^{210}Pb (in %) is as follows: acid-soluble forms (40.2%) > exchange forms (11.7%) > water soluble forms (0.4%). Analysis of obtained results shows that there are higher contents of lead-210 in samples taken within the sectors; this is particularly so for the sector "Caspii."

REG.P04 (Id: 29)
DETERMINATION OF CATION EXCHANGE CAPACITY OF FUCOIDIC SANDS FOR Cs^+ AND Sr^{2+} UNDER DYNAMIC COLUMN CONDITIONS

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In the framework of the development of remediation scenario of underground areas affected by chemical mining of uranium in the locality of Stráž pod Ralskem a complex geochemical and transport model is proposed, which comprises interaction of rocks and groundwater affected by acid leaching. The chemical remediation processes also require the knowledge of the properties of the affected rocks. One of the important rock constituents are fucoidic sands constituting significant part of the cenoman aquifer. Therefore, it is of great importance to determine, among others, their cationic exchange capacity (CEC) toward univalent and divalent cations. In this paper results on the study of sorption and desorption behavior of Cs^+ and Sr^{2+} on column of fucoidic sands under dynamic flow conditions are presented and their CEC for these two cations are determined. The determination of CEC is based on the construction of respective breakthrough curves using ^{137}Cs and ^{85}Sr radionuclides as isotopic indicators in laboratory experiments. The samples were taken from several parts of the bore hole in the area of interest. Undisturbed cores of 5 cm in diameter and 10 cm long were put in the glass columns and the cores were perfectly tightened using acrylate resin. For the study of sorption/desorption cycle the so-called background groundwater was applied. The concentration of 10^{-6} mol/dm^3 of Cs^+ and Sr^{2+} in liquid phase individually was established using neutral salts of $CsNO_3$ and $Sr(NO_3)_2$, resp. The groundwater was introduced at the bottom of the columns by a multi-head peristaltic pump at about 4 cm^3/h of a constant flow-rate. The results show that the CEC capacity of the investigated fucoidic sands for ^{137}Cs and ^{85}Sr is 0.1-1.5 μmol/100g and 0.05-0.5 μmol/100g, respectively, in dependence on the evaluation of corresponding breakthrough curves. Some differences in the behavior of the cores during the experiments have also been explained.

REG.P05 (Id: 36)
ORIGIN OF ^{129}I IN THE ENVIRONMENT OF SLOVENIA

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^{129}I is considered as a global pollutant and its role as a global tracer to follow the dissemination of radionuclides from a source point such as nuclear fuel reprocessing plants increases. The natural ^{129}I/^{127}I isotopic ratio of the order of 10^{-12} was significantly influenced by releases of anthropogenic ^{129}I to the environment. The ratio of ^{129}I/^{127}I in the marine environment has increased to 10^{-11} - 10^{-10}, and in the terrestrial environment to 10^{-9} - 10^{-7}, even 10^{-6} in the vicinity of nuclear fuel reprocessing plants. Anthropogenic ^{129}I predominates in the biosphere, soil and in upper layers of the oceans, therefore it can be expected that the isotopic ratio ^{129}I/^{127}I is increasing in these compartments of the ecosystem. At the Josef Stefan Institute we have developed a radiochemical neutron activation analysis method (RNAA) for the determination of ^{129}I in environmental samples and the detection limit of the method is $5x10^{-14}$ g ^{129}I/g of solid sample. The developed method was used to trace ^{129}I in the environment of Slovenia. From marine environment seawater, alga, thorny oyster and sediment samples were analyzed and from terrestrial environment precipitation, soil and pine needles. The results found were in the range from 7.2 to 120.8 x 10^{-7} Bq/kg for precipitation, up to 75 x 10^{-4} Bq/kg for soil, from 0.1 to 2.12 x 10^{-4} Bq/kg for seawater, from 7 to 62 x 10^{-4} Bq/kg for thorny oyster and from 17 to 73 x 10^{-4} Bq/kg for brown alga Fucus virsoides (Donati) J. Agardh., which is endemic to the Adriatic Sea. The content of ^{129}I in marine sediment and pine needles samples analyzed till now was below the detection limit of the method. The data of this study represent a survey of ^{129}I in the environment of Slovenia. The most likely source of ^{129}I are nuclear fuel reprocessing plants in La Hague and Sellafield, which are known to be the major sources of ^{129}I in the environment of North Europe. ^{129}I is transferred to the atmosphere and washed out to the marine and terrestrial environment of Slovenia by precipitation, so it is of atmospheric-precipitation origin.

REG.P06 (Id: 37)
BACKGROUND LEVEL OF RADIOACTIVE ISOTOPES AROUND A L/ILW DISPOSAL FACILITY BEFORE IT STARTED OPERATION AT BÁTAAPÁTI, HUNGARY

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The new Hungarian National Radioactive Waste Disposal Facility was established in the granite of the Mórágy Block Mountains to store low and intermediate level radioactive waste (L/ILW) originating from the Paks Nuclear Power Plant. The safe operation of the radioactive waste disposal facilities requires a long-term environmental monitoring to gain information about the radiation properties of the site together with the radiation exposure of the personnel and the environmental media. Before the start of the operation of the facility the environmental characteristics of the site and its vicinity, i.e. the so-called zero level was determined. The determination of the zero level of the nuclear facilities is inevitable as the evaluation of the measurement data in the course of the operation should be related mainly to this zero level. In the course of the measurements the monitoring of the environmental elements, i.e. air, soil, water (springs, streams, precipitation), fall-out, wash-out, plant and animal samples, was performed from several points of view. From the samples collected radiocarbon, tritium, strontium-90, γ emitters, gross α, gross β and field γ measurements were carried out. The results are obtained before of the operation of the facility, they can approximately be considered as the Hungarian background data.

REG.P07 (Id: 38)
TESTING AUTOMATIC GROUNDWATER SAMPLING UNIT BY THE ISOTOPE ANALYTICAL AND DISSOLVED ION TESTS

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Automatic water sampling unit was developed in Herteleni Laboratory of Environmental Studies of MTA ATOMKI for monitoring the radioactive emission from nuclear facilities into the groundwater. The efficiency of existing and renewed geometry units and the reproducibility of survey data have been examined in the course of this work. A testing method was developed for this purpose, and ion binding efficiencies of ion exchange resins were analysed for different ion concentrations. These efficiencies have to be taken into consideration when we estimate the amount of the contamination transferred into the groundwater on the basis of the proportion of ions gained back from the resin. The model tests were executed under controlled laboratory circumstances. These circumstances were tried to be formed into facts true to nature. It has been found during the chain of tests that the sampling unit is suitable for well reproducible sampling. It can be stated that all tested geometrical lay-outs are usable and work with proper efficiency in small/low range of concentration as well. Taking the different efficiencies into consideration the activities can be corrected for every element if necessary. A correcting factor should be introduced during the ^{14}C anion exchanging sampling because samples taken by exchanging have systematically lower radiocarbon content than the actual one. We are working on continuing the tests. The γ activity measurement of existing gained back cation samples and giving the exact value of ^{14}C correction can give more reliable picture and direction to developing existing and possibly new systems.

REG.P08 (Id: 50)
RADIOCESIUM ACTIVITY CONCENTRATION MEASUREMENTS IN GAME MEAT AS A TOOL FOR MONITORING RADIOACTIVE CONTAMINATION IN WILDLIFE AND ENSURING RADIOLOGICAL SAFETY FOR CONSUMERS

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An increased level of cesium radioisotopes was noted in many foodstuffs after the Chernobyl disaster. The radiocesium activity concentrations may remain high in products such as game meat, wild mushrooms, and forest berries. Therefore, an official monitoring of radiocesium in game meat was established by Polish Veterinary Inspection. Generally, consumption of game meat in Poland is low. However, in hunters' families this sort of food can contribute a large portion of meat to a diet. Moreover, some quantities of Polish game meat are exported to many countries. Meat samples of wild boar, red deer, and roe deer were taken at game processing facilities by veterinary inspection officers and then transported to laboratories for analyses. Radiocesium activity concentrations were determined by γ-ray spectrometry using scintillation (NaI(Tl)) detectors. The ^{134}Cs activity concentrations were negligible (below MDA) in all the samples analysed. Generally, the ^{137}Cs activity concentrations varied between and among the animal species even in the same region ranged from MDA values to some hundreds Bq/kg. The effective dose, which general population in Poland received from consuming game meat, may be considered very low with the exception of hunters' families. Assuming the mean annual game consumption of 20 kg in hunters' families and the mean effective dose of 0.23 μSv per kg (two year studies), an individual in the most exposed group may receive the effective dose of 4.6 μSv. In conclusion, consumption of local game meat is safe in terms of contamination with radiocesium and radiological protection.

REG.P09 (Id: 65)
DETERMINATION OF STRONTIUM-90 IN FOODSTUFF

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The Nuclear and Technological Institute (ITN) has the legal responsibility to carry out the environmental radiological monitoring at a national level. This survey was planned to provide relevant information on radioactivity levels in different components of the ecosystem (atmosphere, aquatic and terrestrial environments). As concerns the terrestrial environment the strontium-90 (^{90}Sr) concentrations in food samples have been determined by analyzing milk, complete meals, meat and vegetables. Strontium-90 (^{90}Sr) is a radioactive isotope of strontium, with a long half life (28.8 years) that could be taken by man through food chain transfer due to its biochemical similarity with calcium. A method based on the separation of ^{90}Sr by extraction chromatography and β determination by Liquid Scintillation Counting technique was used for strontium analysis in food samples. The trials were carried out using 7g of ash samples, and then dissolved in concentrated nitric acid. Following additional precipitation steps the sample is loaded onto a column with 3 grams of commercial Sr-resin. This resin is specific to Sr ions and enables a rapid and simple separation of strontium from calcium, potassium and many other elements. The column is rinsed with 8M HNO_3 and 3M HNO_3 and after this two washing steps, the strontium retained in the column is stripped at the end with 0.05M HNO_3. The strontium solution eluted is collected in a beaker and the chemical yield was determined by gravimetric method. The strontium precipitate is dissolved in 8 mL of 0.1M HCl and added to 12 mL of the Ultima Gold LLT scintillation cocktail. The ^{90}Sr activity was determined after ^{90}Y ingrowths in the channel region 250-800 keV using a counting time of 120 minutes. Validation trials to evaluate the accuracy and the precision of the method were performed using ^{90}Sr spiked samples. The method has been applied to the ^{90}Sr determination of complete meals, meat and vegetables. Results of validation trials and food analysis will be presented and discussed in this paper.

REG.P10 (Id: 68)
AGE DATING OF THE HOT SPRING WATERS IN KOREA USING NATURAL RADIONUCLIDES

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The use of radioactive isotopes as a groundwater-dating tool plays an important role in assessing the dynamics of groundwater systems, essential for the characterization of water resources and planning its exploitation. In hydrogeological studies the application of radioisotopes with a short half-life (below 100 year) is limited in dating old groundwater. However, they can be extremely helpful in solving another type of questions such as the identification of mixing between old and young groundwater systems. Within the environmental radioisotopes, ^{3}H cannot be detected in waters more than approximately 50-60 years old due to the short half-life ($t_{1/2}$ = 12.32 year). Among the radioactive isotopes with a half-life greater than 1 ka, ^{14}C ($t_{1/2}$ = 5730 year) represents the most important tool in groundwater dating. This radioisotope is present in the atmosphere, soil, aquifer matrix, eTc. Using these two radioisotopes, the age of the hot spring waters in Korea were estimated. Also some other natural radioisotopes, Ra and U, were analyzed to know the characteristics of the hot spring waters. Most hot spring waters are found in granite region in Korea and the Mesozoic granites at the southern part in the Korean Peninsula are divided into two groups, Jurassic Daebo-granite and Cretaceous Bulguksa granite. High temperature hot springs with more than 40 °C occur in the above granite areas. Therefore, fifteen hot spring waters were collected and the contents of ^{3}H, ^{14}C and other radionuclides were determined. Tritium concentrations in hot spring waters were very low, therefore, they were concentrated using the Ni-Ni electrolytic enrichment method. They were analyzed using low background liquid scintillation counter. Dissolved carbonate was precipitated with $BaNO_3$ to $BaCO_3$ form and it reacted with phosphoric acid to produce CO_2. Finally, CO_2 was converted to graphite. After then, it was analyzed using AMS. In most hot spring samples tritium could not be detected and its concentrations ranged <0.5-1.31 TU. And ^{14}C contents ranged 2.62 - 94.13 pMC(%). From the ^{3}H and ^{14}C analysis, we found that some hot springs are mixed with recent groundwater and that hot spring water aged from 490 years to 33680 years.

REG.P11 (Id: 79)
USE OF SELECTED CHELATING AGENTS TO MOBILIZE RADIOCESIUM FROM THE BODY

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Examinations were carried out to compare the effects of Prussian Blue (PB), Ca-gluconate, and Na-citrate on removal of radiocesium from male Wistar rats. The animals were randomly divided into 5 groups of 10 animals each. Radiocesium was administered by intragastric intubation to all tested rats for 5 consecutive days with a daily dose of 20 kBq. Animals in group 1 (the controls) were administered only cesium-137 chloride whereas animals in groups 2 to 5 were subjected to the same radiocesium schedule as rats in group 1 and then treated as follows: groups 2 and 3 were given PB by gastric intubation at a dose of 20 mg in 0.5 mL of distilled water 1 hr or 1 hr and 5 hr, respectively, after cesium-137 contamination whereas rats in group 4 after each PB treatment were subsequently injected ip for 5 consecutive days with a daily dose of 20 mg of sodium

citrate and calcium gluconate in 0.5 mL of distilled water. Rats in group 5 were treated similarly to rats in group 4 but without PB administration. Animals were killed 6 days after termination of the experimental protocol. The whole-body retention of cesium-137 was measured in a well type scintillation counter. Mean values were compared by Student's t-test. Prussian Blue, Ca-gluconate and Na-citrate failed to produce any unfavourable effects on body weight gains and organ to body ratios of the liver, kidneys, heart, and testes in all rats tested. Control rats retained 71.2% of administered radiocesium in the whole-body. Fivefold and tenfold administration of PB or fivefold treatment with PB plus 5 injections of Na-citrate and Ca-gluconate decreased significantly the whole-body retention of radiocesium to 49.7%, 38.4%, and 43.2%, respectively. On the other hand, fivefold treatment with Na-citrate and Ca-gluconate (witout PB treatment) failed to decrease radiocesium retention in comparison to that in the controls. The present results showing a high efficiency of Prussian Blue in removal of radiocesium from animal bodies are in accordance with earlier reports of others. On the other hand, no effects of Ca-gluconate and Na-citrate injection on radiocasium mobilization from the body were in contrast to the opinion that citrate and gluconate enhance the removal of radiocesium from animals.

REG.P12 (Id: 89)
SPECIATION OF ^{129}I AND ^{127}I IN SEAWATER PROFILES FROM THE KATTEGAT AND BALTIC SEA

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Long physical half life, long residence time in the marine environment and continuous releases from nuclear fuel reprocessing plants make ^{129}I a suitable tracer for the study of marine geochemical cycle of stable iodine and conversion mechanism of iodine species by speciation analysis of ^{129}I and ^{127}I. Up to date there are few data on chemical speciation of ^{129}I in seawater and no ^{129}I chemical speciation analyses in seawater profile were reported. The converting mechanism of iodine chemical species is still unclear. In the present work, depth profile samples of seawater collected from the Kattegat Belt Sea and Baltic Sea are analyzed for ^{129}I, ^{127}I as iodide, iodate by using anion exchange chromatography coupled with accelerator mass spectrometry (AMS) and inductively coupled plasma mass spectrometry (ICP-MS), respectively. A relatively high concentration of ^{129}I (2-18x10^{10} atom/L) was found in the Kattegat comparing with that in the Baltic Sea (<2 x 10^{10} atom/L). The results show that in the Baltic Sea the concentrations of ^{129}I, ^{127}I increase with depth and salinity, while the same trend does not occur in the Kattegat Basin. In Baltic Sea the predominant species of iodine is iodide while in the Kattegat the ratio $^{129}I^-/^{129}IO_3^-$ is 1-2. Along the water profile, the atomic ratios of $^{129}I^-/^{127}I^-$ and $^{129}IO_3^-/^{127}IO_3^-$ decrease from the northern Kattegat to the central Baltic Sea. Speciation analysis of ^{129}I in seawater profile is indispensable for a better understanding of geochemical cycle of stable iodine and the converting mechanism of iodine species in the marine environment.

REG.P13 (Id: 93)
RADIATION MONITORING METHOD FEATURES OF CONTAMINATION AREAS AGEING IN LANDSCAPE

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The aim of this work is to generalize experimental research data received in zone of Chernobyl trace in 2007 in Bryansk region in order to distinguish automorph, transit and accumulation areas. Variability of ^{137}Cs levels is shown at the 3 experimental sites.

REG.P14 (Id: 96)
DISTRIBUTION OF NATURAL RADIONUCLIDES AND ^{137}Cs IN THE SEDIMENTS OF A MEDITERRANEAN FJORD-LIKE EMBAYMENT, AMVRAKIKOS GULF, GREECE

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Five small sediment cores were collected from the seafloor of Amvrakikos Gulf for the study of the spatial and downcore distribution of natural radionuclides and ^{137}Cs in the sediments. Amvrakikos Gulf is a shallow (< 65m) marine embayment lying on the west coast of Greece having a surface of some 405 km^2 and a coastline length of 256 km. It is separated from the Ionian Sea by a beach barrier and is connected to the sea through a narrow channel, 600 m wide and less than 8 m deep. Amvrakikos Gulf receives the freshwater inputs of the Arachthos (2202x10^6 m^3 yr^{-1}) and Louros (609x10^6 m^3 yr^{-1}) rivers at its northern shoreline. The Gulf is characterized by a general two-layer type of stratification in the water column and is considered as the only Mediterranean fjord. Sediment samples were analysed for specific activities of ^{238}U, ^{232}Th, ^{226}Ra, ^{232}Th, ^{40}K and ^{137}Cs together with grain size and $C_{org.}$ ^{238}U and ^{226}Ra concentrations range from 37.2 to 124.0 and 8.5 to 27.2 Bq kg^{-1} with an average value of 62.1 and 17.9 Bq kg^{-1}, respectively. The concentrations of ^{232}Th and ^{40}K range from 11.2 to 46.5 Bq kg^{-1} and 238 to 892 Bq kg^{-1} with an average value of 36.6 and 710 Bq kg^{-1}, respectively.

The activities of ^{232}Th and ^{40}K reported in the present study are comparable to those of the world average. On the contrary, the reported ^{238}U activities are significantly higher than those of the world average (UNSCEAR, 2000). The value of the ^{226}Ra/^{238}U ratio ranges from 0.09 to 0.66 with an average value of 0.35 showing disequilibrium between the two radionuclides in all sediment samples that can be ascribed to the weathering of phosphorites of Epirus (at the northern margin of Amvrakikos Gulf) as well as to the high phosphate fertilizers inputs due to the intensive application of fertilizers in the surrounding agriculture areas. It is well known that phosphorites and phosphate fertilizers are characterized by high ^{238}U concentrations. The spatial distribution of ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K, in the surface sediments of Amvrakikos Gulf shows a clear increasing eastward trend. Maximum activities were observed at the eastern deep basin, while minimum values were found at the western basin of the Gulf. The man-made radionuclide ^{137}Cs was found in measurable concentrations (5.2-20.2 Bq kg^{-1}) in all surface sediments (0-5 cm). The higher specific activities of ^{137}Cs were found in the deeper sediment layers (8-44 cm) than in the surface layer. The high content of the clay minerals and organic matter found in the sediments of Amvrakikos Gulf play very important role in the high level of ^{137}Cs. Moreover, the elevated specific activities of ^{137}Cs in the deeper sediment layers (44 cm) suggest a high sedimentation rate for Amvrakikos Gulf.

REG.P15 (Id: 105)
NATURAL RADIOACTIVITY IN TUNISIAN AND IN SOME IMPORTED PHOSPHATE FERTILIZERS USED IN TUNISIA

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The radioactivity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in different phosphate fertilizers, triple superphosphate (TSP), diammonium phosphate (DAP), monoammonium phosphate (MAP) and in phosphoric acids produced and used in the agricultural soils in Tunisia were measured. Other imported and used phosphate fertilizers in the country consisting of some NPKs were also subject to radioactivity concentrations measurement. Gamma spectrometry using a high purity germanium (HPGe) detector was used for the measurement. It was found that generally the Tunisian fertilizers contain the highest activity concentrations with the exceptions of ^{40}K. TSP contains the highest concentration of ^{226}Ra (186.2±14.5 Bq/kg) and of ^{232}Th (33.7±3.5 Bq/kg). The highest amount of ^{40}K was found in one type of NPK (9969.5 Bq/kg). The radium equivalent index was calculated for all the analysed fertilizers and was found to be the highest in the imported NPKs samples (the maximum value was about 775 Bq/kg) because of their high content in ^{40}K. For the Tunisian fertilizers the maximum radium equivalent index was about 238 Bq/kg in TSP.

REG.P16 (Id: 107)
FURTHER RESULTS IN SEARCH OF TRANSURANIUM ISOTOPES IN EFFLUENTS DISCHARGED TO AIR FROM NUCLEAR POWER PLANTS

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In this work we present data on transuranium isotopes in effluents (quarterly, since 2006 half-yearly determined activity concentrations of ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{242}Cm and ^{244}Cm in discharged effluents, annual discharged activities of individual radionuclides) discharged to air from 7 stacks in 2004-2009. In the effluents discharged to air from one stack low-level activities of transuranium isotopes were present throughout the period under study. Transuranium isotopes had been discharged to air from this stack also in previous years since 1996 when defect in the cladding of a fuel element and consequent contamination of the primary circuit occurred. In the effluents discharged to air from another stack transuranium isotopes were present only in some monitoring periods in the years under study. We did not find transuranium isotopes in the effluents of the other stacks up to 2006. The transuranium isotopes in discharged effluents were registered in the second half-year of 2006. In other years (2007-8) especially low-level ^{241}Am was found in these effluents.

REG.P17 (Id: 116)
RADIOECOLOGICAL SITUATION IN AREAS OF URANIUM LEGACY OF UZBEKISTAN

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Central Asia countries were the main supplier of the uranium in former USSR and one of them was the Republic of Uzbekistan. The mining activity and treatment of uranium ores resulted in formation of large amounts of radioactive wastes making an exigent problem with securing radiation safety on the territories of uranium mines, tails and adjacent settlements. In this work, the results of measurements of the radon concentrations on the territories of former uranium mines and nearby populated sites are presented. Electronic units of RRA-01M (Russia) and PRM-145 (Slovenia), acting on semiconductor detector and scintillation cells, respectively, were used for radon measurements. Both units record α particles of daughter radionuclide ^{218}Po. For reliable estimation of the annual efficient doses (AED) of inhabitants and their lifetime fatal risks (LFR) a long time registration of radon α particles by nuclear solid track detectors CR-39 (Italy) has been carried out. Residences and working premises were selected on free basis and radon exposure with CR-39 was monitored for two and three months at summer and winter time. In settlement Yangiabad,

volume activity of indoor radon was 60 - 100 Bk/m^3, values of AED of radon for inhabitants 1.7 - 2.8 mSv/year and LFR estimation at (1.3 - 2.3) x10^{-4}. In village Chorkesar in windless and matutinal period radon activity on territory of the mine reached 70-100 Bk/m^3 at a distance of 50-70 cm from ground. Indoor radon level are in the range from 60 to 450 Bk/m^3 and 1.7 - 12.6 mSv/year for AED, (1.3 - 10.5)x10^{-4} for LFR at summer and from 250 to 1200 Bk/m^3 and 7.0 - 33.6 mSv/year for AED, (5.6 - 27)x10^{-4} LFR at winter time.

REG.P18 (Id: 125)
STUDY OF ^{7}Be CONCENTRATION IN THE NORTH OF THE SPAIN

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From the Sun and interstellar spaces of the universe the primary cosmic radiation comes to the Earth. These cosmic rays interact with the nuclei of atmospheric constituents, producing an interaction cascade and secondary reaction and also produce a number of radioactive nuclei known as cosmogenic, ^{7}Be between others as a result of spallation reactions. In Bilbao (north of Spain) there is a high flow rate atmospheric sampler which belongs to the Radiological Surveillance Network of the Autonomous region of the Basque Country. Among the radionuclides present in the air aerosols ^{7}Be is found. The network is in operation since October 2001 and so a long record of ^{7}Be measurements is available. To study the behaviour of ^{7}Be in air, the recorded values have been considered as a succession of data what is usually known as a Time Series. It is made up of 4 components: trend, cyclical component, seasonal component and irregular component. The cyclical component is not fully developed because the studied period (2001 - 2009) is shorter than the solar cycle (eleven years period), which is the ultimate cause of that component. A trend and seasonal components have been determined and finally an irregular component has been observed. This is caused by occasional events, such as rain, which washes ^{7}Be out depositing it onto the ground. However, it has been found that the atmospheric concentration of ^{7}Be is negligibly affected by rain.

REG.P19 (Id: 152)
RADIOACTIVITY CONCENTRATION IN SOIL SAMPLES TAKEN FROM REGION OF BANJA LUKA (BOSNIA AND HERZEGOVINA)

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Surface soil samples (0-15 cm) were collected from the region of Banja Luka (Bosnia and Herzegovina), in order to evaluate their radioactivity. Concentrations of radionuclides in samples were determined by γ-ray spectrometer using HPGe detector. The obtained results of uranium and thorium series as well as potassium ^{40}K and ^{137}Cs activity concentrations are discussed. The radioactivity levels are compared with the results form other countries.

REG.P20 (Id: 158)
SPECIATION OF ^{129}I AND ^{127}I IN SOIL AND SEDIMENT SAMPLES

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Iodine is a biophilic tracer element with thirty-four isotopes including one long-lived isotope, ^{129}I (15.7 My), and one stable isotope, ^{127}I. Toxicity, mobility, bioavailability, bioactivity, and the uptake of iodine in environment are governed by its chemical speciation and the soil or sediment conditions. It is therefore important to identify and quantify different physicochemical contaminant species. In this work, a sequential extraction procedure combined with accelerator mass spectrometry (AMS), and inductively coupled plasma mass spectrometry (ICP-MS), respectively, was applied for investigation of ^{129}I and ^{127}I in different physicochemical forms in soil and sediment samples. The fractionation allowed identification of water soluble, exchangeable, carbonate, oxides, iodine bound humic acid, iodine bound fulvic acid and iodine bound humin forms. This is the first study to identify humic acid, fulvic acid and humin bound ^{129}I. A Danish soil sample, a soil reference material (IAEA-375), an anoxic sediment sample collected from Helvik Fjord (South Norway) and an oxic sediment sample collected from the Barents Sea (Russia) were investigated. The results of the work show that in the investigated samples ^{129}I bound to organic matter accounted for more than 50% of the total iodine. Approximately 90% of the ^{129}I is bound to organic matter and oxides, and 10% was found in the readily exchangeable fractions. Speciation analysis of ^{129}I in soil/sediments is indispensable for a better understanding of bioavailability, mobility, bioactivity, uptake and toxicity of iodine in the environment.

REG.P21 (Id: 168)
Cs, Pu AND Am SORPTION TO NATURAL CLAY AND THEIR VARIOUS COMPONENTS: LABORATORY EXPERIMENTS AND MODELING

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Natural clay and iron minerals of complex composition are reactive mineral phases which can affect retardation and transport of radionuclides in the environment. Therefore, it is important to understand and quantify sorption of radionuclides on them. Sorption of Cs, Pu(IV), Pu(V) and Am(III) at trace concentrations on three well characterized samples of Triassic clay as a function of pH and composition of solution and contact time was studied. Sorption experiments were also performed with three iron oxide minerals found in the clay mineral coatings and microorganisms (bacteria and fungi) isolated from the clay and groundwater samples with the aim of better understanding the effects of various natural clay components on the speciation and sorption behavior of radionuclides. The character of bonding of Cs, Pu and Am to the clay samples was analyzed by sequential extraction (SE). Solvent extraction techniques (using TTA, HDEHP, DBM and PMBP), ultrafiltration and α spectrometry as well as ICP-MS were employed to characterize the oxidation states of the plutonium species in liquid and solid phases. The results have indicated that iron oxide coatings play an important role in binding of Pu(IV) on the clay, whereas ion exchange and $CaCO_3$ were found to be responsible for the binding of Am(III). The coatings also affected Cs sorption from solutions of variable ionic strength. Sorption experiments with microorganisms indicated that bacteria and fungi can exert different effect on the sorption behavior of Pu. Kinetic data evaluated by kinetic models derived for six different control processes mostly indicated a sorption mechanism controlled by Pu or Am diffusion in the inert layer on the surface of clay. Corresponding kinetic coefficients were determined. Surface complexation modeling of the sorption dependence on pH using a two-site surface complexation model showed high affinity of all the minerals for $Pu(OH)_3^+$ at pH > 4. Iron oxide minerals also sorbed $Pu(OH)_4^0$: goethite at pH>8, hematite at pH = 7-9 and magnetite at pH > 5.5. Am^{3+} and $Am(NO_3)_2^+$ were found to be the most selectively sorbed species on all the minerals from $NaNO_3$ solutions in the pH range of 3.5-5, whereas $AmOH^{2+}$ and $Am(OH)_2^+$ were sorbed to a different extent on different minerals at pH 5-9. The stability constants obtained by modeling have indicated that the sorption affinity of the clay for Pu is higher than that of the iron oxides studied, while the sorption affinities for Am are mutually comparable. In addition, it has been found that Pu is much more selectively (i.e. strongly) bound than Am on all the minerals studied. This well corresponds with the higher exchangeability of Am found by SE and can explain its higher mobility in the environment.

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REG.P22 (Id: 188)
ANTROPOGENIC RADIOTRACERS ASSESSMENT AS A TOOL TO ENVIRONMENTAL COMPLIANCE RULES AND MANAGEMENT

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A framework, within which models and studies can be applied and results analyzed to develop coherent and logical environmental impact management methodologies for ionizing radiation, is essential. A number of components, which could form the basis for such a system, has to include the dilution factor for radioactive liquid effluent releases. The regulatory mechanism in Brazil established that the operational management concerning the radioactive liquid effluents release must take into consideration the characteristics of the discharged liquid, the knowledge of the dispersion conditions after discharge into the system receptor (sewage and environment), the characteristics description of the effluent recieving system environment and the estimate of the dose. In this study a strategic, fast and cheap methodology was tested to estimate the dilution factor in the release of liquid radioactive effluent at Instituto de Pesquisas Energéticas e Nucleares (IPEN). The radioisotopes ^{3}H, ^{54}Mn, ^{60}Co, ^{65}Zn and ^{137}Cs, generated in the routine operation of the Research Reactor IEA-R1, were used as radiotracers. In the generated liquid radioactive effluent, stored in a tank of 300 m^3, the radioisotopes initial concentration was determined. The tank flow rate output was estimated to 10.9 ± 0.9 m^3 h^{-1} for liquid controlled dispenser. A planned release of tank effluent stored was carried out. Simultaneously, a sample was taken upstream of the storage tank discharge point for monitoring the concentrations of ^{3}H, ^{54}Mn, ^{60}Co, ^{65}Zn and ^{137}Cs, respectively, in the mix sewage system discharge point E1 at IPEN. The initial concentration of the ^{3}H, ^{54}Mn, ^{60}Co, ^{65}Zn and ^{137}Cs was determined as 56881 ± 3255 Bq L^{-1}, 41.5 ± 2.9 Bq $^{-1}$, 1332 ± 11 Bq L^{-1}, 401 ± 8 Bq L^{-1} and 291 ± 7 Bq L^{-1}, respectively. The dilution factors, in the discharge point of the aqueous effluent, were found to be 4.3 and 7.4 for ^{3}H, 12 and 16.1 for ^{54}Mn, 12.6 and 14.2 for ^{60}Co, 12 and 27.9 for ^{65}Zn and 6.2 and 13.9 for ^{137}Cs, respectively. These determined values correspond to two consecutive days of planned release and diluted effluents sampling. The developed methodology was rapid and without additional environmental and financial costs, because the radiotracers ^{3}H, ^{54}Mn, ^{60}Co, ^{65}Zn and ^{137}Cs had already existed routinely in the effluent. The current goal in the world is the development and improvement of cleaner production technologies.

REG.P23 (Id: 202)
PLUTONIUM 241 - IMPORTANCE AND WAYS OF DETERMINATION

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Plutonium 241 is the only β emitting plutonium isotope formed by a nuclear reactor operation. In contrast to the other ones, its half life is relatively short (about 14 years). Emitting β radiation, it decays to another important radionuclide, ^{241}Am. Hence, the activity of americium 241 is still increasing in the area of Chernobyl, Ukraine. Nuclear fission leads to higher-order activities of the ^{241}Pu than of the other plutonium isotopes. On the other hand, the β energy of this radionuclide is only 20 keV, which, in addition with no γ radiation, falsely decreases its importance. For example, determination of isotopes activity ratio between ^{241}Pu and other isotopes can lead to the recognition of the isotope mixture source.

REG.P24 (Id: 226)
URANIUM AND LONG-LIVED DECAY PRODUCTS IN WATER OF THE MULDE RIVER

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The Mulde River, a tributary of the Elbe River in east-central Germany, is formed by the confluence of the Freiberger Mulde and the Zwickauer Mulde, both rising from the Erzgebirge. Running north, the two rivers merge near the small village of Sermuth to form the Vereinigte Mulde, which flows into the Elbe River near Dessau. The Erzgebirge or Ore Mountains are a mountain range, which is located at the border between Saxony / Germany and the Czech Republic. Due to its rich uranium deposits the area of the Zwickauer Mulde River became the world's third largest uranium supplier during the time of the Warsaw Pact. Today, clean-up of the legacy of the former mining and milling industry represents one of the largest remediation projects in progress. Being part of the project "Transport and availability of uranium and decay products in alluvial soils of the Mulde River", this work deals with the investigation of radionuclides in the water of the Mulde River. The radionuclide contents of water and sediment indicate the overall condition of a river, with the water showing a faster response to variations. 20 samples were collected along the course of the rivers Zwickauer Mulde and Vereinigte Mulde between the city of Aue in the Erzgebirge and the Saxon border. For comparison, further samples were taken at the headwaters of the Zwickauer Mulde, along the Freiberger Mulde and the Leine River (Hannover), respectively. A total of 26 samples of water were taken and analysed for uranium, polonium-210, and radium-226 content using α-spectroscopy, liquid scintillation counting, and mass spectroscopy, respectively. The work focuses on present contaminations deriving from tributary streams or river sediments and the detection of changes as a result of remediation effects. Own results are compared with results from earlier investigations, carried out from 1991 to 1993.

REG.P25 (Id: 242)
LEACHABILITY OF NATURAL RADIONUCLIDES (^{238}U, ^{226}Ra, ^{210}Pb, ^{232}Th AND ^{228}Ra) IN BRAZILIAN PHOSPHATE FERTILIZERS AND PHOSPHOGYPSUM

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The presence of natural radionuclides of the U and Th decay series in phosphate mineral ores and their redistribution in products, by-products and residue is well known. The most common phosphate fertilizers used in agriculture are single superphosphate, triple superphosphate, monoammonium phosphate and diammonium phosphate, together with phosphogypsum which is used as soil amendment. For a long-term safe application of these fertilizers it is important to study the bioavailability of the radionuclides to the environment. For this purpose, the evaluation of radionuclides concentration in the labile fraction is more suitable than the total concentration since this fraction is more available for the absorption by plants and water contamination. This paper aims to study the leachability of radionuclides (^{238}U, ^{226}Ra, ^{210}Pb, ^{232}Th and ^{228}Ra) present in phosphate fertilizers and phosphogypsum, using a solution of EDTA as extracting agent. U and Th activity concentrations were measured by instrumental neutron activation analysis. ^{226}Ra, ^{210}Pb and ^{228}Ra were measured by gross α and β counting after radiochemical separation.

REG.P26 (Id: 250)
NATURAL AND ARTIFICIAL RADIOACTIVITY IN SOILS FROM ROMANIAN SITES DETERMINED BY γ-RAY SPECTROMETRY

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This paper presents the radioactivity levels of ^{137}Cs man-made and naturally occurring radionuclides (^{40}K, ^{235}U, ^{238}U-decay series, and ^{232}Th-decay series) in Romanian soils from

several industrial sites, determined by low background γ-ray spectrometry. Agricultural soil samples were collected from the vicinity of the phosphate fertilizer plant at Turnu Magurele, as well as from non-ferrous and chemical industry sites at Copsa Mica and Pitesti. Control samples from agriculture and non-specific industry locations were considered (Crevedia and Magurele). Surface soil samples were collected from six locations with different degrees and types of industrial activity (Baia Mare, Copşa Mică, Deva, Galaţi, Oradea, Afumati), and a background site with relatively clean air in the Carpathian Mountains (Fundata). This method makes it possible to assess U, Th, and K concentrations in soil samples by measuring ^{238}U and ^{232}Th (in equilibrium with their radioactive daughters), and ^{40}K specific activities. Their values were found to be in agreement with those determined by Instrumental Neutron Activation Analysis (INAA), through neutron irradiation of soil samples and appropriate standards at TRIGA reactor of the Institute of Nuclear Researches in Pitesti. The radioactivity levels in the investigated soils were compared with Romanian norms for the environmental radioactivity and literature data.

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REG.P27 (Id: 251)
AIRCRAFT-CARRIED SAMPLING SYSTEM FOR AERIAL RADIOACTIVITY MONITORING

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The monitoring airborne radioactive particle became a prominent figure for early warning to form the basis of effective and successful prevention against disasters like the misfortune in Chernobyl. Air sampling and analyzing techniques are essential for early detecting nuclear activities and/or accidents in neighboring countries. Aircraft-borne sampling system is the best way to approach the aerial point of interest. In the earlier study, we designed passive type sampling system using high speed cruise of aircraft. The design concept was focused on maximizing the suction flow necessary for achieving high efficiency of radioactive particles sampling, while minimizing disturbance to the aircraft which carries the system. The optimization was performed with the computational fluid dynamics (CFD) code, FLUENT (FLUENT Inc., 2006). A rocket launcher of a fighter was remodeled into the sampling equipment. The sampler contained a cylindrical filter paper to collect radioactive dust and a charcoal filter to capture radioactive iodine. Replacing the samplers as the launchers at the fighter wings, the aircraft passed in the safety evaluation. Several sampling flights have been performed to provide against emergencies and to assess environmental background. Right after each flight, the filters were radio-analyzed in high purity germanium detectors. The long-half-life radionuclides likely to be made by nuclear experiments or accidents drew main attentions. Fortunately, no nuclide of concern was detected over minimum detectable activity.

REG.P28 (Id: 267)
INVESTIGATIONS ON SEEPAGE WATERS OF THE TEST SITE GESSENWIESE BY TRLFS

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The test field “Gessenwiese” was installed on a leaching heap at the former uranium mining area Ronneburg (western Thuringia) for investigations in acid mining drainage and in heavy metals retention, especially uranium [1]. The uranium speciation in seepage water of the Gessenwiese was determined by TRLFS. Time-resolved laser-induced fluorescence spectroscopy (TRLFS) posses some superior features, above all a very high sensitivity for fluorescent heavy metal ions. The predominance of TRLFS compared to other spectroscopic techniques, e.g. XRD and IR was showed in [2] in analyzing the speciation of U(VI) in a thin layer of an alteration product formed on depleted uranium. TRLFS analyses were carried out to compare it in a later stage with the uranium speciation in plants, which grow on that grassland and may take up uranium contaminated water. The uranium content in the seepage water samples was 75.1 and 291 ppb, respectively, and both samples delivered an evaluable fluorescence signal for TRLFS. The positions of the six peak maxima from these signals are in both water samples in concordance with data for uranium sulfate species published in the literature [3] at 477, 493, 513, 537, 562 and 591 nm. Moreover, the time-resolved fluorescence signals of both water samples possess a mono-exponential decay, indicating the presence of one main species. These two characteristics, i.e. positions of peak maxima and lifetimes revealed without doubt that the uranium speciation in the seepage water is dominated by uranium (VI) sulfate species. TRLFS measurements with plant compartments (e.g. roots, leaves, shoots) which grow in association with the seepage water will be carried out in future investigations. Samples could be obtained from the plant compartments by centrifugation as cell sap, or as solid milled plant compartment sample and subsequently analysed by TRLFS. The reactivity and toxicity of uranium depend on the speciation of heavy metals [4] and accordingly have to be considered as important possible risk factor as uranium may enter economic plants and eventually arrive in the food chain.

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REG.P29 (Id: 277)
RADIOECOLOGICAL CRITERIA AND NORMS DURING REMEDIATION OF SHORE INFRASTRUCTURE OF RUSSIAN NUCLEAR FLEET

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Remediation of sites and facilities belonging to the sites of temporary storage (STS) of spent nuclear fuel (SNF) and radioactive wastes (RW) at Andreeva Bay and Gremikha village on the Kola Peninsula is one of the regulatory functions of radiation protection. After termination of operation of the ex-Navy serviced facilities, their infrastructure degraded resulting in radioactive contamination of some parts of the site. As one end-goal of remediation is putting STS into ecologically safe conditions, elaboration of quantitative radiation-ecology criteria and norms for STS site and facility conditions is urgent. Remediation criteria and norms defining requirements for radiation protection of workers, public and limits of environmental contamination have been developed for three main options: conservation, conversion (partial or overall renovation) and liquidation in the form of:

- dose limits and dose constraints;
- levels of radioactive superficial contamination of workshops and equipment inside them;
- specific activity of radionuclides in marine media, including fish;
- activity concentration of radionuclides in ground waters on-site STS.

The Environmental radiation monitoring findings served as a basis for the associated databank arrangement. The experimental results received have been plotted on the electronic map of the place. Further steps relate to generation of full geographic information system, which permits to carry out the computer calculation of the main indexes for simulation and prognosis of radio-ecological situation with the purpose of the radiation safety regulation.

REG.P30 (Id: 304)
THE ESTIMATION OF RADON ACTIVITY IN MULTISTOREYED BUILDINGS OF INDUSTRIAL IRON-ORE REGION

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Some regions of Ukraine are radon-dangerous. Geologic peculiarities of Krivbass region, available mining tunnels, historical habits in house construction, increased mortality on malignant tumor of population, specify the actuality of "Radon" problem investigations in iron-ore region which should be considered in the estimation of radiation exposure to population. In our own research it has been determined that as a rule radon is accumulated in basement and on the ground floor of buildings. Though significantly higher doses of radon EEVA were registered in the upper stores of five-storied dwelling houses built in the period 1968-1970. Thus the levels of ^{222}Rn EEVA in five-storied dwellings were registered as follows: 33 - 113 Bq m^{-3} on the ground floor, 21-63 Bq m^{-3} on the first floor, 43-69 Bq m^{-3} on the second floor, 22-85 Bq m^{-3} on the third floor, and 67-93 Bq m^{-3} on the fourth floor. During the measurement the daily variation of radon content in air of the dwellings it was determined that the radon volume activity depends directly on ventilation regime in the dwelling. Thus the radon level was measured in two apartments of the fourth floor with two different ventilation regimes - with regular opening of the window and without this procedure. In the first case the family consisted of three employed adults. Radon level was measured in the kiTchen with regular ventilation by window. This level was 67 Bq m^{-3}. Effective dose of radon exposure was 2.9 mSv $year^{-1}$. Radon level was measured in the room with vacuum ventilation provided by the house design. This level was 93 Bq m^{-3}. In the second case the residents of the apartment were three employed adults. Radon level was measured in the room with vacuum ventilation provided by the house design. This level was 93 Bq m^{-3}. Effective dose of radon exposure was 4.0 mSv $year^{-1}$. In both cases exposure doses were significant in spite of additional ventilation. Enhanced radon concentration in the upper stores is caused by lack of ventilation. The rate of air near ventilation holes was < 0.1 m s^{-1}. This peculiarity appears during the period of heating the apartments, when windows are closed hermetically and the air inflow is lower. As a result the contingent of population exposured to radon increases.

REG.P31 (Id: 316)
FRACTIONATION OF Sr(II), Th(IV), U(VI) IN THE NATURAL WATER SAMPLES BY NANOCOMPOSITE TRACK MEMBRANES

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Knowledge of the speciation and partitioning of radionuclides and their natural analogs in nature water have great radioecological significance for all environmental systems and Ural region in particular. Distribution of interesting elements in geochemical fractions in water solutions is one of the more important points for understanding and modeling mechanism of radionuclide migration in natural water. In this work the method of ultrafiltration was used for the determination of fractionation composition of Sr(II), Th(IV), U(VI) in natural basin in the vicinity of the Mayak Production Association (South Urals, RF) [1]. Samples of natural water from the Malishevo Lake; Sosnovskoe Lake; Techa River, Shelkun Lake; Karasie Lake, Komarovo Pond, Cherviannoe Lake were investigated. Sampling of the natural water was carried out in spring (May) 2009 to determine radionuclides and investigate their physicochemical state (speciation). Samples selection and preparation techniques met the recommendations of the Public Health Ministry of the USSR. For the separation of each of the fractions we used the synthesized nanocomposite track membranes NCTMs with conducting titanium oxynitride coating to determine fractionation and chemical composition of suspensions and colloids in natural water. This NCTM were obtained from polymer track membrane by modification of the surface and volume of pore space by deposition inorganic high-strength titanium oxynitride layers with different thickness by the method of ion-plasma sputtering [1]. In this work we used membranes produced in Flerov Laboratory of Nuclear Reactions, JINR (Dubna, Russia) with initial pore size 100-3000 nm as a precursor to synthesize membranes with advanced chemical and mechanical properties. These coatings make it possible to simultaneously vary the size of the entrance pores within the necessary limits (from 100 nm to 1-10 nm) and the physicochemical characteristics of the final composite. NCTMs allowed not only to fractionate suspensions, colloids and molecular-ions fractions, but visualized and described natural nanodimensional objects. Using conducting NCTM we have carried out non-invasive chemical identification of biological and geochemical suspensions and colloid materials by means of EM and EDX methods. NCTM has been shown to separate about 10-20 % of Sr(II), Th(IV), U(VI) concentrations from natural water samples with the size >0.1 μm. These fractions consist of Mg-Si-Ca-Fe, $CaSO_4$, biological materials (diatomaceous algae). Our collaborators from IPAE UB RAS have investigated and identified the types of algae. It was shown that molecular-ions fractions of the above elements are in the range 80-90 % of their concentrations.

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REG.P32 (Id: 325)
ENVIRONMENTAL MONITORING OF NUCLEAR MATERIALS FOR SAFEGUARDS PURPOSES BEFORE DECOMMISSIONING OF NUCLEAR FACILITIES

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A comprehensive environmental monitoring and analysis is very important before the decommissioning of a nuclear facility to assure the database for reveal undeclared clandestine nuclear activities. Experiences in the process and sampling concerning decommissioning are not yet available in Hungary because the facilities have not still accomplished the end of their lifecycle. Decommissioning is the final phase in the lifecycle of a nuclear installation and is to be considered as part of a general strategy of environmental restoration after the final suspension of the industrial activities. The first research reactor in Hungary will need to be decommissioned over the next 10 years therefore the environmental monitoring will be necessary before the commencement of the process. The international regulation and the European Union also specify the environmental monitoring and an environmental impact study before the decommissioning procedure. The development of a comprehensive environmental monitoring system including sampling strategy and method development for the analysis of environmental samples, originating from the vicinity of the Hungarian nuclear facilities has been begun at the Institute of Isotopes. The developed method was tested by analysis of real samples. Environmental samples and its nuclear material content were analyzed in the near of a Hungarian nuclear facility.

REG.P33 (Id: 330)
PLUTONIUM SPECIATION IN THE SOUTHERN BALTIC SEA SEDIMENTS

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Wet and dry atmospheric fallout from nuclear weapon tests is one of the most important sources of plutonium in Baltic Sea. The other sources: plutonium releases from spent fuel facilities in Sellafield (UK) and Cap de la Hague (France) are less impor-

tant. Since April 26, 1986 there is a new source of plutonium - Chernobyl plutonium, which should be taken under note in estimation of its radiological effects on the environment. In marine environment plutonium exists on III, IV, V and VI oxidation state and in the Baltic Sea 99% of total plutonium is deposited in sediments. In this study 6 different chemical forms of plutonium (the fraction dissolved in water, connected to carbonates, connected to oxides, complexed with organic matter, mineral acids soluble and the rest) in sediments from the delta of Vistula River, Gdańsk Bay, Gdańsk Deep and Bornholm Deep were determined. The distribution of $^{239+240}$Pu in analyzed sediments samples was not uniform and depended on its chemical form, depth and geomorphology of the sediments. The highest $^{239+240}$Pu concentrations were found in muddy sediments of Gdańsk Bay at 8-9 cm layer while the lowest, 10 times lower than in Gdańsk Bay, near the delta of Vistula River. The lowest plutonium concentrations were found in the lowest layers (below 22 cm). According to all analyzed fractions the biggest amount of $^{239+240}$Pu in all sediments was found in the fraction connected to carbonates: the delta of Vistula River - 34%, Gdańsk Bay - 42%, Bornholm Deep - 35%. In sediments of Gdańsk Deep plutonium was mostly connected to fraction soluble in mineral acids (40%). Significant $^{239+240}$Pu amount was also connected to organic matter (29%), but the lowest amount of plutonium was in fraction dissolved in water.

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REG.P34 (Id: 332)
NATURALLY EXISTING ^{210}Po IN HUMAN AND DOG HAIR SAMPLES

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More than 100 samples of human hair and 15 samples of dog fur were collected from Pomeranian area for polonium analysis. The ^{210}Po concentration in analyzed hair samples ranged from 0.33±0.02 to 12.84±0.80 mBq.g^{-1} dw (mean value is 3.41 mBq.g^{-1}). The highest ^{210}Po activity values were found in hair sample collected from men had rich fish diet and smoked about 20 cigarettes per day. The lowest ^{210}Po concentration was found in hair sample collected from a lady who did not consume fish and did not smoke cigarettes. The lowest amounts were also found in children's hair (0.43±0.03 and 0.84±0.08 mBq.g^{-1} dw) who did not eat much fish and lived at homes free of cigarettes. In the case of a child living at home where exposed at cigarettes this concentration was much higher - 4.02±0.37 mBq.g^{-1} dw. Among dogs fur the highest ^{210}Po concentration was found in 7 years old dachshund dog - 4.48±0.54 mBq.g^{-1} dw, but the lowest ^{210}Po concentration was found in 3 years old staffordshire bull terrier biTch - 1.96±0.26 mBq.g^{-1} dw.

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REG.P35 (Id: 333)
POLONIUM ^{210}Po AND URANIUM ^{234}U AND ^{238}U IN PHOSPHOGYPSUM AND SURFACE WATER AT WASTE DUMP IN WIŚLINKA FROM PHOSPHORIC FERTILIZERS INDUSTRY OF GDAŃSK AND THEIR ACCUMULATION IN PLANTS

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Phosphogypsum refers to the gypsum formed as a by-product of processing phosphate ore into fertilizer with sulfuric acid. They are radioactive due to the presence of naturally occurring uranium and radium in the phosphate ore and enriched in natural polonium ^{210}Po, while the uranium radionuclides (^{234}U and ^{238}U) tend to be in waters around waste dump. The migration and distribution of uranium and polonium radionuclides in analyzed water samples are not uniform. All analyzed phosphogypsum samples contained higher ^{210}Po activity in comparison with uranium radionuclides. The values of uranium and polonium concentration in water with immediate surroundings of waste heap are considerably higher than in the waters of the Martwa Wisła River. The activity ratio of ^{234}U/^{238}U is approximately about 1 in the phosphogypsum and between 0.92-9.99 in the water of retention reservoir and pumping station, while in the water from the Martwa Wisła River is slightly higher than 1. Polonium and uranium concentrations in water samples of the Martwa Wisła are relatively low in comparison with value in retention reservoir and pumping station near phosphogypsum waste heap. This suggests that radionuclides could be leached from dumping site to the surrounding environment. The major source of polonium and uranium in plants is wet and dry atmospheric fall containing the soil and the air dust from the phosphogypsum waste dump and also accumulation through the root system. The highest uranium and polonium concentrations were found in older part of grasses (yellow oat-grass, meadow foxtail, moneywort), turned for atmospheric fall for a long time.

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REG.P36 (Id: 335)
TEMPERATURE EFFECTS ON EMANATION OF RADON FROM ROCK TO WATER AND ON ITS PARTITION BETWEEN WATER AND AIR

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Emanation of radon (^{222}Rn) from rock and partition of radon between water and air are important parameters, so its evaluation is of significance in the study of radiation protection, environmental geochemistry, climate change and so on. In this study, emanation of radon from rock particles (1-2 mm) to water and partition of radon between water and air by temperature of 0, 10 and 20 °C have been determined using an equilibration partitioning in a closed system (EPICS) method. Specific activity of radon in the rock particles used here were 4.990 ± 20 Bq/kg. The results show that emanation of radon from rock and partition of radon on air increase with increasing the system temperature, however partition of radon on water slightly decreases with increasing temperature. In conclusion, radon emanation from bed rock or soil and partition of radon between water and air is controlled by temperature change, which in turn is also governed by climate change.

REG.P37 (Id: 337)
MICROBIAL ACTIVITY IMPACT ON THE CHANGE OF Pu OXIDATION STATES

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The potential of migration of Pu at contaminated sites and also from the waste repository depends on the Pu environmental behavior determined by its chemical speciations. Depending on the ambient conditions plutonium exists in several oxidation states due to the low differences in the oxidation - reduction potentials between the oxidation states [1]. The geochemical and physical characteristics of the environment (mineralogy, pH, chelating agents, redox conditions, temperature, and humidity) and microbial activity play an important role in plutonium behavior in various systems. Under appropriate conditions the activity of microorganisms could affect the chemical nature of plutonium due to changing redox condition and biotransformation of its oxidation states. The oxidation states control the solubility, complexation and thus the geochemical action of Pu [2]. The direct enzymatic or indirect nonenzymatic interaction of microbes with plutonium could considerably cause its solubility or immobilization because of the formation of stable complexes with metabolites and organic degradation products. This study is aimed at investigations on the change of plutonium oxidation states due to activity of aerobic bacteria and fungi. Both microorganisms and fungi were isolated and identified from samples collected from the low-level radioactive waste repository. Aerobic bacteria Bacillus mycoides, Rhodococcus lutes, unidentified Gram-bacteria, and fungi Paecillomyces lilacinus, Absidia sp., Gliocladium virens have been detected in dust. Oxidized and reduced Pu was tested by two radiochemical procedures [3,4]. One procedure (co-precipitation with NdF_3) only differentiates between reduced Pu [Pu (III) and Pu (IV)] as well as oxidized Pu [Pu (V) and Pu (VI)]. The second (extraction chromatography) procedure was designed to differentiate between Pu (III) and Pu (IV). The amount of reduced and oxidized Pu was determined by measuring α activity after radiochemical separation. The results of the experiment have shown that all bacteria and fungi can very slightly alter oxidation states of plutonium due to their microbial activity. No more than 8-9 % and 15 % of Pu (IV) was reduced to Pu (III) by bacteria during one hour and 24 hours of the interaction respectively. Pu by fungi was reduced no more than 1%.

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REG.P38 (Id: 340)
CURRENT STATUS OF GROSS α/β ACTIVITY ANALYSIS IN WATER SAMPLES: A SHORT OVERVIEW OF METHODS

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In the last few decades, increasing attention is paid to restrict exposure of the public to the naturally occurring radiation. The WHO (WHO, 2004) and the EU Council (EC, 1998; EC, 2010-in preparation) have determined the reference level of the effective dose received from drinking water consumption at 100 μSv y^{-1}. This value excludes the dose received from ^{3}H, ^{40}K, ^{222}Rn, and radon decay products, but it includes the other α- and β-emitting radionuclides. In general, gross α-β analysis is used as the first step of the radiological characterization of drinking waters as a screening method. Its main advantages are the relatively low costs, simplicity, and stability. In the third edition of WHO guidelines for drinking water quality (WHO, 2004) the recommended levels are 0.5 Bq L^{-1} for gross α and 1 Bq L^{-1} for gross β activities, respectively. If the measured values are below the reference levels of gross activity, the

drinking water examined is acceptable for human consumption without any further action with respect to its radioactivity. Otherwise, nuclide specific analysis is required to determine the radionuclide content using more sophisticated, more expensive and time-consuming procedures. Due to the uncertainties of gross α and β measurements this method is often the subject of discussions and debates. The aim of this work is to collect information about recently used standard and routine methods concerning gross α and β activity determination in drinking waters in order to evaluate their possibilities. Sample preparation methods - e.g. evaporation, co-precipitation - and detection systems - e.g. gas flow proportional counting, liquid scintillation counting and scintillation counting - are compared on the ground of literature data. In the course of our work, the following parameters were analyzed: background, counting efficiency, interferences, sample capacity, minimal detectable activity, typical counting time, time demand of sample preparation. On one hand, the paper gives an overview of the recently used techniques and, on the other hand, tries to help finding a suitable gross α β radioanalytical tool adapted to the laboratory's demands. This work is part of our effort to develop a reliable method to determine reference values for gross α and β activity in water samples to be used for an interlaboratory comparison between EU monitoring laboratories in the near future.

REG.P39 (Id: 348)
STATE AND MIGRATORY ABILITY OF URANIUM AND RADIUM IN THE SOILS OF BELARUS

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Alpha-emitting uranium and radium are present practically in all ecosystems and together with their decay products play an important role in formation of internal radiation dose of population from natural radionuclides. This dose depends essentially not only on the content of radionuclides in environmental components, but also on the radionuclides' state and migratory ability in a soil medium. The aim of this work is the determination of uranium and radium species in soils and natural soil waters and evaluation of radionuclide migratory ability in different soils. The objects of investigation were samples of 0-10 cm layers of soils from different regions of Belarus. The natural system "solid phase - pore water of soil" have been used for determination of uranium and radium migratory active forms in the soil samples. The potentially mobile forms and potentially biologically available forms were determined using accordingly the model systems "soil - 1 mol/L solution of ammonium acetate" and "soil - 1 mol/L solution of HCl". Radionuclide species in soil waters were investigated by passing of the water samples through the filters of different pore size with subsequent separation of complex radionuclide forms of different electrostatic charge using the method of ion exchange chromatography. Radionuclide activity in the samples was determined by radiochemical analysis with radionuclide identification by α spectrometer SOLOIST U0450 with low-background detectors 576 A 600 RV. The specific activities of the soil samples are 4.8-22 Bq/kg for ^{238}U and 4.5-29 Bq/kg for ^{226}Ra. It was found that both ^{228}U (84-94%) and ^{226}Ra (77-91%) are mostly in the fixed forms (insoluble in 1 mol/L HCl). The radionuclide rate in migratory active forms for ^{238}U was 0.06-0.7 % and for ^{226}Ra 0.01-1.0 % of the total radionuclide content in soil samples. The rates of potentially mobile radionuclide forms are 3.1-9.3 % for ^{228}U and 1.8-4.5 % for ^{226}Ra but the radionuclide rates of potentially biologically available forms are respectively 6-16 % and 9-23 % of the corresponding radionuclide content in the soil samples. The main part of ^{228}U and ^{226}Ra of natural soil water samples (65-91 %) is in dissolved state or in composition of fine colloidal (less than 0.45 μm) particles. The radionuclides in this state are the most mobile in environment. In composition of this portion of natural water samples ^{226}Ra is mainly in the cationic form, but ^{228}U coexist in anionic, cationic and neutral complexes. In organic soil waters, the anionic uranium complexes prevail, but in mineral soil waters, the cationic and neutral complexes are the main portion of radionuclide. The received information allows estimating the uranium and radium rates in forms participating actively in radionuclide distribution in the soil medium as well as evaluating the radionuclide reserves in forms that can enter the soil solutions and participate in processes of biogeochemical radionuclide migration in ecosystems. The results of investigation are the basis for differentiation of soils according to migration ability of uranium and radium and for modeling of radionuclide transferring in the environment.

REG.P40 (Id: 349)
RADIOANALYTICAL INVESTIGATIONS OF URANIUM CONCENTRATIONS IN NATURAL SPRING, MINERAL, SPA AND DRINKING WATERS IN HUNGARY

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As many other countries in the Central European region, (e.g. Czech Republic, Slovakia, Romania) Hungary is rich in spring-, thermal-, and mineral waters as well. Recently the consumption of natural mineral- and spring waters comes to be more and more popular in a certain populations. It is well known some of these waters have elevated level of dissolved naturally origin radionuclides, but their concentration may vary in a wide range. In some cases elevated level of dose exposure can be expected. In spite of this fact most of the recommendations do not apply to natural mineral waters and to waters that are classified as of medicinal benefit. From dosimetric point of view, it has a great importance to screen the radioactivity of these waters as well. Within this work, the activity concentrations of uranium isotopes (^{234}U, $^{23\%}$U, and ^{238}U) were analyzed in

some of the popular and regularly consumed Hungarian mineral-, spring-, therapeutically waters and tap waters. Samples were selected randomly and were taken from different regions of Hungary (Balaton Upland, Bükk Mountain, Somogy Hills, Mezőföld, Lake Hévíz). Uranium isotopes were separated from impurities by extraction chromatographic resin and the activity concentrations were determined by using α spectrometry. Concentration (mBq L^{-1}) of ^{234}U, ^{235}U, and ^{238}U in the waters is varied from 0.71 to 741.95, from <0.3 to 9.43, from 0.5 to 274.3 respectively. In general, the highest uranium concentrations were measured in spring waters, while the lowest were found in tap waters. It can be established, in most cases radioactive disequilibrium was observed between uranium isotopes. The activity ratio between ^{234}U and ^{238}U varies from 0.630 to 4.717. The doses for the analyzed samples of spring water are in the range 0.04 - 35.87 μSv y^{-1} with an average 4.86 μSv y^{-1}.This is well below the 0.1 mSv y^{-1} reference level of the committed effective dose recommended by WHO. The other naturally occurring α emitting radionuclides (^{226}Ra, ^{210}Po) will be analyzed later to complete the dose assessment. This study provides preliminary information for consumers and authorities about their internal radiological exposure risk due to annual intake of uranium isotopes via water consumption.

REG.P41 (Id: 248)
CHARACTERISTICS OF CONCENTRATION CORRELATIONS FOR THE PAIRS OF $^{238}U/HCO^{3-}$, $^{234}U/HCO_3$-, $^{226}Ra/^{238}U$, $^{228}Ra/^{226}Ra$, $^{226}Ra/HCO_3$-, $^{228}Ra/HCO_3$-, $^{210}Po/^{238}U$, $^{210}Po/^{226}Ra$, $^{228}Th/^{232}Th$, $^{228}Th/^{228}Ra$, $^{228}Th/HCO_3$- AND $^{210}Po/^{210}Pb$ IN DRINKING WATER

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Some important naturally occuring α and β radionuclides in seventeen brands of drinking water samples collected in Italy were determined. The mean activity concentrations (mBq L^{-1}) of the radionuclides in the water samples were in the order: 26±36 (^{234}U) > 21±30 (^{238}U) > 8.9±15 (^{226}Ra) > 4.8±6.3 (^{228}Ra) > 4.0±4.1 (^{210}Pb) > 3.2±3.7 (^{210}Po) > 2.7±1.2 (^{212}Pb) > 1.4±1.8 (^{224}Ra) > 1.1±1.3 (^{235}U) > 0.26±0.39 (^{228}Th) > 0.0023±0.0009 (^{230}Th) > 0.0013±0.0006 (^{232}Th). Based on the HCO_3^- concentrations and the radionuclide concentrations in the analysed waters, correlation analyses were made, and statistical positive correlations were found among the pairs of $^{228}Ra/^{226}Ra$, $^{226}Ra/HCO_3^-$, $^{228}Ra/HCO_3^-$, $^{210}Po/^{238}U$, $^{210}Po/^{226}Ra$, $^{228}Th/^{232}Th$, $^{228}Th/^{228}Ra$, $^{228}Th/HCO_3^-$ and $^{210}Po/^{210}Pb$ in drinking water.

REG.P42 (Id: 67)
LONG-TERM MONITORING OF RADIOACTIVITY IN ENVIRONMENTAL OF THE CITY OF MOSCOW

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Moscow is the historical center of the atom project of the former USSR. Radioecological assesment of the territory of Moscow has been provided in compliance with the conception and program of comprehensive radioecological monitoring of the City of Moscow approved by the Moscow Administration. The methodology of the envitonmental monitoring is based on long-term determination of concentration of the major dose-forming radionuclides in natural environment and some components of metropolitan megapolis accumulated by mobile and stationary systems. Such an approach ensures to monitor variations in temporary-and-spatial distribution of radiation parameters of the environmental objects as well as to identify the areas where radiation values are abnormal ones and to assess the radiation situation both at separate sites and in the city in general. Monitoring data are used in Radiation-Hygiene Passport of the City of Moscow.

REG.P43 (Id: 136)
THE ACCUMULATION OF TRANSURANIC ELEMENTS OF THE CHERNOBYL EMISSION BY MEADOW VEGETATION OF THE ZONE CHERNOBYL NPP

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The Chernobyl accident was accompanied by release into the atmosphere of a large number of radionuclides with long half-lives. With respect to the exposure of biological objects the most dangerous nuclides in the long term are α-emitters, particularly transuranic elements (TUE-239, ^{240}Pu, ^{241}Am) from the fuel. Radionuclides with different half-lives and environmental features found in the terrestrial ecosystems in various ways become widespread in the ecosystem. To build realistic models of behavior of transuranic elements it is necessary to carry out a focused analysis of the features of the long-lived radionuclides distribution in various types of ecosystems. The aim of this work was to study the behavior of long-lived radionuclides of the Chernobyl genesis in meadow phytocenosis. The evaluated accumulation rates, numerically equal to the ratio of specific activity of TUE in overground phytomass of plants and their concentration in soil (Bq/kg), have been used for characterizing the level and species specificity of the $^{239,240}Pu$ and ^{241}Am accumulation in plants. Fluctuation of values of specific activity phytomass of $^{239,240}Pu$ was observed in range from 0.11 to 0.77 Bq/kg and ^{241}Am - from 1.20 to 21.0 Bq/kg. TUE uptake in plants depends on soil conditions, time of selection and climatic conditions. The experiments were conducted for several years. The results exhibit very large scatter, but a number of peculiarities can be observed. Studies

identified vegetation types that are most active in the TUE uptake. For ^{239,240}Pu the following plants were found to be the most active ones: Oenothera biennis L.> Helichrysum arenarium (L.) Moench> Vicia cracca L.; for ^{241}Am: Koeleria gracilis Pers.> Oenothera biennis L.> Elytrigia repens L. > Lysimachia vulgaris L. > Cytisus ruthenicus Fisch. Biological characteristics and life cycle of plants will undoubtedly affect the value of radionuclide accumulation, but the spread of values of accumulation factor on one site within the same family has definite boundaries, characteristic for the family. We have found that the contribution of ^{241}Am contamination of vegetation is predominant among TUE, which indicates its greater biological mobility in comparison with Pu isotopes. This should be taken into account in decisions concerning the use of forage resources in regions polluted in different degrees. The significant uptake of ^{241}Am activity should be taken into consideration when calculating the dose for the common public.

REG.P44 (Id: 339)
DISTRIBUTION PATTERN OF NORM IN RED SEA SHORE SEDIMENTS AND THEIR RELATION TO NON-NUCLEAR INDUSTRIES

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The Red Sea is a deep semi-enclosed and narrow basin that has an intensive non-industrial activities on and near its shore. Oil exploration, phosphate mining and trading, navigation activities and intensive touristic activities are considered as non-nuclear pollution sources. They could impose a serious radiological and ecological impacts on the Red Sea marine environment. Both oil and phosphate related activities could increase the concentration of Naturally Occurring Radioactive Materials - NORM such as ^{238}U series, ^{232}Th series and ^{40}K. Forty representative shore sediment samples were collected from the Egyptian Red Sea shore, from Shuqeir to Marsa Alam City region. Activity concentration of ^{238}U, ^{232}Th, ^{40}K were measured using ICP-MS analytical techniques. Previous study showed the possible impact of industrial activities on the activity concentration of NORM in shore sediment. This study will investigate such relationship and the distribution pattern of NORM in relation to the elemental composition of the shore sediment.

REG.P45 (Id: 367)
SPECIFIC ACTIVITY OF ^{40}K IN DRINKING WATER IN SLOVENIA

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The European legislation (Council Directive 98/83/ec) requests the member sates to control the radioactive contamination of drinking water. As a part of these measurements γ-ray spectrometric measurements are performed. Samples of 50 L of water are evaporated and the residue after evaporation is measured. Typically, 20 g - 40 g of residue is obtained. Since by γ-ray spectrometry activity concentrations of radioactive isotopes emitting γ-rays can be determined also the concentration of natural ^{40}K in the samples is measured. The measurements of activity concentration of ^{40}K are relatively easy since it radiates at an energy, where no interference with other γ-ray emitters occurs. Drinking water in Slovenia is gained mainly from the ground water. Therefore the concentration of potassium in drinking water reflects the properties of the rock of the aquifer as well as the geochemical conditions there. The activity concentration of ^{40}K in drinking water may bear information on the circumstances in the aquifer from where drinking water is extracted. In the contribution the correlation between the activity concentration of ^{40}K in drinking water and the potassium concentration in the soil will be presented. The correlation will be discussed in terms of the geological properties of the aquifers and the level of the water table.

REG.P46 (Id: 338)
RADIOECOLOGICAL IMPACTS OF NORM FRACTIONATION IN PHOSPHATE ROCK BENEFICIATION PROCESSES

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Phosphate rock beneficiation processes (crushing, screening, washing, magnetic separation and wet screening) aims to increase the phosphorus content of the run-of-mine (ROM) ore. It starts with the ROM ore and ends with the wet rock, and different rejects (by-products). These by-products have potential environmental hazards due to their content of Naturally Occurring Radioactive Materials – NORM especially uranium-238 series. They have also potential industrial and agricultural useful applications due to their physicochemical properties such as their relative high content of phosphorus, clay and iron. Representative samples of ROM ore, wet rock, and beneficiation processes by-products (wet screening, magnetic separation, slim, and clay and dolomite rocks) were collected. Natural radionuclides (^{238}U, ^{235}U, ^{232}Th, ^{40}K, ^{210}Pb, ^{210}Po) were measured using γ-ray spectrometer, α particle spectrometer and ICP-MS analytical techniques. Radiologically, internal hazards index, external hazard index, representative level index, γ absorbed dose rate and occupational dose equivalent due to inhalation were calculated. Potential hazards due to beneficiation processes and their by-products were discussed. Some of the by-products could have potential useful applications such as clay rock and slim for agricultural soil reclamation. The aspects of these useful applications were discussed.